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The Planned Natural Gas Distribution Network Expansion in the Patras Area

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1. Introduction

The Greek National Energy and Climate Plan (NECP) as published in the Official Journal in December 2024 in preparation to its being submitted to the European Commission (belatedly, as it should have been by July 2024), calls for a reduction of emissions in the residential and tertiary sectors by 56% and 44% respectively by 2030 and almost 100% by 2050. To accomplish this, the use of fuel oil is to be reduced by 75% and 50% in the residential and tertiary sectors respectively by 2030 and almost eliminated in both by 2040. In addition, the use of natural gas (NG henceforth) according to the NECP is to be maintained at the present level till 2030 and then reduced to ca 15% of its current use by 2050.

If the use of NG is to remain constant till 2030 and then to be reduced continuously, it would be inconsistent with policies and measures to increase NG penetration in the residential and tertiary sector, especially to replace fuel oil consumption. Yet, this seems to be the case in view of the expansion plans presented for approval to the Greek Regulatory Authority for Waste, Energy and Water (RAAEY) by the enterprises that operate the NG distribution grid in Greece.

It is then of interest to compare the use of NG in the residential and tertiary sectors vs other means of covering the energy demand, and in particular the use of heat pumps. The comparison to heat pumps only to the exclusion of other policies and measures (PaMs) is based on the following considerations:

a. Measures to upgrade the building stock by increasing insulation would clearly reduce both energy use and emissions but that would be applicable to both NG systems as well as to heat pumps
b. Heat distribution networks are not prevalent in Greece and the ones already installed were dependent for heat on lignite-fired electricity production units which are being phased out by 2028 at the latest and are already being converted to NG.
c. The use of biomass is small, mostly restricted to rural areas and is hampered by environmental restrictions
d. The use of geothermal energy would also involve the utilization of heat pumps
e. Solar heating for water use is already present in over 50% of the households.

Taking the above into consideration, in this report a comparison of replacing fuel oil installations in the building stock of an urban area (the Patras borough of the Municipality of Patras) by expanding the NG distribution grid vs. installing heat pump systems is attempted. The comparison includes the costs for customers for the purchase of the equipment, the operation over the equipment lifetime, taken to be 20 years, the energy required and the ensuing greenhouse gas emissions.

2. The planned National Gas Distribution Network Expansion in the Patras area

In November 2024, enaon EDA, the enterprise that is already the owner and operator of the NG distribution networks in Central Macedonia, Attica and Thessaly, submitted[1] to RAAEY, the Greek Authority for Waste, Energy and Water its plan for the expansion of its NG grid to the

[1] https://www.raaey.gr/energeia/wp-content/uploads/2024/11/19.-Enaon-EDA-DP-2025-2029-WGR.pdf

Western Greece Region which includes the Municipality of Patras. Enaon EDA holds a license to build and operate NG grids in addition to the Regions of Thessaly and Attica in the Regions of Central Macedonia, Eastern Macedonia and Thrace, Central Greece, Epirus, Western Greece and Peloponnese under Decision PAE 1319/2018, ΦΕΚ Β' 5903.

The plan, submitted in accordance with Art 58 of the Code for the Operation of the Distribution Network (ΦΕΚ Β' 3276/12.08.2021), covers development works for the 5-year period 2025-2029 in Western Greece, which comprises 20 municipalities. The development plan covers expansion works in five of those municipalities, namely those of Patras, Pyrgos, West Achaia, Erymanthos and Agrinio. Most of the low-pressure (LP) grid expansion which will service residential and tertiary sector customers, will take place in the Patras Borough of the Municipality of Patras which has the largest number of residents (171484 out of the 215992 in the Municipality and of the 648220 in the Region) and an industrial park with a considerable number of units.

The basic financial aspects of the plan are shown in Table 1 below (reproduced from the unnumbered table on page 12 of the submission).

Table 1: Investments by work category (€Million)						
	2024	2025	2026	2027	2028	2029
Grid expansion works*	19.60	8.19	11.88	8.50	0.51	1.49
Connection works*	0.17	1.32	4.61	3.72	2.04	1.47
Grid safety and enahncement works*	0.11	0.10	0.11	0.16	0.16	0.16
Digitization works	0.24	0.04	0.09	0.05	0.06	0.04
Energy conservation works*	0.04	0.0	0.0	0.0	0.0	0.0
Miscellanious invstments*	0.49	0.19	0.33	0.21	0.31	0.32
Total 2025-2029	20.65	9.84	17.02	12.64	3.08	3.48
enaon EDA Development Plan 2024-2028	20.65	13.7	8.64	1.57	3.78	

