Green PE
Regional Mapping of the Sectoral Specialisation in some Baltic Sea Region Countries / Regions

Factors and regulations influencing the market uptake of advanced power electronics solutions

Interreg
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1. Introduction

One main goal of the Green Power Electronics (Green PE) project is to promote the integration of advanced power electronics in the portfolio of companies in the Baltic Sea Region aiming to minimize the environmental impact of the technical solutions. Supporting companies in the transition to incorporate new technologies needs solid competence to strategically identify markets and conditions that will facilitate or hinder the market uptake of these innovative technologies.

The aim of the regional mapping is to make a regional analysis of relevant aspects influencing the market uptake of power electronics for green applications. Therefore, this output presents the compilation of relevant factors at some region or country participating in the Green PE project. In a separate document, we present the Transnational Technology and Product Roadmap providing information on the technological state-of-the-art and future capabilities within the field of wide bandgap (WBG) materials (GaN and SiC) for different power electronic application fields/categories.

The main target group of this document is companies in the process of integrating power electronic technologies in their business. The roadmap aims to support them with information about relevant policies and regulations influencing the market. The information on the document is also important for policy makers benchmarking regional differences of the regulations.

Why advanced power electronics?

Progress that was made in recent years in the field of digitization, renewable energy and electrical energy storage provides an opportunity to increase energy and economic efficiency in all areas of activities. An important advantage of this new group of technologies is the ability to reduce the pressure exerted on the environment resulting from the combustion of fossil fuels. The level of industrial development has reached a scale so large, that it has a global impact on the environment, air quality and radically accelerates global warming. The pace of environmental changes is so fast that the natural rate of development and implementation of renewable energy and e-mobility is too slow in the context of increasing climate and ecological threats. Hence the need for additional actions to stimulate the growth of energy efficiency and encourage the elimination of harmful technologies. The development of semiconductor devices with wide bandgap (WBG) technologies is stimulated by the demand for highly efficient power electronics devices, which are most used in electric drives, connection of renewable energy sources (RES) and "smart home" energy devices.

The business development of enterprises using WGB depends on local conditions - the structure of industry, the level of advancement of energy transformation and energy costs. Although all BSR countries involved in the project are EU members, the conditions shaping the demand for energy-efficient devices with increased energy efficiency and durability are quite different.

Therefore, for each country separately, we present a set of factors that stimulate and inhibit technological development in the three areas determining the demand for WGB solutions.

Life-time energy saving potential of the new technologies

Calculation models have significant impact on the strategy and scale of support for digitization and technological transformation of the energy sector, as they quantify the benefits resulting from moving away from fossil fuels to use RES. The benefits of vehicle electrification and the implementation of Smart Housing technologies are in a significant part linked to the development of renewable energy. Therefore, the benefits from implementing e-mobility should be part of the overall benefit model. By nature, energy companies do not include external benefits in their calculations, but they highly value the risks associated with the transition to new technologies and increase the competitiveness of the energy market. In the circles of traditional energy one can even find an argument that the market of prosumer investments in microgrids results in hyper-competition mechanisms, damaging the profitability of conducted activities in the area of energy, and in an unacceptable reduction of network stability. An important element of each calculation model is assumption of price regression associated with the learning curve specific to a given industry. For example, in relation to the costs of power electronic components of photovoltaic installations, the methodology should include the laws governing the market for the production of electronic devices and the inclination of the learning curve specific to this sector. For PV panels, it is important to consider Swanson's law[1]. Global costs resulting from greenhouse gas emissions are determined by the amount of emission fees. The ineffectiveness of the current climate policy suggests that they are underestimated or incorrectly taken into account. Perhaps the essence of the problem is ineffective enforcement of these costs. In every country and case, a full calculation model should be implemented, taking into account all elements of the transformation process, because only then can we get a full economic picture. The use of an incomplete calculation model may be the result of a lack of competence or forced by political factors.

As an example, in Poland, there is no publicly available, reliable forecast of energy price growth in the coming years. Its lack properly prevents the introduction of a unified and constantly updated calculation model. The benefits calculation used in Poland is based on the model made under the pressure of the coal-fuel lobby and state-owned grid operators. Therefore, it does not contain most of the external costs related to, among others with increased costs of health care resulting from dust emissions, reclamation of mining and emission damage, socio-economic benefits from economic activity in the RES sector, the impact of new technologies on the creation of new jobs, etc. The calculations are generally based on inflated prices of electricity from RES, inflated costs of network modernization do not take into account the price regression resulting from learning curves, etc .

[1] Swanson's law is the observation that the price of solar photovoltaic modules tends to drop 20 percent for every doubling of cumulative shipped volume. At the year 2011, costs were estimated to halve about every 10 years. The law is named after Richard Swanson, the founder of SunPower Corporation, a solar panel manufacturer. (Wikipedia)

2. Partner involvement

The technology transfer (TT) partners in the Green PE consortium have contributed to the collection of relevant information to identify the sectorial specialization related to the acceptance of WBG-technologies for green applications at their countries/regions.

No	Acronym	Organisation	Country
PP3	EEH	Renewable Energy Hamburg	DE
PP5	RISE	RISE Research Institutes of Sweden	SE
PP7	LTC	Latvian Technological Center	LV
PP10	PROTECH	Applied Research Institute for Prospective Technologies	LT
PP14	KSTP	Kaunas Science and Technology Park	LT
PP15	Clean	CLEAN	DK
PP16	Kigeit	Polish Chamber of Commerce for Electronics and Telecommunications	PL

Table 1: Green PE technology transfer partners contributing to this document

Country-specific Factors and Regulations

Note: At the time you are reading the document the compilation of regulations in each country specific chapter might differ from current legislation status in each country due to new revisions in the meantime

3. Latvia

Last update: 2018-10-16

Latvia	E-mobility	Renewable energy	Smart houses
Drivers	- Governmental initiatives	- EU policy and energy independence	- Striving for comfort
Barriers	- High prices of electric cars	- Suspension of the guaranteed procurement scheme for electricity produced from renewable energy sources	- Lack of sufficient information
Energy efficiency	- N/A	- Additional source of energy	- Optimisation of temperature regime in houses
Noise emission	- Decreased noise level	- Wind power plants – source of additional noise	- Eventually source of additional noise in houses

Table 2: Summary Latvia

In Latvia there are no industries that produce WBG semiconductors, but there are companies which use WBG semiconductors in products based on WBG components.

The Latvian electrical engineering and electronics industry is one of the largest employers of technically and scientifically trained people in Latvia. Companies in Latvia manufacture products such as electronic control and monitoring devices used in many industrial and scientific applications. The high proportion of exports (80%) and the variety of export destination countries point to the competitiveness of the Latvian electronics industry in the international arena. Latvian companies specialize in specific niche products where in-depth technical expertise in specific technologies is utilised to create unique, high value added products. The key strengths of Latvian companies are know-how in current technologies and creativity in solutions.

More than 200 companies make up the Latvian electrical engineering and electronics industry. In Latvia there is a lot of companies which sell equipment, apparatus and appliances which contain power electronics elements, as well as offer services to install these products. These companies mostly use foreign produced, ready to use, complete devices, and company's services are limited to assembling and installing these products into functioning systems on site. A smaller number of companies develop and produce original electronics products with advanced power electronics components. The companies purchase power electronic components in global markets and integrate in their products. The main criteria for choosing suppliers are price and functionality.

The companies operating in the field of electrical engineering and electronics are united in the Latvian Electrical Engineering and Electronics Industry Association.

In the following, we present specific information related to e-mobility, renewable energy and smart houses in Latvia.

3.1. E-mobility (LV)

One of the trends in the development of transport is to promote usage of electricity. It concerns various types of transport including electric cars. The focus of this session is on electric cars and not on other e-mobility subjects (trains, boats, etc.)

3.1.1. Drivers

There are two main drivers that promote usage of electric vehicles. The one is governmental/ state policy that stimulates usage of electric cars as means of transport. The other are private companies that operate in niche applications (sport and entertainment) – electric car races and go-cart racing.

3.1.1.1. Policies & regulations

To promote e-mobility the Cabinet issued a document which outlined the electro-mobility development plan for years 2014-2016. Afterwards there were adopted several laws and regulations in Latvia which favoured usage of electric cars. The cars with electric motors (electric cars) are exempted from the car tax payment. For electric cars, a special design of a vehicle number plate is introduced (Fig. 1).

Figure 1: Latvian Electric vehicle number plate

Source: http://www.e-transports.org/index.php/jaunumi/138-elektromobiliem-jaunas-vizuali-atskirigas-numura-zimes

The initial registration of a electric car is free of charge. The aid for electric car owners is provided also by local authorities for example, in municipal parking places of many municipalities, electric cars can be parked free of charge and without time limit. Electric cars have the right to drive within the city public transport lanes. All these measures increase the interest to purchase and use electric cars. The plan to cover the country with a network of electric car rapid charging stations will increase the usage of advanced power electronics in these stations. By Summer 2018 there were 70 fast chaging stations in operation. It is planned to build 150 stations by the year 2021.

3.1.1.2. Recommendation on stimulation policies

Re-enact programs that support purchase of electric cars for companies.

3.1.1.3. Latvian WBG companies on e-mobility

- JSC Rīgas elektromašīnbūves rūpnīca (RER) - design and production of original power electronics elements. The leading machinery building plant in the Baltic States with a focus on the production of AC/DC traction motors and electrical traction equipment for electric trains, passenger carriages, locomotives, underground train carriages, other city transport and dump trucks (Figure 2), as well as electrical equipment and motors for general industrial purposes.

Figure 2: RER. 750 kW DC/AC converter for dump trucks asynchronous motor drive
Source: http://www.rer.lv/lv/electric-equipment-dump-trucks/control-equipment

- Drive-eO, SIA – operates in the field of e-mobility under the leadership of the former racing car pilot A. Dambis. The company has developed racing cars with electric drive for Dakara off-road race (Figure 3 Left) and for the Pikes Peak International Hill Climb competition (Figure 3 Right).

Figure 3: Drive-eO
Left: Off-road race car with electric drive. Source: https://www.flickr.com/photos/driveeo/6801586367/;
Right: Supercar designed for the Pikes Peak International Hill Climb.Source: https://www.flickr.com/photos/driveeo/19268541316/

- Blue Shock Race, SIA - develops electric drives for go-karts and bicycles (Figure 4). Owns several racing halls for go-karts.

Figure 4: Variety of go-karts for sports and entertainment
Source: https://www.instagram.com/p/8KqLUUuN3J/?taken-by=blue_shock_race

- Electric Mobility, SIA - engineering and production of light electric vehicles - electric scooters, controllers for LEVs (light electric vehicles), wireless solutions for electrical drives and electric motors.
- EMI Electronics, SIA - specialized in electric vehicle charging station design and manufacture.

3.1.2. Barriers

The main barrier for wider implementation of e-mobility in Latvia is the relatively high price of electric cars (in comparison with conventional cars). It is especially important taking into account the relatively small income of the majority of the population

3.1.2.1. Policies & regulations

No specific/significant regulation barriers.

3.1.2.2. Implication barriers (e.g. infrastructure)

A barrier for wider usage of electric cars is the low number of charging stations. The operation of these vehicles depends on accessibility to electricity supply (charging) points. The electric vehicle charging stations are not located in all parts of Latvia which is an obstacle to use electric cars in remote regions (Figure 5).

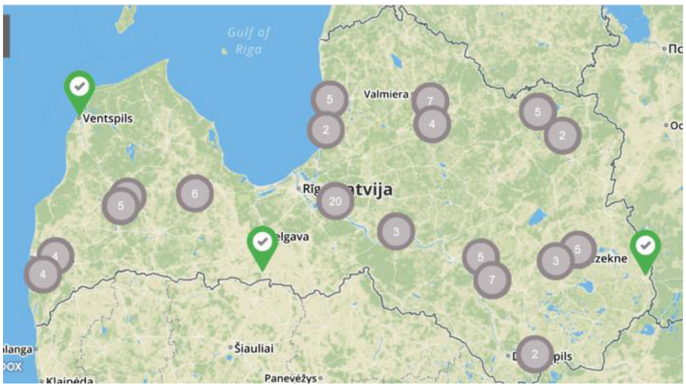

Figure 5: Location of the electric vehicle charging stations in Latvia
Source: http://portal.e-mobi.lv/lv/sakumlapa/

3.1.3. Energy efficiency

No specific Latvian issues about energy efficiency in the implementation of new technologies

3.1.4. Noise emission

No specific Latvian issues about energy efficiency in the implementation of new technologies

3.2. Renewable energy (LV)

The competitiveness of the Latvian economy, energy security and energy sustainability are key words for implementing the energy policy until 2020 and beyond.

3.2.1. Drivers

Latvia has one of the largest proportion of renewable energy in its energy mix within the EU. Renewable energy sources make up one third of Latvia's energy mix. Wood and water are the most widely used renewable energy resources: wood is used as fuel for district heating, both centralised and local, and for the heating of individual buildings. The majority of electricity generated by public limited company Latvenergo comes from renewable and environmentally friendly energy sources, whereas the remaining electricity is generated by combined heat and power plants working in cogeneration mode. Nevertheless, the policy is to increase the usage of renewable energy sources.

3.2.1.1. Policies & regulations

The general energy development strategy is outlined in the Cabinet's order "About Energy Development Guidelines for 2016-2020". The general provisions for energy effective, safe and quality supply on reasonable price diversifying energy sources are stated in the "Law on Energy". It includes several points encouraging usage of local renewable and secondary energy resources as well as promoting use of clean, environmentally friendly and efficient technologies minimising impact on the environment. The "Energy Efficiency Law" relates also to renewable energies, stating that the energy should be used and managed in a way that contributes to sustainable economy and limit the climate change. There is a support program that directly supports and promotes the transition to use of renewable energy resources in the processing industry and a program that supports the use of renewable energy sources in local district heating. The programmes that stimulate improvement of energy efficiency in buildings include provisions on increasing the use of renewable energy sources. The realisation of projects in these programmes increase the application of power electronics in various systems and installations.

The favourable national feed-in support scheme for renewable electricity until 2011 year provided a guaranteed purchase price that was significantly higher than the electricity market price. The public trader (JSC „Energijas publiskais tirgotajs") purchase electricity from merchants, which have been granted the right to sell electricity produced from renewable energy resources within the scope of a mandatory procurement for electricity prices which have been determined in accordance with the price formulas in Cabinet Regulations. The mandatory procurement of electricity is compensated by electricity end-users' payments.

Cabinet Regulation No 221 of 10 March 2009 „Regulations regarding electricity production and price determination upon production of electricity in cogeneration" prescribes the criteria for qualification of cogeneration units for them to acquire the right to sell the produced electricity within the framework of the mandatory procurement or to receive guaranteed payment for the electric capacity installed in a cogeneration unit.

Cabinet Regulation No 262 of 16 March 2010 „Regulations regarding the production of electricity using renewable energy resources and the procedures for the determination of the price" prescribes conditions for acquiring rights to sell electricity generated from renewable energy sources (sun, wind, etc.) within the framework of mandatory procurement.

Support level for the production of electricity from renewable energy sources and high efficiency cogeneration depends on the type of energy source used, the installed capacity of the plant, number of working hours as well as natural gas sales price. Contrary to the forecasts in recent year's natural gas prices have rapidly risen, contributing to the substantial growth of support intensity and respectively to the increase of number of supported electricity producers. Thus, support paid to the producers within the framework of mandatory procurement, which raises the overall electricity price, has also significantly increased. The analysis revealed that

volume of the mandatory procurement of electricity will continue to grow without changes in the historically applied support scheme.
Since availability of energy resources and their prices have always been one of the determinant factors of national and regional economic competitiveness, Latvia by January 1, 2016 has suspended the granting of the right to sell the produced electricity as the volume of electricity to be mandatorily procured and the right to receive a guaranteed fee for the electric capacity installed in a power plant.

Currently the support scheme is being revised to provide a stable, transparent and predictable investment environment for renewable energy and other industries, as well as reduce the burden of mandatory procurement on the Latvian electricity consumers.

Investment support for renewable energy sources has been also commenced utilizing Cohesion Fund resources and the Climate Change Financial Instrument (CCFI).

