

Report on the promotion of efficiency in heating and cooling

Article 14 of Directive 2012/27/EU

I. Executive summary

1. Introduction

The purpose of this document is to fulfil France's regulatory requirements with regard to Article 14(1) and (3) of Directive 2012/27/EU on energy efficiency and Annexes VIII and IX thereto, as amended. It also supports the Multiannual Energy Programme in transposing Article 15(8) of Directive (EU) 2018/2001 on the promotion of the use of energy from renewable sources. The focus of the Multiannual Energy Programme includes assessing the potential of high-efficiency cogeneration and efficient district heating and cooling. This document presents the cost-benefit analysis referred to in Article 14(3) of Directive 2012/27/EU on energy efficiency.

The method used to carry out this assessment is derived from Annexes VIII and IX to Directive 2012/27/EU, as amended by Delegated Regulation (EU) 2019/826 of 4 March 2019, and on the documents provided by the EU's Joint Research Centre: *Best practices and informal guidance on how to implement the Comprehensive Assessment at Member State level* by Jakubcionis, Santamaria, Kavvadias, Piers de Raveschoot, Moles, Carlsson, (JRC Science for policy report, 2015). Nevertheless, the specific characteristics of the French energy mix required the latter to be adapted.

2. Scope of the study

The analysis was carried out at national level and covered only mainland France (apart from areas not connected). The selected system is therefore 'mainland France'.

'Heating and thermal processes' and 'domestic hot water' are addressed as separate uses.

In line with the recommendations from the *Guide to socioeconomic evaluation of public investments in France* by Gostner, C., Ni, J., Auverlot, D., Delozier, B., Loublier, A., (France Stratégie, 2017), a 'long-term' analysis must be carried out. As the main forecasts by France and Europe cover the period up to 2050, we will also be applying this timeframe.

The analysis will distinguish between the lifespans of the different systems. However, calculations will be carried out for the entire period (i.e. 2018-2050) and in respect of all systems. The generation systems covered by the analysis all have a lifespan of less than 32 years.

It is worth noting that the National Low Carbon Strategy adopted in 2015 has been taken into account as its review was finalised on 21 April 2020. However, footnote 7 of Delegated Regulation (EU) 2019/826 of 4 March 2019 clarifies that:

'The cut-off date for taking into account policies for the baseline scenario is the end of the year preceding to the year by the end of which the comprehensive assessment is due. That is to say, policies enacted within a year prior to the deadline for submission of the comprehensive assessment do not need to be taken into account'.

Finally, in its Multiannual Energy Programme, France chose to prioritise the use of heating in its objectives for the use of biomass.

Extract from the Multiannual Energy Programme (page 70):

'Prioritise biomass for heating purposes over high-efficiency cogeneration. Heating will have far greater priority as regards using biomass for energy purposes.'

France therefore decided not to update the study on the potential for high-efficiency cogeneration.

3. Identifying demand

Thermal energy demand for ‘heating and thermal processes’ and ‘domestic hot water’ is analysed in relation to four sectors (individual residential, collective residential, tertiary and industry/agriculture). Demand in these sectors is broken down by vector (one system and one resource).

Data and forecasts on thermal consumption drew on general modelling work carried out by the Ministry of Ecological and Inclusive Transition for the purposes of the following recurring initiatives:

- the National Low Carbon Strategy
- the Multiannual Energy Programme (based on the same scenarios as the National Low Carbon Strategy)

Final thermal energy demand for all uses combined was calculated to be 742 TWh in 2018. Projections indicate that this demand will decrease throughout the period covered by the study: 668 TWh in 2025, 608 TWh in 2030, 496 TWh in 2040 and 417 TWh in 2050 (divided by a factor of 1.7 compared to 2018).

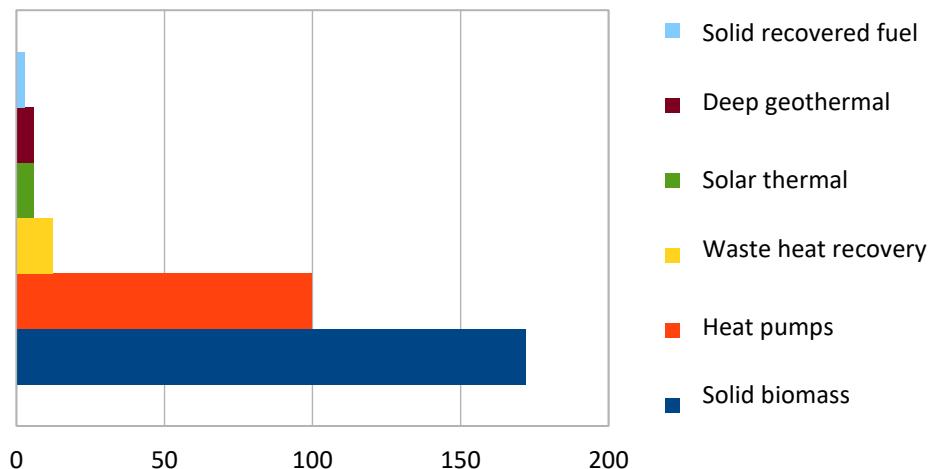
4. Maximum technical potential of renewable thermal solutions

The following efficient solutions were examined:

System	Resource(s)	Considered an individual solution	Considered a centralised solution
Biomass burner	Wooden logs	X	
Biomass burner	Wooden pellets	X	X
Solar thermal	Solar radiation	X	X
Air-to-air heat pump	External heat and electricity	X	
Air-to-water heat pump	External heat and electricity	X	
Ground source heat pump	External heat and electricity	X	X
Industrial waste heat recovery	Heat		X
Waste heat recovery from waste-to-energy power plants	Heat		X
Solid recovered fuel burner	Solid recovered fuel		X
Deep geothermal	Ground heat and electricity		X

Table 1: Inventory of efficient solutions examined

The **maximum** potential for these systems (overall maximum) in TWh is as follows:



Data came from the scenarios in the National Low Carbon Strategy and from statistical information and studies by the Ministry of Ecological and Inclusive Transition.

The potential referred to is the final energy potential. Strong potential for solid biomass and for the development of heat pumps can be seen.

Given this potential, the European Commission has recommended that Member States carry out two analyses enabling an estimation of the net present values in scenarios which realise this potential. These are namely a financial analysis, carried out from the perspective of the consumer, and an economic analysis, carried out from the perspective of society. The difference between these lies in the consideration given to externalities, i.e. costs (capital, maintenance, inputs, etc.).

Table 2 summarises the calculated net present values:

NPV (alternative - baseline)	'Heating and thermal processes, and domestic hot water'
Financial analysis	EUR 55 billion
Economic analysis	EUR 58.5 billion

Table 2: Summary of the results

As the net present values are positive in both analyses, the benefits of implementing the alternative scenario outweigh the costs.

5. Conclusion of the study

The focus of this analysis was on examining systems which are considered efficient in France. These systems were integrated to differing degrees into two scenarios reflecting two different trajectories. The two scenarios depict a supply response to the projected heating demand in mainland France for the period 2018-2050. The maximum potential for deploying efficient systems was projected and served as a basis for drawing up the 'alternative' scenario. Under this scenario,

efficient solutions are exploited to their maximum potential, with conventional solutions being used to bridge the remaining gap between demand and supply.

A positive net present value means the alternative scenario performed better. We would point out that in all cases, the alternative scenario – which dedicates much of its mix to efficient and sometimes very capital-intensive solutions – performs better than the baseline scenario. Besides the lower social cost incurred by its impact, the alternative scenario stands out by improving overall efficiency across all thermal energy production systems.

The trajectories for deploying the efficient solutions described in the alternative scenario are the trajectories as set out in the Multiannual Energy Programme, meaning that this analysis confirms that France chose an appropriate trajectory in its programme.

Table of contents

I.	Executive summary.....	2
1.	Introduction	2
2.	Scope of the study	2
3.	Identifying demand	3
4.	Maximum technical potential of renewable thermal solutions	3
5.	Conclusion of the study.....	4
II.	Designing the scenarios	8
1.	Projecting heating demand	8
2.	Designing the baseline scenario	11
3.	Understanding of the technical potential examined	13
4.	Designing the alternative scenario	16
i.	Alternative scenario – all sectors.....	16
ii.	Alternative scenario – collective residential.....	17
iii.	Alternative scenario – tertiary	19
iv.	Alternative scenario – industry and agriculture	20
v.	Alternative scenario – district heating mix.....	21
III.	Cost-benefit analysis.....	22
1.	Financial analysis.....	22
i.	Techno-economic data.....	23
ii.	Benefits.....	23
iii.	Input costs.....	24
2.	Economic analysis	24
IV.	Outcomes	27
1.	Financial analysis.....	27
2.	Economic analysis (externalities based on JRC data)	29
3.	Economic analysis (shadow price of carbon)	31
V.	Sensitivity analysis	33
VI.	Conclusion	36
VII.	References.....	37
VIII.	Index of images.....	38
IX.	Index of tables	38
1.	Demand projection - data.....	39
i.	Heating and thermal processes	39
ii.	Domestic hot water.....	40
2.	Baseline scenario – data	41
i.	Individual residential	41
ii.	Collective residential	42
iii.	Tertiary	43
iv.	Industry and agriculture	44
v.	District heating	44

3.	Technical potential by sector.....	45
i.	Solid biomass.....	45
ii.	Solar thermal.....	46
iii.	Heat pumps	47
iv.	District heating solutions (deep geothermal and waste heat recovery).....	48
v.	Development of district heating (supply)	48
4.	Alternative scenario – data	49
i.	Individual residential	49
ii.	Collective residential	50
iii.	Tertiary	51
iv.	Industry	52
v.	District heating	52
5.	Techno-economic data.....	53
i.	Individual residential	53
v.	District heating	57

II. Designing the scenarios

For the purposes of the analysis, a baseline scenario (referred to as ‘business as usual’) needs to be designed which reflects the likely trend in thermal energy consumption in mainland France. This baseline scenario will serve as a basis with which to compare the alternative scenarios. Consideration was given to this in general terms, taking into account the national trend in thermal energy demand.

Energy consumption forecasting models which were previously adopted for national forecasts¹ were used to source information on possible trends in France’s thermal energy consumption profile in the following sectors: individual residential, collective residential, tertiary and industry/agriculture.

1. Projecting heating demand

Heating demand in the aforementioned sectors was projected by means of a modelling exercise started for the purposes of the Multiannual Energy Programme and National Low Carbon Strategy. The models used for this work were calibrated to the following data:

1. Demographics of the system examined (population in ‘000)

This data is taken from projections by INSEE (the French National Institute of Statistics and Economic Studies).

Year	2015	2020	2025	2030	2035	2040	2045	2050
Mainland France	64 293	65 684	66 918	68 064	69 157	70 143	70 961	71 628

Table 3: Macroeconomic framework – Demographic trend under the system examined

2. Increase in gross domestic product

The EU framework for France is followed until 2035. This is then extended until 2050, with the same growth rate maintained as for the period 2030-2035. Dynamic growth beyond 2035 is consistent with the Ageing Report.

Annual growth in real GDP (adjusted to inflation)	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
	1.6%	1.3%	1.4%	1.7%	1.7%	1.7%	1.7%

Table 4: Macroeconomic framework - GDP growth

3. Trend in industrial value added

The EU framework is followed until 2035. This is then extended until 2050, with the same growth rate maintained as for the period 2030-2035.

Annual growth in real industrial value added (adjusted to inflation)	2015-2020	2020-2025	2025-2030	2030-2035	2035-2040	2040-2045	2045-2050
	1.40%	1.00%	1.10%	1.30%	1.30%	1.30%	1.30%

Using this macroeconomic framework linked to assumptions regarding energy efficiency improvements, the trend in France’s thermal energy demand can be modelled until 2050. (This

¹National Low Carbon Strategy and Multiannual Energy Programme.

scenario takes into account measures which have already been adopted and additional measures needed to achieve carbon neutrality by 2050).

For heating and thermal processes:

In TWh final energy	2020	2025	2030	2050
Individual residential	247	229.55	207.48	123.74
Collective residential	81	77.61	72.3	50.83
Tertiary	115	98	84	48
Industry	213	202.19	188.98	147.49
Total	656	608	552.5	370

Table 5: Projected demand – Heating and thermal processes

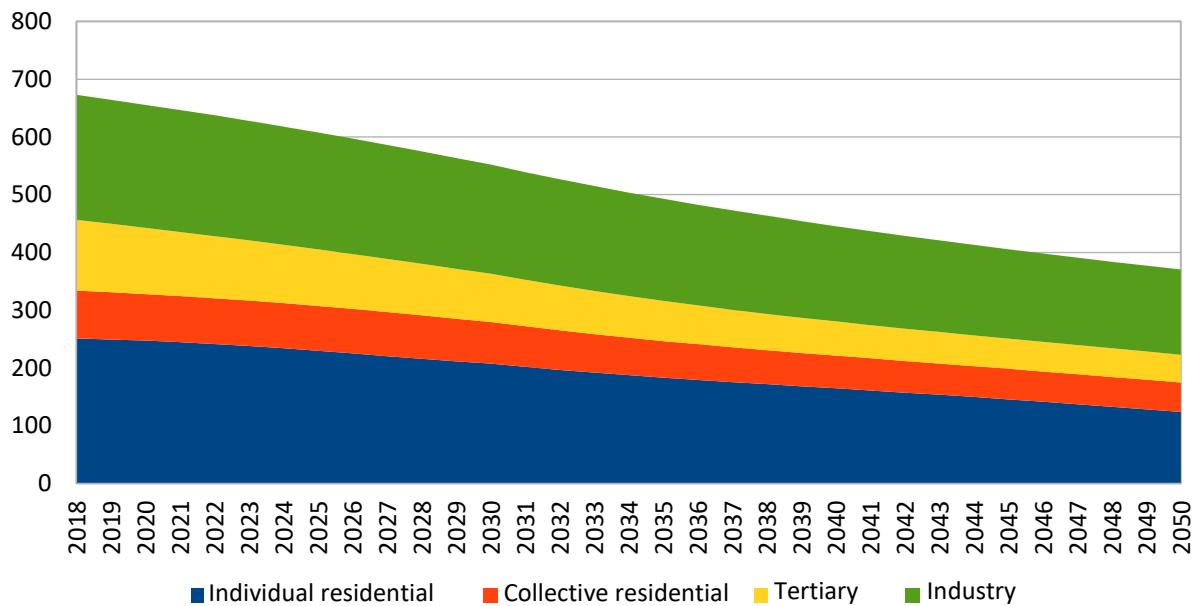


Image 2: Demand projection – Heating and thermal processes

For domestic hot water:

In TWh final energy	2020	2025	2030	2050
Individual residential	28	23.8	20.7	19.6
Collective residential	14.7	13.6	11.7	11
Tertiary	23.2	22.2	22	15
Industry	0	0	0	0
Total	66	59.6	55	45.6

Table 6: Projected demand – Domestic hot water

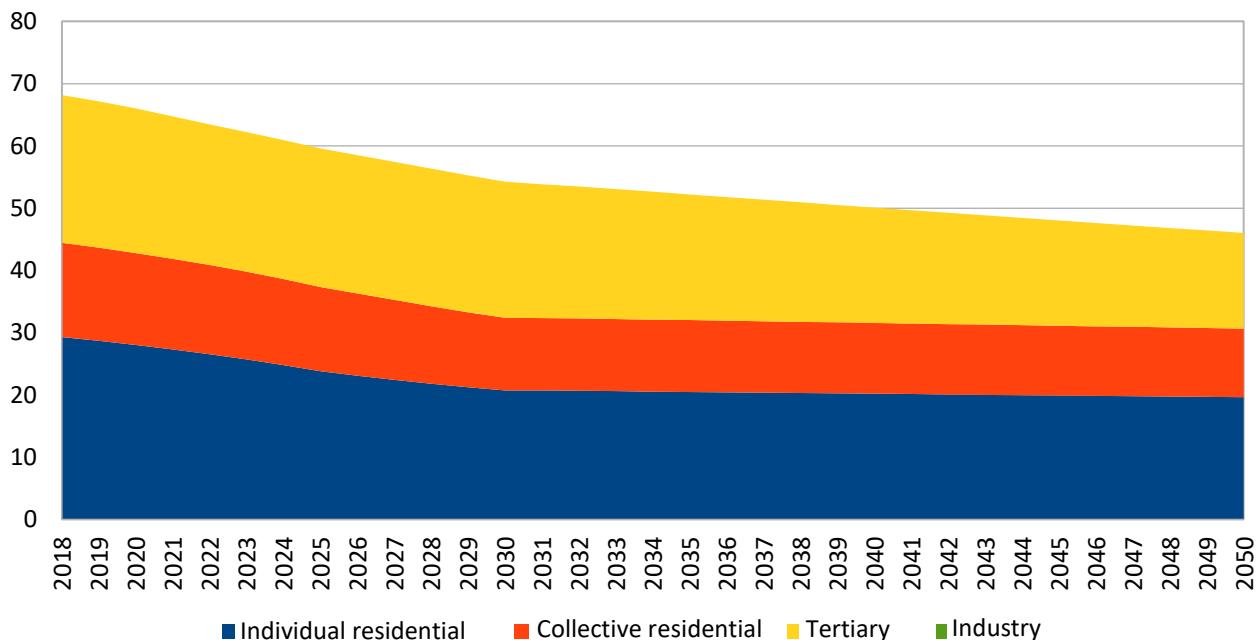


Image 3: Demand projection – Use of domestic hot water

The decline in consumption is mainly due to energy efficiency policies (building renovation), changes in consumer habits, France's continued economic shift towards a service economy and, indirectly, as a result of climate change.

The complete statistics can be found in Annex 1 (1. Demand projection – Data).

This data will enable us to design the baseline scenario and alternative scenario. Bearing in mind that both scenarios must satisfy the same demand, the only difference is in supply. Consequently, the focus of the paragraphs below is on presenting the supply mix.

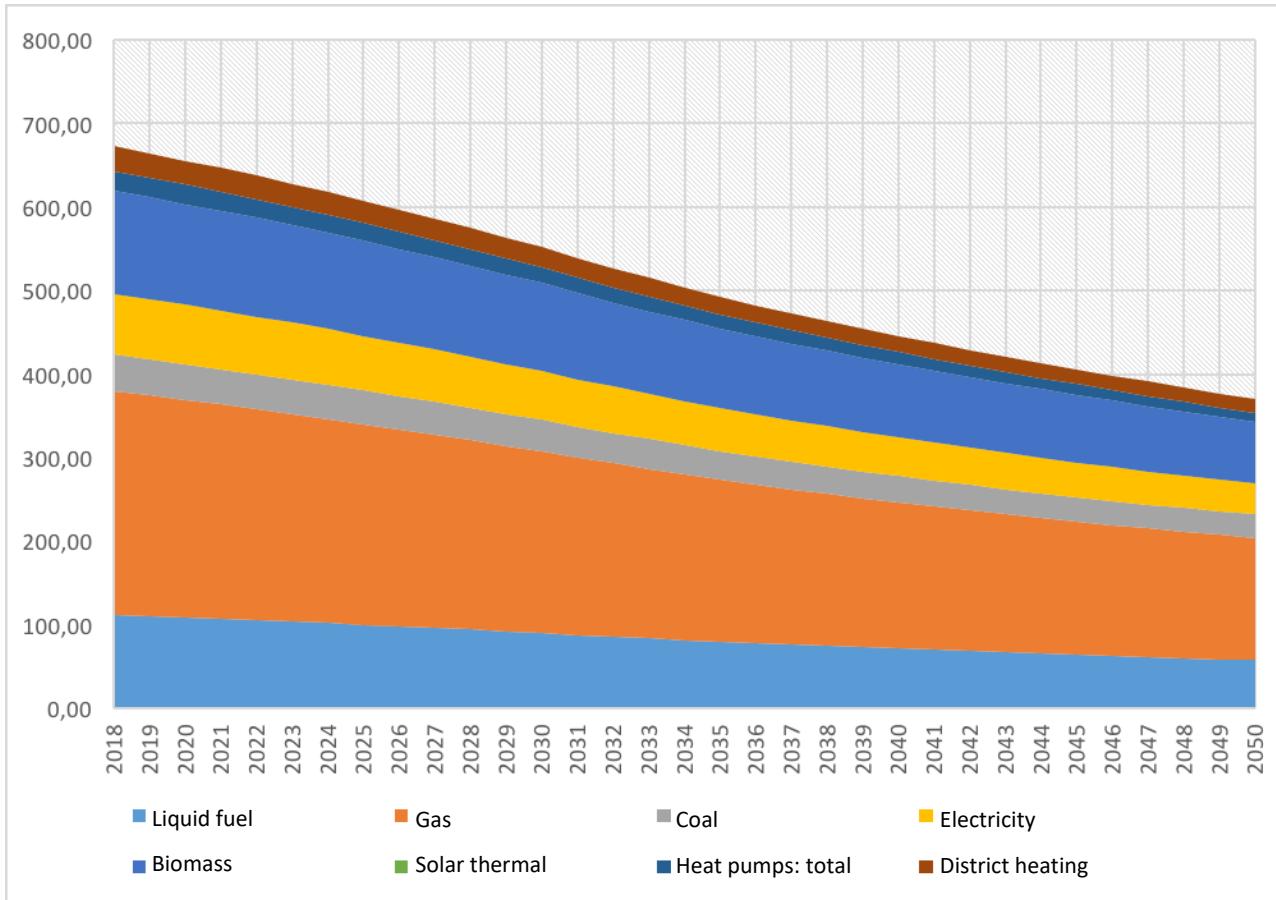
2. Designing the baseline scenario

The baseline scenario was designed in such a way that the proportions of the current technology mix are maintained whilst the decline referred to in the previous paragraph is also applied. In order to present the baseline scenario, it is therefore enough to describe the initial mix. The complete statistics are contained in Annex 2.

