# D8.6 Lessons learnt to draw business models in use case SE#2
# Version 1.0

*Deliverable D8.6*

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# EXECUTIVE SUMMARY


The aim of this report is to describe the lessons learned when developing new business models for the optimization of DSO operation by exploiting the interaction with district heating and district cooling. Complex software development is for a wider market and scaling up, not a single site only. That is why a more general market assessment, limited to the EU, has been carried out in order to develop the business model required.
To store excess generation in thermal grids and building envelopes is a cost-efficient way to avoid grid investments and store energy. There are several means to connect the electric and the thermal sectors, for example:

- Heat pumps and boilers delivering heat into the district heating networks
- Connection to a large number of heat pumps (and cooling machines) that will be centrally steered and controlled
- Generation of hydrogen by electricity

The demo has focused on how to connect heat pumps that uses excess heat and thus simultaneously providing cooling and heat to a secondary heating and cooling grid. This is an E.ON innovation named ectogrid. The demo has developed the possibility to use ectogrid, or rather the connected software named ectocloud, to provide flexibility to the DSO. In practice, this development might be applicable for heat pumps in general. The focus of the business model development has therefore been the business model of the software itself, especially the part that would provide DSO services.

The major questions to be answered have been:

- Whom are the customers?
- What is the product or service that will be offered?
- What will the future market look like?

The focus in the development of the business model has been to identify potential value pools and how to monetize from these value pools. The value pool that has been identified and has been further developed in this project is the future value pool of optimization of capacity and the provision of this as a service to the DSO.

The thermal market will most probably be more electric, at the same time the transportation fleet is going electric and the share of RES are increasing. The challenge for DSO will increase and the market for DSO services will develop. This business development was first focusing on how to connect ectogrid™ to a DSO flex market via ectocloud™. Quite soon reaching the step where this market was too limited to actually make a huge impact on the DSO operations. Utilizing the same software and connecting also stand-alone heat pumps to the platform will improve the business case, but not to the full extent. Including the possibility to license the software as a service has significantly increased the reachable customer group, and possibility to access more markets within Europe.

The major conclusion is that there will be a large market for thermal flexibility, this needs to be designed in a manner that encourages customers to connect and provide flexibility. Without flexibility it will be hard from a DSO point of view to support the electrification.

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# 1. INTRODUCTION

## 1.1. Scope of the document

The aim of this report is to describe the lessons learned when developing new business models for the optimization of DSO operation by exploiting the interaction with district heating and district cooling.

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| 8 | New business models for optimization of DSO operation by exploiting the interaction with district heating and district cooling | E.ON |

The development of the business models is based on:

- Technical development and learnings
- Discussions with external customers
- Studies of the European heat and flexibility market


*Figure 1 A decarbonization of the thermal market is necessary. The transformation needs to take place in a responsible manner, taking customers and the overall energy system into account.*

The business model development focus on how to create a business model that will aggregate thermal loads and supply this as a service to the DSO. The focus will not be the development of DSO services and optimization, although these are very interconnected.

## 1.2. Work progress business models

Complex software development is for a wider market and scaling up, not a single site only. That is why a more general market assessment, limited to EU, has been carried out in order to develop the business model required.

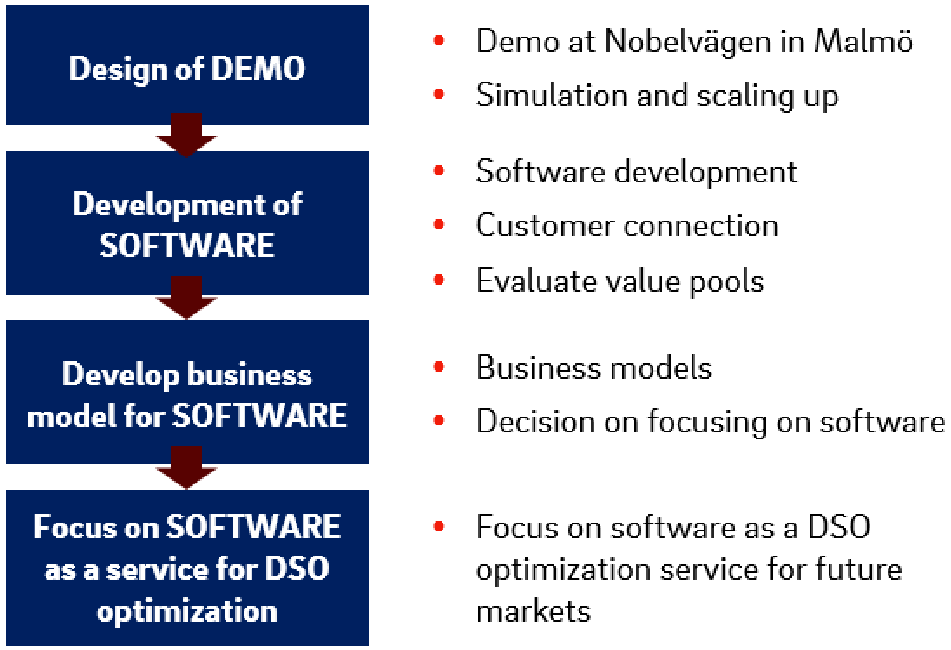


*Figure 2 The development of business models focuses on how to develop a business model for a software that aggregates thermal loads, in this case as a service to the DSO.*

The development of a software in a secure manner is costly and require time and iterative work. To develop a software that is safe and secure, and that will actually make a difference in the market, the market itself needs to be identified. Today, the full value of flexibility is not utilized. In order to increase the amount of renewable energy without reinforcing the entire electric grid and create large battery storage or similar, there is a possibility to increase the flexibility on the demand side. To store excess generation in thermal grids and building envelopes is a cost-efficient way to avoid grid investments and store energy. There are several means to connect the electric and the thermal sectors, for example:

- Heat pumps and boilers delivering heat into the district heating networks
- Connection to a large number of heat pumps (and cooling machines) that will be centrally steered and controlled
- Generation of hydrogen by electricity

The demo has focused on how to connect heat pumps that uses excess heat and thus simultaneously providing cooling and heat to a secondary heating and cooling grid. This is an E.ON innovation named ectogrid™. The demo has developed the possibility to use ectogrid™, or rather the connected software named ectocloud™, to provide flexibility to the DSO. In practice, this development might be applicable for heat pumps in general. The focus of the business model development has therefore been the business model of the software itself, especially the part that would provide DSO services.

The major questions to be answered have been:

- Whom are the customers?
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The focus in the development of the business model has been to identify potential value pools and how to monetize from these value pools. The value pool that has been identified and has been further developed in this project is the future value pool of optimization of capacity and the provision of this as a service to the DSO.

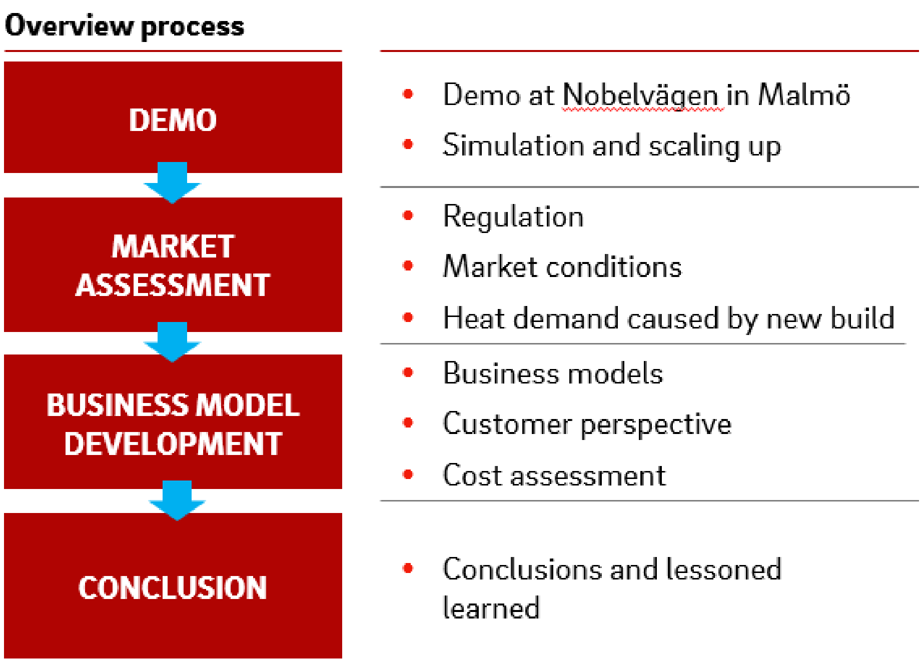



*Figure 3 Process when developing DSO business models.*

DSO services are not yet fully explored towards the thermal market on the demand side. In some application, there is a connection between thermal assets and the trading market. In this project, the trading or spot market is considered but the focus is on how to provide service to the DSO and the introduction of RES into the system due to controllable thermal use.