Aim of CCFI is to prevent global climate change, adaptation to the effects of climate change and contribute the reduction of greenhouse gas emissions (for example, implementing activities to improve the energy performance of buildings in both public and private sectors, the development and implementation of technologies that use renewable energy resources, as well as the implementation of the integrated solutions to reduce greenhouse gas emissions).

3.2.1.2. Recommendation on stimulation policies

To develop balanced support scheme for procurement of electricity produced from renewable energy sources.
To introduce coordination mesures for optimization of the use of locally produced energy.

3.2.1.3. Latvian WBG companies on renewable energy

- JSC LATVENERGO - Wind and solar energy, wood products.
- Energolukss, SIA - Emergency power supply solutions.
- FONONS, SIA - Heat pumps.
- Solar KEJ, SIA - Solar, heating and water systems. Delivers and installs solar collectors, solar cells, hot water equipment and heat pumps.
- Institute of Physical Energetics - Smart grids.

3.2.2. Barriers

3.2.2.1. Policies & regulations

The issue is that the programmes supporting a wider usage of renewable energies are mostly short-term programmes.

3.2.2.2. Implication barriers (e.g. infrastructure)

Uncertainty about future policies in support of production of electricity from renewable sources of energy.

3.2.3. Energy efficiency

The usage of renewable sources of energy usually is accompanied by measures that increase the efficient utilisation of energy.

3.2.4. Noise emission

Wind wind generators may be a source of additional noise thus it should be taken into account in planning of the location of wind power plants as well as in implementation of new technologies.

3.3. Smart houses (LV)

3.3.1. Drivers

3.3.1.1. Policies & regulations

The construction process is regulated by several laws and regulations which also applie to smart buildings. A special law is about energy performance of buildings. There are several operational programmes that stimulate investments in energy efficiency in buildings – one in residential buildings, the other in public buildings. Although both programmes are more focused on increase of heat isolation, they set several energy saving parameter values which should be met after the projects' realisation. It is easier to reach these energy saving parameters by applying powers electronics in energy regulating and measurement devices. It is expected that with increase of prosperity more and more people will arrange smart houses with higher comfort. Thus, it is a huge market for various devices with power electronics components.

3.3.1.2. Recommendation on stimulation policies

No recommendations.

3.3.1.3. Latvian WBG companies on smart housing

- Istabai, SIA – developers, producers and suppliers of smart home systems.
- LATTELECOM, SIA – suppliers of solution for of smart home systems.

3.3.2. Barriers

3.3.2.1. Policies & regulations

There are no specific programmes that support investments in smart houses.

3.3.2.2. Implication barriers (e.g. infrastructure)

In Latvia a significantly smaller proportion of the population than in more prosperous European countries can afford a smart home comfort. Nevertheless, with the increase of prosperity of society, the interest in smart houses rapidly increases. It causes another problem – shortage of qualified certified specialists that can install smart building systems.

3.3.3. Energy efficiency

As a rule the smart house systems increase energy efficiency, as they alow to keep temperature at optimum level.

3.3.4. Noise emission

The smart house systems include various sensors and regulatory devices which can be source of noise in houses. To avoid increased noise level, solutions should be chosen as far as possible without mechanical relays. They can be replaced by WBG switches operating without noise. A special attention should be be paid to the location of different noisy nodes in the house – farther from living spaces.

3.4. Latvia. List of Literature

[1] Ministru kabineta rīkojums Nr. 129 "Par Elektromobilitātes attīstības plānu 2014.-2016. gadam", 2014, Latvijas Vēstnesis, 62 (5122).

[2] Likums "Par vieglo automobiļu un motociklu nodokli", 2013, Latvijas Vēstnesis, 188 (4994).

[3] Likums "Transportlīdzekļa ekspluatācijas nodokļa un uzņēmumu vieglo transportlīdzekļu nodokļa likums", 2015, Latvijas Vēstnesis, 248 (5566).

[4] Ministru kabineta noteikumi Nr. 858 "Transportlīdzekļa ekspluatācijas nodokļa un uzņēmumu vieglo transportlīdzekļu nodokļa maksāšanas kārtība", 2012, Latvijas Vēstnesis, 201 (4804).

[5] Ministru kabineta noteikumi Nr. 1080 "Transportlīdzekļu reģistrācijas noteikumi", 2015, Latvijas Vēstnesis, 254 (5572).

[6] Ministru kabineta noteikumi Nr. 338 "Klimata pārmaiņu finanšu instrumenta finansēto projektu atklāta konkursa "Siltumnīcefekta gāzu emisijas samazināšana transporta sektorā – atbalsts elektromobiļu un to uzlādes infrastruktūras ieviešanai" nolikums", 2014, Latvijas Vēstnesis, 120 (5180).

[7] Rīgas domes saistošie noteikumi Nr.206 "Rīgas pilsētas pašvaldības maksas autostāvvietu apsaimniekošanas un lietošanas saistošie noteikumi", 2016, Latvijas Vēstnesis, 142 (5714).

[8] Ministru kabineta noteikumi Nr. 279 "Ceļu satiksmes noteikumi", 2015, Latvijas Vēstnesis, 122 (5440).

[9] Ministru kabineta rīkojums Nr. 129 "Par Enerģētikas attīstības pamatnostādnēm 2016.-2020. gadam", 2016, Latvijas Vēstnesis, 32 (5604).

[10] Likums "Enerģētikas likums", 2016, Latvijas Vēstnesis, 52 (5624).

[11] Likums "Energoefektivitātes likums", 2016, Latvijas Vēstnesis, 52 (5624).

[12] Ministru kabineta noteikumi Nr. 590 "Veicināt efektīvu energoresursu izmantošanu, enerģijas patēriņa samazināšanu un pāreju uz AER apstrādes rūpniecības nozarē" īstenošanas noteikumi", 2016, Latvijas Vēstnesis, 174 (5746).

[13] Ministru kabineta noteikumu projekts "Veicināt energoefektivitāti un vietējo AER izmantošanu centralizētajā siltumapgādē" pirmās projektu iesniegumu atlases kārtas īstenošanas noteikumi", 2016.

[14] Ministru kabineta noteikumi Nr. 710 "Darbības programmas "Izaugsme un nodarbinātība" 4.2.1. specifiskā atbalsta mērķa "Veicināt energoefektivitātes paaugstināšanu valsts un dzīvojamās ēkās" 4.2.1.1. specifiskā atbalsta mērķa pasākuma "Veicināt energoefektivitātes paaugstināšanu dzīvojamās ēkās" īstenošanas noteikumi", 2016, Latvijas Vēstnesis, 220 (5792).

[15] Ministru kabineta noteikumi Nr. 534 "Darbības programmas "Izaugsme un nodarbinātība" 4.2.1. specifiskā atbalsta mērķa "Veicināt energoefektivitātes paaugstināšanu valsts un dzīvojamās ēkās" 4.2.1.2. pasākuma "Veicināt energoefektivitātes paaugstināšanu valsts ēkās" pirmās projektu iesniegumu atlases kārtas īstenošanas noteikumi", 2016, Latvijas Vēstnesis, 164 (5736).

[16] Likums "Būvniecības likums", 2016, Latvijas Vēstnesis, 241 (5813).

[17] Ministru kabineta noteikumi Nr. 500 "Vispārīgie būvnoteikumi", 2014, Latvijas Vēstnesis, 191 (5251).

[18] Likums "Ēku energoefektivitātes likums", 2016, Latvijas Vēstnesis, 57 (5629).

[19] Investment and Development Agency of Latvia, 2014,"Electrical Engineering and Electronics Industry in Latvia".

[20] CSDD mājaslapa "E-transports", atrodama <http://www.e-transports.org/index.php>.

[21] Veļķere, A., 2016. Būvinženieris, 51, pp.22-26.

[22] LATVENERGO mājaslapa “Uzlādes punktu karte”, atrodama <http://www.latvenergo.lv/lat/iepirkumi_konkursi_piedavajumi/e_transporta_uzlades_punktu_karte/#info_1>.

[23] Ministru kabineta rīkojums Nr. 202 “Par Alternatīvo degvielu attīstības plānu 2017.-2020. gadam”, Rīgā 2017. gada 25. aprīlī (prot. Nr. 20 25. §), <https://likumi.lv/doc.php?id=290393>.

Ref.	Document name in Latvian	Document name in English
[1]	Par Elektromobilitātes attīstības plānu 2014.-2016. gadam	On electromobility development plan for 2014 to 2016
[2]	Likums “Par vieglo automobiļu un motociklu nodokli”	Law “On the passenger car and motorcycle tax”
[3]	Transportlīdzekļa ekspluatācijas nodokļa un uzņēmumu vieglo transportlīdzekļu nodokļa likums	Law on vehicle operating tax and company car tax
[4]	Transportlīdzekļa ekspluatācijas nodokļa un uzņēmumu vieglo transportlīdzekļu nodokļa maksāšanas kārtība	Procedure for payment of vehicle operating tax and company car tax
[5]	Transportlīdzekļu reģistrācijas noteikumi	Vehicle registration rules
[6]	Klimata pārmaiņu finanšu instrumenta finansēto projektu atklāta konkursa “Siltumnīcefekta gāzu emisijas samazināšana transporta sektorā – atbalsts elektromobiļu un to uzlādes infrastruktūras ieviešanai” nolikums	Regulations for climate change financial instrument projects financed by the open call for proposals “Reducing greenhouse gas emissions in the transport sector – support for electric vehicles and their charging infrastructure implementation”
[7]	Rīgas pilsētas pašvaldības maksas autostāvvietu apsaimniekošanas un lietošanas saistošie noteikumi	Riga Municipality paid parking place management and use binding rules
[8]	Ceļu satiksmes noteikumi	Road traffic law
[9]	Par Enerģētikas attīstības pamatnostādnēm 2016.-2020. gadam	Guidelines on energy development 2016-2020
[10]	Enerģētikas likums	Energy law
[11]	Energoefektivitātes likums	Energy efficiency law
[12]	Veicināt efektīvu energoresursu izmantošanu, enerģijas patēriņa samazināšanu un pāreju uz AER apstrādes rūpniecības nozarē" īstenošanas noteikumi	The implementing rules for promotion of efficient use of energy resources, reduction of energy consumption and transition to RES in the manufacturing sector
[13]	Veicināt energoefektivitāti un vietējo AER izmantošanu centralizētajā siltumapgādē” pirmās projektu iesniegumu atlases kārtas īstenošanas noteikumi”	The Implementing rules for the first project call “Promotion energy efficiency and use of RES in local district heating"
[14]	Darbības programmas "Izaugsme un nodarbinātība" 4.2.1. specifiskā atbalsta mērķa "Veicināt energoefektivitātes paaugstināšanu valsts un dzīvojamās ēkās" 4.2.1.1. specifiskā atbalsta mērķa pasākuma "Veicināt energoefektivitātes paaugstināšanu dzīvojamās ēkās" īstenošanas noteikumi”	Implementing rules of the operational programme "Growth and Employment” 4.2.1. the specific aid to the objective "Promoting energy efficiency in residential and public buildings” 4.2.1.1. specific aid to target measure "Promoting energy efficiency in residential buildings"
[15]	Darbības programmas "Izaugsme un nodarbinātība" 4.2.1. specifiskā atbalsta mērķa	Implementing rules for the first call of the operational programme "Growth and

Ref.	Document name in Latvian	Document name in English
	"Veicināt energoefektivitātes paaugstināšanu valsts un dzīvojamās ēkās" 4.2.1.2. pasākuma "Veicināt energoefektivitātes paaugstināšanu valsts ēkās" pirmās projektu iesniegumu atlases kārtas īstenošanas noteikumi"	Employment" 4.2.1. the specific aid to the objective "Promoting energy efficiency in residential and public buildings" 4.2.1.1. specific aid to target measure "Promoting energy efficiency in public buildings"
[16]	Būvniecības likums	Construction Law
[17]	Vispārīgie būvnoteikumi	The general construction regulations
[18]	Ēku energoefektivitātes likums	Law on the energy performance of buildings
[20]	CSDD mājaslapa "E-transports"	The Road Traffic Safety Directorate website "E-transport"
[21]	Būvinženieris	Journal "Civil Engineer"
[22]	LATVENERGO mājaslapa "Uzlādes punktu karte"	LATVENERGO website "Charging point chart"
[23]	Ministru kabineta rīkojums Nr. 202 "Par Alternatīvo degvielu attīstības plānu 2017.-2020. gadam"	Cabinet Order No. 202 "On the Development Plan for Alternative Fuel for years 2017-2020."

4. Poland

Last update: 2018-08-31

Poland	E-mobility	Renewable energy	Smart houses
Drivers	- Reduction of the levels of Particulate Matter Pollution - Low operating costs - Lowering of crude oil imports - Increasing the efficiency of using power grids	- Reduction of fossil fuels usage - Reduction of fuels import - Electricity cost reduction - Increasing energy security - Creating new jobs	- Reducing the cost of house maintenance - Increasing the comfort of use - Increasing the safety of using devices - Stimulation of neighborly cooperation
Barriers	- High purchase cost - Limited range of EV - Lack charging points - Low RES share in the electrical grid - Low level of citizens' wealth	- He need to invest in network automation to manage the system of distributed energy resources - Interests of the fuel and coal lobby - Immaturity of energy storage technology	- High implementation costs in existing buildings - Low level of awareness of the benefits of using SH technology - Low level of citizens' wealth
Energy efficiency	- The possibility of using only RES - Higher efficiency of the propultion systems - Energy storage with RES to use in periods	- Increasing the efficiency of fossil fuel usage	- Better use of energy from RES - Reduction of transmission losses - Implementation of DSR services
Noise emission	- Reduction of noise from internal combustion engines	- A small increase in the noise level from wind turbines - Noise reduction resulting from the progressive elimination of internal combustion engines	- Creating conditions for eliminating internal combustion engines

Table 3: Summary Poland

4.1. E-mobility (PL)

4.1.1. Drivers

4.1.1.1. Policies & regulations

In February 2018, the Polish President signed the Act on Electromobility and Alternative Fuels which is the first set of rules in Poland addressing the issue of electromobility, and is intended to promote electromobility and alternative fuel vehicles. The Act transposes Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure.

This Act defines basic terms such as charging point, charging station, electric vehicle and alternative fuels. Most importantly, it establishes a framework for building a basic alternative fuels infrastructure (including electrical energy, LNG, CNG and hydrogen).

The new law on electromobility aimed at turning Poland into an e-mobility leader in Europe. Poland wants to have 1 million EVs on the road by 2025

The new law includes:

- proactive approach to critical raw materials to boost strategic independence:
- Facilitating access to secondary raw materials through recycling in a circular economy of batteries
- Through free trade agreements securing fair and sustainable access to raw materials from resource-rich countries outside the EU.
- Stepping up EU research and innovation to better link it with industry's future needs:
- In 2018-2019, 110 mil EUR available for battery-related research and innovation projects;
- In 2018-2020, a budget of 2.7 bn EUR available under the European Innovation Council for potential breakthrough projects and batteries could be part of it.
- Establishing robust regulatory requirements for safe and sustainable batteries production to comply with when placed on the EU market

Source: https://ec.europa.eu/commission/commissioners/2014-2019/sefcovic/announcements/speech-e-mobility-summer-day-polish-electricity-association-brussels_en

In Poland, economic growth and technology modernization are particularly intensive. However, in the process of political transformation, the privatization of the energy sector could have not be completed. That is why the process of decarbonising the economy takes place in a conflictual way. The interests of modern digital and electromechanical industry collided sharply with the interests of the state energy oligopoly and turned into a social and political conflict. That's why we have a number of inconsistencies in legal acts and programs implementing low-carbon policies. On the one hand, a very ambitious program for the development of the electric motorisation was established, but the management of this development was entrusted to the Ministry of Energy, which is a political hostage of the coal-fuel lobby.

The RES Act and the Landscape Protection Act are used to inhibit the development of distributed energy, which increases the risk of a serious energy crisis. Enterprises take this risk into account and are more and more willing to invest in modern energy technologies, which will reduce their sensitivity to the worsening condition of Polish power grids. The political blocking of investments in RES and Smart Grids causes the growth of wholesale electricity prices, which in turn promotes investments to increase energy efficiency.