Heating and thermal processes until 2050:

Technology	Individual residential	Collective residential	Tertiary	Industry	Agriculture	All sectors
Fuel oil burner	21.7%	9.8%	19.5%	12.3%	0.0%	16.5%
Gas burner	23.9%	59.5%	51.2%	47.7%	53.6%	39.5%
Coal burner	0.1%	0.0%	0.0%	19.0%	0.0%	6.5%
Joule effect	14.0%	15.0%	15.4%	5.6%	0.3%	10.5%
Log biomass burner	37.1%	0.0%	0.0%	0.0%	27.7%	18.2%
Pellet biomass burner	2.0%	0.1%	0.1%	6.5%	18.4%	
Solar thermal	0.0%	0.0%	0.7%	0.0%	0.0%	0.8%
Air-to-air heat pump	0.9%	0.5%	6.5%	0.0%	0.0%	3.5%
Air-to-water heat pump	0.4%	0.0%	0.1%	0.0%	0.0%	
Ground source heat pump	0.0%	0.0%	0.0%	0.0%	0.0%	
District heating	0.0%	15.2%	6.4%	6.4%	0.0%	4.5%
Solid recovered fuel incineration	0.0%	0.0%	0.0%	2.5%	0.0%	0.0%

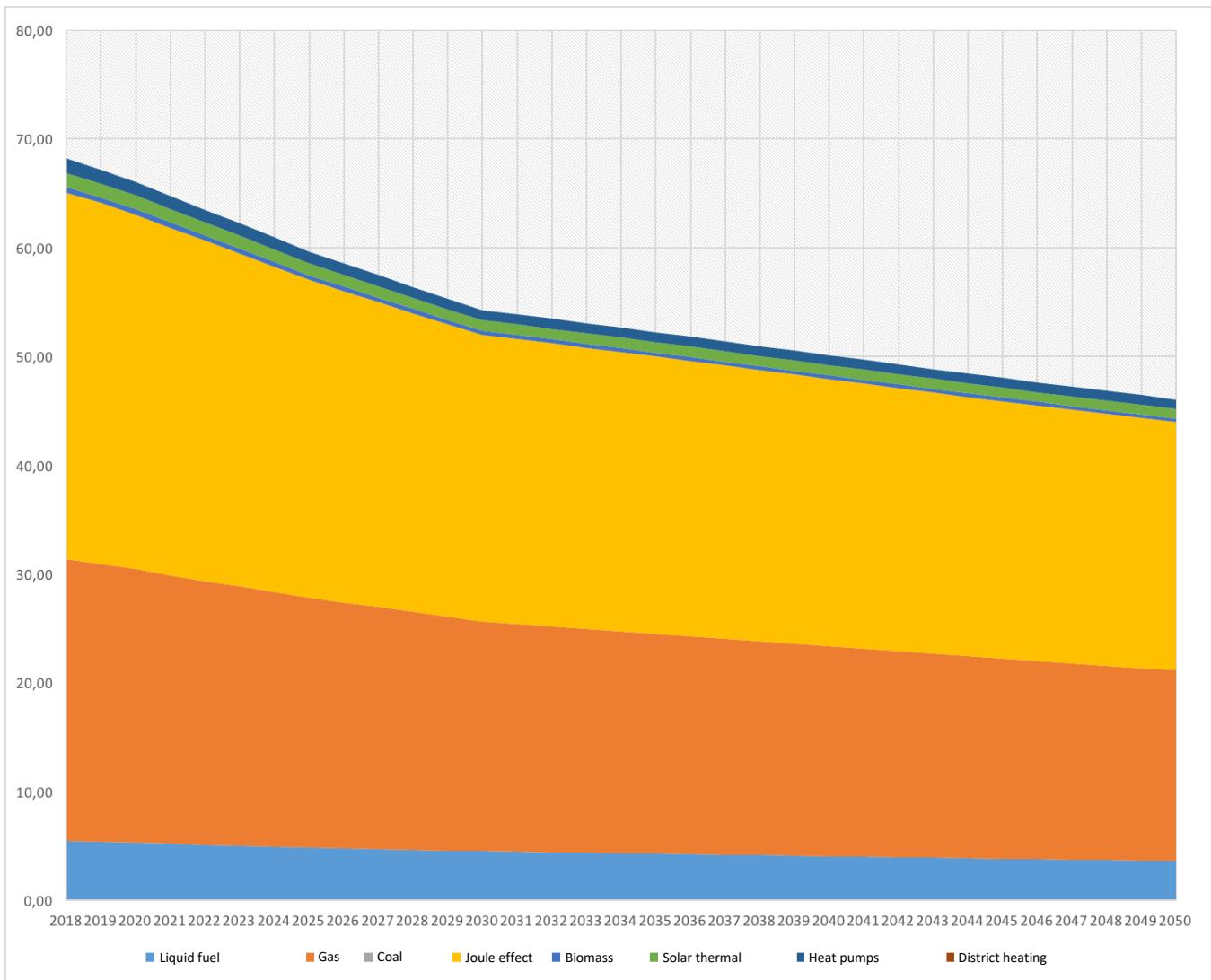
Table 7: Vector mix – Baseline scenario – Heating and thermal processes



Domestic hot water until 2050

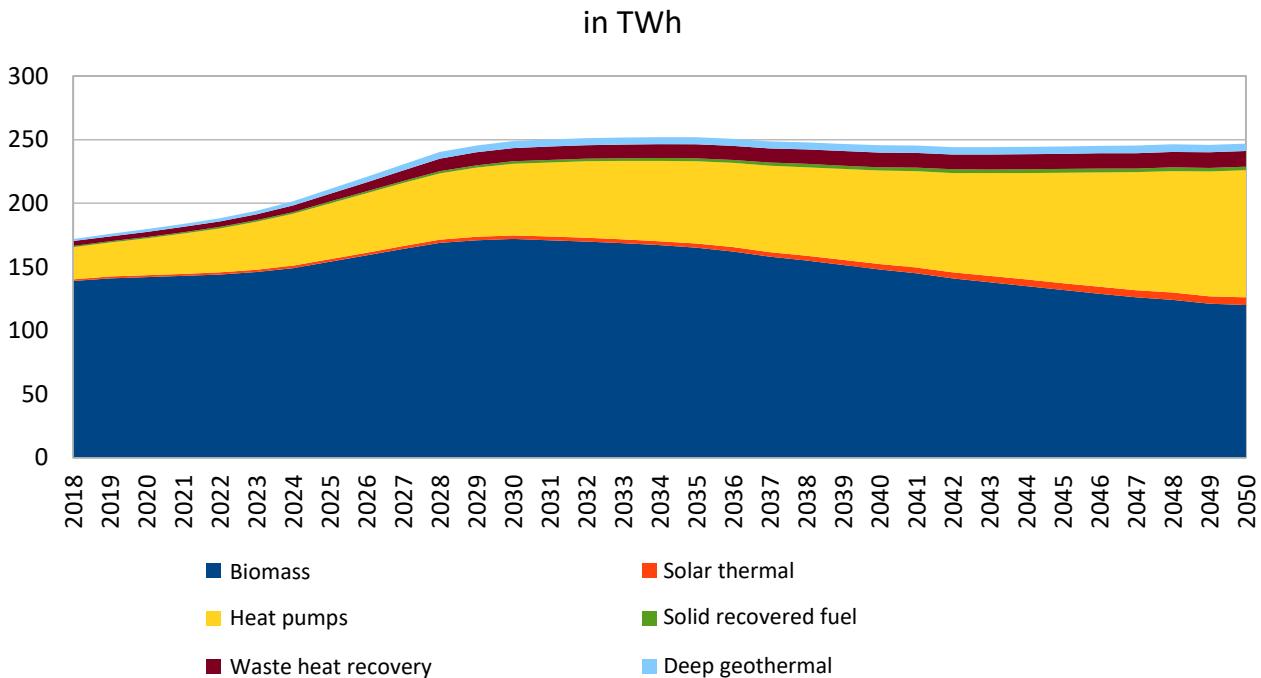
Technology	Individual residential	Collective residential	Tertiary
Fuel oil burner	7.5%	2.2%	9.5%
Gas burner	27.0%	42.8%	34.9%
Joule effect	60.7%	40.6%	30.8%
Log biomass burner	0.0%	0.0%	0.0%
Pellet biomass burner	0.5%	0.0%	0.3%
Solar thermal	2.7%	2.0%	6.5%
Thermodynamic water heater	0.5%	0.1%	10.4%
District heating	0.0%	12.2%	7.8%

Table 8: Vector mix – Baseline scenario – Domestic hot water



3. Understanding of the technical potential examined

Alternative scenarios are drawn up by understanding the technical potential of the systems examined within the system under consideration. Given the selected system, the technical potential examined is time-dependent. For example, the use of solid biomass for the purposes of generating thermal energy is forecast to be 172 TWh in 2030; the introduction of gasification processes and the redistribution of this resource to the transport sector will reduce the share subsequently examined (120 TWh available in 2050). The following chart clarifies these variations. The potential by sector is presented in the annex to this report.



The potential for using biomass was identified when drawing up the National Biomass Strategy. Solid biomass has a maximum potential of 172 TWh in 2030 (in final energy).

France has a strong solar energy supply, with forecasts predicting a solar-thermal maximum potential of 6 TWh by 2050 (see Multiannual Energy Programme).

Deep geothermal energy can only be exploited in geological formations which are sufficiently deep and permeable, and which contain aquifers in which the water is heated deep below where there is contact with rock. One of the challenges facing the sector is to develop deep geothermal energy in connection with district heating in the Île-de-France region (setting up, extending existing district heating, converting district heating from fossil fuels to geothermal) and other aquifers which are less well known than the Dogger aquifer. Other deep aquifers have excellent supply potential. However, little is known about the precise amount available. This is the case, for example, with the Trias and Lusitanien aquifers in Île-de-France, and with aquifers in the Aquitaine, Alsace and Hauts-de-France basin, and in the Provence-Alpes-Côte d'Azur region. Deep geothermal has an estimated maximum potential for heat generation of 5.8 TWh.

There is particular potential for developing heat pumps in the individual residential (new and refurbished) and tertiary sectors. AFPAC (the French association for heat pumps) estimates a maximum potential of 120 TWh in 2050.

The maximum supply of industrial waste heat over 30°C is estimated at 109 TWh and the national supply of waste heat from household waste treatment plants (not taking into account the optimisation of existing plants), waste water treatment plants and data centres is estimated at 8.4 TWh. Bearing in mind the share which can be used outside of this supply, there is 12.3 TWh of waste heat over 60°C available near existing district heating networks, including 56 sites near an existing district heating network which together amount to 9 TWh. With industry consuming less energy by 2035, recovery from district heating is estimated to have a maximum potential of 7.7 TWh².

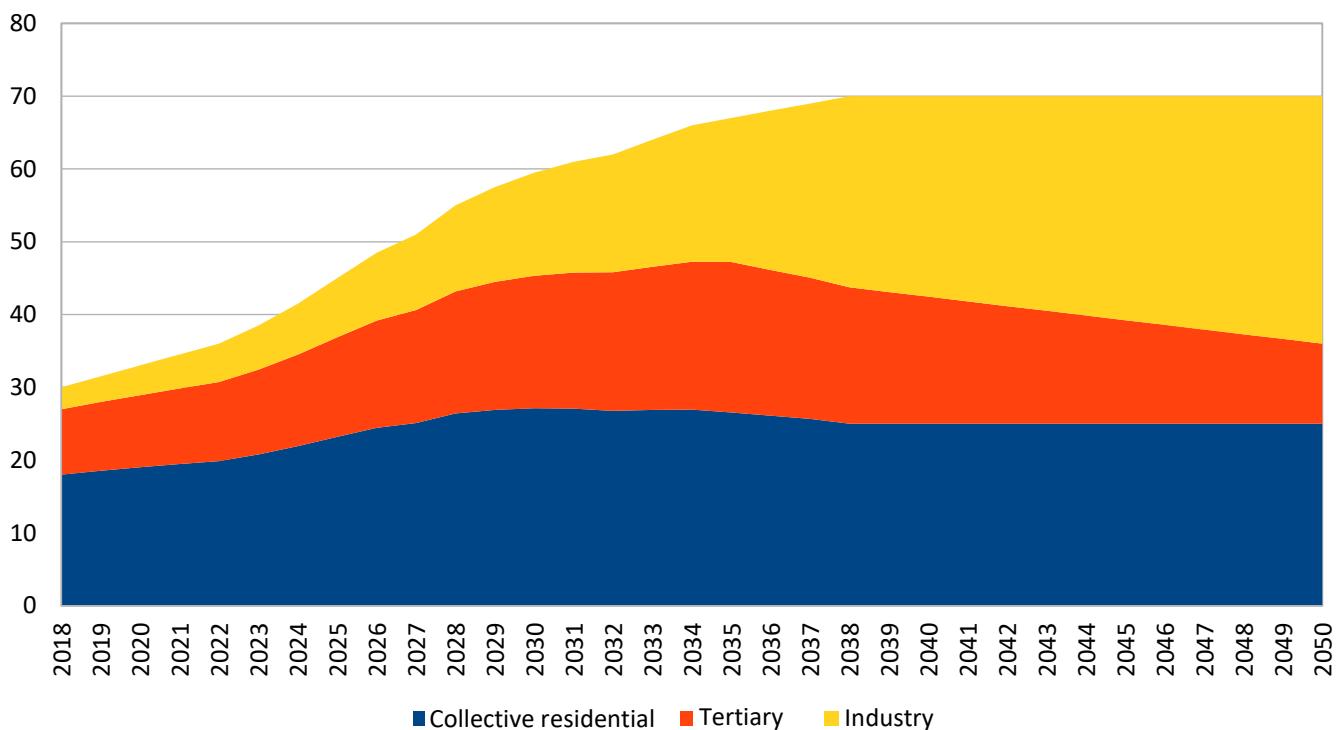
The maximum potential for household waste-to-energy power plants after optimisation/modification of existing plants is estimated at 10 TWh of additional heat compared to

²ADEME study on waste heat.

2009, with 60% intended for district heating and cooling (equivalent amount of waste burned). This corresponds to a potential of between 8.9 TWh and 10.5 TWh of heat supplied by district heating from energy provided by waste-to-energy power plants.

Finally, solid recovered fuel could also help with the development of heat recovery from district heating and cooling by providing 1.7 TWh.

The potential for developing district heating involving centralised solutions is presented in the chart below.



District heating is efficient in dense areas. Taking into account the minimum supply density of 4.5 MWh per linear metre in order for heating networks to be cost-effective, the SNCU (the national union of district heating) gauges that district heating has a supply potential 11-times greater than that of 2012. By cross-referencing this data against the supplies of renewable and recovered energy, the ADEME believes the maximum potential is approximately 70 TWh.

4. Designing the alternative scenario

With the supply potential for the entire duration of the analysis lower than heating demand, a comparison was performed against a single alternative scenario in which the entire supply of renewable and recovered energy could be mobilised. The supply of efficient vectors presented earlier satisfies the projected demand, with conventional solutions being used to bridge the remaining gap.

The complete statistics are contained in the annex to this report.

i. Alternative scenario – all sectors

Supply is distributed sector by sector until 2028 following the forecasts from the Multiannual Energy Programme and by extending the development of the renewable and recovered energy sector until 2050.

A sharp decline is observed in liquid fuel, gas and coal in favour of district heating, biomass and heat pumps. The share corresponding to the Joule effect remains essentially constant. ‘Solar thermal’ and ‘deep geothermal’ do not appear on the graphs as they are conveyed by district heating.

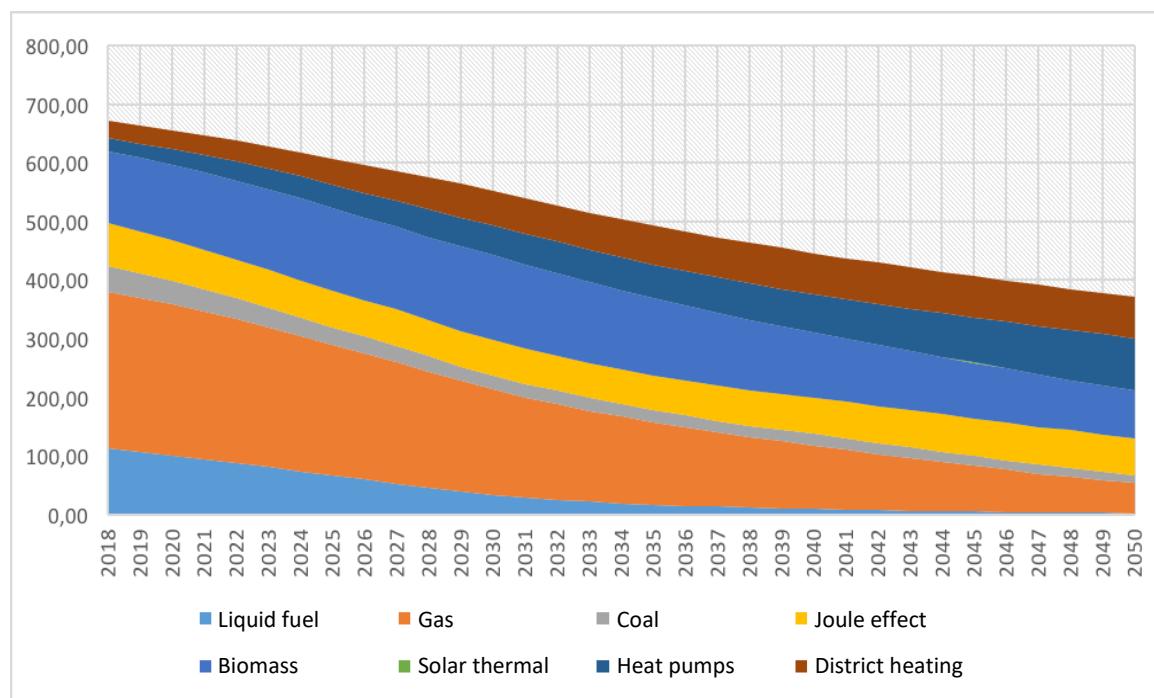


Figure 1: Alternative scenario: Heating mix trend – All sectors combined – Heating and thermal processes

In the area of domestic hot water, a complete disappearance of liquid fuel and a reduction in gas can be seen. The share corresponding to the Joule effect remains high, while solar thermal increases until 2050.

