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Library of model outputs at MS and EU level

D2.3

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LOCALISED

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List of Abbreviations

LTS	Long Term Strategy
NECP	National Energy and Climate Plans
CCS	Carbon capture and storage
NDC	National determined Contributions
GHG	Greenhouse gas

Executive Summary

This deliverable provides the library of model outputs of decarbonization pathways at European Union (EU) and Member State level (MS) to the LOCALISED consortium. The approach described in Deliverable 2.1 to reproduce national pathways using the EUCalculator model is extended to the Long Term Strategies (LTS) submitted to the European Commission by countries as of 29 September 2022. In cases where a LTS document is not available (the case of 4 MS), or they do not provide sufficiently detailed modelling results until 2050 on an adequate sectoral resolution (the case of 8 MS); provisions are made to guarantee that a decarbonization pathway is generated. This is done by making use of the country's National Energy and Climate Plan (NECP) - which sets policies until the 2030 time horizon - and extending assumptions to 2050.

In this deliverable, decarbonization pathways following the assumptions in the LTS/NECP documents of 27 MS are reproduced. In addition, this deliverable provides for a variant of the LTS/NECP pathways in which individual behavioural change in terms of material and energy consumption is strengthened to the maximum level allowed in the EUCalculator framework. In total 54 pathways are included in the library. For each pathway about 790 outputs are generated covering multiple aspects of the energy/economy system such as vehicle fleet, area of residential building renewed, energy demand by carrier, energy production by technology, land use, agricultural or industrial production. Some indicative figures of these outputs per member state are provided.

Given the state of flux in the EU's energy strategy motivated by geopolitical shocks and the 2024 progress check of NDC's embedded in the UNFCCC process, it is expected that existing pathways could be subject of partial revision within the time-frame of the project.

1 Country-level pathways & modelling approach

1.1 Country-level pathways considered

For the purpose of the pathway library, we focus on reproducing the key assumptions of consumption and technological deployment entailed in each of the EU member state's Long Term Strategy submission (LTS). In these strategies EU Member States are required to detail how they plan to achieve the greenhouse gas emissions reductions needed to meet their commitments under the Paris Agreement and EU objectives. The LTS document has to cover

at least 30 years and typically runs until 2050. At the time of writing, 4 member states have yet to submit their LTS documentation to the European commission (see Table 1). For the remaining member states, the LTS documentation available varies considerably in terms of detailed sector description, modelling assumptions and presentation of quantitative results in an adequate level of granularity. For example, emission of the building sector are merged with those of the power sector (e.g., Latvia) or emissions are only reported for a limited number of sectors and only until 2030/2040 (e.g., Czechia, Denmark) or some sectors are not explicitly modelled (e.g., Greece). In cases for which the LTS documentation lacks quantitative detail, or is missing altogether, this deliverable makes use of the country's National Energy and Climate Plan (NECP). Although the NECP document only sets forward climate policies and their effects until 2030 it is more rich in quantitative details in terms of renewable generation, socio-economic assumption, renovation rates and transport evolution. Accordingly, when the LTS documentation is deemed too vague the NECP report is used to align key consumption and technological assumptions until the year 2030 with the implicit assumption that these will continue until the year 2050.

Table 1 - Long-term mitigation strategies of MS currently reported to the European Commission and auxiliary National Energy Climate Plans

Country/pathway	Document	Summary	Evaluation of sectoral projections
Portugal PT-RNC2050	Roteiro para a Neutralidade carbónica 2050 Publication year: 2019	The roadmap sets the path to carbon neutrality in a sustained manner, establishes the main guidelines and identifies cost-effective options to achieve this end in different socio-economic development scenarios Accomplishing carbon neutrality in Portugal implies reducing greenhouse gas emissions by more than 85%, compared to 2005, and ensuring an agricultural and forestry carbon sequestration capacity of around 13 million tonnes. As Portugal is one of the countries that is most potentially affected by climate change, ensuring a sustainable and resilient agriculture and forest, and fighting desertification, are the biggest challenges we face, they must be coordinated with territorial cohesion and the protection of biodiversity, in order to ensure we achieve the said neutrality.	Projections available on adequate sectoral level until 2050
France FR-SNBC2050	SNBC2050: Stratégie national bas-carbone Publication year: 2020	The national low-carbon strategy describes France's roadmap for conducting climate change mitigation policy. It provides guidelines for implementing the transition to a low-carbon economy in all sectors of activity. It defines targets for reducing greenhouse gas emissions at the scale of France in the short/medium term – carbon budgets – and has two ambitions: to achieve neutrality carbon, i.e. zero net emissions, by 2050 (target introduced by the July 2017 climate plan and enshrined in law), and reduce the carbon footprint of the French people.	Projections available on adequate sectoral level until 2050
Germany	Germany on	The analyses illustrate the urgency of the political	Projections

DE-KPA245	the way to climate neutrality by 2045 - scenarios and paths in a model comparison Publication year: 2021	need for action in order to achieve climate protection goals and to adjust the course to climate neutrality by 2045. Comparing the sector-specific transformation milestones with the current policy goals reveals significant discrepancies. Without additional measures in all sectors, the climate protection targets for 2030 and 2045 will in all likelihood not be met.	available on adequate sectoral level until 2050
Italy ITLS2050	Italian long-term strategy on GHG reductions Publication year: 2021	To reach ambitious climate targets, it is necessary to electrify final consumption as much as possible and encourage the massive deployment of renewable energy capacity and smart power networks. Along with climate/environmental imperatives, the need to rethink our energy system.	Projections available on adequate sectoral level until 2050
Poland PL-NECP2050	National Energy and Climate Plan for the years 2021-2030 Publication year:2019	NECP document used as proxy	No LTS submission
Spain ES-EDLP2050	Strategia de Descarbonización a Largo Plazo Publication year: 2020	The document sets the pathways for Spain to reduce, no later than 2050, its greenhouse gas (GHG) emissions by 90% compared to 1990. THis means reducing CO2 emissions from the 334 MtCO2eq emitted in 2018 to a maximum of 29 MtCO2eq in 2050. The remaining 10% of emissions will be absorbed by carbon sinks to reach climate neutrality.	Projections available on adequate sectoral level until 2050
Luxembourg LU-SNLTL2050	Stratégie nationale à long terme en matière d'action climat Publication year: 2021	Successfully transitioning to climate neutrality in Luxembourg by 2050 at the latest requires a committed, diversified and targeted action. After defining the strategic vision and principles guiding the transition, this strategy sets out the enabling framework needed to achieve these objectives.	No detailed sectoral projections available by 2050 LTS submission not supported by scenario modelling
Netherlands NL-LTSNL2050	Long term strategy on climate mitigation Publication year: 2019	The strategy specifies that the Netherlands must strive to cut its emission level by 49% by 2030 compared to 1990. It prevents the need for the introduction of abrupt measures after 2030 to achieve the 2050 target. A gradual transition will contribute to cost efficiency, offer the Dutch business sector a competitive edge in the longer term and give every Dutch citizen an opportunity to do his or her bit.	Does not detail sectoral projection until 2050 (only 2030)
Belgium BE-LTSB2050	Long term strategy for Belgium Publication year: 2020	Reaching climate neutrality in Belgium by 2050 is technically feasible, even though it is particularly challenging and requires systemic changes. New technologies such as hydrogen, e-fuels, direct air capture or bioenergy with carbon capture (BECCS), as well as new consumption and production patterns are needed in all scenarios.	Projections available on adequate sectoral level until 2050

Denmark DK-DLTS2050	Denmark's Long-term Strategy Publication year 2019	The strategy focuses on achieving the targets of reducing greenhouse gases by 70% by 2030 (relative to 1990 level), to reach net zero emissions by 2050 at the latest, and to set milestone targets based on a five-year cycle. Moreover, the Danish Government will develop Climate Action Plans that will outline concrete policies to reduce emissions in relevant sectors.	No detailed sectoral projection until 2050 (only 2040)
Sweden SE-SLTS2050	Sweden's long-term strategy for reducing greenhouse gas emissions Publication year: 2019	By 2045 at the latest, Sweden is to have no net emissions of greenhouse gases to the atmosphere, after which negative emissions are to be attained. The target means that greenhouse gas emissions from Swedish territory are to be at least 85 per cent lower than emissions in 1990. To achieve this aim, the capture and storage of carbon dioxide emanating from fossil fuels may be counted as a measure where no other viable alternatives exist. Emissions from fuels used for international aviation and maritime transport are not included in the target. Emissions and removals from land and forestry are not included directly.	Projections available on adequate sectoral level until 2050
Finland FI-CNF2050	Carbon neutral Finland 2035 – national climate and energy strategy Publication year: 2022	The National Climate and Energy Strategy outlines measures by which Finland will meet the EU's climate commitments for 2030 and achieve the targets set in the Climate Change Act for reducing greenhouse gas emissions by 60 per cent by 2030 and being carbon neutral by 2035.	Projections available on adequate sectoral level until 2050
Czechia CZ-CPPC2050	Climate protection policy in Czech republic Publication year: 2019	Strategy defines the main goals and measures in the field of climate protection at the national level in such a way as to ensure the fulfilment of the goals of reducing greenhouse gas emissions in line with the obligations arising from international agreements. This strategy in the field of climate protection focuses on the period 2017 to 2030, with a view to 2050, and should thus contribute to the long-term transition to a sustainable low-emission economy.	No detailed sectoral projection until 2050 (only 2030)
Bulgaria BG-ENCPB2050	Energy and climate plan of the republic of Bulgaria Publication year: 2019	NECP document used as proxy	No LTS submission
Romania RO-INPR2050	Integrated National Energy and Climate Change Plan for 2021 - 2030 Publication year: 2019	NECP document used as proxy	No LTS submission
Malta MT-MLCD2050	Malta low carbon development strategy Publication year 2021	The strategy is the result of a three-year process whereby mitigation measures have been researched and short-listed, possible abatement levels quantified through Marginal Abatement Cost Curve (MACC) modelling, and stakeholders consulted, leading to a list of realistic and cost-effective measures. The social and environmental effects and the cost to society from taking such measures are considered in specific assessments and thus allow	Projections available on adequate sectoral level until 2050

		policy to be designed in a way that is beneficial to society in economic and environmental terms.	
Cyprus CY-CLED2050	Cyprus' Long-term low GHG emission development strategy Publication year 2022	The Long-Term Low Greenhouse Gas emission (GHG) Development Strategy for 2050 is a Roadmap for the Republic of Cyprus on Climate and Energy, as part of the country's participation in the collective European goal of a successful and sustainable transition to a climate-neutral economy by 2050.	Projections available on adequate sectoral level until 2050
Austria AT-LTSA2050	Long-Term Strategy 2050 - Austria Publication year: 2019	The strategy that includes a comprehensive transformation of both our energy supply and our consumption patterns and that includes an adapted but competitive economic system goes far beyond merely reducing greenhouse gas emissions. It contains all three pillars of sustainability –economic, social, and environmental aspects – as this is the only way to achieve far-reaching changes by the population.	Projections available on adequate sectoral level until 2050
Estonia EE-RCNE2050	Reaching climate neutrality in Estonia Publication year: 2019	The report concludes that reaching climate neutrality in Estonia by 2050 is technically possible if all the sectors (private, public and non-profit) contribute to the aim. Climate neutrality can also be potentially profitable in the long term provided that strategically wise investments are carried out to reach the goal.	Projections partially available on adequate sectoral level until 2050 Building sector not explicit
Latvia LV-SLACN2050	Strategy of Latvia for the Achievement of Climate Neutrality by 2050 Publication year: 2019	The Strategy is a long-term policy planning document which has been developed to increase the economic competitiveness of Latvian national economy, as well as to ensure a safe living environment for inhabitants of Latvia concurrently with the restriction and mitigation of climate change.	Projections partially available on adequate sectoral level until 2050 Building sector not explicit
Lithuania LT-LNCMA2050	National climate change management agenda Publication year: 2021	The national climate change management agenda defines Lithuanian climate change management policies until 2030, 2040 and 2050.	Projections partially available on adequate sectoral level until 2050 Building sector and LULUCF not explicit
Ireland IR-LSTI2050	Long term strategy on greenhouse gas emissions reductions 2019 Publication year: 2023	Ireland's current Long-term Strategy on Greenhouse Gas Emissions Reductions sets out indicative pathways, beyond 2030, towards achieving carbon neutrality for Ireland by 2050. The Strategy builds upon the decarbonisation pathways set by the carbon budgets, sectoral emissions ceilings and Climate Action Plan 2023.	Projections partially available on adequate sectoral level until 2050
Croatia HR-LDSC2050	Low-carbon development strategy of the republic of Croatia until 2030 with a	The Low-Carbon Development Strategy leads to a vision of a society in which we will live healthier and more comfortably, with low-carbon growth and efficient resource management. The existing national building stock will be renovated, and new buildings	Projections available on adequate sectoral level until 2050

	view on 2050. Publication year: 2021	will be built according to the principles of nearly zero energy buildings and the circular economy.	
Slovenia SL-SLTS2050	Slovenia long-term climate strategy until 2050 Publication year: 2021	For the period up to 2030, the document is based on the already adopted decisions defined in Slovenia's Development Strategy 2030, the Integrated National Energy and Climate Plan of the Republic of Slovenia, the Resolution on the National Programme for the Development of Transport of the Republic of Slovenia until 2030 and other sectoral documents. The Climate Strategy upgrades the relevant documents, sets the vision and long-term objectives by 2050 and provides the guidelines for its attainment.	Projections available on adequate sectoral level until 2050
Slovakia SK-LCSD2050	Low-Carbon Development Strategy of the Slovak Republic until 2030 with a View to 2050 Publication year: 2020	This Strategy aims to identify measures, including additional measures, to achieve climate neutrality in Slovakia by 2050. This ambitious target was formally defined only at the last stage of preparation for this Strategy (after the completion of the modelling of possible emission scenarios), and therefore other less ambitious emission reduction (and increase in removals) scenarios are analysed in detail.	Projections available on adequate sectoral level until 2050
Greece HL-HLS2050	Long-term Strategy for the year 2050 Publication year: 2020	The Long-term Strategy for the year 2050 is a road map for the Greek Government on Climate and Energy issues, in the context of the country's participation in the collective European goal of a successful and sustainable transition to a climate-neutral economy until the year 2050, at the level of the European Union.	Projections partially available on adequate sectoral level until 2050 Agriculture and LULUCF not explicit
Hungary HU-NCDS2050	National Clean Development Strategy 2020-2050 Publication year: 2021	The National Clean Development Strategy (NCDS or Strategy) outlines a 30-year vision of socioeconomic and technological development pathways. Hungary's long-term Strategy will help reach climate neutrality targets while focusing on the well-being of the Hungarian people and ensuring the protection of natural assets and economic development.	Projections available on adequate sectoral level until 2050

2 Pathway documentation

This section documents the lever choices of the EUCalculator energy model that best represent the assumptions and narrative of the decarbonization pathways entailed in the long term strategies of MS in section 1. In brief, the outputs of the EUCalculator model (see complete list) are controlled by a comprehensive range of levers representing changes one could make to mitigate climate change by 2050 (see complete list in Table A1 of the Annex section). A lever in the EUCalculator model represents an input to the model, a predefined trajectory of a quantity, e.g., distance travelled per person; insulation level for refurbished houses; efficiency and type of steel production; offshore wind capacity. In turn, these inputs to the model will drive energy demand and supply projections, and ultimately GHG emissions.

Level 1	Level 2	Level 3	Level 4
Projections of **historical trends.**	**Intermediate scenario**, more ambitious than a projection of historical trends but not reaching the full potential of available solutions.	**Very ambitious but realistic** scenario, given the current technology evolutions and the best practices observed in some geographical areas.	**Transformational requiring additional breakthroughs** or efforts such as cost reduction for key technologies, very fast deployment of infrastructures, technological advances, strong societal change, etc...

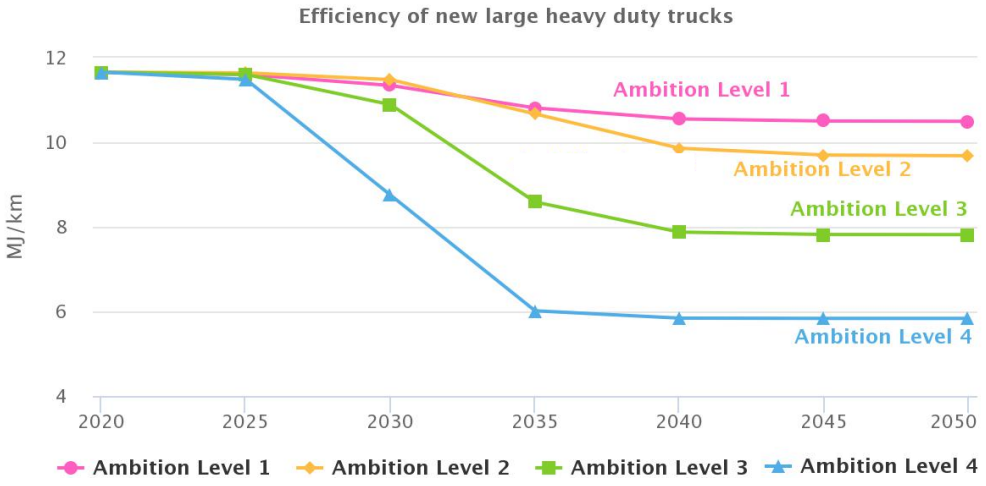


Figure 1 - Ambition levels definition in the EUCalc model and trajectory example

Each lever has four different levels of effort that have been consistently defined across sectors. As a rule, when looked at in isolation, the higher the ambition levels of a lever, the higher its abatement potential. In detail, ambition Level 1 (see Figure 1) is a technical measure, key behaviour or management practice that would yield the lower abatement potential. In the EUCalculator model, this level is associated with the respective historical trends of technology deployment or consumption behaviour. Thus, this level of mitigation efforts will not go substantially above those associated with current policies and could even worsen GHG emissions. Following, the choice of model levers that better represent the assumption and results entailed in the long-term strategies of each MS is documented.

The procedure to compare the outcomes of the EUCalculator model involves the following steps:

1. Reading of the scenario documentation in Table 1 and extraction of the main assumptions on the evolution of activities and technology/policy deployment (not the final emission nor energy results). In case no specific assumption can be linked to a lever in the EUCalculator (see Table A1) the default value assumed is the one that matches as far as possible the baseline scenario published by the European Commission (European Commission 2018).

2. Selection of the lever level that would better represent the choice made in step 1 and documentation of the rationale.

3. Comparison of key energy indicators and GHG emissions in 2050 at sectoral level and explanation of the observed mismatches.

For example, say that in a given national pathway by 2045 the electrification of the passenger car fleet is 60%, that energy efficiency of the passenger car fleet increases by 30% and that travel demand drops to 1100 Million km per year (step 1). Then, step 2 will consist in choosing the technology trajectory and demand trajectories in the EUCalculator that more closely reproduces the boundary conditions published in the national pathway. In step 3 it is then evaluated what energy and emissions values are returned by the EUCalculator for the transport sector and the results compared to the national pathway. The alignment of the assumptions from national pathways in the model and the associated results will always contain a certain degree of disagreement. This is unavoidable and differences will be minimised as far as consistency and the impositions of the national pathways' documentation impose. In this regard it is important to underline that the original scenario documentation and model employed might not match one-to-one with the granularity of assumptions and levers available in the EUCalculator model. The differences can go both ways, that is, sometimes a particular module of the EUCalculator model is more detailed, other times the model that originated the pathway can be more detailed. In such cases the team is forced to make "best guesses" – taking into account the overall narrative of the scenario being reproduced – or derive relevant metrics indirectly using related proxies provided in the scenario documentation. Despite the significant flexibility of the EUCalculator in exogenously setting demand and technological evolution, it cannot be assumed a-priori that any national pathway can be reproduced in an acceptable way. In case essential features of a pathway are not reproduced because the ambition levels in the EUCalculator falls short from that in the national strategy, the model will run using the most ambitious level available. In the final documentation it will be noted the respective assumption where alignment between the EUCalculator and the national pathway was not possible. This implies the level of ambition in the national pathway for a particular technology or behaviour is higher than the expert-level considerations on feasibility made in the EUCalculator.

2.1 Portugal

Transportation

RNC2050 forecasts a slight population decrease of -1.3% while 81.2% of the population living in cities. The plan anticipates 1.7% GDP growth through 2045-2050, leading to more medium-range travel but fewer short-range distances. Remote working gains momentum as a lifestyle choice. The plan envisions a remarkable 100% share of Zero-Emission Vehicle (ZEV) sales for both passenger and freight transport by 2050. Moreover, carsharing and autonomous vehicles account for 33% of total passenger mobility. With an impressive 69% share of electricity and 24% share of hydrogen in transport energy, RNC2050 exemplifies a bold vision for sustainable mobility.

Industry

In RNC2050 material substitutions become evident as glass replaces plastic in packaging, steel industries grow, cement finds replacement in novel construction materials, and paper production decreases. Energy efficiency takes centre stage with a 25% increase, driving industries towards greener practices. The plan acknowledges that Carbon Capture and Storage (CCS) might not yet be economically viable at scale.

