

IDEAS: Intelligent Neighbourhood Energy Allocation & Supervision



Deliverable 2.3

Generalised business models

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ACRONYMS

ARENH	Regulated. Access to Incumbent Nuclear Electricity
BLT	Build-Lease-Transfer contracting model
BOO	Build-Own-Operate contracting model
BOOT	Build-Own-Operate-Transfer contracting model
BOT	Build-Operate-Transfer contracting model
BRT	Build-Rent-Transfer contracting model
CCHP	Combined Cooling, Heat and Power
CHP	Combined Heat and Power
CRE	Commission de Régulation de l'Énergie (Energy Regulatory Commission)
D&B	Design and Build Public-Private partnership model
DBFO	Design-Build-Finance-Operate contracting model
DECC	Department of Energy and Climate Change
DH	District Heating
DHC	District Heating and Cooling
DHW	Domestic Hot Water
DNO	Distribution Network Operator
DREG	Distributed Renewable Energy Generation
DSM	Demand Side Management
DSMO	Demand Side Management Operator
DSO	Distribution System Operator
EDF	Électricité de France (Electricity of France)
EDN	Electricity Distribution Network
ENTSO-E	European Network of Transmission System Operators for Electricity
EPC	Energy Performance Contracting
EPBD	Energy Performance of Buildings Directive
EPEX	European Power Exchange
EPN	Energy Positive Neighbourhood
EPNSP	Energy Positive Neighbourhood Service Providers
ERDF	Electricité Réseau Distribution de France (Electricity Network Distribution of France)
ESC	Energy Supply Contracting
ESCo	Energy Service Company
FIT	Feed-In Tariff
FFIT	Fixed-price Feed-In Tariff
HVAC	Heating, Ventilation and Air Conditioning
ICT	Information and Communication Technology
IEC	Integrated Energy Contracting
IDNO	Independent Distribution Network Operators
IUT	University Institute of Technology at the University of Bordeaux
PFI	Private Finance Initiative

PFIT	Premium based Feed-In Tariff
PPP	Public Private Partnership
PV	Photovoltaic
PWN	Private Wire Network
RES	Renewable Energy Systems
RTE	Réseau de Transport de l'Electricité
ROI	Return on Investment
SSM	Supply Side Management
TNO	Transmission Network Operator

GLOSSARY

Demand Side Management

Demand Side Management (DSM) is commonly used to refer to demand side electrical load management. It involves actions that influence how much energy is used or when energy is used. The goal of DSM is to encourage users to use less energy during peak hours, or to move the time of energy use to off-peak times such as night-time and weekends.

Distribution Network Operators

Distribution Network Operators (DNOs) are often also referred to as Distribution System Operators (DSO). They are responsible for the transport of electricity at a regional level and as such they transport electricity at gradually reducing voltages from national grid supply points to final customers, both residential and none residential. Throughout the EU, electricity distribution is a regulated monopoly business.

Dynamic electricity tariffs

Dynamic electricity tariffs often referred to as real-time pricing. Prices change usually on an hourly basis reflecting the cost of generating and/or purchasing electricity at the wholesale level at the time of delivery.

Distributed renewable energy generation

Distributed renewable energy generation (DREG) or local, decentralized renewable energy production involves solar photovoltaic (PV), small hydroelectric, small-scale biomass facilities, and micro-wind.

Energy performance contract

An energy performance contract (EPC) is a contractual arrangement between the beneficiary and the provider of an energy efficiency improvement measure, verified and monitored during the whole term of the contract, where investments (work, supply or service) in that measure are paid for in relation to a contractually agreed level of energy efficiency improvement or other agreed energy performance criterion, such as financial savings.

Energy Supply Contract

The key element in Energy Supply Contracting (ESC) is the efficient supply of energy. The contracting partner provides products/services such as supplying electricity, gas, heat. Financing, engineering design, planning, constructing, operation and maintenance of energy production plants as well as management of energy distribution are often all included in the complete service package. For example district heating providers are the most widely implemented example of energy supply contracting in the residential sector.

Electrical Load management

Electrical load management, often referred to as simply load management, is achieved through controlling the power flow in the electric system at the generating end (supply side management) or the customer end (demand side management).

Electricity Supply

Electricity supply is the process of buying electricity in bulk and selling it on to the final customer. Electricity supply in most EU countries is a competitive market.

Energy Supplier

Energy suppliers buy electricity and /or gas in bulk and sell it to final consumers.

Energy Service Company

An Energy Service company (ESCO) is a company that offers energy services which

may include implementing energy-efficiency projects (and other sustainable energy projects). The energy services supplied by ESCOs can include a wide range of activities such as energy analysis and audits, energy management, project design and implementation, maintenance and operation, monitoring and evaluation of savings, property/facility management, energy and/or equipment supply, provision of service (space heating/cooling, lighting, etc.) advice and training,

Green lease contracts

In Green lease contracts, the building owner and tenant share both heat and electricity costs.

Integrated Energy Contract

An Integrated Energy Contracting (IEC) combines ESC with EPC into one integrated project to deliver maximum savings, both environmentally and economically. This is achieved by implementing efficiency measures on the whole chain: from production to delivery and final consumption. By also choosing to switch from fossil fuels to renewables the CO₂ emissions can be lowered considerably. .

Local renewable energy sources

Includes solar PV, wind and hydro power, as well as other forms of solar energy, biofuels and heat pumps (ground, rock or water) that is generated within 100 kilometres of the neighbourhood.

Private wire networks

These are local electricity grids that although connected to the local distribution networks are privately owned.

Property market

Property market is defined in a wide sense to refer to the construction or renovation of buildings and the buying, selling, and renting of land or buildings.

Supply Side Management

Supply Side Management (SSM) is commonly used to refer to supply side electrical load management. It refers to actions taken to ensure that energy generation, transmission distribution and storage are conducted efficiently, on the supplier's side of the energy supply chain.

Time-based pricing

Time-based pricing is a pricing strategy where the provider of a service or supplier of a commodity, may vary the price depending on the time-of-day when the service is provided or the commodity is delivered. Therefore dynamic electricity tariffs are a form of time-based pricing. The rational background of time-based pricing is expected or observed change of the supply and demand balance during time.

Transmission network operators

Transmission Network Operators (TNOs) are responsible for the bulk transport of electricity by high voltage power lines from power stations to grid supply points. The transmission system is generally referred to as the national grid. Throughout the EU Transmission is a regulated monopoly business.

Utilities industry

Utilities industries in its broad sense refers to electricity, gas and water supply companies and integrated energy service providers. The term is most often used to refer to the companies involved in the generation, transmission and distribution of energy.

EXECUTIVE SUMMARY

This report concerns business models for Energy Positive Neighborhoods (EPNs) and is based on research conducted as part of the IDEAS project.

EPNs are areas in which annual energy demand is lower than annual energy supply from local renewable energy sources. Their energy infrastructures are connected to and contribute to the efficient operation and security of the wider energy networks. The aim is to support the integration of distributed renewable energy generation into wider energy networks and provide a functional healthy user friendly environment with as low energy demand and little environmental impact as possible.

The IDEAS project has developed business models to enable existing companies with expertise in the energy industry to evolve into a new type of service provider. We called this new type of service provider an Energy Positive Neighbourhood Service Provider (EPNSP).

The key service required for the development of an EPN is the optimisation of the production, storage/retrieval and selling of local renewable electricity and heat in the local area. Distribution Network Operators (DNOs), Energy Service Companies (ESCOs) and District Heating (DH) Providers are the envisaged service providers in the business models developed to enable the roll out of EPNs in the IDEAS project. There is an overlap in the unique value propositions for these types companies to extend their current business models and become EPNSPs. Specifically:

In the case of DNOs;

- Up to a 100 % reduction in the investments required for the reinforcement of the wider electricity distribution network to service new urban developments,
- Significant reductions in the total investments in network reinforcement required to integrate DREG into current electricity networks,
- Enabling the incremental upgrading of the ‘dumb’ electricity distribution networks to the ‘smart’ networks required to integrate DREG into current electricity networks.

In the case of DH Providers and ESCOs

- Up to 30% increase the revenue generation from distributed renewable electricity and heat production
- Up to 10 % increase in the efficiency of distributed renewable plant.

While the concept underpinning the notion of an EPN, in the IDEAS project, is that local energy demand is serviced by local renewable energy supply we are not advocating ‘islanded micro grids’ that operate separately from the national energy networks. It is envisaged that the energy infrastructures of EPNs are not only connected to the wider energy networks but that they contribute to the optimisation and security of those wider energy networks, acting as ‘good citizens’ whenever viable to do so given market conditions.

Earlier research, conducted as part of the IDEAS project, developed business models for EPNSPs tailored to the requirements of the key stakeholders at the project pilot sites in France and Finland. These business models have two key ‘revenue streams’ which represent the source of profits for an EPNSP:

1. Energy arbitrage and efficiency gains obtained through optimising the production, storage/retrieval and selling of local renewable electricity and heat production.
2. Integrated Energy Contracts (IEC) which combine energy efficiency and renewable energy supply and management in large buildings and groups of buildings in the same locality owned by the same organisation.

The more innovative of the two revenue streams is that which concerns energy arbitrage and optimisation as Energy Service Companies (ESCOs) offering IEC already exist in some countries in the EU. It must also be noted that as markets for heat trading are both limited and

in their infancy, the business models developed in IDEAS focus is on trading in electricity markets.

To assess the applicability of the IDEAS business models beyond the IDEAS pilot sites the research presented in this report identifies how the different structures of the utilities industry and property markets in different EU states impact on their key revenue streams. The best case scenario for EPNSPs are summarised in the following table:

Key structures	Role in supporting EPNSPs	Prevalence in the EU
Time based tariffs for the electricity EPNSPs purchase and sell	Providing a potential to optimise neighbourhood energy supply resources based on their market value.	Most prevalent in Finland, Norway ¹ and Sweden where spot price tied contracts are commonly marketed.
Distribution network charges which reflect the distance is electricity transported	Offering a financially viable method of distributing electricity to consumers in the neighbourhood and avoiding the duplication of current electricity distribution networks with private wire networks.	This is not implemented in the EU. A lack of differentiated local and national network tariffs does not necessarily negate the IDEAS business models. However it does mean that the cost optimisation of the production may not work in favour of the local consumption of distributed renewable energy.
'Active' or 'smart' local electricity grid	Providing the monitoring, control and advanced protection systems required for the supervision and operation of bidirectional power flows in a distribution network.	Most countries in Europe are moving toward the development of 'active' or 'smart' electricity distribution networks. Countries with national implementation plans include Austria, Belgium, Cyprus, Denmark, Finland, France, Greece, Luxembourg and Norway.
Exploitation of the economies of heat/cooling and electricity cogeneration supplied by CHP or CCHP.	Enabling the economical provision of both heat/cooling and electricity within an EPN. It must also be noted that should other forms of renewable energy production be available that can supply the heating/cooling and electricity demand of a neighbourhood more cost effectively than CHP or CCHP then the business models could be adapted as required.	In line with the EU RES-Directive 2009/28/EC an increasing number of national governments have identified District Heating and Cooling (DHC) as an efficient technology to achieve the main objectives of the European legislation regarding sustainable energy. The current market opportunities are greatest in North, Central and Eastern Europe where market shares of DH often reach 50% and more of the total heat demand.
Regulatory and voluntary instruments to encourage high standards of building energy efficiency	Reducing energy demand making it easier to be met by renewable supply and reducing the need to invest in new generation facilities.	The Energy Performance of Buildings Directive ((EPDB recast, 2010/31/EU) is the key regulatory driver. Rates of implementation of the different elements of the directive vary between countries in the EU. In addition to mandatory energy certification schemes, arising from the EPBD, there are voluntary building certification schemes used throughout the EU. The uptake of these schemes is greater in the countries that have developed their own schemes compared to those which apply schemes developed in other countries.
Legal, regulatory and business contexts that enable PPP (in the public sector) to fund Integrated Energy Contracts (IEC)	To underpin life cycle approaches that offer financial rewards to those responsible for the design, construction and management of buildings if they reduce the running costs.	With the increasing interest in community energy finance, IECs, PPPs, green leasing and other forms of life-cycle contracting across the EU, the possibilities for funding an EPNSP is growing in most EU countries.

¹ Norway is not a member state of the European Union (EU), but is closely associated with the Union through its membership in the European Economic Area (EEA), in the context of being a European Free Trade Association (EFTA) member.

The findings, summarised in the table above illustrate that no European country currently offers the best case scenario for the structures of the utilities industry and property markets for the development of the IDEAS business models for EPNSPs. However some come close enough to offer markets for EPNSPs. In particular Denmark, Finland, Norway and Sweden are potential markets for EPNSPs. They all have mature district heating markets. They are moving towards smart distribution networks, while in Sweden Finland and Norway spot price tied electricity contracts are commonly marketed. Denmark, Finland, Norway and Sweden are also among those EU countries that are implementing the different elements of the EPBD in earnest suggesting a national policy commitment to the development of energy efficient buildings. In addition they have residential market structures which favour the development of efficient housing and commercial and regulatory practices which support IECs and lifecycle approaches.

However it must be noted that:

1. Some current renewable energy subsidies, usually in the form of Feed in Tariffs (FITs), can distort the energy markets and reduce the amount of locally produced renewable electricity that is consumed locally in an EPN, when cost optimisation is applied to energy management. However it would be simple to resolve this issue if FITs were paid to energy producers regardless of whether the energy is sold outside of an EPN or sold directly to customers within the EPN and premium based FITs (PFITs) which pay a premium on top of the variable market price are applied.
2. The lack of dynamic network tariffs which favour the local consumption of DREG does not necessarily negate the business models for EPNSP. However it does mean that once again the optimisation of the production, storage /retrieval and selling of local renewable electricity and heat production may not always work in favour of the local consumption of distributed renewable energy; as the distribution charges do not differentiate as to the extent that the distribution network is actually being employed.

The idea that ‘community energy project’ financing offers a route to community engagement in the development of EPNSPs is supported research undertaken in the IDEAS project. A survey of Finnish people living in and around the Omenatarha residential neighbourhood in Finland, found that 75 percent of people felt they were more likely to invest in co-operative community renewable energy projects than they were to invest in renewable technologies in their houses such as PV panels on their homes. The possibilities of community energy project financing for funding EPNSPs also seems to be supported by the growth of community energy projects across the EU.

1 INTRODUCTION

1.1 Purpose and target group

This report is concerned with business models to underpin the development of Energy Positive Neighbourhoods (EPNs). For the scope of this study, “*a business model is defined as the rationale of how an organisation creates, delivers, and captures value from delivering products and services*” (Osterwalder and Pigneur, 2010).

EPNs are those in which the annual energy demand² is lower than annual energy supply from local renewable energy sources³. Their energy infrastructures are connected to and contribute to the efficient operation and security of the wider energy networks. The aim is to support the integration of distributed renewable energy generation into wider energy networks and provide a functional healthy user friendly environment with as low energy demand and little environmental impact as possible.

While the concept underpinning the notion of an EPN in the IDEAS project is that local energy demand is serviced by local renewable energy supply, we are not advocating ‘islanded micro grids’ that operate separately from the national energy networks. It is envisaged that the energy infrastructures of EPNs are not only connected to the wider energy networks but that they contribute to the optimisation and security of those wider energy networks⁴. In this regard the idea that the energy demand of the neighbourhood is predominantly serviced by local renewable energy supply is significant. This is because matching local supply (e.g. solar and wind power) with local demand can mitigate congestion on the electricity distribution network enabling savings on the investments in grid capacity and congestion management required to support distributed renewable energy generation (DREG) in the electricity industry (Van der Oosterkamp, et al. 2014).

The DREG in an EPN will not put extra pressure on congested electricity networks, while electricity can be stored and sold outside of the EPN when national energy demand is high. To realise an EPN it will be necessary to develop business models to enable existing companies with expertise in the energy industry to evolve into a new type of service provider. In the IDEAS project we called this new type of service provider an Energy Positive Neighbourhood Service Provider (EPNSP).

Distribution Network Operators (DNOs), Energy Service Companies (ESCOs) and District Heating (DH) Providers are the envisaged service providers in the business models developed to support the roll out of ENPs in the earlier phases of the project⁵. These business models, for what might be called Energy Positive Neighbourhood Service Providers (EPNSPs), are tailored to the requirements of the key stakeholders at the project pilot sites.

- Part of a University campus in Bordeaux, France, which houses the University Institute of Technology (IUT).

² Energy demand of a neighbourhood includes the energy demand of buildings and other urban infrastructures, such as waste and water management, parks, open spaces and public lighting.

³ Local Renewable energy sources includes solar PV, wind and hydro power, as well as other forms of solar energy, biofuels and heat pumps (ground, rock or water) that is generated within 100 kilometres of the neighbourhood.

⁴ This approach is informed by that proposed in the COOPERaTE project which is running concurrent with the IDEAS project, in which an EPN is defined as “*a neighborhood which can maximize usage of local and renewable energy resources whilst positively contributing to the optimization and security of the wider electricity grid*” (Pesch et al. 2013).

⁵ See Deliverable 2.2 “*Specific Business Models for Demo Cases*” (Crosbie et al 2013).

- The Omenatarha residential neighbourhood in the Skaftkärr area in Porvoo, Finland.

The business models for EPNSPs have two key ‘revenue streams’ which represent the source of profits for an EPNSP:

1. Energy arbitrage and efficiency gains obtained through optimising the production, storage/retrieval and selling of local renewable electricity and heat production.
2. Integrated Energy Contracts (IEC) which combine energy efficiency and renewable energy supply and management in large buildings and groups of buildings in the same locality owned by the same organisation.

The more innovative of the two revenue streams is that which concerns energy arbitrage and optimisation as Energy Service Companies (ESCOs) offering IEC already exist in some countries in the EU. The business models developed in IDEAS focus is on trading in electricity markets because markets for heat trading are both limited and in their infancy. The research conducted as part of the IDEAS project indicates that the efficiency gains that can be obtained through optimising the production, storage/retrieval and selling of local renewable electricity and heat production can increase in the effective value of renewable electricity by up to 30 percent and improve the efficiency of energy plant by up to 10 percent.⁶

Although it must also be noted that the earlier research conducted in the project⁷ identified, the following regulatory and financial barriers to the implementation of elements of the business models for EPNSPs:

- EU policy approaches to encouraging DREG;
- Distortions in wholesale and retail electricity costs;
- Current charges for the use of electricity distribution networks;
- Rigid public procurement practices in the public sector;
- Over burdensome urban planning regulations

The research presented in this report builds on the earlier findings related to the regulatory and financial barriers to the development of EPNSPs. To do so, it assesses the applicability of the business models developed in the IDEAS project beyond the pilot sites by identifying how the different structures of the utilities industry and property markets in different EU states impact the proposed revenue streams of the business models for EPNSPs and the provision of the services required to underpin those revenue streams. In this way the work presented identifies the utility industry and property market structures that offer the best opportunity for the development of EPNSPs. As such the research presented in this report is of relevance to the IDEAS consortium and the wider research, business and policy communities interested in increasing the penetration of DREG and the concept of EPNs.

1.2 Research methods

The research presented took a business driven approach which engaged with energy, utilities and public sector experts and consultants to assess the applicability of the context specific business models developed in earlier research conducted as part of the IDEAS project. The research methods used include:

- Extensive reviews of the business and academic literature,
- 22 in-depth semi-structured interviews conducted with energy, utilities and public sector experts and consultants [see appendix A],

⁶ See IDEAS Deliverable D5.5 ‘Publication’ which consists of a paper by Short et al submitted to the Applied Energy Journal which at the time of writing is under review.

⁷ See Deliverable 2.2 “*Specific Business Models for Demo Cases*” (Crosbie et al 2013).

- A workshop with the IDEAS sister projects focusing on fostering learning between research into the development of business models for EPNs [see appendix B].
- Computational experiments examining the practical impacts of a differentiated distribution tariff on the utilisation of DREG to explore the potential of differential distribution tariffs to support the roll out of EPNs [see appendix C].
- Questions related to the willingness of Finnish people to invest in community energy project included in a survey ran as part of Task 5.5 “Operate and evaluate the upgraded neighbourhood in the Finnish demo-site”⁸.

1.3 Relations to other activities in the project

As illustrated in Figure 1.1 the relationship between the research presented in this report and that conducted in the other work packages and tasks in the IDEAS project are it:

- Builds on the earlier work conducted in in the IDEAS project as part of Work Package 2 in Task 2.1 “Business and Community Requirements” and Task 2.2 “Specific Business Models for Demo Cases;”
- Contributes to the plans developed for the commercial exploitation of the assets produced by the IDEAS project in Task 2.4 “Exploitation Planning”;
- Is framed by the stakeholder engagement undertaken as part of Work Package 6 “Dissemination and Community Engagement”.
- Informed the work undertaken in the pilot studies as part of Work Package 5 in Task 5.4 “Operate and evaluate the upgraded neighbourhood in the French demo-site” and Tasks 5.5 “Operate and evaluate the upgraded neighbourhood in the Finnish demo-site”.

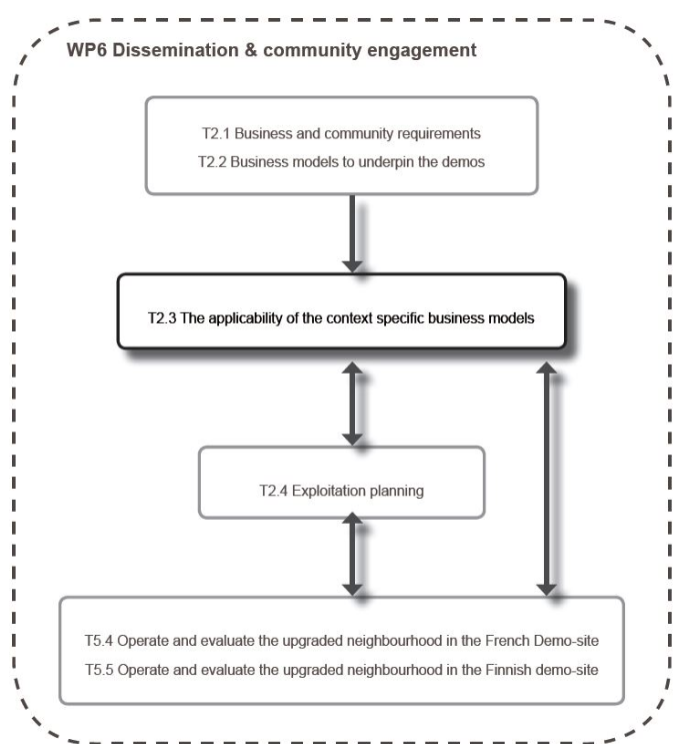


Figure 1.1: Relationship between the research presented and the wider tasks in the project

⁸ For further details see Backstrom (forthcoming) IDEAS Deliverable 5.5 “Impact Report Finnish Demo.” This report is currently being written concurrent with this deliverable of the IDEAS project.

1.4 Structure of the report

Chapter 2 of this report begins by summarising the key elements of the business models developed for EPNSPs in the IDEAS project. It then discusses how the operation of property markets and the utilities industry impact on the feasibility of the proposed business approaches. Chapters 3 and 4 respectively present detailed discussions of the extent to which the current structures of the utilities industry and property markets in France and Finland support the key requirements of the IDEAS business models for EPNSPs. Chapter 5 builds on the work presented in chapters 3 and 4 to present an overview of the extent to which the prerequisites for business models for EPNSPs are represented in the structures of the utilities industries and property markets within the whole of the EU. Chapter 6 concludes this report with a discussion of the contribution of the work presented to the IDEAS project overall, the impact of this work on the other tasks in the project and the lessons learned in relation to the wider research domain.

2 BUSINESS MODELS: THE ROLE OF THE UTILITIES INDUSTRY AND PROPERTY MARKETS

2.1 Introduction

Two distinct business models for EPNSPs were developed in the earlier research in the IDEAS project (Crosbie et al. 2014). One of the business models developed is for what might be called a ‘District Energy Supplier’ and the other is for what might be called an ‘Integrated Energy Service Provider.’ Both are “*integrated business models, in which innovating firms bundle innovation and product together, and assume the responsibility for the entire value chain*” (Teece, 2010) related to supplying affordable and locally produced renewable energy. So they generate distribute and sell renewable energy within an EPN⁹.

This chapter focuses on identifying the key structures of the utilities industry¹⁰ and property markets¹¹ that impact the proposed revenue streams of the IDEAS business models. Revenue streams are generated through the sale of product/services, commissions from suppliers or partners etc. They are the focus of the analysis presented because they are key to the success of all business models as they represent the source of profits for a company (Crosbie et al. 2014). However in considering the revenue stream the feasibility of the proposed products and services which underpin those revenue streams are also considered.

The remainder of this chapter is broken down into three sections. The first outlines the business models for EPNSPs developed in the earlier research undertaken in the IDEAS project (see Crosbie et al. 2014). The second discusses how different utilities industry and property market structures can impact on the feasibility of each business model’s proposed revenue stream. The third section concludes the chapter by summarising the key requirements for the utilities industry and property markets needed to underpin the business models if they are to encourage the local consumption of distributed renewable energy.

2.2 Business approaches for EPNSP

2.2.1 District Energy Supplier

The business model developed in the context of the Finnish demonstration site is for an ESCO which acts as a District Energy Supplier, which generates, distributes and supplies heat and electricity from renewable resources (bio-fuelled CHP and wind turbines) in a predominantly residential area (see figure 2.1). The company has a contract to sell electricity and heat with most of the occupants in the neighbourhood. It interacts with the energy market (buying and selling electricity) and has the means to control local energy production and distribution. The

⁹ This differs from other approaches which incorporate ‘prosumers’ that generate renewable energy at the household level. This is because the IDEAS business models were developed to fit the contexts at the IDEAS projects’ pilot sites at neither of which is a sensible approach. In Finland, this is because there is no Government subsidised feed-in-tariff to encourage people to implement renewable energy generation at the household level making its penetration very low (Crosbie et al. 2014). In the case of the business model developed in the context of the French pilot site as the site is a university campus it made little sense to consider the role of householders as energy producers (Crosbie et al. 2014).

¹⁰ The term utilities industry is often used to refer to electric, gas and water companies as well as integrated energy providers and Energy Service Companies (ESCOs). The focus of the discussion here is related to utility companies and ESCOs - involved in the supply, distribution and generation of electricity and heat. This is due to the fact that it is these sectors of the utilities industry which are required to deliver the services underpinning the business models

¹¹ Property market is defined in a wide sense to refer to the construction or renovation of buildings and the buying, selling, and renting of land or buildings.

production, storage/retrieval and buying/selling of energy is optimised to increase profits. The district energy supplier also provides DSM services to its customers to help them shift their energy demand to times when it is available from local renewable sources, and to help smooth out peaks in electricity or heat demand.

