Critique of Draft NECPs 2023 coverage of Research, Innovation & Competitiveness for ten Member States

Scope & introduction

This document examines the 'Research, Innovation and Competitiveness' content related to renewable energy of the draft National Energy and Climate Plans of ten Member States:

- The Netherlands
- Spain
- Italy
- Sweden
- Denmark
- Slovakia
- Luxemburg
- Lithuania
- Germany
- Portugal

The source material was the automatic machine translation of the NECP from the original national language to English as posted on the official europa.eu NECP website.

The paper is divided two sections:

Part 1 analyses NECPs on a country-by-country basis, discussing the extent to which each NECP takes account of the adoption of the legislation in the "Fit for 55" package; the country's renewable energy and R&I strategy; and funding mechanisms illustrated in the NECP.

Part 2 looks at how countries have covered a few selected cross-cutting themes. These are not commented on in Part 1:

- Digitalisation
- Skills/education/training
- The SET Plan (EU's Strategic Energy Technology Plan)
- Collaboration within the research community

Headline finding

The NECPs will, as the European Commission noted, need a "renewed and stronger focus on competitiveness, innovation and investments within the Energy Union."[1] In all 21 of the country-specific 'Recommendations' it has released at the time of writing, the European Commission asks the

[1] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52023DC0796

Members States to “include an indicative target for innovative renewable energy technologies by 2030” in line with the Renewable Energy Directive amended in 2023.

With the Net Zero Industry Act agreed and set to become law by the time final version of NECPs must be submitted (30 June 2024), Member States should, in the time remaining, anticipate their obligation under Article 30 of NZIA to “take [it] into consideration” in NECPs, particularly regarding the dimension “research, innovation and competitiveness”.

Acknowledgements

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Contents

Part 1 – country-by-country analysis of draft NECPs

The Netherlands

The Netherlands' draft NECP does not take the revised Renewable Energy Directive into account, meaning that it does not address the 42.5% target for renewables by 2030. It provides a partial estimate of investment needs but does not estimate the gap between those needs and the available funding sources, nor mention investment programmes targeted at specific renewable energy sectors.

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- The Netherlands has experience in using non-price criteria for tenders
- Claims that 'Research, Innovation and Competitiveness' focus is shifting from lowering the cost of renewable electricity generation to integrating renewable electricity, but a chart showing where funding is going doesn't clearly show spending on RES-E integration has increased. Refocusing on RES generation technology (all kinds) may be necessary to align with the aims of the Net Zero Industry Act.
- Claims of a great increase in spending on green hydrogen R&D are not evident in the chart either.
- Spending via a key programme, DEI+, has been in decline since 2020 at the same time as a scheme for the same area, 'NIKI', has been delayed.
- Inconsistent reasoning behind the proposal for mandatory batteries in solar parks
- Appears to be that country most closely aligned with technology performance goals of the European Heat Pump Accelerator

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

The Netherlands' NECP contains the headline "Contribution to the binding EU target of at least 32 % renewable energy by 2030" as well as (rather astoundingly) the observation that the Netherlands is "well on track with the indicative path agreed at European level towards the 27% target for 2030" (pg. 29). A later line confirms that RED III was not taken into account: "Red III is still in the final phase, after which it will be translated into national targets" (pg. 152).

Presumably with respect to the 32% EU target for renewables, and the Netherlands' national share under that, by 2030, "at least 35 TWh of electricity generated on land [will come] from wind and solar energy" in addition to "at least 49 TWh of electricity […] from offshore wind" (pg. 151). We would expect to see a total figure for these sources around 100 TWh when the Dutch NECP is updated for the 42.5/45% RES target under the adopted RED III.[2]

[2] 100 TWh is what EREF/TU Wien's 2022 study predicts for NL for RES electricity from wind and PV under its "EE9 with barriers scenario". This scenario, under which renewable energy accounts for 45.1% final energy consumption in 2030 and energy demand is cut by 9% most closely matches the outcome of REPOWER EU legislation, under which RES must reach 42.5% of consumption and energy demand must be cut by 11.7%.

The Netherlands is a pioneer in the use of non-price criteria for tenders for wind parks[3] and this is detectable in some of the language in the NECP; for example, "non-price criteria can strengthen innovation on key challenges for an accelerated, cost-efficient and responsible discharge of offshore wind". This positions the Netherlands well for the NZIA era – even though the use of non-price criteria in wind energy installations envisioned in NZIA and the European Wind Power Action Plan does not concern the environmental impact of the turbine at its installation site.

R&D Strategy

The Netherlands' 'Top Sector Energy' has since 2012 been the strategy for its energy innovation, linking the public & private sectors (the private sector has on average put in "around EUR 100-150 million per year since the launch […] represent[ing] around 40 % of total investment" and spends outside of the strategy, too).

Mandatory batteries in spite of a repeated claim of abundant flexibility

The NECP states three times that "there is already a lot of flexibility in the system" pointing to "large consumers who are flexible and responsive to real time prices by switching up, up to or off." This makes the announced policy of "mandatory batteries in large-scale solar parks" (pg. 9) baffling. This policy should not be introduced at least until the incentives for flexibility from PV installations created or removed by the Electricity Market Design Regulation are clear.

European Heat Pump Accelerator

In indicating an intention to help "compact, smart, cost-efficient heat pumps", the Netherlands appears today to be the country (of the ten analysed) most closely aligned with the technology performance goals of the European Heat Pump Accelerator as put forward by a broad coalition in June 2023.

The announcement of the "Collective Heat Supply Act, which encourages the construction of new heat networks through a parcel system" is welcome and something other Member States should aspire to. R&D spending from the National Growth Fund seems aligned with this strategy (see discussion of Figure 1 copied from the NECP, on the next page).

Funding

The NECP identifies the following funding sources:

- "'Energy Energy Sustainability' (*sic*) mission is supported through a toolbox of grant instruments (DEI +, HER +, MOOI, TSE Industrie R&D). Approximately EUR 200 million per year is available for this purpose. The National Growth Fund has so far mobilised EUR 1.1 billion for energy topics in programmes that will run over the next decade".

  The National Growth Fund made a big investment in the national programme 'SolarNL' in summer 2023: EUR 312 million.

- "Industry is eligible for the Demonstratie Energie Innovatie (DEI +) subsidy scheme, which is budgeted in EUR 2023 65 million [2021: EUR 71 million, 2020: EUR 95 million]". There is no explanation as to why the DEI+ subsidy scheme trends downward.

[3] Windenergiegebied Hollandse Kust (west) | RVO.nl; Staatscourant 2022, 7101 n1 (See "tabel 4 ecology")

- A new funding source was to come at the end of 2023: "The NIKI (National Investment Scheme for Climate Projects Industry) is a subsidy scheme for investments and operating costs of large-scale innovative investments in industry. NIKI is broadly similar to the European Innovation Fund. Preparations for this scheme are under development and publication of the scheme is expected in the second half of 2023." Consultants are still awaiting its publication.

Since the last NECP, public funding for energy research has trended upwards with the exception of the year lost to COVID of 2020:

Figure 1: Public investment in energy research based on committed subsidy, in current prices. Source: RVO (2022)

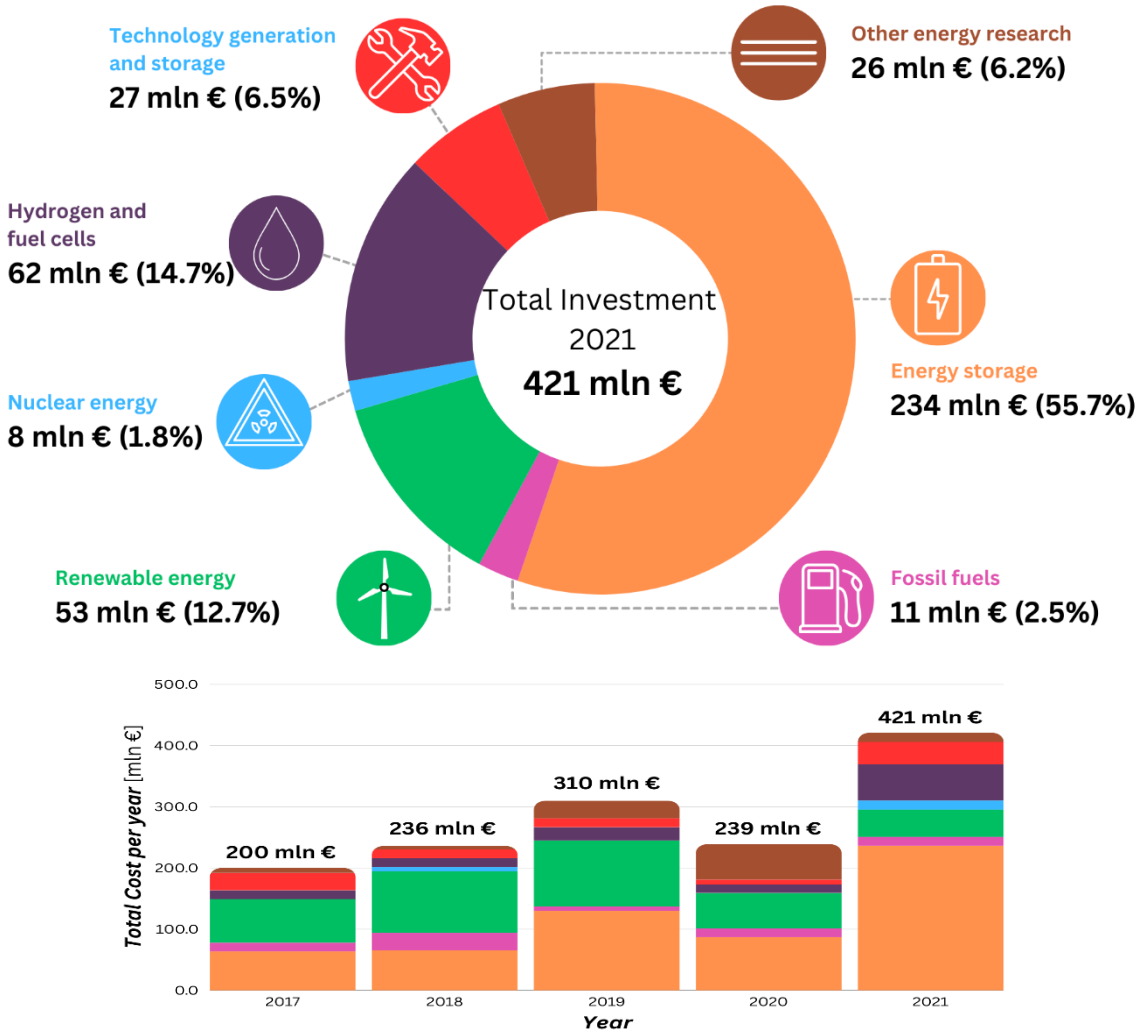

Figure 1: The Netherlands reports a surge in R&D spending on energy efficiency 2020 -> 2021. This might be due to the National Growth Fund, an "important tool to finance climate and energy technologies", which has financing of EUR 200 million for research and innovation for heat infrastructure. There are huge differences between Member States's spending in energy efficiency, with Spain indicating in the same year EUR 35.8 million (Reproduced from Figure 4.32 in the NECP).

