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A Critical Review of the Revised Greek NECP and the Greek LTS 2050 Roadmap

January 2020

This work has been carried out in the scope of Contract DG-1909-59603 with the European Climate Foundation whose financial support is gratefully acknowledged.

Dimitri Lalas and Nikos Gakis, technical personnel of FACET³S, S.A., contributed to the work described in this report.

Athens, January 2020

Summary

In this note, a comparison of the original Greek NECP as submitted to the European in January of 2019 and the revised on as submitted in December 2019 is made to bring out differences and improvements undertaken in the scope of the September 2019 announcement for an accelerated decommissioning of all lignite units by 2028. In addition, an analysis of the Greek Long-term Strategic 2050 Roadmap announced in December 2019 is presented and analyzed.

The revised NECP is seen to be much more ambitious than the original one as its main targets have been upgraded reaching ca. 43% GHG emission reductions wrt 1990 (vs 33% of the original), RES contribution to gross final energy consumption of 35% (vs 31.5%) and final energy consumption of 16.5Mtoe (vs 18Mtoe). These are the result primarily of the much earlier decommissioning of all the lignite plants by 2023, earlier than 2028, the originally announced date in September 2019 and much earlier than the previous version which still included 2.7GW of lignite plants (70% of existing) in 2030. This resulted in the installation to meet the demand of an additional 1.3GW of PV and wind bringing the RES total to 19.1GW (vs. 17.8GW) and a substantial increase in NG based generation from 10.7TWh to 18.3TWh.

The energy consumption, inland or final, differs very little between the 2 versions (22.2Mtoe vs 23Mtoe and 17.4Mtoe vs 18Mtoe respectively) but with the distribution by fuel reflecting the absence of lignite, the increased NG and RES use in the 2019 version (10% and 8.3% reduction in NG and oil respectively and a 4.2% and 5.3% increase in electricity and RES). The reduction in FEC vis-a-vis the 2018 version comes from savings in the residential (ca 60%) and the industrial (ca. 30%) sectors.

The revised and more ambitious NECP would need €36.8Bil of investment for the same categories over the 10-year 2020-2030 period (vs. €34.7Bil). The increase is due to additional investment for energy efficiency improvements (€2Bil), RES electricity installations (€500Mil) and electricity distribution system (€200Mil), but with a savings of €600Mil from planned improvements in the lignite plants that are now unnecessary. The revised NECP also includes an additional €700Mil for promoting circular economy and addressing climate change impacts in forests and areas susceptible to floods bringing the total to €43.8Bil.

The revised NECP includes an administrative structure for coordinating policies and measures between ministries at both ministerial and service level with a Working Group running a Supervising Mechanism tasked with following progress and recommending changes when needed. It does not include though a timetable or assignment of responsibility for the large number (over 150) of measures to assure successful implementation. Unfortunately, the sectoral information provided in the new version basically stops in 2030 (2040 in the 2018 version) information that is surely available. It does include some results of modelling for the same period carried out by PRIMES paralleling the main computations carried out by TIMES. The comparison shows noticeable differences which should be kept in mind as PRIMES was the model utilized for the Long-term Strategic 2050 Roadmap which takes 2030 as its starting point.

The LTS 2050, which was released on 10 December 2019 is designed as an exercise to investigate the potential to reach emission reductions in line with the Paris Agreement targets of 2^{o}C and 1.5^{o}C, namely 85% and 95% decarbonization by 2050. Six scenarios are defined which are based on (i) extending and enhancing policies and measures included in the NECP (scenarios NECP2030 and NeCP2050) (ii) extensive use of energy efficiency and electricity (scenarios EE2^{o}C and EE1.5^{o}C) and (iii) utilization of new energy carriers mostly H2 and synthetic gases to be produced through explosive use of RES (scenarios NC2^{o}C and NC1.5^{o}C).

The results of the computations with the PRIMES model for these six scenarios show emission reduction of 56% and 74% for the two NECP ones, 83% and 84% for the two 2°C ones and 94% and 95% for the two 1.5°C ones. This range is also found in the final energy consumption of the six scenarios (14.9Mtoe, 13.4Mtoe, 12.1Mtoe, 10.6Mtoe, 12.2Mtoe for the two NECP, the two 2°C EE and NC, and the two 1.5°C EE and NC scenarios respectively).

The main instruments for reaching these high reductions is the energy conservation measures and the energy carrier switching with RES taking the leading role, directly and indirectly. RES installed capacity, mostly wind and PV but also biomass, increases; from 8.5GW in 2015 and 19.1GW in 2030 to 24.8GW, 26.5GW, 28.7GW, 49.9GW, 33.9GW and 63.9GW respectively. The extraordinary amount of RES in the NC1.5°C scenario, producing 145TWh in 2050, is needed to manufacture the necessary H_2 and synthetic fuels to meet the 95% reduction target.

The yearly necessary investment needed is €6.7Bil/yr, €7.2Bil/yr, €7.9Bil/yr, €8.6Bil/yr, €9.4Bil/yr and €10.2BIl/yr for the two NECP, the two 2°C EE and NC, and the two 1.5°C EE and NC scenarios respectively (compared to €3.4/yr and €3.7Bil/yr of the NECP 2018 and 2019) which represent from 2% to 2.9% of GDP per year. This is a very large amount of investment funds to be attracted every year for 20 years. Combining these amounts with the emission reduction achieved in each scenario, it is clear that the EE scenarios have an advantage in cost effectiveness including the higher potential for increased domestic value added, but also because the NC ones depend on almost double amounts of RES to be installed for which daunting obstacles of social acceptance would need to be overcome.

The LTS 2050 as put out for public consultation has a number of shortcomings including the lack of sufficient detail (such as summary balance tables) to fully analyse and evaluate the plausibility of the results of each storyline and policy mix. It also lacks sensitivity analyses of the effect of the major exogenous parameters such as the carbon price which doubles in the 5-year period after 2030 and reaches the unlikely values of €180/tCO_2 and €380/tCO_2 in the two 1.5°C scenarios by 2050.

Despite its many shortcomings, the Greek LTS 2050 Roadmap does provide a very useful mapping of the possibilities and difficulties to transform the Greek economy toward a near zero GHG emissions state by 2050, that is in the next 30 years. This 30-year period might look long-term but in reality, has become almost tomorrow. The LTS 2050 also lays out the main approaches, i.e. enhancement of the PAMs already catalogued in the 2019 NECP, an more aggressive energy conservation, a major switch to electricity, use and the massive introduction of H_2 and synthetic fuels, for the future of the energy sector past 2030 mainly and as it affects all the other sectors all society, the whole development of the economy. In this way, it provides both a compass and an impetus for the political system to start thinking past the 4-year cycle in view of their obligations to future generations.

1. The 2019 Greek NECP

1.1. Overview of the revised Greek NECP

Following the EC recommendations on the first NECP (C(2019) 4408 final) that was submitted in January 2019, a new draft NECP was put out for public consultation on 28 November 2019 which included the major upgrades announced in September 2019 especially regarding the accelerated delignitization. In particular, it included an increase of the marque targets from the 2018 version of RES from 31.5% to 35% on gross final energy consumption (GFEC), of the GHG emission reduction from 33% to 42% wrt to 1990, of a reduction of final energy consumption (FEC) from 18.1Mtoe to 16.3Mtoe and a very ambitious schedule for decommissioning of all lignite plants by 2028.

On 19 Dec 2019, taking into account the submissions of the public consultation, the Greek Government submitted to the EC the final revised version of the Greek NECP. In this note, the emphasis is on presentation of the differences between the two versions submitted to the EC, caused notably by the lignite phase-out and the increased RES deployment.

The major features of the 2019 revision of the Greek NECP are:

1. An even more accelerated schedule for the **decommissioning** of the lignite plants as shown in Table 1 below. The REF scenarios are those of the latest ECF commissioned study with lignite plant shutdown as initially announced (REF) and with accelerated schedule by 4 (REF-4) and 6 years (REF-6)

Table 1: Lignite Plants Decommissioning Schedule

	Net MW	Age	Efficiency	Decommission year				
				NECP2018	NECP2019 as submitted 19Dec2019	REF scen	REF-4 scen	REF-6 scen
Kardia I	275	42	28.9%	2021	2019	2019	2019	2019
Kardia II	275	42	28.9%	2021	2019	2019	2019	2019
Kardia III	280	37	30.3%	2023	2021	2020	2020	2020
Kardia IV	280	36	30.3%	2024	2021	2020	2020	2020
Megalopolis III	255	43	30.1%	2028	2021	2019	2019	2019
Megalopolis IV	256	29	29.7%	2032	2023	2028	2024	2022
Amyntaio I&II	546	31	30.2%	2021	2020	2022	2021	2021
Ag. Dimitrios I	274	33	30.7%	2029	2022	2028	2024	2022
Ag. Dimitrios II	274	33	30.7%	2029	2022	2028	2024	2022
Ag. Dimitrios III	283	32	30.9%	2029	2022	2028	2024	2022
Ag. Dimitrios IV	283	32	33.4%	2029	2023	2028	2024	2022
Ag. Dimitrios V	342	22	39.1%	2040	2023	2028	2024	2022
Meliti I	289	15	32.4%	2038	2023	2028	2024	2022
Total 2019	3912							
Ptolemais V	614	Comm. in 2021	41%		2028	2050	2046	2044
Meliti II	450	Permit issued			Not built			
Total -end 2022				**3976**	1501	**2615**	**2326**	0
Total -end 2023				**3441**	614	**2615**	**2467**	0
Total -end 2025				**3611**	614	**2359**	**614**	614
Total -end 2028				**3065**	0	**614**	**614**	614

As can be clearly seen in Table 1, the 2019 version decommissioning falls half way between the REF-4 and REF-6 scenarios of the latest modelling results (except for the fate of the Ptolemais V unit which is now supposed to stop operating as a wholly lignite-fired plant in 2028) of the 2020 study commissioned by ECF on accelerated delignitization in Greece, Bulgaria and Romania.