Key Partners 1. District heating provider- to implement run and maintain the CHP & DH network plus other forms of renewable energy generation. 2. Energy supplier- to bill customers and accept payment 3. Electricity distribution network operator	Key Activities 1. Local renewable heat & electricity generation distribution and supply 2. Optimizing the production, storage/ retrieving & buying / selling of energy 3. Supplying variable energy tariffs which reflect actual energy costs during the day 4. Predicting local electricity & heat supply/ demand 5. Buying electricity to cover imbalances in local supply & demand 6. Supplying variable electricity tariffs which reflect actual energy costs during the day 7. Supplying customers demand side management services	Value Propositions Providing customers renewable energy 1. affordable renewable energy 2. DSM services to help customers reduce their energy costs 3. Green, sustainable eco-friendly local neighbourhood/ community 4. Reduced carbon foot print	Customer Relationships 1. Energy supply contracts which offer a discount for buying both heat and electricity which reflect time of day energy production costs 2. Compulsory use of local district heating network - unless a more efficient heating option is available	Customer Segments 1. Residential energy customers 2. Small commercial energy customers (small shops offices schools etc.)
	Key Resources 1. A bio-fuel powered CHP plant & heat distribution network 2. A local energy management system to optimise storage / retrieving and buying / selling energy in real time 3. A smart electricity distribution network 4. User interfaces to interact with customers 5. Professional staff with the required skills in marketing, engineering and finances		Channels 1. Electricity and heat distribution networks 2. Local media, TV, newspapers and public screens etc. 3. Energy bills 4. Company websites 5. Smart meters and home based user interfaces	
Cost Structure 1. Energy production storage and distribution costs 2. Electricity purchased from day ahead market 3. Maintenance of heat and electricity networks and generation plant 4. Marketing costs to encourage people in the neighbourhood to buy heat and electricity from the company		Revenue Streams 1. Reduced costs for energy production and increased profits from arbitrage, i.e. cost-optimising the production, storage/retrieval and buying/selling of energy 2. Enhanced company green image increases customer base & in turn lowers production costs.		

<http://www.businessmodelgeneration.com>

Figure 2.1: Business Model for a District Energy Supplier

The business model is underpinned by the increased revenue from:

1. Reduced costs for energy production and increased profits from arbitrage, i.e. cost-optimising the production, storage/retrieval and buying/selling of energy;
2. Enhanced company green image which increases the customer base reducing the average cost to supply services to each customer.

The idea is that District Heating (DH) providers can profitably extend their Energy Service Contract (ESC) to their customers to include the generation, supply and distribution of locally produced renewable electricity. The current business models of DH providers encompasses the entire process of providing heat from the purchasing of fuel to the delivery and invoicing of the heat they supply. In the case of DH providers with CHP they also generate electricity which is most often sold to the national grid with no attempt to achieve the best price for the electricity produced using energy arbitrage. Here it is suggested that the current business model of DH providers is adapted to include the generation distribution and supply of locally produced renewable electricity as well as heat to customers within a given neighbourhood and that energy arbitrage is used to cost optimise the production storage /retrieval and buying and selling of energy. Thus leveraging the efficiency that can be gained through energy cogeneration and co-optimisation of heat and electricity production.

2.2.2 Integrated Energy Service provider

The concept behind the business model developed in the context of the French demonstration site is for an EPNSP that installs, maintains and runs renewable electricity and heat production for a public or private organisation that owns a group of buildings in the same geographical location. It is also responsible for the energy costs associated with running those buildings (see Figure 2.2). Therefore prospective customers include universities, as in the case of the French pilot site, larger schools, hotel complexes, hospitals etc.

Key Partners 1. District heating provider -to implement run and maintain the CHP powered DH and other forms of renewable energy generation. 2. Electricity distribution network operator 3. Environmental consultant -to provide the information required to understand the ROI on the different renewable energy technologies 4. A building construction company to implement the building renovations	Key Activities 1. Local renewable heat and electricity generation distribution and supply 2. Optimising the production, storage /retrieving & buying/selling of energy 3. Consultancy services related to the assessment of most energy efficient option for building renovation and the renovation/replacement of energy infrastructures 4. Calculation of ROI on the required investments 5. Promoting the concept of an EPN to future customers and occupants of the EPN 6. Renovations to improve building energy performance Key Resources 1. A bio-fuel powered CHP plant & heat distribution network and other forms of renewable energy generation 2 A local energy management system to optimise storage / retrieving and buying / selling energy in real time 3. A smart electricity distribution network 4. User interfaces to interact with building occupants 5. Professional staff with the required skills in marketing, engineering building construction and renovation finances and energy constancy 6. An energy decision support urban planning tool to estimate the ROI on different renewable energy supply options and future building development and redevelopment. 7. Professional staff with the required skills in marketing, engineering building construction and renovation finances and energy constancy,	Value Propositions Providing customers: 1. guarantees for the total cost savings and overall performance of the energy services; 2 .affordable renewable heat and electricity; 3. reduced energy costs; 4. increased green, sustainable eco-friendly credentials; 5. reduced carbon footprint.	Customer Relationships Performance based profit sharing Integrated energy contract Channels 1. Electricity and heat distribution networks 2. Marketing channels include a) Company website b) community based screens to inform the occupants of the buildings of current energy consumption and promote the concept of an EPN	Customer Segments 1. Public and private organisations responsible for the management and energy costs of buildings in the same location. i.e. University Campuses, hospital sites, and larger schools etc.
Cost Structure 1. Energy production storage and distribution costs 2. Electricity purchased from energy supplier 3. Maintenance of heat and electricity networks and generation plant 4. Construction staff and equipment required for building renovation 5. Marketing costs for new customers		Revenue Streams 1. Reduced costs for energy production and increased profits from arbitrage, i.e. cost-optimising the production, storage/retrieval and buying/selling of energy; 2 Integrated Energy Contracts (IEC) which combine energy efficiency and renewable energy supply and management in large buildings and groups of buildings in the same locality		

<http://www.businessmodelgeneration.com>

Figure 2.2: Business Model for an Integrated Energy Service Provider

Essentially this business model is based on existing energy service companies increasing their revenue by:

1. Reduced costs for energy production and increased profits from energy arbitrage, i.e. cost-optimising the production, storage/retrieval and buying/selling of energy;
2. Integrated Energy Contracts (IEC) which combine energy efficiency and renewable energy supply and management in large buildings and groups of buildings in the same locality (see figure 2.3).

In this case the EPNSP is not only involved in optimised energy supply, distribution and generation, but the company also supplies consultancy services and renovates buildings. The consultancy services help their customers select the most energy efficient building renovation and energy infrastructure investments, and implement building renovations as part of an IEC. An IEC is a newly developed energy service business model that combines elements from both Energy Service Contracting (ESC) and Energy Performance Contracting (EPC).

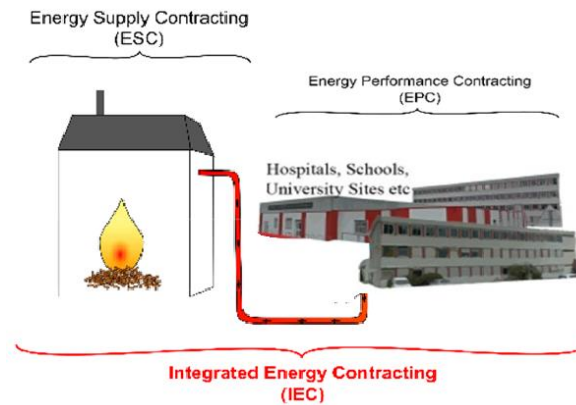


Figure 2.3: Integrated energy contracting model (adapted from Bleyl, 2009).

The concept behind IEC is an integrated business model which delivers maximum savings, both environmentally and economically, by implementing efficiency measures on the whole chain: from production (supply side) to delivery and final consumption (demand side) (Bleyl, 2009). The IEC approach advocated in the IDEAS project extends the approach in earlier research which focused on the notion of IECs for individual buildings (Bleyl, 2009). This is principally because the proposal here is that an EPNSP offers an IEC which covers a group of buildings in the same area. In the case of the Integrated Service Provider business model it is also envisaged that the production, storage/retrieving and buying/selling energy is also optimised to increase profits.

2.2.3 The combined business model

The IDEAS business models reflect the current aspirations of key stakeholders at each of the IDEAS pilot sites in terms of their customer focus and key partners. However they could be combined. An EPNSP could be a District Energy Supplier in a mixed use neighbourhood, with both residential, commercial and industrial buildings and also offer IEC to their larger customers (see figure 2.4).

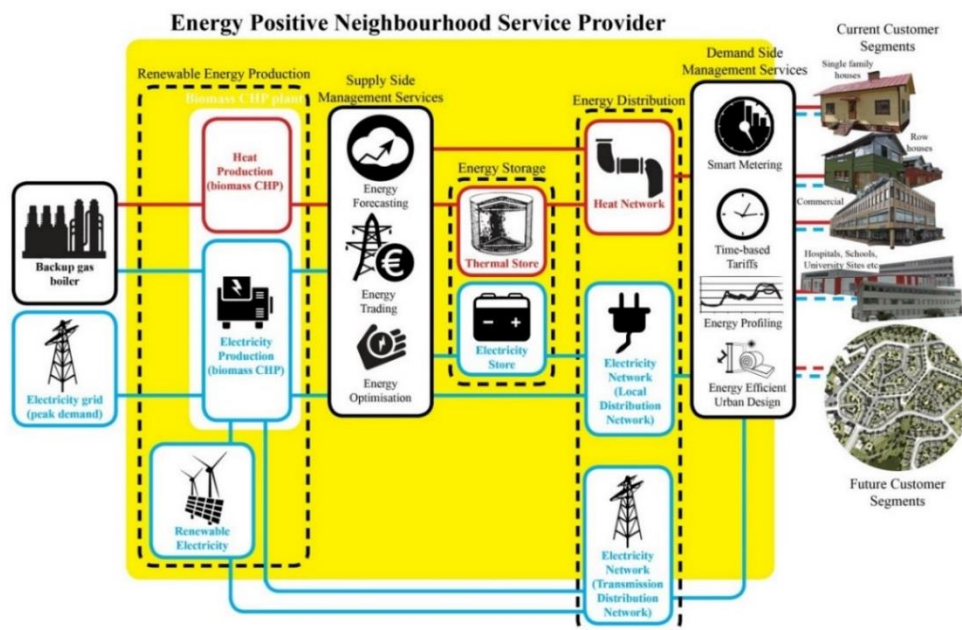


Figure 2.4: A district energy supplier that offers IES contracts to commercial customers

2.3 Key structures of property markets and the utilities industry

2.3.1 Requirements related to utilities industry

2.3.1.1 Energy markets

One of the key revenue streams of the business models for EPNSPs lie in energy arbitrage and efficiency gains obtained through optimising the production, storage/retrieval and selling of local renewable electricity and heat production. As wholesale markets for heat trading are both limited and in their infancy¹², in the case of the business models for EPNSPs developed in the IDEAS project the focus is on energy trading on electricity markets.

In relation to electricity, when national electricity demand is low, supply comes from relatively inexpensive base load generation. When demand is high and base load generation is exhausted, supply comes from relatively expensive peaking generators. This creates rapidly fluctuating energy costs throughout the day in wholesale electricity markets see figure 2.5. Therefore optimising the production, storage/retrieval and buying/selling of electricity to increase profits should, if wholesale energy markets are operating efficiently, create what might be called an ‘economic demand response’.

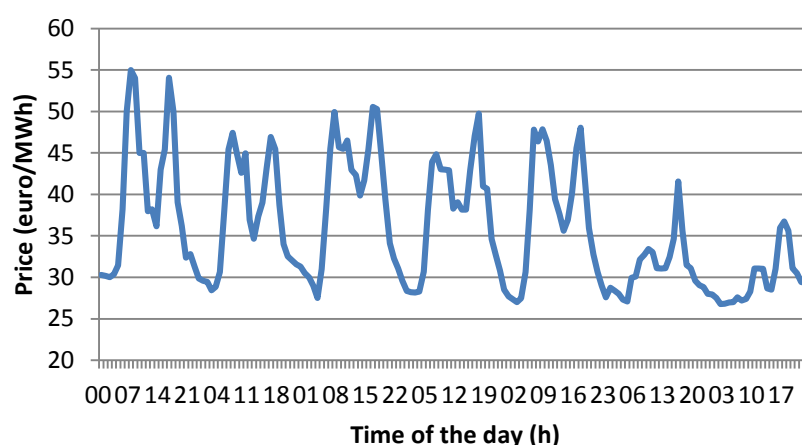


Figure 2.5: Example of the fluctuation in EU energy markets: Nord Pool Spot prices during an average week (Monday to Sunday) in Finland in February.

2.3.1.2 Time based electricity tariffs which reflect electricity demand and supply

For competitive electricity markets to operate efficiently time-based pricing, which reflects the price variations on the wholesale market¹³, are required for the prices end users pay and the prices paid to electricity producers regardless of their scale of production (Crosbie et al. 2014).

¹² Wholesale markets for trading of heat are much rarer than those for electricity. Nevertheless, they do exist - albeit on a smaller scale - and are increasingly used in parts of Scandinavia. For example, in eastern Denmark there are a large number of thermal plants involved in heat trading, with delivery through a large centralised district heating network covering Copenhagen and the surrounding towns and suburbs (Ommen et al. 2014). In such a market daily fluctuation is still present, with more pronounced seasonal variation due to the high correlation of heat demand with weather conditions. Therefore optimisation of heat production, storage/retrieval and buying/selling could also lead to increased profits, and dynamic tariffs for heat would be required.

¹³ Such variations would include both regular oscillations due to the demand pattern of users and supply issues (such as availability of intermittent distributed renewable energy), and occasional exceptional price peaks.

When looking at the prices paid by end users, time-based tariffs for electricity include, but are not limited to:

- **Time-of-use pricing (TOU pricing)**, in this case electricity prices are set in advance for a specific time period, in general they are changed twice a year. Prices paid for energy consumed during these periods are pre-established and known to consumers in advance, allowing them to vary their usage in response to such prices and manage their energy costs by shifting usage to a lower cost period or reducing their consumption overall;
- **Critical peak pricing** in this case time-of-use prices are in effect except for certain peak days, when prices may reflect the costs of generating and/or purchasing electricity at the wholesale level.
- **Dynamic pricing or real time pricing**: in this case electricity prices change, usually on an hourly basis, in accordance with variations on the wholesale market. Price signals are usually provided to the user on an advanced or forward basis, reflecting the cost of generating and/or purchasing electricity at the wholesale level.

When thinking about the prices paid to electricity producers, as depicted in figure 2.6, there are basically three ways in which an EPNSP can interact with a variable electricity market:

- It can purchase electricity from and sell electricity to an Electricity Supplier;
- It can operate on the wholesale electricity market through an aggregator or broker that sells and purchases electricity on the behalf of a number of electricity producers;
- It can directly operate on the wholesale electricity market to purchase and sell electricity.

Whether the EPNSP sells electricity to and buys electricity from the wholesale market or an Energy Supplier or operates through an energy broker will depend in part on the generating capacity of the EPNSP. The minimum magnitude of energy transactions that are eligible to be placed on a wholesale energy market are normally at the MWh level (certainly within the EU). However the transaction costs associated with this kind of trading make it unprofitable for smaller energy producers. Therefore to enable smaller companies to operate on the wholesale market aggregators or energy brokers are beginning to emerge and in most EU countries, very small scale electricity producers can currently sell their energy to the incumbent Energy Suppliers. Which of the three approaches to interacting with variable energy markets presented in figure 2.6 are taken will depend on the regulation of the markets and energy generators in different EU states as well as the generation capacity of the EPNSP.¹⁴

Regardless of generation capacity of an EPNSP or which the three approaches to interacting with energy markets is taken in the best case scenario for the business models for EPNSPs time-based prices for electricity would be available for:

- The price the EPNSP pays for the electricity it purchases from outside the neighbourhood to balance short term imbalances in neighbourhood supply and demand;
- The price the EPNSP is paid when selling electricity to its customers within the neighbourhood;

¹⁴ In terms of embedded electricity generation (connected to the distribution network) the thresholds that define small, medium and large generators vary dramatically. This is because they depend on the network capacity and thus the voltage level of distribution systems. These vary dramatically across European distribution networks (See appendix D for further details). To offer a rule of thumb we can assume a small EPNSP has an energy generation capacity of less than 50MW, a medium EPNSP would have a capacity between 50-99MW and a large EPNSP have a capacity of more than 100 MW. This follows the example of thresholds for England and Wales for embedded electricity generation (see Energy Networks Association 2014).

- The price the EPNSP is paid when selling electricity outside of the neighbourhood.

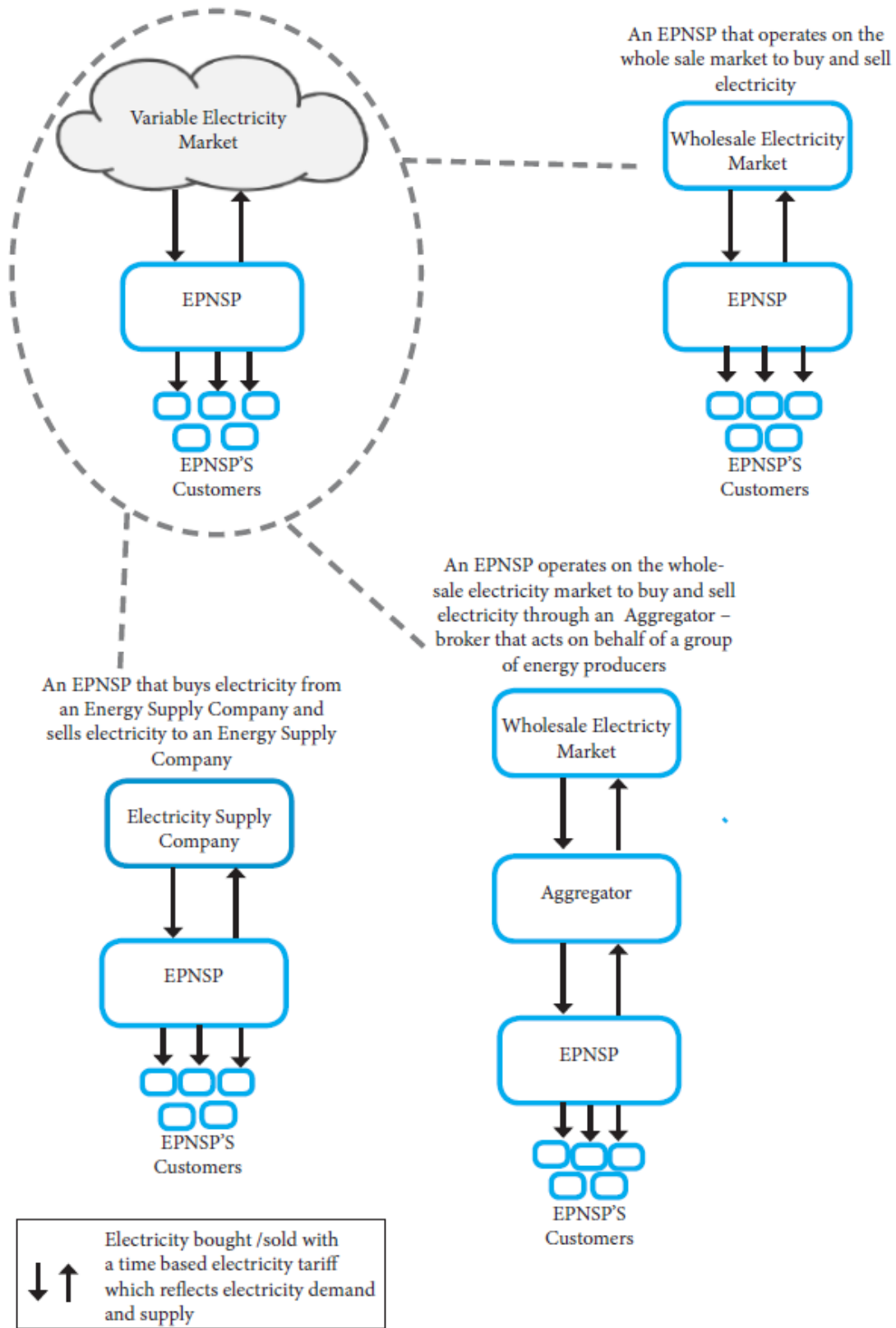


Figure 2.6 The relationship between EPNSP's and wholesale markets / energy suppliers

2.3.1.3 Differentiated local and national electricity distribution charges

For the EPNSP business approach to support the local consumption of DREG there must also be a financially viable method of transporting the energy to the consumers in the neighbourhood in which the energy is generated. Essentially there are two ways electricity from distributed renewable energy sources can be transported to consumers in the neighbourhoods or localities in which it is produced:

- It can be transported over the wires of the local Distribution Network Operator [DNO]¹⁵ and sold directly to local users. This incurs a standard network ‘use of system’ charge.
- It can be transported over a private wire network (PWN), incurring a charge set by the owner of the PWN.

Currently across the EU, DNOs have set a standard volumetric charge for the use of their electricity distribution networks which usually makes up between 22 and 54 percent of a domestic customers’ bill. The costs for industrial and commercial customers vary across the EU, however network costs make up between 20 and 50 percent of all customers’ bills (Eurelectric, 2013a). Therefore the best prices for the sale of DREG to local consumers can usually be obtained using a PWN (TCPA, 2006). However the investment costs for implementing a PWN can be high and were they to be implemented in many areas it would be a wasteful duplication of current distribution networks (Boait, 2009). Thus a more differentiated approach to DNO charges that reflects the distance over which electricity is physically transported would be advantageous to support the efficient economical transportation of DREG to consumers in the neighbourhood in which the energy is generated.

Following Boait (2009), it is suggested that if a local EPNSP has a significant level of reliable electricity generation capacity then they should be able to benefit from the further ‘unbundling’¹⁶ of the local distribution network. This further unbundling of distribution networks must be on the basis of continuing shared use of that network to enable competition in the supply of electricity (Boait, 2009). Taking this approach an EPNSP could be charged an appropriate cost-reflective tariff for the use they actually make of a DNO’s network. A simple approach to this would be to differentiate between ‘locally generated electricity’ and ‘non-locally generated electricity’ based upon transactions remaining inside or crossing the EPN geographical boundary, and use an appropriate two-tiered distribution charge. Research conducted as part of the IDEAS project suggests this approach both encourages the use of local generation, and reduces the net amount of electricity handled wholesale and requiring transportation over transmission and distribution networks by up to 50% (see appendix C).

2.3.1.4 Smart local networks

Optimising the production, storage/retrieval and selling of local renewable energy production requires changes to the physical infrastructures of energy distribution. Specifically a ‘smarter’ local energy grid. This is required to support the monitoring, control and advanced protection systems that enable the supervision and operation of bidirectional power flows in a distribution network. As discussed above, it is suggested that this might be provided by the current distribution network operators, rather than building ‘smart’ private wire networks. Thinking about how the idea that the DNO provides the smart local network required by and EPN there are essentially two possible basic business structures for EPNSPs:

¹⁵ Traditionally DNOs transported electricity at the regional level at reducing voltages from national grid supply points to final customers. In recent years they have also begun to transport energy from DREG.

¹⁶ Disaggregating electric utility services into its basic components and offering each component separately for sale with separate rates for each component.

Business structure 1: The EPNSP provides energy supply, energy generation and energy distribution in the neighbourhood. While the distribution services are subcontracted by the EPNSP from the local DNO, and the EPNSP pays a fee to the DNO for the distribution services which it recoups from its customers. The EPNSP is responsible for paying the distribution cost of the electricity it purchases from outside of the EPN and recouping the cost from its customers.

Business structure 2: The EPNSP could operate like the Independent Distribution Network Operators (IDNOs) in the UK that develop, operate and maintain local electricity distribution networks (Ofgem, 2015). IDNO networks are directly connected to the DNO networks or indirectly to the DNO via another IDNO. Essentially they own and operate smaller networks located within the areas covered by the DNOs. Currently IDNO networks are mainly extensions to the DNO networks serving new housing and commercial developments. What we are suggesting here is that an IDNO owns the renewable energy plant in the area, is also the electricity supplier, and owns and runs distributed renewable energy in the network area it services.

2.3.1.5 Exploiting distributed renewable energy generation

Almost 50% of the total energy consumed in Europe is used for the generation of heat for either domestic or industrial purposes with space heating and hot water in buildings making up a large proportion of this demand (European Technology Platform, 2011). Both business models for EPNSPs involve the use of biofuel powered CHP combined with other forms of renewable electricity production. This is because it is inherently more efficient to generate heat and electricity together (L'Abbate et al. 2008, Connolly, et al. 2013) as depicted in figure 2.7.

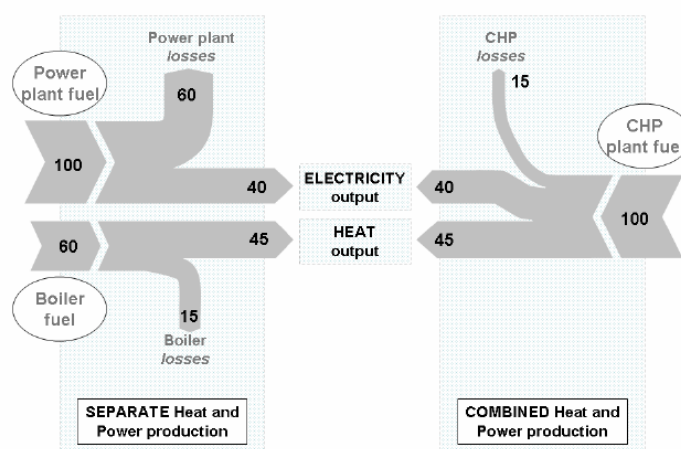


Figure 2.7 Separate and combined heat and power production (source L'Abbate et al 2008).

However it must be emphasised that the business models are not limited to bio fuelled CHP. A natural extension would be the use of Combined Cooling Heat and Power (CCHP) which uses thermal energy for both heating and cooling, as well as electricity generation. It must also be noted that should other forms of renewable energy production be available that can supply the heating/cooling and electricity demand of a neighbourhood more cost effectively than CHP or CCHP then the business models could be adapted as required.

