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Policy Brief:

To RES or to Conserve? this is the question (in the Greek road to decarbonization)

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1 The new >55% landscape

The recent (April 2021) adoption of the European Climate Law and the enshrinement of both the >55% GHG emission reduction target by 2030 and the near zero emissions one by 2050, calls besides amazement, self-congratulation and even for some relief, for a renewed concern on how these lofty targets will be reached, both at European Union (EU) and at Member State (MS) level. It has become clear that the 2030 target cannot be seen independently of the new longer horizon 2050 target but rather as a milestone on the way. This implies that regardless of the short time attention time spans of political personnel, serious consideration should be given to the whole commitment period to 2050.

At present, as required by Regulation 2018/1999, Member States (MSs) and the European Union (EU), have submitted by the end of 2019 National Energy and Climate Plans (henceforth NECPs) on how they plan to meet the initial target of >40% GHG emission reduction by 2030 and by January 2020 they also submitted Long-Term Strategy Roadmaps for near zero reductions by 2050 (henceforth LTS). It should be mentioned here that, similarly to the so-called 20-20-20 by 2020 targets set in 2010, the 2030 targets also include a >32.5% obligatory target for renewable energy sources (RES) contribution to Gross Final Energy Consumption and a >32% reduction in energy consumption. In addition, specific targets per MS have been agreed for the non-ETS sector and yearly obligatory energy efficiency improvement targets have also been put in place.

All these targets would need to be revised upwards to be in line with the new target of >55% GHG emission reduction. The European Commission (EC) is expected to announce by July 2020 proposals for the revision of all relevant legislation including the Regulation 2018/842 and Decision 2020/2126 on MS targets, the revised ETS Directive 2018/410, the energy efficiency Directive 2018/2002 and the RES-recast Directive 2018/2001 and Regulation 2018/2000.

Regulation 2018/1999 (the so-called Governance Regulation) specified (Art 3(1)) that by 31 December 2019 MSs shall submit NECPs for the period to 2030 “taking into account the longer-term perspective”. As a result, most NECPs provided details and quantitative information that ended in 2030. In addition, it specified (Art 15(1) that MSs will also submit by 1 January 2020 LTSs “with a perspective of at least 30 years”, that is in effect roadmaps to 2050. It did not provide guidance on how NECPs and LTSs are to dovetail. Furthermore, as no legal decision on a target for 2050 had been taken, LTSs were not constructed with net decarbonization targets in mind.

This resulted in trajectories in the NECPs for the numerous indices specified in detail in the Annexes of Regulation 2018/1999, that ended in 2030. In view of the fact that most of the NECPs were based on modelling, especially of the energy sector, employing well-regarded models such as PRIMES, TIMES-MARKAL and others whose projections go on for at least 10 years past the period reported to avoid the possibility of abrupt and unrealistic changes after the end of the period of interest, it would have been interesting to see the results of this modeling to 2040 at least and possibly even to 2050. This would have made reviews and assessments of the NECPs more meaningful, especially on how they have “taken into account the longer perspective” and how the trajectories of the LTSs as submitted merge or diverge.

2 The Greek NECP and LTS2050

The Greek NECP and LTS2050 were no exception. The NECP was based on modelling primarily by TIMES-MARKAL while the LTS2050 was based on PRIMES results that overlapped for at least the 2030 milestone. The exogenous inputs to both models were roughly aligned up to 2030 for which year data in the NECP are available. These include Gross Domestic Product, population/number of households, oil and natural gas, EU Emission Trading Scheme (ETS) allowance (see **Table 1**) and technology prices (see **Table 2**). Of particular interest is the evolution of the ETS allowance prices for which there is large divergence between the NECP and the LTS after 2030, but also with current prices which by 2020 have reached already values above €50/tCO_2.

Table 1: ETS allowance 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 (all)	7.5	24	28.8	31.2	64	127.5	183	380

Similarly large differences are seen in the technology prices for RES, with the LTS ones substantially higher from those in the NECP which again seem to be about current prices especially for PV.