Building Efficiency and Renewable Energy

The plan underscores building efficiency and renewable energy adoption. In buildings, solar constitutes 12% of the fuel mix, while biomass takes up 26%, marking a substantial shift from fossil fuels. A 50% increase in thermal isolation for existing buildings enhances energy conservation. The integration of renewable energy in heating and cooling reaches an impressive 66%, reflecting the plan's commitment to reducing the carbon footprint of the built environment.

Energy Generation

RNC2050 envisions a dynamic energy generation landscape. Solar power attains a capacity of 26 GW, while onshore wind contributes 12 GW and offshore wind reaches 0.2 GW. Gas and hydro each contribute 0.2 GW and 8.5 GW, respectively, while biomass and residues add 1.8 GW. This diversified energy mix underscores the plan's commitment to clean, reliable, and renewable energy sources.

Agriculture and Sustainable Forestry

RNC2050 drives change in agricultural practices and forestry management. Waste in agriculture sees a 50% reduction, and synthetic-based fertilisers decrease by 57%. A dietary shift towards plant-based consumption promotes sustainability. The plan embraces sustainable forestry management to increase the overall carbon pool, reflecting its holistic approach to mitigating climate change.

Table 2 - Key sectoral indicators on activities, energy and emissions in RNC2050 and EUCalc

Scope	RNC2050	Key levers/ambition	EUCalc pathway
General			
Population change	-1.3%	Population - 1.1	-1.2%
Population living in cities	81.2%	Urban population - 1.7	81.1%
Transport			
Total passenger transport	"1.7% GDP growth throughout 2045-2050" "... more medium range transport" but "lower short range distances" "increases in remote working…"	Passenger distance - 2	No direct quantification from the pathway. Best guess based on economic growth and assumed reduction of travelling due to remote work and services by 10%.
Active transport	14%	Mode of transport - 1.8	14.5%
Share of ZEV sales (passenger)	100%	Passenger technology - 4	100%
Share of ZEV sales (freight)	100%	Freight technology - 4	100%
Total passenger mobility via carsharing and autonomous vehicles	33%	Car own or hire - 2.5	No direct quantification. Best guess based on the substantial share of total mobility
Vehicle occupancy	Not disclosed quantitatively but as a "*significant increase of public transportation rate*"	Occupancy - 2.5 (Increase of 30% in car occupancy)	Guarantees consistency with the choice for lever "Car own or hire" in which occupancy increases due to more availability of carsharing services.
Electricity share in transport energy	69%	Not set exogenously but responding to demand and technology	62%
Hydrogen share in transport energy	24%	Not set exogenously but responding to demand and technology	23%
Industry			
Material substitution	Glass replaces plastic in packaging; Increases in steel industries, replacement of cement by new construction materials, lower paper production	Material switch - 3 Material efficiency - 3.5	Material switches range from 7% (substitution of conventional wall insulation with cellulose) up to 40% (substitution of concrete with timber in buildings). In transport

			lightweight aluminium replaces steel and other components, in buildings natural fibres replace fossil-based chemicals, timber substitutes cement. Efficiency improvements range between 10 and 33% due to smart product and material design.
Energy mix	Oil consumption residual, circa 12% of final energy consumption by Natural gas.	Fuel mix - 4	Full potential of electrification of heat, substantial switch to sustainable biomass in all manufacturing and production sectors, Very small shares of fossil-fuels in the energy mix.
Energy efficiency increases	25%	Energy efficiency - 4	Range between 10% (wood products) up to 35% (food, beverages and tobacco). In energy-intensive sectors the range is between 13% and 24%.
CCS	Not enough scale to be economically feasible.	Carbon Capture in manufacturing - 1	No commercially viable carbon capture technology option in place by 2050. Major research and development efforts are still required, as well as high investments.
Energy mix	Electricity - 55.5% Gas - 12.6% Biomass - 9.7%	Not set exogenously but responding to demand and technology	Energy mix of steel, glass, chemicals and cement industries: Electricity - 47.4% Gas - 13.6% Biomass - 26.7%
Buildings			
Fuel mix	Solar represents 12% of consumption and biomass 26%, strong phaseout of fossil fuels	Technology and fuel share - 4	Fossil fuel use reduction in 2050: gas -95%; coal -95%; oil -95%. These fuels are substituted by heat pumps (60%), biomass (20%) , solar (12%), geothermal (4%), biogas (2%), biofuel (2%)
Thermal isolation in existing buildings	50% increase	Building envelope - 1.5	50% of the renovations are shallow (-30% energy demand), 38% are medium (-40%) and 18%

			are deep (-60%). 20% of new constructions have the lowest level of efficiency, 60% are medium efficient and 20% highly efficient.
Renewable energy in heating and cooling	66%	Not set exogenously but responding to demand, technology and electricity mix	73.4%
Electricity (GW)			
Solar	26	Solar - 2.5	22.1
Wind (onshore)	12	Wind - 1.7	12.3
Wind (offshore)	0.2		0.03
Gas	0.2	Not set as ambition in the model but rather responds to the capacities of renewable energy and coal.	1.6
Hydro	8.5	Hydro and geo - 1	9.4
Geo	0		
Biomass/residues	1.8	Responds to the demand and fuel mix of sectors.	2.5
Coal	0	Coal - 4	0
Agriculture and forest			
Waste in agriculture	Reduced by 50%	Climate smart crop production - 3 Climate smart livestock - 3	In 2050 sustainable intensification crop production system is fully deployed. Food waste and losses are limited to about half the 2015 level. Decrease of inputs such as synthetic fertilisers and pesticides. Livestock yields are slightly higher by 2050 compared to 2015, due to an increase of the livestock slaughter age. As with crop production, food losses and waste are halved compared to 2015.
Reduction of synthetic-based fertilisers	57%		
Diets	Shift to more plant-based diet	Diet - 2	Consumption of meat, sugars and sweeteners decreases and fruits and vegetables increase towards WHO standards

			(but without fully reaching them). Significant departure from current diets.
Forestry	Sustainable management of forest with a view to increase the overall carbon pool. Fire risk reduction in 60%	Forestry practices - 2	Climate smart forestry practices are deployed in public forests by 2050 (approximately 40% of European forests), leading to increased biomass production and carbon pool potential. Fire dynamic not included in the EUCalculator. Hence this feature of the RNC 2050 cannot be mirrored

2.2 France

Transportation Landscape

SNBC2050 envisions a transformation in transportation patterns. While passenger-km for all modes is projected to rise by 26% between 2015 and 2050, private car traffic is expected to decrease by around 2% during the same timeframe. Freight transport is set to grow by 40%, with improvements in the loading rates of heavy goods vehicles.

Sustainable Mobility Solutions

SNBC2050 emphasises the importance of sustainable mobility. The plan envisions a significant increase in the modal share of cycling, multiplied by four after 2030. Car sales are projected to shift entirely to electric vehicles (EVs) after 2040, with a parallel transformation in freight transport through a balanced mix of renewable gas, electricity, and biofuels. Furthermore, heavy goods vehicles are targeted for efficiency improvements of 35-40% by 2050, and aviation aims to incorporate 50% biofuels by the same year.

Building Renovation and Energy Efficiency

The plan highlights building renovation and energy efficiency as critical components. SNBC2050 targets an average of 700,000 equivalent complete renovations in the residential sector from 2030 to 2050, mirroring a similar rate in the tertiary sector. Building efficiency is emphasised through the goal of achieving 100% low consumption buildings (BBC) by 2050. Electrification is promoted for all uses apart from heating, which will transition to a more varied energy mix, including heat pumps and urban heat networks.

Forestry and Carbon Sequestration

SNBC2050 recognizes the significance of forestry practices in carbon sequestration. The plan emphasises intelligent and sustainable forest management to preserve the carbon pump effect while enhancing resilience to climate risks and conserving biodiversity. This includes afforestation efforts, leading to an increase in forest area. Forest harvest is projected to grow from 48 Mm^3 in 2015 to 65 Mm^3 in 2030 and 83 Mm^3 in 2050.

Dietary Shifts and Agricultural Evolution

SNBC2050 addresses dietary habits and agricultural systems. The plan envisions modifying domestic demand in accordance with nutritional indicators, recommending a reduction in excess meat consumption and an increase in legumes, fruits, and vegetables. Agricultural systems are expected to evolve towards agroforestry, agro-ecology, organic agriculture, grass-fed livestock, and limited land use.

Renewable Energy and Carbon Capture

SNBC2050 outlines a progressive energy production landscape. By 2035, the plan targets 50% of electricity generation from nuclear sources, with total electricity consumption projected at around 600TWh. To further mitigate carbon emissions, the plan includes carbon capture and storage (CCS) strategies. CCS is anticipated to avoid approximately 6 MtCO2/year in industry and achieve around 10 MtCO2 of negative emissions annually through energy production installations using biomass (BECCS).

Table 3 - Key sectoral indicators on activities, energy and emissions in SNBC2050 and EUCalc

Scope	SNBC2050	Key levers/ambition	EUCalc pathway
Transport			
Passenger transport	"passenger-km for all modes together will rise by 26% between 2015 and 2050" "private car traffic which will decrease by around 2% between 2015 and 2050"	Passenger distance - 1.4 Mode of transport - 2.7	Total pkm increase from 1160 to 1550 Billion (~ 25.2%). Reduction of car transport of ~3.1%
Freight transport	"tonnes-km will grow by 40%" "loading rates of heavy goods vehicles will increase"	Freight distance - 1.3 Freight utilisation rate - 4	Increase of ~41% Trucks have a 15% higher load in 2050 with respect to 2015 and trucks will run 10% more km per year than in 2015.
Modal share of cycling	"multiplied by 4 after 2030"	Mode of transport - 2.7	Multiplied by ~2 after 2050
Sales for cars	"100% of	Passenger technology - 4	100% ZEV in new car

	sales for new cars will be electric after 2040" "In 2030, the scenario attains a 35% share for private electric cars and a 10% share for private rechargeable hybrid cars in sales of new vehicles"		sales by 2050 and 35% by 2030.
Efficiency for thermal vehicles	"4L/100km in real consumption for new vehicles sold in 2030" *4L/100km = 1.368Mj/km*	Passenger efficiency - 4 Freight efficiency - 3	By 2035 passenger vehicle efficiency is of 1.382 Mj/km
Freight transport	"A more balanced mix (renewable gas, electricity, biofuels)"	Fuel mix - 2.5	Biofuels reach 50.4% of total road fuel.
Heavy goods vehicles	"improvements in efficiency of 35-40% " by 2050	Freight efficiency - 4	By 2050, trucks' energy consumption (MJ/tkm) decreases by 41.5%.
aviation	50% biofuel by 2050	Fuel mix - 3.5	Biofuels reach 52.5% of total aviation fuel.
Final energy consumption for domestic transport	Total: ~200TWh Electricity: ~100TWh Biofuel: ~50TWh	Not set exogenously but responding to demand, technology and electricity mix	Total: 193 TWh Electricity: 109 TWh Biofuel: 34 TWh
Industry/Waste			
Efficiency	"In 2030, the scenario assumes gains of between 10% and 30%. In 2050, the gains will rise by between 20% and 40%."	Energy efficiency - 3.5	The estimated range of increased energy efficiency is between 10% (wood products) up to 35% (food, beverages and tobacco). In energy-intensive sectors the range is between 13% and 24%.
Electrification	"rate will rise slightly between 2015 and 2030 (from 38% to 41%) then more rapidly until 2050 to reach over 70% of final consumption at this point."	Fuel mix - 4	Full potential of electrification of heat, use of zero-carbon hydrogen and a switch to sustainable biomass are expected to take place in all manufacturing and production sectors, leaving very small shares of fossil-fuels in the energy mix.
Recycling	"Incorporation rates of recycled raw materials that increase drastically to around 80% in 2050, particularly for	Technology efficiency - 4	For seat scrap-EAF technology will reach a share of 70% on average in Europe.

	steel, aluminium, paper, plastics and glass, thus making production processes more efficient."		Paper production from recycled fibres could reach a maximum of 90% Secondary aluminium reaches a maximum of 55%. Recycled paper reached 90% and glass 100%.
Material	"using more materials with low carbon impacts (low carbon cement, bio-based chemicals, carbon-free hydrogen, etc.). A more systematic use of wood as a material should also reduce reliance on materials with a higher carbon footprint"	Material shift - 4 Material efficiency - 4	Material switches range from 10% (substitution of conventional wall insulation with cellulose) up to 60% (substitution of concrete with timber in buildings). In transport lightweight aluminium replaces steels and other components: 50% substitution of steel by aluminium in cars and 45% in trucks. Improvement in material efficiency ranges between 10 and 33% in 2050 due to smart product and material design, re-use of materials and circularity concepts of additive manufacturing. This results in 31% reduction in CO2 intensity.
Buildings			
Behaviour	"proper individual behaviour (heating temperature reduced by an average of 1°C by 2050)."	Space cooling and heating - 2	indoor temperatures are set at 1°C degree more/less than the observed comfort temperature
Renovation	700000 equivalent complete renovations on average over the 2030-2050 period in the residential sector. The tertiary sector will also undergo a similar rate of renovation.	Building envelope - 3	Renovation rates of residential and non-residential buildings reach 2%. (700000 equivalent complete renovations in a universe of 35 million dwellings in 2015 results in ~2% renovation rate.)

Efficiency	"100% BBC (Bâtiments Basse Consommation/ Low Consumption Buildings) on average in 2050"	Building envelope - 3 (both residential and non-residential buildings)	Only 10% of the renovations are shallow (-30% energy demand), while the remaining 90% and medium/deep resulting in energy cuts of -40 to -60%
Energy Mix	"totally carbon free by 2050" "electrifying all uses apart from heating and a more varied energy mix for this latter use, with particularly significant recourse to heat pumps and urban heat networks."	Technology and fuel share - 4	Fossil fuel use reduction in 2050: gas -95%; coal -95%; oil -95%. These fuels are substituted by heat pumps (60%), biomass (20%) , solar (12%), geothermal (4%), biogas (2%), biofuel (2%).
Forest/Land sector			
Forestry practices	"Intelligent and sustainable forest management will allow us to preserve the carbon pump effect while improving its resilience to climate risks and better conserving biodiversity."	Forestry practices - 2	Climate smart forestry practices are deployed in public forests by 2050 (approximately 40% of European forests), leading to increased biomass production and carbon pool potential.
Forest area	"The forest area will increase through afforestation."	Not set exogenously but as result of material demand/forest practice levers	25.6% increase in forest area between 2015 and 2050.
Forest harvest	"from 48 Mm^3 in 2015 to 65 Mm^3 in 2030 and 83 Mm^3 in 2050"	Not set exogenously but as result of material demand/forest practice levers	
Agriculture			
Diets	"domestic demand will be modified (in line with nutritional indicators for 2035" "nutritional recommendations, leading to a limiting of excess consumption of meat products and meat in particular, and increasing the consumption of legumes, fruit and vegetables.	Type of diet - 3 Food waste - 4	assumed that countries aim to fulfil the healthy dietary requirements set by WHO 2003 and WCRF 2017. This means that countries converge to a diet where meat consumption does not exceed 90g/day (of which only up to 71g/day is red meat); where sugars and sweeteners are kept below 10% of calorie consumption and where

			fruits and vegetables consumption is of at least 400g/day. Countries achieve a 75% food waste reduction at the consumer level by 2050.
Management practices	Agricultural systems will evolve (towards agroforestry, agro-ecology, organic agriculture, grass-fed livestock and limited land take)	Climate smart crop production - 4 Climate smart livestock - 4	Production system follows the agroecology standards. Food waste and losses are limited to a third of the previous level or about 6 times lower compared with 2015. The extensive approach leads to yield decline by 20-40% compared with 2015, but the agricultural land potential for carbon storage is fully exploited. Grasslands are used extensively, with a maximum livestock population of 1 Livestock Unit per hectare (LSU/ha). Livestock yields are constant compared with the level of 2015, and an increase of the livestock slaughter age is set to meet organic farming standards.
Energy production and carbon capture and storage			
Electricity mix	By 2035 50% of electricity generation from nuclear	Nuclear - 3.8	Nuclear production ~ 62.7% of electricity production in 2035
Total electricity consumption	~ 600TWh	Not set exogenously, results of the sectoral demand	~ 554TWh
Final energy consumption	Total ~ 1060TWh Industry ~ 250TWh Transport ~ 200TWh	Not set exogenously, results of the sectoral demand	Total ~ 732TWh Industry ~ 221TWh Transport ~ 270TWh
CCS	"allow us to avoid around 6 MtCO2/year in industry and to annually achieve around 10 MtCO2	Carbon capture in manufacturing - 4 Carbon capture to fuel - 4	By 2050 a total of 10.9 MtCO2/year are removed

	of negative emissions with energy production installations using biomass (BECCS for bioenergy with carbon capture and storage)"	Carbon capture ratio in power - 4	

2.3 Germany

Table 4 - Key sectoral indicators on activities, energy and emissions in KPA2045 and EUCalc

Scope	KPA2045	Key levers/ambition	EUCalc pathway
Transport			
Passenger transport	1360 Mpkm	Passenger distance - 1.1	1373 Mpkm
Bicycle Rail	84 Mpkm 174 Mpkm	Mode of transport - 1.5	91 Mpkm 143 Mpkm
Total freight transport	29% increase compared to 2020	Freight distance - 1.8	26% increase
BEV fleet share (passenger)	74%	Passenger technology - 4	70%
BEV fleet share (freight)	44%	Freight technology - 3.6	47%
Passenger transport efficiency	2.4x increase	Passenger efficiency - 2.1	By 2050, car energy consumption (MJ/tkm) decreases by 27%, bus energy consumption by 20%, rail energy consumption by 25%, aviation energy consumption by 11%. Resulting in a 2.4x improvement
Freight transport efficiency	2.0x increase	Freight efficiency - 2.1	By 2050, truck energy consumption (MJ/tkm) decreases by 17%, rail energy consumption by 13%, aviation energy consumption by 7% and shipping energy consumption by 13%. Resulting in a 2.2x improvement
Energy demand	358 TWh	Not set exogenously but depending on the demand and technology settings	330.9 TWh
% of electricity in overall demand	55%	Not set exogenously but depending on the demand and technology settings	48.3%
% of hydrogen	14%	Not set exogenously but depending on the demand and technology settings	15.1%
Buildings			

Rate of retrofitting	Between 1.5 and 2% a year	Building envelope - 2.5	The annual renovation rate is 1.8%. 8% of the renovations are shallow (-30% energy demand), 50% are medium (-40%) and 20% are deep (-60%). The demolition rate is 0.5%/annum.
Renewable share in heating and cooling	96%	Technology and fuel share - 4	Fossil fuel use reduction in 2050: gas -95%; coal -95%; oil -95%. These fuels are substituted by heat pumps (60%), biomass (20%) , solar (12%), geothermal (4%), biogas (2%), biofuel (2%).
Energy efficiency gains	1.9x increase	Heating and cooling efficiency - 3	The efficiency of boilers increases slowly across the stock to an average of 91% for gas boilers, 87% for oil boilers and 69% for wood boilers.
Energy demand	608 TWh	Not set exogenously but depending on the demand and technology settings	612.9TWh
Fuel mix	Electricity - 380 TWh Heat - 201 TWh Biogas - 10 TWh Natural gas 0.03 Twh	Not set exogenously but depending on the demand and technology settings	Electricity - 329.4 TWh Heat - 133.3 TWh Biogas - 10.1 TWh Natural gas - 2.8 TWh
Industry			
Efficiency		Technology efficiency - 3 Material efficiency - 2 Material switch - 2	In energy-intensive industries a more rapid shift from energy-intensive production technologies to emerging, low-carbon technologies is observed. For example in the steel sector, the secondary route (scrap EAF), HIsarna and Hydrogen DRI gain shares (65% in total), geopolymer cement production becomes significantly more important (10%).
Production	Non-ferrous metals - 2Mt Non metallic min. - 63Mt Chemicals - 44Mt Steel - 40Mt	Not set exogenously but depending on the demand and technology settings	Non-ferrous metals - 1.7Mt Non metallic min.- 44.1Mt Chemicals - 31.3Mt Steel - 35.7Mt
Primary vs secondary steel	50%	Technology efficiency - 2.3	46%

Energy	672 TWh	Not set exogenously but depending on the demand and technology settings	467 TWh
% of electricity	44%	Fuel mix - 4	29.8%
Electricity generation			
Solar	29%	Coal phase out - 4 Solar - 3 Wind - 3 Hydro, geo and tydal - 1 Nuclear - 4 Bioenergy capacity - 1	22%
Wind	62%		63%
Nuclear	0%		0%
Hydro	2%		5%
Geo	0.55%		0.20%
Biomass	1%		3%
Coal	0		0
Others	5%		0.1%
Gas	0%		6%
Agriculture			
Not explicitly modelled		Climate smart crop production - 2 Climate smart livestock - 2 Food waste - 3	In 2050 sustainable intensification crop production systems remain limited compared to conventional practices. The intensification of the crop production system enables to increase the yields and input uses in line with historical trends. Land requirement is lower per output unit. In 2050 sustainable intensification livestock production system remains limited compared to conventional practices. The intensification of the livestock production system enables to increase the yields and input uses following historical trends. Given the intensification, the land requirement is lower per output unit. 50% food waste reduction at the consumer level, thus complying with Sustainable Development

			Goal (SDG) target 12.3

2.4 Italy

Population Dynamics

ITLS2050 takes into account a projected population decrease of approximately 3.3% between 2015 and 2050. This demographic trend highlights the evolving landscape of society and underscores the plan's focus on sustainable practices in a changing world.