2.3.2 Key requirements related to property markets

2.3.2.1 Energy efficient buildings

The investments required in renewable energy production within an EPN could be reduced if the buildings within the EPN are energy efficient. Therefore it would be beneficial if those responsible¹⁷ for planning neighbourhoods and constructing, renting/managing and occupying the buildings in that neighbourhood have a commitment to energy-efficient buildings as well as renewable energy. This requires a mix of regulatory and voluntary instruments (Lee and Yik, 2004). These include:

- Building energy codes that are regulatory requirements and as such are legally binding;
- Eco-labelling schemes, including those that adopt a single threshold performance rating or labels of different grade corresponding to progressively higher standards, legally non-binding building energy codes and voluntary building environmental performance assessment schemes;
- Incentive-based schemes, that provide subsidies or allowances to offset the costs of energy efficiency improvements;

2.3.2.2 Financial incentives to reduce building running costs

The business case for EPNSPs requires that the stakeholders responsible for the costs related to the design and construction of a building (or the renovation of a building) have a financial incentive to reduce the running costs of that building. In the case of owner-occupied buildings this is often the case. For example many home owners renovate their homes and some people ‘self-build’ their homes (i.e. commission the construction of their own home) and are therefore responsible for both the capital costs of the build/renovation and the costs related to running their home. In the case of non-residential buildings many public and private organisations commission new buildings and renovate their existing building stock. So once again the organisation commissioning building construction/renovation is responsible for capital build/renovation costs and building running costs.

In the case of rented buildings in the residential sector it is the landlords that pay the capital costs for the building construction or renovation while the tenants pay the running costs of the building. Under such circumstances both landlords and tenants can have little incentive to invest in energy efficiency improvements to the building fabric or systems (OECD, 2003). In the case of non-residential rented buildings, the energy costs are often included in the rent. This can encourage landlords to seek to reduce the energy costs related to running the buildings to increase their profits. Although it must also be considered that if flat rate energy costs are included in the rent the building tenants have little incentive to seek to reduce their energy use.

2.3.2.3 Access to financing and new contracting models

It is also essential that both public and private organisations can access the financing required to perform energy efficient building renovation and construction and the implementation of renewable energy production. There are many contractual models which enable a share of responsibilities – abbreviated D&B, DBFO, BOO, BOT, BOOT, BRT, and BLT – in which the private partner either designs, builds, finances, owns, operates, leases, rehabilitates, rents, and/or transfers the building. Typically the financing is left for an investor (called “third party financing”). Often these types of contractual models include a contract on energy performance or energy supply. These long term projects are typically referred to as “life cycle projects” or “life cycle contracts”. (Gallimore et al., 1997; Heimonen et al., 2007; Heimonen et al., 2012;

¹⁷ These actors include includes City Authorities, construction companies, building owners, facility managers and private individuals

Tieva and Junnonen, 2009). In these types of contracts the client (typically public sector organisations) transfers several risks to the service provider who can be committed to a certain energy performance over 15-30 years. In EPCs which focus on energy refurbishment through certain technological solutions, the contract type can be shorter, e.g. 5-10 years. Typically these types of contracts are made for large public sector buildings such as nursery schools, schools, universities, hospitals and swimming pools. In the public sector one of the ways to access financing is being tackled is through contractual models underpinned by public-private-partnerships (PPPs).

2.3.3 Summary of key requirements

The business models presented are designed to underpin the development of neighborhoods in which annual energy demand is lower than annual energy supply from local renewable energy sources: with local energy infrastructures that are connected to wider energy networks and contribute to the optimisation and security of those wider energy networks. The main revenue stream of the IDEAS business models for EPNs lie in:

1. Energy arbitrage and efficiency gains obtained through optimising the production, storage/retrieval and selling of local renewable electricity and heat production.
2. IEC which combine energy efficiency and renewable energy supply and management in large buildings and groups of buildings in the same locality owned by the same organisation.

In the best case scenarios for the development of EPNs underpinned by the IDEAS business models the key required structures of the utilities industry and property markets include:

1. Time based tariffs linked to day ahead and intra-day markets for the electricity EPNs purchase and sell. To provide the potential to optimise neighbourhood energy supply resources based on their market value. These include tariffs for:
 - a) the electricity an EPNSP purchases from outside the neighbourhood to balance short term imbalances in neighbourhood supply and demand;
 - b) the price the EPNSP is paid when selling electricity to its customers within the neighbourhood;
 - c) the price the EPNSP is paid when selling electricity outside of the neighbourhood.
2. Distribution network charges which reflect the distance that electricity is transported, to provide a financially viable method of distributing electricity to consumers in the neighbourhood.
3. An 'active' or smart local electricity grid that can support the monitoring, control and advanced protection systems that enable the supervision and operation of bidirectional power flows in a distribution network.
4. The wide use of the economies of heat and electricity (and in some cases cooling) cogeneration offered by bio-fuelled CHP and CCHP. This will enable the most efficient provision of both heat and electricity to an EPN.
5. A mix of regulatory and voluntary instruments to encourage high standards of building energy efficiency that reduce overall energy demand making it easier to be met by renewable supply and reducing the need to invest in new generation facilities.
6. Legal, regulatory and business contexts that enable IEC underpinned by PPP (in the public sector) and life cycle approaches that offer financial rewards to those responsible for the design, construction and management of buildings if they reduce the running costs.

3 THE FINNISH CONTEXT

3.1 Introduction

This chapter presents an in-depth review of how the operation of the utilities industry and property markets in Finland impact on the feasibility of the proposed business approaches for EPNSPs. The work presented is based on a literature review and the findings from twelve interviews with actors involved in the property and utilities markets [see interviewees 1-12 listed in appendix A].

3.2 Regulation of electricity industry in Finland

The National energy regulator in Finland, was called the Energy Market Authority until 2014 when it became known as the Energy Authority. This marked the introduction of new roles for the Finnish Regulator in the promotion of energy efficiency, counselling and communication, ecological design and energy labelling.

In Finland, in common with most of Europe the DNOs are regulated monopoly businesses.¹⁸ As such customers are obliged to buy electricity transportation services from the local DNO. The electricity supplier, on the other hand, can be freely chosen by the customer from the companies that sell electricity in their area. Since beginning of 2007 DNOs with more than 100,000 customers (CEER, 2013) have to be legally unbundled from electricity trade operations and electricity generation¹⁹. There are no requirements for the ownership unbundling of the energy industries and many of the DNOs in Finland belong to the same group of companies as the electricity generator or retailer.

Many of the DNOs in Finland are municipal utilities, or companies where the municipality is the major shareholder. About 20-25 % of DNOs are private or state owned. There are several ways in which the operational, managerial, and financial responsibilities are shared between the companies belonging to the same group, but usually the DNO and the retailer have at least common customer services (Energy Authority, 2014). In some cases these companies already have many characteristics that could enable them to develop into an EPNSP, or to establish one together. There are also many different ways for organising the construction, maintenance, operation and ownership of the network inside the DNOs. Part of these tasks may be outsourced to independent service providers or the network can be leased (Energy Authority, 2014).

The electricity retail market is not regulated by the Energy Authority, and therefore there are no requirements for licencing or registration by the Energy Authority, nor regulated tariffs. The Energy Authority estimates that four electricity retailers have more than five per cent share

¹⁸ Energy Authority is the regulator for the 80 distribution network operators, 12 regional high-voltage distribution network operators and one transmission network operator in Finland. (Energy Authority, 2014). Following the European Electricity Directive 2009/72/EC (European Commission 2009b) the Finnish the transmission network operator does not exercise control or other rights directly or indirectly over an actor performing generation or supply functions and over a transmission system operator (Energy Authority, 2014). The Electricity Market Act (588/2013) sets obligations to the DNOs and electricity retailers on setting up the electricity connection (20 §), transfer of electricity (21 §) and delivery of electricity (67 §). The basic purpose of the law is to secure the end users reliability, competitive prices and reasonable service principles in electricity supply (Finlex, 2013a).

¹⁹ Some DNOs that do not exceed the threshold values, have legally unbundled network activities: although only 35 of 85 DNOs were over the threshold value in 2013, in 2014 there were 52 legally unbundled DNOs of total 80 DNOs (Energy Authority, 2014).

of retail market, and that the market share of the three largest companies in the retail market for small and medium sized customers is 35-40 %. There are also efforts to establish a common end-user market for electricity in Finland, Denmark, Sweden and Norway (Energy Authority, 2014).

The interviewees felt that the statutory right to choose the electricity retailer may be a barrier for the EPNSP business model for a district energy supplier, as they think this would require a private wire network (PWN) in current structure of the Finnish electricity system. However regardless of the ownership of the network solutions would need to be implemented that enable customer situated inside the EPN network to buy electricity from a retailer other than the EPNSP as discussed in Section 5.2 in Chapter 5.

Energy generation is regulated by the Energy Authority. The electricity generation market is dominated by two companies: Fortum and Pohjolan Voima. Together these companies owned 50.5% of the production capacity in 2012. Apart from these companies, in 2012, there were approximately 120 companies producing electricity from 550 power plants. Over half of the electricity plant in Finland are hydro power plants. The power plants are relatively well distributed all over the country, increasing the stability and security of the supply. Almost a third of the electricity produced in Finland comes from combined heat and power plants. Finland is part of the Nordic energy market (more in Appendix E), where a significant amount of renewable energy in form of hydro power is available, but the capacity of the power lines between the countries limits the amount of electricity that can be bought from the Norwegian and Swedish hydro power plants during peak demand (Finnish Energy Industries, 2015a).

3.3 Electricity distribution networks and electricity tariffs

3.3.1 The current state of distribution networks

As discussed in chapter 2, in section 2.3.1.4, the business concept underpinning EPNSP demands an upgrade to electricity distribution networks transforming them from the current passive networks into active or 'smart' networks. This will demand both technical changes to distribution networks and organisational changes to the roles of TNOs and DNOs. This section outlines the current state of the electricity distribution networks in Finland in terms of the ability to support electrical load management and the possibilities of DNOs to take more active role in load management.

3.3.1.1 Network structure and load balancing

The Finnish electricity network can be divided roughly into the main grid, regional networks and distribution networks. The main grid is used in long-distance transmission connections and high transmission voltages (400 kV). The main grid is connected further to the regional networks, which transmit electricity regionally, for example, in a certain province, at the voltage of 110 kV. The distribution networks operating at low voltage level (20, 10, 1 or 0.4 kV) can use the main grid through the regional network or they can connect directly to the main grid. The division between the regional and the distribution network is based on the voltage level. Homes are connected to the distribution network, whereas the industry, commerce, services and agriculture as consumers and the power plants as generators can be connected to any of the network levels (Finnish Energy Industries, 2015b).

Finnish electricity production capacity is typically not able to cover energy demand during winter consumption peak periods, or this is not economically feasible. Although the total installed capacity (16,500 MW in 2013) would be adequate, all of it is not available during peak load situations. (Energy Authority, 2014).

It is the responsibility of the market operators to plan and balance their production and consumption in advance. In reality, there are however always deviations from the plan, and then it is the duty of the TNO (Fingrid in Finland) to see that the balance is maintained each hour. The balance between consumption and production is ensured by activating regulating bids from the balancing power markets and by reserving capacity. For times when the demand exceeds the planned purchase of electricity, Finland also has a peak load reserve system. These reserves can be either power plants or controllable loads (Fingrid, 2015).

DSM has been used for long time in Finland to balance loads in the electricity network. The clients receive a price reduction which depends on the amount and frequency of the controllable capacity they offer for the DSM actions. Especially the large industries in Finland have typically made DSM contracts with the utilities. Also the wide use of electrical heating and Domestic Hot Water (DHW) storage in Finnish single-family houses and their operation mainly during night time can be regarded as a DSM activity.

There are some other characteristics of the Finnish building stock that could support the use of DSM these are discussed in section 4.4 below.

3.3.1.2 Smart metering and smart grid capabilities

In February 2015, over 95 % of Finnish DNOs' customers had smart meters capable of hourly metering and remote reading (Energy Authority, 2014). One of the requirements set by the 2009 Degree of the Council of State is that the metering equipment must be capable of receiving and forwarding demand control messages sent through the communication network. This means that the current electricity distribution network in Finland already contains features that support electrical load management. However, according to the interviewees this requires changes in the current contract models, and also some technical development is needed, e.g. in relation to the standardisation, the format of messages sent and the delay times. There are already examples where industrial partners have given the DNO (or TNO) the right to cut down some of their energy use during peak load situations.

In Finland, the electricity network already contains, in addition to the smart meters, other capabilities required from a Smart Grid, including automatic fault locating and separation and optimisation of network use. The smart energy meter and two-way data transfer between the customer interface and the grid play a key role in the smart grid (Finnish Energy Industries, 2015b).

3.3.1.3 The current and potential future role of Finnish DNOs in load management

The role of the DNOs in Finland is mainly the distribution of electricity and the operation and maintenance and sometimes the construction of the distribution networks. By the law, they are also responsible for measuring the electricity consumption of their customers with smart meters, and giving this data to the customer and the electricity supplier. However, some DNOs also offer other services, like the street lighting, which usually includes the whole package consisting of planning, construction, maintenance and energy supply (e.g. in the case of Porvoon Sähköverkko).

Currently it is mainly the role of the TNO to balance the demand and production of electricity through electrical load management, after the basic day-ahead balancing has been made by the actors at the energy exchange, and most of the interviewees in the utility sector thought that this is the most reliable and logical way to do it, and that there are no needs for change. The traditional role of the DNOs is to make sure that the network is in good shape for electricity transfer and supply to the customers, and they are not so interested in managing the flows or their intensity, although the smart metering would give possibilities to realise load

management. Many of the interviewees thought that the fact that the pricing of the electricity connection is related to the maximum power available is enough to encourage for peak load reduction. This is challenged by the study made by LUT (2012), where it was noted that the choices for e.g. individual house owners regarding the main fuse are very limited (for small-scale customers, typical alternatives are 3x25 A and 3x35 A).

It is the common understanding in the utility field, that Finnish electricity network is able to cope in most load situations, as it is dimensioned for the peak (heating) load situations in winter, which is many times the capacity needed for average load situations. On the other hand, the property sector actors saw some benefits of controlling the demand according to the availability of local renewable electricity. However, even these actors didn't think that it is necessarily a natural role for the DNO, but rather some new, independent actor or the retailer. But as some of the DNOs are ownership bundled with local retailers, there are possibilities that they might have willingness to co-operate in this area.

In general, if some other actor than the TNO would take on the load management in smaller areas than the national grid, the interviewees thought that this would be most natural for the individual customer, handled with home or building automation system. This way the customer is able to make changes in the control according to his own needs and interest. The interviewees doubted strongly the willingness of Finnish customers to use a service where an outsider decides when to use the devices in the house, while it was considered feasible that the service provider only gives notifications, and the consumer can self-decide how to act, along the lines that is suggested in the EPNSP business model.

3.3.2 Time based electricity tariffs in Finland

3.3.2.1 Time based tariffs for the purchase of electricity by consumers

This section reviews the prevalence of time based market linked tariffs for the purchase of electricity by consumers in Finland to indicate the feasibility of an EPNSP offering this type of tariff to its customers.

In Finland, the price paid by for electricity includes procurement, sales, distribution, taxes and regional and main grid transmission (see breakdown for household customers in Figure 3). It must be noted that the tariffs for the sale of electricity vary remarkably depending on the type of customer and the type of agreement between the retailer and the customer²⁰.

Time based market linked tariffs are already available for all customers and all retailers offer such products. The products available in Finland include Time or price-based programs, such as time-of-use (TOU) pricing, real-time pricing (RTP) and critical peak pricing (CPP) (Annala, et al. 2014), the real-time tariffs options are usually spot price tied contracts, including a marginal. Although there are currently many electricity suppliers that offer this type of real-time dynamic tariffs, only about 4% of the household customers have made this kind of contract. It is more usual for industrial customers. Several interviewees, suggested that the reason for this is that Finnish customers tend to appreciate predictability, and this might be why they are more tempted to choose a fixed price tariff although TOU tariffs are widely accepted and preferred over CCP (Annala, et al. 2014).

²⁰ For example, for an average customer in high-rise building, the average price in 2015 can be as high as 8.5 €/kWh, while for a customer in single-family house with DHW storage the average price is less than 5 €/kWh, representing a difference of 40%. However, the electricity prices in Finland are relatively low in European context (Figure C2 in Appendix E).

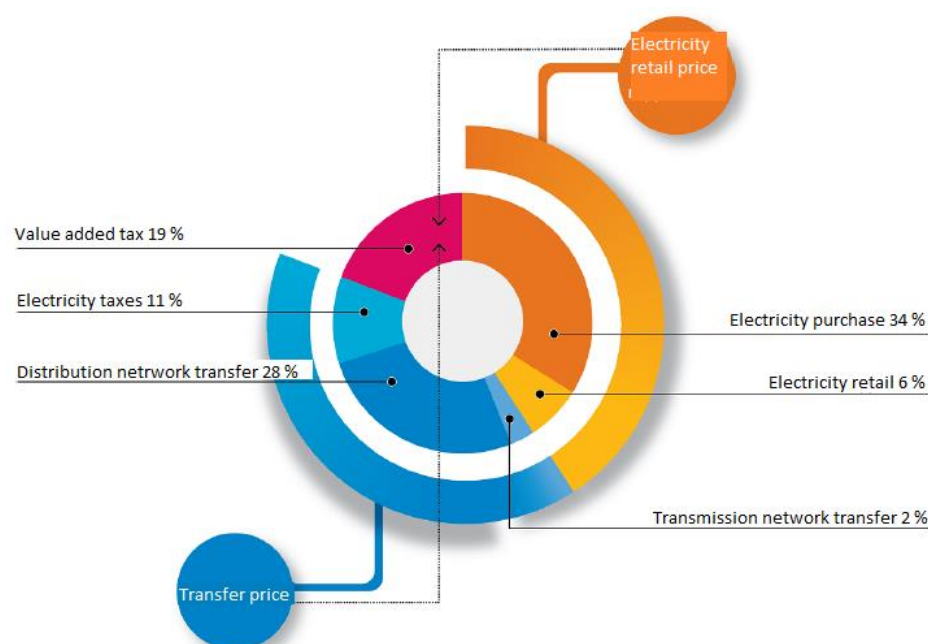


Figure 3.1 Electricity price formation for a domestic customer (translated by authors from Finnish Energy source Finnish Energy Industry and Fingrid, 2012).

Other possible reasons for the unpopularity of dynamic tariffs are the low profits compared to the effort required and the small potential for electrical load management usually available for average citizens or companies. Here, a service like the one developed during IDEAS for the notifications on suitable timing for using the devices might increase the interest for dynamic tariffs, as it would make it easier for the customer. Different ways for the price structuring might also help. The current structure and the low electricity price together make the savings for customers very small. However as distribution and transmission costs make up some 30 percent of domestic consumer's energy costs a tariff which reflects the distance over which electricity as suggested in the previous chapter in section 2.3.1.3 could offer the possibility to increase the profitability of this approach.

It must also be considered that, despite the freedom of choice, the Finnish consumers tend to be loyal to their original, usually local, electricity supplier: in 2013, the rate of supplier switching among electricity users was a little over 10% (Energy Authority, 2014). Interestingly, this coincides well with the results of the energy market study conducted in 2008 where only 11% of the Finnish respondents said that it has no significance if the supplier is a local company or not (Adato Energia, 2008 cited in Annala et al. 2009). One potential explanation for this loyalty is the ownership structure explained earlier: many of the electricity retailers are owned by the municipalities, and the citizens might think that they get value for their municipal taxes when supporting their "own" energy company - the money stays in the region or municipality.

3.3.2.2 Time based tariffs for the purchase and sale of electricity by an EPNSP

Here two issues need to be considered: One concerns energy tariffs for the sale of small scale renewable energy generation sold to energy suppliers and the second involves larger scale operations which can interact with wholesale energy markets either independently or through energy brokers or agitators.

In the case of larger scale energy producers in Finland, time based dynamic tariffs for purchase of electricity are already very common, as most of the electricity purchase happens through the Nordic Power Exchange. The Nordic Power Exchange is the wholesale electricity market

through which Finnish electricity producers, retailers and large electricity users to buy and sell electricity. The next day's wholesale prices of electricity are determined by the Elspot market of Nord Pool Spot (see Appendix E for more information). The Nord Pool Spot prices change considerably during the day. Typically the prices are low during the night when the consumption is low and peak in the morning and afternoon when the consumption is high. The Elspot market of the power exchange is used for the wholesale market for the following 24-hour period (so called day-ahead market). But as there are always deviations from the planned demand, or faults in the generation systems, there needs to be a way to balance the demand in shorter time period. For this purpose, the Nordic actors use the Elbas intra-day market, where the price level is usually higher and much more volatile than on the day-ahead market. (Finnish Energy Industries, 2015b).

It is generally not possible for small scale generators, with a capacity of less than 50 MW, to operate effectively on the wholesale electricity markets, as there are fees for both membership and trading on that market, and the price setting requires a fair amount of expertise. Some of the smaller municipal energy companies in Finland establish a jointly owned company to act as an energy broker or energy aggregator on their behalf on the wholesale electricity market. For example, Porvoo Energia²¹ has joined forces with three other municipal electricity companies and their commonly owned company operates on the electricity wholesale market on their behalf. This is part of a recent development in Finland which has seen the rise of new actors in the energy market. Essentially these companies combine smaller scale consumption and production to a larger entity, which can participate in different markets (Fingrid, 2015). Therefore energy aggregators or brokers which could enable an EPNSP to interact with variable wholesale markets, as depicted in figure 2.6 in section 2.3.1.2 in the previous chapter, already exist in Finland.

In the case of energy tariffs for the sale of very small scale renewable energy generation (less than 1MW capacity) sold to Energy Suppliers time based energy tariffs are less prevalent than is the case for larger scale operations which can interact with wholesale energy markets either independently or through energy brokers or agitators. In Finland, there is no obligation by law for any actor in the electricity market to purchase the electricity generated by the individual house owners (prosumers) or other small energy generators. However, nowadays the electricity retailers accept to buy small amounts of e.g. PV production from their customers (20% according to one of the interviewees). The price is usually tied to the Nord Pool Spot prices, with a small margin. The price for this purchase is always subject to negotiation between the retailer and the customer. However, this is currently a very marginal business in the electricity market, there are only very few examples available today. Therefore in the case of a small scale EPNSP that interacts with viable wholesale markets through and Electricity Supplier as depicted in 2.6 in section 2.3.1.2 in the previous chapter is less promising than is the case for larger scale operations discussed above.

The prices paid when selling renewable energy are also effected by FITs in Finland. While there are no FITs in Finland for small scale renewable energy production at the domestic level Finland has an attractive feed-in tariff scheme designed to promote larger scale wind power and other renewable energy sources. In order to be eligible, projects need to fulfil certain operational and economic prerequisites. For example in the case of wind power, a wind power plant is eligible for the FIT if the plant has not received other state grant, it is built entirely of

²¹ This company owns and runs CHP powered district heating systems in Porvoo and Loviisa, as well as being an electricity supplier. It generates about 80 GWh electricity in Porvoo annually and owns shares of electricity generation facilities outside Porvoo that generate about 100 GWh. Annually the company buys about 60% of the electricity it sells to their customers from the NordPoo while their district heat generation is around 350 GWh annually.

new parts and the combined nominal capacity of the generators is at least 500 kVA.

“The amount of the feed-in tariff is the difference between the fixed target price and the average market price (minimum of EUR 30 per MWh) of the previous three months. Wind energy producers are paid an increased feed-in tariff until end of 2015. The target prices are set forth in the Act on Production Subsidy for Electricity Produced from Renewable Energy Sources (1396/2010) as follows:

- *Increased target price until 2015: EUR 105.30 per MWh*
- *Target price from 2016 onwards: EUR 83.50 per MWh*

The feed-in tariff is paid for a period of 12 years” (Bergmann 2015).

3.3.2.3 Charges for electricity distribution

Finland, led by the Energy Authority, applies the ex-ante regulation of network pricing as required by the current Electricity Directive (Energy Authority, 2014). The charges for the use of the distribution network are regulated by the Energy Authority in Finland and are the same regardless of how far the electricity is transported. The electricity distribution charges in Finland are based on the maximum power supply related to the connection rather than the distance of transport. The aim is to guarantee equality in the electricity supply.

The DNOs have an obligation by law to offer transmission and distribution services for reasonable price in their operation area, both to the consumers and generators of electricity. The DNOs are allowed to take charges for the transfer of the electricity supplied to the grid (max. 0.07 c/kWh) and e.g. the measurement services, if the supply is sold in the market. If the supply is not sold, then these charges can't be executed. The DNOs are also obliged to connect those generators and consumers that fulfil the technical requirements in their operation area, for a reasonable price. The requirements have to be reasonable and no discrimination is allowed (Finlex, 2013a).

According to the interviewees, the distance based charges would require dramatic changes in the thinking and current ways of measuring and this would not be possible with current technologies. However a simple balancing calculation could be used to indicate that electricity used in the neighbourhood is coming from the local sources. This suggests that it would be possible to have a simple two tiered tariff which differentiates between ‘locally generated electricity’ and ‘non-locally generated electricity’ based upon transactions remaining inside or crossing the EPN geographical boundary as suggested in section 2.3.1.3 of the previous chapter.

A two tiered distribution tariff of the type outlined above would help to address one clear barrier hindering PV production, mentioned by different types of stakeholders that are involved in planning of districts with high level of DREG (city planners, land and property owners, energy companies). Namely the taxation of electricity distribution. If PV energy is produced in a different place than where it is used, electricity distribution taxes have to be paid while sometimes the optimal place for production would be outside own property and land. The difference for the solution's profitability is significant.

3.3.3 District heating network and market in Finland

In 2014, about 30 % of electricity supply in Finland was based on domestic renewable sources (hydro, biomass, wind), 27 % on nuclear power, 24 % on fossil fuels or peat, while 19 % was imported, mainly from the Nordic energy market (see figure 3.2). As mentioned earlier almost a third of the electricity produced in Finland comes from CHP. Thus DH is widely applied and is used to heat almost half of the Finnish building stock (see Figure C5 in Appendix E), in

some large towns 90 % of the buildings are heated by DH. Some 95% of apartment buildings and public and commercial buildings are heated by DH. The figure is a lot lower in single family home with only 7 % of these being heated by DH (Finnish Energy Industry, 2015x). The heat sources for DH are largely the same as for electricity (except that nuclear energy is not used for DH), as 70-75 % of the DH is generated in CHP plants or from waste heat of industrial processes (e.g. 74 % in 2014, Finnish Energy Industry, 2015d). The share of biomass and biogas is increasing. In Helsinki, the waste heat from sewage water is used to feed the DH network²².