2. There are notable differences in the values of the exogenous parameters of **GDP, population, fuel and EU ETS allowance prices** which affect the results of the modelling of the 2 versions. The decrease in population is reduced in the 2019 NECP resulting in 400,000 more inhabitants by 2030. At the same time the GDP increases already by 2020, as the economy seems to be recovering faster than anticipated with rates in the last two years of near or even over 2%. A major difference is the evolution of the EUA price. In the 2019 version, the price is already at €24/tCO_2 in 2020 (vs. €15.52/tCO_2 in the 2018 version) but it only reaches €31.23/tCO_2 in 2030 (vs. €34.66/tCO_2). While this would affect considerably the load factors and hence the production of the lignite plants vis-à-vis the NG plants and RES in the 2018 version, it would only influence slightly the NG production in the 2019 version after 2023 as almost all lignite plants are decommissioned by then. Finally, the NG prices used are lower, to reflect the negative NG market trends of the last years.

3. The total **GHG emissions** in the 2019 version are substantially lower (70.6 $MtCO_{2eq}$ vs 61 $MtCO_{2eq\ in}$ in 2030 compared to 91.6 $MtCO_{2eq}$ in 2016, 136.3 $MtCO_{2eq}$ in 2005 and 103.1 $MtCO_{2eq}$ in 1990). This reduction, as expected, is due to the elimination of 8.1$MtCO_2$ of electricity generation emissions resulting from the lignite plant early decommissioning. In addition, there is a 50% reduction in the residential sector (albeit only 2 $MtCO_2$ in absolute numbers) and a 20% reduction in the industrial sector (1.6 $MtCO_2$). This is mostly due to the substitution of oil by NG for the residential sector. Surprisingly both the transport and the energy sectors show increases of 0.8 $MtCO_2$ and 0.6 $MtCO_2$ respectively.

   In the transport sector, which already by 2022 is at 18.2 $MtCO_{2eq}$ (vs. 15.1 $MtCO_{2eq}$ for electricity, the second one) is the largest contributor of GHG emissions, the 2019 NECP foresees lower amounts of passenger transportation (135Gpkm vs 145Gpkm in passenger road transport) but increased energy consumption in road and rail (490ktoe vs. 4200ktoe in the 2018 version). This is reflected also in the increased oil use coupled with lower use of electricity in view of the fact that by 2030 the percentage of BEVs in the fleet is 10.1% in the 2018 NECP and only ca 6.6% in the 2019 NECP (82000 BEVs and PHEVs/yr in 2030). As regards, the energy sector, basically refineries, which also shows an increase of 0.6 $MtCO_2$ from the 2018 version, unfortunately no information is available to determine its cause.

4. The **RES installed capacity** has increased to 19.1GW in 2030 from 17.8GW of the 2018 version (from 10.1GW in 2019), responsible for 66% of net electricity produced (from 26% in 2019) and 56% in the 2018 version. This increase comes from an additional 400MW of wind and 900MW of solar compared to the 2018 version. The large increase of PV is due to the lower PV investment costs used in the 2019 version (€552/kW vs €737/kW already in 2020 with the percentage gap remaining the same in the whole 2020-2030 decade -reaching €420/kW vs €559/kW in 2030). Investment costs of all other technologies are the same. No direct financial incentives are included but large emphasis is placed on streamlining the permitting procedures and the enhancement of the grid to accommodate this considerable increase in wind and PV installations.

5. A further increase of **energy efficiency** is to be achieved, resulting in a 38% reduction of FEC wrt the 2007 projection from 32.5% of the 2018 version. This is accomplished by a doubling of the energy intensity (from 1.5% yearly to 2.9% for the 2019 NECP) and a 7.3% reduction of energy use per family in the residential sector for the 2020-2030 period wrt NECP2018. In the industry sector the use of solid and liquid fuel is reduced by 50% and 35% respectively between the 2 versions, while in the household sector the reduction comes mostly from the enhanced decrease of oil use and, surprisingly, NG due to the energy upgrading of the building stock.

   The energy conservation in the household sector calls for the upgrading of the stock so that by 2030 12-15% has been renovated. That translates into 60000 buildings per year which in the light of the experience of an ongoing very similar project which managed to refurbish 90000 dwellings in eight years, seems administratively overly ambitious. At the same time, ELECTRA a new initiative for the facilitation of the energy upgrading of public buildings (at the mandated 3% per year rate) is included and the further extension of the current private dwelling energy upgrading scheme (Exiconomo) with a budget of €250Mil was just announced. In view of the investment of €1.1Bil/yr for energy efficiency improvements in all sectors inscribed in the NECP, a reasonable estimate of the expected investment per building comes out to ca €10k. This amount seems low and there is a danger that the energy improvements would be so small that they would not even cover increases in use due to the rebound effect, leading to much lower savings than those computed.

   No noticeable differences are seen in the transport and tertiary sectors either as to the total amount or the fuel shares.

   The enhanced energy efficiency is reflected in both the gross inland consumption with the difference between the 2018 and the 2019 NECP increasing from 500ktoe in 2025 to 800ktoe in 2030 with the total amount for both showing a sharp decrease in the first 5-year period of about 1%/yr mostly in the use of solid fuels i.e. lignite, followed by a constant efficiency period until 2035 when an increasing trend of ca 0.5%/yr kicks in. Despite the decrease in gross consumption, the final consumption grows with very low or even zero rates as low efficiency lignite plants are replaced by RES and NG units. The FEC in the 2019 NECP remains virtually constant from 2025 to 2040 at ca. 16200ktoe (w/o bunkers).

6. Of interest is also to examine **Imports**. The 2 main ones, oil and NG (larger by more than an order of magnitude from the others), follow diverging paths as oil decreases in housing, industry and the shutdown of oil fired power stations in the islands, in particular Crete and Rhodes, and NG increases as the consumption in the electricity and the residential sectors increases. The difference between the 2 versions as regards oil comes from the accelerated electrical connection of the islands in the 2019 NECP and increases continuously reaching 10% by 2040. The difference between the 2018 and 2019 NECP of NG imports jumps initially to cover the lignite plant closing but after 2030, the NG imports in the 2019 NECP fall below those of the 2018 one as energy efficiency measures kick in.

   Electricity imports are very close for the 2 versions and remain more or less constant at 400-430ktoe after 2025, well below current levels of ca 750ktoe. It is interesting to note that solid fuel and bioenergy imports (mostly for industry) follow the same pattern as electricity at about 250ktoe a little over half the level of electricity again for both versions. No additional interconnections are included. As a result, the energy import dependence index remains fairly high but with a gradual decrease from ca. 75% to ca 65% by 2040 as RES increase. There seems to be a large decrease in the 2018 NECP from

2025 to 2030 which is mostly due to a decrease in oil consumption as the islands are connected and the households switch fuel to NG.

7. Unlike the previous version, the 2019 one provides information on the **cost of electricity** to consumers (albeit without a concise definition of which customers, retail or wholesale, with or without taxes and fees). The cost remains fairly constant at €130/MWh with a slight decrease reaching €127/MWh by 2030. Its breakdown though changes with the variable cost component decreasing from 33% to 20% by 2030 with a commensurate increase of the transmission and distribution costs.

8. The 2019 NECP calls for 20% more **investment** in the 10-year period 2020-2030 for a total of €43,8Bil (vs €34.7Bil) fairly evenly distributed over the period. The extra amount is primarily invested for adaptation measures in forests and flooding (€5il) and measures to enhance circular economy (€2Bil). An additional amount of €2Bil is included for energy efficiency improvements which is not considered adequate for the refurbishment of the 600000 dwellings called for in the NECP.

9. Both NECPs provide estimates of the **economic benefits from the investments** in RES installations and energy efficiency improvements carried out utilizing Input-Output tables (unfortunately those of 2010) for GVA, jobs, wages and public health. The results are given in Table 2 below.

Table 2: Economic impacts from RES installations and energy improvements in housing

	RES		Energy Efficiency improvement- Buildings	
	2019 NECP	2018 NECP	2019 NECP	2018 NECP
GVA increase (€Bil)	12.6	11	8.3	10
Income increase of those employed in the sector (€Bil)	4.8	4.5	3.4	4
New jobs yearly (1000s)	37.4	30	22	25
Public health gains (1000 DaLY)	19.5	8.5	1.1	17

The benefits are higher in the 2019 version from the RES sector but not from the Buildings sector where there is an order of magnitude difference in DALYs (disability-adjusted life years) most likely a decimal error. The lower values of the 2019 NECP in the buildings sector are surprising in view of the fact that the 2019 calls for the energy upgrading of 12-15% of the stock (vs 10% in the 2018 version) but at a lower unit investment. As the FEC in this sector is lower in the 2019 NECP, this clearly implies that the upgrading will be shallower in the hope that in this way there will be better selection of low hanging fruits (but also higher administrative costs).

10. The number of policies and measures for meeting the ambitious targets set, do not differ noticeably in numbers except the ones that refer to GHG emission reduction which in the 2019 are double in number as can be seen in Table 3 below and include PAMs for adaptation to climate change and for promotion of transition to a circular economy, marine transport and tourism.

Table 3: Number of Policies and Measures to achieve targets		
	2019 NECP	2018 NECP
Emission reduction	15	8
RES installation and utilization	27	31
Energy efficiency	47	51
Energy security	18	19
Internal market	20	20
Agriculture, Tourism, Marine Transport	32	NA
Reserch and Innovation	10	6

11. A further difference is in the **administrative** aspects for the implementation of the NECP that are included in the 2019 version. Heeding to wide criticism during the public consultation of the 2018 NECP, the 2019 NECP includes a detailed plan for a permanent mechanism to follow progress and recommend changes during its 10-year implementation period. A new National Committee for Energy and climate was established by a Ministerial Council Act (MCA 31/30/9/2019) with representatives from all ministries involved, to set policy and provide guidance, a Surveillance Mechanism is to be established with a Working Group to follow progress through KPIs and milestones and monitor all reporting to international organizations, and a Strategic Reference Framework for the planning, constructing and enhancing major electricity and NG grid infrastructure and the utilization of the development funds, national and Community, earmarked for the energy sector.

