Comprehensive Assessment of the Potential for Efficient Heating and Cooling Report for Point G

Report for Point G - An Overview of the Legislative and Non-Legislative Measures to Realise the Economic Potential

Report for Ministry of Energy Commerce and Industry (MECI) of the Republic of Cyprus

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Table of contents

1 Introduction

In the Point F report, the economic potential for efficient heating and cooling for the Republic Cyprus is set out. This potential was evaluated via a Cost Benefit Analysis (CBA) involving a Discounted Cash Flow (DCF) for a range of efficient heating and cooling technologies.

The CBA describes the economic potential as those technical solutions that have a positive Net Present Value (NPV), using a DCF and a Discount Rate (DR) of 4%, when evaluated against an established baseline technology or technologies. The baseline technology varies by sector and building type. The range of high efficiency technologies evaluated and the established baselines are set out in detail in the Point F report.

The high efficiency technology solutions under consideration here fall into two broad categories:

(1) District Heating and Cooling (DHC) solutions using, as the centralised source of heat, high efficiency cogeneration (both renewable and non-renewable), non-combustion high efficiency renewable heating technologies (heat pumps) and the recovery of waste heat from large combustion sites, and

(2) Individual site or building level high efficiency technologies

These two broad solution types compete against each other to cost effectively supply the heating and cooling demand in 877 Post Codes and 2 sub post code tourist areas[1]. Where a DHC solution is found to provide the heating and cooling demand at a lower cost than a suite of individual site/building level solutions, DHC is declared the cost effective technology, and vice versa. As discussed in the Point F report, in the vast majority of cases, individual site/building level solutions outcompete DHC.

The existing policy measures applying in the Republic of Cyprus, which have an effect on heating and cooling, are discussed in the Point E report. In the sections below we discuss the results of the CBA in the context of existing policies affecting heating and cooling, specifically from the point of view of whether these existing policies are able to support the realisation of the identified cost effective potential. Where it appears that the existing policies are not sufficient to support realisation of the potential, policy suggestions are made.

2 Existing Policy Measures and District Heating and Cooling (DHC) Solutions

<u>Issue</u> - In the modelling, out of 877 post code areas and 2 detailed sub post code areas, there is only one example of a DHC solution that is cost effective (i.e. positive ENPV). This involves the recovery of waste heat from one power station. Policy suggestions to increase the number of cases where this could become cost effective are discussed later.

With the exception of two sub post code detailed tourist areas evaluated, for all other DHC solutions, both the ENVP and FNPV are negative. In the case of the two tourist areas, the FNPV is positive but ENPV is negative. When pollution costs are removed from the ENPV analysis, the ENPV for the two tourist areas turns positive, as it does for 19 other Post Codes. However, for these 19 post codes, the FNPV remains negative. From this finding two things can be proposed:

That, given the very low discount rate used in the ENPV analysis (4%) it is difficult to justify, on grounds of value for money, the formulation of policy interventions to bring forward the vast majority of DHC schemes defined in the modelling. This view is further reinforced by the other non-financial barriers to DHC deployment, such as resistance to the situation of energy centres near to residential areas and the uncertainty with DHC operators gaining the security represented by long term energy supply contracts, necessary to re-risk projects.

[1] Owing to considerations of grade of heat, not all technologies are capable of supplying all the heat demand. Susceptible heat demand here therefore means the demand for heat in a post code (or sub post code area) which is of a grade that can be satisfied by the technology under consideration.

However, the cost effectiveness of the two detailed tourist areas raises the distinct possibility that, if the DHC cost effective potential analysis is carried out at a more granular level than the Post Code level used in this Comprehensive Assessment, then more cost effective DHC potential is likely to be found.

Under Article 14 paragraph 5 of the Directive 2012/27/EU, the results of this Comprehensive Assessment should be taken into account when a new thermal electricity generation installation is planned. In so far as these are very likely to be located on the same site or very close to the existing power stations and this CBA has found cost effective potential for the recovery of heat from one existing power station and its supply to a DHC scheme serving the post code in which it is located, this supports the view that cost benefit analyses should continue to be carried out in respect of new thermal electricity generation installations.