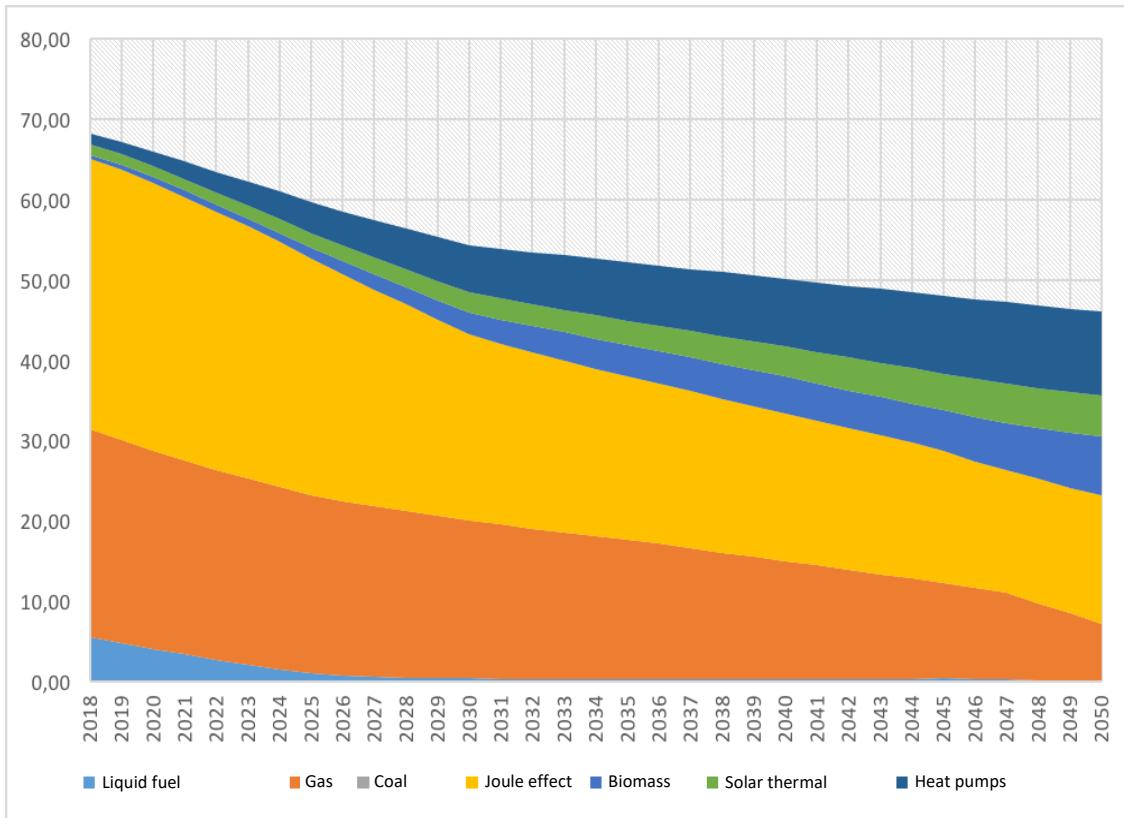


Figure 2: Alternative scenario: Heating mix trend – All sectors combined – Domestic hot water

ii. Alternative scenario – collective residential Heating and thermal processes:

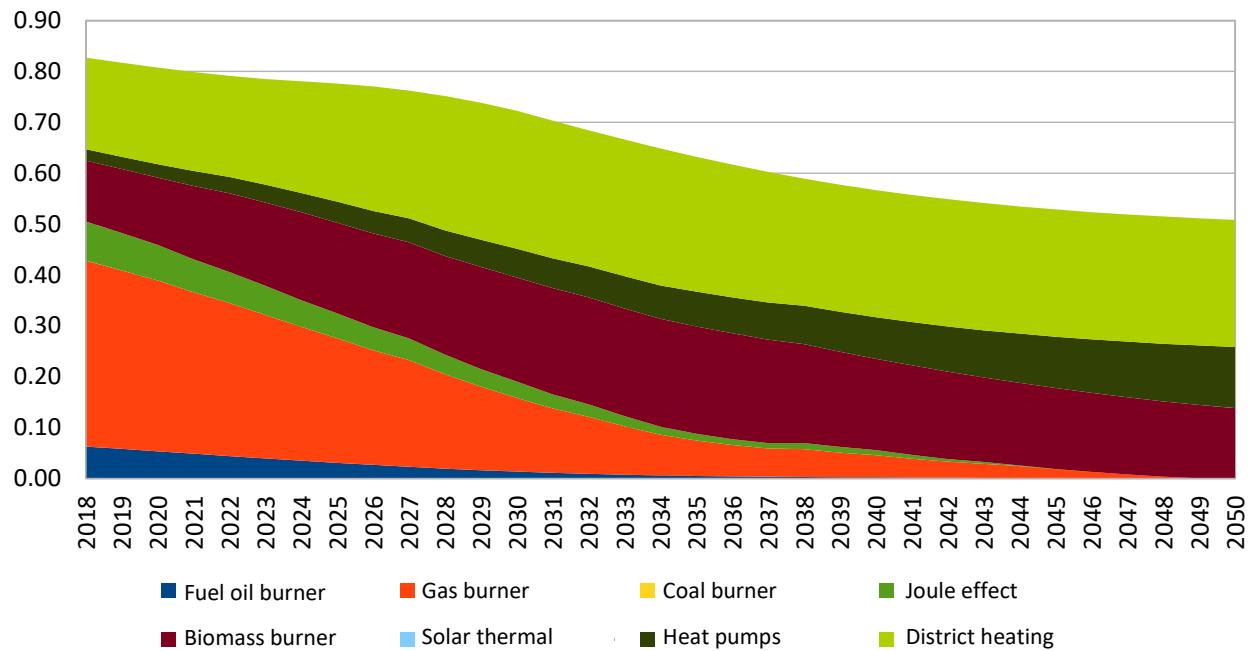


Image 6: Alternative scenario: Heating mix trend – Collective residential – Heating and thermal processes

District heating maintains and increases its share in the mix. The use of biomass is also noticeable, as is the use of heat pumps. By 2050, gas, fuel oil and electricity (apart from electricity used by heat pumps) are at zero.

Domestic hot water:

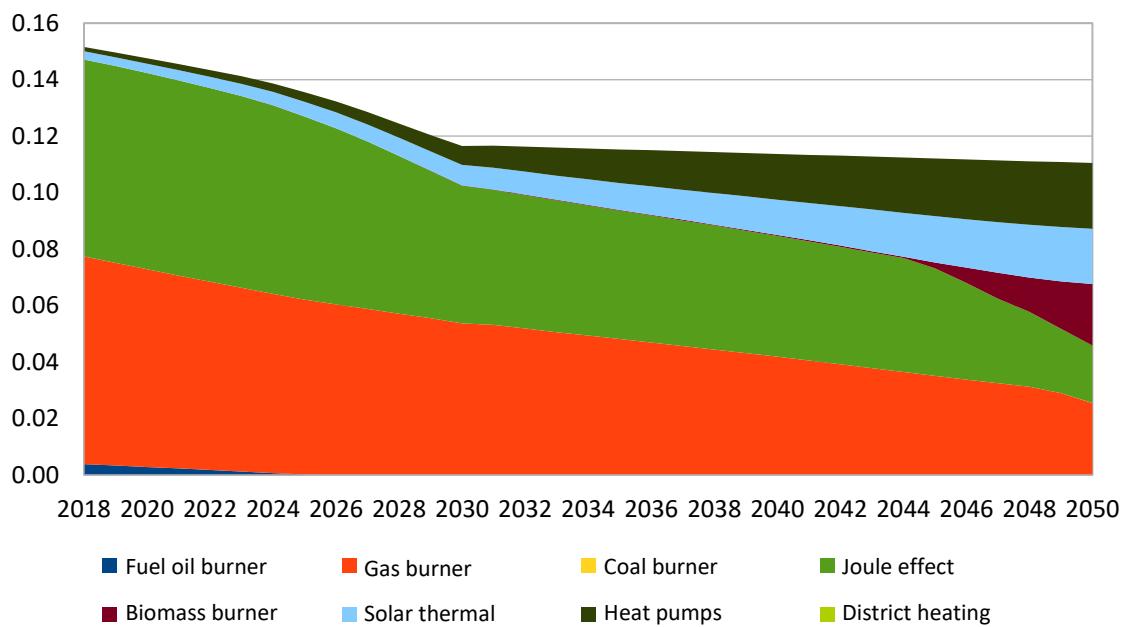


Image 7: Alternative scenario: Heating mix trend – Collective residential – Domestic hot water

A sizeable share is maintained by gas and the Joule effect, before being replaced by thermodynamic water heaters and biomass boilers. Significant growth in solar thermal can also be observed. (2.53 TWh in 2050).

iii. Alternative scenario – tertiary

Heating and thermal processes:

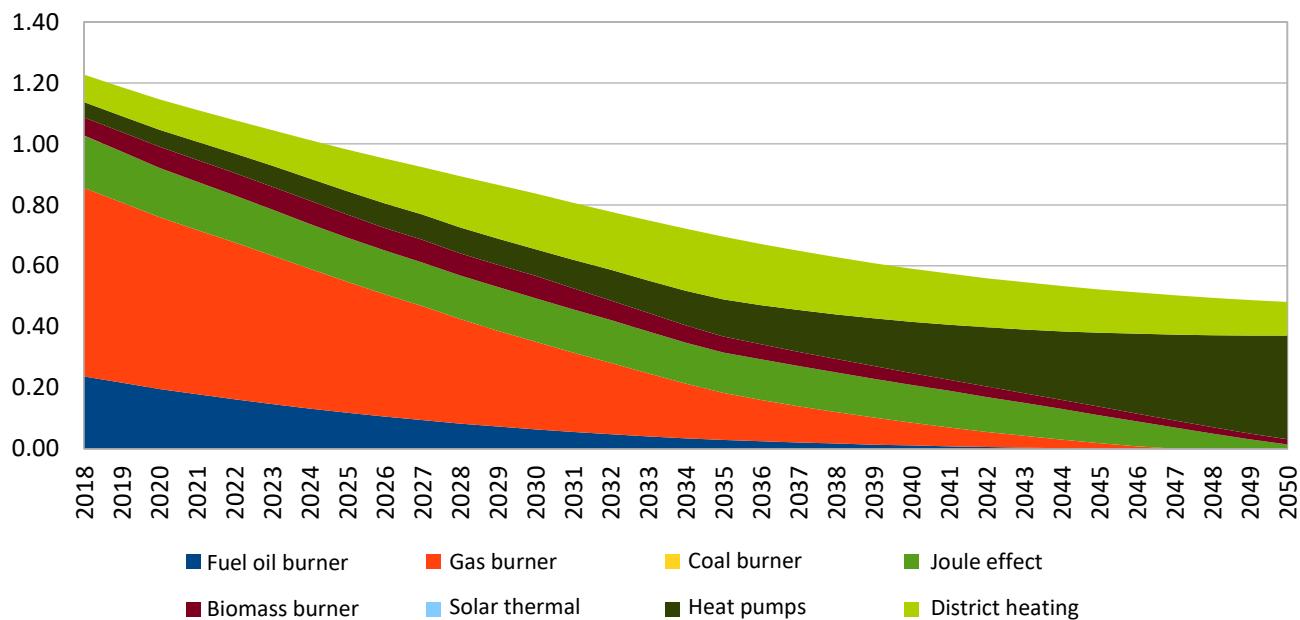


Image 8: Alternative scenario: Heating mix trend – Tertiary – Heating and thermal processes

The tertiary sector has the particular characteristic that heat pumps are frequently used due to their reversible nature. Heat pumps will cover 70% of demand in 2050. By 2050, gas, fuel oil and electricity (apart from electricity used by heat pumps) are at zero.

Domestic hot water:

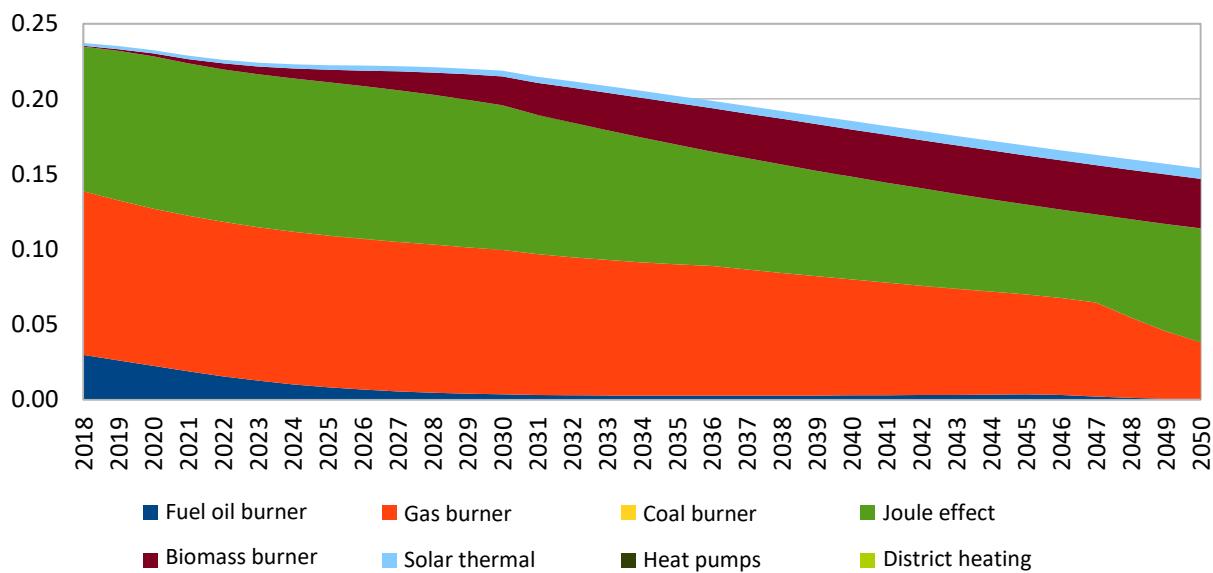


Image 9: Alternative scenario: Heating mix trend – Tertiary – Domestic hot water

Centralised biomass solutions account for a sizeable share in the mix as of 2030. The use of gas declines, while the Joule effect remains constant before later increasing. The share accounted for by solar thermal increases from 0.19 TWh in 2018 to 0.7 TWh in 2050.

iv. Alternative scenario – industry and agriculture

Heating and thermal processes:

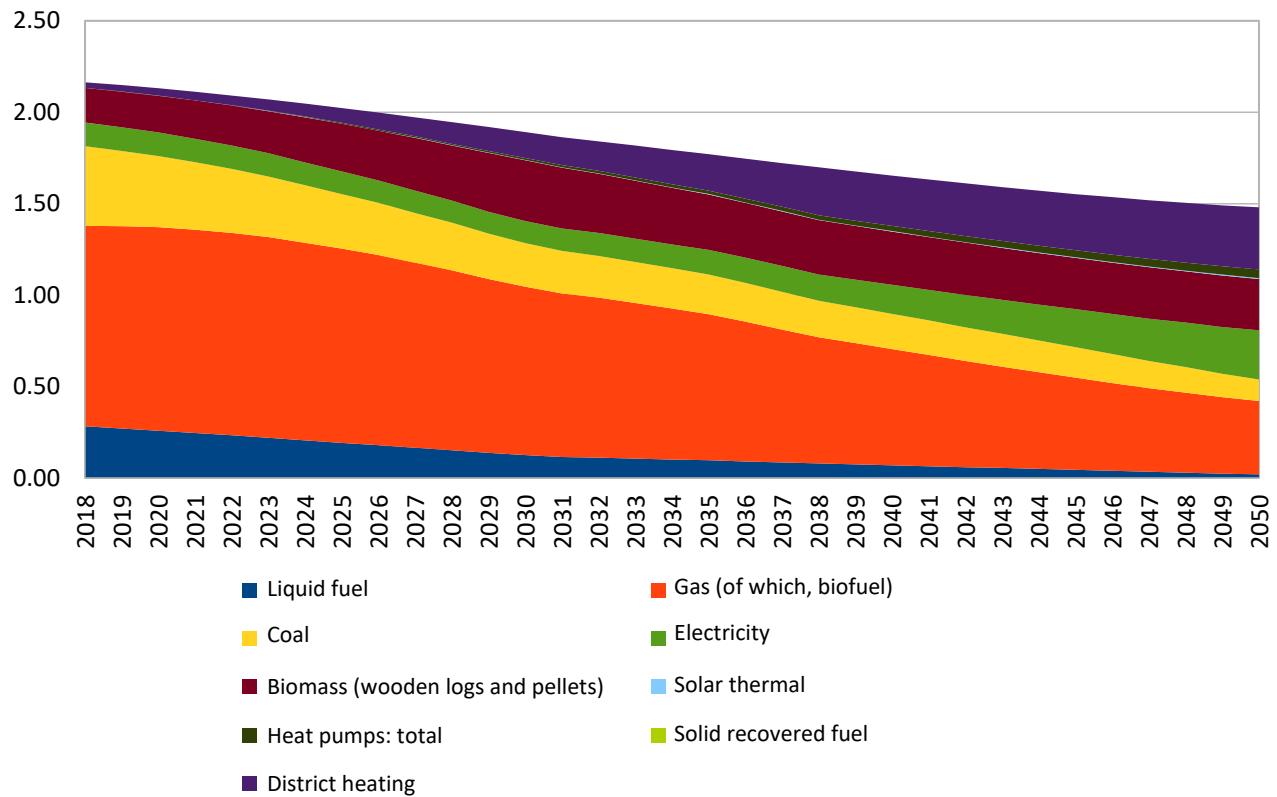


Image 10: Alternative scenario: Heating mix trend – Industry and agriculture – Heating and thermal processes

Gas burners retain a notable share in the mix given the difficulty in renewable systems reaching an identical thermal performance for industrial processes. District heating and biomass burners offset the decrease in fuel oil and coal vectors.

v. Alternative scenario – district heating mix

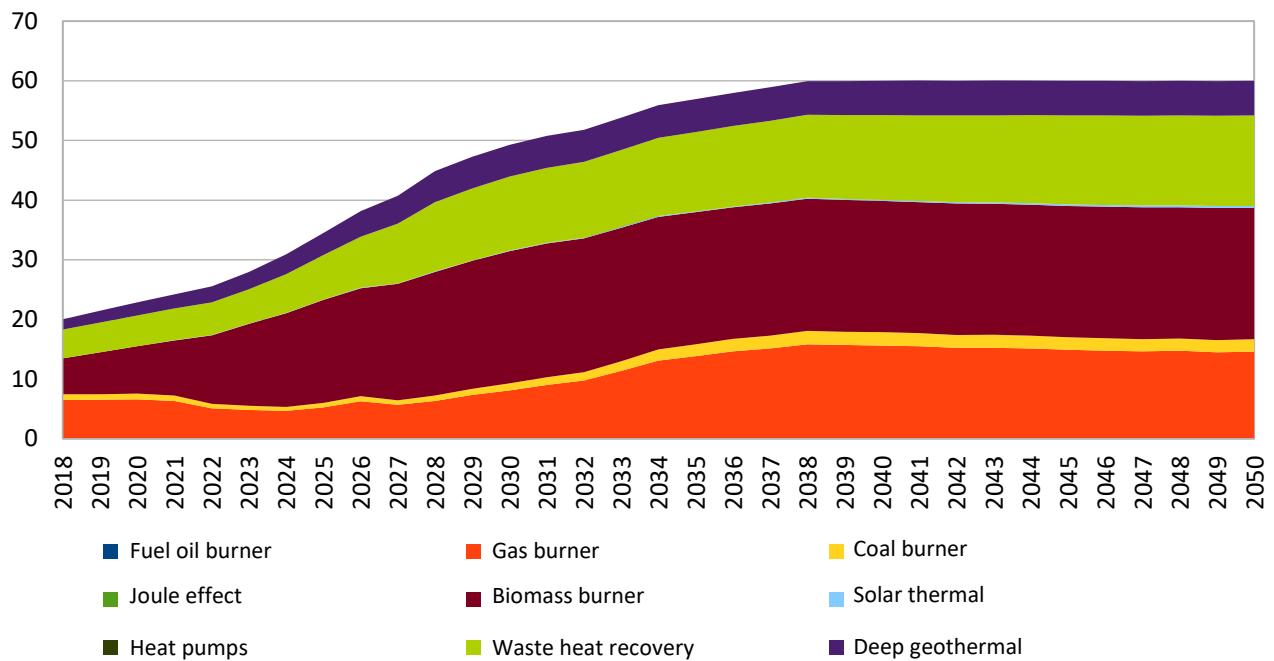


Image 11: Alternative scenario: Heating mix trend –District heating

The district heating mix moves towards a mix of renewable and recovered vectors:

- 37% biomass in 2050
- 1% solar thermal in 2050
- 25% recovered energy
- 10% deep geothermal

In other words, a mix comprising 73% renewable or recovered energy in 2050.