Detailed listing of the 2018 and 2019 NECP data is provided in the Annex.

1.2. Some Overall Comments

A common **shortcoming** of the revised NECP, which was highlighted in submissions of a wide range of respondents to the public consultation, is the lack of a timetable (let alone a truly realistic one) for the design and implementation of the large number of policies and measures included which are called upon to realize the major structural changes envisioned. This is crucial in view of the only ten-year span remaining till 2030 and the legendary friction of the Greek administration processes.

An additional **shortcoming** is that in the possible sources for investment to cover the ca €4Bil yearly required there is overreliance on EC funds of the 2021-2027 period (mainly Cohesion -€10.2Bil and ERDF €3,6Bil), ESF). Available for Target #2 funding comes out to €7.2Bil including the national co-funding. This indeed is a good start, but it is not clear that it would be adequate to attract private funding to fill the gap to the €43Bil needed.

Another **shortcoming** of the 2019 (but also of the 2018) NECP is the lack of specific PAMs to ameliorate the resistance - sometimes extreme - of local communities to the installation of wind and to a lesser degree large PV installations. This barrier is already causing large delays (reaching 7-10 years) of projects. In view of the doubling of wind installations by 2030 which would exacerbate the problem as installation density in high wind potential areas would increase, specific PAMs to address this should have been included.

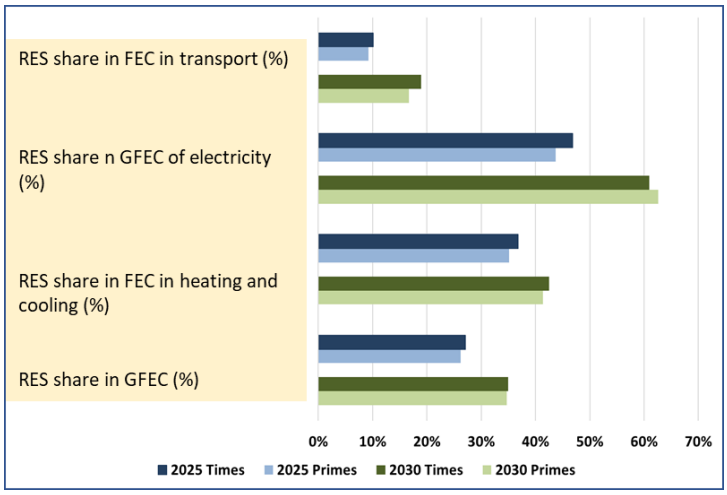
A further **shortcoming** of the 2019 NECP is that it provides very limited sectoral information past 2030. Clearly, the calculations time horizon went further to at least 2040, as information included in the 2018 version certify,

and almost certainly to 2050. It is not clear why this information is not included, as this raises questions of possible abrupt changes after 2030 and makes analysis of the Greek LST 2050 road map difficult in view of the fact that the latter should match predictions (and commitments) until at least 2030.

A final point that needs to be brought up is inre the benefits to be reaped from the very early decommissioning of the lignite plants. Even though, with the addition of the 804MW Mytilinaios NG plant under construction and possibly an additional one of 400-600MW (to be constructed by one or more of the additional five enterprises that have production permits totalling 2900MW already at hand) the installed capacity of NG would cover the mean demand, questions arise as to whether this would be enough to also cover peaks. It should be noted that The Greek TSO in its draft system adequacy report of December 2019 calls for an additional 2400MW (with the 804MW plant included) NG plants in the next 5-8 years. It is worth considering whether the newer lignite plants of Ag. Dimitrios V and Meliti might not be kept in the system two years further as spinning reserve thus providing the time for the wind and PV installations to be realized and avoiding the installation of more than one additional NG plant as the NECP report calls for.

For the 2019 NECP, the TIMES-MARKAL model of the Center for Renewable Source and Energy Efficiency (CRES) was utilized. Computations were also carried out in parallel **utilizing the PRIMES model**. The PRIMES model is the only one utilized for the LTS 2050 results. The large majority of the results included in the 2019 NECP come from the TIMES model computations. The 2019 NECP also includes summary results (in figures only) from the PRIMES computations as well as a comparison with those from TIMES. The exogenous inputs for the basic parameters of GDP, fuel and allowance prices used in PRIMES are not given but it is assumed that they are the same or similar to those used in TIMES. It should be pointed out though that this is not the case in the LTS results as will be discussed later.

The main differences between the results of the two models are: (i) a slightly (2%) higher GHG emissions reduction in PRIMES, (ii) a noticeably lower gross inland consumption of oil (by 23% vs 10%) and higher consumption of NG (by 17% in 2025 dropping to 6% by 2030) in PRIMES, (iii) a higher in 2025 and a lower in 2030 final energy consumption (<2%) with very similar sectoral shares by 2030, (iv) a higher electricity consumption (by <5%) and an slightly lower (by ca. 1.5% reaching 6% for wind and PV) RES installed electricity capacity coupled by a higher (by 3%) RES generation in PRIMES due to much increased (250%) bioenergy utilization and higher capacity factor for wind (30% vs 28%) plus an earlier construction of off-shore plants (see Figure below).



In using the data included in the revised version of the Greek NECP, one should keep in mind that some economic parameters are given in 2010 Euros rather than in 2016 Euros of the 2018 NECP. This might necessitate applying an inflation factor with amounts to 1.07 to convert 2010 Euros to 2016 Euros. The investment figures for the 2020-2030 period are not labelled as to fixed Euro values of a particular year.

2. The Greek Long-term Strategic Energy Plan 2050

2.1. Overview of the Greek LTS Plan 2050

On 10 December 2019, the draft text for the Greek Long-Term Strategy to 2050 (LTS2050) was put out for public consultation which was concluded on 27 December 2050. The text is 78 pages long and provides commensurate information.

As stated in the LTS text its "The purpose of PM50 is to evaluate alternatives and transition paths to an economy that will approach climate neutrality. The aim of the measures and policies is to drastically reduce greenhouse gas emissions by 2050 and to develop two strategies, and the other aimed at reducing emissions, as required in the pursuit of 2^{o}C (i.e. EU reduction by 80-85%), and one aimed at climate neutrality. to reduce emissions for the purpose of 1.5^{o}C (i.e. EU reduction by >95%)". Furthermore, it follows the widely accepted premise that the reductions can follow a (approximately) linear trajectory from 2030 to the 2050 target of near zero emissions.

The LTS 2050 utilizes the PRIMES model to examine 6 scenarios and declares that "The analysis of the solutions and the indicative pathways is intended to assess the potential for transformation of the energy system at national level and not to decide on a specific solution among those considered" and that "All the PM50 scenarios consider the achievement of the NECP objectives by 2030 as a given, assume full implementation of the NECP policy priorities and measures and do not include additional measures for the period 2020-2030".

The six scenarios examined are

1. NECP2030: The PAMs of NECP continue to operate till 2050 but no new ones are applied
2. NECP2050: The same PAMs of NECP continue to operate till 2050 but are enhanced appreciably
3. EE2: Energy efficiency and Electrification (i.e. replacement of fossil fuels by electricity, conservation and circular economy) to meet the 2^{o}C target
4. NC2: New energy Carriers (i.e. H_2, biogas, synthetic CH_4 and also conservation etc) to meet the 2^{o}C target
5. EE1.5: Energy efficiency and Electrification to meet the 1.5^{o}C target
6. NC1.5: New energy Carriers to meet the 1.5^{o}C target

All six scenarios incorporate the following policy priorities also included in the NECP:

1. Improving energy efficiency in all sectors, with a focus on large-scale energy upgrading of homes and buildings;
2. Development of RES use in all sectors and in particular in the field of power generation, along with zero carbon dioxide emissions from combustion of solid fuels in power generation;
3. Electrification of transport and heat along with the reduction of the carbon footprint of electricity;
4. Development of domestic biomass fuels and gas by advanced techniques
5. Further expansion of interconnections for electricity and gas systems and completion of the coupling of markets in the wider region.

Turning first to the evolution of **major exogenous parameters** imputed, the major one that differentiates the LTS 2050 from the NECP is the price of carbon which is shown in Table 4 below.

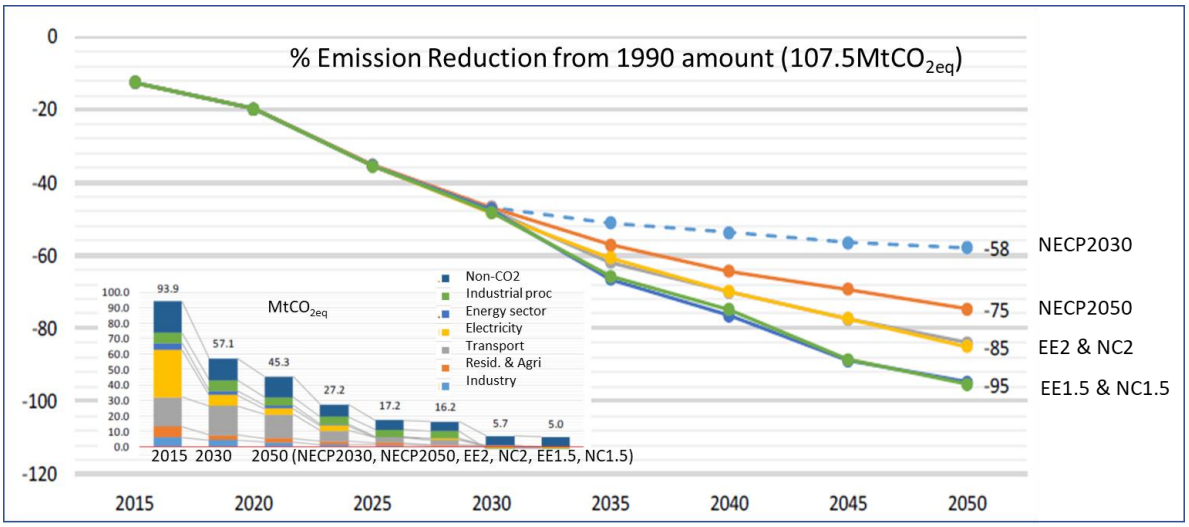
Table 4: Carbon price evolution (€$_{2016}$/tCO$_2$)								
	2015	2020	2025	2030	2035	2040	2045	2050
NECP	7.5	24	28.8	31.2	43.5	51.7	72	88
LTS 2050 scenarios ALL	7.5	24	28.8	31.2	64	127.5	183	380

The price follows the NECP trajectory till 2030 and explodes afterwards with a doubling of its value in the next 5 years with this extraordinary rate of increase continuing till 2050. These values are in line with the ones that were used in the In-depth analysis of the EC in support of the Commission Communication COM (2018) 773 of 28 November 2018. It is not clear whether this is exogenously specified in which case a justification is necessary, or is the nominal value resulting from imposed constraints of emission reduction in the modelling. Such doubling of price in 5 years would require political will to modify the MSR and allocation rules, of strength not demonstrated before in the EU. It also raises questions as to the scope (will it be extended to transport and the rest of industry?) and the efficacy of the current structure of the ETS system past 2030 (would a mixed tax/trading system and border adjustment be necessary?). These high prices affect crucially the electricity sector and also to a lesser degree the industrial sector.