Energy Demand Reduction

ITLS2050 aims to drastically reduce energy demand. With a projected energy demand of about 1221 TWh in 2050, reflecting a significant 43% decrease from 2018 levels, the plan showcases a commitment to energy efficiency and sustainable consumption patterns.

Passenger and Freight Transport

The plan envisions a transformed transportation landscape. Passenger car transport is targeted for a 15% reduction by 2050, while passenger train transport is projected to increase by 23% in the same timeframe. Freight transport sees a notable shift, with a 23% increase in freight transported by train and a ~19% decrease in freight transported via trucks by 2050.

Electrification and Energy Efficiency in Buildings

Renewable energy plays a pivotal role in ITLS2050. With a target of achieving 55% of final energy consumption from renewables by 2050, the plan demonstrates a robust commitment to cleaner and sustainable energy sources. ITLS2050 places a strong emphasis on building retrofitting. The plan envisions a ~2% annual renovation rate, with a focus on deep renovation, aiming for 80% of renovations to be comprehensive. Energy efficiency gains are expected through the application of advanced technologies and complete renovation measures.

Industrial Transition and Carbon Capture

The plan outlines significant shifts in industrial production. Steel production is projected to decrease by ~10% by 2050 compared to 2017, while cement production is anticipated to increase by ~21% and chemical production by ~6% in the same timeframe. Carbon capture and storage (CCS) is targeted to capture up to 20 Mt CO2eq.

Renewable Electricity Generation

ITLS2050 emphasises the importance of renewable electricity generation. By 2030, the plan projects contributions from solar energy (37 TWh), wind power (42 TWh), hydroelectricity (49 TWh), geothermal energy (7 TWh), biomass (12 TWh), and gas (implicitly noted as significant in the mix, ~152 TWh). The plan sets a target of 55% penetration of renewables in the electricity mix by 2030.

Agriculture and Livestock Practices

The plan highlights changes in agriculture and livestock practices. Poultry production is projected to increase by 25% in 2050 compared to 2050, while pig production is expected to increase by about 10% and bovine production to decrease by about 22% in 2050 compared with 2015.

Table 5 - Key sectoral indicators on activities, energy and emissions in ITLS2050 and EUCalc

Scope	ITLS2050	Key levers/ambition	EUCalc pathway
General			
Population	Population decreases by ~3.3% between 2015 and 2050	Population -3.6	Population decreases by 3.5% between 2015 ans 2050
Renewables	55% of final energy consumption in 2050	Not set exogenously but depending on the demand and technology settings	
Transport			
Passenger transport	15% reductions in passenger car transport by 2050 23% increase of passenger train transport in 2050	Passenger distance - 4 Occupancy - 1	~12% reductions in car transport by 2050 ~18% increase of train transport in 2050
Freight transport	Freight by train increases 23% while freight via trucks decreases ~19% by 2050	Freight distance - 2 Freight mode - 3.2	By 2050, there is a 22% increase in freight demand
BEV fleet share (passenger)	About 79% in 2050 (and ~16% hydrogen)	Passenger technology - 3.1 Car sharing - 4	~ 70% of passenger fleet is electric and ~ 28% hydrogen
BEV fleet share (freight)	Not explicitly stated in the LTS documentation. Broadly lever levels are aligned to passenger technology	Freight technology - 3.8	~ 37% of trucks are electric and 28% hydrogen
Passenger transport efficiency		Passenger efficiency - 3.1	By 2050, cars energy consumption (MJ/pkm) decreases by 35%
Freight transport efficiency		Freight efficiency - 3.1	By 2050, trucks energy consumption (MJ/tkm) decreases by 35%
Electricity demand	115 TWh by 2050	Not set exogenously but depending on the demand and technology settings	~116 TWh in 2050
% of electricity in	~20% in 2030	Not set exogenously but	~ 13% in 2030 (60% in

overall demand		depending on the demand and technology settings	2050 for electricity, 26% for hydrogen in 2050)
Buildings			
Rate of retrofitting	~ 2% renovation rate/year with 80% deep renovation	Building envelope - 3	Building renovation ~2% and 90% are medium/deep.
Floor area per person	Not specified in LTS. Assumed to increase overall (but below historical 1990-2014 trends) given the projected drop in population.	Floor area - 2	Floor area grows modestly by 1.6% in 2050 compared with 2015
Energy efficiency gains	No explicit quantification. The underlying narrative is: "Increasing the efficiency of pre-existing buildings, enhanced by the increase in complete renovation measures and the application of particularly high-performing technologies"	Technology and fuel share - 4 Appliance efficiency - 3.5 Heating & cooling efficiency - 3.5	By 2050 fossil gas, oil and coal are reduced by 95%. Heat pumps rise by 60%, biomass by 20%, solar by 12% and geothermal and others by 8% The efficiency of boilers increases slowly across the stock to an average of 87% for gas boilers, 83% for oil boilers and 66% for wood boilers. The appliance efficiency is set to 70%
Electricity demand	209 TWh by 2050	Not set exogenously but depending on the demand and technology settings	~196 TWh in 2050
Renewable share in heating and cooling	34% renewables in 2030	Not set exogenously but depending on the demand and technology settings	32% renewables in energy
Industry			
Production	~10% less steel production in 2050 compared to 2017 ~21% more cement production in 2050 compared to 2017 ~ 6% more chemical production in 2050 compared to 2017	Material switch - 1 Material efficiency - 1	~11% less steel production in 2050 compared with 2015 -10% cement production in 2050 compared with 2015 ~3% more chemical production
CCS	Up to 20 Mt CO2eq captured	Carbon capture in manufacturing - 3.2	~ 19 Mt CO2eq captured
Energy	~ 244 TWh in 2050	Not set exogenously but depending on the demand and technology settings	225 TWh in 2050

Energy			
% of renewable energy final consumption	30% in 2030	Not set exogenously but depending on the demand and technology settings	
Electricity generation	By 2030		2030 (2050)
Solar	37 TWh	Solar - 2.1 Wind - 2.2 Hydro, geo and tydal - 1.9 Bioenergy capacity - 4 Coal phase out - 3	36 (73) TWh
Wind	42 TWh		44 (86) TWh
Nuclear	-		-
Hydro	49 TWh		49 (48) TWh
Geo	7 TWh		6 (7) TWh
Biomass	12 TWh		8 (17) TWh
Coal	0 TWh		0 (0) TWh
Others	-		-
Gas	Not mentioned explicit but implicitly significant in the mix as noted by the penetration of renewables accordingly, about 45% generation capacity with gas is estimated ~ 152 TWh		153 (22) TWh
Penetration of renewables	55% in 2030	Not set exogenously but depending on the demand and technology settings	52% in 2030
Agriculture/Forest			
Livestock	Poultry increases by 25% in 2050 compared with 2050 Pig production increases by about 10% in 2050 compared to 2015 Bovine production decreases by about 22% in 2050 compared with 2015	Diet - 1 Smart livestock production - 2	Poultry production increases by ~17% in 2050 compared with 2015 Pig production decreases by 5% in 2050 compared with 2015 Bovine production decreases by 24% in 2050 compared with 2015
Cropland	Growing trend in agricultural land assumed until 2040 and a stabilisation thereafter Increase is dominated by cereal areas and a decrease in woody and industrial crops	Land management - 1 Smart crop production - 2	Cropland expands by 10% until 2040 in relation to 2015 to 9.3Mha and in 2050 cropland area is ~9 Mha Cereal production rises by ~20% in 2050 compared with 2050
Forest	Forest grows until 2030 and stabilises thereafter	Forest practices - 2 Land management - 1	Forest area rises from 9.3 Mha in 2015 to 10.8 in 2030. In the year 2050

			forest area is about

2.5 Poland

Transportation

Transportation is at the heart of NECPP2050's transformation. By 2025, the plan envisions 1 million electric vehicles in Poland's roads, a staggering number for electricity-fueled vehicles. Furthermore, by 2030, 3,000 electric buses are set to revolutionize the collective transport landscape. We explore how these initiatives align passenger and freight transport efficiency with the overarching energy efficiency target of 23%. A significant milestone on this path is achieving a 14% share of renewable energy in the transport sector by 2030.

Buildings and heating

The buildings sector plays a pivotal role in NECPP2050's decarbonization narrative. This chapter explores the plan's ambitious goal of retrofitting existing buildings to reach a remarkable 70% share of thermo-insulated structures in the national housing stock by 2030. This transformation from ~59% in 2015 is a testament to Poland's commitment to energy-efficient and sustainable living spaces. We also uncover how the plan aims to increase the share of renewable energy sources in heating and cooling while achieving significant energy savings, totaling 43,440.1 MWh, between 2021 and 2030.The plan envisions the modernization and expansion of district heating systems while and cooling technologies based on district heating. NECPP2050 sets an annual target of increasing the share of renewable energy sources (RES) in heating and cooling by 1-1.3 percentage points, contributing to a greener future for Latvia.

Transforming Electricity Generation

The NECPP2050 plans for achieving 10 GW of wind energy capacity by 2040, diversifying the nation's energy sources. Nuclear energy, anticipated to contribute 6-9 GW by 2043, takes a significant place in the energy mix. Furthermore, the plan is dedicated to reducing the share of coal and lignite in electricity production to 60% by 2030. This chapter also details how NECPP2050 aims to maintain stable gas production while dramatically increasing the share of renewable energy sources (RES) in net electricity generation to 27% by 2030.

Table 6 - Key sectoral indicators on activities, energy and emissions in NECPP2050 and EUCalc

Scope	NECP2050	Key levers/ambition	EUCalc pathway
General			
Energy	Efficiency improvements of 23%	See sectors	
Transport			
BEV fleet share (passenger)	"1 million electric vehicles on roads in the segment of electricity-fuelled vehicles by 2025" "3000 electric buses in the collective transport segment at the national level in 2030"	Passenger technology - 3.4	1.1 million BEV by 2025
Passenger transport efficiency	Aligned to overall target of 23%	Passenger efficiency - 2.3	25% efficiency improvments
Freight transport efficiency	Aligned to overall target of 23%	Freight efficiency - 3	30% efficiency improvements
% of renewables	"share of renewable energy in transport is 14 % by 2030"	Not set exogenously but depending on the demand and technology settings	18% renewables penetration in transport
Buildings			
Rate of retrofitting	"share of thermo-insulated buildings in the aggregate housing stock will amount to 70% in 2030" from ~59% in 2015	Building envelope - 4	34% of renewd building stock
District heating	"modernising and expanding district heating systems and developing district heating-based cooling technologies"	District heating share - 3	No quantitative comparison
Fuel mix	"The share of RES in heating and cooling should increase by 1-1.3 percentage points annually"	Technology and fuel share - 3.3	~ 1% increase in renewables in heating
Electricity generation	variable		
Solar		Wind - 2.3 Hydro -	
Wind	10 GW in 2040		11.2 GW in 2040
Nuclear	6-9 GW by 2043		9GW in 2040
Hydro			

Geo		Coal phase out - 2	
Biomass			
Coal	"Reduction of the share of coal and lignite in electricity production to 60% in 2030"		~ 66% coal in 2030
Others			
Gas	"The main objective for 2030 in the segment is to maintain stable gas production"		
Share of renewables	"RES in net electricity generation is expected to grow to 27 % by 2030"	Not set exogenously but depending on the demand and technology settings	33% renewables
Agriculture			
Not explicitly modelled			

2.6 Spain

Population Growth and Sustainable Diets

EDLP2050 acknowledges a projected population of approximately 49.3 million by 2050, highlighting the challenges and opportunities associated with a growing society. To promote sustainable living, the plan emphasises the promotion of the Mediterranean diet, encouraging healthier and environmentally friendly eating habits.

Reducing Waste and Energy Consumption

In alignment with sustainability goals, EDLP2050 aims for a 20% reduction in food waste by 2030. The plan also recognizes the importance of energy consumption and envisions a final energy consumption of about 674 TWh in 2050. This reflects a commitment to reducing energy usage while maintaining a sustainable and thriving society.

Transformation in Transportation

EDLP2050 envisions a transformation in transportation patterns. The plan projects a 13% increase in total passenger distance by 2030. While car transport is expected to drop by 11% in the same timeframe, bus transport is set to increase by a remarkable 200%, and rail transport is expected to surge by 260% compared to 2015. Freight transport is also projected to increase by 23% by 2030.

Embracing Renewable Mobility and Transport

Renewable energy in the transport sector is a key focus of EDLP2050. The plan aims for renewables to account for 28% of mobility-transport energy consumption by 2030 through electrification, with a projected 5 million electric vehicles on the road by that year. The plan anticipates an astounding 79% share of renewables in the transport sector by 2050, reflecting a robust commitment to cleaner mobility solutions.

Sustainable Buildings and Industrial Transformation

EDLP2050 places great emphasis on building efficiency and sustainability. The plan envisions a higher renovation rate and the construction of nearly zero-energy buildings or positive energy buildings by 2050. Similarly, the industrial sector is targeted for transformation, with a projected energy demand of around 227.5 TWh by 2030. The plan seeks to achieve a 40% renewable energy consumption in the industry by 2050.

Renewable Electricity Generation

EDLP2050's commitment to renewable electricity generation is exemplified by its projected energy mix. By 2030, the plan anticipates contributions from solar energy (93.8 GWh), wind power (119.5 GWh), nuclear energy (24.9 GWh), hydroelectricity (28.1 GWh), biomass (10 GWh), and gas (48 GWh). This diversity of renewable sources underscores the plan's dedication to a cleaner and more resilient energy landscape.

Agricultural and Forest Practices for Sustainability

EDLP2050 outlines innovative agricultural practices that include digitization and smart technologies to optimise input management and resource use. The plan also underscores the importance of agroforestry systems, forest management improvements, and responsible land management strategies to foster sustainable land use.

Table 7 - Key sectoral indicators on activities, energy and emissions in EDLP2050 and EUCalc

Scope	EDLP2050	Key levers/ambition	EUCalc pathway
General			
Population	Same assumption s in "2018 Ageing Report: Economic and Budgetary Projections for the EU Member States" In 2050 population ~49.3 Millions	Population - 2.2	~49.1 Millions
Diet	No quantifiable indicator but reference to the	Diet - 3	By 2050 Spain fulfils the healthy dietary

	objective of: "Promotion of the mediterranean diet" Interpreted as: high consumption of unprocessed cereals, legumes, olive oil, fruits,[4] and vegetables. Moderate intake of fish, dairy products (mostly cheese and yoghourt), and meat products.		requirements set by WHO 2003: meat consumption does not exceed 90g/day; where sugars and sweeteners are kept below 10% of calorie consumption and where fruits and vegetables consumption is at least 400g/day.
Waste	20% less food waste by 2030	Food waste - 3.5	Compared to 2015 food waste is reduced by 22% in 2030 and 55% by 2050
Energy	~ 674 Twh final energy consumption in 2050 (~ 954 in year 2050)	Not set exogenously but depending on the demand and technology settings	~700 Twh
Transport			
Passenger distance	Total passenger distance increases 13% in 2030 compared to 2015	Passenger distance - 1.2	Passenger distance increases 15% in 2030 compared to 2015
Passenger transport	Car transport drops 11% in 2030 compared to 2015 Bus transport increases 200% by 2030 compared to 2015 Rail transport increases 260% by 2030 compared to 2015 Aviation sector not considered	Passenger mode - 4	Car transport drops by12% in 2030 (and by 2050) Bus transport increases by 57% by in 2030 (and by 2050) Rail transport increases by 91% in 2030 (and 290% by 2050)
Freight transport	Increases 23% by 2030	Freight distance - 1	By 2050, there is a 49% increase in freight demand (~ 25% by 2030)
Rail	Rail share ~ 4% by 2030 compared to 2015	Freight mode - 1	In 2050 rail makes up 13% of freight transportation (~3.5% in 2030)
BEV fleet share (passenger)	Presence of renewables in mobility-transport reaching 28% by 2030 through electrification (5 million electric vehicles in that year) and "the electrification of passenger transport could be practically 100% in 2050"	Passenger technology - 3.8	BE and hydrogen vehicles combined reach 27.8 % of the fleet in 2030 (and 98% in 2050).
BEV fleet share (freight)	No specific quantification.	Freight technology - 3.8	Electric and hydrogen truck sales are ~30% in

	Aligned with the assumption on BEV fleet for passenger transport		2030
Passenger transport efficiency	31% improvements until 2030 for cars 70% improvement for planes until 2050	Passenger efficiency - 4	By 2050, car energy consumption (MJ/tkm) decreases by 50%, bus energy consumption by 30%, rail energy consumption by 45%, aviation energy consumption by 30%.
Freight transport efficiency	Not explicitly mentioned. Assumed to be in line with that of passenger transport.	Freight efficiency - 4	By 2050, truck energy consumption (MJ/tkm) decreases by 50%, rail energy consumption by 40%, aviation energy consumption by 22% and shipping energy consumption by 40%.
Energy demand	24.5TWh of renewables (excluding electricity) in 2030 ~ 337.9 in 2030	Not set exogenously but depending on the demand and technology settings	~ 400 Thw of demand
Renewables in the transport sector	79% in 2050 (includes passenger and freight)	Not set exogenously but depending on the demand and technology settings	~ 72% in overall transport
Buildings			
Rate of retrofitting	renovation rate to be increased from the current level of 1.2% over the period 2020-30	Building envelope - 2	Renovation rate of about 1.5% (same for 2030 and 2050)
New constructions	By 2050, only nearly zero-energy buildings (NZEB) or positive energy buildings will be built.	Building envelope - 2	By 2050 the annual renovation rate is 1.5% and only 20% of the renovations are shallow, meaning they achieve a 30% reduction in energy demand
Fuel mix	22.5% renewables in 2030 Renewables in the 'heating and cooling' sector: 97% in 2050	Fuel mix - 4	Fossil fuel use reduction in 2050: gas -95%; coal -95%; oil -95%. These fuels are substituted by heat pumps (60%), biomass (20%) , solar (12%), geothermal (4%), biogas (2%), biofuel (2%).
Industry			
Paper	85% collection and recycling	No recycling lever in EUCalculator	-
Energy demand	~ 227.5 in 2030	Not set exogenously but depending on the demand and technology settings	~250 in 2030
% of electricity	~ 40% of total energy consumption in 2050	Not set exogenously but depending on the demand and technology settings	33% in 2050

Electricity generation	in 2030		2030 (2050)
Solar	93.8 GWh	Solar - 2.9 Wind - 3.9 Nuclear - 3.4 Hydro, geo and tydal - 1.8 Bioenergy capacity - 4 Coal phase out - 4	93.2 (-) GWh
Wind	119.5 GWh		103.8 (202) GWh
Nuclear	24.9 GWh		24.5 (0) GWh
Hydro	28.1 GWh		27.7 (25.7) GWh
Geo	-		-
Biomass	10 GWh		9.1 (17.3) GWh
Coal	0 GWh		0 (0) GWh
Others	-		-
Gas	48 GWh		58 (0) GWh
Agriculture/Forest			
Agricultural practices	Digitization and smart technologies for the development of precision agriculture on a larger scale, optimising input management and, especially, nitrogen fertilisation and irrigation. Conversion of 0.5 Mha of herbaceous crops to agroforestry systems and densification of 0.5 Mha of dehesas by 2050	Climate smart crop production - 1 Climate smart livestock production - 1	-
Forest practices	Improve forest management in 3 Mha by 2050	Forestry practices - 3	-
Land			
Forest area	4% higher than in 2020	Not set exogenously but depending on the demand and technology settings	3% higher than in 2015
Land cover	Slight increase in the area of forest land to 16.1 Mha in 2050 (compared to 15.7 Mha today) Drop in cropland and pasture 19.4 Mha in 2050 (compared to the current 20.0 Mha) and 11.5 Mha in 2050 (compared to the current 11.9 Mha), respectively.	Not set exogenously but depending on the demand and technology settings	Positive change in forest area to 17 Mha in 2050

2.7 Luxembourg

Rapid Urbanization and Population Growth

SNLTL2050 anticipates a significant population growth of around 50% in comparison to 2020, signifying the increasing challenges and opportunities that come with urbanisation. This surge in population underscores the urgency to transition towards cleaner energy systems and infrastructure to support sustainable growth.

Energy Efficiency and Ambitious Targets

An energy-efficient future is a cornerstone of SNLTL2050. The plan commits to an ambitious energy efficiency target of 40-44% by 2030, reflecting a resolute dedication to optimising energy consumption across sectors and reducing carbon emissions.

Transportation

SNLTL2050 envisions a transformative shift in transportation. The plan emphasises traffic avoidance through a substantial expansion of public transport options, encouraging sustainable modes of mobility. The transportation sector aims to have 49% of electric cars and plug-in hybrids by 2030, driving down emissions and promoting clean energy adoption. Passenger transport efficiency is targeted to improve by 38% in 2030, indicating a commitment to greener and more efficient transportation systems.