III. Cost-benefit analysis

The scenarios were assessed according to the ‘net present value’ (NPV) criterion. Once the scenarios were drawn up, their respective costs and benefits were quantified and discounted.

In other words, $Costs_{Alternative,i}$ costs attributed to the alternative scenario for year i, $Costs_{Baseline,i}$ costs attributed to the baseline scenario for year i, $Benefit_{Alternative,i}$ benefits attributed to the alternative scenario for year i and $Benefit_{Baseline,i}$ benefits attributed to the baseline scenario for year i:

where r is the discount factor which can vary depending on the sector or system.

The cost-benefit analysis was carried out from two perspectives:

- a financial analysis, carried out from the point of view of a private investor. For this exercise, the investors concerned were heating consumers.
- an economic analysis, carried out from the point of view of society and required to reflect the social welfare impact. The term ‘welfare’ in this context encompasses the prosperity of society and the welfare of members of society.

The economic analysis is based on the financial analysis, with the addition of a number of parameters intended to reflect the impacts of the choices made. These impacts can be costs or benefits and are referred to as ‘externalities’. Carrying out the cost-benefit analysis from these two perspectives is useful for identifying areas for improvement.

1. Financial analysis

The financial analysis was carried out following the specific characteristics below:

- Only cash inflows and outflows were considered.
- The analysis was carried out using constant values.
- The analysis must be carried out net of VAT if recoverable by the investor.
- The analysis must be carried out inclusive of tax on the price of inputs, (e.g. electricity, fuel, etc.).

The following costs are to be taken into account:

- Capital cost.
- Operation and maintenance costs.
- Input costs.

The following benefits are to be taken into account:

- Public support.
- Residual value of equipment at the end of the analysis.

The analysis should ideally apply different discount factors in line with the sector and technology. These discount factors are intended to reflect inflation and the capital cost (risk).

Sector	Discount rate
Individual residential	1.00% (corresponding to the rate applied to the Livret A (Savings Account A) (*))
Collective residential	4.50% (rate applied to public investment)
Tertiary and agriculture	6.00%
Industry	10.00%

Table 9: Chosen discount rate by sector – Financial analysis

* : 2019 base as at date of study.

i. Techno-economic data

The costs necessary for acquiring efficient and conventional systems were taken into account by calculating an annual rate of renewal across all such systems. The renewal rate is calculated by taking into account the projected lifespan of the systems. The power needed for all systems to provide the final energy required is calculated using the chosen load factors.

The following techno-economic data is time- and sector-dependent.

Data	Unit	Variable over time
Yield	No unit	Yes
Capital cost (CAPEX)	€/MW	Yes
Operation and maintenance cost (OPEX)	€/MW	Yes
Load	Hours/year	No
Lifespan	Years	No

Table 10: Inventory of techno-economic data

The complete statistics can be found in Annex 5.

ii. Benefits

- The residual value of equipment was calculated on the basis of a linear decrease in value, this being zero at the end of the equipment's lifespan.
- The analysis takes into account the Heat Fund, French state aid to renewable heating installations in the collective residential, tertiary and industrial sectors, or to district heating where efficient systems have been opted for (biomass, solar thermal, ground source heat pumps or deep geothermal, recovered energy, exceeding 50%). The systems are subsidised at a rate of approximately 30% of the capital cost. Continuation of this support is assumed for the full period analysed under the study

iii. Input costs

Input costs were projected for the period 2018-2050 with the help of forecasts presented in the EU document ‘Trends for energy costs’. Variations resulting from those forecasts were applied to price levels as recorded in France in 2018. Some inputs followed a growth trend based on assumptions regularly applied for identical exercises performed by the DGEC (Directorate-General for Energy and Climate) under the National Low Carbon Strategy.

The cost data used for the financial analysis is presented in the annex to this report.

2. Economic analysis

The economic analysis was carried out from the point of view of society and was required to take externalities into account. These externalities formed two categories.

The first category brings together **environmental externalities**:

- Impact on climate change
- Impact on the depletion of natural resources
- Impact on the occupation of agricultural land
- Particulate matter formation
- Health impact (toxicity level)

In order to be taken into account, these impacts need to be quantifiable (EUR/unit). Quantification work is assisted by a life-cycle analysis of the systems. There are international databases which track emissions from certain systems during their life cycle. Such quantification exercises present a number of problems. Results may sometimes differ depending on calculation methods and where major uncertainties exist. Data may also vary from one system to another. Moreover, it is difficult to obtain generic data for a single technology. Such costs may also change over the course of the analysis. Nevertheless, the report *Subsidies and costs of EU energy* by Alberici, S., Boeve, S., Van Breevoort, P., Deng, Y., Förster, S., Gardiner, A., Van Gastel, V., [...] Wouters, K.. (Ecofys, 2014) (study commissioned by the JRC) allowed us to obtain specific values which we used in the study.

Technology	Environmental impact: €/MWh
Fuel oil burner	32
Gas burner	32
Coal burner	45
Joule effect	41.7
Biomass burner	13.2
Solar thermal	9.6
Heat pumps	12.5
Industrial waste heat recovery	11.2
Deep geothermal	12.5

Table 11: Value of environmental externalities used

The second category brings together **macroeconomic externalities**:

- Impact on energy dependence
- Impact on gross domestic product
- Impact on the reliability of the energy network
- Impact on GDP

To date, these externalities have not, however, been integrated due to a lack of data and understanding.

In contrast with the calculation carried out for the financial analysis, the economic analysis uses a single discount rate, namely the social discount rate. The rate must be that used by the owners of public investment projects. It was set by the Quinet Commission (2013) and, for the purposes of our study, is 4.5%.

Sector	Discount rate
Individual residential	4.50%
Collective residential	4.50%
Tertiary	4.50%
Industrial	4.50%
Agricultural	4.50%
Heat production (networks)	4.50%

Table 12: Chosen discount rate by sector – Economic analysis

The objective of the 2013 Quinet Commission was to lay down a framework for socio-economic assessments. As part of its work, the Commission set ‘unit values’. One of those unit values is the shadow price of carbon. France Stratégies is currently reviewing this value.

Carbon value:

There are a range of methods for quantifying the impact of releasing a tonne of CO₂ into the atmosphere.

- The first is to quantify and attribute a value to each individual impact. Under this approach, it is possible to establish a social value of CO₂, namely a cost of EUR 43.33 (2012) per tonne of CO₂ released. This is the value which was incorporated into the impacts listed in Table 9.
- The second approach – the approach of the Quinet Commission – incorporates national commitments to reducing greenhouse gas emissions. It involves determining the cost which an emitted tonne of CO₂ would have in terms of achieving the 2050 carbon neutrality objectives. This value is the shadow price of carbon. According to the most recent reviews of this value, the price stands at EUR 250 in 2030, EUR 500 in 2040 and EUR 776 in 2050.

The difference in value is due to the variation in perspective and methodology when calculating the impact. These differences cause the results and conclusions of the analyses to vary considerably. Bearing in mind that the shadow value of carbon must be used in economic analyses (recommendation from France Stratégies), we decided to carry out two analyses:

- the first taking into account the cost of technology-related externalities as defined in the report *Subsidies and costs of EU energy*, and therefore the carbon cost of EUR 43.33 (2012)/tCO₂ emitted;
- the second excluding externalities other than carbon emissions caused by heat generation and following the values laid down by the Quinet Commission (under review).

In order to quantify process carbon emissions, we used the ADEME database which provides precise information on carbon emissions resulting from combustion of the resources covered in this analysis.

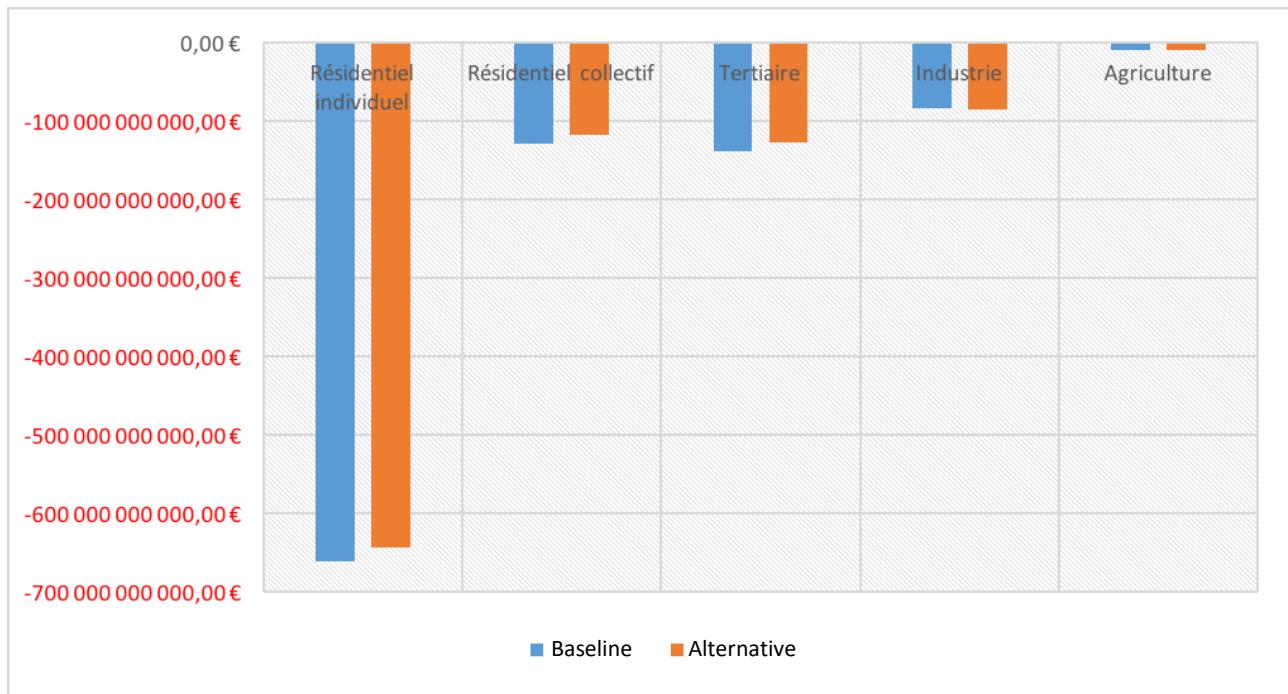
<i>Energy type</i>	<i>tCO₂ emitted/MWh</i>
Fuel oil	0.32
Gas	0.24
Coal	0.38
Electricity	0.06
Log biomass	0.03
Pellet biomass	0.03
Solid recovered fuel (4165 kWh/tonne) equating to cardboard	0.01
Waste-to-energy power plants (1500 kWh/tonne)	0.24

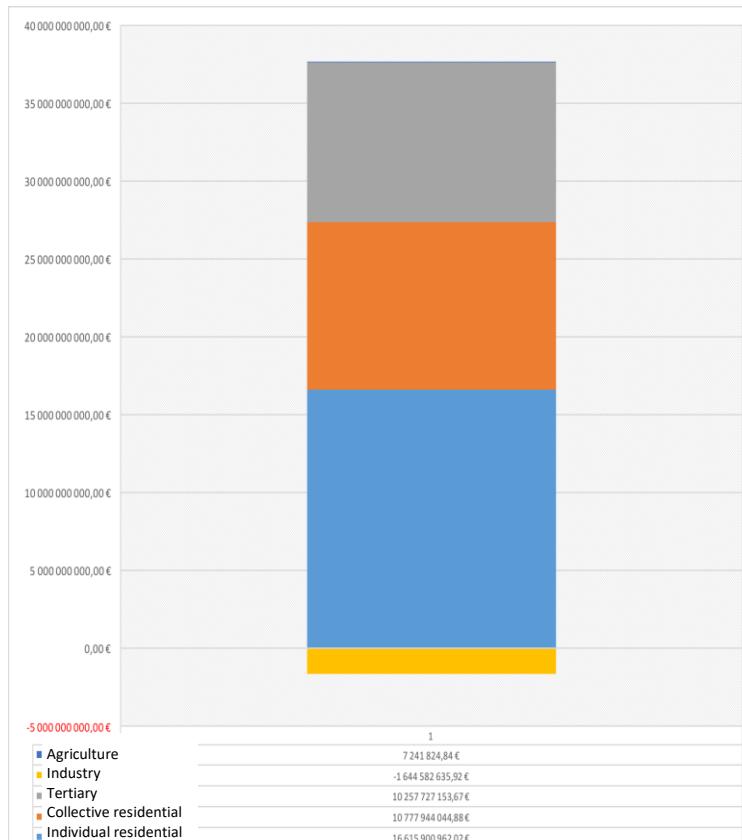
Table 13: Tonnes of CO₂ emissions per MWh of energy consumed – ADEME

IV. Outcomes

1. Financial analysis

The following chart presents the benefits minus costs (zero benefits in this case) for each sector and scenario. A major advantage can be seen in the alternative scenario. The high cost for the individual residential sector is due to the low discount rate applied to this sector (1%).

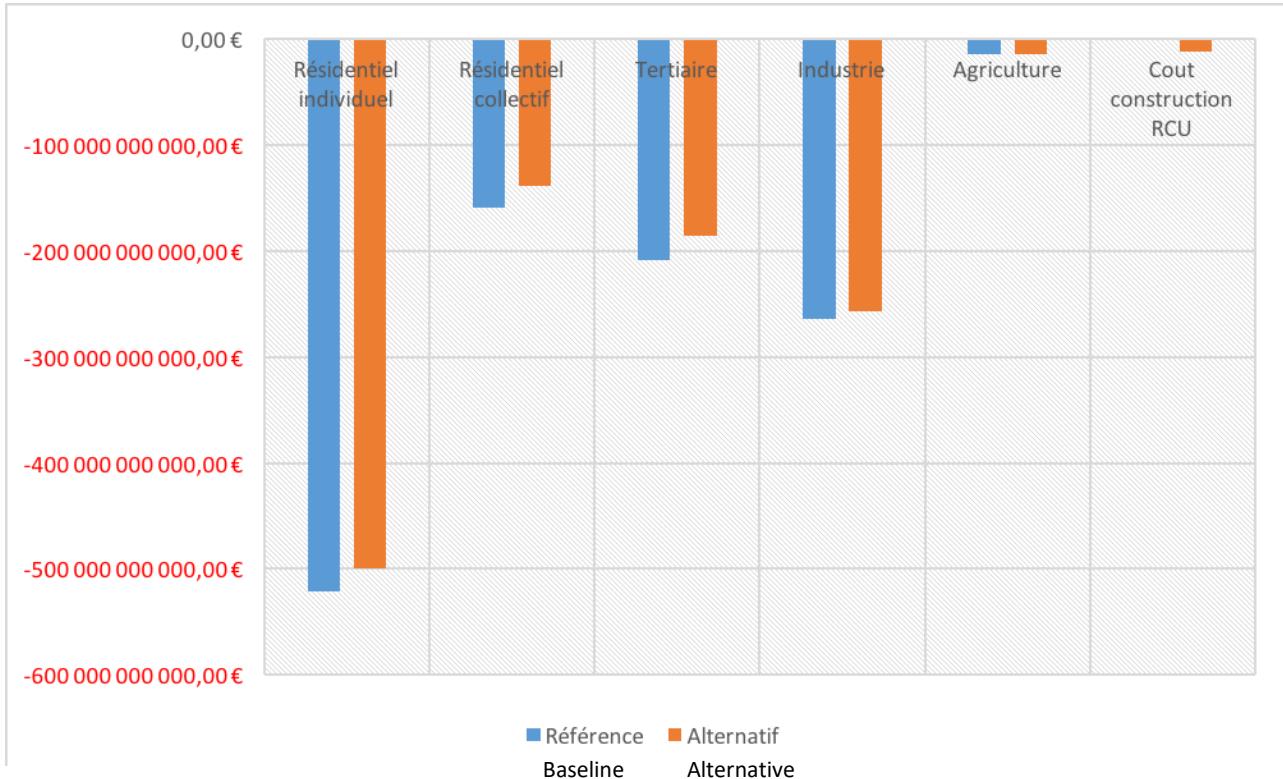




NPV = EUR 36 billion

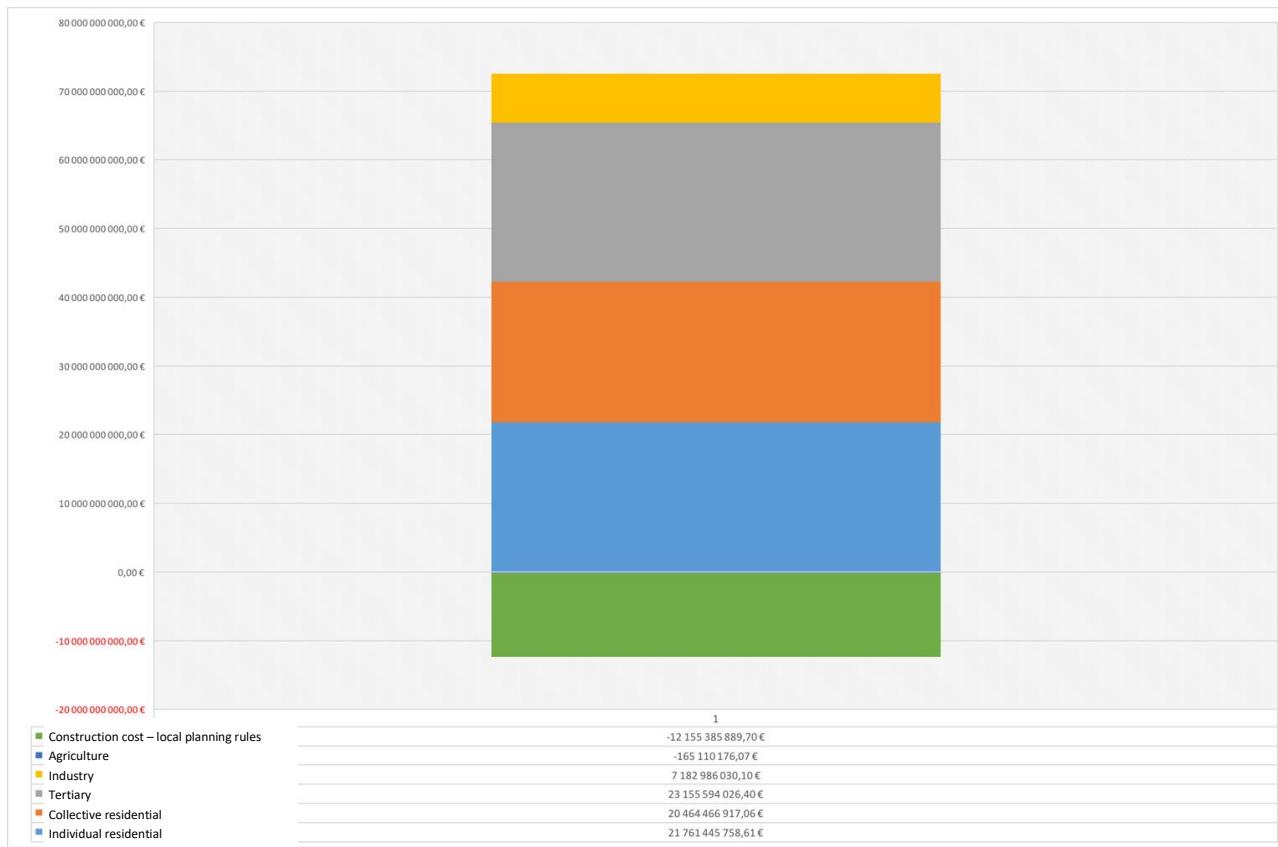
2. Economic analysis (externalities based on JRC data)

For this analysis we have incorporated externalities concerning energy consumption (EUR/MWh).



The environmental impact of industry can be clearly seen. Costs in relation to this sector are more than twice as high in comparison to the financial analysis. The discount rate (of 4.5%) also inflates the results when compared to the financial analysis. The difference is further increased between the baseline and alternative scenarios.