Today, all electricity customers in Sweden are able to buy electricity of the spot market. Several projects have been exploring this possibility. At the same time, the district heating market has introduced more heat pumps into the generation, so has E.ON. In some applications it will be more efficient to have the heat pumps closer to the customer due to more beneficial temperature levels. Applications with distributed heat pumps are also more likely to be utilized in regions where there aren´t any large district heating systems today. Going from for instance gas heating to electric heating utilizing a heat pump also means more burden on the electric grid.

In an area of electrification of the transportation sector and the introduction of intermittent energy sources, the DSO flexibility has been identified as a value pool in focus. This doesn´t mean that the trading market value pool is out of scope, but this hasn´t been the focus in this work. Even without a DSO flexibility market, the grid capacity is of interest, since it is always an interest to minimize the network connection. This functionality will be very similar if viewed from a LES point of view.

## 1.3. Notations, abbreviations and acronyms

The table 1 below provides an overview of the notations, abbreviations and acronyms used in this report.

*Table 1: List of notations, abbreviations and accronyms*

| | |
|---|---|
| DSO | Distribution System Operator |
| LES | Local Energy System |
| HP | Heat Pump |
| CM | Cooling Machine |
| TSO | Transmission System Operator |
| BEMS | Building Energy Management System |

# 2. DESCRIPTION OF THE USE CASE

## 2.1. The demo site

The heat pump at the demo site in Malmö is installed to decrease the overall demand of energy used at a local energy centre in an industrial park. Low temperature waste energy is upgraded to a temperature useful for comfort heating in a couple of commercial buildings, while simultaneously producing cool water that is used to cool off the stacks of a data centre.

The heat pump is utilized to deliver two necessities at the same time, both heating and cooling. If there is a grid constraint, or an excess of district heating energy, the heat pump will be turned off and the system will run in a mode, providing:

- Cooling to the data centre by using a cooling machine and a conventional cooling tower
- Heating to the commercial buildings by the district heating grid.

The system is up and running connected to a control system, ectocloud™, that can be set in a “power control” mode if there is a need of change of energy carriers and/or peak shaving. A series of test runs has been developed and will be carried out during the cold heating season.

### 2.1.1. Changes in the demo set-up - increasing the potential of the business model

From the start, the demo was supposed to include the integration of an industrial size heat pump that has been installed to deliver heat from the water treatment plant in Malmö to the district heating grid. That control of the industrial heat pumps was supposed to be developed in a similar way as for the commercial heat pump. The demo site was changed for several reasons, one was the possibility to develop business models and applications for a large scale. Most countries within EU, or the world, do not have the benefit of large district heating system, they rather have the large amounts of gas boilers and single site electric air conditioning units. In order to decarbonize, these systems will be converted into highly efficient electric system utilizing waste heat and providing the thermal needs based on renewable electric energy. The transfer to electric system will indicate larger constraints on the electric grid and at the same time the transportation is being electrified. The current demo site will therefore be more scalable and more widely applicable. The industrial heat pumps have been installed and is operated with regards to the DSO, but the focus in the demo is on the new, more widely distributed energy market.

An evaluation of using industrial or commercial heat pumps to provide flexibility showed that commercial heat pumps have a higher potential due to the number of installations, the nature of distributed energy systems and local balancing. At the time for the application, E.ON hadn´t realized the full potential of this new heat pump innovation, now called ectogrid™, and the potential impact on flexibility. With a large number of commercial heat pumps, connected with both heating and cooling demands, the DSR is of greater importance and can be managed on a much shorter time scale. The concept that is being used in this demo is called ectogrid and has a great potential to be directly connected to a locally balanced system. The replicability of the installation is much greater with the commercial size heat pump than the industrial size heat pump. The conclusion was, that the thermal sector needs to decarbonize, and the number of heat pumps will therefore increase. This needs to be done in an efficient way and a successful business model is crucial.

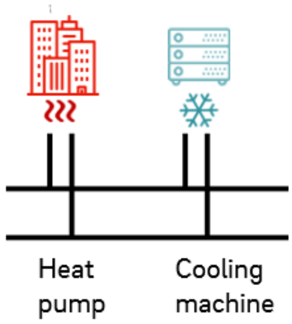



*Figure 4 In the demo, a data centre is suppling heat to commercial office buildings.*

## 2.2. The simulated system with data from the demo site

The demo site in Malmö has facilitated a further development of the system and this development is a part of the overall business model development.

To make the system work from a technical and financial point of view the concept has been further developed beyond the demo case in Malmö, although the technical evolution is still based on the demo in Malmö. ectogrid™ is in the business model development considered to be a 5th generation district heating solution which offers:

- Heating and cooling with one low temperature grid
- Heating and cooling balanced against each other
- Possibility to use low temperature excess heat

Decentral energy generation and heat transfer at ambient temperature minimize energy losses. The above-mentioned properties give ectogrid™ the benefit of being cheaper to build, having a higher operational efficiency, and at the same time better energy efficiency performance compared to most other alternatives.

*Figure 5 Descriptive overview of an ectogrid system*

ectogrid™ is composed of four main building blocks:

1) Building integrated equipment provides buildings throughout the grid with the desired level of thermal comfort. A heated building provides the ability to deliver a cooled flow to other buildings and vice versa. Furthermore, water pumps ensure that the heat pumps are adequately supplied. The components include heat pumps,

optional cooling machines/freezers, heat exchangers, a water pump, and an optional peak load heat generation.

2) The distribution grid is a passive and simple hydraulic piping system whose only purpose is to hydraulically connect different parts of the grid via two uninsulated plastic pipes using water mixed with bioethanol (~5%). The thermal inertia of the ground surrounding the pipes is utilized, while temperatures in the warm and cold pipe vary in a predetermined range. Consequently, the grid has minimal heat/cold losses. Pumping losses are reduced as distribution work is decentralized through the building integrated equipment.

3) Balancing capacity ensures that the cooling and heating needs are always met. An accumulator water tank smooths short term variations in heat/cool supply and helps to control the overall temperature of the grid. A back-up generation unit can provide the necessary heat (or cold) generation capacity to the accumulator as required to balance the thermal and electrical grid's overall needs. When there is plenty of electricity in the grid, the DSO can advise to store thermal energy in the balancing unit and vice versa.

4) Energy management software (ectocloud™) is a cloud platform which acts as the "brain" of ectogrid™ to optimize the balancing of heating and cooling supply and demand. This is also the function that is optimizing the when and how electricity is used and provides flexibility services to the DSO as the business model is approached. The system uses Energy Managers, two-way communication devices that transfer data between different components of the thermal grid, and the ectocloud™ algorithm engine.