The described conflict reduces the effectiveness of the entire low-emission policy, which is why recommendations regarding Poland should be naturally aimed at resolving it and increasing the coherence of the established regulations and stimulation programs.

The main drivers of the evolution of E-mobility in Poland are:

- Intensive development of the sector of storage technology and energy storage management
- Increase in competitiveness in the energy market, forcing a shift towards innovation
- Cleaner air - Poland is among the many Eastern European countries struggling with severe air pollution. On 22 February 2018, the European Court of Justice concluded that Poland had failed clean air obligations and infringed EU law
- In 2017 a factory for lithium-ion batteries for electric cars was buit and it is one of the largest of its kind in Europe and located near Wroclaw. This is a great opportunity for the Polish industry. Noticeable falling prices of energy storage worldwide and the fact that in Poland it is foreseen that the energy will be getting more expensive, that will increase the profitability of power electronic companies that could invest in alternative energy sources despite lack of subsidies
- Dynamic development of energy storage may result in further investments (factories) located in Poland, which will try to meet the demand for batteries resulting from the development of electromobility. Poland sees an opportunity to reach a significant position in this regard in Europe
- Diminishing energy storage prices and associated costs of 1MWh shift. By reducing the participants' downsizing costs, will increase the demand for intelligent electronic networks and the production of energy at the place of its consumption bypassing transmission lines. This mainly concerns rural areas where the cost of energy distribution is very high – there will be a demand for local power grids and the use of energy storage.

4.1.1.2. Recommendation on stimulation policies

The digital industry is the most innovative share of the Polish economy. It has the technology, competencies and the production capacities necessary for the production development of technologically advanced electronic energy devices. The condition for the effectiveness of stimulation activities is to launch them on the appropriate scale and with necessary intensity. The main barrier is the lack of internal demand that would allow to justify economically undertaking R & D efforts and to prepare references allowing entry into external markets.

In Poland, it is necessary to launch three demand mechanisms that will increase the effectiveness of the e-mobility program.

1. Schedule for the implementation of electric bus transport in individual cities
2. Schedule for the introduction of zero-emission zones in cities
3. Introducing incentives for private investment in electrification of car traffic in city-suburban relation.

The slowdown in the development of the internal RES market also resulted in a reduction of R & D activity in the field of e-mobility. In Poland, we have an efficient system of starting sectoral R & D programs. Therefore, despite being underdeveloped in some areas, it is possible to join the leaders if we correctly define the technological specialization that we can support through the intermediation of these sectoral programs. Polish specialization can be, for example, electric car software.

4.1.1.3. Polish WBG companies on e-mobility

- **APTIV:** car management center of the future. (https://aptivkrakow.pl)
- **SOLSUM sp. z o.o.:** installation of electric car charging stations. (https://solsum.pl)
- **MEDCOM:** manufacture of chargers, inverters and energy storage.(http://medcom.com.pl)
- **Greenway Polska:** assembly and operation of vehicle chargers (https://greenwaypolska.pl)
- **RELPOL S.A.:** manufacturer of car chargers. (https://www.relpol.pl/)

4.1.2. Barriers

4.1.2.1. Policies & regulations

The entire energy policy and resulting regulations arise under the dictation of the coal and fuel lobby. The purpose of the regulation and policy supporting the development of e-mobility is to reduce oil imports, increase the demand for electricity and increase the innovativeness of the automotive industry. The official calculation model supporting decarbonisation has not been developed, so the development of e-mobility is not logically connected with low-emission policy and the policy of increasing energy efficiency. Regulations enabling the development of renewable energy have a minimalistic form and their task is to meet formal EU regulations in this area. Support for increasing energy efficiency is also limited by the interest of the mentioned lobby. Removal of these barriers will only be possible in the face of a significant electricity deficit in the system. It should be expected that current support regulations for electric motoring may be suspended at the moment of crisis.

4.1.2.2. Implication barriers (e.g. infrastructure)

Poland has lagged behind other European countries when it comes to use of electric vehicles charging infrastructure. Only 324 public points were available in the country in 2016. Same year out of 1.45 million vehicles imported into the country, just 556 were electric.

Poland is one of a few European countries that still don't have an incentive scheme to encourage to buy EV although the government is working on it and we may see it come into life in the near future.

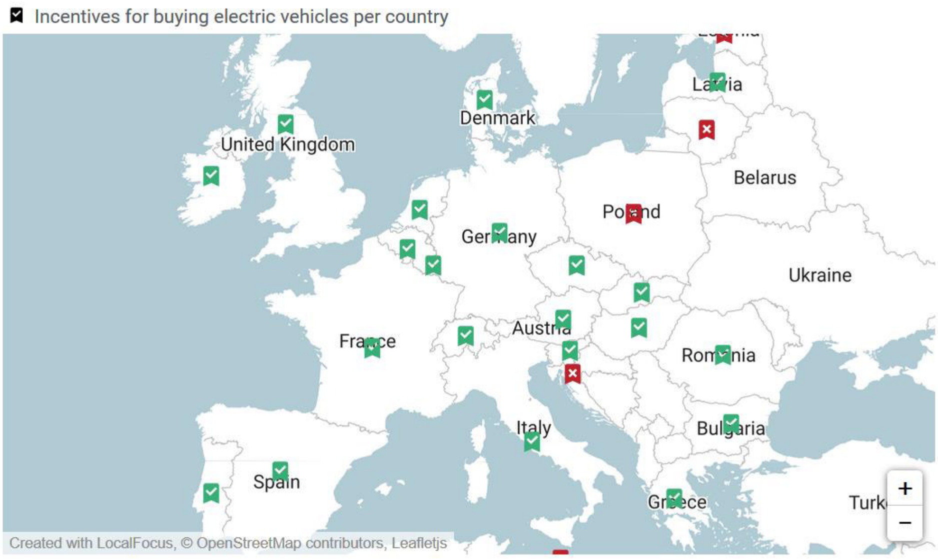

Figure 6: Incentives for buying electric vehicles in European countries
Source: acea.b

4.1.2.3. Energy efficiency

Considering the fact that electric vehicles will be loaded with electricity generated from coal, the influence of e-mobility on the increase of energy efficiency measured by the efficiency of fossil fuel energy in road transportation - will be small. The main mechanism of improving energy efficiency will be better use of current energy units. Measuring the energy efficiency of the Polish energy sector with the emission level (around 650g / kWh), it can be assumed that it will be lower because it will force an increase in the amount of RES in the system. Assuming that an electric car consumes approx. 0.28 kWh / km, it means that a market will be created for approximately 3 TWh from RES.

4.1.2.4. Noise emission

Electric cars are much quieter than the internal ones, so the noise level in cities will decrease. The noise level in large cities is at the level of 75 dB, while in small towns it is at a level of a few dB less. Their main source is motorization. The basic source of noise from an electric car is the noise of tires. There is no measurement data to determine the extent to which the transition to the electric motorization will reduce noise in the city. Assuming that this noise will be reduced in the same proportions as the noise generated by a car into its electrical equivalent, we can expect a reduction in the average noise level in the city by up to 6 dB.

4.2. Renewable energy (PL)

4.2.1. Drivers

4.2.1.1. Policies & regulations

The total amount of electricity generated from renewable energy sources (RES) confirmed by certificates of origin amounted to 15,28 TWh in 2017 compared to 20.17 TWh a year earlier, according to the data of the Energy Regulatory Office (URE).

In installations using wind energy, 11.18 TWh of energy was generated, in hydroelectric installations 0.58 TWh, in installations using biogas 0.79 TWh, in biomass installations 2.14 TWh, in co-firing installations for biomass, bioliquids, biogas or agricultural biogas with other fuels 0.72 TWh, while in photovoltaic installations 0.06 TWh.

Rodzaj instalacji OZE	Ilość [MWh] Okres wytwarzania energii elektrycznej					
	2012 r.	2013 r.	2014 r.	2015 r.	2016 r.*	2017 r.*
(1)	(9)	(10)	(11)	(12)	(13)	(14)
Instalacje wykorzystujące biogaz	530 524,345	665 143,194	803 435,552	875 773,032	1 001 422,954	792 820,012
Instalacje wykorzystujące biomasę	2 208 508,115	3 921 142,685	4 619 577,891	4 729 573,315	4 617 788,102	2 136 742,654
Instalacje wykorzystujące energię promieniowania słonecznego	1 177,532	1 418,771	4 514,874	43 180,678	81 771,422	58 468,649
Instalacje wykorzystujące energię wiatru	4 612 893,792	6 078 433,878	7 640 802,091	10 706 934,242	12 491 320,697	11 180 002,607
Instalacje wykorzystujące hydroenergię	2 031 724,612	2 439 460,373	2 181 373,529	1 829 456,571	779 416,120	583 431,557
Instalacje wykorzystujące technologię współspalania biomasy, biopłynów, biogazu lub biogazu rolniczego z innymi paliwami	6 961 549,734	3 785 104,165	4 462 167,696	4 260 440,561	1 194 468,274	723 764,167
Łącznie	**16 346 378,130**	**16 890 703,066**	**19 711 871,633**	**22 445 358,399**	**20 166 187,569**	**15 475 229,646**

Table 4: Types of OZE installations (PL)

Source: Energy Regulatory Office (https://www.ure.gov.pl/en/)

The notion of renewable energy sources (**"**Renewable Energy Sources Act 2015 (**RES**)**"**) is gaining a clear recognition within Poland's energy and environmental policies. Reforms introduced by the **RES** which came into force *1 July 2016* marked a significant step forward, however, subsequent amendments illustrated how the Polish government is in a difficult position of striking a balance between developing RES for energy diversification and rescuing its coal industry (around 80% of Polish coals mines are unprofitable). Poland has also severely limited growth in wind generation by passing a bill, signed on 22 June 2016 aimed at restricting wind power development. The law makes it illegal to build turbines within 2km of other buildings or forests, which rules out 99 % of land. In addition, the bill significantly raises the rate of tax payable on existing turbines, making them unprofitable.

Another amendment to the renewable law made in June 2016, installations over 0.5MW that produce renewable energy will no longer receive guaranteed financial payments in exchange for their generation as of January 2018. Instead they need to turn to auction based incentive scheme. Under this system financial sources available within the incentive scheme are collected from energy consumers by DSOs and TSO (Res payers) and then shifted by public company (Zarządca Rozliczeń) to RES operators that won the auctions. Installations below 0,5MW will need to go through so called "obliged suppliers".

In August 2017, Polish government voted an amendment later signed by the President to the Act on renewable energy sources. The amendment eliminates the fixed rate of the so-called alternative fee. Instead, it will be linked with the market price of energy origin certificates for specified RES, i.e. the so-called green and blue certificates. The sector believes that the new regulation will cause bankruptcy of the private wind farms sector and will benefit large energy companies, which will be able to fulfil their RES requirements but not via direct contracts with green energy sellers, but via, e.g. paying the alternative fee, which will be significantly lower.

RES acts includes also some incentives for microinstallations (not exceeding 40 KW). It provides a general feed in tariff under which obliged suppliers purchase electricity from microinstallations at average electricity market price of previous quarter as announced by the President of Regulator office.

Latest legislation update: Poland's upper house of parliament approved an amendment to the country's renewable energy law on Friday (29 June 2018) meant to remove obstacles to green energy investment and help Warsaw meet EU targets.

Recent changes in the government:

There has been a recent reshuffling of the governmental ministries as well as deeper changes in the competencies of the ministries that would be of interest to Power Electronics in Poland.

Minister of energy Krzysztof Tchórzewski kept his position. Jadwiga Emilewicz has become the minister of entrepreneurship and technology. Ministry of Digitalization has been closed.

Jerzy Kwieciński has become the minister of investments and development. Minister of infrastructure and construction Andrzej Adamczyk remained the minister of infrastructure – without construction.

This means that changes in public administration can be expected, more importantly we clearly see yet no clear division of competences within the government. These changes are very important for energy (including renewables) and environment sector.

The main drivers of development of renewable energy in Poland are:

- Switch to (low-carbon) environmental policy
- Further availability of EU funds (subsidies) for innovation investments. In December 2017 European Union has approved Poland's 9.4 billion euro plan for developing renewable energy sources, the EU's
- Rapid development of technology (technological breakthrough) in generation technology and control of power systems
- Rapid evolution of technology in the field of renewable energy sources and power engineering electronics for renewable energy sources
- Making the Polish economy independent of fossil fuel imports
- striving to optimise the use and diversification of energy sources in other, especially European, countries
- Increase in the level of foreign investment and multiplication of links with the global market
- Progressive harmonisation of regulations related to the power technology and industry in Europe
- Diversifying production in the manufacturing industry associated with electronics (extension beyond the currently dominant TV sets)
- European and global trend concerning increasing the role of renewable energy sources
- Elimination of legal barriers concerning the energy market, increase in the demand for prosumer systems
- High cost of power generation, state subsidies in Poland amounting to 50 %
- Steady increase in energy demand of the economy and individual users in Poland and abroad

- In December 2017 European Union has approved Poland's 9.4 billion euro ($11 billion) plan for developing renewable energy sources, the EU's
- The PPPEM (Porozumienie Polskiego Przemysłu Energetyki Morskiej) has gathered 40 entities, including the Polish Offshore Wind Energy Society (PTME), that see the development of offshore energy investments, especially offshore wind energy, as an opportunity for creating an innovative, competitive and powerful Polish industry, according to FNEZ. As part of the PPPEM, FNEZ has created and launched a programme called Baltic Energy for Poland 2025, aiming to advance Poland on its path to utilising its untapped offshore wind potential.

4.2.1.2. Recommendation on stimulation policies

From a point of view of energy and climate policy, more pressure of realizing postulates from Mateusz Morawiecki's plan (Strategy of Responsible Development) should be expected. Ambitions of the Clean Air program may be hindered by the ministry of energy. The nuclear program does not have its main opponent within the government.

The current level of support for renewable energy is the result of the game of interests, in which the coal lobby has a significant advantage. Blocking changes in this area is supported by an anti-innovative culture of shaping economic policy and all programs supporting R & D.

Large opportunities for improving the situation result from the energy needs of the economy and the falling costs of electricity from photovoltaics. Therefore, the policy of stimulating RES development can be particularly effective in the prosumer segment and will not generate significant costs. Significant opportunities to improve the situation are in the change in the way the prosumer is accounted for the energy given to the grid.

Currently, a prosumer providing 1 kWh of electricity during high demand hours can only receive 0.8 kWh in low demand hours. Switching to a multi-tariff system would increase interest in investments in microinstallations and heat pumps for heating real estate. It would also allow to limit daily fluctuations in demand in the household segment.

4.2.1.3. Polish WBG companies on renewable energy

- **X-Disc:** Manufacturer of PV modules (standard and flexible) and modules for BIPV systems (photovoltaic systems integrated with the building). Production capacity: 65MW / year). (http://www.xdisc-panele.pl)
- **SOLSUM sp. z o.o.:** design and installation of photovoltaic installations / energy storage facilities (https://solsum.pl/ Solar power plants
- **SELFA GE S.A.:** manufacturer of PV modules. (http://www.selfa-pv.com)
- **EASYSOLAR:** design and installation of photovoltaic installations. (http://easysolar.pl)
- **HANPLAST Sp.zo.o.:** manufacturer of PV modules (http://www.hanplast.com/fotowoltaika)

4.2.2. Barriers

4.2.2.1. Policies & regulations

The Polish power system is underperforming and Poland faces the risk of disturbances in the operation of the power system, but the remedial measures are not future oriented. Public consultations up to date and the information released during the work on the energy policy, energy legislation, RES, and the act on energy efficiency lead to the conclusion that we are still making decisions based on past information, we are solving ad hoc problems of the present and fail to mention in the public debate any macroeconomic consequences of these actions in a time horizon exceeding 10 years. Although we are aware that energy investments have a time horizon of 30–40 years, we still adopt regulations that do not go beyond a few years.

