Development of a Heating and Cooling Strategy at Local Level (Cyprus)

Technical Assistance Report

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Executive summary

This Technical Assistance Report is the third and final report on the project SRSS/C2017/004, "Development of a Heating and Cooling Strategy at a Local Level". This project sets out to identify the potential for high efficiency heating and cooling solutions in agreed areas of Cyprus, where high efficiency solutions include District Heating and Cooling (DHC) and local, building level heating solutions, including Combined Heat and Power (CHP), heat pumps and solar thermal solutions.

Accompanying this Technical Assistance Report is an Excel spreadsheet based "Model" used to evaluate this potential. This Model visibly sets out for inspection all of the significant data and assumptions feeding into the evaluation of potential and incorporates a User Guide. The Model allows the user to vary a number of key parameters feeding into the analysis so that the impact of these on the potential can be ascertained. Specifically, the Model includes a facility to graphically explore the sensitivity of the Economic and Financial performance of any of fifteen specific technical solutions in any of ten specific geographical areas studied to a range of key parameters.

The earlier Inception Report set out the results of the discussions held between the Ministry of Energy, Environment, Industry and Tourism (MECIT), Ricardo Energy & Environment (REE) and the Structural Reform Support Service (SRSS) between 27th-29th March. In this report the agreed aims, scope and boundaries of the project are set out. The Inception Report also confirmed the agreed geographical areas to study, the overall approach to the analysis and the outstanding data requirements pertaining at the time of writing.

The earlier Data Report set out the main data sets that would be used in the analysis of the potential for high efficiency heating and cooling solutions. It was submitted at the beginning of August 2017, after exhausting a number of leads pursued to fill gaps in the data. The Data Report is clear about the areas where primary data were not available and the workarounds used to overcome this. However, in developing the model used to evaluate the potential for high efficiency solutions, it has been necessary to draw upon a large number of sources of data and information. Therefore, the Data Report is not exhaustive on all data sources. All data sources are, nevertheless, set out in the "Model". The structure and functionality of the Model has been explained to MECIT representatives at a specifically convened training session.

The key findings arising from this Technical Assistance Report are as follows:

- There is only clear cost effective potential for District Heating and Cooling (based upon Discount Rate of 6%) in two of the ten geographic areas analysed, relative to a baseline.[1]. The geographic areas where this potential exists are the two tourist areas analysed: Poseidonos Avenue, Paphos and Kryo Avenue, Ayia Napa. The technologies showing cost effective potential were: Refuse Derived Fuel (RDF) CHP and oil fired CHP.

- When a Discount Rate of 12% (DR 12%) is applied a number of the solutions identified as cost effective at DR of 6% for the two tourist areas become non-cost effective, implying that these projects would not stack-up on a commercial basis.

- The existence of cost effective DHC potential is very sensitive to the load factor of the plant serving the modelled DHC scheme during the cooling season, with higher load factors favouring cost effectiveness. This is the main reason why potential is identified in the tourist areas and not in the other areas, since cooling is in demand for a higher proportion of the time in the hotels making up these areas than is the case for other areas, which are comprised of offices, other commercial buildings and residential buildings.

- There are five main assumptions which have a profound impact upon the cost effectiveness of a District heating and Cooling solution, which are independent of the technology. However, the ranking of these in terms of importance is technology dependent. The five main assumptions are: Capex of central DHC plant, Capex of individual thermal plant being displaced by central DHC plant, electricity price, thermal energy demand served by the DHC plant and fossil fuel prices.

[1] The baseline reflects our understanding of how space heating, space cooling and sanitary hot water is currently supplied

Assumptions on electricity price are especially important for CHP based solutions with relatively high efficiencies of electricity generation.

- For the modelled DHC schemes showing cost effective potential, District Heating and Cooling based upon Refuse Derived Fuel (RDF) CHP can be relied upon to deliver CO_2 savings over the lifetime of the project. However, the ability of District Heating and Cooling based upon oil fired CHP to deliver CO_2 savings over the lifetime of the project is less reliable and dependent upon the specifics of the solution and the heating and cooling demand characteristics of the geographical area under consideration.

- While District Heating and Cooling based upon Refuse Derived Fuel (RDF) CHP is attractive from a cost effective and CO_2 savings point of view, the modelling indicates that it would not generate Primary Energy Savings, relative to the baseline. This finding is driven by the assumption made in this study about how efficiently grid electricity would be generated in the future. The model can be used to explore the impact on primary energy savings of different efficiencies of plant feeding into the grid.

- Where a technology is analysed as applying at the district level and the individual building level, the pattern of results is broadly similar.

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1 Introduction

This Technical Assistance report is divided into the following main sections:

Section 2 **Geographical Areas (GAs) Evaluated** – This sets out 10 distinct geographical areas for which the potential for DHC and individual, building level solutions were evaluated. It sets out the full characteristics of these areas, including but not limited to: the number and type of buildings which the primary data indicate are in each area; the calculated Gross Floor Area of these buildings; the calculated annual demand for space cooling, space heating and sanitary hot water; the calculated peak demand for these and the calculated DHC pipe length that would be required to supply the buildings in the GAs with heating and cooling.

Section 3 **District Heating and Cooling (DHC) Solutions Evaluated** – This describes three different types of DHC solution that were evaluated, which differ from each other according to:

(i) Whether the schemes are able to supply heating and cooling simultaneously from central plant (4-pipe solutions)

(ii) Whether schemes, at any one time, can only supply heating or cooling from a central source (2-pipe solutions), and

(iii) Whether cooling is generated centrally and distributed to the point of use, or whether it is generated locally using absorption chillers (2-pipe solution + distributed absorption chillers)

This section explains that these three types of solution, when applied across a range of heating and cooling technologies, lead to 15 specific solutions. All 15 of these specific solutions were evaluated for GAs adjacent to the sea. For inland areas, 12 solutions were evaluated. The characteristics of these 15 solutions are explained in detail in Table 2. The characteristics differ according to whether they are 2-pipe or 4-pipe solutions, the technologies used for main, centralised generation of heating and cooling, the technologies used for topping up heating and cooling and whether these top-up plant are centralised or locally situated. The main heating technologies evaluated are: Biomass CHP, Oil fired CHP, LPG fired CHP, Refuse Derived Fuel (RDF) fired CHP and Water Source Heat Pumps (WSHPs). The main cooling technologies evaluated are Absorption Chillers and WSHPs.

Section 4 **Individual Building Level Solutions Evaluated** – This describes the main heating and cooling technologies evaluated for individual, building level solutions. These are: Biomass CHP (with absorption chillers for cooling), Oil fired CHP (with absorption chillers for cooling), LPG fired CHP (with absorption chillers for cooling), heat pumps (for heating and cooling) and solar thermal (with absorption chillers for cooling). Working with these main heating and cooling technologies are top-up heating and cooling plant. The main and top-up plant are set out in detail in Table 3. It should be noted that for technical reasons, not all of these individual building level solutions are evaluated against all of the GAs. The most important examples of where this is the case are: (i) If the GA is comprised only of residential buildings, individual building level solutions involving CHP are not evaluated, and (ii) Solar thermal solutions are only evaluated where information available indicates that buildings do not currently use this technology at all (i.e. it is not in the baseline) and where there is likely to be enough roof space to support installation.

Section Results and Discussion – This sets out the results of the modelling of both the DHC and individual, building level heating and cooling solutions across all of the relevant GAs evaluated. This section is supported by detailed results tables in Appendix 8 (DHC results) and Appendix 10 (individual building level solutions). The sensitivity of the results for the DHC solutions to the key assumptions underpinning the analysis is also explored in this section. An explanation for the most important aspects of the results is also provided.

Section Key Findings– The most important findings falling out of the results and foregoing discussions are set out as a series of bullet points.

Section Policy Implications and Recommendations – In this section the implications of these results for the setting of policy in Cyprus are discussed.

2 Geographical Areas (GAs) Evaluated

As discussed in the Inception and Data Reports, ten separate and distinct Geographical Areas (GAs) were selected for evaluation of the economic and financial potential for high efficiency heating solutions, which include District Heating and Cooling (DHC) solutions and building level efficient heating and cooling solutions. These GAs are:

GA 1 Post Code 1097 (PC_{1097}) Nicosia – This post code selected on basis that it is understood to be primarily comprised of service sector buildings. All buildings in this post code were included in the analysis.

GA 2 Post Code 1097 (PC_{1097}) Nicosia – A selection of buildings in this post code were included in the analysis.

GA 3 Poseidonos Avenue, Paphos, incorporating parts of PC_{8041}, PC_{8042} and PC_{8204}. This area captures 25 hotels dispersed across this avenue.

GA 4 Kryo Avenue, Ayia Napa (PC_{5330}) - This area captures 20 hotels dispersed across this avenue.

GA 5 (PC_{1082}) Nicosia – This post code selected on basis that it is understood to be a mix of service and residential buildings. All buildings in this post code were included in the analysis.

GA 6 Post Code 2003 (PC_{2003}) Nicosia – This post code selected on basis that it is understood to be primarily composed of residential buildings. All buildings in this post code were included in the analysis.

GA 7 Post Code 3105 (PC_{3105}) Limassol – This post code selected on basis that it is understood to be primarily composed of service sector buildings. All buildings in this post code were included in the analysis.

GA 8 Post Code 3106 (PC_{3106}) Limassol – This post code selected on basis that it is understood to be a mix of service and residential buildings. All buildings in this post code were included in the analysis.

GA 9 Post Code 6022 (PC_{6022}) Larnaca – This post code selected on basis that it is understood to be a mix of service and residential buildings. All buildings in this post code were included in the analysis.

GA 10 Post Code 6023 (PC_{6023}) Larnaca – This post code selected on basis that it is understood to be primarily composed of service sector buildings. All buildings in this post code were included in the analysis.

Table 1 sets out in detail the main characteristics of these ten GAs, which are key inputs to the analysis of the potential for DHC.

Appendix 1 provides an example map of the DHC scheme modelled for post code 1097 in Nicosia.

Table 1 Full characteristics of geographical regions analysed in this study

Area Name	Relevant Postcodes	DHC Model ID	Post Code Wide/Detailed Analysis	Total No. Buildings	Total No. Properties	No. Apartments	No. Houses	No. Service Buildings	Gross Bldg. Floor Area (m^2)
Area 1 PC_{1097} Nicosia 1097 Nicosia	1097	1	Post Code Wide	51	59	21	6	32	114,233
Area 2 PC_{1097} Nicosia	1097	2	Detailed	6	6	0	0	6	37,055
Area 3 Poseidonos Avenue, Paphos	8041, 8042, 8204	3	Detailed	25	25	0	0	25	209,665
Area 4 Kryo Avenue, Ayia Napa	5330	4	Detailed	20	20	0	0	20	117,157
Area 5 PC_{1082} Nicosia	1082	5	Post Code Wide	213	871	748	78	45	272,213
Area 6 PC_{2003} Nicosia	2003	6	Post Code Wide	179	1,104	992	83	29	223,931
Area 7 PC_{3105} Limassol	3105	7	Post Code Wide	89	703	673	30	0	113,120
Area 8 PC_{3106} Limassol	3106	8	Post Code Wide	250	1,165	1,012	150	3	288,123
Area 9 (PC_{6022}) Larnaca	6022	9	Post Code Wide	115	584	557	23	4	173,406
Area 10 PC_{6023} Larnaca	6023	10	Post Code Wide	169	535	503	32	0	254,254

Table 1 (cont.)

Area Name	Relevant Postcodes	DHC Model ID	Post Code Wide/Detailed Analysis	Space Cooling Consumption (MWh)	Space Heating Consumption (MWh)	Sanitary Hot Water Consumption (MWh)[2]	Peak Space Cooling Demand (kWth)	Peak Space Heating Demand (kWth)	Peak Sanitary Hot Water Demand (kWth)	Length of DHC Network (m)
Area 1 PC_{1097} Nicosia 1097 Nicosia	1097	1	Post Code Wide	23,806	15,028	1,312	98,089	22,327	150	3,266
Area 2 PC_{1097} Nicosia	1097	2	Detailed	6,773	5,812	0	28,320	7,709	0	384
Area 3 Poseidonos Avenue, Paphos	8041, 8042, 8204	3	Detailed	44,373	16,909	9,808	111,035	10,772	1,119	5,451
Area 4 Kryo Avenue, Ayia Napa	5330	4	Detailed	24,695	9,710	5,647	61,795	6,186	644	2,400
Area 5 PC_{1082} Nicosia	1082	5	Post Code Wide	9,832	5,423	0	26,075	5,253	154	10,287
Area 6 PC_{2003} Nicosia	2003	6	Post Code Wide	9,337	5,196	0	25,011	5,084	173	9,090
Area 7 PC_{3105} Limassol	3105	7	Post Code Wide	10,022	5,092	0	46,814	6,056	152	6,404
Area 8 PC_{3106} Limassol	3106	8	Post Code Wide	11,439	5,561	0	50,845	6,293	235	11,981
Area 9 (PC_{6022}) Larnaca	6022	9	Post Code Wide	6,798	3,262	0	30,449	3,720	112	5,976
Area 10 PC_{6023} Larnaca	6023	10	Post Code Wide	15,510	5,306	0	72,448	6,310	164	7,866

[2] Estimated consumption where not currently supplied by solar thermal

3 District Heating and Cooling (DHC) Solutions Evaluated

The cost effectiveness, primary energy and CO_2 savings of a number of "Types" of DHC solutions were evaluated. Each type was evaluated against the different GAs, that is DHC Model IDs listed in Table 1 (DHC Model IDs 1-10). This means that the DHC solutions are modelled to supply all of the buildings listed against each DHC Model ID in Table 1, and supply the listed consumption demands of Space Cooling (SC), Space Heating (SH) and Sanitary Hot Water (SHW), where the last is not currently supplied using solar thermal. Where SHW is assumed to be currently supplied using solar thermal, it is assumed that this arrangement will continue, even though SH and SC are supplied via the DHS scheme. Table 1 also sets out the peak demands for SC, SH and SHW that the DHC would have to meet and the length of the DHC pipework that would have to be laid in trenches.