Regarding the cost effectiveness of the one heat recovery DHC solution, this is aided by the absence of fuel and environmental costs and by the fact that the waste heat is generated in reciprocating engines.

However, as it stands, recovery of heat from <u>other</u> power stations is not viable. There are two reasons for this.

- Power stations using technologies from which waste heat is available without the need to alter the technology (i.e. open cycle gas turbines) have load factors which indicate that they are operating as peaking plant and, therefore, would not be reliable sources of heat for DHC.
- With the exception of the one cost effective example mentioned above, all other power stations that are not operating as peaking plant (and therefore could act as reliable sources of heat for DHC), are understood to be using condensing steam turbines. In order for heat to be extracted from these, the steam turbines would need to be pass-out condensing steam turbines. The cost of replacing existing condensing STs with POCO STs would be prohibitive.

However, the marginal additional cost associated with specifying a POCO ST as opposed to condensing ST when a power ststion is designed is far lower and, for that reason, much more likely to yield a DHC scheme that is cost effective.

<u>Recommendation</u> – In light of the issue highlighted above, we would recommend that consideration should be given for new thermal power stations undergoing planning to be made CHP ready, with the caveat that a cost benefit analysis is carried out in respect of each individual case before this is made a condition of permitting. Recent studies carried out in Cyprus have shown that even for large planned power stations, the supply of heat extracted from the steam turbine of a CCGT would have to be delivered to a heat network no further than 4 km away for this to be cost effective. Similar distance constraints on heat linking can be anticipated for other planned power stations. There are other constraints that could have a deleterious effect on the cost effectiveness of making a power ststion CHP, which would only come to light via a proper study. Examples of such constraints are the possible need for the power station to provide frequency response to the network, which could adversely affect the economics of heat supply, and the ability of the installation to meet the primary energy saving requirements. Space constraints for auxiliary equipment, such as district heating heaters and hot water storage may also materially impact the proposition.

As explained in the Point F report, by far the most cost effective high efficiency heating and cooling technologies, as applicable to the residential and Service sectors, is the generation of electricity using PV and the use of this electricity as an input to heat pumps to provide space heating and cooling and, where not currently provided by solar, sanitary hot water.

There are two existing policy instruments which should be reviewed in order for this potential to be realised. These are the “proper recovery systems for F-gases equipment” and the “support scheme for the production of electricity from renewable sources for own use”. These are discussed in Sections 2.1 and 2.2.

2.1 Preparation of a Proper Recovery System for F-Gases in Equipment

Issue - This is an obligation according to EU and national legislation but, as explained in the Point E report, is still not properly implemented. Implementation of this becomes especially important if the number of heat pumps in deployment increases, as the number reaching the end of their lives will also increase going forward. It is understood that preparation of a proper recovery system has been delayed, but is due to commence this year (2021), and that a budget of €1 million has been set aside.

Recommendation - Review the work to date on the F-gas recovery system in the context of the large cost effective potential for heat pump deployment in the residential and service sectors. Ensure that delivery timelines and budget set aside for the preparation of this system are commensurate with the opportunity presented by significant deployment of heat pumps.

2.2 Support Scheme for the Production of Electricity from Renewable Energy Sources for Own Use

Issue - The large potential for PV + heat pumps in the residential and service sectors is partly underpinned by assumptions relating to the sizing of the PV panels and specifics of their operation. As explained in the Point F report, PV panels are modelled such that the capacity is sufficient to generate, over the year, all heat pump electricity demand to deliver space heating and space cooling. Since PV generation will not always be in phase heat pump electricity demand, as driven by the demand for heating and cooling, either electricity storage or net metering is required. In the modelling net metering is assumed. This avoids the need for battery storage and therefore has the advantage of keeping the Capex of the solution down and obviating any issues with the availability of space for battery storage.

As explained in the Point E report, the support scheme for the production of electricity is capped at 5 MW for residential and at 15 MW for non-residential per annum and is renewed each year. The total PV capacity needed to realise the cost effective potential where PV + heat pump is the best solution is 1,928 MWe, with approximately 50% of this is each of the residential and service sectors. Clearly, for the current net metering provision to support more than a modest proportion of this capacity the capacity caps would have to be raised significantly.