The same is true for the scenario of the NG price evolution. Here there is also a difference with international prices being lower than the NECP, not only after 2030 (€ 338382/toe vs € 317/toe) but also from 2020 onward (€ 284327/toe vs € 258/toe). This parameter also has a significant impact on the evolution of the energy sector and, in particular, of the electricity mix.

Finally, the LTS2050 computations assume cost prices of RES technologies (Annex, Chapter 6.1 of the LTS 2050). These values come from the 2018 ASSET program and are overestimated compared to those in the 2019 NECP for both wind (20-25%) and PV (30%).

Turning next to the main results, the **GHG emissions** are seen (Figure below) to reach the average EU targets for both 2°C (83-84% reduction) and 1.5°C (94-95% reduction) only for the EE and NC scenarios and not for the NECP 2030 and NECP 2050 ones, which shows the clear need to rely on massive electrification, energy efficiency and synthetic fuels as even the enhanced existing PAMs of NECP 2050 only lead to ca 73% GHG emissions reduction.



It should be pointed out that the remaining emissions are in the majority non-CO_2 gases and are not attributable to the energy use. This is shown in the GFEC which is almost entirely covered by RES generation (96-99% in the 1.5°C scenarios). In addition, in the 1.5°C scenarios only, CCS is included for the mostly NG electricity plants totalling 1.2GW and 1.9GW with 6.9MtCO_2 and 10 MtCO_2 of GHG captured respectively.

The **Final Energy Consumption** in the four EE and NC scenarios vary between 10.6 and 13.0Mtoe lower than the two NECP ones (13.4 and 14.9Mtoe) in 2050 which is lower than the 16.1Mtoe in 2030 which again is lower than the NECP 2019 one (17.4Mtoe and 16.3Mtoe w/o bunkers and HPs) in 2030. The distribution by activity sector from 2030 to 2050 again does not show large variations; it is dominated by transport (38-41%) followed by residential (22-25%) and industry (19-21%). The fuel distribution is more interesting; to reach near zero emissions, the oil and NG use decreases to almost zero in the 1.5°C scenarios with the electricity and RES (which includes H_2, biogas and synthetic CH_4) taking over 95% in the 1.5°C scenarios, but with different ratios (60/40 for EE and 49/51 for NC due to the emphasis of the EE one on electricity).

RES as is to be expected has a central role with all technologies contributing (but with wind and PV constituting between 71% and 85% of the total) reaching up to 63.9GW for NC1.5°C (from 19.1GW in 2030 and 8.5GW in 2015). In Table 5 below the RES installed capacity and production is shown. The difference between the EE and NC scenarios is striking (almost double) for both RES electricity generation installed capacity and production.

Table 5: RES electricity installed capacity and production (and % to total)

	Installed (GW)		Production (TWh)	
	2030	2050	2030	2050
NECP2030 (LTS)	19.1 (73%)	24.8 (78%)	40.6 (67%)	60.4(86%)
NECP2050 (LTS)	19.1 (73%)	26.5 (80%)	40.6 (67%)	67.7 (89%)
EE 2°C (LTS)	19.1 (73%)	28.7 (84%)	40.6 (67%)	78.5 (93%)
NC 2°C(LTS)	19.1 (73%)	49.9 (92%)	40.6 (67%)	121.2 (91%)
EE 1.5°C (LTS)	19.1 (73%)	33.9 (87%)	40.6 (67%)	84.7 (88%)
NC1.5°C(LTS)	19.1 (73%)	63.9 (89%)	40.6 (67%)	145.4 (87%)

This very large RES capacity is used to generate H_2 and to a lesser extent synthetic CH_4 both for direct use and for storage. In all scenarios the use of pumped storage is limited and does not exceed 1.7GW (from 0.7GW currently) whereas the electrolysis installations in the 2 NC scenarios reach 15.1GW and 23.5GW respectively. It is thus clear that the difference between the EE and NC scenarios is in the use of electricity which in the NC scenarios is almost double from that of the EE ones, with the additional amount going to produce H_2 and CH_4 whose use is almost non-existent in the EE scenarios (see Table 6 below); the opposite is true as regards natural NG and biomass (also with over 40% going to generate biofuels and biogas). This biomass (ca 450-475ktoe in the EE and NC scenarios) will be produced by cultivation of energy crops (ca 40%) and agricultural residues (ca 30%).

Table 6: Persentage use in FEC

	2030	2050					
		NECP2030	NECP2050	EE 2°C	NC 2°C	EE 1.5°C	NC1.5°C
Electricity	27%	32%	39%	48%	46%	59%	48%
Biomass	8%	10%	8%	29%	22%	34%	19%
Synthetic fuels	0	0	0	1%	17%	1%	30%
Fossil fuels	66%	59%	53%	22%	15%	7%	4%

These extremely large amounts of stochastic renewables require means to meet demand when their production is low. This is addressed in the EE and NC scenarios primarily by the use - in order of importance - of H_2 and e-gases directly and from their **storage** primarily but also from **batteries** and pumped hydro. The NECP scenarios do not include H_2 and e-gas use.

The LTS 2050 Roadmap also assumes that **imports** will play a role in meeting low RES production through increased interconnections which will reach 6.9-7.1GW capacity by 2050 from 2.5GW currently. Although it is mentioned that in the long term, Greece will be a net exporter, the tables indicate a net import of 3.4TWh uniformly in all 6 scenarios. No information is included on whether these comments and values are based on modelling that takes into account the evolution of the electricity sector in the neighboring countries similar to that carried out in SEERMAP and now in the ECF commissioned delignitization study.

As the FEC is reduced going forward to 2050 from 2030, this is based on substantial **energy efficiency** increases especially in the EE scenarios. In the Residential sector this calls for large energy upgrading of the existing stock and near-zero energy consumption in new buildings. The LTS 2050 plan (see Table 7) calls for a rate of upgrading, mostly by increased insulation of the building envelope, that is very close to the one for the 2020-2030 period (1.3%/yr), with the EE scenarios somewhat higher and the NC scenarios lower. In the buildings of the tertiary sector these rates are lower (ca. 0.78% to 0.94% an increase from 0.57% for the 2020-2030 period). This leads to values of FEC per area of 31.3kWh/m^2 and 40.6kWh/m^2 for the EE scenarios and much higher of 44.1kWh/m^2 and 57.2kWh/m^2 for the NC ones (from 60.5kWh/m^2 in the 2020-2030 period). There is a change of modes energy with heat pump use doubling and the use of gas (of all kinds) increasing by 20% matching an almost equal reduction of biomass. Individual room space heating units (mostly electric) all but disappear (a 90% reduction).

Table 7: Upgrading Schedule for Buildings (1000s)

	2011 Sensus	2021-2031	2031-2050					
		NECP	NECP30	NECP50	EE2	NC2	EE1.5	NC1.5
Existing Building Stock	4105k							
Residential	3179							
Upgraded		600	728	856	913	872	1136	956
Remaining			1904	1775	1719	1759	1495	1675
Tertiary	908							
Upgraded			19	31	35	33	42	37
Remaining			96	84	80	83	73	78

Whereas in the **industrial sector** there is very small potential for energy efficiency improvements as all the low hanging fruits have been picked in the 2020-2030 period, there is room in the **transport sector** mainly through the introduction of electric vehicles. Thus, even though the transportation load increases from 148Gpkm in 2015 and 185Gpkm in 2030 to 218-224Gpkm in the 6 scenarios for passenger vehicles and similarly from 46.5Gtkm (2015) and 58.3Gtkm (2030) to 70-74.3Gtkm for commercial cargo, FEC is reduced from 9770ktoe in 2030, to 6835-7855ktoe for the 4 EE and NC scenarios, with the former lower by 10-15%. This is made possible by a drastic change in the composition of the vehicle fleet and especially the electric ones which from virtually zero in 2015 and 450k in 2030 reach 4712k and 4823k passenger vehicles for the 2^{o}C scenarios and 7861k and 7178k for the 1.5^{o}C ones. At the same time the use of internal combustion engines decreases from 6496k vehicles in 2030 to 123k and 395k for the EE1.5^{o}C and NC1.5^{o}C scenarios. This is not the case for the bus-truck fleet which remains mostly with internal combustion engines which though use mostly biodiesel and biofuels, natural and synthetic, with the use of fossil fuel reaching very small percentages in the 1.5^{o}C scenarios as can be seen in Table 8 below.