There are three basic "Types" of DHC solution evaluated, defined according to the approach taken to meeting the demands for cooling and heat in the buildings served by the solution. These are summarised below:

Type 1 – This is a 2-pipe solution, whereby the same flow and return pipes are used to supply hot water (for SH and SHW) and chilled water (for SC). This means that, at any one time, only heating or cooling can be supplied via the DHC network. Therefore, only hot water will flow in the DHC pipework in the winter/heating season (assumed to be November to April) and only chilled water will flow in the DHC pipework during the summer/cooling season (assumed to be May to October). A consequence of this supply arrangement is that the demand for SHW, which occurs throughout the year, cannot be met by the DHC network in the summer months when the network is dedicated to supplying chilled water for cooling. At these times, heat customers on the network will have to use their own local plant to meet all of their SHW demand.

Type 2 – This is a 4-pipe solution, whereby there are separate flow and return pipes for hot water and chilled water. This means that at any one time both heating and cooling can be supplied by the DHC network, as required by the customers on the network. In contrast to the situation for Type 1, there is no need for local SHW heating plant (unless the end user is modelled to be currently using solar thermal for SHW, in which case the modelling assumes that particular arrangement continues).

Type 3 – This is a 2-pipe solution whereby the flow and return pipes are used only to supply hot water. No chilled water is carried by the DHC network. Instead, cooling is achieved locally using localised absorption chillers, but only where the building requiring cooling is a service sector building. Where the building in question is residential, it is assumed that the installation of localised absorption chillers to meet residential cooling demand would be prohibitively expensive, and in these cases the cooling demand is met by local heat pumps.

There are variations of each of the three Types of DHC solution mentioned above, with each variation relying on different primary, central heat generating plant. There are five types of primary, central heat generating plant. These are: Biomass CHP, Oil CHP, LPG CHP, RDF CHP and Water Source Heat Pumps (WSHP). WSHPs are only applicable for coastal post codes. This means that WSHPs are not relevant to the solutions investigated for Nicosia post codes, but are relevant for all of the other post codes investigated in this study.

Taking the three different types of DHC solutions and the five primary, central heat generation technologies means that we have investigated fifteen combinations of DHC solution type and primary, central heat generating technology. Depending upon the type of solution, heat and cooling top-up plant, used to supplement the primary plant heat and cooling outputs, may or may not be necessary. Table 2 sets out in detail the primary plant, top-up plant and DHC pipework arrangements associated with each of the fifteen combinations.

Table 2 Detailed characteristics of 12 combinations of DHC evaluated in this study

Combination No.	DHC Solution Type	No. Pipes (2 or 4)	Primary, Central Heating Plant	Top-up Central Heating Plant	Primary Central Cooling Plant	Top-up Central Cooling Plant	Localised Top-up SHW	Localised Top-up Cooling Plant
1	Type 1	2 pipe	Biomass CHP	Biomass boiler	Absorption chiller	Electric chiller	As per baseline	Not required
2	Type 2	4 pipe	Biomass CHP	Biomass boiler	Absorption chiller	Electric chiller	As per baseline	Not required
3	Type 3	2 pipe	Biomass CHP	Biomass boiler	N/A (Cooling generated locally)	N/A	As per baseline	Local Absorption chiller + Reversible heat pump (for residential buildings)
4	Type 1	2 pipe	Oil CHP	Oil boiler	Absorption chiller	Electric chiller	As per baseline	Not required
5	Type 2	4 pipe	Oil CHP	Oil boiler	Absorption chiller	Electric chiller	As per baseline	Not required
6	Type 3	2 pipe	Oil CHP	Oil boiler	N/A (Cooling generated locally)	N/A	As per baseline	Local Absorption chiller + Reversible heat pump (for residential buildings)
7	Type 1	2 pipe	LPG CHP	LPG boiler	Absorption chiller	Electric chiller	As per baseline	Not required
8	Type 2	4 pipe	LPG CHP	LPG boiler	Absorption chiller	Electric chiller	As per baseline	Not required
9	Type 3	2 pipe	LPG CHP	LPG boiler	N/A (Cooling generated locally)	N/A	As per baseline	Local Absorption chiller + Reversible heat pump (for residential buildings)
10	Type 1	2 pipe	WSHP	Not required	WSHP	Not required	As per baseline	Not required
11	Type 2	4 pipe	WSHP	Not required	WSHP	Not required	As per baseline	Not required
12	Type 3	2 pipe	WSHP	Not required	WSHP	Not required	As per baseline	Not required
13	Type 1	2 pipe	RDF CHP	RDF boiler	Absorption chiller	Electric chiller	As per baseline	Not required
14	Type 2	4 pipe	RDF CHP	RDF boiler	Absorption chiller	Electric chiller	As per baseline	Not required
15	Type 3	2 pipe	RDF CHP	RDF boiler	N/A (Cooling generated locally)	N/A	As per baseline	Local Absorption chiller + Reversible heat pump (for residential buildings)

4 Individual Building Level Solutions Evaluated

For each of the 10 geographical areas listed in Table 1 the potential for their Space Cooling (SC), Space Heating (SH) and Sanitary Hot Water (SHW) consumption demand to be satisfied using individual, building level high efficiency solutions was evaluated. These high efficiency solutions are:

- CHP (biomass, oil and LPG fired), with individual building level absorption chillers and appropriate top up for heating and cooling. (Note the following: (1) RDF fired CHP is not considered an appropriate solution at the individual level and so is not modelled here, and (2) CHP solutions are only modelled for non-residential buildings)
- Individual heat pumps for SH and SC, with solar for SHW generation
- Solar SH, SC (using absorption chillers) and SWH. This solution is only evaluated for GAs where the information available indicates that they are not currently used (i.e. it is not in the baseline) and where there is deemed to be enough roof space for its installation. (N.B. These restrictions in practice mean that this solution is only examined for Areas 3 and 4.)

These solution types are set out in detail in Table 3.

Table 3 Detailed characteristics of the individual building level solutions evaluated

Combination No.	Primary Heating Plant	Top-up Space Heating Plant	Primary Cooling Plant	Top-up Cooling Plant	Primary SHW Plant	Top-up SHW Plant
1	Biomass CHP	Biomass boiler	Absorption chiller	Electric chiller	Where not solar thermal, Biomass CHP/biomass boiler	Where not solar thermal, Biomass CHP/biomass boiler
2	Oil CHP	Oil boiler	Absorption chiller	Electric chiller	Where not solar thermal, Oil CHP/Oil boiler	Where not solar thermal, Oil CHP/Oil boiler
3	LPG CHP	LPG boiler	Absorption chiller	Electric chiller	Where not solar thermal, LPG CHP/LPG boiler	Where not solar thermal, LPG CHP/LPG boiler
4	Heat pump	None	Heat pump	None	Where not Solar thermal	Electric resistance (for hotels) Electric resistance (for other non-domestic buildings) Baseline (for domestic buildings)
5	Solar thermal	Oil boiler (for hotels) Baseline (for other non-domestic and domestic buildings)	Absorption chillers	Electric chillers (for hotels) Baseline (for other non-domestic and domestic buildings	Solar thermal	Oil boiler (for hotels) Baseline (for other non-domestic and domestic buildings)

5 Results and Discussion

5.1 District Heating and Cooling (DHC) Solutions

The economic and financial potential of the 15 combinations of DHC solution set out in Table 2, when applied to the geographical areas set out in Table 1, was evaluated. This potential was evaluated using Discounted Cash Flow (DCF) analysis relative to the baseline technology mix for each geographical area. The baseline technology mix was set out in Sections 1.1 and 1.2 of the Data Report for the post code level and detailed level analyses, respectively. In summary, for the post code level analysis, the JRC's projection of the proportion of different technologies used to provide SH, SC and SHW, in each of the four sectors of the economy (residential apartments, other residential, services and industry), for the years out to 2050 was used to define the baseline. For the detailed analysis bespoke baselines, based on actual observations, were used. Specifically, in the tourist areas, the baseline was set as oil boilers for SH and SHW and non-reversible heat pumps for cooling. For the other area undergoing detailed analysis (Post Code 1097) the baseline technology mix is the same as that established for the service sector in this post code from the JRC data.

The economic potential is evaluated using a Discount Rate (DR) of 6% and the financial potential was evaluated using a DR of 12%. The economic potential is evaluated including an external cost associated with the deployment of the different technologies, in order to reflect the cost to wider society of fuel use. The external costs included here are the costs of CO_2 arising from the combustion of fuel. The CO_2 costs are those used by the European Investment Bank in their guidelines for the appraisal of investment projects[3]. These costs are set at € (2006) 25/tCO_2e for emissions made in 2010, with the cost increasing by €1/tCO_2/year for each year after 2010. These costs have been inflated to 2016 prices using the inflation rate for the EU28 given by Eurostat. This means that the external cost associated with the generation of 1 tonne of CO_2 in 2016 expressed in 2016 Euros is € (2016) 37.23. Appendix 2 shows these CO_2 costs expressed in € (2016) for a range of years in which the emission is made. Only the Central costs have been used in the analysis.

The financial potential is evaluated <u>excluding</u> the above mentioned external costs but including the cost of CO_2 where the combustion capacity of the plant would mean that it was covered under EU ETS. This cost only becomes relevant for the larger DHC solutions. The assumed prices of ETS emission allowances are taken from Figure 2 of the report: EU Reference Scenario 2016 Energy, transport and GHG emissions Trends to 2050[4]. These prices are set out in Appendix 3. The cost of taxes levied on fuel is excluded from both the economic and financial analyses[5].

Another key input to the analysis is the electricity price. The installation of local electricity generation plant (as would be the case with DHC based upon CHP) has potential benefits for the whole electricity generation, transmission and distribution system. As the demand for electricity in Cyprus increases and a greater proportion of it is supplied from intermittent renewable sources, upgrades to the transmission and distribution infrastructure would be required. However, the generation of more electricity locally, which need not use this infrastructure, has the potential to avoid the costs associated with these upgrades. In order to reflect these potential cost savings, we have used electricity prices from the report by the Royal Institute of Technology, Sweden: Cost optimal scenario analysis for the Cypriot energy system (known as the "Cypriot Energy System Report") and, with agreement with MECIT added an additional cost of €38/MWh plus 4% profit to reflect the infrastructure cost associated with the cost optimal scenario investigated in that report. The resulting unit price of electricity was then used in the analysis. By using this unit price in the analysis, any solution involving the generation of electricity (i.e. the CHP solutions) or a reduction in electricity taken from the grid, would displace electricity with this unit cost. Since the unit cost includes the infrastructure cost, the value of this cost avoided is credited to the solution. In this way the analysis implicitly includes the cost savings associated with the infrastructure where the solution saves electricity which would otherwise have to be generated centrally and supplied via the grid.

There are a number of factors which, to a greater or lesser degree, have an impact upon the economic and financial potential of the solution being considered relative to the baseline. These factors can be increased or decreased by a fixed percentage about a central value and the model run to reflect these changes. In this way the sensitivity to these factors of the economic and financial potential of the solution can be investigated. Unless otherwise stated, the results presented and discussed below are for these factors set at 100%. A separate section on sensitivity (Section 5.1.4) discusses the effect of setting these factors at values other than 100% (specifically ±20% in this

[3] 'The Economic Appraisal of Investment Projects at the EIB' by the European Investment Bank http://www.eib.org/attachments/thematic/economic_appraisal_of_investment_projects_en.pdf?f=search&media=search

[4] https://ec.europa.eu/energy/sites/ener/files/documents/20160713%20draft_publication_REF2016_v13.pdf

[5] Except in the case of domestic supplies where VAT of 5% in the financial analysis.

report, although the Model can accommodate any percentage change): The factors which can be explored in this way, in *general* decreasing order of sensitivity, are[6]:

- Capex and Opex of central plant in the solution
- Electricity price
- Thermal energy demand being served by the solution
- Capex and Opex of individual plant associated with the baseline
- Fossil fuel prices
- Environmental (external) and CO_2 costs (note this sensitivity is applied to both the external CO_2 cost (relevant to the Economic analysis) and the EU ETS CO_2 cost (relevant to the financial analysis)
- Capex of DHC primary network
- Renewable fuel prices (this applies to biomass and RDF)
- The Opex expressed as a percentage of Capex
- Capex of connecting to DHC network and (where applicable) installation of a wet system

A **Central Scenario** is established whereby the above listed factors are set at 100% and the fuel prices are set at Energy Price Set 1, as set out in Appendix 5. The salient feature of energy price set 1 is that electricity and diesel fuel prices are grounded in the report into the Cypriot Energy System and the biomass price is consistent with biomass import prices in the UK. The rationale behind this second point is that, as Cyprus would have to import its biomass, it would be subject to the same international biomass market as the UK, which also imports significant quantities of biomass as a fuel.

