Netherlands Enterprise Agency

Sustainable biomass production and use

Lessons learned from the Netherlands Programme Sustainable Biomass (NPSB) 2009-2013

» *Sustainable. Agricultural. Innovative. International.*

Content

Colophon

The Netherlands Programmes for Sustainable Biomass (NPSB) bundle and disseminate knowledge from the biomass project portfolio of Netherlands Enterprise Agency and complete knowledge gaps with supplementary research. The NPSB project portfolio consists of the Global Sustainable Biomass Fund and the Sustainable Biomass Import Fund. These programmes are funded by the Dutch Ministry of Economic Affairs and the Dutch ministry of Foreign Affairs.

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Highlights

of the report

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The Netherlands Programme Sustainable Biomass (NPSB) was developed to gain experience in the production and certification of sustainable, based on practical experiences. The NPSB programme has run from 2008 to the end of 2013. During its run, the programme has clustered knowledge from the biomass project portfolio and filled the knowledge gaps with supplementary research.

The project portfolio[1] consisted of projects from the Global Sustainable Biomass tenders (DBM projects), from the Sustainable Biomass Import tenders (the DBI projects) and of several relevant projects from the Daey Ouwens Fund.

Objective of this report

The objective is to give a compilation of the overall lessons learned from the NPSB programme to promote the sustainable production of biomass for export and local use. Key findings and results of the 40 projects (see annex 1) and 30 assignments for additional research are presented.

Map
Geographical presentation of the different NPSB biomass projects in the world, (RVO, 2014)

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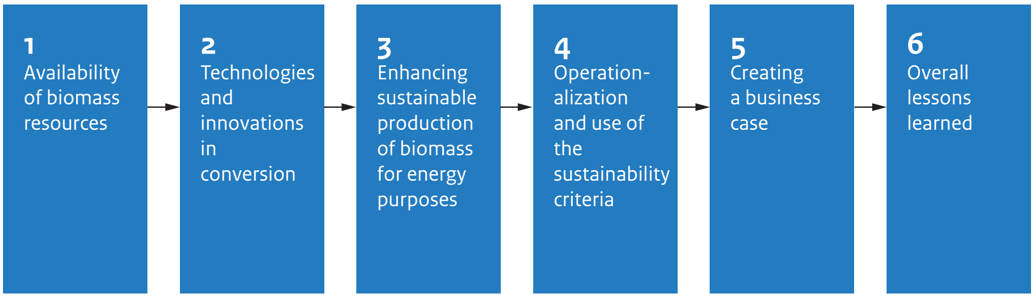
[1] A summarized project description of the DBM and DBI projects is provided in annex 1 of the main report. Also available online: www.rvo.nl/biomass. Information of the DBM and DBI projects can also be found on: www.rvo.nl/biomass/projects

The report provides recommendations to different stakeholder groups (e.g. on certification, making a business case) at the end of each of the in total six chapters. Each chapter discusses a specific topic (see the figure below). Those interested in a specific topic (e.g. Jatropha, financing or ILUC), are recommended to read the relevant chapter in the report for more details and specific lessons learned. This summary presents the highlights.

Figure
Description of main parts of the report with lessons learned



Part 1
Availability of biomass resources

There is a growing demand for biomass production with local markets and export markets, both coming from biomass importing and producing countries. This highlights the importance of creating affordable, sustainable biomass resources over time.

Main observations

Resource assessments indicate untapped biomass potentials from residues and waste in countries such as Indonesia or Vietnam. The use of industrial processing residues such as rice husk in Indonesia (DBM02053) or bagasse in Colombia (DBM0205) has been promising and it provides perspectives for replication. Also, other waste streams have been successfully identified such as POME (DBM01015), coffee wastewater (DBM02032) and discarded transport pallets (DBI02006). This valorisation and more efficient use of waste and residues is still underutilized but seems to offer opportunities for meeting the demand in bioenergy.

Future estimates, as for the Ukraine and Mozambique, show a considerable biomass potential. Assessments of available land in Mozambique for 2030 for bioenergy production range between 6.4 and 16.5 million ha in 2030. In developing countries especially there is still a considerable yield gap because of inefficiencies in agriculture. The bioenergy sector can possibly contribute to bridging this gap, especially when a transition is made to upscaling. Reaching the full technical potential in agriculture and forestry requires considerable efforts and investments to enhance productivities. These efforts should be integrated in a region's rural development and land use to optimize benefits.

Projects as Inbio (DBI01006) and the bamboo project in Colombia (DBI02006) successfully used resource assessment as a screening tool to identify biomass opportunities in a country. Theoretical resource assessments do generally not consider discounting factors as applicability, sustainability, land rights, etc. This results in a gap between the amount of biomass that is theoretically available and the biomass that is practically available on the ground, as was experienced by the Mozambique project (DBM02045).

Commodity-based biomass resources have been developed and are traded internationally in large volumes. The soy project in Argentina (DBM02037) and the sugarcane project in Brazil (DBM01011) teach us that utilizing these resources can start within a short timeframe in a cost-efficient manner. Production is available and infrastructure is well developed. Main focus for these crops should be on promoting sustainable production models, especially in expansion areas, as was the case for the NPSB projects.

Alternative, yet unexploited, resources for bioenergy production are available. The projects (DBI01010) and (DBI02006) have succeeded in growing fast-growing grasses such as reeds, bamboo and switchgrass. Their potential is promising, especially for use on marginal lands. Biomass has also successfully been produced from alternative crops such as cassava (DBM02024) as well as from agroforestry systems (DBM02031). Only parts of these crops are harvested for biomass production so as not to harm food production and to create multiple benefits. A charcoal tool has been developed under the NPSB program that presents alternative feedstocks, and their selection criteria, for charcoal use for local markets.

Developing alternative biomass resources is challenging and requires additional effort and time compared to running business as usual. Quickly emerging promising crops such as Jatropha, as well as the disappointing results of several of the Jatropha projects, have shown the importance to have adequate risk management and to perform thorough assessments (e.g. on economics) on project development and investments. This is to avoid compromises on the longer term.

Selected key lessons for next steps

- Project developers can use resource assessments as first screening tool for identifying suitable areas and to get insight into new, underexploited opportunities. In a next stage, it is key to determine the “wish list” on sustainability requirements and other feedstock selection criteria, and to define the impact of exclusion criteria to understand how much biomass is realistically available on the ground.
- Demand needs, technological developments and available resources change over time, depending on multiple factors. With this in mind, it is recommended to policy makers to apply flexibility in defining bioenergy targets for a country (volume, time) to adjust expectations for real outcomes, especially in countries that largely rely on imported biomass.
- More insight is needed into the upscaling of production of biomass and into how large amounts of sustainable and affordable biomass can be realized to meet future demand, while being integrated in a region’s rural development and land use to optimize benefits.

Part 2
Technologies and innovation in conversion

Conversion technologies have been addressed in the NPSB projects in various ways: as established technology (sometimes implemented in new countries); as part of supply chain development or by testing specific innovative technologies in projects.

Main observations

As part of supply chain development, alternative feedstocks for bioenergy have been tested successfully. Examples are the use of bamboo or reed pellets for bioenergy. This demonstrates the applicability of still largely untapped land-based feedstocks for bioenergy production. However, there are still few buyers in the market for alternative feedstocks because of their doubts on the quality of alternative feedstocks, and lack of standardized requirements.

Sweet sorghum (DBM01004) and cassava (DBM02024) have successfully been used for bioethanol production. It has been shown that the benefits they yield can be optimized when used for multiple end-uses, and when they are grown intercropped with other food crops. Valorisation of residues and waste (e.g. POME in the project DBM02021) has been tested successfully as well. Technology, as the use of waste management technologies, creates direct economic and sustainability benefits.

Bioenergy technologies, both mature and innovative, have been introduced in new countries. An example is the project (DBM02053) introducing the first rice husk gasification plant in Indonesia. Another example is the project on methane capture from POME in Indonesia (DBM0104), an innovative project in its local context.

The market can contribute to the introduction of unexplored technologies in countries by project development. This is especially beneficial in countries where a transition is being made from a traditional to a modern use of biomass and additional positive impacts (as deforestation, health benefits) can be created. Doing so requires a choice in conversion technology embedded in the local context, although this may not per definition be the most effective one.

Selected key lessons for next steps

- Adaption of conversion facilities and the development of quality standards for alternative feedstocks are needed to open new markets for yet unexplored, untapped feedstock resources.
- In developing countries, projects should focus on the transition from traditional use towards modern biomass use, as this can generate a spin-off towards multiple sustainability impacts when carefully designed.
- New technologies should be embedded in and adapted to the local context. This requires a good understanding of local capacities and demand so as to better align introduced technologies with local needs. Cooperation between NGOs and the market has an added value here.

Part 3
Enhancing sustainable production of biomass for energy purposes

The NPSB projects were encouraged to carry out sustainability assessments, but were not obliged to use a standardized approach to evaluate the degree of sustainability of the project. The intention of the program was to learn from practical experiences in improving the sustainability of biomass chains. The large variation in projects provides a great added value with regard to lessons learned about sustainability impacts.

Main observations

All NPSB projects contributed to sustainability in some way. Some projects worked on gaining experience in certification; others focused on the valorisation of residues and waste streams, yet others through the use of degraded land for biomass production, or by working with smallholders.

Environmental impacts

The NPSB projects demonstrate that positive environmental impacts from bioenergy production can be brought about. The use of wastewater (DBM02012) and the use of algae to produce biofuels (DBM02020) have contributed to cleaner water. Jatropha trees in Mali (DBM01002) have been planted to avoid soil erosion. Agroforestry projects (DBM02031, DBM02045) have contributed to increased on-site biodiversity. Risks of negative impacts and possible benefits differ per feedstock (category), per management system, per end-use technology and per operating region. A blueprint for sustainable production therefore does not exist; risks and benefits must be considered on a case-by-case basis. The BioESoil tool has been developed under the NPSB programme to assess the impacts of bioenergy on soil quality on a project basis.

Socio-economic impacts

Positive effects and lessons learned have been demonstrated for a range of socio-economic impacts (e.g. income, employment, food and energy security) especially in those developing countries where energy security and poverty reduction are key priorities. Co-cultivation of shrimps and algae (DBM02020) have created an additional income stream for small farmers, for example. More than 200 jobs have been created in the South African project (DBM02037), creating an economic spin-off in this rural area.

Several projects such as (DBM01004) in Indonesia address land rights issues and the risk these pose for possible conflicts. Risks increase when small-scale projects scale up. Social and environmental concerns will therefore need to be monitored and managed more intensively when a project scales up.

Competition and indirect impacts

NPSB projects have demonstrated that bioenergy production with a low risk of indirect land use change is possible through production on underutilized lands, by creating yield increases, by applying *integrated systems* or through optimal valorisation of residues and wastes.

An example of an integrated system is the agroforestry system in Mozambique (DBM02045). This project contributed to reducing the famine risk for farmers by generating additional income. A second example is the sweet sorghum project in Indonesia (DBM01004), generating outputs for food-fuel and feed markets. This is especially beneficial for smallholders, as the report "Combining bioenergy and food security" confirms. This report, together with the overall experiences from the NPSB projects, demonstrates that there exists a nexus between food security, energy security and income generation - a nexus that that, if duly considered, can generate positive impacts. Attention is however needed towards designing business models in such way that positive impacts are created, monitored and measured.

There is an interaction between impacts. This is also shown by the positive spin-off when biomass is used to replace woody resources in areas where wood is traditionally used for heating (e.g. DBM02032). Impacts and solutions may also conflict with one another. Mechanization of sugarcane harvesting in Brazil has environmental benefits and it results in the improvement of labour quality in the sector. But his transition also requires an effort to avoid employment loss. The project (DBM01011) provided dedicated capacity building to accommodate for a sustainable transition in the sector. Understanding the trade-offs between impacts is important in order to determine the appropriate balance of sustainability and development, and to take precautions where needed.

The use of sustainable well-designed business models (such as agroforestry, integrated systems) is crucial to create a spin-off in the form of multiple direct and indirect benefits. It is therefore important to stimulate these business models via policies and careful design of projects. Given the close interrelations between impacts, it is also important to look at sustainability through the full scope of impacts, instead of narrowing this definition down to one or two compliance requirements.

Selected key lessons for next steps

- Realization of long-term sustainable development may impact the business case of a project (e.g. factors as higher salaries or higher yields). Projects should have better risk assessments and monitoring of crucial factors to give insight into these dynamics and their impacts on the performance of their business case and to allow timely adjustments.
- Biomass projects can enhance energy and food security. Making optimal use of these benefits requires governments to consider biomass projects as a policy for rural development in a broader sense than renewable energy alone, especially in those countries where energy and food security are at risk and where these are key priorities for local communities.
- Given the benefits that can be brought about by sustainable, integrated business models it is worthwhile not merely to steer policies on the results (the impacts), but to also drive 'the road *towards* the result' by providing incentives for using such business models.

Part 4
Operationalization and use of the sustainability criteria

Lessons have been learned in the NPSB programme regarding the operationalization and use of the sustainability criteria in certification systems and policy frameworks to measure and guarantee sustainability.

Main observations

Worldwide progress has been made in recent years with the formulation of policy sustainability frameworks for bioenergy. Most existing policy frameworks such as in Europe or in the US are directed at biofuels. The NPSB programme has contributed to the development of sustainability policy frameworks in Mali, the Ukraine and in Mozambique.

Different parts of the world use different criteria to ensure sustainability. For example, safeguarding energy and food security is key for Mali and Mozambique, while these are not demanded as such under EU or US legislation. This results in stricter domestic sustainability requirements in a country (e.g. the presence of social criteria in a country) or the other way around (e.g. ISPO versus RSPO in Indonesia). These differences also exist between certification systems.

Other sector-wide policies are of importance as well to safeguard sustainability. The importance of participatory land use planning and land rights is stressed by the project (DBM02038). Project (DBM01011) mentions that a strong policy framework enhances better sustainability practices. Policy frameworks differ from country to country. This demands a responsibility from companies to commit to sustainable business.

Impact, criteria and indicator development

The NPSB projects contributed to criteria and indicator development. The certification module for Low Indirect Impact Biofuel methodology (LIIB) has shown that a low risk for indirect land use change can be demonstrated through certification. Sustainability criteria are developed for alternative feedstock resources as algae. At the same time, the debate about sustainability impacts is still going. New impacts have emerged in recent years (cascading, ILUC, carbon debt). This learns that the debate about sustainability is dynamic and still requires continuously new insights and repositioning of stakeholders involved on these issues and on their vision about sustainability as holistic concept.

The project (DBM02038) explored the use of social criteria in certification. Stakeholders on local level defined region specific impacts (as food security) as important. Prioritization of criteria on a local level can thus be substantially different than criteria designed on national or international level, or by certification systems. These differences in requirements play especially a role when bioenergy is traded internationally.

Experiences with certification in the market

Certification for biomass and bioenergy is still in a learning curve, especially in unexplored countries and for alternatives feedstocks and end-uses. Gaining experience and the development of certification procedures is, however, crucial for innovative biomass resources (as bamboo, reed) and/or biomass producing countries (as Ukraine, Mozambique) to get access to the international market. At the closure of the program, three NPSB projects (DBI02009, DBI02011 and DBM02024) have achieved sustainability certification of their biomass. Other projects are still in the process towards certification.

The NPSB projects contributed significantly in those areas where certification still needs to be further explored. Tools and guidance materials have been developed for selecting an appropriate certification system, both for biofuels and for solid biomass, and for smallholder certification. Self-assessment tools were considered as useful and have been developed by projects themselves. Capacity building has been provided. The NPSB portfolio served as a capacity building catalyst in this area.

Competition between certification systems has increased considerably. Examples are mentioned by (DBI02009) in Argentina between RTRS, ISCC and 2BSvS and by (DBM02038) in Indonesia between RSPO and ISPO. Whereas RSPO is on various aspects a higher quality standard, ISPO reaches (through legal obligation) a larger market. This presents the dilemma on how to reach impact with certification schemes: through market volume or requiring highest quality, with often a smaller market volume?

Systems with a wider scope of sustainability, and stricter requirements, ask for an effort from companies in terms of costs, effort in time and adjustments to be made. Looking at the current developments, the market does not choose (alone) for the highest standard. For biofuels towards Europe, there is for example a tendency towards 'easier' certification systems for proving compliance towards the sustainability requirements as laid down in the European Renewable Energy Directive EU-RED). The EU-RED has no or limited coverage of social or assurance requirements.

Capacity building

Capacity building is essential to promote and safeguard sustainable, innovative value chains from various perspectives: to enhance for example governance, policy development, capacity and skills (agronomics, organization) of producers, to create awareness and community involvement. For further inclusion of smallholders in certification, and in the bioenergy sector in general, more flexible compliance mechanisms, capacity building, and organizational support to form cooperatives are key requirements. This requires an additional effort from producers.

There are different interpretations of sustainability. Examples of this are found in the coverage of principles or on the level of strictness and assurance to secure sustainability. This is reflected in policy frameworks and in certification systems. It is therefore essential for stakeholders to get mutual understanding of the interpretation of sustainability. Stakeholder consultation and participatory approaches are in that respect key for project acceptance, consensus building and shared ownership.

Certification systems and policies are clearly closely interrelated. How, varies per context and per country. In the EU, certification is used as a tool in policy making. In this case, policies should define clear frameworks and requirements to ensure that certification systems are robust to proof legal compliance. In other regions, where the policy framework is weakly defined, certification can partly take over enforcement. For sector transition, certification can be used to drive learning and the process of certification is used as a framework for implementation of better practices through continuous improvement.

It is key to understand the (im)-possibilities of available tools to steer sustainability. Certification and policy frameworks are together instrumental to safeguard sustainability impacts of biomass and bioenergy production. Concerted action is required on multiple levels to enhance the operationalization of sustainability criteria, and safeguarding them. On international level, certain consensus on accepted sustainability requirements is required. Shared ownership and taking responsibility is in that respect crucial for the success of international multi-stakeholder processes. The NPSB projects learned that multi-stakeholder consortia and Roundtable initiatives could facilitate this process. Tools and experiences from the NPSB programme have been pro-actively shared with these initiatives.

Selected key lessons for next steps

- It is important to select a certification scheme at the start of a project, even at the design phase, to understand what type of data management system is needed to meet requirements, and to align this with day-to-day business.
- Self-assessment tools are beneficial for projects during project development and implementation to enhance continuous improvement of better practices. Certification systems should therefore enhance their use in their standards.
- Integrating sustainability requirements in policy frameworks and law allows governments to have a mechanism in hand to regulate and enhance sustainability in economically viable chains. These policy frameworks should be carefully designed to avoid a tendency towards the use of recognized certification systems that guarantee a lower level of assurance.

Part 5
Creating a feasible business case

Creating a feasible business case for successful deployment of sustainable biomass production and supply depends on multiple factors. Lessons are learned in the NPSB projects on all these factors.

Factors that determine the feasibility of a business case

- Enabling policy environment
- Presence of sustainable supply (competitiveness feedstock, availability supply)
- Efficiency in logistics and distribution
- Efficiency in conversion
- Presence of markets (price, unexplored markets, flexibility to switch between markets)
- Strong project partnership and management
- Capital (investment needs, opportunities for funding)

Main observations

Demand, markets and bioenergy policies have been growing worldwide in the last years. Reasons for doing so differ. Malaysia aims, for example, to stimulate the palm oil sector while reducing fuel dependency in the country. Markets in developing countries aim to move away from traditional inefficient wood stoves to renewably energy including biomass while Europe has introduced targets – mainly from a climate mitigation perspective. Most of the introduced policies are limited to blending requirements and mandates without a supporting framework. The lack of an enabling policy environment and/or a regulatory framework hampers the business case of projects.

Sufficient business opportunities exist worldwide but may be constrained by the project's ambitions. For example, projects searching for opportunities to trade large volumes of biomass in a short time frame require locations with secured, available resources from existing commodity chains and already established infrastructure. This will practically constrain opportunities to a limited number of countries and biomass resources.

Linking enabling environment and policies

Targets and bioenergy policies exist in many countries but an action plan and pricing policies receive little attention. This hampers the business case of bioenergy projects: they cannot compete with fossil fuel projects and large investments are still needed for infrastructure development. To overcome these bottlenecks, an enabling policy environment is needed to support investments and attract business. This should be integrated with rural development. Best practices of projects can provide a large added value to this development, especially in countries where biomass and bioenergy production is still relatively unexplored. They can demonstrate possibilities and failures on the ground, and can trigger the development of new policy procedures, knowledge transfer, and capacity building. This has also been the experience in the NPSB programme, where effort has been put in both the enabling environment and structuring the business case itself. This pleads for the development of public private partnerships.

Innovative projects: perseverance to compete with business as usual
Innovation is interpreted in this report as projects that extend sustainable best practices, with an element of social innovation (start-up in an unexplored country, smallholder involvement), or the use of alternative feedstocks, production systems or technologies. As explained in earlier parts of the report, innovative projects are desirable and more sustainable (also economically) on the long term. This transition requires, however, an additional effort from companies to do so. Innovative projects have more difficulty to get financing or may need to put more effort into project acceptance as shown in Mozambique (DBM02045). Additional effort is needed for procedure development, or into supply chain and technology development. All these factors enlarge the lead-time (and therefore the Internal Rate of Return) of a project compared to "business as usual" projects. Perseverance, attention, and market implementation is therefore continuously needed to enable for transition.

Feasible innovative projects: the essence of a robust and structured business case
When carefully developed and conditions are met, the NPSB projects learn that innovative projects can successfully be implemented for commercialization. A feasible project requires a robust and structured business case with careful management of risks, also for further upscaling and financing. Vice versa, certification also contributes to obtaining financing and enhancing the business case. This pleads for an integrated approach towards sustainability (including economic performance). The NPSB programme paid attention to structuring the business case of projects, and a tool for doing so has been developed.

Upscaling of projects can potentially be reached through a step-wise approach. Local use of biomass can potentially serve as a stepping-stone for large-scale production and exports in the long term. The feasibility of large-scale production for the international market has been explored by the project (DBM02045) in Mozambique. This turned out to be challenging. The project therefore decided to work on local biomass use and solutions. Only when an enabling environment will be created, further upscaling could be possible in the future.

Although opportunities may differ from country to country, high potential projects perform well in all operating world regions when conditions for a feasible business case are met. The NPSB projects, as the cassava project in Panama (DBM02024) learn that the valorisation of co-products enlarge and diversify the income stream and market outlets for a project, enlarging the cash flow. Several of the NPSB projects worked on the valorisation of carbon credits. This market, however, collapsed. Also the importance of strong project partnerships and having a local partner has been highlighted.

Spin-offs
Although several of the NPSB pilot projects have not fully commercialized yet, they have created a spin-off in knowledge, business opportunities and replication and transfer of technologies. Examples are the establishment of a biomass research centre in the Ukraine (DBI01010), the application of a local patent in Vietnam (DBM02020), or the on-going replication of technology transfer to other comparable processing sites from coffee wastewater (DBM02053), rice husk facilities (DBM02053) or trapiches (DBM02045). Clearly, this process is still on-going. More time is needed to fully optimize the benefits of these pilot projects, especially in countries where new, innovative technologies have been introduced.

Selected key lessons for next steps

- A structured approach of business development is recommended from the conceptual phase onwards to adapt for changes, enhance funding opportunities, foresee possible risks and improve better practices. This requires the further development of an integrated approach towards sustainability (including economic performance) in day-to-day business.
- To better align with the use of certification as a tool for moving towards better practices, certification systems should more recognize the importance of a feasible business case for being able to do so.
- When a transition towards more efficient and sustainable use of resources is desired, additional financial support is needed to bridge the gap in competition between innovative projects compared to "business as usual" projects. This includes support and investments in supply chain and infrastructure development in producing and end-use countries.

Towards sustainable biomass supply chains: next steps

An increased demand in biomass resources is expected for both local markets and export markets, for existing uses and for opening new markets in the biobased economy. The future possibilities for biomass importing countries to use biomass not only depend on available sustainable production potentials, but also on demand from other countries.

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More biomass needs to be unlocked in time to increase the availability of and affordable biomass in the future. The NPSB projects demonstrate the need for an integrated approach of sustainability (including economic performance) given the interaction between impacts, as the nexus food security and rural development, and risks for possible trade-offs. The debate on sustainability is however dynamic and new impacts (ILUC, carbon debt, cascading) have emerged in recent years and are still debated, also in the context of the vision and concept on sustainability. This means that a sustainability framework will be subject to change and changes will always be needed. This stresses the importance of multi-stakeholder processes.

Unlocking sustainable and affordable biomass requires a transition towards using resources more efficiently and creating alternative resources. The NPSB projects have shown that alternative biomass resources can be successfully unlocked, with multiple positive sustainability impacts. This is especially true for integrated, sustainable production models with multiple market outlets, as well as for the valorisation of residue and waste streams. These "best practice" production systems serve the food-fuel-feed sector and contribute as such to regional development. Benefits can be further optimized in the supply chain, through efficient use of technologies.

The NPSB projects demonstrated the possibility of creating optimized, sustainable biomass production chains, but faced competition compared to "business as usual" projects from different perspectives. Examples are the higher risk profile to get financing, procedures that need to be developed or market acceptance for new products. Consequently, one has to realize that a transition towards more sustainable, innovative production models requires time, investment and effort. Lessons learned throughout this report point to the need for integrated approaches with concerted action from multiple stakeholders. Examples are given in the box below.

Box
Selection of examples of concerted actions from multiple stakeholder groups:
- Projects can serve as best practices in countries. Creating an enabling environment and practical experiences on the ground should go hand in hand.
- The formation of international consortia, representing different stakeholder groups, brings added value to project development by exploiting each other's strengths.
- Integrating sustainability requirements in policy frameworks and law allows governments to have a mechanism in hand to regulate and enhance sustainability in economically viable chains.
- Markets can uptake to good governance to demonstrate compliance or more, possibly through certification – before, during and after project implementation. This also enhances their possibilities to get financing.
- A transition towards higher productivities and sustainable business models requires capacity building and knowledge transfer towards a large group of stakeholders.
- Enhancing capacity building, sustainability and biomass production collectively asks for a shift in business and program development. It calls for an approach where sustainability, optimization of productivity (technology, agronomics, knowledge) and the business case (finance) are fully integrated by all stakeholders' activities.

The shift towards innovation and stimulating best practices in large-scale bioenergy production implies some trade-offs and choices to be made:
- A transition towards more innovative, sustainable business models for multiple market outlets may require a change in how to design biomass policy frameworks and targets. It implies a choice from "business as usual" to alternative business models and/or unexplored feedstock resources.
- Increased developments of sustainable bioenergy frameworks in producing countries, adapted to their local context, show differences in priorities on sustainability and biomass use (see part IV). This requires the flexibility that "sustainability" can be broadly interpreted, while recognizing the need for a set of internationally accepted standards.
- Competition between certification systems in the market is fierce. Certification is increasingly used as mechanism for legal compliance, where policy requirements determine the fixed legal standard of sustainability. This results in the emergence of certification systems that are solely developed to meet legal compliance. On the other hand, there is a plead to use certification systems as tool for learning, embedded in business, as framework towards promoting better management practices in a sector or company. This requires a certain level of flexibility to allow for continuous learning, towards a moving threshold of sustainability and improvement.

This chapter concludes with two key recommendations for each stakeholder group on next steps towards generating sustainable biomass supply chains, although they are not inclusive for one stakeholder group alone. More recommendations are given in the main report.

Project developers
- Project developers should carefully look and prepare for business opportunities; they do exist (in the broadest) sense for developing sustainable biomass supply chains, especially when residual flows can be valorised and multiple outputs can be created. A structured approach of business development and implementation from the conceptual phase onwards is key to adapt for learning, foresee possible risks, and to succeed.
- Project developers should fully integrate sustainability, certification, stakeholder consultation and capacity building as components in business development and implementation. These elements contribute to a project's feasibility and finance, as has been demonstrated in the NPSB projects.

Governments

- Governments should design local, national and international policies and commitments to support a transition towards using and developing affordable, sustainable, innovative biomass resources (away from the "business as usual" commodities) in large volumes, and to facilitate for the investment and effort needed to do so. These policies should be integrated in regional policies of rural development. Some flexibility in policy targets to allow for learning may be desired.
- Governments should provide a stable enabling environment for the successful deployment of an energy sector. Setting targets for bioenergy and biofuels production alone is not enough. Supporting frameworks and incentive mechanisms that approach bioenergy development in an integrated manner are key to the successful and sustainable deployment of biomass resources. Setting up such policy framework requires choices, cooperation with the market and other stakeholders, and careful insight in possible risks and benefits on regional and local level. This is enhanced through integrating lessons learned from implementation on the ground into policy development.

NGOs

- NGOs can play a role in projects to articulate the voice of the local communities and to translate concerns on the grassroots level to government and policy level; this to ensure that the local context of sustainable biomass production is well presented. This requires cooperation with governments and the market.
- To enhance sustainable biomass production and use, NGOs should provide support in capacity building, awareness and knowledge transfer, especially to more vulnerable groups.

Knowledge institutions

- Knowledge institutions should do more research (learning by doing) on optimized models for innovative sustainable biomass chains, in line with the concept of climate smart agriculture. More insight is especially needed on how to develop large-scale affordable and sustainable value chains. This includes not only technology development and improvements in agronomic practices but also better scientific insight in new sustainability impacts (e.g. carbon debt), their possible trade-offs and interaction on sustainability as a whole. Lessons learned should be used to optimize sustainable business models or technical potential studies.
- Institutions should take the lead to transfer this knowledge between institutions, between countries, from research to business, and vice versa – within a broader supporting network of governments and other international organizations. Capacity building is essential to create the desired transitions in sectors, unexplored countries, and to adapt best practices to the local context to optimize sustainability benefits.

Introduction

Introduction

The demand for energy is increasing globally and fossil fuel stocks are diminishing. Diversification of energy sources is needed to provide for this increasing demand. Also in order to achieve significant emission reductions in the energy sector, sustainably produced bioenergy will play an increasing role in the future with expectations of demand increasing threefold to 2050 (IEA Bioenergy, 2013).

Biomass-based energy accounted for roughly 10% of world total primary energy supply in 2009. Most of this is consumed in developing countries for cooking and heating using inefficient open fires or simple cook stoves with considerable impact on health and environment. Modern bioenergy supply is still comparably small (IEA Bioenergy, 2013) but continued to increase in recent years. Biomass accounts for over 10% of global primary energy supply and is the world's fourth largest source of energy (following oil, coal, and natural gas). Total primary energy supplied from biomass increased 2–3% in 2012 to reach approximately 55 EJ (REN, 2013).

The increase in demand has been stimulated by the introduction of renewable energy policies, the desire to reduce imports from fossil fuels and diversification of energy resources. In 2012, in total 138 countries had defined renewable energy targets. Supporting policies were in place in 127 countries. From which two third was based in merging and developing countries. Demand for biomass is increasing worldwide, for a growing variety of end-uses (REN, 2013).

The target of the Dutch government is to generate 16% of its total energy consumption from renewable energy sources in 2020. Beside, 10% of the energy for transport has to come from renewable sources. Biomass is one of the key renewable energy sources in the Netherlands if produced under the right conditions: sustainably. The Netherlands does not produce enough biomass to meet the needs of its energy and chemicals sector and therefore needs to import biomass.

The (increasing) production of biomass and its conversion to useful energy has varying potential environmental and socioeconomic impacts – both positive and negative - that depend on a number of factors. The sustainability of biomass production therefore needs to be guaranteed. The Netherlands is stimulating the sustainable use of biomass as a raw material for energy and chemistry.

Introducing the NPSB programme

The Netherlands Programme Sustainable Biomass (NPSB) has been developed to gain experience in the production and certification of sustainable biomass to strengthen the framework for the production of sustainable biomass, based on practical experiences. The programme consisted of a subsidy fund and a supporting programme and has run from 2008 to end of 2013.

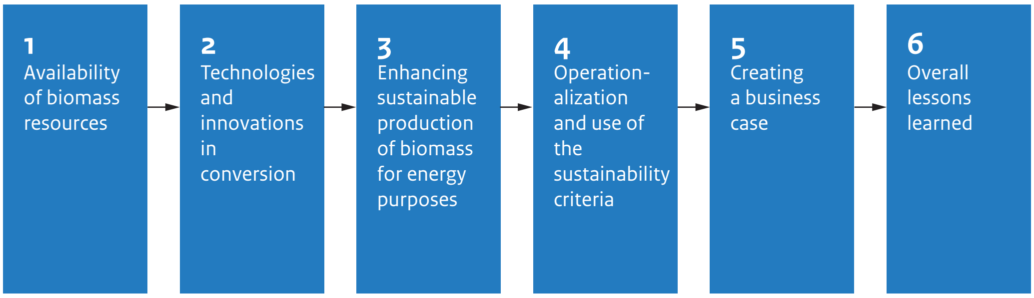
The project portfolio consisted of projects from the Global Sustainable Biomass tenders (DBM projects) and from the Sustainable Biomass Import tenders (the DBI projects) and the relevant projects of the Daey Ouwens Fund. The program clustered the knowledge from the biomass project portfolio and has filled the knowledge gaps with supplementary research. Within the project portfolio, the DBM projects aimed to stimulate, support and facilitate the promotion of sustainability of the production, processing and import of biomass produced in developing countries, leading to the application of biomass for energy purposes. The DBI projects had a similar aim but focus on production of biomass for export to the Netherlands rather than local markets.

The project portfolios have a wide variety in terms of content, approach and context. Some of the projects actually biomass (attempt to) produce biomass; other projects have worked on the preconditions for sustainable production. A summarized overview of the projects is given in annex 1. The program and projects are together referred to as the NPSB projects or program in the report.

Objective of this report

The overall objective of the report is to evaluate the overall lessons learned in the NPSB programme to promote the sustainable production of biomass for export and local use, and to give recommendations for future development. The report is divided into 6 main parts, each of them discussing the key objectives of the NBPS program (see figure 1).

Figure 1
Description of main parts of the report with lessons learned



Outline of the report

Each topic (see figure 1) is addressed in a separate chapter. Specific project findings, examples and conclusions (e.g. on Jatropha, financing, smallholder certification) are discussed in detail in the individual chapters. Each chapter ends with generic conclusions and recommendations. These are defined for different stakeholder groups (NGOs, program developers, government and knowledge).
The report ends with a final chapter VI in which generic, overall conclusions and lessons learned on how to develop sustainable biomass projects for import and local use are discussed.

Approach

This report presents the key findings and results of the 40 projects and 30 assignments. Its aim is to present a compilation of the lessons learned.

Information from the projects is based on the submitted final reports and the project experiences during the implementation in the last years. All final reports and underlying project reports from the NPSB support program are available on the RVO website, and can be used for more background information. The report also makes use of previous analyzes that are made within the NPSB programme on specific topics (e.g. NL Agency, 2013c, RVO 2014a).

Reader group

This report and lessons learned are targeted towards the stakeholder groups that have been, directly and indirectly, involved in the NPSB programmes:

- Government;
- Entrepreneurs in the market (producers, project developers);
- Knowledge management institutes (universities, standard owners, certification bodies);
- Non-governmental organizations (NGOs).

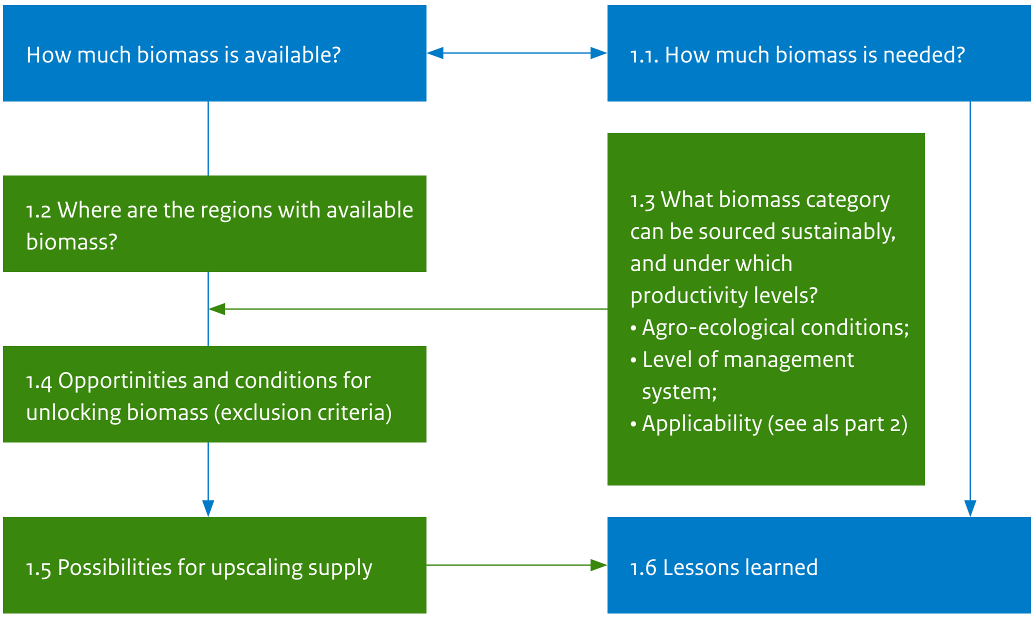
Part 1

Creating availability of biomass for local use and for export

Part 1
Creating availability of biomass for local use and for export

The availability of biomass is crucial when relying on it as source for meeting renewable energy targets, especially when it requires a certain volume within a certain timeframe (see introduction). Several stages are involved when discussing the availability of biomass (see figure 2). Together, they provide insight how much biomass is realistically available. First, how much is needed and where (1.1). Secondly (in 1.2), how much is available, where and under which conditions (1.3). The final sections of this chapter discuss conditions and possibilities to unlock biomass availabilities (1.4).

Figure 2
Factors determining biomass availability, as discussed in the sections of this chapter



1.1
How much biomass is needed: drivers for demand increase

Demand for modern biomass is increasing worldwide for a wide variety of end-uses, while its use for traditional use for cooking and heating in developing countries is still substantial (see introduction). In 2012, the global heating capacity from modern biomass totalled to around 293 GW, with Europe being the leading consumer. Bioheat demand from modern biomass is also increasing steadily in other countries. In China, the number medium- to large-scale biogas plants increased from some 10,000 in 2006 to some 80,000 by 2011 (REN, 2013).

End of 2012, global bio-power capacity from modern biomass was reaching 83 GW, up 12% over 2011, with notable increases in some of the BRICS countries (REN, 2013). Europe is a large consumer of wood pellets for heat and power demand with the UK, The Netherlands, Belgium and Denmark as the biggest importers of wood pellets (NL Agency, 2013). Demand in wood pellets is expected to grow substantially in the coming years in Europe (Info I, 2013), while consumption is rising in other regions as well. Eight new pellet plants were for example under construction as of early 2013 in South Korea (REN, 2013).

The use of modern biomass for liquid biofuels continues to make a small, but growing, contribution to transport fuel demand worldwide. Biofuels currently provide about 3% of global road transport fuels, while there is also a small but increasing use in the aviation and marine sectors. On a regional basis, North America is the leading country in ethanol production; Europe for biodiesel. However, production of bioethanol and biodiesel is also increasing rapidly in Asia. Also in Africa, production of feedstock and biofuels has been growing, both for use in national markets and for export (Info III, 2010). Biofuels markets are thus slowly expanding, and ethanol production rose from 270 million litres in 2011 to an estimated 300 million litres in 2012 (REN, 2013).

Box 1
Upcoming new markets further fuelling demand

- In various EU member states the development of a biobased economy has been gaining a lot of attention. In 2011, the Socio-Economic Council (SER) advised the Dutch government on how to guide the development towards a bio-based economy (Info I, 2011). Large investments have been made end of 2013 to further explore the possibilities of the biobased economy in Europe. Similar large investments have been taking place in the US (Info II, 2013).
- On both European and US continents, there is also a move towards the recognition of biojet fuels as part of the renewable energy policy. This redrawing of the political framework of biojet fuels goes hand in hand with a market wish to further develop this sector. More than 1,500 commercial biofuel flights have been completed since 2011. In 2013, KLM has operated its first transatlantic flight with a blend of kerosene and 25% recycled cooking oil to New York. KLM aims for a one percent blending target by 2015, or around 30,000 to 35,000 tonnes of jet biofuel (Info, 2013).
- Targets have been defined by an increasing number of biomass producing countries in the last years, also in developing countries (see also annex 2).

In Europe and worldwide, an increasing number of countries have set targets and blending mandates. Biomass is increasingly needed to meet the share of biofuels in transportation fuels, for meeting its targets for renewable energy in heat and power, and for meeting the demand in new, upcoming markets (see box 1 and annex 2). The influence of policies on creating an enabling environment for biomass projects is further discussed in part 5. These developing policies have fuelled demand for biomass– next to its already existing demand for food, feed and fuel.

Recent analysis indicates that there will be a need for biomass of 1600 PJ for energy in the Netherlands, based on the ambitions for 2050. The report estimates that around 200 PJ of biomass can be sourced in the Netherlands at that time. The remaining should be supplemented with import – if available (PBL, 2014).

Key conclusions and lessons learned

- Worldwide, there is increasing demand for biomass production for modern use of bioenergy in both domestic markets and export markets, next to its use for already existing markets (food, feed and traditional use of biomass for cooking and heating) and upcoming, new markets (aviation, chemical sector);
- To meet this demand, worldwide more biomass needs to be unlocked over time, putting pressure on its sustainable production;
- The introduction of targets in biomass producing countries and the creation of upcoming markets may result into increased biomass use for local demand, and in a shift of trade flows. This may mean that less biomass becomes available for countries, which rely for a large part on the import of biomass for meeting their targets.

1.2 Biomass availabilities on regional level

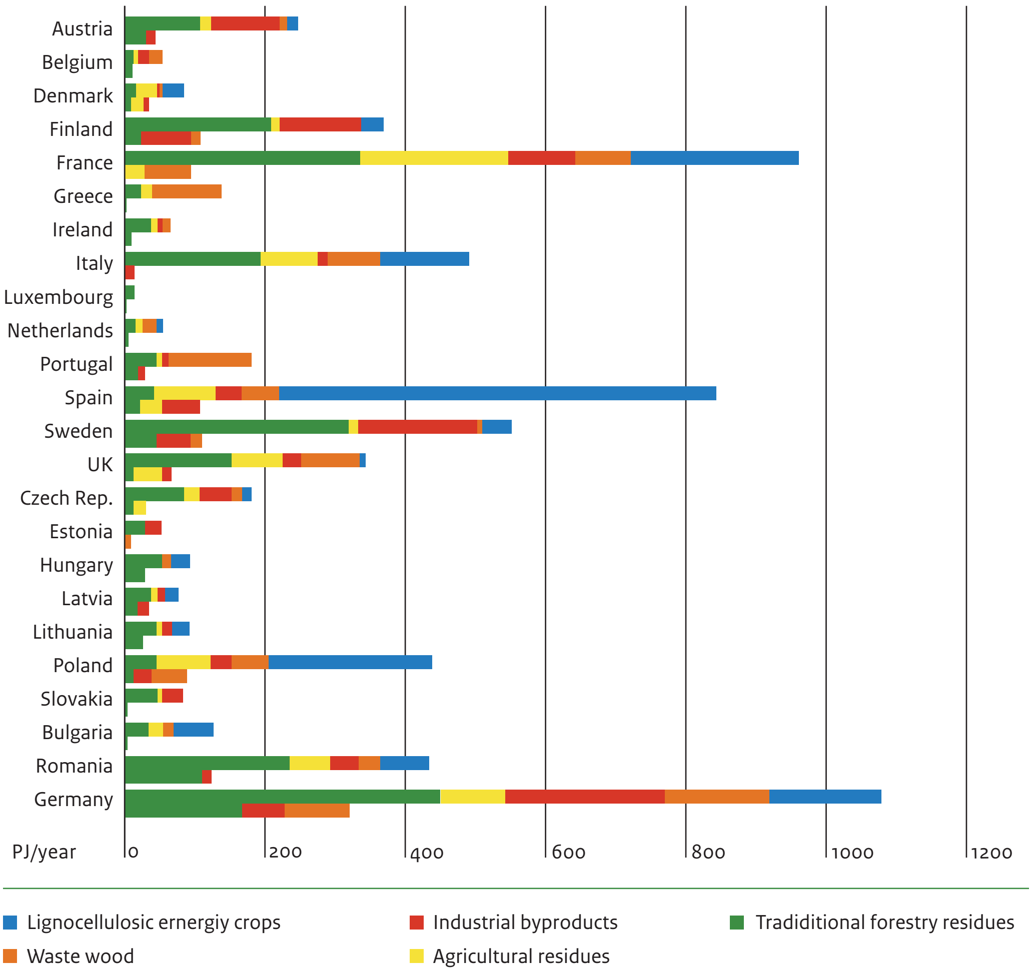
The growing demand for biomass worldwide has increased production and trade in biomass resources worldwide. Currently, main biomass exporting countries are Malaysia and Indonesia (palm oil), South America (soybeans), the US (ethanol, pellets), Canada (wood pellets), Brazil (for ethanol), and the Ukraine in the European region. A country as Brazil has experienced a rapid expansion of biomass production (DBI02011) in the last years, mainly to meet domestic demand. This resulted in a quick expansion of production of soy (for biodiesel) and sugarcane (for bioethanol).

1.2.1 Regional and country potential assessments

In the last decades, many studies have been undertaken to assess the (future) biomass availability in regions and countries to contribute to future energy supply. Most of these studies focused on land use and availabilities. The report from (RVO, 2014b) learns that current main biomass suppliers (e.g. Brazil, USA) are indeed the countries that have access to large land use areas. The same is true for countries as South Africa, Mozambique, Ukraine or Colombia, although to less extent.

The European regional biomass potential assessment (RVO, 2014b) shows that all countries have their own, untapped biomass resources, see figure 3. Some countries show a clear surplus availability of resources (e.g. France, Spain). This is more restricted for other countries, as the Netherlands.

Figure 3
Overall potential and current energetic use of solid biomass (based on RVO, 2014b)



Under the NPSB programme, country studies and factsheets have been developed to provide project developers more insight in opportunities in promising countries for sustainable biomass production, focusing amongst other on current and expected biomass availabilities.

Within these countries (see table 1), resource assessment estimations have been promising. The factsheets refer to the presence of considerable amounts of biomass potential in the explored countries, which are still untapped or unexplored. Potential large, unexplored, availability of residues and waste streams are mentioned for Vietnam and Indonesia. Both the Ukraine and Mozambique are considered promising countries for sustainable biomass production because of the large availabilities of land and favourable environmental conditions for agricultural production.

Table 1
Resource assessment indications for explored countries in NPSB programme

Country	Untapped potential
Indonesia	• Unexplored potential from dedicated crops forestry and agricultural residues, waste, sewage sludge, and landfill gas. Highlighted is the promising use of alternative biofuels crops, used cooking oil and animal fats for biodiesel production (Factsheet Indonesia, 2012). • Studies indicate also a potential for collected annual forest biomass of 135 dry million tonnes (Factsheet Indonesia, 2012).
Vietnam	• Large untapped potential from mainly residues, or waste materials and by- products. Biomass residues available that are not fully utilized yet, or even endangering the environment. Examples: rice husk, rice straw, coconut pith, sugar cane bagasse and coffee waste (NL Agency, 2012); • The algae project (DBM02020) also identified large potentials on macro-algae (seaweed) that can be grown in the brackish water areas of South Vietnam.
Colombia	• Biomass in Colombia has been calculated at 15 million tonnes/year according to the Agriculture Ministry statistical review. • From this figure, 872.116 tonnes/year are allocated to Palm Oil. 27% of this production is located in the North Coast; the location of the POME project (DBM01015).
Ukraine	• A largely undeveloped potential for the production of biomass feedstock. • The estimated availability of land for energy crops is 4.7 million hectares of free land (Factsheet Ukraine, 2012).
Mozambique	• A land zoning assessment, carried out by the government, identified almost 7 million ha of available land; 54% of this land is considered suitable for large-scale agricultural projects including biofuels (Factsheet Mozambique, 2012).

In Mozambique and in the Ukraine, future biomass potential estimates are even higher. By 2020, an estimated 3 Mha (9% of current cultivated land) could potentially be used for lignocellulosic energy crops in the Ukraine. This could satisfy 13-15% of the country 's demand in primary energy (Factsheet Ukraine, 2012). Predictions in availability of land in Mozambique for 2030 for bioenergy production range between 6.4 for the Business as Usual scenario to 16.5 million ha, if agricultural practices significantly improve (Factsheet Mozambique, 2012).

Key conclusions and lessons learned

- Current main biomass suppliers are those countries that have access to large land areas;
- Resource assessments indicate untapped biomass potentials in countries as Indonesia, Vietnam (mainly residues) and in the Ukraine and in Mozambique, the latter due to large land availabilities;
- Future estimates for the Ukraine and Mozambique show considerable amounts of biomass potentials. The full technical potential requires considerable improvements in productivities to bridge the yield gap. This is especially true for developing countries.
- Creating more biomass is possible through: i) untapping unexplored resources domestically, ii) importing biomass from areas that have surplus availability and iii) enlarging availability through productivity improvements.
- The European resource assessment shows that all individual European countries have untapped biomass potentials, some more than others. Given the rising demand (see 1.2.1), attention is needed to deploy these domestic biomass resources (next to stimulating import streams).

1.2.2
Selected country locations of the NPSB projects

The NPSB projects have been located in many different countries, spread over different world regions in Africa, Asia and South America (see also map 1). In Africa, multiple projects have been implemented in Mozambique. Indonesia has been the working country for multiple projects in the Asian region. Within the project portfolio, the DBI projects focused on the development of chains for import of biomass; assurance of sufficient biomass availabilities to create sufficient volume has been of importance.