It should be noted that the sum of the yearly amounts for the 6-year period in Table 1 is € 66.71Million. Of that, the amount for the years up to 2026 is €47.31Million, which is not in agreement with the €53.95Million implied on page 13 where the amount to be provided by the Cohesion Fund for this expansion is stated as €28Million to comprise 51.9% of total expenditure. Furthermore, nowhere are the asterisks in the table defined. The previous enaon EDA development plan for the 5-year period 2024-2028[2] called for substantially less (€49.51Million to be compared to €63.23Million for the current one for the same period 2024-2028)

The NG for the expansion in Western Greece is to be provided by a high-pressure (HP) pipeline connected to the National NG Transmission Grid nearest point in Megalopolis. According to the latest 10-year Rolling Plan[3] of DESFA, the National NG grid operator, an amount of €101.4Million is earmarked for the HP pipeline to feed Western Greece for which though a final investment decision is scheduled by May 2025 and its planned operating date if the decision is positive, is December 2026. The operating date of the HP pipeline implies that until at least 2027 by which time according to the enaon EDA development plan, the over 5000

[2] https://www.raaey.gr/energeia/wp-content/uploads/2024/03/enaon-EDA_DP-2024-2028_WGR.pdf

[3] https://www.desfa.gr/userfiles/consultations/DRAFT_TYDP2024-2033.pdf

customers in the Patras borough of the Patras Municipality will be online, will most likely be serviced by LNG or CNG to be trucked in.

In the following, attention will be focused on the Patras Borough of the Patras Municipality as this is the only borough out of the 5 of the Patras Municipality in which grid development is envisaged at least till 2029. In particular, the emphasis will be on the retail and tertiary sectors to be serviced by the LP network, i.e. multi- and single-residence buildings and small enterprises of the tertiary sector.

In Table 2, the expected number of connections[4] to the LP grid are presented.

Table 2: Expected Number of connections									
Connections		2023	2024	2025	2026	2027	2028	2029	Cumm.
Central heating buildings	#			40	250	300	175	90	855
Households with own systems	#			350	2494	2968	1746	910	8468
Small commercial enterprises	#			2	40	50	33	15	140
Large commercial enterprises	#			8	24	17	8	4	61
Industrial units	#			2	4	2	1	0	9
CNG customers	#								0
Total	#			402	2812	3337	1963	1019	9533
Grid length		2023	2024	2025	2026	2027	2028	2029	Cumm.
Medium pressure grid	m	2100	9600	3500	5600				20800
Low pressure grid	m			15500	39000	35000	5000	5000	99500

The Development Plan calls for the connections to the NG grid to reach 9541 by the end of 2029 of which all but 218 are from the residential sector. Here it should be noted that there are a number of differences between the 2025-2029 report itself and the accompanying detailed excel sheet[5]. The quantitative information that has been used in this assessment follows the excel sheet which is more detailed in the origin of the various data it contains while the report itself lacks explanations and definitions in its tables (all unnumbered). It should also be noted that the excel sheet itself has been submitted to RAAEY.

The corresponding consumption is provided in Table 3.

Table 3: Expected NG Consumption							
(MWh/yr)	2024	2025	2026	2027	2028	2029	Cumm.
Central heating buildings		42	477	1166	1822	2175	5682
Households with own systems		900	13582	32518	53149	62446	162595
Small commercial enterprises		245	2430	6480	10215	12510	31880
Large commercial enterprises		3957	42779	86602	113264	126894	373496
Industrial units		31482	61268	86652	101516	105110	386028
CNG customers							0
Total		36626	120536	213418	279966	309135	959681

The total expenditures for the construction of the MP and LP grid and the connections to residential/tertiary sector buildings in the 5-year period 2025-2029 for the Patras Borough are

[4] https://www.rae.gr/wp-content/uploads/2024/11/20.-%CE%91%CE%BD%CE%AC%CE%BB%CF%85%CF%83%CE%B7-%CE%A0%CF%81%CE%BF%CE%B3%CF%81%CE%AC%CE%BC%CE%BC%CE%B1%CF%84%CE%BF%CF%82%CE%91%CE%BD%CE%AC%CF%80%CF%84%CF%85%CE%BE%CE%B7%CF%82_2025_2029_WGR.xlsx

[5] ibid

projected to reach €20,753,071, of which €16,733,310 refer (see Table 4 for a breakdown) to the LP network which supplies households and small commercial enterprises.