Another characteristic of the Central Scenario are the assumptions made about the hours of occupancy of the different types of building making up each post code. This is a key variable directly affecting the economics for DHC. The method by which the energy demand for SC, SH and SHW for different post codes was derived was set out in the Data Report. Having established this demand, the size of plant needed to satisfy it is calculated within the model and from there the Capex is determined. The lower the hours of occupancy, the more compressed in time is the energy demand and the larger the plant needed to satisfy it. This means that, for the same quantity of energy demand within an area, the lower the hours of occupancy the larger is the plant required and the higher the Capex. The occupancy factors assumed in the Central scenario are set out in Appendix 4. These occupancy hours may be changed, as desired, and the model re-run.

Alternative energy price sets of (known as Energy Price Sets 2 and 3) are also available in the Model. Appendix 5 provides detailed explanation of the origin of the energy prices used.

5.1.1 Economic and Financial Performance of DHC Solutions

The economic and financial potential for the Central Scenario, as described in Section 5.1, applied to all Geographical Areas (GAs), is presented in the tables in Appendix 8. The results are presented for both the economic and financial analyses for each of the 15 DHC solutions examined. For some geographical areas there are no results presented for solutions 10-12 (Water Source Heat Pump based solutions), as these areas are inland and the WSHP solutions rely on the sea as the source of heat extraction/deposition.

The Net Present Value (NPV) is presented for each solution for each geographical area relative to the baseline. A positive NPV means that the solution is cheaper than the baseline over the lifetime of the solution. The NPV under the economic analysis is known as ENPV and the NPV under the financial analysis is known as the FNPV. In order to understand the impact that each solution might have on the all-important balance of electricity supply and demand, the grid electricity consumption reduction and the electricity generation associated with each solution is also presented. To illustrate, it will be observed that the electricity consumption reduction for the WSHP based solutions is negative and this is because this solution results in an increase in the consumption of grid electricity, relative to the baseline, to drive these heat pumps. For the same solution, the electricity generation is zero, while the

[6] The ranking order of sensitivity is different for different geographical areas.

electricity generation for the CHP based solutions is positive. The quantity of Space Cooling (SC), Space Heating (SH) and Sanitary Hot Water (SHW) delivered by each solution, which is economic, is also presented.

With the exception of a few isolated examples, economic potential (Discount Rate = 6%) for DHC is only found in Areas 3 and 4, that is the two tourist areas of Poseidonos Avenue, Paphos and Kryo Avenue, Ayia Napa. Moreover, economic potential is only found for solutions based on oil fired and RDF fired CHP. Of these two technologies, the RDF fired option tends to have the higher NPV and this is substantially due to the relatively low price assumed for RDF compared against oil. With agreement from MECIT, the RDF price assumed here is €2/MWh. In the future, there could be financial benefits associated with the use of RDF, such as the avoidance of fines and avoided landfill tax, should one be instigated in Cyprus.

For Areas 3 and 4, the solution with the highest ENPV is solution 6, i.e. oil fired CHP 2-pipe solution with distributed absorption chillers. However, when RDF CHP based solutions are considered, the ENVP for the 4-pipe solution (Solution 14) has a higher ENVP than Solution 6 (2-pipe solution with distributed absorption chillers). This is a reflection of the higher operational cost savings relative to the baseline associated with RDF fired solutions than with oil fired solutions, which are due to the lower assumed price of RDF than for oil. These additional operational cost savings for the RDF solutions offset to a greater degree the additional Capex associated the 4-pipe solution than is possible with the oil fired solutions. The fact that the 4-pipe solutions are cost effective at all for these areas is an indication that the savings associated with delivering SHW during the cooling season (which is not possible with the 2-pipe solution) are sufficiently high to justify the extra infrastructure expense associated with the additional pipework. This in turn is a reflection of the large demand for SHW projected for the cooling season in these tourist areas.

The reason for finding economic potential in these two areas rather than other areas is due to the hours of occupancy assumed for hotels (hotels are the only buildings in these modelled areas). In these hotels, demand is far more extended over time than for the other building types, with the result that smaller capacity plant can deliver the same quantity of heating and cooling energy than for areas where the demand for cooling and heating is more compressed and the peak demand higher.

In terms of financial potential (Discount Rate = 12%), a number of the schemes in the tourist areas found to have economic potential turn out not to have financial potential, implying that these projects would not stack up from the private investment perspective without some form of support. **In the opinion of Ricardo, private investment in DHC is usually only brought forward when the return on investments are consistent with Discount Rates above 20%. Under this assumption, some of the solutions currently showing as financially cost effective may ultimately not prove attractive from a financial perspective. The model can be used to explore in detail the sensitivity of economic and financial cost effectiveness to the discount rates assumed.**

5.1.2 CO_2 Saving Performance of DHC Solutions

The CO_2 savings that would be achieved by the DHC solutions are a function of the type of technology deployed and does not depend on assumptions regarding price, economic or financial considerations. The CO_2 savings delivered by the solutions are also determined to a large extent by the CO_2 intensities projected for grid electricity into the future. This is because some solutions will generate their own electricity and displace this grid electricity (i.e. CHP based solutions), while other solutions will draw upon grid electricity (WSHP solutions). The efficiency with which grid electricity is assumed to be generated and delivered to the point of use and the CO_2 intensity of this electricity out into the future are set out in Appendix 9.

As would be expected, for all areas, all solutions involving the use of biomass fuel produce the greatest CO_2 savings, followed by the RDF fired solutions (RDF being assumed to be majority biomass). For all solutions based upon WSHPs, CO_2 savings are produced in all areas. With one or two isolated exceptions, solutions based on LPG fired CHP produce CO_2 savings. In the case of solutions based upon oil fired CHP, the delivery of CO_2 savings is less certain over the lifetime of the project. Solution 6 (i.e. oil fired CHP, 2-pipe solution with distributed absorption chillers) does not deliver CO_2 solutions in any area. For some areas, other solutions based on oil fired CHP also fail to deliver CO_2 savings. The borderline nature regarding the ability of oil fired CHP solutions to deliver CHP savings is due to the fact that oil has the highest emission factor of all the fuels used to fire CHP in this study. Negative CO_2 savings for oil fired CHP solutions are further exacerbated for Solution 6 (2-pipe distributed absorption chillers, i.e. Type 3 solution). Under this arrangement top-up cooling is assumed to be provided by local boilers generating heat at 81% efficiency (GCV) and supplying this heat to absorption chillers with a COP of 0.7[7]. This generates cooling with a primary energy efficiency of 81% x 70% = 57%[8]. Comparing this against what it is displacing in the baseline, which is electricity currently generated with an efficiency of 30.6% (raising to 47.7% in 2030) powering electric chillers operating with a COP ~3.0, this cooling would be generated with an efficiency of 0.306% * 300% = 91.8% in the baseline, meaning that the provision of top-up cooling in Type 3 solutions is expensive in terms of primary energy and CO_2 emissions relative to the baseline. This makes this solution type always appear worse than the baseline in terms of CO_2 savings. For the same reasons, the PES for all Type 3 solutions are invariably worse than the Type 1 and Type 2 solutions using the same technology.

5.1.3 Primary Energy Savings (PES) Performance of DHC Solutions

The primary energy savings, relative to the baseline, associated with the various DHC solutions are determined to a large extent by the assumed efficiency of generation and delivery to the point of use of grid electricity. This is because the solutions either displace grid electricity (CHP based solutions) or consume it (WSHP based solutions). Solutions based upon biomass or RDF fired CHP fail to generate PES in any of the areas. This is primarily the result of the relatively low efficiency of power generation in the steam turbines used in these solutions. Where they are applied, WSHP always generate primary energy savings relative to the baseline, and this is a result of WSHP's high efficiency of turning electrical energy into heating and cooling.

The delivery of primary energy savings by solutions based upon LPG and oil CHP is not always positive. For some areas it is negative, but only for solutions based on 2-pipe with distributed absorption chillers (i.e. Type 3 solutions). The reasons for this are explained above in Section 5.1.2.

[Note: The primary energy savings stated here are measured against a baseline comprised of heating and cooling demand, with the cooling demand satisfied by either of reversible or non-reversible heat pumps. As explained above, these heat pumps are inherently very efficient devices for generating cooling relative to the alternative of generating heat to drive an absorption chiller, which is the workhorse cooling device in the DHC schemes based on CHP. However, based upon the efficiency of generating power and heat, the CHP at the heart of the modelled DHC schemes would meet the definition of high efficiency cogeneration, as set out in the Energy Efficiency Directive. Moreover, the DHC schemes based on CHP are modelled to deliver 75% of the cooling demand from CHP heat and can therefore be considered "efficient" DHC schemes. The inherently high COP of the WSHP based solutions means that over 50% of the heating and cooling is derived from a renewable source and therefore these DHC solutions meet the definition of "efficient"]

5.1.4 Sensitivity of DHC Results to Key Assumptions

It is instructive to evaluate the impact that changes to the values of key assumptions have on the ENPV and FNPV, relative to the baseline.

As set out in Section 5.1, the model developed allows the sensitivity of the results to 10 different assumptions feeding into the analysis to be investigated. These are:

- Capex and Opex of central plant in the solution
- Electricity price
- Thermal energy demand being served by the solution
- Capex and Opex of individual plant associated with the baseline
- Fossil fuel prices
- Environmental (external) and CO_2 costs
- Capex of DHC primary network
- Renewable fuel prices (where applicable)

[7] As seen in Table 1, the top up cooling for the other CHP DHC solutions is electric chillers, operating with a COP of 3.l
[8] It is assumed that buildings on the DHC network would not have individual electric chillers to top-up cooling.

- The Opex expressed as a percentage of Capex
- Capex of connecting to DHC network and (where applicable) installation of a wet system

Sensitivity of results to the above assumptions can be explored in the model for any area. To illustrate the impact that the assumptions can have on the results, here we explore Solution 14 modelled for Paphos.

The ENVP for this area/solution combination is €48 million, relative to the baseline. Varying the above assumptions by +20% and -20% causes the ENPV of the project to change in the way depicted in Figure 1.

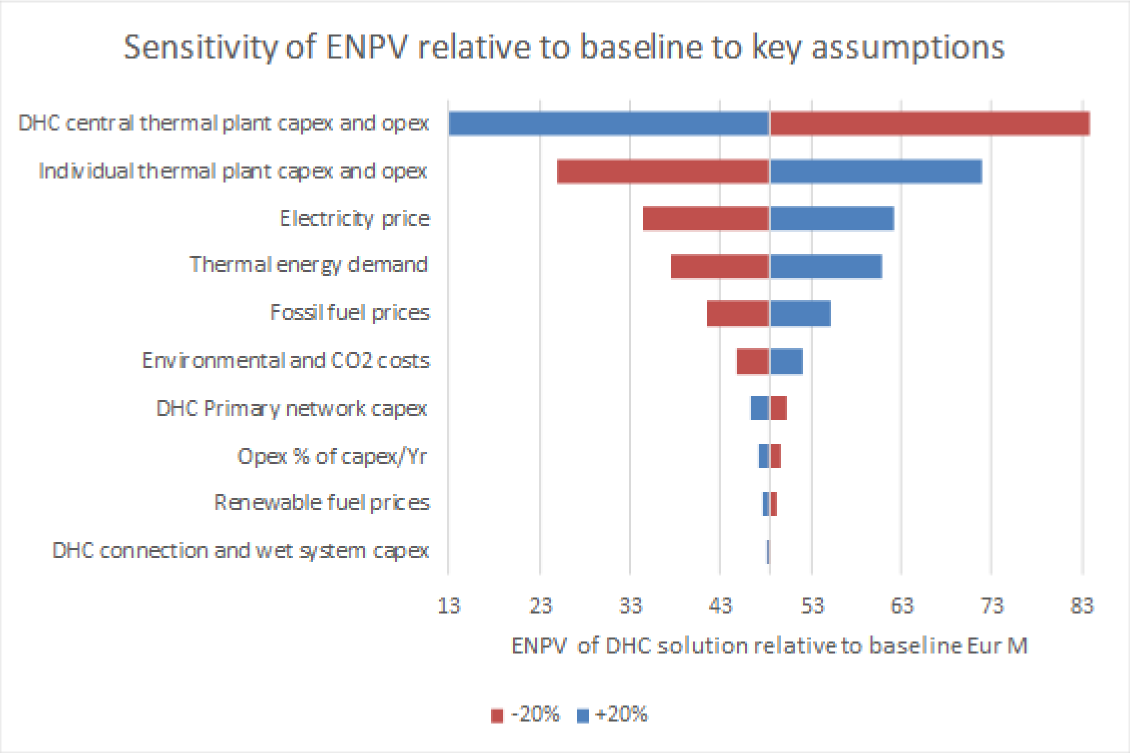

Figure 1Sensitivity of the ENPV of the scheme modelled for Paphos (Solution 14) to assumptions