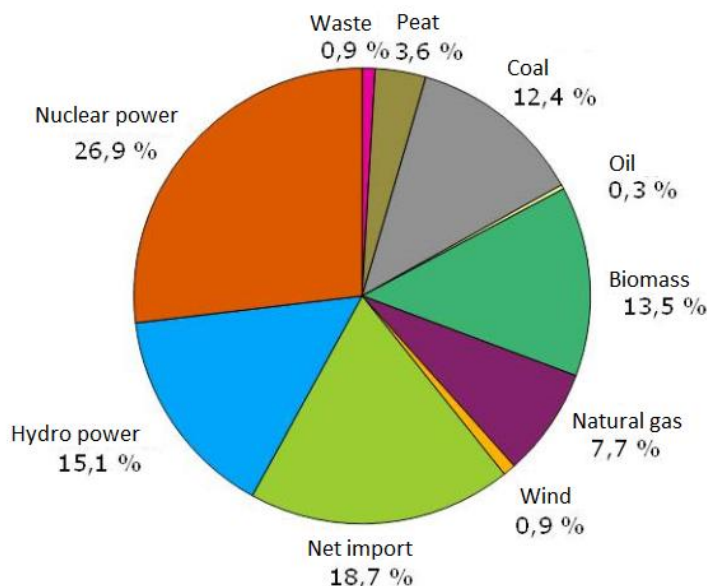


Figure 3.2: The energy sources for Finnish electricity mix. (Finnish Energy Industries, 2015a)

DH is by nature a local monopoly, as it is not profitable to transport heat at long distances. There is no regulation for the DH tariffs in Finland, but usually the DH is cheaper than using electricity for heating. The tariffs applied usually divide the price into connection fee, power charge and energy charge. In 2014, the average price of district heat was 7.5 €/kWh. Taxes account for about 29 % of the price of district heat (Finnish Energy Industry, 2015 c).

It is quite common that the price varies for DH according to seasons or months, being higher in wintertime and lower in summer. For example Helen's prices vary according to the months, and are related to the prices in 2011 (Helen, 2015a). It is not likely that hourly based dynamic tariffs will be largely applied in near future, since the delay in control of heating is slower than in the case of electricity. The structure of the electricity market guides the CHP plants to run the plants according to the need of heating rather than need of electricity, but in some cases short term storage is used to optimise the production according to electricity need. Also the DH network can to some extent be used for storing the heat. The industrial plants are also usually optimised according to the process, rather than pricing of heat or electricity or availability of renewables. A new emerging business is the transfer of the heat from the district cooling to heating customers, usually done centralised by the DH system operator. Currently district cooling is available in eight cities in Finland.

²² One potential barrier for extensive use of waste heat is the current interpretation of the Renewable Energy Systems (RES) directive. It is not clear whether the waste heat from different sources will be treated as renewable energy or not.

3.4 Property markets and energy efficient buildings

This section considers the way in which the different structures of the property markets in Finland support the engagement of those responsible for the running costs of buildings in the design and construction of those buildings or their renovation.

The EPBD (European Commission 2010) sets as a target for all buildings to be nearly zero-energy by 2020 (2018 for public buildings). In addition, it requires the use of an energy performance certificate (EPC). The Finnish application of the latter part (Finlex, 2013b) requires the energy certificate with some exceptions for all new buildings and for existing buildings when those are sold or rented. It is obligatory since 2013 only for buildings built in 1980 or after. After the beginning 2017 it will be required also for older buildings. The energy consumption figure is theoretical primary energy use weighted with factors of energy sources (1 for fossil fuels; 1.7 for electricity; 0.7 for district heating; 0.4 for district cooling; 0.5 for renewable energy sources). In addition, also delivered energy consumption should be declared if it is available.

The European Ecodesign directive 2009/125/EU, on the other hand, sets energy efficiency requirements for building parts, HVAC equipment and consumer devices (European Commission, 2009a).

The Finnish building regulations set the following minimum requirements for the energy efficiency of new buildings: 150 kWh/m²/a for terraced house, 130 kWh/m²/a for apartment buildings, 170 kWh/m²/a or 240 kWh/m²/a for office and commercial buildings depending on their type, 170 kWh/m²/a for educational buildings (university, schools and nursery schools) and 450 kWh/m²/a for hospitals (Finlex, 2013b). Especially private people often choose to build with higher energy standards.

The Finnish state provides three types of financial support for energy efficiency and renewable energy investments: 1) support for energy audits aiming at energy saving or choice of energy source, 2) investment support for projects that improve energy efficiency using new technologies or energy refurbishment with more conventional methods, or enhance use of renewable energy, and 3) ESCO support for ESCO projects (Motiva, 2015).

3.4.1 Non-residential property markets

Life cycle contracts – that are a form of PPP with life cycle commitment in energy performance and other issues – are, according to the interviewees, becoming more popular in large projects of Finnish municipalities. In these projects, the municipality prepares an invitation for tenders defining the targets for the project and the service providers offer their solutions in competition typically committing themselves to at least the design, building and maintenance of the building over 15-30 years. The quality criteria are defined case by case but typically relate to energy performance, indoor environment quality, usability and adaptability. Financing of the project, different user services or even operation and maintenance of renewable energy systems are sometimes also part of the contract. In most of the cases these projects are for schools or nursery schools and in some cases also for larger complexes including e.g. hospitals, libraries and/or swimming pools (Korhonen, 2013).

This form of contract helps the municipalities to start a project quickly and have predictable quality and costs for the building over a long time period. Life cycle thinking guides the preparation of these projects and usually their quality is higher than usual, the environmental impacts lower, and especially the municipality doesn't need to worry about the maintenance that will be timely to maintain the performance commitments (Korhonen, 2013).

Typically, the life cycle contract includes quite high requirements for energy performance. In

some cases, the competition also includes requirements for renewable energy that the service provider will also operate and maintain. In such case the form of contract is very close to the contract type “Integrated Energy Contract” and thus some service providers in Finland already use the business model of the “Integrated Energy Service Provider”.

The targets and financing models in the life cycle projects differ between municipalities and the contractual models have the reputation of being complex. To make them clearer, a model for the service contracts has been prepared nationally (Korhonen and Rontu, 2013). It contains a complete contract model and in addition specifies the following sections of the life cycle contract: description of the service, maintenance and repair plan, contractual documents, paying mechanisms, description of performance requirements in hand-over, description of a quality steering and monitoring system, guide for occupation rate and time, and distribution of responsibilities.

The interviewed service provider and client both have very positive experiences of life cycle projects. An interviewed life cycle service provider says that the main advantage of life cycle projects for them is the predictable and stable cash-flow with good level of profitability over a long time period. The main risks relate to changes in the building’s use patterns or use purpose and unforeseen needs for refurbishment. From the client’s point of view also the difficulty to predict changing needs in future is mentioned as a challenge but otherwise most of the challenges relate to small details for which the division of responsibilities is not clear and hasn’t been specified in the contract. Risk sharing is seen as an advantage and the fact to know in advance who will pay if there is some problem is important for the client. An interviewee says that in practice construction and operation and maintenance activities are still often done by separate companies and even more attention on the optimization of the whole process and life cycle would still be needed.

Examples of life cycle contractors in Finland include the big construction and building service companies YIT, Caverion, Lemminkäinen and Skanska.

In the private real estate life cycle projects and other ESCO solutions have not gained popularity. Based on an interview and literature the reason is the mismatch between the long-term features of these projects and the volatile nature of companies that own offices and retail buildings as well as the quick profits that the property actors typically want to make (Martoldi et al., 2014).

In office properties running energy costs are often included in the rent. However, to motivate to users to reduce their energy consumption there are contract types in which the energy costs are shared between the owner and user organizations, for example “Green lease contracts” in which in energy consumption is monitored regularly and targets for the consumption are set. It could be beneficial if the user organization paid for all the energy costs but quite often there is still the problem that the energy consumed by the building and the users cannot be monitored separately. Also in properties with many tenants the consumption of each is sometimes difficult to separate.

3.4.2 Residential property markets

In Finland there are 2.8 million housing units in 1.2 million buildings of which 44% are apartments, 41% are detached houses and 14 % are terraced or row houses. There are 2.5 million households in Finland 66% live in owner-occupied buildings and 30% rent their house (Confederation of Finnish Construction Industries, 2015).

According to several surveys and studies (Kairos Future, 2012; Kananen and Tyvima 2011; RTS, 2013; TNS-Gallup, 2010), Finnish people would like Finnish buildings to be more

environmentally friendly and energy-efficiency is an important factor when buying a new building. According to the survey of Kairos Future (2012) one third of Nordic house-owners belong to the archetype for which energy economy is the most important characteristic of a dream home. Based on the survey of Kananen and Tyvimaa (2011), 78% of Finns think that all the solutions used in houses should be environmentally friendly and 53% think that houses are currently not environmentally friendly enough. According to a survey of RTS (2013) energy efficiency is included in most important selection criteria in Finland by 38% of the respondents, while the appearance and the reliability of the supplier is mentioned by 52% of the respondents. According to a survey energy efficiency affects the choice of a new building in around 57% of the cases for new buildings and 46% for old buildings (TNS-Gallup 2010).

Also based on the interviews there is part of the population that truly value green energy and some of them could even be willing to pay a bit more for it. In Helsinki, the local energy company installed solar panels on a building and sold the panels with a regular monthly fee to its customers (Helen 2015b). All of them were sold within 36 hours. While this shows that there is demand for green energy it is still difficult to determine the size of the demand. The recession in Finland since 2008 has made people much more cautious when making investment decisions and this can be seen also in green investments, mentions one interviewee. Most of the interviewees however think that at larger scale customers wouldn't be willing to pay anything extra for local renewable energy, especially not the larger property owners.

In addition to the choice of energy source, building energy efficiency and energy efficient consumer devices, users can save energy through their behaviour. The most powerful method to support that (in addition to education) is to make energy consumption visible. This is usually done through monitoring metered energy consumption and visualising it with help of a user interface. Many different home energy management systems are nowadays available, often offered by energy companies. Those can also provide tips to save energy. They can also have easy-to-use properties that help to set targets for energy consumption, visualise the economic savings and show possible solutions to achieve the targets.

Detached houses and terraced houses are usually owner-occupied and the users pay for energy according to exactly what they use. This makes them usually more responsible for their energy use. However, in rental apartment buildings the situation may be different. Energy consumption is often monitored only for the whole building (for the housing company) and it is not possible to meter the consumption of each tenant separately. As a consequence, the tenants don't pay for their actual energy consumption but those costs are included in their rent and are based on the consumption of the whole building. This doesn't motivate the users to save energy. The solution to this is to promote apartment specific metering practices that enable the tenants to pay for their actual consumption.

The next step after monitoring the energy consumption of the whole house is to measure the energy consumption of the most energy intensive equipment in the house individually. For an eager saver this is a powerful method to achieve further savings but on the other hand it is quite costly compared to the savings. One has also always to bear in mind that all ICT and devices have their own environmental footprint and it is the net savings that count.

In older Finnish single-family buildings electrical heating is still widely used, and the houses have individual DHW storages. These are already in a way used for DSM, when the two-time tariffs are applied. Usually the customers get the electricity cheaper during night-time, when the loads are smaller, and heat up their storages then. These could be used also for shorter time DSM, realised by the EPNSP, but this requires an agreement between the electricity supplier and the customer, and probably an upgrade of technology to allow for remote control of the DHW storages. In the current price structuring it would be challenging to find a way for

reasonable way to divide the benefits. For a DNO there is not much economic benefit if the DSM is optimised according to the price of electricity in the spot market, nor the availability of renewables, since their income from the sales is independent of these situations. It would then be more natural role for the retailer, whose profit is more dependent on the price variations on the market (LUT, 2012).

One way to use the building stock for DSM is to raise the indoor temperature slightly during low demand periods, and then cut off the electrical heating for a few hours during peak load situations, and allow a slight decrease in the indoor temperature. The Finnish buildings are relatively well insulated, and could in general very well be adapted for such DSM actions without compromising the indoor thermal comfort. Again, it is a question of contract negotiations. The new buildings more often have controllable appliances and home automation that could also be controlled by an external actor. Also the home automation systems for older buildings, using e.g. wireless technology, are becoming more affordable even for individual home owners.

Concepts of demand side management with load shifting though dynamic pricing and user interfaces have been developed as part of the IDEAS project and the interviewees were asked about end-users willingness to change their consumption patterns to save some money in their energy costs. Based on the interviews, the idea is welcome and end-users would in principle be willing to change their consumption patterns if they can save money, but the interviewees also mention several challenges that need to be overcome, e.g. related to: the low price of electricity, affecting the economic benefit available; the easiness required by the end-users; support needed to interpret the tariffs and optimal timing for energy use; legislative and practical limitations for the independent operation of the appliances²³; challenges in individual control of HVAC systems in only parts of large buildings (like universities); lack of incentives for energy management and metering. However, controllable devices do not have many of the previously mentioned challenges, and their share is increasing. Advanced building automation and control systems help to achieve even much more significant savings in load management.

3.5 The possibilities for EPNSPs in Finland

In general, the attitude in Finnish energy field is favourable for the idea of EPNSP, in the sense that the Finnish actors in the energy field are agile in adopting the ideas of service provision business. Service provision is the fastest-growing industry in the energy industry sector in Finland (Finnish Energy Industries, 2015b) with many companies offering services in the energy field, related to design, operation, maintenance, construction of networks and power plants etc.

The utilities industry in Finland also has many features that support the EPNSP business model proposed in the IDEAS project: the traditional loyalty of Finnish customers to the local electricity company, the dynamic tariffs, the smart metering, the automatic fault locating and separation, the optimisation of network use, the long traditions for load management by the network operator, the possibility to choose the electricity supplier and the free pricing of electricity. Also one feature in support of the EPNSP is the relation of pricing of distribution connections to the maximum power of the connection, which could motivate the customer in the peak demand reduction. But this only represents small part of the price of electricity²⁴, and would be more profitable in case of one connection point to the grid in the neighbourhood,

²³ For example in Finland it is officially not allowed to use a washing machine without supervision, and the night time operated machines need to be silent.

²⁴ For example the distribution network transfer accounts for 28 % of the electricity cost for a domestic customer (see Fig 3.1)

which then induces other challenges, like how to solve the statutory requirement of free choice of retailer.

The points that make the business model less feasible are the Finnish customers' strive for predictability, the big share of distribution costs in the electricity bill and the current law requiring equal services to all customers independent of the distance to the power generators. While the Finnish customers could eventually change their views on the importance of predictability, it is not likely according to the interviewees that the billing structure or the law would be changed in near future. High share of taxes in the energy prices and the way the taxation is structured was also mentioned as potential barrier by the interviewees. Also the low price of electricity affects strongly the profitability of investments. The actors need to consider very carefully if the efforts they put into development of the services really pay off in reasonable time. Many of the interviewees pointed out that it is finally the end user that pays for all the services and all the investments that are put into the development and provision of the services and infrastructures. In a very hard competition, it is not profitable to invest much in new services, which creates pressure to raise the prices, which in turn can result in fewer customers.

Another point which makes the business model less feasible is that as discussed in the earlier research conducted in the IDEAS project (Crosbie et al 2014) FIT policies and other forms of renewable energy subsidy distort the values of electricity in a way which is detrimental to the local consumption of DREG. With the current very generous of FIT for wind energy generation above 500KVA for selling energy to the national network it is very unlikely that an EPNSP would find it more profitable to sell the electricity produced by wind turbines within the EPN than to the national network. In research conducted as part of the IDEAS project²⁵ it was found that while an EPN with the EMS optimiser achieves a clear reduction in the CO₂ emissions, the FIT in Finland for wind energy distorts the market limiting the possibilities for proposed business model in the case of an EPNSP that has wind turbines as part of the electricity production capacity of an EPN. However current policies for FIT are only intended to stimulate the market for wind energy production and will be slowly reduced in the future.

Currently there are many actors responsible for different tasks of an EPNSP, e.g. owner, user, Maintenance Company and Energy Company. For the creation of an EPNSP, the most natural option seems to be that it is an energy company (retailer/generator or DNO) and its services are developed based on market needs. However, some of the interviewees see regulatory challenges: e.g. DNO is not allowed to sell energy and retailer cannot be seen as a monopoly. However as discussed in chapter 5 section 5.2 European regulation is not so inflexible and as long as the EPNSP did not service more than 100,000 customers then regulation does not prevent this approach.

Based on the interviews also other actors than energy companies are interested in taking the role of an EPNSP. Demand side management with a remote neighbourhood energy control and monitoring centre is of interest for facilities management companies. In Otaniemi, in Espoo, there is an ongoing large campus development project in which one of the local building owners is seriously considering the possibility to be an EPNSP²⁶. There are however some potential regulatory, contractual and financial barriers. In order to resolve those one option could be to create a development company by the different stakeholders (e.g. property owners, city, Maintenance Company) for the whole area. It could own the distribution network, trade

²⁵ Bäckström (2015) IDEAS Deliverable D5.5 Impact report Finnish demo which is under preparation at the same time as this report and will be available at <http://www.ideasproject.eu>

²⁶ More information at <http://www.openenergy.fi/en>

energy and optimise the energy flows, envisions one of the interviewees.

Some actors already provide services that are part of the EPNSP business model developed in IDEAS. In addition to the aggregators mentioned earlier (in ch 3.3.2.2), there is e.g. a self-sustaining ecovillage (in Kempele) where local renewable energy is used for the needs of the ten low-energy single-family houses, but this village is not connected to public network. There are also energy companies (retailers) offering remote control and demand management, Helen's Termo and Hima products or Fortum's Fiksu as examples (see Appendix E).

In the Helsinki metropolitan area, that consists of several cities and where several energy companies operate, there is already some smart regional heating energy optimisation through energy trading between the different energy companies, according one of the interviewees. The district heating distribution networks operated by the different companies are connected to each other over the whole area. Technically the whole region could be operated and optimised together but it seems too complicated to calculate and distribute the economic benefits between the different companies (unless they would create a common company for that, which none of them wants either).

The interviewees mentioned some examples where local energy services that resemble EPNSP activities have been provided by some actors, e.g. a big housing company with several buildings could run and operate a heating plant in the area, or a big rental building owner bought the electricity and sold it to their residents. Also there have been cases where there is one connection to the whole property, having several types of activities: shops, offices and homes. However, these actors have given up the business. One possible reason is the small profit compared to the effort needed. A big enough customer base/volume is needed for this business to be profitable.

The contractual form of life cycle projects in Finland is already very similar to the business model "Integrated Energy Contract". Life cycle contracts do not necessarily require provision of energy by renewables but in cases that this has been specified as criterion, as in the nursery school in Omenatarha, Porvoo, they do.

3.5.1 Summary of key requirements for EPNSPs existing in Finland

In conclusion is if fair to say that the following key requirements for the best case scenario for the development of EPNSPs exist in the structures of the Finnish utilities and property markets

- **Time based tariffs linked to day ahead and intra-day markets for the electricity an EPNSP purchases and sells**, providing the potential to optimise neighbourhood energy supply resources based on their market value. However some of the current subsidies in Finland for renewable energy (FITs) limit this potential.
- **Exploitation of the economies of heat/cooling and electricity cogeneration** offered by bio-fuelled Combined Heat and Power (CHP) and Combined Cooling Heat and Power (CCHP) driven district heating (DH). Thereby enabling the economical provision of both heat/cooling and electricity within an EPN.
- **Regulatory and voluntary instruments to encourage high standards of building energy efficiency** that could reduce the overall energy demand making of a neighbourhood making it easier to meet with renewable supply and reducing the need to invest in new generation facilities.
- **Legal, regulatory and business contexts that enable Public Private Partnerships (PPP) (in the public sector) to fund Integrated Energy Contracts (IEC)** underpinned by life cycle approaches that offer financial rewards to those responsible for the design, construction and management of buildings if they reduce the running

costs

The utilities in Finland are also working toward the development of **an ‘active’ or ‘smart’ local electricity grid** that can support the monitoring, control and advanced protection systems that enable the supervision and operation of bidirectional power flows in a distribution network.

However there are strong objections, by key stakeholders in the distribution industry, to the notion of **distribution network charges which reflect the distance electricity is transported**. A lack of differentiated local and national network tariffs does not necessarily negate the IDEAS business models. However it does mean that the cost optimisation of the production may not work in favour of the local consumption of distributed renewable energy.

4 THE FRENCH CONTEXT

4.1 Introduction

This chapter presents an in-depth review of how the operation of the utilities industry and property markets in France impact on the feasibility of the proposed business approaches for EPNSPs. The work presented is based on a literature review and the findings from six interviews with actors involved in the property and utilities markets [see interviewees 1, 15, 16, 18, 19, 20 listed in appendix A].

4.2 Regulation of the electricity industry in France

The French power market is highly concentrated. Electricity generation is still largely dominated by Électricité de France (EDF) the vertically integrated French incumbent utility is still controlled by the French state²⁷. The French transmission system operator, Réseau de Transport de l'Electricité (RTE), and the distribution network operator, Electricité Réseau Distribution de France (ERDF), are 100% owned by EDF. ERDF manages about 95% of the electricity distribution network. In France electricity suppliers and distributors are regulated by the Commission de Régulation de l'Énergie (CRE) that ensures adherence to market regulations²⁸. The French energy supply market was opened up to competition in 2007. Since which time alternative suppliers to EDF have emerged (see figure 4.1). However it continues to be challenging for alternative suppliers to enter the French electricity market and while consumers can choose their electricity supplier competition is limited.



Figure 4.1: Active electricity suppliers in France, as of 31 December 2012 – Source CRE (2014).

A recent study shows that while consumer awareness of the opening of the electricity market is growing it is still very limited. As illustrated in Figure 4.2, in 2013 only 53% of French consumers were aware of the possibility to change of electricity supplier and only 9% of customers in France have changed their energy provider (CRE 2014). The motivation for 70%

²⁷ EDF was created in April 1946 as a public industrial and commercial establishment (EPIC) and changed its status in November 2004 to become a public limited company (SA).

²⁸ CRE contributes to the smooth operation of energy markets for the benefit of the consumer. Its missions involve regulating both electricity and gas networks and the electricity and gas markets. This involves: Monitoring transactions on the electricity, natural gas and CO₂; Ensuring the proper functioning of retail markets; Contributing to the implementation of measures to support electricity generation and supply of electricity and gas; Informing all consumers

of those that switched supplier is to get more competitive tariffs (CRE 2014) which suggests that some French consumers are looking to reduce their energy costs.

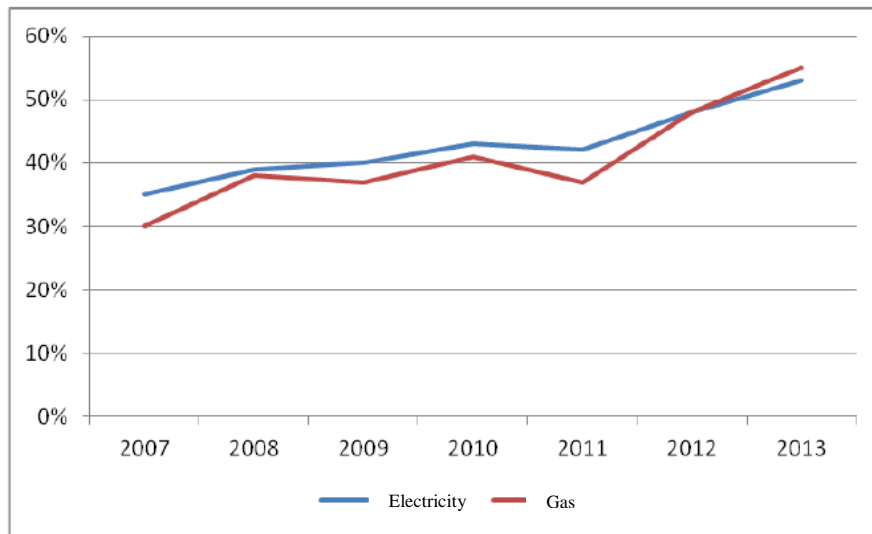


Figure 4.2: Percentage of people aware of the possibility to select an alternative supplier for electricity and gas. (Source CRE 2014)

CRE also regulates electricity generation in France. As illustrated in figure 4.3 nuclear power is the primary source of energy in France. EDF owns and manages 73 nuclear reactors in operation in France and the United Kingdom. Its production in France covered 74.8% of the country's electricity supply in 2012. The second largest French electricity producer is GDF Suez. GDF is the historical French gas supplier. In August 2004, GDF changed its status to become a public limited company (SA). In 2008, GDF merged with Suez to form GDF Suez. GDF Suez controls the Compagnie nationale du Rhône and the Société Hydro-Electrique du Midi (SHEM). These companies run hydroelectric facilities. The German E.ON is the third largest electricity producer in France. It runs a significant number of thermal power plants. The breakdown of the amount of electricity produced by the EON, GDF and EDF are shown in figure 4.4.

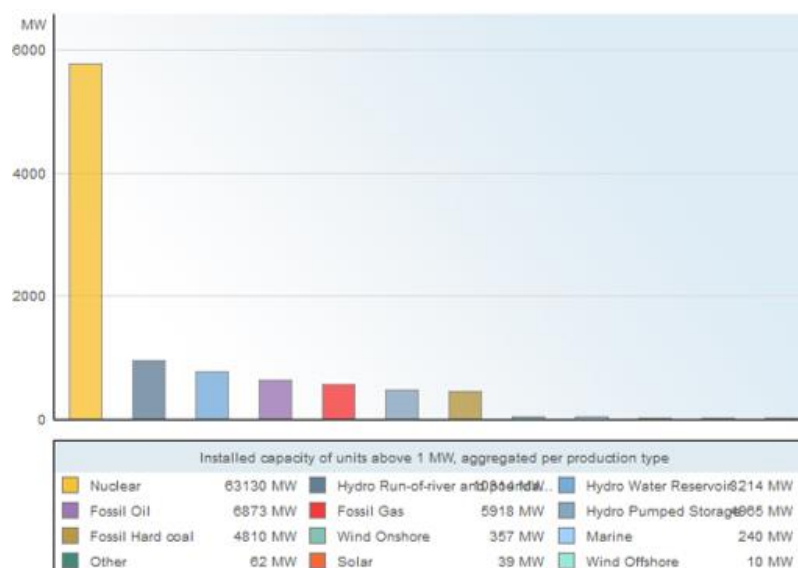


Figure 4.3: Installed capacity of units above 1MW, aggregated per production type in 2015 (Source RTE 2015).