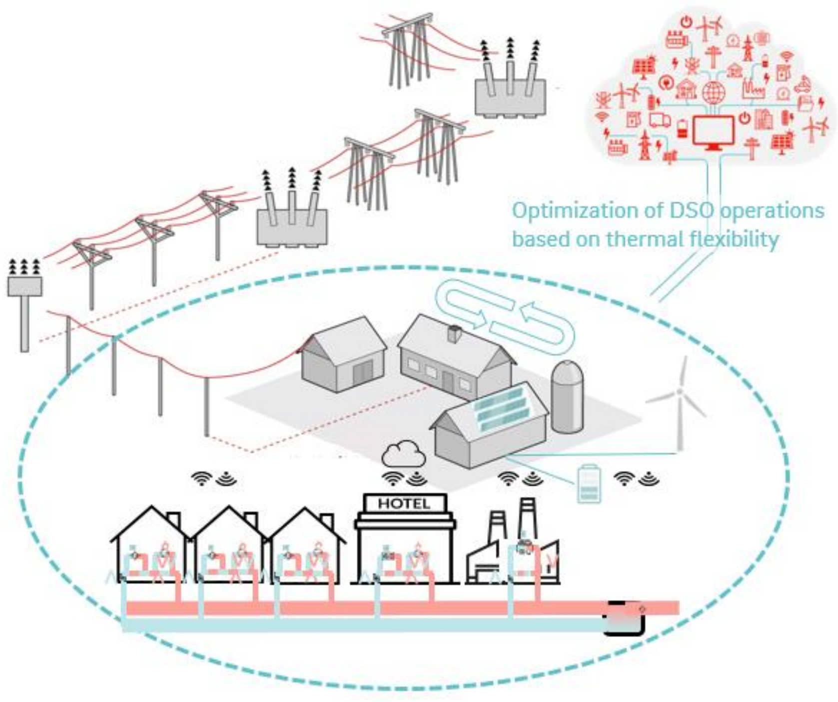



*Figure 6 The platform for thermal flexibility will provide flexibility to the DSO.*

# 3. APPROACH

The assumption when working with the business model development was the following:

- Large portion of the thermal EU market is fossil, a transformation will take place and the market is likely to be more electric.
- The market that is more likely to be electric is the new build sector.
- Regulation will widely impact if there will be an electric thermal market and/or benefits of connecting the electric assets, such as heat pumps, to an aggregator.

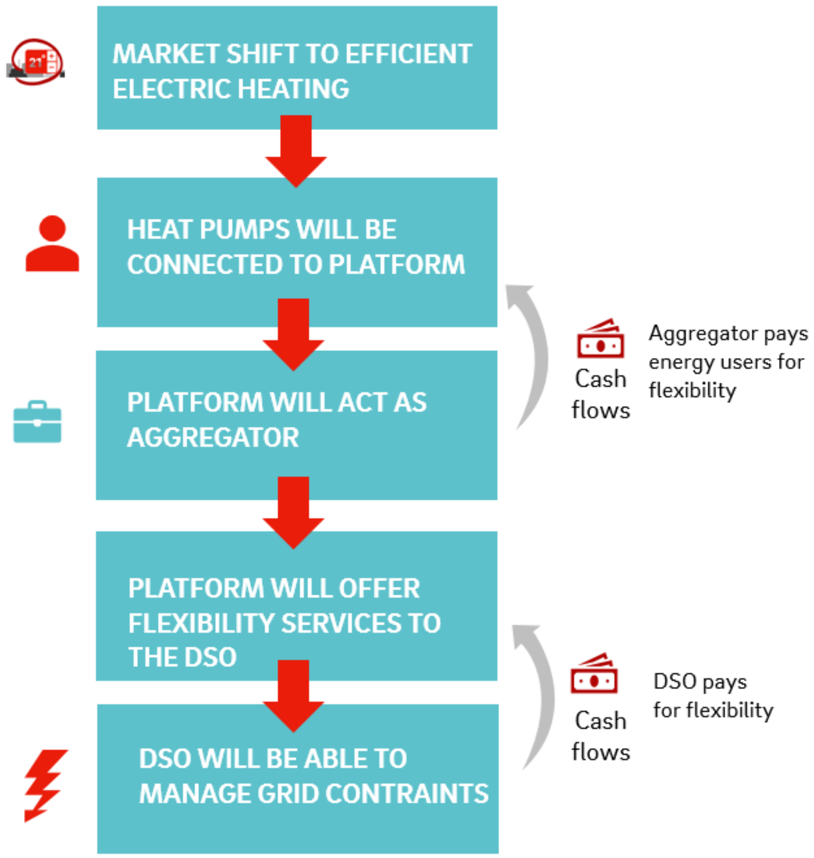



*Figure 7 There is no final market design for thermal DSO services established, although, such a market might be widely beneficial for the DSO.*

In the case of the demo site in Malmö Sweden, there is no DSO market optimization that is fully developed. Since the electric grid and the thermal is owned and operated by E.ON there is a knowledge and understanding on how this market could develop in the future. In the technical and business case development the future DSO market design has been considered, but the assumption is that functionality that does peak shaving and do have capabilities to store electric energy as thermal energy will serve the future market design. Essentially, keeping a lower grid connection for an area by control and steering functionalities will be the solution benefiting from a future DSO flex market.

The market design will not be the same in all countries and the platform need to be adjusted accordingly. This will need to be considered in the technical development and in the development of the business model.

## 3.1. Market assessment

### 3.1.1. Introduction

The market assessment is built on the assumption that there will be a future DSO flexibility market for thermal loads. Three areas have been selected for further studies due to the assumption that they will be crucial for the possibility to create a thermal flexibility business. In order to have any steerable loads, the assumption is that the market needs to convert from mainly gas boilers to electric loads. Combined heat and power assets are not combined since they deliver electricity and are in some markets already considered as a part of a system of virtual power plants. In this project, highly efficient thermal assets such as mass-market commercial heat pumps have been studied.

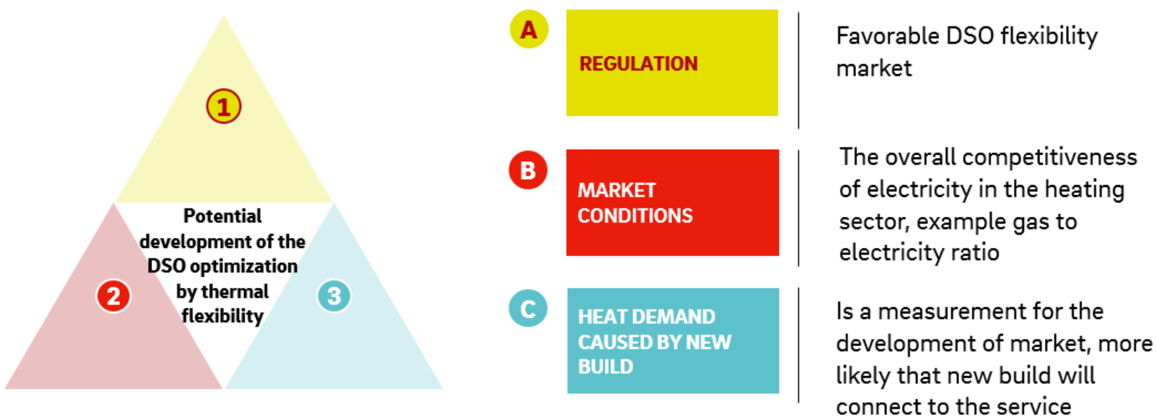



*Figure 8 Three areas have been selected as crucial for the potential development of the DSO optimization by thermal flexibility.*

### 3.1.2. Regulation

With regards to regulation there is an interest to identify markets that are under transition. The markets will be transformed mainly due to regulation based on political decisions. For several reasons this regulation is mainly valid for new build areas or buildings that are heavily renovated, but also for existing electrical infrastructure. The regulation on the supply side, especially RES, are also depending on regulation.

*Thermal energy market needs to be transformed - general*

Heating and cooling in our buildings and industry accounts for half of the EU's energy consumption[1].

[1] https://ec.europa.eu/energy/en/topics/energy-efficiency/heating-and-cooling


*Figure 9 The transformation of the thermal sector is complex and do have several stakeholders.*

In EU households, heating and hot water alone account for 79% of total final energy use. Cooling is a fairly small share of total final energy use, but demand from households and businesses such as the food industry is rising during the summer months. This trend is also linked to climate change and temperature rises. In industry, 70.6% of energy consumption was used for space and industrial process heating. The numbers for cooling are smaller and not as accurate.

84% of heating and cooling is still generated from fossil fuels while only 16% is generated from renewable energy. In order to fulfil the EUs climate and energy goals, the heating and cooling sector must sharply reduce its energy consumption and cut its use of fossil fuels. The thermal sector accounts for 13% of oil consumption and 59% of total EU gas consumption (direct use only) – which equates to 68% of all gas imports.