As can be seen in Figure 1, the ENVP is most sensitive to a change in the assumptions regarding the capex of the central thermal plant, i.e. the plant centrally located and serving the DHC scheme. On increasing the capex of this cost category by 20%, the ENVP is reduced from +€48 million to +€13 million, a change of -73%. The next most significant assumption affecting the ENVP is the assumption regarding the Capex of the individual thermal plant being displaced by the DHC solution. When the Capex of this plant is increased by 20% the ENVP of the solution is increased (improved) to +€73 million (an increase of 52%). The assumptions regarding the electricity are also important. As the electricity price increases this particular DHC solution improves, with the ENVP increasing from +€48 million to +€62 million (an increase of 29%). This is because this solution is a generator of electricity and the more expensive the electricity it displaces is, the more valuable is the solution relative to the baseline. The value of the solution is also rather sensitive to the assumption about the thermal demand for the area being served – as this falls so does the value of the project as the savings from the displaced baseline heating and cooling have less of an offsetting effect on the initial Capex. For this cost category, a 20% decrease in the thermal demand results in the ENVP falling to +€38 million (a 21% decrease). It is noticeable that the results are relatively insensitive to assumptions on Capex of the DHC primary network.

When considering the sensitivity of the FNPV to the assumptions feeding into the modelling, a broadly similar ranking of sensitivities is produced, as set out in Figure 2.

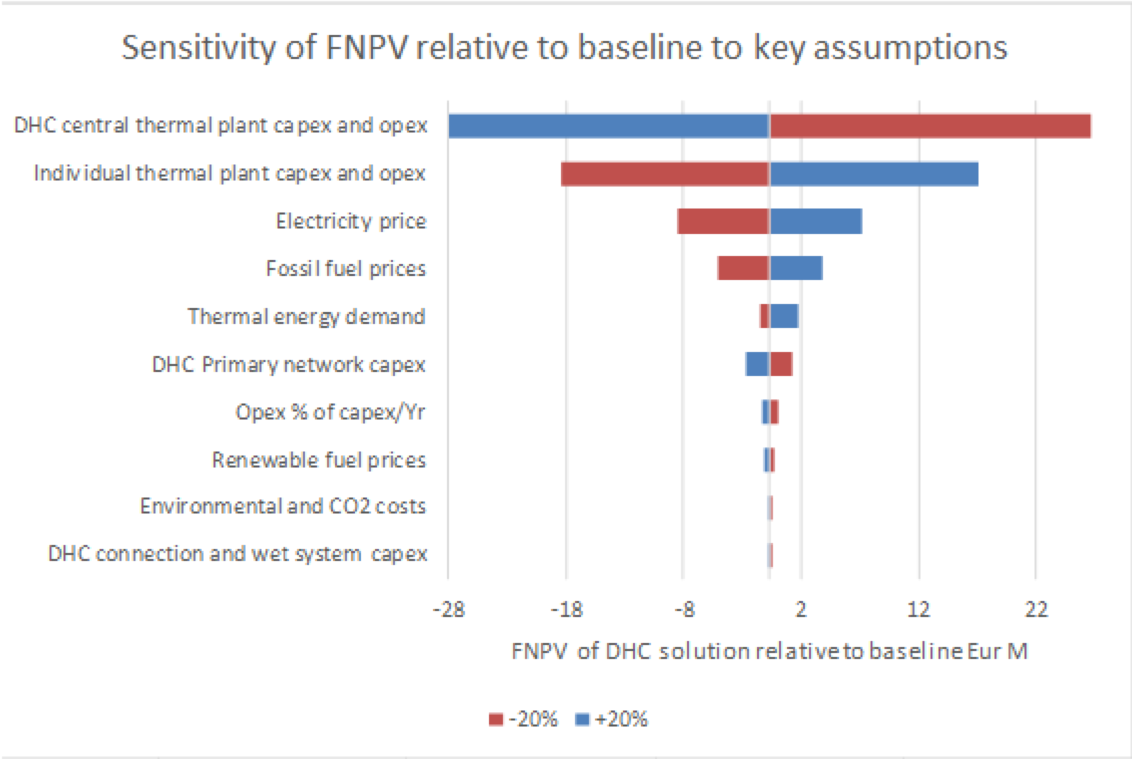

Figure 2 Sensitivity of the FNPV of the scheme modelled for Paphos (Solution 14) to assumptions

The five assumptions with the most impact on the ENPV are the same five assumptions with the moist impact on the FNPV, with a minor change in the ordering.

It is instructive to further examine the sensitivity of the ENVP and FNVP for another solution for the modelled Paphos scheme. Looking at the ENVP of solution 5 (oil fired CHP 4-pipe solution). In the Central scenario this solution has an ENVP of +€31 million. A 20% change to the value of the assumptions produces a sensitivity of the form presented in Figure 3

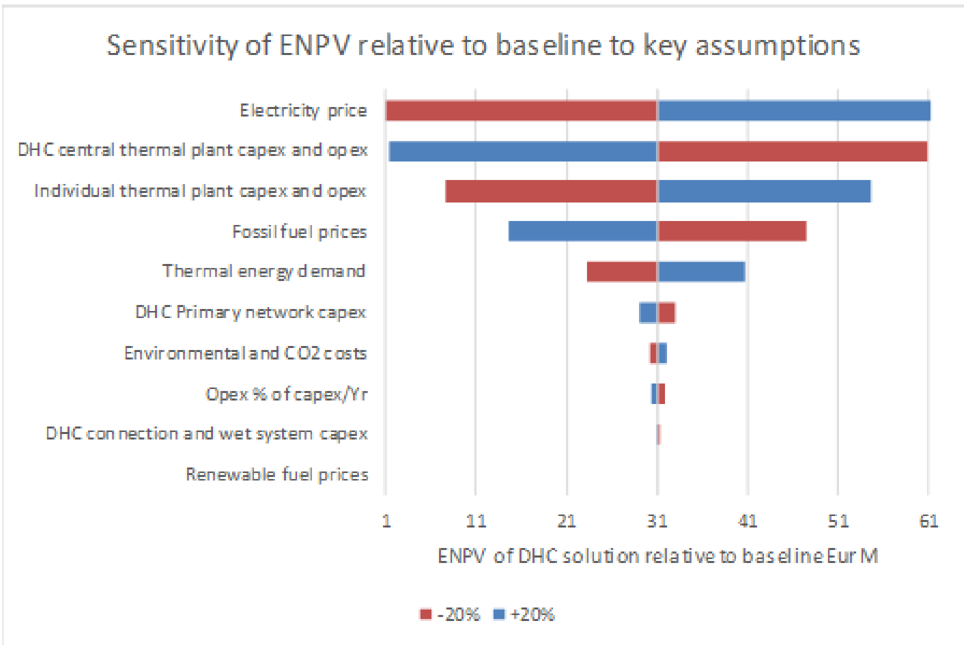

Figure 3 Sensitivity of the ENPV of the scheme modelled for Paphos (Solution 5) to assumptions

The same five assumptions have the greatest impact upon the ENPV, however the assumptions on the electricity price are now much more important than for solution 14. This is a reflection of the efficiency of electricity generation of oil fired CHP relative to RDF fired CHP, with the former being larger than the latter (Reciprocating Engine versus Steam Turbine). Raising the value of the electricity price raises the value of the oil fired CHP project to a greater extent than for the RDF fired CHP project, as there is proportionately more electricity to sell for the same heat generation from this solution. For the same reasons, a fall in the price of electricity has a proportionately more detrimental effect on the economics of the oil fired CHP project than the RDF fired CHP project. Reducing the price of electricity by 20% almost removes all the solution's cost effectiveness, as measured by ENPV. This highlights the importance of having good estimates for the electricity price in the future when evaluating this type of solution.

Considering the sensitivity of the FNVP of solution 5 for the Paphos modelled scheme, produces a sensitivity of the form presented in Figure 4.

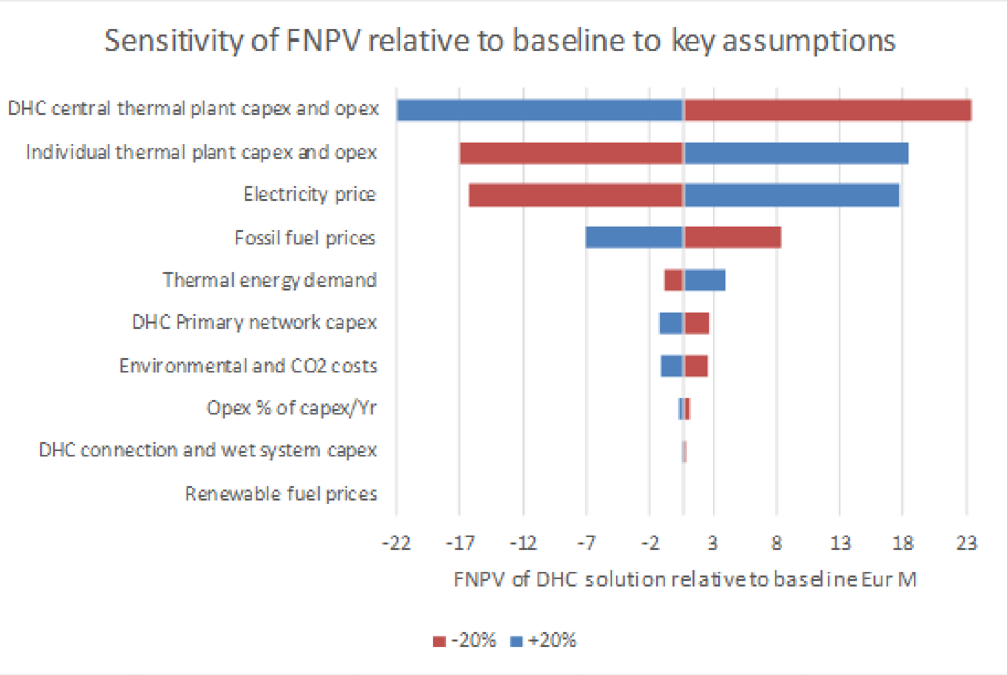

Figure 4 Sensitivity of the FNPV of the scheme modelled for Paphos (Solution 5) to assumptions

Again, the same five assumptions have the greatest impact upon the FNPV as for the ENPV. However, it is notable that the electricity price is no longer the assumption with the greatest impact upon the value of the FNPV (ranked 3rd), as it was for the ENPV (ranked 1st). This is because the electricity generation in this solution produces a revenue stream each year, the value of which is discounted more under the FNPV analysis than under the ENPV analysis. This means that the revenue associated with electricity sales offsets the upfront Capex associated with Central and Individual plant less under the FNPV case than under the EMPV case, making the financial performance of the solution less sensitive the assumptions made about the electricity price.

For the Paphos area, the size of the thermal input of the plant is such that it would be covered under EU ETS. As explained above, the cost of purchasing EU ETS allowances is included in the FNPV analysis. It is notable for the FNPV analysis for Solution 5 that the assumption about environmental and CO_2 costs are more significant than in the FNPV analysis for Solution 14 (considered above). This is a reflection of the fact that oil fired CHP will generate more CO_2 than RDF fired CHP, for supplying the same quantity of heat. It should be noted that not all areas evaluated would have DHC schemes large enough to have liabilities under EU ETS. This can be explored through the model.

These sensitivity results show that the assumptions having the greatest impact upon the value of a project are broadly the same for evaluations based upon ENVP and FNVP and between different solutions. However, the relative ordering of importance of these assumptions is a function of the technology involved and also the size of the scheme, as the latter determines whether a scheme would be in EU ETS. These sensitivity results give important insights into where the greatest effort should be expended in getting precision on costs, should a more detailed analysis be contemplated for a specific scheme.

5.2 Individual Building Level High Efficiency Solutions

The economic and financial potential for individual building level solutions was evaluated. As set out in Section 4, these are:

- Biomass CHP
- Oil fired CHP
- LPG fired CHP
- Heat pumps
- Solar thermal

Individual CHP solutions were sized on the cooling demand in each non-residential building[9], as this is usually the larger than the heating demand Where the SHW is not currently supplied by solar thermal, the CHP is sized to meet the cooling and SHW demand. Where the SHW is currently supplied by solar thermal, this is assumed to continue in the solution and the CHP is not modelled to meet this SHW demand. The same principle regarding the provision of SHW was applied for the non-CHP building level solutions.