Table 8: Persentage of fuel use in Transport								
	2015	2030	2050					
		NECP2030	NECP2030	NECP2050	EE 2°C	NC 2°C	EE 1.5°C	NC1.5°C
Electricity	1%	2%	7%	14%	20%	16%	28%	19%
Biofuel & biogas	2%	6%	7%	35%	53%	36%	67%	27%
Synthetic fuels	0	0	0.0009849	2%	2%	27%	3%	53%
Liquid Fossil fuels	97%	90%	81%	40%	22%	18%	1%	1%
NG	0%	2%	5%	9%	4%	3%	1%	0%

The **investments** necessary for this energy sector transformation are substantial and range from €19.24Bil/yr for the NECP30 to €23.56Bil/yr for the NC1.5 and represents 5.44% for the NECP2030 scenario increasing almost linearly to 6.65% of GDP for the NC1.5 one, an enormous amount to be attracted on a yearly basis over 20 years. Of that, the major sector in terms of investment needs is transport with 64% for NECP2030 to 56% for NC1.5 in 2050, followed by residential equipment purchases with 19% for NECP2030 decreasing to 16% for NC1.5 respectively. The energy supply and demand sector amount vary between €1.51Bil/yr and €2.97Bil/yr for the 5 scenarios and €4.03Bil/yr for the NC1.5 one, to be compared with the €3.68Bil/yr of the NECP 2019.

Ii should be noted that the LTS2050 starts with the total investment cost in 2030 of the 2018 NECP (€34.7Bil over the 10-year period) rather than the final 2019 NECP amount which is higher reaching €36.8Bil for the same categories.

The LTS 2050 Roadmap also includes information on the **cost of electricity** to consumers which declines from €130/MWh in 2030 to near €105-110/MWh by 2050 with the NC scenarios in the lower end. As mentioned above, the ratio of OPEX to CAPEX goes from 44/52 in 2030 to 18/49 in 2050. In view of the enhanced interconnections mentioned and the coupling of the energy markets, this value needs to be compared with the prices of the neighboring countries, both MSs and outside the EU, as there cannot be substantial price differential. This makes imperative either the inclusion in the modelling of the neighboring countries or the elaboration of a sensitivity analysis to determine the changes to the cost of electricity by higher imports. The regional interconnectors are also important in better estimating the need for and cost of the additional storage required vis-a-vis a further increase of interconnector capacity, taking into account the covariance of stochastic RES production.

2.2. Some Overall Comments

It should be appreciated that the LTS 2050 Roadmap version analysed above is the version put out for public consultation. The haste to do so before the end of 2019 so as to meet the 1 Jan 2020 EU deadline has resulted in a number of **shortcomings**, in addition to what has been mentioned above on specific parts.

The first, and most serious is the omission of the summary tables for each scenario which should have been included in Section 6.2 of the Annex (currently empty) as was obviously the intension. The second, not necessarily in order of importance, is the large number of errors many of which would have been corrected with a more careful proofreading (reference to figures that do not exist, data lists that do not sum correctly, unit mislabelling, etc.). The third is the lack of energy balances (the corresponding section 6.2 in the Annppex is empty), not even in the summary sheets used in previous PRIMES reports to EC or the ones in the NECP.

These would have made things much easier to track and compare. The fourth is the incidental and limited information on the evolution from 2030 to 2050, information which clearly was available and again is included in the 2018 NECP at least for 2040. This lack of complete trajectories from 2020 to 2050 and beyond if possible, does not help the considerable number of enterprises especially in the energy sector are trying to decide on investments that have life cycles of 30 and 40 years. In this respect it would have been interesting to have the results of TIMES for at least the NECP and EE scenarios till 2050 to compare. The fifth is the discontinuity between these results and those of the NECP, which is partially due to the philosophy and structure of the model itself as well as to the exogenous inputs.

In addition to the above, the LTS 2050 Roadmap as presented **is not in compliance** with Art. 15 and Annex IV of Directive 2018/1999 as it does not include any information on the Impact of the Socio-economic aspects or PAMs on related research, development and innovation.

It is interesting here to mention the comments submitted in the public consultation process. Of the 29 comments submitted, 20 were from individuals and only 9 from societies/organizations/enterprises. Of the 20, four were from the same person who noted the (real) problems on defining biogas and especially its synthetic versions, seven suggested more and better utilization of NG (and CNG), four together with the Greek Ornithological Society were just against wind and others complained about the too high FIT prices, the very limited time for consultation (true), the unrealistic cost of BEVs and the underutilization of forest sinks. Of the institutional ones, PPC's only comment was the over-reliance on synthetic fuels not justified in view of the high costs vs other storage means, as opposed to the Union of PPC Engineers who submitted a long analysis that stresses the unrealistic (in their view way too fast) timetable for RES installation and lignite decommissioning, points out the need for more storage (not using H_2 or e-gases) and asks for support of energy crops in lignite regions and more participation of domestic industry in RES equipment production; the Greek Association of Electricity Producers considered the LTS 2050 as good overall and asked for more information on CCS costs and suggested the use of green bonds; the 2 Biogas Associations again stress the benefits of biogas utilization and the problems from the definition vagueness; the Institute of Energy in Southeast Europe is positive but asks for much more detail on scenario description; and finally WWF together with Greenpeace after regretting the very limited time allotted for responses, submitted a long list of items which are well worth repeating, i.e.

- only the 1.5^{o}C scenarios should be included
- the reliance on H_2 and synthetic CH_4, which are very expensive, is unreasonable
- the prices for PV are too high
- the possibility of extensive use of energy crops for biofuel is not given due consideration
- NG and oil price trajectories are overestimated
- There is no mention of LULUCF measures
- GDP growth rate is too optimistic
- No sensitivity analysis on the exogenous parameters including on capex costs has been carried out
- No estimates of impacts on society (e.g. health, infrastructure etc.) and no analysis on how to address them are included
- No discussion of energy poverty aspects is available

as all these points are valid.

Looking at the LTS2050 Roadmap in toto, a number of conclusions can be drawn.

1. Based on the results of the model computations, the policies and measures included in the NECP, even if an effort is made to enhance their scope, result in reductions of the order of 75% or less by 2050, substantially away from the 85% of the 2°C target let alone the >95% of the 1.5°C target reached by the EE and NC ones. This points out the need for investigating additional and/or different PAMs than those in the NECP.

2. The difference in investments needed over the 20-year period to go from 75% to 95% reduction is less than 20%. Based on that alone, the cost-benefit ratio would lead to giving preference to the EE scenarios which reach almost the same reduction with the NC scenarios at lower investment needs; in particular the investment for EE2 scenario is almost the same as that of NECP2050 (€10.16Bil/yr vs €20.47Bil/yr) even though the emission reduction goes from 75% to 85%.

3. The inclusion of huge amounts of RES in the NC scenarios vs. the EE ones (63.9GW vs 33.9GW in the 1.5°C scenarios), necessary for the production of H_2 and synfuels, which would need to overcome strong social reactions coupled with the increased cost and virtually the same GHG reduction, militates against this option which leads to the EE scenarios as the most plausible.

4. Even though the cost figures for the New Carriers (H_2, synfuels, storage etc.) are provided in the Annex (Tables 16 & 17 of the LTS 2050 annex), no documentation for them is provided except a reference to the PRIMES model itself. This increases uncertainty especially in the NC scenarios which would make their use in guiding policy very difficult.

5. The scale of works necessary for reaching near zero emissions is so large and profound that the political leadership (with its short horizons) needs to be nudged into putting in place long-term structures for this transformation of the economy. The same holds for the attraction of investments. As this is a EU-wide transition, the political leadership should continue carrying out such analyses and modelling including their updating and spend the effort to fully understand the messages and limitations for use in the very difficult negotiations for the European Green Deal that start immediately.

6. Greece has lost numerous opportunities to participate in the production of RES equipment in the past. In view of these results, it is important to design policies so as to increase the local content of these technologies and the benefits to local and national economy. Such policies should include training of technical personnel and support of research and innovation in both enterprises and academia/research centers.

In conclusion, despite the many shortcomings presented above, the Greek LTS 2050 Roadmap does provide a very useful mapping of the possibilities and difficulties to transform the Greek economy toward a near zero GHG emissions state by 2050, that is in the next 30 years. This 30-year period might look long-term but in reality, it has become almost tomorrow. The LTS 2050 also lays out the main approaches, i.e. enhancement of the PAMs already catalogued in the 2019 NECP, an aggressive conservation and rational use of energy and the massive introduction of H_2 and synthetic fuels, for the future of the energy sector past 2030 mainly and as it affects all the other sectors all society, the whole development of the economy. In this way, it provides

both a compass and a impetus for the political system to start thinking past the 4-year cycle in view of their obligations to future generations.

Detailed listing of the LTS 2050 Greek Roadmap together with the corresponding 2018 and 2019 NECP data is provided in the Annex.

3. Annex

In this Annex the major quantitative information of the energy supply and demand together with the resulting GHG emissions for the period to 2050 that is included in the 2018 and 2019 versions of the NECP and the LTS 2050 Roadmap are presented in a fashion that facilitates easy comparison. It includes (i) major exogenous parameters that are imputed in the models, (ii) summary energy balances, (iii) selected principal indices, (iv) electricity installation and generation data, (v) energy use in the main four activity sectors namely residential, tertiary, industry and transport, and (vi) investments.