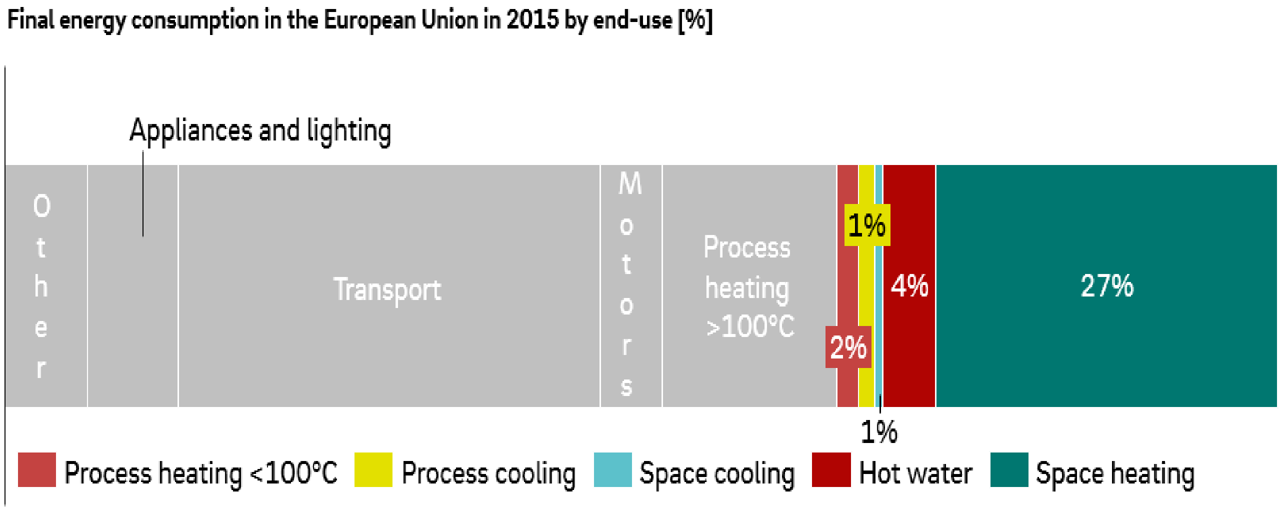



*Figure 10 This project focuses on the hot water, space heating and space cooling sector. The process heating sector is still interesting since this sector might serve the space heating sector with residual waste heat.*

Transforming the energy consumed by heating and cooling in buildings and industry are crucial and new technologies needs to be developed. On the demand side, this can be achieved through scaling up the use of advanced construction and design techniques and high-performance insulation materials when renovating buildings. High building standards for new build are one way to improve the performance, although most buildings and industries are of an older date. Other renewable heating and cooling technologies such as biomass boilers and solar heating systems cut the use of fossil fuels, although they will probably not be commonly used in urban areas. There are sufficient amount of waste heat from industries, such as manufacturing plants, data centres and food industries to heat large residential areas if some electricity is added in for an energy system upgrade.

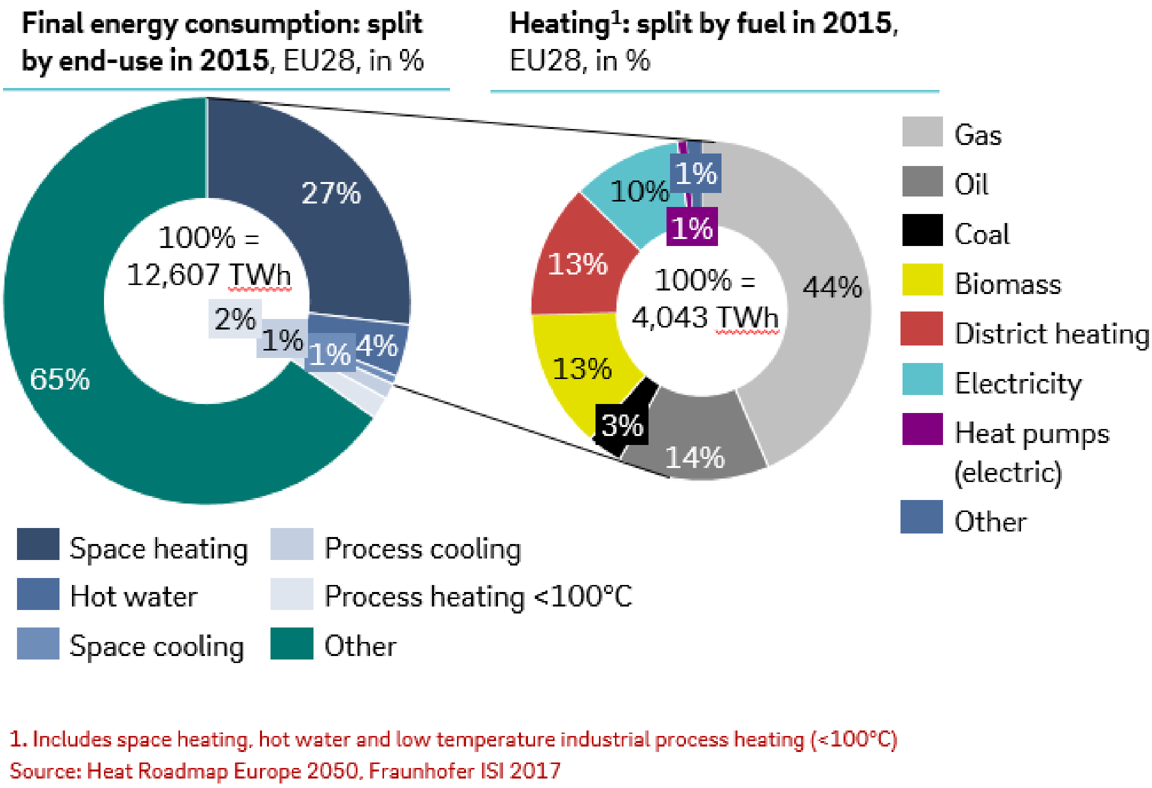



*Figure 11 Heating is the largest energy sector and is gas dominated. It is most likely that the number of heat pumps will grow.*

DSO services are not yet explored towards the thermal market on the demand side. In some application, there is a connection between thermal assets and the trading market. In this project, the trading or spot market is considered but the focus is on how to provide service to the DSO and the introduction of RES into the system due to controllable thermal use.

When creating an offer based on improved thermal efficiency, cooling and heating, and a possibility to access the flexibility market, regulation is of great importance.

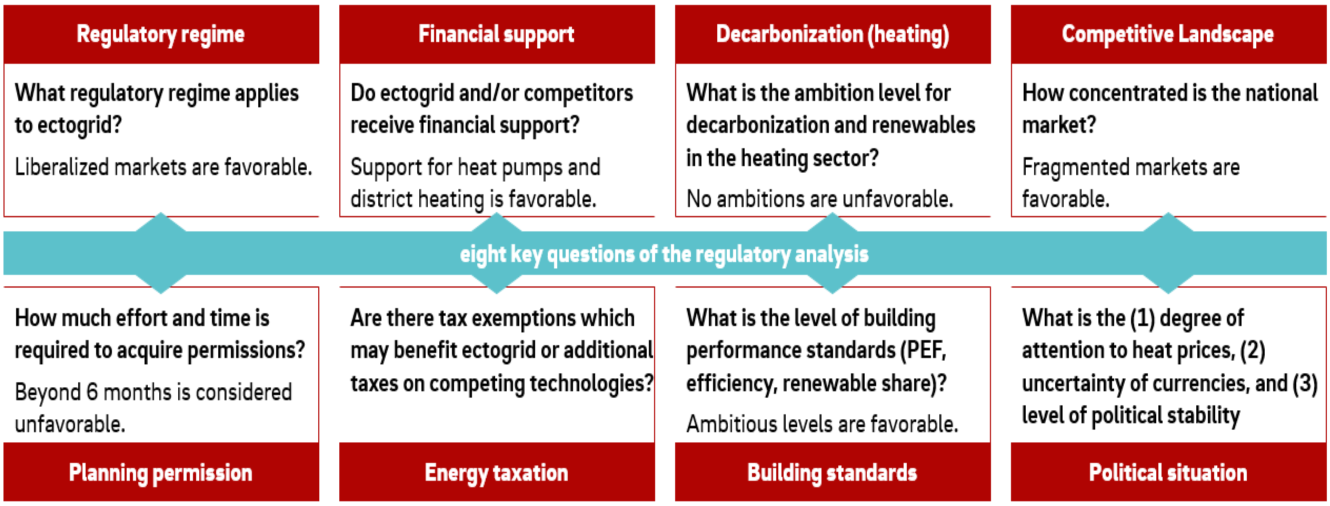



*Figure 12 Summary of regulatory analysis.*

The analysis was performed through desktop research and interviews of regulatory experts and interview with experts within E.ON. When transforming an energy market such as the thermal market with regards to the possibility to create flexibility, several components are crucial in addition to the technical performance:

1) Addressable market: Increased heat and cooling demand caused by new build per year
2) Competitiveness: Electricity to gas price ratio and price setting flexibility
3) Market development: Number of heat pumps installed per thousand households per year

The business model development is focusing on how thermal flexibility might be useful for the DSO, but also attract end customer to join the platform. The thermal system as such therefore needs to be competitive with or without access to a future DSO flexibility market.