In Poland, there is practically no horizontal analysis dedicated to elementary technical problems that determine the development of industry and infrastructure. For this reason, the legislative process takes place without any information whether in a given area innovation can be stimulated by adopting certain standards on the form of regulations, or if there any grounds to allow a competition between standards. Adopting standards as national norms, by means of regulations, happens rarely even if it was advisable for the sake of macroeconomic interest or security reasons. The defective intervention usually results from the Public Procurement Law, which favours the cheapest offers, i.e solutions which are typically mature, so by definition obsolete. It is a consequence of the common belief that the system of public procurement should guarantee the lowest price and not the best price. The public sector abandoned the rule of reason which fares very well in the private sector that always checks if 'cheaper' in reality won't turn out to be 'more expensive'

Power production in Poland is still based on traditional energy sources like coal and lignite and only a small percentage of energy is generated by hydroelectric plants, mostly located on rivers. Renewable energy is only beginning to be used on a major scale, with wind farm projects being implemented by municipalities, as well as developers. In recent years the consciousness of the environmental harms caused by conventional power has grown in Poland and the membership in the European Union has created an additional impulse giving rise to the restructuring of the Polish energy sector.

The track record of implementing new legal regulations suggests that the support for innovation on the legislative level by means of exercising influence is introduced with reluctance and mainly takes place due to the pressure of the responsibilities of an EU member state. The practice of drafting and implementing regulations defining interoperability standards and framework – which should be used to boost digitisation and technological development without directly spending taxpayers' money – looks even worse. Such an intervention is by definition more cost efficient.

4.2.2.2. Implication barriers (e.g. infrastructure)

- Focus on nuclear power as a solution to the Polish energy problems and reliance on foreign technologies
- There is a need for establishing energy clusters. Still regulations proposed by the government are not favorable and do not allow the development of business models.
- Limiting the use of renewable energy sources and energy storage systems, resulting from legal regulations
- Monopoly / oligopoly in the area of power supply, characterised by the major players' preference for closed solutions, which hampers access to the market to new entrants and including alternative sources of energy
- Strong system mechanisms lengthening the list of research priorities, preventing the concentration of resources allocated to innovation in a manner consistent with the National Research Programme
- Competition with foreign innovation centres with an established market position
- Low rate and less efficient system of implementation of European regulations concerning the power sector in Poland
- Different approaches to new technologies in the Government. For instance, Ministry of Development wants to develop electromobility and construct intelligent energy networks, while Ministry of Energy wants to remain with the current energy production system

4.2.2.3. Energy efficiency

The current energy policy is not conducive to a raise in the energy efficiency of the economy by increasing the level of electricity production from RES. However, it should be expected that the situation will improve. The driving forces are rapidly falling costs of solar installations. The Polish consumer is very active and sensitive to the economic impact, an example of which is the number of cars adapted to use LPG. Poland is the European leader in this field. We can expect the same type of activity on the photovoltaic microgrids market.

4.2.2.4. Noise emission

Noise was one of the media arguments used in the campaign to limit the development of wind energy in Poland. However, this should be treated as an excuse in propaganda campaign financed by the coal lobby, not a real problem. With the dissemination of knowledge that electricity from wind is cheaper than coal, there will be growing social pressure to eliminate current restrictions.

4.3. Smart houses (PL)

4.3.1. Drivers

4.3.1.1. Policies & regulations

The following legislations shape the uptake of smart housing: Act on energy efficiency, environmental protection policies, construction law, telecommunications law, act on development of telecommunications services and networks.

The main drivers for development of Smart Houses in Poland are:

- Poland’s energy market regulator has approved a new anti-smog tariff to encourage households to switch to electric heating from coal or oil-fuelled heaters as part of a wider attempt to improve air quality.
- Technical development of software and hardware used in advanced networks will accelerate in the coming years. Now we can observe favorable conditions for development in the areas of robotics and intelligent machines Their adoption requires universal wireless access to broadband wireless networks able to serve all main markets including energy market. For this purpose, (RAN 5G) network will be needed and will use wide bandgap power electronics operating at high frequencies. The base stations that will be built may be counted in hundreds of thousands in whole Europe. These will allow to exchange the date serving distributed energy, e-mobility and many others. New business models will appear as the network is established. EU has the plans to build such network between 2020 and 2025 and will cover all major European roads and cities. This will be a perfect opportunity for manufacturing companies as well as for these that develop power semiconductors.
- Positive impact of closer cooperation between the heat pump industry and the automation industry together with market for other sources of energy (wind, sun). To manage this there is a need of network and standards that will allow effective communication at households’ level.
- Companies in Poland see opportunities for development of power electronics in Poland mainly due to (in longer term) construction of new RAN 5G networks, rapid change of existing regulations for RES and development of standardization. Electromobility is also an important point, and the Ministry of Development is involved in the works on e-mobility market in Poland (including buses). This will cause of the widespread network of charging and storage of energy which should develop the market of automation and power engineering. In Poland there is a discussion on energy clusters, but the plans of the Ministry of Energy in this area are not yet clearly defined.

- High demand resulting from the development of new power grids will result in the demand for semi-conductor products that could be manufactured in Poland.
- Gallium nitride and power electronics companies became active in Poland.

4.3.1.2. Recommendation on stimulation policies

In Poland, we are coming to an end with the implementation of simple projects to improve energy efficiency, such as, for example, building insulation. National Fund for Environmental Protection and Water Management has significant funds for the implementation of subsequent programs. One of them should be the program funding for devices and software implementation for automation of energy, water and ventilation management. The investment support program should be supplemented with marketing support serving to stimulate demand for smart building systems. Dissemination of knowledge about savings that can be obtained by automating the control of home appliances and improving their energy efficiency - effective tools to stimulate business and civic activity in this area. This support is necessary for installation and project design companies.

4.3.1.3. Polish WBG companies on smart housing

- **FIBARO:** solutions in the field of building automation.(https://www.fibaro.com/pl)
- **SOLSUM sp. z o.o.:** manufacturer of heat pumps for home use. (https://solsum.pl/ Pompy ciepła)
- **Fabryka Energii sp. z o.o**.: assembly of heat pumps, fans, PV panels. (http://www.fabrykaenergii.com)
- **Keemple Polska:** design and installation of smart home systems. (https://keemple.com/pl)
- **APA Sp. z o.o**.: design and installation of smart home systems. (http://apagroup.pl)

4.3.2. Barriers

4.3.2.1. Policies & regulations

Customers' willingness to install devices and software for energy management in a building depends on the expected economic effects. With the current tariff system there is no justification for this type of investment. Poland is one of the few EU countries in which the ESCO services market does not exist. That is why we recommend introducing a system of dynamic tariffs and regulations allowing for the construction of ESCO business models.

4.3.2.2. Implication barriers (e.g. infrastructure)

The main implementation barriers for the market uptake of smart housing are:

- Anti-innovation procurement policy gives a competitive advantage to solutions based on well-proven technologies.
- A large share of energy-intensive companies applying old technologies present in the group of companies controlled by the Treasury
- Low domestic demand for products related to power specialisation (lack of investment in SMEs, farms and households)
- There is a lack of law on technical specifications. Currently devices (like energy meters) are regulated by more than one act. There is no common regulation to define communication between meters. Meter is regulated one hand by energy law and on the other hand by measurement law. There is no common understanding which law should be applied. Therefore, there is a need of new digital generation of the devices to be regulated by special dedicated law. There is also a need to become a part of the pan-European standardization process.
- There is a need for freeing up electricity tariffs. KIGEiT and launch so called Tariff K. Introducing such tariffs will increase interest in microgrids.

- Entrepreneurs demand mandatory integrated infrastructure development. Network and nods should be available for anyone who wish to connect any element to the network. There is no such obligation. Introducing this law may speed up development of power electronics sector
- Building law – deployment of base stations for the purpose of new advanced network – there should be a simplified regulation regarding obtaining the permits like new rules for fiber optic lines and infrastructure sharing.
- There is lack of procedures to handle the security of an extensive IT network. In the future, new procedures will need to be developed for the security of collected information.

4.3.2.3. Energy efficiency

In the design of electrical power equipment, there are still large opportunities for improving energy efficiency. It can be raised by design changes and the use of a more advanced bases elements (including WBG). In a significant part of the cases, the current efficiency can be increased by up to 20%. Margins are also in control of the operation of these devices. Companies supplying HVAC device control systems are increasingly using cognitive software (using artificial intelligence). This allows to build usage profiles, forecasts, automatically provide information about the building usage plans and combine this information with detailed weather forecasts. In many cases, the savings in the building's operating costs reach 30%. The main source is the systematic increase of the energy efficiency of the facility.

4.3.2.4. Noise emission

Air heat pumps, air conditioning and ventilation can be an important source of noise. Raising structural and installation competences and skilful control of intelligent building software significantly reduce the negative effects of the operation of the mentioned devices.

4.4. Poland. List of literature

Długookresowa Strategia Rozwoju Kraju Polska 2030 – Trzecia fala nowoczesności (Long-term National Development Strategy Poland 2030 - Third wave of modernity)

PROGRAMME FOR THE DIGITAL DEVELOPMENT of Infrastructure and Industry

Strategia Rozwoju Kraju 2020 (The National Development Strategy 2020)

Strategia Bezpieczeństwo Energetyczne i Środowisko 2020 (Strategy: Energy Security and the Environment 2020)

Strategia Rozwoju Transportu 2020 (Transport Development Strategy 2020)

Strategia zrównoważonego rozwoju wsi, rolnictwa i rybactwa na lata 2012–2020 (The strategy for sustainable rural development, agriculture and fisheries for the years 2012-2020)

Prawo energetyczne (Energy law)

Ustawa o EE (The Law on Energy Efficiency)

Ustawa o OZE (RES act)

Rozporządzenie Ministra Gospodarki z dnia 4 maja 2007 r. w sprawie szczegółowych warunków funkcjonowania systemu elektroenergetycznego (Regulation of the Minister of Economy from May 4th 2007 on detailed conditions for the operation of the power system)

Prawo budowlane (construction law)

„Megaustawa" (ustawa z dnia 7 maja 2010 r. o wspieraniu rozwoju usług i sieci (MegaAct from May 7th 2010 regarding support of the development of telecommunications networks and services)

Rozporządzenie budynkowe (Regulations for buildings)

Strategia na rzecz Odpowiedzialnego Rozwoju (Strategy for Responsible Development)

Pakiet na rzecz czystego transportu (The package for clean transport)

Adam, D.J., 1984. Stakeholder analysis. 2nd ed. Oxford:Oxford University Press.

Adam, D.J., 2003. Stakeholder analysis today. Royal Journal of Management///, 42(7), pp.34-66.

Polska 2030 – Wyzwania rozwojowe (Poland 2030 - Challenges for Development)

GUS: Office of Statistics: Energia ze źródeł odnawialnych w 2017 r. (Energy from Renewable Sources 2017), Warsaw, 2017

Paiz - Legal framework for renewable energy projects in Poland

http://www.renewableenergyfocus.com/view/44664/reforming-poland-s-renewable-industry/

The Polish Wind Energy Association The State of Wind Energy in Poland in 2016

5. Lithuania

Last update: 2018-10-02

Lithuania	E-mobility	Renewable energy	Smart houses
Drivers	- Expanding infrastructure	- Energy independence	- Nearly zero-energy buildings
Barriers	- High prices	- Bureaucratic barriers	- No significant barriers
Energy efficiency	- N/A	- Annual savings	- Class A++ buildings
Noise emission	- N/A	- Wind power plants	- N/A

Table 5: Summary Lithuania

5.1. E-mobility (LT)

5.1.1. Drivers

5.1.1.1. Policies & regulations

Lithuania's charging infrastructure is still expanding - currently there are over 50 electric vehicle charging stations in highways, cities and towns. In the year 2018, the charging stations are planned to be installed on main roads every 50 kilometers. By the year 2022, 28 public high-capacity electric vehicle charging stations are planned to be installed on state roads.

Despite of the fact that the e-mobility infrastructure is still at the early stages, the number of electric cars is steadily increasing — by the 1st of June, 2018 there were 780 registered electric cars and more than 10000 hybrid cars, compared to about 340 electric and 3500 hybrid cars by the end of the year 2016. The Ministry of Transport and Communications has set a goal to increase the number of sold electric cars per year to 5% by the year 2020, and to 10% by the year 2025, by focusing on the infrastructure development in cities and The Trans-European Transport Network (TENT-T) roads.

To increase the development of e-mobility in the country, the government made a possibility for electric vehicles in some cities to drive in bus and taxi traffic lanes. The users of electric vehicles are also permitted to park their vehicles for free in municipal parking lots in all major cities. Electric vehicles are allowed to be charged for free at public charging stations, for both fast and standard charging stations.

5.1.1.2. Recommendation on stimulation policies

It is recommended for the incentives to be raised to introduce VAT reliefs for electric and hybrid cars (5% reduced VAT rate for electric cars and 9% rate for hybrid cars).

5.1.1.3. Lithuanian companies working on the extension of the charging infrastructure

UAB "Elinta Charge", UAB "Energy Solutions Centre", UAB "ABB", UAB "Renerga" and other Lithuanian e-mobility companies are working on the extension of the charging infrastructure. UAB "Elinta Charge" reaches about 70% of the Lithuanian electric vehicle charging stations market.

5.1.2. Barriers

5.1.2.1. Policies & regulations

Lithuania does not offer any part of the price compensation or tax relief for purchasing an electric vehicle or installing its charging stations at home. The VAT relief for electric cars is still not well received by the government, although the problem has been raised more than once. Unrestricted public access is only valid at some stations, while different station owners apply different charging rules.

5.1.2.2. Implication barriers (e.g. infrastructure)

The main barrier for e-mobility implementation is that the prices of electric cars in Lithuania are still higher than diesel and gasoline-powered cars. The number of electric vehicle charging stations is also not high enough, and unrestricted public access is only valid at some stations, while different station owners apply different charging rules.

5.1.2.3. Energy efficiency

Not specific Lithuanian issues related to energy efficiency.

5.1.2.4. Noise emission

No specific Lithuanian issues related to noise emission

5.2. Renewable energy (LT)

5.2.1. Drivers

5.2.1.1. Policies & regulations

NATIONAL STRATEGY FOR ENERGY INDEPENDENCE.

This strategy states energy policies and actions to ensure Lithuania's energy independence by 2020, by strengthening Lithuania's energy security and competitiveness.

5.2.1.2. Lithuanian energy sector until 2020

The strategy provides essential tasks and solutions for, among other fields, renewable energy increase, environmental protection and greenhouse gas reduction areas.

- In the electrical energy sector the main attention is focused towards the implementation of strategic projects and decisions that will have a crucial impact to achieve Lithuania's energy independence. This ensures competitive local electricity production capacity.
- Increasing the scale of electricity production from renewable energy resources.
- The main task in the heating sector is to increase energy efficiency in heat production, distribution and consumption while at the same time shifting from mainly gas-based production towards biomass. The state will support initiatives aimed at increasing the heat consumption efficiency, utilization of waste energy potential and the use of biomass. The target of the deacrease of households' and public buildings' heating consumption for the year 2020 is 30-40%.
- In the natural gas sector, Lithuania will strive in the long run to decrease gas consumption by replacing it with renewable energy sources, while ensuring gas supply alternatives in the short run.
- In the oil sector, the goal is to change the oil products to renewable energy sources and increase competition in the Lithuanian market.

Lithuania's National strategy for energy independence also sets out general guidelines for the development of Lithuania's energy sector until 2030 and 2050. By 2030 Lithuania seeks to have a competitive and environmentally-friendly energy sector, with most of the energy produced from renewable energy sources and nuclear energy, and by 2050 Lithuania plans to be independent from imports of fossil fuel and produce its energy only from nuclear energy and renewable energy sources.

5.2.1.3. Lithuanian energy security

It presents the problems of Lithuanian energy security, energy security research methods and methodology, the application of which enables the determination of Lithuanian energy security level. The research is of interdisciplinary character – energy security problems integrate the aspects of energy, economics, politics and sociology. Five energy sector development scenarios were analysed when researching the level of energy security in Lithuania. The basic scenario lasting up to 2017 was considered the main. It included the most important development projects in the Lithuanian energy sector (the liquefied natural gas (LNG) terminal, electricity connections with Sweden "NordBalt" and Poland "LitPol Link" and the development of renewable energy sources), but no more projects are developing. It is in further plans to gradually (up to 2025) close the old units of the Lithuanian nuclear power plant (LPP). Other development scenarios focus on renewable energy source power plants, cogeneration power plants, regional nuclear power plant in Visaginas and the newly constructed units of the combined cycle. In the renewable energy scenario, the capacities of renewable energy sources are rapidly increasing from 2018 and by 2025 achieve a twice higher level than it was predicted. Renewable energy sources are subsidised up to 2025. The Lithuanian energy sector development scenarios based on the dominant electricity import or only on the renewable energy sources would ensure lower energy security in the longterm perspective in comparison with alternative scenarios according to which basic electricity generation is implemented in the newly built units of combined cycle or in the new NPP (a new nuclear power plant).