Unsurprisingly, once externalities are taken into account, solutions with a ‘high burden’ on the environment – which are more obvious in the baseline scenario – worsen the costs for industry and tip the balance in favour of the alternative scenario.



NPV = EUR 72.4 billion

3. Economic analysis (shadow price of carbon)

Finally, in order to explore externalities from all possible angles, the figure below presents the results of the economic analysis taking only carbon-related (CO_2) externalities into account. The value attributed per tonne of carbon is the shadow price of carbon, which is currently undergoing review. Carbon costs are presented separately.

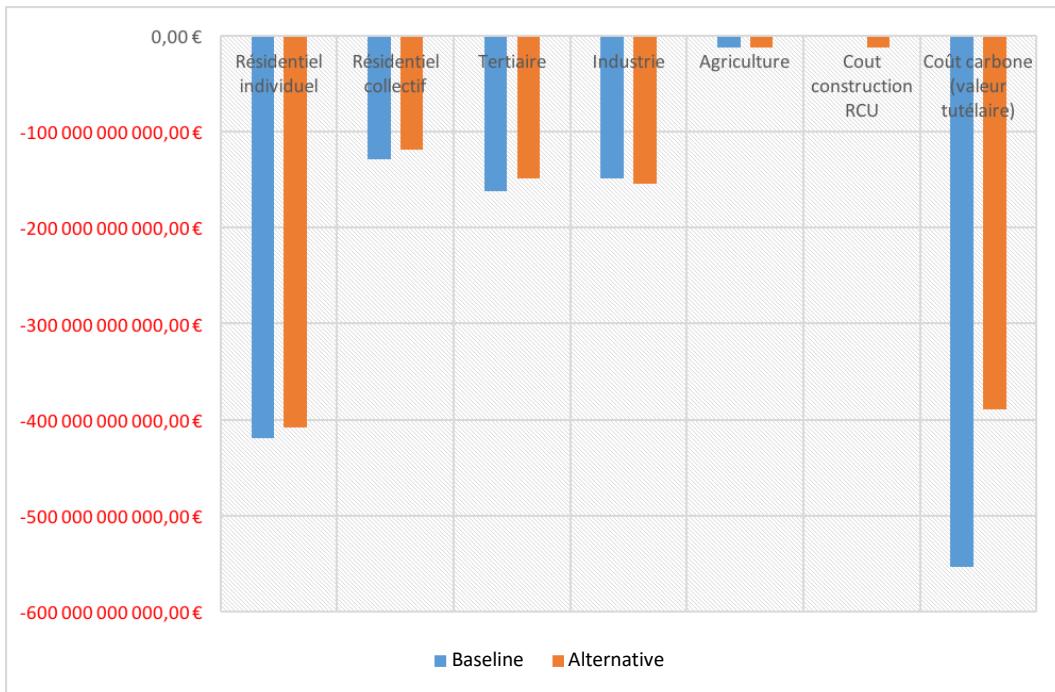


Image 15: Cost comparison by sector – Economic analysis with shadow price of carbon

The strong impact of the value per tonne of carbon can be seen in the economic analysis. To reiterate, only the environmental impact of emitting CO_2 into the atmosphere is evaluated.

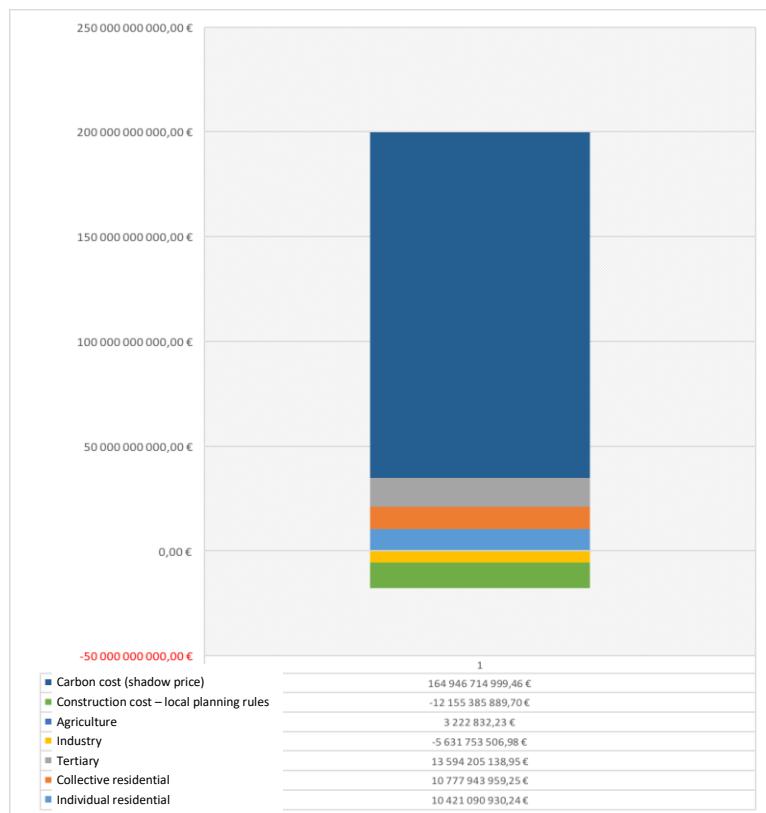


Image 16: Detailed NPV – with shadow price of carbon

NPV = EUR 182 billion

V. Sensitivity analysis

A sensitivity analysis will only be carried out on the financial analysis as the approach of both perspectives used for the economic analysis amounts in itself to a single perspective. As the economic analysis is derived from the financial analysis, the sensitivity of the model would only be changed slightly as a result.

The initial NPV is EUR 36 billion

Factor	-10.00%	-5.00%	5.00%	10.00%
Discount rate	€ 38 billion	€ 37 billion	€ 35 billion	€ 34 billion
Capital cost of efficient solutions	€ 58 billion	€ 51 billion	€ 2.7 billion	-€ 78 billion
Capital cost of conventional solutions	€ 40 billion	€ 39 billion	€ 30 billion	€ 18 billion
Maintenance cost	€ 58 billion	€ 51 billion	-€ 2.7 billion	-€ 112 billion
Fuel oil price variation during the period	€ 26 billion	€ 31 billion	€ 41 billion	€ 46 billion
Gas price variation during the period	€ 41 billion	€ 35 billion	€ 23 billion	€ 17 billion
Electricity price variation during the period	€ 41 billion	€ 39 billion	€ 33 billion	€ 31 billion
Biomass price variation during the period	€ 38 billion	€ 37 billion	€ 35 billion	€ 34 billion
Price variation in heating sold by networks during the period	€ 38 billion	€ 37 billion	€ 35 billion	€ 34 billion

Table 14: Sensitivity analysis – Values

The results are as follows when expressed as a percentage of the middle value:

Factor	-10.00%	-5.00%	5.00%	10.00%
Discount rate	105.6%	102.7%	97.4%	94.9%
Capital cost of efficient solutions	161.1%	141.3%	7.5%	-216.2%
Capital cost of conventional solutions	111.9%	107.7%	84.3%	49.2%
Maintenance cost	161.5%	142.2%	-7.5%	-310.1%

Fuel oil price variation during the period	71.3%	85.8%	113.8%	128.3%
Gas price variation during the period	114.8%	97.1%	62.8%	46.1%
Electricity price variation during the period	115.0%	107.5%	92.6%	85.3%
Biomass price variation during the period	105.6%	102.8%	97.3%	94.7%
Price variation in heating sold by networks during the period	104.4%	102.2%	97.9%	95.8%

Table 15: Sensitivity analysis – Variations

The sensitivity analysis shows the following:

- The NPV is very sensitive to variations in capital costs
- The NPV is extremely sensitive to variations in maintenance costs
- The NPV is sensitive to variations in fuel oil, gas and electricity prices.

In terms of input costs and the relatively low sensitivity of the NPV, variations were applied for the entire period (2018-2050). If biomass or another vector were to increase by $2*x\%$ per year instead of the predicted $x\%$, it is highly likely that the NPV would be very sensitive to this.

Limitations and criticisms

The results presented above should be regarded as trends.

The number of assumptions made and the level of modelling used creates considerable uncertainty, hence the need for a sensitivity analysis.

However, certain assumptions are more robust than others. Below is a brief overview of those assumptions.

- Systems are considered to be generic, i.e. a gas burner is considered to have a specific level of efficiency, which is not the case in reality. Across all gas burners, there are efficient burners (condensation boilers) and older systems. Differences in OPEX and CAPEX are also removed by this assumption of a single system.
- The load considered (operating hours) should also be looked at critically. The underlying assumption is that systems only operate at their rated capacity, which is obviously not the case in reality.
- The rate of renewal across all systems is assumed to be constant. However, due to certain measures or economic assumptions, this is unlikely.
- Depending on the perspective of the analysis, inputs sometimes have to be considered minus taxes or other fiscal measures. Due to the difficulty in separating costs, we were required to

use values which were inclusive of tax for CAPEX, OPEX and energy costs (other than for industry where energy costs excluded tax).

VI. Conclusion

The focus of this analysis was on examining ten systems which are considered efficient in France. These systems were integrated to differing degrees into two scenarios reflecting two different trajectories. The two scenarios depict a supply response to the projected heating demand in mainland France for the period 2018-2050. The maximum potential for deploying efficient systems was projected and served as a basis for drawing up the ‘alternative’ scenario. Under this scenario, efficient solutions are exploited to their maximum potential, with conventional solutions being used to bridge the remaining gap between demand and supply.

The results of the analysis show that for both uses covered by the study, the alternative scenario has a better economic and financial performance. The trajectories for deploying efficient solutions are those used in the Multiannual Energy Programme.

There are two factors which explain the cost-effectiveness of the alternative scenario. Firstly, efficient solutions, although often more capital intensive, have the advantage of being characterised by a better performance. The overall efficiency of the scenario is considerably improved and input costs become much lower. Secondly, externalities have a noticeable impact on the results in sectors which are high emitters of greenhouse gases or particles. This demonstrates the importance of internalising environmental impacts (carbon tax, emissions trading scheme).

The variation in maintenance costs has a considerable impact on the final result. Systems are efficient and remain this way if regularly maintained. Furthermore, the cost of maintaining efficient solutions is higher than for conventional solutions as the technology is often sophisticated. It is therefore important to ensure that maintenance costs remain stable so that efficient systems continue to be cost-effective in the long term.

VII. References

- Guillerminet, M-L., Marchal, D., Gerson, R., Berrou, Y. (2016), *Coûts des énergies renouvelables en France*, ADEME.
- Alberici, S., Boeve, S., Van Breevoort, P., Deng, Y., Förster, S., Gardiner, A., Van Gastel, V., ... Wouters, K, (2014), *Subsidies and costs of EU energy*, Ecofys.
- Boucher, M., Streiff, F., (2017). *La chaleur fatale*, ADEME.
- Jakubcjonis, M., Santamaria, M., Kavvadias, K., Piers de Raveschoot, R., Moles, C., Carlsson, J., *Best practices and informal guidance on how to implement the Comprehensive Assessment at Member State level*; EUR 27605 EN, doi: 10.2790/79453.
- European Commission, (2016). *EU Reference Scenario: Energy, transport and GHG emissions trends to 2050*.
- SNCU, (2017), *Enquête nationale sur les réseaux de chaleur et de froid*.
- MTES (Ministry of Ecological and Inclusive Transition), SDES (Data and Statistical Studies Department), (2017), *Prix des énergies en France*.
- INSEE (National Institute of Statistics and Economic Research), (2017), *Les consommations d'énergie dans l'industrie*.
- MTES (Ministry of Ecological and Inclusive Transition), (2018), *Stratégie nationale de mobilisation de la biomasse*.
- ADEME, (2018), *Base carbone*.
- ADEME, ENR&R study
- BRGM data
- ADEME data
- AFPAC data on the Multiannual Energy Programme
- DLCES data
- EM3LAB data
- SRCAE data
- SDES (Data and Statistical Studies Department)
- INSEE (National Institute of Statistics and Economic Research)
- DGEC (Directorate-General for Energy and Climate) internal data
- MTES (Ministry of Ecological and Inclusive Transition) internal data
- Data from the Multiannual Energy Programme/National Low Carbon Strategy/National Biomass Action Strategy

VIII. Index of images

- Image 1: Maximum potential of efficient solutions examined
- Image 2: Demand projection – Heating and thermal processes
- Image 3: Demand projection – Domestic hot water
- Image 4: Trend in the maximum potential of the efficient solutions examined
- Image 5: Potential for developing district heating by sector
- Image 6: Alternative scenario: Trend in thermal mix – Collective residential – Heating and thermal processes
- Image 7: Alternative scenario: Trend in thermal mix – Collective residential – Domestic hot water
- Image 8: Alternative scenario: Trend in thermal mix – Tertiary – Heating and thermal processes
- Image 9: Alternative scenario: Trend in thermal mix – Tertiary – Domestic hot water
- Image 10: Alternative scenario: Trend in thermal mix – Industry – Heating and thermal processes
- Image 11: Alternative scenario: Trend in thermal mix – District heating

IX. Index of tables

- Table 1: Inventory of efficient solutions examined
- Table 2: Summary of the results
- Table 3: Macroeconomic framework – Demographic trend under the system examined
- Table 4: Macroeconomic framework – GDP growth
- Table 5: Projected demand – Heating and thermal processes
- Table 6: Projected demand – Domestic hot water
- Table 7: Vector mix – Baseline scenario – Heating and thermal processes
- Table 8: Vector mix – Baseline scenario – Domestic hot water
- Table 9: Chosen discount rate by sector – Financial analysis
- Table 10: Inventory of techno-economic data
- Table 11: Environmental impact value
- Table 12: Chosen discount rate by sector – Economic analysis
- Table 13: Financial analysis: Results by sector – Heating and thermal processes
- Table 14: Financial analysis: Results by scenario – Heating and thermal processes
- Table 15: Financial analysis: Results by sector – Domestic hot water
- Table 16: Financial analysis: Results by scenario – Domestic hot water
- Table 17: Economic analysis: Results by sector – Heating and thermal processes
- Table 18: Economic analysis: Results by scenario – Heating and thermal processes
- Table 19: Economic analysis: Results by sector – Domestic hot water
- Table 20: Economic analysis: Results by scenario – Domestic hot water

VIII. Annex

1. Demand projection - data

i. Heating and thermal processes

In TWh final energy

Year	<i>Individual residential</i>	<i>Collective residential</i>	<i>Tertiary</i>	<i>Industry</i>	Total
2018	251.08	82.72	122.73	216.34	672.87
2019	249.26	81.75	118.66	214.78	664.45
2020	247.14	80.79	114.59	213.05	655.57
2021	244.52	79.9	111.15	211.16	646.72
2022	241.46	79.13	107.78	209.11	637.48
2023	237.92	78.52	104.5	206.92	627.87
2024	233.94	78.05	101.3	204.61	617.9
2025	229.59	77.61	98.17	202.19	607.56
2026	225	77.06	95.23	199.68	596.96
2027	220.33	76.26	92.32	197.09	585.99
2028	215.75	75.17	89.44	194.43	574.79
2029	211.43	73.83	86.57	191.72	563.56
2030	207.48	72.3	83.74	188.98	552.5
2031	201.83	70.36	80.72	186.25	539.16
2032	196.65	68.46	77.78	183.91	526.8
2033	191.87	66.63	74.93	181.55	514.98
2034	187.44	64.88	72.21	179.17	503.7
2035	183.3	63.23	69.62	176.77	492.93
2036	179.37	61.69	67.19	174.38	482.64
2037	175.59	60.27	64.92	172.01	472.79
2038	171.91	58.96	62.81	169.66	463.34
2039	168.27	57.78	60.87	167.35	454.26
2040	164.64	56.71	59.09	165.08	445.52
2041	160.98	55.75	57.46	162.87	437.07
2042	157.27	54.89	55.98	160.74	428.88
2043	153.49	54.13	54.63	158.68	420.93
2044	149.61	53.46	53.41	156.72	413.2
2045	145.62	52.87	52.3	154.86	405.65
2046	141.52	52.35	51.3	153.11	398.28
2047	137.29	51.9	50.39	151.49	391.06
2048	132.92	51.49	49.56	150	383.98
2049	128.4	51.14	48.81	148.67	377.02
2050	123.74	50.83	48.19	147.49	370.25

ii. Domestic hot water

In TWh final energy

Year	<i>Individual residential</i>	<i>Collective residential</i>	<i>Tertiary</i>	Total
2018	29.28	15.16	23.72	68.16
2019	28.67	14.96	23.51	67.14
2020	28.02	14.75	23.23	66.01
2021	27.31	14.55	22.87	64.73
2022	26.53	14.34	22.6	63.47
2023	25.68	14.12	22.42	62.22
2024	24.76	13.87	22.31	60.94
2025	23.79	13.56	22.25	59.59
2026	23.08	13.23	22.21	58.51
2027	22.43	12.85	22.17	57.45
2028	21.81	12.44	22.11	56.36
2029	21.23	12.03	22.01	55.28
2030	20.72	11.65	21.89	54.26
2031	20.7	11.66	21.48	53.85
2032	20.64	11.63	21.17	53.45
2033	20.59	11.6	20.86	53.04
2034	20.53	11.56	20.53	52.63
2035	20.47	11.53	20.21	52.21
2036	20.41	11.5	19.87	51.79
2037	20.36	11.47	19.54	51.36
2038	20.3	11.43	19.2	50.94
2039	20.24	11.4	18.86	50.51
2040	20.18	11.37	18.53	50.08
2041	20.13	11.34	18.19	49.66
2042	20.07	11.31	17.86	49.24
2043	20.01	11.27	17.54	48.82
2044	19.96	11.24	17.22	48.41
2045	19.9	11.21	16.9	48.01
2046	19.84	11.18	16.59	47.6
2047	19.78	11.14	16.28	47.21
2048	19.73	11.11	15.97	46.81
2049	19.67	11.08	15.67	46.42
2050	19.61	11.05	15.38	46.03

2. Baseline scenario – data

i. Individual residential

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	54.02	59.54	0.17	35.21	85.57	0	16.58	0
2019	53.63	59.1	0.17	34.95	84.95	0	16.45	0
2020	53.18	58.6	0.17	34.65	84.23	0	16.31	0
2021	52.61	57.98	0.16	34.29	83.34	0	16.14	0
2022	51.95	57.25	0.16	33.86	82.29	0	15.94	0
2023	51.19	56.42	0.16	33.36	81.09	0	15.71	0
2024	50.34	55.47	0.16	32.8	79.73	0	15.44	0
2025	49.4	54.44	0.15	32.19	78.25	0	15.16	0
2026	48.41	53.35	0.15	31.55	76.68	0	14.85	0
2027	47.41	52.24	0.15	30.89	75.09	0	14.54	0
2028	46.42	51.16	0.15	30.25	73.53	0	14.24	0
2029	45.49	50.13	0.14	29.65	72.06	0	13.96	0
2030	44.64	49.2	0.14	29.09	70.71	0	13.7	0
2031	43.43	47.86	0.14	28.3	68.79	0	13.32	0
2032	42.31	46.63	0.13	27.57	67.02	0	12.98	0
2033	41.28	45.5	0.13	26.9	65.39	0	12.67	0
2034	40.33	44.45	0.13	26.28	63.88	0	12.37	0
2035	39.44	43.46	0.12	25.7	62.47	0	12.1	0
2036	38.59	42.53	0.12	25.15	61.13	0	11.84	0
2037	37.78	41.64	0.12	24.62	59.84	0	11.59	0
2038	36.99	40.76	0.12	24.1	58.59	0	11.35	0
2039	36.21	39.9	0.11	23.59	57.35	0	11.11	0
2040	35.42	39.04	0.11	23.09	56.11	0	10.87	0
2041	34.64	38.17	0.11	22.57	54.86	0	10.63	0
2042	33.84	37.29	0.11	22.05	53.6	0	10.38	0
2043	33.02	36.39	0.1	21.52	52.31	0	10.13	0
2044	32.19	35.47	0.1	20.98	50.99	0	9.88	0
2045	31.33	34.53	0.1	20.42	49.63	0	9.61	0
2046	30.45	33.56	0.1	19.84	48.23	0	9.34	0
2047	29.54	32.55	0.09	19.25	46.79	0	9.06	0
2048	28.6	31.52	0.09	18.64	45.3	0	8.77	0
2049	27.63	30.45	0.09	18	43.76	0	8.48	0
2050	26.62	29.34	0.08	17.35	42.17	0	8.17	0