The country choice of most DBI projects does therefore indeed correspond to those countries where large biomass availabilities are present, either by availability of land, or by the availability of untapped residues or waste. Most of the DBI projects have successfully identified biomass availabilities for exploration, although sufficient scale and volume has not always been generated within the three years time of the program (see also part 5).

Map 1
Geographical presentation of the NPSB biomass projects in the world, based on (RVO, 2014)

1.2.3
Experiences in NSPB projects to use regional potential assessments as guidance for project location

Various NPSB projects have indicated that the operating country was selected beforehand because the availability of biomass resources was expected to be good. The Pellets for Power project (DBI01010) selected for example the Ukraine as promising country. Main reasons were the large availabilities of unused and marginal land, the vast amounts of straw produced, and the large areas of reed available. The project developed a business model based on 3 promising biomass resources in the country: straw, reed and switchgrass. The most suitable feedstock (reed) was finally selected.

The project (DBM02053) selected Indonesia because of its sufficient availability of agro-waste in the country. The South African project (DBM02037) mentions the large presence of arable land that can be developed for agricultural purposes as interesting trigger for project exploration. Fallow lands in rural areas have been exploited in the project for biomass production. A development of 1,000 hectares of land was achieved in two areas in the Eastern Cape Province – Elliot and Engcobo.

Box 2
Criteria selection of promising regions with help of resource assessments
The Inbio project (DBI01006) developed country potential studies to gain insight into the net volumes of urban wood and other low-value residual flows in the USA and in the Baltic States. Within the USA, sufficient residual streams were identified to supply three large pellet mills. After a comparison, such quantities were not identified in the Baltic States. After the country selection, most suitable supply regions in the USA were selected as next step.
The Colombia project (DBI02006) selected a suitable supply region by looking at the national and regional potentials of bamboo production, as residue from processing sites and plantations, or as dedicated energy crop. Based on the estimates, a case study area was selected as next step: the coffee region in Colombia with an estimated potential of 600 to 1800 kton / year.

The projects (DBI01006) and (DBI02006) selected, on the other hand, first the desired feedstock. They used national or regional resource assessments to identify a promising country as next step, searching for the most interesting area for exploration in terms of availabilities (see box 2). A similar regional screening was done in the project (DBM02045) to get an indication where, and how much, bamboo was located in Mozambique. As no documentation was available about bamboo resources in the country, an alternative tool was used: aerial scouting. Sample tests have been collected as the scouting was done by helicopter, allowing on the ground inspection and sample collection.

Experiences with linking regional potentials with availabilities on the ground

Resource assessments (see 1.2.1) reflect the potential (technical) availability of biomass in a region or country. The report (NL Agency, 2012) concludes that most biomass potential studies in Vietnam focused on theoretical or technical potentials only. This particular approach is considered not satisfactory. Discounting factors such as sustainability requirements (see part 3), ownership, distribution and seasonality typically (see 1.4) results in overestimating the resource potential.

The project (DBM02045) experienced for example difficulty in finding sufficient underutilized sustainable biomass that matches the required minimum scale for export although theoretical potentials in Mozambique are high (Factsheet Mozambique, 2012).

Large biomass resource estimates may offer entrepreneurs new business opportunities and may provide insight on resources that are still underexploited. An example is the use of residues in Indonesia or the large potential for aquatic biomass that exists (Factsheet Indonesia, 2012). Overestimated amounts of biomass (and required adjustments) may have, however, an impact on the availability, reliability and scale on the input side of the chain (see also 1.5) - and hence on the business case of a project.

Key conclusions and lessons learned

- Projects have successfully used resource estimates to i) select a promising area for a selected feedstock or ii) to select an area where large potential resources are available for exploration; this is followed up by further feedstock selection (with its own exclusion criteria) as next step;
- At the end, projects search for the most promising feedstock-country combination;
- Aerial scouting can be a useful tool to identify biomass (categories) in a country when biomass potential studies are not (yet) developed;
- Resource estimates in studies are in most cases based on theoretical and technical potentials and do not consider exclusion criteria as sustainability or land rights (see figure 4). Consequently, there is a gap between what is potentially available and what amount of biomass meets at the end the criteria from the project developer or government, especially when a combination of business and project / policy sustainability requirements need to be fulfilled;
- It is recommended for project developers to use resource assessments as first screening tool for identifying suitable areas and to get insight into new, underexploited opportunities;
- More research is needed for merging the gap between "on the ground" availabilities of biomass and more theoretical resource estimates, by integrating the realities for biomass exploitation in potential studies.

1.3
Suitability and availability of biomass resource categories

Biomass resources can be divided into several biomass categories. Each biomass category has its own characteristics, requirements and sustainability risks (see part 3). Productivity levels, and possibilities for further improvement, are of importance for enlarging potentials in a country (see also 1.2). Productivity is again influenced by multiple factors as agronomic practices (input level, selected varieties, management practices) and agro-ecological conditions of an area. Relevant experiences and lessons learned on agronomic practices, species selection and production models in the NPSB projects are discussed in this chapter. Lessons learned on their end-use applicability for conversion is further discussed in part 2.

Table 2
Discussed biomass categories and selected crops in NPSB projects

Biomass category	Selected crops in NPSB projects
1.3.1 Fast growing grasses	Bamboo, reed, switchgrass
1.3.2 Agricultural food crops	Commodity crops: palm oil, soybean, sugarcane
1.3.3 Agricultural food crops	Other crops: sweet sorghum, sugar palm
1.3.4 Agricultural non-food crops	Jatropha
1.3.5 Biomass from trees	Native trees, candlenut and castor bean tree
1.3.6 Residues and waste	Agricultural residues Forest residues Waste
1.3.7 Algae	Macro and micro-algae

1.3.1 Fast growing grasses

Reed, swithgrass and bamboo are fast growing grasses that can be used for bioenergy production, but their potential is still unexplored. Therefore, they have been looked at in more detail in the NPSB programme.

Bamboos

Bamboos are woody grasses that grow in the tropical, subtropical and temperate regions of the world; they cover an estimated total area of 36 million hectares worldwide. From these, 65% in Asia, 28% in America, and 7% in Africa (DBI02006). Six African countries reported over 2.7 million ha of bamboo forest. Bamboo grows fast, in particular in the rainy season. In Ethiopia it reaches its full height (typically well above 10m) in about four months (Charcoal, 2013). Bamboo has multiple end-uses. It has the potential as lignocellulosic feedstock for energy, chemicals and as building material, for the development of sugars and lignin based biorefineries (DBI02006).

Lessons learned on agronomic practices and species selection

Many different bamboo species exist worldwide. More than 100 varieties are already registered in Colombia. In the project (DBI02006), suitable bamboo species have been selected for a region in Colombia. This was based on e.g. biomass productivity and growth site characteristics. The project learns that the techno-economic potential of the bamboo biomass chain differs according to selected species, maturity stage, and site and cultivation practices.

Lessons learned on production models

Bamboo is available directly from growing areas or as a processing residue (DBI02006). In Mozambique, native feedstock bamboo was identified as encroacher feedstock and abundantly available for harvesting. When done sustainably, this provides a win-win situation for local communities. This requires, however, community resource management schemes to prevent overharvesting or resource-induced community conflicts. The Mozambican policy and socio-cultural setting provides clear handles for this, but in reality overharvesting is quite common (DBM02045).

Reed

Reed is a tall, perennial grass. Reed can yield up to 15 tdm/ha per year. Wetlands in the Ukraine consist mainly of reed and cover approximately 1,2 million ha. Most reeds in the Ukraine have no alternative uses and grow on non-utilized lands. Large potentials are underutilized. Using reed for energy pellet production is therefore a potentially attractive option.

Lessons learned on production models

The project (DBI01010) concludes that reed can be successfully harvested from wetlands. Wetlands are vulnerable ecosystems though, and care has to be taken to maintain them. Harvesting reed areas is therefore complicated and potentially costly (DBI01010). The project put a lot of effort in developing sustainable harvesting guidelines.

Switchgrass

Switchgrass is a perennial C4 grass. The "Pellets for Power project (DBI01010) conducted experiments with switchgrass cultivation on different soil qualities in the Ukraine.

Lessons learned on agronomic practices and species selection

Within the project, switchgrass experiments were carried at 4 sites in the Ukraine. Tests in the (DBI01010) project showed what varieties are adapted to Ukraine, when and how Switchgrass can be established, what row spacing is best suited and what management should be applied. Expertise was generated to establish large-scale switchgrass fields, as evidenced by the establishment of large (> 5 ha) fields in the Lviv region of Ukraine.

Key conclusions and lessons learned

- Switchgrass, reed and bamboo are potentially interesting crops for harvesting from marginal or underutilized lands: reed on wetlands, bamboo as native encroacher and switchgrass on marginal land areas. Their use limits the risk for indirect land use change;
- Win-win situations can be created, such as economic benefits or environmental services;
- In the NPSB projects, reed and bamboo are grown on community lands. Community resource management schemes and harvesting guidelines are needed to prevent overharvesting or resource-induced community conflicts;
- Fast growing grasses can be grown in various regions of the world; their potential seems promising but is still unexploited while supply chain infrastructure is still largely missing. Further development of these feedstocks requires support from both the private sector as well as from governments in both producing as well as in end-use countries.

1.3.2 Agricultural food crops: commodity crops

Growing demand for biofuels has increased production and trade worldwide. Bioethanol and biodiesel originate mostly from commodity crops as soybeans, palm oil, sugarcane or corn (see also box 3). Commodities as palm oil and soy are largely traded in the world and are typically grown in large volumes and at high intensity, specifically for the purpose of trade and sale to the commodities market through established infrastructural networks.

Box 3
Use of main commodities for the biodiesel and bioethanol market: some figures
Soybeans:
- Commodity source for biodiesel (as well for the food and feed market);
- Cultivation is concentrated in the United States, Brazil, and Argentina, which account for 80% of grain production and 85% of world exports. Exports from these countries continue to grow steadily (NL Agency, 2013a);
- Soy-based biodiesel was one of the main flows of biomass imported into the Netherlands. Figures have dropped in 2013 since the introduction of the anti-dumping tariffs by the European Commission (see also part 4)
- The Netherlands remains a large importer of soybean meal.

Palm oil:
- Commodity source for biodiesel (as well for the food market);
- Palm oil reached more than 30 MT of global imports in 2012 (the EU imports amounted to about 6 MT). Dominating palm oil producing countries are Malaysia and Indonesia (NL Agency, 2013a);
- About 0.78 MT out of 1.63 MT of totally imported palm oil is converted into biofuels (mainly in the form of HVO) in the Netherlands and exported to other European countries (NL Agency, 2013a);
- Palm oil imports to Europe for various end-use markets have consistently increased over the past ten years: a near tripling of palm oil imports to Europe (DBM02038).

Sugar cane:
- Commodity source for bioethanol (also for the food market); with Brazil as main producer;
- The export of sugarcane ethanol to the EU has dropped significantly in the past few years due to several reasons like shortage in Brazil and market incentives in the US (NL Agency, 2013a).

Corn:
- Commodity source for bioethanol (also for the food and fuel market);
- Since 2011, there has been cross trade of cane and corn- based ethanol between Brazil and US;
- Between 2009-2011, there has been a steep increase of US ethanol import into the EU, but it dropped again in 2012. The US is also a large exporter of wheat and maize.
- Other major wheat producers are the Former Soviet Union, the EU, Australia, Canada and Argentina. The Ukraine is an important maize producer (NL Agency, 2013a).

While section 1.3.1 mainly looked at possibilities to exploit alternative new feedstocks, activities undertaken on agricultural commodity crops looked primarily at possibilities for making existing agricultural commodity chains more sustainable. This was for example done by optimizing the use of their residue and waste streams (see 1.3.6). Experiences on sustainability are further discussed in part 3 and 4. No crop area was planted or extended, except in the project (DBM02027) in South Africa where maize was intercropped with soybeans.

Palm oil
The area for palm oil is scheduled to increase tremendously in Indonesia since its government has set a national target of doubling palm oil production from around 20 million tons in 2010 to 40 million tons per annum by 2020/25 (DBM02038).

Five of the 7 NPSB projects in palm oil are located in Indonesia; the two others in Colombia and in Sierra Leone. Four of these projects focused on enhancing the sustainability of existing supply chains (see part 3), while the other three focused on demo facility, feasibility study and research on how to better use palm oil effluents during processing. The promising use of residues and waste from palm oil production and processing is further discussed under the category “wastes and residues”.

Soybean

Soybean is included in two NPSB projects and both focused on the sustainable development of the chain and on its expansion areas. As example: Mato Grosso, Goiás, Rio Grande do Sul and São Paulo in Brazil concentrate 82% of its biodiesel production from soybeans. The volume of the supply chain that was subject of the project in Argentina (DBI02009) is approx. 30,000 tons of soy annually.

Soybean formed also part of the selected crops in the South African project (DBM02037), intercropped with maize. Smallholders in both Elliot and Engcobo planted 500 hectare – 250 maize and 250 soybeans (see also 3.3.2). Results from the project will be used to continue with the overall project goal of developing 20,000 ha of arable land in South Africa.

Sugarcane

Sugarcane is included in two NPSB projects, both focused on Brazil as one of the largest sugarcane producers in the world. The project (DBM01011) developed a sustainable supply chain of ethanol from sugarcane produced in Brazil; the first shipment of certified ethanol from Brazil (see also 4.4) reached the port of Rotterdam in November 2012.

The northeast (NE) of Brazil is the second largest producing sugarcane region of the country, although its production is still far behind that achieved in the most efficient and competitive central-south region. There are also concerns about the sustainability of the production system in the NE region. A potential assessment in the project (DBM1011) showed that the theoretical potential to improve the economic perspective of the NE sugarcane industry in a sustainable manner (e.g. by changes in production system, higher yields) is present. There is also interest amongst stakeholders.

Key conclusions and lessons learned

- Commodity crops have as advantage that they can be produced in a cost-efficient manner and with large volumes on the international market. The, often non-varied, large-scale production scale poses however considerable risks on sustainability (see also part 3 and 4).
- NPSB projects on established commodity crops focused less on improving agronomic practices (varieties, optimizing yields); they already optimized for production. Instead, the main focus of these projects was to promote sustainable production models, especially in expansion areas;
- Effort on optimizing yields and sustainable production systems may still be needed when introducing established commodity crops in relatively new or ineffective production areas, as learned by the sugarcane project (DBM1011) in Brazil. This requires transfer of knowledge and experience from more advanced production regions to other regions.

1.3.3
Other agricultural food crops: cassava, sweet sorghum and sugar palm

The NPSB projects deployed biomass from different agricultural food crops, as sweet sorghum, cassava or coffee (for residue use). Many of these crops have been introduced in the projects as multi end-use crops. This means that only that only part of the crop is used for bioenergy production (mostly the part with the lowest value) while other parts are used or sold in alternative markets as the food or feed market; while the overall aim was to make the whole value chain more sustainable.

Agricultural crops, as sweet sorghum or sugar palm, have relatively smaller trade volumes compared to commodity crops (see 1.3.2) or are practically not traded. They are not commonly materials used for bioenergy production (as e.g. sugarcane) and there are no to limited existing supply chains of some of these biomasses. Developing these biomass resources for the market may therefore lead to the establishment of completely new supply chains.

Cassava
Cassava is a staple crop in many tropical countries with little rainfall. Cassava is included in a variety of foods all over the globe. Moreover, cassava is a crop suitable as feedstock for ethanol production. As an ethanol feedstock, cassava is appropriate due to its high starch content and its year-round availability. The project (DBM02024) aimed to increase the productivity of cassava through using new varieties and better techniques, which are today not used in Panama.

Lessons learned on agronomic practices and species selection
Farmers in Panama are currently using only two varieties of cassava. Based on the progress of the testing and certification of the 13 Colombian cassava varieties, the project (DBM02024) was able to select 4 varieties, which have been reproduced in this year's planting season 2012. Part of the stems and branches of the cassava plants are used as propagation agents ("seeds").

Lessons learned on production models
Input and technology levels for cassava production are low in Panama. The project has planted the first mechanically planted plot of cassava in Panamá. Part of the planted area will be produced in rotation with other crops, laid down in an Integrated Crop Management Plan.

Sweet sorghum
As variety of the sorghum plant, it can be used for multiple end-uses: for sugar, for bio-ethanol, or processed into animal feed as substitute for corn, or milled, or as flour as alternative for wheat flour. The project (DBM01004) looked at its possible use for bioethanol production in Indonesia.

Lessons learned on production models
Sweet sorghum in Indonesia was successfully grown in rotation, following rice (rice – sorghum rotation). The project made recommendations to the government to include sweet sorghum in the Crop Growing Master Plan of the Province, and in the fertilizer subsidy program.

Lessons learned on agronomic practices and species selection
The project did various tests to select four varieties that grew successfully. The selected varieties produce 140 to 210 tons /ha/year of stalks and 9 to 12 tonnes of grains/ha per year. Four high yielding sweet sorghum varieties were grown as feedstock for bioethanol processing in a 50 Ha pilot.

Sugar palm
The cultivation of sugar palm, under beneficial conditions, can result though in higher yields compared to sugar cane. Sugar palm is a native species in the North of Sulawesi, Indonesia. The juice is used for producing sugar syrup or for, mainly illegal, alcohol consumption. As alternative, the juice can be used for bioethanol production (DBM02036).

The project (DBM02036) aimed to develop a more sustainable processing of sugar-palm to sugar pursuing a 100% zero waste policy. This was based on the concept of the Village Hub Model, further explained in section 1.5. Sugar palm grows in 'mixed stands', which offers opportunities for additional sources of income for small farmers (Info II, 2011). The project learned that there is a demand for sugar from sugar palm, making it an interesting crop for further exploitation.

Key conclusions and lessons learned

- NPSB projects put effort on optimizing yields and select varieties for bioenergy production for other, less common, agricultural crops. This requires substantial effort.
- This is also worthwhile, as substantial higher yields can be achieved than is common practice in a region (see DBM02024), especially in developing countries where substantial yield gaps exist.
- Project experiences on sweet sorghum, cassava and sugar palm use only parts of agricultural food crops for bioenergy production. This does not harm or contradict with food.
- This requires optimized production models (see 3.3.3) and the optimal use of the plant (stalks, grains, oils) for various end-uses (see also part 2 and 5.5.2).

1.3.4 Agricultural non-food crops: Jatropha

Different components of the Jatropha fruit – oil, seedcake, shells and husks - can be used in different ways, for energy or non-energy purposes. A large number of Jatropha projects have been implemented in the last years in various countries, especially in the African region. During the start of the NPSB projects, Jatropha was considered a very successful and promising crop. In that timeframe, more than 12 Jatropha projects have received funding under the NPSB programme.

Since 2005, commercial Jatropha production has been through a decade of boom and bust. Because of disappointing results, a Jatropha Assessment (2013) has been undertaken in three different countries, as part of the NPSB programme. Experiences on Jatropha cover the experiences from individual NPSB projects (see table 3), as well as results from the Jatropha Assessment, which had a larger scope than the NPSB projects alone. Shared conclusion is that project results have been disappointing for various reasons. Some positive experiences have been made as well.

Lessons learned on agronomic practices and species selection

Disappointing yields were experienced in the 23 evaluated Jatropha projects in Tanzania, Mali and in Mozambique from the (Jatropha Assessment, 2013) as well as in the individual NPSB projects. Yields were partly limited because of the young age of trees, as well as by limitations by drought and pests and diseases. Yield increases can be expected when technical developments are achieved in Africa (Jatropha assessment, 2013). This requires improvement in agronomic practices, as:

- Need of improvement for specific crop management and techniques: Insufficient data are available so far to allow for a quantitative analysis of the effects of specific crop management on seed yield. Too many factors are involved. The NPSB projects do provide some specific recommendations. Different fertilisation treatments were compared in the Jatropha pilots (DBM01018), showing that a higher effort results, expectedly, in better results. Experiences in the Mali project (DBM01002) learned that planting by cuttings is more effective than planting seeds.
- Need for cultivation methods adapted to local conditions: The three companies in the Jatropha project in Mexico (DBM02050) based their plantations on cultivars acquired all over the world and hence grown at different conditions, so they were not adapted to the local soils and weather conditions. Disappointing low yields learned that it is necessary to develop a cultivation method particular to local conditions, before the establishment of large commercial plantations.
- Need for genetic improvements and improved varieties: Most Jatropha is grown with local plant material and breeding for improved varieties is still in its infancy. Genetic improvements may increase yields, and should be combined with good crop management to utilize the potential (Jatropha assessment, 2013).

Table 3
Key results achieved and lessons learned in individual Jatropha projects from NPSB programme

Project	Result achieved	Explanation
Mali project (DBM01002)	• Plots installed in 2010; Production started in 2013. In total, 166 growers produced 124.75 ha.	Low yields; did not result into commercialization.
Diligent product in Tanzania (DBI02007)	• Based on already existing Jatropha production: 3500 ha was already planted. In 2010, Diligent produced approximately 100 metric ton of bio-oil, and with this volume was one of the larger producers in the world, with around 50.000 outgrowers supplying	Diligent went bankrupt at the end of the project period
Jatropha biodiesel, Mexico (DBM02050)	• Field-testing and laboratory testing to select suitable varieties. • Feasibility of performance	Yields were too low, and not sufficiently adapted to local conditions. Economically not feasible/
The Jatropha project "Macha Works Zambia	• Within the project 250 ha of Jatropha was planted and a nursery with 600.000 seedlings established (B2Match, 2013).	
Jatropha Fairtrade project (DBM01018)	• 5 demo plots in three different sites (instead of 7)	Intercropping of Jatropha successfully introduced/

Lessons learned on production models

Outgrowers cultivate Jatropha in two basic arrangements: on fields and as hedges. Within each of these arrangements, there is a further distinction between those who intercrop with other types of plants, and those who don't (Jatropha assessment, 2013). In Tanzania, for example, smallholder farmers are producing subsistence crops in small plots of 1-1.5 ha on average. This usually consists of a mixture of maize, beans, pigeon peas, and cassava.

The pilot of the Jatropha Fairtrade project (DBM01018) is based on a model of intercropping Jatropha with subsistence crops (maize) in a specific planting model. The mixed farming system model consisted out of 40% Jatropha and 60% food crops. The test at the demo plots was well executed in all 3 locations in 5 trials out of 7 planned. The Jatropha project in Mali (DBM01002) had similar successful experiences of intercropping Jatropha in association with other food crops.

Seed yield is a major goal of Jatropha cultivation grown for bio-energy production. Farmers, however, may also have other goals with Jatropha (e.g. as fence for animals). Intercropping of Jatropha with other crops may as well limit yield of Jatropha itself but improves production of the field as a whole, because of more efficient use of all resources (Jatropha assessment, 2013).

Key conclusions and lessons learned

- The lessons learned on the NPSB projects are further substantiated by a Jatropha Assessment, carried out in Tanzania, Mali and Mozambique and supported by NL Agency.
- The program has gained experience on the risks and opportunities of investing widely in promising emerging crops as Jatropha. This demonstrated the importance to have appropriate risk management and a reality check (e.g. on economics) on project development and investments to avoid compromises on the longer term.
- Intercropping of Jatropha with food crops is possible (see also 3.3.3). The NPSB projects confirm that intercropping is more successful than the establishment of large-scale commercial plantations.
- The agronomic pilots carried out give strong reasons to believe that smallholder food production can benefit from intercropping with Jatropha, provided strict instructions are followed, and that food production can be improved.
- The (Jatropha Assessment, 2013) concluded that, mainly due to low yields and lack of sufficient agronomic expertise, large-scale Jatropha plantations in African countries are currently not economically viable. Until improved seed varieties and agricultural practices are available, it is recommended that smallholder farmers concentrate on small-scale applications from Jatropha (e.g. hedges) providing a complementary income source outside regular harvest seasons.
- To study best management practices and their effects on seed yield, experiments have to be carried out, where results can be verified objectively. For implementers of Jatropha or similar projects, the project (DBM0205) stresses the need to adapt generic crop data to local conditions.

1.3.5
Biomass from trees

Biomass from trees includes biomass that can be obtained directly from trees (or other wooded land), tree plantations, and trees outside forests. The use of forest processing residues is further discussed in chapter 1.3.5. Two NPSB projects focused on planting trees for bioenergy purposes: the project (DBM02031) in Indonesia and the project (DBM02045) in Mozambique.

- In Mozambique, at the closing of the project, 1,300 farmers had planted a total of 216 hectares of trees. The wood of the trees is destined for bioenergy, interplanted crops are used for food;
- In Indonesia, the project (DBM02031) has contributed to planting and sustaining candlenut and castor supply chains. The castor bean is a large, native tree. Its beans contain oil that can possibly be used for biofuel production (although not as such used in this project); the stems and leaves can be used for bioenergy applications. Candlenut is also a multipurpose tree (shells, kernel, timber), where the nuts can be consumed; its shells and kernel can be used for bioenergy.:

Lessons learned on agronomic practices and species selection

Feedstocks obtained from the agroforestry component in both projects are promising. However, maximum production needs time to mature. Trees in the project (DBM02045) took 3 to 5 years to grow to maturity, and can eventually amount to a maximum production of 800 to 1,000 tons a year – if a replanting program was being introduced. Expectedly, from the nurseries that were developed, and the candlenut trees planted in Lombok during the project period, around 8,500 tonnes of shells will become available in 5 years. This amount increases over time when the trees reach maturity.

Lessons learned on production models

Both NPSB projects applied (partly) the agroforestry model for planting trees. Biomass sources in the Indonesian project (DBM02031) come from existing candlenut growers in community agroforestry systems and from establishing new nurseries, and some bought from neighbouring islands. During the project, 20 community nurseries for biomass crops were established. The project in Mozambique (DBM02045) used the agroforestry model for planting trees.

The agroforestry program in Mozambique (DBM02045) helped farmers' transition away from less sustainable practices, as slash-and-burn with low productivity rates, to a more permanent and varied agricultural model. The socio-economic benefits for farmers of this varied production model are also highlighted in the project (DBM02031), see also part 3.

Key conclusions and lessons learned

- Agroforestry, as a more permanent and varied agricultural model, can well be integrated with agricultural food production. This provides the often necessary additional benefits to local communities and can as well benefit food production (see 3.3.3).
- The project (DBM02031) learned that, unlike many restoration trees, communities accepted candlenut, since they derived multiple benefits from the tree.
- The feedstock coming from the agroforestry component in both NPSB projects are promising but maximum production needs time as trees need to mature.

1.3.6 Residues and waste

Residues include primary residues (i.e. leftovers from cultivation and harvesting or logging), secondary residues (resulting from all further industrial processing and tertiary residues as used biomass (i.e. demolition wood etc.) or organic waste. Lessons are learned in the NPSB projects for all these three categories.

Primary, agricultural residues

Cotton stalks are available in large quantities in Africa and have no or few alternative uses. Cotton stalks are usually burned in the fields to avoid cotton pests. The annual availability of cotton stalks in Africa is calculated at approximately 10 million tonnes. The stalks can be used for alternative charcoal production (Charcoal, 2013). Cotton stalks seemed of interest for the project (DBM2045) in Mozambique but were not available in sufficient quantities, too much dispersed and only seasonally available. This created significant logistical constraints and exaggerated logistical costs.

The straw potential in Ukraine is very large. Some 10 million tons of dry matter is assumed to be available every year and few alternative uses are currently available. The project (DBI01010) worked on setting up a production chain for straw pellet production. The project concluded at the end that straw was a less attractive option for their business due to sustainability implications (see 3.1.4) and high potassium and chloride contents of straw pellets that would pose a problem for most boiler systems.

Secondary, processing agricultural residues

Processing residues and by-products (and waste streams) seem to be underutilized. The Indonesian project (DBM02053) used rice husk, a residue, for bioenergy generation in a gasifier. Rice husk from processing is abundantly available in Sulawesi and is not used for other applications; it is disposed of in the environment, where it slowly decomposed. The project has considerable potential for widespread replication, given the abundance of rice husk.

Trapiches ('presses') are production facilities for so-called 'panela'. Colombia is the second largest producer of panela, producing about 1.4 million tons per year with about 15.000 small-scale trapiches in the country. At the trapiches, the sugarcane is milled in a press, producing sugarcane juice. The project (DBM02050) improved the energy efficiency of the production process of existing sugarcane presses, this way generating surplus bagasse for energy production.

Box 4 and described project results learn that the more efficient use of processing residues, by-products (and waste) can offer opportunities for meeting the demand in bioenergy, improving sustainability (see part 3) and generating additional income (see 5.5.2).

Box 4
Valorization of palm oil (mill) residues
The report (NL Agency, 2013b) looked at how by-products of palm oil extraction (Empty Fruit Bunch (EFB), Mesocarp Fibre, Shells and Palm Oil Mill Effluent (POME)) are generated in the Palm oil Mill. Under current practice (based on an average productive palm oil plantation system) 2.5 tons dry weight per hectare per year of surplus mill residues are available. Most of this biomass consists of Empty Fruit Bunches (EFB) (1.88 tons dry weight) and shells (0.61 ton dry weight). If the energy efficiency of the mill is increased, and the mill switches to using energy generated from biogas generated by the POME and a fraction of the EFBs, the surplus mill residue available for other uses will increase to 4.23 ton per ha per year.

Forestry residues

Wood pellets are a main commodity for bioenergy production for heat and power. Its demand is strongly increasing and expected to do so in the coming years (see also introduction). They mainly originate from primary and processing forest residues. Canada (especially British Colombia) is a main provider of wood pellets, with 1.96 MT in 2012. The imports from US also increase steadily since 2008, stimulated by increasing investment of European utilities in North America (NL Agency, 2013a).

NPSB projects looked at potentials from primary and secondary residues. The pyrolysis project (DBI02002) identified a promising potential of non-used primary residues in a forest in Catalaya (Spain), as small stems and other residual streams, to use for conversion into pyrolysis oil.

Secondary forestry residues were looked at in the Vietnam project (DBI01002), where a potential of wood waste from the furniture sector was identified; possibly for export after pelletization. The amount of already FSC CoC certified wood waste in the Binh Duong province was estimated around 800.000 ton/ year, while large potentials of non-certified wood were available as well. A potential of wood residues from the many sawmills in the Ukraine was also identified in the project (DBI01013). At this moment, the mills throw away their waste (saw dust, branches and tops), because there is no market. The project (DBI01013) aimed to unlock this wood waste to produce pellets in a local built plant for the Netherlands, while organizing certification for sustainable production (see also part 4). Although potentials are available, the project did not manage set up a local pellet plant for building the value chain, largely because of financial reasons (see part 5).

Tertiary residues: waste

NPSB projects looked at different types of waste streams, as coffee wastewater, palm mill oil effluents (POME) and discarded wood pallets for transport. All identified waste streams originate from resources of widely used commodity streams and processes.

In practice, coffee wastewater is often dumped or insufficiently treated. By introducing techniques to reduce water consumption, the project (DBM02032) treated wastewater and turned the generated methane into energy instead of emissions. Activities were undertaken at 19 different sites (small, medium and large scale) in Nicaragua, Honduras and in Guatemala. The pilot Beneficio El Cascajal, treated 21,200m^3 of wastewater during the harvest 2012-2013, resulting into 950m^3 of biogas as estimated maximum daily production (equivalent to approximately 3300m^3 per month during the harvest).

Palm oil processing gives rise to highly polluting wastewater, known as POME. The projects (DBM01015) in Colombia and (DBM01014) in Indonesia both used POME successfully for bioenergy generation. In Colombia the focus was on the use of methane from POME to generate biogas. Up to March 2013, the lagoons have mitigated 4 MM m^3 biogas equivalent. The project in Indonesia demonstrated an innovative technology for conversion of biomass waste into biogas for power generation.

The Inbio project (DBI01006) estimated that about 189,000 tonnes (in 2012) and expectedly 210,000 tonnes per annum (period 2020-2030) of discarded transport pallets might become available in the Southeast of the USA. The collected pallets mainly consist of clean non-contaminated wood waste. The project realized a pilot with 6 MT test production of pellets from mixed resources, showing that quality requirements can be met – also when using post-consumer waste wood.

Key conclusions and lessons learned

- Potentials of straw and cotton residues, with no to few alternative uses, have been identified in large quantities in the Ukraine and in Mozambique. At the end, both options turned out not to be attractive enough for a business case due to various reasons. This shows the possible impact of exclusion criteria on this category of residue streams.
- Potentials of non-used primary and secondary forestry residues are identified in three projects; two of them made use of FSC certification for enhancing the sustainability of the resources. The valorisation of residual streams from forest and plantations might be an incentive for increasing forest management (DBI02006).
- The use of industrial processing residues (rice husk in Indonesia and bagasse in Colombia) has been successful in both projects and gives good perspective for widespread replication given the abundance of the residues and processing facilities in both countries.
- The NPSB projects also successfully identified and used successfully waste streams from resources of widely used commodity streams and processes (e.g. coffee wastewater, POME, discarded transport pallets) for bioenergy generation;
- More efficient use of processing residues, by-products and their waste streams offers opportunities for meeting the demand in bioenergy, improving sustainability and generating additional income. This potential may be rather large, but exploitation barriers exist, and therefore needs to be investigated in more detail.

1.3.7 Algae

Aquatic micro and macro-algae (seaweed) can be used for bioenergy production, as well as for other end-uses (e.g. health products). The use of micro-algae was tested on small scale in the (DBM02021) project in Indonesia as intermediate step for cleaning wastewater and generating biomass. The use of macro-algae was tested in the project (DBM02020) in Vietnam: a country with a total of over 300,000 hectares of brackish water areas. In this project, the algae serve as a source of food for the shrimp and clarify the water by taking up excess nutrients. The project (DBM02020) investigated which macro-algae can be best used for ethanol production in the Mekong Delta. Biological tests were performed in the field and in the lab to look at the most suitable algae species, highest biomass productivities, best ways for harvesting and the interaction of the algae cultivation with shrimp cultivation. Cultivation methods have been optimized.

Key conclusions and lessons learned

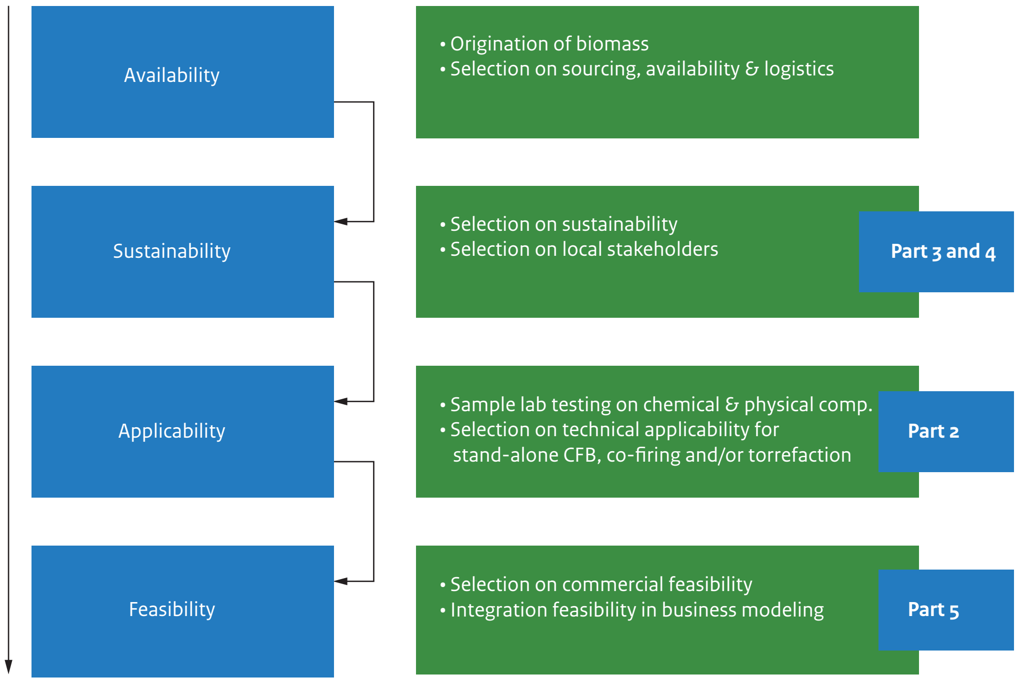
- Potential from algae resources is potentially large but still in its infancy; research is needed to look at the most suitable algae species and cultivation methods adapted to local conditions;
- Algae have been tested successfully for ethanol production but can also be used for other end-uses (see also part 4);
- The use of macro-algae is successfully combined with food production in Vietnam; environmental benefits are created from the cleaning of (waste-) water from excess of nutrients;

1.4
Opportunities and conditions for unlocking biomass resources

Selecting suitable region – resource combinations (availability) is one of the conditions for a project developer for unlocking biomass. Other criteria play a role as well as logistics or sustainability considerations (see also 1.3). Feedstock selection criteria are covered in the tool from (Charcoal, 2013) on Charcoal use from alternative feedstocks for local markets. Criteria include feedstock availability, sustainability, logistics, and production technology. Other criteria may start to play a role as well when shifting to international markets, as presence of a supply chain or a sales market.

During the sourcing of biomass in Mozambique in the project (DBM02045), various possible feedstock resources have been analyzed on their technical applicability, potential sustainable volume availability, on logistical constraints and to process the material. Furthermore an indicative economic assessment was made. This form of screening has also been done in the Ukraine project (DBI01010), where reed was selected as most promising source, mainly for economic reasons. This tunnel of narrowing down options based on exclusion criteria is shown in figure 4. As shown, some of these relevant exclusion criteria are discussed more extensively in other parts of this report.

Figure 4
Tunnel of exclusion criteria for narrowing done options for suitable feedstock



1.4.1
Experiences in the NPSB projects on feedstock exclusion criteria

Lessons are learned in the NPSB projects on the impacts of exclusion criteria on biomass availability. They are discussed below. The combined impacts of these exclusion criteria have their impact on the possibilities for a project to unlock biomass resources for bioenergy, as learned in the project (DBM02045) in Mozambique. When scouting for suitable biomass feedstock, it became for example apparent that building a large scale, viable biomass supply chain for export in the short-term period would become unrealistic; more time would be needed to do so. The project also learned that some of the exclusion criteria (see figure 4), to identify a suitable feedstock could be conflicting. A sustainable resource would not be applicable or sufficiently available etc.

Exclusion criteria on availability

Beside the identification of suitable region – resource combinations, exclusion criteria include as well:

- **Meeting volume requirements required for a project plan**

The projects (DBM01031) and (DBM0205) mention the challenges to create sufficient volumes to pay-off the investment and demand required for a good business case (see also part 5). This is especially an issue for small-scale plantations, trials or pilots.

- **Timings of supply: seasonability**

In the project (DBM02032), coffee wastewater is only produced during the harvest season in Nicaragua, Guatemala and Honduras. Therefore, the medium and large scale the biogas installation only operated during the harvest season. The small-scale ones operated all year around by combining coffee wastewater during harvest season with manure (if there was presence). Timing of supply and transportation was also an issue for the project (DBM02031) in Indonesia. The project managed to commit 2,985 farmers and 223 tobacco farmers. Three supply contracts for sustainable biomass fuels from multiple resources (candlenut and palm kernel shells) resulted in contracts of 13,400 tons overall from 2011-2013.

- **Timing of supply: availability from start of project**

Sufficient availability of feedstocks once processing operations starts is key for a business case: there should be a readily amount of biomass available (DBM02045). Perennial crops or trees (bamboo, agroforestry) need time to mature and cannot be harvested from the first year onwards. They may deliver feedstock on the medium and longer term.

- **Level of scatterings or centralization of resources**

Residues and waste are often dispersed in location and collection is labour intensive. This is both an opportunity (to generate employment) and a challenge (to organize this effectively). The scatteredness of resources in Vietnam was identified as a barrier for biomass collection and transport in (NL Agency, 2012), although in large quantities available. For export of biomass from Vietnam to the Netherlands, only export of large amounts would be economically interesting; the scatterings of residues makes contracting these large amounts difficult

Resources from energy crops or large plantations are more centralized but have their own implications as well. Apart from possible sustainability impacts (see part 3), the setting up of a large plantation is more complex and requires more investments in plantations and in logistic throughout the supply chain. The project (DBM02045) concludes that Mozambique currently has no competitive business environment to offer for large-scale plantations for products, which are high in volume and low in added value.

- **Distribution and logistics**

Generally speaking, the biomass type with the shortest supply chain will have a logistic advantage over other types of biomass feedstocks as each step in the supply chain represents efforts, money and possible complications (see also 5.3.1 for more details). Logistic indicators for biomass are e.g. the length of supply chain, bulk density and moisture content (Charcoal, 2013) According to the Sweet sorghum project (DBM01004), the distance from the feedstock production area to the bioethanol factory should be at maximum of 15 km radius to minimize transport cost.

Exclusion criteria: Sustainability

Biomass categories each have some specific sustainability risks. As example: the use of energy crops and harvest residues could potentially lead to additional extraction of nutrients and carbon from the soil. Processing residues are already extracted from the soil and usually do not lead to additional extraction of nutrients (Charcoal, 2013). Meeting certain sustainability aspects (e.g. tenure), or the risk for undesired impacts, can limit the availability of biomass on local scale. The impact of sustainability on biomass availability is extensively discussed in parts 3 and 4.

Exclusion criteria: applicability for conversion
The applicability of feedstocks for conversion is more extensively discussed in part 2 of this report. Relevant indicators to select a suitable feedstock for applicability in conversion are for example: biomass forms and characteristics such as composition, moisture content, morphology, and bulk density (Charcoal, 2013). It is also of importance to understand the state of technology in the area.

Exclusion criteria: Feasibility
Relevant indicators for the feasibility of biomass feedstock are the required investment costs, production costs and the competitive sales price. Economic feasibility, affordable biomass and bringing the biomass on the market, is crucial for successful deployment of biomass projects. These aspects are further discussed in chapter 5.

Key conclusions and lessons learned
- Exclusion criteria on availability, sustainability, applicability and economic feasibility may further narrow down the options for availabilities of biomass in a region.
- As biomass resources are highly diverse in their characteristics, the possible impacts of the exclusion criteria on biomass resources are diverse as well.
- This together requires from a project developer a clear understanding of the “wish list” for the biomass resources before the start of its project. Sourcing biomass that meets the requirements of this wish list against affordable costs and an acceptable economic price is crucial for the successful deployment of biomass projects.
- Some exclusion criteria for identifying a suitable feedstock can be conflicting, which requires choices on priorities of the “wish list”.
- The deployment and use of alternative feedstocks requires an effort, and may be considered as a risk, even when proven to be applicable;

1.5
Impact of exclusion criteria and opportunities to overcome some of the bottlenecks: upscaling supply
Although the exclusion criteria (see figure 4) have their impact on the potential for unlocking biomass resources, solutions and models are mentioned in various of the NPSB projects on how to overcome these bottlenecks, and to create a reliable volume of biomass in a region for further use, see table 4.

Table 4
Solutions for creating more biomass volume in the region – upscaling supply

Solution	NPSB Project examples:
Optimize availability of resources in time taking into account harvest periods over the year and growth periods by combining multiple flows and suppliers **Contributes to:** • Timing and guarantee of supply; • Volume increase	• The Ukraine project (DBI01010) aimed to combine straw in summer and fall, reed in winter and switchgrass in winter and spring. • The Inbio project (DBI01006) combined three types of raw materials for pellet production: wood from the forest, wood residues from the forest industries and post-consumer waste.
Merging short-term biomass with available feedstock on the longer term **Contributes to:** • Availability biomass from start of project; • Volume increase	• The nucleus-outgrower model (DBM02045) offers opportunity to merge short-term available biomass resources with feedstock that comes available on the mid to long term. In this case: agricultural residues and SRC in Mozambique; • The Ukraine project (DBI01010) would first start with using straw and then switch to also using reed, and later to switchgrass, as these options would become available
Full integration of biomass flows and concepts **Contributes to:** • Volume increase for multiple end-uses; • Optimizing distribution and logistics	• Village Hubs are like mini factories producing sugar and bioenergy production in an efficient and environmentally friendly way. The village hub combines multiple concepts in one integrated model: algae production, bioethanol and biogas production (DBM02036); • The technical feasibility has been successful. Implementation is challenging; it is also important to look at the technical suitability of the location, and the social acceptance.
Efficient design of the supply chain **Contributes to** • Centralizing resource streams	• A system needs to be developed where residues can be efficiently picked up and dropped off at a central power station or processing location (NL Agency, 2012)
Identify resource within limited radius of processing unit **Contributes to** • Optimizing distribution and logistics	• Optimal scenario would be in the (DBM02045) project to have biomass processing close to an existing sizeable resource of biomass.

Key conclusions and lessons learned
Solutions for enlarging biomass availability and to overcome bottlenecks of exclusion criteria are identified in the NPSB projects and include solutions to:
- Optimize availability of resources in time taking into account harvest periods over the year and growth periods by combining multiple flows and suppliers;
- Merge short-term biomass with available feedstock on the longer term;
- Fully integrate of biomass flows and concepts;
- Efficiently design the supply chain;
- Identify resources within limited radius of processing unit.

1.6
Recommendations and lessons learned in creating biomass for import and local use

Biomass plays an increasingly important role in society. There is a growing demand for biomass production for local markets and export markets, and both from biomass importing and producing and countries. This highlights the importance of creating affordable sustainable biomass resources in good functioning markets over time.

Current main biomass supplier countries are those countries that have access to large land areas, as Brazil or the USA. Resource assessments indicate untapped biomass potentials in countries as Indonesia, Vietnam (mainly residues and waste) and in the Ukraine and in Mozambique, the latter due to their large land availabilities. Future potential indications are promising, on the condition that productivity increases are indeed realized to bridge yield gaps, especially in developing countries. This is challenging and requires large investments in infrastructure and supply chain development.

The European regional assessment learns that all individual European countries have untapped resources available – some more than others. Countries with small amounts of available biomass have the option to explore untapped resources in their country and/or import biomass from those countries where sufficient sustainable biomass is available to meet domestic targets. Introduced policies and upcoming markets in biomass producing countries may mean that not sufficient biomass is available in the future for countries that rely largely on import of biomass. Attention is therefore needed for biomass importing countries to deploy its domestic biomass resources.

Potential resource estimates are often based on theoretical and technical potentials. They provide a useful tool to screen and identify new biomass opportunities in a country, which are so far unexplored. Theoretical resource assessments do generally not consider discounting factors as applicability, sustainability, land rights, etc. Consequently, there is a quantity and quality (including sustainability) gap between what biomass is potentially available and what biomass meets requirements of the project developer or the policy framework in a country, to be eligible for meeting the targets.

Biomass resources are highly diverse. Consequently, they also differ in their possible impacts and possibilities for further deployment. Exclusion criteria relate to availability (guarantee of supply, logistics, scatteredness), sustainability, applicability and feasibility (costs, investment level). Some of these exclusion criteria for identifying a suitable feedstock can be conflicting, which requires choices on the requirements of biomass that should at least be met.

Commodity based biomass resources are already developed and traded internationally in large volumes. The NPSB projects on palm, sugarcane and soy show that unlocking these resources, possibly for import to the Netherlands, can start potentially within a short time frame as production is available and infrastructure is well developed. Main focus for these crops should be on promoting sustainable production models, especially in expansion areas.

There is an under-utilization of by-products, residues and waste streams, especially in developing countries. More efficient use of these biomass sources seems to offer opportunities for meeting the demand in bioenergy, improving sustainability and generating additional income. Experiences in the NPSB projects (e.g. on rice husk, bagasse) have been promising and provide good perspective for widespread replication. The NPSB projects also successfully identified and used waste streams of widely used commodity streams (e.g. coffee wastewater, POME) and their processes for bioenergy generation. The use of primary residues seems to be more difficult, and exclusion criteria seem to be more limiting for deployment.

Alternative resources for bioenergy production (as algae, reed, bamboo) are also available. The NPSB projects learn that they can be successfully exploited. Several of these biomass resources also provide additional environmental and socio-economic benefits when appropriate methods are used. Developing the potential of these resources is, however, challenging and requires additional effort and time. The program has gained experience on the risks and opportunities of investing widely in promising emerging crops as Jatropha. This demonstrated the importance to have appropriate risk management and a reality check (e.g. on economics) on project development and investments to avoid compromises on the longer term.

It is worthwhile, to explore alternative biomass resources to meet future biomass demand while improving sustainability. Efforts to develop potentials of biomass resources should be embedded in a regional development and also require interventions in land use and in the agriculture and forestry sector, especially when biomass will be produced on larger scale to meet demand.

Specific recommendations and conclusions are given throughout this chapter. Below, overall lessons learned and recommendations are summarized for the different stakeholder groups:

Project developers

- Opportunities for unlocking biomass can be found in many regions in the world. Current biomass producing countries are those countries that have access to large land availabilities. However, also other countries have (potential) untapped biomass resources;
- Resource assessments can be used as a first screening tool for identifying suitable areas and to get insight into new, underexploited opportunities. In a next stage, it is key to determine the "wish list" on sustainability requirements and other feedstock selection criteria, and to define the impact of" these exclusion criteria to understand how much biomass is realistically available.
- Solutions are given by projects to enlarge biomass availability in an area. Optimization models can be used to overcome some of the feedstock exclusion criteria and to enlarge volume.
- There is a difference between investing in already matured biomass resources (e.g. commodity crops) or in new, alternative crops. Developing the full potential of alternative biomass resources is challenging and requires additional effort and time to optimize varieties, and to understand technical implications. This could also include possible investments in infrastructure and logistics, when not yet developed.

Governments

- Demand needs, technological developments and available resources change over time, depending on multiple factors. With this given, it is recommended to keep some flexibility in defining bioenergy targets (volume, time) in policies to be able to adjust to reality.
- Time and efforts are needed to exploit new biomass – country – technology combinations, while potentials from established feedstocks can be unlocked in short time.
- To fully utilize the potential of available biomass resources worldwide, substantial efforts and investments are required, which should be embedded in a regional development with interventions in land use, in agriculture and in forestry.
- Realizing efficiency and productivity improvements is one solution to enlarge the availability of biomass worldwide. This requires knowledge transfer and experience from more advanced production regions to other regions. Committed governmental organizations can help to drive this transition of change in innovation by stimulating certain agricultural management practices.
- Most of the agricultural crops have different parts that can all be used for available alternative market outlets. Bioenergy is one of them. The option to access multiple market outlets provides producing countries a range of options to enlarge the revenue streams for their farmers. This opportunity requires, however, a shift in thinking towards identifying optimal integrated, combined production systems that contribute mostly to rural development.