5.2.1.4. Lithuanian market drivers

Lithuania has undertaken, according to Directive of the European Parliament and of the Council No 2009/28/EC on the promotion of the use of energy from renewable sources, to increase the renewable energy sources (RES) share in the final national energy consumption up to 23% by 2020 and to increase the share of RES in all modes of transport up to at least 10% of the final consumption in the transport sector.

The Republic of Lithuania Law on Energy from Renewable Sources (Law on RES) contains sectoral objectives: to increase the share of electricity generated from RES up to at least 20% of the final national consumption, to increase the share of centrally supplied heat energy, produced from RES, up to at least 60 %, of the heat energy balance, and to increase the share of RES used in households up to at least 80 % of the total energy consumption balance.

According to the Law on RES, Lithuania currently use feed-in-tariff (FiT) system and auctions for wind and biogas energy producers. For fotovoltaic FiT system was used until 2012 but now is closed. Net metering system for prosumers was introduced, starting 2014.

The Republic of Lithuania Law on Electricity (Law on Electricity), where tehnical requirements for RES producers are described, plays an important role for RES regulation. Electricity equipment installation, operation and safety requirements in the electricity sector are established, the compliance with the requirements of electricity transportation reliability and service quality is also checked by The National Commission for Energy Control and Prices.

5.2.1.5. Recommendation on stimulation policies

Existing stimulation policies (FiT and net metering system) are sufficient to increase the RES share in the final national energy consumption.

5.2.1.6. Lithuanian companies that are important to drive the market for renewable energy

Below is the list of Lithuanian companies that are relevant in driving the market for renewable energy in LT:

Wind:

- UAB “4energia” – subsidiary of Estonias 4enegy SIA – 139MW
- UAB “Amberwind” – 74 MW,
- UAB “Silutes vejo parkai” – 60 MW,
- UAB “Renerga” – 58 MW,
- UAB “Pamario jegainiu energija” – 45 MW,
- UAB “Naujoji energija” – 45 MW

Total of 198 wind power stations with 530 MW are currently operational in LT.
State owned biggest energy producer and distributor AB “Lietuvos energija” started development of wind park with 60 MW.

Solar:

- Main developers: UAB “Modus energija” and AB “Lietuvos energija”.
- Installing companies: UAB “Solet technics”, UAB “Saules graza”, “I+D Energias Lietuva” - aSpanish company, which started activities in LT in 2017.
- PV modules producers: UAB “Solet Photovoltaics”, UAB “Solitek Cells” and UAB “Viasolis” with the capacity of 200 MW/year.

Hydro:

- Kaunas hydro power station – 100 MW power.

5.2.2. Barriers

5.2.2.1. Policies & regulations

Due to the abscence of a strong legal basis, there are a lot of excessive bureaucracy and poor financing mechanisms, where RES target needs to be met by Lithuania. The main obstacles in development of RES are bureaucratic barriers: for the final start of action of power station it is necessary to prepare 24 documents and it takes up to 6 months to fulfil all requirements even for small installations. These requirements come from the Law on Electricity and subordinate legislation prepared by local public grid operator. Net metering systems are allowed: for private consumers – up to 10 kW and for commercial and public entities – up to 100 kW. Total installation limit of net-metering for all country is 100 MW. Still there are no permissions to construct off shore wind farms even when the onshore sites are already completed. There is some support for RES market development using income from selling tradable green certificates, however system is very complicated and unstable therefore it loses its attractiveness.

5.2.2.2. Implication barriers (e.g. infrastructure)

Lithuania is facing three main implication barriers in the energy sector: security of energy supply, competitiveness of the energy sector and its sustainability. After closing Ignalina Nuclear Power Plant, electricity prices and demand increased, today most of Lithuania’s energy resources are imported from a very limited number of countries. Lithuania's energy independence strategy will ensure the freedom to choose the type of energy resources and their supply sources.

There are barriers of constructing wind farms in the southern part of the Klaipeda region. Although the region is very favourable in terms of wind currents, it borders with Russia’s Kaliningrad Region, and large wind farms make it very difficult for military radars to observe the NATO border. Therefore, the Lithuanian Ministry of National Defence is restricting the construction of new wind farms near the border with Russia. Also, the transmission grid is poorly developed in this region. In many cases, additional requirements for the investors due to the installation of long power transmission lines to the operating high voltage networks reduce the economic attractiveness of wind farms.

5.2.2.3. Energy efficiency

Considering the energy efficiency, the target is to achieve annual savings of 1.5 % of the total final energy consumption in the period through 2020, and in such way to contribute to the enhancement of Lithuania's energy independence, competitiveness and sustainable development.

By 2020 the use of RES will progressively be increased, to ensure that no less than 23 % of final energy consumption will consist of RES (no less than 20 % in the electricity sector, no less than 60 % in the central heating sector, no less than 10 % in the transport sector).

By the year 2020 the target for decrease in households' and public buildings' heating consumption is 30–40 %. Compared to 2011, it will allow to save annually as much as 2 to 3 TWh of heat.

5.2.2.4. Noise emission

The noise level of wind power plants in adjacent residential areas must comply with the noise limit values specified by the Minister of Health.

5.3. Smart houses (LT)

5.3.1. Drivers

5.3.1.1. Policies & regulations

Lithuania is working towards implementing the EU directive 2010/31/EU on the energy performance of buildings. In order to properly implement the requirements of the Directive, Lithuania has set a goal for newly constructed buildings or their parts to comply with the requirements for Nearly Zero-Energy Buildings (NZEB). Additionally, according to Law on Construction, newly built state and local authorities‘, institutions‘ and companies‘ buildings must comply with NZEB requirements, starting 2019.

5.3.1.2. Recommendation on stimulation policies

Existing stimulation policies are sufficient to meet the targets of the Directive on the energy performance of buildings.

5.3.1.3. Lithuanian WBG companies on smart housing

Not applicable.

5.3.2. Barriers

5.3.2.1. Policies & regulations

There are no barriers in existing policies and regulations to meet the implementing requirements for NZEB.

5.3.2.2. Implication barriers (e.g. infrastructure)

Existing infrastructure is allowing full achievement of set targets.

5.3.2.3. Energy efficiency

The EU Directive 2010/31/EU states the objectives to increase the energy efficiency of buildings. To implement these goals, Lithuania has set the requirements for newly constructed buildings in 2018 and 2021 under building energy efficiency classes:

- From 2018 new buildings or their parts shall comply with the requirements for class A+ buildings (for energy efficiency class A+ building, the costs of non-renewable energy for heating, cooling and lightning shall be from 2,67 to 4 times lower than that of class C buildings);
- From 2021 new buildings or their parts shall comply with the requirements for class A++ buildings (for energy efficiency class A++ building, the costs shall be more than 4 times lower).

5.3.2.4. Noise emission

No specific Lithuanian issues about noise emission to include.

5.4. Lithuania. List of literature

[1] Development of electric vehicle infrastructure (in Lithuanian) https://sumin.lrv.lt/lt/veiklos-sritys/kita-veikla/pletra-ir-inovacijos/elektromobiliu-infrastrukturos-pletra

[2] Number of electric vehicles in Lithuania (in Lithuanian) https://sumin.lrv.lt/lt/veiklos-sritys/kita-veikla/pletra-ir-inovacijos/elektromobiliu-skaicius-lietuvoje

[3] Reliefs for electric vehicles in Lithuania (in Lithuanian) http://www.100procentuelektrinis.lt/lengvatos-elektromobiliams/lengvatos-elektromobiliams-lietuvoje/

[4] Statistics for electric vehicle charging stations (in Lithuanian) http://elektrodegalines.lt/ikrovimo-stoteliu-statistika.html

[5] The Republic of Lithuania national strategy for energy independence (in Lithuanian) https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.429490 ; (in English) https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.432271?jfwid=-wbkgqsizz

[6] The Republic of Lithuania Law on Energy from Renewable Sources (in Lithuanian) https://www.e-tar.lt/portal/lt/legalAct/TAR.FC7AB69BE291 ; (in English) https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/648259603c3b11e68f278e2f1841c088?jfwid=rivwzvpvg

[7] The Republic of Lithuania Law on Electricity (in Lithuanian) https://www.e-tar.lt/portal/legalAct.html?documentId=TAR.F57794B7899F ; (In English) https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/6a2831f0b99d11e3bda4be6f16c2da2b?jfwid=rivwzvpvg

[8] https://enmin.lrv.lt/uploads/enmin/documents/files/Recommended%20Key%20Guidelines%20of%20the%20National%20Energy%20Strategy%20of%20Lithuania.pdf

[9] Directive of the European Parliament and of the Council No 2009/28/EC http://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX:32009L0028

[10] Lithuanian energy security annual review 2012-2013 (in Lithuanian) https://eltalpykla.vdu.lt/bitstream/handle/1/34326/ISSN2335-7037_2014.pdf?sequence=1&isAllowed=y ; (in English) https://eltalpykla.vdu.lt/bitstream/handle/1/34327/ISSN%202335-7045.pdf?sequence=1&isAllowed=y

[11] The Republic of Lithuania Law on Construction (in Lithuanian) https://www.e-tar.lt/portal/lt/legalAct/TAR.F31E79DEC55D; (in English) https://e-seimas.lrs.lt/portal/legalAct/lt/TAD/TAIS.312477?jfwid=q86m1vqmd

[12] National plan for increasing the number of nearly zero-energy buildings in Lithuania http://www.buildup.eu/sites/default/files/content/Lithuania%20Report%20EN.pdf

[6] Lithuanian energy security annual review 2012-2013 (in Lithuanian) https://el-talpykla.vdu.lt/bitstream/handle/1/34326/ISSN2335-7037_2014.pdf?sequence =1&isAllowed=y ; (in English) https://eltalpykla.vdu.lt/bitstream/handle/1/34327/ ISSN%202335-7045.pdf?sequence=1&isAllowed=y

[7] Development of electric vehicle infrastructure (in Lithuanian) https://sumin.lrv.lt/lt/veiklos-sritys/kita-veikla/pletra-ir-inovacijos/elektromobiliu-infrastrukturos-pletra

[8] Reliefs for electric vehicles in Lithuania (in Lithuanian) http://www.100procentuelektrinis.lt/ lengvatos-elektromobiliams/lengvatos-elektromobiliams-lietuvoje/

[9] Statistics for electric vehicle charging stations (in Lithuanian) http://elektrodegalines.lt/ ikrovimo-stoteliu-statistika.html

[10] National plan for increasing the number of nearly zero-energy buildings in Lithuania http://www.buildup.eu/sites/default/files/content/Lithuania%20Report%20EN.pdf

6. Sweden

Last update: 2018-10-03

Sweden	E-mobility	Renewable energy	Smart houses
Drivers	- Regulations and subsidies controlled by the Swedish Government and Agencies. - Increased awareness on environmental issues in general and the effect this has on company strategical decisions to keep the international competitiveness of their products		
	- The Swedish transport sector is expected to be the main driving force in the process of the green conversion	-	-
Barriers	- Short-term political decisions have damaged the environmental transicion during many years		
	-	- The existing systems for electricity production are based on hydroelectrical power and nuclear power	-
Energy efficiency	-	-	-
Noise emission	-	-	-

Table 6: Summary Sweden

The electricity market in Sweden both the wholesale and the retail electricity markets are deregulated and part of the Nord Pool power market, that also includes Norway, Finland, Denmark, Lithuania, Latvia and Estonia.

The Nord Pool provides day-ahead and intraday markets. Most of the trading occurs in the day-ahead market (Elspot), that provides prices changing hour by hour [1]. The wholesale prices can vary significantly from hour to hour depending on which power plants are available to deliver electricity. This means that the price is low when cheap electricity sources, such as hydro and nuclear, are enough to meet the demand, but can rise a lot when other sources are required [2].

The retail electricity market involves 130 retailers. There are different possible contracts available for the customers:

Fixed price

The most common contract periods are one, two or three years.

Variable price

Charged an electricity price that mirrors the developments on the Nordic power exchange Nord Pool Spot. There are two types of variable contract: rolling and fixed term. With a rolling contract, it is possible to exit with a period of notice. In a fixed-term contract, you have committed yourself to buy your electricity from the same supplier for the entire time you have the contract. It is also possible to sign for hourly pricing: the price follows the Nord Pool Spot hour by hour.

Mixed contract

A portion of the electricity is set at a variable price and another at a fixed price. Many electricity suppliers allow for transfer of the variable part of a mixed contract to a fixed price.

Designated contract

If no actively choice is made the distribution network operator will assign an electricity supplier. Then a designated contract is assigned, usually at a high price level. The variable price contract is the most common one [3]. The variety of available contracts and differences in the pricing policies between the different suppliers result in a great variation of the electricity price for the consumers. Four base factors contribute to the total electricity price: electricity, grid, green certificates and taxes.

6.1. E-mobility (SE)

The development towards a fossil-fuel independent vehicle fleet is Sweden has gone slowly for many years and had increased since 2014. Economic incentives contributed to new sales of cars with alternative fuels to businesses and governments.

A transition to alternative fuels is necessary to achieve the goal of a fossil fuel-independent vehicle fleet by 2030.

The goal is to develop a robust electrical system, with high delivery-reliability, low environmental impact and electricity at competitive prices. By 2040, electricity production to be 100 percent renewable and energy use to be 50 percent more effective than 2005 by 2030. The government's target is 100 percent renewable energy.

According to a from Transport Analysis [6], growth in the number of vehicles powered by alternative fuels has been low, despite a comprehensive package of policy instruments and incentives intended to boost their sales. This low growth is attributable to the sales of ethanol-powered vehicles having ended, even as sales of electric cars, electric hybrids, plug-in hybrids, and natural gas-powered vehicles were insufficient to offset the lost ethanol vehicles. (Source: Transport Analysis, www.trafa.se, [6])

The process of electrification of the vehicle fleet started to be more significant during the year 2014. By the end of 2018, Sweden is expected to have a total amount of 72.000 recheargable cars running. (Fig 7)

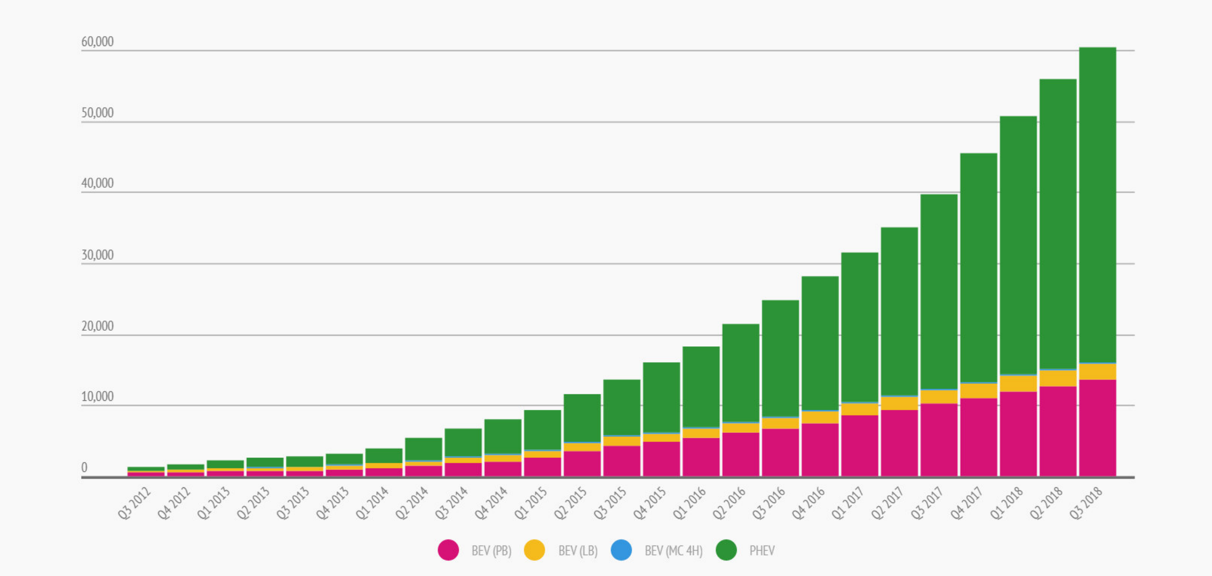

Figure 7: Rechargeable cars in Sweden 2012-2018.