Building Retrofitting and Renewable Integration

Efforts towards energy-efficient buildings are highlighted by SNLTL2050's focus on building retrofitting. A 3% renovation rate with an average renovation depth of 72% underscores the plan's dedication to improving the energy performance of existing structures. Renewable integration is also a priority, with a goal of approximately 22% renewables in buildings by 2040, reflecting a commitment to cleaner heating and cooling systems.

Transitioning Industry and Energy Demand

SNLTL2050 recognizes the importance of industrial transition. The plan projects an energy demand of 4948 GWh in the industrial sector by 2040. This emphasis on industrial energy consumption aligns with the overall goal of reducing emissions and fostering cleaner production processes.

Renewable Electricity Generation

The heart of SNLTL2050's energy strategy lies in renewable electricity generation. The plan outlines a diverse mix of renewable sources for electricity generation. Solar energy is projected to contribute 1442 GWh, wind power 1166 GWh, hydroelectricity 107 GWh, biomass 338 GWh, and gas 180 GWh by 2040. This comprehensive approach to electricity generation underscores the commitment to a low-carbon and sustainable energy landscape.

Table 8 - Key sectoral indicators on activities, energy and emissions in SNLTL2050 and EUCalc

Scope	SNLTL2050	Key levers/ambition	EUCalc pathway
General			
Population	In 2050 population grows by ~50% in comparison to 2020	Population level - 1	Population forest by 5% in 2050
Energy efficiency	Energy efficiency target of 40-44% by 2030		
Transport			
BEV fleet share (passenger)	49% of electric cars / plug-in hybrids in 2030	Passenger technology - 3.3	50% of electric cars
Passenger transport efficiency	38% improvement in 2030	Passenger efficiency - 3	42% improvements in 2030
Energy demand	11224 GWh in 2040	Not set exogenously but depending on the demand and technology settings	1080 GWh in 2040
Renewable of renewables	54% in 2040	Not set exogenously but depending on the demand and technology settings	42% in 2040
Buildings			
Rate of retrofitting	3% renovation rate with 72% renovation depth on average	Building envelope - 4	3% renovation rate
Share of renewables	~22% in 2040	Not set exogenously but depending on the demand and technology settings	~ 19% ub 2040
Energy demand	2715 GWh	Not set exogenously but depending on the demand and technology settings	2123 GWh
Electricity generation	In 2040		
Solar	1442 GWh	Solar - 2.5 Wind - 2.1 Hydro -3 Biomass capacity - 3	1032 GWh
Wind	1166 GWh		972 GWh
Nuclear	-		-
Hydro	107 GWh		88 GWh
Geo	-		-
Biomass	338 GWh		300 GWh
Coal	-		-
Others	-		-
Gas	180 GWh (Mentioned only		~ 200GWh

	for Ref scenario - No further expansion of the national gas infrastructure either transmission nor at the distribution level)		

2.8 Netherlands

Demographic Changes and Sustainable Living

The NLTSNL2050 plan takes into account the projected population growth of approximately 4.4% by 2030 compared to the baseline year of 2015. This growth necessitates a strategy that optimises energy efficiency and resource consumption despite a larger populace. In response to changing household compositions, the plan anticipates a 5% rise in floor area by 2030. This growth is motivated by a decrease in average household composition from 2.2 to 2.1 persons and an increase in single-person households by approximately 13%. The plan acknowledges the need to balance housing demands with sustainable practices to minimise the environmental impact of urban expansion.

Sustainable Diet and Food Production

The Netherlands' decarbonization plan emphasizes achieving a balanced and sustainable diet that aligns with the principles of health, affordability, safety, and environmental responsibility. The plan seeks to strike a healthy equilibrium between animal and vegetable proteins in the Dutch diet. By doing so, it aims to reduce the carbon footprint associated with food production and promote sustainable agricultural practices.

Energy Transition and Demand Reduction

To address the energy sector's contribution to carbon emissions, the LTSNL2050 outlines a comprehensive approach to energy transition and demand reduction. The plan identifies a substantial total energy demand of approximately 652.7 TWh (primary) and 555.5 TWh (final). In response, the plan aims to achieve a 13% reduction in total energy consumption between 2020 and 2030. This reduction is anticipated to result from a combination of energy efficiency measures and a shift towards renewable energy sources.

Transportation Transformation

The decarbonization plan introduces measures to transform the transportation sector, a significant contributor to carbon emissions. By 2030, the plan aims to reduce business-related travel by eight billion kilometres. Moreover, it targets

the establishment of zero-emission zones for urban logistics in at least the 32 largest municipalities by the same year. The plan envisions a significant shift towards electric vehicles (EVs), with a goal of 1.9 million electric passenger vehicles on the road by 2030. Additionally, the plan aims for 100% emission-free new passenger car sales in 2030 and emphasizes promoting alternative modes of transportation such as cycling and public transit.

Energy-Efficient Buildings

The Netherlands' decarbonization plan places a strong emphasis on enhancing the energy efficiency of buildings. It sets a goal to retrofit 3% of the central government's building stock annually until 2030. Energy efficiency gains are anticipated to result from increased insulation measures, efficiency enhancements, and a higher adoption rate of heat pumps. The plan also calls for a reduction in reliance on natural gas, with 200,000 existing homes per year transitioning away from the natural gas network. By 2030, the aim is for at least 20% of building energy consumption to come from renewable sources.

Sustainable Industry Practices

The industrial sector is a focal point in the decarbonization plan, with a focus on material efficiency and carbon capture technologies. The plan aims for a 50% reduction in the consumption of primary raw materials through improved material efficiency practices. Carbon capture and storage (CCS) are to be utilized effectively, with a cap of 7.2 Ton of emissions. The plan acknowledges the diverse nature of industries, with growth projected for the metallurgical and food and beverage sectors, moderate growth for others, and reduction in sectors such as paper, glass, and building materials.

Renewable Energy Generation

The LTSNL2050 strategy revolves around a significant increase in renewable sources. Wind energy is a cornerstone, with an estimated 49 TWh generated offshore and an additional 35 TWh from onshore wind and solar sources. The plan also encourages small-scale renewable energy generation up to approximately 10 TWh. Importantly, the plan legislates the prohibition of coal-based electricity generation by law starting from 2030.

Sustainable Agriculture and Livestock Practices

Acknowledging the role of agriculture in emissions, the plan addresses livestock and agricultural practices. The aim is to optimise animal feed, improve manure processing and storage, and adopt sustainable soil management practices. By doing so, the plan strives to mitigate the environmental impact of agriculture while ensuring food security.

Table 9 - Key sectoral indicators on activities, energy and emissions in LTSNL2050 and EUCalc

Scope	LTSNL2050	Key levers/ambition	EUCalc pathway
General			
Population	Population increases by ~ 4.4% by 2030 compared to 2015	Population - 1.1	Population increases to 3% in the year 2030 compared to 2015
Floor area	Estimated to rise by about 5% in 2030 motivated by a decrease on the household composition from 2.2 to 2.1 persons an an increase of single-persons households in the range of ~ 13% by 2030	Floor area - 1.2	Floor area in 2030 is 5.2% higher than in 2020.
Diet	"strive to achieve a good balance between sustainable, healthy, safe and affordable food, and a healthy balance between animal and vegetable proteins in our diet"	Diet - 3	By 2050 diet where meat consumption does not exceed 90g/day (of which only up to 71g/day is red meat); where sugars and sweeteners are kept below 10% of calorie consumption and where fruits and vegetables consumption is of at least 400g/day.
Energy demand	~ 652.7 TWh (primary) ~ 555.5 TWh (final) Reduction of 13% between 2020 and 2030	Not set exogenously but depending on the demand and technology settings	
Transport			
Passenger transport	By 2030 there is a reduction of eight billion kilometres travelled for business purposes	Passenger distance - 3	The growth in travel distance is conditioned by a 25% reduction in travel spent for travelling to work/study and a drop in 20% in time needed for accessing services. Travel time spent for leisure activities continues to grow.
Freight transport	"At least the 32 largest municipalities have zero-emission zones for urban logistics" by 2030	Freight distance - 3.3	By 2030, there is a 7% decrease in freight demand (and 22% reductions until 2050)
BEV fleet (passenger)	1.9 million electric vehicles by 2030 "electric transport (including passenger transport) aimed at 100% emission-free new sales of passenger cars in 2030"	Passenger technology - 3.8	About 1.3 million electric cars by 2030
Passenger transport mode	"200000 extra bicycle commuters" "various measures are aimed at making alternatives such as bicycles and public transport"	Passenger mode - 3	-
Fuel mix	"The use of biofuels between 2021 and 2030 is estimated at around 35 petajoules per year" (~ 87.5 TWh in 2030) Electricity demand to grow to	Fuel mix - 3	-

	14.3 PJ in 2030 (~ 3.8TWh in 2030)		
Renewables in the transport sector	"1/3 of energy consumption in mobility is renewable by 2030"	Not set exogenously but depending on the demand and technology settings	30% of RES in transport
Buildings			
Rate of retrofitting	"3% of central government's building stock on an annual basis" until 2030 No information on the renovation rate for private buildings so its assumed to be at 2% (in line with other countries)	Building envelope - 2.5	2.5% renovation rate
Energy efficiency gains	"consumption in the built-up environment is decreasing primarily due to the increase in insulation measures, efficiency measures and the number of heat pumps."	Heating/cooling efficiency - 3.5 Appliance efficiency - 3.5	No quantitative reference for comprison
Share of electricity	At least 20% energy from renewables by 2030	Not set exogenously but depending on the demand and technology settings	18% in 2030
Industry			
Material efficiency	50% fewer primary raw materials are consumed	Material efficiency - 4	30% drop in material consumption
CCS	CCS is used cost effectively up to a maximum of 7.2 Mton	CCS in industry - 2	8 Mton
Production	"the metallurgical industry assumes growth" "the food and beverage industry assumes its growth" of recent years will continue, albeit at a more moderate pace" "the production volume in the paper industry will shrink" "the production of glass will decrease" "production of the building materials industry is expected to increase in the future"	Not set exogenously but depending on the demand and technology settings	-
Electricity generation	2030		2030
Solar	(see below)		
Wind	49 TWh (offshore)		59 TWh

		Solar - 4 Wind - 3 Coal phase out - 4 Biomass - 2.5	
Wind/solar	35 TWh (onshore and solar) "Encouraging small-scale renewable generation up to circa 10 TWh"		11 TWh (onshore) 9 TWh (solar)
Hydro	-		-
Geo	-		-
Biomass	(not explicit)		
Coal	"From 2030, the use of coal to generate electricity will be prohibited by law."		0 TWh
Others	-		
Gas	(not explicit)		29 TWh
Agriculture/Forest			
Livestock practices	"optimising animal feed and improving manure processing and storage methods"	Climate smart livestock - 1.5	Increased productivity through continued intensification patterns. Due to more intensive systems, manure management is improved as livestock is spending less time outdoors.
Agricultural practices	"sustainable management of all Dutch agricultural soils in 2030"	Climate smart crop production - 3	Sustainable intensification crop production system is fully deployed. Crop yields are increasing slightly compared to 2015, but much less compared with the previous levels. In this scenario, food waste and losses are limited to about half the 2015 level. The land requirement is slightly lower per output unit compared to 2015, but much higher compared to previous levels.

2.9 Belgium

Population Growth and Material Consumption

LTSB2050 plan takes into account a projected 6% increase in population by 2030 compared to the baseline year of 2015. To align with sustainability goals, the plan targets a 30% reduction in the materials consumption footprint in the Flanders region by 2030. This reflects Belgium's commitment to minimising resource consumption and promoting responsible production and consumption patterns.

Energy Demand and Consumption

With an energy demand of approximately 384 TWh in 2030, Belgium aims to optimise energy consumption and transition to cleaner sources. The plan addresses energy consumption across various sectors, including transportation, buildings, and industry, with the overarching goal of reducing the country's carbon footprint.

Transformation of Transportation

The LTSB2050 outlines a transformative approach to transportation. In Flanders, the plan envisions a maximum reduction of 51.6 billion vehicle-kilometres by 2030, aiming for a 15% decrease in passenger car and van travel and a maximum 14% increase for lorries. Brussels targets a 21% reduction in vehicle kilometres. The plan promotes 'soft' modes of transport, with a goal of 20% of commuting journeys using electric bikes, walking, cycling, and limited-speed motor vehicles by 2030. Low-carbon and zero-emission vehicles are also a focus, with targets set for their adoption in various vehicle categories.

Building Renovation and Efficiency

Belgium's energy plan emphasises the importance of improving the energy efficiency of buildings. Regions are focusing on large-scale building renovations to enhance energy performance. The target is to achieve an energy level equivalent to an energy score of 100 kWh/m². Renewable energy sources are set to contribute to 11% of heating and cooling energy needs.

Industrial Emission Reduction and Energy Demand

The energy plan recognizes the importance of reducing industrial emissions and energy demand. It aims to achieve carbon neutrality in industry by 2050, compensating for remaining emissions through natural and technical sinks. With an estimated energy demand of around 153.1 TWh in 2030, the industrial sector is poised for improvements in efficiency and sustainability.

Renewable Energy Generation

Belgium's energy generation strategy revolves around increasing the contribution of renewable sources. The plan envisions solar energy generating 10 TWh, wind energy contributing 24 TWh, and biomass, hydro, and other sources making up the rest. Notably, the plan entails the discontinuation of nuclear and coal-based electricity generation.

Sustainable Agriculture and Livestock Practices

The LTSB2050 acknowledges the role of agriculture in emissions and the need for sustainable practices. It outlines reductions in livestock production

emissions, with a decrease in certain categories and an increase in others. Sustainable intensification and smart farming practices are highlighted to promote efficiency improvements and reduce the environmental footprint of food production.

Maximising Carbon Storage through Forestry

The plan recognizes the critical role of forests in carbon sequestration. The plan aims to maximise carbon storage in forests and natural areas by 2050. As part of this effort, an additional 10,000 hectares of forest will be planted by 2030 in the Flanders region.

Table 10 - Key sectoral indicators on activities, energy emissions in LTSB2050 and EUCalc

Scope	LTSB2050	Key levers/ambition	EUCalc pathway
General			
Population	Population increases by 6% in 2030 compared with 2015	Population - 1	Population rises by about 5.1% in 2030 compared to 2015
Consumption	"30% reduction in the footprint of materials consumption in Flanders by 2030"		
Diet	na (see Livestock production)	Diet - 3	In 2050 the healthy dietary requirements set by WHO are fulfilled. This means that meat in diets does not exceed 90g/day (of which only up to 71g/day is red meat); where sugars and sweeteners are kept below 10% of calorie consumption and where fruits and vegetables consumption is at least 400g/day.
Energy demand	~ 384 TWh in 2030	Not set exogenously but depending on the demand and technology settings	
Transport			
Passenger transport	Flanders: "A maximum reduction of 51.6 billion vehicle-kilometres will be achieved by 2030. This equates to a 15 % decrease from 2015 levels for passenger cars and vans, and a maximum increase of 14 % for lorries" Brussels: "21 % reduction in vehicle kilometres in the Brussels region by 2030"	Passenger distance - 3	No regional distribution in EUCalculator only national
Mode	"20% of commuting	Mode of transport - 3	No regional distribution in

	journeys to be made using 'soft' modes of transport (electric bikes, walking and cycling, with other motor vehicles limited to 25 km/h) by 2030"		EUCalculator only national
BEV fleet share (passenger)	For Flanders: By 2030, 25 % of all new buses (including tour buses, school buses and coaches) will be low carbon. From 2030, all new passenger cars sold will produce low levels of carbon emissions8, and at least half will be zero-emission vehicles.	Passenger technology - 3.8	No regional distribution in EUCalculator only national
BEV fleet share (freight)	For Flanders: 30% of new light commercial vehicles and vans will be low-emission vehicles by 2030.	Freight technology - 2.8	No regional distribution in EUCalculator only national
Energy demand	~ 127 TWh in 2030	Not set exogenously but depending on the demand and technology settings	No regional distribution in EUCalculator only national
Renewables in the transport sector	24% by 2030	Not set exogenously but depending on the demand and technology settings	No regional distribution in EUCalculator only national
Buildings			
Rate of retrofitting	"Regions are concentrating on the large-scale renovation of their buildings" In Walloon: "renovation rate will have to increase significantly to achieve the 2050 target"	Building envelope - 2.5 (aligned with other countries)	No regional distribution in EUCalculator only national
Energy efficiency gains	In all regions, the improvement of the energy efficiency of buildings by 2050 is key "Regarding the energy performance indicator, the target will be to achieve an energy level equivalent to an energy score (building energy performance index) of 100 kWh/m²"	Heating/cooling efficiency - 3.7 Appliance efficiency - 3.7	No regional distribution in EUCalculator only national
Fuel mix	11% renewables in heating and cooling	Technology and fuel share - 3	No regional distribution in EUCalculator only national

	In Flanders: "phasing out oil-fired boilers in new buildings and major energy renovations"		
Energy demand	~ 128 Twh in 2030	Not set exogenously but depending on the demand and technology settings	No regional distribution in EUCalculator only national
Industry			
CCS	Remaining emissions in 2050 to be compensated by natural sinks, and technical sinks (CCU/CCS)	Carbon capture in manufacturing - 2 Carbon capture to fuel - 2	No quantification possible
Energy demand	~ 153.1 Twh in 2030	Not se exogenously	~ 111 THw in 2030
Electricity generation	2030		
Solar	10 TWh	Solar - 3.3 Wind - Nuclear phase out - 4 Hydro - 1.9 Biomass capacity - Coal phase out - 4	9.1 TWh
Wind	24 TWh		16 TWh
Nuclear	0 TWh		16 TWh
Hydro	0.5 TWh		1 TWh
Geo	-		-
Biomass	3 TWh		3.5 TWh
Coal	0 TWh		0 TWh
Others	1.5 TWh (oil)		0 TWh
Gas	53 TWh		15 TWh
Agriculture/FOrest			
Agricultural practices	"Sustainable intensification should promote further efficiency improvements. " "Reliance on smart farming (agriculture intelligent) or precision agriculture where inputs are optimised to the maximum" "Direct technological intervention, with better management of the agri-food chain to reduce the environmental footprint of food production (e.g. limiting food losses from the producer to the consumer, greater consumption of plant-based and alternative protein	Climate smart crop production - 3	In 2050 sustainable intensification crop production system is fully deployed. Crop yields are increasing slightly compared to 2015, but much less compared with the previous levels. In this scenario, food waste and losses are limited to about half the 2015 level. The land requirement is slightly lower per output unit compared to 2015, but much higher compared to previous levels. Thus, spare lands are limited but the production system enables the soil carbon capture to be higher, and the emissions to be lower thanks to the decrease of inputs such as synthetic fertilisers and pesticides.

	sources, development of the associated flows, improving the sustainability of the fisheries sector)."		
Forestry	"By 2050, carbon storage in forest and natural areas these areas will be maximised" Planting of additional 10,000 ha by 2030 (in Flanders)	Forestry practices - 4	Climate smart forestry practices are deployed in all European forests by 2050, leading to maximise biomass production and carbon pool potential.

2.10 Denmark

Population Growth and Waste Management

Denmark's decarbonization plan acknowledges the challenge posed by a 10% increase in population between 2015 and 2040. This growth necessitates sustainable practices to ensure that increased consumption and waste do not exacerbate environmental issues. Despite a 30% rise in municipal waste by 2040, the plan aims to manage waste in an eco-friendly manner.

Energy Efficiency and Transportation

DLTS2050 has a commitment to energy efficiency of at least a 32.5% improvement by 2030. The plan addresses transportation patterns, projecting a 20% increase in passenger kilometres travelled by car and an 11% rise in rail travel between 2015 and 2040. The plan boldly aims to halt the sale of new diesel and petrol cars by 2030, ushering in a new era of electric mobility.

Energy Demand and Renewables in Transport

Denmark's plan acknowledges the challenges of energy demand in the transport sector. A projected 2.7% increase in passenger transport energy demand and a 4.3% rise in freight transport energy demand between 2015 and 2040 require strategic solutions. The goal is to achieve significant renewable energy integration, with approximately 8.5% of the transport sector's energy demand met by electricity and nearly 18.5% supplied by renewable sources by 2030.

Building Efficiency and District Heating

The DLTS2050 focus on building efficiency aims to significantly improve the energy performance of its building stock. The plan outlines rigorous requirements for building renovations in building codes, leading to significantly

improved energy efficiency. By 2030, the goal is for district heating to rely on non-coal, non-oil, and non-gas energy sources for 90% of its supply.

Transformation of Electricity Generation

Denmark's plan envisions a profound transformation of its electricity generation mix. The goal is to achieve a fully renewable energy system by 2050, with solar energy contributing 9.9 TWh, wind energy providing 39 TWh, biomass supplying 6.7 TWh, and coal and gas-based generation being nearly phased out. Offshore wind power will play a crucial role in achieving these targets.

Carbon Capture and Emission Reduction

Denmark's DLT 2050 recognizes the importance of carbon capture as a means of offsetting emissions. Remaining emissions in 2050 will be compensated through natural sinks and technical solutions such as carbon capture and utilisation (CCU) and carbon capture and storage (CCS).