NGOs

- NGOs can play an important role in monitoring the dynamics in demand and availability of biomass, and possible impacts, especially in developing countries where biomass is still used in large amounts for traditional heating and cooking. Support can be provided to make the transition towards modern use of biomass for energy uses.
- Given the connections with local communities, NGOs can contribute to providing a better understanding on the impact of some exclusion criteria (e.g. sustainability, land rights) on realistic biomass availabilities on the ground.
- Support can be provided the development of resource management schemes and harvesting guidelines for biomass resources that are community based biomass resources (e.g. reed, agroforestry, bamboo): this to prevent overharvesting or resource-induced community conflicts.

Knowledge institutes

- Research is needed to optimize yields, applicability, cultivation methods and varieties for bioenergy production from promising feedstock varieties. Insight is needed to understand how this can be achieved through climate smart agriculture (low inputs, sustainable production models).
- A similar effort is needed when introducing established crops in relatively new production areas to diversify varieties to local context. To study best management practices and their effects on seed yield, experiments have to be carried out, where results can be verified objectively;
- More insight is needed in the upscaling of biomass, and on how large amounts of sustainable and affordable biomass can be realized to meet future demand.
- This requires efforts to perform detailed mapping and zoning initiatives in countries to identify available land resources as well as suitable feedstock varieties for bioenergy development.
- When doing so, further insight is needed in merging the gap between “on the ground” availabilities of biomass and resource estimates, by integrating the realities for biomass exploitation in potential studies.

Part 2

Technologies, applicability of feedstock and innovations in conversion

Part 2
Technologies, applicability of feedstock and innovations in conversion

One of the objectives of the NPSB programme was to stimulate biomass production in developing countries, and to promote its sustainable production. This objective has resulted into the ambition of various NPSB projects to introduce biomass production and conversion in new countries and/or to develop innovative, and more sustainable, technologies.

Conversion, and its technologies, has not been included in all NPSB projects. When included, it has been addressed in various ways:

- As part of supply chain development: in some cases already established in a country for a feedstock (e.g. biodiesel production in Argentina, DBI02009), in some cases exploring the use of alternative feedstock for conversion (e.g. castor beans for bioenergy, DBM02031) or exploring the deployment of an existing technology in a new country (e.g. biogas in South Africa, DBM01012);
- As focus point for technology development and innovation. The majority of these projects focused on improving efficiency of existing conversion technologies (e.g. by better using waste streams);
- Or a combination of both.

Different categories of conversion technologies have been used, or (further) developed, in the NPSB projects. The majority focused on biogas and power generation, followed by conversion technologies for liquid biofuels – as also pyrolysis oil. Impacts of the technology choice, and its level of maturity, on the feasibility of a business case are further discussed in part 5.

2.1 Applicability of technologies for alternative feedstocks

Part 1 of the report identified various promising alternative feedstocks for bioenergy. A requirement for bioenergy use, and a possible exclusion criterion (see 1.4), is that feedstock meets the quality requirements to be successfully used as input for conversion.

2.1.1 Alternative feedstock use for bioenergy for heat and electricity

Several of the NPSB projects looked at the possible use of alternative feedstocks (reed, switchgrass, bamboo) for thermal conversion.

The use of bamboo pellets for thermal conversion has been tested in Colombia (DBI02006). While the use of bamboo replacing coal and charcoal for (domestic) heating is common practice in some producing countries, its use for power generation is still limited or non-existent (DBI02006). Tests show that the bamboo species Guadua is a good candidate for fossil fuel (coal) replacement in power plants (DBI02006), especially after pre-treatment of torrefaction (see below).

Ten tonnes of reed pellets were exported in the (DBI01010) project from the Ukraine to the Netherlands for testing in a municipal biomass heating installation. The project shows that acceptable biomass quality of reed pellets for thermal conversion can be achieved. Results also learn that switchgrass is an option for large-scale biomass production for thermal conversion in the Ukraine. In both cases, continued testing is recommended to further optimise production practice, reduce cost and improving the right quality for thermal conversion (DBI01010).

Torrefaction

Torrefaction is a process, which optimizes the raw material for energy production, while reducing the volume and therefore creating advantages in logistics. Two projects looked at the use of torrefaction (DBM02045, DBI02006), possibly also for export to the Netherlands. In both projects, bamboo was used as untreated raw material. The Colombia project (DBI02006) learns that torrefaction enhanced the fuel quality of the bamboo pellets. Torrefaction of bamboo was also considered successfully in the Mozambique project (DBM02045), where 20 ton of native bamboo from the Beira corridor has been brought to Namibia for further processing and torrefaction into pellets and briquettes.

Further adaption of conversion facilities may be needed to open a market and make a larger feedstock potential applicable. At this moment there is only a limited market for “herbaceous” pellets as reed or switchgrass pellets.

Key conclusions and lessons learned

- Alternative feedstocks for bioenergy use have been successfully tested in the NPSB projects.
- Torrefaction of bamboo is successful.
- Bamboo pellets, especially after torrefaction, switchgrass and reed pellets can be good candidates for thermal conversion and/or fossil fuel replacement in power plants, although they have to face competition with high standardized wood pellet requirements and its relatively low cost levels, which cannot (yet) be met.
- Further adaption of conversion facilities to herbaceous biomass, and development of herbaceous pellet quality standards, is needed to enlarge the market and fully exploit the potential of this category of biomass resources.

2.1.2
Alternative feedstock use for biofuels production

Several of the NPSB projects looked as well at the possible use of alternative feedstocks for biofuels production. This includes the use of algae (discussed in 2.3), sweet sorghum and casssava for bioethanol, and the use of Jatropha for biodiesel or alternative end-uses.

Both sweet sorghum and cassava can be used for the food, fuel and feed market, and can as such be used for bioethanol, or processed into animal feed or as flour. The project (DBM02024) is pioneering a hybrid processing model that will allow producing flour and other cassava products alongside alcohol production for ethanol.

Both projects (DBM01004) and (DBM02024) successfully tested the sweet sorghum and cassava varieties for bioethanol use. Within the project (DBM01004), the total potential available bioethanol recoverable 90% alcohol per tonnes stalk is estimated on 70 litres, when a project area of 3,500 ha is targeted. The grains can be used for alternative end-uses. Ethanol was also successfully produced in a demo ethanol plant from cassava (DBM02024), with further upscaling ongoing.

Two projects further explored the end-use of Jatropha for multiple end-uses. The different components of the Jatropha fruit – oil, seedcake, shells and husks - can be used in different ways, for energy or non-energy purposes:

- The Jatropha oil can be used for various energy based applications
- The seedcake and shells-husks can be used for various energy-based applications or for non-energy based applications as soap, medicinal use or fertilizer.

The Jatropha Mexico (DBM0205) project carried out experiments in laboratories to identify suitable technologies and end-uses. Diligent (DBM01018) has tested the use of Jatropha press cake for briquettes (green charcoal), for biogas production and for animal feed. A developed economic calculation model (see part 5) helps to decide in early stage whether or not the use of Jatropha in an intercropping model (see part 1) and for which end-use.

Analysis learned that the Jatropha seedcake could best be used for animal feed, which is possible from a technological point of view. The bottleneck is the detoxification of the press cake. The project (DBM02025) further developed a process for phorbol ester extraction, removing the main toxic component, lowering the phorbolester concentrations in press cake to below 15 ppm. Further protein extraction can possibly yield a protein rich feed. A pilot plant design has been developed.

Key conclusions and lessons learned

- Sweet sorghum and cassava (and algae, see 2.2) are successfully tested for bioethanol use. Both crops can be used for the food, feed and fuel sector.
- While Jatropha can be used for biodiesel production, the press cake, as co-product, is successfully tested for animal feed production.
- Benefits from sweet sorghum, cassava and Jatropha are optimized when used for multiple end-uses (see also part 5), and intercropped with other food crops (see part 1).

2.2
Further developing innovative technologies

A number of NPSB projects have implemented technical equipment (hardware) for valorisation of biomass residues, thereby contributing to the increased use of biomass residues (see also 1.3.6). Examples of these are the project (DBM02021) in Indonesia and the pyrolysis project (DBI02002) in Spain (see box 5). The general focus in these projects was on proving technical feasibility of innovative technological solutions for residue and waste valorisation, or on enhancing availability in unexplored countries (see 2.3). Economic and sustainability benefits are further discussed in parts 3 and 5 of this report.

Box 5
Examples from technology development for valorisation waste and residue streams
The project (DBM02021) researched on how palm wastewater (POME) can be converted into aquatic biomass (algae): results learn how much biogas can be produced from POME wastewater, combined with the use of algae for cleaning the waste. The algae clean the wastewater by taking the nutrients. The algae can be used for feeding supplements.
The project (DBI02002) carried out preliminary tests on pyrolysis oil filtering showing that the content of solids can be reduced to less than 0.02 wt%. For energy optimization, first applications for the existing excess heat have been identified and assessed. The project concludes that biomass ash recycling is not feasible on short term in Spain or in the Netherlands. The biomass ash could be used in road construction though.

The algae project (DBM02020) in Vietnam has successfully produced at pilot scale 95% dry ethanol (scaled to a 200 litre fermenter). The project produced the first available metrics on seaweed to ethanol yields. The development of the co-products protein and bacterial soil inoculants has also been successfully demonstrated.

Key conclusions and lessons learned

- Valorisation of waste (POME) for bioenergy, and of residue streams to pyrolysis oil has been successfully tested in NPSB projects.
- Bioethanol production from algae has been successfully tested, including the development of protein and bacterial soil inoculants.

2.3 Introducing established technologies in new countries

Several projects installed or introduced successfully conversion technologies in countries where that specific process was not yet available or commercialized. Most of these projects worked with waste streams (see part 1.3.6 for complete overview), also to enhance sustainability (see part 3), and produced bioenergy as end-use. Some examples are given in the table 5.

The report (Charcoal, 2013) discusses in more detail the technology choice when operating in countries with no long-term experience on technologies, This is the case with carbonisation and briquetting technologies of feedstocks such as cotton stalks, processing residues and bamboo at commercial scale in Africa for charcoal production. The report concludes that the highest and most consistent efficiencies for charcoal production can be achieved with (semi-) industrial retorts. These are, however, expensive and often not affordable in the African context. Briquetting technologies have wider capacity ranges and varying degrees of mechanization and automation, and are therefore considered to be more of use.

Table 5
Project examples working that introduced conversion technologies in unexplored countries

Project	Operating country	Modification	End-use
Project (DBM02050)	Colombia	The trapiche underwent several technical, infrastructure and operational modifications. Efficiency improvements resulted also into higher yields of juice / unit sugarcane processed	Bagasse for own power production, surplus bagasse for alternative fuel uses.
Zebra project (DBM0104)	Innovative for Indonesia	Developed expertise and appropriate technology for capturing methane from palm oil production. The plant has become operational in March 2013.	Up to 70% of diesel consumption can be replaced by biogas
Project (DBM02021),	Indonesia	Research on how palm wastewater (POME) can be converted into aquatic biomass (algae). Research learns how much biogas can be produced from POME wastewater, combined with the use of algae for cleaning the waste. The algae can be used for feeding supplements	Biogas
Project (DBM02053)	Indonesia	First rice husk gasification plants at rice processing sites	Biogas
Project (DBM01012)	South Africa	Development biogas plant from manure: especially experiences in social innovation	Biogas
Project (DBM02045)	Mozambique	Specific biomass (bamboo) under African conditions, to prove applicability in the local context	Torrefaction

The technology choice therefore depends not only on the highest effectiveness, but also on the feasibility for realizing it in a local context. The implication on the feasibility of a business case when introducing technologies in a new country is further discussed in part 5.

Key conclusions and lessons learned

- Project developers can contribute to the introduction and embeddedness and of unexplored technologies in countries, and the capacity building needed for this.
- Bioenergy technologies, both matured and innovative, have been successfully introduced in new countries by several NPSB projects. The majority of these NPSB projects contributed to bioenergy for heat and power.
- Most of these projects looked at the technical feasibility of (innovative) solutions for residues and waste valorisation in (unexplored) countries. Conversion of residue and waste streams shows that technology, as the use of waste management technologies, creates direct economic and sustainability benefits.
- The introduction of new technologies in developing countries requires a robust business case. Complex technical solutions may turn out hard (and too costly) to implement in rural areas, alongside the possible risk of introducing ways of working that will not be adopted by (nor make sense to) the local workforce (DBM02050).
- Technologies (in terms of investment needs, capacity, knowledge) need to be adapted to the country's framework conditions.

2.4
Recommendations and lessons learned in innovative conversion technologies

Several of the NPSB projects demonstrated that increased efficient utilisation of biomass is possible. Alternative feedstocks for bioenergy use have been successfully tested in the NPSB projects, demonstrating the applicability of using still largely untapped land-based feedstocks (reed, switchgrass, bamboo) for bioenergy production. Results learn that benefits from sweet sorghum, cassava and Jatropha for biofuels production are optimized when used for multiple end-uses, and intercropped with other food crops.

The technical feasibility of (innovative) technological solutions for residues and waste valorisation in (unexplored) countries has been demonstrated, showing the potential to further explore these biomass resources (see part 1). Conversion of residue and waste streams shows that technology, as the use of waste management technologies, creates direct benefits, as efficiency improvements or sustainability benefits (further discussed in part 3).

Project developers can contribute to the introduction and embeddedness and of unexplored technologies in countries, and the capacity building needed for this. This requires, however, a robust business case.

Specific recommendations and conclusions are given throughout this chapter. Below, overall lessons learned and recommendations are summarized for different stakeholder groups:

Project developers

- The market can play a front-running role in enhancing a technology transition in a country by demonstrating best practices.
- Improvements in processing facilities may enhance efficiencies for the market, not only to generate bioenergy but also to enhance product efficiency. This may provide cost benefits.
- Adaption of conversion facilities and the development of quality standards for alternative feedstocks are needed to open new markets for yet unexplored, untapped feedstock resources.

- When deploying (yet unexplored) technologies in a (new) country, long-term commitment of time and resources by the project developer is crucial for success (DBI02002). This requires a robust business case and careful risk management, see also part 5.

Government

- Closing cycles, biocascading, and highly efficient utilisation of biomass is key to for the development of a biobased economy and a transition towards a more sustainable economy.
- For further developing technologies, support for upscaling and building solid, innovative business cases are important next steps, while the local context and possibilities should be taken into consideration.
- In developing countries, the focus should more lie on the transition from traditional use towards modern biomass use; this may mean that other technology choices may be more suitable – especially in some rural areas – although they may not be the most effective ones.

NGOs

- NGOs can contribute to the transition from traditional use of biomass towards more efficient and sustainable technologies in developing countries. This can be supported through providing projects a better understanding on local capacities and demand, to better align introduced technologies to local needs. Cooperation with the market on these aspects has added value.
- Support is needed for social embeddedness, local user acceptance and capacity building of yet unexplored technologies and markets.

Knowledge institutions

- The NPSB projects learn that ongoing research and knowledge transfer is still needed, and worthwhile, to improve the feedstock applicability and efficiency of bioenergy conversion technologies.
- Attention should be given to the creation of multiple product outlets (in the line of biorefineries), while as well transferring knowledge on existing technologies to yet unexplored regions.

Part 3

Enhancing the sustainable production of biomass for energy purposes

Part 3
Enhancing the sustainable production of biomass for energy purposes

Increased use of biomass for energy production (see part 1) has led to growing concerns over possible negative environmental and socio-economic impacts of biomass chains. In the past decade, a variety of potential negative impacts of biomass chains have been highlighted, including losses of biodiversity, land right conflicts, or others (RVO, 2014a). Potential positive impacts have been highlighted as well, and have often been the objective for developing bioenergy policies. Examples are rural development, income generation, contributing to mitigating climate change or decreasing import dependency of fossil fuels. In response to the growing concerns over biomass sustainability, there have been a variety of initiatives to demonstrate that biomass production and use is sustainable. In other words: negative impacts are avoided and positive impacts are enhanced.

The Cramer Commission, installed in 2006 by the Dutch government, was one of the first multi-stakeholder initiatives to systematically define sustainability risks associated with production of biomass for bioenergy and to define criteria to mitigate these risks. Its report, 'the Dutch Testing Framework for Sustainable Biomass' (2008), often referred to as 'Cramer Criteria' (see box 6) has provided a basis for further policy development and other work in this area (RVO, 2014a).

Box 6
Cramer Principles in Testing Framework: guidelines for sustainability.
- Greenhouse Gas (GHG) emissions reductions;
- Competition with food and other local applications;
- Biodiversity
- Environment;
- Prosperity (contribution towards the local economy)
- Social Well-being: social living conditions of the local population and employees.

Examples of measures for sustainable production are for example the use of degraded lands, the participation of smallholders or best agricultural practices.

Key objectives of the NPSB projects were to focus on gaining experience of sustainable biomass production in developing countries, and on stimulating import of sustainable biomass for energy production in the Netherlands. This was further translated into the following objectives:
- Rendering the biomass chain sustainable, contributing to meeting the Cramer Criteria and the Millennium Development Goals (poverty reduction, sustainable development and sustainable use of natural resources);
- Counteracting undesired indirect effects of biomass production.

Projects were encouraged to carry out sustainability assessments, but were not obliged to use the same systematic approach in doing this. The intention of the program was to learn from practical experiences in improving the sustainability of biomass chains, not to evaluate the level of sustainability of each project. The large variation in projects provides a great added value on lessons learned on sustainability impacts.

The NPSB projects varied widely in their activities related to 'sustainable biomass production and use'. The project portfolio contained projects of different scale (e.g. business models for smallholders or large-scale import chains), different approaches (e.g. focusing on one aspect only, or on a wider range of issues) and different focus points. This variety in approaches and activities has generated a rich pallet of lessons learned, which will be discussed following the framework of sustainability as defined in the NPSB programme (see table 6), and based on the conclusions drawn in the report "Implementing sustainable biomass projects Lessons learned in the NPSB project portfolio 2009 – 2013 (RVO, 2014a).

It is important to realize that generally, all NPSB projects contributed to sustainability given the scope of the program. Some worked on gaining experience in certification, others focused on the valorisation of residues and waste streams, others through the use of degraded land, or by working with smallholders. The description of the impacts present the key findings based on specific project examples, while it should not be overlooked that other projects worked just as well on these aspects.

Table 6
Framework of sustainability and structure in this part of report on where discussed

		Topics discussed
3.1	Sustainable development of natural resources	• GHG emission reductions • Carbon stock changes • Biodiversity • Environment (soil, air and water)
3.2	Poverty reduction - Social well-being: social living conditions of the population	• Health and safety impacts, gender • (Improved market access and capacity building) • Land rights
3.3	Poverty reduction: Contribution towards local economy	• Energy security • Employment and income generation • Food security • Other benefits for rural development
3.4	Sustainable use of natural resources	• Competition with food and other local applications • Indirect Land Use Change

Key conclusions and lessons learned
- There are socio-economic and environmental risks associated to biomass production, which need to be avoided. This is further discussed in part 4.
- All NPSB projects contributed in some way to sustainability. The description of the impacts in this part of the report present the key findings based on specific examples, while it should not be overlooked that other projects worked just as well on these aspects.

3.1
Sustainable development of natural resources

In addition to preventing negative impacts, notable positive impacts on the sustainable development of natural resources have been reported by the NPSB projects. These were mainly in the areas of GHG emission reductions, carbon stock changes, biodiversity, soil, air and water.

3.1.1
GHG emission reductions

Given that most NPSB projects started in a pilot phase, realized (possible) GHG reductions have been largely based on ex-ante assessments. Throughout the portfolio, a number of projects presented high GHG reduction savings (see table 7), and possibilities to do so.

Table 7
Presented GHG calculation reductions for a selection of the NPSB projects

Project	Calculated GHG reduction %[1]	Remarks
Pellets for Power project (DBM01010), Ukraine	85 to 89% over entire chain	Fast growing grasses, coal as GHG reference
Candlenut (DBM01021), Indonesia	> 70%	Use of candlenut shells to replace coal in the production of heat
Project (DBM02053), Indonesia	Around 72%	Rice husks
Wood pellets Vietnam (DBI01002)	94%	Wood pellets from Vietnam in Dutch power plant; coal as reference
Jatropha to (Tanzania project)	55 – 65%	Used for biokerosene
Project Brazil (DBI02011)	< 24 g CO2eq/MJ fuel	Sugarcane for bioethanol
Project (DBM01012), South Africa	17,396 tonnes/a	Biogas from animal manure
Jatropha Mexico (DBM02050)	69%	Jatropha for biodiesel
Zebra project (DBM01014), Indonesia	80%	During CPO extraction through methane capture of POME (ex-ante assessment)

[1] Calculations have not been verified.

Generally, high GHG savings could be achieved through:

- Using biomass feedstocks with low GHG emissions, as residues, waste or fast growing grasses, while using marginal lands, as presented in table 7;
- Further efficiency improvements in agricultural management practices, as indicated in the Argentinean project (DBI02009). This results into possible GHG reductions in the soy value chain, also lower than the defined default value by the European Commission (see 4.2.1);
- Efficiency improvement in logistics and technologies on the conversion site, as demonstrated in table 7 by project (DBM01014). The project (DBI02002) learns that GHG reductions of pyrolysis plants can be increased by optimal utilisation of excess heat and by careful selection of logistics.
- A combination of the approaches described above. For example, the coffee wastewater project (DBM02032) combined the use of waste with a technology to capture the methane gas emissions contributing to mitigating climate change.

Key conclusions and lessons learned

- Using biomass feedstocks with low GHG emissions, and further efficiency improvements in management and processing, results into optimal reduction of GHG emissions in the value chain.

3.1.2 Carbon stock changes

Looking at the possible impacts of projects on the carbon stock change was considered as relevant for a variety of NPSB projects, focusing on (RVO, 2014a):

- Net carbon stock changes, as mentioned by projects working with:
  - New land for biomass growing: In the case of the bamboo project in Colombia (DBI02006), this leads first to a reduction of original carbon stock, followed by a potential increase of carbon stock after planting;
  - Changed practices on existing farm land, leading to a net carbon stock change, as is the case for the project (DBI02007) where existing hedges are replaced by Jatropha hedges;
- Reduced carbon stock changes, as mentioned by three type of projects:
  - Projects focusing on yield increases, thereby (at least theoretically) reducing the need to develop new land, thus (indirectly) reducing carbon stock change (DBM02047);
  - Projects that focused on reducing erosion and desertification, thus indirectly contributing to reduced carbon stock losses (Mali project, DBM01002);
  - Projects focusing on replacing firewood by alternative biomass resources, indirectly contributing to reduced carbon stock losses, as is the case in the projects (DBM02032) in Colombia and (DBM02045) in Mozambique.

Key conclusions and lessons learned

- Positive carbon stock changes can be created by biomass production on land e.g. through rehabilitation of degraded lands.
- Carbon stock changes have a relation with soil quality, GHG reduction emissions and biodiversity.

3.1.3 Biodiversity

The risk for biodiversity impacts is largely linked with production of land-based biomass resources (crops). The majority of the NPSB projects worked with waste and residual resource streams, where risks for biodiversity impacts play much less of a role, and were therefore also not addressed as such.

One of the potential negative impacts of land-based bioenergy production is the conversion of biodiversity rich lands due to its expansion. Also, a decrease (or increase) of the biodiversity is possible on existing lands that are used for bioenergy production. The report (NL Agency, 2013d) highlights for example the biodiversity risk (amongst others) for the wood biomass sector in the Ukraine when no precautionary measures are taken. It is generally agreed that this should be avoided (see RVO, 2014a).

Two types of NPSB projects highlighted positive impacts from biomass production on biodiversity:

- Projects that improve biodiversity on-site through the selection of suitable biomass resources, management practices, or a combination of them.
  - An example is the project (DBM01010) in the Ukraine where biomass reed harvesting seems to be in support of wetland protection and in increased biodiversity, provided that necessary precautions are taken. This has been guided through a set of best practices (see 4.4.4).
  - A second example is the agroforestry projects (DBM02045) and (DBM02031), mentioning about an increase in species variation on the project site indicating an increase in biodiversity richness.
- A second category of projects highlights the use of biomass, as alternative use of woody resources, for local appliances. Replacement of firewood to biomass use has as indirect benefit that forest clearings are prevented, as mentioned in the projects in Colombia (DBM02032) and in Mozambique (DBM02045). This is especially of relevance in regions where wood is still used as the main traditional resource for energy (see also 3.3.1) and an important cause of deforestation.

Key conclusions and lessons learned

- Experiences in the Ukraine learn that precautionary measures are needed to secure (amongst others) biodiversity, to ensure its reliable and long-lasting source of energy from wood. This has implications for the realistic availability of biomass on the ground when such measures are taken.
- Biodiversity impacts are avoided through valorisation of residue and waste streams.
- Positive biodiversity impacts are demonstrated through enhancing biodiversity on-site, e.g. through providing alternatives biomass resources for woody resources.
- Impacts are interrelated. The use of alternative biomass for wood to produce charcoal indirectly contributes to conservation of carbon stocks and reduces pressure on deforestation, which is of high relevance in countries where wood is still used as source for traditional biomass use.

3.1.4 Soil quality and quantity

Several of the NPSB projects mentioned about the risk for negative impacts and the creation of positive impacts on soil quality and quantity. The risk for nutrient depletion for biomass projects working with agricultural crops and primary residue streams (see part 1) should be avoided. The risk for nutrient depletion especially plays a role when more nutrients are removed from the soil during harvest then put into the soil (e.g. by manure or fertilizers). This risk for nutrient depletion was mentioned by the Jatropha project (DBI02007) in Tanzania and by the Pellets for Power project (DBM01010) in the Ukraine. See also box 7.

Box 7

Experiences on the risk for nutrient depletion in two NPSB projects.

While the conclusion for the Jatropha project (DBI02007) was that nutrient depletion was not at risk when smallholders grow Jatropha in hedges, this turned out to be a concern for the project (DBM01010).

The harvesting of straw turned out to be not possible under current management conditions without decreasing the soil carbon. This has resulted therefore in the exclusion of the straw for feedstock use in this specific project. To change this picture, and avoid the risk for nutrient depletion, a change in management practices in the region (e.g. more manure input, increased yields) would be needed.

Under the NPSB programme, the tool BioESoil has been developed to assess the impacts of bioenergy on soil quality. It takes into account nutrient losses during bioenergy production, potential nutrient return with bio-energy production residues and effects on soil organic matter (RVO, 2014e).

Several NPSB projects demonstrated how the use of by-products or waste streams in bioenergy projects could be used for compost as fertilizer, herewith enhancing the soil quality. The POME technology (DBM01015) creates for example a rich sludge, which can be used as compost for the soil. The Indonesian project (DBM02053) has trialled the use of biochar rice husk for soil quality improvements. The processing of the waste in the South African project (DBM01012) created a rich fertilizer.

Soil quality can also be enhanced through the use of biomass crops on degraded land. In the Jatropha project in Mali (DBM01002), farmers used Jatropha trees against soil erosion. Poor plots have been rehabilitated by the project.

Key conclusions and lessons learned
- Within the NPSB project portfolio, the risk for decreased soil quality is discussed in relation to the risk for nutrient depletion when crops or primary residues are used for bioenergy.
- A demonstrated positive impact from processing residues and waste streams on soil quality is to use them as soil fertilizer.
- Suitable biomass feedstocks, combined with sustainable practices, can contribute to rehabilitation of degraded land. This results into improved soil quality.
- The results learn (see also 3.1.5) that the risks for environmental impacts, as well as their possible benefits, differ per feedstock (category), management system, end-use technology, and operating region (degraded land, nutrient rich lands or not).

3.1.5 Water quality and quantity

The risk for impacts on water quality and quantity through production of land-based biomass resources (crops) is related to the depletion or pollution of water resources on and around the production area. While negative impacts have not been taken place under the NPSB projects, positive impacts have been highlighted by the candlenut project (DBM01031) in Indonesia and the Algae project (DBM02012) in Vietnam.

This project (DBM01031) has created opportunities for using the candlenut and castor beans trees, combined with community forestry measures, for watershed protection and for land rehabilitation. Community groups have been facilitated in the project. Activities have been taking place on four sites in West, Central and East Lombok, covering a total degraded area of 1350 ha land critical for watershed protection. In relation to the project, a Central Lombok District Forum is established, which will further support promotion of sustainable watershed management and forest use.

The project (DBM02020) in Vietnam mentioned the benefit of using algae, in co-cultivation with shrimps, to clean the water from surplus nutrients.

Risks for impact on water quality and quantity can also take place at processing facilities that use water for processing and/or have wastewater streams. Negative impacts have not been taken place under the NPSB projects. Positive impacts have been especially highlighted by those projects working on wastewater treatment: the more efficient use of wastewater generates bioenergy, and also cleans the wastewater as positive impact. The pilot Beneficio El Cascajal in the project (DBM02032) in Colombia treated 21,200 m^3 of wastewater during the 2012-2013 harvests: 84% contamination was eliminated from the coffee wastewater. The project (DBM01012) also provided a sustainable solution for vast amounts of organic waste. Doing so stops the leakage of toxins into groundwater. The project (DBM02012) in Indonesia highlighted as well the benefit of using algae in the processing of POME to reduce nutrients from the wastewater.

Key conclusions and lessons learned
- Using wastewater for bioenergy production, and the use of algae for biofuels, have additional benefits to clean contaminated or nutrient-rich water streams;
- Suitable biomass feedstocks, combined with sustainable practices, can contribute to rehabilitation of degraded land. This results into improved watershed protection;
- The intensity of the impacts (both positive, negative) depends on the project scale.

3.1.6
Air quality

Impacts on air quality received limited attention (also due to characteristics of the NPSB project portfolio). The impact was given attention in projects that included the (envisaged) construction and/or operation of a biomass/biogas combustion plant, including the (treatment of) exhaust gases, (RVO, 2014a), as for example ((DBM01012) or (DBM02053).

Key conclusions and lessons learned

- Air quality was especially given attention in projects that included the (envisaged) construction and/or operation of a biomass/biogas combustion plant.

3.2
Poverty reduction: contribution towards social well-being

Contribution towards social well-being covers a range of issues. The survey on direct impacts from (RVO, 2014a) used a set of five indicators to cover them: (i) contribution to capacity building, (ii) improved market access, (iii) health and safety aspects, (iV) gender, and (v) organized liaison and negotiation with employees. Land rights are discussed as separate issue. Especially the areas of working conditions and land rights have been discussed in the NPSB projects. Health and safety aspects, and gender, are discussed only to (very) limited extent.

Aspects as enhanced capacity building, improved market access, and organized liaison and negotiation with employees have been key contributions in the NPSB projects. Creation of improved market access is enhanced through lobbying (e.g. 4.2.1 or 4.5.1), improving sustainability in the value chain (4.4), organization of producers (4.4.4) or by creating higher value of products or access of facilities for producers (e.g. 5.5.2). These aspects are discussed in more detail in other parts of this report. Contributions to capacity building and negotiation with employees are addressed in part 4.

3.2.1
Health and safety aspects and gender

Health and safety aspects have been improved in the NPSB projects through direct project measures, or as indirect benefit as result from technical improvements on processing sites:

- Examples of direct, practical measures in several of he NPSB projects include for example providing first aid training, first aid kits, or training in the handling of manure to workers and other people (RVO, 2014a).
- Indirect health and safety benefits resulting from technical improvements on processing sites have been highlighted by the trapiche project in Colombia (DBM02050) and the Village Hub project in Indonesia (DBM02036). Modifications on the mill improved the usually harsh working and operational conditions of the trapiche (DBM02050). The introduction of mechanical processing also improved the labour conditions of the sugar palm tappers. This processing step no longer had to take place (illegally) on-site in the forest. Note that the introduction of mechanical improvements may have as side-benefit that less manual labour is needed (see also 3.3).

A specific impact, mentioned in various NPSB projects, is the indirect benefit of improved health for local communities when fuel for cooking stoves is replaced by cleaner biomass resources.

Few projects specify practical aspects related to the position and role of female workers. In the cassava project in Panama (DBM02024) women are contracted for ‘tasks that do not need physical strength’. In the project in Brazil (DBI02011), separate training courses were provided for females.

Key conclusions and lessons learned

- Mechanization and technical improvements in processing sites not only enhance effectiveness, but also have as indirect benefit to create positive health and safety impacts;
- This is especially of relevance in sectors and regions where current working conditions are harsh and labour intensive. While shifting towards mechanization, adverse impacts on job generation may be created, which need to be taken care off.
- In countries that rely on traditional woody resources for heating, health benefits can also be created when fuel for cook stoves is replaced with cleaner biomass resources.

3.2.2
Land rights

In the last years, an increasing number of reports have been published on the possible impacts of large-scale biofuels production on land tenure, and on social conditions of farmers. Examples are the Oxfam report Land and Power" (2011), calling for companies and governments to take urgent steps to improve land rights for people living in poverty. Similar recommendations are made in the report "Land rights and the rush for land" from 2012 from the Global Commercial Pressure on Land Research Project (Info I, 2012). Within Europe, there has been a debate on the possible impact of increased EU biofuels demand on land grabs in producing countries, as reflected by the report "Land grabs for biofuels" from 2013. This report concludes that the area of land possibly subject to land grabbing caused by EU biofuels demand is far less than often presented in the debate (Info II, 2013).

The risk, and importance for avoiding conflicting land rights and overlapping land claims is mentioned in several of the NPSB projects. This risk does not only involve the start of project implementation. The Jatropha Assessment (2013) highlights the risk that local communities can suffer permanent loss of rights of access to key land-based resources when projects withdraw, which leaves them worse off than before the project arrived. Risk for conflicting land rights and overlapping land claims should therefore be taken seriously, especially in areas where:

- Large expansions in land-based production for biomass (plantations) are expected, especially when this development takes place within a short time frame. For example, most of the planned expansion of palm oil areas to meet Indonesia's national target of palm oil production (see part 1) is on lands which Indigenous Peoples, which may create a high risk of increasing conflicts (DBM02038). The survey in the Jatropha assessment (2013) suggests as well that the arrival of large plantations has given rise to incidental land rights problems. No land issues are reported for smallholder-based systems, as no land transfers occur in this business model;
- There is a lack of transparency in the process of land use planning, as mentioned by the project (DBM02047) in Mozambique and in Indonesia ((DBM01004);
- There is a weak institutional governance framework, as mentioned by the Jatropha Assessment (2013), which results into lack of enforcement when companies misuse their position.

The responsibility to avoid overlapping land right claims and land grabbing is a mutual responsibility of governments and companies. Land use planning, and setting land rights, is primarily a government responsibility (see 4.1.3). This includes as well the sufficient consideration of rights of local communities in the land use planning process in the country and the level of consultation when giving out new concessions. Respecting land rights is the responsibility from companies.

Especially in countries with a weak institutional and legal framework on land rights and land use planning, a positive outcome on respecting land rights depends much on the social responsibility and capability of investors and producers to negotiate in a fair, capable and transparent manner (Jatropha Assessment, 2013).

Solutions for project developers and investors on how to do so are provided in the NPSB programme. In assessing land (use) right distribution, a thorough investigation on land use planning in government (especially provincial and district) offices is required. Land planning processes may provide opportunities for the participation of stakeholders, including biomass project developers, depending on the country's national (and potentially regional) institutional framework for land planning (NL Agency, 2013). Additional tools and mechanisms that can be used are further discussed in part 4 and include for example the use of interviews, participatory mapping with local communities, or the Free Prior Inform Consent Mechanism (see 4.5).

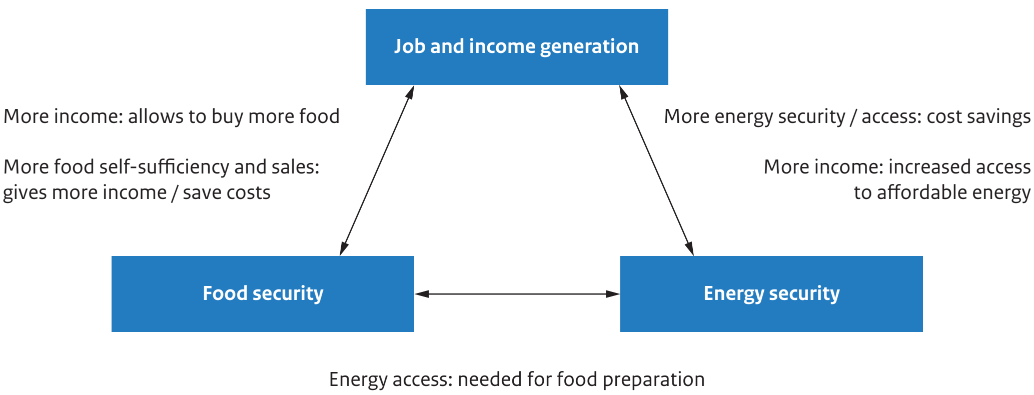
Key conclusions and lessons learned

- Establishing land rights, and recognizing them, is a mutual responsibility from governments, project developers and investors.
- Not sufficiently recognizing land rights and access to resources can have significant impact on local communities; both at the start of a project or afterwards when projects may withdraw.
- The intensity of impacts (both positive, negative) depends on the project scale: the larger the scale of operation (through upscaling and/or replication), the larger the possible impacts in a region.
- The risk for conflicting land rights and overlapping land claims in an areas increases when: i) large-scale plantations are introduced, in a short time frame, ii) there is lack of transparency in the process of land use planning, and/or iii) there is a weak institutional framework.
- Also in these contexts, risks can be avoided. This asks for the social responsibility of producers and investors. Solutions and examples on how to do so are provided. Examples the use of the FPIC mechanism, participatory mapping and interviews with local communities (see also part 4).
- Preferably, this should be combined with (international) government support to enhance the institutional framework of land use planning and land rights in these high-risk areas.

3.3 Poverty reduction: contribution towards prosperity

Poverty is multidimensional: impoverished people are deprived of services, resources and opportunities, as well as from income. When discussing poverty reduction, especially the contributions towards energy security, job and income generation and food security are discussed in several of the NPSB projects. Clearly, these aspects are interrelated, as shown in figure 5.

Figure 5
Interrelation of job and income generation –energy security and food security to reduce poverty.



3.3.1
Energy security

On a country level, energy security is determined by the level of import dependence, on one hand, and by the level of energy access (in %) on the other hand. Countries that are largely dependent on fossil fuels import are for example Mexico (DBM02050), Mali (DBM01002) and Indonesia. Domestic bioenergy production for own use can improve a country's self-sufficiency and save external currencies. On a producer or community level, increased domestic bioenergy production may result as well into benefits through less reliance on (often expensive) fossil fuels.

The UN (2013) indicates that more than 1.4 billion people worldwide have no access to electricity, and 1 billion more only have intermittent access. Within Mozambique, about 15% of the population has access to electricity (Factsheet Mozambique, 2012). Electricity coverage in Mali is estimated at 16% (DBM010002). Meanwhile, Some 2.5 billion people worldwide still rely on traditional biomass for cooking and heating (UN, 2013). For example, 70% of the firewood and charcoal production in Mozambique is used to meet basic energy needs of the population (Factsheet Mozambique, 2012).

Considering the important role of energy in food production and consumption for the provision of safe and nutritious food, energy is a crucial prerequisite for resilient livelihoods (IFES, 2013). This is also reflected in the established UN Sustainable Energy for All initiative in 2011, to which more than 75 countries have currently committed (SE4All, 2014).

Availability of energy: increased accessibility to energy while replacing fossil fuels

Several of the NPSB projects reported as positive impact on the creation of increased access of energy, especially in rural areas, through bioenergy production. Some of these examples are shown in table 8. They meet especially the local energy needs for heat and electricity.

Table 8
Examples of created increased access of energy from a selection of the NPSB projects

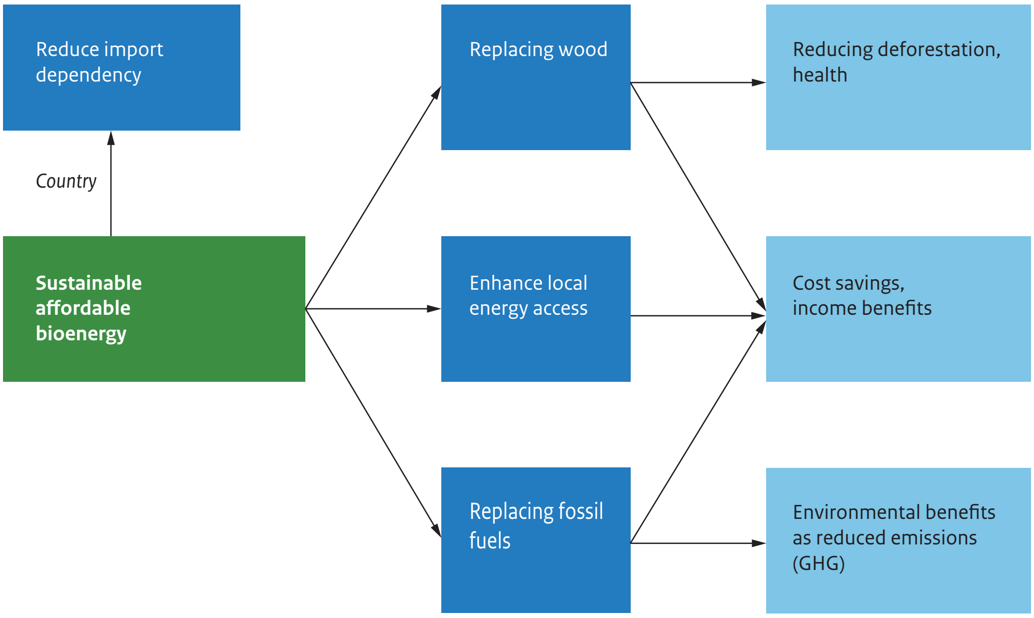
Project	Result
DBM02050	• Fuel self-sufficiency of the trapiche. • The surplus bagasse can be used to make briquettes to replace coal or firewood in local (cooking) stoves and/or kilns.
DBM02032	• Biogas for farmers to run pulping machines, heat kitchen stoves and other appliances. Small farmers have the possibility to use cook stoves on gas instead of wood, benefiting also health impacts (see 3.2), while cooperatives and larger mills replace the use of fossil fuels.
DBM01015	• In the POME system, 4 MM m^3 biogas equivalent has been mitigated up to March 2013, which generated 520.000 kWh of energy. The project also offered the opportunity for Tequendama to install an 2.25 mW electricity generator set because of the continuous availability of sufficient quantities of biogas.

Availability of energy: creation of affordable alternatives

Availability of energy relies not only on the level of accessibility, but also on its affordability. In Beira, Mozambique, demand and prices in the (mostly) informal charcoal market are high. Prices are even higher than the export market (Factsheet Mozambique, 2012). Suitable, sustainable biomass sources are identified by the project (DBM02045) to supply the local charcoal market at affordable price.

There is also a large need for cheap electrification for rice millers due to high diesel prices in Indonesia. The use of rice husk for electricity in the project (DBM02053) can substantially reduce electricity costs, estimated to be around -68% for the rice miller. Ex-ante assessments in the Zebra project (DBM01014) also indicate that the utilisation of POME methane may replace over 207 tonnes of diesel annually (at 100,000 tonnes of FFB processed), resulting into cost-savings of EUR 186,701.

Figure 6
Spin-offs of benefits through creating a higher level of energy security on local level



The realisation of a higher energy security from sustainable, affordable bioenergy resources on local level contributes to poverty reduction, and other sustainability impacts (see figure 6).

Key conclusions and lessons learned

- Energy access, and its affordability, is worldwide recognized as key priority, especially for many developing countries.
- Several of the NPSB projects demonstrate that sustainable bioenergy for local use, especially for heating and cooling, can enhance energy security and reduce dependence on fossil fuels. This is especially of relevance in rural areas in developing countries with low levels of energy access.
- Also when export proves to be financially beneficial for farmer households and local communities, a spin-off for improved access to clean local energy should be achieved in parallel to export (DBM01018) given the multiple positive impacts that can be achieved when doing so.

3.3.2
Employment and income generation

Increased income and employment generation has been highlighted by several of the NPSB projects as important positive impact. Those two aspects are interrelated: the creation of employment automatically results into income.

Employment creation

Positive impacts on employment generation have been especially achieved when (see also box 8):
- The project is located in rural areas with high unemployment rates, combined with little job opportunities. This was for example the situation for the fallow, arable lands in the South African project (DBM02037);
- Biomass production requires a low capital investment and is labour intensive, as is the case for bamboo (DBI02006) or Jatropha (Jatropha Assessment, 2013). Both crops can be managed by smallholders as side crop, and on small scale.

Box 8
Examples of job creation by NPSB projects in rural areas with high levels of employment
- The South African project (DBM02037) worked on two project sites: Elliot and Engcobo. About 100 jobs were secured amongst the Elliot farmers and 150 jobs were created seasonally. At Engcobo, 20 permanent jobs were created and about 100 jobs were created seasonally. In addition, the communities harvested a substantial amount of maize and soy, which could be solid at a reasonable price. This money could be used to buy inputs for the coming season.
- The evaluated projects in the Jatropha assessment (2013) have generated in total more than 600 permanent jobs and 1000 temporary jobs. Most of the permanent jobs were created in Mozambique (+500), while most of the temporary jobs were created in Tanzania (537).

In addition, various NPSB projects also mention the creation of direct jobs on-site at the factory. The POME project in Colombia (DBM01015) created 9 jobs. The project (DBM0103) employed 25 staff members.

Income generation through supply and sales of biomass

Opportunities for producers and farmers to supply and sell their biomass, creates (additional) sources of income and provides farmers opportunities to diversify their sources of income. This makes them less dependent on one sale revenue stream. The NPSB projects highlight several ways of creating additional income, next to employment (see table 9).

Table 9
Opportunities for income generation, as demonstrated here from selection of NPSB projects

Opportunities of income generation through:	Project examples
Income creation through new sales stream of products	• Farmers supplied the sugar palm juice to the factories and received an income from this in the Village Hub project (DBM02036); • The hybrid model in the cassava project (DBM02024) offers farmers the opportunity to sell their cassava with several alternatives to create premiums. The project is developing a market for alternative products, and can guarantee a steady price, providing farmers more security. • The Zebra project (DBM01014) receives palm oil from smallholders. Higher economic margins on processing were achieved through technological modifications in the mill. This allows paying IDR 100 per kg fruit as premium to the supplying smallholders, resulting into a substantial increase of annual income per smallholder producer of an indicated 8.4%.
Valorisation by product diversification and adding value to residues	• The project (DBM01031) assisted candlenut farmers in creating added value to their produce through the sell of shells and kernel for bioenergy production. • Valorisation of residues, as gasification of rice husks in Indonesia or energy generation (DBM02053) from bagasse in Colombia (DBM01015).
Adding value through integrating new crop in existing production: intercropping	• Farmers in the project in Indonesia (DBM01004) planted sweet sorghum after one crop of rice was harvested (traditional cropping), which resulted into 2 crop sorghum harvests. This provided additional income from that of the sales of rice. • The co-culture approach algae-shrimps in the project in Vietnam (DBM02020) resulted into improvement in quality and yield of the shrimp crop. Farmers and labourers also enjoyed a new revenue stream. Farmers are paid to gather and dry the harvested seaweed, which represents a new source of rural income.
Adding value to underused lands	• The project (DBI01010) in the Ukraine showed that the use of wetlands could contribute to income creation for local communities. • Poor plots in the Mali project have been rehabilitated with Jatropha (DBM01002). Farmers sell the seeds to diversify their sources of income.

Spin-offs from employment and income generation

The creation of additional income from jobs may create further economic spin-offs, as shown in the South African project (DBM02037). Some of the Elliot farmers were able to buy machinery. This increased the economic sustainability of farmers by reducing their reliance on outside contractors. These farmers were also able to offer mechanisation services to other farmers, which created an additional income stream.

Support and training for suppliers and sectors in transition for job and income creation

A sectoral transition towards more efficient, and in most cases mechanized, production systems (see also 3.1) may in some cases lead to job losses: less labour may be required or other job qualifications are needed. This has been the case in Centre-South Brazil, where manual cane cutting is being phased out and is replaced by mechanical harvesting, also as requirement for upcoming legislation. As a consequence, more than 90,000 poorly educated cane cutters will lose expectedly their job without having qualifications for alternative employment in Brazil's labour market.

The sugarcane millers association UNICA, together with labour union FERAESP, several other partners and the majority of its members, had therefore started a retraining program called 'Projeto RenovAção'. The aim of this program is to increase the employability of this group of redundant cane cutters. This program, now running for three years, has so far re-qualified 4,550 workers. The vast majority of retrained workers have found alternative employment. These are better quality jobs, and their income increase was between 28% and 62%. The project (DBM01011) focused on retraining redundant cane cutters, so as to improve their employability. Through cooperation with UNICA and FERAESP, the project was able to promote the inclusion of two underrepresented and vulnerable groups of cane cutters: women and functional illiterates. This has been copied and scaled up by the government – making the project's influence even more relevant.

Also other NPSB projects had capacity building activities to improve farmers' capabilities to meet the project's requirements. This is further elaborated in part 4.