As the figure above indicates, spending on renewables (the green bar) seems to be in decline from 2017 to 2021. "For renewable energy, the focus is shifting from lowering the cost of renewable electricity to its integration into the energy system and the surrounding area," states the NECP. Whether system integration has been benefitting from the shift in focus from renewables is not clear

from the charts. In any case, the trend should be reversed so that innovation strategy can support the hoped-for revival of EU-based manufacturing of key technologies for net-zero. As the NECP states, "Industry needs to take place here and not elsewhere, as sustainable industrial production is important for the future resilience of the economy and contributes to strategic autonomy."

The National Growth Fund became operational in 2021. The NECP suggests that the National Growth Fund's spending on R&D 2020-2021 explains both the jump in spending on energy efficiency research and in spending on hydrogen. But at least the allocation for hydrogen in 2021 is not reflected in the chart above, which shows *an* increase in spending, but not on the scale of the NECP: "In the two completed rounds [of NGF financing], EUR 876 million have been mobilised for research, knowledge development and scale-up in renewable hydrogen production and use. EUR 200 million has also been made available for research and innovation in heat infrastructure."

Italy

Italy's draft NECP explicitly references a commitment to support "innovative" renewables – detailing some specific innovative technologies – and has a draft plan to support the designation of renewables acceleration areas. However, it does also plan to increase national gas production.

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- NECP does list some innovative renewable technology. 200 MW of such technology was to be supported with EUR 680 million of grant funding under Italy's National Recovery Plan. The NECP is silent about the implementation of that budget.
- Although several renewable energy sectors are specified (wind, solar, offshore energies, etc.), they do not have dedicated funding programmes.
- Misguided idea to blend hydrogen in the natural gas grid
- Implausible enthusiasm for nuclear technology.
- Unexplained jump in private sector spending for energy R&D 2014-15 presented in Table 1 (Table 75 in the NECP).
- "FER 2" law to support "under competitive procedures" 4.5 GW of innovative renewable energy capacity has been under development since 2021. Why so long?

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

Italy's NECP does take into account the latest FF55 legislation and even references NZIA. There is commitment to support "innovative" renewable energy technologies explicitly, but this stems from a commitment made in Italy's National Recovery and Resilience Plan and is not therefore a response to RED III, which was adopted much later.

R&D Strategy

Priority areas for renewable energy R&D

Italy references innovative or less deployed renewable energy technologies in the NECP but does not detail specific amounts of earmarked funding for their R&D activities. For example, R&D for hydrogen will use "various support/funding instruments", without referencing specific programmes (pg. 149). Geothermal energy receives attention (ETIP-Geothermal and EGEC are even named directly). Wind energy – both floating and onshore – is supported in the NECP. The aims for onshore wind's development relate to "the optimisation of performance" for Italian conditions and "material use"; Italy wants the "development of a national reblading industry." The NECP's statements on Innovation in solar PV relate to agrivoltaics, offshore PV and "sustainably produced" Si-HJT cells.

The enthusiasm for nuclear technology is unexplained. The claims "There is also great potential for Italy to contribute to the revitalisation of nuclear energy in Europe and worldwide" and "Italy has always been at the forefront of nuclear innovation and, in particular, in the conceptualisation, engineering and qualification of passive safety systems for nuclear applications." seem unfounded, especially considering that Italy has not operated a nuclear plant since the Chernobyl disaster.

In hydrogen, Italy intends to use "existing infrastructure to add increasing amounts of hydrogen blended with natural gas," "[to make gas networks] more sustainable". This is unlikely to be the best use that can be made of hydrogen, at least in this decade, when according to the EU strategy on hydrogen, green hydrogen should be displacing grey hydrogen in existing industrial uses.

Funding for energy research

"Italian public research in the "energy" sector is implemented through the following main programmes:

- *'Electrical System Research*' (RdS) in support of relevant technological innovation general for the electricity sector, structured on a three-year basis;
- 'Italian Mission Innovation Programme';
- '*Research on hydrogen NRRP*' under the National Recovery and Resilience Plan."

Private research spending is stimulated by:

> *Tax credit: measure included in the National Industry 4.0 Plan and aimed at stimulating private R&D spending to innovate processes and products and ensure the competitiveness of businesses. The measure grants a tax credit of 50% on incremental R&D expenses, up to a maximum of EUR 20 million per year per beneficiary. The instrument was from 2023 to 2025 with a budget of EUR 55.2 million/year;*

The European Commission should ask Italy to explain the giant leap in private R&I spending 2014->2015, apparently not correlated with increase in public spending (A and B in Table 1, shown below). Furthermore, Italy should provide data on more recent R&D spending, from 2017 to 2023. These five years are significant to determine Italy's recent energy R&D expenditure and how it has improved or decreased over time (particularly since the last Italian NECP report).

Table 1: Italy's energy R&D expenditures (in EUR '000 current)

	Public sector (A)	Public undertakings (B)	Private companies (C)	Total Enterprise (D)	Total (A+D)
2007	152.748			359.085	511.833
2008	176.412			370.146	546.558
2009	241.544			474.385	715.929
2010	204.460	226.034	282.112	508.146	712.606
2011	234.470	218.800	226.731	445.531	680.001
2012	272.142	203.754	244.542	448.296	720.438
2013	279.596	199.653	306.306	505.959	785.555
2014	263.400	292.762	369.732	662.494	925.894
2015	268.959	217.645	1.044.232	1.261.877	1.530.836
2016	251.480	174.684	1.082.099	1.256.783	1.508.263
2017	275.065	232.009	1.106.889	1.338.898	1.613.963

Table 1: This table was reproduced from Table 75 of Italy's NECP

Funding

Italy has budgeted EUR 680 million of grant funding for 200 MW of innovative renewable energy technologies. This money is from the Resilience and Recovery Programme and was first mentioned in Italy's National Recovery and Resilience Plan. There is no update on how much of it has been spent so far, or on what, which is a shortcoming. Comparing the figures of EUR 680 million and 200 MW reveals that the average CAPEX of installations supported under this measure is expected to be >3 €/Wp, which is huge (10x more than PV module prices at non-dumping prices). The European Commission should ask for details.

Italy recognises that measures beyond CFDs and PPAs might be needed "to support plants based on innovative technologies." A piece of legislation to support the deployment of innovative renewables "FER-2", awaited since 2021 is "being drawn up" to support "under competitive procedures" 4.5 GW of capacity in the technologies mentioned above under 'Priority areas for renewable energy R&D'. Given the time Italy has already taken to gestate this legislation, the European Commission should ask for more details than are currently offered.

Before REPOWER EU challenged Member States to multiply by 10 their production of biomethane output 2021-2030, Italy had already focused on the area in its National Recovery and Resilience Plan:

> *NRRP M2C2 1.4 'Development of biomethane, in accordance with criteria for promoting the circular economy' supports investments in the construction of new biomethane production plants and the conversion, in whole or in part, of existing biogas plants. In line with the Ministerial Decree of 2 March 2018, the purpose of the Ministerial Decree of 15 September 2022 is to promote incentives for biomethane injected into the natural gas grid through capital support (up to 40% of the expenditure incurred, using resources provided for in the NRRP) and an energy incentive (incentive tariff applied to net biomethane production).*

The title of Table 1 needs clarifying to indicate whether it presents Italy's view of the strengths of each tool/policy or whether it is showing what each tool/policy itself claims is its scope. If the latter, then the scope of intervention of Innovation Fund is understated.

Spain

Spain's draft NECP demonstrates an awareness of its vulnerability to global heating and notes the need to adapt to it. The NECP also identified sectors facing a labour shortage.

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- Spain has embraced the concept of regulatory sandboxes for "onshore & offshore renewable energy" and "the electricity system".
- Measure 1.4 of the NECP nods to the "5% innovative renewables" provision of RED III, but the examples of deployment indicated under measure are not of GW scale
- Spain identifies a number of innovative technologies (i.e. offshore wind, biogas conversion to biomethane, floating PV, etc.), but the foreseen deployments would fall short of the RED III target.
- Biogas-related work should be more focused on biomethane to support REPOWER EU
- The Recovery and Resilience Funding money Spain uses is not for R&D, rather strengthening existing programmes. What is Spain's long-term strategy for innovation?
- Spain puts 50% more public money into nuclear energy than into renewable energy. This needs to be better explained. Why does RES not get priority?

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

The Spanish NECP does quote EU targets that "have been agreed at European level by 2030." Spain is the only Member State to embrace the idea of Regulatory sandboxes[4], although the Netherlands brief allusion to its "RES 1.0" and "RES 2.0" regions might relate to something similar. Spain's sandboxes would focus on two areas: "onshore & offshore renewable energy (including "floating offshore wind")" and "the electricity system" (see pg. 302 and 320).

Spain's measure 1.4 "Development of innovative renewable energy installations" (detailed on pg. 110) appears to attempt to implement the "5% innovative renewables" provision of the RED's new Article 3 although the examples of 'specific support' listed under it relate, with one exception, to tenders published before an informal trilogue agreement on RED III had even been reached.

The measure focuses on offshore wind, energy storage, biogas for direct use and conversion to biomethane; floating PV and 'other technologies' concentrated solar power and deep geothermal. R&D and grants for pilot projects are offered to these projects. None of the envisaged deployments under the measure of these technologies can be said to be GW-scale, which is the intention of the "5% innovative renewables provision". That is a shortcoming.

To support the REPOWER EU strategy and decarbonise heavy industry, we would advise focusing biogas work more closely on the upgrading of biogas to biomethane.

R&D Strategy

Spain's research, innovation & competitiveness strategy for renewable energy is governed by two policies, which predate the NECP:

[4] See New European Innovation Agenda (2022); committed to by Member States in Net Zero industry Act (2024)

- State Plan for Scientific, Technical and Innovation Research 2021-2023 (PEICTI)
- Spanish Strategy for Science, Technology and Innovation (EECTI 2021-2027)

Spain wants to work on PV, concentrated solar energy, biomass, offshore wind energy with an emphasis on floating wind energy, deep and shallow geothermal and the demonstration of ocean energy technologies (pg. 93). Another list with similar technologies (including energy storage technologies and hybrid projects) appears on pg. 111 under Measure 1.4.

While Italy expresses an interest in building up a reblading industry, Spain is interested in the recycling of turbine blades, proposing to grant investment aid for "repowering (leading to an increase in power), […] and the construction of innovative recycling facilities, such as the recycling of blades at the end of the life of wind farms." It wants to develop "techniques for uninvasive manufacturing [of floating offshore wind], assembly, operation in the marine environment."

Spain's Measure 5.18 includes "Support for new components manufacturing", which could include "advanced manufacturing of photovoltaic technologies"; while Measure 1.18 talks of "investment […] to support the implementation or upgrade of manufacturing facilities for renewable generation, storage and generation/storage/distribution" such as "photovoltaic panel factories, larger or technologically improved wind turbine blades," or factories for batteries or electrolysers. An additional EUR 1 billion will be available under the "More Energy Security Plan". For this, "a Manifestation of Interest (MDI) (*sic*) has recently been held […], with the aim of gathering information, proposals and ideas from projects from companies, associations, and from all civil society."