Table 11 - Key sectoral indicators on activities, energy emissions in DLTS2050 and EUCalc

Scope	DLTS2050	Key levers/ambition	EUCalc pathway
General			
Population	Population increases by 10% between 2015 and 2040	Population - 1	Population increases by about 5% in 2030 compared to 2015
Waste	Municipal waste rises by 30% between 2015 and 2040	Food waste - 2 Use of plastic and packaging - 1	Rises 23% in 2040
Energy efficiency	Target of at least 32.5% improvements in 2030	See transport, building and introductory settings	-
Transport			
Passenger transport	Passenger kilometres travelled by car increases 20% between 2015 and 2040 Travelling with rail increases by 11% in the same time frame Aviation not included	Passenger distance - 1 Mode of transport - 2.5	Rail increases 8% Pkm rise 24%
Fuel	"stop sales of all new diesel and petrol cars as of 2030"	Passenger technology - 4	-
Passenger transport efficiency	Aligned with the other target of 32% improvement	Passenger efficiency - 3.8	-
Freight transport efficiency	Aligned with the other target of 32% improvement	Freight efficiency - 3.8	-

Energy demand	2.7% rise between 2015 and 2040 for passenger transport 4.3% rise between 2015 and 2040 for freight transport	Not set exogenously but depending on the demand and technology settings	3% rise until 2040
% of electricity in overall demand	Electricity in transport sector reaches ~8.5% of demand in 2030	Not set exogenously but depending on the demand and technology settings	~ 6% demand in 2030
Renewables in the transport sector	Renewable energy in transport sector reaches ~18.5% in 2030	Not set exogenously but depending on the demand and technology settings	~ 12% in 2030
Buildings			
Rate of retrofitting	na	Building envelope - 2.5 (aligned with other country reports)	-
Energy efficiency gains	significantly increased energy efficiency through the requirements to the renovation of buildings in the building codes	Heating/cooling efficiency - 3.8 Appliance efficiency - 3.8	-
Fuel mix	By 2030, 90% of district heating based on energy sources other than coal, oil or gas	Technology and fuel share - 4	88% in 2030
Electricity generation			
Solar	9.9 TWh	Solar - 3 Wind -2 Biomass capacity - 2 Coal phase out - 4	8.8 Twh
Wind	39 TWh		38 TWh
Nuclear	-		
Hydro	-		
Geo	-		
Biomass	6.7 TWh		10 Twh
Coal	0.6 TWh		0 Twh
Others	0.1 TWh (oil)		0.7 TWh
Gas	0.4 TWh		2 TWh
Land/negative emission			
CCS	Remaining emissions in 2050 to be compensated by natural sinks, and technical sinks (CCU/CCS)	CCS in manufacturing - 2 Carbon capture to fuel - 2	No direct comparison possible

2.11 Sweden

Sustainable Growth and Energy Efficiency

Sweden's SLTS2050 anticipates a 20% population growth by 2040 compared to 2014. Despite this increase, the plan sets an impressive target of achieving 50% more efficient energy use by 2030. By ensuring efficient energy utilisation, Sweden aims to accommodate growth without exacerbating energy consumption and carbon emissions.

Bio-Energy and Constant Consumption

Bio-energy plays a crucial role in Sweden's energy landscape. While bioenergy consumption remains relatively constant after 2020 until 2040, it continues to be a reliable and sustainable energy source. This underscores Sweden's commitment to utilising bio-energy as a steady and low-carbon energy solution.

Energy Demand and Transport Transformation

The SLTS2050 outlines primary consumption of 482 TWh and final consumption of 364 TWh by 2030. In the transport sector, a target of an 11 TWh increase in biofuels by 2030 emphasises the importance of transitioning to cleaner fuels. With about 80 TWh of energy demand from domestic transport in 2040, Sweden is dedicated to reducing emissions while ensuring efficient and sustainable mobility.

Building Efficiency and District Heating Expansion

The approach to energy-efficient buildings is exemplified by a goal to achieve 140 TWh energy demand in buildings by 2040. District heating, a hallmark of Sweden's sustainability initiatives, is set for a 10% expansion by 2030. This expansion aligns with Sweden's commitment to providing efficient and eco-friendly heating solutions.

Sustainable Industry Practices and Electricity Generation

Recognizing the role of industry in energy consumption, Sweden envisions an energy demand of approximately 150 TWh by 2040. The country aims to balance industrial growth with sustainability goals. Sweden's electricity generation plan envisions a fully renewable energy system by 2040, with solar, wind, nuclear, hydro, and biomass collectively contributing to 100% of the energy mix.

Pioneering Renewable Electricity Generation

SLTS2050 commitment to renewable electricity generation is evident in its plan. The plan outlines the production of approximately 5 TWh from solar

energy and around 50 TWh from wind power by 2040. Hydropower, a longstanding contributor, is projected to provide around 73 TWh. The commitment to renewables is further emphasised by the plan's aim to achieve 100% penetration of renewables in the electricity generation mix.

Table 12 - Key sectoral indicators on activities, energy and emissions in SLTS2050 and EUCalc

Scope	SLTS2050	Key levers/ambition	EUCalc pathway
General			
Population	Population grows by 20% in 2040 compared with 2014	Population - 4	Population grows 8% compared to 2015
Bio-energy	After 2020, bioenergy consumption remains more or less constant until 2040	Bioenergy capacity - 2	No significant change to 2015
Transport			
Passenger transport	-	Passenger distance - 2.4	-
Rail	-	Modal share - 2.5	-
BEV fleet share (passenger)	-	Passenger technology - 3	-
BEV fleet share (freight)	-	TFreight technology - 3	-
Passenger transport efficiency	-	Passenger efficiency - 3	-
Energy demand	About 80TWh total in 2040 (only domestic transport)	Not set exogenously but depending on the demand and technology settings	~ 75 Twh in 2040
% of electricity in overall demand	Less than 10% in 2040	Not set exogenously but depending on the demand and technology settings	About 13%
Renewables in the transport sector	About 50% of total demand in 2040	Not set exogenously but depending on the demand and technology setting	~ 43%
Buildings			
Rate of retrofitting	-	Building envelope - 3	-
New constructions	-		-
Renewable share in buildings	-	Fuel mix - 3	-
District heating	10% expansion by 2030	District heating - 2	8% increase
Energy demand	140 TWh by 2040	Not set exogenously but depending on the demand and technology settings	~ 122 TWh
Electricity generation	In 2040		
Solar	~ 5 TWh	Solar - 2.3	~ 7TWh
Wind	~ 50Twh		~ 55 TWh
Nuclear	production from nuclear power until 2045	Wind -3.1 Nucelar - 4	-
Hydro	~ 73 TWh		

Geo	-	Biomass capacity - 2	
Biomass	~ 18 TWh		~ 15 TWh
Coal	-		
Others	-		
Gas	-		
Land/negative emission			
Forest area	-	-	-
CCS	Remaining emissions in 2045 to be compensated by natural and technical sinks	ccus - 2.1	-

2.12 Finland

Growing Population and Sustainable Mobility

Finland's decarbonization plan forecasts a 6.5% increase in population by 2040 compared to 2016. Recognizing the importance of sustainable transportation, the plan focuses on passenger kilometers, aiming to increase them by approximately 4.3% in 2045 compared to 2020. Freight transport also witnesses an 8% increase in 2045 compared to 2020, as Finland ensures that economic growth aligns with sustainable mobility.

Electric Mobility and Efficiency Gains

CNF2035 commitment to electric mobility is reflected in its goal to have 80% of cars be electric by 2045. This emphasis on Battery Electric Vehicle (BEV) adoption is a significant step towards reducing transportation-related carbon emissions. The plan also targets a 12% improvement in road transport performance by 2030 through enhanced passenger transport efficiency. Additionally, a 5% annual car replacement rate ensures that cleaner vehicles replace older, less efficient ones.

Energy Demand, Buildings, and Renewable Heating

CNF2035 projects an energy demand of approximately 35 TWh in the transport sector by 2040. In the buildings sector, a projected energy demand of around 85 TWh by 2040 underscores the importance of energy-efficient construction and heating solutions. The plan sets a goal for renewables to constitute 50% of district heating by 2030, emphasising the role of clean energy in Finland's heating landscape.

Sustainable Industry and Electricity Generation

With an estimated energy demand of about 145 TWh by 2040, the industry sector is a focal point of Finland's decarbonization plan. Efforts to balance industrial growth with sustainability are evident in the plan's goals. Electricity generation takes centre stage, with solar energy contributing 26 TWh, wind power providing 33 TWh, nuclear energy generating 30 TWh, hydro contributing 15 TWh, and biomass supplying 18 TWh. These ambitions are supported by the phasing out of coal energy by 2029 and halving the use of peat by 2030. The plan contemplates the scaling of CCS technologies in order to abate 4 Mt CO2e via BECCS.

Renewable Energy Generation

Finland's decarbonization plan reflects its commitment to renewable energy. The goal of achieving an 80% penetration of renewables in electricity generation by 2050 is a testament to Finland's dedication to creating a cleaner energy landscape. Solar, wind, nuclear, hydro, and biomass collectively contribute to this sustainable vision.

Table 13 - Key sectoral indicators on activities, energy and emissions in CNF2035 and EUCalc

Scope	CNF2050	Key levers/ambition	EUCalc pathway
General			
Population	Population increases by 6.5% in 2040 compared to 2016	Population - 1.3	Population increases 5%
Transport			
Passenger transport	Passenger kms increase by ~ 4.3% in 2045 compared to 2020	Passenger distance - 1.3	Increase of 3.8%
Freight transport	Freight transport increases ~ 8% in 2045 compared to 2020	Freight distance - 1.5	Increase of 5%
BEV fleet share (passenger)	by 2045 80% of cars are electric	Passenger technology - 3.7	75% of BEVs in 2040
Passenger transport efficiency	12 % in road transport performance by 2030 5% car replacement /year	Passenger efficiency - 2	10% increase in efficicency
Energy demand	~ 35TWh in 2040	Not set exogenously but depending on the demand and technology settings	~ 29 TWh in 2040
Buildings			
Rate of retrofitting	-	Building envelope - 3	-
Renewable share in buildings	-	Fuel mix - 3	-
Energy demand	~ 85 TWh in 2040	Not set exogenously but depending on the demand	~ 75 TWh in 2040

		and technology settings	
Fuel mix	Renewables reach 50% of district heating by 2030	Not set exogenously but depending on the demand and technology settings	~ 38% in 2030
Electricity generation	2050 (taken from the Finish version of LTS)		
Solar	26 Twh	Solar - 2 Wind -3.2 Nucelar - 4 Biomass capacity - 3	~20 Twh
Wind	33 Twh		~38 Twh
Nuclear	30 TWh		~30 TWh
Hydro	15 TWh		~12 TWh
Geo	-		-
Biomass	18 TWh		~11 TWh
Coal	Phase-out of coal energy by 2029 at the latest and halving at least the use of peat by 2030		
Others			
Land/negative emission			
CCS	~ 5 Mt via BECCS	Carbon capture - 3	~ 6 Mt

2.13 Czechia

Sustainable Energy Demand for Transportation

CPPC2050's vision for transportation is guided by a sustainable energy demand goal. The plan envisions 1.2 TWh of energy demand for passenger cars and 0.6 TWh for trucks by 2030. To align with renewable energy targets, the plan aims for 14% renewables in the transport sector by the same year, signalling a pivotal shift towards cleaner and greener mobility solutions.

Transitioning Towards Cleaner Buildings

CPPC2050 prioritises energy efficiency in buildings, targeting a reduction in electricity demand. By 2030, the plan seeks to allocate 5.7% of the electricity demand for buildings, emphasising the importance of efficient energy consumption practices. The plan further advocates for a fuel mix transformation, aiming for 30% renewables in heating and cooling systems by 2030 to reduce carbon emissions associated with building energy consumption.

Progressive Electricity Generation Mix

CPPC2050 underscores the significance of a progressive electricity generation mix. The plan outlines specific goals for various energy sources. Nuclear energy is projected to constitute at least 46% of the generation mix,

contributing to a low-carbon energy landscape. Additionally, coal and gas are allocated at least 11% and 5% of the generation mix, respectively. While acknowledging the role of conventional sources, the plan centres its efforts on the penetration of renewables, particularly solar and wind energy.

Scaling Up Renewable Energy

CPPC2050 recognizes the transformative potential of renewable energy sources. The plan places particular emphasis on the centrality of solar and wind energy in the renewable energy mix. By 2030, CPPC2050 aims for renewables to account for 14% of the energy mix, a milestone reflecting a growing commitment to cleaner energy sources. Looking ahead to 2040, the plan envisions renewables contributing to 25% of the energy mix, emphasising a progressive transition away from carbon-intensive sources.

Table 14 - Key sectoral indicators on activities, energy and emissions in CPPC2050 and EUCalc

Scope	CPPC2050	Key levers/ambition	EUCalc pathway
Transport			
Energy demand	1.2 TWh for passenger cars by 2030 0.6 TWh for trucks by 2030	Not set exogenously but depending on the demand and technology settings	-
% of electricity in overall demand		Not set exogenously but depending on the demand and technology settings	-
Renewables in the transport sector	14 % renewables by 2030	-	
Buildings			
Rate of retrofitting	-	Building envelope - 3.2	-
Fuel	-	Fuel mix - 3	-
Share of electricity	5.7 % of demand by 2030	Not set exogenously but depending on the demand and technology settings	~ 4.8%
Fuel mix	30 % renewables in heating and cooling by 2030	Not set exogenously but depending on the demand and technology settings	-
Electricity generation	2040		
Solar	-	Solar - 3	-
Wind	-		-
Nuclear	at least 46% of generation	Wind - 3	~ 55% generation
Hydro	-	Nuclear - 1	-

Geo	-		-
Biomass	-		-
Coal	At least 11% of generation		About 8%
Others	-		-
Gas	at least 5% of generation		About 10%
Agriculture/F0rest			
Agroforestry practices	-	Smart crop production - 2	-
Waste	-	Waste - 2	-

2.14 Bulgaria

Bulgaria's Long-Term Strategy, builds upon economy-wide and sectoral emissions trajectories, modelled in 2020 using the same tool as its National Energy and Climate Plan. It does not set emission reduction targets, but rather presents the projections of emissions levels in 2050, and does not set a target for reaching net zero emissions. Accordingly, in order to allow Bulgari to achieve Net-Zero, the pathway adopted is that of the Tech scenario as documented in Costa et al 2021. In the Tech scenario, levers related to individual behaviours are kept at LTS Baseline while those related to Technology and fuels are set to higher ambition levels as found to be technically feasible. For example, the renovation rate of buildings increases to 3% yr−1, and Zero Emission Vehicle reach 100% of car passenger sales in 2050. The exceptions are levers setting renewable energy capacities in Europe that do not increase substantially beyond the LTS Baseline, otherwise it would lead to an oversupply of electricity due to large gains in efficiency assumed in transport, buildings and manufacturing sectors. Crop and livestock production systems explore all the potential for further intensification.

2.15 Romania

The submission of Romana's LTS arrived late in the process of writing this deliverable and hence the same approach if followed as explained in the previous section fot he case of Bulgaria.

2.16 Malta

Sustainable Growth and Urban Development

MLCD2050 acknowledges a projected population growth of approximately 15.5% by 2050 compared to 2020. With urbanisation on the rise, the plan addresses the expansion of floor space, accounting for a ~17% increase between 2020 and 2050, including both residential and office spaces.

Balancing growth with sustainability remains a cornerstone of the MLCD2050 initiative.

Energy Efficiency and Final Energy Consumption

MLCD2050's commitment to energy efficiency is evident through its ambitious target of achieving a 32.5% improvement by 2030, measured in reference to 2007. This goal reflects a dedication to optimising energy consumption and reducing carbon emissions. The plan envisions a final energy consumption of 0.012 TWh by 2030, further emphasising the pursuit of a more efficient energy landscape.

Transformation of Transportation

Private vehicle usage is a focal point of MLCD2050, with a projected 20% increase in the private vehicle fleet between 2017 and 2040. This increase is balanced by efforts to enhance energy efficiency and reduce emissions. The plan targets an energy demand of 160 GWh from biofuels and 50 GWh from electricity in the transport sector by 2030. Renewables are projected to constitute 14% of the sector's energy consumption by the same year.

Renewable Electricity Generation

MLCD2050 underscores the importance of renewable electricity generation. The plan envisions 1000 GWh of electricity from renewables by 2050, with solar energy contributing around 400 GWh by 2030. To achieve the target of 11.5% renewable penetration by 2030, the plan emphasizes the significance of Photovoltaic (PV) solar systems.

Energy dependency

Although the plan embraces innovative technologies and strategies, including offshore floating wind energy, it relies extensively on the establishment of a third interconnector to Italy, and the import of hydrogen technology. MLCD2050 recognizes the importance of collaboration and electricity imports. The plan envisions an import of 4000 GWh of electricity by 2050. This emphasis on imports reflects a dedication to cross-border cooperation and shared efforts in achieving regional and global decarbonization goals.

Table 17 - Key sectoral indicators on activities, energy and emissions in MLCD2050 and EUCalc

Scope	MLCD2050	Key levers/ambition	EUCalc pathway
General			
Population	Population grows by ~ 15.5% on 2050 compared to 2020	Population - 4	8% increase

Floor space	Floor space increases by ~ 17% between 2020 and 2050 (including office space and residential)	Living space per person - 1	Increase by 10%
Transport			
Passenger transport	Private vehicle fleet to increase about 20% between 2017 and 2040	Passenger distance - 1.2	Increases of 15% betwee 2015 and 2040
Renewables in the transport sector	14% RES share in the transport sector in 2030	Passenger technology - 3	~ 10% in 2030
Electricity generation	1000 GWh electricity from renewables by 2050.		
Solar	~ 400 GWh (in 2030)	Wind - 2.5 Solar - 3	~ 340 GWh in 2030
Wind	-		-
Nuclear	-		-
Hydro	-		-
Geo	-		-
Biomass	-		-
Coal	-		-
Others	-		-
Gas	-		-
Penetration of renewables	PV solar systems needed to reach the 11.5% renewable target by 2030 Reducing emissions by 2050 entails offshore floating wind, a third interconnector to Italy and hydrogen technology	-	-

2.17 Cyprus

Enhanced Recycling and Circular Economy

CLED2050 underscores the importance of recycling in promoting a circular economy. With a 15% increase in paper and package recycling targeted by 2030, the plan emphasizes the need to reduce waste and minimise environmental impact, aligning with global sustainability goals.

Energy Efficiency and Reduced Final Energy Demand

Energy efficiency is at the forefront of CLED2050's agenda. With a goal of achieving a final energy demand of 23 TWh by 2050, the plan sets the stage for optimising energy consumption and reducing carbon emissions across sectors.

Transformation of Transportation

CLED2050 envisions a radical transformation of transportation, focusing on electric mobility. The plan targets a remarkable 777% increase in the electric vehicle (EV) fleet by 2040, underlining the importance of clean transportation options. The energy demand in transport is projected to be 2.1 TWh from electricity in 2050, reflecting a shift towards cleaner and more efficient energy sources. Notably, a ~28% reduction in energy from road transport by 2040 compared to 2020 highlights the plan's commitment to reducing emissions.

Retrofitting and Energy-Efficient Buildings

The plan underscores the role of energy-efficient buildings through a strategic approach to retrofitting. Public sector buildings are required to renovate 3% of their structures, aligning with energy efficiency goals. The fuel mix in buildings reflects a commitment to cleaner energy sources, aiming for approximately 20% electricity in heating and cooling by 2040.

Renewable Electricity Generation

CLED2050 places renewable electricity generation at the core of its strategy. The plan outlines a diverse mix of renewable sources. Solar energy is projected to contribute 1892 MW, wind power 198 MW, hydroelectricity 130 MW, biomass 58 MW, and gas 648 MW by 2040. This ambitious approach to electricity generation reflects the plan's commitment to a sustainable and resilient energy landscape.

Carbon Capture Strategies

CLED2050 recognizes the importance of carbon capture as a means of offsetting emissions. The plan underscores the role of Carbon Capture and Storage (CCS) activities in various sectors, including electricity, cement, and ceramics. From 2040 onwards, CCS activities will be integrated into all Emission Trading Scheme (ETS) installations, showcasing an innovative strategy to achieve carbon neutrality.

Table 18 - Key sectoral indicators on activities, energy and emissions in CLED2050 and EUCalc

Scope	CLED2050	Key levers/ambition	EUCalc pathway
Paper	Paper and package recycling increases 15% by 2030	Packaging - 3	20% decrease in packaging
Transport			
BEV fleet share (passenger)	EV fleet increases by 777% by 2040	Passenger technology - 4	Increases of 400%
Efficiency	-	Passenger eficiecncy - 3	-
Energy demand	~ 28% drop of energy from road transport in	Not set exogenously but depending on the demand	~ 31% drop in road

	2040 compared to 2020	and technology settings	transportation energy demand in 2040 compared to 2015
Buildings			
Rate of retrofitting	public sector will be required to renovate 3% of its buildings	Bulding envelope - 4	Renovation rate of 3%
Fuel mix	~ 20% electricity in heat and cooling by 2040	Fuel mix - 2.6	~ 28% electricity
Electricity generation	2040		
Solar	1892 MW	Solar - 4 Wind - 3 Hydro - 1 Coal phase out - 4 Biomass - 1	1444 MW
Wind	198 MW		171 MW
Nuclear	-		-
Hydro	130 MW		130 MW
Geo	-		-
Biomass	58 MW		58 MW
Coal	-		-
Others	-		-
Gas	648 MW		548 MW
Land/negative emission			
CCS	CCS activities to all ETS installations from 2040 – electricity, cement, ceramics	-	-

2.18 Austria

Sustainable Buildings for Sustainable Living

LTSA2050 places a strong emphasis on resource-efficient building practices. Buildings are designed to optimise space use, prevent land overuse, and promote flexibility in long-term usage. By 2050, only nearly zero-energy or positive energy buildings will be constructed, ensuring that structures have a minimal carbon footprint. Nearly all suitable roof and facade surfaces will be utilised for renewable energy generation, further reducing CO2 emissions associated with building operations.