Key conclusions and lessons learned

- Production of biomass resources (as bamboo or Jatropha), which require low capital investment and are labour intensive, may provide considerable job opportunities – especially for smallholders;
- Other ways for creating income is through i) new sales stream of products or the valorisation of sales streams, ii) by product diversification and adding value to residues, iii) by integrating new crops in existing production or iv) by exploiting underused lands.
- Fallow areas, though not strictly unused, create opportunities for income generation for local communities, especially when these are in rural areas with high level of unemployment rates;
- Local effects (both positive and negative) are sensitive to the success and/or failure of projects: not only at the start but also on the longer term (Jatropha Assessment, 2013).
- Successful realization of sustainable rural development may impact the business case of a project on the long term (e.g. higher salaries, changed efficiencies, less or more availability of biomass) and requires that projects have insight in key criteria and flexibility to adjust in time.
- A transition towards more efficient production systems creates benefits but may lead as well to job losses in a sector, also due to change in required qualifications. Dedicated capacity building efforts towards farmers and workers can accommodate a sector towards a sustainable transition.
- Influencing change in a sector and maximizing impact is best achieved by linking up project activities with existing or latent initiatives in an effort to give direction to them (DBM01011);

3.3.3 Food security

Modern bioenergy development may have positive or negative effects on food security: bioenergy may create new job and income generating opportunities, with positive effects on people's access to food. However, if good practices are not implemented, bioenergy production may lead to negative impacts on e.g. the productive capacity of land, with negative impacts on food security (IFES, 2013). The risk and relation of biofuels on food security, and possible solutions have been heavily discussed in the last years. International organizations and governments, including the Dutch government, have emphasized the importance of food security (see box 9).

Box 9
Food security and bioenergy: discussions in the public arena in the last years
The discussion on the risk for negative impacts of biofuels on food security and increasing food prices has been fed with the publication of various reports in the last years. The critical report, 'Fuel for thought,' from the NGO ActionAid pointed out that increased demand for biofuels might push global food prices to crisis levels (Info II, 2012). The E-Pure report "Biofuels and food security - Risks and opportunities" (2013) concluded, on the other hand, that the contribution of biofuels to price changes remained small.
The Dutch government has set four goals for food security in the Dutch Development Cooperation policy. These are increased sustainable food production, improved access to food of sufficient quality, improved functioning of markets and improved investment climate (Info II, 2013). In 2011, the Dutch State Secretary of Foreign Affairs stressed the importance of food security and that biomass activities should be seen in this framework (Info II, 2011). In 2013, the Netherlands and AGRA (Alliance for a Green Revolution for Africa) concluded an agreement to reduce food shortages and increase incomes of millions of small farmers by stimulating climate smart agriculture projects, also through cooperation with Dutch agricultural companies (EZ, 2013).
The Committee on World Food Security (CFS) stressed in 2013 the link between biofuels and food security, saying that "progressive realization of the right to adequate food for all" should be a priority concern in biofuel development" (Info II, 2013). The UN Conference on Trade and Development (UNCTAD) report "Wake Up before it's too late" (2013) also stressed the need to make a shift in agricultural production systems. Priority is given in the report to find ways to optimize agricultural systems for food and fuel (Info II, 2013).

Generally, two pathways are mentioned to improve food security in rural economies:
- By creating jobs and boosting incomes (see also section 3.3.1), as stated in by the FAO. If managed responsibly, bioenergy production may also promote much-needed investment in agricultural and transport infrastructure in rural areas (see also part 5).
- By combining biomass production for energy and for food security.

Combining producing biomass for energy and food security
Given the Dutch priorities, RVO looked for practical solutions on how bioenergy can be combined with food security. The report "Combining bioenergy production and food security" shows that biomass production is possible without endangering food security and that good examples are available (RVO, 2014).

RVO also cooperated with the Food and Agricultural Organization (FAO) in the project Integrated Food Energy Systems (IFES). In the IFES project, food and energy crops are grown simultaneously, which allows bioenergy production without endangering food security. This involves intercropping, in which energy crops can be used in a smart way alongside food crops as well as using waste flows for energy. Integrated systems may lead to many synergies by adopting as well different agro-industrial technologies (e.g. gasification) that allow maximum utilization of crops, livestock and their by-products (IFES, 2013).

Some examples of IFES systems are successfully demonstrated in the NPSB projects (see box 10).

Box 10
Examples of Integrated Food-Energy Systems (IFES) under the NPSB projects

- The sweet sorghum varieties in the project (DBM01004) in Indonesia produced stalks, grains and leaves. The leaves (45-55 tons/ha/yr) can be given to animals as fodder or return in the field as fertilizer. The bagasse component of the stalk can be used as fuel for a boiler or serve as roughage feed to cattle.
- The agroforestry component in the project in Mozambique (DBM02045) demonstrates that the production of biomass energy can just as well be a delivery mechanism for improved availability and quality of food. At the closing of the project, 1,300 farmers planted a total of 216 hectares of trees. It helped people to get more varied diets, by the introduction of beans, tomatoes and other produce, contributing to food security. Many farmers started producing a surplus, which they sell in the local market.
- Intercropping models are also demonstrated in other NPSB projects. Examples are the co-cultivation of algae-shrimps in the project (DBM02020) or the intercropping of Jatropha with food crops (DBM01018)

Food-feed-fuel crops combinations are attractive. One must ensure, however, that certain conditions are in place at the project and policy level. Amongst others, displacement should be avoided, land titles should be properly addressed and earning possibilities for low-income households have to increase. These impacts are discussed in other sections of this chapter.

Key conclusions and lessons learned

- Integrated Food and Energy Systems (IFES) allow bioenergy production without endangering food security. Food-feed-fuel crops combinations are attractive and allow maximum utilization of crops, livestock and their by-products.
- IFES examples are demonstrated under the NPSB projects. The bioenergy project in Mozambique (DBM02045) learns for example that the period of hunger has been shortened.
- Most of the IFES examples also created positive impacts on income generation. This demonstrates the nexus between food security – energy security and income generation.
- Food-feed-fuel crop combinations are especially often attractive for smallholders, since they have multiple marketing outlets.
- Small farmers provide the bulk of food production under, often difficult, conditions and suboptimal productivity levels. This means there is especially substantial scope for simultaneous increase in production of biomass for food and energy in these areas.
- These opportunities for creating multiple benefits stress the importance to promote local benefits and rural development when developing a bioenergy project (Factsheet Mozambique, 2012); especially in areas where poverty levels are high and food security is at risk.
- Multiple benefits can be created for local communities when production systems are well designed. This requires capacity building and knowledge transfer.

3.4
Sustainable use of natural resources: competition and indirect impacts

Most cited indirect impacts of bioenergy production are the risk for increased competition in resources, increased price levels and indirect land use changes (ILUC).

3.4.1
Competition with food and other local applications

The increased demand and production of resources can, directly or indirectly, result into competition. This may again result into price increases, which is again strongly related with the risk on food security (see 3.3). This section also relates closely to section 5.5.2, where the competition of products and prices is discussed from an economic business perspective. Various NPSB projects refer to the risk for competition in relation to:

- Competition with other applications (next to energy)
- Competition with other energy markets

Competition with other applications (next to energy)

Competition with other applications may develop when the biomass resource is also used for other applications. Increased demand for wood for bioenergy may for example indirectly lead to competition with the use of wood for the timber market. This may result into higher costs of wood products, and/or wood products being replaced by other (cheaper) materials (NL Agency, 2013a).

The NPSB projects (DBI01006) and (DBI02006) looked at possible risks for competition (see box 10). Project (DBI01006) concludes that the risk for competition is currently non-existent but may change in time (e.g. influenced by macro-economics). The same conclusion is drawn by the project (DBI02006), highlighting that opening of new markets may also provide opportunities for a sector.

Box 11
Competition of feedstocks for energy and other end-use applications

- The project (DBI01006) uses, amongst others, discarded wood waste streams from the US for wood pellets for bioenergy. There is currently no competition in demand in the US for wood waste. The rehabilitation of the housing sector may change this. More wood demand for houses will indirectly influence the availability of wood waste for energy applications – both positive (more primary wood is harvested for timber) and negative (more wood waste used for board industry). (SQ and CUC, 2013).
- For bamboo, possible competition to existing markets (as building material) may be an issue as well in some countries. According to the project (DBI02006), access to international markets of bamboo products from Colombia is very limited. Opening new markets (local and international) and product diversification would therefore highly benefit the bamboo sector.

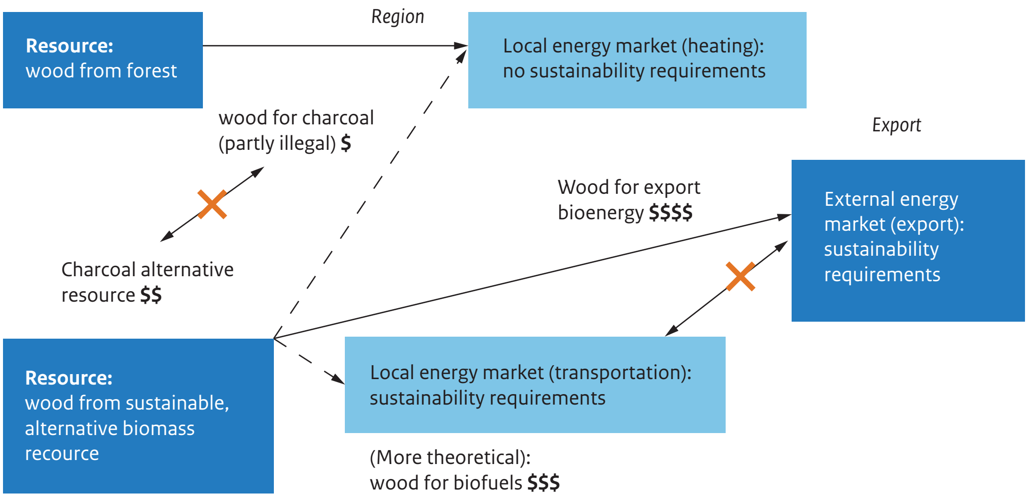
Biomass projects can also decrease competition in other sectors. The optimal use of the Jatropha press cake as co-product for animal feed in the Jatropha bioenergy project (DBM02025) reduces resource competition in the feed sector in Tanzania. Animal feeds are costly in this country; imports of proteins for animal feed are needed and there is an increasing shortage of local production. Proteins and minerals from Jatropha press cake form an attractive alternative and can reduce import dependency– and save money. As example, larger farmers now pay around 700 $/ton for imported soy meal, compared to an estimated value of 300 $/ton press cake from Jatropha.

Competition with other (local) energy markets

Increased global demand for bioenergy, and increased exports, may put (indirectly) pressure on local energy security in areas where biomass for export is produced. For example, woody biomass for local energy needs may be redirected to export, and is therefore no longer available for the local population (NL Agency, 2013a). This risk for competition exists especially in areas where energy security (affordability and accessibility) is a serious problem. See also 3.2.

Competitiveness between energy resources (see part 5) does not only take place when talking about domestic use versus export. Competition could also take place within a regional scale when biomass is directed to alternative energy end-uses (e.g. biofuels instead of local heating). Sustainable biomass resources may, on the other hand, have difficulty to compete with existing, traditional biomass uses. Small-scale production of briquettes from Jatropha residue (DBM02025) is not competitive against the large volumes of charcoal from wood, although likely more sustainable (see 3.1). Possible dimensions in competition are reflected in figure 7.

Figure 7
Theoretical reflection of areas of competition on regional and international level



Key conclusions and lessons learned

- Trade flows and competition in bioenergy resources is steered by demand (price) and does not always reflect the most sustainable choice for energy production; both on international scale (local use or export) and on a regional scale;
- Optimal valorisation of by-products from biomass resources may reduce competition in alternative markets where competition (as well) exists;
- Increased demand in resources may not only create negative impacts, but may also create opportunities in a sector for product diversification and for opening new markets;
- For project developers, it is important to monitor availability and competition of resources in time. Price and demand competition on the supply side can be partly avoided through setting long term contracts, responding to market developments and ensuring a diversity of feedstock resources;
- Government may place a framework in the market (e.g. sustainability requirements, feedstock preferences) in which competition operates; there is, however, a risk for market distortion.

3.4.2
Indirect Land Use Change (ILUC)

ILUC takes place when existing agricultural production (food, feed) is used to produce bioenergy, leading to displacement of production of food and animal feed (the demand for these do not change) into previously non-agricultural areas, such as forests or grasslands. Conversion of forest or grassland to agricultural land can, again, lead to significant releases of CO_2 to the atmosphere. As a result of ILUC, the GHG benefits of biofuels replacing fossil fuels could be significantly reduced (see also RVO, 2014d).

Part 4 of this report further discusses options to demonstrate a low risk of ILUC under projects. This chapter shows examples on how ILUC can be mitigated. In the LIIB (DBM02047) project, four key ILUC mitigation solutions have been identified, being:
a. Production on unused or abandoned land;
b. Yield increase above the trendline yield increase;
c. Integration of biofuel feedstock production with existing production;
d. Using residues and wastes as biofuel feedstock without displacing current uses of the material.

Examples and lessons learned in the NPSB projects on mitigating ILUC are described per category.

a. Production on unused land

Biomass production on unused or degraded land can reduce the pressure on land that is already used for agricultural production. Although extensive or underutilised lands are available, various projects mentioned that 'unused land' is not likely to be available. The project (DBM02045) in Mozambique calls the large amount of extensive land rather 'underused land'. The Jatropha Assessment (2013) learns that converted agricultural land in Mali appears to have been predominantly fallow land.

The project "Pellets for Power" (DBI01010) in the Ukraine demonstrated the possibility to grow switchgrass on marginal or underutilised land, contributing to mitigating ILUC.

Using underused, fallow or degraded lands for biomass production requires some points of attention:
- Land use systems relying on natural means of soil regeneration, do need to maintain regular fallow to maintain productivity. It is therefore important that remaining fallow lands are used in a sustainable way to avoid a decline in soil quality and productivity over time (DBM02047). To solve this, projects would need to assure fertiliser applications by the farmers on a sustained basis (Jatropha Assessment, 2013) and adapt the rotation cycle (DBM02047).
- Due to the difference in productivity and input (fertilizer) levels, switchgrass production on marginal lands (DBI01010) would lead to a higher cost per unit of biomass produced and to higher GHG emissions per ton of biomass produced (within the production chain) when compared to growing the crop on good quality land. There may therefore be a possible trade-off between producing ILUC free biomass, GHG reductions in the value chain, and production costs.
- Projects are not naturally attracted to selecting degraded (harsh, infertile) lands and may therefore search for more fertile areas (Jatropha Assessment, 2013).

b. Yield increase above the trendline yield increase

Intensification of production, compared to business as usual, may "free up" land that can be used for biomass production. This solution is especially of interest in developing countries, where there is a significant potential for yield improvements. Efficiency of bioenergy usage can also be enhanced by promoting cascading use of feedstock by using it as a source for food and material first before recovering the energy content (DBM02047).

Due to current low level of inputs and technology, the potential for intensification in Mozambique is for example high. If production can be intensified, it is likely that a significant part of the land used can be made available for other uses without displacement. This may lead to considerable potentials (see part 1) but requires investments, efforts and considerable yield improvement measures to be successfully implemented; else there remains a risk for displacement (DBM02045). The project (DBM02047) also focused on biofuel production resulting from increased yields in existing oil palm plantations, demonstrating that yield increases are possible.

Both projects (DBM02045) and (DBM02047) concludes that capacity building is a key requirement for a transition towards more intensive cultivation. In addition, it requires effort to change the farmer's approach in plantation management and support to finance the inputs needed for additional yield increasing measures, although this may also economically benefit farmers on the long term.

c. Integration of bioenergy feedstock production with existing production

Integration models combine different land use activities to maximize efficiency. For example, the pilot carried out in Brazil (DBM02047) looked at the integration of sugarcane and cattle. The project estimated that an area of 1.0 Mha ha of corresponding reduction of ILUC area could be created, based on a realistic share of 20% of the surplus bagasse moving into these types of systems. This would result into a volume of low ILUC-certified ethanol of 6.7 billion litres, showing the large potential to avoid ILUC, although the model hardly exists at this moment in Brazil.

Clearly, this model is closely linked to the IFES systems, from which examples have been successfully demonstrated under section 3.3.3. Other examples on integrating bioenergy production with existing production are shown in box 12.

Box 12
Examples under the NPSB projects of integrated bioenergy production with existing production

- The dominating model in the Diligent project (DBI02007) is the cultivation of Jatropha in hedges as living fence around cropland. The newly planted Jatropha mainly replaces different species of local thorny bushes. Non-productive hedges have been transformed into productive hedges while not competing with future demand for feed and food (ILUC, 2012).
- The Fairtrade project (DBM01018) successfully intercropped Jatropha in maize plots by introducing good maize seed varieties, healthy fertiliser systems and good agricultural practices. Farmers increased the overall productivity of their land allowing cultivation of Jatropha without losing food production (ILUC, 2012).
- Other examples are the co-cultivation of shrimps and algae in the project (DBM02020) in Vietnam, or the agroforestry models from (DBM02045) and (DBM02031).

d. Bioenergy production from residues

The use of residues and waste streams can mitigate ILUC through reducing the pressure on land. Many of the NPSB projects worked on the valorisation of residues and waste streams because of their general high level of sustainability and high direct GHG savings.

Residues and waste are not necessarily ILUC-free. For example, when a quantity of straw was used for animal feed and is now being used for ethanol production, more animal feed production is needed to compensate the loss of animal feed. This may indirectly result into an increase in agricultural land. Waste and residue materials have varying low ILUC potentials. The report (Ecofys, 2013) concludes that still substantial sustainable quantities of e.g. cereal straw and forestry residues could be harvested for biofuels use.

Key conclusions and lessons learned

- Project examples demonstrate that bioenergy feedstock production with a low ILUC risk is possible through production on underutilized lands, creating yield increases, integrated systems or using residues and waste;
- Project developers are not naturally attracted to degraded lands and there is a possible trade-off between GHG reduction versus producing ILUC free and additional production costs. Producing ILUC free biomass on degraded or marginal lands may therefore in many cases only be attractive if this biomass is somehow rewarded and GHG reduction requirements are not outside of reach;
- Using fallow, degraded lands should be looked at with caution, as these are vulnerable areas, which need to be managed as such. On policy level, it may be needed to define the "marginal" areas (e.g. through zoning) where growing perennial biomass crops are possible or preferred to mitigate ILUC outside competition with food (DBI01010), and the conditions for doing so.
- Yield intensification has considerable potential to free land for biomass production (see part 1). Considerable investments and efforts for capacity building are needed to realize this transition.
- The approach of integrating sectors (e.g. sugarcane and cattle) shows promising results and is economically feasible, although margins are small.
- Many of the NPSB projects successfully demonstrated the valorisation of residue and waste streams for bioenergy. These streams are not per definition ILUC free. The use of maximum removal rates for primary wastes and residues is recommended to avoid negative sustainability impacts (Info II, 2013).
- Certain non-financial barriers and competition in the market prevent LIIB solution types from being implemented at large scale. Therefore, a policy incentive could stimulate biofuel feedstock producers to use these solution types (LIIB, 2013).

3.5 Recommendations and lessons learned in sustainable production of biomass for local use and import

The NPSB programme aimed to contribute to improving the sustainability of the biomass chains (according to the Cramer Criteria) and to the achievement of the Millennium Development Goals (poverty reduction, sustainable development and sustainable use of natural resources). This framework is followed throughout this chapter by discussing the following four main categories of sustainability impacts: (i) sustainable development of natural resources, (ii) social well-being, (iii) contribution towards the local economy, and (iv) avoiding competition and indirect impacts.

Projects were encouraged to carry out sustainability assessments, but were not obliged to use the same systematic approach in doing this. The intention of the program was to learn from practical experiences in improving the sustainability of biomass chains, not to evaluate the level of sustainability of each project. The large variation in projects provides a great added value on lessons learned on sustainability impacts.

All NPSB projects contributed in some way to sustainability. Some projects worked on gaining experience in certification, others focused on the valorisation of residues and waste streams, others through the use of degraded land, or by working with smallholders. The described impacts in this report present the key findings. They are based on specific project examples, while it should not be overlooked that other projects worked just as well on these aspects.

The NPSB projects demonstrate that positive sustainability impacts from bioenergy production can be created. The risks for negative impacts, as well as their possible benefits, differ per feedstock (category), management system, end-use technology, and operating region. A blueprint for sustainable production does not exist; risks and benefits have to be considered on a case-by-case basis, and also depend largely on the local context. Clearly, this may also impact on the realistic availability of biomass for deployment on the ground.

Positive benefits and lessons learned have been demonstrated for a range of socio-economic impacts (as income and employment generation, food and energy security) especially in those developing countries where energy security and poverty reduction are key priorities.

Land rights, and the risk for possible conflicts, are addressed by various projects. This risk is increased when small-scale project scale up. Social and environmental concerns will therefore need to be monitored and managed more intensively when a project upscales towards large volumes.

The interaction between impacts has been discussed in various sections throughout part 3. Projects demonstrate the nexus food security – energy security and income generation, and their relation with competition in resources. A second example is the positive spin-off when using biomass to replace woody resources in areas where wood is traditionally used for heating (see figure 6). When carefully developed, biomass can provide solutions to some of the consisting problems in especially developing countries.

Impacts and solutions can be conflictive. For example, the mechanization of sugarcane harvesting in Brazil creates environment benefits and results into improvement in the quality of labour in the sector. This transition requires, on the other hand, an effort to avoid losses in employment; alternative solutions for cutters have been sought in the project (DBM01011). Understanding the trade-offs between impacts is important in order to determine the appropriate balance of sustainability and development, and for taking precautions where needed.

The use of sustainable well-designed business models (as agroforestry, integrated cropping systems, residue use) is crucial for creating a spin-off in multiple direct and indirect benefits. It is therefore important to stimulate these business models via policies and careful design of projects. .

Given the close interrelation between impacts, it is as well important to look at sustainability impacts as a holistic set of variables that influence each other, instead of narrowing this definition down to one or two compliance requirements. Tools as ex-ante or self-assessments are available (see also part 4) and allow anticipating in time on possible negative, positive or conflictive impacts.

Project developers

- Positive impacts can be created in biomass projects, when carefully designed.
- It is recommended to promote local benefits and regional development when developing a project, given the multiple benefits that can be created, especially in developing countries.
- Local impacts are sensitive to the success and failure of a project, not only at the start but also during implementation. Projects have the responsibility to ensure that generated impacts are long-lasting to avoid undesired drawbacks after project withdrawal.
- Realization of long-term sustainable development may impact the business case of a project (e.g. factors as higher salaries, less or more biomass availability, changed productivities). Projects should have better risk assessments and monitoring of crucial factors to have insight in their dynamics and their impacts on the performance of their business case, to be able to adjust.
- Projects can optimize their benefits when linking up with existing and latent initiatives in a country, to give further direction to them.

Governments

- Biomass projects can enhance energy and food security. Making optimally use of these benefits requires from governments to consider biomass projects as serious option for rural development, in a broader sense than renewable energy alone, in those countries where energy and food security are at risk and a key priority for local communities.
- Given the benefits that can be generated by sustainable, integrated business models, it is worthwhile not only to steer policies on the results of implementation (the impacts), but also on “the road towards the result” by providing incentives for using such business models.
- This may also imply a choice which business models are not desired, which may again impact on the realistic availability of biomass for further deployment.

- Transition in production systems means change and requires support to certain stakeholder groups that "miss the boat" because of lack in skills or employment losses in a sector. Governance programs can anticipate on this by providing alternatives or training.
- Institutional frameworks can play a role to securing benefits in the market (e.g. sustainability requirements, feedstock preferences, zoning, land use planning) to avoid undesired impacts and enhance benefits from biomass production.

NGOs

- It is desirable to further contribute to capacity building and on the promotion of integrated, sustainable business models that contribute to poverty reduction, especially for smallholders.
- NGOs can also play a role in advocating recognition of land rights of local communities, especially in areas where biomass production is expanding quickly combined with a weak enabling environment.

Knowledge institutes

- Strong agrarian countries and their institutes, as the Netherlands, can play a key role in transferring knowledge and capacity building to regions with underproductive, less sustainable agricultural systems.
- Further insight and evidence is needed for the development and effectiveness of sustainable production models that enhance sustainability impacts in the broadest sense, in line with the research needed for optimized, climate smart agriculture production models (as discussed in part 1), while gaining more insight in the interaction and possible trade-offs between impacts.
- Provide further insight in the ILUC risk and maximum removal rates from especially primary residual streams to avoid negative sustainability impacts.

Part 4

Guaranteeing sustainability: operationalization and use of the sustainability criteria

Part 4
Guaranteeing sustainability: operationalization and use of the sustainability criteria

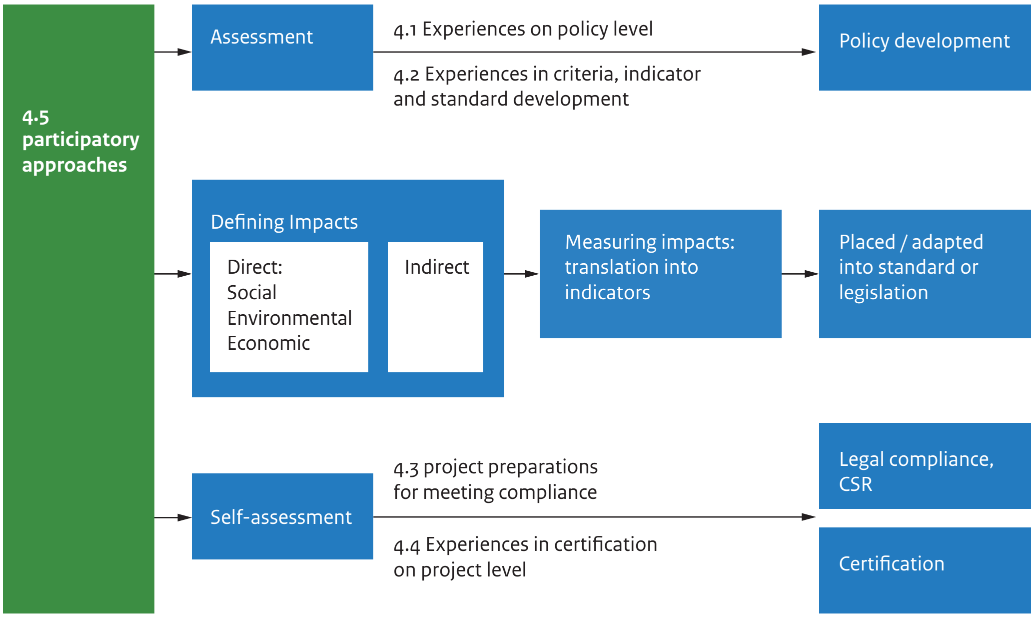
Together with the development of the biomass sector, increasing evidence became available of undesired side effects (and possible benefits) which biomass projects may have if not planned, implemented or operated properly (NL Agency, 2013), see also part 3. This has resulted into the need to develop policy frameworks and tools to measure and guarantee sustainability.

As explained in the introduction of part 3, the Cramer Commission was installed in 2006 by the Dutch government. This was one of the first multi-stakeholder initiatives to systematically define sustainability risks and criteria. Key recommendations in its report, 'the Dutch Testing Framework for Sustainable Biomass' (2008) were to extend consultation in producing countries and to gain experience in the operationalization of criteria, especially on the socio-economic criteria. This was also one of the prime objectives of the NPSB projects.

Sustainability criteria often include environmental, social and economic criteria on the project site. Criteria may also refer to macro impacts or indirect impacts that take place outside the production area. Examples are food security or competition in resources. The sustainability criteria from the Cramer Commission are introduced in part 3.

How criteria are designed, how strict they are, and in how far they are incorporated depends on priorities given in the tool or policy framework. Biomass certification focuses on reducing sustainability risks associated with the activities in the unit of certification, i.e. activities, which are in the sphere of influence of the operator of the unit. Certification of biomass does not cover indirect sustainability risks of biomass production and use (NL Agency, 2013a). Policy frameworks are better capable of doing so through their regional or national policies.

Figure 8
Descriptions of lessons learned as followed in Part 4 of this report



This chapter discusses the lessons learned on the operationalization and use of the sustainability criteria through four different sections, as explained in figure 8. The findings make largely use of the lessons learned in the report from (RVO, 2014a).

4.1 Experiences on policy level

Since the start of the NPSB projects, the policy playing field on operationalizing sustainability criteria for bioenergy has substantially changed. Sustainability criteria have been developed in the US, in Europe and in its Member States (see 4.1.1), but also for example in Brazil.

4.1.1 Developments on sustainability requirements on EU and US policy level

Within the EU and the US, sustainability requirements for biomass for biofuels and other bioliquids have been developed since 2009.

Sustainability requirements on biofuels and other bioliquids in Europe

Biofuels must meet the sustainability criteria set by the Renewable Energy Directive (EU-RED), if these biofuels are to be counted towards the 10% renewable energy target in transport energy use by 2020 (Info III, 2010). Criteria aim at preventing the conversion of areas of high biodiversity and high carbon stock for the production of raw materials for biofuels. The entire biofuels' production and supply chain has to be sustainable in terms of GHG emission reductions. Social criteria are not covered under the EU-RED, although there is a reporting obligation. The first renewable energy progress report (EC, 2013) of the European Commission (EC) looked at three main social issues: land rights, labour and food availability.

Since 2011, the EC started recognizing certification schemes to demonstrate that biofuels put in the EU market comply with the RED mandatory sustainability requirements. In the beginning of 2014, the Commission has approved 14 certification systems.

Box 13
Ongoing process of implementation of EU RED on sustainability criteria biofuels

- The EU-RED had to be fully implemented by all Member states end 2010 (Info I, 2012). Countries as the Netherlands, Germany and Sweden had fully implemented compliance in 2012. Other countries were delayed (Info I, 2012). The first Progress Report of the EC (2013) stresses that Member States' implementation of the biofuels scheme is considered too slow (Info I, 2013).
- Under the EU-RED, waste and residues and lignocellulosic feedstock can be double counted to promote their use. The double counting implementation of biofuels is up to each Member State. This resulted in different approaches and lack of harmonization of rules. In the Netherlands, 40% of the national target for 2011 was complied with double counted biofuels (Info II, 2012).
- Since the establishment of the EU-RED, changes have been adapted or discussed. In 2012, the EC proposed to amend the RED and the Fuel Quality Directive (FQD) to promote advanced biofuels that will help achieve substantial GHG reductions and which do not directly compete with food production. This includes a proposed cap on crop-based biofuels (see also 4.2.3). Beginning of 2014, the EC still needs to provide clarity regarding the definition of grasslands as well as the rules to prevent ILUC (Info II, 2013).

The process of transposition of the EU-RED has not been exempt of problems (see box 13) and is a learning process. Since the start of the NPSB projects, considerable progress has been made, however, in the development of a European policy framework and the recognition and development of certification systems to guarantee the sustainability of biomass. Only in 2010, biofuels and feedstock production was still fully unregulated in terms of sustainability (Info II, 2013).

Sustainability requirements on solid biomass in Europe

By means of a public consultation in 2011, the EC sought advice on sustainability criteria for solid and gaseous biomass for their use in electricity, heating and cooling. End of 2013, the EC has reached no agreement. No binding requirements are established on EU level so far. Consequently, some EU Member States have started developing sustainability criteria on national level (see box 14).

Next to these developments, the EU Timber Regulation (EUTR) came into effect in 2013 to counter the trade in illegal timber, which also covers forest residues. It prohibits the placing of illegally harvested timber on the European market and gives some first reporting conditions on e.g. the place or origin and traceability (Info I, 2013).

Box 14
Sustainability requirements solid biomass in EU Member States: policy developments

- The UK will implement mandatory sustainability requirements for solid biomass for heat and electricity in 2015. Criteria will include increasing GHG reduction targets (from 60% to 70% over time), requirements on sustainable forest management and biodiversity protection. Land use rights for indigenous populations and land criteria are defined as well (Info II, 2013).
- The Netherlands is also developing sustainability criteria for solid biomass, as laid down in the Dutch Energy Agreement from the Social Economic Council (SER). The criteria will be based on the NTA8080 and FSC standard for sustainable forest management, and will be combined with requirements regarding ILUC, and carbon debt. They will be determined at the latest end of 2014, and further adopted in 2015 as condition for receiving subsidies.
- Other Member States such as Germany, Belgium and Poland have also developed policy initiatives in the direction of establishing mandatory criteria for solid biomass (Info II, 2013).

Developments of sustainability requirements in the US

The Renewable Fuel Standard (RFS) sets the renewable fuel mandates in the United States. Specific GHG emission thresholds for four types of renewable fuels are set in the RFS, requiring a percentage improvement compared to a baseline. This includes for example a 50% GHG reduction in order to be classified as biomass-based diesel or advanced biofuel. Compliance by the market is reported directly to the authorities. There are no sustainability requirements for solid biomass. The US Lacey Act (2008) bans trade in illegally sourced wood products.

The NL Agency report "Sustainability requirements in EU and US" from 2011 concluded that EU and US biofuel legislative frameworks are incomparable when looking at overall structure, definitions, sustainability requirements, methodology, and reporting requirements. Most important differences relate to the GHG emission reduction targets and calculation methodology (Info II, 2011).

Key conclusions and lessons learned

- Considerable progress has been made in Europe in the development of policies and the recognition and development of certification systems to guarantee the sustainability of biofuels.
- No binding sustainability requirements for solid biomass are established on EU level. Consequently, some EU Member States start to develop sustainability criteria on a national level.
- Policy frameworks on sustainability criteria for biomass and bioenergy in European countries make largely use of approved biomass sustainability certification schemes as means of compliance.
- The holistic character of sustainability (3Ps: social, economics, environment) cannot be fully covered in legislation and policies when operating cross-boundary, as shown by the EU-RED., due to WTO requirements.
- Sustainability requirements for biofuels are developed in the US as well. The policy framework is different than the European approach, and does not make use of certification systems.

4.1.2
Experiences in the NPSB programme in developing national sustainability frameworks for biomass

The NPSB programme has contributed to the development of national sustainability frameworks for biomass in three different countries: Mozambique, the Ukraine and Mali.

Experiences in Mozambique

Mozambique published its National Biofuels Policy and Strategy in 2009, which laid down principles aimed at ensuring that biofuel development does not lead to land conflicts or threaten food production. In 2011, the Government adopted mandatory blending targets for 2012 and onwards, with the aim to create a local market for biofuels (see also 5.1). To operationalize the principles, the Mozambican government developed with support from RVO the Mozambique Biofuel Sustainability Framework (MBSF). The MBSF consists of 8 principles (see table 10) and 22 indicators, which formulate requirements for biofuel companies. Each indicator refers to one or more verifiers and to evaluation guidance. Verifiers are references to Mozambican legislation and policies (RVO, 2014c).

Box 15
Lessons learned from piloting the Mozambican Biofuels Sustainability Framework (MBSF)

- Participants in the pilot considered the MBSF as useful. Pilot companies found the MBSF assessment process valuable and the interaction with the government delegation enriching. Government delegates found the MBSF a useful tool to monitor compliance and progress of biofuel projects;
- The MBSF was considered ready for implementation. Pilot compliance results were good, and allow moving forward towards MBSF implementation. The MBSF was further improved during the pilot. Affected actors know the MBSF well and consider it as a valuable tool with clear guidance. The MBSF does not impose a new burden on biofuel actors since it refers to existing Mozambican legislation and policies;
- Three follow-up actions are suggested in the report (RVO, 2014c): (i) put in place a support program for implementation, (ii) explore whether a framework as MBSF is useful for other sectors and (iii) determine a realistic and acceptable pricing structure.

The MBSF has been designed for use in the Mozambican project application and land acquisition process, to assess, monitor and evaluate investment proposals and land use plans. The MBSF regulation details the procedures to apply the MBSF to investment proposals and biofuel projects. This regulation has been submitted for approval to the Inter-Ministerial Biofuel Commission (CIB) of the Mozambican government. In order to facilitate the operationalization and implementation of the MBSF, the government decided to undertake a pilot, funded by RVO. The pilot was centred on learning-by-doing. Main conclusions and lessons learned are presented in box 15 (RVO, 2014c).

Table 10
Developed sustainability principles for biofuels in national frameworks in Mozambique and Mali

Country	Environmental	Socio-economic
Mali	• Reduction of GHG emission • Protection of land with high value in terms of biodiversity • Protection of soil, water and air	• Ensuring food security (incl. that production should not affect food prices in local market); • Securing / protecting the land tenure; • Assurance of socio-economic sustainability
Mozambique	• Environmental protection; • Agricultural productivity	• Legality; • Social responsibility; • Energy security; • Economic and financial viability; • Public consultation; • Food security

Experiences in Mali

The NPSB project (DBM01005) has contributed to a national certification system in Mali. Through multi-stakeholder consultations, a set of sustainability criteria, principles and indicators have been developed, adapted to the Mali context (see also table 10). A written guide on the “adoption of biofuel sustainability criteria and certification systems” describes the certification process. This is known in Mali as the “Schéma d’Approbation Nationale” (SAN) or National Approval Scheme in English. The guide gives, amongst others, an introduction to the context of the need for certification and the legislative framework, and also details the principles, criteria and indicators developed.

A certification commission has been put in place to carry out the certification process in the future. The structure, roles and responsibilities have been defined for the national authority ANADEB and for the National Standards Agency. The project provided training and developed a variety of tools (e.g. timeframe for certification, monitoring and evaluation of projects) to allow the certification commission to carry out the SAN procedure. In the future, all biofuel production activities, which are judged to be medium to large scale, will have to go through the SAN certification process. This will promote sustainability in the biomass chains for those producers.

Experiences in the Ukraine

RVO has supported the Ukrainian government in the development of a biomass action plan. The plan aims to translate the country's biomass targets towards a plan for implementation. The biomass action plan also aims at improving the investment climate for bioenergy in Ukraine and dealt with various issues of supply and availability of biomass in Ukraine. An example is the report on "implementation of sustainability assessment for wood biomass project proposals in the Ukraine" (NL Agency, 2013d), which is an elaboration on the implications for sustainability of the growing wood biomass production in the country. This report concludes that there is a need for more and stronger sustainability legislation and enforcement in the Ukraine.

Key conclusions and lessons learned

- Developed frameworks for bioenergy learn that different parts of the world use different criteria and frameworks to safeguard sustainability. For example: safeguarding socio-economic impacts is key for Mali and Mozambique while not required under EU and US legislation.
- Given the different priorities in a country (see Mali and Mozambique), national sustainability frameworks need to be based on a country's reality and existing legislation. This may result into stricter domestic sustainability requirements in a country (e.g. the presence of social criteria in Mali), or the other way around (e.g. ISPO versus RSPO in Indonesia);
- These differences play especially a role when bioenergy is traded internationally. In this case, there is a stronger need for harmonization in an international trading market. This could be reached through working with international accepted certification systems.
- When not yet present or fully developed, the development of a bioenergy sustainability framework in the political and legal context may be desired. The findings in (RVO, 2014c) and in (DBM02039) learn that this requires a process-oriented approach, learning by doing, flexibility and constant adapting to changing conditions.
- The embeddedness of a developing certification process in the national socio-political landscape requires market acceptance and a responsible, involved government authority.
- It also requires considerable capacity building, time and support into development of instruments and tools that have to support the realization of a Sustainability Framework.

4.1.3
Sustainability in relation to a country's (land use planning) policy framework

Countries may have a strong policy and enforcement framework on environmental and socio-economic issues, although not specifically designed for bioenergy. Examples are laws and policies on biodiversity protection, soil pollution, labour rights or land use.

The importance of land rights and land use planning policies for sustainable biomass production is highlighted in various parts in this report (e.g. 3.2.2), as condition to safeguard macro sustainability impacts of bioenergy production and land use. Land use issues are specifically addressed in the Indonesian project (DBM02038), where community mapping is used as a tool to develop a balanced regional spatial plan that takes into account local food production and customary land-use rights.

Certification systems often refer to a country's existing legislation as indicator for compliance (see 4.2). In areas where national and international legislation is weak, certification systems may also be used to ensure corporate social responsibility (see 4.4).

Linking policies and market change on sustainability

The link between policies and the drive towards better management practices is demonstrated in several of the NPSB projects:

- The project (DBM01011) mentions an increase in effectiveness of law enforcement in Brazil during the course of project implementation. Reaching legal compliance has therefore become a major driver for many farmers in striving towards Bonsucro compliance in the project, which brought farmers in São Paulo close to being certifiable as well. Changes in these policies and markets (see also part 4) may, however, result into a shift to other markets, as the concept of certification is not yet fully embedded in Brazil.
- The project (DBM01011) also addresses that uptake of Bonsucro was substantially pushed by the EU-RED requirements on certification (see 4.1.1).
- The Indonesian Government launched in 2009 the Indonesian Sustainable Palm Oil (ISPO) standard. ISPO is a mandatory national sustainability scheme introduced in 2011 and is based on Indonesian national laws and regulations. All palm oil produced in Indonesia must meet these requirements once the scheme is fully implemented. The project (DBM02038) highlights the difference between the national used ISPO criteria and the stricter requirements of the international used criteria of the RSPO.

The project (DBM01011) highlights that a change in policies and supplier markets may result into different choices by producers on for example better management practices, or choices for and in certification systems.

Tools for developing, monitoring and evaluating national policies

On international level, effort has been put to develop tools to support national governments in the assessment of sustainability impacts of bioenergy, and in this context the feasibility for bioenergy development in the country. Examples are the GBEP and BEFS framework tools.

The Global Bioenergy Partnership (GBEP) is a global co-operation of governments of, among others, the United States, Brazil, the Netherlands, and Indonesia. GBEP has established in 2011 a set of 24 sustainability indicators for bioenergy (Info II, 2011). The indicators can serve governments, and other stakeholders, to monitor, evaluate and respond to impacts of modern bioenergy development on regional or national level.

The GBEP report “first lessons learned from pilot studies” from 2013, and supported by RVO, draws overall lessons of five of the GBEP pilot studies that used those indicators; the ones conducted in the Netherlands, Ghana (see box 16), Germany, Indonesia and Colombia. The study learned that the indicators provide a good basis for developing (further) bioenergy policies, if applied intelligently and selectively. They can also serve to develop successful bioenergy projects and guide investors, if adapted to the local framework conditions (B2Match, 2013). For a realistic implementation of the GBEP methodology and indicators, country-specific modifications and firm institutional support is needed for successfully implementation in most countries (B2Match, 2013).

Box 16
Enhance capacity in Ghana using the GBEP sustainability indicators
Ghana is developing fast. It is therefore very important for policymakers to be able to assess developments in the bioenergy sector, to steer developments in the wanted direction and to monitor the progress towards the goals set. RVO supported institutes in Ghana to gain experience and enhance capacity in using the GBEP indicators, for ultimately two objectives:

- To assess sustainability of bioenergy sector and;
- To develop sustainable bioenergy policies

The governmental institutes assessed all GBEP indicators as (very) relevant, as they addressed key issues and developments, although data collection was at some times difficult.

The FAO Bioenergy and Food Security (BEFS) analytical framework can be used to formulate or review bioenergy policies and strategies based on a thorough assessment of the domestic sustainable bioenergy potential.

Key conclusions and lessons learned

- Tools as GBEP or BEFS are developed to support governments in evaluating their national bioenergy policies.
- Next to the existence of a bioenergy sustainability framework, other non-sector specific policies are of importance as well to safeguard sustainability, especially spatial planning and customary land rights.
- Good land use planning, better practices and securing land rights are the responsibility of multiple stakeholder groups, which all have to 'do their part' to ensure sustainable practices. This close relation is for example also shown in the fact that most certification systems require legal compliance as first condition to meet the standard's requirements.
- A (increasingly) strong policy framework in a producer country and/or biomass importing country enhances better management practices (DBM01011).
- Biomass importing countries may include aspects as spatial planning and land-use rights more in bilateral agreements with producing countries (DBM02039). Reporting on spatial planning could also be a part of the reporting requirements in the EU-RED.
- Political and legal processes may change, and may differ from country to country. Companies therefore have to take their responsibility to commit to responsible business;

4.2
Experiences in impact, criteria and indicator development

Once impacts and principles are defined, they can be further developed into criteria and indicators as framework for the set of rules in a certification scheme (4.3) or in a policy framework (4.1). This sets the rules to define what sustainability requirements are met, possibly supported by guidance materials. The NPSB projects have provided lessons learned on criteria development and the verification of these criteria. These are discussed in more detail in the report (RVO, 2014a).

4.2.1
Criteria and indicator development for environmental impacts

For the GHG emission reduction, a standardized methodology has to be used for calculating this saving ('actual value'), or with using a 'default value', which are predefined values developed for specific chains. If compliance cannot be proven with a default value, economic operators shall calculate actual values. For environmental impacts, NPSB projects contributed especially to collecting actual data for calculating soil carbon and/or GHG emissions.

The project (DBI02009) did for example research on the actual GHG data for the soy value chain (see box 17). Other NPSB projects looked at specific aspects of GHG calculations. The project (DBI01010) looked for example to the aspects of soil carbon in relation with GHG emissions.

Box 17
collection of actual data for research and market access for the soy value chain
The EU-RED has set a GHG-reduction default value of 31% for soy-to-biodiesel chains, which is lower than the current threshold value of 35% (which will increase to 50% in 2017). The sector therefore has a considerable challenge to determine the actual value for soybean biodiesel based on recognised verification methods, while investigating further possibilities for GHG emission savings (see 3.1.1). In the soy project in Argentina (DBI02009), relevant GHG parameters have been collected for research to be able to demonstrate that indeed higher GHG savings can be achieved than is assumed under the current default values for soy set in the EU-RED. Adjustment of these EU-based default values based on (collected) Argentinean soy chain data is believed to make compliance easier for Argentinean farmers, thus improving market access to EU biofuels markets.

During the course of the NPSB programme implementation, the issue of 'carbon debt' became a topic in the debate, which is the temporal imbalance between carbon emission and carbon sequestration in a forest due to harvesting biomass for energy purposes. The topic is debated in the last years and there is general consensus amongst stakeholders that the issue of carbon debt needs to be translated into specify policy measures and/or additional requirements in sustainability certification schemes. This is also emphasized in the Dutch 'Energy Agreement for Sustainable Growth' (2013). The current key question is what is the most appropriate approach, given the scientific uncertainties on methodologies for quantification of carbon debt, and the magnitude of effects in specific situations (NL Agency, 2013a). Given that this discussion started relatively late, this impact is not considered as such under the NPB projects.

Key conclusions and lessons learned
- Further research in GHG default values is needed, especially for chains that may not meet the GHG requirement as default values may vary regionally and depend on farming management practices.
- There is a need for developing further scientific insights, policy instruments and practical tools for dealing with carbon debt in the coming years.
- How (future) standards on carbon debt impact upon their projects is in particular of interest for project developers involved in forest biomass chain (NL Agency, 2013a).

4.2.2
Criteria and indicator development for socio-economic impacts
For criteria and indicator development for socio-economic impacts, projects worked especially on gaining insight in the formulation of social criteria and how these could be further improved for adequate social criteria for ensuring assurance.

The project (DBM02038) explored the use of social criteria in certification in an Indonesian context. The legal status of Indigenous Peoples is not clear in Indonesia and ambiguous. The lack of recognition of Indigenous Peoples rights in Indonesia has created a weak legal context for palm oil development and already created many conflicts. The consultation on the impacts of palm oil development in the project (DBM02038) focused on the social criteria formulated in the Dutch NTA8080 certification system.

During the assessment, negative local impacts were reported on all social issues covered in the NTA8080 certification system for sustainable biomass. This demonstrated the need for adequate social criteria and the need to use robust certification systems with a high level of assurance. The project provided suggestions for NTA8080 for improving and concretizing the social themes. This regarded the importance to use Free Prior Informed Consent (FPIC), developing guidelines, concretizing existing criteria and developing additional criteria and indicators.

The outcomes of the project have been used and disseminated in various ways:

- They have been communicated to the Dutch Commission Corbey, who used the findings in its advice on social responsibility. This advice discusses the social sustainability criteria of the European biofuels policy and stresses the need for social criteria in the EU biofuels policy. The FPIC mechanism can for example be included in legislation.
- The results have been shared with the NTA8080 certification system.
- As outcome of the project, a declaration of 11 local civil society organisations actively working on palm oil issues in Indonesia was signed to stress the need to include social-economic impacts (of palm oil production) in European biofuels policies. A similar declaration was prepared by 4 civil society organizations from Malaysia.

Key conclusions and lessons learned

- Especially in countries with a weak legal context on socio-economic issues, there is a need for adequate social criteria and robust certification systems with a high level of assurance to ensure avoidance of negative impacts; reference to compliance of laws and policies may not be sufficient.
- The FPIC mechanism can for example be included in legislation.

4.2.3 Tools to mitigate indirect impacts

Most cited indirect impacts of bioenergy production are the risk for increased competition in resources, increased price levels and indirect land use changes (ILUC). Project examples on how these indirect impacts can be mitigated are discussed in part 3. This section discusses in more detail how the 'size' of the impacts can be estimated, and how solutions can be measured and verified.

Most of the current work on indirect impacts so far has focused on 'sizing the problem' – to estimate the amount of indirect impacts from a certain amount of biofuels and the GHG-emissions associated with this. Several studies also estimated the effect of biofuel mandates on food commodity prices. Examples are the reports from the UK Department for Transport on "Modelling indirect land use change impacts of biofuels" (2010), IEA Bioenergy report on "Bioenergy, land use change and climate change mitigation" (Info III, 2010) or the report from Ecofys (2013a).

Under the NPSB programme, effort has especially been put in gaining more insight in measuring the effectiveness of solutions that mitigate food security and indirect land use change.

Measuring effective solutions on food security

Until now, only anecdotal information is available about the impacts and benefits of systems that integrate energy and food security. With support from RVO, the FAO has executed a project to investigate the different options to secure and replicate food and bioenergy production (see 3.3.3). This was facilitated through the development of an analytical framework, which focused on both the sustainability and the replicability of different IFES scenarios.