Domestic hot water: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	2.11	7.61	0.00	17.14	0.46	0.81	1.15	0.00
2019	2.07	7.46	0.00	16.78	0.45	0.80	1.13	0.00
2020	2.02	7.29	0.00	16.40	0.44	0.78	1.10	0.00
2021	1.97	7.10	0.00	15.98	0.43	0.76	1.07	0.00
2022	1.91	6.90	0.00	15.53	0.42	0.74	1.04	0.00
2023	1.85	6.68	0.00	15.03	0.40	0.71	1.01	0.00
2024	1.79	6.44	0.00	14.49	0.39	0.69	0.97	0.00
2025	1.72	6.19	0.00	13.92	0.37	0.66	0.93	0.00
2026	1.66	6.00	0.00	13.51	0.36	0.64	0.91	0.00
2027	1.62	5.83	0.00	13.13	0.35	0.62	0.88	0.00
2028	1.57	5.67	0.00	12.76	0.34	0.61	0.86	0.00
2029	1.53	5.52	0.00	12.42	0.33	0.59	0.83	0.00
2030	1.49	5.39	0.00	12.13	0.32	0.58	0.81	0.00
2031	1.49	5.38	0.00	12.11	0.32	0.57	0.81	0.00
2032	1.49	5.37	0.00	12.08	0.32	0.57	0.81	0.00
2033	1.48	5.35	0.00	12.05	0.32	0.57	0.81	0.00
2034	1.48	5.34	0.00	12.01	0.32	0.57	0.81	0.00
2035	1.48	5.32	0.00	11.98	0.32	0.57	0.80	0.00
2036	1.47	5.31	0.00	11.95	0.32	0.57	0.80	0.00
2037	1.47	5.29	0.00	11.91	0.32	0.56	0.80	0.00
2038	1.46	5.28	0.00	11.88	0.32	0.56	0.80	0.00
2039	1.46	5.26	0.00	11.85	0.32	0.56	0.79	0.00
2040	1.46	5.25	0.00	11.81	0.32	0.56	0.79	0.00
2041	1.45	5.23	0.00	11.78	0.32	0.56	0.79	0.00
2042	1.45	5.22	0.00	11.75	0.31	0.56	0.79	0.00
2043	1.44	5.20	0.00	11.71	0.31	0.56	0.79	0.00
2044	1.44	5.19	0.00	11.68	0.31	0.55	0.78	0.00
2045	1.43	5.17	0.00	11.64	0.31	0.55	0.78	0.00
2046	1.43	5.16	0.00	11.61	0.31	0.55	0.78	0.00
2047	1.43	5.14	0.00	11.58	0.31	0.55	0.78	0.00
2048	1.42	5.13	0.00	11.54	0.31	0.55	0.77	0.00
2049	1.42	5.11	0.00	11.51	0.31	0.55	0.77	0.00
2050	1.41	5.10	0.00	11.48	0.31	0.54	0.77	0.00

ii. Collective residential

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	6.26	36.55	0	7.68	12	0	2.23	18
2019	6.18	36.12	0	7.59	11.86	0	2.2	17.79
2020	6.11	35.7	0	7.5	11.72	0	2.18	17.58
2021	6.04	35.3	0	7.42	11.59	0	2.15	17.39
2022	5.99	34.96	0	7.35	11.48	0	2.13	17.22
2023	5.94	34.7	0	7.29	11.4	0	2.12	17.09
2024	5.9	34.49	0	7.25	11.33	0	2.1	16.99
2025	5.87	34.29	0	7.2	11.26	0	2.09	16.89
2026	5.83	34.05	0	7.15	11.18	0	2.08	16.77
2027	5.77	33.69	0	7.08	11.07	0	2.06	16.59
2028	5.69	33.22	0	6.98	10.91	0	2.03	16.36
2029	5.58	32.62	0	6.85	10.71	0	1.99	16.07
2030	5.47	31.95	0	6.71	10.49	0	1.95	15.73
2031	5.32	31.09	0	6.53	10.21	0	1.9	15.31
2032	5.18	30.25	0	6.36	9.94	0	1.85	14.9
2033	5.04	29.44	0	6.19	9.67	0	1.8	14.5
2034	4.91	28.67	0	6.02	9.42	0	1.75	14.12
2035	4.78	27.94	0	5.87	9.18	0	1.7	13.76
2036	4.67	27.26	0	5.73	8.95	0	1.66	13.42
2037	4.56	26.63	0	5.59	8.75	0	1.62	13.11
2038	4.46	26.05	0	5.47	8.56	0	1.59	12.83
2039	4.37	25.53	0	5.36	8.38	0	1.56	12.57
2040	4.29	25.06	0	5.26	8.23	0	1.53	12.34
2041	4.22	24.63	0	5.17	8.09	0	1.5	12.13
2042	4.15	24.25	0	5.1	7.97	0	1.48	11.95
2043	4.09	23.92	0	5.03	7.86	0	1.46	11.78
2044	4.04	23.62	0	4.96	7.76	0	1.44	11.63
2045	4	23.36	0	4.91	7.67	0	1.43	11.51
2046	3.96	23.13	0	4.86	7.6	0	1.41	11.39
2047	3.93	22.93	0	4.82	7.53	0	1.4	11.29
2048	3.89	22.75	0	4.78	7.47	0	1.39	11.21
2049	3.87	22.6	0	4.75	7.42	0	1.38	11.13
2050	3.84	22.46	0	4.72	7.38	0	1.37	11.06

Domestic hot water: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	0.38	7.35	0.00	6.98	0.00	0.30	0.15	0.00
2019	0.38	7.26	0.00	6.88	0.00	0.29	0.15	0.00
2020	0.37	7.16	0.00	6.79	0.00	0.29	0.15	0.00
2021	0.37	7.06	0.00	6.70	0.00	0.29	0.14	0.00
2022	0.36	6.96	0.00	6.60	0.00	0.28	0.14	0.00
2023	0.36	6.85	0.00	6.50	0.00	0.28	0.14	0.00
2024	0.35	6.73	0.00	6.38	0.00	0.27	0.14	0.00
2025	0.34	6.58	0.00	6.24	0.00	0.27	0.13	0.00
2026	0.33	6.42	0.00	6.09	0.00	0.26	0.13	0.00
2027	0.32	6.23	0.00	5.91	0.00	0.25	0.13	0.00
2028	0.31	6.04	0.00	5.73	0.00	0.24	0.12	0.00
2029	0.30	5.84	0.00	5.54	0.00	0.24	0.12	0.00
2030	0.29	5.65	0.00	5.36	0.00	0.23	0.12	0.00
2031	0.29	5.66	0.00	5.37	0.00	0.23	0.12	0.00
2032	0.29	5.64	0.00	5.35	0.00	0.23	0.12	0.00
2033	0.29	5.63	0.00	5.34	0.00	0.23	0.11	0.00
2034	0.29	5.61	0.00	5.32	0.00	0.23	0.11	0.00
2035	0.29	5.59	0.00	5.31	0.00	0.23	0.11	0.00
2036	0.29	5.58	0.00	5.29	0.00	0.23	0.11	0.00
2037	0.29	5.56	0.00	5.28	0.00	0.22	0.11	0.00
2038	0.29	5.55	0.00	5.26	0.00	0.22	0.11	0.00
2039	0.29	5.53	0.00	5.25	0.00	0.22	0.11	0.00
2040	0.29	5.52	0.00	5.23	0.00	0.22	0.11	0.00
2041	0.29	5.50	0.00	5.22	0.00	0.22	0.11	0.00
2042	0.29	5.48	0.00	5.20	0.00	0.22	0.11	0.00
2043	0.28	5.47	0.00	5.19	0.00	0.22	0.11	0.00
2044	0.28	5.45	0.00	5.17	0.00	0.22	0.11	0.00
2045	0.28	5.44	0.00	5.16	0.00	0.22	0.11	0.00
2046	0.28	5.42	0.00	5.14	0.00	0.22	0.11	0.00
2047	0.28	5.41	0.00	5.13	0.00	0.22	0.11	0.00
2048	0.28	5.39	0.00	5.11	0.00	0.22	0.11	0.00
2049	0.28	5.37	0.00	5.10	0.00	0.22	0.11	0.00
2050	0.28	5.36	0.00	5.08	0.00	0.22	0.11	0.00

iii. Tertiary

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	23.74	61.82	0	17.15	5.94	0	5.07	9
2019	22.95	59.78	0	16.58	5.75	0	4.91	8.7
2020	22.16	57.72	0	16.01	5.55	0	4.74	8.4
2021	21.5	55.99	0	15.53	5.38	0	4.6	8.15
2022	20.85	54.3	0	15.06	5.22	0	4.46	7.9
2023	20.21	52.64	0	14.6	5.06	0	4.32	7.66
2024	19.59	51.03	0	14.16	4.9	0	4.19	7.43
2025	18.99	49.45	0	13.72	4.75	0	4.06	7.2
2026	18.42	47.97	0	13.31	4.61	0	3.94	6.98
2027	17.86	46.51	0	12.9	4.47	0	3.82	6.77
2028	17.3	45.05	0	12.5	4.33	0	3.7	6.56
2029	16.74	43.61	0	12.1	4.19	0	3.58	6.35
2030	16.2	42.18	0	11.7	4.05	0	3.46	6.14
2031	15.61	40.66	0	11.28	3.91	0	3.34	5.92
2032	15.04	39.18	0	10.87	3.77	0	3.22	5.7
2033	14.49	37.75	0	10.47	3.63	0	3.1	5.49
2034	13.97	36.37	0	10.09	3.5	0	2.99	5.3
2035	13.47	35.07	0	9.73	3.37	0	2.88	5.11
2036	13	33.85	0	9.39	3.25	0	2.78	4.93
2037	12.56	32.7	0	9.07	3.14	0	2.68	4.76
2038	12.15	31.64	0	8.78	3.04	0	2.6	4.61
2039	11.77	30.66	0	8.51	2.95	0	2.52	4.46
2040	11.43	29.77	0	8.26	2.86	0	2.44	4.33
2041	11.11	28.95	0	8.03	2.78	0	2.38	4.21
2042	10.83	28.2	0	7.82	2.71	0	2.31	4.11
2043	10.57	27.52	0	7.64	2.65	0	2.26	4.01
2044	10.33	26.91	0	7.46	2.59	0	2.21	3.92
2045	10.12	26.35	0	7.31	2.53	0	2.16	3.84
2046	9.92	25.84	0	7.17	2.48	0	2.12	3.76
2047	9.75	25.38	0	7.04	2.44	0	2.08	3.69
2048	9.59	24.97	0	6.93	2.4	0	2.05	3.63
2049	9.44	24.59	0	6.82	2.36	0	2.02	3.58
2050	9.32	24.27	0	6.73	2.33	0	1.99	3.53

Domestic hot water: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	2.97	10.88	0.00	9.61	0.06	0.19	0.00	0.00
2019	2.95	10.79	0.00	9.53	0.06	0.19	0.00	0.00
2020	2.91	10.66	0.00	9.42	0.06	0.18	0.00	0.00
2021	2.87	10.49	0.00	9.27	0.06	0.18	0.00	0.00
2022	2.83	10.37	0.00	9.16	0.06	0.18	0.00	0.00
2023	2.81	10.29	0.00	9.09	0.06	0.18	0.00	0.00
2024	2.80	10.24	0.00	9.04	0.06	0.18	0.00	0.00
2025	2.79	10.21	0.00	9.02	0.06	0.18	0.00	0.00
2026	2.79	10.19	0.00	9.00	0.06	0.18	0.00	0.00
2027	2.78	10.17	0.00	8.98	0.06	0.18	0.00	0.00
2028	2.77	10.14	0.00	8.96	0.06	0.17	0.00	0.00
2029	2.76	10.10	0.00	8.92	0.06	0.17	0.00	0.00
2030	2.74	10.04	0.00	8.87	0.06	0.17	0.00	0.00
2031	2.69	9.86	0.00	8.71	0.05	0.17	0.00	0.00
2032	2.66	9.72	0.00	8.58	0.05	0.17	0.00	0.00
2033	2.62	9.57	0.00	8.45	0.05	0.16	0.00	0.00
2034	2.57	9.42	0.00	8.32	0.05	0.16	0.00	0.00
2035	2.53	9.27	0.00	8.19	0.05	0.16	0.00	0.00
2036	2.49	9.12	0.00	8.05	0.05	0.16	0.00	0.00
2037	2.45	8.97	0.00	7.92	0.05	0.15	0.00	0.00
2038	2.41	8.81	0.00	7.78	0.05	0.15	0.00	0.00
2039	2.37	8.66	0.00	7.65	0.05	0.15	0.00	0.00
2040	2.32	8.50	0.00	7.51	0.05	0.15	0.00	0.00
2041	2.28	8.35	0.00	7.37	0.05	0.14	0.00	0.00
2042	2.24	8.20	0.00	7.24	0.05	0.14	0.00	0.00
2043	2.20	8.05	0.00	7.11	0.04	0.14	0.00	0.00
2044	2.16	7.90	0.00	6.98	0.04	0.14	0.00	0.00
2045	2.12	7.75	0.00	6.85	0.04	0.13	0.00	0.00
2046	2.08	7.61	0.00	6.72	0.04	0.13	0.00	0.00
2047	2.04	7.47	0.00	6.60	0.04	0.13	0.00	0.00
2048	2.00	7.33	0.00	6.47	0.04	0.13	0.00	0.00
2049	1.97	7.19	0.00	6.35	0.04	0.12	0.00	0.00
2050	1.93	7.06	0.00	6.23	0.04	0.12	0.00	0.00

iv. Industry and agriculture

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	Solid recovered fuel	District heating
2018	28.25	109.63	43.59	12.87	19.01	0.01	0	0	3
2019	28.02	108.75	43.24	12.77	19.02	0.01	0	0	2.98
2020	27.77	107.78	42.85	12.66	19.05	0.01	0	0	2.95
2021	27.49	106.72	42.42	12.53	19.07	0.01	0	0	2.92
2022	27.19	105.57	41.96	12.39	19.1	0.01	0	0	2.89
2023	26.87	104.34	41.47	12.25	19.13	0.01	0	0	2.85
2024	26.53	103.04	40.94	12.09	19.17	0.01	0	0	2.82
2025	26.18	101.68	40.39	11.93	19.23	0.01	0	0	2.78
2026	25.8	100.25	39.82	11.76	19.3	0.01	0	0	2.74
2027	25.42	98.76	39.22	11.59	19.39	0.01	0	0	2.7
2028	25.02	97.23	38.61	11.4	19.5	0.01	0	0	2.66
2029	24.61	95.66	37.98	11.22	19.64	0.01	0	0	2.61
2030	24.19	94.05	37.33	11.03	19.81	0.01	0	0	2.57
2031	23.79	92.53	36.72	10.84	19.83	0.01	0	0	2.53
2032	23.45	91.21	36.19	10.69	19.89	0.01	0	0	2.49
2033	23.1	89.87	35.65	10.53	19.94	0.01	0	0	2.45
2034	22.75	88.52	35.1	10.37	20	0.01	0	0	2.42
2035	22.4	87.16	34.56	10.21	20.06	0.01	0	0	2.38
2036	22.04	85.8	34.01	10.05	20.13	0.01	0	0	2.34
2037	21.69	84.45	33.47	9.89	20.2	0.01	0	0	2.3
2038	21.34	83.12	32.93	9.73	20.26	0.01	0	0	2.27
2039	21	81.8	32.4	9.57	20.34	0.01	0	0	2.23
2040	20.66	80.5	31.88	9.42	20.41	0.01	0	0	2.19
2041	20.33	79.24	31.38	9.27	20.49	0.01	0	0	2.16
2042	20.01	78.01	30.88	9.12	20.57	0.01	0	0	2.13
2043	19.71	76.83	30.41	8.98	20.65	0.02	0	0	2.09
2044	19.41	75.7	29.95	8.85	20.73	0.02	0	0	2.06
2045	19.13	74.62	29.52	8.72	20.82	0.02	0	0	2.03
2046	18.86	73.61	29.11	8.6	20.91	0.02	0	0	2
2047	18.62	72.66	28.73	8.49	21	0.02	0	0	1.98
2048	18.39	71.79	28.38	8.38	21.1	0.02	0	0	1.95
2049	18.18	71	28.06	8.29	21.2	0.02	0	0	1.93
2050	18	70.29	27.77	8.2	21.3	0.02	0	0	1.91

V. District heating

In TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	Industrial waste heat recovery	Deep geothermal
2018	0	6.51	0.92	0	6.05	0.01	0	4.8	1.7
2019	0	6.4	0.91	0	5.94	0.01	0	4.71	1.67
2020	0	6.28	0.89	0	5.84	0.01	0	4.63	1.64
2021	0	6.18	0.87	0	5.74	0.01	0	4.55	1.61
2022	0	6.08	0.86	0	5.65	0.01	0	4.48	1.59
2023	0	5.99	0.85	0	5.57	0.01	0	4.42	1.56
2024	0	5.91	0.84	0	5.49	0.01	0	4.36	1.54
2025	0	5.83	0.83	0	5.42	0.01	0	4.3	1.52
2026	0	5.75	0.81	0	5.34	0.01	0	4.24	1.5
2027	0	5.66	0.8	0	5.26	0.01	0	4.17	1.48
2028	0	5.55	0.79	0	5.16	0.01	0	4.09	1.45
2029	0	5.43	0.77	0	5.05	0.01	0	4	1.42
2030	0	5.31	0.75	0	4.93	0.01	0	3.91	1.39
2031	0	5.16	0.73	0	4.79	0.01	0	3.8	1.35
2032	0	5.01	0.71	0	4.66	0.01	0	3.69	1.31
2033	0	4.87	0.69	0	4.53	0.01	0	3.59	1.27
2034	0	4.74	0.67	0	4.4	0.01	0	3.49	1.24
2035	0	4.61	0.65	0	4.29	0	0	3.4	1.2
2036	0	4.49	0.64	0	4.17	0	0	3.31	1.17
2037	0	4.38	0.62	0	4.07	0	0	3.23	1.14
2038	0	4.28	0.61	0	3.98	0	0	3.15	1.12
2039	0	4.18	0.59	0	3.89	0	0	3.08	1.09
2040	0	4.1	0.58	0	3.81	0	0	3.02	1.07
2041	0	4.02	0.57	0	3.73	0	0	2.96	1.05
2042	0	3.95	0.56	0	3.67	0	0	2.91	1.03
2043	0	3.88	0.55	0	3.61	0	0	2.86	1.01
2044	0	3.82	0.54	0	3.55	0	0	2.82	1
2045	0	3.77	0.53	0	3.5	0	0	2.78	0.98
2046	0	3.73	0.53	0	3.46	0	0	2.75	0.97
2047	0	3.68	0.52	0	3.42	0	0	2.71	0.96
2048	0	3.65	0.52	0	3.39	0	0	2.69	0.95
2049	0	3.61	0.51	0	3.36	0	0	2.66	0.94
2050	0	3.58	0.51	0	3.33	0	0	2.64	0.94