BEV: Battery Electric Vehicle: PHEV: Plug-in Hybrid Electric Vehicle; PB: Personal car; LB: Light truck; MC: motorcycle; 4H: 4 wheels. Source: Power Circle, www.elbilsstatistik.se

6.1.1. Drivers

The transport sector is expected to be the main driving force in the process of electrification of the society. To begin with, the development of the infrastructure to charge vehicles is playing a very important role in the increase of electrical cars in Sweden.

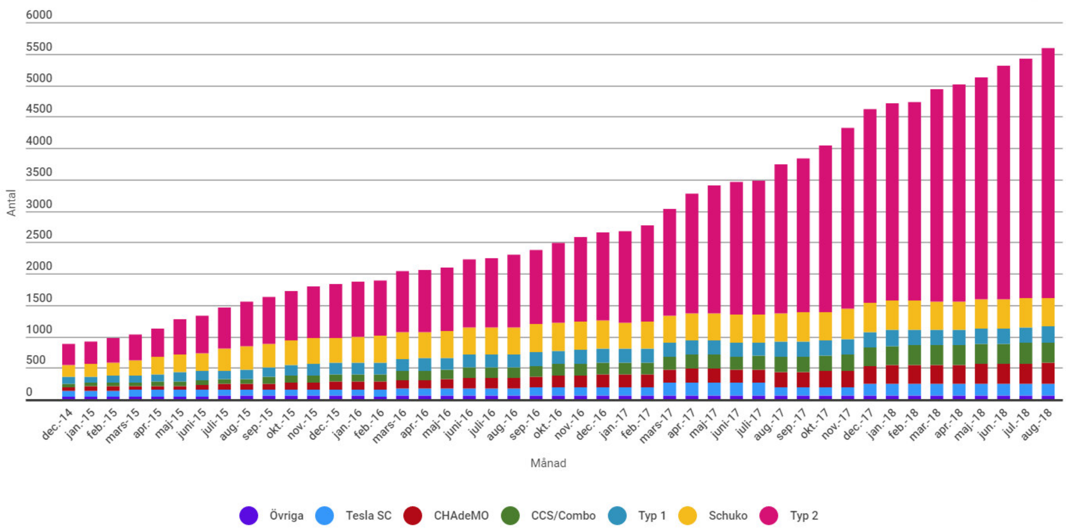

Figure 8: Charging stations in Sweden 2015-2018.

Source: Power Circle, www.elbilsstatistik.se

6.1.1.1. Policies & regulations

A “Bonus-Malus” system is ruling since 1 July 2018.

Eco-friendly vehicles with low emissions of carbon dioxide, receive a bonus at the moment of purchase, while the vehicles with high emissions of carbon dioxide will have higher taxes for the first three years (malus). The transport sector accounts for a third of the emissions in Sweden. The government has recently submitted a proposal to parliament that transport emissions will be cut by 70 percent by 2030, compared with 2010. The purpose with the bonus-malus system is to increase the proportion of environmentally friendly vehicles and contribute to achieve the goal of achieving a fossil free fleet. The vehicles which are affected by the new system are new cars, light trucks and light buses.

The following rules apply:

- The maximum bonus amount of 60 000 SEK is given to cars that emit zero grams of carbon dioxide. The minimum bonus of 10000 SEK is given to cars that emit no more than 60 grams of carbon dioxide per km. Gas cars get a fixed bonus 10000 SEK. Max bonus is 25 % of the price of the new car.
- For petrol and diesel light vehicles a heavily elevated vehicle tax (malus) during the first three years is applied. For vehicles that run on ethanol or gas no malus is charged.

The former ‘Supermiljöbilspremie’ (Super green-car rebate), of a level of 40 000 SEK for all Electric vehicles was replaced by Bonus Malus 1st of July 2018.

Charging Infrastructure

As from 1 February 2018 as a private person, you can now apply for a contribution from the Swedish Environmental Protection Agency to install a charging station for electric car or hybrid car in connection with your private property.

You are allowed 50% support of the cost of both equipment and installation of the charging station, up to a maximum of 10 kSEK of the total cost.

Support for installation of charging infrastructure is still provided by the Swedish Energy Agency and the Environmental Protection Agency, for all types of organizations, companies, municipalities, foundations and associations housing associations. Support for the charging stations must be no more than 50 percent of the investment cost.

Electrical buses

The Swedish Energy Agency is commissioned by the government to pay a premium for electric buses. The investment covers SEK 100 million per year until 2023.

Electric buses entitled to the electric bus premium are buses powered entirely by electricity, where charging from the mains can take place at the garage, at the loading area at the end of the journey or during travel.

More than 50 percent of Swedish public transport is conducted by bus and there are about 14,000 buses in commercial traffic on the Swedish roads.

Since 2016, regional public transport authorities and municipalities have been able to apply for a premium for the purchase of electrically powered buses. On 21 December 2017, the regulation was amended on a number of points, which means that more players can now apply for the premium.

Public transport companies by bus can also search the electric bus premium. The traffic can either be conducted in contracted traffic, commercial bus traffic or in order traffic.

In the previous regulation, only regional public transport authorities and certain municipalities could apply for the electricity bus premium.

The size of the electric bus premium is calculated on the additional cost of the bus instead of the size. The premium now accounts for 20 percent of the bus's purchase price, but up to 100 percent of the price difference between the bus and the nearest comparable diesel bus.

This means that if an electric bus costs SEK 6 million, the prize amounts to SEK 1.2 million. If the comparable bus with an internal combustion engine costs SEK 5 million, the premium is limited to SEK 1 million.

In the previous regulation the size of the premiere was based on the size of the bus, ie the bigger the bus the bigger the contribution.

The application for electric bus premium can be made before the buses are ordered. This means that the applicant knows if they are granted the electrical bus premium in advance.

Even smaller buses from 15 passengers and upwards are entitled. Fuel cell buses are also eligible.

Who can search the elbus premium?

The Elbus premium is addressed to the regional public transport authorities, to municipalities with which the regional public transport authorities have given power to conclude public service contracts and to public transport undertakings.

How much support is allowed?

Since an electric bus is more expensive to acquire compared to an internal combustion engine, the electric bus premium will cover some of the electric busloads. The Elbus Premium may not be combined with other forms of government grants for the acquisition of electric buses.

The premium size is 20 percent of the bus's purchase price, but a maximum of one million kronor per bus. Charging hybrider receives half premium and other electric buses earn a whole premium.

Electrical bicycles

From 1 February 2018 you can apply for grants from the Swedish Environmental Protection Agency when purchasing an electric bicycle, electric moped or electric motorbike. The purpose of the contribution is that more people will be able to replace the car with a more environmentally friendly means of transport, thus contributing to reduced emissions, less congestion and less noise. The grant does not include segway, electric scooter or hoverboard. Electric moped or electric motorcycle must have a so-called CoC, which is a type of vehicle certificate. Electric bicycle must be CE marked or conform to SS-EN 15194 Bicycles - Electric Assisted Bikes - EPAC. The contribution can amount to a maximum of 25 % of the cost, or a maximum of 10,000 kronor.

6.1.1.2. Recommendation on stimulation policies

6.1.1.3. Swedish WBG companies on e-mobility

- Bombardier Transportation Sweden AB
- Inmotion Technologies AB
- Scania AB
- CEVT (China Euro Vechicle Technology) AB
- Micropower AB
- Powerbox AB

6.1.2. Barriers

The costs of electrical vehicles and a somehow delayed start in the development of the charging infrastructure delays the market development.

6.1.2.1. Policies & regulations

There is a general need of long-term policies and regulations related to sustainability to ensure consumers the safety of their investments.

A clear example is the lack of agreement amont the political blocks related to the introduction or mantainance of support policies for e-mobility and increased taxations and fees for fossil fuel driven vehicles that will have a mayor impact in the e-mobility market.

6.1.2.2. Implication barriers (e.g. infrastructure)

Despite of the fact that the infrastructure is being developed there is still some time to go to acchieve a fossil-free car fleet.

6.1.3. Energy efficiency

There is a need of coordination in the use of energy to improve the energy efficiency of the charging infrastructure.

6.1.4. Noise emission

No specific Swedish issues related to noise emission are influencing the market uptake of e-mobility solutions.

6.2. Renewable energy (SE)

The Swedish government has, during the last years, stated the goal of Sweden becoming fossil-free 2045 and not have any net greenhouse gas emissions to the atmosphere.

The decision shows the understanding of the need of a clearer framework for the work and a long-term and stable climate policy. A new climate policy framework was created consisting of new climate targets, a climate law and a climate policy council to evaluate policy. The framework has been decided by the Parliament with broad support.

It was decided to provide support for companies, municipalities, regions and organizations totaling 1.5 billion kronor this year and 2 billion next year.

Source: https://www.regeringen.se/artiklar/2018/04/sverige-ska-bli-ett-fossilfritt-valfardsland/

6.2.1. Drivers

6.2.1.1. Policies & regulations

Photovoltaic (PV) support

In Sweden, there are several photovoltaic (PV) support policies in existence [4]. Currently these are:

Investment grant:

Since 2009 the Swedish government introduced subsidies for PV installations, in the form of partial refund for the installation cost. As the installation cost of PV panels has been decreasing every year, the government also decreases the grants.
As from 2018 the level is raised from 20% to 30% of the total PV investment. And 915 MSEK has also been added to the total budget of funding of the subsidies.

"ROT" (= repair and maintenance, remodelling and extension) grant:

ROT can be used for the work-part of the PV installation. The level is currently at 30% of the cost.
The Investment grant and the ROT cannot be combined and in reality, the most favorable subsidy used by small-scale installation is the Investment grant. However, the slow process, about 2 years, to get the approval and the uncertainty if the amount of the total governmental approved funding would cover all applications lead to application for both the Investment Grant

and the ROT. The ROT is given instantly at the installation but must be repaid in case of approval of investment grant.

Green certificates.

Since 2003 every electricity generator must have a minimum number of green certificates. Green certificates are gained by producing renewable electricity: one certificate is given per MWh of renewable electricity produced. They can also be bought and sold in a deregulated market [5]. Green certificates are approved for about 30 % of the new installed PV systems in Sweden. Green certificates will become an increasing part of future installations.

Guarantees of origin

These are documents that state the origin of the electricity. Since 2010 each electricity producer receives a guarantee per MWh of electricity produced. The guarantees can be sold and bought in the same way as the green certificates. The customers can then choose their electricity source. Applying for guarantees of origin is not compulsory, but voluntary. Their contribution to PV support is currently negligible.

Tax-credit.

Since 2015 it is possible for prosumers (electricity producers and consumers at the same time) to apply for tax-credit. The prosumer receives a tax reduction of 0.6 SEK per kWh electricity fed into the grid. The tax-credit is given for an amount of kWh that is lower or equal to the amount of kWh bought, anyway no more than 30000 kWh. This represent a maximum of 18 000 SEK of tax-credit per person and year. The tax-credit system will be evaluated by the government when it has been in operation at least two years.

Exemption from VAT accounting

Since 1 January 2017 there is an exemption from VAT accounting for business turnovers up to 30 kSEK/year. This is applicable for most micro-producers of PV electricity.

No entry fees

Network companies cannot charge for entry subscription or replacement of electricity meters for the photovoltaic systems which has a max power of 43.5 kW and the microproducer is a net consumer on annual basis. The subscription itself is required to enter the limited use of the power grid

Subsidies for Storage installations, such as battery

Since 1 January 2017 it is possible to receive 60 % subsidy for the installation of energy storage systems such as batteries in private homes as part of a PV installation. Maximum of the subsidy per installation is 50 000 SEK.
Up until end of December 2017 an amount of 28,1 MSEK has been provided by the Swedish Energy Agency.

Other benefits

Another strong element influencing the market and driving the installation of PV systems is the compensation for the surplus electricity produced by the PV micro-producer and sold to electricity retailer. An electricity retailer will buy at either a fixed price or at a price following the hourly rates on the spot market.

There is also compensation for the “network benefit”.

The electricity network company does reimburse the micro-producer for the benefit of the surplus production creates in the grid. The network benefit represents the reduced costs for the transmission of electricity which the network company have.

Most electricity, in Sweden, is produced in the North of the country and consumed in the South. This implies significant transmission losses. Residential PV systems produce electricity in the same area where the electricity is consumed. Therefore, the transmission losses from PV energy are lower. The PV micro-producer grid compensation is between 0.02 and 0.07 SEK per kWh fed into the grid.

Comments

The return of investment (ROI) 2018 for PV micro-producer installations are in the order of less than 10 years.

The subsidy for battery installation does not create an attractive ROI for the micro-producer since the electricity retailer today is offering a price level for surplus electricity which is in balance with the consumer price today. Hence there is no incentive for local energy storage such as battery.

Wind Power

There is only one form of subsidy of wind power in Sweden, i.e. the Green certificates.

Green certificates are gained by producing renewable electricity: one certificate is given per MWh of renewable electricity produced. They can also be bought and sold in a deregulated market [5]. Green certificates are approved for about most of the installed Wind Power. systems in Sweden.

There are a number of steps in getting g approval from Swedish Authorities to build Wind turbines. There are many laws that take into account before and during the construction of wind turbines.

Some laws, however, are more central, as the environmental code (MB) and the planning and building Act (PBA). But the regulatory review or consultation may be required even under other legislation. If for example, antiquities may be altered or damaged, it requires permission from the County Administrative Board in accordance with the cultural heritage Act, and to build electric High-Power lines requires authorization under the electricity Act.

The decision raised under various statutes vary, depending on the individual case: wind power plant's design, location and sometimes the municipality's willingness to design the current area.

6.2.1.2. Recommendation on stimulation policies

No recommendations included

6.2.1.3. Swedish WBG companies on renewable energy

In the south of Sweden, in the small village Simris, **E.ON** has invested in a electrical production plant based on renewable energy, wind and solar power, with a shared energy storage network to demonstrate the viability and sustainability of a local energy system. (https://www.eon.se/om-e-on/innovation/lokala-energisystem.html)

The project is supported by the EU innovation project Horizon2020 and their InterFlex programme. The project has cost approximately 35 million SEK, whereof E.ON has funded 50 percent.

The production of electricity in the local energy system is one hundred percent renewable. It comes from three different types of production sources – wind, solar cells and a backup power generator powered by renewable fuel. Most of the electricity production in the local energy system usually comes from a wind turbine but solar power plays an important role in the energy systems. Since both sun and wind are intermittent energy sources, there is a need for support in the form of adjustable electricity production. A backup power generator is installed to provide this when the energy system is in “island mode”. When the local energy system is not in operation, the central grid will supply the electricity that is not produced locally.

The backup power generator runs on HVO (Hydrogenated Vegetable Oil) Diesel 100, a renewable diesel fuel. HVO Diesel 100 uses 100 % renewable material – more specifically, slaughterhouse waste.

Other Swedish companies working in the field of WBG-based renewable energy solutions are:

- ABB AB
- EK Power Solutions AB
- GE Power Sweden AB

6.2.2. Barriers

6.2.2.1. Policies & regulations

6.2.2.2. Implication barriers (e.g. infrastructure)

The most significant barrier for introduction of investment and introduction of renewable energy in Sweden is the fact that the installed systems for electricity production today are based on hydroelectrical power and nuclear power, about 90 % of the total.

The price of electrical power is relatively low due to overcapacity. As a result, there is hardly any investment in new power generation at present, neither renewable nor nuclear.

The political agreement 2016 to remove the capacity tax on nuclear power by 2018 and to greatly reduce property tax on hydropower by 2020 does further reduce the incentives for investments in renewable energy.