Indirect Land Use Change (ILUC): proof of ILUC mitigation on policy level

ILUC (see also RVO, 2014d) associated with biofuel production has been discussed on policy level since 2008. Effort has been especially put in sizing the problem of ILUC. In view of the ongoing discussions on ILUC, the European Commission requested for example several scientific studies on the topic. Outside Europe, efforts (modelling work, policy discussions) have also been undertaken in the US. The discussion on ILUC among experts and policy makers is largely confined to the EU and the US, and is focusing increasingly on policy approaches to prevent or diminish ILUC (Info I, 2011), see box 18.

Box 18
Proposed policy approaches in Europe to prevent or diminish ILUC
The European Union has introduced in the EU-RED mandatory sustainability criteria for biofuels, which focus on direct sustainability impacts. In view of the ongoing discussions on ILUC, the European Commission asked for advice in a public consultation in 2010 (Info III, 2010). This resulted into a legislative proposal published in 2012 with the objective to minimise the ILUC impact of biofuels. The proposal includes several measures aimed at reducing the role of crop-based conventional biofuels while increasing the role of advanced biofuels produced from wastes, residues or (ligno) cellulose materials (Info I, 2013). So far, no consensus has been reached.

ILUC is not always a topic of discussion in other countries. As example, the project (DBI02009) mentions that European ILUC measures are considered in Argentina as an attempt to disqualify – what they see as – sustainably produced Argentinean soy.

Proof of ILUC mitigation on project level: the LIIB certification module

As explained in the introduction, certification schemes do not consider potential indirect effects of biomass production (NL Agency, 2013). As indirect effects of biofuels form one of the key challenges of sustainable bioenergy, a certification module was developed in the (DBM02047 or LIIB) project to credit biofuels with a low risk of indirect impacts.

The Low Indirect Impact Biofuel methodology (LIIB) allows biofuel producers to assess potential ILUC impacts of their operations, and to demonstrate that their production does not cause ILUC. Biofuels are ILUC-free if produced from feedstocks cultivated additionally without displacing current agricultural production, or if produced from wastes or residues without displacing current other uses of these materials. The LIIB certification module focuses on avoiding negative *indirect* sustainability impacts and has to be used together with an existing credible sustainability certification scheme in order to ensure the *direct* sustainability of bioenergy production (LIIB, 2013). RSB embraced the implementation of LIIB approach as complementary module to its standard in 2013. (Info II, 2013).

This field-testing version of the LIIB methodology has been tested in different countries: Brazil, Indonesia, South Africa and Mozambique (DBM02047). The LIIB methodology is also tested in the Ukraine project (DBI01010) and in selected Jatropha projects in Tanzania: the Diligent project (DBI02007), the Fairtrade project (DBM01018) and the Animal feed project (DBM02025).

The LIIB certification module contains four ILUC mitigation solutions. Section 3.4.2 explains how ILUC can be mitigated under these options. Methodological experiences to demonstrate ILUC mitigation are explained in this section. The results (see box 19) show that a low ILUC risk could indeed be objectively demonstrated with the LIIB methodology (ILUC, 2012). Companies and certification systems are thus able to assess if their biomass project impact on food security or create a risk for land use change and take measures accordingly to avoid these undesired effects (NL Agency, 2013).

Box 19
Pilot experiences with the LIIB methodology for different solution options

Solution 1: Proof low ILUC risk through "biofuel production on unused land":
- The project Mozambique (DBM02047) tested the LIIB category "Unused Land projects". Fieldwork at several research sites did not lead to the identification of unused lands defined in the LIIB methodology. The analysis concluded that most of the land is "underused", rather than "unused".
- Projects with underused land do not meet the definition of unused land under the LIIB requirements and are thus not eligible for LIIB certification.

Solution 2: Proof of low ILUC risk through introducing productivity increases
- Demonstrated by the project (DBM02047): through increased yields in existing oil palm plantations in Sumatra, Indonesia. Proof that implementation of better practices could lead to significant yield increases; and thus eligible for certification.

Solution 3: Proof of low ILUC risk through introducing integration models.
- The project in Brazil (DBM02047) demonstrated in the category "Integration of Sugarcane and Cattle" that a "compression" of cattle per unit area indeed reduced the need to expand cattle ranching at the deforestation frontier; thus eligible for certification.

Solution 4: Proof of low ILUC risks through category "End-of-Life Feedstock projects"
- Demonstrated through a pilot carried out in Cape Town, South Africa, focusing on Used Cooking Oil (UCO) as biodiesel feedstock. It was not possible in this pilot to define the surplus quantity of the UCO and what could be used to produce biodiesel without displacing other uses. Establishing this surplus is difficult when no reliable statistics exist. A more thorough assessment may lead to better insights.

The pilot studies also showed their challenges to demonstrate the ILUC risk and revealed solutions for further development of the LIIB methodology (ILUC, 2012), see table 11. The pilots learned that the information needs for the LIIB module are aligned with information needs for certification systems (e.g. NTA8080), or with regular business management (DBM02047 Brazil), If this is not yet established, the LIIB module requires an extra effort from the producer, next to already existing compliance requirements for RED certification. Estimates suggests that certification against the LIIB methodology does not add significant costs to the cost of certification (LIIB, 2013).

The project (DBM02047) learned that the LIIB methodology itself, and sharing of results, raises awareness on possibilities to include competition and land use changes in policy making:
- The experiences in Mozambique are used as input for the development of the national biofuels legislation and to advice expanding other sectors, such as the pulp and paper sector.
- In Indonesia, the concept of using unused, degraded land is being considered by the regional land use planning in Kalimantan.
- The European Commission dedicated an annex in its ILUC Impact Assessment, which accompanied its ILUC proposal, to ILUC mitigation and the LIIB solution types.

Table 11
Challenges and recommendations for further improvement LIIB methodology based on the various projects in which LIIB was tested:

Challenges in evaluated projects	Solutions and recommendations for further development
In an ex post assessment, complete information on previous use of the land	***Project developer:*** • Apply for LIIB certification before the project is implemented. • Concentre and file all actions and documents right from the project start. • Install a proper monitoring system to facilitate certification. • Align data management with regular business management.
Setting the baseline (DBM01018), including historical data and insight in future expected yields	• *Project developer:* Next to recommendations above, cooperation with local partners is key to meet information requirements. • *Standard owner:* Demand application of "best available" option, which might not cover all conditions, but reflect local circumstances.
Collecting the right information for smallholders	• *Standard owner:* Adjust monitoring requirements to smallholder certification. • *Project developer:* Ensure that smallholders are successfully certified against NTA8080 or RSB; monitoring requirement of LIIB will be met as well.

Key conclusions and lessons learned

- On policy level, it seems difficult to obtain consensus on the exact size of ILUC emissions because ILUC cannot be measured, only modelled with large global economic models. Individual biofuel projects cannot influence modelling outcomes.
- LIIB takes a bottom-up approach and enables producers to demonstrate that their production does not cause ILUC: the results learn that mitigation of ILUC can be successfully demonstrated in certification with the LIIB certification module.
- LIIB can be used as add-on to existing voluntary certification schemes since it only addresses indirect aspects. Direct sustainability aspects should be covered by an existing certification scheme.
- LIIB can also be used as a practical tool to stimulate ILUC-free biofuel production.
- Biomass supply chain operators and other stakeholders are recommended to follow developments in the debate on ILUC, and to assess how (future) standards impact upon their situation and projects (NL Agency, 2013a).
- For project developers, it is important to decide at the start of a biofuel feedstock production project what type of data management system is needed to meet (LIIB) certification requirements, and to align this with day-to-day business. Involvement of smallholders in (LIIB) certification requires adjustment in guidance and requirements.
- It is important to test IFES production systems more extensively and to gain more practical and result-based experience on what works well and what does not.

4.2.4 Criteria development for alternative feedstocks, residues and wastes

Within the NPSB programme, specific effort has been put in criteria development for aquatic biomass. A final draft standard on aquatic biomass value chain indicators has been developed as discussion document and includes eight sustainability principles for use in future developments of a voluntary standard for algae biomass (Info I, 2013). Results have been shared with other systems.

The experiences in the macro-algae project in Vietnam (DBM02020) have been used as input on further elaborating the draft sustainability criteria for algae production. The project identified some key social, environmental and ecological sustainability issues as the risk for monocultures, labour conditions (especially during the harvesting), water rights, or pollution risks. The project also concludes that the risk for sustainability may differ between the models used for algae production (macro algae or micro algae in closed environments) and between production scales (large or small).

The development of sustainability criteria for algae is still in its infancy. A starting point is made for identifying best practices and risks. The pilot (DBM02020) identified some issues that require further research as e.g. on how to define the impact of non-sustainable shrimp cultivation on algae production or how to identify HCV areas on water.

Relevant in the discussion of criteria development for residues and waste is the possibility for the upgrading of biomass residues, which leads to new marketable products in their own right. In the Colombia project (DBM02011), it is for example expected that the excess of bagasse pellets can be sold to third parties as a second product next to panela. The optimal valuation and competition of and between biomass products in the broadest sense is expected to become of increasing importance in the biobased economy. Competition and cascaded use of and between resources is at this moment hardly addressed in certification systems and policy frameworks.

Key conclusions and lessons learned

- Final draft sustainability criteria are developed for aquatic biomass, but need to be further elaborated. Sustainability impacts for algae differ from those from land based crops. Risks for sustainability may differ between business models used for algae production and between production scales.
- The impacts ‘competition between resources” and ‘cascading’ are still hardly explored in policy frameworks and certification systems, but may become of increased importance when developing a biobased economy;

4.3
Project preparations for meeting compliance: self-assessments and tools

A self-assessment of a project is a systematic assessment of the project's potential sustainability impacts, and shows how a project 'scores' on various sustainability criteria. They can be undertaken by the project itself, by an external advisor, or by an external auditor as 3rd party audit as pre-condition for certification or financing. Most NPSB projects have executed a sustainability self-assessment (RVO, 2014a). Project developers indicated various objectives for doing a self-assessment (RVO, 2014a), as shown in table 12.

Table 12
Objectives for project developers for doing a self-assessment for sustainability

Objective	Examples and further explanation
Ensuring legal compliance of the biomass projects. May be done in combination with efforts to better embed the project locally.	• Prevalent for projects focusing on local biomass production and use in countries without biomass sustainability requirements from government or market. Example: the rapid livelihood and rural industry fuel assessment from project (DBM01013). • Self-assessments focus on sustainability aspects relevant in legislation or local context, and not cover the whole set of sustainability criteria covered by comprehensive certification schemes (and often needed for export).
As first step towards certification against a recognised sustainability standard	• As 'gap analysis' of the current status of the NPSB project, and the requirements set by the certification scheme (as e.g. done in the project DBM02053). • This objective is prevalent for projects aiming to export biomass to markets with mandatory sustainability standards • A specific 'sub-category' is the NPSB projects aiming to achieve carbon certification; its registration requires a sustainability self-assessment of the envisaged carbon project, including a stakeholder consultation.
In relation to research activity	• A number of projects used a sustainability self-assessment to collect data for specific research activities, to improve methodologies and tools for assessing sustainability aspects. Generally, the scope of these sustainability self-assessments is limited, and focused on the data needs for research. • Examples: project (DBI02009) in Argentina (see box 17), or the Inbio project (DBI02005), that used sustainability self-assessments to collect data and develop recommendations to refine NTA 8080 requirements.
For business or financing needs	• A self-assessment, in the framework of a Social and Environmental Impact Assessment (SEIA) can also be a pre-condition for financing. • Various biomass project developers in the have executed a SEIA or EIA. One example is the Bio2Watt project in South Africa (DBM01012).
Good corporate governance	• As a tool during the planning phase of a project (NL Agency, 2013) • The project (DBM02045) in Mozambique stresses the importance of carrying out a professional sustainability assessment before the start of a project.

Clearly, a self-assessment helps a project to overcome in time issues, which may turn out to be a risk for sustainability during project implementation. A good example is the rice husk project (DBM02053) in Indonesia that aimed for compliance with RSB certification requirements. The gap analysis learned that strong management plan was needed to address technology risks, environmental and social aspects, and residue management. As this can be overcome, the assessment concludes that the project has good potential for positive sustainability impacts and reaching compliance.

It should be realized that, at the time when projects undertook their self-assessments (2009-2011), the referenced international biomass certification schemes were relatively new. This means that practical experiences with these schemes were also relatively limited. Meanwhile, more experiences have become available, on the basis of which schemes have further clarified their requirements and developed guidance documents and tools to help scheme members to work with (RVO, 2014a).

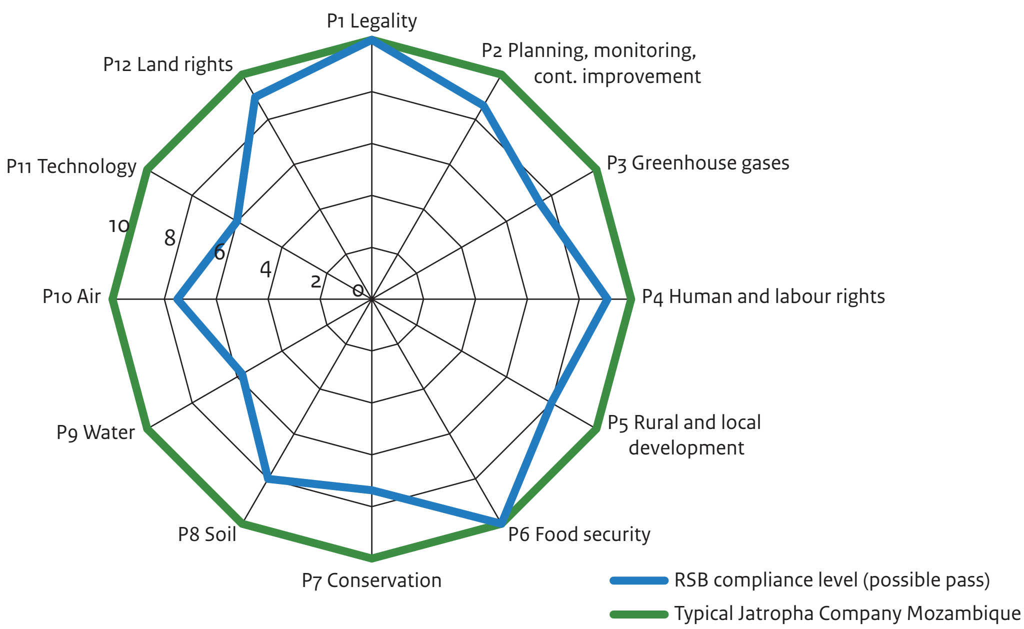
4.3.1
Guidance documents and tools to facilitate sustainability self-assessments and to move towards better practices

Various NPSB projects in the project portfolio have delivered guidance documents and tools (spider maps, road maps, improvement tools) to facilitate sustainability self-assessments of biomass projects and to move towards better practices. These are described in more detail by (RVO, 2014a). In addition, some developed guidance documents and tools on specific sustainability aspects (see also 3.1) or on stakeholder consultation (3.4) can also be used as support and guidance.

The use of gap analyses, spider maps and road maps to reach certification

A gap analysis (see also table 12) learns which improvements should be made in a project to reach compliance of sustainability principles of a certification system. Outcomes can be summarized in spider maps, and translated into a specific road map (see figure 9).

Figure 9
Spider map RSB compliance in project (DBM01003)



Cap scores against RSB:
10: adequate
8: needs improvement
5: needs significant improvement
0: not covered

This approach has been followed in the Jatropha project (DBM01003), where three plantations (intercropping, small scale and large scale) have been assessed against the RSB principles.

The Producer Support & Loyalty Tool (PSLT)

The Producer Support & Loyalty Tool (PSLT) from Solidaridad was introduced in the project (DBM01011) as innovative instrument to engage farmers in a process of continuous improvement that could result in Bonsucro certification over time. The tool allows farmers to self-assess their sustainability performance and identifies areas for improvement. Producers receive recommendations on next steps for improvement. A group analysis report can be developed showing weaknesses in the performance of farmers as a group allowing for a concerted effort of moving towards certification. The results feed directly into an Integrated Control System, which is a database to make group certification of farmers more feasible and cost-effective. The company Raízen, as well as several mills and farmer associations inside and outside of Brazil, have shown eagerness to start using the tool, which will outreach to thousands of farmers in the next years.

Testing the PSLT tool in Brazil, in partnership with the largest mill group and a strong farmer association, was experienced as a strong basis for quickly steepening the development curve of the tool. Once the basic functionality of the tool was well developed and the setting for applying it was well understood, the tool was adapted to less developed sectors in Brazilian agriculture, and will also be adapted for less developed and more challenging settings (Bolivia, Colombia, Mexico).

Key conclusions and lessons learned

- Self-assessment tools serve multiple objectives and can be beneficial for project developers on their road towards reaching e.g. legal compliance, certification, financing, or local acceptance. It allows to mitigate risks, have insight in possible trade-offs and to adjust the project where needed.
- The envisaged use of the biomass (local or export) is a decisive factor for the scope of the sustainability self-assessments. Projects envisaging export of biomass focus their self-assessments on the (elaborated) requirements of a certification scheme. Projects envisaging local use of biomass tend to focus their self-assessments more on ensuring legal compliance, long-term profitability and benefits of the project.
- Experiences learned that a sustainability self-assessment could be a difficult exercise for a biomass project developer. The experienced difficulty depends on the scope and level of detail of the assessment, and the available expertise and know-how.
- The NPSB portfolio served as a capacity building catalyst in this area for various projects. Tools have been (further) developed under the NPSB programme to facilitate sustainability self-assessments and to move towards better practices in time.
- Given their multiple benefits, self-assessments deserve more attention in certification schemes, project development and capacity building.
- It is useful to start piloting a tool in a country with availability of strong expertise and partners; its impact will trickle later down to more traditional development settings, where tool development would be constrained by lack of an enabling learning environment (DBM01011).

4.3.2
Experiences in measuring and demonstrating impacts to proof compliance

The NPSB projects' activities have created a wide range of sustainability benefits, which are explained in part 3. For reaching compliance with legislative or certification requirements, these impacts need to be demonstrated and verified. Lessons are learned in the NPSB projects.

Experiences in measuring and demonstrating environmental impacts

Aspects commonly included in criteria to define sustainable biomass production and use is the estimated GHG reduction and carbon stock change. Other environmental impacts that are mostly included are biodiversity, soil, water and air – although there is variation in how they are addressed. Table 13 shows experiences on how these impacts have been demonstrated and measured. Clearly, the relevance of the impacts differs per project, largely depending on the feedstock used. The conservation of carbon stocks and biodiversity is for example mostly relevant for producers working with the cultivation of crops, and less relevant for the many NPSB projects that worked with residues and waste streams (see also part 3).

Table 13
Translation of environmental criteria into requirements to proof compliance under NPSB projects (based on RVO, 2014a)

Translation of criteria into following requirements:	Experiences	Considerations
GHG reduction savings • Estimated GHG reduction is compared with a fossil fuel reference, as e.g. defined in the EU-RED. • Based on a defined methodology (as e.g. included in the EU RED or specified in certification systems)	• All NPSB projects made use of actual values to prove a certain GHG emission reduction, instead of the (easier) use of default values.	• Collecting actual GHG data is considered time consuming. In some cases, data were not available in sufficient detail. • This seems to be particularly the case for (groups of) small producers, for whom relevant data are not or incompletely registered at central (e.g. cooperation) level
Conservation of carbon stocks • Biomass production not allowed on land with high carbon stocks; • Or only allowed if the loss of carbon stock during land use change can be 'paid back' by biomass production, in a specified maximum period.	• Few projects have (yet) quantified carbon stocks. • They have or will be quantified by means of using pre-set default values, literature data on carbon stocks, (e.g. for bamboo in DBI02006) or by field measurements (DBI01010).	• Default values are more straightforward to use than actual values, but not available yet for many specific situations (e.g. bamboo forests). • Field measurements are perceived as a complex exercise (DBM01014, DBM02031). • Difficulties in collecting field data on carbon relevant emission sources are considered also an obstacle for GHG calculations.
Biodiversity: • Compliance with relevant laws and regulations on biodiversity. • Various NPSB projects specifically looked at assessment of High Conservation Values (HCV) areas, and ways of dealing appropriately with those values.	• Five of seven NPSB projects executed a HCV assessment, mainly on a generic level. • Few projects reported on taking specific measures to maintain or enhance biodiversity.	• There is a need for further guidance on HCV assessments. • Although benefits of enhancing biodiversity have been reported (see part 3), they are not reported (and therefore not acknowledged) as such.
Soil: • Focus primarily on (compliance with) legal requirements. • Supplemented by an assessment of agronomic aspects on maintaining or improving soil quality for some projects.	• Some NPSB projects (DBI01010, DBM02011, DBM02053) have specifically studied effects of intensive harvesting of biomass (residues) on soil quality (see also 3.1.4).	• The results are expected to be a valuable contribution to discussions on further development of standards to protect soil quality.
Water and Air: • Focus primarily on (compliance with) legal requirements.	-	-

Table 13 shows that projects have verified their compliance with multiple environmental criteria through (partly) demonstrating compliance with the Law (see also 4.1.3). In various cases (for example for carbon measures or HCV values), the need for more detailed (field measurement) data turned out to be more complicated and time intensive. The use of good default values is therefore of importance for biomass value chains.

Experiences in measuring and demonstrating socio-economic impacts

The relevance for demonstrating the socio-economic impacts differed for projects. Land rights are, for example, only relevant for those projects that worked on biomass cultivation.

Projects reported in very different ways on their possible contribution to the different socio-economic indicators (see table 14). This is not surprising, given the large variety in (business models of) the projects, the local embedding of projects, and in the variation in countries where projects have been executed. At the same time, this makes it difficult to draw overall conclusions on achieved impacts.

Table 14
Translation of socio-economic criteria into requirements to proof compliance under NPSB projects (based on RVO, 2014a)

Translation of criteria into following requirements:	Experiences	Considerations
Land rights • The majority looked at the issue of land rights in the framework of a process towards certification of their project, and the requirements set by the envisaged certification scheme. • Claims on land rights have primarily been verified by referring to legal compliance and document checks.	• Stakeholder consultation is a requirement for projects seeking certification from some of the major international certification schemes, though not all.	• Claims on land rights have less been verified by reference to explicit stakeholders' consent gained in a stakeholder consultation process • This is further discussed in 4.5.
Impact on the local economy • Certification schemes use different wordings to indicate this criterion • Examples are 'positive contribution of private company activities to the local economy and activities' (NTA 8080) or 'fair opportunities for employment and provision of goods and services are given to the local population' (RTRS).	• The NPSB projects provided a variety of indicators to (qualitatively) substantiate that their project contributes positively to the local economy. • Examples are increased incomes, creation of jobs, diversification of income sources or reduced dependence on fossil fuels (see 3.3.1). • Only few NPSB projects provided quantitative data on, for example, the number of jobs created.	• Projects experienced it as difficult to substantiate claims on impacts on the local economy with specific, quantitative data. • This is in particular the case if projects cooperate with (many) small family farms, where economic aspects such as investments, job creation and income benefits are less easy to quantify. • This makes it difficult to draw solid (quantitative) conclusions on the overall contribution of projects to local economies.
Well-being local population: • Different wording and indicators are used by certification systems to cover the criteria on 'social well-being'. • In the survey (RVO, 2014a), projects were questioned on five different indicators: capacity building, improved market access, health and safety aspects and gender	• Capacity building: Training provided. • Improved market access: Organizing cooperatives, product improvement, guarantee sustainability, lobbying. • Health and safety: Considered as part of SEIA or sustainability assessment. • Gender: Reporting on equal opportunities, involvement males-females, presence of company gender policy.	• Capacity building: Scope and extent varies strongly amongst projects. • Improved market access: High variety of indicators used to demonstrate market access. • Health and safety: Large variety of aspects are addressed under the NPSB projects. • Gender: Information provided is limited; not elaborated how this principle worked out in practice.

Key conclusions and lessons learned

- To demonstrate compliance, the NPSB projects focused (at least partly) on compliance with legal requirements for most environmental impacts.
- Collecting detailed data and field measurements were needed to calculate actual data for carbon emissions and GHG calculations. This was experienced as time consuming and complicated;
- It is recommended to make project developers aware of the option to use (pre-set) default values, while extending the number of chains for which these can be used (e.g. for bamboo) and to make (further) available existing practical tools and guidance documents related to carbon stock field measurements.
- It is also recommended to facilitate the execution of HCV assessments and broader biodiversity assessments under biomass projects;
- Data collection for measuring socio-economic impacts proves to be difficult, especially when this concerns projects working with (groups) of small farms. Precisely here lie the opportunities and risks for poverty reduction (see 3.3).
- Given the benefits that can be achieved, it is necessary that claims in relation to a projects' contribution to the local economy and well-being are better demonstrated, with the use of a harmonized set of indicators and guidance from certification schemes.
- This requires the further development of tools and guidance for quantifying biomass projects' contribution to local economies.

4.3.3 Experiences in measuring and demonstrating sustainability compliance for residues and wastes

A number of NPSB worked with residual materials from forestry and agriculture. For this feedstock category, there has been discussion on the applicability of the criteria, and on the terminology of the feedstocks.

On policy level, the EU-RED has excluded residues and wastes from certain land-based sustainability criteria for biofuels. The use of residues, wastes and lignocellulosic materials is also rewarded under the EU-RED through double counting (see box 13). For compliance, a feedstock must meet the established definitions for residues and wastes. On EU policy level, these are developed on Member State level for wastes and residues for biofuels. Definitions differ from country to country. Certification systems refer to these national legislations, or have developed their own definitions or lists.

Exclusion criteria and requirements for residues and wastes for solid biomass are not or hardly developed in policy frameworks. This has resulted into different perceptions on what is perceived as a residue from a project developer or from a policy perspective. For example, in the bamboo project in Colombia (DBI02006), biomass may be either a crop or residue, depending on what material is used. Depending on market circumstances, all crop elements may be considered a residue for pellet production (or not). Similar gaps exist under certification systems for solid biomass. The Inbio project (DBI01006) learned for example that there was not a terminology and protocol for post-consumer wood waste under the NTA8080.

The termination of the definition of a feedstock (residue or not) can have far consequences for a project developer in terms of the scope of its sustainability assessment (what criteria included), data collection needs and costs and market applicability.

Key conclusions and lessons learned
- Further action is needed, together with other stakeholders, to harmonise definitions for residues and wastes for biofuels to ensure a level playing field for market actors;
- There is a gap in terminology on wastes and residues for solid biomass. Consequently, perceptions differ and requirements are not clear in the market. Definitions for residues and waste for solid biomass, and what sustainability requirements apply, need to be developed, and agreed upon.

4.4 Experiences with certification in the market

A significant number of NPSB projects have worked on sustainability certification of their biomass (project). For some projects, certification was an envisaged project result. For other projects, certification was a longer-term objective for which project activities were supposed to lay a solid basis. Objectives for certification differ between project developers. They are explained in detail by (RVO, 2014a) and include the following categories of motivations:
- Compliance with regulatory requirements, as stipulated by (DBI02011) or (DBI0200);
- Compliance with market requirements, or developing new market opportunities;
- Requirements from stakeholders, as e.g. the financing sector, and civil society;
- As a tool in the Corporate Social Responsibility policy (CSR);
- To build a quality assurance and management system.

In the last category, obtaining the certificate may not be the first priority. The added value here is in the process of working systematically with a certification system, as framework for (part of) the company's quality assurance and management

In addition to the projects working on biomass certification, five projects have worked on carbon registration (CDM or Gold Standard). Table 15 summarizes the projects, which worked on biomass certification and on carbon registration, and their intended certification scheme (RVO, 2014a). At the closure of the program, three NPSB projects have achieved sustainability certification of their biomass. These are the Argentinean project (DBI02009), the sugarcane project (DBI02011) and the cassava project in Panama (DBM02024). Other projects are still in the process towards certification.

This section describes the learned lessons in relation to experiences in selecting a certification system, competition, costs and benefits of certification, and experiences in the process towards certification, with specific attention for smallholder certification.

4.4.1 Selecting a certification system

Since the start of the NPSB projects, multiple certification schemes have been developed and today, many different certification schemes exist. Some are specifically aimed at biomass for biofuels, other schemes focus on one particular type of biomass. Schemes also differ in the way they are being governed (e.g. multi-stakeholder governance), the scope of sustainability aspects covered, and the level of audit quality (NL Agency, 2013).

The availability of different voluntary systems has created competition in the certification market and provoked debates on their effectiveness, costs and levels of assurance. Companies have expressed the need for transparency on systems' information within ongoing developments (see box 20), in order to select a certification system that applies best to their businesses (Info I, 2012).

Box 20
Developments in certification systems: in number and in content: Some highlighted developments

- In the beginning of 2014, the EU has recognized 14 voluntary schemes (3.1). In the Netherlands, ISCC is the most used sustainability system for biofuels, with an increased market share 57.5% in 2011 to 76.2% in 2012;
- For solid biomass, the Green Deal report 2013 and monitoring report (NL Agency, 2013a) show that the GGL is the most used sustainability system (52.3%) for solid biomass by those parties that signed the Green Deal, followed by the use of Laborelec, which certifies mainly energy efficiency (28.4%). Other systems that have a minor share in the market are forest certification systems or the NTA8080 (0.6%) (Info II, 2013).
- Since their EC recognition, biofuels schemes continue to make changes to their standards and guidance documents, as well as to implement cross-acceptance procedures among them. This possibility exists for ISCC, REDcert or 2BSv (Info II, 2013). Due to this possibility, it is well possible that different systems are used at the beginning of the value chain than reported at the end of the chain by the economic operator (Info II, 2013);
- Biofuel certification schemes are also looking for further harmonization between each other. Not only within the scope of biofuels but also in relation to schemes used in competing sectors. Meanwhile, both ISCC and NTA8080 are working on extending the scope of their certification to a broader range of products: the biobased economy (Info I, 2013).

Table 15
Key characteristics of biomass projects working on certification and carbon registration.

Selected scheme	Project, operating country, biomass source	Considerations for selecting certification system
NTA8080	Wood waste Vietnam (DBI01002) Torrefied bamboo pellets Colombia (DBI02006) Jatropha - Tanzania (DBI02007) Pyrolysis project, Spain (DBI02002)	• As 'a robust and credible scheme managed in the Netherlands'. • Most appropriate scheme for the pyrolysis project (DBI02002) after a benchmark between NTA8080, ISCC-RSB and EU RED.
Fair Trade	Jatropha – Tanzania (DBM01018)	• The project concentrated on 3 key Fairtrade requirements: food security; local access to energy and economic viability. Fairtrade certification is possible. • Follow-up is not recommended as economic analysis learned that the product will not be traded for export but locally used.
RTRS	Soy, Argentina (DBI02009)	• Credible crop-specific scheme • The project developer has an interest as board member and wishes to improve the credibility and position of the scheme.
RSB	Jatropha, Mozambique (DBM01013) Soy / maize, South Africa (DBM02037)	• As the most preferred one to work with smallholders. • After a multi-criteria analysis, the RSB has been selected for certification of the Jatropha plantations in Tanzania, in that time frame and context.
ISCC	Cassava – Panama (DBM02024)	• Most widely applied in the international biofuel markets
IWBP	Torrefied biomass – Mozambique, (DBM02045)	• Intention that product is globally applied for biomass pellets.

Rainforest Alliance (later Plan Vivo)	Candlenut and castor bean – Indonesia (DBM01031)	• Plan Vivo instead of opting for Rainforest Alliance because of better applicability in the local context • Plan Vivo was considered to have higher added value as a Payment for Ecosystem Services standard; potentially solving some longer-term financing of certification;
BonSucro	Sugarcane – Brazil (DBI02011)	• Credible crop-specific scheme. • The project developer has an interest as board member and wishes to improve the credibility and position of the scheme;
CDM	POME – Indonesia (DBM01014) POME – Colombia (DBM01015) POME – Sierra Leone (DBM02026)	• Carbon standard required
Gold Standard	Biogas, South Africa (DBM01012) Coffee waste, Colombia and Nicaragua (DBM02032)	• Carbon standard required
To be decided	Inbio project (DBI01006)	• After a benchmark, the project concludes that there is no single framework that 100% complies with the selection criteria, see also 4.3.3

Which biomass certification scheme is most appropriate in a specific situation depends on a variety of factors. A company's most suitable certification system depends amongst others on the company's own strategy, costs, benefits, structure and position in the market. Project developers have chosen a wide variety of certification schemes for various reasons (see table 15).

Selecting a certification scheme is an important and not always easy step for project developers, as it may impact on operational practices, market perspectives, stakeholder perceptions, and has cost implications. Guidance materials and handbooks have therefore been developed under the NPSB programme to guide the biomass producer through the options of certification systems. These are:

- Selecting a biomass certification system: a benchmark on level of assurance, costs and benefits (2012)
- How to select a biomass certification scheme? (2011);
- The Handbook sustainability certification of solid biomass (2013) and;
- The Handbook sustainability certification of biogas (in Dutch only), (2013).

Other organisations have executed benchmark studies of operational certification schemes. The results of these studies have further assisted the scheme selection process for a particular project (NL Agency, 2013) and shed light on the different characteristics of the schemes, see table 16:

Table 16
Benchmark studies on certification schemes, published during the course of the NPSB programme

Report	Key findings
"Social sustainability of EU-approved voluntary schemes for biofuels - Implications for rural livelihoods", CIFOR (2011)	• Evaluated the social sustainability approach of EU recognized sustainability schemes for biofuels • Two of the evaluated schemes (Abengoa, 2BSvs) lack any social sustainability requirements. When covered by the schemes, poor coverage of critical social sustainability components and gaps in procedural rules are expected to undermine achieving social sustainability (Info I, 2011).
How to select a certification scheme - a benchmark on level of assurance, costs and benefits (NL Agency, 2012)	• There is a relation between costs, benefits and level of assurance between voluntary certification systems. • It can be concluded that the systems that are most compatible with the requirements as benchmarked in the study (e.g. the Roundtables), are also the more expensive ones.

Searching for sustainability - Comparative analysis of certification schemes (WWF, 2013)	• The study concluded that various EU recognized schemes fall short of ensuring that Europe's targets towards increased biofuel use is not contributing to negative environmental and social impacts. • The study found that many of the analysed standards had middle to low-level performance (Info II, 2013).
"Betting on best quality certification for biomass, soy and palm oil" (IUCN, 2013)	• Provides insight in the quality and assurance level of voluntary schemes from biomass, soy and palm oil; helps stakeholders bet on best quality certification. • An indicative score of high, good, medium and low quality is given to all 10 compared schemes (Info II, 2013).

The overall conclusions from these benchmark studies are that:

- There is a difference between the level of assurance and quality of certification systems, also when all recognized by the EC (NL Agency, 2013a). The certification systems that are more holistic and have a higher quality and assurance level are also the more demanding ones, both in requirements and in costs.
- Generally, the schemes that are scored with middle to low-level performance, and are less expensive, have the highest market share in the European market (and in the Netherlands).
- There is a difference between the coverage of criteria by certification systems: socio-economic criteria are not covered by all the EU recognized schemes.
- The project (DBM02050) learns, on the other hand, that the choice of a system may also result into limited coverage for presenting positive impacts. The sustainability analysis of the biomass itself (the bagasse as residue) was performed according to the NTA 8080. As residue, economic impacts (benefits for this project) do not have to be reported reported. These were presented under the Global Reporting Initiative, whose indicators were used to analyse the sustainability analysis for the trapiche itself.

Competition between certification schemes

A number of project developers indicated that they were confronted with 'competition' between biomass certification schemes. This was in particular the case for project developers who aim for certification of biofuel destined for the mandated EU market. Biomass schemes actively tried to position themselves as 'attractive', 'cost effective' or 'easy to implement' in project's specific circumstances. Some project developers indicated that this had led to reconsideration of and/or doubt over their original choice for a certification scheme. However, there are no indications that this has indeed led to selecting another scheme (see table 15) under the NPSB projects.

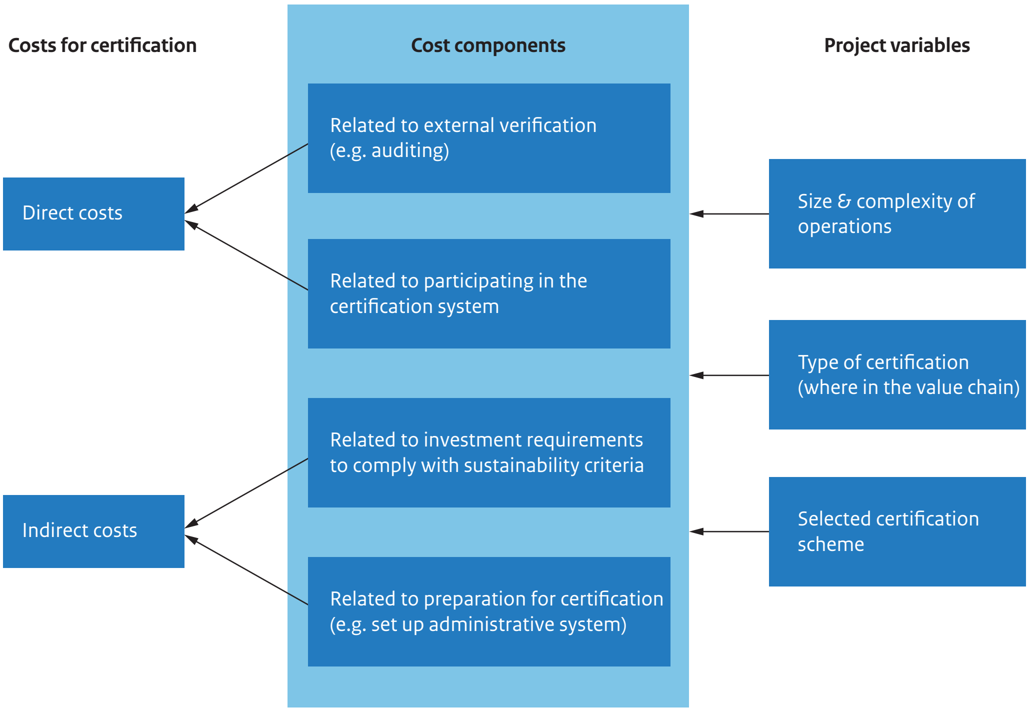
The Argentinean project (DBI02009) and the Indonesian project (DBM02038) specifically highlighted the aspect of competition under certification schemes. The project (DBM02038) mentions that the commercial benefit of working with a good quality standard (as RTRS) has eroded. Underlying given reason is the EC approval of other standards, that are meant to cover minimum requirements of the EC biofuel regulations but do not add additional social or environmental criteria. The project experienced fierce competition between 2BSvs, ISCC and RTRS on the biodiesel certification market. The project (DBM02038) confirms the differences in the level of assurance offered by the various certification systems to prove compliance with the EU-RED. The majority of companies choose the systems with the lowest level of assurance.

Differences do not only exist between the EU approved schemes. The project (DBM02038) also highlights the difference between RSPO and ISPO in requirements. ISPO is a government certification scheme issued through a ministerial regulation. All oil palm producers in Indonesia obliged to follow it. ISPO is a system less strict for specific requirements than the RSPO (see also 4.1).

Costs and benefits of certification

Generally, it is difficult to compare figures from individual projects, as project variables and cost components vary from project to project (see also figure 10). Certification has a cost, which may differ per certification scheme. Certification also generates benefits.

Figure 10
Cost components and project variables that determine certification costs



In some cases, the cost (for a specific scheme) may be considered too high, as was the case for NTA8080 certification in the Colombia project (DBI02006). The Jatropha assessment (DBM01013) learns that the RSB (as standard with high level requirements) asks for extensive resources to prepare for certification, which was experienced as a hurdle for smallholders (see also 4.4.3). Versus the cost of certification, there are also benefits. For project developers, it is important that the benefits outweigh the costs, where costs for certification can be seen as 'upfront investment', required to ensure market access or other benefits.

Direct benefits of certification may include:
- A direct financial premium for certified biomass, which will offset the investment costs. Sustainability certification of biomass for energy applications generally does not lead to substantial market premiums and is increasingly considered as part of biomass chain actors' licenses to operate, without premiums being paid by buyers of that biomass (RVO, 2014a).

Indirect benefits may include:
- Access to markets, which require certified biomass;
- Improved stakeholder relations, as requested under a certification scheme;
- Better access to capital, as certification may reduce project risks for financers;
- Better quality management and improved operational practices, leading to more efficiency and/or cost reductions (see box 21).

Box 21
The economic benefits of certification through better quality management
In the Centre-south of Brazil, there is a fierce competition between mills over sugarcane. Sugarcane farmers cannot be paid substantial premiums in sugarcane to motivate them into certification, given the competitive and basically cost-driven market environment in which the mills operate. Farmers therefore need to be engaged in certification on the basis of a positive agenda.
The project (DBM01011) learned, that even advanced farmers could be supported in increased understanding of their own business, enabling them to make better business decisions. Whereas certification against the BonSucro producer standard appeared not attractive, the work executed to prepare for certification helped in better organising the management and operational control of the companies. Certified mills mentioned that certification challenged them to take a fresh look at their operations and helped them realize where improvements could be made. An internal study performed by one of the mill groups recently demonstrated an 87% return on investment as a result of Bonsucro certification (DBM01011).

(Expected) benefits of certification are primarily indirect. The financial benefit is more difficult to quantify (RVO, 2014a), but may result worthwhile, as indicated by one of the mills in Brazil indicating the 87% return of investment as a result of Bonsucro certification.

Key conclusions and lessons learned
- Knowledge and experience in certification has grown substantially, both within the NPSB programme as externally, especially for biofuels.
- Three NPSB projects have become certified; other projects are still in the process of certification (see table 15) and need more time to reach full compliance. Considerable lessons are learned.
- Competition between certification systems has increased considerably.
- The use of certification for compliance of regulation has resulted in the emergence of systems that only comply with laws and regulations. Consequently, for biofuels towards Europe, there is a tendency towards 'easier' non-holistic certification systems for proving compliance towards EU-RED with no or limited coverage of social or assurance requirements. This entails a risk for securing the role of EU renewable energy policies towards poverty reduction and sustainable development.
- The EU has to provide stronger guidance in auditing requirements, and needs to develop procedures on monitoring schemes (and their changes) after recognition.
- Competition between schemes is also signalled between RSPO and ISPO. Whereas RSPO is on various aspects a higher quality standard, ISPO reaches (through legal obligation) a larger market. This presents the dilemma on how to reach impact with certification schemes: through market volume or requiring highest quality, with often a smaller market volume?
- Certification has indirect and direct costs and benefits, and both can be different from project to project. For project developers, it is important that benefits outweigh the costs. For doing so, a careful selection of the certification scheme is required.
- Sectors change in their potential for compliance, affordability, and preference for standard over time, while standards adapt their requirements over time. The optimum standard for a producer is therefore dynamic and not fixed in time.
- Certification can be considered as a tool for reaching better management farmers. When certification is seen through this viewpoint by projects and their suppliers, this can result in increased long-term beneficial relationships to create an enabling environment to jointly improve the social and environmental impacts of a sector or industry;
- They should be better aligned with business plan development and already start to play a role during the design phase of projects to have real impact.

4.4.2
Lessons learned in the process towards certification

Within the NPSB programme, multiple lessons have been learned in the process towards certification. Most of the NPSB projects are still in the process towards certification, and did not become certified within the timeframe of the programme. Delays encountered reflect the fact that (working towards) certification can be a complex exercise for projects that are innovative in feedstock choices, technologies and in their country selection.

Three projects did become certified:

- The Argentinean project (DBI02009) imported batches of RTRS certified traceable biodiesel into the port of Rotterdam: at least 10,000 tons of certified biodiesel from each pilot.
- Under the (DBM01011) project, the mill 'Raízens Maracaí' certified more than 20,000 hectares of sugar cane. A Bonsucro certified batch arrived in the Port of Rotterdam; the first batch of Bonsucro certified ethanol to enter into a European port.
- The cassava project in Panama (DBM02024) reached ISCC certification.

This section discusses the experiences and lessons learned on certification on specific aspects (e.g. introducing certification in new countries), which are inherent to the innovativeness of the NPSB project portfolio. This is also discussed in more detail by (RVO, 2014a). Five of the NPSB projects aimed for carbon certification (see also table 15). Specific experiences and lessons learned on certification under carbon mitigation projects are highlighted in box 22.

Box 22
Lessons learned in certification under carbon mitigation projects
Carbon mitigation projects require that its benefits are generated in the producing country. This implies for biomass projects that the bioenergy is used for the local market. This is one of the reasons that the need for sustainability certification for biomass (as add-on next to carbon certification) was not considered by most of the carbon mitigation projects (Carbon Finance, 2012). Other reasons had to do with the fact that: i) most projects used biomass consisting of waste streams, where sustainability certification is less relevant, ii) the end-use market was not subject to mandatory certification requirements and iii) carbon certification is in itself considered as sufficient proof to be sustainable, as mentioned by (DBM02032 and DBM01015). This is especially true in the arena of people working with projects on climate mitigation. Perceptions on sustainability differ per context, country and expertise.
Climate projects can indirectly contribute to sustainability certification by contributing to compliance requirements of a certification system (e.g. GHG reduction, better handling waste). In practice, there are not many projects where both climate finance and sustainability certification apply to the very same biomass (Climate Finance, 2012). There are overlaps in requirements between climate finance instruments and sustainability certification schemes. However, the instruments and schemes differ in their strictness and in the level of detail they require. There is currently very limited possibility to actually substitute reporting and monitoring requirements under one track with reporting and monitoring under the other track (Climate Finance, 2012).
Three of the carbon projects in the portfolio focus on biogas capture from POME, generated at the processing unit of oil palm fruits. In these projects, two different types of (processes towards) certification go alongside: the certification of the carbon project (biogas capture), and the certification of the biomass plantation and processing unit from which the wastewater stream was generated. These certification processes are not necessarily interrelated, and can be undertaken independently: for carbon project registration, sustainability certification of the crop from which the residue/waste stream is derived, is not required. On the other hand: for certification of oil palm certification against e.g. RSPO requirements, biogas capture from wastewater is an explicit requirement.

- Processes towards biomass sustainability certification, and certification of a related carbon project, are thus not necessarily linked. Procedures, scope and requirements differ. Situations may occur in which a carbon project focusing on treatment of biomass waste (water) becomes formally registered, while the sustainability performance of the (related) biomass project generating the waste (water) is unknown.
- There is currently very limited possibility to actually substitute reporting and monitoring requirements under one track with reporting and monitoring under the other track. Further harmonization is desired to better synchronize efforts needed for both procedures.

Lessons learned on certification in relation to development phase of the project
Certification is generally easier for existing biomass projects than for new biomass projects as the certification process can build on the available basis of existing policies, operational procedures, etc. New, not yet operational biomass projects do not have this existing basis of information. Project developers and suppliers may also need time to familiarise themselves with the principles and requirements of certification, which was especially true for those projects that worked on certification of smallholders or outgrowers. This is further discussed in 4.4.3 and 4.4.4.

Thus, evidence (and experience) required for certification therefore needs to be built 'from scratch' for not yet operational biomass projects (RVO, 2014a). However, when certification requirements are well defined from the start, they can be optimally integrated in regular business planning and development (see also part 5).

Lessons learned on certification in relation to the introduction of alternative feedstocks
Sustainability certification is well developed for a number of mainstream biomass streams, and many experiences exist for certification of e.g. wood, oil and sugar crops. Experiences are more limited for innovative biomass streams or alternative crops. Several NPSB projects worked with innovative biomass streams, for which experience with certification is not yet or limited available. Examples are the use of reed for pellets in the project (DBI01010) in the Ukraine, or the bamboo project in Colombia (DBI02006). Consequently, required terminology, procedures (DBI01006) or default values (DBI02006) may not have been developed yet for these streams. As examples:
- Bamboo is not included in the list of default biomass chains considered by the EC. Achieved GHG emission reductions therefore needed to be demonstrated, as was done successfully in the project (DBM02006), see also 3.1.1. This required additional monitoring activities compared to the use of default values.
- One of the key hurdles in the project (DBI01006) was the impossibility to certify the pellets against the Green Gold Label (GGL), due to lack of a protocol and terminology on post-consumer wood waste. This resulted in the impossibility to find a suitable buyer, despite the successful realization to pilot the 6 MT test production of pellets from mixed woody resources from Virginia (USA) and the presence of a market and buyers. The final sales of 12 million tonnes have not been realized during the project time. Buyers require that sustainability conditions are met and proven with a certificate. The development of a protocol for post-consumer wood waste is in development under GGL;
- Several projects also worked with the valorisation of residues and waste streams. Unfamiliarity for some of these biomass streams, especially on their terminology and their categorization as residue – or not (see also 4.2.4), resulted into uncertainties.

Lessons learned on certification in relation to "new countries"
Several of the NPSB projects contributed to gaining lessons in countries, where experiences in certification are still limited for producers, suppliers and for certification systems themselves. Working in a new country may require in some cases an adaptation in a standard to adapt to specific local conditions, as was for example experienced in the Ukraine and in Mozambique:
- To prove wood biomass sustainability in the Ukraine one may refer only to voluntary certification schemes and procedures (NL Agency, 2013d). In the Ukraine, the project "Pellets for Power" (DBI01010) translated, and tested, the NTA8080 into the local context. Overall NTA8080 certification seemed possible. Some non-conformity risks were identified as well, regarding certain provisions for legislation and stakeholder consultations. These issues are strongly related to the country circumstances in the Ukraine. The Ukraine project (DBI01013) realized a first forest location in the Volin region to become FSC certified in 2013.
- In Mozambique, the supply chain in the project (DBM020245) was used as first pilot for testing the sustainability principles from the IWPBI (see also table 15). The pilot project learned for example that the data need for an HCV assessment was either coarse or absent. Assessing the distribution of land rights was also found to be challenging in Mozambique, due to limited availability of documentation and lack of transparency in the process of land use planning (see also 3.2.2). The Jatropha project in Mozambique (DBM01013) mentioned that the Jatropha industry has little experience with sustainability standards, which has its influence on data collection.