Funding

Recovery and Resilience Facility addendum, approved by the Council of Ministers on 6 June 2023 and now being assessed by the European Commission, provides for more than EUR 10 billion in grants and up to EUR 84 billion in loans including for energy. This money, while not for R&D, is intended to "strengthen [] Spain's and Europe's strategic autonomy in the energy, agri-food, industrial, technological and digital fields." In energy, Spain pledges to use it to continue "exceptionally successful support programmes, such as those related to self-consumption and storage behind meter or renewable hydrogen, as well as to open new strategically essential lines such as those related to industrial value chain support linked to the energy transition."

Figure 2: Distribution of RD&I expenditure by technologies and public investments in RD&I per technology in 2021

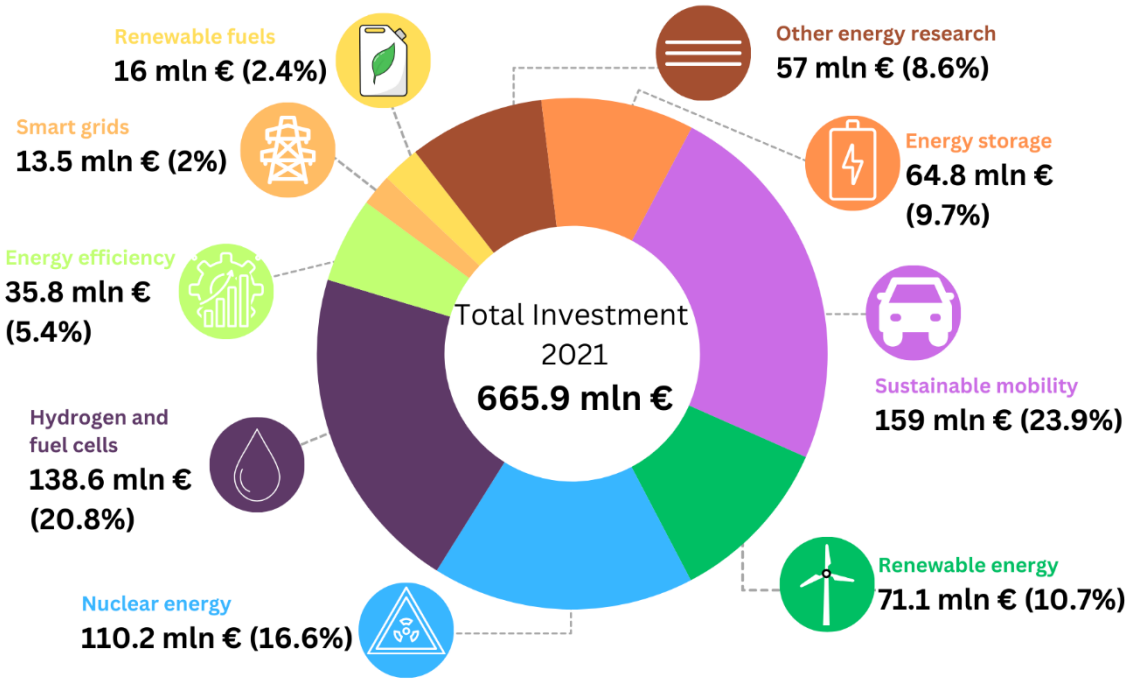

Figure 2: Produced by using the data from Figure A.11. in Spain's NECP (pgs. 497). Source: Estadística de Créditos Presupestarios. SICTI. Ministry of Science and Innovatión.

Spain puts 50% more public money into nuclear energy than into renewable energy. This should be better explained. Is Spain's contribution to ITER counted here?

Denmark

According to the draft Danish NECP, Denmark plans to generate 70% of its energy from renewables by 2030 (Figure 6, pg. 48 in the NECP), with a step up between 2029 and 2030 for offshore wind as two parks enter into operation. The NECP also sets high targets for the development of renewable and low-carbon gases. However, it has "considerable uncertainty" over the means to reduce greenhouse gas emissions by 70% compared to 1990 by 2030.

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- Wind energy is the dominant renewable energy source for Denmark – and the NECP states a wish for a "sevenfold" increase in offshore wind by 2030 – yet wind energy is not the focus of Denmark's clean energy research.
- Instead, Denmark prioritises PTX and CCS.
- Denmark identifies an expert committee to assess the impact of R&I by 2024. The new NECP should include at least the initial findings of this group in terms of future research efforts.
- Remarkably, Denmark still subsidises research into unabated fossil fuels. We recommend no future subsidies paid to the fossil fuel sector.

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

Fit for 55 is acknowledged, as are REPOWER EU targets. For EPBD, Denmark even relates its remarks on EPBD to "the general position of the Council [of Ministers]".

"In 2020, the Danish Parliament adopted the Danish Climate Law." Denmark appears to think that this law, detailed in Section 4.1 of Box 1 on pg. 19, which contained the national target "to reduce greenhouse gas emissions by 70% compared to 1990 by 2030", is compatible with Fit for 55: it writes, "The Fit for 55 package [which was proposed in 2021 and debated until 2023] is expected to contribute to Denmark's achievement of the 70% target." But doubt creeps in: "how the 70% target is achieved through national measures in Denmark" is subject to "considerable uncertainty."

The EU legislative basis assumed by Denmark for its NECP is therefore unclear.

R&D Strategy

"Wind energy plays a key role in a Nordic context and is considered to be dominant in the future electricity system." Furthermore, Denmark wants a "sevenfold" increase in its offshore wind capacity by 2030. Yet wind is not the focus of Denmark's clean energy research.

Its EUDP programme – the highest-funded of its programmes – prioritises "Research into key technologies such as CCS, PTX and pyrolysis […] and support [for] their uptake." The emphasis on PTX and CCS is consistent with a new climate goal of carbon neutrality by 2045 and being 10% carbon negative by 2050 (pg. 6). CCU is included alongside CCS (pg. 85). PTX is for the purpose of making "green fuels for transport and industry."

Denmark "will construct two energy islands": Bornholm energy, 2 GW, by 2030; and North Sea, 3 GW first phase by 2033 combining wind energy production with PTX and cross-border trade of electricity. They would "reduce the number of interruption minutes by about 26 minutes in West Denmark and 18 minutes in East Denmark."

Funding

"In 2023, a total of DKK 2.4 billion [EUR 320 million] has been earmarked for green research," with a commitment to maintain this level "until 2025".

Denmark has three main instruments for funding "green" research:

- Danish Innovation Fund (DKK 150 million [approximately EUR 20.2 million] to energy projects in 2022)
- ELFORSK (DKK 20 million [approximately EUR 2.7 million] to three projects in 2022)
- Danish Free Research Fund

Additionally, there are three development and demonstration programmes:

- Energy Technology Development and Demonstration Programme (EUDP) (DKK 498 million [approximately EUR 66.9 million] in 2022, DKK 510.5 million [approximately EUR 68.5 million] in 2023)
- Environmental Technology Development and Demonstration Programme (MUDP)
- Green Development and Demonstration Programme (GUDP)

Additionally, "In 2021-2023, a large majority in the Danish Parliament allocated a total of DKK 1.3 billion [approximately EUR 174.4 million] to four green research and innovation partnerships. Overall, the Innovation Fund is responsible for these. The partnerships will bring together its researchers, businesses and organisations to put Denmark at the forefront of *storage and use of CO_2*, PTX*, climate, environmentally friendly agriculture and food production*, and *circular economy."*

An expert committee "strengthen[s] the knowledge base on the impact of the offensive green research and innovation efforts, and will, inter alia, present orientations on green forging and innovation for the future." – this translation of the original Danish text is rather hard to understand. It was "set up in June 2022" to "develop an analytical framework to assess the impact of research and innovation efforts on the development and maturity of solutions contributing to the reduction of greenhouse gas emissions. The work should be completed by 2024," when "the Danish government will take a position on funding for research missions focusing on forward-looking efforts, including the long-term climate targets beyond 2030."

We recommend that this group also advises Denmark on the implementation of the indicative target of 5% of capacity from innovative renewable energy technologies and that no subsidies are paid to the fossil fuel sector, for research or any other purpose.

Remarkably, Denmark still subsidises research into unabated fossil fuels: a part of EUDP money goes to "environmentally friendly and energy-efficient production of oil and gas." This is in contradiction with the later line, "There are neither direct nor [*sic*] subsidies for fossil fuels in Denmark."

Lithuania

The European Commission commended Lithuania's NECP for showing the "right ambition in terms of quantification of the climate mitigation impacts of various policies and measures".[5] and its identification of clear objectives for non-CO_2 emissions in waste management and agricultural emissions and ambition to reach 100% renewable energy share in electricity by 2030.

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- Lithuania heavily relies on EU money for the public funding of its NECP work.
- Too much public money seems to destined for deployment of RES compared to RES R&D
- Sources of funding for the "Planned policies" have not been pinpointed.
- Many outside government were consulted for the NECP. This consultation infrastructure should now be used specifically to set the strategy to deploy 5% innovative RES technologies in total new RES capacity.

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

Lithuania takes account of Fit for 55 legislation, indicating in Table 2 (on the next page) the national contribution it will make to reaching EU targets.

[5] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52023DC0796

R&D Strategy

"A National Climate Change Committee has been established to provide independent scientific advice on the design, assessment and implementation of national climate change management policies. It is composed of 11 representatives from different higher education institutions in the country. Scientists will provide advice on research or funding pathways."

As to the NECP, the writing of this update "was initiated by the Ministry of Energy and the Environment in autumn 2021, with the aim of making it as inclusive as possible. To this end, five working groups on decarbonisation (industry, transport, waste and circular economy, energy and agriculture and forestry) and three energy (energy efficiency, internal market and research, innovation and competitiveness) working groups have been set up." All the Groups were consulted for the NECP: "Consultations took place during meetings of the Decarbonisation and Energy Working Groups, which are open to the public. These included the presentation of existing measures, the consultants' analyses of existing measures, Lithuania's progress since the start of the plan;"

Another advisory group is "the Collective Leadership Platform Industry 4.0, which was established in 2017, […] to increase and strengthen the competitiveness and productivity of the Lithuanian industry and to promote the integration of digital solutions and new green technologies. Through a bottom-up approach, the Platform consists of a High-Level Industrial Competitiveness Commission chaired by the Minister of Economy and Innovation, a Coordination Group and seven thematic working groups addressing current challenges and future related issues in the following areas: digital production, as well as services promoting digitalisation, standardisation, energy efficiency and the circular economy."

Consultation has therefore been extensive. One of these groups could be used to define innovative renewable energy technologies for Lithuania to deploy to meet its 5% i-RES indicative target.

Funding

Key tables on the funding of NECP work are unclear. Table 2 describes "planned funding" for "existing policies":

Table 2: Planned funding for the implementation of existing policies in 2021-2030.

Sector	Global funds in EUR million	Public money in EUR million
Transport	3270,80	1460,26
Industry	1717,50	913,97
Agriculture	961,70	908,02
CO2 storage	383,52	383,52
Wastes	721,12	549,24
Renewable energy resources	1077,25	910,92
Energy efficiency	2814,96	1094,68
Internal Market	1024,42	777,58
Energy security	1056,11	569,35
R&D	775,22	633,66
Total:	**13802,59**	**8201,20**

Table 2: "Funding is intended to cover infrastructure, human resources, research and experimental development (R&D) activities and running costs," explains the text. The Table was reproduced from Table 5.3.1. in Lithuania's NECP.