3.1. General Input parameters

General Input parameters								
	2015	2020	2025	2030	2035	2040	2045	2050
GDP								
NECP-2018 (Million €2016)	176,920	191,554	210,054	229,652	251,078	270,482		
NECP-2018 (Million €2010)	184,311	200,082	221,662	244,733				
LTS2050 (Million €2016)				238,126	261,938	286,822	312,636	340,774
GVA								
NECP-2018 (Million €2016)	143,567	153,764	167,991	183,592	200,629	215,732		
NECP-2018 (Million €2010)	165,151	177,986	202,347	223,407				
LTS2050 (Million €2016)								
Population (1000)								
NECP-2018	10,858	10,594	10,285	9,979	9,705	9,456		
NECP-2019	10,858	10,691	10,538	10,368				
LTS2050				10,392	10,225	10,046	9,861	9,663
Number of Households (1000)								
NECP-2018	4,081	4,039	3,977	3,915	3,864	3,821		
NECP-2019	4,120	4,076	4,081	4,107				
LTS2050								
Crude Oil [€2016/GJ]								
NECP-2018	6.80	11.90	15.73	17.33	18.08	19.14		
NECP-2019		11.90	15.73	17.33				
LTS2050		9.70		14.33	15.41	16.36	16.84	17.13
Natural Gas [€2016/GJ]								
NECP-2018	4.66	7.59	9.64	10.49	11.20	11.58		
NECP-2019 (with transport cost)		6.8 (7.8)	7.71 (8.7)	8.12 (9.1)				
LTS2050		6.16		7.57	7.88	8.36	8.84	9.08
Coal [€2016/GJ]								
NECP-2018	2.16	2.85	3.16	3.79	4.01	4.18		
NECP-2019		3.31	4.37	4.81				
LTS2050		2.15		2.68	2.87	2.99	3.10	3.27
ETS allowance prices [€2016/tCO2]								
NECP-2018	7.76	15.52	23.28	34.66	43.45	51.73		
NECP-2019		24.00	28.77	31.23				
LTS2050				31.20	64.00	127.50	183	380

3.2. Summary Energy Balance

Summary Energy Balance [ktoe] - 1												
	NECP-2018 and NECP-2019						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
Primary Energy Production												
NECP-2018	6762	6475	6068	8052	7872	8630						
NECP-2019		5799	6031	7021	8145	9128						
Solid fuels												
NECP-2018	3973	3561	2234	2109	1030	896						
NECP-2019		2180	940	1	2	2						
Oil Products												
NECP-2018	218	281	408	536	536	536						
NECP-2019		281	408	536	536	536						
Natural Gas												
NECP-2018	10	21	48	64	64	64						
NECP-2019		21	48	64	64	64						
RES												
NECP-2018	2562	2613	3379	5343	6242	7134						
NECP-2019		3317	4615	6420	7543	8526						
Net Imports												
NECP-2018	19046	19326	18816	17142	17472	17315						
NECP-2019		19985	18440	17406	16366	15907						
Solid fuels												
NECP-2018	397	230	229	231	234	223						
NECP-2019		158	137	152	179	186						
Oil Products												
NECP-2018	14331	13882	13307	12178	11925	11623						
NECP-2019		13774	12742	11612	11125	10647						
Natural Gas												
NECP-2018	3480	4400	4491	3934	4582	4501						
NECP-2019		5230	4784	4800	4238	4230						
Electricity												
NECP-2018	756	533	447	357	298	446						
NECP-2019		533	425	394	411	429						
LTS2050				411			292	292	292	292	292	292
Bioenergy												
NECP-2018	135	281	342	442	434	521						
NECP-2019		290	351	448	413	415						
International Marine Transport (oil)												
NECP-2018	1719	1922	2063	2175	2292	2416						
NECP-2019		1931	2111	2237	2369	2516						
Gross Inland Consumption												
NECP-2018	24142	23879	22822	23020	23052	23529						
NECP-2019		23853	22360	22190	22142	22519						
LTS2050			20200	18800			15600	16000	15600	20800	15600	24000
Solid Fuels												
NECP-2018	4370	3790	2463	2340	1264	1120						
NECP-2019		2339	1097	153	181	188						
Oil Products				0			0	0	0	0	0	0
NECP-2018	12830	12241	11653	10540	10169	9743						
NECP-2019		12124	11039	9912	9292	8667						
LTS2050			8400	6500			3000	1200	400	1200	100	1200
Natural Gas												
NECP-2018	3490	4421	4539	3998	4646	4565						
NECP-2019		5250	4832	4864	4302	4294						
LTS2050 (incl synth)			5800	5100			3800	3600	1600	2400	1400	3400
Electricity												
NECP-2018	756	533	447	357	298	446						
NECP-2019		533	425	394	411	429						
RES												
NECP-2018	2637	2894	3720	5785	6676	7655						
NECP-2019		3608	4966	6868	7956	8942						

Summary Energy Balance [ktoe] - 2 Final energy Consumption												
	NECP-2018 and NECP-2020						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
Final Energy Consumption by sector												
NECP-2018	16941	17494	17822	18043	18195	18477						
NECP-2019 (w/o bunkers & HPs)		16291	16286	16297	16050	15975						
LTS2050 (w/o bunker)			16700	16129			14890	13451	12081	12983	10632	12184
Industry												
NECP-2018	3073	3391	3372	3447	3536	3608						
NECP-2019		3011	2943	2879	2930	2968						
LTS2050				3086			2878	2935	2506	2819	2373	2660
Residential												
NECP-2018	4326	4518	4549	4595	4615	4693						
NECP-2019		4691	4480	4465		4253						
LTS2050				3931			3500	3279	2981	3190	2346	3018
Tertiary												
NECP-2018	2235	2181	2314	2441	2539	2634						
NECP-2019		2177	2331	2451	2576	2643						
LTS2050				2096			2202	1934	1736	1858	1577	1711
Transport												
NECP-2018	6789	6868	7026	6957	6884	6887						
NECP-2019 (w/o bunkers)		6997	7163	7066	6887	6815						
LTS2050				6808			6092	5103	4663	4925	4149	4616
Agriculture												
NECP-2018	519	535	561	603	622	655						
NECP-2019		459	487	523	523	529						
LTS2050				208			218	200	195	191	187	179
Final Energy Consumption by fuel												
NECP-2018 (with Bunkers &HPs)	16941	17494	17822	18043	18195	18477						
NECP-2019 (with Bunkers &HPs)		17336	17406	17384	17244	17208						
NECP-2019 (with Bunkers)		16926	16713	16508	16227	16121						
LTS2050 (w/o Bunkers &HPs)				15947			15096	13651	12305	13109	10652	12027
Solid Fuels												
NECP-2018	199	230	232	233	236	226						
NECP-2019		160	139	153	181	188						
LTS2050				0			0	0	0	0	0	0
Oil Products												
NECP-2018	9495	9661	9234	8436	8076	7649						
NECP-2019		9287	8551	7750	7190	6624						
LTS2050				7247			5472	2061	1039	1618	28	32
Natural Gas												
NECP-2018	1048	1346	1750	2025	2243	2487						
NECP-2019		1244	1597	1759	1933	2031						
LTS2050				1711	0	0	1792	1915	1245	712	406	97
Electricity												
NECP-2018	4597	4497	4463	4671	4840	5031						
NECP-2019		4612	4680	4852	5143	5383						
LTS2050				4974			5653	5981	5684	5757	6071	5711
LTS2050				5131			5825	6142	5841	5911	6221	5854
District Heating (solid fuels)												
NECP-2018	51	47	45	38	38	33						
NECP-2019		43	41	39	37	35						
LTS2050				49			38	25	22	23	16	21
RES (direct use)												
NECP-2018	1552	1713	2099	2640	2761	3051						
NECP 2019 (direct use)		1580	1705	1955	1743	1860						
NECP 2019 Heat pumps		410	692	876	1018	1027						
LTS2050				1966	0	0	2141	3669	4315	4999	4131	6166

Summary Energy Balance [ktoe] - 3 Energy sector												
	NECP-2018 and NECP-2020						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
Energy Consumption for Electricity Production												
NECP-2018	7405	6513	5184	4715	4666	4861						
NECP-2019		6605	4331	3671	3562	3959						
Solid Fuels												
NECP-2018	4160	3270	2467	2179	1085	894						
NECP-2019		2178	959	0	0	0						
Oil Products												
NECP-2018	892	592	430	234	222	212						
NECP-2019		746	431	140	120	90						
Natural Gas												
NECP-2018	2233	2605	2178	1411	1835	1595						
NECP-2019		3608	2816	2666	1929	1763						
Bioenergy												
NECP-2018	119	47	110	349	405	465						
NECP-2019		72	125	322	394	410						
Geothermal												
NECP-2018	0	0	0	542	1119	1695						
NECP-2019		0	0	542	1119	1685						
Energy Consumption of Energy Sector												
NECP-2018	1961	1424	1473	1596	1635	1635						
NECP-2019		1602	1583	1574	1523	1500						
Oil Products												
NECP-2018	1802	1245	1255	1256	1256	1257						
NECP-2019		1443	1414	1379	1344	1308						
Electricity												
NECP-2018	145	163	164	176	165	167						
NECP-2019		100	100	103	104	107						
Bioenergy												
NECP-2018	0	26	36	179	186	182						
NECP-2019		59	69	92	76	86						
Net Electricity Production												
NECP-2018	4158	4426	4467	4778	4989	5033						
NECP-2019		4504	4667	4920								
LTS2050				5202			6071	6561	7197	11470	7790	13310
Losses & Auto-consumption in Electricity Production												
NECP-2018	443	548	489	428	424	394						
NECP-2019		498	433	419	347	337						
Non-energy Uses												
NECP-2018	593	765	765	765	765	765						
NECP-2019		765	765	765	765	765						