Table 2: RES Investment cost by technology (€/kW)

		2015	2020	2030	2040	2050
Wind	NECP-2019	1250	1161	860		
	LTS2050		1200	1066	915	848
PV	NECP-2019	1000	552	420		
	LTS2050		721	690	567	495
PV roofs	NECP-2019	1400	1019	816		
	LTS2050		1435	930	745	610
Solar thermal with storage	NECP-2019	4700	4100	3370		
	LTS2050		5500	4237	3437	3075
Geothermal	NECP-2019	4400	4400	3400		
	LTS2050		4970	4586	3749	3306
Hydro-Small	NECP-2019	1950	1900	1900		
	LTS2050					
Biomass-Large	NECP-2019	2750	2700	2700		
	LTS2050		2000	1800	1700	1700
Biomass-Med./Small	NECP-2019	3500	3500	3500		
	LTS2050					
Biogas	NECP-2019	4450	4350	4350		
	LTS2050		1300	1250	1150	1050

Both modelling exercises started well before 2020 and should have similar results at least in the 2020-2030 time period. The main differences between the two include:

(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 natural gas (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 a slightly lower (by ca. 1.5% reaching 6% for wind and PV) RES installed electricity capacity coupled by higher (by 3%) RES generation in PRIMES due to much increased (250%) of bioenergy utilization and higher capacity factor for wind (30% vs 28%) plus an earlier construction of offshore plants (see Figure 1 below).

A comparison of the role of RES between the two for that time span is given in **Figure 1** below.

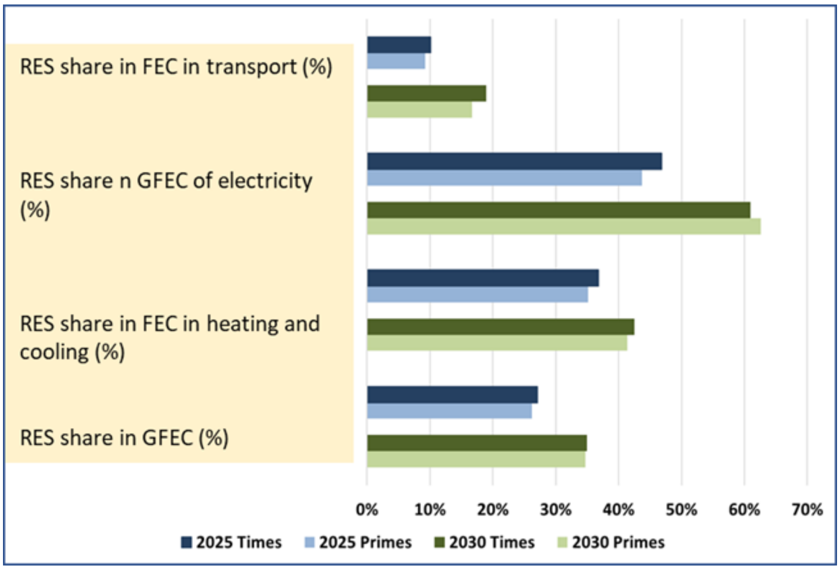

Figure 1: Comparison of the RES shares in various sectors of the Greek NECP as estimated by the TIMES-MARKAL (primary) and PRIMES (secondary and primary for the LTS) models (see NECP - Fig. 52)

The LTS examined six scenarios with different baskets of priorities, and policies and measures (PAMs) for the period after 2030 to 2050, namely:

1. NECP2050a: The PAMs of NECP continue to operate till 2050 but no new ones are applied.
2. NECP2050b: The same PAMs of NECP continue to operate till 2050 but enhanced appreciably.
3. EE2: Energy efficiency and Electrification (i.e., replacement of fossil fuels by electricity, conservation, and circular economy) to meet the 2°C target.
4. NC2: New energy Carriers (i.e., H2, biogas, synthetic CH4 and also conservation etc) to meet the 2°C target.
5. EE1.5: Energy efficiency and Electrification to meet the 1.5°C target.
6. NC1.5: New energy Carriers to meet the 1.5°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 dwellings and buildings
2. Development of RES 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.