3. Technical potential by sector

i. Solid biomass

In TWh

Biomass	Individual residential	Collective residential	Tertiary	Industry and agriculture	District heating
2018	86	12	6	19	6
2019	87	13	7	19	7
2020	88	13	7	20	8
2021	89	14	7	21	9
2022	90	15	8	22	12
2023	91	16	8	23	14
2024	91	17	8	25	16
2025	89	18	8	26	17
2026	88	18	8	27	18
2027	86	19	9	29	19
2028	85	19	9	30	21
2029	85	20	9	32	21
2030	85	20	9	33	22
2031	83	21	9	33	22
2032	82	21	9	32	22
2033	80	21	9	32	22
2034	78	21	8	31	22
2035	76	21	8	30	22
2036	72	21	8	30	22
2037	71	20	8	30	22
2038	68	19	7	30	22
2039	65	19	7	29	22
2040	62	18	7	29	22
2041	59	18	7	29	22
2042	57	17	7	29	22
2043	54	17	6	28	22
2044	52	16	6	28	22
2045	50	16	6	28	22
2046	48	16	6	28	22
2047	45	16	6	28	22
2048	42	16	5	28	22
2049	41	16	5	28	22
2050	39	16	5	28	22

ii. Solar thermal

In GWh

Solar thermal	Individual residential	Collective residential	Tertiary	Industry and agriculture	District heating
2018	813	297	187	13	7
2019	800	311	195	24	15
2020	815	333	207	35	22
2021	850	362	223	45	29
2022	897	397	241	56	37
2023	952	435	261	67	44
2024	1010	475	282	79	52
2025	1070	517	302	91	60
2026	1129	560	322	103	68
2027	1186	602	342	115	77
2028	1241	644	360	127	85
2029	1294	687	377	139	93
2030	1346	729	394	151	101
2031	1396	771	410	163	109
2032	1445	814	425	175	117
2033	1495	858	440	188	126
2034	1546	904	455	200	135
2035	1600	952	471	214	144
2036	1656	1004	487	228	153
2037	1716	1059	503	243	164
2038	1781	1118	521	259	175
2039	1849	1181	539	277	186
2040	1922	1249	559	295	199
2041	1999	1322	579	315	212
2042	2079	1398	599	335	226
2043	2160	1478	619	357	240
2044	2240	1560	638	379	255
2045	2318	1642	656	401	270
2046	2390	1723	672	423	285
2047	2452	1799	684	444	299
2048	2500	1866	692	463	312
2049	2529	1922	694	478	323
2050	2533	1960	689	490	331

iii. Heat pumps

In TWh

Heat pumps	Individual residential	Collective residential	Tertiary	Industry and agriculture	District heating
2018	18	2	5	0.0	0
2019	19	3	5	0.0	0
2020	20	3	6	0.1	0
2021	22	3	6	0.1	0
2022	24	3	6	0.2	0
2023	27	4	7	0.3	0
2024	29	4	7	0.4	0
2025	31	4	8	0.5	0
2026	33	5	8	0.6	0
2027	35	5	8	0.7	0
2028	37	6	9	0.8	0
2029	39	6	9	1.0	0
2030	40	6	9	1.1	0
2031	41	7	9	1.3	0
2032	42	7	10	1.4	0
2033	42	7	11	1.6	0
2034	42	8	11	1.7	0
2035	43	8	12	1.9	0
2036	43	8	13	2.1	0
2037	43	9	14	2.3	0
2038	43	9	15	2.5	0
2039	44	9	16	2.6	0
2040	44	10	17	2.8	0
2041	44	10	18	3.0	0
2042	45	11	19	3.2	0
2043	45	11	21	3.4	0
2044	46	12	23	3.6	0
2045	46	12	24	3.8	0
2046	47	13	26	4.0	0
2047	47	13	28	4.2	0
2048	47	14	30	4.4	0
2049	47	14	32	4.5	0
2050	47	14	34	4.7	0

iv. District heating solutions (deep geothermal and waste heat recovery)

In TWh

2031	2	11	5
2032	2	11	5
2033	2	11	5
2034	2	11	5
2035	2	11	6
2036	2	11	6
2037	2	11	6
2038	3	11	6
2039	3	11	6
2040	3	12	6
2041	3	12	6
2042	3	12	6
2043	3	12	6
2044	3	12	6
2045	3	12	6
2046	3	12	6
2047	3	12	6
2048	3	12	6
2049	3	12	6
2050	3	12	6

v. Development of district heating (supply)

In TWh

District heating	Individual residential	Collective residential	Tertiary	Industry and agriculture
2018	0	18	9	3
2019	0	19	9	4
2020	0	19	10	4
2021	0	19	10	5
2022	0	20	11	5
2023	0	21	12	6
2024	0	22	13	7
2025	0	23	14	8
2026	0	24	15	9
2027	0	25	16	10
2028	0	26	17	12
2029	0	27	18	13
2030	0	27	18	14
2031	0	27	19	15
2032	0	27	19	16
2033	0	27	20	17
2034	0	27	20	19
2035	0	27	21	20
2036	0	26	20	22
2037	0	26	19	24
2038	0	25	19	26
2039	0	25	18	27
2040	0	25	17	28
2041	0	25	17	28
2042	0	25	16	29
2043	0	25	16	29
2044	0	25	15	30
2045	0	25	14	31
2046	0	25	14	31
2047	0	25	13	32
2048	0	25	12	33
2049	0	25	12	33
2050	0	25	11	34

4. Alternative scenario – data

i. Individual residential

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	54.02	59.54	0.17	35.21	85.57	0	16.58	0
2019	52.25	58.5	0.08	34.74	86.26	0	17.42	0
2020	49.87	57.13	0	34.14	87.28	0	18.72	0
2021	46.91	55.47	0	33.41	88.4	0	20.33	0
2022	43.47	53.67	0	32.63	89.55	0	22.14	0
2023	39.77	52	0	31.99	90.13	0	24.04	0
2024	35.86	50.48	0	31.51	90.15	0	25.95	0
2025	32.04	49.51	0	31.5	88.74	0	27.79	0
2026	28.15	48.71	0	31.64	86.96	0	29.53	0
2027	24.13	47.68	0	31.61	85.77	0	31.13	0
2028	20.29	46.68	0	31.62	84.58	0	32.58	0
2029	16.6	45.28	0	31.33	84.36	0	33.86	0
2030	13.39	44.07	0	31.2	83.84	0	34.98	0
2031	10.58	42.58	0	30.76	82.35	0	35.56	0
2032	8.27	41.19	0	30.47	80.79	0	35.94	0
2033	6.39	39.75	0	30.15	79.38	0	36.2	0
2034	4.97	38.91	0	30.41	76.78	0	36.37	0
2035	3.82	37.94	0	30.6	74.44	0	36.5	0
2036	2.96	37.45	0	31.33	71.02	0	36.6	0
2037	2.23	36	0	31.23	69.42	0	36.7	0
2038	1.69	34.76	0	31.41	67.22	0	36.83	0
2039	1.29	33.92	0	32.13	63.95	0	36.99	0
2040	0.98	32.95	0	32.86	60.64	0	37.21	0
2041	0.73	31.59	0	33.32	57.86	0	37.48	0
2042	0.54	29.82	0	33.43	55.69	0	37.79	0
2043	0.4	28.32	0	34.06	52.56	0	38.14	0
2044	0.29	26.36	0	34.28	50.18	0	38.51	0
2045	0.2	24.04	0	34.12	48.42	0	38.85	0
2046	0.14	21.89	0	34.42	45.94	0	39.14	0
2047	0.09	19.61	0	34.77	43.49	0	39.33	0
2048	0.06	17.33	0	35.49	40.69	0	39.36	0
2049	0.03	14.61	0	35.67	38.91	0	39.18	0
2050	0.01	11.8	0	36.09	37.12	0	38.72	0

Domestic hot water: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	2.11	7.61	0.00	17.14	0.46	0.81	1.15	0.00
2019	1.82	7.41	0.00	16.79	0.47	0.80	1.39	0.00
2020	1.52	7.19	0.00	16.34	0.48	0.82	1.66	0.00
2021	1.23	6.96	0.00	15.80	0.49	0.85	1.98	0.00
2022	0.94	6.71	0.00	15.17	0.49	0.90	2.32	0.00
2023	0.66	6.46	0.00	14.44	0.48	0.95	2.69	0.00
2024	0.38	6.20	0.00	13.63	0.47	1.01	3.07	0.00
2025	0.11	5.94	0.00	12.77	0.45	1.07	3.45	0.00
2026	0.00	5.67	0.00	11.88	0.56	1.13	3.83	0.00
2027	0.00	5.41	0.00	11.01	0.61	1.19	4.20	0.00
2028	0.00	5.16	0.00	10.18	0.67	1.24	4.56	0.00
2029	0.00	4.91	0.00	9.40	0.73	1.29	4.89	0.00
2030	0.00	4.68	0.00	8.71	0.78	1.35	5.20	0.00
2031	0.00	4.55	0.00	8.42	0.90	1.40	5.44	0.00
2032	0.00	4.34	0.00	8.27	0.95	1.45	5.63	0.00
2033	0.00	4.14	0.00	8.14	1.00	1.50	5.81	0.00
2034	0.00	3.94	0.00	8.01	1.05	1.55	5.97	0.00
2035	0.00	3.75	0.00	7.90	1.11	1.60	6.12	0.00
2036	0.00	3.56	0.00	7.79	1.16	1.66	6.25	0.00
2037	0.00	3.37	0.00	7.68	1.21	1.72	6.39	0.00
2038	0.00	3.17	0.00	7.56	1.26	1.78	6.52	0.00
2039	0.00	2.98	0.00	7.44	1.31	1.85	6.66	0.00
2040	0.00	2.78	0.00	7.31	1.36	1.92	6.81	0.00
2041	0.00	2.57	0.00	7.17	1.42	2.00	6.97	0.00
2042	0.00	2.37	0.00	7.03	1.47	2.08	7.13	0.00
2043	0.00	2.16	0.00	6.87	1.52	2.16	7.30	0.00
2044	0.00	1.96	0.00	6.72	1.57	2.24	7.47	0.00
2045	0.00	1.75	0.00	6.57	1.62	2.32	7.64	0.00
2046	0.00	1.56	0.00	6.43	1.67	2.39	7.79	0.00
2047	0.00	1.36	0.00	6.32	1.73	2.45	7.93	0.00
2048	0.00	1.18	0.00	6.24	1.78	2.50	8.03	0.00
2049	0.00	1.00	0.00	6.22	1.83	2.53	8.08	0.00
2050	0.00	0.83	0.00	6.29	1.88	2.53	8.08	0.00

ii. Collective residential

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	6.26	36.55	0	7.68	12	0	2.23	18
2019	5.81	35.1	0	7.33	12.56	0	2.42	18.52
2020	5.35	33.6	0	6.98	13.19	0	2.66	19.01
2021	4.85	31.73	0	6.52	14.4	0	2.93	19.46
2022	4.39	30.04	0	6.13	15.48	0	3.22	19.87
2023	3.93	28.22	0	5.7	16.37	0	3.52	20.79
2024	3.48	26.29	0	5.26	17.29	0	3.81	21.91
2025	3.08	24.47	0	4.89	17.84	0	4.12	23.22
2026	2.67	22.56	0	4.54	18.41	0	4.43	24.44
2027	2.32	20.92	0	4.32	18.87	0	4.74	25.09
2028	1.93	18.55	0	3.85	19.4	0	5.04	26.4
2029	1.61	16.4	0	3.47	20.09	0	5.35	26.91
2030	1.33	14.53	0	3.19	20.46	0	5.66	27.13
2031	1.09	12.67	0	2.77	20.88	0	5.87	27.08
2032	0.91	11.22	0	2.46	20.98	0	6.11	26.78
2033	0.73	9.53	0	2	21.15	0	6.34	26.88
2034	0.59	8.02	0	1.57	21.21	0	6.57	26.93
2035	0.48	6.97	0	1.32	21.13	0	6.8	26.53
2036	0.4	6.16	0	1.15	20.83	0	7.05	26.11
2037	0.34	5.56	0	1.06	20.35	0	7.3	25.67
2038	0.29	5.47	0	1.23	19.41	0	7.57	25
2039	0.24	4.85	0	1.08	18.74	0	7.86	25
2040	0.2	4.38	0	0.99	17.96	0	8.17	25
2041	0.17	3.71	0	0.73	17.62	0	8.51	25
2042	0.14	3.16	0	0.51	17.21	0	8.88	25
2043	0.11	2.77	0	0.37	16.62	0	9.27	25
2044	0.09	2.33	0	0.16	16.2	0	9.68	25
2045	0.07	1.79	0	0	15.91	0	10.11	25
2046	0.06	1.26	0	0	15.5	0	10.54	25
2047	0.04	0.73	0	0	15.16	0	10.96	25
2048	0.03	0.33	0	0	14.77	0	11.36	25
2049	0.03	0	0	0	14.41	0	11.71	25
2050	0.02	0	0	0	13.83	0	11.99	25

Domestic hot water: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	0.38	7.35	0.00	6.98	0.00	0.30	0.15	0.00
2019	0.33	7.18	0.00	6.97	0.00	0.31	0.17	0.00
2020	0.28	7.01	0.00	6.95	0.00	0.33	0.19	0.00
2021	0.23	6.83	0.00	6.92	0.00	0.36	0.21	0.00
2022	0.18	6.66	0.00	6.87	0.00	0.40	0.24	0.00
2023	0.12	6.50	0.00	6.79	0.00	0.43	0.27	0.00
2024	0.07	6.35	0.00	6.67	0.00	0.48	0.30	0.00
2025	0.01	6.19	0.00	6.49	0.00	0.52	0.34	0.00
2026	0.00	6.03	0.00	6.24	0.00	0.56	0.39	0.00
2027	0.00	5.87	0.00	5.93	0.00	0.60	0.44	0.00
2028	0.00	5.71	0.00	5.58	0.01	0.64	0.50	0.00
2029	0.00	5.55	0.00	5.22	0.01	0.69	0.57	0.00
2030	0.00	5.37	0.00	4.87	0.01	0.73	0.67	0.00
2031	0.00	5.31	0.00	4.79	0.01	0.77	0.78	0.00
2032	0.00	5.18	0.00	4.73	0.01	0.81	0.89	0.00
2033	0.00	5.06	0.00	4.67	0.02	0.86	1.00	0.00
2034	0.00	4.93	0.00	4.61	0.02	0.90	1.10	0.00
2035	0.00	4.81	0.00	4.55	0.02	0.95	1.19	0.00
2036	0.00	4.69	0.00	4.50	0.03	1.00	1.28	0.00
2037	0.00	4.57	0.00	4.45	0.03	1.06	1.37	0.00
2038	0.00	4.44	0.00	4.39	0.03	1.12	1.45	0.00
2039	0.00	4.32	0.00	4.33	0.03	1.18	1.54	0.00
2040	0.00	4.19	0.00	4.28	0.04	1.25	1.62	0.00
2041	0.00	4.06	0.00	4.22	0.04	1.32	1.70	0.00
2042	0.00	3.92	0.00	4.16	0.04	1.40	1.79	0.00
2043	0.00	3.79	0.00	4.09	0.05	1.48	1.87	0.00
2044	0.00	3.65	0.00	4.03	0.05	1.56	1.96	0.00
2045	0.00	3.51	0.00	3.81	0.20	1.64	2.04	0.00
2046	0.00	3.37	0.00	3.42	0.54	1.72	2.12	0.00
2047	0.00	3.24	0.00	3.00	0.91	1.80	2.19	0.00
2048	0.00	3.12	0.00	2.66	1.22	1.87	2.25	0.00
2049	0.00	2.90	0.00	2.27	1.69	1.92	2.30	0.00
2050	0.00	2.55	0.00	2.03	2.17	1.96	2.33	0.00

iii. Tertiary

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	23.74	61.82	0	17.15	5.94	0	5.07	9
2019	21.66	59.18	0	16.67	6.42	0	5.27	9.47
2020	19.66	56.32	0	16.17	6.91	0	5.59	9.93
2021	17.92	53.89	0	15.82	7.13	0	5.99	10.4
2022	16.28	51.37	0	15.49	7.35	0	6.43	10.87
2023	14.71	48.64	0	15.13	7.51	0	6.87	11.65
2024	13.22	45.81	0	14.78	7.61	0	7.3	12.57
2025	11.84	42.96	0	14.48	7.55	0	7.68	13.66
2026	10.56	40.09	0	14.37	7.44	0	8.02	14.74
2027	9.41	37.35	0	14.37	7.37	0	8.3	15.53
2028	8.29	34.32	0	14.27	7.26	0	8.51	16.78
2029	7.29	31.48	0	14.29	7.28	0	8.67	17.57
2030	6.38	28.73	0	14.37	7.29	0	8.77	18.21
2031	5.54	25.99	0	14.24	6.88	0	9.37	18.7
2032	4.79	23.38	0	14.12	6.44	0	10.01	19.03
2033	4.08	20.62	0	13.83	6.05	0	10.68	19.68
2034	3.45	17.94	0	13.48	5.64	0	11.37	20.33
2035	2.89	15.49	0	13.19	5.28	0	12.1	20.67
2036	2.46	13.61	0	13.28	4.93	0	12.88	20.02
2037	2.06	11.92	0	13.14	4.69	0	13.73	19.38
2038	1.71	10.35	0	12.96	4.41	0	14.65	18.74
2039	1.39	8.88	0	12.72	4.13	0	15.66	18.09
2040	1.1	7.5	0	12.41	3.85	0	16.78	17.45
2041	0.85	6.2	0	11.99	3.6	0	18.02	16.8
2042	0.62	4.97	0	11.45	3.41	0	19.39	16.16
2043	0.41	3.84	0	10.83	3.15	0	20.89	15.51
2044	0.23	2.78	0	10.08	2.93	0	22.52	14.87
2045	0.07	1.78	0	9.19	2.74	0	24.29	14.22
2046	0	0.86	0	8.14	2.54	0	26.17	13.58
2047	0	0.02	0	6.95	2.35	0	28.14	12.93
2048	0	0	0	5.01	2.11	0	30.15	12.29
2049	0	0	0	3.08	1.94	0	32.14	11.64
2050	0	0	0	1.44	1.7	0	34.04	11