…with Table 2 breaking down the amount of 8201,20 to different public funding sources.

But there is another table of "indicative needs" for "planned policies" lacking a corresponding table identifying the public funding source for these planned policies.

Table 3: Indicative needs for the implementation of planned policies in 2021-2030

Sector	Global funds in EUR million	Public money in EUR million
Transport	3009,57	747,61
Industry	386,90	169,04
Agriculture	222,20	126,34
CO2 storage	45,44	45,44
Wastes	3,00	3,00
Renewable energy resources	864,10	726,20
Energy efficiency	7064,94	2179,17*
Internal Market	165,00	0,00
Energy security	0,00	0,00
R&D	8,70	8,70
Total:	**11769,84**	**4005,50**

Table 3: This table was reproduced from Table 5.3.3. in Lithuania's NECP.

The NECP identifies "existing" policies with the suffix "-E" at the end of the measure (e.g. MT9-E Pre-commercial purchases in LT) and "planned" policies with suffix "-P" (e.g. MT13-P Assess the feasibility of adapting the gas transport system to the transport of green hydrogen-methane blends and implement pilot projects for the development and adaptation of the system). A source of funding for the planned ones must be found.

The EUR 8.7 million for R&D under "planned policies" in Table 3 seems low compared to the other amounts: might it not make sense to use somewhat less public money for the deployment of renewable energy sources and increase the funding for R&D?

In any case, Lithuania's heavy reliance on EU money for the public funding of its NECP work is apparent.

Luxembourg

Like Spain, Luxembourg analysed its exposure to the risks of climate change. Its NECP is designed to mitigate these risks, including with measures to adapt to climate change. The country's focus has been on generating renewable electricity from wind, PV and biomass. It claims biomass will play a smaller role in future. Permitting for small PV installations will be streamlined...

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- Slightly unrealistic ambition on PV manufacturing
- Interest in an "energy island" is mentioned – further details for how this landlocked country would be involved in one should be provided.
- Luxembourg is the first country to participate in the Renewable Energy Financing Mechanism (alongside Finland) and mentions it extensively.
- Pilot projects to use geothermal energy are promised

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

Luxemburg takes account of Fit for 55 legislation (even assuming 45% RES for 2030, not 42.5%[6]) upgraded by REPOWER EU, providing estimates for annual domestic RES production 2030 (Table 23 on pg. 53 of the NECP) and annual RES-electricity production (Table 7 on pg. 36 of the NECP).

In response to REPOWER EU, permitting for PV is speeded up for small installations: "With the entry into force of Council Regulation (EU) 2022/2577, the authorisation procedures for photovoltaic installations are subject to one-month time limits with tacit agreement for installations with a total capacity of less than or equal to 50 kW, which includes the majority of installations in the residential sector. All other photovoltaic installations must be processed within three months." [Sweden goes further: "Since the first August 2018, as a rule, no building permit is required to assemble a photovoltaic or solar installation on a building if it follows the shape of the building."[7]]

The indicative target of 5% innovative renewables is not mentioned, but the "national Strategic RDI agenda", to be prepared under Measure 116 could be the vehicle to define the first set of qualifying technologies and the measures that would support them. A few candidates are already mentioned in the NECP – see below under 'R&D Strategy'.

R&D Strategy

"The electricity sector derives its renewable energy mainly from three resources: wind, photovoltaic and biomass. Wind and photovoltaic will remain the two springs with the greatest potential."

There is some overlap between these families of technologies and the innovative technologies that Luxemburg claims an interest in: Assuming a good outcome from the pilot tender (in October 2022) for **Agri-PV**, "As early as 2025, it is intended to organise regular calls for tenders for agrivoltaism (in the order of 50 MW per year)."

Luxemburg has failed to roll out **PV** as fast as it wanted ("Since 2018, 74,9 MW of tenders [were] awarded from 155 MW capacity on offer"), due to the "pandemic, surge in costs, energy crisis, supply chain, lack of skilled labour." One of the solutions it proposed is to alleviate "the supply difficulties […] by the production of photovoltaic panels on the national territory with a capacity […] corresponding to approximately 50 MW per year." A standalone 50 MW production plant will never be competitive, so we would advise either aiming for a plant at least 20x bigger and exporting, abandoning the idea, or collaborating with a neighbouring country, which the Luxemburg seems open to: "A good integration of the Luxembourg research ecosystem in an international context is crucial given the limited resources and capacities of the country."

There is a single intriguing reference to "**energy islands**" ("energy islands and the development of hydrogen and its renewable liquid and gaseous transport fuels of non-biological origin (RFNBO)"). Luxemburg being landlocked, the European Commission should enquire how Luxemburg intends to involve itself in "energy islands".

Luxemburg will authorise "new sites for the installation of **wind turbines** using new technologies for the **protection and detection of birds and bats**;" (Measure 224)

[6] Section 2.1.2.13.3

[7] Sweden's NECP, pg. 61. "However," it continues, 'municipalities may impose other requirements in the development plan."

A pledge made for heating technologies is "Accelerated installation deployment to use surface **geothermal** energy (up to 400 m depth) in combination with **heat pumps** through regular reassessment and, if necessary, adaptation of financial incentives;" this in view of "Exploiting the potential of medium depth geothermal energy (400-2 000 m)." "Pilot projects" will come first.

Funding

Luxemburg is the first country to pair up with another (Finland) to receive a statistical transfer of RES production under the Renewable Energy Financing Mechanism (see Box 1)[8]. It is the only country analysed so far to refer to the REFM (a passing reference is made in Finland's NECP) and does so extensively. The REFM could, we hope, be used to finance innovative renewable energy technology.

> "After a first unsuccessful call for applications, due to the lack of successful projects on the part of host Member States (countries carrying out projects on their territory), Luxembourg again participated in the second call for applications launched on 4 March 2022. Luxembourg committed itself in February 2023 with a budget of EUR 40 million with a host State, namely Finland, which has submitted sufficient capacity to the mechanism."

Box 1: From paragraph 2.1.2.13.2 of Luxemburg's NECP. Luxemburg and Finland are the first countries to use the Renewable Energy Finance Mechanism.

Sweden

Sweden has somewhat increased its ambition for its renewable energy future, anticipating 75% RES in final energy consumption by 2030. The bulk of this renewable energy will be from bioenergy and wind sources.

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- Sweden's R&I effort focuses on biofuels/bioenergy, although it is wind energy that has grown the most, in percentage terms, since 2005.
- It seems there is a good opportunity for Sweden to take account of the 5% innovative renewables target in a forthcoming Bill setting a 4-year strategy for research and innovation in the field of energy.
- Funding from the Swedish Energy Agency for energy research (the largest single source) has been stable for the past four years, with private co-funding for R&D projects exceeding the public component.

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

Sweden only partially anticipates adoption of Fit for 55 files. The text refers to the old EU RES target of 32% by 2030 and says it does not "take into account political decisions and new revisions of EU directives" after 30 June 2022. But the date in last official NECP dated 16 January 2020 by which it will achieve 65% RES in final energy consumption is brought forward from 2030 to 2027, with a forecast of 75% made for 2030[9]. So, there has been some increase of ambition between the NECPs.

Sweden writes that its chapter *Current state of play of existing instruments and measures and projections based on them* "will therefore need to be adjusted in view of the submission of the final updated NECP in June 2024." **The Commission should ask for a second publishable draft** before the final one to allow stakeholders an opportunity to review the adequacy of Sweden's approach taking

[8] Section 2.1.2.13.2
[9] Table 25

account of the important changes brought by the Renewable Energy Directive (formally adopted in Oct 2023).

R&D Strategy

Priority areas for R&D in energy generation

There is one area that stands out as a priority for Sweden: "Efficient biofuels for low-carbon energy transition, forestry and bioenergy", although the country recognises that "wind energy is the renewable energy source that has grown most in percentage terms since 2005" and, under the (now out-dated) scenario of meeting an EU target of 32% RES by 2030, will account for "the largest increase in renewable energy […] between 2021 and 2030."

Another family of renewable energy technologies featured on the Swedish Energy Agency website is Renewable Heating and Cooling, funded through the Termo programme (SEK 250 million 2018-2024 [approximately EUR 22 million])

Sweden also funds low carbon technologies for the transport sector, and batteries.

Work on defining 'innovative renewable energy technologies' can be part of Sweden's 4-year R&D strategy from 2025

In common with other FF55 targets, Sweden ignores the new target in RED for 5% of new capacity from innovative renewable energy technologies. However, it writes of its "overall research and innovation policy" that it is laid down in a Bill every four years[10]. "The preparation of the forthcoming proposal for research and innovation in the field of energy is ongoing and the Government has instructed the Swedish Energy Agency to prepare the basis for the bill in 2023" to come in force in 2025. The timing allows Sweden to use its deliberations on that legislation to define its approach on "5% i-RES".

Funding

Table 29 from the NECP, reproduced as Table 4 below, shows funding for energy research has held steady in current prices for the past four years. Most public funding for energy comes from the Swedish Energy Agency. The table could include a fifth column for 2023: "According to the Budget Bill for 2023 [its] allocation amounted to SEK 1.4 billion" (approximately EUR 126 million).

"Companies/industry bodies" means Energiforsk, rather like Denmark's industry association Green Power Denmark's Elforsk initiative. Sweden also has a "cooperation with the automotive industry on joint funding of research, innovation and development activities across several focus areas, including zero emissions and circularity," called FFI.

[10] The most recent, in force, is Bill 2020/21:60 'Research, freedom, future – knowledge and innovation for Sweden'.

Table 4: Public and private funding under the National Energy Research and Innovation Porgramme 2019 – 2022.

	2019	2020	2021	2022
Swedish Energy Agency	SEK 1 295 million (43 %)	SEK 1 344 million (44%)	1 319EIA (44 %)	SEK 1 300 million (45 %)
Companies/industry bodies	SEK 1703 million (57 %)	SEK 1 707 million (56 %)	SEK 1 713 million (56 %)	SEK 1 589 million (55 %)
Total State and Enterprise Funding	SEK 2 898 million (100 %)	SEK 3 051 million (100 %)	SEK 3 032 million (100 %)	SEK 2 889 million (100 %)

Table 4: This table was reproduced from Table 29 in the Swedish NECP

Further public funding "relevant to the transformation of energy systems" comes from the Government Research Council Formas (2018: SEK 75 million [approximately EUR 7.3 million]; 2021 onwards: approx. SEK 230 million [approximately EUR 20.8 million]), the Swedish Agency for Innovation Systems Vinnova, the State Research Council for Basic Research (funding of "around SEK 125 million per year" [approximately EUR 11.4 million per year] for "sustainable community building"), the Scientific Council and the Public Research Foundation Mistra".

A separate fund, Industriklivet, funds industry decarbonisation like SEA funds energy research: "Industriklivet covers a total of approximately SEK 1.354 million in 2023 [approximately EUR 123 million] and can finance projects running until 2030. The annual budget is decided in the context of the Budget Bill."

There is a dedicated "Future electricity system research programme" on electrification: "The programme runs from 2022 to 2027 but may be extended if necessary. Initially, the financial framework is SEK 552 million [EUR 50 million] for the entire programming period."