The resulting GHG emissions by 2050 for the 6 scenarios of the Greek LTS are given in **Figure 2**. In view of the now legally binding target of net decarbonization by 2050, the first four scenarios should be discarded and used simply as indication of the effectiveness of pathways and associated PAMs and the focus should be given to the last two namely the EE1.5 and the NC1.5. One should note that none result in full decarbonization with the relatively small amounts of ca 5MtCO_2eq comprising non-CO_2 emissions. This would mean that an equal number of sinks need to be available to reach net decarbonization.

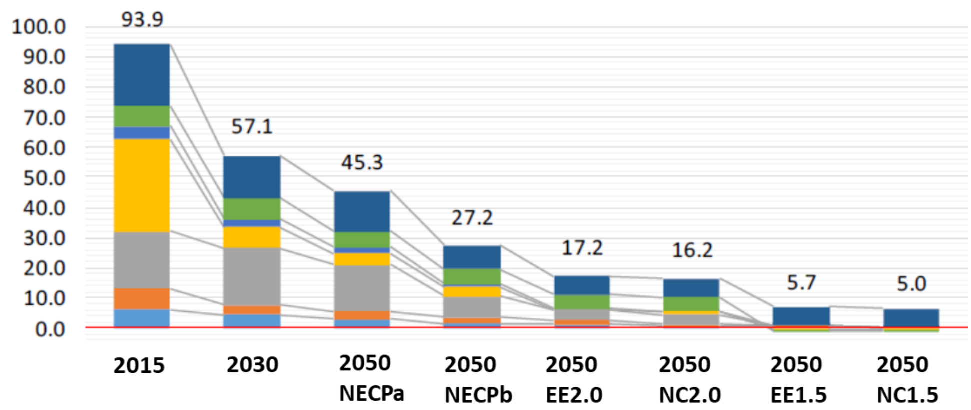

Figure 2: GHG Emissions (in $MtCO_2eq$) of the 6 scenarios examined in the Greek LTS 2050 Plan of which only the EE1.5 and the NC1.5 meet the net zero by 2050 condition (LTS2050 Fig. 7)

It is important to examine the energy use aspects of these two near-zero scenarios. In **Figure 3**, the primary inland energy consumption is given and in **Table 3** the final energy consumption broken down by energy carrier is provided.

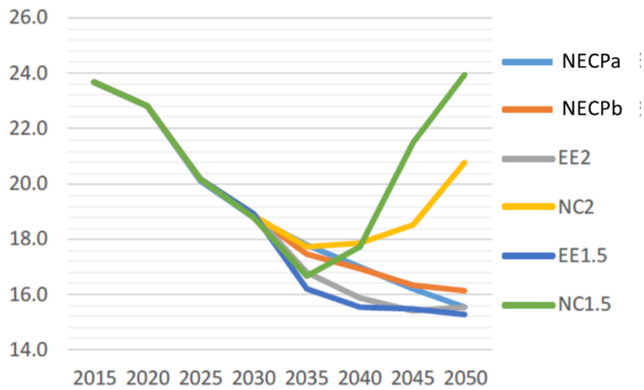

Figure 3: Primary Energy Consumption (in Mtoe) of the 6 scenarios examined in the Greek LTS 2050 Plan of which only the EE1.5 and the NC1.5 meet the net zero by 2050 condition (LTS2050 Fig. 11).

Table 3: Percentage of energy carriers in FEC			
	2030	2050	
		EE1.5	NC1.5
Electicity	27%	59%	48%
Biomass	8%	34%	19%
synthetic Fuel	0	1%	30%
Fossil Fuel	66%	7%	4%

NB: from LTS2050, Fig. 27

RES, as is to be expected, have a central role with all technologies contributing but with wind and PV constituting between 71% and 85% of total installation. In **Table 4** below the RES installed capacity and production for the two near zero scenarios is shown. The difference between the EE and NC scenarios is striking, with the NC1.5 one reaching 63.4GW, almost double that of EE1.5 (34.3GW) which in turn is almost double that of NECP in 2030 (19.1GW) which is itself almost double that of

2020 (10.3GW) amount. The difference in generation between the two near-zero scenarios is also striking.