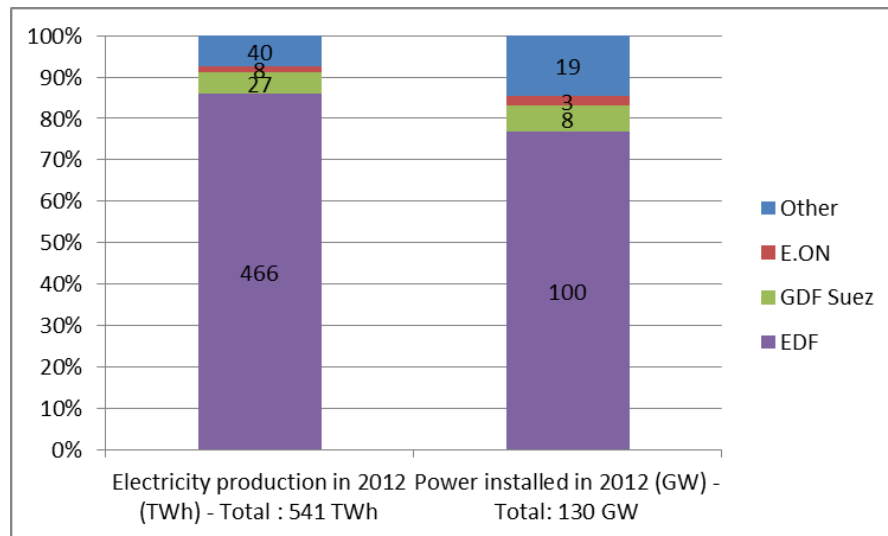


Figure 4.4: Electricity production in France (2012) – The data provided here are orders of magnitude

One of the reasons for the lack of competition in the French supply market is argued to be related to the regulation of the French electricity tariffs and EDF's market dominance in the energy generation market (Leveque 2010). Two systems co-exist for electricity tariffs in France:

- regulated tariffs proposed by the CRE and validated by the French Ministry in charge of economy and energy
- non-regulated tariffs (also called market tariffs)

All energy suppliers (the historical supplier and the alternative suppliers) can offer non-regulated tariffs. However, regulated tariffs are only offered by the historical energy supplier (EDF) and local distribution companies (ELD). As of September 30th 2014, there are still 90% of the sites using regulated tariffs, representing 71% of the total electricity consumption, as represented in the figure below.

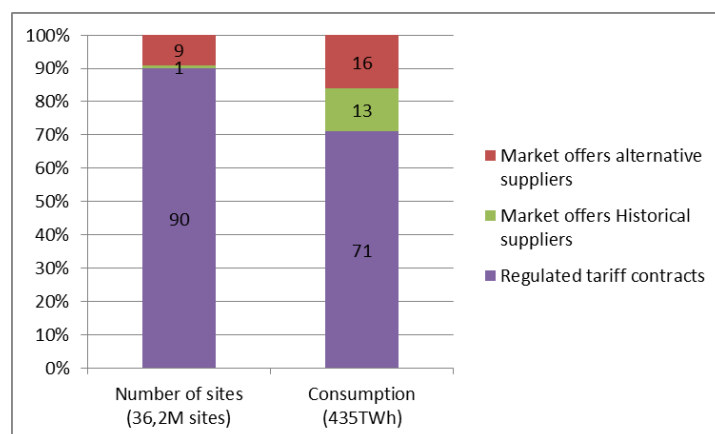


Figure 4.6: Regulated vs. non-regulated electricity tariffs in France, as of 30 September 2014

For commercial and industrial customers²⁹ (i.e. customers with a contract higher than 36 kVa), regulated tariffs will end in 2015, so they must choose a market tariff for their contract before January 1st 2016.

²⁹ Professional customers include high power contracts (yellow contract, >36kVa) that can be related to commercial or industrial customers but also to customers with professional activities requiring a high power installed (large building of offices, farms,).

This move from regulated commercial electricity tariffs is the result of an Act passed by the French Government in 2010, intended to reform the electricity market and introduce competition into electricity supply. The 2010 Act also brought in changes in the French electricity wholesale market which is dominated by EDF, as it produces such a large percent of electricity in France. The 2010 Act obliges EDF to make available up to 25 % of the nuclear electricity it generates to alternative suppliers on the wholesale market at a regulated price called ARENH (Regulated Access to Incumbent Nuclear Electricity)³⁰. It is a right that entitles suppliers to purchase electricity from EDF at a regulated price, in volumes determined by the French energy regulator CRE. In order to exercise their ARENH rights, suppliers are required to sign a standard agreement with EDF, to provide a contractual framework for the sales concerned³¹.

The regulated retail and wholesale electricity prices in France are argued to be a major barrier to the development of an efficient energy market (Leveque, 2010). The 2010 Act's aim of encouraging competitive supply is argued not to be the core required electricity sector reform in France (Leveque 2010). Economists argue this should be the development of competition in electricity generation and the organisation of an efficient wholesale market. The competition agency is very sceptical about the idea that the current approach enshrined in the 2010 Act will in fact even many years down the line encourage alternative suppliers to invest in generation. Five years on the figures related to EDFs dominance in the market would seem to reinforce this argument.

There is also a lack of competition in the renewable electricity supply in France, as only the incumbent energy supplier (EDF) can purchase renewable electricity from the companies and householders that generate that electricity. This is a key regulatory barrier to the business model for an EPNSP that is a District Energy Supplier discussed in section 2.2.1. As it would not be possible, under current French law, for a 'District Energy Supplier' to generate electricity and heat using a CHP and sell the electricity produced locally, unless that company were wholly owned by EDF. Although, it must be noted that innovative community based co-operatives such as Enercoop, along with current political thinking in France, are beginning to challenge this situation and it is likely that sometime in the future the purchase and sale of renewable energy will be opened up to further competition. However some of those interviewed felt that the fact that all renewable energy must be sold to EDF is a major barrier to new entrants into the renewable energy generation markets abilities to diversify into retail electricity markets.

4.3 Electricity distribution networks and electricity tariffs

4.3.1 The state of distribution networks

In France, distributors ensure the delivery of electricity from the production site to the point of delivery (customer). In addition, they ensure the proper functioning of the network

³⁰ The current ARENH price is 42 €/MWh.

³¹ CRE is tasked with managing this system and calculating the rights, which it notifies to the contracting parties. Suppliers wishing to exercise their ARENH rights make an application to CRE, providing forecasts of their customers' electricity consumption. Both those detailed forecasts and the rights calculated for each supplier are known only to CRE and the supplier concerned. Payments are handled by the Caisse des Dépôts et Consignations, the French deposit and consignment office. To avoid any windfall effects, a retrospective mechanism has been set up to offset any surplus volumes allocated, in the event that the supplier's portfolio has not developed in line with forecasts. This mechanism takes the form of a price premium for any surplus quantities of electricity allocated. It is done by CRE on an ex post basis, according to actual electricity consumption by the supplier's customers for each sub-category of consumers (RTE, 2012).

maintaining, renewing and expanding it. Figure 4.5 presents an overview of the electricity transmission and distribution networks in France. RTE, a subsidiary of EDF, is the French transmission system operator. As such RTE manages the high and very high voltages lines above 50 kV. RTE is in charge of a network of roughly 105 000 km and 2 700 substations. ERDF manages 95% of the electricity distribution network in continental France. ERDF manages medium and low voltage lines below 50 kV, and is in charge of 1.3 million km of lines. This network belongs to local authorities (French municipalities or groups of municipalities), who subcontract to ERDF as an operator through a public service delegation. Like RTE, ERDF is a subsidiary of EDF. The remaining 5% of the distribution network is operated by several Entreprises Locales de Distribution (ELD) or Local Distribution Companies. These companies are engaged in the carriage of gas or electricity in geographic areas not served by ERDF. There are nearly 170 Local Distribution Companies such as RMET, GEG - Gaz Electricité de Grenoble, Electricité de Strasbourg, etc.

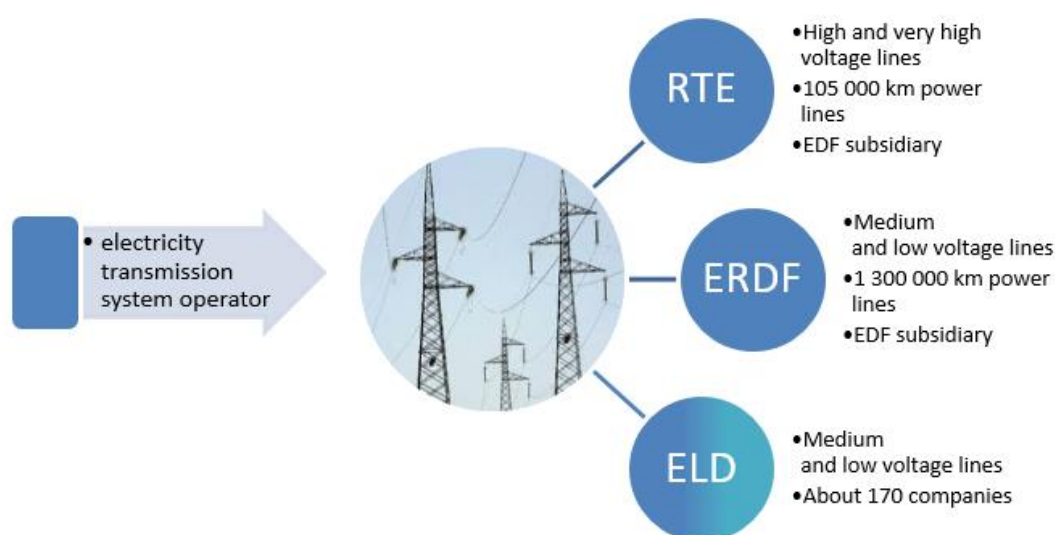


Figure 4.5: Overview of the electricity transmission and distribution in France

ERDF acknowledges that the French electricity distribution network must adapt to new commercial, technological and environmental demands. ERDF is therefore active in developing innovative research actions to explore smart grid technologies that support data exchange in real time. For example, ERDF leads the GRID4EU project (<http://www.grid4eu.eu>), the largest smart grid project to be funded by the European Union (€54 M budget with a European Commission co-funding of €25M). GRID4EU tests the potential of smart grids in areas such as renewable energy integration, electric vehicle development, grid automation, energy storage, energy efficiency and load reduction.

A central piece in the modernisation of the distribution network is related to the deployment of the French 'smart' meter Linky by ERDF. The Linky meter is able to receive orders and transmit information remotely³². After an experimentation phase, the French government agreed to start the roll-out of Linky smart meters: 35 million Linky will be installed by the end

³² It communicates to a hub, a kind of mini-computer installed inside transformation substations managed by ERDF. The hub is linked to the ERDF supervision centre

of 2021³³.

There are three key drivers beyond a pure economic approach which explain why ERDF is interested in load management:

- To anticipate future constraints linked to intermittent energy production from renewables.
- To prepare the network for a possibly massive growth in electric cars charging points.
- To allow customers to be more active in the management of their consumption.

However, for the time being government regulations in France are not specifically designed to encourage DNOs to take a more active role in load management.

The current debate around ‘self-production’ and ‘self-consumption’ of electricity in France could potentially have a significant impact on the future regulation surrounding the electricity distribution industry³⁴. This is leading “a right for experimentation”, which the interviewees felt could potentially lead to interesting feedback and new regulations.

4.3.2 Time based electricity tariffs in France

4.3.2.1 Time based tariffs for the purchase of electricity by consumers

This section reviews the prevalence of time based market linked tariffs for the purchase of electricity by consumers in France to indicate the feasibility of an EPNSP offering this type of tariff to its customers.

Time of use (TOU) tariffs and Critical time of use (CTOU) have been in place for some years in France through different contract offers proposed by the historical energy supplier EDF: for example the “Heures creuses / Heures pleines” contract, or the “TEMPO” contract.

- The contract “Heures creuses / Heures pleines” (“full hours / light hours”) features a predefined schedule of full hours / light hours which are set by ERDF. During “light hours”, electricity is 30% cheaper than during “full hours”. The schedule of light vs. full hours is set when the contract is established with the customer, according to its location. It remains then unchanged.
- The “Tempo” contract includes “Blue, White and Red days” combined with “full hours / light hours” for each colour, making a total of 6 potential different tariffs. The contract signed with the consumer sets that there will be every year 22 red days, 43 white, and 300 blue. Light hours are predefined from 10pm to 6am every day and full hours from 6am to 10pm. The consumer is informed every day from 8pm of the colour for the next day (blue, white or red). To get the colour of the day-ahead, the consumer can look at its electricity meter, on the EDF website (EDF, 2015), or can even subscribe to a phone & email notification service. Tempo has been available in France since 2009; the colour of the day-ahead is defined by RTE.

However, there is no real-time dynamic pricing as such in France today for residential customers. In the near future, with the ongoing deployment of Linky smart meters across France (see section 5.2.1, it is forecasted that additional dynamism will be offered through energy contracts. Typically this will be materialised through an increased variability (duration, number of days, etc.) of the “light hours” intervals. “Light hours” signals will be sent to consumers the previous day. Intervals will be defined according to a more accurate analysis of the demand on the electric network.

³³ See Ministère de l’Ecologie, du développement durable et de l’Energie, (2014).

³⁴ Direction générale de l’énergie et du climat, (2014).

The smart meter Linky is central for those new offers since it facilitates the process to send a “light hour” signal to the customers, and allows a more accurate analysis of the electric load.

Those more dynamic contract offers will obviously be proposed through “non-regulated tariffs” contracts, thereby potentially by all French energy suppliers (EDF and all alternative suppliers). Those offers will be marketed alongside the Linky smart meter deployment.

4.3.2.2 Time based tariffs for the purchase and sale of electricity by an EPNSP

Following the discussion in chapter 2, section 2.3.1.2, related to how EPNSPs interact with energy markets two issues need to be considered: One concerns energy tariffs for the sale of small scale renewable energy generation (Less than 1MW) sold to energy suppliers and the second involves larger scale operations which can interact with wholesale energy markets either in their own right or through an energy broker.

In the case of the former the current FIT policy in France is a non-variable tariff which guarantees a fixed price for every unit of produced electricity and interviewees did not envisage the adoption in France of dynamic tariffs for the sale of electricity by small scale energy generators in the near future. In addition the current FIT is so generous that it is currently more profitable in France to sell energy back to the utility supplier than it would be for small scale electricity producers to use the energy they generate even if they were allowed to do so³⁵. This obviously reduces the commercial value in balancing energy supply and demand between the buildings.

In relation to the tariffs for the purchase of electricity by larger sale EPNS that could operate on wholesale markets, once again in France there is a lack of dynamic pricing available. Almost all electricity in France is traded using bilateral agreements rather than on the day ahead or intraday markets and the energy market.

4.3.2.3 Charges for electricity distribution

The charges for the use of the distribution network are set by the regulator in France and are the same regardless of how far the electricity is transported. This makes it very difficult for small scale distributed renewable electricity generation to compete with larger scale, often fossil fuel based, electricity generation. With regards to charges for electricity distribution, the “postage stamp” principle is followed. Interviewees said that end-users are charged the same price/tariff no matter their location for equity reasons, this is the case whether they are living in rural or metropolitan area or in French overseas territories. The French energy industry experts interviewed as part of this study (see appendix A) argued that likelihood of changes to the charges for the distribution network which would reflect the distance electricity is transported is very low. They argued that from a technical point of view, there is no possibility to detect from where electrons are coming from on the network making distance-based electricity distribution tariffs difficult to implement. They also argued that such a policy would not be fair since it would penalise some customers in rural areas and create a fracture between territories.

4.3.3 Demand Side Management (DSM) in France

DSM is already used in France (Veyrenc, 2013 and Veyrenc, 2014). DSM has already become a new market per se in France where independent new entrants are competing with established suppliers (VOLTALIS, DIRECT ENERGIE... for instance). The question related to who

³⁵ Users receive 29.69 c€/kWh if the supply required for their energy system is under 9kW. Users get 15.21 c€/kWh if the supply required for their energy system is between 9kW and 36kW and 14.45 c€/kWh if it is between 36 and 100kW. EDF purchases generated electricity with a bonus of around 5%.

should be in charge of DSM is still open (suppliers, consumers?). The NEBEF project has been initiated in this frame and enables any consumer in mainland France to use its electricity demand reductions on the energy markets, either directly by itself becoming a Demand Side Management Operator (DSMO), or indirectly through a third party that is a DSMO. However, as a transitory arrangement, only those consumers connected to Distribution System Operators applying a generalised flow adjustment system (i.e. generalised profiling) can participate at the present stage of the mechanism (RTE 2013).

4.3.4 District heating network and market in France

There are close to 500 DH networks in France (SNCU, 2014). They provide heating to more than 2 million people. In France 4% of total heat use is supplied by district heating (ADEME1, 2014). Over a quarter (26%) of the district heating systems in France are situated in Ile-de-France (one of the French Regions) supplying 10% of the heat used in the region which houses 18% of the total population of France. In Ile-de-France more than 120 DH systems are in operation, yet the share of renewables in the energy mix was only 30% in 2012. This figure should increase to 50% by 2020, according to the regional action plan (SRCAE, 2012). 25 TWh of thermal energy were delivered by the French heating networks in 2013 mainly in the residential sector (53%) and the tertiary sector³⁶ (35%) (SNCU, 2014). Natural gas is still the main energy source used for district heating networks and tends to replace other fossil energies such as fuel. The energy mix is still becoming greener, and the threshold of 40% of renewable energies has been reached for the first time in 2013. In Ile-de-France barely 30% of the heat injected in heat networks does not come directly from fossil fuels

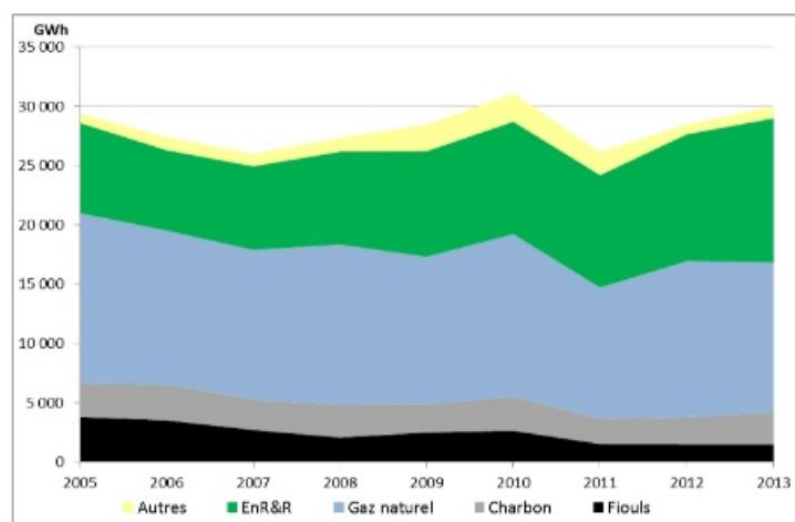


Figure 4.7: Energy used for district heating networks in France (SNCU, 2014)

³⁶ The segment of the economy that provides services to its consumers. This includes a wide range of businesses including financial institutions, schools, transports and restaurants

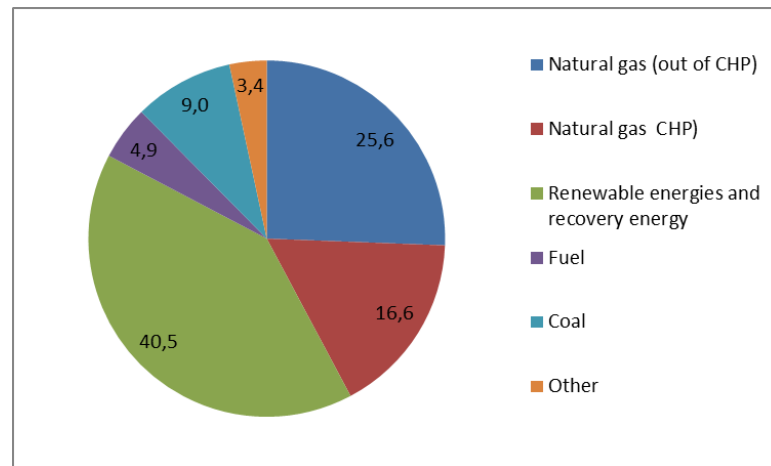


Figure 4.8: Energy mix of district heating networks in France (SNCU, 2014)

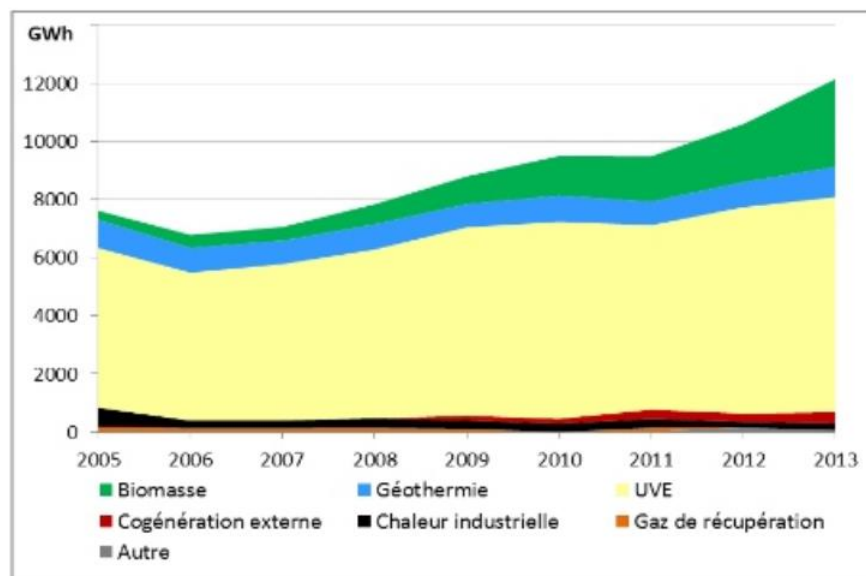


Figure 4.9: Renewable and recovery energies feeding the heating networks (SNCU, 2014)

As an example, the energy mix of district heating in Ile-de-France is shown in figure 4.10.

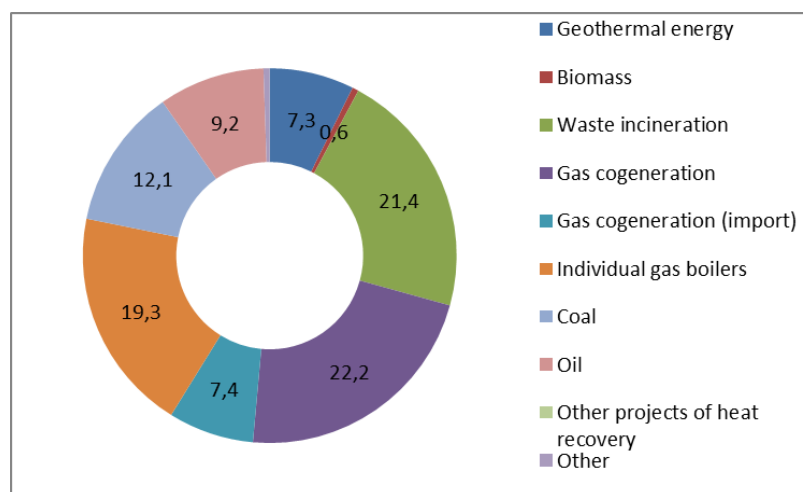


Figure 4.10: Energy mix of district heating in Ile-de-France (ADEME1, 2014)

One out of two heating networks has a CHP. In France, the Fonds Chaleur (in English Heat

fund) supports the development of use of biomass (forestry, agricultural, biogas,...), geothermal, solar thermal, energy from waste, as well as the development of heating networks using these energies (ADEME2, 2014). The Fonds chaleur provides incentives that help the projects dealing with the introduction of renewable energy sources associated with heating network.

It should be emphasised that the question of the choice between renovation and connection to district heating will be discussed in many cases during the coming decades (ADEME1, 2014). A rough approximation of the lifetime of a building is 100 years, whereas a district heating network is paid back after approximately 10 years and has a lifetime of around 20 years. So actually, low-energy buildings growth and district heating development are anyway compatible. Thus, district heating is part of the French energy action plan towards 2020 and the sector is expected to grow during the next decade. France should follow the examples of Sweden and Denmark, where advanced challenges like the case of low-energy buildings are already discussed.

In most of the cases, district heating systems are built and exploited by private companies (Dalkia, Cofely, Idex, Coriance are the leaders) on the request from municipalities. “Public service delegation contracts” are signed, in which the initial heat price is given, and formulas explain how the heat price should evolve over the time.

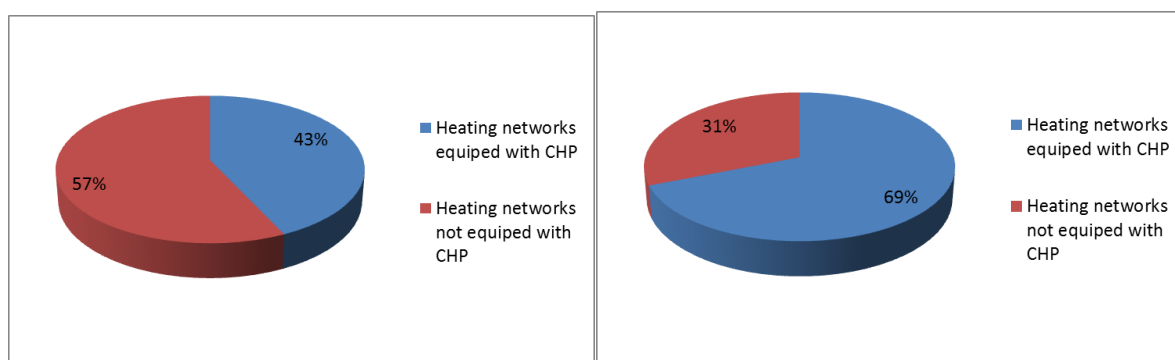


Figure 4.11: Share of district heating network equipped with CHP (number of networks on the left and thermal energy delivered by heating networks equipped or not with CHP on the right)

The energy mix of CHP providing heating network is illustrated in figure 4.12.

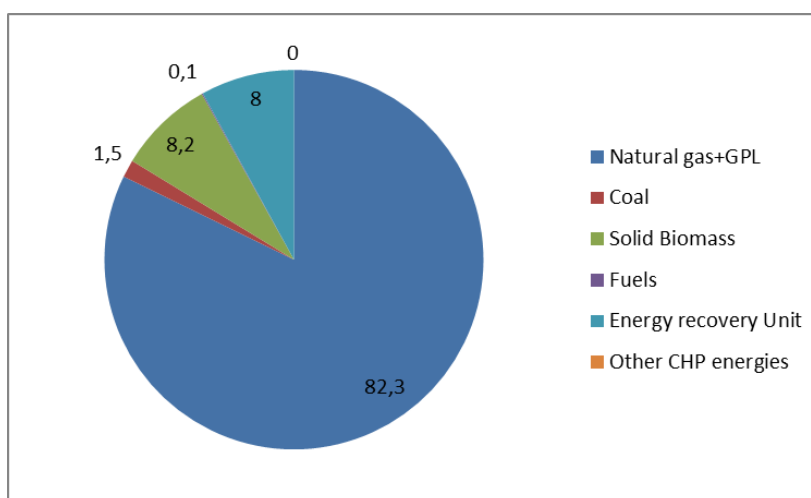


Figure 4.12: Energy mix of CHP in heating networks (SNCU, 2014)

4.4 Property markets and energy efficient buildings

In France, until relatively recently EPC and IEC have not been applicable for energy efficiency investments in the public sector because French law usually precludes investment by the private sector in public facilities. But a law on public-private partnerships (PPPs) first enacted in 2004 greatly facilitates the use of EPCs in the public sector” (Dilip et al., 2013). This law was amended to further improve its ability to enable energy efficient investments in public buildings the amendments are:

- Global contract allowed after life-cycle cost-balance;
- Design, build, finance, operate “design for build” system;
- Environmental targets, performance targets, share benefit & under performance penalty system;
- Procedure based on competitive dialogue.