Dietary

LTSA2050 recognizes the significant role dietary habits play in resource consumption. While not specifying the exact dietary changes, the plan acknowledges the impact these shifts can have on livestock farming. This

emphasizes the interconnectedness of our choices with sustainability, including the food we consume.

Energy Efficiency Advancements

To reduce energy consumption and greenhouse gas emissions, LTSA2050 targets a remarkable 52% improvement in energy efficiency compared to 2005 levels. This ambitious goal reflects the commitment to optimise resource use, reduce waste, and enhance overall sustainability.

Transformation of Transportation

LTSA2050 envisions a sustainable and efficient transportation system. Public transport forms the backbone of urban and regional travel, offering an eco-friendly alternative to private cars. Active transport is promoted through the doubling of cycling paths by 2025, encouraging healthier and more sustainable commuting options. Rail transport plays a vital role, with a focus on shifting freight traffic to rail and expanding combined transport, further reducing the environmental impact of transportation.

Building Retrofitting and Industry Innovations

Retrofitting existing buildings is pivotal to LTSA2050's success. The plan outlines an increase in the renovation rate from 1% to an average of 2% between 2020-2030. In industry, product value and lifespan are increased, and materials are chosen based on recyclability, reducing waste and promoting resource efficiency.

Renewable Energy

LTSA2050 is committed to achieving 100% renewable energy by 2030. This involves a substantial expansion of solar, wind, and hydro power capacity. The plan also promotes the use of heat pumps to significantly reduce CO2 emissions in buildings. This renewable energy revolution ensures a sustainable and clean energy future. Due to the lack of precise information on electricity production in Austria’s LTS documentation values for 2040 were taken from WWF’s ENERGIE- UND KLIMAZUKUNFT ÖSTERREICH: SZENARIO FÜR 2030 UND 2050.

Sustainable Agricultural Practices and Waste Reduction

The plan focuses on sustainable agricultural practices, including reducing fertiliser use, promoting dual-purpose cattle farming, expanding organic farming, and preventing nitrogen losses. This not only reduces the environmental impact of agriculture but also ensures food production is

resource-efficient. Waste reduction is another key element of LTSA2050, affecting various sectors, including the food industry.

Carbon Capture and Compensatory Sinks

Remaining emissions in 2050 can be offset through natural sinks, the import of renewable energy (including hydrogen), and technical sinks like carbon capture and utilisation (CCU) and carbon capture and storage (CCS). This approach ensures that emissions are balanced through various means, contributing to overall carbon neutrality.

Table 19 - Key sectoral indicators on activities, energy and emissions in LTSA2050 and EUCalc

Scope	LTSA2050	Key levers/ambition	EUCalc pathway
General			
Floor area	Use of buildings which limits and prevents extensive Land use as well as oversizing	Floor scape - 2.6	-
Diet	Some changes in dietary habits that have an impact on livestock farming	Diet - 2.5	-
Transport			
Passenger transport	Public transport forms the strong backbone of the transportation system in urban areas and on regional and long haul routes outside of cities.	Mode of transport - 3.2	No direct comparison possible
Active transport	Doubling cycling path by 2025		
Rail	Shift in freight traffic to rail and expansion of combined transport.		
Passenger transport efficiency	Reduce the average emissions of their new passenger cars and light commercial vehicles by 15% from 2025 and by 37.5% from 2030 (31% for light commercial vehicles) compared with 2021 levels.	Passenger and freight efficiency - 3.5	-
Freight transport efficiency			
Buildings			
Construction/use	Use of building over the long term must provide sufficient flexibility in their use for rapid and low - resources.	-	-
Rate of retrofitting	Renovation rate to be increased from the current level of around 1% to an	Building envelope - 3	Renovation rates between 1 and 2.5%

	average of 2% over the period 2020-30		
New constructions	By 2050, only nearly zero-energy buildings (NZEB) or positive energy buildings will be built		
Fuel mix	Due to the use of heat pumps electrical energy accounts for a large share of the total energy demand for space heating, hot water supply and cooling of buildings Nearly all suitable roof surfaces are used for photovoltaics, and the share of facade surfaces used to colle ct energy (such as solar thermal and photovoltaic elements).	Fuel mix - 3,5	No direct comparison possible
Industry			
Materials and design	Materials will be chosen based on recyclability. There are only few composite materials that cannot be separated	Material efficiency - 3.4	-
CCUS	Promotion of carbon capture and utilisation (CCU) in industry as bridging technology	ccs/ccu - 2.5	No direct comparison possible
Hydrogen	Push Austria's initiatives at European and international level for a competitive hydrogen application, especially for initiatives after 2030	Fuel mix - 3.2	No direct comparison possible
Electricity generation	In 2030		
Solar	16.1 GW	Solar - 3 Wind - 3 Hydro - 1 Coal phase out - 2	12.1 GW
Wind	15.2 GW		20.1 GW
Nuclear	excluded		excluded
Hydro	42 GW		42 GW
Geo	-		-
Biomass/bioenergy	-		-
Coal	~ 1GW		0.5 GW
Others	-		-
Gas			
Agriculture/FOrest			

Agricultural practices	Fertiliser use and production will be reduced by avoiding food waste. Very ambitious measures will be taken to prevent nitrogen losses. Dual-purpose cattle (milk and meat) and increased pasture grazing will be promoted. Organic farming will be expanded further.	Climate smart crop production - 4 Climate smart livestock - 4	Production system follows the agroecology standards. Food waste and losses are limited to a third of the previous level or about 6 times lower compared with 2015. The extensive approach leads to yield decline by 20-40% compared with 2015, but the agricultural land potential for carbon storage is fully exploited. Grasslands are used extensively, with a maximum livestock population of 1 Livestock Unit per hectare (LSU/ha). Livestock yields are constant compared with the level of 2015, and an increase of the livestock slaughter age is set to meet organic farming standards.
Forestry practices			
Waste	The lower volume of waste will also have effects on the food industry	Waste - 3	-

2.19 Estonia

Electrifying Transportation

RCNE2050 places a strong emphasis on sustainable transportation. The plan envisions a significant shift towards Electric Vehicles (EVs), with a fleet of 504,000 electric passenger cars, constituting approximately 46% of the 2021 fleet. Additionally, 101,000 hydrogen-powered cars are expected to join the roads. The transition to EVs results in an energy demand of 866 GWh for the electric fleet. Renewables are set to play a pivotal role in the transport sector, targeting an impressive 52% renewable share by 2050.

Buildings

RCNE2050 advocates for a substantial rate of retrofitting, including both the renovation of existing buildings and the construction of new energy-efficient

structures. This approach not only reduces primary energy consumption but also fosters a transition towards sustainable and eco-friendly housing.

Renewable Energy

RCNE2050 commits to achieving 100% renewable energy by 2050, paving the way for a sustainable and clean energy future. Solar power capacity is expected to reach 677 MW, while wind power capacity will soar to 1,700 MW. The ambitious goal of 75% penetration of renewables by 2050 underscores the commitment to combat climate change through the adoption of clean energy sources.

Agroforestry Practices

RCNE2050 recognizes the vital role of agroforestry in carbon sequestration and emission reduction. The plan outlines a range of measures to capture greenhouse gas emissions, including afforestation, the conversion of peat soils to natural grasslands, and soil liming. Responsible forestry practices are central to the plan's mission, aiming to decrease annual felling volumes from around 10 million cubic metres to approximately 8 million cubic metres per year during the 2040-2050 period. While the total forest reserves may decrease, the plan seeks to enhance carbon sequestration to offset any remaining emissions in 2050.

Table 20 - Key sectoral indicators on activities, energy and emissions in RCNE2050 and EUCalc

Scope	RCNE2050	Key levers/ambition	EUCalc pathway
Transport			
BEV fleet share (passenger)	504000 electric vehicles (about 46% of 2021 fleet) 101000 hydrogen cars	Passenger technology - 3	38% of fleet
Renewables in the transport sector	52% by 2050	Not set exogenously but depending on the demand and technology settings	48% penetration
Buildings			
Rate of retrofitting	Renovation of the building stock and construction of new energy-efficient buildings will have a wider impact on reduced primary energy consumption.	Building envelope - 2	-
Electricity generation	100% renewables in 2050		
Solar	677 MW	Solar -3	771 MW
Wind	1700 MW		1809 MW
Nuclear		Wind - 3.1	

Hydro			
Geo			
Biomass			
Coal			
Others			
Gas			
Agriculture/FOrest			
Agroforestry practices	Felling volumes should decrease to about 10 million cubic metres per year During 2040-2050, annual felling rates should be around 8 million cubic metres per year	Agroforestry practices - 1.1	-
Land/negative emission			
CCS/sinks	Remaining emissions in 2050 to be compensated by enhanced carbon sequestration	ccs/beccs - 2	-

2.20 Latvia

Population and Economic Growth

While the population is projected to decrease to 1.5 million by 2050, Latvia's economy continues to grow, with a GDP reaching EUR 42 billion. This economic growth is aligned with sustainable practices, ensuring a thriving future.

Transition to Renewable Energy

A fundamental goal of SLACN2050 is to achieve a 50% share of renewable energy sources (RES) in the final energy consumption by 2030. This transition away from fossil fuels reduces carbon emissions and environmental impact, contributing to a greener and more sustainable Latvia.

Energy Efficiency

The plan targets a 37% improvement in energy efficiency compared to 2005 levels. By enhancing energy efficiency in various sectors, Latvia reduces energy waste and minimises its carbon footprint.

Electrifying Transportation

SLACN2050 emphasizes the electrification of transportation. It aims to increase the share of electric vehicles (BEVs) to 50% of the total registered vehicles by 2030. This transition not only reduces greenhouse gas emissions but also promotes clean and sustainable mobility.

Sustainable Buildings

New constructions in Latvia will adhere to strict energy efficiency requirements. By 2030, the goal is to increase the energy efficiency of buildings by 50%. These measures ensure that buildings are constructed with sustainability in mind, reducing energy consumption and environmental impact.

Sustainable Agriculture and Forestry

SLACN2050 promotes sustainable agricultural practices, such as reducing synthetic fertilizer use by 20% by 2030 and increasing the share of organic farming to 30% of the total agricultural area by the same year. These practices minimise the environmental impact of agriculture and promote healthier ecosystems.

Forest Expansion

One of the ambitious goals of the plan is to increase the area of forests and other wooded land to 56% of the total land area by 2030. This expansion not only sequesters carbon but also contributes to biodiversity and ecosystem health.

Waste Reduction

While specifics on waste reduction are not provided, it can be inferred that SLACN2050 likely includes waste reduction strategies across various sectors, minimising waste generation and promoting recycling and sustainable waste management practices.

Table 21 - Key sectoral indicators on activities, energy & emissions in SLACN2050 and EUCalc

Scope	SLACN2050	Key levers/ambition	EUCalc pathway
General			
Population	The number of inhabitants will decrease to 1.5 million	Poulation - 1	Population decreases 0.8 millions
GDP	GDP of Latvia will continue to increase and will reach EUR 42 billion in 2050	-	-
Transport			
Passenger transport	-	Passenger distance - 1	Reflecting continuous economic gorwth
BEV fleet share (passenger)	Increasing the share of electric vehicles in the total number of registered vehicles to 50% by 2030.	Passenger technology - 3.6	15% BEV fleet
Buildings			
Rate of retrofitting	-	Building envelope - 3	Renovation rate at 2.5%

New constructions	Strict energy efficiency requirements to be applied in the construction of new buildings		
Energy efficiency gains	Increasing the energy efficiency of buildings by 50% by 2030.		
Electricity generation			
Solar	-	Solar - 3 Wind - 3 Hydro - 1 Coal phase out - 2	-
Wind	-		-
Nuclear	-		-
Hydro	-		-
Geo	-		-
Biomass	-		-
Coal	-		-
Others	-		-
Gas	-		-
Agriculture/FOrest			
Agroforestry practices	reducing the use of synthetic fertilisers by 20% by 2030. Increasing the share of organic farming to 30% of the total agricultural area by 2030.	Climate smart crop production - 2.8 Climate smart livestock - 2.5	Production system follows the agroecology standards. Food waste and losses are limited to a third of the previous level or about 6 times lower compared with 2015. The extensive approach leads to yield decline by 20-40% compared with 2015, but the agricultural land potential for carbon storage is fully exploited. Grasslands are used extensively, with a maximum livestock population of 1 Livestock Unit per hectare (LSU/ha). Livestock yields are constant compared with the level of 2015, and an increase of the livestock slaughter age is set to meet organic farming standards.

2.21 Lithuania

Table 22 - Key sectoral indicators on activities, energy & emissions in LNCMA2050 and EUCalc

Scope	LNCMA2050	Key levers/ambition	EUCalc pathway
General			
Population	-	Population 2.3	-
Transport			
BEV fleet share (passenger)	EV fleet increases by 777% by 2040	Passenger technology - 4	Increases of 400%
Efficiency	-	Passenger eficiecncy - 3	-
Energy demand	~ 28% drop of energy from road transport in 2040 compared to 2020	Not set exogenously but depending on the demand and technology settings	~ 31% drop in road transportation energy demand in 2040 compared to 2015
Efficiency	-	Passenger eficiecncy - 3	-
Renewables in the transport sector	90% by 2050	-	
Buildings			
Rate of retrofitting	-	Building envelope - 3.2	-
Fuel	-	Fuel mix - 3	-
Share of electricity	5.7 % of demand by 2030	Not set exogenously but depending on the demand and technology settings	~ 4.8%
Fuel mix	30 % renewables in heating and cooling by 2030	Not set exogenously but depending on the demand and technology settings	-
Electricity generation			
Solar	-	Solar - 3 Wind - 3 Hydro - 1 Coal phase out - 2	-
Wind	-		-
Nuclear	-		-
Hydro	-		-
Geo	-		-
Biomass	-		-
Coal	-		-
Others	-		-
Gas	-		-
Penetration of renewables	100% by 2050	-	-

2.22 Ireland

Electricity

The LSTI2050 plan aims to increase the share of renewable energy in electricity generation to at least 70% by 2030 and to achieve net zero emissions in the electricity sector by 2050. This will require significant investment in renewable energy infrastructure, energy storage, and smart grid technologies.

Economy

The plan aims to support the transition to a low-carbon economy by promoting innovation, research and development, and sustainable business practices. This will involve working with businesses to reduce their carbon footprint, promoting the circular economy, and supporting the development of low-carbon technologies and products.

Built Environment

The plan aims to reduce emissions from buildings by improving energy efficiency, promoting the use of renewable energy, and encouraging the adoption of low-carbon heating systems. This will require retrofitting existing buildings, improving building standards, and promoting sustainable urban planning and design.

Transport

The plan aims to reduce emissions from the transport sector by promoting the use of low-carbon transport modes, such as electric vehicles, public transport, and cycling. This will require significant investment in public transport infrastructure, the development of low-carbon fuels, and the promotion of sustainable transport policies.

Agriculture, Forestry and Land Use

The plan aims to reduce emissions from the agriculture and forestry sectors by promoting sustainable land use practices, such as afforestation, agroforestry, and sustainable farming practices. This will require significant investment in research and development, the promotion of sustainable land use policies, and the development of low-carbon farming practices.

Waste and the Circular Economy

The plan aims to reduce emissions from the waste sector by promoting the circular economy, reducing waste generation, and increasing recycling rates. This will require significant investment in waste management infrastructure, the development of sustainable waste policies, and the promotion of sustainable consumption and production practices.

2.23 Croatia

Energy Efficiency

One of the central pillars of LDSC2050 is a significant improvement in energy efficiency. The plan targets a remarkable 37% increase in energy efficiency compared to 2005 levels. Achieving this goal reduces energy consumption, lowers carbon emissions, and minimises environmental impact.

Electrifying Transportation

LDSC2050 places a strong emphasis on transforming the transportation sector. To accomplish this, the plan aims to increase the share of hybrid and electric vehicles (BEVs) by an impressive 85%. This transition to cleaner and more efficient vehicles reduces greenhouse gas emissions, lessens air pollution, and promotes sustainable transportation options.

Buildings

The plan sets an ambitious target for retrofitting existing buildings, with a rate of 3.0% by 2030 and an increase to 4.0% by 2050. These retrofitting efforts enhance energy efficiency, reduce energy consumption, and lower carbon footprints. As for new Constructions: Beginning in 2021, LDSC2050 mandates that all newly constructed buildings meet the nearly zero-energy (NZEB) standard. This standard ensures that new buildings are designed and constructed with sustainability in mind, incorporating energy-efficient technologies and reducing long-term energy costs.

Nuclear Phase-Out

LDSC2050 outlines a phase-out of nuclear energy. By 2043, nuclear power generation will be entirely phased out. This shift away from nuclear energy aligns with the plan's broader goals of reducing reliance on non-renewable energy sources and promoting a cleaner energy mix.

Table 23 - Key sectoral indicators on activities, energy and emissions in LDSC2050 and EUCalc

Scope	LDSC2050 pathway	Key levers/ambition	EUCalc pathway
Transport			
BEV fleet share	85% increase in the	Passenger technology -	-

(passenger)	share of hybrid and electric vehicles	3.8	
Buildings			
Rate of retrofitting	3.0% in 2030, up to 4.0% in 2050	Building envelope - 4	3% rrate
New constructions	All newly constructed buildings from 2021 onwards to be in nearly zero-energy (NZEB) standard		
Electricity generation			
Solar	-	Nuclear - 1	-
Wind	-		-
Nuclear	Phase out by 2043		-
Hydro			-
Geo	-		-
Biomass	-		-
Coal	-		-
Others	-		-
Gas	-		-

2.24 Slovenia

Energy Efficiency

At the core of SLTS2050 is a commitment to improving energy efficiency. The plan targets a substantial 33% improvement from 2005 levels. This ambitious goal involves adopting energy-efficient technologies and practices across various sectors to reduce energy consumption and minimise environmental impact.

Sustainable Transportation

A significant facet of SLTS2050 is the goal to transition the transportation sector toward renewable energy sources. By targeting 65% renewables in the transport sector by 2050, the plan aims to reduce reliance on fossil fuels and promote cleaner alternatives, such as biofuels and electricity. SLTS2050 emphasizes the need for behavioural change in passenger transport. Incentives are introduced to encourage individuals to make environmentally conscious choices when it comes to transport modes and vehicle purchases.

Renewables in Buildings

The plan envisions a future where buildings significantly reduce their carbon footprint. To achieve this, SLTS2050 sets a target of 50% renewables in

heating and cooling systems for buildings. This transition to renewable energy sources in the building sector helps decrease greenhouse gas emissions associated with heating and cooling.

Renewable in Industry

SLTS2050 promotes the widespread adoption of renewable energy sources in the industrial sector, with an ambitious target of 80% renewables by 2050. Special emphasis is placed on hydropower generation and biomass, as these sources offer sustainable and low-carbon alternatives to conventional industrial energy sources.

Low-Carbon Technologies

To achieve the low-carbon goals, SLTS2050 explores the use of nuclear energy and synthetic natural gas. These technologies provide cleaner energy alternatives and contribute to the reduction of carbon emissions, aligning with the plan's overall objectives.

Carbon Capture and Sinks

SLTS2050 acknowledges the importance of carbon capture and sinks in mitigating carbon emissions. The plan sets the stage for using both natural and technical sinks to compensate for remaining emissions in 2050.

Advanced Biofuels

Biofuels, particularly advanced sustainable biofuels derived from woody biomass, are prioritised in SLT 2050. These advanced biofuels offer a cleaner and more sustainable alternative to traditional fossil fuels, contributing to a greener and more environmentally friendly energy mix.