Further recently a decision has been taken to allow for six, of the existing ten, nuclear power plants to remain in operation for a lifetime of 50 years which means in reality beyond 2040.

Barriers for the implementation of WBG-based solutions to green applications are basically originated in the novelty of the new WBG materials. Even when the new materials are proved to have the capability to enable more energy efficient power systems, it is difficult for companies to commit to the integration of these new materials before there was time enough to prove their long-term reliability.

6.2.2.3. Energy efficiency

No specific issues about energy efficiency are included at this point.

6.2.2.4. Noise emission

No ‘noise emission’ issues are relevant.

6.3. Sweden. List of literature

[1] Nord Pool, http://www.nordpoolspot.com, 2016.

[2] Lion Hirth. Reasons for the drop of Swedish wholesale electricity prices, 2010-15, 2016.

[3] Energimarkadinspectionen (Swedish energy market inspectorate), http://ei.se, 2015.

[4] Johan Lindahl, National survey report of PV power applications in Sweden, 2014, Ångström Solar Center, Uppsala University, Uppsala, 2015.

[5] Swedish Energy Agency and NVE. The Norwegian-Swedish electricity certificate market: Annual report 2013, 2014.

[6] Transport Analysis, ‘Summary report 2016_11 A car fleet independent of fossil fuels – development and policy instruments’

7. Denmark

Last update: 2018-09-13

Denmark	E-mobility	Renewable energy	Smart houses
Drivers	- Well-developed charging infrastructure - Normalisation of the tax exemption compared to conventional cars - The sales of electrical cars have fallen - The government is considering changing the legislation - Special parking with charging	- Danish energy system - Establishment of new offshore wind turbines, subsidy scheme for the utilization of RE in process energy in the industry, etc. - The green transition in Denmark	- Tax exemptions or grants based on the energy savings - Minimum standards for building new houses - Energy consumption in buildings - Integrated energy design
Barriers	- Removing the subsidies for the registration fee - The sales of electrical vehicles have fallen - Quick charge of a battery - The production price remains very high - The lithium used in lithium batteries	- At least 50% of Denmark's energy demand by RE in 2030 and becoming a "low-emission society" by 2050 - Implication barriers (e.g. infrastructure)	- Varmeplan Danmark - Building guide - Politically decided to launch a series of initiatives that make it easy to get qualified advice on energy conversion and energy savings
Energy efficiency	- Costs per 50ilometer are lower compared to conventional cars - Storing excess electricity generated - Return electricity to the grid in the hours	- Increasing energy efficiency - Innovation Fund Denmark - Lowering of energy consumption at end user level	- Energy renovation - New build - Energy framework and component requirements - Recycled building materials
Noise emission	- Reduction of traffic noise with significant socioeconomic gains - Considered whether to be equipped with artificial	- Offshore and "nearshore" - Wind turbines, onshore wind turbines	- No sense in talking – in broad terms – about the noise emissions for smart houses

Table 7: Summary Denmark

7.1. E-mobility (DK)

7.1.1. Drivers

7.1.1.1. Policies & regulations

Denmark has a well-developed charging infrastructure (figure 7) for electrical vehicles due to several foreign providers (e-on and Betterplace) and national ones (Clever), who decided to use Denmark as test bed for e-mobility due to 1) a high level of penetration of renewable energy sources (RES) and 2) a stable energy supply.

Electrical cars were exempt for registration fees until December 2015, when the government decided to, at first, abolish the exemption completely, but at the end, this was changed to a gradual normalisation of the tax exemption compared to conventional cars. The normalisation of taxes is going to be faced in gradually until 2020. Because of this legislation, the sales of electrical cars have fallen drastically, since the introduction of the normalisation (1). Presently, the government is considering changing the legislation since the impact has been higher than anticipated. Right now, the industry for electric cars in Denmark craves after political action, as the sale of electric cars has almost ceased.

Concerning road and weight taxes on electrical vehicles, there is an incentive for buying them nonetheless. The tax is calculated based on CO_2 emissions, which gives the electrical vehicles the upper hand in relation to conventional cars [2] [3].

In the larger Danish cities, electrical cars have special parking (and charging) opportunities, which gives better and cheaper parking in the cities. This makes the driving of electrical cars more convenient. Furthermore, there are several car sharing services like Drive Now (access to 400 BMW i3 in Copenhagen that is part of the public transportation system) and local initiatives like Tadaa, which is providing electrical car sharing to members of select housing associations [16] [17].

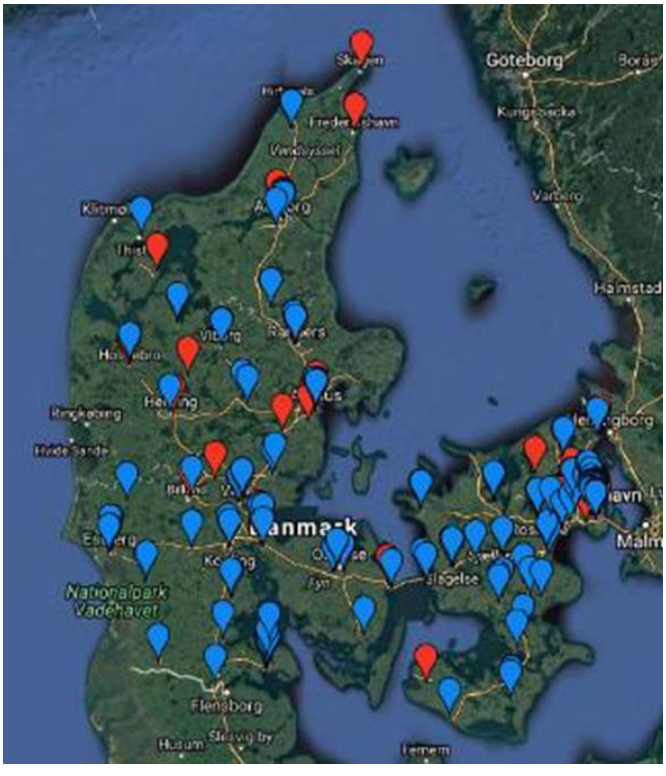

Figure 9: Overview over charging stations in Denmark.

The red is operated by Eon and the blue is operated by Clever.

Source: www.elbilerne.dk

7.1.1.2. Recommendation on stimulation policies

Initiated according to the Danish Energy Agency [20]:

- In 2014, 23.5 million DKK were distributed to 4 major strategic partnerships. This causes about 1400-1500 new electric cars and doubles the electric cars in Denmark
- An electric-based city sharing-car project with 400 electric cars in Copenhagen was launched
- The Capital Region, companies and municipalities launch more than 500 electric cars. A purchasing agreement – procurement - is established for all municipalities
- In the triangle, Dansk Elbil Alliance collaborates with municipalities, companies and organizations to increase the number of electric cars with almost 100
- Avis Danmark A / S, Clever A / S and Nissan Nordic A / S offer public institutions, companies and private attractive, targeted and flexible leasing of 400 electric cars with ssociated charging infrastructure

The Danish Parliament requires the government to present concrete proposals on how a number of measures to divert the transport sector's energy can help reduce traffic CO2 emissions. Below is a sample of possible actions taken from the unpublished report of 2015 from the Ministry of Transport, "Roadmap for Phasing out Fossil Fuel" [17]:

- Extension of tax exemptions for new technologies
- Extension of partnerships for electric cars
- Strong energy requirements and requirements for purchasing more energy efficient cars in the public sector
- Reduced driving charges for new technologies
- Exemption for payment for parking (new technologies), ie. exemption from payment of parking for cars with the new climate and environmentally friendly technologies
- Grants for strengthening the grid

<u>Electric car versus diesel car</u>

If a drive had been driven in a Mitsubishi i-MiEV, consumption would have been 7.35 x 0.12 kWh = 0.882 kWh. Since one liter of diesel fuel contains 10.4 kWh, the energy consumption of the electric car is equivalent to 86.6 km/litre against the 25 km/litre of the diesel car. In short, an electric car's energy efficiency is 3-4 times better than the best diesel car (see below):

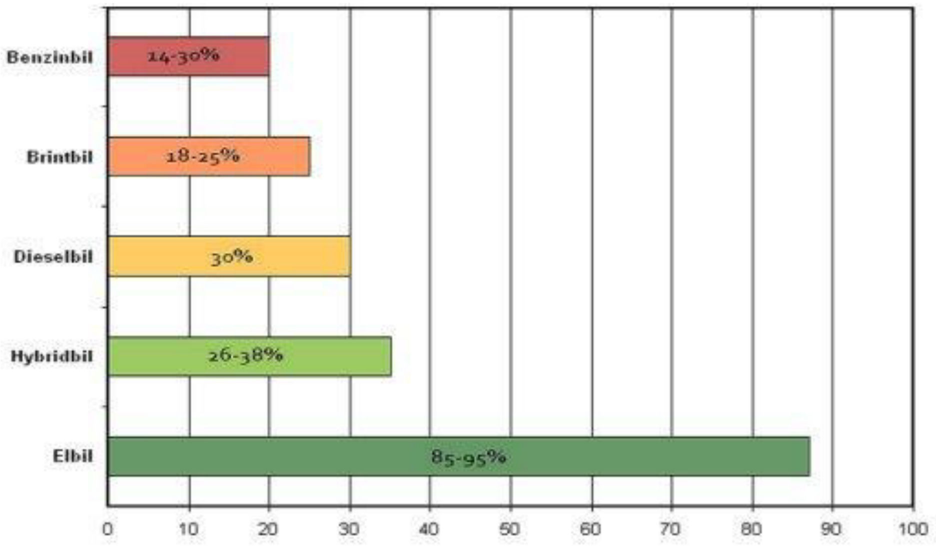

Figure 10: Efficiency of different car types
Source: http://www.danskelbilkomite.dk/Elbil_energi.htm

7.1.1.3. Danish WBG companies on e-mobility

Please find below a list of companies working with e-mobility, either in the manufacture / delivery of components or the development of different types of electric vehicles:

- CLEVER
- EWII Mobility
- Fenris Motorcycles
- Nissens ApS
- Mate.bike International IVS
- Banke Electromotive ApS
- SERENERGY A/S
- LYNX ApS
- ZENVO AUTOMOTIVE A/S
- WOLTURNUS A/S
- Flux A/S
- Nihola bikes
- Ballard Europe
- Lithium Balance
- Wattsup power
- Himex

7.1.2. Barriers

7.1.2.1. Policies & regulations

Denmark has a high level of charging infrastructure already in place for electric vehicles. At the moment, there is more than 600 charging stations covering most of Denmark. This is a driver since it creates the necessary level of convenience for consumers. Nonetheless the new legislation concerning removing the subsidies for the registration fee and facing it out until 2020 has already hit the market severely. After being put in place the sales of electrical vehicles have fallen significantly and in January of 2017, there was only 5 new cars registered [15]. Until this barrier is overcome with new legislation, it does not bode well for the Danish E-mobility sector. The market for electrical car sharing services seems to be growing though [16] [17].

7.1.2.2. Implication barriers (e.g. infrastructure)

Challenges and barriers of electric vehicles [19]:

Range: The range of electric vehicles depends largely on the type and size. Most electric cars available on the market today have a range of less than 170 km. To achieve greater reach, the battery will be disproportionately heavy. A range of less than 200 km imposes several restrictions on the use of electric cars: long distance driving and certain types of occupational use of the vehicle.

Long charging time: A full charge of the electric cars currently available on the market typically takes place in the area of 4-8 hours. However, charging time depends on several conditions; battery type, battery maximum capacity, and current used. It is technically possible to make a so-called quick charge of a battery, where the battery is charged for half an hour. However, such charging may result in increased battery wear out. It requires infrastructure to handle very high current levels.

Price: The production price for electric cars remains very high compared to regular cars. This is since several components for electric cars differ from normal cars and therefore are not mass produced today. Electric car batteries today represent a significant cost. The price of a battery system for a normal electric family car will be in the region of 67,000-120,000 DKK.

Environmental impact from battery production: There are significant local environmental impacts associated with extraction of the lithium used in lithium batteries. It is also discussed whether there are sufficient lithium resources to cover a significantly increased use of lithium in electric car batteries.

Battery safety: There have been problems with lithium-ion batteries for electronic devices where the batteries were overheating and, in some cases, erupted in fire or exploded. However, there are no reports of similar problems with the lithium-ion battery systems used for electric cars.

Heating and cooling of the cabin: An electric car also requires energy from the battery or other propellants on board for heating and cooling the cabin. If the battery is used to produce heat or cooling, the capacity of the battery is reduced, and if fossil fuels are used, this results in CO2 emissions. In addition, it may be necessary to isolate the cabin to hold the heat / cold. This leads to higher production costs of the electric car.

7.1.2.3. Energy efficiency

Due to the high energy efficiency and low energy consumption, operating costs per kilometre are lower in an electric car compared to conventional cars. The more simple engine technology, transmission line and environmental equipment, where for example. do not have to change the engine oil, filter and spark plugs, and in the absence of coupling, transmission, exhaust, catalyst, etc. also contributes to lower operating costs.

Electric vehicles have great potential to support the existing power system by storing excess electricity generated by wind turbines at night and other times of the day, when electricity demand is low. Work on the electric car batteries could eventually return electricity to the grid in the hours, when there is a large electricity need.

The figure below shows the expected energy efficiency of different fuels in 2020 (Source of Energy Agency) [21]:

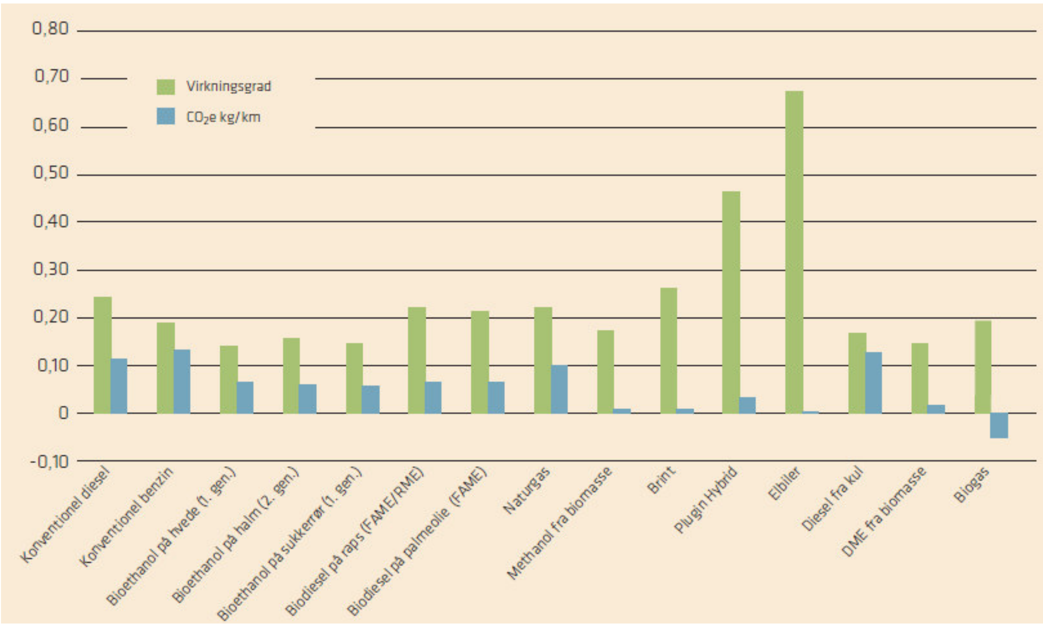

Figure 11: Expected energy efficiency of different fuels in 2020

Source: Energy Agency [21] The graph shows with green the efficiency and in blue the different fuels in CO_2 kg/km

As can be seen, there is a very high utilization of the energy of an electric car that far exceeds other car types. Where in an electric vehicle utilizes approximately 70% of the energy on the battery for propulsion, about 75% of the energy is lost in a modern diesel car i.e. well over half of the energy is not for propulsion, but is lost as heat. Even after 2020 there will be an opportunity to streamline combustion engines, they will always have significantly lower efficiency than electric motors.

7.1.2.4. Noise emission

In comparison with ordinary cars, electric cars do not cause much noise. A switch from normal cars to electric cars will lead to a significant reduction of traffic noise with significant socioeconomic gains. Road noise from gasoline and diesel cars causes over 95% of noise in major cities in Denmark.