Certification for biomass just recently started and experiences still need to be built. Clearly, starting certification in a country where this tool is still unexplored requires an effort from project developers, certification systems and governments to learn, gain experience and prepare for required data and documentation.

Lessons learned on certification in relation to introducing alternative or multiple end-uses

Project experiences towards certification of alternative end-use markets or technologies have been limited because of various reasons:

- On the technology side, most of the projects were in the R&D and pilot development phase, where certification is no priority. This will be needed when starting commercialization.
- On the market side, certification has not been a priority either as this is for most end-use markets (e.g. feed or food markets) not a legal requirement. How to deal with the use of biomass for multiple end-use markets is, however, under discussion (see box 23).

Box 23

Certifying biomass in a market for multiple end-uses: the biobased economy

The growing biobased economy has gone hand in hand with ongoing policy debates on how to better design policies to promote the bioeconomy, and how to best use biomass resources according to the cascading principle (Info II, 2013). In 2012, the Dutch multi-stakeholder Commission Corbey concluded that the increasing use of biomass in a biobased economy strengthens the need to guarantee the sustainability of biomass. Biomass will increasingly be used for different applications. The sustainability debate must 'centre on sustainable land use, and not the type of biomass or its employment'. This shall be facilitated by one generic set of sustainability criteria for biomass, which is not dependent on the application of the biomass (NL Agency, 2013a).
The need to certify biomass regardless of its application has also been recognised by certification schemes. RSB, ISCC and NTA 8080 are currently in the process of specifying standards that allow certification of biomass used for bio-based applications other than bio-energy (NL Agency, 2013a).

Few experiences and lessons learned have been shared: The POME project (DBM01015) did actively participate in the RSPO to disseminate its experiences on the sustainability assessment of capturing methane emissions from palm oil effluents. The project (DBI02002) concluded in a self-assessment that pyrolysis oil can be certified under NTA8080, and can therefore be placed on the market as a sustainable biofuel.

Spin-offs in learning of operationalization sustainability criteria: feedback to Roundtables and other certification schemes

An important spin-off from the NPSB projects has been the input from individual projects to Roundtable initiatives and other certification schemes on lessons learned on practical experiences in working with the standard. This was in some cases complemented with specific recommendations to improve the standard. Examples are given in table 17 and discussed in more detail in (RVO, 2014a):

Table 17
Spin-offs NPSB projects to roundtables and other certification schemes

Certification scheme	Output	Explanation
NTA8080	Report	Lessons learned from the pyrolysis project in Spain (DBI02002)
NTA8080	Report 'Concretizing the social themes incorporated in NTA8080'	• From the project (DBM02038) in Indonesia. Suggestions as on e.g. how social themes in NTA8080 could be specified further and; • Where possible, on verifiable indicators to measure the implementation of the relevant criteria.
Bonsucro	Shared initial experiences made with chain of custody (CoC) certification standard with the BonSucro EU Working Group	• Lessons learned in the project (DBI02011) led to adaptations in the CoC standard and made it more practical for operators to work with. • This includes the development of a group certification protocol, which is currently being piloted in Brazil. • A training manual on Better Environmental Practices in alignment with the Bonsucro Standard.
UTZ certified	Based on the experiences in the coffee wastewater project (DBM02032), UTZ guidance material has been developed	• A new Guide called: Guide for the Construction and Management of Biodigesters for Smallholder Coffee Processing • UTZ is further looking into possibilities to adapt the Code of Conduct to better integrate the efficient use of wastewater.
RSB	Lessons learned and recommendations are addressed to the RSB for further improvement of the standard.	• The POME project (DBM01015) has been instrumental in internal testing of the RSB framework to compare the GHG emissions to business as usual companies. • The RSB Jatropha assessment (DBM01013) recommended some improvements in definitions
RTRS	The Argentinean project (DBI02009) shared experiences and information on GHG data of soy cultivation and processing in Argentina. A registry platform was developed as well for the RTRS under this project (DBI02009).	• Results on GHG emissions were shared with the RTRS EU-RED Working Group and the European Commission. It is likely that these reports will become part of the review of the coming EU-RED default value evaluation. • The registry platform functions as a practical tool (database) under the EU-RED mass balance verification methodology. The manual for the RTRS Trading Platform and the Certificate Trade Platform is available through the following link: https://platform.responsiblesoy.org
RSPO	Recommendations to the RSPO	• The PLUP project in Indonesia (DBM02039) provided detailed recommendations, namely in relation to integration of community maps in spatial planning.

Key conclusions and lessons learned

- Certification for biomass just recently started and experiences still need to be built.
- The NPSB projects contributed significantly in those areas where certification still needs to be further explored: for its use for alternative feedstocks, unexplored countries or alternative technologies.
- Results have been shared with certification schemes to adapt in their future standards.
- Certification in unexplored countries and of alternatives feedstocks and end-uses is more complex. No standard templates, references, default values or databases are available. Also, the selection of a certification scheme may be more difficult (RVO, 2014a).
- Gaining experience and the development of these certification procedures is crucial for innovative biomass resources and/or biomass producing countries to get access to the international market and to drive a change in sustainable practices.
- The future for certified sustainable biomass produced in a country with limited certification experience, or the use of alternative feedstocks and technologies for bioenergy, depends on concerted action on multiple levels: Between governments, legislators, certification systems and biomass producers to overcome barriers (DBI01010).
- It is essential that this effort include an ongoing discussion and cooperation with the users of certification systems (buyers, producers) to understand the realities and practicalities of certification on the ground.
- Capacity building is in many countries crucial to realize certification. Sustainability criteria and certification should be a part of knowledge sharing and capacity building in a project to personnel, local governments and communities (DBM01013).
- This may also require additional efforts from governments and research organizations to enhance data availability and maps in a country, e.g. in the identification of HCV areas.
- Standard developers and certification bodies can help improve the implementation of sustainability standards. Among others, this requires adjustments to used terminology and improved methods for verification to adapt to the local context of a country (DBI01010).

4.4.3
Experiences in smallholder certification

Around 2.5 billion people in the world are involved in smallholder agriculture; they have a large role in managing sustainable resources and food productivity. It is also a vulnerable group, often facing high poverty rates. Given the characteristics of smallholders, and looking from a sustainability and poverty reduction perspective, it is an important group to work with (see table 18). Several of the NPSB projects worked with smallholders, as specific target group in the context of production and certification of agricultural production and with the ambition to include them in the supply chains.

Table 18
Specific characteristics of smallholders

Characteristic	Explanation
Small-scale	• Limited volumes for sale and production: organization in groups of farmers needed to enlarge volumes or supply;
Production management	• Around 2.5 billion people are involved in smallholder agriculture; they have a large role in managing sustainable resources and food productivity; • Farmer is often combined with subsistence farming, low-inputs (and therefore relatively low yields), especially in developing countries
Limited financial resources	• Vulnerable group with often high poverty rates – with considerable potential for improvement when well supported; • Limited financial resources for investment.
Limited human resources	• No to limited expertise.

The smallholder' characteristics (see table 18) may result into some specific barriers for getting smallholders certified, especially when compared to larger biomass producers. A number of the NPSB projects have come across these barriers for small producers, e.g. in sugarcane (BonSucro), palm oil (RSPO) and Jatropha (NTA8080) certification. Solutions are provided as well to overcome those barriers. They are discussed below one by one.

Certification costs in relation to financial capacity

Unlike large companies, small producers are unable to make the required investments for certification. The Zebra project (DBM0104) intended, for example, to verify and certify the oil palm smallholders against the RSPO sustainability criteria, with support from other partners. The farmers needed to be compensated with extra additional costs as well with an incentive premium to join the certification process. The agreement with the buyer didn't materialise, making certification of the supply base from smallholders economically non-viable.

Solutions

- The national certification framework in Mali (DBM01005) uses a cost differentiation for the certification fee to different types of farmers, differentiated to the size or complexity (small, medium, high) of a company. The large companies paying the highest costs. Very small producers do not need to be certified. This approach can be copied by other certification systems.
- Project developers or down-stream suppliers could accommodate for further inclusion of smallholders in the supply chain, from a CSR perspective.

Meeting standard requirements for certification

To facilitate certification of small producers, major certification schemes such as RSPO, RTRS, NTA8080 and others have developed specific regulations, which aim to make (the process towards) certification for small producers less complex and more cost-effective. However, in practice these provisions insufficiently take away barriers for small producers to become certified.

Within the NPSB projects, two projects (DBI01013 and DBI02007) looked at the feasibility of gaining certification for smallholder Jatropha production. In the project (DBI01013), RSB certification was still considered too demanding for two smaller Jatropha companies in Tanzania (DBI01013). These lessons were shared to the RSB and the Jatropha sector.

Similar experiences were found in the project (DBI02007) for obtaining NTA8081 certification for a smallholder outgrower scheme under Jatropha production in Tanzania. By the end of 2008, Diligent contracted about 50.000 outgrowers scattered over distances of over 350 km (B2Match, 2013). The project learned that NTA8080 certification of smallholders to African realities was difficult and expensive, due to the scheme's requirements. Especially the requirement on soil quality, and the need to collect multiple samples was considered very costly. The experiences showed a collision between Tanzanian agrarian realities and the context in which the NTA8080 norm was designed.

Solutions

- It is important that a scheme is adapted to the local context and reality.
- The project (DBI02007) considers it amongst the responsibilities of the user markets (in Europe) to develop workable formats for certification schemes which smallholder farmers in developing countries can comply with (B2Match, 2013). A similar recommendation is given in (ILUC, 2012) to develop a smallholder LIIB version with reduced demanding criteria for smallholders in rural developing countries;
- Adaptations and simplifications can be made in bioenergy sustainability policy frameworks to support export of local biomass chains from smallholders (B2Match, 2013). Doing so implies the need for a balanced trade-off between facilitating the access of smallholders into the systems and the desired level of requirements and information needs (ILUC, 2012).
- It should be realized that these approaches require a certain level of flexibility, more in line with the tools discussed in section 4.3.1, which may be contradictive to the "false-good" approach that is currently followed when certification is used as proof for legal compliance.

Meeting organizational requirements

Given the small-scale, in which smallholders are operating, smallholders require a certain level of organization (e.g. in a cooperation) to enlarge the supply base, and to meet administrative requirements and/or certification requirements more effectively. Various certification systems allow therefore for the option of group certification.

When starting with biomass production, a well-established and well-functioning cooperation is not always present. Several of the NPSB projects have contributed to the establishment of cooperation models for production and supply, as part of capacity building. The project (DBM01031) in Indonesia has established a legal Association representing project stakeholders, producers and processors. The candlenut producers themselves were organised in the form of a Cooperative. Producers in the Mali project (DBM01002) have organized themselves in a cooperative of Jatropha growers.

Solutions

- The establishment of well-functioning cooperation models is key for smallholders to enlarge their possibilities to meet certification requirements. This requires under farmers a sense of common purpose and presence of local leadership (DBM02045);
- Farmers are best approached for improving practices through farmer organizations or mills, rather than directly. This allows for benefitting from the communication structures that are already there and it creates a level of trust with the farmers. Their 'membership offer' needs to be valid for all. A continuous improvement package that helps everyone to advance, regardless of the performance levels, is therefore needed. For the top performers, this may mean certification – as outcome rather than a goal (DBM01011).

Capacity requirements

For certification, a certain level of expertise and capacity is required in terms of data collection, management, monitoring and certification procedures. Smaller producers generally do not have the (financial) options to either build up expertise in-house or hire external expertise to guide the process of certification, as is the case for larger companies. Practical constraints can be e.g. illiteracy.

Capacity building touches on meeting the standards' requirements to proof better management practices. In other words: to meet the sustainability requirements of the standards. This relates strongly to agronomic practices. Capacity building also touches on meeting the administrative and procedural requirements of a standard. Examples are meeting data requirements, time given to meet compliance, or organizational aspects.

Box 24
Learning and capacity building under standards: what can certification systems do?
Recognizing the urgency for stronger learning and capacity building under producers, the recently written paper for ISEAL (2014), representing standards worldwide, presents examples from within and outside the 'standard's community' to provide new insights in how standard systems can contribute in bridging the capacity constraints in a sector. The following perspectives are leading in promoting learning and assurance:

- Create more participatory assurance models to enable learning;
- Design standard structure and incentive mechanisms to promote improvement and impact;
- Make a radical shift to capacity building and improvement.

The FSC Modular Approach Program (MAP) approach shows for example how a step-wise approach can facilitate and incentivize improvement and eventually compliance with the full standard.

Solutions

- Concerted action on multiple levels is needed to overcome the gaps in multiple fields of expertise (agrononomy, economics) under smallholders. This is further discussed in section 4.4.4.
- Project developers have to put effort in skills development, time and support on the ground, when aiming to impose sustainability demands on smallholders (DBM02037). The project (DBM02037) estimates this process to be a 3-year process.
- Standard systems themselves could incorporate various other mechanisms to allow for learning and capacity building under smallholders. Some examples are given in box 24.

Key conclusions and lessons learned

- From a poverty reduction and sustainability perspective, the many smallholders in the world are an important group to work with and to include them in the supply chains; several of the NPSB projects worked with smallholders.
- NGOs and governments have a role to play to make sure that vulnerable groups can be included in the transition towards sustainable management practices, as well as to promote training for people who are not returning in the industry due to this change. This should be done together with the market (DBM01011).
- The involvement of small farms at the supply base requires additional effort from project developers. The process towards certification is challenging and requires time.
- Certification systems (by differentiated fees), project developers or down-stream suppliers could accommodate for overcoming cost barriers of certification for smallholders.
- Biomass certification schemes may have to look fundamentally different at small producers. Rather than solely follow an approach focused on minimizing (sustainability) risks, the focus shall be more on creating real benefits for small producers. Adaptations fit to the local context and reality, and simplifications can be made in certification systems and bioenergy sustainability policy frameworks to support export of local biomass chains from smallholders.
- Doing so implies the need for a balanced trade-off between facilitating the access of smallholders into systems and the desired level of requirements and information needs. Standard systems could incorporate various other mechanisms to allow learning and capacity building under smallholders.
- It should be realized that these approaches require a certain level of flexibility, considering certification more as a “learning tool”, which may be contradictive to the “false-good” approach that is currently followed when certification is used as proof for legal compliance.
- The formation of a cooperation and association empowers farmers to take an active part in the supply chain. This helps to create common sense, and to access as group a commercial outlet market, where certification may be needed. This enhances their social and economic status.
- Understanding the group dynamics in farmer and supply organizations is crucial to drive improvement, and ultimately certification. It also changes the function of certification from confirming the status quo to driving improvement (DBM01011)
- Capacity building, and development of guidance and tools, is essential to prepare smallholders for certification and to raise awareness (see also 4.4.4).

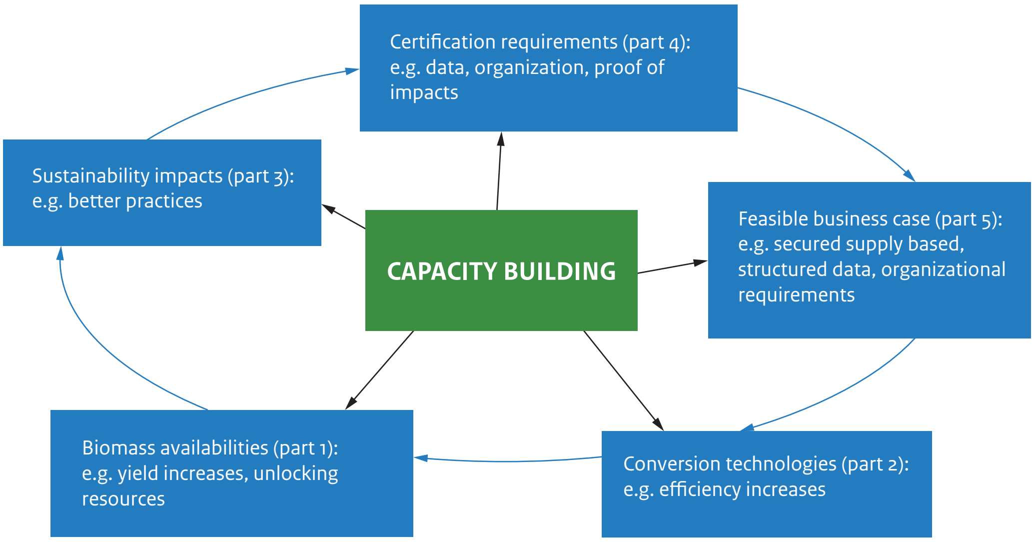
4.4.4
Capacity building

To enhance sustainable biomass production and use (as one of the main aims in the NPSB programme), capacity building has been used in the NPSB projects for various objectives:

- Familiarizing with new, sustainable models, crops, methods;
- Transfer knowledge and skills to improve sustainable production methods, skills or organization;
- Dissemination and sharing experiences of lessons learned in a project;

Capacity building basically touches all aspects of sustainable biomass production and use, as discussed throughout the various parts in this report, and reflected in figure 11. The Jatropha Fairtrade project (DBM01018) stresses for example the importance of intensive farmer extension and capacity building in small producer organizations as key pre-condition for success project deployment. This was explicitly shown by the farmer trials, which were less successful than the outcomes of the pilots, for various reasons (considered too risky for intercropping, not following instructions). The performance of the farmers showed that direct, personal guidance is imperative when starting with a new production model, as intercropping Jatropha.

Figure 11
Contribution of capacity building to various elements of sustainable biomass production and use.



Efforts have been undertaken in several of the NPSB projects to enhance capacity building of producers by developing manuals, guidance, training and support in organizing production and supply, and often in combination (see table 19). Training consisted of group training, individual trainings and trainer of trainers programs – who again can train farmers.

Table 19
Examples of capacity building undertaken in NPSB projects

Project	Objective	Tools (training and guidance)
DBI01010 – Ukraine	Sharing experiences on sustainable cultivation methods	• Manuals and guidance: (i) a first manual for growing Switchgrass in the Ukraine, (ii) instructions for local farmers and municipalities on how to harvest reed in a sustainable way. • Training for local farmers and municipalities on how to harvest reed in a sustainable way; all prepared and distributed 10 villages.
DBM02024 - Panama	Better agricultural practices	• Developed training material on 'Good Agricultural Practices', demonstration pilot plot, established a training facility, shared training materials to other farming networks.
DBM02036 - Indonesia	Understanding of a new model	• An operation manual of the village hub has been developed. • Training: A better understanding of the concept of the village hub model and the changes needed for adapting it
Fairtrade project – Tanzania (DBM01018)	Familiarize the small-farm producers with the agricultural aspects related to growing Jatropha	• Manuals and guidance: (i) A pilot Planting Manual for the agronomists; (ii) a more comprehensive guide "Growing Jatropha" for individual farmers; (iii) a short instruction folder in Swahili, (iv) carbon Credits from Planting and Utilizing Jatropha, an Introduction for Small Producer Organizations. • Training: Training provided to farmers and agronomists.
Mozambique project (DBM02045)	Transfer farming knowledge and experience	• Knowledge sharing to the group of engaged farmers and individually. • Training: The training of trainers program with contact farmers worked well.

DBM02037 – South Africa	Supporting farmers' process towards certification	• The development of a farmers' handbook for record keeping. • This was combined with training in sustainable practices.
DBM2050 - Colombia	Better management practices, dissemination of lessons learned	• A sustainability guide has been developed to complete the picture for key stakeholders on how improved bagasse management and fuel use can be implemented. • Based on the experiences in the pilot project.
Mali project (DBM01002)	Training of cultivation methods of Jatropha	• More than 1200 farmers of 12 villages in Mali have been trained in Jatropha farming techniques, technical maintenance and management of Jatropha farms.
Indonesian project (DBM01031)	Developing a sustainable supply chain (organization, skills, cultivation)	• A number of 1,280 castor bean farmers, 1,024 candlenut farmers and 45 tobacco farmers have been involved in different training programmes. • Training for producers, entrepreneurs and project staff is provided.

Key conclusions and lessons learned

- Good performance of producers is key for a feasible and sustainable bioenergy project.
- Capacity building is crucial to realize certification and sustainable development on the ground. The project (DBM01017) confirms that intensive farmer extension and capacity building in small producer organizations is a key pre-condition for success.
- Capacity building (training, manuals or combination) can be used to familiarize producers with new models, transfer knowledge and disseminate experiences and lessons learned.
- Transferring knowledge and capacity building has multiple benefits. Enhanced agronomic practices may result to improved sustainability impacts and a good business case, and vice versa.
- Capacity building should therefore be an integrated key element in project and program development, especially for those sectors, producer groups, and countries where this is at need.
- An integrated approach also touches the development of training materials: Manuals on agronomic practices should be holistic and cover economic, environmental and socio-economic aspects.
- Capacity building requires an effort from all stakeholders involved, and should be disseminated to a wide group of stakeholders involved in biomass and bioenergy production. These include farmers, policymakers, investors, project developers, etc. This concerted action is needed to facilitate success stories of investments (B2Match, 2013).

4.5 Participatory approaches

Participation can be defined as the process through which people with an interest (stakeholders) influence and share control over initiatives and the decisions and resources that affect them. There are close links between stakeholder participation and some sustainability impacts as poverty reduction, gender equity and good governance. Participation can take different forms, depending on the stakeholders involved (directly involved or affected by the development) and the depth of participation (e.g. information sharing, joint decision making). Stakeholder consultation also takes place in different processes, which are discussed one by one:

- Policy development (4.5.1)
- Formulation of impacts (4.5.2)
- Self-assessment, embeddedness and certification on project (development) level (4.5.3).

4.5.1
Participatory processes in the development of policies

Participatory processes in the development of policies include the involvement of stakeholders in the consultation processes for policy development, to reach multiple consensuses. The relevance of participatory processes in policy making have been highlighted by the projects (DBM01005) in Mali, and by the project (DBM02039) in Indonesia.

Consultation meetings were held in Mali on the biofuels certification criteria and the SAN process (DBM01005, see 4.1.2) to reach consensus and to make the process as broad as possible. Consultation meetings were held through a cross-sectoral multi-stakeholder working group representing government, civil society and private sectors. On a grass roots level, the project has been in contact with NGOs, civil society and representatives of grassroots organisations.

Box 25
Experiences in the Participatory Land Use Planning (PLUP) project in Indonesia (DBM02039)
The project objective was to develop a guideline with a step-wise methodology on possible PLUP procedures, and to illustrate the process showing the need for PLUP. To ensure that the interests of local people were truly taken into account, a pilot was established to integrate maps in spatial planning. Participatory community maps can include the interests of local farmers and should account for local land uses, customary land rights and local development aspirations.
The project has put efforts into building trust and alliances between the stakeholders involved in the project through e.g. the establishment of a Joint Secretariat to involve government partners from the very beginning and to share ownership over the process.
The project successfully put PLUP and community mapping on the agenda of the Sanggau district government in Indonesia. The district government publically announced its commitment to the demarcation of Rural Areas based on locally produced community maps and financed community mapping in several villages in 2013. The project also managed to include a new paragraph in the draft spatial planning regulation.

A participatory approach (see box 25) was also followed in the Participatory Land Use Planning (PLUP) project in Indonesia (DBM02039). Given the sensitivity of land-related issues, these issues need to be taken into account by looking for shared interests and common concepts among the different stakeholders. The project successfully put participatory land-use planning and community mapping on the government agenda in Indonesia, while having put a lot of effort in stakeholder involvement and sharing ownership.

Key conclusions and lessons learned

- Sharing ownership is deemed crucial for the success of multi-stakeholder processes (DBM02039).
- Consensus building and stakeholder consultation processes required patience and flexibility in the approach for (DBM01015). Innovative thinking is required in order to keep a large number of stakeholders satisfied with the process.
- The involvement of 'neutral' academics can help to deal with contested issues.
- In case NGOs want to make participatory spatial planning (or another issue) more inclusive in policy making, this works best through finding a political and legal window of opportunity.
- Communication of local-level (grassroots) experience with detailed (spatial) policy planning to the national level (DBM02039), where regulations can be made, may be needed. NGOs can be of help.
- Staying informed and updated about national, provincial and district policies is key for timing interventions carefully (DBM02039).
- As political will is important in policymaking, it is crucial for local NGOs to invest in good working relationships with local government officials. The same goes for the relationship between NGOs and the private sector.
- The experience in the PLUP project (DBM02039) shows that it is worthwhile to invest in long-term relationships with government actors. Influencing policy is a matter of long breath and patience.

4.5.2
Stakeholder consultation for the formulation of impacts

Participatory approaches and stakeholder consultations are also needed to identify sustainability impacts on a local and regional level, which can again be translated to policy making (4.5.1). The project in Brazil (DBI02011) aimed to learn from local stakeholders in two communities what they understand sustainability to encompass, and to start a dialogue on this. For doing so, the project combined the Cramer Criteria (see introduction) with the sustainability concept as understood by the stakeholders in Brazil.

Based on field research, and through an iterative process, the project identified the most important impacts, on grass-root level. The identified impacts differed from the "common" impacts as used in most certification systems and policy frameworks. Priority was given to, for example:

- The impossibility to access to federal programs or national programs;
- The increased frequency of a number of diseases related to exposure to pesticides;
- The hinder for small-scale farmers to produce food for their region because of the pressure on vast areas of land and the intensive use of agrochemicals.

Based on these concerns, the project has defined sustainability principles that should tackle these negative impacts. An example is "allow the local population surrounded by the large-scale soy- and sugarcane producing areas to maintain their own livelihoods".

The project developed a monitoring tool to get more and improved independent and verifiable information on the key, identified impacts of the production of sugarcane and soy in Mato Grosso State. The tool is designed to fit the purpose of ensuring a participatory process.

Key conclusions and lessons learned
- It is fundamental to study the dynamics of local and regional sustainability. This can be understood through participatory approaches on grassroots level.
- Prioritization of impacts on a local level can be substantially different than impacts designed globally or in international certification systems.
- The project (DBI02011) stresses that the entire context in a production area needs to be considered when aiming for sustainable production. National crop / bioenergy programs should be designed such to support the surrounding local population and food production as well.

4.5.3 Self-assessment, local embeddedness and certification on project level

The importance of stakeholder consultation and involvement on project level is highlighted by various NPSB projects as a crucial requirement for certification, project acceptance and local embeddedness.

Stakeholder consultation as requirement for certification

In certification systems, stakeholder consultation can be used to verify compliance to certain sustainability impacts and as element of demonstrating compliance in sustainability requirements, e.g. for HCV assessments (see 4.2.1) or land rights. The importance of stakeholder consultation in land rights is confirmed in the project (DBM02038). This project learned that Indigenous Peoples' communities consulted in the project were generally not well informed, nor consulted or asked for consent for the development of palm oil plantations – and possible impacts - in their territories.

Findings in the NPSB projects (RVO, 2014a) learn that local stakeholder consultation is addressed only to limited extent in HCV assessment and to ensure explicit agreement on land use. Local stakeholder consultation, and the FPIC mechanism, is however especially of importance in countries with a weak and non-transparent framework (see 4.2.2).

Stakeholder consultation can also be a requirement in the verification procedure of auditors. An auditor survey in the Mato Grosso project (DBI02011) learned that this is time intensive, and difficult under some circumstances, to do well and constructively. This is especially true in areas where experiences with biomass production have not been positive so far. Given that stakeholder participation is not a requirement under the EU-RED, and time-intensive and costly, competition for doing a stakeholder consultation is fierce and economically often not a priority.

Embeddedness and acceptance of project implementation in local context

Even when not required as condition to become certified, various NPSB projects mentioned the importance to include and involve local stakeholders in their project to ensure local embeddedness and acceptance, see also table 20.

Table 20
Mentioned benefits of stakeholder inclusion and involvement in several NPSB projects:

Project	Target groups	Benefits
Mozambique (DBM02045)	• Local farmers, directly and largely involved in the supply chain; • Local communities	• To ensure that feedstock supply with local stakeholders is managed properly; • Process will need to be managed through a local entity capable of meeting all stakeholders' interest like e.g. stable pricing, and government commitment.
Indonesia (DBM01004	• Promoted participation of farmers in the growing of sweet sorghum	• After implementation of the pilot project, many surrounding farmers wants to participate as plasma holders, and became interested in growing sweet sorghum, also as feed for their animals; • Well socialized with the communities around the project and local government authorities.
Ukraine (DBI01010)	• Community consultations in the "Pellets for Power" project	• Makes the project less vulnerable to corruption and abuse by individual village council members and officials; • Broad support: Long-term reed harvesting programs were signed with thirteen villages.

Key conclusions and lessons learned

- Experiences on stakeholder participation and consultation varied under the NPSB projects, depending on the context, possible benefits, and past experiences of the local community.
- Stakeholder consultation and participatory approaches are key for projects as requirements for certification, enhance local embeddedness and project acceptance. The last two aspects are key indicators for creating a feasible business case (see part 5).
- Not all certification systems have included stakeholder consultation as requirement in their standard. Stakeholder consultation allows, however, using a standard optimally in a local context, adapted to specific circumstances while understanding possible trade-offs between impacts and choices to be made.
- Participation of stakeholders on project level is key. This requires informed stakeholders. Supporting the capacity building of stakeholder groups (e.g. on mapping, negotiation) is therefore an important element of promoting participatory development (DBM02038).
- Stakeholder consultation is time intensive and costly, and not a requirement under the EU-RED and in various certification systems, and therefore economically not a direct priority – despite the project benefits (when well performed) and the relevance of safeguarding social and economic well-being of local communities.
- The relevance of stakeholder consultation could be better recognized in policy making through embedding the FPIC principle in legal frameworks (see 4.2.2).
- It is also recommended to further disseminate information and guidance on stakeholder consultations to project developers and others.

4.6
Recommendations and lessons learned in operationalization and use of sustainability criteria

Worldwide progress has been made in the last years in the formulation of policy sustainability frameworks for bioenergy. Most existing policy frameworks, as in Europe or the US, are directed to biofuels. The NPSB programme contributed to the development of sustainability policy frameworks in Mali, the Ukraine and in Mozambique.

Different parts of the world use different criteria and criteria to safeguard sustainability. For example, safeguarding energy and food security is key for Mali and Mozambique while not required as such under EU and US legislation. This results into stricter domestic sustainability requirements in a country (e.g. the presence of social criteria in a country) or the other way around (e.g. ISPO versus RSPO in Indonesia). These differences also exist between certification systems.

Other sector-wide policies are of importance as well to safeguard sustainability, as land use planning or land rights. The project (DBM01011) mentions that a strong policy framework enhances better practices. Policy frameworks differ from country to country. This asks from companies a responsibility to commit to sustainable business.

The NPSB projects contributed to impact, criteria and indicator development. The LIIB project has shown that a low risk for indirect land use change can be demonstrated through certification. Criteria are developed for alternative feedstock resources as algae. At the same time, the debate about sustainability impacts is still ongoing. New impacts have emerged in recent years (cascading, ILUC, carbon debt). This learns that the debate about sustainability is dynamic and still requires continuously new insights and repositioning of stakeholders involved on these issues and on their vision about sustainability as holistic concept.

The project (DBI02011) explored the use of social criteria in certification. Prioritization of impacts on a local level can also be substantially different than impacts designed on national or international level, or by certification systems. These differences in requirements play especially a role when bioenergy is traded internationally. Participatory approaches can facilitate to adapt sustainability optimally to the local context and to understand possible trade-offs.

Certification for biomass and bioenergy is clearly still in a learning curve, especially in unexplored countries and for alternatives feedstocks and end-uses. Gaining experience and the development of these certification procedures is, however, crucial for innovative biomass resources and/or biomass producing countries to get access to the international market. The NPSB projects contributed significantly in those areas where certification still needs to be further explored. Tools and guidance materials have been developed for selecting an appropriate certification system, both for biofuels and for solid biomass, and for smallholder certification. Self-assessment tools were considered as useful and have been developed by projects themselves. Capacity building has been provided. The NPSB portfolio served as a capacity building catalyst in this area.

Competition between certification systems has increased considerably. Examples are mentioned by (DBI02009) in Argentina between RTRS, ISCC and 2BSvS and by (DBM02038) in Indonesia between RSPO and ISPO. Whereas RSPO is on various aspects a higher quality standard, ISPO reaches (through legal obligation) a larger market. This presents the dilemma on how to reach impact with certification schemes: through market volume or requiring highest quality, with often a smaller market volume?

Systems with a wider scope of sustainability, and stricter requirements, ask for an effort from companies in terms of costs, effort in time and adjustments to be made. Looking at the current developments, the market does not choose (alone) for the highest standard. For biofuels towards Europe, there is for example a tendency towards 'easier' certification systems for proving compliance towards EU-RED with no or limited coverage of social or assurance requirements. Part 3 shows, however, the importance to ensure sustainability in a holistic way, given the trade-offs and interaction between impacts.

Capacity building is essential to promote and safeguard sustainable, innovative value chains from various perspectives: to enhance for example governance, policy development, capacity and skills (agronomics, organization) of producers, to create awareness and community involvement. It should be an integrated element in project and program development. For further inclusion of smallholders, more flexible compliance mechanisms, capacity building, and organizational support to form cooperations, are key requirements. This requires an additional effort from producers.

There are different interpretations of sustainability, as for example on the coverage of principles or on the level of strictness and assurance to secure sustainability. This is reflected in policy frameworks and in certification systems. It is therefore essential for stakeholders to get mutual understanding of the interpretation of sustainability. Stakeholder consultation and participatory approaches are in that respect key for project acceptance, consensus building and shared ownership.

Certification systems and policies are clearly closely interrelated. How, varies per context and country. In the EU, certification is used as a tool in policy making. In this case, policies should define clear frameworks and requirements to ensure that certification systems are robust to proof legal compliance. In other regions, where the policy framework is weakly defined, certification can partly take over enforcement. For sector transition, certification can be used to drive learning and the process of certification is used as a framework for implementation of better practices through continuous improvement.

It is key to understand the (im)-possibilities of available tools to steer sustainability, also when used in a domestic or international context. Certification and policy frameworks are together instrumental to safeguard sustainability impacts of biomass and bioenergy production. Concerted action is required on multiple levels (public-private, between countries) to enhance the operationalisation of sustainability criteria, and safeguarding them. On international level, some certain consensus on accepted sustainability requirements is required. Shared ownership and taking responsibility is in that respect crucial for the success of international multi-stakeholder processes. The NPSB projects learned that multi-stakeholder consortia and Roundtable initiatives could facilitate this process.

Project developers

- For project developers, it is important that certification costs outweigh the benefits. This requires a careful selection of the certification scheme. The optimum standard for a producer can change over time and is not fixed.
- It is important to select a scheme at the start of a project, even at the design phase, to understand what type of data management system is needed to meet requirements, and to align this with day-to-day business. Self-assessment tools can be beneficial for project developers in multiple ways during project development and implementation.
- Certification can be considered as a tool for reaching better management. When certification is seen as a framework for learning and business improvement by introducing best practices, this can result in increased long-term beneficial relationships to jointly improve a sector or industry. Understanding the group dynamics in farmer and supply organizations is in that respect crucial to drive improvement.
- It is recommended to follow developments on ILUC and carbon debt, and to assess how (future) standards impact upon projects. The NPSB projects learn that mitigation of ILUC can be successfully demonstrated in certification with the LIIB certification module.
- Capacity building, and participatory approaches are key requirements to enhance capacity of the project, local embeddedness and acceptance; key aspects for creating a feasible business case.
- Involvement of small farms at the supply base requires additional effort from project developers.

Governments

- Given the different priorities in a country, national sustainability frameworks need to be based on a country's reality and existing legislation. Some international consensus on sustainability requirements is required given the international dimension of the bioenergy sector. This also includes international harmonization of definitions for residues and wastes for bioenergy to ensure a level playing field in the market.
- Integrating sustainability requirements in policy frameworks and law allows governments to have a mechanism in hand to regulate and enhance sustainability in economically viable chains, although law and regulation cannot grasp and enforce the full concept of sustainability alone. These policy frameworks should be carefully designed to avoid a tendency towards the use of recognized certification systems that guarantee a lower level of assurance, as is the case in Europe. The EU should provide stronger guidance in auditing requirements, and needs to develop procedures on monitoring schemes (and their changes) after recognition.
- To ensure socio-economic aspects, biomass-importing countries may also include aspects as spatial planning and land-use rights in bilateral agreements with producing countries. The relevance of stakeholder consultation could be better recognized in policy making through embedding the FPIC principle in legal frameworks.
- Governments have a role to play to make sure that vulnerable groups can be included in a transition towards sustainable management practices. This includes capacity building and support.
- Aiming for a stronger inclusion of smallholders in the bioenergy sector may also require a more flexible approach in policy requirements. Considering certification more as a learning tool to improve better sustainability practices is contradictive to the required high level of assurance and "false-good" approach that is currently followed – and desired - when certification is used as proof for legal compliance.
- A (increasingly) strong policy framework in a producer country and/or biomass importing country enhances better management practices. When not yet present or fully developed, a change in the political and legal context may be desired. This requires a process-oriented approach, learning by doing, flexibility, involvement of stakeholders and constant adapting to changing conditions.

Certification schemes

- Certification schemes can help to improve the implementation of standards for unexplored countries and/or innovative feedstocks by making adjustments to used terminology (e.g. for residues and wastes) and improve methods for better practicality in the local context of a country. This requires an ongoing discussion and cooperation with its users (buyers, producers) to understand the realities and practicalities of certification on the ground.
- ILUC can be demonstrated through certification, when the LIIB module is used as add-on to existing voluntary certification schemes. More practical experiences are needed.
- There is a need for developing standards and practical tools for dealing with "new" impacts as carbon debt, competition between resources" and 'cascading'.
- Especially in countries with a weak legal context on socio-economic issues, there is a need for adequate social criteria and robust certification systems with a high level of assurance. Also to demonstrate benefits, it is necessary that claims in relation to a projects' contribution to the local economy and well-being are better demonstrated, with guidance from certification schemes.
- More insight is needed in the added value of stakeholder consultation in certification; as a means to better understand the local context, risks and possible trade-offs between impacts.
- It may be needed to look fundamentally different at certification of small producers, with a focus on creating real benefits for small producers, adapted to local context and reality, and allowing simplifications. Doing so implies the need for a balanced trade-off between facilitating the access of smallholders into systems and the desired level of requirements and information needs.
- Certification systems should play a larger role in the design of projects to have actual impact on better practices in project development and implementation. Given their multiple benefits, self-assessments deserve more attention in this context.
- To better align with the use of certification as a tool for moving towards better practices, it is recommended to recognize the importance of a feasible business case for being able to do so.

- Self-assessment tools are beneficial for projects during project development and implementation to enhance continuous improvement of better practices. Certification systems should therefore enhance their use in their standards.

Knowledge institutions

- There is a need for developing further scientific insights for dealing with impacts as carbon debt, competition between resources, and cascading, and how this impacts on sustainability as a whole.
- More research is also needed in specific questions on sustainability impacts for emerging biomass resources as the production of aquatic biomass for bioenergy.
- Further tool development to quantify biomass projects' contribution to local economies is desired.
- It is useful to start piloting a tool in a country with availability of strong expertise and partners; its impact will trickle later down to more traditional development settings, where tool development is more constrained by lack of an enabling learning environment;
- Capacity building (technical, agronomics, organizational, economics) to a range of stakeholder groups (policy makers, farmers, project developers) is key to enhance certification and policy development on the sustainability of bioenergy.
- The involvement of 'neutral' academics can help to deal with contested issues.

NGOs

- NGOs can play an important role to make sure that vulnerable groups can also be included in a transition towards sustainable management practices.
- This includes assisting farmers in the formation of cooperations to empower them to take active part in the supply chain, and to access a commercial market, where certification may be needed.
- Supporting the capacity building of project developers, and stakeholder groups in general, is also an important element of this, and also contributes to participatory developments.
- Biomass certification can be enhanced by facilitating project developers in e.g. the execution of HCV assessments, making them aware of the use (pre-set) default values, and to distribute existing practical tools and guidance documents related to carbon stock field measurements.
- Especially small farmers can be facilitated in data collection for measuring socio-economic impacts, as precisely here are opportunities and risks for poverty reduction.
- Through participatory approaches on grassroots level, NGOs can contribute to better understand the dynamics of local and regional sustainability. NGOs can also be of help through linking experiences on local grassroots level with national (spatial) policy planning.
- In case NGOs want to make participatory spatial planning (or another issue) more inclusive in policy making, this works best through finding a political and legal window of opportunity.
- As political will is important in policymaking, it is also crucial for local NGOs to invest in good working relationships with local government officials. The same goes for the relationship between NGOs and the private sector.
- Here, NGOs can also play a crucial role in information provision, by e.g. enhancing transparency on quality differences between certification systems or CSR practices of companies and governments on (specific) sustainability impacts.

Part 5

Creating a feasible business case

Part 5
Creating a feasible business case

Earlier parts of this report learn that sufficient availability of sustainable biomass resources for energy purposes is key. Lessons learned are shown. Creating and developing a feasible business case for successful deployment of long-term sustainable biomass production and supply depends, however, on more factors. Also, priorities and success factors may differ depending on the development phase of the business case (see figure 12).

Figure 12
Development phases in developing a business case

Most of the NPSB projects started their activities in the first phase of project development (see figure 12), focusing on sustainable development of the supply chain (see part 3 and 4), testing or searching for a market, and as such facilitating the step towards commercialization and upscaling.

The work done in (RVO, 2014b) looked at the first phase: business opportunities in countries. Based on a survey. Key priorities for the Dutch market when making a country selection were identified. They included e.g. presence of a market, a strong local partner, investment opportunities or presence of enabling policies. The project “How to build a bankable undertaking in biomass?” (NL Agency, 2013c) looked more to the transition from the second to the third phase of business development (see figure 12) and explored the commercial financing options for the many start-up NPSB projects. As part of the NPSB support programme, this project created a support structure for projects by the development of a commercial tool. This structure is based on a set of eight indicators (with sub-indicators) that define the potential or risk for making a good business case. These are: project input-output, proven technology, availability O&M, team characteristics (day to day management, project management), local embeddedness, and scalability.

Figure 13
Layout and structure of sections discussed in this chapter

5.1 Enabling policy environment
- Opportunities: Supportive policies
- Creating a business case: Administrative and legal context

5.2 Presence of sustainable supply
- Opportunities: parts 1 to 4: Available resources; Guaranteeing sustainable supply
- Creating a business case: Competitiveness of feedstock

5.3 Efficiency in logistics and distribution
- Opportunities: Status of infrastructure in country / commodity
- Creating a business case: Costs, determined by: volume, distance, transport mode

5.4 Efficiency in conversion
- Opportunities: Demand, feedstock applicability (in other sections)
- Creating a business case: Introducing (new) technologies in countries

5.5 Presence of markets
- Opportunities: Where is the demand?
- Creating a business case: Introducing products in unexplored markets; Competitiveness of sales price; Creating added value: valorisation of co-products

5.6 Strong project partnership and management
- Opportunities: Searching the right local partner and partnerships
- Creating a business case: Local partners; Partnerships and experiences in consortia, project management

5.7 Capital
- Opportunities: Good indication of capital and banks in the region
- Creating a business case: Ensuring (up front) capital and investment; Investment needs for upscaling; Opportunities for funding (experiences in CDM projects)

5.8 Feasible business cases in the NPSB projects: Sizeability (local versus export), upscaling and spin-off opportunities. Tool development for enhancing the business case

5.9 Recommendations and lessons learned

This chapter discusses the main lessons learned on developing a feasible business case in the NPSB projects based on key criteria, which combine the indicators developed or mentioned in (RVO, 2014b) and (NL Agency, 2013c) for the various business development phases (see figure 13).

When discussing the feasibility of a business case, it is good to keep in mind that the type of companies and stakeholders involved in the bioenergy sector is largely diverse. Respondents in the survey from (RVO, 2014b) differ greatly in how, and to what extent, they operate internationally (see RVO, 2014b). This diversity is also reflected in the consortia of the NPSB projects (see annex 1). Consequently, the type of business case differed between the projects, ranging from "selling" knowledge on sustainability to building a factory.

It is important to realize that lessons learned by the individual projects themselves on setting up a feasible project during the program is in some cases broader than the more narrow description used by (NL Agency, 2013c) that specifically looked at the potential for upscaling and commercialization of the projects in a structured way. This, to enlarge possibilities for commercial or donor funding after the closure of the NPSB programme.

Box 26
Definition of innovative projects
This chapter refers in various sections to innovative projects. Innovation is interpreted in this report as projects that extend sustainable best practices, with an element of social innovation (start-up in an unexplored country, smallholder involvement), or the use of alternative feedstocks, production systems or technologies.

5.1
Presence of an enabling policy and legislative environment

The presence of an enabling environment is important when screening for business opportunities (RVO, 2014b). When trading internationally, the enabling environment of the importing country is of importance as well. Examples of enabling policies are:
- The presence of mandates and/or targets stimulates both supply and demand;
- Economic instruments (e.g. exemption of taxes, subsidies) that provide incentives;

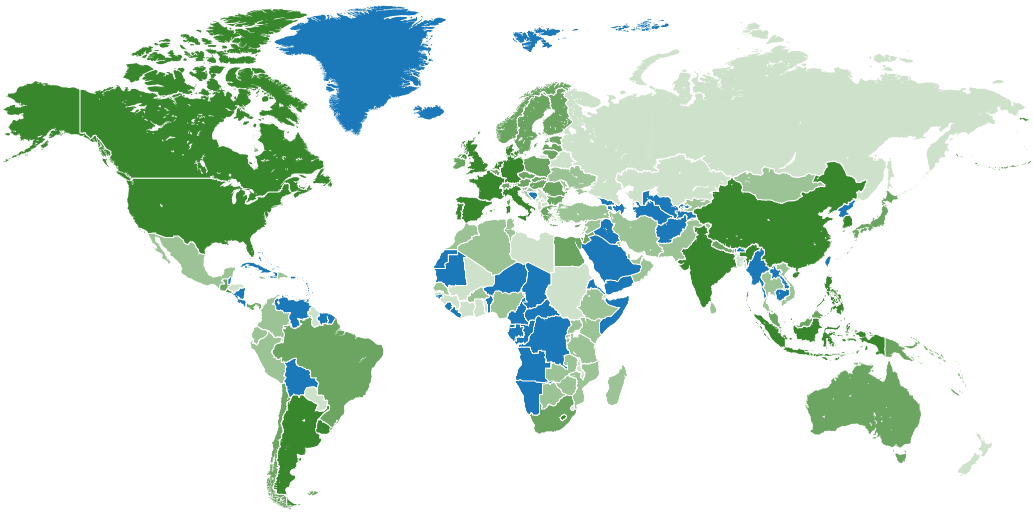
When project implementation starts, specific requirements in legislation and procedural rules start to become of importance for creating a feasible business case (see 5.1.2).

5.1.1
Business opportunities: enabling policy and legislative environments

As mentioned in the introduction, many countries have started developing renewable energy policies in the last years in different parts of the world. Countries with supporting renewable energy policies (beginning 2013) are shown in map 2 (from RVO, 2014b). Policies are largely developed in Northern America, the US and for large parts in southern Asia and Southern America. Large parts of Africa and northern Asia are lagging behind in policy development, but developments have started in these regions as well.

Examples of introduced policies or legislation from the last years in Africa, South America or Asia are shown in annex 2. The overview, as pointed out in the introduction, shows that many countries have installed blending targets, or starting to do so as first step. Both Malaysia and Indonesia target, for example, strong increases of biofuels from palm oil in the coming years. However, a much smaller number of countries have developed policy tools to guide this implementation smoothly. The experiences learn that this is, however, of evident importance as well for successful project deployment (see also 4.1.2).

Map 2
Number of policy types enacted (from RVO, 2014b)



■ 9 - 13 ■ 3 - 5 ■ no policy or no data
■ 6 - 8 ■ 1 - 2

Developments in the African region

At the start of the NPSB programme in 2010, only a few African countries had introduced biofuel policies (Info III, 2010). Since then, various countries have started developing their policies (see annex 2). First experiences on policy developments have been shared and summarized in the report with outcomes from the regional workshop (B2Match, 2013) organised by NPSB. The NPSB programme has contributed to further policy developments in Mozambique, Mali and the Ukraine, see for more details 4.1.2 and box 27.

Box 27
Creation of an enabling policy environment in Mozambique.
In Southeast Africa, Mozambique has been leading the way for the creation of an enabling environment to facilitate private investment in bioenergy projects (B2Match, 2013). Capacity has been created within the Government to conduct a comprehensive investment analysis on biofuels for national and international markets (see also box 15). Between 2008 and 2012, the Mozambican government received 40 biofuel investment proposals. Fourteen of them were officially approved. Projects are typically designed for large-scale biofuel production. At present, however, many projects are still in their early stages of development with small areas planted and biofuel production in its infancy (RVO, 2014c).

Annex 2 shows that several of the introduced African policies have identified specific crops and/or land uses for bioenergy production to steer bioenergy development. For example, Mozambique has selected sugarcane and sorghum as suitable crops for bioethanol. Countries also highlight the importance of sustainability (social) impacts, as local energy use or social benefits in general.

With the right support climate (i.e. policy environment, financial situation and incentives) in place, some African countries were succeeding in 2010 in securing foreign investment into feedstock and biofuels production (Info III, 2010). This increased interest in investments from the market stimulated as well some governments, as in Mozambique, to further develop their policies. The private sector engagement in the bioenergy sector of Mozambique is two years later less than expected although policies have been developed (B2Match, 2013).