3.3. Indices

Indices - GHG emissions												
	NECP-2018 and NECP-2019						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
Total GHG Emissions (Mt CO_2 eq)												
NECP-2018	91.6	87.1	76.3	70.6	65.4	62.1						
NECP-2019		82	69	61	58	55						
LTS2050			69.5	57.1			45.3	27.2	17.2	16.2	5.7	5
ETS Emissions												
NECP-2018	46.3	39.7	29.7	26.1	21.4	20						
NECP-2019		36	26	19	17	16						
LTS2050												
Non-ETS Emissions												
NECP-2018	44.9	47.4	46.6	44.5	44	42.1						
NECP-2019		46	44	42	41	38						
LTS2050												
GHG Emissions Reduction wrt 1990 (103.1Mtoe)												
NECP-2018	11%	16%	26%	32%	37%	40%						
NECP-2019		20%	33%	41%	44%	47%						
LTS2050				45%			56%	74%	83%	84%	94%	95%
CO_2 Emissions by Sector (Mt CO_2)												
NECP-2018	71.1	67	56.7	51.2	45.7	43.4						
NECP-2019		60.9	49.2	40.6	38.1	36.2						
LTS2050				42.9			31.9	19.5	11.2	10.2	-0.3	-1.0
Electricity												
NECP-2018	31.3	27.9	18.5	14.7	9.9	8.1						
NECP-2019		22.6	12.7	6.6	4.8	4						
LTS2050				7.0			3.6	3.0	0.2	1.3	-0.6	-0.6
Energy Sector												
NECP-2018	5.6	3.6	3.8	3.8	3.8	3.7						
NECP-2019		4.7	4.6	4.4	4.3	4.2						
LTS2050				2.5			2.1	0.8	0.2	0.1	0.0	0.1
Industry (with process emissions)												
NECP-2018	11.3	10.9	10.2	10.4	10.6	11.2						
NECP-2019		9.9	9.4	8.8	8.7	9.0						
LTS2050				11.3			8.2	6.6	6	4.6	-0.1	-0.6
Residential												
NECP-2018	4.7	5.8	5.4	4.9	4.9	4.6						
NECP-2019		4.9	3.5	2.9	2.9	2.5						
LTS2050				3.2			2.4	1.9	1.4	0.6	0.2	0.0
Tertiary												
NECP-2019	1.1	1.9	1.8	1.7	1.6	1.6						
NECP-2019		1.4	1.5	1.4	1.3	1.2						
LTS2050												
Transport												
NECP-2018	17.1	17	17	15.7	14.9	14.2						
NECP-2019		17.4	17.5	16.5	16.1	15.3						
LTS2050				18.8			15.6	7.1	3.5	3.0	0.2	0.1
Total GHG emission Intensity (kt CO_2 eq/ktoe)												
NECP-2018	3.8	3.6	3.3	3.1	2.8	2.6						
NECP-2019		3.4	3.1	2.7	2.5	2.4						
LTS2050												

Indices - 2 RES, FEC, Dependency												
	NECP-2018 and NECP-2019						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
RES in Gross Final Energy Consumption [%]												
NECP-2018	15.20%	18%	23%	31.5%	33%	35%						
NECP-2019		20%	27%	35%	38%	41%						
LTS2050				35%			48%	67%	82%	96%	99%	114%
RES in Heating/Cooling Final Energy Consumption [%]												
NECP-2018	24.20%	25%	28%	32%	33%	34%						
NECP-2019		31%	37%	43%	43%	43%						
LTS2050				41%			44%	54%	60%	81%	80%	93%
RES in Gross Electricity Consumption [%]												
NECP-2018	23.80%	29%	41%	56%	61%	63%						
NECP-2019		29%	47%	61%	70%	72%						
LTS2050				64%			82%	86%	105%	104%	97%	96%
RES in Final Energy Consumption in Transport [%]												
NECP-2018	1.70%	6%	9%	20%	29%	40%						
NECP-2019		7%	10%	19%	29%	41%						
LTS2050				17%			51%	230%	340%	290%	495%	330%
Energy Import Dependence [%]												
NECP-2018	74%	75%	76%	68%	69%	67%						
NECP-2019		78%	75%	71%	67%	64%						
LTS2050							60%	48%	38%	27%	34%	23%
FEC Reduction wrt 2007 projection (%)												
NECP-2018		34%	33%	32%	31%	30%						
NECP-2019		38.6%	38.6%	38.6%	38.8%	38.8%						
LTS2050				39%			44%	49%	54%	51%	60%	54%
Energy Intensity [mil. € '16/ktoe]												
NECP-2018	7.31	8.02	9.2	9.98	10.89	11.5						
NECP-2019		8.98	10.60	11.80	13.05	14.04						
LTS2050				13.1			23.1	22.2	22.2	16.9	23.1	14.8
Primary Energy Consumption per capita [toe/cap]												
NECP-2018	2.18	2.18	2.14	2.23	2.3	2.41						
NECP-2019		2.16	2.05	2.07	2.1	2.17						
LTS2050				2.3			1.6	1.7	1.6	2.2	1.6	2.5

3.4. Electricity

Electricity Generation Installed Capacity [GW]												
NECP-2018 and NECP-2019							NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
Solid Fuels (Lignite)												
NECP-2018	3.9	3.4	3.5	2.7	1.5	1.3						
NECP-2019		3.9	0.7	0								
LTS2050				0			0	0	0	0	0	0
Oil Products												
NECP-2018	1.7	1.8	1	0.5	0.1	0.1						
NECP-2019		1.9	1	0.3								
LTS2050				0			0	0	0	0	0	0
Natural Gas												
NECP-2018	5.2	5.2	5.2	5.4	4.9	4.6						
NECP-2019		5.2	6.9	6.9								
LTS2050				7.1			7.1	6.5	5.3	4.3	4.9	7.9
Bioenergy												
NECP-2018	0.1	0.1	0.1	0.3	0.3	0.4						
NECP-2019		0.1	0.1	0.3								
LTS2050			0.2	0.6			0.6	0.7	0.7	1	0.8	1.1
Hydro												
NECP-2018	3.4	3.4	3.7	3.9	3.9	4						
NECP-2019		3.4	3.8	3.9								
LTS2050			4.2	4.6			4	4	4.5	5	4.7	5.1
Wind												
NECP-2018	2.4	2.8	4	6.6	7.3	7.4						
NECP-2019		3.6	5.2	7								
LTS2050			4.6	6.5			10.3	11.6	12.6	17.2	13.4	19.7
PV												
NECP-2018	2.6	3.5	5.3	6.8	7.4	8						
NECP-2019		3	5.3	7.7								
LTS2050			6.5	7.4			9.7	9.8	10.5	26.2	14.6	37.3
Solar Thermal												
NECP-2018	0	0	0.1	0.1	0.1	0.1						
NECP-2019			0.1	0.1								
LTS2050							0	0	0	0	0	0
Geothermal												
NECP-2018	0	0	0	0.1	0.2	0.3						
NECP-2019		0	0	0.1								
LTS2050							0.2	0.4	0.4	0.5	0.4	0.7
Total												
NECP-2018	19.3	20.2	22.9	26.4	25.7	26.2						
NECP-2019		21.1	23.1	26.2								
LTS2050							31.9	33	34	54.2	38.8	71.8
New Storage												
NECP-2018	0	0	0	0.7	0.7	0.7						
NECP-2019			0.7	1.6								
LTS2050				1.6			3.9	4.8	5.9	18.7	8.5	28.1

Net Electricity Generation [GWh]												
	NECP-2018 and NECP-2020						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
Solid Fuels (Lignite)												
NECP-2018	14800	13128	9213	9026	5197	4588						
NECP-2019		8114	4536	0								
LTS2050				0			0	0	0	0	0	0
Oil Products												
NECP-2018	5381	3529	2913	1536	1525	1509						
NECP-2019		3597	2209	828								
LTS2050				0			0	0	0	0	0	0
Natural Gas												
NECP-2018	13218	17163	15265	10255	13017	11503						
NECP-2019		22963	19169	18304								
LTS2050 (plus synth & H2)				19900			10200	8600	5800	12300	11700	21300
Bioenergy												
NECP-2018	253	269	518	1736	2023	2361						
NECP-2019		425	772	1575								
LTS2050				3700			4200	6400	10500	11900	7700	12600
Hydro												
NECP-2018	5603	5152	5983	6269	6361	6453						
NECP-2019		5453	6528	6596								
LTS2050			6800	7000			6900	6900	8000	9300	8400	9200
Wind												
NECP-2018	5146	6575	9491	15508	17302	18055						
NECP-2019		7280	12610	17208								
LTS2050			10500	18000			32400	36400	40400	54400	42400	61100
PV												
NECP-2018	3930	5655	8310	10342	11039	11827						
NECP-2019		4548	8202	11816								
LTS2050			9700	11200			15900	16000	17600	42800	24000	58900
Solar Thermal												
NECP-2018	0	0	257	260	264	267						
NECP-2019		0	257	260								
LTS2050				0			0	0	0	0	0	0
Geothermal												
NECP-2018	0	0	0	631	1301	1971						
NECP-2019		0	0	631								
LTS2050				700			1000	2000	2000	2800	2200	3600
Total (with refineries)												
NECP-2018	48339	51471	51959	55563	58029	58533	71.2	77	84.7	134.6	97.5	169.8
NECP-2019		52379	54283	57220			70.6	76.3	83.7	133.4	95.8	166.6
LTS2050				60500			70600	76300	84300	133500	96400	166700
Net Imports (GWh)												
NECP-2018	8792	6200	5196	4156	3460	5191						
NECP-2019		6200	4946	4578	4780	4885						
LTS2050				4900			3400	3400	3400	3400	3400	3400
RES in Gross Elec Production (%)												
NECP-2018	24%	29%	14%	56%	61%	63%						
NECP-2019		33%	51%	66%								
LTS2050 (incl H2+synthHC4)				64%			82%	83%	106%	104%	97%	97%
Electricity Emis. (MtCO2)												
NECP-2018	31	28	18	15	10	8						
NECP-2019		23	13	7								
LTS2050				7			3.6	3	0.2	1.3	-0.6	-0.6
Electricity Costs (€/MWh)												
NECP-2018												
NECP-2019		131	129	127								
LTS2050		130						110	108	104	106	104