According to the law, public-private partnerships are considered the most appropriate legal frame to promote energy saving contracts in public buildings (Langenheld, 2010).

4.4.1 Instruments to encourage building energy efficiency

France has 31 million residential buildings covering an area of more than two billion square meters. Commercial buildings account for more than 900 million square meters. 20 million dwellings were built before the first thermal regulations were introduced in 1975. Highly demanding in energy, these dwellings represent 58% of the housing sector and account for more than 75% of its energy consumption. Their renovation has therefore become a priority. As part of the Grenelle Environnement, a goal was set to reduce primary energy consumption in existing buildings by 38% by 2020 and to renovate 400,000 dwellings per year from 2013.

France is also gradually reinforcing its thermal regulations (TR) for new buildings. The objective for metropolitan France is that:

- “Low Energy Consumption Buildings” will become widespread with TR 2012,
- “Positive Energy Buildings” will be the target of TR 2020.

The challenge is the following: to make “low energy consumption buildings” consume 10 to 20 times less than buildings built before 1975.

To accompany this change, numerous regulatory instruments and mechanisms, and several R&D programmes, have been set up by public authorities. For example, the Programme for Research and Experimentation on energy in Buildings (PREBAT), launched in 2004, enables experimentation and dissemination of new solutions for energy efficiency in new and old buildings. On the private side, a large number of research laboratories, engineering and research departments, architects, services managers, construction companies and manufacturers, are also involved. Training in all aspects of construction has been adapted to new technical requirements and new professions have emerged.

The Grenelle Environnement includes a major program to reduce energy consumption in all sectors of the construction industry. Ambitious goals in terms of thermal regulations set a maximum limit on the energy consumption of buildings depending on their use (commercial, residential, etc.) and their nature (new or existing).

For new constructions, the Grenelle Environnement has set a target of low-energy buildings (BBC - “Bâtiments Basse Consommation”) becoming widespread by 2012 and positive energy buildings by 2020.

For existing buildings, the Grenelle Environnement has set an overall goal of reducing primary energy consumption in existing buildings by 38% by 2020.

Specific targets have been adopted for the renovation of public buildings, the renovation of council housing, private commercial buildings and private housing, the renovation of dwellings in tropical climates.

Numerous financial incentive schemes and awareness campaigns have been launched to achieve these goals (Interest free eco-loan, Council housing eco-loan, Certificates for energy savings (CEEs), Tax credits for sustainable development, the European Regional Development Fund (ERDF).

Since 2006, EPAs (Energy Performance Assessment) have provided information on the energy performance of a dwelling or building, assessing its energy consumption and its impact in terms of greenhouse gas emissions. An EPA certificate is required for the sale of a building or residential and commercial premises as well as for rental housing.

Table 4.1 Overview of major French regulatory instruments to encourage high standards of building energy efficiency

Organisation	Programme	Description
French Ministry of Ecology, Sustainable Development, Transport and Housing	Grenelle de l'environnement	<ul style="list-style-type: none"> The "Grenelle de l'environnement"(2007) set ambitious goals for France in many areas of sustainable development implemented in 2 laws "Grenelle 1" and "Grenelle 2." Building and Housing main commitments: generalisation of standards of low consumption in new housing and public building, new incentives for the renovation of housing and building heating. Energy main commitments: development of renewable energy to achieve 20% of total energy consumption by 2020, ban on incandescent lamps by 2010 and a tax based on goods and services energy consumption ("carbon tax").
French Ministry of Ecology, Sustainable Development, Transport and Housing	RT2012 – Réglementation Thermique 2012	<ul style="list-style-type: none"> Sets the new minimum standard of thermal insulation of dwellings and other types of construction in France. Applicable to all new planning applications submitted for non-residential buildings from Oct 2011 and for all new residential properties from January 2013. Although a complex set of standards, broadly speaking, the regulations require that all new dwellings must have an energy consumption level less than 50 kWh/m² per year, although varied by locality and altitude within the range 40kWh/m² to 65kWh/m².
French Ministry of Ecology, Sustainable Development, Transport and Housing	DPE – Diagnostic de Performance Energétique – Energy Performance Diagnosis	<ul style="list-style-type: none"> Since 2008, the DPE of some French public buildings must be displayed in the main entrance of the buildings. This obligation applies to public buildings larger than 1000m², and must be financed by the building owner The template of DPE to be used for building occupied 24H a day such as hospitals.

French Companies such as COFELY (subsidiary of GDF Suez) or DALKIA (subsidiary of EDF and VEOLIA) provide sustainable solutions enabling its customers to reduce energy consumption, improve economic performance, and control their environmental impact. They are active with both tertiary and residential buildings, and involved in French eco-districts³⁷ developments where they help to define the most appropriate energy mix.

Those companies provide exploitation and maintenance contracts which include a result based approach (energy performance contracts).

³⁷ Ministère du Logement, de l'Égalité des territoires et de la Ruralité, 2014

The barriers are mainly related to regulatory constraints and allotment process, to the requirement to discuss with electricity and gas distribution franchises (concessions). The French laws are also increasing the difficulty to have a perfect sync between these different types of actors.

Nevertheless, all the experimentations that are currently conducted in France (call for projects (for instance “Réinventer Paris” which is a competition for innovative urban projects), partnership contracts...) and that aim at demonstrating the benefits from new technologies, new approaches are good drivers for such business.

4.5 The possibilities for EPNSPs in France

Compared to most other European countries, France has relatively low retail electricity rates (currently at €0.147/kWh) and there is no remuneration for self-consumption of electricity from PV, therefore it is currently not an attractive proposition. However changes to the FIT are currently being as part of the debate around the self-consumption of renewable energy in France.

A key barrier in terms of the business model for an EPNSP that is a District Energy Supplier is that only the incumbent energy supplier (EDF) can purchase renewable energy. Therefore it would not be possible for a District Energy Supplier to generate electricity and heat and sell that electricity and heat locally, unless that company were wholly owned by the current incumbent utility company in France. However this means that the regulation of the French electricity market means that EDF are currently primarily placed to develop EPNSPs that are District Energy Suppliers in France. As only EDF can currently buy electricity from embedded electricity generation and only they can sell this energy on the retail market.

The picture is more positive for the development of what we have described as an Integrated Energy Service provider. Since the 19th century, energy service contracts have existed in France where the idea of the ESCO was born. The largest ESCOs that currently operate in France operate as subsidiaries of the main utility companies, offering heating service in the form of ‘chauffage’ contracts. Therefore the EPNSP actor proposed in the IDEAS business concept for an “Integrated Energy Supplier” corresponds to existing energy service providers and aggregators such as COFELY, DALKIA, Transenergies or EMBIX (Alstom & Bouygues subsidiary). For example, COFELY offers IEC (“Integrated Energy Contract”)-like contracts through Energy Performance Contracts and provides recommendations for actions based on energy performance that can involve renovation or renewable energy infrastructure investments. Another option for an EPNSP actor proposed in the concept for an “Integrated Energy Supplier” could be envisaged is municipalities that would create dedicated agencies (in French they are called “régies”), although those existing are currently rather mono-energy.

4.5.1 Summary of key requirements for EPNSPs existing in France

In conclusion it is fair to say that the following key requirements for the best case scenario for the development of EPNSPs exist in the structures of the French utilities and property markets

- **Exploitation of the economies of heat/cooling and electricity cogeneration** offered by bio-fuelled Combined Heat and Power (CHP) and Combined Cooling Heat and Power (CCHP) driven district heating (DH).
- **Regulatory and voluntary instruments to encourage high standards of building energy efficiency** that could reduce the overall energy demand making of a neighbourhood making it easier to meet with renewable supply and reducing the need to invest in new generation facilities.

- **Legal, regulatory and business contexts that enable Public Private Partnerships (PPP) (in the public sector) to fund Integrated Energy Contracts (IEC)** underpinned by life cycle approaches that offer financial rewards to those responsible for the design, construction and management of buildings if they reduce the running costs

It would also seem fair to conclude that ‘**Active**’ or **smart distribution networks capable** of balancing the local electricity distribution network are likely in the long term.

However the issue of time based tariffs is more complex a question in the French context. Time-based tariffs for the retail market are not unusual in France and can be used as an input into the optimisation of the production, storage/retrieval and selling of local renewable electricity and heat production. Given the current operation of the French Electricity markets it is however unlikely that time based tariffs linked to day ahead and intra-day markets for the electricity an EPNSP purchases will be available in France in the near future. This may reduce the revenue available from cost-optimising the production, storage/retrieval and buying/selling of energy and therefore reduce investment in local energy storage as it may not be financially viable. Also in relation to the current fixed FIT for PV in France research conducted as part of the IDEAS project suggests that this reduces the amount of locally produced renewable energy in an EPN that is consumed locally when a cost optimisation is applied to optimising the production, storage/retrieval and selling of local renewable electricity and heat production. Although this does not negate the business model as the payback or ROI for an EPN taking this approach was shown to be as little as 12 years³⁸.

Distribution network charges which reflect the distance that electricity is transported are also highly unlikely in France in the near future. As commented in the previous chapter this does not negate the business models for EPNSPs however this means that the cost optimisation of the production may not work in favour of the local consumption of distributed renewable energy.

³⁸ Brassier, P. et al (2015) D5.4 Impact report French demo, which is under preparation at the same time as this report and will be available at <http://www.ideasproject.eu>

5 EUROPEAN CONTEXT

5.1 Introduction

This chapter presents an overview of how the structure and operation of property markets and the utilities industry in the EU impact on the feasibility of the proposed business approaches for EPNSPs. It is based on an extensive literature review, the findings of a workshop with the IDEAS sister projects focusing on fostering learning between ongoing research into the development of business models for EPNs³⁹ and information from the experts interviewed as part of the research presented [see interviewees 1-22 listed in appendix A].

5.2 Regulation of the utilities industries

The utilities industries have four main service areas: generation (putting into the system); transmission (moving across the country); distribution (the local pipes and wires); and supply (generating the bills and dealing with customers). Regulatory measures, introduced at the European level⁴⁰ mandate that the companies supplying each of these services are legally unbundled from companies supplying one of the other three service areas. Taken at face value this would seem to preclude the development of EPNSPs that assume the responsibility for the entire value chain related to generating, distributing and supplying locally produced renewable energy in a neighbourhood. However the EU policy approach to the regulation of the utilities industries, while being designed to support competition, is not so inflexible as to prevent this type of business innovation. For example in most EU member states the requirement to legally unbundle distribution network operators from energy supply only applies to those companies with more than 100,000 customers (CEER, 2013). Therefore it does not preclude the setting up of an EPN in which an EPNSP is both the energy supplier and the local network operator as long as there are not more than 100,000 customers within the EPN.

In some countries the structure of the electricity distribution industry is moving in a direction that is favourable to current DNOs becoming involved in the setting up of EPNSPs. For example in Great Britain within some DNOs geographical areas smaller local networks are operated by Independent Distribution network operators (IDNOs) (Ofgem 2015). These are mainly extensions to the DNO's networks serving new housing and commercial developments (Ofgem 2015). IDNO's offer a perfect opportunity for the development of EPNSP as they are built for new developments and their scale of operations suits the development of EPNs.

It is important to note that regardless of the ownership of the local electricity network in the case of a District Energy Supplier that has multiple customers within the energy positive neighbourhood, some kind of local network 'unbundling' of the type suggested in section 2.3.1.3, will be required to comply with European law. In May 2008, the European Court of Justice delivered a judgment on a case known as 'Citiworks', which was concerned with the rights of suppliers to access customers on local electricity distribution systems run as private wires. The judgment noted that a fully open market must allow all consumers to choose their suppliers freely and all suppliers to deliver to their customers freely. To allow for this, suppliers should have the right to access all the different distribution systems that carry electricity or

³⁹ This workshop took place at the INTERNATIONAL CONFERENCE FOR SUSTAINABLE PLACES NICE October 2014 and the key findings are presented in Appendix B.

⁴⁰ Under the Third Energy Package (3rd Package) Directives 2009/72/EC and 2009/73/EC European energy networks are subject to unbundling requirements which oblige Member States to ensure the separation of vertically integrated energy companies, resulting in separation of the various stages of energy supply (generation, distribution, transmission and supply) (CEER, 2013).

heat to customers (Ashurst, 2011).

5.3 Existing electricity distribution networks and tariffs

As discussed in chapter 2 section 2.3.1.4, an upgrade to electricity distribution networks (EDNs) transforming them from the current passive networks into active or 'smart' networks capable of local load management is required to support the business models for EPNs if we are to avoid the wasteful implementation of PWNs. The required transformations of EDNs will demand both technical changes to distribution networks and organisational changes to the roles of TNOs and DNOs. Chapters 3 and 4 explored this issue in the case of France and Finland, here a more general perspective is taken, which focuses on the current state of the electricity distribution networks across the whole of the EU in terms of their ability to support load management and the possibilities for DNOs to take a more active role in load management.

5.3.1 The current state of distribution networks across the EU

The EU's distribution networks resemble "*a huge patchwork.....[s]ubstantial differences arise regarding operated voltage levels, the scope of activities, the size and number of DNOs in a country, the level of unbundling, applied regulation, etc.*" (Ruester et al., 2013). As such the scope of the activities of DNO's vary across the EU. All DNOs operate the grid, although concrete grid operation activities and complexities depend on operated voltage levels which vary from EU country to country (see Appendix D for further details). Other activities are part of the DNO business model in certain countries but not in others such as public service obligations which include supply of last resort and public lighting etc. In most member states the meter is also owned and managed by the distribution network operator. However in the UK this is not the case and interviewees identified this as causing problems with the roll-out of smart metering, saying that it is delaying the development of 'active' or smart 'EDNs'.

It is estimated that European electricity networks will require six hundred billion Euros of investments by 2020 (Eurelectric, 2013b), with two thirds of these investments required in EDNs (Eurelectric, 2013b). By 2035 the distribution share of the overall network investment is estimated to grow to almost 75 percent and to 80 percent by 2050 (Eurelectric, 2013b). These estimated levels of investment suggest that there is some way to go before we have 'active' or smart EDNs capable of local electrical load management. Although it is evident that DNOs are being pushed into the investment required to transform their 'passive' low voltage and medium voltage networks into 'active' or 'smart network' by the rapid deployment of DREG.

Given this a sensible business approach is for DNOs to expand their business portfolio to embrace the new services required by these smart networks. In fact it is predicted by industry insiders that "*DNOs will increasingly act as local systems operators*" (Mallet et al 2014) moving beyond their traditional role of building and connecting towards connecting and managing EDN (Eurelectric, 2013b). However there are differences between the rates of smart grid implementation required to enable DNOs to act as local systems operators and some resistance within the utilities industry to change as concluded in chapters 3 and 4 of this report.

The commitment of the EU countries to the development of Smart electricity distribution networks is reflected in the fact that all are developing policies to drive this forward⁴¹ (CEER, 2014). As 'active' or 'smart' EDNs require smart meters it is also useful to look at the rate of progress on implementing smart meters across the EU. Sixteen member states (Austria,

⁴¹ Ten European states have national smart grid implementation. The countries which have published these include; Austria, Cyprus, Denmark, Finland, France, Greece, Luxembourg and Norway (CEER, 2014).

Denmark, Estonia, Finland, France, Greece, Ireland, Italy, Luxemburg, Malta, Netherlands, Poland, Romania, Spain, Sweden and the UK) are committed to the roll-out of smart meters by 2020 some have already done so (European Commission, 2015). As of 2014 there were close to 45 million smart meters already installed in three Member States (Finland, Italy and Sweden), representing 23% of envisaged installation in the EU by 2020 (European Commission, 2015).

However the roll-out of ‘smart grids’ involves more than just the introduction of smart meters. There is a wide ranging set of technical and commercial arrangements required, which are being implemented in a number of EU countries, as illustrated in table 5.1.

Table 5.1 technical and commercial Arrangements required for Smart distribution network (Source CEER, 2014)

Technical and Commercial Arrangements required for Smart distribution networks	Implementation: No of EU states
Meshed network	15
Real time thermal ratings	7
Fault current limiters	13
Enhanced automatic voltage control	14
Dynamic network reconfiguration	11
Distribution – flexible AC transmission systems	5
Electrical energy storage	9
Other forms of storage of energy balancing	11
Generator providing network support	14
Demand side response	14
Demand reduction	13
Other	3

5.3.2 The roll-out of time based electricity tariffs in the EU

5.3.2.1 Time based tariffs for the purchase of electricity by consumers

According to the business literature smart meters and smart networks demand dynamic tariffs (Utility Week 2010). In line with this in some of the EU countries that are/have rolled out smart meters, time based electricity tariffs for the purchase of electricity by consumers are beginning to be marketed indicating the feasibility of an EPNSP offering this type of tariff to its customers. Spot- price- tied contracts are commonly marketed to residential and small commercial customers in Sweden and Finland and in Norway spot-price-tied contracts had 55% market share as early as 2011 (Dromacque, 2013). Typically, however, customers on spot-price-tied contracts pay the average monthly spot price on the NordPool power exchange plus a mark-up (Dromacque, 2013) rather than a using a dynamic tariff which varies in accordance with the spot -price on the energy markets throughout the day.

The prevalence of time-based tariffs for small scale consumers varies throughout the EU and is dependant not only on the roll out of smart meters but also the efficient operation of wholesale electricity markets. A comparison of the average retail electricity price to the day ahead prices of key European power exchanges between 2009 and 2011 (see figure 5.1) illustrates that there is still some way to go before there is a clear link between end user and wholesale energy prices on the day ahead and intra-day energy markets (Dromacque, 2013).

The link between end-user and wholesale prices in the European residential electricity markets are strongest in Finland, Norway and Sweden (Dromacque, 2013) where eighty percent of the electricity used in the area is traded through the NordPool market (Hildmann et.al., 2014). In the rest of the EU electricity is largely sourced through internal procurement or bilateral transactions (Dromacque, 2013). Given the link between wholesale and end-user prices in Denmark Finland, Norway and Sweden it is not surprising that dynamic market based

electricity tariffs which reflect prices on the wholesale energy markets for both domestic and commercial customers are much more prevalent in these countries than in other parts of the EU (Dromacque, 2013).

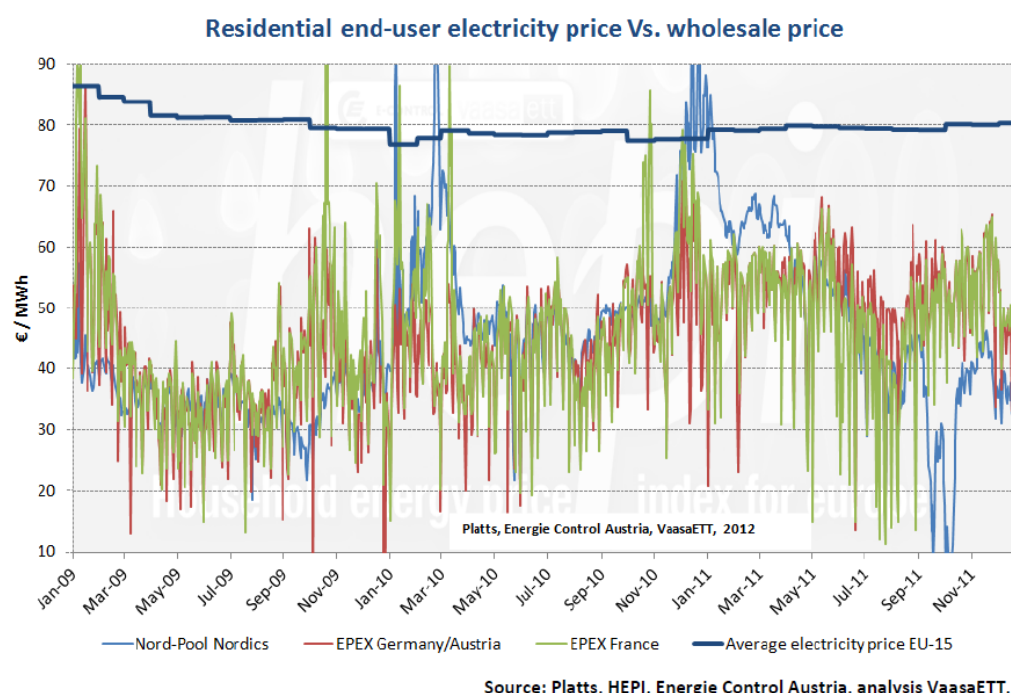


Figure 5.1 a comparison of the average retail electricity price to the day ahead prices of key European power exchanges between 2009 and 2011

5.3.2.2 Tariffs for the purchase and sale of electricity by energy producers

Following the discussion in chapter 2, section 2.3.1.2, related to how EPNSPs interact with energy markets two issues need to be considered: One concerns energy tariffs for the sale of small scale renewable energy generation sold to energy suppliers and the second involves larger scale operations which can interact with wholesale energy markets either in their own right or through an energy broker.

In Denmark, Finland, Norway and Sweden dynamic market based electricity tariffs for the sale of small scale renewable energy generation to energy suppliers are more prevalent than in the rest of the EU. This is partly due to the design of the FIT policies implemented in these countries. The price paid to individuals and organisations that generate renewable energy in many EU states is subsidised by FITs. Essentially FITs guarantee a price for the electricity produced by DREG. Two types of tariff schemes are commonly applied: fixed-price FITs (FFITs) which guarantee a fixed price for every unit of produced electricity and premium based FITs (PFITs) which pay a premium on top of the market price. *“FFITs do not provide any incentive to produce electricity when marginal production costs are high. Also, costs for balancing intermittent electricity production may be significantly lower with PFITs. Therefore, PFITs provide an incentive to match renewable power output better with marginal production costs in the system”* (Schmidt, 2013).

As discussed in chapter 3, there is no FIT policy in Finland for micro-scale energy production however energy suppliers commonly market spot-price-tied contracts to buy electricity from

‘prosumers’ and in Denmark, Norway and Sweden PFITS are employed ensuring that spot-price-tied contracts are commonly marketed to residential and small industrial ‘prosumers’.

In the case of larger scale EPNSP that can either operate independently on the wholesale energy market, or group together with other companies through an energy broker, dynamic energy tariffs exist: as companies are remunerated for the energy they sell on the day ahead and intraday markets according to the value of the energy at the time of sale.

However, as mentioned earlier, in many of the power markets in Europe, a significant amount of energy is sold through bilateral contracts, which addresses the absence of long-term market signals, but which reduces market participation. *“The implications for systems with highly variable renewables but significant bilateral contracts are threefold.*

1. *First, most energy delivery is purchased months to years in advance, locking in generation that could be inflexible, and leaving a small day-ahead and real-time market for new, innovative, and flexible supply.*
2. *Second, spot-market prices might be inconsistent with marginal costs due to the limited supply of flexibility.*
3. *Third, limited participation in the day-ahead and real-time markets can decrease market efficiency by reducing the potential for market software to optimize supply resources based on their bid costs”* (Alliance for Sustainable Energy, 2013).

In those EU states with sizable DREG capacity in which a large proportion of energy is sold using bilateral contracts rather than on the day-ahead and intraday markets, the price for energy sold on these markets is severely distorted by the well documented ‘merit order effect’ which has even led to negative prices on day ahead and intra-day markets (Hildmann et.al., 2014). However in those EU states in which a large proportion of electricity is traded on the day-ahead and intraday markets this problem does not occur and the prices for electricity on those markets largely reflect short-term supply availability consumer demand (Hildmann et.al. 2014). For example in the Nord Pool Spot in the Nordic countries a market share of more than eighty percent of the respective total demand is achieved and this market operates efficiently (Hildmann et.al. 2014). This is stark contrast to the European Power Exchange (EPEX), which is the dominant day-ahead and intra-day power market in Central and Western Europe, directly serving Austria, France Germany and Switzerland. In the EPEX less than twenty five percent of daily energy demand is traded on the day ahead and intraday market, with the rest being traded well in advance of these markets with bilateral contracts fulfilled with dispatchable (mainly traditional) forms of generation.

It has been suggested that the issues with the merit order effect on the EPEX power exchange mean that power only markets are increasingly failing due to growing feed-in shares of subsidised renewable energy (Hildmann et.al. 2014). The conclusion reached in recent research (Hildmann et.al., 2014) is that this is not the case, but for markets to operate efficiently it will be necessary for regulatory intervention to be taken to increase the day-ahead market share of overall load demand using true marginal costs (Hildmann et.al., 2014).

It would seem reasonable to conclude that those states in which a large proportion of the overall electricity demand is traded on the day ahead markets will offer the best opportunity for dynamic tariffs for the sale of electricity by an EPNSP. Therefore those countries taking part in the Nord Pool energy markets (Denmark, Finland, Norway and Sweden) where some eighty percent of energy is traded on the day ahead and intraday markets offer good markets for large scale EPNSPs that operate on the wholesale energy markets.

However we have to consider that the cost of energy production or purchase is only makes up part of the energy cost. Essentially end-user electricity prices breakdown into four main

components (energy, distribution, energy taxes and VAT).” *On average, the energy price component (including retail margins) represents 43% of the total cost; distribution 30%; energy taxes 13% and VAT 14%. Denmark is a special case since the cost of energy represents less than a fifth of the end-user price, whereas energy taxes represents 35% (three times the average) and 55% if VAT is included. In countries where the energy component represents a small proportion of the end-user price such as Denmark, France, Germany and Portugal, end-user prices are so heavily influenced by a combination of taxes, distribution costs and wholesale prices that any variation in supplier costs has a relatively small, if any noticeable, influence on the prices paid by the customer”* (Eurelectric, 2013a). This means that to have a significant impact on the cost of energy in ways that encourage the local consumption of DREG it is necessary to have innovative approaches to the charges for electricity distribution to be considered.

5.3.2.3 Charges for electricity distribution

As outlined in chapter two in the best case scenario for the EPNSP business approaches there is a method of promoting the use of locally produced renewable energy and making it financially viable. It is suggested that this can be achieved by having a distribution cost for electricity which reflects the distance it is transported. This will demand changes in the way DNOs charge for carrying energy as in the majority of EU countries, network tariffs for households and small businesses are almost entirely based on energy volume (kWh) (Eurelectric, 2014). In fact across the EU about 50-70% of the allowed DNOs revenue is usually recovered using such volumetric charges (Eurelectric, 2014). While volumetric tariffs set signals to reduce energy consumption, they do not reflect cost arising from consumption at peak hours or enable suppliers to encourage the local use of local renewable energy production.

Research conducted as part of the IDEAS project suggests that a two-tiered distribution tariff that differentiates between ‘locally generated electricity’ and ‘non-locally generated electricity’:

- Helps to encourage an increase in the amount of renewable energy that is locally consumed in the neighbourhood in which it is produced;
- Helps to decrease the net amount of electricity handled wholesale and requiring transportation over transmission and distribution networks by up to 50% (see appendix C).