Recommendation – Consider raising the capacity cap for PV with net metering. Further work should be undertaken to understand how far the capacity cap could be raised in a way that is sustainable for the stakeholders involved. In respect of a revised cap, the modelling could be refined to identify the tranche of potential where savings are maximised for this cap. Policy could be formulated to facilitate the realisation of this specific tranche of potential. In respect of the currently identified potential which would exceed any new cap, the modelling would have to be refined to assess the relative cost effectiveness of the following options (1) importing electricity at times when PV generation is insufficient to meet heat pump demand, and (2) installing storage batteries of the required capacity and whether this can be done at the individual building level or at the system level, whereby central battery storage is employed. When that work is complete, it should be possible to assess whether new fiscal measures and policies are required to realise potential available which would not fall within the cap.

In further assessing options it should be kept in mind that, in the vast majority of cases, Point F has shown that heat pumps powered by grid electricity also serves as a cost effective option relative to the baseline.

3 Existing Policy Measures and Individual Site Level Industrial Heating and Cooling Demand

Within the industry sector, the most cost effective heating and cooling solutions are either oil or LPG fired CHP with absorption chillers, for architypes requiring process cooling[2]. These CHP solutions are cost effective from both the Economic (ENPV) and Financial (FNVP) perspectives. Therefore, when viewed through the architypes modelled in this work, oil and LPG CHP technologies are justified from a public and private investment perspective. In this regard, policy intervention should be unnecessary. However, this does raise the question of why CHP has only been deployed in the agriculture and waste management sectors, even though there is a net-billing scheme available for CHP deployed in the commercial/industrial and public administration sectors.

The deployment of CHP in agriculture and waste management is driven by the need to deal with waste arising in these sectors, where the waste can be used as a fuel. Oil and LPG fired CHP, if run efficiently can not only achieve the primary energy savings required under the definition of high efficiency cogeneration but can achieve CO_2 emissions per unit of electricity generated of less than the 0.55 $kgCO_2/kWh$ required by some investors. This is the case if the fuel for heat is stripped out of the calculation using the reference value for the separate generation of heat.

Given the cost effective potential of CHP, it is likely that a lack of experience with the implementation and maintenance of CHP is playing a role in the fact that it has not been implemented in industrial sectors like food and drink and some large commercial establishments. Given that natural gas is not available at the moment and will not be available for consumption in the future outside of the areas occupied by the power stations, the need to store LPG and oil on site to enable CHP deployment may also present as a physical obstacle for some industrial sites.

These cost effective CHP solutions (oil and LPG CHP), while they are found via the modelling to save primary energy relative to the baseline over the project lifetime, do not save CO_2. This is due to the significant decarbonisation of the electricity grid anticipated going forward. Biomass CHP, when applied to the industrial architypes, saves CO_2 and also produces a positive FNPV, but produces a negative ENPV. This is due to the pollution costs ascribed to the burning of biomass, specifically the cost attached to PM10 emissions. When these pollution costs are dis-applied (as is the case in the FNPV analysis) a positive ENPV is returned for biomass CHP against all industry architypes.

<u>Recommendation</u> – Regarding the near term implementation of oil or LPG fired CHP, which is efficient from an economic and primary energy point of view, but has not penetrated industry, consider measures that can address the current issues of lack of skills and experience with the implementation of CHP projects.

Further work is needed to assess what additional costs would have to be incurred to remove the PM10 issue from biomass CHP and what effect this would have on the cost effectiveness of the solution relative to the baseline and relative to the other CHP options that appear cost effective. In light of this work, assess whether there is any policy intervention needed to bring forward biomass CHP

4 Impacts of Realising the Economic Potential

Assuming policy measures are designed and put in place to realise the identified economic potential, the following benefits would result in 2030, 2035, 2040, 2045 and 2050, relative to the “With Existing Measures” (WEM) baseline.

[2] Process cooling is modelled as necessary in the Chemicals and Food and Drink sectors.