Key conclusions and lessons learned

- The number of introduced bioenergy policies worldwide has grown strongly in the last years. Most of them are limited to blending requirements and mandates, without a supporting framework.
- The development or existence of Laws or policies alone is not a 100% guarantee for increased investments in countries. To facilitate private investment in bioenergy projects, an enabling policy environment needs to be created through realistic, stable and long-term policies and a regulatory framework, including the presence of a local regulatory framework (see 5.1.3).
- Policies need to be supported by clear implementation and action plans, developed in close collaboration with all stakeholders involved in the whole bioenergy value chain. Experiences in the NPSB program (see 4.1.2) learn that sufficient time and efforts are needed for doing so.
- It is of importance that a policy framework addresses sustainability framework conditions. Outcomes from the regional workshop (B2Match, 2013) stress that policies should focus on biomass and bioenergy in an integrated manner, addressing the needs of the local population relying on traditional biomass resources (see also part 4).
- Presence of a policy framework, addressing sustainability, serves to attract international and national investors, rather than causing investors to shift attention to regions with lower sustainability requirements (B2Match, 2013), although the spin-off effects take time and also depend on other factors.
- An increase in investments can, on the other hand, also trigger a country to develop policies and to steer bioenergy development.
- The increase in policies, mandates and targets in biomass producing countries will increase competition in biomass, and may trigger price increases worldwide. This may influence the future economic availability of biomass resources for importing countries and requires a prioritization on where (locally, international trade) and how to use biomass, and under what conditions.

5.1.2 Impact of changing enabling environments on business opportunities

Respondents in (RVO, 2014b) indicate a stable local government with 25% as the second most important success factor for doing business (after presence of a local partner). Changing enabling environments in countries have consequences for the business environment and feasibility for a setting up a feasible project. Some examples are given by the NPSB projects.

During the start of the project (DBI02009), Argentina was a large (potential) supplier of biofuels towards Europe: nearly 90% of the 1.6 million tonnes of biodiesel export was sent to the EU in 2012. The commercial potential for importing certified biodiesel from Argentina in the project (DBI02009) has worsened due to the fact that the EU announced a tax regime on imported biodiesel in 2013, which changed the original business case.

Other projects mentioned the impact on changing subsidies in the Netherlands and in other countries on the feasibility of their project:

- Two projects mentioned the changes in the SDE+ subsidies in the Netherlands as implication on their business case for importing biomass to the Netherlands. The building of the pyrolysis plant and import of sustainable biomass (DBI02002) could not take place during the implementation period (2010-2012), because the key consumers were not yet able to obtain the necessary SDE+ incentives needed for commercial operation.

- The project (DBI01002) concluded that it was not economically feasible to import biomass from Vietnam to the Netherlands, partly because of the dynamic policy and subsidy changes in the Netherlands in 2009-2010. Uncertainties caused delay in investment decisions.
- The unexpected introduction of subsidies on LPG in Indonesia affected, combined with its (too) small scale, the commercial viability of the castor bean oil supply chain project (DBM01031). The subsidizing of gas and the introduction of LPG cook stoves being given for free, made further dissemination and eventual market-case for the Protos plant oil stoves highly dubious.

Government support is in many cases required for R&D projects and projects in an early stage adaptation stage. This entails, however, also a risk. This risk should be kept within acceptable limits. On the longer term, when a project is in the phase of commercialization, government support is (and should) no longer be necessary, and the subsidy regime (and related risks) should therefore no longer be relevant (NL Agency, 2013c).

Unexpected delays

Unexpected disasters (political, climatic) can always cause unforeseen delays in project implementation or investments. Examples are the coup and rebellion in Mali during implementation of the project (DBM01005). This caused unforeseen delays and a period of uncertainty during which it has been difficult to make progress. Another example is given by the POME project (DBM01015), which experienced some unexpected delays because of unusual flooding in the area.

Key conclusions and lessons learned

- Government support is in many cases required for R&D projects and projects in an early stage adaptation stage. This entails also a risk. Uncertainties may result in delay or cancelling of investments and projects. This risk should therefore be kept within acceptable limits.
- For project developers, this implies mitigating risks by anticipating on possible political change, finding alternative financing sources and moving to the phase of full commercialization.
- For governments, this implies the development of stable, stimulating bioenergy policies combined with long-term incentives for potential bioenergy investors.

5.1.3 Administrative and legal exploitation barriers

When starting a project, compliance with the country’s legal and administrative framework is key for further implementation. This entails receiving the right permits and compliance with procedures. This has been challenging in several of the NPSB projects, also because of the unfamiliarity of bioenergy in some countries.

For example, bureaucratic procedures on e.g. pre-engineering, and receiving authorization to build and commission the construction of the pellet plant have taken up much more time and efforts than planned in the Ukraine project (DBI01013). Likewise, the project (DBM02045) mentioned the complicated legislation for shipping of torrefied biomass in Mozambique.

Lack of transparency and communication in procedures

Procedures and transactions were experienced as little transparent in some of the operating countries, as in the Ukraine (Factsheet Ukraine, 2012). The Village Hub project (DBM02036) in Indonesia mentioned problems of corruption, and not issuing of permits.

Arranging permitting for harvesting and export appeared to be challenging in the Mozambique project (DBM02045) as well. Gathering the required information on building a business case requires local on the ground investigation and communication (see also 5.8), with a risk for creating false expectations. Importance of communications with local stakeholders was considered key and should be embedded into a local framework (DBM02045).

Conflicting or non-harmonized rules and definitions in legislation and policies

Conflicting or unclear rules or definitions in policies may result into confusion for the market. Attention was given in the Inbio project (SQ and CUC, 2013) on whether post-consumer wood waste, to be used for pellets, should be considered waste or not. Having the "waste or no waste" status was crucial for this project (DBI01006) to understand which procedures and paper work were further needed. Terminology and interpretations on post-consumer wood differed when looking to the EU Waste Directive and the national translations of this Directive in various EU member states. This resulted in uncertainty about the status of the product, and related consequences, as in the extent of administrative requirements.

Paving the road for innovative projects in a country

In various cases, the challenges of receiving the right permits and paperwork are due the unfamiliarity and lack of experience with the feedstock, processing, technology or end-use in the operating country. There are simply no procedures and experiences yet. Some examples are given in box 28. Experiences learn that the start of projects can also trigger the development of new procedures in a country.

Box 28
Experiences on absence of procedures and new procedure development

- Based on European legislation, press cake from Jatropha cannot be used as produced feed in Europe. In Tanzania, legislation is much less clear and does not seem to obstruct the use of feed from Jatropha press cake so far. Legislation may need to be developed as soon as the project (DBM02025) (follow-up) tries to register and/or sell the use of Jatropha press cake from animal feed.
- The regulatory framework for the Guardua bamboo chain in Colombia (DBI02006) poses a barrier for market development based on the use of natural forests as currently described. A regulatory framework needs to be developed where bamboo is clearly defined as a forestry / agricultural or agro-forestry resource. This will smoothen the handling of permits.
- In much of current Ukrainian legislation there is no clear reference to reed as a particular category of plant, natural resource or ecosystem either. So, in order for local authorities to make any informed decisions on issuing permits for reed harvesting, the project (DBI01010) first had to develop a protocol for defining the legal status of reed areas before concessions from the local communities could be obtained. This was successfully achieved in the project. The effort should also benefit other initiatives focusing on certified reed harvesting for energy purposes in Ukraine.
- South Africa had so far no experiences with procedures, regulation and permits for large-scale biogas plants. The project (DBM01012) obtained all required licensing. This included interacting with a substantial number of national and local agencies. The challenge when navigating this path has been that the project's concepts were equally new for the government. An important factor in complying with the regulatory framework has been an enabling government. The project experienced delays by collecting the necessary permits required.

Key conclusions and lessons learned
- It is important to implement activities of innovative projects step-by-step, as implementation can be complicated.
- Incorporating local stakeholders and government, and bringing tangible added value right at the beginning of the project, is key to success. This requires a local partner (see also 5.8).
- Lack of clarity and non-harmonized rules between neighbouring countries create confusion in the market, especially when it involves products that are internationally traded. Especially medium-sized businesses need government support in resolving trade barriers (RVO, 2014b).
- Innovative projects (in technologies, feedstock and/or in unexplored countries) should put additional effort and time in establishing new protocols, procedures and permits. When overcome, the road is paved for other, follow-up projects as procedures have been developed.
- Delays in these administrative procedures lengthen, however, the lead-time of a project, and subsequently the IRR of a project.

5.2 Presence of sustainable supply

Earlier parts of this report stress the importance of having sufficient sustainable biomass available for developing a reliable bioenergy chain:
- Opportunities and conditions, and exclusion criteria, for deploying sufficient biomass resources are discussed in part 1. It is for example important that a readily and constant amount of biomass is available when starting processing operations in a project for securing investment.
- Part 2 discusses the impact of feedstock applicability for the selected conversion technology.
- Parts 3 and 4 highlight the importance of guaranteeing the sustainability of the biomass supply for bioenergy production. Herewith it is important to make a distinction between biomass for local use and for international markets, where compliance with a certification system is often needed to proof sustainability.

All these aspects have influence on the realistic biomass availabilities on the ground, as well as on the economics for a project to source the available biomass (see figure 4). These factors together determine the cost level of the input resources for a project that is sourcing the biomass itself. Solutions are provided in 1.5 to overcome such bottlenecks. Project experiences learn, however, that it is challenging to make biomass available on the ground against economically feasible cost levels.

Most projects, depend however on suppliers or harvesters for their biomass sourcing. In this case, competitiveness of biomass prices and its availability in the market become of more importance when defining a feasible business case.

5.2.1 Ensuring biomass supply in the chain at competitive prices

Sufficient supply of feedstock, at competitive prices, and/or the ability to long-term hedge the biomass is important for a setting up a good business. Risk free presence of feedstock is one of the key identified investment criteria for a feasible business in (NL Agency, 2013c).

Sustained contracting

For biomass crops, this relates to the development and sustained contracting of a large enough farmers' supply base (e.g. in the Diligent Jatropha project in Tanzania,). For projects, uncertainty about productivity of plantings is considered a risk. This was for example the case in the Jatropha project in Mexico (DBM02050). For biomass residues, the risk relates to ensuring supply of residue and waste biomass streams. Sufficient presence of manure guaranteed the input side in the South-Africa project (DBM01012).

Price and competitiveness of feedstock

Beside sustained availability of biomass in time, buying or sourcing the feedstock against a competitive price is key for the feasibility of the business case. The criterion is defined by (NL Agency, 2013c) as "input" and links to two aspects:

a. Cost and price ramifications of the feedstock as secured option for further processing for bioenergy;
b. The competitiveness of the feedstock in the market in relation to other end-uses;

Cost and price feedstock as secured option for bioenergy

The cost of the input price is sensitive for price fluctuations on the market (elasticity, determined amongst others by availability and demand) and its relation with the expected output price of the end product (see 5.5.2): the input-output ratio. Generally, a project that receives a low price for its product requires also a cheap input resource to remain profitable.

When inputs are not yet pre-defined, buyers have the option to source the most economically attractive inputs for further processing at the start of the project. The report on "Biomass merits of bamboo, switchgrass, wheat and rice straw" shows that each feedstock has its own costs ramifications. In this report, switchgrass seems to be the cheapest option if this is the main application due to the low production cost involved (Info II, 2013). The "Pellets for Power" (DBM01010) project shows that the use of reed pellets for biomass is economically interesting, while the project (DBM02045) in Mozambique learned that bamboo and sawmill residues were not secured enough to legitimize an investment in a biomass processing facility.

Sales prices of commodities (e.g. soybeans, palm oil) are generally determined on the international market and are sensitive for volatility and price fluctuations. For less common biomass resources, this is determined more case-to-case based on demand and offer, especially when traded in the domestic market. The project (DBM01031) in Indonesia mentions for example that the price of candlenuts and POKS is now economically interesting to use for tobacco curing. When this competitiveness may change in the market, these inputs may no longer be popular and the sector may change to using other – possibly more unsustainable input sources – especially as no sustainability framework exists to prevent this.

The analysis from (NL Agency, 2013c) learned that it is important for a project developer to be able to anticipate on these possible input fluctuations due to changes in availability and the price elasticity in the market.

Competitiveness of feedstock in the market for other end-uses

Some feedstocks have multiple market destinations. Examples are the food-fuel markets for sugar palm (DBM02036), the fuel-building markets for bamboo (DBI02001) or the timber – fuel markets for forest residues. Directing the feedstock towards the bioenergy market asks for an interesting market (and thus price level) compared to price levels in other markets.

In the case of the project (DBM02045), the wood produced in the agroforestry system is more likely to be sold to the construction market where farmers get a price that is four times higher than paid in the market for charcoal. This is particularly the case for Eucalyptus. It is also for this reason that many of the participating farmers preferred Eucalyptus to the more environmentally sustainable option of indigenous tree species that better fit into an agroforestry system. The Vietnam project (DBI01002) also noticed the possible competition of sawdust for bioenergy with local brick making kilns.

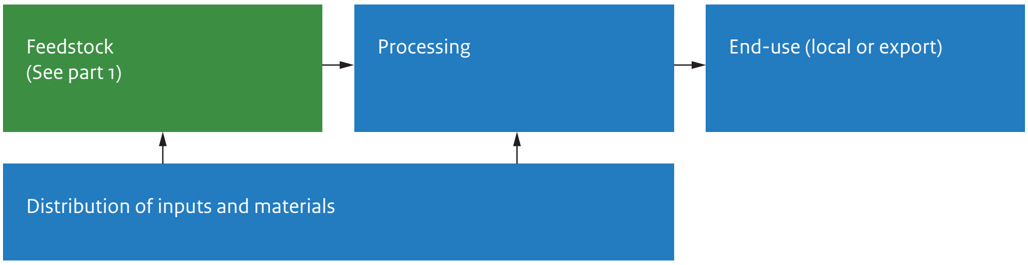
Key conclusions and lessons learned

- Markets are looking for sourcing the most competitive option in feedstock resources.
- Feedstocks with multiple end-use markets will therefore most likely be sold to the market offering the most attractive prices. This economic market principle relates to the aspects of the cascading principle and competition of resources (part 3-4).
- The market destination is also influenced by defined quality and sustainability requirements, which are defined by buyers further in the value chain. These requirements can vary between end-user markets. For example, quality safety requirements are stricter for the food market than the bioenergy market. These requirements can also vary between local and international markets.
- Given the changes in availability and price fluctuations on the market for feedstocks, it is recommended that projects anticipate on these dynamics – especially when working with innovative projects. This can be done through a sensitivity analysis.
- Investments in biomass projects related to agricultural projects with limited commercial experience require a good understanding of crop science, technical implications and potential risks (see also part 1).

5.3 Efficiency of logistics and distribution

The importance of logistics is already highlighted in part 1, for guaranteeing the supply of biomass feedstock to the processing location. Logistics is also crucial for the next steps in the supply chain (see figure 14), for bringing the product to the market. The importance of costs of logistics in biomass supply chains is highlighted in the IEA Bioenergy Task 40 report from 2013 on “Low cost, Long Distance Biomass Supply Chains” (Info II, 2013).

Figure 14
Logistics and distribution aspects in the biomass supply chain.



Logistics and distribution is vital for distributing the product to the buyer, but also vice versa. The project sweet sorghum in Indonesia (DBM01004) stresses the importance to have secured availability of material inputs. Also the Village Hub project in Indonesia (DBM02036) mentions as hurdle for implementation the unrealized supply of hot steam from the nearby industry for the mechanic processing of sugar palm juice to sugar.

When selecting a business case, it is thus important to have insight in the availability and status of infrastructure in the country and/or of the supply chain. Determining factors for a cost-effective infrastructural supply chain are the distance, volume and mode of transportation.

An existing infrastructure in a country is key to success of a tangible biomass export project. The status of infrastructure depends partly on the characteristics of a country. For example, the presence of the many islands in Indonesia makes logistics a challenge when transporting equipment and products from and to minor islands (Factsheet Indonesia, 2012).

The presence of a deep-sea export port with sufficient infrastructure is an important assess for facilitating international trade from and to a country (DBM02045). For example, the large sea harbours are a key asset for transporting pellets in large volumes from Canada and the US to Europe. This may result in competitiveness for port capacity and infrastructure between markets. For example, the presence of a deep-sea export port in Mozambique has been recognized by the coal sector. A massive coal export project will always outcompete a relatively small-scale biomass initiative (DBM02045).

5.3.1 Availability and status of infrastructure

Established commodities have highly established infrastructure and processing capacity, as the extensive soybean and sugarcane processing capacity and infrastructure in Argentina (DBI02009) and Brazil (DBI02011) respectively. This may differ for other, small-scale or innovative bioenergy chains where infrastructure and capacity still needs to be developed.

This was for example the case for project (DBM02045) in Mozambique, where unlocking the potential and building a supply chain towards and intermediate or end product ready for transport to export or regional application turned out to be the most important challenge. The lack or infrastructure and lack of organization implied that the entire supply chain has to be built up from scratch. (Existing) scale and volume is thus determining for the trade opportunities in the international market. This is confirmed by the report (Charcoal, 2013), stressing the requirement for additional techniques, investments and organisation structure for charcoal from alternative feedstocks, compared to an existing, usually informally organised charcoal sector.

The status of infrastructure depends also on the coverage and level of maintenance of infrastructure. Despite improvements in the last years, infrastructure in Mozambique is, for example, still limited. This makes transport for long distances relatively expensive (Factsheet Mozambique, 2012).

Key conclusions and lessons learned

- The status of infrastructure in a country depends on the characteristics of a country, its coverage and maintenance of infrastructure. Presence of a deep seaport is an asset, especially for export.
- A weak or lack of infrastructure in countries has impact on the feasibility of a business case, as infrastructure has to be built from scratch and costs for logistics are relatively high.
- Investing in countries with a weak infrastructure is needed to improve the country’s private sector competitiveness and enhance opportunities for large-scale production and trade of biomass.
- Infrastructure for commodities is already established. This may still need to be developed for small-scale, innovative bioenergy chains with specific infrastructural requirements. Scale and volume is thus determining for the trade opportunities in the international market.

5.3.2
Distance, volume and mode of transportation

Costs for logistics in the value chain are largely determined by the distance, volume and mode of transportation.

Distance

The larger the distance, the higher is the cost. The market price for charcoal depends for example to a significant extent on the charcoal transportation costs, and will therefore be high for long transport distances. The main competitive advantage for alternative charcoal may therefore be that it can be produced closer to urban demand centres, with small distances and thus lower transportation costs (Charcoal, 2013). In the case of the project (DBM02045), the shipping distance to Europe from Mozambique is not considered competitive for wood pellets. The picture changes when orientating for closer, domestic markets.

Volume

The larger the transported volume, the lower the costs per unit transported. The Ukraine project (DBI01010) stresses therefore that the economic viability of the biomass export depends on further shipment cost reductions, which can be achieved through further economy of scale. Opportunities can also be achieved through enlarger the energy density per transported volume: one of the objectives of the torrefaction technology (DBI02006, DBM02045).

Mode

The project (DBI02002) looked at the most cost-effective and sustainable modes (road, ship, bulk ship) for transport. Bulk ship transport had the best scoring for pyrolysis oil transport from Spain to the Netherlands. This cheapest solution was also the least carbon intensive option. The advantages of barges and further ship transport on sea were also recognized in the screening of locations for the pellet factory of the Vietnam project (DBI01002): close to the riverside.

Key conclusions and lessons learned

- Distances, volumes and modes of transport are interrelated and determining factors for the costs for logistics. Only large volumes of commodities allow for long distance shipment.
- Small export volumes for transport result into high costs, especially for innovative chains, hampering the feasibility of a business case for export of biomass.

5.3.3
Selected options in NPSB projects

Costs for logistics and distribution are especially important factors for projects where biomass and bioenergy is traded over larger distances (see figure 15). Logistics have not been an implication for the projects in Argentina and Brazil (DBI02011, DBI02009), where infrastructure is well established for the commodities bioethanol from sugarcane and biodiesel from soybeans. Because of large transportation distances, products are transported over sea, in large volumes.

Smaller volumes for transport have brought implications for other projects, and moved them for example into more expensive transport modes. In the "Pellets for Power" project (DBI01010), mainly vessels would have to be used for relatively small quantities. The implications in transport were one of the reasons for the project in Mozambique (DBM02045) to conclude that a local-to-local approach to start up and explore and develop the initial infrastructure was needed. Later in the project, developed infrastructure could possibly be extended and scaled up.

Figure 15
Role of logistics variables on transport modes and logistic efficiency in selected NPSB projects

Project number	Country	Product	Implication (Y/N)	Established commodity in country	Infra-structure in country for this product	Transport mode	Remarks
DBI01006	USA	Pellets	N	Y		Sea vessel	
DBI01010	Ukraine	Pellets	Y	N		Smaller vessel	Searching for options local use
DBI01013	Ukraine	Pellets	Y	N		Smaller vessel	Searching for options local use
DBI02002	Spain	Pyrolysis oil	N*	N			In testing phase
DBI02006	Colombia	Torrefied pellets	Y*	N			In testing phase
DBI02007	Tanzania	Jatropha	Y	N	Limitations		Searching for options local use
DBI02009	Argentina	Biodiesel from soybeans	N	Y	Wel developed	Sea vessel	
DBI02011	Brazil	Bioethanol from sugarcane	N	Y	Well developed	Seavessel	

Key conclusions and lessons learned

- Biomass projects from existing commodities can benefit from already established infrastructure and capacity. This allows the use of cost-effective options for transport. This is not the case for innovative chains with small volumes for transport;
- When starting small-scale, a local-to-local approach to start up and explore, develop and upscale the initial infrastructure is recommended for project developers.
- When aiming for the production, or use of new biomass sources or products, support for development of these innovative supply chains is recommended in both producing and end-use countries. Investments are needed for infrastructure developments.

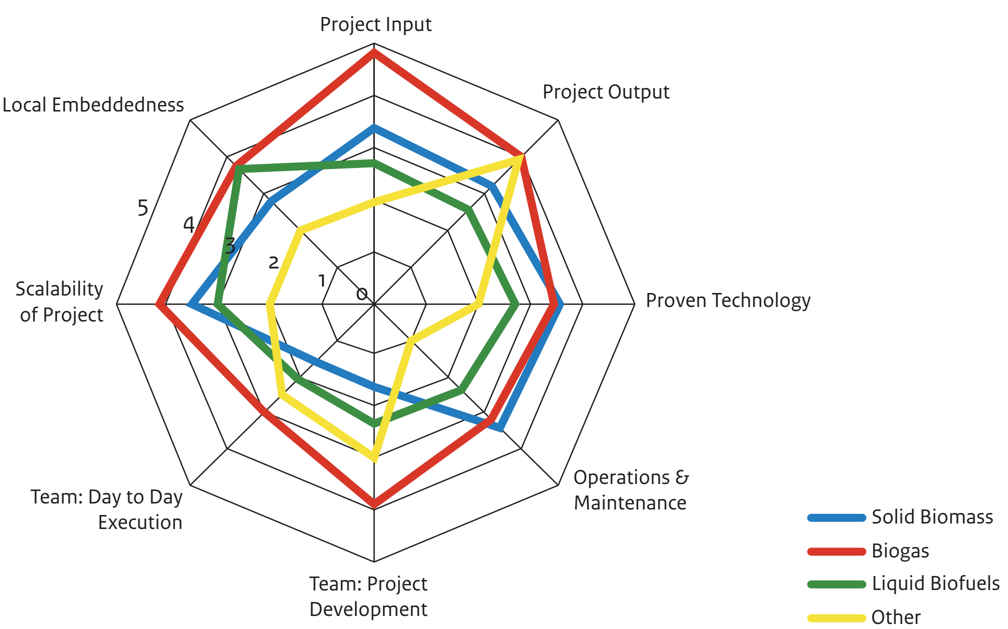
5.4
Conversion (technologies)

Experiences and lessons learned on conversion technologies and feedstock applicability are discussed in part 2 of this report. The selected project technology is a factor for the feasibility of a business case and is as such one of the criteria used by (NL Agency, 2013c).

The analysis from (NL Agency, 2013c) shows the relation between technology, O&M, and profit margin. Generally, those projects that apply a relatively matured technology have (for that business criterion) a higher availability of operations and level of maintenance (O&M), see figure 16. Established technologies are for example gasification and/or anaerobic digestion technologies, relative standard technologies for solid biomass (like pelletizing and briquetting) or standard technologies for biofuels production.

More innovative projects generally have to put more effort into O&M, meaning that the profit margin should be such to cover this ratio (NL Agency, 2013c). Required technological progress to improve the quality of the output-(s) and the range of usable inputs or to explore an untapped source of biomass, results into a higher risk for investment. Results in efficiency and economics may. However, be good or even better when these innovations are realized (NL Agency, 2013c). This does, however, require a robust business case where risks are carefully managed.

Figure 16
Spider diagram comparing technology options through presenting indicators on feasibility business case for upscaling and commercialization (NL Agency, 2013c)



Key conclusions and lessons learned

- Innovative technologies have to deal with a higher risk for investment. This requires a robust business case. Results in efficiency and economics may be good, or even better, when these innovations are realized.
- Developing a technological innovative project requires a certain profit margin and O&M level to allow for upscaling and commercialisation.
- There is a ratio between profit margin, O&M level and level of technology innovation.
- Funding can anticipate on this ratio by e.g. enlarging the profit margin with a subsidy, and herewith (temporarily) bridging the gap of investment needs for innovative projects.

5.5 Presence of market and demand

The introduction and section 5.1 mentions the worldwide rising demand of biomass. Demand for biomass is triggered by the presence of stimulating renewable energy policies (see 5.1), existing markets and by the level of import dependency of a country (see RVO, 2014b). New, upcoming markets for biomass (biojet fuels, chemical sector) further trigger demand next to its already existing end-uses in traditional sectors as the timber, food or feed sector.

For project developers, there are generally three potential destinations for energy: own local use, local markets and export markets. The NPSB projects focused on the sustainable production, used for (upcoming) local markets, or for sustainable import to the Netherlands.

In all cases, the (potential) presence of a market for the project's products, at a realistic price, is important for making a feasible business case. This criterion is defined as "output" by (NL Agency, 2013c). Project outputs are broadly interpreted and also include for example business intelligence.

5.5.1 Introducing products in unexplored markets

Various NPSB projects started their activities in countries with an upcoming, or still non-existent, market for their product, with the objective to contribute to the development of a market. This includes the development of new biomass chains or first activities of certification, as for example introduced by (DBM01012) in South Africa.

Lack of market and demand

Lack of market and demand hampers the feasibility of a business case, and therefore may not justify required investments for further development. This was the case for the Mozambique project (DBM02045). The project concludes that the lack of tangible import demand for solid biomass in the Netherlands (see also 5.1) did not justify development of large-scale biomass projects for export in Mozambique. The project also mentions that, as some targeted project markets (as torrefaction) do not yet exist, a premium price would be needed to cover required development costs. At the time of implementation, this would not have been accepted by off-takers as many existing pilot torrefaction producers in Europe were close to bankruptcy at that time.

Unfamiliarity products

Because of the unfamiliarity with new or alternative products, efforts are needed when introducing them in the market. Examples of such efforts are mentioned by several NPSB projects:

- A marketing strategy was part of the project (DBM01031) to promote the use and development of candlenut. By doing so, new markets were stimulated, and other chains to home industries, such as the snack industry, were further strengthened.

- The report (Charcoal, 2013) mentions the need for marketing efforts when introducing alternative charcoal briquettes in the local market as a possible substitute for lump charcoal. User acceptance under the local population when introducing a new and alternative form of energy fuel was considered as crucial.

Key conclusions and lessons learned

- Long-term uptake (sale) of the biomass, against a reasonable price, is needed to justify biomass deployment and investments. Lack of or uncertainty in demand does not justify large investments.
- A number of market variables are beyond the influence of a project developer. A careful risk assessment, that includes a sensitivity analysis on key variables, can provide crucial insight on their impact on the feasibility of the business case, and how risks can be mitigated (NL Agency, 2014c).
- For a project developer, it is important to have insight in the market opportunities on the short and long term. This requires a clear definition of project deliverables, translation them into marketable products (e.g. biofuels, certification), and insight into the availability of a market. This requires as well the flexibility to switch between local, domestic and international markets – depending on opportunities.
- Marketing efforts, information and publicity campaigns support the introduction of a new product in an unexplored market. Doing so, the market can contribute significantly to the introduction of more sustainable energy use. User acceptance under the local population when introducing a new and alternative form of energy fuel is crucial.

5.5.2
Competition and level of sales price

The economic viability of the sales product is of key importance for making a good business case and depends on various factors:

- Profitability: the buyer's price and the margin with the production costs;
- Competitiveness with fossil fuels;
- Competitiveness with alternative bioenergy products and end-uses;

Profitability: the buyer's price and the margin with the production costs

It is key for a project developer to have a margin between the sales of its project in relation to its costs and return of investments. This is called by (NL Agency, 2013c) as the 'input-output ratio' and depends on costs on the input side (see other sections) and on sales on the output side. Support was provided to various NPSB projects by (NL Agency, 2013c) to clearly define expected project's deliverables, which enables to better secure (opportunities) of a buyer.

Too low sales prices have an impact on the business case. Sales price of woodchips in the Netherlands were for example considered too low in the Ukraine project (DBI01013). Too low sales prices for Jatropha charcoal from Jatropha seedcake on the local market were also mentioned by the Jatropha project (DBM01018). In both projects, alternatives were looked for to make the chain more effective, profitable or by finding alternative end-uses.

The cassava project in Panama (DBM02024) gives a good example that having multiple output markets secures the output side of a project (see also 5.5.3). The presence of a committed private sector partner in the Indonesian project (DBM01031) had secured the demand side and enabled further testing of products from castor beans. In other projects (e.g. DBI01002, DBI020009), buyer's commitments disappeared after the start of the project. This stresses the need for long-term commitment from buyers throughout the full project implementation.

Changes in product prices in the market have an impact on the original business case of a project (as it changes the input-output ratio), as was experienced by he Brazilian project (DBM01011) and the Argentinean project (DBI02009). Both projects targeted commodity crops for bioenergy:

- In the project (DBM01011), a combination of strong internal demand, an expensive Brazilian Real, and an influx of cheap corn ethanol from the USA changed the bioethanol market significantly. The project decided to develop a supply chain on a smaller scale.
- The Argentinean project (DBI02009) did not come to an agreement with the producers on a price for the certified soy biodiesel. This was due to a combination of changed policy conditions (see 5.1) and the higher price of RTRS certified biodiesel compared to competing schemes. Importing certified soy biodiesel to the Netherlands was no longer considered an interesting business case.

Competitiveness with other (fossil) fuels

The economic viability of the biomass export depends partly on price developments for fossil alternatives (DBI01010), as diesel or wood charcoal. The latter is looked at more closely by (Charcoal, 2013). The project mentions that competition of alternative charcoal with traditional wood charcoal is a challenge because externalities of the wood price (e.g. deforestation) are not being factored in the market price of wood charcoal. This rules out many African countries as candidate manufacturing sites, despite possible sustainability advantages of briquettes from biomass.

The biogas project in South Africa (DBM01012) learns, on the other hand, that the private market was willing to pay more for renewable energy, making the project further feasible.

Competitiveness with alternative bioenergy products and markets

Beside competitiveness with fossil fuels, bioenergy products also have to compete with alternative bioenergy products, e.g. from other feedstocks. This is especially the case when small-scale, innovative resources have to compete with already established market commodities, as reed pellets (DBI01010) or torrefied bamboo pellets (DBI02006) versus wood pellets. First estimations learn that the torrefied bamboo pellets from Colombia could cost between 5 to 8 Euros/GJ at the port of Rotterdam, which is economically competitive.

Another form of price competition exists between the bioenergy and alternative end-use markets. First estimations in the Jatropha press-cake project (DBM02025) learn that animal feed has a potential value of 300 $/ton press-cake, compared to 160 $ for briquettes and 50-60 $ for biochar. Producing feed from Jatropha press-cake therefore seems pricewise a more promising route to increase the output value compared to alternative bioenergy end-uses.

Creating added value: valorisation of co-products

Valorisation of co-products enlarges the project's 'output' by generating more sales revenue streams. This improves the so-called input-output ratio (see 5.5.2), and therefore creates possibilities, and is in some cases even the condition, for developing a viable business case. Various NPSB projects provide examples on this (see table 22). Creating added value from environmental benefits (as carbon) also enlarges the revenue stream of a project. This option is discussed under 5.7.

Table 22
Examples under NPSB projects on valorisation of co-products and added value created

Project	Added value created
Project aquatic biomass, Vietnam (DBM02020)	• Bioethanol production combined with the sales of protein extraction for the food industry. • Combination required for making a feasible business case.
Sweet Sorghum project (DBM01004), Indonesia	• Bioethanol processing from sweet sorghum, complemented by feedlot fattening. • Combination is considered a viable sustainable business case.
Algae grown in wastewater POME, Indonesia (DBM02021)	• Biogas production combined with algae for feeding supplements: Combination required for making a feasible business case.
Animal feed Jatropha press cake, Tanzania (DBM02025)	• The "valorisation" of the Jatropha press cake contributes to the overall economic competitiveness of the Jatropha chain.
Cassava, Panama (DBM02024)	• Diversification of product outputs: fresh cassava (for local market or external market), cassava flour and ethanol.

The (Jatropha Assessment, 2013) stresses the importance of efficiency in the value chain and full utilization of by-products for making business from a low value crop, as Jatropha. Within this context, the project (DBM0205) mentions the use of biorefineries as an interesting exploitation strategy.

Key conclusions and lessons learned

- The economic viability of bioenergy products depends on competitiveness with and price developments for a) fossil fuels, b) alternative bioenergy products and c) alternative end-use markets as the feed, food or material sector. The dynamics between alternative markets relates directly to the discussion of cascading and competition of resources.
- Bioenergy projects working with internationally trade commodities are more sensitive for price changes due to macro-economic factors than products that are sold on the local market.
- Having more insight in the input-output ratios of innovative projects, compared to business-as-usual projects, gives clear insight in financing gaps. This provides concrete tools for investors and funding organizations to provide required support (NL Agency, 2013c).
- A balanced input-output ratio is important for the economic feasibility of a project. On the output side, projects select the most promising route for selling their project to increase value. On the input side, projects look for the cheapest option to purchase inputs if other conditions are met.
- Projects can secure the output side of a project's business case through (i) a committed consortium partner to secure sales and investment, (ii) creating multiple outlet markets, (iii) anticipating on market developments and (iV) the valorisation of co-products.
- Lead-time and investment costs are generally higher for innovative projects. To compensate, a premium price would be desirable to cover these additional costs. Willingness or possibilities for companies to pay a higher price seems to be, however, limited, especially in competitive, struggling markets where margins are low.
- It is key for project developers to define their project deliverables and to have insight in their sales market (potential). Results from (NL Agency, 2013c) learn that defining and estimating the business case for delivering knowledge or capacity is not common practice, especially not for NGOs.
- A clear definition of a project's output is increasingly required by (international) funding organizations and banks. This may require a different, more structured, project approach.

5.6
Presence of strong (project) partnerships and management

Companies and project developers mention the presence of a reliable local partner and strong local partnerships as key requirement when starting up a business (RVO, 2014b). Three of the eight criteria for developing a good business case (NL Agency, 2013c) relate to the quality of the managerial team: project development, day-to-day execution and local embeddedness of the project.

5.6.1
Presence of strong project partnership, and organized project management

One key characteristic of the NPSB project partnerships was that coalitions were formed with different stakeholder groups in one consortium. Project partnership experiences in the NPSB projects have been both positive and negative but turned out to be vital for successful project deployment.

Working in consortia

Different forms of consortia with participation of business, NGOs and research organizations have brought added value to several of the NPSB projects, and their strengths have been highlighted throughout various projects in the portfolio.

Table 23
Experienced added values from working in consortia under NPSB projects

Stakeholder	Strengths in project development and implementation
Private market	• Project developer: experience in business and project development, connections in the market (DBM01012). • Buyer as part of the project team: enables to secure or promote sales.
NGOs	• Guaranteeing and adding value on sustainability (DBM02011). • Voice for and strong network with local communities (local NGOs).
Research	• Increased credibility of the Ukraine project when engaging with authorities and rural communities (DBI01010). • Neutral partner (DBM02039). • Knowledge development (technology, tools, agronomics), (DBI02002). • Knowledge sharing (DBM02020).
Government	• Combined project support through public private partnership (DBM02037). • Embeddedness (DBM01005), acceptance. • Facilitates uptake and replication (DBM02011).
Producer or trade associations	• Enhances replication and sharing of knowledge and awareness of project (DBM02050). • Enhances acceptance.

Several of the NPSB projects combined multiple stakeholders in one consortium and experienced this as beneficial for the outcomes and potential for upscaling in the project. One example is the project (DBM02050) in Colombia where amongst others the panela producers association FEDEPANELA, the local government and The Department of Antioquia were all linked together. Another example is the project (DBM02011) in Brazil where the NGO Solidaridad worked amongst other together with millers association UNICA and labour union FERAESP to set up a training program.

Working in cross-cultural, international consortia has also been a learning experience for the NPSB projects. The South-African project (DBM02037) mentions for example that the public-private partnership in the project was a new form of cooperation for the project partners.

Flexibility in implementation

The capacity of a project team to be flexible to adapt to changes in policies or market, is mentioned by several of the NPSB projects as important for a good business case. The Mexican project (DBM02050) mentions that the original project strategy should not be followed too rigidly in order to be capable of incorporating required adaptations. This does not only reflect to technical issues but also in the way of working of the project team members, and in the interaction with different organisations, farmers and suppliers. Flexibility during project implementation of all partners is considered the major contribution to the ultimate success of the project (DBM02045) in Mozambique. During the three years of its implementation, many new insights have been gathered, which have been incorporated in further implementation.

Organizational management and monitoring

Following a structured approach in project development, and implementation, is key to avoid pitfalls and to adapt in time to changes in key financing variables, input streams or other variables in project development (NL Agency, 2013c). Various benefits are mentioned for and by projects that were able to consolidate their information centrally in a set of uniform documents:

- It enables to better articulate the investment value of their projects, thus increasing the likelihood of finding continued funding for their projects on the long-term (NL Agency, 2013c);
- Adequately monitoring of project deliverables contributed in the trapiche project (DBM02050) to achieving the project's objectives and activities in time;
- The added value of data records and monitoring was mentioned in the coffee wastewater project (DBM02032) as tool to maintain documented control of the most relevant information needed for the operation of the reactors. This evaluation allowed to improve their efficiency over time;
- Adequate data collection, reporting and monitoring of project outputs is as well a requirement for certification and/or CDM projects (see part 4).

Key conclusions and lessons learned

- The NPSB projects have shown that good project management with strong project partners, is key for successful project implementation;
- Working in consortia where NGOs, companies, producer associations and governments bring in their expertise and strengths, brings added value to a project's business case and allows transferring knowledge across countries and chains.
- Within this context, (NL Agency, 2014b) recommends a joint approach to international business through the development of market-oriented networks in which value chains work together on integrated solutions (as the Netherlands Water Partnership). An important starting point for these networks seems to be that they are organized demand-driven, especially from the market.
- Doing so also requires understanding of each other's interests and cultural differences, and time and effort for learning and to get acknowledged with new forms of partnerships.
- A strategy of a project should not be followed too rigidly. The impact of a project increases when the project team can show some flexibility to adapt to changing conditions (policies, technical, partners) and to include lessons learned.
- Structured data collection and monitoring contributes to meeting requirements in certification and CDM projects, investment opportunities and the degree of success in project implementation.
- Certification, as tool, can contribute to improving the business case and investment opportunities. Herewith, it is important that sustainability is looked at in a holistic approach (including economic performance), from the design phase of a project towards full implementation.

5.6.2 Presence of local partners and partnerships

Experiences in the NPSB projects learn that a strong, local partner can provide added value (or in the contrary) to virtually all aspects that are important for successful business development. Under the respondents from (RVO, 2014b) this is considered as the most important success factor for business development. Lessons learned from working with local partners in the NPSB projects are summarized in table 24.

Table 24
Summarized lessons and added value from working with local partner in NPSB projects

	A strong, reliable partner helps to:
Policy environment	• Fully understand the existing procedures and policies (Factsheets Ukraine and Mozambique and Ukraine, 2012). • Generate the necessary permits (DBM02045). • Enhance local support from government and local producer organizations (DBM02050).
Supply and demand	• Understand the competing price mechanisms (Factsheets Ukraine and Mozambique and Ukraine, 2012). • Facilitates arrangement of secure agreements, preventing corruption and unreliability of companies (DBI01013, Ukraine).
Infrastructure and processing	• The project can piggyback ride on a solid, existing business infrastructure (DBM02045) when developing a processing site, sales and procurement. • Provide technical support on-site (DBM02045).
Cross-cultural differences	• Understanding the culture and position of the country (and partner), (DBI01013, Ukraine). • Build up a local business and sales network of contacts (DBM02045).

Establishing good local partnerships is not easy. The project in Mozambique (DBM02045) has entered for example into discussions with various potential business partners. None of these pathways have resulted in a commercial commitment to develop a biomass supply chain. Project experiences give several recommendations to take into account when searching for a strong, local partner (DBM02045, DBI01013):

- Reliable and actively committed to the project;
- Preferably, the local partner owns or manages existing operations in the area;
- A clear commercial stake in the project to enlarge commitment.

Key conclusions and lessons learned

- Understanding the local context is essential. A strong, local partner is therefore key in a project and can provide added value to virtually all aspects that are considered key requirements for successful business development.
- Project developers need information about potential foreign business partners.

5.7 Investment opportunities and ensuring up-front capital

The presence of (possible) investors and investment opportunities is of importance for project developers when selecting a region for business development (RVO, 2014b). The importance of generating assets or capital goods is also mentioned as key identified investment criteria in the report (NL Agency, 2013c).

Presence of attractive business and investment environments on country level clearly depend on various factors (e.g. markets, policies, potentials), which are discussed throughout this chapter. Peaks and falls in investments in bioenergy on country level are mentioned by several of the NPSB projects. Reasons mentioned include the world economic crisis from the last years, hypes (and falls) in specific crops (e.g. Jatropha) or policy changes (see 5.1) (B2 Match, 2013, Factsheet Mozambique 2012, Info I 2012, DBM02020). Peaks and drops in investment interest can be a problem for realizing projects.

Future growth rates or economic indices on country level may give an indication on interesting countries for investment. An example is the 2011 Ernst & Young Renewable Energy Country Attractiveness Indices, where Ukraine is mentioned as an emerging market for renewable energy due to attractive policies and good available potentials (Factsheet Ukraine, 2012).

5.7.1 Ensuring (up-front) capital and investment: experiences in the NPSB projects

The need for capital and investment clearly differed between the NPSB projects and does not play a large role in projects that have low investment costs and/or limited cash flows. The local orientated project coffee wastewater (DBM02032) had for example relatively low investment costs. The operating cost of the wastewater treatment system was US$0.31 per quintal green coffee, compared to US$1 per quintal of green coffee when for the treatment in the anaerobic lagoons. The additional costs include the salaries of two workers for manning the treatment plant.

Cash flow problems and financing starts to play a larger role, and impacts on the cash flow, when a project has high initial (fixed) investment costs and/or a long return of investment: This is for example the case for:

- The analyzed Jatropha projects (Jatropha Assessment, 2013), which deal with a slow and insecure yield curve. This is especially the case when following the large-scale Jatropha plantation model.
- Some other projects require further financing for commercial upscaling, follow-up or duplication, as the pilots did not (yet) fully manage to become self-sufficient within the project time. This is for example the case for the algae project (DBM02020) or the South-African project (DBM02037).

Solutions to secure or enlarge the capital flow and (pre-) financing, especially for innovative chains, are given by several of the NPSB projects in table 25.

Table 25
Possible solutions to secure or enlarge the cash flow in projects

Reduce the costs from the start-up	• To reduce production costs in the start-up, the (Charcoal report, 2013) recommends to run a (semi-) industrial scale charcoal operation best (initially) as a side business, with the main business being capable of absorbing costs associated with e.g. overheads and facilities. • Starting small-scale is recommended (Jatropha Assessment, 2013).
Anticipate on higher O&M costs	• Projects working with innovative chains or products, or in underexplored countries, have a relatively high O&M (e.g. for securing input). The input-output ratio should be secured by increasing the market price and/or additional financing (RVO, 2014c). • The project (DBI01013) stresses as well the importance to first securing sufficient funding before entering into commitments.
(Additional) financing and cash flow from own means	• Guarantee the necessary resources (time, financial inputs) from own means. This requires a commitment. This commitment is reflected in the degree of success amongst the NPSB projects (RVO, 2014c).
Additional support from investors or banks	• Projects working with innovative chains or products, or in underexplored countries, may face a higher risk profile under especially commercial banks. This may be an obstacle to obtain pre-financing. • See also next section 5.7.2 for possibilities for financing.

Various projects faced obstacles to obtain (pre-) financing from especially commercial banks because they where considered to have a high risk. Unfamiliarity with the technology in a new country (see 5.5) has been the main obstacle for receiving pre-financing, as was experienced by the biogas project (DBM01012) in South Africa. Also the Ukraine project (DBI01013) and the candlenut project in Indonesia (DBM01031) found difficulties in obtaining external financing to pre-finance their feedstock. Risk factors for financing played a role because of the operating country, scope of the project (DBI01013) or the unfamiliarity with the resource and value chain set up (DBM01013).

Key conclusions and lessons learned

- Future growth rates or economic indices may give an indication on interesting countries for investment. Investment opportunities are partly determined by dynamics in worldwide economics. Peaks and drops in investment interest may be a problem for realizing projects.
- Obtaining capital and the risk for cash flow problems start to play a larger role when a project has to deal with high initial (fixed) investment costs, while return of investment takes a longer time. Projects also have to deal with a higher investment risk when operating in high-risk countries, or when working with innovative crops or technologies. These characteristics are inherent to several of the NPSB projects. This, combined with the "minimal risk approach" of commercial banks, explains the challenge to obtain external funding.
- Solutions are provided to secure or enlarge the capital flow and (pre-) financing. This can be (partly) overcome by (i) starting small-scale, (ii) possibly (initially) as side business so the main business, (iii) anticipate on higher costs and secure funding in advance and (iv) look for additional financing from own means or from additional funding possibilities (see 5.7.2).

5.7.2 Generating financial support: Opportunities for funding

Project finance for development, implementation and upscaling of a biomass project is a critical success factor for entrepreneurs. Respondents in (RVO, 2014b) highlight the need for financial support, the possibility to obtain credit and/or loans as important factor for successful business development (RVO, 2014c). Financing is available from banks, the sale of carbon credits, the use of (new) climate financing instruments and/or development funds.

Loans from banks

A list of international banks in different operating regions is provided by (NL Agency, 2013c). There is a difference between commercial banks, investment banks and development banks (as e.g. the World Bank). Since the start of the NPSB programme, there has been an increasing reluctance of especially international commercial banks and absence of local commercial banks to fund biomass projects (see 5.6). Risk mitigation plays a much smaller role for development banks (NL Agency, 2013c), where financing seems to be available. This is of interest for more innovative bioenergy projects (see 5.6).

Generally, international Investors seek cooperation with local banks as local alliances provide security and risk-mitigation for international investors. The presence of a local bank is therefore of importance when starting up a project in a country.

Sale of carbon credits: experiences in carbon mitigation projects

The valorisation of carbon credits from CO2 reduction (see also 5.5.3) is included in several of the NPSB projects as option to obtain additional sources of income. The Clean Development Mechanism (CDM) has been the main climate financing mechanism for biomass projects in the past. An alternative for the CDM and the corresponding compliance market is the voluntary carbon market. Volumes traded on the voluntary markets are relatively small (Climate Finance, 2012).

Table 26
NPSB projects using climate finance that reach(-ed) further stage of approval

Project	Activities undertaken
Generating biogas from POME, Colombia, (DBM01015)	• Fedepalma has developed the CER monitoring framework and acquired verification of by the UNFCCC as a CDM project. The project is listed on the UNFCCC website. • The monitoring process with CAEMA is implemented successfully. The amount of generated CERs is small (75000 over 2010-2012) and is not yet sold.
Capturing methane emissions from POME, Indonesia (DBM01014)	• The Project Design Document (PDD) was prepared and submitted, but not granted by DNA Jakarta. CDM project verification was therefore not possible. • The project partners tried to have the CO_2 credits verified and registered through CER (CDM) and VER (Gold Standard). No CER/VER buyers were found; the amount of credits generated remained too low for various investors.
Generating biogas from coffee waste, Central America (DBM02032)	• Registered under a Program of Activities (PoA). A PDD has been submitted to the Gold Standard Board instead of the UNFCCC, as it is a Gold Standard micro-scale project. During the reporting period, questions were posed by the Gold Standard and the project submitted the responses back, which are currently reviewed for feedback. Once the PDD is successfully validated, the project can be registered. • The project is also UTZ certified. This is to be the first CDM on gaining credits from energy from coffee wastewater. • No funding found so far: looking for opportunities on the voluntary CDM market.
Jatropha, Tanzania (DBM01018)	• Max Havelaar and ICCO developed a methodology for Climate Financing for local biofuel production and GHG abatement. The tool is available for use.

Since the start of the NPSB programme, the attractiveness of the CDM has been rapidly fading, as carbon markets are currently going through stormy weather. Demand for, and prices of CDM credits are low with no outlook of recovery any time soon. Prices on the voluntary market recently have become more comparable to those on the compliance market. The implication of these external developments is that income from carbon credits in the NPSB projects has become consistently lower than originally expected, which had an impact on the business case (Climate Finance, 2012).

Several NPSB projects decided therefore in an early stage that a CDM project was not feasible. Three NPSB projects decided to proceed and reached a far stage of approval. The POME project (DBM01015) and coffee wastewater project (DBM02032) are continuing working on the CDM procedure.

The NPSB projects learned that the costs of developing the carbon assets of a project should be carefully weighed with the expected revenues from climate finance, as the prices of carbon credits in the current market are relatively low (Climate Finance, 2012). For a carbon project to be economically viable, the income from carbon credits need to cover the costs of certifying the resulting emission reductions or sequestration, and in addition provide a significant income to support the project itself. Given that entering into a carbon project could require much time and resources, it is wise to only go for carbon credits if the benefits far outweigh the costs (Carbon credits, 2013), see also box 29 for further considerations.