To the authors knowledge, at the time of writing, none of the European DNO’s have ‘unbundled’ of the costs related to the use of local distribution network. This is despite the fact that the Energy Efficiency Directive (2012/27/EU, art. 15.4) requires that network tariffs contribute to overall efficiency by providing signals for power saving/optimal utilisation of energy infrastructure assets, including demand side participation. The UK distribution network experts interviewed (see appendix A) argued that the distribution industry recognises the need for changes to the current flat volumetric approaches to electricity distribution charging, and this is echoed by the business literature (see for example Mallet et al., 2014, Pérez-Arriaga, 2013).

However, the experts interviewed in Finland and France, as discussed in chapters 3 and 4 were very much against the notation that it is even possible to introduce differential charging for the use of the electricity distribution system, arguing that it is technically problematic and inequitable. However a simple two tiered tariff two-tiered tariff to differentiate between ‘locally generated electricity’ and ‘non-locally generated electricity’ based upon transactions remaining inside or crossing the EPN geographical boundary would not be difficult to

implement from a technical perspective and would not be unequitable per-se⁴². At present, energy trading activities are required to have both transparency and reputability in order for TNO to schedule the power systems (and levy post-fact regulation charges to both supply and generation companies violating agreed contracts), and thus a radical reshuffling of current procedures would not be required. This would seem to suggest that the fact that the incumbent companies in France and Finland do not want things to change is a barrier but a change in the tariffs for the distribution of electricity to benefit small scale local generation is not in itself impossible or inequitable.

5.3.3 Exploitation of combined heat and power for district heating

Both the business models for EPNSPs, presented in chapter 2, involve the use of biofuel powered CHP combined with other forms of renewable electricity production. This is because it is inherently more efficient to generate heat and electricity together (Connolly, et al. 2013). So the question becomes what is the size of the current DH market and how likely is it to expand.

DH covers 10% of the total heat demand in Europe. There are more than 5,000 medium and large scale district heating systems, with an annual turnover of 20 billion Euros and 556 TWh heat sales. However, market penetration of district heating is unevenly distributed. While district heating has an average market share of 10% in Europe, it is particularly widespread in North, Central and Eastern Europe where market shares often reach 50% and more. On average, over 80% of heat supplied by DH originates from renewable energy sources or heat recovery (i.e. from electricity production or industrial processes). The combined heat and power share of total heat generation in 27 EU states is shown in figure 5.2.

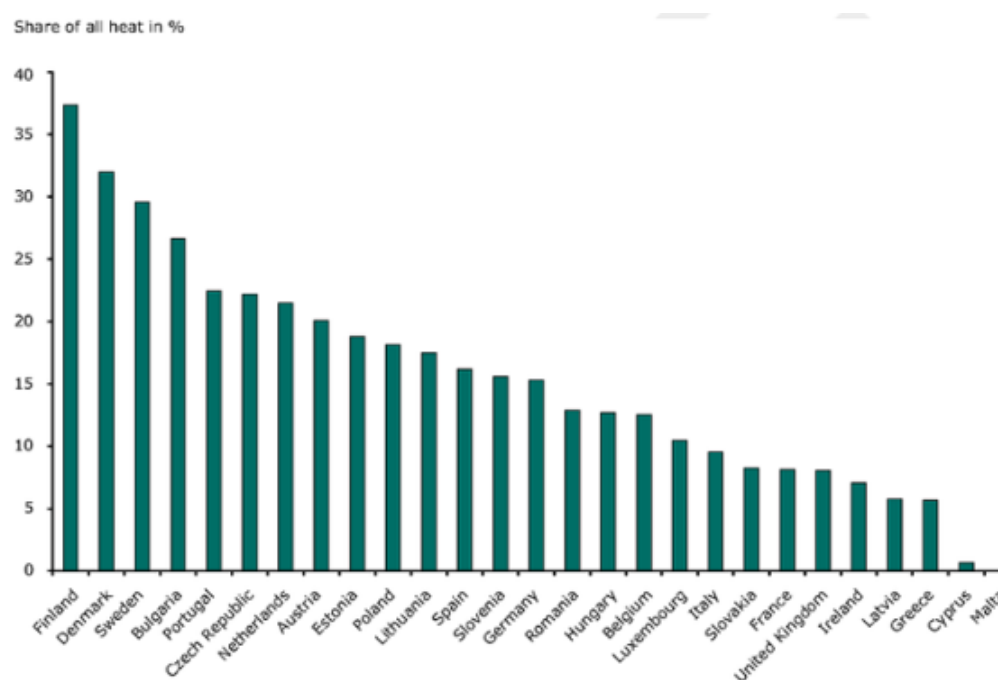


Figure 5.2 Combined heat and power share of total heat generation in 27 EU counties

Figure 5. 2 clearly shows that Finland, Sweden and Denmark are the leaders in this area once again highlighting their suitability for the development of EPNSPs underpinned by the

⁴² The introduction of the two distribution tariff in an EPN would be no more inequitable than the current benefits of cheap renewable energy enjoyed by those who invest in current ‘community energy projects’ discussed in section 5.4.3.2.

business models presented in chapter 2. However it must also be noted that increasing the use of renewables and the share of CHP powered DH is one target of the EU RES-Directive (European Commission 2009c) for 2020 (Carbon Trust 2010). In line with this an increasing number of national governments have identified district heating and cooling as an efficient technology to achieve the main objectives of the European legislation regarding sustainable energy (Carbon Trust 2010).

5.4 Property markets and energy efficient buildings

This section considers the way in which the different structures the property markets in the EU impact on the markets for the IDEAS business models. As discussed in chapter 2, the investments required in renewable energy production within an EPN could be reduced if the buildings within the EPN are energy efficient. Therefore it would be beneficial if those responsible⁴³ for planning neighbourhoods and constructing, renting/managing and occupying the buildings in that neighbourhood have a commitment to energy-efficient buildings as well as renewable energy. This demands:

- A mix of regulatory and voluntary instruments to encourage high standards of building energy efficiency.
- Property market structures offering financial rewards to those responsible for the design, construction and management of buildings if they reduce the running costs.
- Legal, regulatory and business contexts that enable IEC underpinned by PPP (in the public sector).

5.4.1 Instruments to encourage building energy efficiency

5.4.1.1 Regulatory instruments

The EU's main legislation designed to encourage building energy efficiency is the Energy Performance of Buildings Directive (EPBD, 2002/91/EC). Implemented in 2002, the directive was recast in 2010 (EPDB recast, 2010/31/EU) with more ambitious provisions which include:

- The use of Energy Performance Certificates (EPCs) in all advertisements for the sale or rental of buildings;
- The establishment of inspection schemes for heating and air conditioning systems or measures with equivalent effect;
- All new buildings must be nearly zero energy buildings by 31 December 2020 (public buildings by 31 December 2018);
- A set of minimum energy performance requirements for new buildings, for the major renovation of buildings and for the replacement or retrofit of building elements (heating and cooling systems, roofs, walls, etc.);
- Drawing up lists of national financial measures to improve the energy efficiency of buildings.

Rates of implementation of the different elements of the directive vary between countries in the EU. For example, in 2011 while all countries had implemented functional building energy performance certification (EPC) schemes, 5 countries had not yet implemented the schemes for all required building types and only 11 countries had national EPC register databases (Bulgaria, Denmark, Estonia, Greece, Ireland, Liechtenstein, Netherlands, Portugal, Sweden, Slovak Republic, United Kingdom) while 10 countries had EPC databases at the regional level Buildings Performance Institute Europe 2011. It must be noted that before the EPBD was created

⁴³ These actors include includes City Authorities, construction companies, building owners, facility managers and private individuals

both the Netherlands and Denmark had already set up energy certification schemes for buildings at the national level (in 1995 and 1997 respectively). However, there are not only differences in speeds at which EPC schemes are implemented in different countries but also between building sectors.

5.4.1.1.1 Residential buildings

The rates of implementation of the EPC schemes mandated by the EPBD in different European countries varies remarkably in the residential building sector. For example in 2011 the number dwelling properties issued with an EPC ranged from 1 percent to 24 percent in different European countries see Figure 5.4.

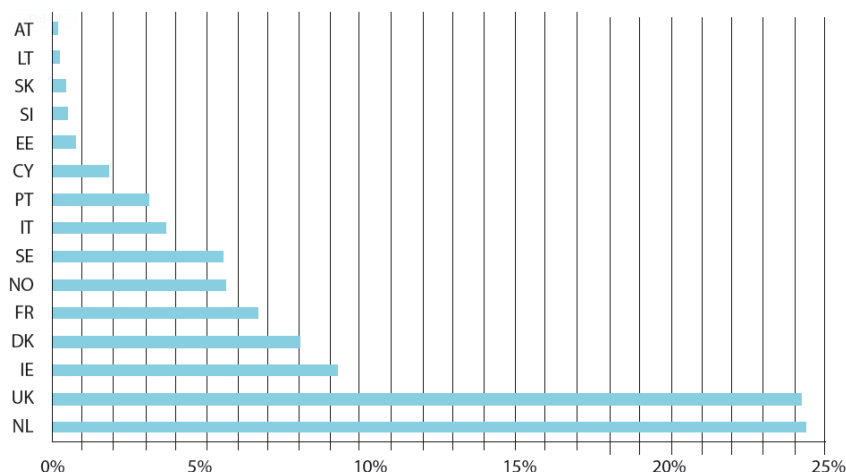


Figure 5.4 Share of dwellings in different European countries with a registered EPC in 2011 (Source Buildings Performance Institute Europe 2011)

5.4.1.1.2 Non-residential buildings

The issue of EPCs for non-residential buildings varies between EU countries and is in general much slower than is the case for residential buildings. In 2011 although the certification schemes had been working for only a couple of years, the proportion of dwellings not yet certified was above 90% for all countries with the exception of The Netherlands and the United Kingdom (Buildings Performance Institute Europe 2011). Figure 5.7 provides an overview of the relative share of certified buildings against the population in each EU country.

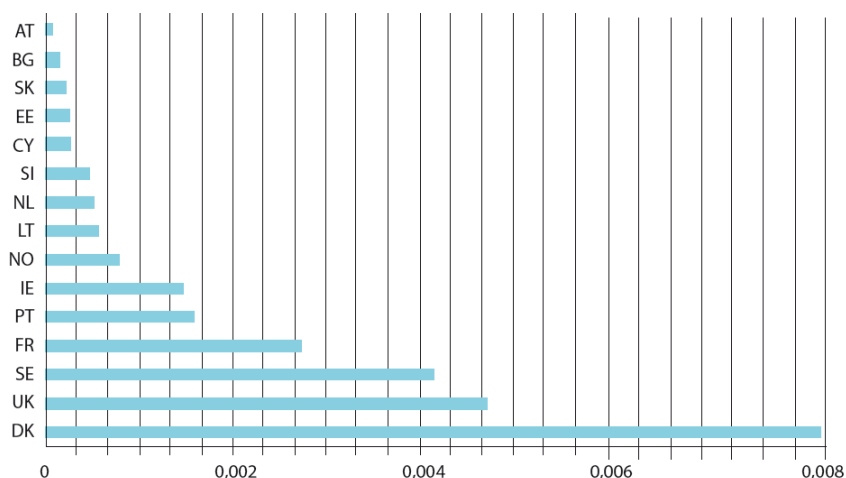


Figure 5.4 the relative share of certified non-residential buildings against the population in each EU country in 2011 (Source Buildings Performance Institute Europe 2011).

5.4.1.2 Voluntary instruments

In addition to mandatory energy certification schemes, arising from EU directives, there are voluntary building certification schemes used throughout the EU, such as BREEAM, HQE, LEED, CASBEE, DGNB, Green Star and BEAM Plus⁴⁴. A screening and analysis of 22 existing market for certification schemes for buildings (both energy only and wider sustainability schemes) in the EU (Rademaekers 2014) concluded that the 27 European states can be roughly divided into two blocks:

1. Countries where voluntary sustainable and energy certification schemes have been developed (see figure 5.3) in addition to the national EPC rating system required by the EPBD,
2. Countries where voluntary certification schemes have not been developed, and which to a large extent utilise the mandatory EPC certification scheme system required by the EPBD and make limited use of additional voluntary sustainability certification schemes.

Country - and national certification system	
The United Kingdom - BREEAM	The Netherlands - NL BREEAM,
France - HQE	Spain - ES-BREEAM, Verde
Germany - DGNB, DE-BREEAM, Passivhaus	Czech Republic - SBTool ICZ
Denmark - DK-DGNB	Austria - AT-BREEAM, OGNI
Sweden - Miljöbyggnad, SE BREEAM	Belgium - Valideo
Italy - Casa Clima	Finland - PromisE assessment tool
Portugal - Lider A	

Figure 5.3 EU Countries which have developed their own certification systems (Source Rademaekers 2014)

5.4.1.2.1 Residential buildings

The residential market for voluntary certification schemes in the EU is immature and only a few European countries have developed voluntary sustainable certification schemes for residential buildings, including the UK, France and Sweden. This is due to a lack of incentives for home owners to certify their homes (e.g. high costs, lack of comparable data, and lack of knowledge) (Rademaekers 2014). Public and private users of schemes for the residential market primarily rely on the mandatory EPCs required by the EPBD (Rademaekers 2014).

5.4.1.2.2 Non-residential buildings

In the case of voluntary energy certification schemes for non-residential buildings most countries are able to use existing schemes from other countries (for commercial buildings) (Rademaekers 2014). However, these international schemes, such as LEED and BREEAM, are used to a very limited extent due to a combination of factors, including the high costs of the schemes, low market demand (e.g. a small country, stagnating construction sector, etc.), and/ or a lack of resources at the national level to develop and run these schemes. Low awareness of the advantages of these schemes has also been mentioned as a potential reason for the low take up (Rademaekers 2014).

⁴⁴ These include indicators for energy efficiency and wider sustainability. The methods of assessment and the role and weight of energy efficiency indicators in the different schemes varies remarkably. This is argued to reduce the credibility of the different schemes and impair the general understanding about their purpose (Häkkinen 2012). It has been shown that as the schemes do not focus purely on energy efficiency issues, they sometimes have no or even a negative effect on energy efficiency or GHG emissions (see for example Chithra and Anilkumar 2013, Scofield 2013). At their best, voluntary certification schemes can however guide the development of building stock towards the general goals of EPNs, which is “to provide a functional, healthy, user friendly environment with as low energy demand and little environmental impact as possible” (Ala-Juusela et al 2013).

5.4.2 Structure of the property market and incentives to reduce building running costs

5.4.2.1 Residential property markets

Owner occupancy in EU residential building stock is over 50 % in all countries, however it is typically around 70 % and up to 90 % in countries see figure 5.5 (Buildings Performance Institute Europe 2011). This is significant when considering the financial incentives to reduce building running costs. This is because, as discussed in chapter 2, the interest of people in the energy efficiency of their home is highly dependent on tenure, as owner-occupiers are more likely to be interested in the energy-efficiency of the building they live in than those living in rented accommodation.

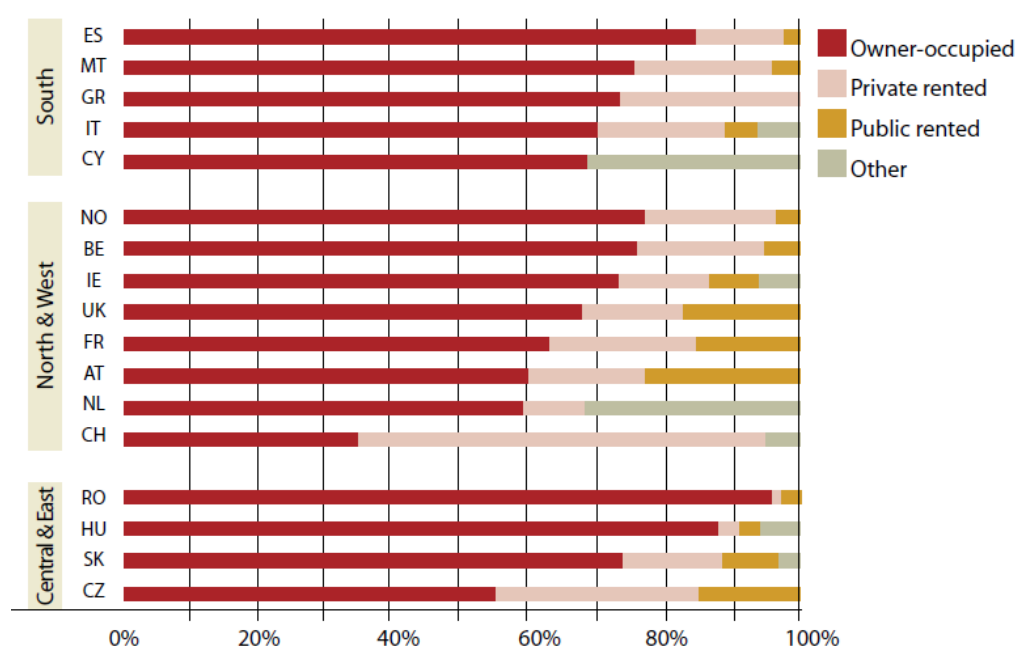


Figure 5.5: The tenure structure of the European residential buildings (Buildings Performance Institute Europe, 2011).

As also discussed in chapter 2, those who self-build their homes often choose to build to higher energy efficiency standards than required by statutory building codes⁴⁵, while housing developers typically build according to the building code. This would suggest that those countries with higher numbers of self-build properties will have more efficient housing stock than those with lower numbers of self-build properties.

As can be seen in Figure 5.6 across the Europe the number of self-build homes is around 50%. However this varies greatly from country to country. In the UK the self-build sector merely accounts for between 7-10% of proportion of homes delivered by self-build, while in Finland it accounts for over 50% in Denmark over 40% and in Sweden over 60% (Wilson, 2015).

⁴⁵ In some cases self-builders are motivated by a desire to create environmentally sustainable housing, looking to develop a genuinely innovative and low or neutral carbon development (Wallace et al., 2013). However for those who self-build energy efficiency is often not the top priority but it is often considered important: for example in Finland energy efficiency was included in most important selection criteria by 38 % of the respondents in a national survey (RTS, 2013).

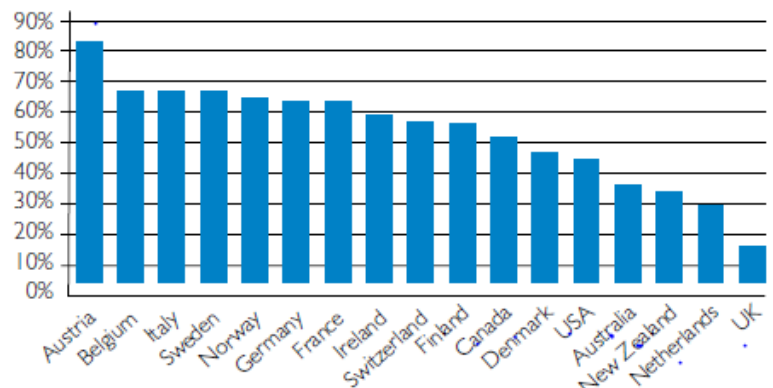


Figure 5.6 proportion of homes delivered by self-build (HM Government, 2011)

5.4.2.2 Non-residential property markets

Non-residential building stock, accounts for 25 % of the floor area in Europe (Buildings Performance Institute Europe 2011). As discussed in chapter 2 the key customers for an Integrated Energy Service Provider that offers IEC are universities, as in the case of the French pilot site, larger schools, hotel complexes and hospitals. Some 35% of non-residential building stock is owned by these types of customers⁴⁶. There is a lack of information about the ownership of non-residential buildings in some countries in the EU (Buildings Performance Institute Europe 2011). However the data available suggests that while a large proportion of the non-residential building stock is privately owned (see Figure 5.7) the share of public buildings is important in some countries (Buildings Performance Institute Europe 2011).

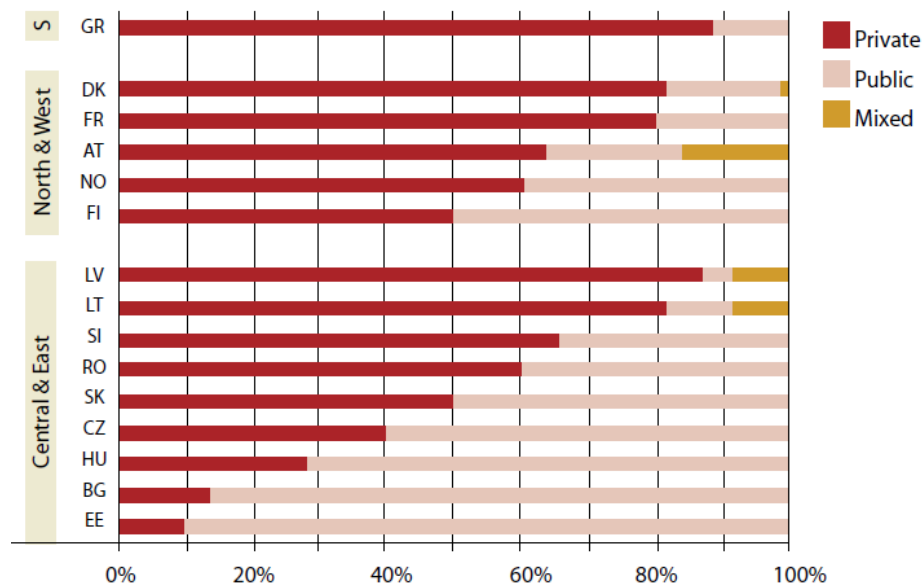


Figure 5.7. The ownership structure of the non-residential buildings in Europe (Buildings Performance Institute Europe 2011).

This is particularly significant in the case of the business model for an Integrated Energy Service Provider that offers Integrated Energy Contracts to its customers. As this type of contract is most suitable for public actors because they are often willing to outsource expertise on long term contracts and regulations force public entities to implement energy policy goals:

⁴⁶ 28 % of non-residential buildings in the EU are used as wholesale and retail premises, 23% is office space, 17% is used for educational purposes 11 % is occupied by hotels and restaurants 7% is occupied by hospitals and 4% is sports facilities, with the other 11% is used for other non-residential purposes (Buildings Performance Institute Europe, 2011).

while on the whole private actors do not tend to commit themselves to such long investments.

5.4.2.3 Access to financing, new contracting models and community energy projects

An innovative approach to financing in the case of an EPNSP that is a District Energy Supplier could be community energy finance which usually involves a local community using a co-operative structure (EEFIG 2015). In community energy projects, the investors live in the area where the investment takes place; they not only have a financial return, but also benefit in-kind, e.g. they have access to renewable energy for free or at a lower tariff. For example, in Germany, there are over 500 energy co-operatives with 80,000 members which have invested up to EUR 800 million in solar plants (EEFIG 2015). There are also a few examples of German community funding for schools energy retrofit through energy performance contracting e.g. EcoWatt in Freiburg (DE) (EEFIG 2015). In Belgium the development of different types of co-operatives related to renewable energy can be observed. Some of them are more citizens' driven than others, and are established alongside initiatives of the Regions. In Denmark, the majority of wind turbines are wholly owned or jointly owned by citizens, communities, landowners and farmers and, according to Government statistics, 150,000 households in Denmark owned or held shares in wind farm projects as far back as 2001.

The idea that 'community energy project' financing offers a route to community engagement in the development of EPNSPs is supported research undertaken in the IDEAS project⁴⁷. A survey of Finnish people living in and around the Omenatarha residential neighbourhood in Finland, found that 75 percent of people felt they were more likely to invest in co-operative community renewable energy projects than they were to invest in renewable technologies in their houses such as PV panels on their homes.

Public private partnerships (PPPs) are becoming an increasingly popular way of realising large public projects in Europe (15 % growth in value in 2014), although only few currently involve building sector (EPEC, 2015), among these e.g. two health campuses in Turkey and a hospital in Denmark. According to latest statistics, UK has been the most active market both in terms of value and number of projects (with 24 closed deals in 2014). In 2014, also France, Greece, German, Netherlands and Denmark had more than 5 closed deals. It is also noteworthy that institutional investors' debt has become a mainstream PPP financing product.

The business model for an Integrated Energy Service Provider is based on Integrated Energy Contracts (IEC). As discussed in chapter two the concept behind IEC is an integrated business model combines EPC and ESC to deliver maximum savings, both environmentally and economically (Bleyl, 2009). The IEC approach was first shown to be successful in large scale projects by Landesimmobilien-gesellschaft Steiermark (LIG) which was the first large institutional building owner that systematically applied the concept of IECs (IEA-RETD 2013)⁴⁸. In the EU while EPCs are argued to be a growing market in commercial and public buildings (EEFIG, 2015) IEC are less well established. Although it must be noted that the market penetration of both these types of contracts varies greatly between different EU

⁴⁷ See Backstrom (forthcoming) IDEAS Deliverable 5.5 "Impact Report Finnish Demo." This report is currently being written concurrent with this deliverable of the IDEAS project.

⁴⁸ LIG is a state of Styria in Austria owned Real Estate Company, which administers and manages more than 420 buildings in Styria. In total about 200 buildings with an area of more than 6000,000 m² are owned by LIG. In 2007/8 LIG made the first Europe-wide call for tenders for five buildings with a net floor area of approximately 11,000 m². In 2009 contracts for pool 2 which considered another three a net floor area of approximately 20,000 m² were procured and implemented. The LIG's call for tenders for IEC contracts were as follows:

1. Implementing demand side saving measure with payback time of less than 15 years in the fields of building technology, building shell and user behaviour and improving the energy indicators of the buildings;
2. Comprehensive refurbishment of all oil-fired heating equipment
3. Reducing CO₂ emissions (which implies a change of energy carriers) and minimising overall energy cost,

countries and they are largely limited to public buildings.

5.5 Conclusions

No European country currently offers the best-case scenario for the structures of the utilities industry and property markets required for the development of the IDEAS business models for EPNSPs. However some come close enough to offer clear markets for EPNSPs.

In relation to dynamic tariffs for the purchase and sale of electricity by an EPNSP those EU states in which a large proportion of the overall electricity demand is traded on the day ahead markets offer the best opportunity. Therefore those countries taking part in the Nord Pool energy markets (Denmark, Finland, Norway and Sweden) where some eighty percent of energy is traded on the day ahead and intraday markets offer potential markets particularly for larger EPNSPs that operate on wholesale markets. As such it is no surprise that dynamic tariffs for the purchase and sale of electricity which reflect the price of electricity on the day ahead and intra-day markets are most prevalent in Denmark, Finland, Norway and Sweden where there is a stronger link between wholesale and end-user prices.

In relation to unbundled electricity distribution tariffs, while there is much current debate about network distribution charges for electricity there is a certain level of stagnation in relation to implementing new innovation in this area. DNOs in France and Finland have a strong resistance to the idea of a differentiated distribution network charge that favours the local consumption of DREG. However those in the UK are more amenable to the possibility especially in the case of Independent Distribution Network Operators (IDNOs).