The same fuel price sets are used for the analysis of solutions at the individual building level as for the DHC analysis, and the same approach is taken regarding the inclusion/exclusion of external and CO_2 costs.

5.2.1 Economic and Financial Performance of Individual Building CHP Solutions

Appendix 10 sets out the results of the analysis of economic and financial potential for individual building level solutions in the 10 geographical areas. As with the DHC results, the Economic Net Present Value (ENPV) and Financial Net Present Value (FNPV) relative to the baseline are presented.

The results are presented for the three CHP technologies evaluated: Biomass CHP, Oil fired CHP and LPG fired CHP and for the heat pumps and solar thermal solutions (Note that RDF fired CHP solutions are not modelled at the individual building level, as this is considered an inappropriate solution in this context.). To reiterate, in interpreting these results the following should be kept in mind:

- The solar thermal solution is only modelled where this is not already in the baseline and where there is deemed to be enough roof space for its installation. (N.B. These restrictions in practice mean that this solution is only examined for Areas 3 and 4.)
- Individual CHP solutions are only modelled for non-residential buildings. In two of the areas (Areas 7 and 10) information from the Department of Land and Surveys indicates that there are no non-residential buildings and so CHP solutions are not modelled for these areas.
- For Areas 1 and 2 (Post Code = 1097) solar thermal is not modelled and the baseline is deemed to be entirely heat pumps for SH and SC. The consequence of these two things means that the individual heat pumps option is not modelled for these two areas.

The results show the following:

[9] CHP solutions were not modelled for individual residential buildings.

- In aggregate across all of the buildings in the area examined, biomass and LPG fired CHP is never cost effective, either in terms of ENVP or FNPV. This is in complete agreement with the results for the biomass and LPG CHP DHC solutions.
- Regarding oil fired CHP, this is only cost effective when applied to the individual buildings in the two tourist areas examined (Areas 3 and 4 Poseidonos and Kryo Avenues). Here, there is cost effective potential on both the ENVP and FNPV bases. The positive result for oil fired CHP for these two areas, when the results are negative for the other areas, is explained by the load factors of the plant, which are higher in Areas 3 and 4 because of the longer hours of occupancy assumed for hotels, which make up all of the buildings evaluated in these areas. These longer hours of occupancy translate to smaller plant for the same absolute quantity of heating and cooling delivered and, therefore, a lower Capex.
- Where evaluated, individual heat pumps for heating and cooling and solar for SHW (where not currently applied) is cost effective relative to the baseline on both ENPV and FNPV bases.
- For the two areas evaluated (Areas 3 and 4), the application of solar thermal for the supply of SH, SC and SHW (with cooling supplied via absorption chillers using solar thermal heat as the energy input) is cost effective on both ENPV and FNPV bases.

5.2.2 CO_2 Saving Performance of Individual Building CHP Solutions

Appendix 10 also sets out the CO_2 savings that the building level solutions provide relative to the baseline. The same general patters emerge as those observed for the DHC solutions. Specifically, the greatest CO_2 savings coming from the biomass fuelled solutions, heat pump based solutions provide CO_2 savings in all cases and, with a few exceptions, oil and LPG fifed CHP solutions also supply CO_2 savings.

5.2.3 Primary Energy Savings (PES) Performance of Individual Building CHP Solutions

Appendix 10 also sets out the PES that the building level solutions provide relative to the baseline. The pattern of these results are broadly in line with the pattern seen for the DHC solutions, i.e. that biomass CHP solutions do not offer PES relative to the baseline while oil and LPG fired CHP solutions do. As explained above, this is due to the relatively low power efficiency of power generation with steam turbines used in biomass CHP solutions displacing grid electricity generated at a higher efficiency, which increases over time (See Appendix 9)

The individual solar solutions evaluated for GAs 3 and 4 are notable in that they produce no PES relative to the baseline. On the surface this is a counterintuitive result as one unit of heat delivered from solar thermal requires one unit of primary energy input, which would be a more primary energy efficient way of supplying heat than using the current technology (oil boilers). However, the cooling under this solution is primarily met using absorption chillers, using the heat from the solar thermal source as an input. This has an efficiency of 70% in the generation of cooling compared to the baseline method of cooling for these areas, which is the use of electric chillers with a COP of 3.0. The solution therefore supplies cooling with an efficiency of 70% while in the baseline this is supplied with a primary energy efficiency of 30.6% (efficiency of electricity generation) multiplied by 300% (efficiency of electric chiller), or 92%. The crucial factor here is that the demand for cooling is significantly higher than the demand for heating in GAs 3 and 4 (see Table 1) and the additional primary energy required to supply this cooling via this particular solution, versus the baseline, outweighs the primary energy savings that this solution offers, relative to the baseline, for supplying heating. *[The analysis leading to this conclusion is based upon treating each unit of primary energy the same, regardless of whether it is primary fossil energy (e.g. oil) or from renewable flows, such as solar thermal. This approach is consistent with national energy balances, where a unit of heat from solar thermal is assumed to have one unit of primary energy associated with it. It is possible to adopt a different approach to evaluation of primary energy savings, by evaluating the primary fossil fuel energy displaced by a solution. Under this alternative approach, the primary energy savings for solutions based on tapping into natural renewable flows, such as solar, would be higher than shown in this report.]*

6 Key Findings

1. District Heating and Cooling (DHC) solutions based upon the CHP technologies fired by Refuse Derived Fuel (RDF) and oil fired CHP are the only solutions found to be cost effective relative to the baseline on an economic basis (i.e. using a Discount Rate of 6%).

2. With one or two isolated exceptions, these solutions are only found to be cost effective in two of the 10 Geographical Areas (GAs) evaluated.

3. The areas where economic cost effective potential is found are the two tourist areas evaluated: Area 3 Poseidonos Avenue, Paphos and Area 4 Kryo Avenue. These areas are comprised entirely of hotels. The positive potential found for these two areas is primarily due to assumed higher hours of occupancy for hotels, compared with other building types, which increases the load factor on the plant and, therefore, reduces plant Capex for the same quantity of heating and cooling energy delivered.

4. When viewed from a financial perspective (i.e. using a Discount Rate of 12%), some of the above mentioned solutions, which were cost effective from an economic perspective (DR=6%), cease to be cost effective, implying that private investment in these particular solutions would not come forward without support. We caution against assuming that projects that are shown to be cost effective with DR=12% in this work would automatically attract private sector investment. In Ricardo's experience, in order to bring forward private sector investment for District heating and Cooling, returns on investment consistent with DRs greater than 20% would be needed. Therefore, the model should be used to explore other DRs, consistent with the private sector investment environment in Cyprus, to understand better the bounds of financial cost effectiveness. The model is an ideal tool for doing this.

5. The cost effectiveness of the RDF based solutions is strongly driven by the relatively low cost assumed for this fuel in this study. Further consideration should be given to the possibility of supplying RDF at this price so that this finding can be validated.

6. The cost effectiveness of oil fired CHP solutions is also significantly driven by the relatively low price assumed for this fuel, when burned in CHP applications. Further consideration should be given to the actual availability of fuel oil at this price.

7. DHC solutions based on the other technologies evaluated (biomass CHP, LPG CHP and Water Source Heat Pumps) are not cost effective relative to the baseline when viewed either from an economic or financial perspective. This indicates that the good CO2 savings that would be delivered by the biomass CHP and WSHPs DHC would not be accessed without support.

8. Of the DHC solutions that are cost effective, the RDF fired CHP solution can be relied upon to deliver CO_2 savings relative to the baseline over the lifetime of these projects. Regarding oil fired CHP solutions (the other cost effective solution) this is true only for Type 1 and Type 2 solutions, with Type 3 solutions showing negative primary energy savings. This negative result for Type 3 is a consequence of the inherently lower efficiency of generating cooling in this solution type, where cooling is supplied exclusively via distributed absorption chillers.

9. In general terms, Primary Energy Savings (PES) are delivered by the DHC solutions evaluated, with the exception of those based on CHP using steam turbines. In practice this means CHP using biomass and RDF. The relatively low efficiency of power generation by steam turbines and the projected increase, over time, of the efficiency of generation of grid electricity in the baseline, which would be displaced by this CHP generated electricity, leads to negative PES over the lifetime of these particular DHC solutions.

10. Sensitivity analysis indicates that the cost effectiveness of the DHC solutions is substantially driven by five key assumptions. These are: (1) The Capex of the plant generating heat at the central location of the DHC scheme (2) The electricity price (3) The thermal demand that the DHC

scheme is assumed to supply (4) The price for fossil fuels, and (5) The Capex of the individual plant generating heat/cooling locally, whose heat/cooling is displaced by the outputs of the DHC scheme. However, the order of importance of these assumptions to the cost effectiveness of the DHC solutions depends on the main heat generating technology for the DHC solution. For DHC solutions based on CHP with relatively high efficiencies of electricity generation (i.e. those based on reciprocating engines) the cost effective results are more sensitive to the electricity price, than for solutions with lower efficiency of electricity generation (i.e. those based on steam turbines). This is because the high electricity outputs for such solutions mean that the economics of the project is more reliant on revenues (or costs avoided, depending on perspective) associated with the electricity generated, the magnitude of which is dependent on the electricity price.

11. The results relating to cost effectiveness of the individual building level CHP solutions evaluated broadly mirror those for the same CHP solutions supplying a DHC network, i.e. oil fired CHP is the only technology that is cost effective from both an economic and financial perspective (RDF fired CHP having not been evaluated as a practical solution at the individual building level). The same physical factors determining the ability of a particular technology to deliver CO_2 and primary energy when applied that the DHC level play out when the technology is applied at the individual building level.

12. Where evaluated for individual buildings, solutions based on heat pumps for SH, SC and SHW are cost effective in terms of ENPV and FNPV and generate CO_2 and primary energy savings.

13. Where evaluated for individual buildings, solutions based on solar for SH, SC (via absorption chillers) and SHW are cost effective in terms of ENPV and FNPV relative to the baseline. While these generate CO_2 savings, they do not generate primary energy savings. These results are highly specific to the baselines for the areas evaluated for this technology, which are oil boilers for SH and SHW and non-reversible heat pumps for cooling.

7 Policy Implications and Recommendations

7.1 Implications of Findings for Cypriot Policy on District Heating and Cooling

As discussed above, clear-cut economic potential (DR=6%) for DHC tends only to be found in the tourist areas, and for DHC technologies based upon oil and RDF fired CHP. When considering the financial potential (DR=12%), we find that the RDF fired solutions are more prone than the oil fired solutions to becoming non-cost effective. On this basis, all other factors remaining unchanged, there would appear to be case for support for RDF fired DHC solutions if private investments are to be brought forward (see section 7.3 for further discussion).

Regarding the incidence of economic potential identified in this project under DR=6%, we would recommend that this is kept under review. Economic (social) potential is often evaluated in other countries using Discount Rates less than 6%. If DRs less than 6% are used in the evaluation of economic cost effectiveness, solutions reported here as not being cost effective may turn out to be and the range of DHC solutions for which the case for support can be made would expand.

Notwithstanding the limited DHC economic potential identified here, it may be prudent to consider placing requirements on significant new developments of multiple buildings to make provision for heat linking. Brand new developments offer the chance for heat/coolth linking infrastructure to be put in at lower costs than in established developments. Moreover, new developments provide the opportunity to define a DHC scheme centred about a smaller number of buildings with significant energy consumption (i.e. anchor loads) than is possible with the post code level analysis carried out here. This would tend to promote cost effectiveness, since the extent and Capex of the inter-building infrastructure would be smaller per unit of heating and cooling demand.

In summary, development of the DHC networks identified in this study as being cost effective from an economic point of view are not cost effective from a financial point of view. As such, there is a barrier to bringing forward the private investment needed to unlock the environmental benefits this study. In order to improve the financial performance of these schemes and reduce the risk faced by the investor, a source of external funding would be needed.

7.2 Implications of Findings for Cypriot Policy on Combined Heat and Power

Currently in Cyprus, other than an exemption on the tax on fuel used in cogeneration, there are no incentive mechanisms in place for cogeneration. This present exemption is reflected in the analysis carried out in this work.

Work is underway in Cyprus to develop a net billing scheme for cogenerated power, which will provide additional financial support to exporting CHP schemes. When the details of this scheme are confirmed, it would be instructive to evaluate the impact of this incentive on the financial cost effectiveness of the CHP based DHC schemes modelled here. Depending on how advanced the preparations of this incentive mechanism are, there may be value in using the results from this modelling to inform the setting of incentive levels in the planned net billing scheme.

As DHC schemes based upon CHP will need to export part of their electricity generation, the technical viability of such schemes would rely on the ability to export the necessary quantities of excess electricity without significant commercial or financial barriers, which would erode the case for investment. Anecdotal evidence received during meetings is that the process of arranging exports is difficult and has to be carried out through a consolidator, and that there may be limitations on the quantity of electricity that can be exported via these arrangements. If this is a true characterisation of the situation regarding exports, then attention to policy facilitating an easier export of electricity would enable realisation of the CHP based DHC potential identified in this study.