Table 4: Expected Expenditures LP grid						
	2025	2026	2027	2028	2029	Cumm.
LP grid						
Length (m)	15500	39000	35000	5000	5000	99500,00
Unit cost (€/m)	124,57	121,31	124,95	102,37	100,27	573,46
Total cost (1000€)	1930,83	4731,11	4373,09	511,83	501,33	12048,20
Meters						
Number	0	396	2792	3322	1956	8466,00
Unit cost (€/unit)	674	443	358	412	477	2363,92
Total cost (1000€)	-	175,48	999,53	1.368,98	933,26	3477,24
Others						
Metering/regulating	49,82	55,48				105,30
Misc	163,55	246,88	193,85	248,93	249,36	1102,57
Total cost (1000€)	213,37	302,36	193,85	248,93	249,36	1207,87
Grand total (1000€)	2.144,20	5.208,95	5.566,47	2.129,74	1.683,94	16733,30

3. The Heat Pump Alternative

As documented above, enaon EDA plans to expand its MP and LP NG network to provide, until 2029, service to 9471 residential and small commercial buildings (as well as to 140 large tertiary sector and 70 industrial sector installations). According to the consumption data of the distribution grid operator, after 2029 it will provide to these new customers, 200,257 MWh/yr. The consumption of these amounts of NG will result in the release of 349,616 tCO2eq/yr. As additional customers may be connected in the future, the amount of emissions can be expected to increase in the future.

At the same time, the Greek Climate Law calls for the national emissions to drop by 80% wrt those of 1990 by 2040 and to net zero by 2050. The Greek NECP published in the Official Journal in late December 2024, calls for a drop by 71% of emissions in the residential sector from NG, i.e. from 466ktoe in 2022 to 135ktoe in 2040, The increase of NG penetration from extensions of the LP grid such as the one in the Patras area and the rest of the Western Greece region certainly is not in line with the NECP target. Alternatives for meeting the energy needs of households and reducing emissions, most of which come from the use of heating oil, exist with the use of heat pumps emerging as the most attractive ones.

It would then be of interest to examine whether the utilization of heat pumps rather than NG might be a better alternative taking into account both the investment cost needed and the cost to customers over the years of operation.

4. Intercomparison Methodological Aspects

To accomplish this, a model[6] previously constructed for the consumption of energy in households has been amended as appropriate for this comparison. The model includes all energy uses, namely space heating and cooling, hot water needs, cooking, lighting, appliance use and use of other electrical and electronic devices, and considers all energy carriers (heating oil, solid fuel, biomass, NG, electricity, solar and distributed heat). It also takes into

[6] https://facets.gr/wp-content/uploads/2024/03/202402_Strategies-for-reducing-the-c-arbon-footprint-and-tackling-energy-poverty-i-n-Greek-households.pdf

account the distribution across the nine energy classes (H to A+) of the building stock. The model then computes the yearly energy use to 2050 which is the expected lifetime of equipment installed to houses by 2029 together with the corresponding GHG emissions.

The model also computes the cost of the energy used year by year till 2050 and the resulting emissions. To this task, current purchase prices of equipment have been used while the costs of energy carriers especially for oil, NG and electricity over the years to 2050 were taken to be those in the NECP and are shown in Table 5 below.

Table 5: Energy prices trajectories NECP 2024							
EUR/MWh)	2022	2025	2030	2035	2040	2045	2050
EU ETS allowance (€/tCO2)	60	80	80	140	290	430	490
EU ETS2 allowance (€/tCO2)*	0	54	54	140	290	430	490
Electricity (€/MWh)	165	145	139	125	116	109	96
Heating Oil (€/MWh)	118	118	118	118	118	118	118
Natural Gas (€/MWh)	120	38	38	38	38	38	38

* The values of allowances for buildings are according to the ETS2 Directive 2023/959 until 2030 and converge with the ETS price afterwards

The prices for electricity in the NECP already include the cost of ETS emission allowances, while the cost of NG was adjusted to also include them in view of the extension of the ETS to the building sector starting in 2027[7]. The costs for the NG and HP systems used were €50/kW and €600/kW including VAT respectively which correspond to market values in 2024.

In applying the model to the buildings in the Patras Borough, it was also assumed that the buildings to be converted to either NG or heat pump use used oil for heating and were not connected to a heat distribution network as this does not exist, and their energy class distribution followed the national one as derived from the building energy certificates data.

In addition, houses with solar water heaters continued to make use of them rather than change to NG or heat pumps as this would entail extra cost, and no fuel switching was made in cooking as this would entail purchasing of new ranges/ovens.

5. Intercomparison Results and Some Concluding Remarks

With these assumptions, calculations were carried out for the 9471 households and small commercial enterprises targeted in the Patras Borough for the two cases of (a) changing from oil to NG and (b) from oil to heat pumps. The results of the calculations for the equipment costs, the running costs and the emissions for the two options are shown in Table 6 below.