When it comes to the business model for the flexibility and DSO services, the market is still not fully developed.

*Technical development in the district heating market*

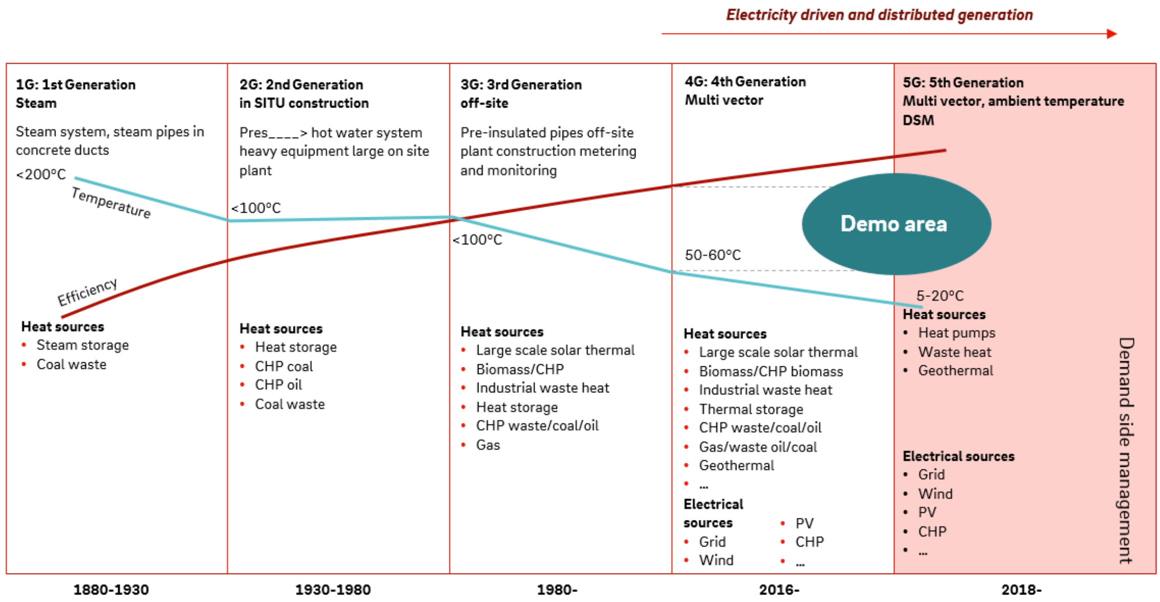



*Figure 13 The district heating market is moving towards heat pump based applications and lower temperatures.*

*Flexibility markets*


*Figure 14 Thermal loads are identified as steerable and flexible and could be forecasted in ectocloud.*

There isn´t one flexibility market in Europe and the market designs are under constant development. There is a possibility to earn saving in the Swedish market through buying electricity on the spot market in a flexible manner, in other markets there are payments for ancillary services and there are means for the DSO to do savings by keeping the overall power outtake down in a subscription area avoiding penalties from the TSO. Other factors that will need to be considered are such factors as self-consumption of PV generation and energy trading models.

In this work, there is no detailed deep dive into flexibility value pools, although they will be taken into consideration in the regulatory work.

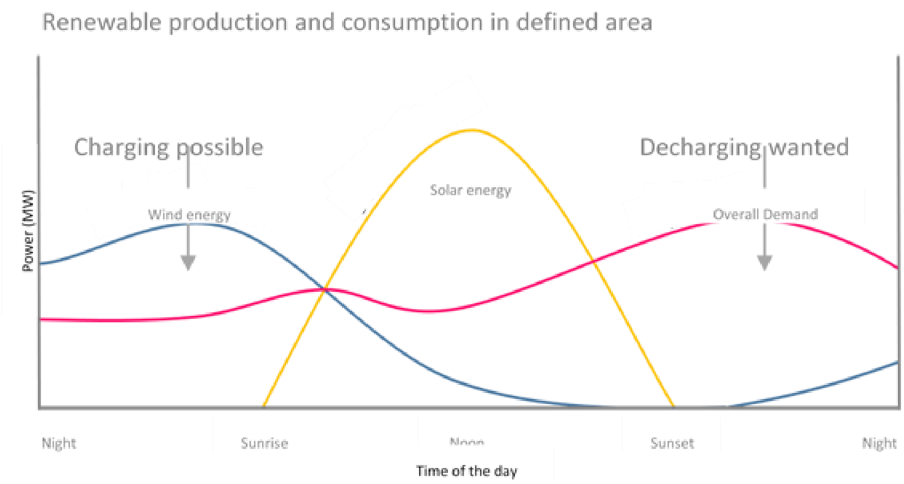



*Figure 15 There are several reasons to provide electric flexibility*

### 3.1.3. Market conditions

There are several aspects to the market conditions, one that has been identified as more straight forward compared to others is the gas to electricity price ratio. To create optimization services for the DSO, the thermal market needs to turn electric.

**Electricity to gas price ratio**

$$= \frac{Electricity\ price}{Gas\ price}$$

*Figure 16 Indicates the likelihood of gas being converted to electric solutions like heat pumps.*

The thermal sector in Europe is dominated by gas and gas boilers. Gas boiler installations do normally have a high temperature in the radiator system and is therefore hard to replace with a heat pump in an efficient manner. For new build, this is not the case since the temperature levels in that radiator systems in general are much lower. If replacing the gas boilers in the older building stock normally required a replacement of the radiator system and if doing so, the likelihood of connecting the building to a thermal aggregator will increase.