7.3 Implications of Findings for Cypriot Policy on Waste

Although it is an area receiving significant attention at the moment, it is understood that there are currently no fiscal measures in place in Cyprus to discourage the sending of waste to landfill[10]. As a consequence of this, Cyprus landfills up to 80% of its municipal waste, compared to an EU average of 28%[11]. While this deprives potential RDF fired DHC projects of fuel and presents a long term environmental hazard, it also misses an opportunity to improve the financial performance for such projects. For example, the implementation of a tax on landfilled waste would effectively amount to a positive revenue stream for projects taking such waste and burning it. The size of this positive revenue stream would depend upon the level at which a “landfill tax” was set, and would derive from the party charged with disposing of the waste being prepared to pay the operator of the DHC scheme a fee to take this waste, with the fee set at a level which would represent lower overall costs than sending the waste to landfill. Moreover, the introduction of such a tax would provide longer term certainty to developers of RDF fuelled projects, further increasing the chances of such projects being brought forward.

As such, as Cyprus moves to implement policies related to waste, pursuant to its meeting obligations under the EU Waste Framework and Landfill Directives, there is an opportunity to pursue fiscal measures which would help to realise the economic RDF fired DHC potential identified in this study.

[10] http://rethink.com.cy/pdf/waste%20management%20in%20cyprus-en.pdf
[11] http://ec.europa.eu/environment/eir/pdf/factsheet_cy_en.pdf

Appendices

Appendix 1 – Example Map of One Geographical Area Evaluated – Showing DHC Pipework Connections (Post Code = 1097, Nicosia)

Appendix 2 - External Costs of CO_2 (Applying Only to Economic Analysis

Eur2016/tCO2e		
Low	Central	High
€12.01	€30.02	€48.04
€12.61	€31.22	€50.44
€13.21	€32.42	€52.84
€13.81	€33.62	€55.24
€14.41	€34.83	€57.64
€15.01	€36.03	€60.04
€15.61	€37.23	€62.45
€16.21	€38.43	€64.85
€16.81	€39.63	€67.25
€17.41	€40.83	€69.65
€18.01	€42.03	€72.05
€18.61	€43.23	€74.45
€19.21	€44.43	€76.86
€19.81	€45.63	€79.26
€20.42	€46.83	€81.66
€21.02	€48.04	€84.06
€21.62	€49.24	€86.46
€22.22	€50.44	€88.87
€22.82	€51.64	€91.27
€23.42	€52.84	€93.67
€24.02	€54.04	€96.07
€24.62	€55.24	€98.47
€25.22	€56.44	€100.87
€25.82	€57.64	€103.28
€26.42	€58.84	€105.68
€27.02	€60.04	€108.08
€27.62	€61.25	€110.48
€28.22	€62.45	€112.88
€28.82	€63.65	€115.29
€29.42	€64.85	€117.69
€30.02	€66.05	€120.09
€30.62	€67.25	€122.49
€31.22	€68.45	€124.89
€31.82	€69.65	€127.29
€32.42	€70.85	€129.70
€33.02	€72.05	€132.10
€33.62	€73.25	€134.50
€34.23	€74.45	€136.90
€34.83	€75.66	€139.30
€35.43	€76.86	€141.70
€36.03	€78.06	€144.11

Appendix 3 Assumed CO_2 Prices for ETS Allowances (Applying only to financial analysis and for solutions projected to exceed the combustion input threshold for EU ETS inclusion)

Year	€/tCO2e (€2015)
2015	6.00
2016	7.60
2017	9.20
2018	10.80
2019	12.40
2020	14.00
2021	15.60
2022	17.20
2023	18.80
2024	20.40
2025	22.00
2026	23.80
2027	25.60
2028	27.40
2029	29.20
2030	31.00
2031	32.80
2032	34.60
2033	36.40
2034	38.20
2035	40.00
2036	41.80
2037	43.60
2038	45.40
2039	47.20
2040	49.00
2041	52.90
2042	56.80
2043	60.70
2044	64.60
2045	68.50
2046	72.40
2047	76.30
2048	80.20
2049	84.10
2050	88.00
2051	88.50
2052	89.00
2053	89.50
2054	90.00
2055	90.50
2056	91.00

Appendix 4 Assumed Hours of Occupancy of Different Building Types (Central Scenario)

Sub_Sector_no	Sub_Sector_list	Average weekly cooling hours in summer e.g. 8-5PM x 5 days per week = 45	Average weekly heating hours in summer e.g. 8-5PM x 5 days per week = 45	Average weekly water heating hours e.g. 8-5PM x 5 days per week = 45	Occupancy factor space cooling	Occupancy factor space heating	Occupancy factor water heating
1	Hotel_3star+	168.00	168.00	168.00	100.0%	100.0%	100.0%
2	Hotel_Other	168.00	168.00	168.00	100.0%	100.0%	100.0%
3	Education_1-2_Public	90.00	90.00	168.00	53.6%	53.6%	100.0%
4	Education_1-2_Private	90.00	90.00	168.00	53.6%	53.6%	100.0%
5	Education_Tertiary	90.00	90.00	168.00	53.6%	53.6%	100.0%
6	Public_Electric_Heating	90.00	90.00	168.00	53.6%	53.6%	100.0%
7	Public_Oil_Heating	90.00	90.00	168.00	53.6%	53.6%	100.0%
8	Supermarket	90.00	90.00	168.00	53.6%	53.6%	100.0%
9	Shopping_Malls	90.00	90.00	168.00	53.6%	53.6%	100.0%
10	Hospital_Public	168.00	168.00	168.00	100.0%	100.0%	100.0%
11	Health_Private	168.00	168.00	168.00	100.0%	100.0%	100.0%
12	Restaurant	90.00	90.00	168.00	53.6%	53.6%	100.0%
13	Office__Electric_Heating	45.00	45.00	168.00	26.8%	26.8%	100.0%
14	Office_Oil_Heating	45.00	45.00	168.00	26.8%	26.8%	100.0%
15	Retail	90.00	90.00	168.00	53.6%	53.6%	100.0%
16	House	90.00	90.00	168.00	53.6%	53.6%	100.0%
17	Apartment	90.00	90.00	168.00	53.6%	53.6%	100.0%
18	Derelict/outbuilding	168.00	168.00	168.00	100.0%	100.0%	100.0%
19	All	168.00	168.00	168.00	100.0%	100.0%	100.0%
20	?	168.00	168.00	168.00	100.0%	100.0%	100.0%

Appendix 5 - Energy Price Set 1

Fuel Prices – Economic analysis (EURO2016/MWh

Fuel	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electricity	119.15	119.15	119.15	122.11	125.84	141.29	144.88	148.72	152.68	130.06	132.66	134.97	135.45	135.91	136.45	137.07
Diesel fuel oil	34.99	34.99	34.99	35.64	32.76	34.46	36.20	38.06	39.99	41.99	44.18	44.64	45.13	45.59	46.08	46.54
Gas oil_CHP	70.14	70.55	70.95	71.36	71.77	72.18	72.29	72.41	72.52	72.63	72.75	73.38	74.02	74.66	75.29	75.93
Gas oil_non_CHP	70.14	70.55	70.95	71.36	71.77	72.18	72.29	72.41	72.52	72.63	72.75	73.38	74.02	74.66	75.29	75.93
Light fuel oil	66.37	66.76	67.14	67.53	67.91	68.30	68.41	68.52	68.62	68.73	68.84	69.44	70.04	70.65	71.25	71.85
Kerosene	78.43	78.88	79.34	79.80	80.25	80.71	80.83	80.96	81.09	81.22	81.35	82.06	82.77	83.48	84.19	84.90
LPG	77.40	77.85	78.30	78.75	79.20	79.65	79.77	79.90	80.02	80.15	80.28	80.98	81.68	82.38	83.08	83.79
Solar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood Chip (20%)	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01
RDF	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Natural gas	51.81	53.29	54.77	56.26	57.74	59.22	58.72	58.22	57.72	57.22	56.72	57.80	58.88	59.96	61.03	62.11
Electricity	119.15	119.15	119.15	122.11	125.84	141.29	144.88	148.72	152.68	130.06	132.66	134.97	135.45	135.91	136.45	137.07
Gas oil_non_CHP	70.14	70.55	70.95	71.36	71.77	72.18	72.29	72.41	72.52	72.63	72.75	73.38	74.02	74.66	75.29	75.93
Light fuel oil	66.37	66.76	67.14	67.53	67.91	68.30	68.41	68.52	68.62	68.73	68.84	69.44	70.04	70.65	71.25	71.85
Kerosene	78.43	78.88	79.34	79.80	80.25	80.71	80.83	80.96	81.09	81.22	81.35	82.06	82.77	83.48	84.19	84.90
LPG	77.40	77.85	78.30	78.75	79.20	79.65	79.77	79.90	80.02	80.15	80.28	80.98	81.68	82.38	83.08	83.79
Solar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood Chip (20%)	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01
Natural gas	33.56	34.53	35.49	36.45	37.41	38.37	38.04	37.72	37.40	37.07	36.75	37.45	38.14	38.84	39.54	40.24

See model for prices out to 2050.

Details: Diesel fuel oil and elec. prices from Cypriot Energy System study by Royal Institute 2016, biomass prices based on UK port prices converted to euros with additional €1/GJ assumed for internal handling, and prices for all other fuels as assumed by JRC inflated to €2016. Diesel fuel oil prices from Cypriot Energy System study and all JRC fuel prices assumed to be on a gross CV basis.

Fuel Prices – Financial analysis (EURO2016/MWh

Fuel	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Electricity	119.15	119.15	119.15	122.11	125.84	141.29	144.88	148.72	152.68	130.06	132.66	134.97	135.45	135.91	136.45	137.07
Diesel fuel oil	34.99	34.99	34.99	35.64	32.76	34.46	36.20	38.06	39.99	41.99	44.18	44.64	45.13	45.59	46.08	46.54
Gas oil_CHP	81.23	81.70	82.18	82.65	83.12	83.59	83.72	83.86	83.99	84.12	84.25	84.99	85.73	86.46	87.20	87.94
Gas oil_non_CHP	81.23	81.70	82.18	82.65	83.12	83.59	83.72	83.86	83.99	84.12	84.25	84.99	85.73	86.46	87.20	87.94
Light fuel oil	67.73	68.12	68.51	68.91	69.30	69.69	69.80	69.91	70.03	70.14	70.25	70.86	71.47	72.09	72.70	73.32
Kerosene	88.75	89.27	89.78	90.30	90.82	91.33	91.48	91.62	91.77	91.91	92.05	92.86	93.66	94.47	95.27	96.08
LPG	77.40	77.85	78.30	78.75	79.20	79.65	79.77	79.90	80.02	80.15	80.28	80.98	81.68	82.38	83.08	83.79
Solar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood Chip (20%)	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01	44.01
RDF	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00	2.00
Natural gas	66.93	68.84	70.76	72.67	74.59	76.51	75.86	75.21	74.57	73.92	73.27	74.67	76.06	77.45	78.84	80.24
Electricity	119.15	119.15	119.15	122.11	125.84	141.29	144.88	148.72	152.68	130.06	132.66	134.97	135.45	135.91	136.45	137.07
Gas oil_non_CHP	96.66	97.23	97.79	98.35	98.91	99.47	99.63	99.79	99.95	100.10	100.26	101.14	102.01	102.89	103.77	104.65
Light fuel oil	80.59	81.06	81.53	82.00	82.47	82.94	83.07	83.20	83.33	83.46	83.59	84.32	85.05	85.79	86.52	87.25
Kerosene	105.62	106.23	106.84	107.46	108.07	108.69	108.86	109.03	109.20	109.37	109.55	110.50	111.46	112.42	113.38	114.33
LPG	77.40	77.85	78.30	78.75	79.20	79.65	79.77	79.90	80.02	80.15	80.28	80.98	81.68	82.38	83.08	83.79
Solar	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Wood Chip (20%)	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82	52.82
Natural gas	66.93	68.84	70.76	72.67	74.59	76.51	75.86	75.21	74.57	73.92	73.27	74.67	76.06	77.45	78.84	80.24

See model for prices out to 2050.

Details: Diesel fuel oil and elec. prices from Cypriot Energy System study by Royal Institute 2016, biomass prices based on UK port prices converted to euros with additional €1/GJ assumed for internal handling, and prices for all other fuels as assumed by JRC inflated to €2016. Diesel fuel oil prices from Cypriot Energy System study and all JRC fuel prices assumed to be on a gross CV basis.