Germany

Germany's draft NECP incorporates several Fit for 55 targets (though not the 5% innovative renewables target), but notably also mentions plans to use solid fossil fuels well beyond 2030.

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- The NECP includes strong national policies for wind and solar, with modest increases in bioenergy and geothermal. However, trajectories and deployment are not detailed.
- There is an ambitious plan to extend district heating networks and to power 50% of them with renewable energy and waste heat by 2030. However, greater detail is needed on the energy sources for these networks.
- While there is considerable funding available for renewable programming, the funding estimates are vague. There should be information regarding impact assessments, investment needs, and future funding amounts
- There should be greater detail on digitalisation and skills in the next NECP, as well as an acknowledgement of the 5% innovative renewables target in RED and the steps which will be taken to achieve that target.

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

Germany's draft NECP covers Fit for 55 targets and measures relatively well, incorporating targets and rules from RED, EED and several from EPBD, a directive that was still being negotiated with the

European Parliament when the NECP was published. While this is positive, there are several gaps that need to be filled, including: an innovative renewable energy target (as required under Article 3 of RED); measures of the EPBD that could not be included, such as the National Building Renovation Plans (Article 3 of EPBD); a compete impact assessments on skill gaps (section 5.2 of German NECP draft), estimation of costs of measures and investments (section 5.3 of German NECP draft) and predictions on energy prices (section 5.4 of German NECP draft).

For renewables under section 3.1.2.1, the draft presents strong national policies to deploy wind and solar in line with REPowerEU, such as setting aside large areas for wind deployment in the Wind Energy Demand Act (WindBG) and speeding up permitting procedures.

R&D Strategy

For renewable energy, the focus is large-scale deployment of wind energy and PV, along with modest increases in bioenergy and geothermal. The draft summarises in section 3.1.2.i the objectives in its Renewable Energy Sources Act (EEG 2023), particularly the following targets in installed capacity by 2030: 30GW offshore wind; 115GW onshore wind; 215GW PV by 2030, which should contribute to. Germany achieving an 80% share of renewables in electricity by that date.

For the final report, the NECP could including more detailed accounts of the sources of renewable energy technologies that will be deployed, the amount of energy that will be produced or where this energy will be used. It is essential that the draft plan completes the following two mandatory sections in the Commission's template:

- 2.1.2.ii. Estimated trajectories for the sectoral share of renewable energy in final energy consumption from 2021 to 2030 in the electricity, heating and cooling, and transport sector
- 2.1.2.iii. Estimated trajectories for the deployment of renewable energy technology to achieve in Mtoe and MW.

The draft makes no mention of the target for innovative renewable energy in Article 3 of RED. To fulfil this requirement, the next version of the plan should list the specific technologies that will be deployed and the total installed capacity expected by 2030. In addition, the draft should also include a trajectory from 2021 to 2030 for each innovative renewable technology in planned installed capacity by 2030 (similar presentation to trajectories in section 2.1.2.iii).

Funding

Following a German supreme court ruling that declared the reallocation of EUR 60 billion from unused COVID-19 aid fund to the Federal Climate and Transformation Fund (KTF) to be inadmissible, Germany's R&D budget for decarbonisation efforts in buildings, industry, and energy supply from 2024-2027 will face potential challenges. While the overall R&D strategy remains in place, the exact impact on the R&D budget is unclear. The German government is currently exploring alternative funding options to fulfil its climate goals. The draft plan is vague on other funding programmes, referring, for example, to the 7th Federal Government's energy research programme of 2018-2022, without giving information on what comes next. We recommend including in the next draft version the priorities and funding amounts of the new 8th programme starting in 2023. More generally, the plan should try to provide an indicative funding objective for each major programme up to 2030.

Section "5.3. Overview of investment needs" provides very little information on current and future funding needs. This section should include a complete impact assessment with spending forecasts till

at least 2030 and ideally till 2045, split into each of the five NECP dimensions, energy sectors, energy technology and the share to be covered by public and private funding.

The draft mentions in section 3.5.1 the Digital Energy Transition Act (DGEW) as the basis for "cross-sectoral digitalisation". The government set priorities for digitalisation and how they can contribute towards the five dimensions of 'Energy Union'. It should evaluate whether the DGEW from 2016 needs to be revised or redone.

In relation to skills shortages, the draft expects that the 2023 Skilled Immigration Act will boost competitiveness in the clean energy sector. The draft should articulate in more detail how and what it can do for the climate and energy, moreover this should be included in the impact assessment in section 5.2.

The draft presents in section 3.1.2 an ambitious plan to extend district heating networks and to power 50% of them with renewable energy and waste heat by 2030. To finance this the Aid Programme for Efficient Heating Networks (BEW) will provide EUR 4 billion up to 2027. This could support the deployment of innovative renewable energies for heating, including shallow geothermal and solar thermal. The draft should be more explicit about the sources of energy that will power this network, along with the funding and measures that these will require. In addition, the draft should include funding estimates of the Efficient Heating Networks (BEW) programme for the period 2028-2030.

Portugal

The former Portuguese science minister is happy with Portugal's "increased strengths" in research and innovation, though the "intensity of R&D funding…remains low compared to the European average".[11]

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- Renewable energy R&D will focus on solar thermal, solar PV, and biomass; R&D focuses on gases from renewable sources and their injection into the gas grid. We caution that the blending of RES-H2 with natural gas, is not in line with the EU hydrogen Strategy and does not deliver the best climate impact from scarce commodity. Portugal also expects to harness and maximise untapped potential in offshore wind energy.
- Hydropower has historically made a high contribution to electricity production - but climate breakdown is making rainfall and hydroelectricity production more uncertain. Reversible hydroelectric plants (i.e. equipped with pumping equipment) are part of the strategy to add flexibility to hydropower production.
- The NECP encourages the spread of (well-regulated) hybrid systems to give greater system flexibility and complementarity between energy systems.
- Despite these energy goals and general recognition of the need to promote R&I projects, there are no concrete details on how these projects will be funded.
- A new "innovation centre" will be created with a focus on sustainable mobility, clean energy, advanced manufacturing and the maritime economy.

[11] https://sciencebusiness.net/viewpoint/research-and-innovation-gap/viewpoint-portugals-experience-could-inspire-widening

- The NECP details Just Transition programmes and a programme to upskill and reskill workers.

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

References to Fit for 55 and corresponding legislation are limited to the EU ETS Directive from which Portugal will benefit via the Modernisation Fund. Portugal intends to use its Modernisation Fund allocation for renewable energy, energy efficiency, storage capacity, and just transition.

R&D Strategy

Portugal's strategy is focused on decarbonisation and the Just Transition, with a heavy focus in the short term on gases from renewable sources (hereafter shortened to 'renewable gases') replacing gases from fossil sources. In the short term, the strategy will consist of a set of mechanisms to:

- regulate the injection of renewable gases into the national natural gas grid;
- implement a system of guarantees of origin for renewable gases;
- concentrate available financial resources on national and European funds to support energy production in the production of renewable gases, in particular renewable hydrogen and biomethane;
- assess the setting of binding targets by 2030 for the incorporation of renewable gases into the natural gas grid.[12]

Other renewable technologies in focus will be solar thermal and solar PV energy, the increased use of biomass and "enhance[d] use of the national hydropower potential". The country will complete a complex consisting of three hydropower plants. New hydropower plants will also be equipped with reversible pumping components to absorb excess electricity production. A new innovation centre, with a focus on sustainable mobility, clean energy, advanced manufacturing and the maritime economy will also be built under the Just Transition Fund. In terms of wind, onshore production is centered around retrofitting and over-equipping. However, Portugal also expressed the fact that there is a high potential for renewable ocean energy – particularly offshore wind energy. While the potential for wave energy will also be explored (including an increased wave energy target from 70 MW to 200 MW by 2030), Portugal's ocean energy future (and investments) will reportedly consist mainly of floating turbines as well as a planned multi-use of space. One such example of Portugal's maritime spatial plans is the planned creation of a Technological Free Zone off Viana do Castelo to support innovation and the development of demonstration projects.

There is a strong emphasis on the need for hybrid systems for flexibility, more efficient use of resources, and complementarity between energy systems, and potentially reducing production costs. However, to properly develop and implement hybrid systems, Portugal must (and has stated plans to) create complementary legal and regulatory criteria.

While Portugal's NECP states that the industrial sector will be "heavily influenced" by digitalisation and robotisation, including increased electrification as well as greater use of biomass and solar thermal technologies, how they will achieve this influence is unclear and robotisation is largely ignored (pg. 1). Robotisation is only referenced as a theme in the Industrial and Manufacturing Agenda (pg. 14).

[12] Portuguese NECP, pg. 10

Upskilling and reskilling of workers will be covered by the "Verdes/Green Skills and Jobs Work and Skills programme," a vocational training programme from the Institute for Employment and Vocational Training in the field of energy (Ministerial Implementing Order No 21/2023, of 6 January).

Finally, Portugal plans regulatory measures to accelerate the uptake and deployment of renewables, such as measures to accelerate permitting. The Mission Unit for Licensing of Renewable Energy Projects (Umer 2030) is a new measure to ensure the objectives of the 2030 NECP are met and to speed up the realisation of renewable energy projects. Umer 2030's responsibilities include procedural operationalisation resulting from the consolidation of the legal and regulatory framework applicable to electrical and environmental licensing, empowering local authorities for permitting procedures, and development of streamlined licensing and monitoring framework.

Funding

The NECP notes the need for R&I in wave and wind but without earmarking specific amounts for these technologies.

Slovakia

PV and air-to-air heat pumps are the only renewable energy forms delivering more energy in 2023 (according to the draft 2023 NECP) than imagined in Slovakia's final NECP 2019. The new draft plan increases ambition for RES's share in gross final consumption from 19.2% to 23% but does not say whether it considers this enough to meet the EU target of 42.5% (mentioned nowhere) or the old target of 32% (which is quoted, the NECP wrongly stating "The European Union's binding target for the share of energy from renewable sources in gross final consumption of energy shall be at least 32% in 2030").

Main points from NECP on Research, Innovation & Competitiveness related to renewables:

- Slovakia focuses on reducing dependency on Russian energy imports. Increasing natural gas production and adding gas storage capacities is part of the plan, alongside nuclear.
- The country puts "energy efficiency first"
- Poorly prepared forecasts of renewable electricity production:
    - Biogas and biomethane are grouped together, despite the fact that they are different products; there is an unexplained predicted boom for biomass without updated policies.
    - There are a number of delays in renewable energy production, in bioenergy as well as solar energy.
    - There is no foreseen uptake in geothermal energy; this lack of ambition is attributed to cost.
    - Reduced expectations for the future of wind energy
- The main measure to boost RES-heat in district heating (mandating an increase on district heating network owners to include more RES-heat) is presented as "new" but had been implemented in response to the old "Clean Energy for All Europeans package"
- There is little detail on the areas national RD&I money for energy has been spent on. Spending is on a slow downward trend, with one anomalous year (2023) where spending plummeted.

- Slovakia's energy R&I strategy, tied to its "Smart Specialisation agenda", is set to be revised in 2024, as part of "an update of the Synthesis Report of the Entrepreneurial Discovery Process"

Anticipates adoption of Fit for 55 files upgraded per REPower EU?