4.1 Greenhouse Gas Emissions Reductions

Table 4-1 In year CO_2 savings associated with the implementation of cost effective best high efficiency solutions, relative to the WEM projection

Year	Baseline CO_2 Associated with Heating and Cooling ($ktCO_2$)	Absolute Reductions w.r.t Baseline ($ktCO_2$)	% Reductions w.r.t Baseline
2030	1,782	1,340	75%
2035	1,424	880	62%
2040	1,207	630	52%
2045	1,036	484	47%
2050	876	363	41%

Since the WEM baseline has ever decreasing CO_2 emissions associated with it, the sooner the high efficiency cost effective potential is implemented, the greater will be the in-year reductions in heating and cooling CO_2 emissions.

4.2 Primary Energy Savings

Table 4-2 In year primary energy savings associated with the implementation of cost effective best high efficiency solutions, relative to the WEM projection

Year	Baseline Primary Energy Associated with Heating and Cooling (GWh)	Absolute Reductions w.r.t Baseline (GWh)	% Reductions w.r.t Baseline
2030	10,360	3,275	32%
2035	9,975	2,182	22%
2040	9,964	1,594	16%
2045	9,946	1,281	13%
2050	9,940	1,027	10%

Since the WEM baseline has an ever decreasing ratio of primary energy input to delivered energy output for electricity generation, as increasing proportions of primary renewables such as solar PV, solar thermal and wind are introduced, the in-year primary energy savings associated with implementation of cost effective high efficiency solutions decreases year on year. Therefore, the sooner the high efficiency solutions are implemented the greater will be the additional benefit to primary energy reduction.

4.3 Impact on Share of High Efficiency Cogeneration

Table 4-3 In year effect of implementation of best CHP high efficiency solutions on CHP electricity generation

Year	Current CHP Electricity Generation (GWh)	Additional CHP Generation Associated with Cost Effective Potential (GWh)	% Increase in CHP Generation w.r.t Baseline
2030	57.4	410	+714%
2035	57.4	410	+714%
2040	57.4	410	+714%
2045	57.4	410	+714%
2050	57.4	410	+714%

N.B For the purposes of this analysis, it is assumed that the CHP electricity generation in 2018 is maintained in the absence of the implementation of additional cost effective CHP potential.

4.4 Impact on Share of Renewables in National Energy Mix in Heating and Cooling Sector

Table 4-4 In-year share of renewable energy in primary energy supply associated with WEM projection and if the cost effective best high efficiency solutions are implemented

Year	Share of Renewables of Primary Energy Supply for Heating and Cooling Generation in Baseline	Share of Renewables of Primary Energy Supply for Heating and Cooling Generation if Economic Potential Realised	Additional Benefit Associated with Implementation of High Efficiency Solutions (
2030	29%	69%	+40%
2035	43%	73%	+30%
2040	52%	77%	+25%
2045	59%	79%	+20%
2050	66%	81%	+15%

The implementation of the best high efficiency always increases the share of renewable energy associated with the provision of heating and cooling, relative to the WEM baseline. However, as share of renewables in the baseline increases, the additional renewables contributed by the best cost effective solutions decreases.

4.5 Cost Savings for the Public Budget and Market Participants

The high efficiency solutions which are cost effective are so because they generate positive cash flow, relative to the baseline technologies, for years outside of capital expenditure. Below, expressed in €2020, are the total in-year savings to be enjoyed, relative to the baseline, if all of the cost effective high efficiency solutions identified in Point F are implemented. With a large proportion of the best solutions constituting PV + heat pumps, with significant free energy flows in the form of ambient heat and solar insulation, the in years are significant in absolute and relative terms.

Table 4-5 In-year economic and financial savings relative to the baseline

Year	In-year Positive Economic Cashflow Associated with Implementation of High Efficiency Solutions (€m)	% Economic Saving	In-year Positive Financial Cashflow Associated with Implementation of High Efficiency Solutions (€m)	% Financial Saving
2030	706	63%	577	59%
2035	709	63%	608	60%
2040	673	61%	590	59%
2045	651	60%	577	58%
2050	629	59%	565	57%

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