It must be noted that the lack of dynamic network tariffs which favour the local consumption of DREG does not necessarily negate the business models for EPNSP. However it does mean that the optimisation of the production, storage /retrieval and selling of local renewable electricity and heat production may not always work in favour of the local consumption of distributed renewable energy; as the distribution charges do not differentiate as to the extent that the distribution network is actually being employed.

Many EU countries are moving toward the development of 'active' or 'smart' electricity distribution networks. Countries with national implementation plans include Austria, Cyprus, Denmark, Finland, France, Greece, Luxembourg, Norway and Belgium. An increasing number of national governments have identified District Heating and Cooling (DHC) as an efficient technology to achieve the main objectives of the European legislation regarding sustainable energy, suggesting a growing market across the EU for EPNSPs. It must be noted that the current market opportunities are greatest in North, Central and Eastern Europe where market shares of DH often reach 50% and more of the total heat demand.

The EU's main legislation designed to encourage building energy efficiency is the Energy Performance of Buildings Directive (EPBD, 2002/91/EC). Implemented in 2002, the directive was recast in 2010 (EPDB recast, 2010/31/EU) with more ambitious provisions including the aim to reach nearly zero energy level for new buildings across the EU in 2020. The regulations are tightening in all European countries, which improves the possibilities to cover the remaining need with local renewable energy sources.

With the increasing interest in IEC, green leasing and life-cycle contracting across the EU, the possibilities for EPNSP business in non-residential buildings will improve, but this development is still in very early stages. The development of Integrated Energy Service Suppliers is probably limited to publicly owned buildings as the time scales involved in EPCs are difficult for private investors to justify and public organisations are more likely to have a commitment to energy efficiency and renewable energy investments.

In conclusion it would seem that Denmark, Finland, Norway and Sweden are potentially the strongest markets for EPNSPs, as most of them have mature district heating markets powered by CHP, they are moving towards smart distribution networks, and dynamic tariffs for the sale and purchase of electricity are commonly marketed. These countries are also among those that are implementing the different elements of the EPBD in earnest suggesting a national policy commitment to the development of energy efficient buildings. In addition they also have residential market structures which favour the development of efficient housing and commercial and regulatory practices which support IECs and lifecycle approaches.

6 CONCLUSIONS

6.1 Contribution to overall picture

A business model at its most basic level describes how a business makes money. As such it identifies the services that a company's customers value and shows the reciprocation of funds for the services the company renders to customers. In the case of the business models for an EPNSP the services valued by customers are generation and distribution of renewable energy. The whole concept underpinning the IDEAS business models is that the EPNSP can do this profitably by utilising energy arbitrage and the efficiency gains obtained through optimising the production, storage/retrieval and selling of local renewable electricity and heat production and in the case of an Integrated Energy Service Provider through the provision of IECs. As such these represent the key revenue streams in the IDEAS business models.

To assess the applicability of the IDEAS business models beyond the IDEAS pilot sites the research presented in this report identified how the different structures of the utilities industry and property markets in different EU states impact on these key revenue streams. In the best case scenarios for the development of EPNSPs the key structures of the utilities industry and property markets include:

1. **Time based tariffs linked to day ahead and intra-day markets for the electricity an EPNSP purchases and sells.** To provide the potential to optimise neighbourhood energy supply resources based on their market value.
2. **Distribution network charges which reflect the distance electricity is transported.** To provide a financially viable method of distributing electricity to consumers in the neighbourhood.
3. **An 'active' or 'smart' local electricity grid** that can support the monitoring, control and advanced protection systems that enable the supervision and operation of bidirectional power flows in a distribution network.
4. **Exploitation of the economies of heat/cooling and electricity cogeneration** offered by bio-fuelled Combined Heat and Power (CHP) and Combined Cooling Heat and Power (CCHP) driven district heating (DH). This enables the economical provision of both heat/cooling and electricity within an EPN.
5. **Regulatory and voluntary instruments to encourage high standards of building energy efficiency** that reduce overall energy demand making it easier to be met by renewable supply and reducing the need to invest in new generation facilities.
6. **Legal, regulatory and business contexts that enable Public Private Partnerships (PPP) (in the public sector) to fund Integrated Energy Contracts (IEC)** underpinned by life cycle approaches that offer financial rewards to those responsible for the design, construction and management of buildings if they reduce the running costs.

No European country currently offers the best case scenario for the structures of the utilities industry and property markets required for the development of the IDEAS business models for EPNSPs. However some come close enough to offer clear markets for EPNSPs.

If energy markets are operating efficiently and energy costs throughout the day reflect the daily energy demand curve then the operation of EPNs could contribute to the optimisation and security of wider energy networks, particularly in the case of electricity networks. In that they should not only service their own energy demand when national demand is high but also produce energy, or have stored energy to sell, at times of high national energy demand.

However the possibilities for the development of EPNs which contribute to the optimisation and security of wider energy networks in this way is very much dependent on the efficient operation of wholesale energy markets and the ability to support network tariffs which favour the local consumption of DREG.

The lack of network tariffs in the EU which favour the local consumption of DREG does not necessarily negate the business models for EPNSPs. However it does mean that the optimisation of the production, storage /retrieval and selling of local renewable electricity and heat production may not always work in favour of the local consumption of distributed renewable energy.

6.2 Impact on other WPs and Tasks

The possible impact of differential network tariffs has been explored through simulations as part of the simulations conducted during the project. The findings of this research is currently being written up in an academic paper to be published from the work of WP2 as part of D2.5. These indicate that the introduction of a simple two tiered distribution tariff can encourage an almost 50% reduction in the amount of electricity it is necessary to import from the grid in an EPN [see appendix C]. While further simulations, informed by the findings presented in this report are being conducted in T5.5 and T5.4 as part of the pilot studies. These explore the impact of different optimisation scenarios based on cost optimisation in two different electricity markets.

6.3 Other conclusions and lessons learned

A sustained growth of DREG in the EU demands an upgrade to electricity distribution networks (EDNs). The problem is that the costs and changes in the roles of the electricity Transmission and Distribution industries associated with transforming the currently 'dumb' EDNs in the EU to 'smart' networks capable of balancing the local electricity network are considerable barriers to the growth of DREG as a percentage of the electricity production in the EU. One of the key advantages of the IDEAS business concepts for EPNSP is that it allows for the economic necessity of incrementally upgrading the distribution networks and transfer of active energy management from national transmission networks to the local distribution networks. A DNO no longer has to fund the upgrade to the whole of its network but can upgrade its' networks incrementally on a neighbourhood by neighbourhood basis. In addition the transfer of the control functions of TNOs can also be incrementally passed to the distribution network operators. It can also use this approach to reduce investment in reinforcing networks for new urban development's etc.

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8 APPENDICES

8.1 Appendix A: Interviewee Details

- Chapter 3 presents an analysis of interviews 1 to 12 in the Finnish context
- Chapter 4 presents an analysis of interviews 1, 15, 16, 18, 19, 20 French context
- Chapter 5 draws on an analysis of interviews 1 to 22 in the wider European context

No	Job title	Industry	Type	Date	Partner
1 2 3	Energy Advisers	Utilities central association	F2F	16.1.15	VTT
4	Executive Director	DREG central association	F2F	28.1.2.15	VTT
5	Development manager	Electricity & DH provider	F2F	13.1.15	VTT
6	CEO	Utilities/ DNO	F2F	26.2.15	VTT
7	Development manager	Utility/ Electricity broker	Tel	23.1.15	VTT
8	Energy Specialist	Building owner, facility management	F2F	19.1.15	VTT
9	Project manager, premises management	Facilities management	F2F	26.2.15	VTT
10	Project manager	LC contractor	F2F	9.2.15	VTT
11	Executive director	Property market	F2F	18.2.15	VTT
12	Expert in Building Services Engineering	Building owner, facility management	Tel	22.1.15	VTT
13	EDF – Direction Collectivités, Territoires et Solidarité Méditerranée	Utilities	F2F	29.01.15	CSTB
14	National energy action	Utilities	F2F	16/01/15	UoT
15	EMBIX	Bureau d'études Smart Grid	Email	11/02/15	CSTB
16	ERDF Méditerranée	French DSO	Tel	03/02/15	CSTB
17	Sustainability consultant	Utilities	F2F	06/03/15	UoT
18	Director of Sustainable Development	Bordeaux city	Tel	06/02/15	NOBA
19	Director of Communities and Housing markets at COFELY services	Facilities management	Tel	17/02/15	NOBA
20	Director, development officer	Utilities green energy supplier	Tel	15/01/15	NOBA
21	Urban Environmental Design Consultant	Property market	F2F	31/03/15	UoT
22	Director	Energy Consultant	skype	01/04/15	UoT

8.2 Appendix B: IDEAS Workshop

The IDEAS project ran a workshop with CityOpt, Odysseus, EEPOS & INTREPID projects. The aim of which was to facilitate a cross fertilisation between the different innovative business models to underpin Energy Positive Neighbourhoods (EPNs) developed by the projects around the table. This workshop took place at the INTERNATIONAL CONFERENCE FOR SUSTAINABLE PLACES NICE October 2014.

Key findings

All the projects around the table

- ✓ Defined EPNs as neighbourhoods in which the annual energy demand is lower than energy supply from local renewable energy sources.
- ✓ Agreed that the concept of an EPN involves encouraging the local consumption of the electricity produced by Distributed Renewable Energy Generation (DREG).
- ✓ Agreed that in an ideal case EPNs would the integration of DREG into current electricity networks
- ✓ DNOs/DSOs are key to the success of increasing DREG.
- ✓ In an ideal case the energy infrastructures of an EPN are connected to and contribute to the efficient operation and security of the wider energy networks.

All the business approaches developed in the projects around the table assume the existence of one or more of the following now or in the near future:

- ✓ Real time electricity tariffs which reflect the cost/ peak demand of electricity
- ✓ Smart building and electricity networks- i.e. building energy management systems, smart local distribution networks and smart electricity metering
- ✓ Economically motivated “prosumers” that not only consume, but can also produce and store electricity.
- ✓ The facility for small to medium electricity prosumers to sell electricity
- ✓ The roll-out of real time tariffs, smart building and electricity networks and the facility for ‘prosumers to sell electricity are developing at different rates across the EU.
- ✓ Investment in, and the regulation of, the utilities industry is key to the possibilities for financially viable business models to support the development of energy positive neighbourhoods.

8.3 Appendix C: Impact of differentiated distribution tariff

This is the case study from a journal article which is currently under development based on the work conducted as part of T2.3 by researchers at Teesside University. In the published version of this report this work will be cited in the text and referenced rather than being presented as an appendix.

Computational experiment of a differentiated DNO tariff

In order to examine the practical impacts of a differentiated DNO tariff on the utilization of DREG in realistic scenarios, a case study in the form of detailed computational experiment has been performed. The case study is concerned with a fictitious Combined Heat and Power (CHP) plant located in Sweden. The plant is assumed equipped with both heat and electricity storage and a gas fired boiler for peak load handling. In the simulations presented it is assumed that the plant is serving a local load (heat and electricity) and operating in the presence of a wholesale de-regulated energy market (spot and intra-day markets) with fluctuating energy prices. CHP is an increasingly important component of energy production technology in Europe and other continents (Petchers, 2003), and since it is effectively a dispatchable generator, it has been suggested the biomass-fired CHP plant is a good candidate to form the basis of an EPN.

In the case study, the plant was operated over the course of a simulated year; at each and every hourly time-step, electricity and heating loads are predicted and an optimal economic dispatch cost minimization problem is solved over a 24-hour future time horizon. A detailed Mixed Integer Linear Program (MILP) is used to model this non-linear and time dependent economic dispatch problem, and it is solved at each step using the open-source MILP solver LP Solve. The aim is to minimize the acquisition costs for energy to serve the local heat and electricity loads. The main decision variables in the dispatch problem are the CHP plant power and heat output settings, the amount of electricity and heat to charge or discharge from storage, the amount of electricity to be bought/sold from/to the grid (via the spot and intra-day markets) and the amount of additional heat to generate via the peaking boiler. Full details of the overall rolling horizon predictive optimization concept are as described in Short et al. (2015a; 2015b).

To facilitate the case study, anonymised sets of hourly data have been obtained for the hourly load on a district heating system located in Angelholm, Sweden along with hourly temperature measurements for the local area for the entire year 2009 (Gadd & Werner, 2013). In addition, electricity demands were obtained for the Sweden SW4 control area (in which Angelholm resides) from the Nordpool spot website. This latter data is publically available. The electricity data for the whole area have been scaled such that the average demand for heat and electricity matches an assumed plant capacity of 42 MW, which is typical of a medium sized CHP plant (DEA, 2012).

In terms of the CHP plant configuration, it was assumed that an extraction-type plant is employed with an adjustable heat to power ratio β in the range $0.4 \leq \beta \leq 0.8$. Constraints on the rate of change of the combined heat and power output (regulation ability) were set to 25% of full capacity per hour. Fuel cost was taken at 0.016 € / kWh, assuming a biomass type of fuel. A fast boiler start-up / shutdown sequence was assumed available, incurring net fuel and labour costs of 100 €. Local heat storage in the form of a 40 MWh capacity lagged tank, with an hourly rate of charge/discharge of 10 MWh per hour, is assumed. Electricity storage in the form of a 10 MWh battery bank, with an hourly rate of charge/discharge of 2.5 MWh per hour, is also assumed. The price of natural gas to produce additional heat is taken to be 0.055 € / kWh for every hour of the day. The selling of heat is assumed not to be an option. The hourly price to purchase electricity on the intra-day market is taken as 110% of the corresponding

hourly spot price, and the hourly price to sell electricity on the intra-day market is taken as 90% of the corresponding hourly spot price. This is a reasonable assumption to make (Rolfman, 2004). Post-hoc regulation charges for electricity imbalances were taken as 150% of the corresponding spot price for both up and down regulation, which is also a representative assumption to make (Skytte, 1999).

Using the plant configuration as detailed above, two experiments were performed. In the first (baseline costs) experiment, electricity distribution charges were taken to be 0.05 € / kWh and were built into the objective function costs as unavoidable acquisition charges levied on all electricity generated or bought wholesale. The simulation was then run over the course of the full year, the costs summed over each time step, and other key metrics calculated.

In the second (modified costs) experiment, electricity distribution charges were again taken to be 0.05 € / kWh and were built into the objective function costs as an unavoidable acquisition charges levied on all electricity bought wholesale; this charge, however, was not applied to units of electricity that were generated and used locally. These latter distribution costs were assumed to be separated from the acquisition costs and charged at a separate (possibly lower) rate. The simulation was again run over the course of the full year, the costs were summed over each time step, and other key metrics calculated. Two sub-cases were considered here: retrospective local distribution billing at 0.05 € / kWh (full local charge) and billing at 0.025 € / kWh (half local charge).

Table I displays summary statistics for each experiment. The average cost to the EPN for acquiring (generating or buying) one unit (kWh) of energy incurred in each case is displayed, along with the equivalent billing cost to the customer after local distribution charges have been applied (note that no additional profit margin is applied here). Also shown are the key measured performance metrics including the number of times the CHP plant was shut down (uncommitted), the average CHP plant load (%) during each hour, the average amount of electricity bought in each hour (kWh), and the CHP plant utilization factor during the course of the experiments. The obtained data are discussed in the next section.

Table I: Comparative summary of the results

Metric	Baseline Costs	Modified Costs	
Net Acquisition Cost (€ / kWh)	0.045869	0.030071	
Equivalent Customer Cost (€ / kWh)	0.045869	0.043404 (Full)	0.036737 (Half)
Shutdown Events (#)	111	33	
Average CHP Plant Load / Hour (%)	73.98	74.7	
Average Acquired Elec/ Hour (kWh)	5626.41	2799.69	
CHP Plant Utilization Factor (%)	98.61	99.62	

Discussion

From the data obtained and displayed in Table 1, several key observations may be made. Firstly, considering the average hourly electricity acquired from the wholesale market, one may observe that the removal of distribution charges from the acquisition costs of bought energy has reduced the energy bought from the grid by an average of over 50%. This is compensated by the plant (i) remaining operational for more hours over the course of the year and (ii) being operated at higher (> 0.7% average) heat and output power levels when running. The data indicate that there were 70% fewer plant shutdowns over the course of the year (in each case, it was more economical to keep the plant running rather than purchase electricity)

resulting in a 1% increase in the CHP plant utilization. Therefore in our experiments, it seems that allowing the EPN to separate the distribution costs for local generation when optimising the raw energy acquisition costs to serve the local load both encourages the use of local generation, and reduces the net amount of electricity handled wholesale and requiring transportation over transmission and distribution networks.

Turning now to the new acquisition costs, as can be expected they are significantly lower when distribution charges are removed from locally generated energy reflected in a reduction in acquisition costs of over 34% per unit. Further interesting observations are related to the subsequent energy costs which are passed on to local customers after addition of local distribution charges by the EPN. When these costs are levied at the same rate (0.05 € / kWh), the customer net cost per unit is actually reduced over the baseline case; this is due to the fact that, although the same net amount of heat and electricity has been handled, the acquisition costs have been lower due to the modified cost structures encouraging local (cheaper) generation by the CHP plant. When these costs are levied at half the rate (0.025 € / kWh), the customer net cost per unit is reduced even further. Thus, allowing the EPN to separate the distribution costs and optimize its raw acquisition costs allows for a greater flexibility in the level of distribution charge passed on to customers, and they are likely to see reduced energy costs as a result.

8.1 Appendix D Distributed electricity: power rating and voltage

The maximum power injected by distributed electricity generation in a single connection point can be evaluated in terms of net active power (MW). This net power results from the nodal difference between distributed electricity power production and load. These power levels depend on the network capacity and thus on the voltage level of the distribution system, which varies across the EU (see Table C1). On this basis no generally applicable maximum net power can be specified for distributed electricity generation: Although various categories of distributed electricity generation have been proposed, generally ranging from few kW to tens of MW (L'Abbate et al 2008).

“Currently cases of distributed electricity generation larger than one hundred MW are rare, especially in absence of a corresponding local load. This is due to the fact that the European distribution networks need special operation and upgrading measures to accommodate these electricity power injections” (L'Abbate et al 2008). It is here that the concept of an EPN could contribute. This is because one of the key advantages of the IDEAS business concepts for EPNSP is that it allows for the economic necessity of incrementally upgrading the distribution networks to cope with DREG and the transfer of active energy management from national transmission networks to the local distribution networks.

Country	Highest Distribution Voltage [kV]	Country	Highest Distribution Voltage [kV]
Austria	110	Latvia	20
Belgium	70	Lithuania	35
Bulgaria	110	Luxembourg	65
Cyprus	22	Malta	132
Czech Rep.	110	Netherlands	150
Denmark	60	Poland	110
Estonia	35	Portugal	60
Finland	110	Romania	110
France	20	Slovak Rep.	110
Germany	110	Slovenia	110
Greece	22	Spain	132
Hungary	120	Sweden	130
Ireland	110	United Kingdom	132
Italy	150		

Figure C1 Highest voltage levels in distribution networks in EU countries (source L'Abbate et al 2008).

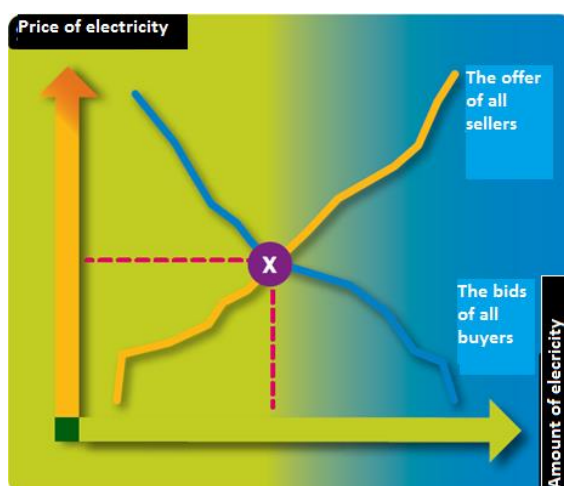


Figure D2. The principle of price determination in electricity exchange market in “Good to know about electricity market”, a presentation of the basic principles of the electricity market for Finnish citizens. (translation by authors from Finnish Energy Industries and Fingrid 2013)

The Nord Pool Spot prices change considerably during the day. Typically the prices are low during the night when the consumption is low and peak in the morning and afternoon when the consumption is high. The prices during a typical week in February are shown in Figure 2.5 in chapter two of this report. Although the Nordic electricity market is an open market, the prices often vary between the countries or areas in the Nordic network. Typically wholesale electricity has the same price throughout the area only for some hours of the year. The different pricing in different areas are related to so-called congestion situations, for example, if more electricity should be transmitted to Finland than the transmission connection between Finland and Sweden is able to deliver, resulting in higher price of electricity in Finland than in Sweden. In these situations it will be necessary to produce more expensive electricity in Finland than the electricity imported from Sweden would cost. The main effort to avoid these situations is to increase the transmission capacity between the countries. (Finnish Energy Industries 2015a).

Smart grid capabilities introduced by the smart metering

A Degree of the Council of State (given in March 2009) required that by the end of 2013 at least 80 per cent of the consumption places per each DNO in Finland should have been equipped with a smart meter capable for registering hourly metering and remote reading (Energy Authority 2014). At end of 2014, over 95 % of the customers had smart meters. Most of the remaining customers were buildings with sporadic use, in remote locations. In addition to the above, the Degree contained some other requirements for the metering equipment, such as:

- The measurement data must be read at least once a day.
- The DNO is obliged to give the measurement data to the customers at the same time when it is given to the electricity supplier. This is provided through an internet site with individual user identification procedure.
- The measurement data must be stored in a database, where it is stored at least six years.
- The metering equipment must be capable of receiving and forwarding demand control messages sent through the communication network.

Tariffs for the end users (customers) in European comparison

The tariffs for the sale of electricity vary remarkably in Finland, but they are relatively low in European context (Figure D4).

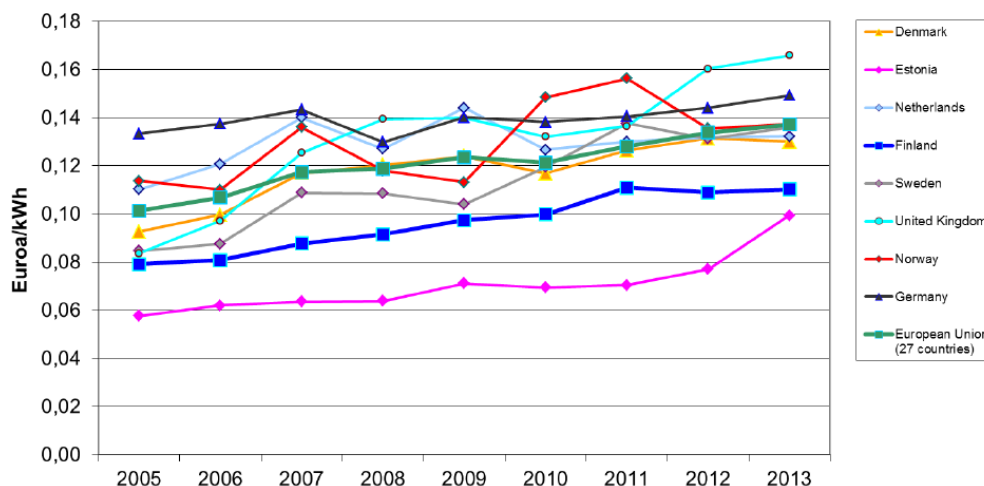


Figure D4. The consumer prices (without taxes) of electricity in selected European countries (consumption 2500 - 5000 kWh/a). (Eurostat as cited in Finnish Energy Industries 2015b)

According to the Energy Authority (2014), in 2013 there were 71 retail suppliers of which 40 offered their products nation-wide. Electricity retail prices are not regulated in Finland, so the retail suppliers are free to set their own tariffs, and there are numerous different opportunities for the customer, varying in energy source, base fee, electricity fee, time-dependency etc. The Energy Authority has since 2006 maintained a web-based tariff calculator to facilitate price comparisons and supplier switching. Another objective of the service is to inform private consumers better about the origin of the electricity. All retail suppliers are obligated to maintain up-to-date information on their public electricity price offers on this website. (Energy Authority 2014)

The heat sources used for heating in Finland

In Finland District heating (DH) is widely applied for heating: almost half of the Finnish building stock is district heated (Figure D5), in largest towns even 90 % of the buildings. About 2.6 million (of total 5,3 million) Finns live in houses heated by district heat. (Finnish Energy Industry 2015d).

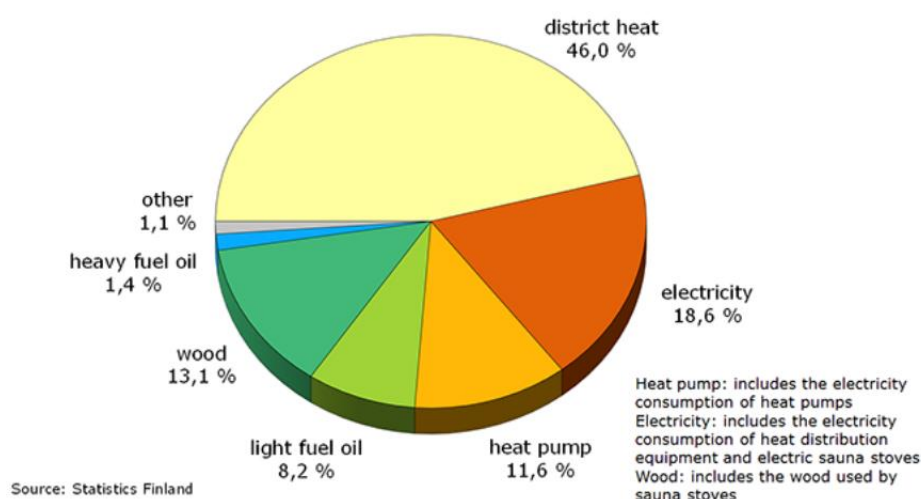


Figure D5. The heat sources used for heating in Finnish buildings. (Statistics Finland cited in Finnish Energy Industry 2015d)

EPNSP services currently offered by energy retailers

Some actors already provide services that are part of the EPNSP business model developed in IDEAS, e.g. some energy companies (retailers) are offering remote control and demand management, Helen's Termo and Hima products or Fortum's Fiksu as examples:

- Helen's Termo controls the electrical heating according to the weather forecasts and electricity price variations on the spot market, and provides an easy access to electricity consumption information
- Helen's Hima provides remote control and management for those homes that are equipped with smart home automation systems
- Fortum Fiksu controls the electrical heating according to the weather forecasts and price variations on the spot market, or chooses between oil or electricity as heating source according to price. It also supports remote control and easy access to the energy consumption data.