Shaken by the impact on its energy system by Russia's 2022 invasion of Ukraine, Slovakia references REPowerEU, but does not reference the new RES target under RED, instead using the old target of 32% by 2030 (pg. 54).

R&D Strategy

The NECP is vague on R&D objectives, stating a focus on "new and renewable, environmentally friendly energy sources, rationalisation of energy consumption in all sectors of the economy and energy distribution" (pg. 100). However, a sense of the RES technologies that matter most to Slovakia is discernible in the tables 12-14 showing how renewables will be deployed.

RES deployment

Tables 12-14 of the NECP set out plans for renewable energy production (MW and GWh or ktoe) to 2030. Similar tables were included in Slovakia's final NECP 2019. Some information from both is combined in Table 5 below.

Table 5: Estimation of the total expected contribution (installed capacity, gross amount of production) of individual renewable energy technologies in Slovakia for electricity generation, heating and cooling, and transport in the period 2023-2030

	2023				2025				2027				2030			
	NECP 2019		NECP 2023		NECP 2019		NECP 2023		NECP 2019		NECP 2023		NECP 2019		NECP 2023	
	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh	MW	GWh
Pumped Hydroelectric Power Plants	916	420	916	420	916	450	916	450	916	450	916	450	916	500	916	500
Hydroelectric plants	1 629	4 473	1 629	4 473	1 641	4 507	1 641	4 507	1 742	4 785	1 742	4 785	1 755	4 822	1 755	4 822
&1 MW	38	110	38	110	40	116	40	116	42	122	42	122	45	131	45	131
1 MW – 10 MW	60	168	60	168	70	196	70	196	90	252	90	252	100	280	100	280
>10 MW	1 531	4 195	1 531	4 195	1 531	4 195	1 531	4 195	1 610	4 411	1 610	4 411	1 610	4 411	1 610	4 411
Geothermal Energy ($/GWh_e$)	0	0	0	0	4	28	4	28	4	28	4	28	4	30	4	30
Directly used Geothermal heat ($/GWh_{th}$)		140		140		349		349		535		535		582		582
Geothermal/Ground source heat pumps ($/GWh_{th}$)		209		47		256		70		302		93		372		128
Solar – *Photovoltaics*	790	830	850	893	870	914	1 000	1050	950	998	1 160	1 218	1 200	1 260	1 400	1 470
Wind - *Onshore*	150	300	3	6	250	500	150	300	350	700	300	600	500	1 000	750	1 500
Biomass: *solid*	200	1 100	200	1 100	200	1 100	200	1 100	200	1 100	200	1 100	200	1 100	200	1 100
Biomass: solid (H&C) ($/GWh_{th}$)		7 269		11 630		7 385		11 630		7 501		11 630		7 560		11 630
Biogas/Biomethane ($/GWh_e$)	160	1 152	95	684	180	1 296	120	864	200	1 440	150	1 080	200	1 440	200	1 440
Biogas/Biomethane (H&C) ($/GWh_{th}$)		930		756		1 047		872		1 163		989		1 163		1 163
Biomethane / RNFBO (Transport) ($/GWh_{th}$)		0		0		6		6		23		23		232		209
Electricity total excluding pumped hydroelectricity power plants	**2 929**	**7 855**	**2 777**	**7 156**	**3 145**	**8 344**	**3 115**	**7 849**	**3 446**	**9 051**	**3 556**	**8 811**	**3 859**	**9 652**	**4 309**	**10 362**

Table 5: Comparing the estimation of the total expected renewable energy contribution between the Slovak NECP in 2019 (pgs. 45-47) and the recent draft in 2023 (pgs. 55-57). Electricity contributions are indicated in yellow, H&C contributions are in red, and transportation contributions are in blue. Note: GWH means "GWh-electric" (GWh_e) unless the row indicates otherwise.

Bioenergy: Disaggregate biomethane and biogas; solid biomass set for unexplained boom

According to Table 5, electricity production from biogas/biomethane will reach 1440 GWh per year three years later than foreseen in the 2019 NECP (2030 rather than 2027). The same delay applies to the use of biogas/biomethane for heating and cooling. Neither delay is explained. Biomethane or RFNBOs are foreseen to be used in transport for the first time in 2025 in both NECPs, but ambition for their use by 2030 is 10% less in the 2023 NECP.

Biogas and biomethane are different products and the REPOWER-EU heralded a EU Biomethane Action Plan (BAP), which urges countries to upgrade biogas to biomethane so it can be distributed via gas mains. The NECP claims "Over 300 million m³/year biomethane is realistic to obtain by 2030", a quantity that also appears in the country's fiche prepared under the BAP, but because the tables quote only a combined total for both, they could correspond to the target being exceeded by about half or missed by >90%.

Solid biomass for heating is set to provide 1000 ktoe energy every year 2023-2030 in the draft 2023 NECP. This is 50% more than the 625 ktoe foreseen in the final 2019 NECP for 2023 and the 650 ktoe steady use in the second half of the decade. This difference is not commented on. Much text related to biomass and its availability is copy-pasted between the two NECPs. Research quoted in the 2019 NECP and now quoted again, is old. This casts doubt on the care with which biomass measures have been prepared.

Advanced biodiesel is given a far greater role by 2030 in the draft 2023 NECP (60 ktoe vs 22) but advanced bioethanol's role is reduced (10 ktoe vs 18).

Geothermal: warmer words in the NECP not matched with deployment plans

Gone from the 2023 NECP is the cautionary language found in the 2019 NECP: "Given current technology and price levels, the extensive use of geothermal energy in the 2020-2022 period is unlikely. The costs connected to the accelerated construction of geothermal equipment would lead to a significant increase in prices for heat consumers." Indeed, "operational support" for geothermal and other heat sources is now mooted, helping to "creat[e] the conditions for the use of geothermal energy." Approximately EUR 13 million was allocated for "Promoting the prospection and exploration of geothermal energy sources with a view to making them available for energy purposes".

Yet in spite of friendlier language, figures for the direct use of geothermal heat are unchanged between the 2019 and 2023 NECPs, and the role of ground-source heat pumps by 2030 is cut by two thirds. Assuming capacity runs at full load for half the year, geothermal heating capacity of 160 MW will be needed. Geothermal electricity, at 4 MW forecast to be installed in 2024 under both NECPs, can be nothing more than decorative.

Wind energy: low expectations

A linear increase of 100 MW is assumed from a standing start (3 MW installed in 2023, 100 MW in 2024 and +100 MW in the years that follow). The 2019 NECP was gloomy about wind's chances, saying "Wind power plants in Slovakia cannot compete with other sources of electricity," but still foresaw that the 3 MW then installed would grow to 150 MW today. The 2023 NECP doesn't hide its low expectations either: "The main obstacle to increasing national ambition in solar and wind power generation is their variability in generation and the existing electricity generation structure, where 55% of electricity is generated from nuclear energy." The 560 MW pumped storage plant is touted as

a technological solution for “balancing […] the output of wind and photovoltaic power plants”. However, NECP 2019 also wrote, in identical text, about this plant that awaits the Midas touch of a “strategic investor”. It remains as hypothetical in 2023 as it was in 2019.

History has shown the 2019 NECP’s forecasts lacked credibility, and there is nothing in the 2023 NECP, with an even less plausible growth rate, resembling the kind of clear determined push needed to propel wind from the launchpad.

District heating with RES and other sources

Slovakia’s “high degree of centralisation of the heat supply creates good technical preconditions for the use of biomass, biomethane and geothermal energy,” says the NECP. It later adds "solar energy and aerothermal, […] hydrothermal energy used in heat pumps, possibly combined with high-efficiency cogeneration plants” as sources that could feed district heating systems, and nuclear heat from the power plants of Bohunice and Mochovcev.

Yet clear statements of intent to capitalise on district heating infrastructure are lacking. For example, the NECP describes plans for the “creation of a support mechanism” for increasing the share of RES in the heating sector and in district heating systems but with no details on structure, funding, or timeline (pg. 143). As to measures to increase the share of renewables in district heating, a policy from NECP 2019 is re-stated and even referred to in the future tense: “increasing the RES share by [a mandatory] one percentage point per year” (2019) “A binding target of at least one percentage point will be set for the district heating and cooling sector“ (2023). Slovakia would have done better to comment on implementation of the policy and discuss the need to improve it.

The government is poised to intervene with tenders if “market conditions” alone are not enough to extend or upgrade district heating networks, as it was in 2019. No information is given on whether the government has intervened since 2019.

Hydrogen

Hydrogen – currently produced from fossil fuels – will be gradually replaced by renewable and low-carbon hydrogen; on the basis of existing use, the NECP estimates that 200 kilotonnes per year of hydrogen will be consumed in Slovakia by 2030. The NECP also vaguely notes that R&D linked to innovation and training for hydrogen technologies can be one of the strategic areas of Slovakia’s energy and industrial policy in the future.

Few regulatory changes are specified. The NECP mentions creating new (or amending old) legislation regarding hydrogen technology permitting processes. Price regulation for electricity and gas is also a suggested policy; that is, regulating prices to energy poor or vulnerable household customers and other household customers and micro-enterprises under specified conditions. Price regulation also applies to large industry, too (pg. 101).

Apart from renewable energies, however, Slovakia’s focus seems to be on reducing dependency on Russia. To wean off Russian gas production, natural gas production is also set to increase in Slovakia. This also includes underground gas storage capacities and gas interconnections within the EU. Slovakia’s NECP also includes measures to secure alternative nuclear fuel supplies. The Commission’s assessment also notes that Slovakia is one of seven Member States to postpone their fossil fuel

phase-out commitments as part of their adopted Territorial Just Transition Plans (TJTPs) (alongside Croatia, France, Germany, Greece, Hungary and Italy.[13]

Slovakia does have a CEF-funded 'Project on Common Interest' with Czechia on the digitalisation of the distribution system, ACON Smart Grids. Further details on Slovakia's interest in digitalisation can be found in the "Digitalisation" section below.

Funding

National spending on energy R&D collapsed from EUR 19 million in 2022 to EUR 4,6 million in 2023 (Table 50, pg. 233), then is expected to recover to EUR 17 million in 2024. The 2023 collapse goes unremarked. 2023 was the last year of a 5-year programme with total budget of EUR 84 million. 2024-2028 will see a small increase in nominal terms to EUR 88 million.

The Modernisation Fund, under which projects are selected nationally, will reportedly be an "important financial mechanism" to reduce energy intensity in industry (pg. 180) but details are lacking. There is ambition to create "more efficient governance" and strengthened RD&I funding using the Recovery and Resilience Plan, but no explanation of how these objectives will be achieved (pg. 180).

Slovakia will reportedly use a "smart specialisation" policy which will emphasise applied research. The priority areas are not detailed as they will be revised in 2024 to reflect changing regional and global trends and societal, economic or environmental developments.

However, these funding measures are insufficient for adequate RD&I uptake of renewables. Due to the limited resources allocated to RD&I, there will be a reduction in the number of R&I priorities in 2024. The aim will be to promote topics with high innovation potential and applicability at home or within the EU.

Part 2 – Cross-cutting themes

Digitalisation

Of the countries analysed, Italy's draft NECP sets out the most ambitious plans for organising, sharing and using data in the service of energy system transformation.