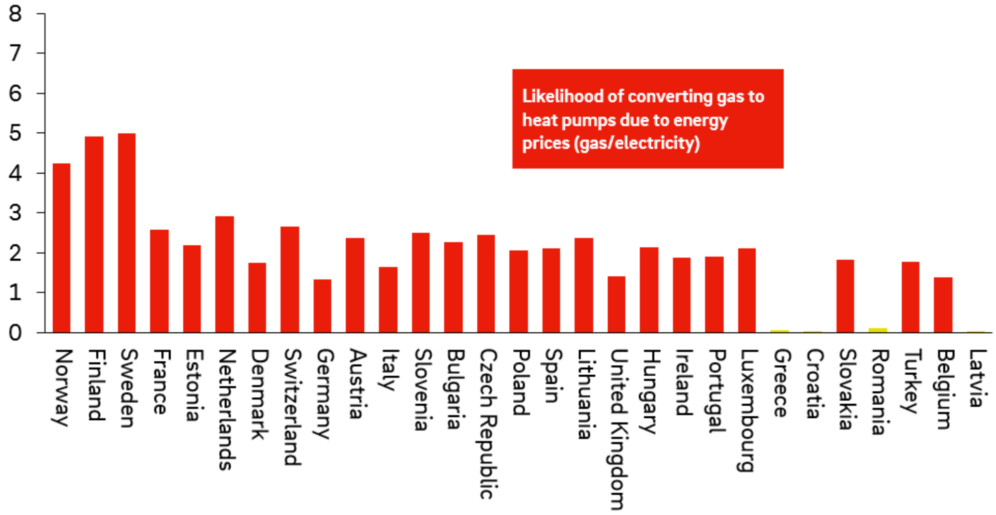
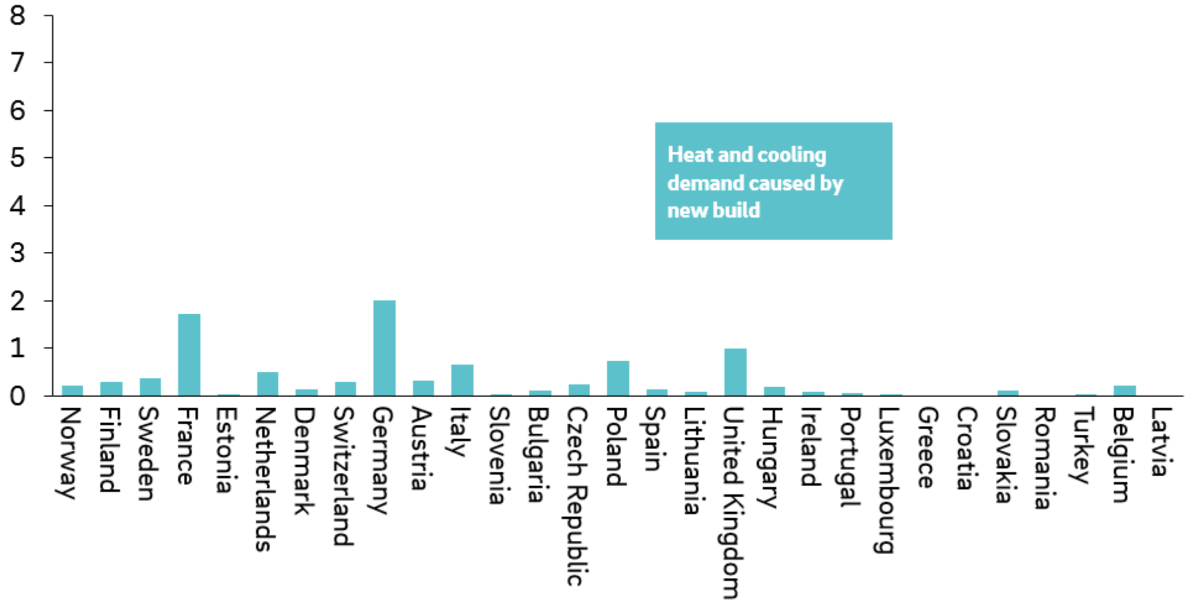



*Figure 17 All data extracted from Eurostat and then converted to likelihood of converting from gas heating to heat pump due to prices. Countries with high numbers being more likely to convert from gas to heat pumps due to the gas/electricity price ratio.*

The gas price and electricity price are widely impacted by taxes and regulations, making this parameter overlap with the regulation to some extent. The electricity and gas prices are the average of residential and non-residential medium sized customer price for a country. It includes all grid fees and taxes, because the end user probably considers the final price at the connection point as relevant.

### 3.1.4. Heat demand caused by new build




$$\text{Heat and cooling demand caused by new build per year} = \textbf{\textit{Residential}} + \textbf{\textit{Non}} - \textbf{\textit{residential space heat/cooling}} + \textbf{\textit{Process heat/cooling}}$$

*Figure 18 The heat demand caused by new build has been evaluated and ranked.*

The assumption is, that new build is more likely to connect their assets to a smart energy system. If there are a large proportion of new build there are more sites that are likely to connect their thermal assets to a platform that will provide services such as rewards for flexibility. New build properties are also more likely to have a radiator system that is suitable, meaning lower temperatures, for heat pumps.

A further disaggregation of the new build sector would give even further insights and urban districts and multifamily homes and commercial buildings would be in the focus. This selection hasn´t been done within the project but would be of interest for further studies. A study of waste heat generation, such as data centres and large chilled logistic centres and proximity to newbuild neighbouring areas would also be beneficial for the estimate of the numbers of customers that would be connected to a platform that provides DSO flexibility.

In general, grid constraints that will be nonbeneficial for DSOs will most probably take place in growing cities and in new build areas. This selection will also be useful in order to understand more of the value pools and avoided costs from a DSO-perspective.

### 3.1.5. Market assessment – conclusion

When developing a business model, the business model has to be relevant for the identified market. The market that would be most accessible for a platform that aggregates thermal loads would be a market in transformation and with a regulation that is beneficial for efficient electric heating. The DSO flexibility market is not fully developed and will be under transformation. The possibility for sector coupling is also beneficial and a crucial part of the demo, the connection to a thermal grid (district heating or/and ectogrid™) is very beneficial and will increase the possibility to provide flexibility to the DSO and optimize the operating cost due to flexible energy prices.

The conclusion is that a market under development with a large fraction of RES and limited and aged grid, at the same time going away from gas to electric heating, are more likely to introduce a favourable DSO market and at the same time have a price structure that will be beneficial for end customers.

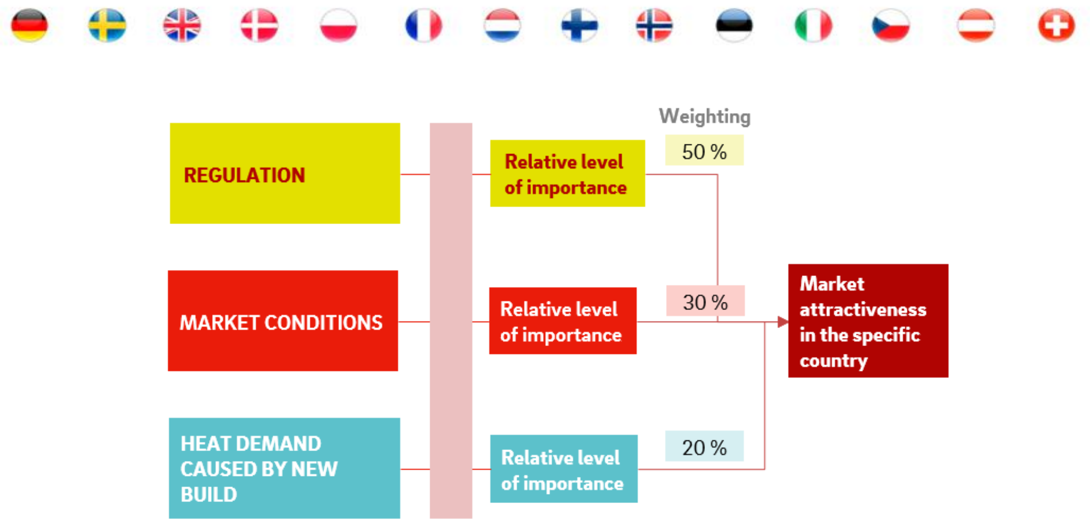



*Figure 19 The impact of the three chosen components on the market assessment might be evaluated with regards to importance. This might vary depending on the region as well.*

The conclusion is that the countries of greatest interest for a thermal aggregator like ectocloud™ and that would be serving as examples for business case evaluations would be Sweden, Norway, Denmark, Germany, Netherlands and United Kingdom.

## 3.2. Business model development

### 3.2.1. Business models

The development of a software integrated with several customers and value pools in a secure manner is a complex task. To develop a software that is safe and secure and that will actually make a difference in the market, the market itself needs to be identified. The focus in the development of the business model has been to identify potential value pools and how to monetize from these value pools. The value pool that has been identified and has been further developed in this project is the future value pool of optimization of capacity and the provision of this as a service to the DSO.