Appendix 6 Heating and Cooling Technology Assumptions

Appendix 3.xlsx

Appendix 7 District Heating and Cooling Pipework Assumptions

Appendix 4.xlsx

Appendix 8 Detailed District Heating and Cooling Solution Results (Central Scenario)

Area Name: Nicosia – Service (1097 Post Code Level)

Solution Combination No.	Solution description	ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-97.4	-92.6	410.6	-540.5	345.0	440.8
2	Biomass CHP with 4 pipe DHC	-100.8	-96.8	425.3	-508.4	365.1	447.4
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-128.9	-120.0	447.2	-808.6	413.5	447.4
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	-46.7	-52.2	-23.9	543.5	345.0	1179.2
5	Oil CHP with 4 pipe DHC	-49.9	-56.2	-15.0	591.5	365.1	1197.0
6	Oil CHP with 2 pipe DH + individual absorption chillers	-42.4	-52.3	-112.3	348.9	413.5	1197.0
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-95.8	-83.2	168.2	525.0	345.0	1179.2
8	LPG CHP with 4 pipe DHC	-99.6	-87.6	179.8	572.6	365.1	1197.0
9	LPG CHP with 2 pipe DH + individual absorption chillers	-95.5	-86.0	132.7	345.0	413.5	1197.0
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	0.0	0.0	0.0	0.0	0.0	0.0
11	Reversible water source heat pumps with 4 pipe DHC	0.0	0.0	0.0	0.0	0.0	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	0.0	0.0	0.0	0.0	0.0	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	-54.3	-67.5	338.7	-484.6	345.0	440.8
14	RDF CHP with 4 pipe DHC	-57.1	-71.3	352.4	-451.7	365.1	447.4
15	RDF CHP with 2 pipe DH + individual absorption chillers	-77.9	-90.3	362.1	-742.4	413.5	447.4

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	0.0	0.0	0.0	4	0.0	0.0	0.0
5	0.0	0.0	0.0	5	0.0	0.0	0.0
6	0.0	0.0	0.0	6	0.0	0.0	0.0
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0

Area Name: Nicosia - Service (1097 Detailed Level)

Solution Combination No.	Solution description	ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-22.4	-19.5	123.6	-194.9	102.0	135.3
2	Biomass CHP with 4 pipe DHC	-22.6	-19.7	123.6	-194.9	102.0	135.3
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-22.5	-19.2	133.6	-263.8	122.4	135.3
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	-8.1	-7.9	-14.2	140.5	102.0	362.1
5	Oil CHP with 4 pipe DHC	-8.3	-8.1	-14.2	140.5	102.0	362.1
6	Oil CHP with 2 pipe DH + individual absorption chillers	3.3	0.9	-31.2	87.0	122.4	362.1
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-23.5	-17.7	46.0	135.7	102.0	362.1
8	LPG CHP with 4 pipe DHC	-23.7	-17.8	46.0	135.7	102.0	362.1
9	LPG CHP with 2 pipe DH + individual absorption chillers	-12.9	-9.4	36.4	87.5	122.4	362.1
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	0.0	0.0	0.0	0.0	0.0	0.0
11	Reversible water source heat pumps with 4 pipe DHC	0.0	0.0	0.0	0.0	0.0	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	0.0	0.0	0.0	0.0	0.0	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	-8.8	-11.6	101.0	-177.3	102.0	135.3
14	RDF CHP with 4 pipe DHC	-9.0	-11.7	101.0	-177.3	102.0	135.3
15	RDF CHP with 2 pipe DH + individual absorption chillers	-6.8	-10.0	107.5	-243.5	122.4	135.3

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	0.0	0.0	0.0	4	0.0	0.0	0.0
5	0.0	0.0	0.0	5	0.0	0.0	0.0
6	6.8	5.8	0.0	6	6.8	5.8	0.0
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0

Area Name: Poseidonos Avenue, Paphos (8041,8042,8204 Detailed)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-34.1	-47.4	796.8	-610.5	353.9	739.6
2	Biomass CHP with 4 pipe DHC	-29.2	-46.1	879.7	-573.1	353.9	799.4
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-44.6	-56.1	945.3	-1024.7	488.1	799.4
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	23.7	-2.2	67.5	1208.6	353.9	1978.1
5	Oil CHP with 4 pipe DHC	31.2	0.9	98.9	1388.6	353.9	2138.3
6	Oil CHP with 2 pipe DH + individual absorption chillers	63.3	28.6	-192.0	1063.4	488.1	2138.3
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-57.0	-53.3	389.8	1177.7	353.9	1978.1
8	LPG CHP with 4 pipe DHC	-55.7	-54.0	445.2	1353.7	353.9	2138.3
9	LPG CHP with 2 pipe DH + individual absorption chillers	-31.6	-31.7	382.2	1037.5	488.1	2138.3
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	-130.7	-121.6	87.4	209.0	-261.1	0.0
11	Reversible water source heat pumps with 4 pipe DHC	-154.2	-142.1	107.0	255.2	-320.9	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	-149.0	-136.9	107.0	255.2	-320.9	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	38.2	-5.2	676.1	-516.6	353.9	739.6
14	RDF CHP with 4 pipe DHC	48.4	-0.8	750.3	-472.4	353.9	799.4
15	RDF CHP with 2 pipe DH + individual absorption chillers	46.6	-2.8	793.1	-906.3	488.1	799.4

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	44.4	16.9	4.9	4	0.0	0.0	0.0
5	44.4	16.9	9.8	5	44.4	16.9	9.8
6	44.4	16.9	9.8	6	44.4	16.9	9.8
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	44.4	16.9	9.8	12	0.0	0.0	0.0
12	44.4	16.9	9.8	12	0.0	0.0	0.0
12	44.4	16.9	9.8	12	0.0	0.0	0.0

Area Name: Kryo Avenue, Ayia Napa (5330 Detailed)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-18.5	-25.7	449.1	-339.4	196.9	414.6
2	Biomass CHP with 4 pipe DHC	-15.3	-24.6	496.8	-317.9	196.9	449.0
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-25.7	-31.8	533.3	-569.2	271.6	449.0
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	13.0	-1.1	39.0	681.1	196.9	1108.9
5	Oil CHP with 4 pipe DHC	17.7	1.1	57.1	784.7	196.9	1201.2
6	Oil CHP with 2 pipe DH + individual absorption chillers	35.4	16.1	-108.3	604.2	271.6	1201.2
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-32.3	-29.7	220.0	664.1	196.9	1108.9
8	LPG CHP with 4 pipe DHC	-31.2	-29.8	251.9	765.4	196.9	1201.2
9	LPG CHP with 2 pipe DH + individual absorption chillers	-17.9	-17.8	216.9	589.4	271.6	1201.2
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	-67.5	-63.4	50.7	122.2	-149.2	0.0
11	Reversible water source heat pumps with 4 pipe DHC	-80.7	-74.9	62.0	148.8	-183.6	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	-78.9	-73.1	62.0	148.8	-183.6	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	22.2	-2.0	381.3	-286.7	196.9	414.6
14	RDF CHP with 4 pipe DHC	28.4	0.9	424.0	-261.2	196.9	449.0
15	RDF CHP with 2 pipe DH + individual absorption chillers	25.6	-1.9	447.8	-502.7	271.6	449.0

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	24.7	9.7	2.8	4	0.0	0.0	0.0
5	24.7	9.7	5.6	5	24.7	9.7	5.6
6	24.7	9.7	5.6	6	24.7	9.7	5.6
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	24.7	9.7	5.6	12	0.0	0.0	0.0
12	24.7	9.7	5.6	12	24.7	9.7	5.6
12	24.7	9.7	5.6	12	0.0	0.0	0.0

Area Name: Nicosia Mixed (1082 Post Code Level)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-14.7	-16.4	186.7	-93.7	144.1	171.8
2	Biomass CHP with 4 pipe DHC	-23.3	-25.1	186.7	-93.7	144.1	171.8
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-46.7	-40.0	138.0	-469.4	61.4	171.8
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	0.7	-4.3	18.9	327.9	144.1	459.6
5	Oil CHP with 4 pipe DHC	-8.0	-13.0	18.9	327.9	144.1	459.6
6	Oil CHP with 2 pipe DH + individual absorption chillers	-19.5	-18.7	-69.1	-25.4	61.4	459.6
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-18.2	-16.2	93.3	320.4	144.1	459.6
8	LPG CHP with 4 pipe DHC	-26.9	-24.9	93.3	320.4	144.1	459.6
9	LPG CHP with 2 pipe DH + individual absorption chillers	-39.9	-31.7	16.2	-25.3	61.4	459.6
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	0.0	0.0	0.0	0.0	0.0	0.0
11	Reversible water source heat pumps with 4 pipe DHC	0.0	0.0	0.0	0.0	0.0	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	0.0	0.0	0.0	0.0	0.0	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	2.0	-6.7	158.9	-72.1	144.1	171.8
14	RDF CHP with 4 pipe DHC	-6.6	-15.4	158.9	-72.1	144.1	171.8
15	RDF CHP with 2 pipe DH + individual absorption chillers	-27.0	-28.5	105.2	-443.8	61.4	171.8

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	9.8	5.4	0.0	4	0.0	0.0	0.0
5	0.0	0.0	0.0	5	0.0	0.0	0.0
6	0.0	0.0	0.0	6	0.0	0.0	0.0
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	9.8	5.4	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0

Area Name: Nicosia Residential (2003 Post Code Level)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-14.4	-16.2	178.5	-86.5	137.8	163.6
2	Biomass CHP with 4 pipe DHC	-24.3	-26.1	178.5	-86.5	137.8	163.6
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-46.2	-39.7	130.9	-449.2	56.8	163.6
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	0.3	-4.6	18.7	314.9	137.8	437.5
5	Oil CHP with 4 pipe DHC	-9.6	-14.4	18.7	314.9	137.8	437.5
6	Oil CHP with 2 pipe DH + individual absorption chillers	-20.0	-19.2	-66.3	-26.5	56.8	437.5
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-17.7	-15.9	89.5	307.8	137.8	437.5
8	LPG CHP with 4 pipe DHC	-27.6	-25.8	89.5	307.8	137.8	437.5
9	LPG CHP with 2 pipe DH + individual absorption chillers	-39.5	-31.5	14.9	-26.4	56.8	437.5
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	0.0	0.0	0.0	0.0	0.0	0.0
11	Reversible water source heat pumps with 4 pipe DHC	0.0	0.0	0.0	0.0	0.0	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	0.0	0.0	0.0	0.0	0.0	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	1.5	-6.9	152.0	-65.9	137.8	163.6
14	RDF CHP with 4 pipe DHC	-8.4	-16.8	152.0	-65.9	137.8	163.6
15	RDF CHP with 2 pipe DH + individual absorption chillers	-27.4	-28.7	99.6	-424.8	56.8	163.6

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	9.3	5.2	0.0	4	0.0	0.0	0.0
5	0.0	0.0	0.0	5	0.0	0.0	0.0
6	0.0	0.0	0.0	6	0.0	0.0	0.0
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	9.3	5.2	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0

Area Name: Limassol Service (3105 Post Code Level)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-14.0	-13.7	181.4	-101.8	144.6	161.7
2	Biomass CHP with 4 pipe DHC	-20.4	-20.1	181.4	-101.8	144.6	161.7
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-66.0	-53.9	126.1	-509.8	50.1	161.7
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	3.2	0.2	14.4	300.4	144.6	432.4
5	Oil CHP with 4 pipe DHC	-3.1	-6.2	14.4	300.4	144.6	432.4
6	Oil CHP with 2 pipe DH + individual absorption chillers	-26.7	-23.2	-81.1	-84.8	50.1	432.4
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-15.1	-11.4	87.0	295.2	144.6	432.4
8	LPG CHP with 4 pipe DHC	-21.4	-17.8	87.0	295.2	144.6	432.4
9	LPG CHP with 2 pipe DH + individual absorption chillers	-46.6	-35.8	2.6	-82.3	50.1	432.4
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	-33.6	-31.2	25.3	104.2	7.4	0.0
11	Reversible water source heat pumps with 4 pipe DHC	-40.0	-37.6	25.3	104.2	7.4	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	-28.3	-26.0	25.3	104.2	7.4	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	2.4	-4.1	154.1	-80.5	144.6	161.7
14	RDF CHP with 4 pipe DHC	-4.0	-10.5	154.1	-80.5	144.6	161.7
15	RDF CHP with 2 pipe DH + individual absorption chillers	-46.5	-42.5	93.6	-484.6	50.1	161.7

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	10.0	5.1	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
12	10.0	5.1	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0

Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	10.0	5.1	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0