Italy will require energy "operators" (though it does not define this role) "to equip themselves with big data capabilities both to improve their operations and to offer new services" by taking advantage of "the accessibility of a huge amount of data generated outside the energy system (e.g. IoT)."

Elsewhere, Italy puts forward a very good idea that should be replicated in all Member States – mandating the DSO to share performance data. Unlike other countries, Italy sees potential for data in the management of operating renewable energy installations, particularly PV:

[13] https://eur-lex.europa.eu/legal-content/EN/TXT/HTML/?uri=CELEX:52023DC0796

"Provision is also made for better information on the performance of the facilities provided by GSE [Italian DSO] on the basis of the stock of data acquired as part of the management of incentive mechanisms. This action will inter alia:

- encourage the deployment of innovative technologies for monitoring performance [explained in more detail for PV in Box 2];
- identify, within homogeneous categories of installations, possible interventions to improve performance and extend the useful life;
- promote the development of a chain associated with the restoration of production performance and the extraordinary maintenance of decayed plants;
- to raise awareness among operators of actions that make it possible to optimise the performance of the installations."

"Operation of photovoltaic (O&M) systems with technical progress on monitoring and detection of system malfunctions and anomalies; forecasting energy production in the short and medium/long term, using artificial intelligence techniques"

Box 2: A quote from Italy's draft NECP, English machine translation

The idea is not a bolt from the blue: it closely resembles a suggestion from a Bulgarian MEP for an amendment (651) to the Renewable Energy Directive, made in 2022. Big Data for O&M monitoring to "improve network maintenance processes and extend the useful life of the assets" is mentioned by **Lithuania**, while **Slovakia** fancies its chances in "processing, analysis, prediction and visualisation of large volumes of data in real time, as well as the use of artificial intelligence based on historical data, […] to predict the evolution of relationships within the chosen ecosystem or energy system."

Data access for consumers

Countries are more comfortable connecting consumers with their energy data. **Spain** acknowledges the "full right of the consumer to have real-time access to his energy data at no additional cost and to transfer it to third parties without hindrance." This right is soon to be enshrined in law for data from building systems for under proposals (thus far uncontested by the European Parliament and Council) from the European Commission for a new Energy Performance of Buildings Directive.

Noting that "the European Commission recently adopted Implementing Regulation of 6.6.2023[14] on interoperability requirements and non-discriminatory and transparent procedures for access to [electricity] metering and consumption data", **Spain** gives space in its Measures 1.6 and 4.8 to the idea of a "data access platform […] set up to make use of, as a minimum, [data from] existing [smart] meters" extended to "final customer data, including measurement and consumption data as well as data necessary for switching supplier, demand response and other services."

In **Denmark**, "All consumers already have access to their usage data on an hourly basis through a dedicated website attached to the open-access DataHub." "Energy networks have set up a data service with data on prices, output, consumption, ancillary services, capacities, etc. The database is open to all actors and individuals, including data on the CO2 concentration in the electricity produced down to 5 minutes intervals. The data service can also provide an overview of the different electricity generation sources and how much they contribute to meeting consumption in each hour."

[14] C (2023) 3477 descended from Article 23 (Data Management) of Directive (EU) 2019/944 Internal Electricity Market directive

Like Italy, Danish "DSOs shall publish anonymised consumption and production data." This data, depending on the level of aggregation and time resolution, could be very useful for scientists studying the dynamics of the electricity grid or for start-ups offering new services promoting flexibility. The Commission should press for a data set to be collected from each of Denmark's 3.3 million connection points and lightly aggregated, and for other Member States to do the same for all metering points connected with a smart meter.

Luxemburg refers to its portal as an "Energy Data Platform" which will have "rules on access" and "[manage] market communication." It will allow "authorised users (that is to say, the end-user himself) to access relevant data on their electricity consumption, taking into account all aspects of data protection which are an absolute priority," says measure 1003.

Portugal intends all electricity meters to be smart meters by 2024, is interested in "making consumption data available with granularity" and has identified funding sources for and initiative to "Encourag[e] the use and interoperability of digital platforms for realising opportunities to improve the energy and water performance of buildings" [15]

The **Netherlands** says comparatively little about data but does at least acknowledge its role in buildings calling for "control algorithms for saving, energy optimisation and sector coupling".

Emergence of data access services

Spain, under its Measure 1.19 ('new business models for the energy transition') wants to see "data access services" emerge. "The digital transformation will enable the development of a data management industry, which is key to energy security. In particular, to incentivise a more active role on the part of consumers, figures such as independent aggregators can guide citizens in managing demand, self-consumption and improving energy efficiency." So reckons **Denmark**, too. Having "achieved the target of deploying remotely read electricity meters for all consumers by the end of 2022, [they can] participate in the electricity market through fast and easy switching of liver, dynamic price contracts and aggregation." **Luxemburg** expects to "facilitate new services such as demand response to system balancing, and help the market to benefit from technical and economic efficiency gains, in particular for large energy customers." Lithuania's policy MT14-P is for "research on the digitalisation of the energy sector related to the use of open data by large energy companies, the creation of digital twinning, etc."

Shortcoming in all NECPs: national 'platforms' and 'hubs' instead utilising the Common European Energy Data Space

Member States make no reference to the Common European Energy Data Space, highlighted by the European Commission most recently in its Digitalising the Energy Sector Action Plan (2022). But at least they invoke national initiatives. Denmark and Lithuania both describe the 'Data Hubs'[16] they will set up. Others, like Luxemburg and Spain, use the word "platform". Spain says, there is "No decision yet on [its] data access platform, which could be centralized like Estonia's or Denmark's[17] or operated by the distribution network operators themselves." Slovakia talks of "supporting the creation of an

[15] Pages 135, 136 and 84 of the English translation of its NECP (Acrobat numbering)
[16] Lithuania's measure VR12-P is to "Create a legal framework for an open-access energy market production, supply and consumption database 'Data HUB'".
[17] Editor's note: Lithuania also proposes a centralised platform.

Energy Data Centre, which aims to streamline and speed up access to the electricity market for new entrants."[18]

There doesn't seem to be a principled objection from Member States against connecting together national data repositories or exchanges at EU level); Member States just need to indicate willingness to take that step. Lithuania's MT14-P, which only started in 2023, is not expected to finish before 2029: there's time to roll it into an EU-wide initiative. This is something the European Commission should push for. Italy is perhaps the most open to using CEEDS, considering a "main area of research" to be "[…] architectures that provide widespread access to shared scalable computing resources," which of course CEEDS could provide.

Additionally, the EC should extract from Member States their thinking on how they will encourage consumers to "authorise access to third parties" to their energy data as Spain hopes.

Skills, Education and Training

The EU announced 2023 as the "European Year of Skills". **Portugal's** NECP noted that skills, along with digitalisation and innovation, are "drivers of development." The **Netherlands** stated that in the energy supply, the shortfall with a job vacancy rate of 55 is higher than average, and that more than 74.000 vacancies were open for technical occupations in January 2023. Yet despite the clear need for education and training to fill employment needs, skills are not at the forefront of most policies described in NECPs.

Member States mention support for higher education and vocational training in skills needed in the energy transition and climate action, yet do not specifically outline a path forward for skills. For example, the Netherlands vaguely references a need to "strengthen governance and reduce fragmentation" as well as remove "obstacles and [remove] bottlenecks that prevent the matching of supply and demand." What is clear from NECPs is that the need for education and skills is a broad spectrum with includes vocational training and apprenticeships as well as secondary and higher-level degrees. **Denmark** defines a need to "strengthen the knowledge base" to assess impacts and prioritise future research and innovation actions and created an expert group on the role of research in the green transition in June 2022 to develop an analytical framework to assess the impact of research and innovation efforts.

Higher-level education

For higher-level education, it is evident that universities require additional support and funding. **Luxembourg** looks to establish research chairs and public-private or public-public partnerships at the University of Luxembourg and public research centres. **Lithuania** clearly notes an aim to increase "synergies among science and research institutions, energy companies and engineering companies" through cooperation with Horizon Europe or national programmes. Other countries, including **Spain**, highlight that the gender gap – such as on the employment level – stems from a gender gap in educational institutions. It is therefore necessary to encourage women and minorities to pursue degrees to obtain skills needed for the energy transition. The **Netherlands** introduced the Platform for Talent and Techniek, a nationwide coalition to develop an integrated approach to increasing the

[18] Page 78 of Slovakia's NECP.

proportion of women in technology (i.e. by improving the attractiveness of working conditions and the image of technology).

The **Netherlands** also stipulates that young people are vital to the transition; getting people at universities equipped with skills needed for the renewable energy sector will address job vacancies and ensure that knowledge and experience is passed down.

Slovakia's NECP stresses the need to prioritise research areas through the continuous development of "smart specialisation" domains. Smart specialisation focuses on assets and resources available to regions and their specific socio-economic status to identify strategic areas for development and growth. If education also tailors its training to smart specialisation, it can address gaps in the energy economy of that Member State.

Re-skilling

Additionally, countries all place high value on "re-skilling" workers from other segments of the energy sector to focus on renewable energy practices. **Portugal** particularly emphasizes the reskilling of workers and the development of new technical skills in order to adapt to a new energy/climate environment and transfer workers between sectors. For example, Portuguese workers in coal thermal power plants which had since been dismantled in 2021 were given the opportunity to receive training in the field of renewable energy. A Portuguese initiative called "Verdes/ Green Skills and Jobs Work and Skills Programme" promoted by the Institute for Employment and Vocational Training also aims to foster the reskilling of workers and qualification of unemployed people in the areas of renewable energy and energy efficiency.

Yet, although there is generally a clear need to support skills development, the path to skilling and reskilling is not always clear. Some NECPs utilise programmes to support training measures. **Luxembourg** references the National Skills Strategy in the context of employment in the EU. Specifically, the NECP notes that the impact of the green transition on the labour market and employment must be analysed to identify jobs created and lost, and thereby amend/develop/complement the National Skills Strategy based on these needs. Other programmes noted were the Green Jobs + Programme (mentioned by **Spain**, launched by the Biodiversity Foundation) to boost the green economy through skills and to improve skills for employment and entrepreneurship. **Portugal** utilised the Just Transition Fund to reskill workers and support research and innovation in small and medium-sized enterprises (SMEs). At the closure of the Matosinhos Refinaria (an oil refinery), the Just Transition Fund will also support the creation of a new innovation centre with a particular focus on sustainable mobility, clean energy, advanced manufacturing and the maritime economy, thereby creating 150 new jobs in supported SMEs and reskilling 170 long-term unemployed.

Finally, training and skills go hand in hand with a certain level of standardization that the EU can provide, namely qualification and certification processes for installers, operators, and maintenance personnel. **Spain** suggested matching qualification levels with labour market needs resulting from the implementation of the NECP.

SET Plan and other cooperation mechanisms

SET Plan

Some countries proclaim great alignment with the SET Plan; others give it zero or one mention. The European Commission should ask for some response from all Member States to its October 2023 Communication on the SET Plan revision[19] in the final version of their NECPs. The countries having plentiful national money to spend on research seem to make least references to the SET Plan.