Table 4: RES electricity installed capacity and production (and % to total electricity produced)				
	Installations (GW)		**Production (TWh)**	
Scenaria	**2030**	**2050**	**2030**	**2050**
EE 1.5°C (LTS)	**19.1 (73%)**	**34.3 (87%)**	**38.4 (67%)**	**85.3 (88%)**
wind	**7**	**13.8**	**18**	**42.4**
Solar	**7.8**	**14.6**	**11.2**	**24**
Hydro	**3.9**	**4.7**	**7**	**8.4**
Biomass	**0.3**	**0.8**	**1.6**	**8.3**
Geothermal	**0.1**	**0.4**	**0.6**	**2.2**
NC1.5°C(LTS)	**19.1 (73%)**	**63.4 (89%)**	**38.4 (67%)**	**146.1 (87%)**
wind	**7**	**19.7**	**18**	**61.1**
Solar	**7.8**	**37.2**	**11.2**	**58.9**
Hydro	**3.9**	**4.7**	**7**	**9.2**
Biomass	**0.3**	**1.1**	**1.6**	**13.3**
Geothermal	**0.1**	**0.7**	**0.6**	**3.6**

NB: from LTS2050 Fig. 22

This very large RES capacity in the NC1.5 scenario is used to generate H_2 and to a lesser extent synthetic CH_4 both for direct use and for storage. In both scenarios the use of pumped storage is limited and does not exceed 1.7GW (from 0.7GW currently) whereas the electrolysis installations in the NC1.5 scenario reach 23.5GW.

These extremely large amounts of stochastic renewables require means to meet demand when their production is low. This is addressed in both the EE and NC scenarios by the use in order of importance of H_2 and e-fuels primarily directly and from storage but also of batteries and pumped hydro.

Of importance is also the very large increase in biomass (which in the Greek LTS includes waste) utilization. Biomass utilization is envisaged mostly in sectors that are difficult to electrify. The majority of biomass (ca 5.22- and 4.25Mtoe in the EE and NC scenarios) is to be provided from cultivation of energy crops (ca 40%) and agricultural residues (ca 30%) with the rest to be imported. Over 40% of this biomass is to go for the generation of biofuels and biogas with electricity generation taking the larger amount (30% in the EE1.5 and 50% in the NC1.5 scenarios).

Turning to the second pole of the LTS namely that of consumption, in **Table 5** below the Final Energy Consumption is presented. Here again there are differences between the two scenarios. The EE1.5 calls (as made clear in its name) for the largest energy conservation with consumption 10% less than that of the NC1.5 one. This difference in consumption is present in almost all sectors (minus Agriculture) with that in the Residential sector reaching 20%.

Table 5: Final Energy Consumption (ktoe)				
	2015	2030	2050	
		NECP	EE1.5	NC1.5
Industry	3089	2879	2373	2660
Residential	4401	4465	2346	3018
Tertiary	2125	2451	1577	1711
Agriculture	271	523	187	179
Transport	8339	7066	6835	7395
Total	18225	17384	13318	14963

NB: from LTS2050 Figs. 12, 13, 14, 16, and 20

The FEC values in Table 5 illustrate the difficulty in making large inroads in reducing energy use which should not only be based on technical means through efficiency improvements but also on utilizing soft measures and behavior changes through promotion of "sufficiency".

3 The Conserve-Hydrogenate dilemma

Tables 4 and 5 together with Figure 3 illustrate clearly two fundamentally different approaches to reaching near zero emissions by 2050. In one, the emphasis is on maximum utilization of RES to produce both electricity but also large amounts of H_2 and synfuel. The other employs deep energy conservation measures to reduce the energy consumption which then would require smaller amounts of RES to be satisfied.

Doubts on costs and timely availability of technology for large scale H_2 and synfuel production aside, it becomes clear that the path that Greece steers between these two substantially different approaches needs to be analyzed and debated further.