Area Name: Limassol Mixed (3106 Post Code Level)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-19.1	-20.2	200.7	-129.9	159.8	183.0
2	Biomass CHP with 4 pipe DHC	-30.5	-31.6	200.7	-129.9	159.8	183.0
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-73.8	-62.0	145.8	-559.2	66.8	183.0
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	-0.5	-5.3	12.8	324.6	159.8	489.3
5	Oil CHP with 4 pipe DHC	-11.9	-16.7	12.8	324.6	159.8	489.3
6	Oil CHP with 2 pipe DH + individual absorption chillers	-32.3	-29.5	-87.9	-78.7	66.8	489.3
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-21.1	-18.3	94.6	318.5	159.8	489.3
8	LPG CHP with 4 pipe DHC	-32.5	-29.7	94.6	318.5	159.8	489.3
9	LPG CHP with 2 pipe DH + individual absorption chillers	-54.7	-43.8	6.6	-75.9	66.8	489.3
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	-40.5	-39.0	24.4	100.7	5.5	0.0
11	Reversible water source heat pumps with 4 pipe DHC	-51.9	-50.4	24.4	100.7	5.5	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	-31.9	-30.4	24.4	100.7	5.5	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	-0.6	-9.4	169.9	-105.9	159.8	183.0
14	RDF CHP with 4 pipe DHC	-12.0	-20.8	169.9	-105.9	159.8	183.0
15	RDF CHP with 2 pipe DH + individual absorption chillers	-51.8	-49.1	109.1	-530.7	66.8	183.0

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	0.0	0.0	0.0	4	0.0	0.0	0.0
5	0.0	0.0	0.0	5	0.0	0.0	0.0
6	0.0	0.0	0.0	6	0.0	0.0	0.0
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0

Area Name: Larnaca Mixed (6022 Post Code Level)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-11.4	-11.1	119.0	-76.0	94.8	108.5
2	Biomass CHP with 4 pipe DHC	-16.9	-16.6	119.0	-76.0	94.8	108.5
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-44.8	-37.2	85.7	-334.4	38.2	108.5
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	-0.6	-1.2	7.8	193.4	94.8	290.1
5	Oil CHP with 4 pipe DHC	-6.2	-6.8	7.8	193.4	94.8	290.1
6	Oil CHP with 2 pipe DH + individual absorption chillers	-19.5	-17.4	-52.7	-49.5	38.2	290.1
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-12.8	-9.2	56.3	189.7	94.8	290.1
8	LPG CHP with 4 pipe DHC	-18.4	-14.8	56.3	189.7	94.8	290.1
9	LPG CHP with 2 pipe DH + individual absorption chillers	-32.8	-25.9	3.2	-48.0	38.2	290.1
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	-21.9	-20.7	14.6	60.3	3.5	0.0
11	Reversible water source heat pumps with 4 pipe DHC	-27.5	-26.3	14.6	60.3	3.5	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	-19.4	-18.2	14.6	60.3	3.5	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	-0.4	-4.6	100.8	-61.8	94.8	108.5
14	RDF CHP with 4 pipe DHC	-6.0	-10.1	100.8	-61.8	94.8	108.5
15	RDF CHP with 2 pipe DH + individual absorption chillers	-31.8	-29.6	64.0	-317.4	38.2	108.5

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	0.0	0.0	0.0	4	0.0	0.0	0.0
5	0.0	0.0	0.0	5	0.0	0.0	0.0
6	0.0	0.0	0.0	6	0.0	0.0	0.0
7	0.0	0.0	0.0	7	0.0	0.0	0.0
8	0.0	0.0	0.0	8	0.0	0.0	0.0
9	0.0	0.0	0.0	9	0.0	0.0	0.0
10	0.0	0.0	0.0	10	0.0	0.0	0.0
11	0.0	0.0	0.0	11	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0
12	0.0	0.0	0.0	12	0.0	0.0	0.0

Area Name: Larnaca Service (6023 Post Code Level)

Solution Combination No.		ENPV relative to baseline for all technical potential (€m)	FNPV relative to baseline for all technical Potential (€m)	CO2 Savings for all technical potential (tkCO2)	PES for all technical potential (GWh)	Electricity consumption reduction for all technical potential (GWh)	Electricity generation for all technical potential (GWh)
1	Biomass CHP with 2 pipe DHC (DC in summer and DH in winter)	-20.3	-18.8	248.7	-159.6	198.4	234.2
2	Biomass CHP with 4 pipe DHC	-26.0	-24.5	248.7	-159.6	198.4	234.2
3	Biomass CHP with 2 pipe DH + individual absorption chillers	-99.2	-79.6	163.0	-791.1	52.2	234.2
4	Oil CHP with 2 pipe DHC (DC in summer and DH in winter)	5.7	1.8	18.0	416.2	198.4	626.1
5	Oil CHP with 4 pipe DHC	0.0	-3.9	18.0	416.2	198.4	626.1
6	Oil CHP with 2 pipe DH + individual absorption chillers	-39.6	-33.2	-129.7	-179.9	52.2	626.1
7	LPG CHP with 2 pipe DHC (DC in summer and DH in winter)	-20.1	-14.5	120.0	406.4	198.4	626.1
8	LPG CHP with 4 pipe DHC	-25.8	-20.2	120.0	406.4	198.4	626.1
9	LPG CHP with 2 pipe DH + individual absorption chillers	-68.0	-51.3	-10.7	-177.8	52.2	626.1
10	Reversible water source heat pumps with 2 pipe DHC (DC in summer and DH in winter)	-57.6	-51.7	27.3	113.0	9.5	0.0
11	Reversible water source heat pumps with 4 pipe DHC	-63.3	-57.4	27.3	113.0	9.5	0.0
12	Reversible water source heat pumps with 2 pipe DH + individual absorption chillers	-50.3	-44.4	27.3	113.0	9.5	0.0
13	RDF CHP with 2 pipe DHC (DC in summer and DH in winter)	2.6	-5.5	210.5	-129.9	198.4	234.2
14	RDF CHP with 4 pipe DHC	-3.1	-11.2	210.5	-129.9	198.4	234.2
15	RDF CHP with 2 pipe DH + individual absorption chillers	-71.5	-63.4	116.8	-755.2	52.2	234.2

Solution Combination No.	Space cooling delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where ENPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	15.5	5.3	0.0
5	15.5	5.3	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
12	15.5	5.3	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0

Solution Combination No.	Space cooling delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Space heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by DHC where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	15.5	5.3	0.0
5	0.0	0.0	0.0
6	0.0	0.0	0.0
7	0.0	0.0	0.0
8	0.0	0.0	0.0
9	0.0	0.0	0.0
10	0.0	0.0	0.0
11	0.0	0.0	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0
12	0.0	0.0	0.0

Appendix 9 Efficiency of Grid Power Generation and CO_2 Intensity

Year	Primary delivered power generation energy efficiency	Delivered electricity CO2 intensity	Primary delivered power generation energy efficiency with sensitivity	Delivered electricity CO2 intensity with sensitivity
	%GCV	TCO2/MWh	%GCV	TCO2/MWh
2015	30.57%	0.879	30.57%	0.879
2016	30.57%	0.879	30.57%	0.879
2017	30.57%	0.879	30.57%	0.879
2018	30.56%	0.879	30.56%	0.879
2019	30.28%	0.889	30.28%	0.889
2020	27.71%	0.988	27.71%	0.988
2021	27.77%	0.985	27.77%	0.985
2022	28.01%	0.975	28.01%	0.975
2023	28.07%	0.973	28.07%	0.973
2024	47.69%	0.450	47.69%	0.450
2025	47.68%	0.450	47.68%	0.450
2026	47.65%	0.450	47.65%	0.450
2027	47.64%	0.450	47.64%	0.450
2028	47.74%	0.449	47.74%	0.449
2029	47.70%	0.450	47.70%	0.450
2030	47.66%	0.450	47.66%	0.450
2031	46.89%	0.457	46.89%	0.457
2032	45.39%	0.473	45.39%	0.473
2033	45.43%	0.472	45.43%	0.472
2034	43.93%	0.488	43.93%	0.488
2035	42.39%	0.506	42.39%	0.506
2036	41.29%	0.519	41.29%	0.519
2037	41.68%	0.515	41.68%	0.515
2038	41.50%	0.517	41.50%	0.517
2039	43.98%	0.488	43.98%	0.488
2040	44.63%	0.481	44.63%	0.481
2041	44.63%	0.481	44.63%	0.481
2042	44.63%	0.481	44.63%	0.481
2043	44.63%	0.481	44.63%	0.481
2044	44.63%	0.481	44.63%	0.481
2045	44.63%	0.481	44.63%	0.481
2046	44.63%	0.481	44.63%	0.481
2047	44.63%	0.481	44.63%	0.481
2048	44.63%	0.481	44.63%	0.481
2049	44.63%	0.481	44.63%	0.481
2050	44.63%	0.481	44.63%	0.481

Appendix 10 Detailed Individual Building Level Solution Results (Central Scenario)

Area Name: Nicosia – Service (1097 Post Code Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0

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Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0

Area Name: Nicosia - Service (1097 Detailed Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	0.000000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0

Area Name: Poseidonos Avenue, Paphos (8041,8042,8204 Detailed)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is positive (GWh)	Total electricity consumption reduction where FNPV relative to baseline is positive (GWh)	Total electricity generation where ENPV relative to baseline is positive (GWh)	Total electricity generation where FNPV relative to baseline is positive (GWh)
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	11.6	15.4	137.1	141.0	1406.2	1465.9	345.8	366.1	1943.9	1943.9
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	27.5	11.4	178.1	178.1	291.1	291.1	-194.5	-194.5	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	47.4	15.1	454.9	454.9	-794.3	-794.3	488.1	488.1	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to baseline is positive	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is positive (GWh/Yr)	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0
2	41.9	16.5	9.6
3	0.0	0.0	0.0
4	44.4	16.9	9.8
5	44.4	16.9	9.8

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to baseline is positive	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is positive (GWh/Yr)	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is positive (GWh/Yr)
1	0.0	0.0	0.0
2	44.4	16.9	9.8
3	0.0	0.0	0.0
4	44.4	16.9	9.8
5	44.4	16.9	9.8

Area Name: Kryo Avenue, Ayia Napa (5330 Detailed)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	5.8	8.1	80.5	80.8	825.3	828.4	203.0	203.7	1092.0	1092.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	15.9	6.6	102.4	102.4	167.1	167.1	-111.8	-111.8	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	26.5	8.2	256.5	256.5	-440.2	-440.2	271.6	271.6	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	24.6	9.7	5.6
3	0.0	0.0	0.0
4	24.7	9.7	5.6
5	24.7	9.7	5.6

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	24.7	9.7	5.6
3	0.0	0.0	0.0
4	24.7	9.7	5.6
5	24.7	9.7	5.6

Area Name: Nicosia Mixed (1082 Post Code Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	5.7	3.8	24.3	24.3	100.0	100.0	5.6	5.6	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.8	0.4	0.0
5	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.8	0.4	0.0
5	0.0	0.0	0.0

Area Name: Nicosia Residential (2003 Post Code Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	5.6	3.8	23.6	23.6	97.5	97.5	5.5	5.5	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.6	0.3	0.0
5	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.6	0.3	0.0
5	0.0	0.0	0.0

Area Name: Limassol Service (3105 Post Code Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	6.0	4.1	24.3	24.3	100.1	100.1	5.8	5.8	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0	1	0.0	0.0	0.0
2	0.0	0.0	0.0	2	0.0	0.0	0.0
3	0.0	0.0	0.0	3	0.0	0.0	0.0
4	0.0	0.0	0.0	4	0.0	0.0	0.0
5	0.0	0.0	0.0	5	0.0	0.0	0.0

Area Name: Limassol Mixed (3106 Post Code Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	6.2	4.2	24.4	24.4	100.8	100.8	5.5	5.5	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	1.2	0.6	0.0
5	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	1.2	0.6	0.0
5	0.0	0.0	0.0

Area Name: Larnaca Mixed (6022 Post Code Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	3.6	2.4	14.5	14.5	59.9	59.9	3.3	3.3	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.6	0.3	0.0
5	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.6	0.3	0.0
5	0.0	0.0	0.0

Area Name: Larnaca Service (6023 Post Code Level)

	Individual CHP solution no.	Total ENPV relative to baseline where positive (€m)	Total FNPV relative to baseline where positive (€m)	Total CO2 savings where ENPV relative to baseline is positive (kTCO2)	Total CO2 savings where FNPV relative to baseline is positive (kTCO2)	Total PES where ENPV relative to baseline is positive (GWh)	Total PES where FNPV relative to baseline is positive (GWh)	Total electricity consumption reduction where ENPV relative to baseline is	Total electricity consumption reduction where FNPV relative to baseline is	Total electricity generation where ENPV relative to baseline is positive	Total electricity generation where FNPV relative to baseline is positive
Biomass CHP	1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Oil CHP	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
LPG CHP	3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Individual heat pumps and solar hot water	4	6.2	4.2	25.4	25.4	104.3	104.3	6.0	6.0	0.0	0.0
Solar space, heating, cooling and hot water in hotels	5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where ENPV relative to	Space heating delivered by individual CHP + top up boilers where ENPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where ENPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0

Individual CHP solution no.	Space cooling delivered by individual CHP + top up electric chillers where FNPV relative to	Space heating delivered by individual CHP + top up boilers where FNPV relative to baseline is	Water heating delivered by individual CHP + top up boilers where FNPV relative to baseline is
1	0.0	0.0	0.0
2	0.0	0.0	0.0
3	0.0	0.0	0.0
4	0.0	0.0	0.0
5	0.0	0.0	0.0

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