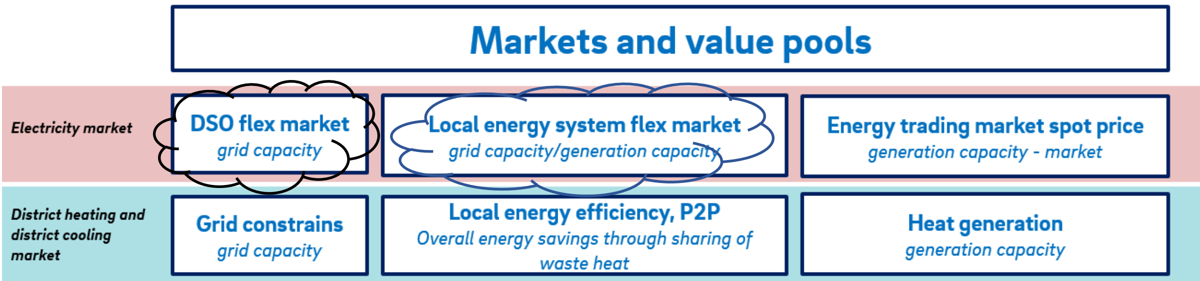



*Figure 20 The DSO flex market is under development in Sweden. The possibility to gain from flexibility vary in between the markets, in general peer to peer markets and local energy markets are likely to increase within Europe*

The DSO optimization could be considered to be a standalone market, developing pricing to facilitate services. This needs to be done in accordance with regulations and all customers should be handled equally. As for today, customers pay for the maximum outtake of the grid. The tariff is capacity based. The pricing today isn´t designed to support the growth of urban areas, nor to avoide large grid investment. The assumption is that there will be a market where the TSO will be offered flexibility from the DSO. The flexibility owners, will be aggregated by a platform owner, for instance ectocloud™.

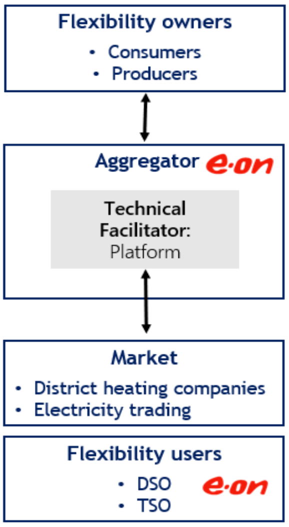



*Figure 21 The thermal market is in transformation and is likely to move toward electrification. If connecting large amounts of thermal assets to a flexibility platform, there is a large potential for DSO-flexibility.*

The markets in mind when developing the business model are all European. This is mainly due to limited knowledge of other markets and a need to limit the scope of the work.


*Figure 22 The market considered in this deliverable is Europe.*

The project for the business model development has focused on the business model for the software that aggregates and shift thermal loads in time, preferably connected to an ectogrid™. The hardware technology hasn´t been in focus, neither the actual market design of DSO services.

One business model for E.ON would be to design, build and operate ectogrids around Europe. The conclusion however is that, although an innovative and efficient innovation, these installations wouldn´t be able to serve the DSOs in a large extent. The software in the business model development will therefore be used for ectorids as well as standalone heat pumps. In order to reach a larger market share, the licensing of the software has also been evaluated.

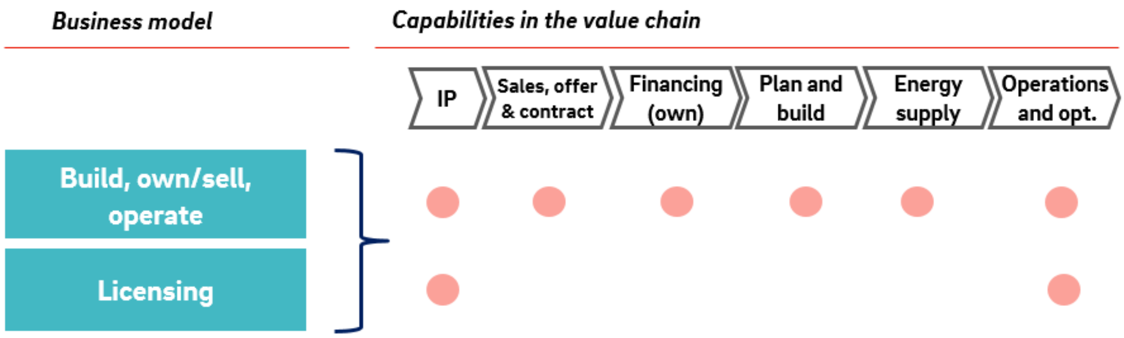



*Figure 23 Examples of business models from a platform developer/owner point of view.*

### 3.2.2. Customer perspective

The customer perspective is important, and many customers have been involved in the development of the business model, providing valuable feedback. The customers have been divided into three groups as in the table below.

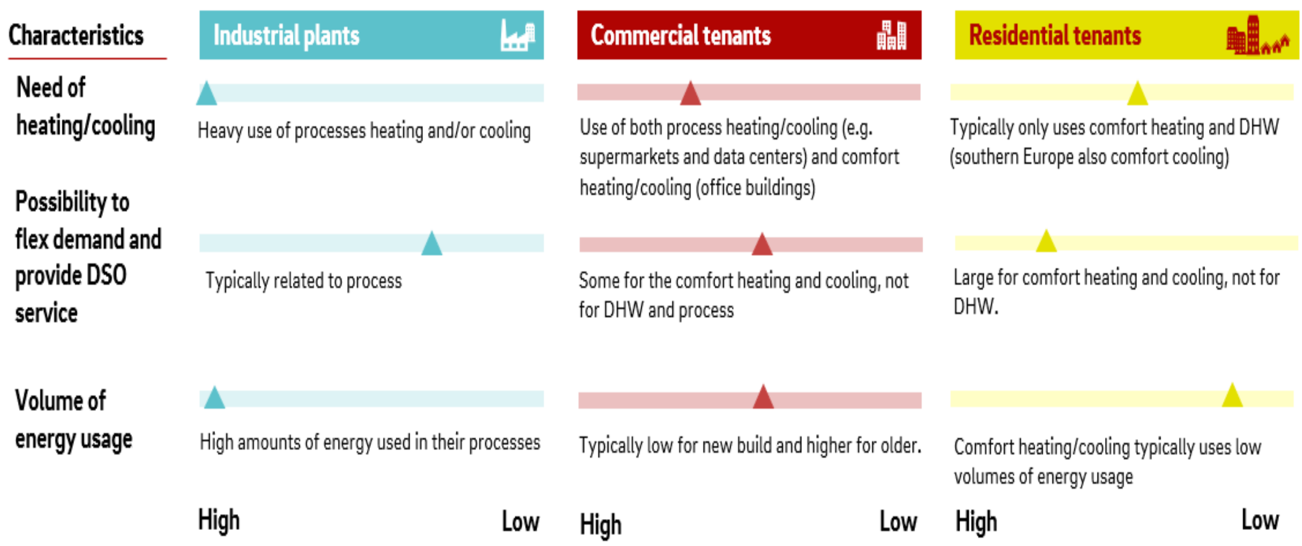



*Figure 24 The potential for different kind of customer segments.*

There are several types of customers, all with varying degrees of flexibility. Heat pumps providing comfort heating to residential buildings and heat pumps that are connected to a grid with a balancing unit (accumulator) will have most flexibility to provide if connected to a platform. Industrial plants might have large volumes, but many times these are interlinked with the major operations such as welding process, bakeries, breweries, and are therefore not accessible.

### 3.2.3. Cost assessment

The cost of accessing thermal flexibility is relatively low due to the rapid development of an internet of things. The integration with the building and /or process is more costly. The customer benefit needs to be clear and the data management and connection needs to be reliable.

The connection of customers could be done in several ways:

- Ex mandatory of installing a heat pump in area with grid constrains, the DSO needs to be able to steer and control
- Voluntarily if the customer will benefit from DSO flexibility through the aggregator
- Aggregator, in this case ectogrid™, will connect the heat pump free of charge and share the revenues with the end customer
- Additional services such as maintenance services will be provided by the platform and the flexibility will be an add on

# 4. RESULTS

## 4.1. Market assessment

When developing a business model, the business model has to be relevant for the identified market. The market that would be most accessible for a platform that aggregates thermal loads would be a market in transformation and with a regulation that is beneficial for efficient electric heating. The DSO flexibility market is not fully developed and will be under transformation.

The market design will not be the same in all countries and the platform need to be adjusted accordingly. This will need to be considered in the technical development and in the development of the business model.

## 4.2. Business model development

One business model will be built, design, invest and optimize. The conclusion is that this business model will play an important part, but in order to reach scale and play a proper role in the flexibility market, the software itself needs to be licensed to other actors.