BOX 29

Considerations for development of carbon projects and developed guidance

Carbon credits enable to enlarge the revenues from a project's output by establishing an additional income stream. The carbon credit Guide for smallholders, developed in (DBM01018) highlights various advantages in how a smallholder producer organization (SPO) can support smallholders in purchasing carbon credits (Carbon credits, 2013). The report on (Cliimate Finance, 2012) summarizes the lessons learned on CDM in the NPSB programme. Summarized considerations for developing a project for receiving income from carbon credits (Carbon credits, 2013), (Climate Finance, 2012), (DBM0202), (DBM0104) are:

1. ***Project benefits outweigh costs: defining ambitions***
- Local use versus export: To be eligible for carbon credit certification, biofuels must be used domestically.
- Restrictions of use and possibility of monitoring end-use.

2. ***Timeline, effort and planning required***
- Timeline when credits can be generated and timing for registration.
- It takes effort to establish the required monitoring and data collection as prerequisite for meeting the requirements of a CDM project (DBM0202).

3. ***Investments and cash flows over time***
- Investment needs for carbon project registration in comparison to income from carbon credits over time.
- In case of a bioenergy project combined with a carbon credit project, investments may be needed for the development of both. Income needs to be saved and managed well, in order to cover the 30-50 years of monitoring and certification costs that the certification requires.

4. ***Project scale***
- For small projects, the investment in carbon asset development may, at least at this moment, not pay back.
- Costs can go down by using economies of scale of a PoA: a bundle that hosts more than one project.

5. ***Certification requirements***
- Using value added standards like the Climate Community and Biodiversity Standards, on top of a voluntary standard, may increase the price for the voluntary carbon credits, but it will also involve additional costs.
- Sequestration projects are generally more complex than other carbon projects in terms of certification and monitoring requirements. Specific expertise is recommended.

6. ***Communication and project management***
- Open communication with the government of the host country is important.
- It is important to anticipate on the non-approval by DNA and embark on an alternative strategy (e.g. VER/Gold Standard instead of CDM). (DBM0104).

(New) climate financing instruments

The development of CDM, and additional instruments are debated in the international climate negotiations for many years. Newly developed instruments include (credited) NAMAs (Nationally Appropriate Mitigation Actions), NMMs (New Market-based Mechanisms), and REDD+ (Reducing emissions from deforestation and forest degradation) mechanisms (Climate Finance, 2012). These mechanisms are also carbon based financing instruments, where demand for, and price levels of carbon are of significant importance to determine their effectiveness as climate financing mechanism (Climate Finance, 2012).

Development Funds

A number of non-market based sources of climate finance for biomass projects are available for developers of biomass projects. These are funds that have a global scope or a specific country or biomass focus. Requirements and conditions to apply for funding are sometimes described in rather general terms and sometimes in great detail (Climate Finance, 2012). Examples of eligibility criteria of the funds include. They are, however, specific and different for each fund (Climate Finance, 2012):

- Sustainable and brings environmental, social and economic benefits;
- Fits into and complies with national policies, strategies and programs;
- Demonstrably financially or commercially viable;
- Unique or innovative and/or with the potential for replication or scaling up.

Generic investor requirements and opportunities

Generally, investors prefer projects with a larger size, preferably over €10 million CapEx per project. Key identified investment criteria are introduced in 5.1 and further explained in other sections of this chapter; compliance, and the ability to structure these criteria, and how to achieve them, in a business case are success factors for financial support (NL Agency, 2013c).

Key conclusions and lessons learned

- Both (RVO, 2014b) and (NL Agency, 2013c) stress the importance of investment and capital for business development. Obtaining credit or loan is perceived as a major problem by the respondents in (RVO, 2014b), especially by smaller companies.
- Having a structured and bankable business case is key to apply for a professional funding request (see also 5.8.3 on developed tools). It is essential to start preparations for funding early in the project development phase to allow for accurate structuring of the project.
- For financing, it is important that a project can demonstrate its sustainability in the value chain, from the start-up phase. This confirms the importance of a holistic approach to sustainability in business development.
- Financing opportunities are available from banks, the sale of carbon credits, the use of (new) climate financing instruments and/or development funds. Microfinance could be used to set op smaller (charcoal) businesses. Larger facilities will require commercial loans, possibly in combination with additional (donor) funding (Charcoal, 2013).
- Commercial banks tend to choose a “minimal risk” approach at this moment. This seems to be less the case for development banks. Development bank may provide better funding possibilities for innovative projects with higher risk profile.
- The development of a loan scheme / guarantee for companies that want to invest and / or a first time to sell their technology abroad is recommended by (RVO, 2014b).
- The presence of local banks in the operating country is of importance for project development.
- Financing opportunities may also be available in the carbon financing market, especially in the private sector. The costs for developing the carbon credits of a project should, however, be carefully weighed with the expected revenues from climate finance.
- Developers of biomass projects are advised to keep a close eye on the developments in the field of emerging climate instruments (REDD+, NAMAs, NIMS) and get involved in pilot projects, as this may give them an ‘early adapter’ advantage (Climate Finance, 2012), wile as well carefully outweighing the benefits for doing so;
- Financing requirements differ for each fund. Project developers are therefore advised to approach the funds directly and discuss the eligibility of their projects with fund managers;
- Considering the preference of investors for projects with a larger size, a key recommendation by (NL Agency, 2013c) is to bundle the NPSB projects in a portfolio fund. This would allow the portfolio to make use of synergies between projects, and it would allow projects to attract investors collectively, enhancing the possibilities of projects for successfully making the step towards further commercialization.

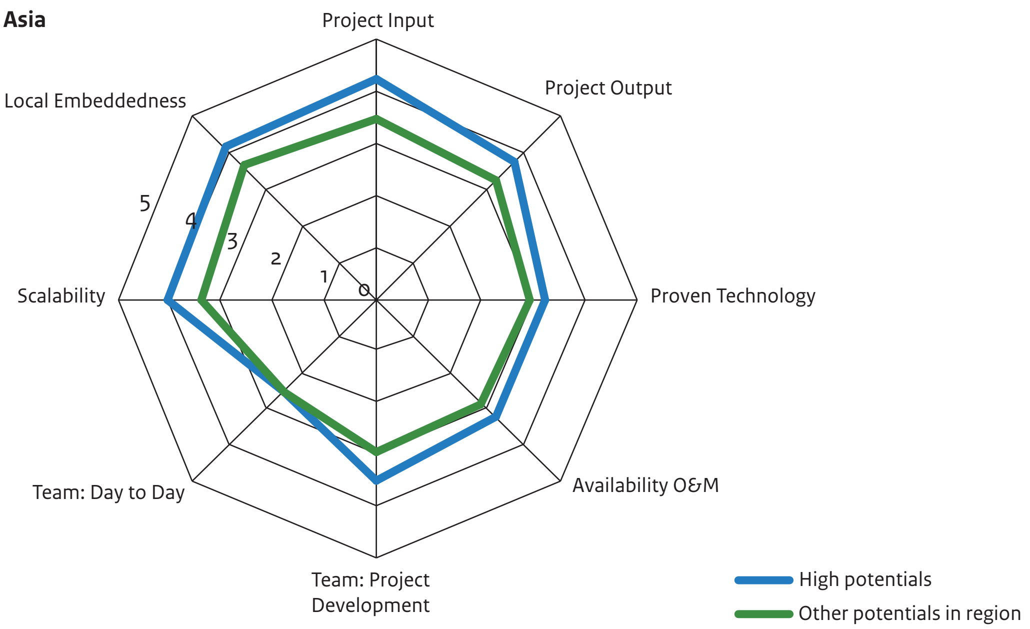
5.8
Feasible business cases in the NPSB projects: sizeability, upscaling and spin-off opportunities

Most of the NPSB projects started their activities in an early phase of project development. The first years have been used for piloting, technology development and the set-up of the value chain and new markets. These activities took place in a variety of countries, with a diversity of project activities. A generic analysis is therefore complicated; some overall conclusions can be drawn.

5.8.1
High potential projects: what makes them successful?

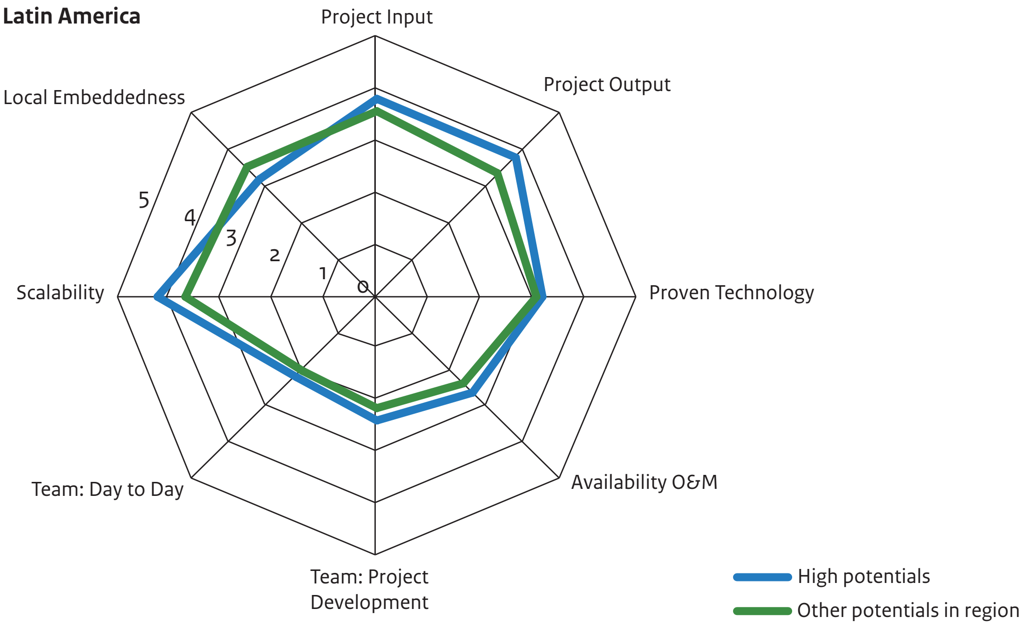
The project "How to build a bankable undertaking in biomass?" (see introduction of this chapter) explored the commercial options for 24 of the NPSB projects (NL Agency, 2013c). During implementation, recurring issues among projects were: difficulties in securing stable input streams, difficulties in securing stable markets and cash flows, and changed carbon prices. Specific implications and opportunities have been discussed in sections 5.1 to 5.7. Under the evaluated NPSB projects, various projects had a high score on the indicators developed by (NL Agency, 2013c), also compared to the average, as reflected in the spider diagrams from figure 17.

Figure 17
Spider diagram showing performance of high potential projects in world regions (NL Agency, 2013c)

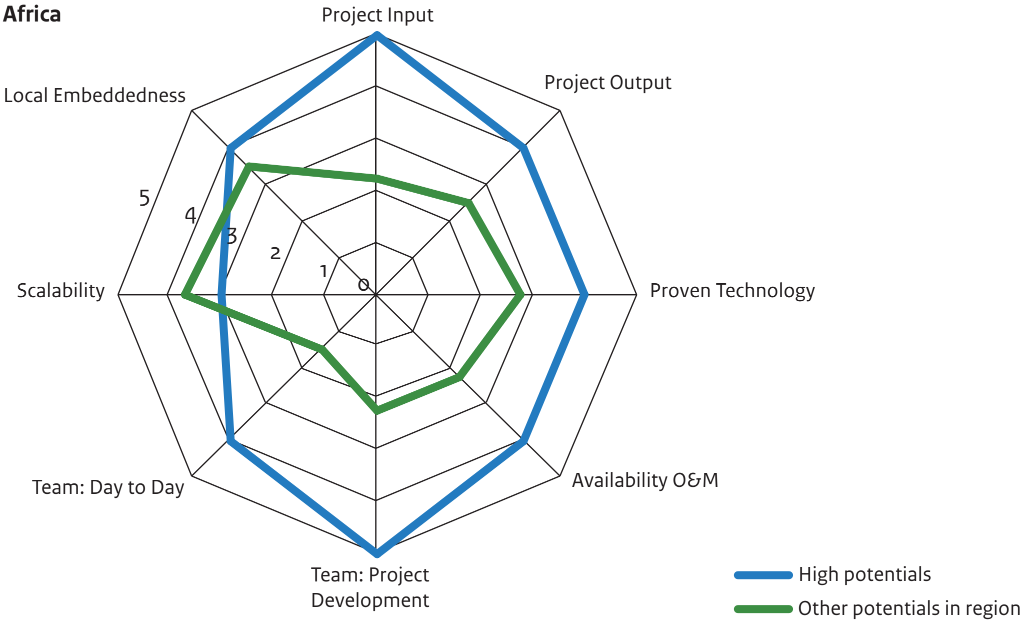


Bases on 24 projects, showing the high potential projects compared tot the average scoring.
This includes all projects, including business intelligence projects.

Latin America



Africa



Bases on 24 projects, showing the high potential projects compared tot the average scoring.
This includes all projects, including business intelligence projects.

Some general conclusions can be drawn:
- High potential projects have arranged the overall business case well. They secured input-output streams, project management, and so on. They made the difference in some specific individual criteria, or a combination of them.
- Arranging the business case on a specific criterion (e.g. being innovative or creating local embeddeness) may make a project outstanding, but is for sure not a condition for the development of a feasible business case. All aspects need to be taken care off.
- Aspects for making a feasible business case are strongly interrelated. Having a good local embeddedness, helps for example to secure input supply. A proven technology requires less availability of O&M.
- Although opportunities may differ from country to country, high potential projects can do a good job in all operating world regions on the condition that business is well arranged.

Opportunities for upscaling and commercial development

Several projects in the NPSB project portfolio are continuing with their project activities through further commercialisation and opportunities for upscaling. Some examples are:
- Based on experiences in the project (DBM02021), it is planned to work also with other wastewater streams and more bioenergy business opportunities in Indonesia along with local partners (Factsheet Indonesia, 2012).
- The project (DBM031) provided PT ELI with an energy alternative that meets the British American Tobacco group policy on fuel wood use. The Tobacco Company in the project (DBM031) has now chosen the direction to support the use of sustainable biomass for tobacco curing. The increasing demand for sustainable biomass has also encouraged in providing alternative stable supplies as palm oil kernel shells from RSPO certified mills in Kalimantan.
- During the realization of the project (DBM01004), the need for scaling up became apparent and so it has been included. A possible follow up on this project is the use of excess gas, which is currently being flared.

Upscaling can be a hurdle for smallholder projects, and may in some cases therefore not be desirable. Upscaling requires for the involvement of more smallholders, who require in addition training and guidance (which has a cost). The upscaling of the algae pilot (DBM02020) to large-scale macro-algae collection from small farmers will most likely give implications in logistics and substantially change the business model (and its sustainability impacts). Options to enlarge impact of those projects will lie more in the replication of the concept to comparable sites (see 5.8.4).

Continued funding is important for upscaling and further commercialization of a project. Section 5.7 gives recommendations to project developers on how to increase funding possibilities, e.g. by consulting financing institutions in time about funding possibilities and requirements. The NPSB programme is meanwhile supporting those projects that show potential and the ambition for further commercialization. This includes looking for additional investment opportunities to bridge the transition towards commercialization (NL Agency, 2013c). In order to meet the requirements of potential financers several projects are bundled into portfolios, see also 5.7.2.

Doing business in unexplored countries, crops and technologies

Many of the projects have been working with innovative crops and technologies, while working in unexplored countries, in line with the objectives of the NPSB programme. This high level of innovation makes this category of projects more sensitive for several of the indicators for creating a feasible business case (NL Agency, 2013c):
- Proven technology
- Project input (agronomics, yield expectations)
- Management
- Embeddedness (acceptance, unfamiliarity)

High potential projects (see figure 17) learn that these obstacles could be overcome in all operating countries, when carefully developed. Clearly, business indicators are interrelated and multiple factors influence the feasibility of a business case and should be considered when developing one.

Key conclusions and lessons learned

- Arranging the business case on a specific criterion (e.g. being innovative or creating local embeddeness) may make a project outstanding. However, all aspects need to be taken care off for making a good business case.
- Although opportunities may differ from country to country, high potential projects can do a good job in all operating world regions on the condition that business is well designed and arranged during implementation.
- Innovative projects in the broadest sense generally have a higher risk profile and are more sensitive on feasibility. A minimal risk approach will most likely result into choosing the “known and common” established feedstocks, countries and technologies. Perseverance, attention, and market implementation is therefore continuously needed to enable for transition.

5.8.2 Sizeability: experiences in small, local or large-scale international chains

The NPSB projects focused on two different types of markets: large-scale international chains for export or domestic markets. Several projects operated in already existing commodity chains. Other NPSB projects had to start implementation small-scale or from scratch, with consequently small volumes for sales and transport. Several of these projects concluded that the establishment of an international chain was not profitable at the time of program implementation for a combination of reasons (see also 5.1 to 5.7), see also table 27.

Table 27
Motivations from projects to work with international chains or to (shift instead to) work with local chains

International chains	
(DBI02011) Brazil, (DBI02009) Argentina	• Working with established commodities, enable to make use of existing infrastructure. • Experienced some uncertainty in changing policies and price expectations.
Preference to focus (first) on local markets instead of international markets for export:	
DBM020245, Mozambique: international chain is not feasible	• Unstable policy dependent markets in Europe. • Competition from other low-cost origins (e.g. Canada, Russia, Brazil). • Insufficient infrastructure in Mozambique to facilitate large-scale biomass exports. • Focus shifted to interesting domestic markets due to large charcoal demand in SE African countries. • A local business case is economically feasible.
Fair-trade certified Jatropha (DBM01018)	• Barriers for certification and unstable policy frameworks. • The cost-benefit analysis local market – export market – local production for smallholders learns that better perspectives exist on the local market when preconditions are met.
The Diligent project (DBI02007)	• Too expensive to export small volumes of biodiesel from Jatropha. • Not competitive when compared to current prices of biodiesel in the market from main commodities. • At current market prices the local market is still more profitable than export, although conditions are not ideal.
Ukraine (DBI01013)	• EU markets are difficult to find for pellets: first focus on local markets.
Ukraine, Pellets for Power (DBI01010)	• High cost: a (preliminary) cost estimate of between €122 and €132 for switchgrass pellets delivered from Ukraine to the Netherlands (not competitive). • Domestic market: Biomass for heating is now taking off in the Ukraine.

When forced to make a shift in business approach, several of these projects also encountered interesting domestic markets with good perspectives (DBI01010, DBM02045). The project (DBM018) highlights the added value of operating locally, as being able to fulfil an important role in the rising local demand for renewable energy sources.

Box 30
Local – to –local or local – to –export?
The Local-to-Local business case has been evaluated in detail by the project (DBM02045). The Local to Export model for either biomass chips, (wood) pellets or torrefied biomass was not viable for the short to medium term with clear uncertainties on the long term.
A business case for charcoal production based on torrefaction technology for local consumption as cooking fuel seems viable (DBM02045). The first is an established, highly competitive international business, whereas the second is largely undeveloped in Africa (Charcoal, 2013).
Local-to-Local applications were preferred in the project (DBM02045). In the absence of a developed market for industrial (higher-value) charcoal products the use of alternative charcoal as a source of energy cooking fuel may help to get the market started (Charcoal, 2013).

Some of the NPSB projects decided to shift at this first stage to local markets, with potential for extending to international markets for export over time. The project (DBM02045) recommends to "start small and think big", see also box 30.

Key conclusions and lessons learned
- For project development, it is recommended to start step by step with the development of a small local-to-local supply chain, followed by upscaling for possible export when infrastructure, market and supply are not yet established in the operating region.
- While upscaling, lessons learned can be continuously integrated in the further implementation of the project (DBM02045). This includes for example technology improvements to meet quality requirements on international markets (DBI01010).
- While increasing, the economy of scale is enhanced by collaboration between producers. This enables to provide security of supply to customers (DBI01010).
- Domestic demand in biomass producing countries show interesting opportunities both from a business as well as from a sustainability perspective, and should not be overlooked.
- Lessons learned on upscaling have been limited in the NPSB projects. To meet future demand, more insight is needed on producing large biomass volumes in an affordable and sustainable way.

5.8.3
Tool development for improving the business case: attracting finance and enhancing commercialization

Tool development and technical support in the NPSB programme has enabled producers and NPSB projects to make a more feasible business case.

How to build a bankable undertaking in biomass?

This project has provided support to individual projects on how to better structure their projects for making a better business case. This allowed contractors to better assess their commercial opportunities and risks, and to enhance opportunities for funding. Project development tools are introduced in the report (NL Agency, 2013c).

Some of the results of the developed tools and methodology are shown in this report (see for example the spider diagrams in 5.7). They are not only of use for project developers, but also for development funds and governments to assess, steer and monitor, the opportunities and risks of a program portfolio.

Economic decision support tools

The Jatropha project (DBM01018) has used the tools from (NL Agency, 2013c) to design an economic calculation model for SPOs (Smallholder Producer Organizations). This enabled them to better assess the economic feasibility of Jatropha production and processing, also with and without the use of carbon credits. The model can be used in the early stages of project development to decide on whether or not the use of Jatropha in an intercropping model would make an interesting business case. This should always be followed by a more rigorous exercise, providing a more tailor made business plan (DBM01018). Next step in model development would be to further test it in the field.

Table 28
Findings for four indicative business cases, scenario based, calculated with model (DBM01018)

	Business case 1: Oil for transport	Business case 2: Oil for power generation	Business case 3: Oil for lighting	Business case 4: Oil for export
IRR 5 years	-46%	Negative value*	5%	Negative value*
IRR 10 years	18%	17%	48%	Negative value*
NPV per ha /year	$ 7	$ 6	$ 20	- $ 63

The project 'Pilots and assessment of alternative feedstocks for charcoal' has also resulted in a decision support tool aimed at facilitating the design of an alternative charcoal supply chain. The tool consists of four parts: feedstock selection, market selection, technology selection, and production costs determination (Charcoal, 2013).

Country Factsheets

Before approaching a market, companies (large and small) make detailed country, market and partner analyses. Respondents from (RVO, 2014b) indicated the need for country-specific information on a wide range of topics. Country factsheets have therefore been developed, covering a wide range of issues as biomass availability, existing policies and the business environment.

Key conclusions and lessons learned

- The NPSB projects have demonstrated the importance to structure next steps and implementation in a structured way, from the idea and conceptual phase onwards.
- Economic calculation models and tools have supported the NPSB projects to better structure their projects for making a better business case.
- This allows projects to better assess their commercial opportunities and risks, to tailor made the business plan, and to attract investors.

5.8.4 Spin-offs in knowledge, replication of concepts, and transfer of technologies

Although various projects (e.g. DBM02050, DBM02020, DBM01012) have not yet fully commercialized, they have already created a spin-off in knowledge, business opportunities and transfer of technologies. This process is still ongoing. More time is needed to fully optimize the benefits of these projects, especially in countries where new technologies have been introduced.

Spin-offs in knowledge and research

Several NPSB projects have generated spin-offs in knowledge and valorisation of research. This includes the creation of in-country knowledge and research, as was achieved by the project (DBI01010) in the Ukraine, and by the project (DBM02020) in Vietnam, see also box 31. Knowledge and qualified staff has been built in the operating country, through extensive knowledge transfer and support to set-up the required organizational and technical infrastructure.

Box 31
Creating in-country knowledge and research

- The Institute for Biomass and Sustainable Development was founded in the "Pellets for Power" project in the Ukraine (DBI01010). The Institute has the ambition of becoming a recognized, independent research organization, aiming at development of research programs and the promotion of NTA 8080 in Ukraine. A MoU has been signed between the Poltava Biomass Institute, Wageningen University and the Dutch National Standardization Organization (NEN).
- A primary deliverable of the algae project (DBM02020) was the establishment of an academic biofuel centre of excellence in the Mekong Delta. This required during the project implementation extensive knowledge transfer to mentor the in-country staff and implement required infrastructure. At the time the algae project (DBM02020) began in Vietnam in 2010, there was little in-country knowledge of bio-energy technologies. Knowledge and qualified staff has been built in macro-algae cultivation, field-testing, and laboratory experiments. Researchers in the laboratory are continuing their work;
- The Sweet sorghum project in Indonesia (DBM01004) established a Research Training Centre for project personnel and plasma farmers.

Spin-offs in knowledge (transfer) have also been achieved through the development of pilot designs, patents and concepts that are uptaken for further development. An example is the developed process design in the Animal feed Jatropha project (DBM02025), which is now further exploited by the company Agroils from the Dominican Republic for building a pilot plant for the production of animal feed from Jatropha. The process designers are consulted for technical advice. There is as well ongoing interest in the Village Hub concept, although commercial rollout failed so far (DBM02036). The Vietnam project (DBM02020) has begun the process of applying for a local patent on its seaweed protein extraction and microbial cultivation methods.

Replication of the projects

Several of the NBSP projects show interesting opportunities to replicate the projects towards comparable sites, herewith upscaling their potential. This is especially true for those projects where:

- Required technological changes (and thus investments) are relatively small, as was the case for the coffee wastewater project (DBM02032).
- The technological changes generate economic benefits for the producers. The POME project (DBM01015) is for example able to sustain itself financially. This is in contrary to the Zebra project (DBM01014). Consequently, interest for further dissemination was limited in this second project under the many small, off-grid mills where the technology could be applied. The local communities have been recognizing the positive effects of the Colombia trapiche project (DBM02050). Hence, many more trapiches in the region are willing and eager to follow a similar path.
- Comparable sites are available in the operating region, as is the case for the widely available small-scale trapiches in the Colombia project (DBM02045), the rice husk processing facilities (DBM02053) in Indonesia or the coffee wastewater plants (DBM02053).

Projects put efforts to *disseminate the findings and experiences*. One of the deliverables of the project (DBM02050) is for example a 'Replication document', which describes the requirements and recommendations for the replication of the design to other trapiches. Also the POME project (DBM01015) put effort in bringing the project under the attention. The project cooperated with Fedepalma (see 5.6.2) and several of its members have replicated the POME investment project at their facilities. The project has put effort in knowledge transfer and capacity building, which is now translating into a pro-active attitude of the oil palm producers and processing mills in the sector.

Key conclusions and lessons learned

- Although several of the NPSB pilot projects have not fully commercialized yet, they have created a spin-off in knowledge, business opportunities and replication and transfer of technologies. Clearly, this process is still ongoing.
- More time and ongoing effort is needed to fully optimize the benefits of these pilot projects, especially in countries where new, innovative technologies have been introduced;
- Putting effort in knowledge transfer and capacity building contributes to enhancing possibilities for replication of technologies when economically attractive.

5.9 Recommendations and lessons learned in creating business case for biomass production for local use and export

Demand, markets and bioenergy policies have been growing worldwide in the last years. Reasons for doing so differ. Malaysia aims, for example, to stimulate the palm oil sector while reducing fuel dependency in the country. Markets in developing countries aim to move away from traditional inefficient wood stoves to renewably energy including biomass. Most of the introduced policies are, limited to blending requirements and mandates without a supporting framework. The lack of an enabling policy environment and/or a regulatory framework hampers the business case of projects.

Sufficient business opportunities exist worldwide but may be constrained by the project's ambitions. For example, projects searching for opportunities to trade large volumes of biomass in a short time frame require locations with secured, available resources from existing commodity chains and already established infrastructure. Business intelligence (e.g. agronomic expertise, provision of machinery) may be more of use in countries that just start to develop bioenergy activities.

Targets and bioenergy policies exist in many countries but an action plan and pricing policies receive little attention. This hampers the business case of bioenergy projects: they cannot compete with fossil fuel projects and large investments are still needed for infrastructure development. To overcome these bottlenecks, an enabling policy environment is needed to support investments and attract business. This should be integrated with rural development. Best practices of projects can provide a large added value to this development, especially in countries where biomass and bioenergy production is still relatively unexplored. They can demonstrate possibilities and failures on the ground, and can trigger the development of new policy procedures, knowledge transfer, and capacity building. This has also been the experience in the NPSB programme, where effort has been put in both the enabling environment and structuring the business case itself. This pleads for the development of public private partnerships.

Innovation is interpreted in this section as projects that extend sustainable best practices, with an element of social innovation (start-up in an unexplored country, smallholder involvement), or the use of alternative feedstocks, production systems or technologies. The previous chapters learned that the stimulation of best practices is needed to create optimized, more efficient bioenergy value chains and sustainable land use for biomass production. Innovative projects are therefore desirable and more sustainable (also economically) on the long term.

The transition towards best practices requires an additional effort from companies to do so from various perspectives. Innovative projects have more difficulty to get financing, may need to put more effort into project acceptance, procedure development, or into supply chain and technology development. All these factors enlarge the lead-time (and therefore the IRR) of a project compared to “business as usual” projects. Perseverance, attention, and market implementation is continuously needed to enable for this transition; especially when future demand should be met with affordable and sustainable biomass resources.

Innovative projects require a robust and structured business case with careful management of risks - also on the long term when welcomed developments in a country are realized, such as higher incomes or a change in productivities, biomass supply and demand. A locked-in situation should be prevented. Conditions for a feasible business case are for example to ensure local embeddedness, input-output ratio, or to have a strong project management. This approach should be followed from the conceptual phase onwards to have insight in the project conditions, to mitigate risks carefully and to allow for flexibility. Also from a financing and business perspective, this should be a holistic approach towards sustainability (including economic performance).

When carefully developed and conditions are met, the NPSB projects learn that innovative projects can successfully be implemented for commercialization. A feasible project requires a robust and structured business case with careful management of risks, also for further upscaling and financing. Vice versa, certification also contributes to obtaining financing and enhancing the business case. This pleads for an integrated approach towards sustainability (including economic performance). The NPSB programme paid attention to structuring the business case of projects, and a tool for doing so has been developed.

Upscaling of projects can potentially be reached through a step-wise approach. Local use of biomass can potentially serve as a stepping-stone for large-scale production and exports in the long term. The feasibility of large-scale production for the international market has been explored by the project (DBM02045) in Mozambique. This turned out to be challenging. The project therefore decided to work on local biomass use and solutions. An enabling environment could be created, which may in the future allow for further upscaling.

Although opportunities may differ from country to country, high potential projects perform well in all operating world regions when conditions for a feasible business case (see table) are met. The NPSB projects, as the cassava project in Panama (DBM02024) learn that the valorisation of co-products enlarge and diversify the income stream and market outlets for a project, enlarging the cash flow. Several of the NPSB projects worked on the valorisation of carbon credits. This market, however, collapsed. Also the importance of strong project partnerships and having a local partner has been highlighted.

Overall lessons learned and recommendations are summarized for the different stakeholder groups:

Project developers

- Business opportunities exist worldwide but strongly depend on the ambition, purpose and expertise of a project.
- A structured approach of business development is recommended from the conceptual phase onwards to adapt for changes, enhance funding opportunities, foresee possible risks and improve better practices. This requires the further development of an integrated approach towards sustainability (including economic performance) in day-to-day business.
- It is recommended to develop and implement innovative projects step-by-step, starting small scale, allowing for learning over time, and managing risks when external project dynamics change.
- The formation of international consortia, representing different stakeholder groups, brings added value to project development by exploiting each other’s strengths. A strong, local partner is key.
- It is recommended to bundle individual NPSB projects in a portfolio fund. This would allow the portfolio to make use of synergies between projects, and would allow projects to attract investors collectively, enhancing the possibility for successfully making the step towards commercialization.

Governments

- Bioenergy policies should be developed together with a strong supporting framework to safeguard sustainability and enable implementation on the ground. It is important that policies focus on biomass and bioenergy in an integrated manner, addressing the needs of the local population.
- The future possibilities for biomass importing countries to source biomass not only depend on available sustainable production potentials, but also the demand from other countries. If biomass becomes economically viable (possibly triggered by the increased number of policies and mandates), then biomass is an attractive renewable resource for many countries and demand will be great. This may lead to insufficient availabilities of biomass, or against high prices.
- Given these dynamics and high level of unpredictability, and to avoid uncertainties in the market, it is essential to have long-term targets in place with clearly defined procedures on monitoring, evaluation and adjustments in time when needed.
- When a transition towards more efficient and sustainable use of resources is desired, additional support is needed to bridge the gap in competition between innovative projects compared to "business as usual" projects. This includes support and investments in supply chain and infrastructure development in producing and end-use countries. International cooperation is recommended to streamline efforts.
- Having more insight in input-output ratios of innovative projects, compared to business as usual projects, provides clear insight in financing gaps and tools for providing individual project support.
- Spin-off effects from policy developments, business development and knowledge transfer take time; patience is needed to evaluate final impacts over time.

NGOs

- Following a structured, project approach, and defining the business case, is recommended, to show impacts and to get funding, as increasingly required by organizations and banks.
- NGOs can support in the development of bioenergy policies worldwide by securing the voice of local stakeholders in stakeholder consultation processes and addressing local energy needs.
- NGOs can support innovative, sustainable projects by using their strengths to enhance (i) local embeddedness, technology acceptance, knowledge transfer, awareness and capacity building.

Knowledge institutions

- Knowledge transfer, capacity building and research are key requirements for developing sustainable, innovative projects and value chains in the bioenergy sector. This requires knowledge for pilot design, agronomic expertise or laboratory or field-testing.
- Through international consortia, knowledge exchange and transfer can be facilitated.
- It is important that research facilitates the first phase of project development (pilot scale, first testing). However, the shift from pilot scale towards commercialization and upscaling, and experience on the ground, is just as important and experiences on how to produce large-scale biomass volumes in an affordable and sustainable manner are limited so far.
- More insight is for example needed in effective transition learning models, social innovation, or how benefits from small-scale production (e.g. working with smallholders) can be maintained when upscaling.

Next steps

towards generating supply from sustainable biomass chains

Next steps towards generating supply from sustainable biomass chains

The results presented in this report show that multiple lessons have been learned in the NPSB programme on biomass availability, conversion technologies, sustainability impacts, operationalization of criteria and the feasibility of a business case. Specific results have been presented through the different parts of this report. Overall conclusions and recommendations can be drawn.

Current main supplier countries are those countries that have large areas of land available; commodities are traded worldwide. Still untapped biomass resources are available and need to be further exploited. Technical potential estimations are high but generically do not include exclusion criteria as applicability, economics or sustainability. The actual amount of biomass is dynamic in time and ultimately determined by the "wish list" of requirements that needs to be met. It requires as well investments in infrastructure and in the agricultural sector to bridge yield gaps, which requires a substantial effort from concerted stakeholders involved.

At the same time, an increased demand in biomass resources is expected for both local markets and export markets, for existing uses and for opening new markets in the biobased economy. The future possibilities for biomass importing countries to use biomass not only depend on available sustainable production potentials, but also the demand from other countries.

More biomass needs to be unlocked in time to increase the availability of and affordable biomass in the future. The NPSB projects demonstrate the need for an integrated approach of sustainability (including economic performance) given the interaction between impacts as the nexus food security and rural development, and risks for possible trade-offs. The debate on sustainability is however dynamic and new impacts (ILUC, carbon debt, cascading) have emerged in recent years and are still debated, also in the context of the vision and concept on sustainability. This means that a sustainability framework will be subject to change and changes will always be needed. This stresses the importance of multi-stakeholder processes.

Unlocking sustainable and affordable biomass requires a transition towards using resources more efficiently and creating alternative resources. The NPSB projects have shown that alternative biomass resources can be successfully unlocked, with multiple positive sustainability impacts. This is especially true for integrated, sustainable production models with multiple market outlets, as well as for the valorisation of residue and waste streams. These "best practice" production systems serve the food-fuel-feed sector and contribute as such to regional development. Benefits can be further optimized in the supply chain, through efficient use of technologies.

The NPSB projects demonstrated the possibility of creating optimized, sustainable biomass production chains, but faced competition compared to "business as usual" projects from different perspectives. Examples are the higher risk profile to get financing, procedures that need to be developed or market acceptance for new products. Consequently, one has to realize that a transition towards more sustainable, innovative production models requires time, investment and effort. Lessons learned throughout this report point to the need for integrated approaches with concerted action from multiple stakeholders.

- In yet unexplored countries, the development of solid sustainable policy frameworks and mechanisms attract business. Projects can serve as best practices to demonstrate possibilities or failures on the ground to learn, to trigger the development of new procedures, experiences on the ground, knowledge transfer and capacity building. The creation of an enabling environment and practical experiences on the ground should go hand in hand.
- The experiences in the NPSB projects learn that the formation of international consortia, representing different stakeholder groups, brings added value to project development by exploiting each other's strengths.
- Innovative projects (e.g. in technology, efficiency, better practices) are needed to make the desired transition in a sector. Such a sector transition requires additional support. Support to bridge the gap between innovative projects and business as usual projects can come from multiple stakeholder groups. Examples are information supply and knowledge transfer from NGOs and knowledge institutes, enabling legislation from governments or specific credit lines from the financial sector.
- Safeguarding sustainability, and enhancing the benefits of biomass projects asks for a shared responsibility from governments, the market, certification systems and NGOs. Integrating sustainability requirements in policy frameworks and law allows governments to have a mechanism in hand to regulate and enhance sustainability in economically viable chains, but should be carefully designed. Markets can uptake to good governance to demonstrate compliance or more, possibly through certification – before, during and after project implementation. This also enhances their possibilities to get financing.
- A transition towards higher productivities and sustainable business models requires capacity building and knowledge transfer on multiple levels, towards a large group of stakeholders. It implies the improvement of agronomic practices, organizational capacity, gaining experiences on developing structured databases, land use planning, stakeholder consultation etc. Stimulating poverty reduction and productivity increases from biomass production implies as well that more vulnerable groups (e.g. smallholders) in rural areas are included in the transition.
- Enhancing capacity building, sustainability and biomass production asks for a collective shift in business and program development, away from business as usual. Stakeholders can learn from each other. A good business case is important for all stakeholders involved. A good sustainability analysis and local embeddedness is of interest for project developers to get a good business case and encourage new local experiences with unexplored feedstocks or technologies. Certification and self-assessments can contribute to identify and steer impacts and improve the business case. A structured business case tackles several of the requirements for certification. This calls for a approach where sustainability, optimization of productivity (technology, agronomics, knowledge) and the business case itself (finance) are fully integrated by all stakeholders' activities - from the conceptual design phase of projects and programs onwards.

It should be realized that this paradigm shift implies some trade-offs and choices to be made:

- A transition towards more innovative, sustainable business models for multiple market outlets may require a change in how to design biomass policy frameworks and targets. It implies a choice from "business as usual" to alternative business models and/or unexplored feedstock resources. At the same time, there is the need for large volumes of sustainable biomass against an affordable price. Bridging these two objectives requires a strong effort, and a certain flexibility to adapt for unexpected dynamics in time. This implies a stronger focus on providing clarity on the roadmap, instead of on the end-result.
- Of the increasing number of sustainable bioenergy frameworks in producing countries, adapted to their local context, show that priorities differ on sustainability and biomass use. The importance for local use, energy security and security of food is for example highlighted in Mali and Mozambique, while not included in legislation in Europe. Biomass producing and importing countries, and companies all have their own responsibilities to deploy their inputs and resources in a sustainable way. Interests to do so differ. This requires the flexibility that "sustainability" can be broadly interpreted, while recognizing the need for a set of internationally accepted standards.

- Competition between certification systems in the market is fierce. Certification is increasingly used as mechanism for legal compliance. In this context, policy requirements determine the fixed legal standard of sustainability resulting in the emergence of certification systems that are solely developed to meet legal compliance. On the other hand, there is a plead to use holistic certification systems as tool for learning, embedded in business, as framework towards promoting better management practices in a sector or company. This requires a certain level of flexibility to allow for continuous learning, towards a moving threshold of sustainability and improvement.

This chapter concludes with two key recommendations for each stakeholder group on next steps towards generating sustainable biomass supply chains, although they are not inclusive for one stakeholder group alone.

Project developers

- Project developers should carefully look and prepare for business opportunities; they do exist (in the broadest) sense for developing sustainable biomass supply chains, especially when residual flows can be valorised and multiple outputs can be created. A structured approach of business development and implementation from the conceptual phase onwards is key to adapt for learning, foresee possible risks, and to succeed.
- Project developers should fully integrate sustainability, certification, stakeholder consultation and capacity building as components in business development and implementation. These elements contribute to a project's feasibility and finance, as has been demonstrated in the NPSB projects.

Governments

- Governments should design local, national and international policies and commitments to support a transition towards using and developing affordable, sustainable, innovative biomass resources (away from the "business as usual" commodities) in large volumes, and to facilitate for the investment and effort needed to do so. These policies should be integrated in regional policies of rural development. Some flexibility in policy targets to allow for learning may be desired.
- Governments should provide a stable enabling environment for the successful deployment of a bioenergy sector. Setting targets for bioenergy and biofuels production alone is, not enough. Supporting frameworks and incentive mechanisms, that approach bioenergy development in an integrated manner are key to successfully and sustainably deploy biomass resources for energy or alternative use. Setting up such policy framework requires choices, cooperation with the market and other stakeholders, and careful insight in possible risks and benefits on regional and local level. This is enhanced through integrating lessons learned from implementation on the ground into policy development.

NGOs

- NGOs can play a role for projects to articulate the voice of the local communities and to translate concerns on the grassroots level to government and policy level; this to ensure that the local context of sustainable biomass production is well presented. This requires cooperation with governments and the market.
- To enhance sustainable biomass production and use, NGOs should provide support in capacity building, awareness and knowledge transfer, especially to more vulnerable groups.

Knowledge institutions

- Knowledge institutions should do more research (learning by doing) on optimized models for innovative sustainable biomass chains, in line with the concept of climate smart agriculture. More insight is especially needed on how to develop large-scale affordable and sustainable value chains. This includes not only technology development and improvements in agronomic practices but also better scientific insight in new sustainability impacts (e.g. carbon debt), their possible trade-offs and interaction on sustainability as a whole. Lessons learned should be used to optimize sustainable business models or technical potential studies.

- Institutions should take the lead to transfer this knowledge between institutions, between countries, from research to business, and vice versa – within a broader supporting network of governments and other international organizations. Capacity building is essential to create the desired transitions in sectors, unexplored countries, and to adapt best practices to the local context to optimize sustainability benefits.

Above all, it is recommended that each stakeholder group takes its responsibility to pro-actively contribute to the next steps for generating sustainable biomass supply chains

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and annexes

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Annex 1
Overview of biomass projects

Information of the DBM and DBI project scan be found on the RVO website via the following link: www.rvo.nl/biomass/projects

A summarized project description of the DBM and DBI projects is given in the table below.

Project number	Operating country	Project title	Resource	Leading organization
DBM02011	Colombia	Sustainability for small trapiches	Sugar cane	Centro Nacional
DBM02020	Vietnam	Vietnam Aquatic Biofuel Project	Algae (seaweed)	Institute of Tropical Biology, Vietnam Academy of Science
DBM02021	Indonesia	Indonesian's aquatic biomass for global sustainable energy production	Algae & palm oil	Maris Projects B.V.
DBM02024	Panama	Sustainable ethanol production from Cassava in impoverished rural Panama	Cassava	Agro2, S.A.
DBM02025	Tanzania	Animal feed from Jatropha press cake	Jatropha	Wageningen Universiteit VVP
DBM02026	Sierra Leone	Best of both worlds: Generating income from palm oil residues to sustain social development	Palm oil	Stichting Lion Heart Foundation
DBM02031	Indonesia	Development and monitoring of sustainable candlenut and castor biomass supply chains in Lombok Island	Candlenut & castor bean	Fauna and Flora International
DBM02032	Nicaragua (Honduras, Guatemala)	Energy from coffee waste in central America	Coffee waste & wastewater	Stichting Utz Certified
DBM02036	Indonesia	Sugar palm for sustainable biomass production	Sugar palm	SPIE Controlec Engineering B.V.
DBM02037	South-Africa	Moving South Africa forward to certified sustainable energy from oilseed crops	Oilseeds	National Development Agency
DBM02038	Indonesia	Improving the social-economic impact of biomass production for local communities and indigenous people	Palm oil & soy	Nederlands Centrum voor Inheemse Volken (NCIV)
DBM02039	Indonesia	Land use planning to promote sustainable biofuel production	Palm oil	Stichting Both Ends
DBM02045	Mozambique	Triple bottom line torrefied biomass supply from Mozambique	Agricultural residues & short rotation coppice trees	Solidaridad
DBM02047	Brazil, Indonesia, Mozambique & South-Africa	Certification system addressing Indirect Impacts of Biofuels (LIIB)	Various (Sugar cane, Palm oil, Jatropha and Vegetable oil)	WWF-International
DBM02050	Mexico	Improvement of the sustainability of the jatropha-biodiesel chain in the Yucatan Peninsula	Jatropha	CICY Centro De Investigación Científica De Yucatán, A.C.

DBM02053	Indonesia	Applying rice husk as feedstock for power generation	Rice husks	PT. Syres Indonesia
DBI 01006	USA	Develop a new biomass chain of urban residual wood for large scale production of industrial pellets for co-combustion in coal plants	“Urban wood” and other low grade residual flows	Nidera Handelscompagnie BV
DBI 01010	Ukraine	Pellets for power: Sustainable biomass import from Ukraine for the International Energy market	Wood pellets, switchgrass, straw, reed	AFSG
DBI 01013	Ukraine	Towards certified sustainable wood pellet production in Ukraine to export to the Netherlands	Wood pellets	Van Den Nagel
DBI 02002	Spain	Import of sustainable pyrolysis oil for extraction of chemicals and energy in the Netherlands	Various	Biomass Technology Group B.V.
DBI 02006	Colombia	Second generation torrefied pellets for sustainable biomass export	Bamboo	ECN
DBI 02007	Tanzania	Certified sustainable Jatropha oil from outgrowers	Jatropha	Diligent
DBI 02009	Argentina	Establishing a sustainable and certified supply chain for import of biodiesel from soy in Argentina	Soja	Solidaridad
DBI 02011	Brazil	Working towards sustainable biomass production in Mato Grosso, Brazil	Biomass	Oxfam Novib

Annex 2

Examples of developments in bioenergy policies countries

Policy developments in African region as highlighted in NPSB programme	
Malawi	Malawi has introduced an obligatory E10 blend and plans to reintroduce a 20% blending standard for ethanol (Info III, 2010).
Tanzania	In March 2006, the Government of Tanzania established the inter-ministerial National Biofuels Taskforce (NBTF) to develop a framework for sustainable bioenergy development (B2Match, 2013). A draft Liquid Bioenergy Act and Regulatory Framework is available. Work on Biofuels Implementation Strategy and Government approval process is ongoing.
Mali	The Government of Mali adopted a National Energy Policy (NEP) in March 2006. Its 2008 national strategy aims to increase local energy production through the development of biofuels (DBM01002).
South Africa	Its biofuels policy aims to reach a 2% share of biofuels in national liquid fuels supply. Feedstocks will be soya, canola, and sunflower for biodiesel production, and sugarcane and sugar beet for ethanol production, to be cultivated on unused land (Info III, 2010). As of 2013, biofuels blending mandates E2 and B5 have come into effect (Info II, 2013).
Zimbabwe	In October 2013, Zimbabwe introduced a mandatory blending ratio of 10% with ethanol, with potential for further increase (Info II, 2013). Promoting the cultivation of Jatropha and sugarcane and the use of sorghum and oilseeds as biofuels feedstock. Social benefits to sugarcane producers are to be addressed through a pricing agreement (Info I, 2012).
Mozambique	In 2009, Mozambique approved a national biofuels policy, which will introduce B2 and E5 blends. Ethanol crops will be sugarcane and sorghum and for biodiesel feedstocks will be Jatropha and coconut (Info III, 2010).
Angola	Angola adopted its new biofuels policy in March 2010, which main focus is it to help attract foreign investment (Info III, 2010).
Nigeria	Government plans call for the development of 20 ethanol plants, using sugarcane and cassava, to be built around the country (Info III, 2010).
Policy developments in Asian region as highlighted in NPSB programme	
Philippines	Approved feed-in tariffs (FITs) for renewable energy generation sources including biomass in 2012 (Info II, 2012).
Thailand	October 2012: Supporting demand for locally produced fuel ethanol and to reduce its imports of crude oil. Halt of gasoline sales would boost demand for ethanol by 19 million to 21 million litres per month (Info II, 2012).
Pakistan	The government announced in November 2012 that it aims to implement several new plants with the aim of creating a total of 304 MW of electricity from city waste. Many projects are already underway, with an aggregated capacity of 57MW (Info I, 2013).
Indonesia	Biofuels meet at least 5% of energy use by 2025 (Factsheet Indonesia, 2012). Decided in August 2013 to boost biodiesel use to support its economy by reaching a B10 blend as fast as possible. Already biodiesel prices in the country are lower than diesel imports (Info II, 2013).
Malaysia	The government aims to increase in 2013 the obligatory sale of biodiesel to 10%, expectedly leading to additional sales of approximately 300,000 tonnes of crude palm oil per year. The plan goes hand in hand with the measure to reduce significantly export levies (Info I, 2013).
Policy developments in American region as highlighted in NPSB programme	
USA	The US Department of Agriculture (USDA) announced in 2012 that $19.4 mln payments to 125 biofuel producers to support the production and expansion of advanced biofuels. The USDA also announced in this month a $41 million investment in 13 projects that will drive more efficient biofuels production and feedstock improvements (Info II, 2012).
Brazil	23 April 2013: the Brazilian government announced support to the sugar- ethanol industry through two measures: Tax cuts and government-subsidized credits (Info II, 2013). July 2013: Brazilian energy regulator ANP outlined new rules to include up to 50% renewable fuel in airplanes (Info II, 2013).
Panama	Mandatory use of ethanol was implemented in September 2013. Tax exemptions and other benefits have been established for biofuel investment projects, amongst others tax credits for companies investing in the technology (Info I, 2013).

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