Table 6: Comparison of costs, energy and GHG emissions till 2050		
	NG systems	Heat Pumps
Equipment costs (€Million)	14.65	90.03
Operating costs (€Million)	292.03	217.46
Total costs (€Million)	306.68	307.49
Energy use (GWh)	280.68	221.13
GHG Emissions (ktCO2)	529.58	141.01

[7] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32023L0959

In the running costs, the charges for the use of the NG distribution grid (€12.5/MWh as estimated by enaon EDA[8] plus €2.6/MWh currently charged for the use of the National NG grid by DESFA) have been included. The electricity prices cited in NECP also include the grid use cost.

The comparison of the two options, use of NG or heat pumps, considered in this work as shown in Table 6 raises a number of questions.

a. The households that use heating oil that have the choice to change energy carriers will have to pay almost the same over the lifetime of the equipment till 2050 for NG and heat pumps.
b. The initial expenditure for the purchase of the equipment is substantially higher for the heat pumps than for the NG boilers. This difference though is negated if one adds to the household investment cost, albeit optionally, a reasonable amount of €2-3000 per household for air conditioning equipment to provide cooling capacity as is the case for the heat pump technology expenditure budgeted in the amount shown in Table 6.
c. The choice of NG results after 2029 in almost 3.5 times the energy used for heating households. This is basically due to the capability of heat pumps to provide ambient heat at a rate of over 3.5 times the electrical energy used. This value of 3.5 for the heat pump COP is a very conservative value as the Greek NECP calls for values reaching 4.5 by 2030. Note that the total energy used as shown in Table 6 which is 21% less when heat pumps are utilized includes all household needs that cover besides heating also cooling, cooking, water heating, lighting and all appliance use.
d. The use of NG results in over 370% higher GHG emissions

Consequently, from the household point of view, the choice of heat pumps or NG will hinge on whether the higher initial cost for heat pumps is balanced by some sort of subsidy either by the electricity providers or the State as has been the case for the initial NG penetration in the greater Athens and Thessaloniki areas.

This disadvantage can be addressed by a number of measures, some of which are already offered by the State. For example, in late December 2024[9] the Ministry of Environment and Energy announced a program for subsidies for the installation of solar water heaters and heat pumps with a total budget of €223.2Million of which €44.6Million are reserved for low-income households. The subsidy for heat pumps may reach 50% of the purchase with the subsidy capped at €5000 per installation which is more than adequate with today's heat pump prices. These funds are part of the RRF allotment to Greece.

As far as the State contribution is concerned, one should also consider the request from enaon EDA for a subsidy of over 50% for the NG grid expansion investment in its report. In the case of the Patras Borough, for which the expenditure (see Table 4) is €16.7Million the 50% subsidy

[8] https://www.rae.gr/wp-content/uploads/2024/11/20.-%CE%91%CE%BD%CE%AC%CE%BB%CF%85%CF%83%CE%B7-%CE%A0%CF%81%CE%BF%CE%B3%CF%81%CE%AC%CE%BC%CE%BC%CE%B1%CF%84%CE%BF%CF%82%CE%91%CE%BD%CE%AC%CF%80%CF%84%CF%85%CE%BE%CE%B7%CF%82_2025_2029_WGR.xlsx

[9] https://allazothermansi-thermosifona.gov.gr

corresponds to €8.35Million an amount that would cover the subsidy to at least 1650 households or alternatively the cost of interest and insurance of loans to all the 9471 households and small commercial enterprises targeted to finance the installation costs.

An additional advantage of installing heat pumps is the extra benefit of air conditioning without the need for extra expenditure for A/C equipment. In view of the increasing temperatures brought about by climate change.

Turning to the difference in emissions between the use of NG and heat pumps (229.69ktCO2), if one were to value this difference in emissions by economic terms, rather than strictly by environmental benefits, using the ETS allowance expected values per tCO2, the resulting gain will amount to €112.16Million.

The expansion of the LP NG distribution network in the region of Western Greece aims to cover more areas besides the Patras Borough, which include the towns of Agrinion and Pyrgos bringing the total amount of the LP customers to 15000. Besides Western Greece, enaon EDA also intends to provide service to other Regions where NG grids do not exist or are now serviced by LPG or CNG trucked in. For all these expansions, State subsidies are also to be requested and most likely approved. As the basic comparison results for the Patras Borough would clearly apply to the expansions to Pyrgos and most likely to Agrinio and other regions, the question whether the use of public funds for subsidies is justified, or better use can be made to support other measures including support for heat pump installation, begs to be answered.

Finally, it is important for both economic and environmental reasons that reputable institutions provide potential customers with appropriate, easily available and robust information on the comparative costs. Such information may include the periodic comparison studied carried out by the National Technical University of Athens[10] and tools such as that available in the European Heat Pump Association webpage[11].

[10] http://www.lsbtp.mech.ntua.gr>system>files
[11] https://myheatpump.ehpa.org/en/heat-pump-cal