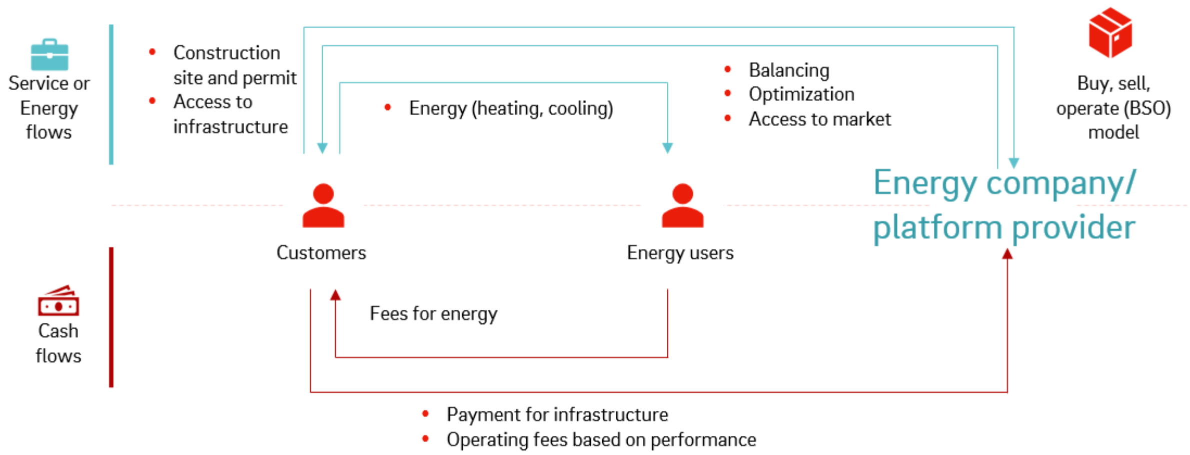



*Figure 25 Example of business model.*

The platform owner will still play an important role as technology provider, but other parties will face the customers. They will also bring the local requirements back to the platform provider that will add those requirements to the service

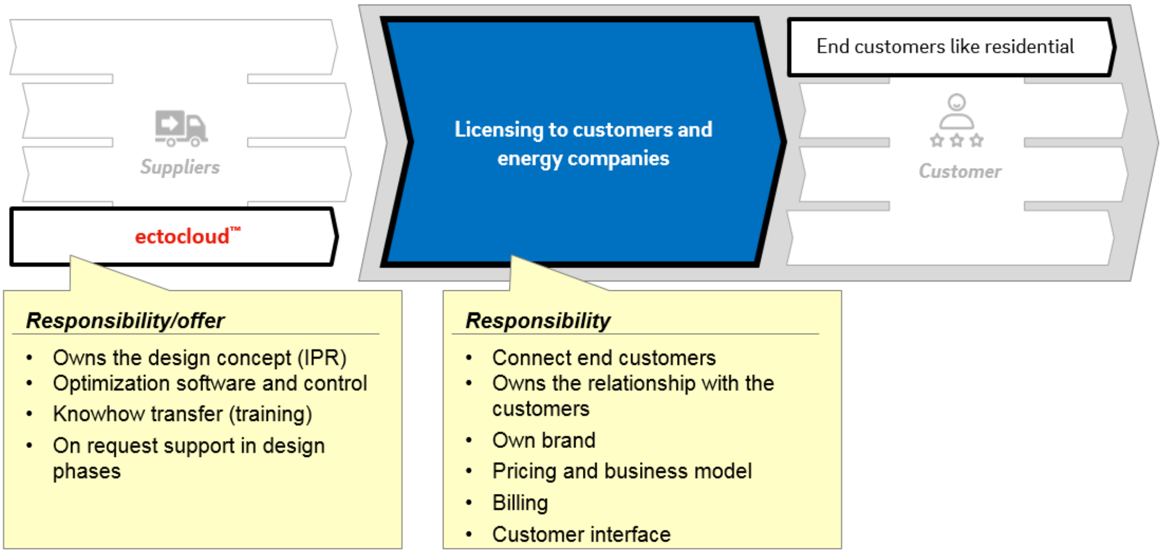



*Figure 26 Business model, example.*

# 5. CONCLUSIONS AND LESSONS LEARNT

The thermal market will most probably be more electric, at the same time the transportation fleet is going electric and the share of RES are increasing. The challenge for DSO will increase and the market for DSO services will develop. This business development was first focusing on how to connect ectogrid™ to a DSO flex market via ectocloud™. Quite soon reaching the step where this market was too limited to actually make a huge impact on the DSO operations. Utilizing the same software and connecting also stand-alone heat pumps to the platform will improve the business case, but not to the full extent. Including the possibility to license the software as a service has significantly increased the reachable customer group, and possibility to access more markets within Europe.

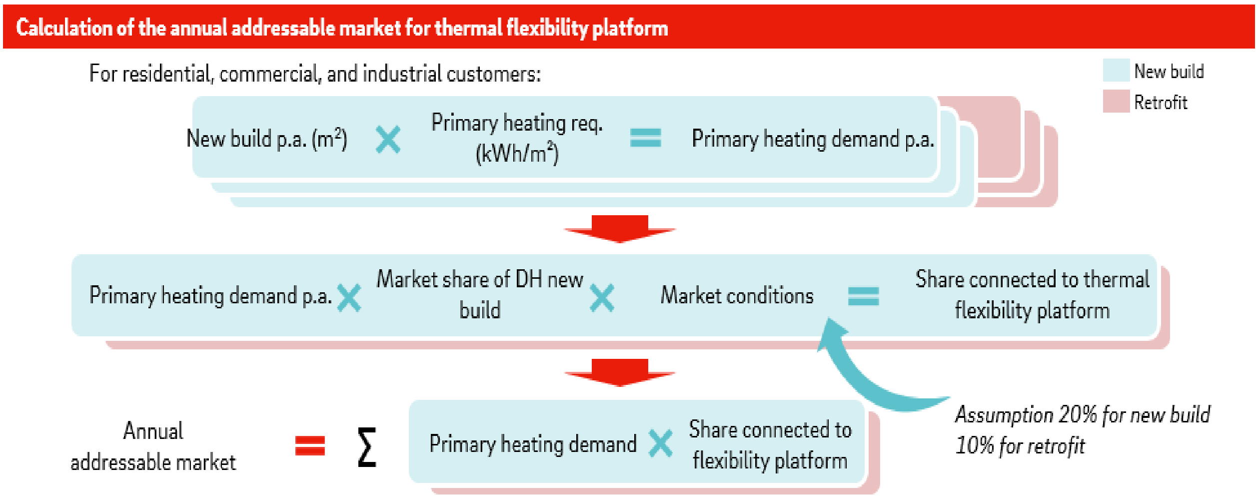



*Figure 27 Calculation of adressable market.*

The business model development has taken place for a market design that isn´t in place yet but do have similarities to the flexibility market served by Virtual Power Plants on the negative response, in this case based on signals from the DSO instead of the electric trading market.

The major conclusion is that there will be a large market for thermal flexibility, this needs to be designed in a manner that encourages customer to connect and provide flexibility. Without flexibility it will be hard from a DSO point of view to support the electrification.

# 6. RECOMMENDATIONS AND FUTURE STEPS

## 6.1. Recommendations

The functionalities of thermal flexibility are similar regardless if the purpose is to serve the DSO, energy trading market or local generation optimization (predominantly PV generation). The development of such a platform is costly and large number of data need to be stored in a safe manner. The algorithms need to be developed based on expected consumption, market and technical constraints. The thermal supply needs to be integrated with the customer needs and thus the BEMS. Connection to a thermal grid and/or an accumulator is always beneficial from a flexibility point of view.

It is clear that a large number of connected thermal assets will be able to serve the DSO, but the business model will in the end be dependent on the countries market design and regulation, as well as the customers willingness to connect to an aggregator.

The customers in this study are a quite wide range, ranging from residential customers to district heating companies. The conclusion is that several segments and stakeholders in the heating market do need to be included in order to connect the desired volumes.

## 6.2. Future steps

Explore further services that will be beneficial for the customers, providing further services for DSO optimization. Evaluate the various DSO market designs that are under development.