Table 24 - Key sectoral indicators on activities, energy and emissions in SLTS2050 and EUCalc

Scope	SLTS2050	Key levers/ambition	EUCalc pathway
Transport			
Passenger transport	Incentives for behavioural change: e.g. choice of transport mode and purchasing decision	Passenger distance - 2.8	No direct quantification
BEV fleet share (passenger)	-	Passenger technology - 3.8	-
Renewables in the transport sector	65% in 2050	-	72%
Buildings			
Rate of retrofitting	-	Building envelope - 3	-
Share of electricity	-	Not set exogenously but depending on the demand	-

		and technology settings	
Energy demand	-	Not set exogenously but depending on the demand and technology settings	-
Fuel mix	50% in heating and cooling	Fuel mix - 3.1	61% renewables in heating/cooling
Electricity generation			
Penetration of renewables	80% in 2050 Focus on hydropower generation and biomass The low-carbon scenarios entail the use of nuclear energy or synthetic natural gas	Solar - 2.4 Hydro - 3.3 Bioenergy capacity - 3.4 Nuclear - 3.3	-
Land/negative emission			
CCS/sinks	Remaining emissions in 2050 can be compensated by natural and technical sinks	ccs/ccu - 2.2	
Biomass	Biofuels will be prioritised towards the development, production and use of advanced sustainable biofuels from woody biomass	See bioenergy capacity	

2.25 Slovakia

The LTS available wdid not contain enough detailed information. Accordingly, in order to achieve Net-Zero, the pathway adopted for SLovakia is that of the Tech scenario as documented in Costa et al 2021. In the Tech scenario, levers related to individual behaviours are kept at LTS Baseline while those related to Technology and fuels are set to higher ambition levels as found to be technically feasible. For example, the renovation rate of buildings increases to 3% yr−1, and Zero Emission Vehicle reach 100% of car passenger sales in 2050. The exceptions are levers setting renewable energy capacities in Europe that do not increase substantially beyond the LTS Baseline, otherwise it would lead to an oversupply of electricity due to large gains in efficiency assumed in transport, buildings and manufacturing sectors. Crop and livestock production systems explore all the potential for further intensification.

2.26 Greece

Table 25 - Key sectoral indicators on activities and emissions in HLS2050 and EUCalc

Scope	HLS2050	Key levers/ambition	EUCalc pathway
Transport			
Active transport	14%	Mode of transport - 1.8	14.5%
Share of ZEV sales (passenger)	100%	Passenger technology - 4	100%
Share of ZEV sales (freight)	100%	Freight technology - 4	100%
Electricity share in transport energy	69%	Not set exogenously but responding to demand and technology	62%
Hydrogen share in transport energy	24%	Not set exogenously but responding to demand and technology	23%
Buildings			
Thermal isolation in existing buildings	50% increase	Building envelope - 1.5	50% of the renovations are shallow (-30% energy demand), 38% are medium (-40%) and 18% are deep (-60%). 20% of new constructions have the lowest level of efficiency, 60% are medium efficient and 20% highly efficient.
Renewable energy in heating and cooling	66%	Not set exogenously but responding to demand, technology and electricity mix	73.4%
Fuel mix	increase of RES in heating and cooling is almost exclusively due to the increase in the use of heat pumps	-	-
Electricity generation			
Solar	26	Solar - 2.5	22.1
Wind (onshore)	12	Wind - 1.7	12.3
Wind (offshore)	0.2		0.03
Gas	0.2	Not set as ambition in the model but rather responds to the capacities of renewable energy and coal.	1.6
Hydro	8.5	Hydro and geo - 1	9.4
Geo	0		

Biomass/residues	1.8	Responds to the demand and fuel mix of sectors.	2.5
Coal	0	Coal - 4	0
Solar	26	Solar - 2.5	22.1
Wind (onshore)	12	Wind - 1.7	12.3
Wind (offshore)	0.2		0.03
Land/negative emission			
CCS/sinks	Remaining emissions in 2050 can be compensated by natural and technical sinks	ccs/ccu - 2	-

2.27 Hungary

Table 26 - Key sectoral indicators on activities, energy and emissions in NCDS2050 and EUCalc

Scope	NCDS2050	Key levers/ambition	EUCalc pathway
Transport			
Total freight transport	29% increase compared to 2020	Freight distance - 1.8	26% increase
BEV fleet share (passenger)	74%	Passenger technology - 4	70%
BEV fleet share (freight)	44%	Freight technology - 3.6	47%
Passenger transport efficiency	2.4x increase	Passenger efficiency - 2.1	By 2050, car energy consumption (MJ/tkm) decreases by 27%, bus energy consumption by 20%, rail energy consumption by 25%, aviation energy consumption by 11%. Resulting in a 2.4x improvement
Total freight transport	29% increase compared to 2020	Freight distance - 1.8	26% increase
Buildings			
Rate of retrofitting	-	Building envelope - 3.2	-
Fuel	-	Fuel mix - 3	-
Share of electricity	5.7 % of demand by 2030	Not set exogenously but depending on the demand and technology settings	~ 4.8%
Fuel mix	30 % renewables in heating and cooling by 2030	Not set exogenously but depending on the demand and technology settings	-
Land/negative emission			

CCS/sinks	Remaining emissions in 2050 compensated by natural and technical sinks. CCS and hydrogen technologies will gain ground after 2030	ccs/ccu - 2	-
Biomass	Uptake of biomass-based electricity generation	Biomass capacity - 2	-

3 Library of pathways

3.1 Overview of outputs

Table 27 shows the sectoral emission values obtained using the EUCalculator model to those reported in the LTS documents of each member state. The comparison is done according to the respective year and by sector, for example: if the LTS reports emissions values in the year 2050 (the most common reporting year) then columns "Mt CO2 emissions in LTS/NECP" and "Mt CO2 emissions in EUCalc" contain the sectoral emissions of 2050. That said, numbers can also refer to the year 2030 or 2040, particularly when NECP's are used. Column "Delta sector" shows the absolute difference between the previous mentioned columns, while the column "Ratio of EUCALC total emissions to LTS/NECP'' shows the ratio between the total emissions obtained using the EUCalculator to those reported in the LTS/NECP of each member state (depending on the year). The table provides the reader with a quick reference to which sectors/Member states the emissions numbers projected by the EUcalculator model are closer to those proposed in the LTS/NECP documents.

Table 27 - Comparison of sectoral emissions in lTS/NECP and those projected with the EUCalculator

MS	Sector	Mt CO2 emissions in LTS/NECP	Mt CO2 emissions in EUCalc	Delta sector	Ratio of EUCalculator total emissions to LTS/NECP
PT	Buildings	1.5	1.8	0.28	0.96
	Agriculture	3.5	3.9	0.37	
	Electricity	0.7	0.5	-0.22	
	Industry	5.5	4.2	-1.28	
	Transport	0.2	0.5	0.26	
	Lulucf	-13	-10.1		
FR	Buildings	5	7.2	2.17	1.19

	Agriculture	47	50.5	3.49	
	Electricity	2	2.4	0.44	
	Industry	16	20.3	4.31	
	Transport	4	7.4	3.35	
	Lulucf	-69.2	-66.4		
DE	Buildings	1	4.4	7.44	1.11
	Agriculture	32.6	34.6	2.01	
	Electricity	2.8	2.3	4.54	
	Industry	10.1	14.8	14.66	
	Transport	0.6	1.5	3.93	
	Lulucf	-47.5	-45.9	1.56	
IT	Buildings	0	9.5	9.45	1.1
	Agriculture	23	21.1	-1.88	
	Electricity	18	6.1	-11.94	
	Industry	22	30.5	8.5	
	Transport	0	2.3	2.28	
	Lulucf	-45	-47.9	-2.94	
PL	buildings	/	27	/	/
	agriculture	/	28.7	/	
	electricity	/	49.1	/	
	industry	/	52.5	/	
	transport	/	32.9	/	
	lulucf	/	-32.2	/	
ES	Buildings	0	3.6	3.58	1.7
	Agriculture	19	20.5	7.54	
	Electricity	0	1.9	1.9	
	Industry	7	17	19.98	
	Transport	2	2.3	0.34	
	Lulucf	-37	-31.1		
LU	Buildings	12	10.8	-1.21	1.1
	Agriculture	0.5	0.8	0.3	
	Electricity	0.062	0.2	0.11	

	Industry	0.14	1.3	1.21	
	Transport	1.9	0.3	-1.57	
	Lulucf	-0.4	-0.3		
NL	Buildings	19	17.7	-1.33	0.85
	Agriculture	25	20.5	-7.5	
	Electricity	14	12.5	-1.45	
	Industry	54	28	-26.03	
	Transport	33	35.5	2.53	
	Lulucf	5.2	3.9		
BE	Buildings	2.5	1.5	-0.98	1.3
	Agriculture	6.3	6.4	0.1	
	Electricity	0	1.3	1.29	
	Industry	1.3	9.3	8.0	
	Transport	0	1.2	1.24	
	Lulucf	NA	0.3		
DK	Buildings	NA	1.2	NA	0.73 (for the sectors with available data)
	Agriculture	11.3	10.6	-0.65	
	Electricity	10.3	7	-3.26	
	Industry	6.9	3.3	-3.62	
	Transport	16.9	10.7	-5.17	
	Lulucf	NA	-3.3		
SE	Buildings	NA	0.2	NA	0.83 (for the sectors with available data)
	Agriculture	5.9	5.2	-0.73	
	Electricity	17.9	16.6	-1.27	
	Industry	7.2	9	1.76	
	Transport	14.2	6.8	-7.42	
	Lulucf	-42.2	-46.6		
FI	Buildings	NA	0.2	NA	1.4 (for the sectors with available data)
	Agriculture	4.5	5.8	1.32	
	Electricity	0.6	1.2	0.6	
	Industry	3.6	6.9	3.27	
	Transport	1.8	0.5	-1.31	

	Lulucf	-16.4	-16.6		
CZ*	Buildings	NA	7.3	NA	Not comparable because buildings, transport and power emissions are aggregated.
	Agriculture	9.4	6.9	-2.54	
	Electricity	78.5	4.6	-73.87	
	Industry	11.4	17.7	6.35	
	Transport	NA	8.1	NA	
	Lulucf	NA	-5.3	NA	
BG	Buildings	0.1	0.2	0.14	0.96
	Agriculture	9.3	7.5	-1.79	
	Electricity	0.6	0.7	0.09	
	Industry	0.2	2.7	2.5	
	Transport	3.2	2.9	-0.29	
	Lulucf	-8.3	-11.3		
RO	Buildings	/	2.7	/	/
	Agriculture	/	7.7	/	
	Electricity	/	1.6	/	
	Industry	/	14.9	/	
	Transport	/	0.4	/	
	Lulucf	/	-31.2		
MT	Buildings	0.02	0	0.01	0.51
	Agriculture	0.07	0.1	0	
	Electricity	1.2	1.1	-0.1	
	Industry	0.03	0	-0.02	
	Transport	1	0	-0.98	
	Lulucf	NA	NA		
CY	Buildings	0.25	0.1	-0.13	0.4
	Agriculture	0.4	0.2	-0.18	
	Electricity	0.25	0.1	-0.1	
	Industry	0.4	0.4	0.02	
	Transport	0.5	0	-0.48	
	Lulucf	-1	-1		
AT*	Buildings	/	1	/	*No provision of

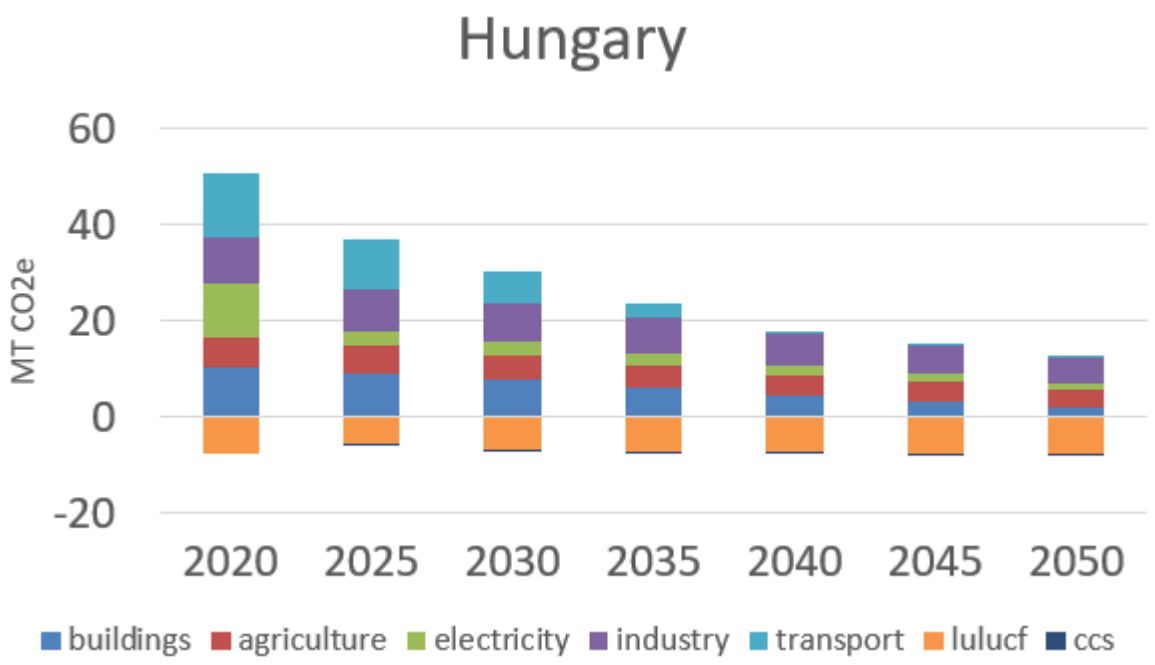
	Agriculture	5.8	8.6	-2.8	detailed sectoral breakdown. Power sector seems to aggregate transport and buildings.
	Electricity	11	1.4	9.6	
	Industry	4	11.8	-7.8	
	Transport	/	0.5	/	
	Lulucf		-2.8		
EE	Buildings	/	0.1	/	0.87 (for the sectors with available data)
	Agriculture	1.5	1	-0.5	
	Electricity	5.3	5.2	-0.1	
	Industry	0.5	0.4	-0.1	
	Transport	0.4	0.1	-0.3	
	Lulucf	-2.57	-2.3		
LV*	Buildings	/	0.2	/	*Relative targets provided with unclear base data.
	Agriculture	+43%	1.4	/	
	Electricity	-86%	0.5	/	
	Industry	+22%	1	/	
	Transport	-47%	0.2	/	
	Lulucf	/	-1.9		
LT*	Buildings	/	0.2	/	[a]No adequate sectoral breakdown. Only transport emissions are noted to drop by 90%, many sectors are said to abandon fossil fuels.
	Agriculture	0	2.3	2.3	
	Electricity	0	0.9	0.9	
	Industry	0	2.4	2.4	
	Transport	-90%	0.1	/	
	Lulucf	/	-6		
IE	Buildings	6	6.2	0.17	1.07
	Agriculture	19	27.7	8.7	
	Electricity	5	3.2	-1.81	
	Industry	8	5	-2.98	
	Transport	7	6.1	-0.93	
	Lulucf	-3	4.4		
HR	Buildings	0.9	0.5	-0.36	0.84
	Agriculture	1.9	2.6	0.66	

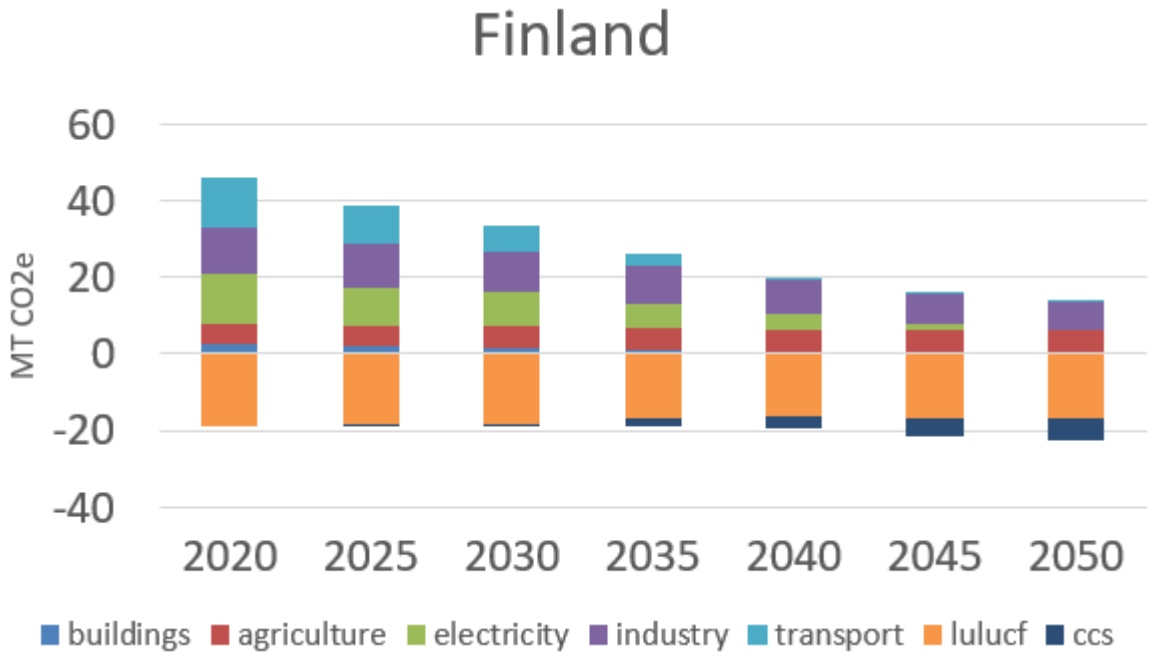
	Electricity	0.6	0.4	-0.23	
	Industry	1.6	2.1	0.5	
	Transport	1.8	0.1	-1.68	
	Lulucf	NA	-2.2		
SI	Buildings	0.07	0.2	0.14	0.93
	Agriculture	1.5	0.5	-1.01	
	Electricity	0.07	0.4	0.34	
	Industry	0.6	0.9	0.29	
	Transport	0.03	0.1	0.07	
	Lulucf	-2.5	-4.1		
SK	Buildings	1.6	1.8	0.22	0.67
	Agriculture	2.6	1.9	-0.72	
	Electricity	4.2	0.9	-3.31	
	Industry	9.9	11.7	1.81	
	Transport	6.2	0.2	-6.04	
	Lulucf	-4.4	-5.8	-1.44	
HL	Buildings	1.4	0.8	-0.56	0.8 (for the sectors with available data)
	Agriculture	NA	2.1	NA	
	Electricity	1.4	1.2	-0.22	
	Industry	6	4.1	-1.88	
	Transport	0.1	0.6	0.54	
	Lulucf	NA	-6		
HU	Buildings	0	2.1	2.11	1.04
	Agriculture	2.1	3.8	1.72	
	Electricity	2	1.1	-0.89	
	Industry	6	5.3	-0.74	
	Transport	2	0.3	-1.75	
	Lulucf	NA	-7.6		

When all member states are accounted for together, the average value of the ratio of EUCalculator total emissions to LTS/NECP is 0.98. That said, this value is not homogenous across member states. In 48% of them the difference between EUCalculator estimates and the LTS/NECP is within a +/- 20% difference range. Note that although this can a priori sound like a substantial

amount we are in fact talking about emission in (mostly) the years 2050 and 2040. By then total emissions are much lower than those current and hence, in absolute terms, a 20% difference is not very substantial. More importantly though, is that these 48% member states account for 84% of EU emissions. It is also important to mention that there are cases in which the EUCalculator has difficulties in projecting the suggested emissions values in the LTS/NECPs documents under the assumptions provided. Cases like Cyprus and Malta are two examples of how the EUCalculator projects significantly lower overall emissions than those in the LTS/NECPs.

While table 27 is concerned with the comparison of emissions in particular years, the emissions pathways supplied to the consortium are made of time series ranging from the years 2020 to 2050 in 5 year steps. Following particular examples of these pathways are visualised.