For this debate to be informed, the question of the RES potential and carrying capacity, especially that of wind and PV, needs to be analyzed not only in technical terms but also as regards societal acceptability, infrastructure development, local content, and job creation. The 42GW wind and an additional 24GW of PV in NC1.5 comprise a ten-fold increase of both from current levels. It should be mentioned that investment interest at least to the extent of requesting energy production licensing already exists, as evidenced by the applications in the latest call by RAE a month ago. Already though, the reaction of local societies to wind parks for whatever reason including possibly malicious motives, is rising. Even though some are starting to use offshore parks as a deflection, it is almost certain that offshore wind parks will also come under attack as was done in the US (Martha's Vineyard) when the first ones, floating or not, are put in place.

An additional point that needs to be considered is the role of electricity net imports. This bears directly on the amount of RES needed either reducing the total installed power if net imports from neighboring countries are available and at competitive prices or increasing it if the possibility of net export is attractive. This requires that the Greek NECP and the LTS should take into consideration the NECPs of at least Bulgaria and Romania, but also available projections from the rest of the neighboring countries. Neither the NECP nor the LTS took that into consideration as evidenced by the almost constant amounts (3.4TWh for all LST scenarios in 2050 down from 4.9TWh in 2030 vs. double that in 2019) inscribed exogenously for the whole period.

4 Some thoughts on the long way forward

This debate cannot be put to the future: and this for two reasons, i.e., (i) after the EC announces its proposals for the new legislation to meet the >55% target in the next month or so, MSs including Greece would need to revise as quickly as possible their NECPs, and (ii) a number of energy sector projects in Greece are in their final planning stages whose life extends to 2050 or beyond (i.e., new NG plants as well as wind and large PV plants with life span of over 20 years) and investors need to have clarity on State planning.

Turning to the *first reason*, it is important that in revising the NECP the need to extend its horizon to at least 2050 is addressed. In essence, this implies that the NECP should actually change to an integrated NECP-LTS one with a time horizon to 2050. This would alleviate some of the weak points brought up in the NECP public consultation process (the consultation of the LTS was almost non-existent both because of its minimal duration and the complete lack of addressing problems the submissions brought up). These problems included differences between NECP and LTS in the common period 2020-2030, the exogenous inputs and assumptions used, and the PAMs included. The integrated NECP can still consider different scenarios like EE1.5 and NC1.5 or new ones in-between as part of a sensitivity analysis. It should also include as a constraint that the emissions of Greece have to drop to near zero by 2050 (as should those of all other MSs). These additional scenarios need to be coherent with the main scenario trajectory till 2030 and can then diverge but still result in near-zero emissions in 2050.

As to the *second reason*, it is important that as soon as possible investors in RES, through their very active associations, should try to debate and agree on their view on the role of RES in the period to 2050 (remember that a wind or PV plant built next year would be operating almost till 2050) including the overall amount to be installed together with its time trajectory taking into account their more realistic estimates of actual technology costs (see Table 2), development capacity, labor force and obstacles to be overcome so that they are fed into the revision process a priori rather than when (and if) the new version is released.

Similar considerations should apply to civil society entities (NGOs) which should also submit their own views (as some have already done for the current NECP) before the revision of the NECP is announced on how to improve and extend it considering their own priorities and factors.

All these participants in the energy sector, be they in the public or the private sector, as well as other interested parties, in engaging in this debate should realize that the time horizon of their considerations must be longer term, possibly decades, and this should also be the basis for their business plans rather than the short term one of 2 or 3 years which is the time scale of political life and bonuses.

This debate needs to start immediately for an *additional reason*. Greece expects to receive over €70Billion from a combination of EU sources including the Recovery and Resilience Facility with its 6-year horizon and the Cohesion and Regional Development Funds with their 7-year horizons. How these funds will be utilized has a direct bearing on the implementation of NECP Policies and Measures and in view of their long-term duration should have been the product of a wider consensus. Such a consensus should be sought for the approval of the revised integrated NECP/LTS plan which should include a wide part of the political spectrum, the private actors of the energy sector as well as civil society and should be based on full transparency of the quantitative aspects of the Plan and in sufficient detail to enable meaningful analysis. In this, the full and immediate engagement of all those active in RES development is a sine-qua-none.