Amendments adopted by the ITRE Committee of the European Parliament on the Net Zero Industry Act would institutionalise a structure they call the SET Plan Board (which maps to the SET Plan Steering Group) and lay down its mission in law. NZIA is likely to be adopted in the next half of the year, and if it contains this idea, the final version of NECPs must take the SET Plan even more seriously.

Italy exaggerates its support to the SET Plan. Twice it says it "supervise[s] each of the Implementation Working Groups with experts in the sector from research bodies and universities," but this supervision is superficial. Praising the predecessors of today's CETP and DUT, it continues, "The intensive work leading to the establishment of the Implementation Plans has seen Italy particularly active in cooperating with the other Member States to identify priorities and indications of financing needs. This cooperation at Community level has often led to the submission of joint partnership projects under the Horizon 2020 programme. This cooperation should be consolidated and intensified, if possible also under the Horizon Europe programme."

Spain pays homage to the SET Plan ("The Strategic Energy Technology Plan […] has been the RD&I pillar of European energy policy since 2007, play[ing] a leading role").

Both countries have mechanisms to collect information for the IWGs or other fora. In Italy, "the national contact points of each working group have in turn set up 'consultation groups' composed of representatives of industry, research and academia, able to provide qualified input to [Implementation Plan] drafting." Spain writes that its network "'ALINNE' has the support and collaboration of the Spanish Energy Technology Platforms (ETPs), which provide an extensive map of national capacities (Energy Efficiency, Biomass, Wind Energy, Solar Concentration, Low-Temperature Solar, Photovoltaic, Geothermal, Hydrogen and Piles, Intelligent Networks, Energy Energy (*sic*), Energy Storage Systems, as well as CO2 Storage and Capture)." ALINNE is "the coordination and monitoring tool that articulates Spain's participation in the global Mission Innovation initiative" and "coordinates Spanish participation in the European Energy Research Alliance."

Lithuania writes that its "representatives participate in the following SET-Plan Implementation Working Groups: batteries; nuclear safety; high Voltage Direct Current (HVDC) technologies."

The Netherlands says it "actively participates in the Steering Group and several Implementation Working Groups (IWGs) of the SET-Plan. The IWGs provide a forum to exchange knowledge and experience between Member States. Relevant knowledge, such as geothermal knowledge, is used in national contexts." But it rules out using research money on SET Plan work that is not also a Dutch priority: "The Netherlands does not have a separate subsidy pot for the SET-Plan or other international partnerships. National subsidy schemes can be used for this purpose, provided that the activities benefit the Dutch economy or other Dutch interests."

[19] Revision of the Strategic Energy Technology (SET) Plan - COM(2023) 634

Sweden states its modest involvement in IWGs, the four ETIPs in which Swedish stakeholders are found (Bioenergy, RHC, Ocean, SNET) and points out that it "is leading" with Austria the CETP.

Denmark makes a single reference to the SET Plan and **Luxemburg** none at all.

North Sea Energy Cooperation

A swathe of near-identical text concerning this inter-governmental coordination forum features in the NECPs of **NSEC members** Denmark, Sweden, the Netherlands and Luxemburg, making it hard to judge the relative value each country sees in the initiative.

Research and Innovation Smart Specialisation Strategies

Some countries with relatively high allocations of European Structural and Investment Funds refer to the "Research and innovation strategies for smart specialisation (RIS3)" mechanism for focusing these funds on R&I and within R&I on areas in which region(s) in a country have a particular strength. This is the case of **Slovakia** (pgs. 229-232) and **Spain** (Measure 5.1 and 5.3).

Public procurement of innovative or green products

Several countries outwardly claim to prioritise adding green conditions to their public procurement routines, but public procurement has generally only been applied to a few areas. Spain's Measure 5.5 sees them "Improving public services and infrastructure, by incorporating innovative goods or services, meeting duly identified and justified public needs, on the basis of environmental protection criteria." Italy thinks "Public Procurement has the capacity to influence the market by supporting the development and uptake of products and services with low environmental impact." Both countries clock the Innovation Partnership approach promoted by the European Commission. Slovakia even claims, "Green public procurement will cover at least 70 % of the total value of all public procurement" under the Slovak Environment Policy Strategy 2030. Lithuania wants "green procurement [to be the] predominant type of public procurement from 2023"). It wants to give more emphasis to "circularity" (K6-P) (also Portugal: the "purchasing [of] low-carbon services instead of products […] will be promoted").

Spain: Measure 1.26 reports a state-owned airport using PV and public procurement of 100% RES electricity; Measure 2.3 talks of green public procurement for "road transport vehicles and services" and other modes of transport, and of "energy efficiency in publicly-owned infrastructure, principally, in street lighting installations"; Measure 2.17 applies GPP to buildings so that the public sector buys "buildings with a high energy performance".

Portugal: intends to "incorporate low-carbon requirements in public purchases" across the board starting with "buildings, in public purchases of vehicles and transport services as well as in road construction works"; change procurement rules to allow collective self-consumption.

Denmark specifically mentioned lighting, too: "Circular No 9909 of 9 December 2020 on energy efficiency in state institutions [requires] government institutions to purchase LED light sources from one of the two most energy efficient energy classes."

Sweden barely covers GPP, and seems happier to talk abouts its potential than about its implementation ("The possibilities for environmental and climate considerations in procurement are set out in procurement legislation, including the Public Procurement Act (2016: 1145)") but has used GPP for transport since 2009.

Slovakia hints that energy-performance contracting and "clean vehicles" have been the object of green public procurement, with "problems" connected to the latter.

Lithuania: "binding green public procurement targets in 2021 for the acquisition of new vehicles or transport services to reorient public transport fleets and encourage public entities to opt for zero-emission vehicles."

Luxemburg: "Contracting authorities and contracting entities shall, when procuring certain road vehicles through public procurement, take into account the life cycle energy and environmental impacts."

Box 2: Several of the countries analysed talk of green public procurement, most often for the same, narrow range of products.

In reality, public procurement has generally been applied only to a few areas: the examples given often relate to cars, lighting or buildings (Box 3). Italy is more adventurous, putting 'minimum environmental criteria' into several areas, from "textiles" to "cultural events".

Lithuania and Spain stand out for talking about public procurement of innovative (as opposed to 'green') goods. Lithuania's measure MT9-E is to "stimulate demand for innovation in all areas of public governance. The share of public investment in innovative procurement is expected to increase steadily until at least 20 % of each ministry's planned public procurement in 2027." Spain has a "Public Procurement of Innovative Technology (CPTI) and Pre-Commercial Technology (CPP)" programme (Measure 5.5), but reveals nothing of the volume of public procurement under the programme, which is a shortcoming. The programme "EECTI 2021-2027" appears to have used these mechanisms since 2021.

Net-zero-delivering hardware itself, such as renewable energy technology, has nowhere been considered for special public procurement conditions. This is a problem because Member States will need to use GPP in Art 19 of NZIA, and maybe for the 5% i-RES target. They must today show they are getting familiar with using the tool in a variety of ways.

Public-public & public-private interaction

Support low-TRL R&D alongside high-TRL work

Italy correctly connects RD&I objectives to the aim of "maintain[ing] and strengthen[ing] the competitiveness of Italian industry," adding, "investment in research and innovation for the development of innovative technologies plays a key role [in the innovation capacity of Italian industry] and therefore requires a step change."

Spain does too, drawing attention to the need to always be bringing forward new ideas from the lab: "The development of innovative renewables and certain energy storage technologies makes it necessary to boost technological development in the early stages in order to gain a differential advantage in the earlier designs of these technologies, and especially at the innovation stage, i.e. at the early stages of the value chain, including the phases of RD&I capabilities, design, manufacturing and logistics."

And **Sweden**, which "was at the top of the European Innovation Scoreboard in 2022": "Research and innovation are a prerequisite for building the knowledge and skills needed for the energy transition and for developing new solutions that can bring about systemic change and accelerate the transition."

From this follows the question of how to organise the interaction between low-TRL research, dominated by the public sphere, and the high-TRL research performed more often in industry.

Models for collaboration

Slovakia strikes a note of despair: "In the field of Research and Innovation, the problem is fragmented and, in particular, undercapitalised manufacturing. Expenditure on business R&D is low in Slovakia. In innovation, cooperation between universities and businesses on R&D is poorly evaluated."

Lithuania wants to see "increasing synergies among science and research institutions, energy companies and engineering companies by promoting various forms of cooperation using investments from the EU research and innovation programme Horizon 2020 (*sic*), national and other programmes." "In Lithuania, clusters are being developed to promote innovation."

Other countries think they've got the hang of it:

"In this spirit of connecting all actors in the value chain," **Spain** uses ALINNE, "as an alliance between public (administrations and knowledge generators) and private actors (technology companies and platforms), […] to bring together and coordinate efforts between all actors to address the main energy R & I challenges."

The **Swedish** government had worked with industry to develop 22 ''fossil-free competitiveness roadmaps" by 2020; its Swedish Energy Agency "has several forms of support aimed at promoting the commercialisation and business development of innovations, aimed at higher education institutions and companies of different sizes and at different stages", including one in controllable PV parks. **The Netherlands** grouped public and private interests in energy innovation into 'Top Sector' consortia, including 'Top Sector Energy' back in 2012.

Luxemburg will set up "research chairs and public-private or public-public partnerships at the University of Luxembourg and at public research centres" creating a new National Centre of Excellence University of Luxemburg supported by a National Research Fund. Hydrogen gets special attention, with a "Task Force for H2" which held its first stakeholder meeting in November 2022. That Task Force will help design tenders for RES-H2 coming in 2024.

There is scope for the European Commission to show Slovakia and other countries in its position how other Member States use their research capacity effectively.

Conclusions

The draft NECPs show varying renewable energy priority areas across Europe, but many have similar weaknesses. First, few acknowledge the recent legislative developments and new targets for Member States. While this is largely due to timing, the final NECP reports must adequately reference RePowerEU, the 42.5% renewable energy target from RED, and particularly the 5% innovative renewables target from RED.

While many of the Member States acknowledge innovation and the need for an uptake in renewables, few plans outline clear objectives, a comprehensive regulatory framework (including accelerated permitting procedures), and dedicated investments to integrate renewables and support technological innovations.

Funding is one of the most important aspects to the energy transition. Too few Member States properly outline and detail the funding programmes and energy research which will be funded in the future.

Data access should be a stronger focus area in the NECP, with a particular reference to utilising the Common European Energy Data Space as a data hub. Member States encourage consumers to "authorise access to third parties" to their energy data.

Finally, skills are not at the forefront of most policies described in NECPs. The need for education and skills is a broad spectrum with includes vocational training and apprenticeships as well as secondary and higher-level degrees – as well as opportunities for re-skilling workers. Yet the path to skilling and reskilling is not clear in many Member States' strategies. NECPs should reference standardization processes, i.e. qualification and certification processes for installers, operators, and maintenance personnel.

EUREC
The Association of European
Renewable Energy Research Centres

ETIP Photovoltaics

ETIP OCEAN
European Technology & Innovation Platform for Ocean Energy

ETIP Geothermal

RHC Renewable Heating & Cooling
European Technology and Innovation Platform

ETIP Bioenergy
European Technology and Innovation Platform

ETIP Wind
EUROPEAN TECHNOLOGY & INNOVATION PLATFORM ON WIND ENERGY

ESTELA
European Solar Thermal Electricity Association