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-20
-40
MT CO2e
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buildings
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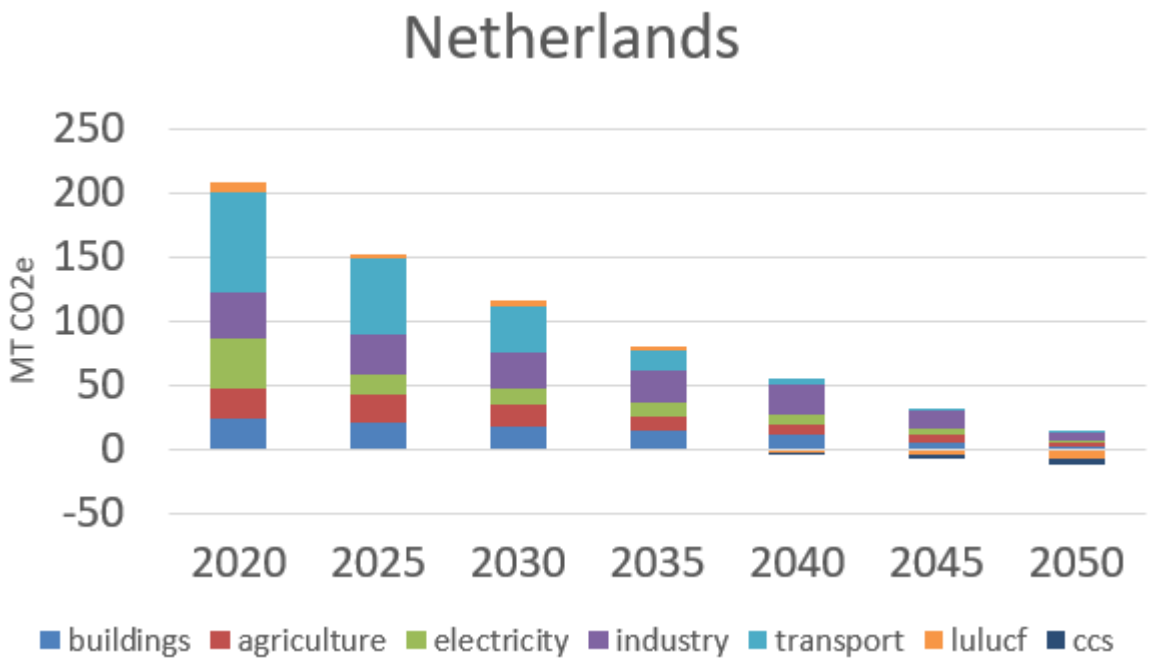
Netherlands
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MT CO2e
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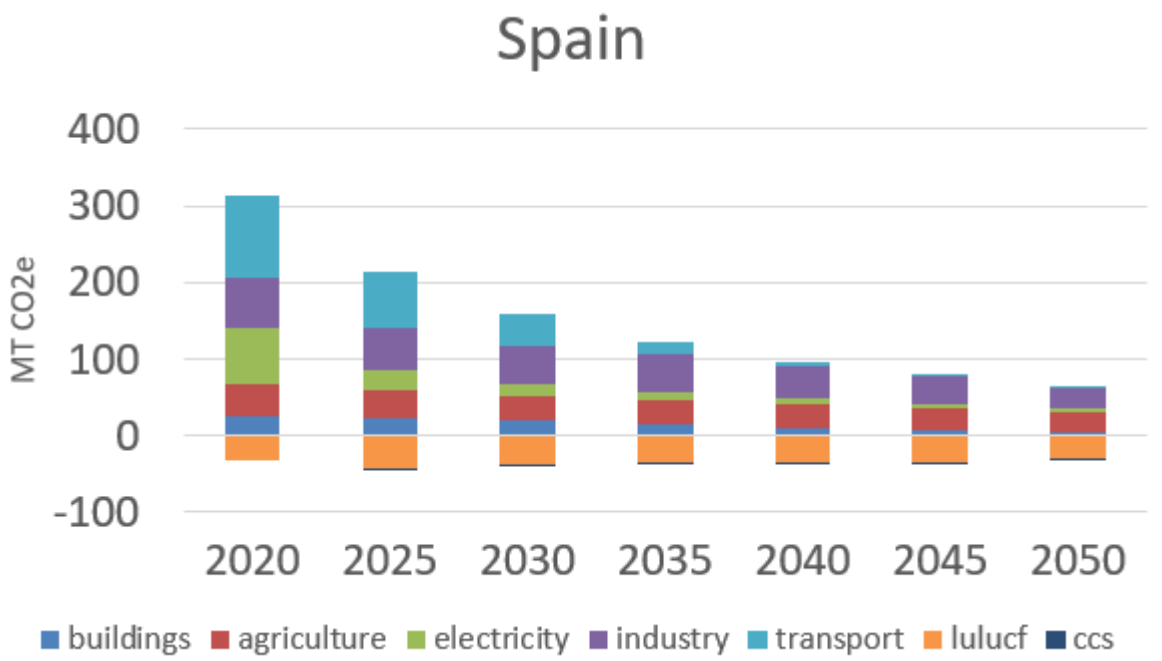
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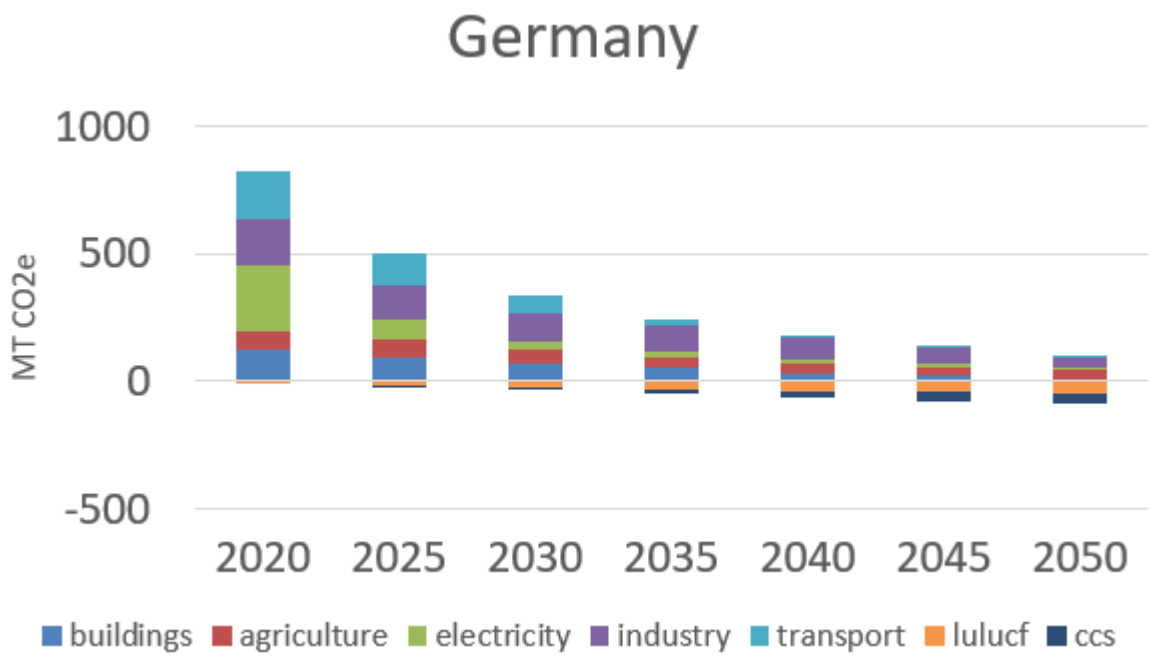
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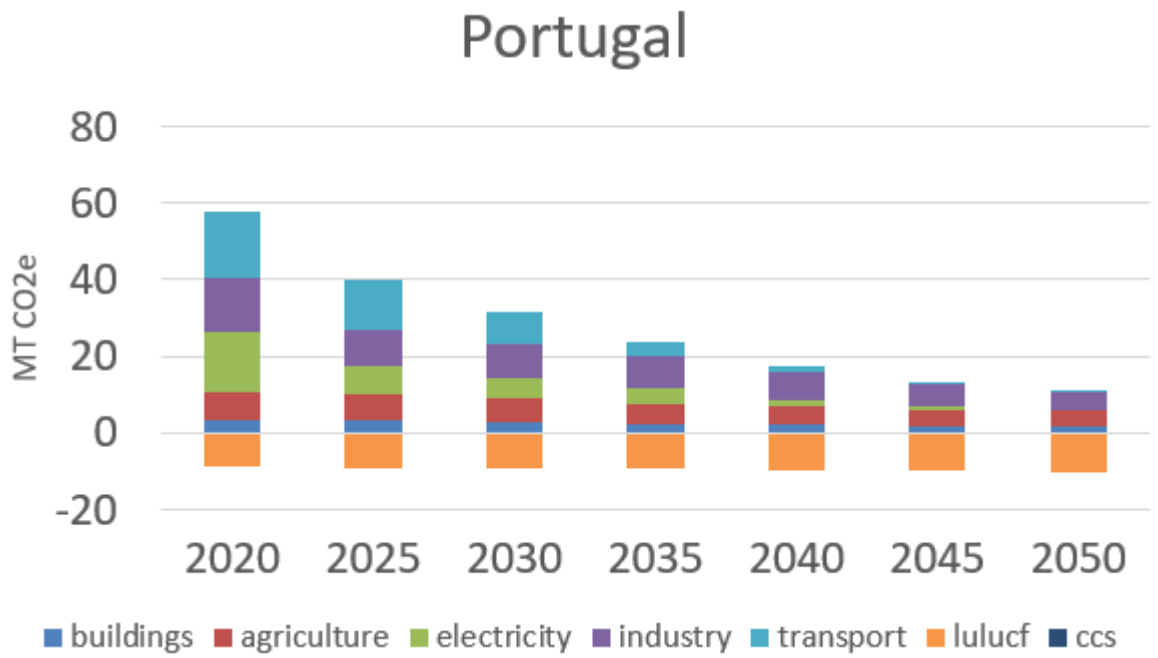

Figure 2 - Pathways of sectoral emissions projected with the EUCalculator for selected member states.

3.2 Behavioural change variant

In addition to the reproduction of the the LTS/NECP pathways described in the previous sections, this deliverable also makes available to the consortium and wider audiences a Behavioural change variant is also included. This scenario variant takes al off the technological assumptions from the LTS/NECP documentations but modifies individual consumptions patterns and energy choices in the population that are conducive with a sustainable lifestyle.

In these pathways variants ambition levels of individual behaviours in the EUCalculator (see Table A1 in the Annex) are raised to the maximum level assumed in the EUCalc. This essentially means smarter and more selective consumption of products and energy services. The ambition levels related to Technology and fuels in the Life scenario correspond to those in the LTS Baseline. Changes in resources and land are made in favour of achieving the maximum feasible agroecology standards in crop and livestock production as well as the sustainable management of forests.

3.3 Naming conventions

All energy, material and emission outputs from the EUCalculator model entailed in both scenarios evaluated are made available to the consortium by means of a .json file. A detailed listing of the model outputs can be accessed following

this link. Each pathway is named according to the following naming convention:

country - document - variant - year - time (day, month,year)

In which *country* refers to the 2 digit ISO code country identifier (e.g., AT, NL, PT); *document* refers to the report used to extract the main technology and policy assumptions (e.g., LTS, NECP); *variant* refers to variations of the pathway (e.g., ST if no variant is available, BC - behavioural change); *year* refers to the last year of simulation (e.g., 2050); and *time* refers to the time of pathway generation using the EUCalculator model. A typical name is for example "PT-LTS-ST-2050-04062022" referring to the pathway for Portugal that reproduces the LTS documentation without any variant until 2050 and generated in June 2022.

3.3 Data access

The library of model outputs to be elaborated throughout the project is made available internally to all partners through the PIK cloud following this link. Upon request, interested third party elements to the project can also access the database. Nevertheless, it is noted that the database will evolve and the team does not discard that some pathways might be updated throughout the timeline of the project in case new technological or policy developments, or interactions between WP's justify.

4 Conclusions

4.1 Country strategy documentation and recomendations

Long Term Strategies (LTS) for decarbonization across European Union member states reveals a spectrum of completeness and sophistication in climate planning. While several countries, such as Estonia, Spain, Finland, and France, have produced comprehensive LTS documents, featuring clear climate goals, detailed strategies, and a robust inclusion of both mandatory and non-mandatory elements, others lag behind. Germany stands out with an outdated and highly incomplete LTS, marked by vague goals and substantial gaps in essential elements. Denmark's strategy lacks depth and covers projections only up to 2040. Furthermore, several countries exhibit varying degrees of completeness. Often LTS documents show the reduction pathways in the form of graphs without clearly outlining the underlying numbers. This makes it hard to check specific values.

Most countries provide some level of detail on the energy sector, particularly in terms of renewable energy targets and the decarbonization of energy

production. However, some LTS documents lack specific projections or milestones for energy emissions reductions. Data on energy consumption by sector is often missing or limited, making it challenging to assess the strategies' feasibility.

The coverage of the industrial sector varies significantly among member states. Some LTS documents include expected emission reductions by industrial subsectors, while others lack this information. Detailed decarbonization options for industries are occasionally provided, but they are not consistently available across all strategies.

The large majority of the LTS documents address the transport sector, offering insights into expected emission reductions, transport decarbonization options, and sometimes emissions and energy sources by transport type. This sector is key for decarbonisation and countries do make some detailed reporting on how the sector is planned to evolve. Nevertheless, important gaps are noted. For example, the inclusion of international maritime and aviation emissions varies, with some LTS documents lacking clarity on whether these sectors are considered in the climate targets.

Information on emissions and energy sources by agriculture type or expected emission reductions in the agricultural sector is often missing or limited in LTS documents. Strategies may lack a comprehensive approach to addressing emissions in agriculture, including specific policies and measures. Finally, most LTS documents lack a comprehensive socio-economic impact assessment, making it challenging to evaluate the broader economic implications of decarbonization efforts. Strategies often miss providing estimated investment needs, hindering a comprehensive understanding of the financial requirements for achieving climate goals.

The primary recommendation to enhance the effectiveness of long-term climate planning revolves around the development of a more comprehensive and coordinated approach. This can be achieved through the implementation of a mandatory template, compelling national governments to provide in-depth information on their long-term vision, including scenarios and targets, as well as specifying how the document will be prepared and utilized. Additionally, it is imperative to establish mandatory regular updates, scheduled slightly ahead of the National Energy and Climate Plan (NECP) updates, to ensure ongoing relevance and alignment with evolving priorities. Furthermore, to foster national ownership of long-term climate strategies, governments should engage a wide variety of stakeholders in strategy preparation, facilitate independent peer reviews by utilizing scientific expertise, integrate a regular review cycle into national policy-making, and specify clear dates for achieving climate neutrality with quantifiable greenhouse gas emissions and removals.

The European Commission should actively support these efforts by providing technical assistance, creating a platform for sharing best practices among Member States, enforcing compliance with LTS requirements, and constructing a bottom-up vision for EU-wide climate neutrality, integrating elements from national LTSs into an updated EU LTS. Overall, these assessments underscore the need for greater sectoral focus, long-term projections, and a more holistic approach to non-mandatory elements to fortify the foundation for effective decarbonization endeavours in the European Union.

4.2 EUCalculator

The flexibility of the EUCalculator model entailed in its ambition levers to convincingly reproduce the major characteristics of energy, technologies and emissions pathways proposed in the LTS documents of member states. For the industry and buildings sectors the projections with the EUCalculator are nearly always above those envisioned by the LTS/NECP documentation. In the particular case of buildings the sector is assumed in the LTS documentation to reach zero emissions at or even slightly before 2050. In the EUCalculator such is not possible because there is always a residual amount of natural gas in the mix for district heating and fuels for cooking. In addition, it cannot be disregarded that the scope of what is modelled in the EUCalculator is not always 1:1 to the sectoral scope of what is reported in the LTS documentation. For example, it is not always clear from the LTS documentation if the building sector accounts always for residential and non-residential buildings. Both are accounted for in the EUCalculator framework. As for the industry sector, the emission pathways projected with the EUCalculator are predominantly linear while it is clear that the LTS are mostly betting on a non-linear evolution of the sector.

4 Annex

Table A1: List of levers in the EUCalculator modules, their scope and definition.

Domain	*Scope*	*Lever*	*Definition*
Key behaviour	Travel	Passenger distance	This lever sets the total average distance people will travel in one year. It includes travel distance by land, water and air.
	Travel	Mode of transport	The transport mode lever sets the mode by which passenger transport is undertaken (walking, cycling, motorbike, car, bus, train, aeroplane and boat).
	Travel	Occupancy	This lever sets the occupancy of passenger vehicles, i.e., the number of people in the average car and bus.
	Travel	Car own or hire	The passenger car utilisation rate lever sets the average number of kilometres travelled by a vehicle every year.
	Homes	Living space per person	This lever sets the amount of residential floor space per person.
	Homes	Percentage of cooled living space	This lever sets the per-capita fraction (percentage) of residential living space cooled.
	Homes	Space cooling	This level sets the room temperature within residential buildings.
	Homes	Appliances owned	This lever sets the number of white and black goods found in each household and comes expressed as appliance/cap.
	Homes	Appliance use	This lever sets the number of hours an appliance (washing machines, dishwashers, dryers, fridges, freezers, computers, TV's and phones) is used in households.
	Diet	Calories consumed	This lever sets the intake of daily calories consumed by individuals and comes expressed in kcal/cap/day.
	Diet	Type of diet	This lever sets the composition of individual diets expressed as daily calorie demand for 26 food groups.
	Consumption	Use of paper and packaging	This lever sets the use of paper for printing and sanitary purposes, and the plastic, paper, aluminium and glass used for packaging.
	Consumption	Appliance retirement timing	This lever sets product substitution rate, the amount of time a consumer wishes to shorten/extend the use of appliances owned beyond their expected lifetime. The appliances considered in households are dryers, washing machines, dishwashers, televisions and computers. Mobile phones are considered on a per capita level.
	Consumption	Food waste	This lever sets the number of calories wasted at the consumer level and comes expressed in kcal/cap/day.

	Consumption	Freight distance	This lever sets the total demand for freight transport (in tonne-km).
Technology and fuel	Transport	Passenger efficiency	This lever sets the efficiency of passenger vehicles. It controls efficiency improvements for all vehicle types (both fossil fuel-powered and low-carbon).
	Transport	Passenger technology	This lever sets how passenger technology in the transport sector will move from fossil fuels to lower emission vehicles. These include hybrid, electric or hydrogen vehicles and their use for passenger, freight and international transport.
	Transport	Freight efficiency	This lever sets the efficiency of freight vehicles and controls efficiency improvements for all vehicle types (both fossil fuel-powered and low-carbon).
	Transport	Freight technology	The freight vehicle technology mix lever sets the technology mix (e.g. Internal Combustion Engine (ICE), Battery Electric Vehicle (BEV), Plug-in Hybrid Vehicle (PHEV), Fuel Cell Electric Vehicle (FCEV), etc.) in the new vehicle sales for road, rail, sea and air. Based on this lever, and on historical fleet data, the model can compute the share of each technology in the total vehicle fleet and then compute the vehicle-kilometres by mode into vehicle-kilometres by mode and by technology.
	Transport	Freight mode	The transport mode lever sets the proportion of freight transport made by road, rail, sea and air.
	Transport	Freight utilisation rate	This lever sets the load factor for trucks, which is the weight of goods carried by each type of truck and sets the average number of kilometres travelled by a truck every year.
	Transport	Fuel mix	The fuel mix lever sets the share of biofuels and efuels in each fuel type (e.g. gasoline, diesel, kerosene, gas, etc.).
	Buildings	Building envelope	This lever sets the average heat loss reduced with insulation and affects the energy needed per floor area.
	Buildings	District heating share	This lever sets the percentage of heating energy demand covered by district heating.
	Buildings	Technology and fuel share	This lever sets the mix of technologies used for space heating.
	Buildings	Heating and cooling efficiency	This lever sets the average energy loss in heating, cooling and ventilation systems.
	Buildings	Appliances efficiency	This lever sets the average rate of energy use for appliances, cooking and lighting. The appliances modelled are fridges, freezers, washing machines, laundry dryers, dishwashers, computers, TV's and phones.

	Manufacturing	Material efficiency	This lever sets material efficiency. It controls decrease in material demand due to activities such as smart design, use of more efficient materials and smart manufacturing.
	Manufacturing	Material switch	This lever sets the percentage of materials substituted by other, more sustainable materials in products.
	Manufacturing	Technology diffusion	This lever sets the percentage of manufacturing materials produced with low-carbon technologies. It also accounts for recycled material used in the production process.
	Manufacturing	Energy efficiency	This lever sets the decrease in energy consumption through technology-based energy efficiency measures.
	Manufacturing	Fuel mix	This lever sets the percentage of energy used along each energy carrier (electricity, coal, oil, gas, biomass, waste, and hydrogen) for each technology.
	Manufacturing	Carbon Capture in manufacturing	This lever sets the percentage of CO2 equivalent carbon emissions captured within the manufacturing industry.
	Manufacturing	Carbon Capture to fuel	This lever sets the percentage of utilisation of carbon captured.
	Power	Coal phase out	This lever sets the phase-out and installation of new coal power plants.
	Power	Carbon Capture ratio in power	This lever sets the ratio of emissions captured in the power sector.
	Power	Nuclear	This lever sets the phase-out and new capacities of nuclear power plants.
	Power	Wind	This lever sets the new on- and off-shore wind power capacities.
	Power	Solar	This lever sets Photovoltaic (PV) and Concentrated Solar Power (CSP) capacities.
	Power	Hydro, geo & tidal	This lever sets the new hydropower, geothermal and marine power capacities.
	Power	Balancing strategies	This lever describes a portfolio of balancing and storage technologies, including: pumped hydroelectric storage, battery, flywheel, compressed air storage and power-to-X technology.
	Power	Charging profiles	This lever sets the charging patterns of electric vehicles, thus influencing when charging happens and its ability to shift demand.
Resource and land	Land and food	Climate smart crop production	The lever sets the ambition regarding the crop production system, from intensive to agroecology approach.
	Land and food	Climate smart livestock	The lever sets the ambition regarding the livestock production system, from intensive to agroecology approach.

	Land and food	Bioenergy capacity	The lever sets the ambition regarding the bioenergy domestic production capacities per energy-type.
	Land and food	Alternative protein source	The lever sets the share of insect and microalgae-based meals for each livestock type, and disable/enable by-product feedstock for other markets.
	Land and food	Forestry practices	The lever sets the ambition regarding the deployment of climate smart forestry.
	Land and food	Land management	The lever sets the ambition level for land-use allocation and dynamics.
	Land and food	Hierarchy for biomass end-uses	The lever sets the hierarchy regarding the agri-food industry by-products and waste uses.
Demo-graphics	Long-term	Population	This lever sets the amount of population living in the EU28+Switzerland.
	Long-term	Urban population	This lever sets the fraction of total population living in urban areas
Domestic supply	Domestic supply	Food production	The lever sets the self-sufficiency ratio for each food group.
	Domestic supply	Product manufacturing	This lever sets the import of products and the impact of trade.
	Domestic supply	Material production	This lever sets the import of manufactured materials.
Mitigation outside Europe	Constraints	Global mitigation effort	This lever sets how the rest of the world may decarbonise.

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