RES Investment cost by technology (€/kW)								
	2015	2020	2025	2030	2035	2040	2045	2050
Wind								
NECP-2018	1250	1161	997	860	774	731		
NECP-2019		1161	997	860				
LTS2050		1200		1066		915		848
PV								
NECP-2018	1000	737	631	559	515	490		
NECP-2019		552	423	420				
LTS2050		721		690		567		495
PV roofs								
NECP-2018	1400	1132	981	864	783	734		
NECP-2019		1019	907	816				
LTS2050		1435		930		745		610
Solar thermal with storage								
NECP-2018	4700	4100	3860	3370	2880	2390		
NECP-2019		4100	3860	3370				
LTS2050		5500		4237		3437		3075
Geothermal								
NECP-2018	4400	4400	4400	3400	2400	2000		
NECP-2019		4400	4400	3400				
LTS2050		4970		4586		3749		3306
Hydro- small								
NECP-2019	1950	1900	1900	1900	1900	1900		
NECP-2019		1900	1900	1900				
LTS2050								
Biomass - large								
NECP-2018	2700	2700	2700	2700	2700	2700		
NECP-2019		2700	2700	2700				
LTS2050		2000		1800		1700		1700
Biomass med/low								
NECP-2018	3500	3500	3500	3500	3500	3500		
NECP-2019		3500	3500	3500				
LTS2050								
Biogas								
NECP-2018	4350	4350	4350	4350	4350	4350		
NECP-2019		4350	4350	4350				
LTS2050		1300		1250		1150		1050

3.5. Sectors

Industry												
	NECP-2018 and NECP-2020						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
FEC by Fuel {ktoe]												
NECP-2018	3073	3391	3373	3447	3536	3608						
NECP-2019		3010	2944	2878								
LTS2050				3085			2878	2935	2506	2818	2374	2659
Solid Fuels												
NECP-2018	194	229	232	233	236	226						
NECP-2019		159	139	153								
LTS2050				0			0	0	0	0	0	0
Oil Products												
NECP-2018	1184	1036	930	842	817	799						
NECP-2019		964	782	588								
LTS2050 (plus district heat)				975			552	13	26	16	6	4
Natural Gas												
NECP-2018	551	712	794	928	1007	1082						
NECP-2019		620	718	770								
LTS2050				404			457	668	503	314	272	95
Electricity												
NECP-2018	970	1165	1156	1180	1208	1230						
NECP-2019		1093	1102	1140								
LTS2050				1177			1258	1570	1291	1336	1499	1473
Bioenergy												
NECP-2018	174	249	261	264	268	271						
NECP-2019		174	203	227								
LTS2050				500			527	638	634	736	576	590
RES												
NECP-2018	0	0	0	0	0	0						
NECP-2019		0	0	0								
LTS2050 (plus Solar+H2+synthCH4)				29			84	46	52	416	21	497
Industry CO2 Emis [Mt CO2]												
NECP-2018	11.3	10.8	10.2	10.4	10.6	11.2						
NECP-2019		9.9	9.4	8.8								
LTS2050 (plus process+energy)				13.9			10.1	7.4	6.2	5.3	-0.1	-0.5
Energy Intensity in Industry [mil. € '16/ktoe]												
NECP-2018	5.87	4.8	5.18	5.54	5.91	6.24						
NECP-2019		7.89	9.02	10.18								
LTS2050												

Tertiary Sector												
	NECP-2018 and NECP-2020						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
FEC by Fuel {ktoe}												
NECP-2018	2227	2175	2299	2429	2526	2627						
NECP-2019		1859	2057	2227								
LTS2050				2095			2201	1934	1736	1858	1579	1711
Oil Products												
NECP-2018	176	221	150	113	100	88						
NECP-2019		159	137	112								
LTS2050				15			0	0	0	0	0	0
Natural Gas												
NECP-2018	148	186	244	229	238	257						
NECP-2019		163	218	214								
LTS2050				179			134	95	65	26	17	0
Electricity												
NECP-2018	1672	1492	1505	1558	1605	1651						
NECP-2019		1541	1521	1539								
LTS2050				1822			1990	1761	1601	1707	1513	1559
District Heating (solid fuels)												
NECP-2018	0	0	7	3	4	0						
NECP-2019		0	0	0								
LTS2050				0			0	0	0	0	0	0
Bioenergy												
NECP-2018	25	13	2	14	11	10						
NECP-2019		9	8	11								
LTS2050 (gas+solid)				27			17	28	28	28	12	32
Solar Power												
NECP-2018	7	5	6	6	7	7						
NECP-2019		15	24	34								
LTS2050												
RES in Hothouses, incl. Geotherm												
NECP-2018	206	263	391	512	568	621						
NECP-2019		290	423	541								
LTS2050 (w/o agriculture/in ind)				52			60	50	42	97	37	120
Tertiary CO2 Emis [Mt CO2]												
NECP-2018	0.7	1.1	1.1	0.9	0.9	0.9						
NECP-2019		0.9	0.9	0.9								
LTS2050												
Energy Intensity in Tertiary [mil. € '16/ktoe]												
NECP-2018	50.74	69.89	74.17	77.81	83.11	88.42						
NECP-2019		66.54	70.52	73.74								
LTS2050												

Transport Sector												
	NECP-2018 and NECP-2020						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
FEC by Fuel {ktoe}												
NECP-2018	6788	6875	7026	6957	6884	6887						
NECP-2019		6997	7163	7066								
LTS2050 (plus synthetic)				6808			6092	5102	4663	4925	4150	4616
Oil Products												
NECP-2018	6592	6609	6668	6266	6057	5856						
NECP-2019		6723	6780	6439								
LTS2050				6127			4913	2042	1008	1596	21	1573
Bioenergy												
NECP-2018	149	212	266	472	470	547						
NECP-2019		228	283	371								
LTS2050 (gas+liquid)				396			439	1781	2457	1776	2788	1250
Natural Gas												
NECP-2018	19	24	35	57	65	77						
NECP-2019		28	42	102								
LTS2050				147			331	439	177	153	61	2
Electricity												
NECP-2018	28	30	57	162	292	407						
NECP-2019		18	58	154								
LTS2050				138			407	720	917	800	1164	891
RES												
NECP-2018												
NECP-2019		0	0	0								
LTS2050 (plus H2+synthCH4)				0			2	120	104	600	116	900
Transport CO2 Emis [Mt CO2]												
NECP-2018	17.1	17	17	15.7	14.9	14.2						
NECP-2019		18.1	18.1	17.2								
LTS2050				18.8			15.6	7.1	3.5	3	0.2	0.1
Electric passenger vehicles (BEVs)%												
NECP-2018	0%	0.2%	2.7%	10.1%	18.9%	23.6%						
NECP-2019			3%	9%								
LTS2050				6.2%			26.5%	37.5%	58.9%	58.8%	95.8%	88.1%

Residential Sector												
	NECP-2018 and NECP-2020						NECP30	NECP50	EE2	NC3	EE1.5	NC1.5
	2016	2020	2025	2030	2035	2040	2050					
FEC by Fuel {ktoe}												
NECP-2018	4324	4516	4548	4595	4615	4693						
NECP-2019		4690	4480	4466								
LTS2050				3930			3379	3225	2981	3190	2346	3017
Oil Products												
NECP-2018	1266	1551	1242	968	862	668						
NECP-2019		1260	676	433								
LTS2050				130			7	6	5	6	1	1
Natural Gas												
NECP-2018	329	424	677	810	933	1071						
NECP-2019		432	618	673								
LTS2050				981			870	713	500	219	56	0
Electricity												
NECP-2018	1719	1562	1484	1490	1446	1439						
NECP-2019		1719	1744	1748								
LTS2050				1837			1998	1930	1875	1914	1895	1788
District Heating (solid fuels)												
NECP-2018	51	47	38	36	34	33						
NECP-2019		43	41	39								
LTS2050				49			38	25	22	23	16	21
Bioenergy												
NECP-2018	728	599	703	800	771	870						
NECP-2019		830	843	860								
LTS2050 (gas+solid)				588			233	324	338	348	184	359
Solar Power												
NECP-2018	192	204	225	269	308	337						
NECP-2019		281	288	377								
LTS2050				in RES			in RES	in RES	in RES	in RES	in RES	in RES
RES												
NECP-2018	39	129	179	222	261	275						
NECP-2019 (heat pumps)		126	270	336								
LTS2050 (plus Solar+H2+synthCH4)				345			233	227	241	680	194	848
Residential CO2 Emis [Mt CO2]												
NECP-2018	4.7	5.8	5.4	4.9	4.9	4.6						
NECP-2019		4.9	3.5	2.9								
LTS2050				3.2			2.4	1.9	1.4	0.6	0.2	0
Energy Intensity in Residential [mil. € '16/ktoe]												
NECP-2018	4.7	5.4	5	4.6	4.5	4.3						
NECP-2019												
LTS2050												
Final Energy Consumption per Household [toe/household]												
NECP-2018	1.06	1.12	1.14	1.17	1.19	1.23						
NECP-2019		1.15	1.1	1.09								
LTS2050												

3.6. Investments

NECP Investment by Policy Sector for 2020-2030 (mil€/yr)	NECP-2018	NECP-2019
RES electricity production	850	900
Grid improvement/expansion	550	550
New conventional power plants and refurbishment of existing ones	190	130
Distribution grid improvements/ smart grids	330	350
Transboundary NG interconnectors	220	220
NG distribution grids and storage	200	200
Energy research and innovation	80	80
Energy efficiency improvements	900	1,100
Refineries	150	150
Climate change-floods-forests		200
Circular economy		500
Total	**3,470**	**4,380**

LTS 2050 Investment by Policy Sector for the 2030-2050 period (mil€/yr)	NECP30	NECP50	EE2	NC2	EE1.5	NC1.5
Industry	149	156	310	208	349	397
Residential-Building upgrading	307	455	551	474	839	618
Residential-household equipment purchases	3,712	3,688	3,901	3,722	4,550	3,761
Tertiary/agriculture -Building upgrading	112	158	183	166	217	208
Tertiary/agriculture equipment purchases	1,084	1,038	1,169	1,050	1,231	1,151
Transport	12,383	12,938	12,555	13,056	13,062	13,390
Electricity generation	436	516	595	1,287	820	2,002
Grids	873	1,048	1,082	1,135	1,241	1,215
Energy industries	187	164	125	553	105	818
Total	**19,243**	**20,161**	**20,471**	**21,651**	**22,414**	**23,560**
Total w/o transport	**6,860**	**7,223**	**7,916**	**8,595**	**9,352**	**10,170**
As % of GDP (w/o transport)	1.9	2.0	2.2	2.4	2.6	2.9