Domestic hot water: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	District heating
2018	2.97	10.88	0.00	9.61	0.06	0.19	0.00	0.00
2019	2.61	10.65	0.00	9.94	0.12	0.19	0.00	0.00
2020	2.24	10.46	0.00	10.13	0.19	0.21	0.00	0.00
2021	1.88	10.35	0.00	10.13	0.28	0.22	0.00	0.00
2022	1.55	10.27	0.00	10.15	0.39	0.24	0.00	0.00
2023	1.26	10.20	0.00	10.18	0.52	0.26	0.00	0.00
2024	1.02	10.15	0.00	10.19	0.67	0.28	0.00	0.00
2025	0.82	10.09	0.00	10.19	0.84	0.30	0.00	0.00
2026	0.67	10.03	0.00	10.15	1.04	0.32	0.00	0.00
2027	0.55	9.94	0.00	10.08	1.25	0.34	0.00	0.00
2028	0.46	9.84	0.00	9.97	1.47	0.36	0.00	0.00
2029	0.40	9.73	0.00	9.81	1.70	0.38	0.00	0.00
2030	0.35	9.61	0.00	9.61	1.92	0.39	0.00	0.00
2031	0.31	9.36	0.00	9.27	2.13	0.41	0.00	0.00
2032	0.29	9.18	0.00	8.95	2.33	0.42	0.00	0.00
2033	0.28	9.01	0.00	8.63	2.50	0.44	0.00	0.00
2034	0.27	8.86	0.00	8.30	2.65	0.46	0.00	0.00
2035	0.26	8.74	0.00	7.95	2.78	0.47	0.00	0.00
2036	0.26	8.63	0.00	7.60	2.89	0.49	0.00	0.00
2037	0.27	8.40	0.00	7.40	2.97	0.50	0.00	0.00
2038	0.27	8.16	0.00	7.20	3.04	0.52	0.00	0.00
2039	0.28	7.93	0.00	7.01	3.10	0.54	0.00	0.00
2040	0.29	7.71	0.00	6.83	3.15	0.56	0.00	0.00
2041	0.29	7.49	0.00	6.65	3.18	0.58	0.00	0.00
2042	0.30	7.27	0.00	6.48	3.21	0.60	0.00	0.00
2043	0.32	7.06	0.00	6.31	3.23	0.62	0.00	0.00
2044	0.33	6.86	0.00	6.14	3.25	0.64	0.00	0.00
2045	0.35	6.65	0.00	5.98	3.26	0.66	0.00	0.00
2046	0.30	6.45	0.00	5.89	3.27	0.67	0.00	0.00
2047	0.20	6.25	0.00	5.86	3.28	0.68	0.00	0.00
2048	0.12	5.34	0.00	6.53	3.29	0.69	0.00	0.00
2049	0.06	4.48	0.00	7.14	3.29	0.69	0.00	0.00
2050	0.06	3.76	0.00	7.58	3.30	0.69	0.00	0.00

iv. Industry

Heating and thermal processes: in TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	Solid recovered fuel	District heating
2018	28.25	109.63	43.59	12.87	19.01	0.01	0	0	3
2019	27.04	110.67	41.16	12.88	19.5	0.02	0.02	0	3.51
2020	25.84	111.28	38.96	12.86	19.99	0.03	0.06	0	4.06
2021	24.55	111.22	36.84	12.8	20.99	0.05	0.12	0	4.64
2022	23.27	110.77	34.92	12.73	21.96	0.06	0.19	0	5.26
2023	21.96	109.77	33.14	12.65	23.07	0.07	0.27	0	6.06
2024	20.57	108.04	31.4	12.51	24.7	0.08	0.36	0	7.01
2025	19.2	106.13	29.85	12.4	26.02	0.09	0.46	0	8.12
2026	17.87	104.01	28.49	12.31	27.1	0.1	0.57	0	9.31
2027	16.47	101.29	27.16	12.2	28.88	0.11	0.69	0	10.38
2028	15.11	98.42	25.98	12.12	30.15	0.13	0.82	0	11.83
2029	13.72	95.03	24.83	12.03	32.13	0.14	0.96	0	13.02
2030	12.43	92.06	23.93	12.04	33.25	0.15	1.1	0	14.16
2031	11.46	89.49	23.28	12.16	33.38	0.16	1.25	0	15.22
2032	11.05	87.53	22.89	12.44	32.41	0.18	1.41	0	16.18
2033	10.57	85.04	22.45	12.72	31.75	0.19	1.57	0	17.44
2034	10.1	82.49	22.08	13.06	30.93	0.2	1.74	0	18.74
2035	9.63	79.81	21.73	13.46	30.42	0.21	1.92	0	19.8
2036	9.06	76.48	21.2	13.8	29.87	0.23	2.09	0	21.86
2037	8.45	72.73	20.58	14.13	29.86	0.24	2.28	0	23.95
2038	7.85	69	19.95	14.5	29.61	0.26	2.46	0	26.26
2039	7.36	66.32	19.62	15.16	29.32	0.28	2.65	0	26.91
2040	6.88	63.65	19.25	15.9	29	0.3	2.84	0	27.55
2041	6.4	60.89	18.88	16.72	28.74	0.31	3.03	0	28.2
2042	5.9	58.06	18.42	17.6	28.68	0.34	3.22	0	28.84
2043	5.41	55.47	17.94	18.6	28.34	0.36	3.41	0	29.49
2044	4.92	52.91	17.37	19.65	28.12	0.38	3.6	0	30.13
2045	4.41	50.39	16.69	20.75	28.02	0.4	3.79	0	30.78
2046	3.9	47.94	15.89	21.88	28.07	0.42	3.98	0	31.42
2047	3.39	45.65	14.99	23.06	28.13	0.44	4.17	0	32.07
2048	2.9	43.67	14.03	24.34	27.98	0.46	4.36	0	32.71
2049	2.4	41.72	12.9	25.56	28.16	0.48	4.54	0	33.36
2050	1.92	40.19	11.72	26.92	28	0.49	4.72	0	34

V. District heating

In TWh final energy

Year	Fuel oil burner	Gas burner	Coal burner	Joule effect	Biomass burner	Solar thermal	Heat pumps	Industrial waste heat recovery	Deep geothermal
2018	0	6.51	0.92	0	6.05	0.01	0	4.8	1.7
2019	0	6.52	0.92	0	7.03	0.01	0	4.96	2
2020	0	6.6	0.94	0	7.95	0.02	0	5.14	2.2
2021	0	6.32	0.9	0	9.26	0.03	0	5.3	2.4
2022	0	5.11	0.72	0	11.5	0.04	0	5.47	2.7
2023	0	4.84	0.69	0	13.73	0.04	0	5.74	2.9
2024	0	4.66	0.66	0	15.7	0.05	0	6.51	3.3
2025	0	5.27	0.75	0	17.25	0.06	0	7.48	3.7
2026	0	6.25	0.89	0	18.1	0.07	0	8.54	4.3
2027	0	5.66	0.8	0	19.49	0.08	0	10.01	4.7
2028	0	6.35	0.9	0	20.73	0.08	0	11.58	5.2
2029	0	7.35	1.04	0	21.42	0.09	0	12.07	5.32
2030	0	8.11	1.15	0	22.2	0.1	0	12.36	5.34
2031	0	9.04	1.28	0	22.42	0.11	0	12.55	5.36
2032	0	9.76	1.38	0	22.42	0.12	0	12.74	5.38
2033	0	11.37	1.61	0	22.39	0.13	0	12.93	5.4
2034	0	13.09	1.85	0	22.24	0.13	0	13.12	5.45
2035	0	13.85	1.96	0	22.16	0.14	0	13.31	5.5
2036	0	14.64	2.07	0	22.05	0.15	0	13.5	5.55
2037	0	15.12	2.14	0	22.2	0.16	0	13.69	5.6
2038	0	15.82	2.24	0	22.16	0.17	0	13.88	5.65
2039	0	15.69	2.22	0	22.09	0.19	0	14.07	5.7
2040	0	15.63	2.21	0	22	0.2	0	14.2	5.75
2041	0	15.5	2.2	0	21.95	0.21	0	14.35	5.8
2042	0	15.22	2.16	0	22.06	0.23	0	14.5	5.8
2043	0	15.25	2.16	0	21.95	0.24	0	14.62	5.8
2044	0	15.14	2.14	0	21.94	0.26	0	14.75	5.8
2045	0	14.9	2.11	0	22.02	0.27	0	14.89	5.8
2046	0	14.75	2.09	0	22.05	0.29	0	15	5.8
2047	0	14.62	2.07	0	22.11	0.3	0	15.05	5.8
2048	0	14.72	2.08	0	21.98	0.31	0	15.1	5.8
2049	0	14.49	2.05	0	22.13	0.32	0	15.15	5.8
2050	0	14.6	2.07	0	22	0.33	0	15.2	5.8

5. Techno-economic data

i. Individual residential

ii. Collective residential

Collective residential	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050		
Fuel oil burner																																			
Performance	0.84	0.84	0.84	0.85	0.85	0.85	0.86	0.86	0.86	0.87	0.87	0.87	0.88	0.88	0.88	0.89	0.89	0.89	0.9	0.9	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93	0.94	0.94	0.94			
Operating time per year	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500			
Investment costs	84000	84700	85400	86100	86800	87500	88200	88900	89600	90300	91000	91700	92400	93100	93800	94500	95200	95900	96600	97300	98000	98700	99400	100100	100800	101500	102200	102900	103600	104300	105000	105700	106400		
Maintenance costs	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000			
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20					
Gas burner																																			
Performance	0.86	0.87	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.9	0.9	0.9	0.9	0.91	0.91	0.91	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.95	0.95			
Operating time per year	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500			
Investment costs	89400	89760	90120	90480	90840	91200	91560	91920	92280	92640	93000	93360	93720	94080	94400	95160	95520	95880	96240	96600	97320	97680	98040	98760	99120	99480	99840	100200	100560	100920					
Maintenance costs	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600			
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20					
Joule effect																																			
Performance	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99		
Operating time per year	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500			
Investment costs	70000	69887.53	69775.06	69662.59	69550.12	69437.65	69325.18	69212.71	69100.24	68987.77	68875.3	68762.83	68650.36	68537.89	68425.42	68312.95	68200.48	68088.01	67975.54	67863.07	67750.6	67638.13	67525.66	67413.19	67300.72	67188.25	67075.78	66963.31	66850.84	66738.37	66625.9	66513.43	66400.96		
Maintenance costs	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000			
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20					
Pellet burner																																			
Performance	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.88		
Operating time per year	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000			
Investment costs	110000	1099114	1098228.6	1097342.9	1096457.2	1095515.1	1094685.8	1093800.1	1092914.	1092028.	1091143	1090257.3	1089371.6	1088485.9	1087600.2	1086714.	1085828.8	1084943.	1084057.	1083171.	1082286.	1081400.	1080514.	1079628.9	1078743.	1077857.	1076931.	1076086.	1075200.	1074314.	1073429.	1072543.	1071657.		
Maintenance costs	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000				
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20					
Air-to-air heat pump																																			
Performance	2.26	2.29	2.32	2.35	2.38	2.41	2.44	2.47	2.5	2.53	2.56	2.59	2.62	2.65	2.68	2.71	2.74	2.77	2.81	2.84	2.87	2.9	2.93	2.96	2.99	3.02	3.05	3.08	3.11	3.14	3.17	3.2	3.23		
Operating time per year	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000			
Investment costs	680000	674000	668000	662000	656000	650000	644000	638000	632000	626000	620000	614000	608000	602000	596000	590000	584000	578000	572000	566000	560000	554000	548000	542000	536000	530000	524000	518000	512000	506000	500000	494000	488000		
Maintenance costs	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000				
Lifespan	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17				
Air-to-water heat pump																																			
Performance	3.3	3.33	3.36	3.39	3.41	3.44	3.47	3.5	3.53	3.56	3.59	3.61	3.64	3.67	3.7	3.73	3.76	3.79	3.81	3.84	3.87	3.9	3.93	3.96	3.99	4.01	4.04	4.07	4.1	4.13	4.16	4.19	4.21		
Operating time per year	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000			
Investment costs	103000	1021000	1012000	1003000	994000	985000	976000	958000	949000	940000	931000	922000	913000	904000	895000	886000	877000	868000	859000	850000	841000	832000	814000	805000	796000	787000	778000	769000	760000	751000	742000				
Maintenance costs	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000				
Lifespan	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17				
Ground source heat pump																																			
Performance	3.6	3.61	3.62	3.63	3.64	3.65	3.66	3.67	3.68	3.69	3.7	3.71	3.72	3.73	3.74	3.74	3.75	3.76	3.77	3.78	3.79														

iii. Tertiary

Tertiary	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050
Fuel oil burner																																	
Performance	0.84	0.84	0.84	0.85	0.85	0.85	0.86	0.86	0.86	0.87	0.87	0.87	0.88	0.88	0.89	0.89	0.89	0.9	0.9	0.9	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93	0.94	0.94	0.94	
Operating time per year	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	
Investment costs	84000	84700	85400	86100	86800	87500	88200	88900	89600	90300	91000	91700	92400	93100	93800	94500	95200	95900	96600	97300	98000	98700	99400	100100	100800	101500	102200	102900	103600	104300	105000	105700	106400
Maintenance costs	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	7000	
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20			
Gas burner																																	
Performance	0.86	0.87	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.9	0.9	0.9	0.9	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.92	0.93	0.93	0.93	0.94	0.94	0.94	0.95	0.95	
Operating time per year	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500	3500		
Investment costs	89400	89760	90120	90480	90840	91200	91560	91920	92280	92640	93000	93360	93720	94080	94400	94800	95160	95520	95880	96240	96600	97320	97680	98040	98400	98760	99120	99480	99840	100200	100600	100920	
Maintenance costs	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600	7600			
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20				
Joule effect																																	
Performance	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99	0.99		
Operating time per year	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500	2500		
Investment costs	70000	69887.53	69775.06	69662.59	69550.12	69437.65	69325.18	69212.71	69100.24	68987.53	68872.83	68650.36	68537.89	68425.42	68312.95	68200.48	68088.01	67975.54	67863.07	67750.6	67638.13	67525.6	67413.19	67300.72	67188.25	67075.78	66963.31	66850.84	66738.37	66625.9	66513.43	66400.96	
Maintenance costs	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000	1000				
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20				
Pellet burner																																	
Performance	0.85	0.85	0.85	0.85	0.85	0.85	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.88	0.88	0.88		
Operating time per year	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000			
Investment costs	110000	1099114	1098228.6	1097342.9	1096457.2	1095571.5	1094685.8	1093800.1	1092914	1092028.7	109114	1090257.3	1089371.6	1088465.9	1087600.2	1086714	1085828.8	1084943	1084057	1083171	1082286	1081400.3	1080514	1079628.9	1078743	1077857	1076971	1076986	1075200	1074314	1073429	1072543	1071657
Maintenance costs	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000	18000				
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20				
Air-to-air heat pump																																	
Performance	2.26	2.29	2.32	2.35	2.38	2.41	2.44	2.47	2.5	2.53	2.56	2.59	2.62	2.65	2.68	2.71	2.74	2.77	2.81	2.84	2.87	2.9	2.93	2.96	2.99	3.02	3.05	3.08	3.11	3.14	3.17	3.2	3.23
Operating time per year	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000		
Investment costs	680000	674000	668000	662000	656000	650000	644000	638000	632000	626000	620000	614000	608000	602000	596000	590000	584000	578000	572000	566000	560000	554000	548000	542000	536000	530000	524000	518000	512000	506000	500000	494000	488000
Maintenance costs	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000			
Lifespan	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17				
Air-to-water heat pump																																	
Performance	3.3	3.33	3.36	3.39	3.41	3.44	3.47	3.5	3.53	3.56	3.59	3.61	3.64	3.67	3.7	3.73	3.76	3.79	3.81	3.84	3.87	3.9	3.93	3.96	3.99	4.01	4.04	4.07	4.1	4.13	4.16	4.19	4.21
Operating time per year	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000			
Investment costs	103000	1021000	1012000	1003000	994000	985000	976000	967000	958000	949000	940000	931000	922000	913000	904000	895000	886000	877000	868000	859000	850000	841000	832000	823000	814000	805000	796000	787000	778000	769000	760000	751000	742000
Maintenance costs	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000	30000			
Lifespan	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17	17				
Ground source heat pump																																	
Performance	3.6	3.61	3.62	3.63	3.64	3.65	3.66	3.67	3.68	3.69	3.7	3.71	3.72	3.73	3.74	3.74	3.75	3.76	3.77	3.78	3.79	3.8	3.81	3.82	3.83	3.84	3.85	3.86	3.87	3.88	3.89	3.9	3.91
Operating time per year	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000	2000		
Investment costs	900000	889050	878100	8687150	856200	845250	834300	823350	812400	801450	790500	779550	768600	757650	746700	735750	724800	713850	702900	691950	681000	670050	659100	648150	637200	626250	615300	604350	593400	582450	571500	560550	549600
Maintenance costs	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000	60000			
Lifespan	25	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48	49	50	51	52	53	54	55	25

iv. Industry

Thermal processes

V. District heating

District heating	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050	
Fuel oil burner																																		
Performance	0.86	0.86	0.87	0.87	0.87	0.88	0.88	0.89	0.89	0.89	0.89	0.9	0.9	0.9	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.95	0.95	0.95	0.96	0.96		
Operating time per year	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000			
Investment costs	160000	161172.18	162344.36	163516.54	164688.72	165860.9	167033.08	168205.26	169377.44	170549.62	171721.8	172893.98	174066.16	175283.34	176410.52	177582.7	178754.88	179927.06	181099.24	182271.42	183443.6	184615.78	185787.96	186960.14	188132.32	189304.5	190476.68	191648.86	192821.04	193993.22	195165.4	196337.58	197509.76	
Maintenance costs	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500	1500		
Lifespan	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25				
Gas burner																																		
Performance	0.89	0.89	0.89	0.9	0.9	0.9	0.9	0.91	0.91	0.91	0.91	0.92	0.92	0.92	0.93	0.93	0.93	0.94	0.94	0.94	0.94	0.94	0.94	0.95	0.95	0.95	0.95	0.96	0.96	0.96	0.97	0.97		
Operating time per year	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000			
Investment costs	96000	96070.33	96140.66	96210.99	96281.32	96351.66	96421.99	96492.32	96562.65	96632.98	96703.31	96773.64	96843.97	96914.3	96984.63	97054.97	97125.3	97195.63	97265.96	97336.29	97406.62	97476.95	97547.28	97617.61	97687.94	97758.28	97828.61	97898.94	97969.27	98039.6	98109.93	98180.26	98250.59	
Maintenance costs	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550		
Lifespan	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25				
Coal burner																																		
Performance	0.82	0.82	0.83	0.83	0.83	0.83	0.84	0.84	0.85	0.85	0.85	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.9	0.9	0.9	0.91	0.91			
Operating time per year	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000			
Investment costs	245000	248600	250400	252200	254000	255800	257600	259400	261200	263000	264800	266600	268400	270200	272000	273800	275600	277400	279200	281000	282800	284600	286400	288200	290000	291800	293600	295400	297200	299000	302600			
Maintenance costs	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550	1550		
Lifespan	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25				
Pellet burner																																		
Performance	0.82	0.82	0.83	0.83	0.83	0.83	0.84	0.84	0.85	0.85	0.85	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.89	0.89	0.89	0.9	0.9	0.9	0.91	0.91			
Operating time per year	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000			
Investment costs	553000	557050	561100	565150	569200	573250	577300	581350	585400	589450	593500	597500	601600	605650	609700	613750	617800	621850	625900	629950	634000	638050	642100	646150	650200	654250	658300	662350	666400	670450	674500	678550	682600	
Maintenance costs	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330	1330		
Lifespan	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25				
Solar thermal																																		
Performance	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		
Operating time per year	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760	8760			
Investment costs	679000	677000	675000	673000	671000	669000	667000	665000	663000	661000	659000	657000	655000	653000	651000	649000	647000	645000	643000	641000	639000	637000	635000	633000	631000	629000	627000	625000	623000	621000	619000	617000		
Maintenance costs	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000	10000		
Lifespan	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25			
Ground source heat pump																																		
Performance	3.3	3.33	3.36	3.38	3.41	3.44	3.47	3.49	3.52	3.55	3.58	3.61	3.63	3.66	3.69	3.72	3.74	3.77	3.8	3.83	3.86	3.88	3.91	3.94	3.97	3.99	4.02	4.05	4.08	4.11	4.13	4.16	4.19	
Operating time per year	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000	3000		
Investment costs	2113000	2105916.67	209833.34	2091750.9	2084666.0	2077583.35	2070500.02	2063416.69	2056333.36	2049250.03	2042166.	2035083.7	2028000.0	2020916.71	201383.38	2006750.05	1999666.72	1992583.3	1985500.0	1978416.7	1971334.4	1964250.07	1957166.74	1950083.41	1943000.08	1935916.7	1928833.4	1921750.0	1914666.76	1907583.43	1900500.1	1893416.77	1886333.4	1882
Maintenance costs	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500	4500
Lifespan	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20	20			
Solid recovered fuel burner																																		
Performance	0.82	0.82	0.83	0.83	0.83	0.84	0.84	0.85	0.85	0.85	0.86	0.86	0.86	0.86	0.87	0.87	0.87	0.88	0.88	0.88	0.88	0.89	0.8											

6. Input costs

i. Variation assumptions

Year	Heavy fuel oil	Domestic fuel oil	Gas	Coal	Electricity	Log biomass	Pellet biomass	Waste heat	Solid recovered fuel	District heating
2018	14.85%	14.85%	4.56%	0.00%	1.10%	1.20%	1.20%	0.50%	0.50%	1.73%
2019	14.85%	14.85%	4.56%	0.00%	1.10%	1.20%	1.20%	0.50%	0.50%	1.49%
2020	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.21%
2021	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.20%
2022	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.19%
2023	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.19%
2024	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.18%
2025	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.18%
2026	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.17%
2027	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.17%
2028	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.16%
2029	2.30%	2.30%	2.29%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.15%
2030	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.17%
2031	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.20%
2032	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.19%
2033	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.17%
2034	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.16%
2035	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.14%
2036	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.13%
2037	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.12%
2038	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.11%
2039	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.10%
2040	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.08%
2041	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.07%
2042	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.07%
2043	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.06%
2044	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.05%
2045	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.04%
2046	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.03%
2047	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.03%
2048	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.02%
2049	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	1.01%
2050	0.70%	0.70%	0.68%	1.90%	1.10%	1.20%	1.20%	0.50%	0.50%	0.00%

ii. Initial costs

In EUR/MWh

Initial input prices (2018)	Individual residential	Collective residential	Tertiary	Industry	District heating
Heavy fuel oil	X	X	X	34	34
Domestic fuel oil	74	74	74	66	66
Gas	80	70	70	28	28
Coal	30	30	30	25	25
Electricity	150	150	120	59	X
Log biomass	41	X	X	X	X
Pellet biomass	75	70	70	40	24
Waste heat	X	X	X	X	45
Solid recovered fuel	X	X	X	70	70
District heating	X	70	70	65	X