Motors for electric cars hardly make any noise at all. This means that the noise in cities, where speed is often of 20-40 km / h with many start / stop, causing the engine noise to dominate, will be more than halved, if all vehicles were electrically driven. The reason that the potential for noise reductions is not even greater is that a large part of the road noise is caused by lorries and buses that are still assumed to run with combustion engines. If the bus operation is switched to electric or gas operation, and the trucks are replaced by electric or gas-powered cars, the potential for noise reductions will be even greater.

Electric cars are so quiet in the urban environment that it is now being considered, whether to be equipped with artificial sound to increase the safety of vulnerable road users. This may, however, reduce noise advantage of electric cars.

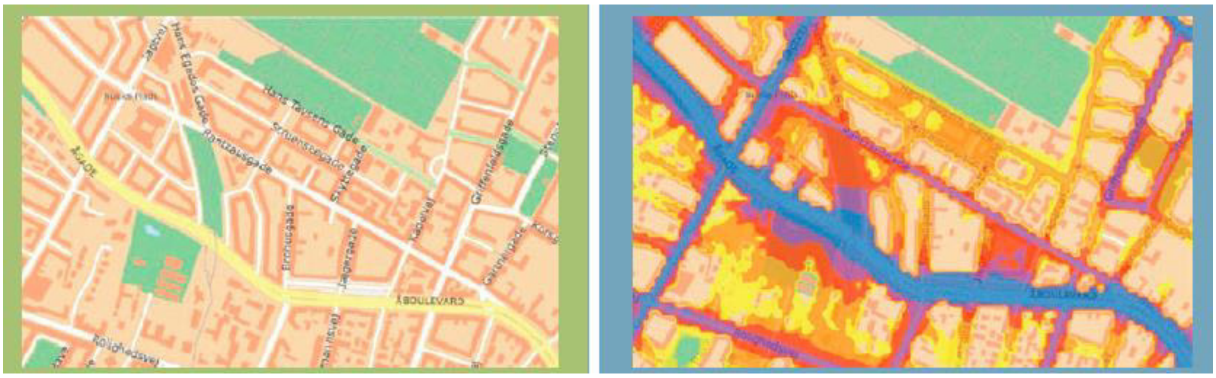

Figure 12: Some central streets in Copenhagen without noise (left) and with noise (right)

Source: Danish Environmental Protection Agency

Noise signatures to the image:

- 59 - 59 db
- 60 - 64 db
- 65 - 69 db
- 70 - 74 db
- Over 75 db

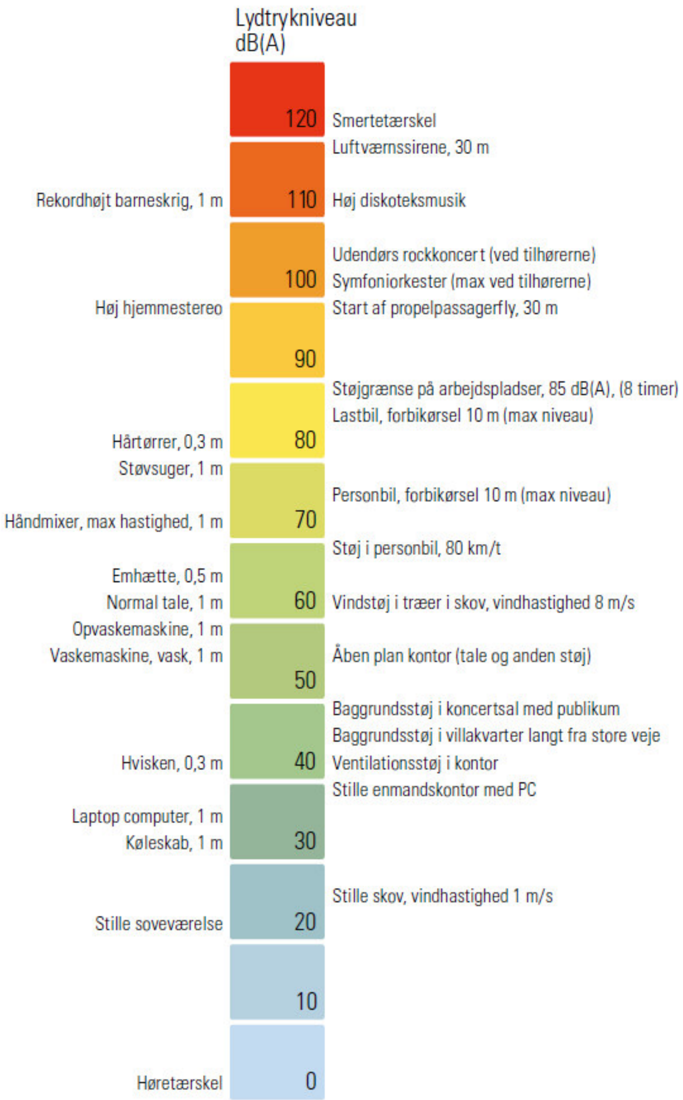

Figure 13: Noise from everyday activities

Source: www.delta.dk

7.2. Renewable energy (DK)

Denmark has historically been a pioneer in the transformation of the energy system include foresighted building regulations, energy companies' energy savings obligations, cogeneration plants and a large extent of district heating, which currently cover more than 60% of all Danish households. This is due to a fundamental belief that the green change is a means of future-proofing Danish society by creating a green economy in growth.

7.2.1. Drivers

In the energy policy initiative 'Our Energy' from 2011, the former government proposed a number of initiatives for the realization of a 100% conversion of the Danish energy system. The proposal on energy centers on four areas; 1) renewable energy (RE), 2) energy efficiency, 3) electrification and 4) research, development and demonstration.

The focus areas should drive the green change through 4 energy policy milestones:

- 2020: Half of traditional electricity consumption is covered by wind
- 2030: Coal should be phased out from Danish power stations and oil furnaces phased out
- 2035: Electricity and heat supply covered by RE
- 2050: Full power supply, incl. transport, covered by RE.

The proposal on energy were in 2012 materialized in the energy agreement until 2020, in which a number of initiatives were launched, including with the establishment of new offshore wind turbines, subsidy scheme for the utilization of RE in process energy in the industry, etc.
The green transition in Denmark is in full swing. For example, the production of electricity from wind turbines is high. Wind turbines delivered power equivalent to 43.6 percent of Denmark's electricity consumption in 2017. This is a new milestone in the effort to transition the energy supply system in the country to be carbon neutral. 2017 ended in a stormy December and the year totalled an output of about 14,700 GWh derived from data from Energinet.dk. Thus, 2017 became a new record year for wind in Denmark. There was a dip in 2016, but the trend is clear once again:

Figure 14: Wind turbines delivered power equivalent from 2005 to 2017
Image credit: Dansk Energi

7.2.1.1. Policies & regulations

Denmark has been actively working towards transforming its national energy system for decades. The energy system started out as being honed towards exploiting fossil energy resources and thereby being relatively simple. Over the last decades, the energy system has been developing towards a system that can handle RE sources by exploiting the synergies between its different parts. Generally, it can be described as two phases:

Phase 1: Focusing on exploiting RE by focusing on efficient cogeneration of heat and power (CHP) combined with district heating. This was done in response to the 1973 oil crisis which created a need to adapt to a new reality. The penetration of in this phase was modest and did not prepare the energy system towards a reality of fluctuating energy production and consumption.

Phase 2: The second phase, happening today, we see RE technology play a larger role in the energy sector, where the system needs to adapt to significant fluctuations. The traditional power producers, small and large scale, are threatened by the growing share of RE since it reduces the spot market prices. This has resulted in the small-scale power CHP plants seek to shift their heat production to biomass boilers or solar collectors and that owners of large scale plants seek to sell these. This is considered an important driver for RE in Denmark.

The Danish Energy Sector has had a long tradition for a holistic approach to the integration of renewables. National schemes and policies have actively supported the goal of being completely independent from fossil fuels by the year 2050 [10].

7.2.1.2. Recommendation on stimulation policies

To understand the market for the uptake power electronics in Denmark, it is important to look at the key figures. The Region of Southern Denmark has energy efficient technologies as one out of three focus areas in their smart specialization strategy. The Region of Southern Denmark recently (2016) conducted an analysis on how this market is in Denmark and specifically in the region. The analysis is based on the following categories:

1. Energy efficient products
2. Energy efficiency in buildings
3. Energy efficient components
4. Energy efficient machinery
5. Consultancy
6. Energy efficiency in energy systems
7. (other – as in companies that does not fit into one single category)

7.2.1.3. Danish WBG companies on renewable energy

A national roadmap of companies within the business area of energy efficient technologies from 2016 for both Denmark as a hole and specially the Region of Southern Denmark shows:

- 1500 private companies in the Region of Southern Denmark (7800 companies in Denmark) working with energy efficient technologies
- 13.543 employed in the region of Southern Denmark. (46.400 employed in Denmark). The Region of Southern Denmark
- Revenue of 3 billion € in the Region of Southern Denmark. (Overall revenue of 10 billion € in Denmark)
- National export value of 4,5 billion € (5 % of the total export in Denmark)

Sector	Employment		Turnover (million €)		Number of companies Denmark
	Denmark	Region	Denmark	Region	
1. Energy efficient products	1165	656	284	195	381
2. Energy Efficiency in Buildings	19842	5089	3068	770	4508
3. Energy Efficient Components	1952	1044	338	176	296
4. Energy efficient machinery	7291	2655	1500	716	585
5. Advisory	4892	1403	662	189	930
6. Energy Systems	1923	819	311	96	352
7. Other	9335	1877	3972	817	713
Total	46400	13543	10135	2959	7765

Table 8: The market overview for energy efficient technologies in Denmark and specially in the Region of Southern Denmark

Source: [12]

As stated above there is a broad spectre of Danish companies working with energy efficient technologies and furthermore that a majority of these are working within power electronics. There are several funding schemes nationally that supports the development, test and large-scale demonstration of said technologies:

7.2.2. Barriers

The Agreement on the Danish Energy Policy 2012-2020 is a short-term tool for creating the future energy system based on renewables, but it cannot stand alone [5]. There is a need for creating long term plan for Danish energy system as suggested in IDA's Energy Vision for 2050 – more investment and a more holistic view on the future development [10].

7.2.2.1. Policies & regulations

Denmark's national targets include: meeting at least 50% of Denmark's energy demand by RE in 2030 and becoming a "low-emission society" by 2050. In addition, Denmark has two binding EU obligations [23]:

- Increase the share of RE in gross final energy consumption to 30% by 2020, from 16% in 2005. Denmark has already exceeded the target with RE accounting for 32.4% of the total in 2016. By 2020, the country is expected to reach 40% with existing measures.
- Reach the share of RE in land-based transport of at least 10% by 2020. The baseline projections suggest that, with existing measures, Denmark will fall short and reach around 8.4% by 2020.

While no further policies are needed to meet the 30% RE target in 2020, additional actions are required to meet the 10% target in the transport sector and the 50% RE target in 2030. Most RE support schemes will expire in the near future, and negotiations on new measures are taking place in 2017. Renewable energy – along with energy efficiency – is the key focus of the 2012 Energy Agreement, which includes the following targets, expectations, and measures:

- Construction of 1 378 MW of offshore and "nearshore" wind capacity; increasing net
- Onshore wind capacity by 500 MW despite decommissioning of old turbines
- Conversion of CHP plants and heat-only boilers from coal to biomass
- Increased use of biogas in CHP plants, industrial processes and transport, as well as increased injection of upgraded biogas into natural gas networks
- Subsidies to promote efficient use of RE and CHP in enterprises
- A ban on installing oil-fired and gas-fired boilers in new buildings from 2013 onwards, and on oil-fired boilers in existing buildings from 2016 onwards in areas with district heating or natural gas
- Information campaigns on support for converting oil-fired and gas-fired boilers in existing buildings to renewable alternatives (solar, heat pumps, etc.)

7.2.2.2. Implication barriers (e.g. infrastructure)

Denmark has a highly-integrated energy system that is slowly transforming into an infrastructure that can handle the fluctuating reality of renewable energy sources (RES). Almost a third of the Danish energy is produced by renewable sources and the grid will continually be developed with large investment. The biggest barriers for creating an energy system based on 100% RE is storage solutions in order to store especially the wind energy.

7.2.2.3. Energy efficiency

Denmark's National Energy Efficiency Action Plan of 2014 (NEEAP) [4] outlines the Development Guidelines for the Danish Energy Sector. Increasing energy efficiency has historically been a focus area of the Danish Government with a long-term goal of being fossil free in 2050. In March 2012, the Danish Parliament issued an energy agreement for 2012-2020 in which energy efficiency has a key role. It is stated that a society in which the goal is 100% reliance on RE, the need for energy efficient technologies are at the core of any development. The goals are to have a fall in energy consumption of almost 7% in 2020 which means a gross energy consumption reduction of 12% compared to 2006 [5].

The overall share of RE in 2012 rose with 5,4% compared to 2011. That is a tendency that will continue in the coming years. In 2012, the overall electricity production accounted for 43.1% of which wind contributed 29.8%. The consumption of renewable energies was 25,8% in 2012 and 29,2% in 2014. The reasons for this development I mainly due to the increased use of wind power, wood pellets, wood waste and forestry wood chips. Danish utilities are furthermore charged with the lowering of energy consumption at end user level (industry and private consumers). If they do not comply they get fined annually. All in all, the transformation of the energy sector is dependent on the uptake of Advanced Power Electronics in order to fulfil the goals of the Danish Government [5] [6].

The Energy Technology Development and Demonstration Programme

Since 2007, the EUDP has supported more than 600 RDD projects through funding of almost DKK 3 billion out of a total budget of almost DKK 6 billion. Of these projects, around 400 are ongoing and have been granted a total commitment of around DKK 2 billion. The focus areas of EUDP are Wind power, District Heating, Efficient use of energy, bioenergy, smart grids and system integration as well as oil and gas. The yearly budget within energy projects is 322 million DKK (43 million €) [13]

Innovation Fund Denmark

Innovation Fund Denmark focuses on results and solutions creating value to society. Innovation Fund Denmark wishes to facilitate cross-investments in knowledge institutions and companies – private as well as public. The investments should address tangible challenges and innovation needs of society and companies. The fund covers demonstration-, development- and research projects. The yearly budget within energy and environmental projects is 250 million DKK (34 million €) [14]

7.2.2.4. Noise emission

It is not possible to talk about noise emissions for all the various RE systems that are in operation in Denmark. Further it also depends on manufactures, etc. As mentioned above – just to mention some – there are systems in operation on, ex.: offshore and “nearshore” wind turbines, onshore wind turbines, CHP plants and heat-only boilers (ex. Run by biomass), biogas in CHP plants, industrial processes and excess heat projects into the district heating net, PV plants (both individual plants and larger installations), thermal solar heating plants (both in connection with district heating and individual systems), many heat pumps plants where the source might be from the ground, water, air, and etc.

7.3. Smart houses (DK)

There is an intense focus on energy efficiency in buildings in Denmark. Thereby there is a market for advanced power electronics. For matters of convenience it will be best to divide smart buildings into two different areas: 1) residential buildings and 2) industry.

1. Denmark has invested heavily in the energy efficiency of buildings in relation to subsidy programmes as well as setting high minimum standards for residential buildings. It is possible to get a subsidy for renovation of residential buildings based on the net energy saving in kWh. This contribution is part of the obligations of the utility companies to create a move towards energy efficiency at end user level [7]. It is also possible to receive a tax reduction on energy refurbishment (labour) [8].
2. Large Danish companies (following the EU definition) must report on their energy efficiency measures. This forces Danish industry companies to ensure that they have a reduction in energy consumption. The screening is followed up every 4th year [11]

7.3.1. Drivers

7.3.1.1. Policies & regulations

In Denmark, there are several incentives in place for smart buildings on refurbishment of buildings to be more energy efficient through tax exemptions or grants based on the energy savings. The minimum standards for building new houses are very strict as well ensuring that new buildings must comply to some of the highest standards in Europe on energy efficiency especially. Even though this is the case there is a behaviour barrier with at house owner level since energy refurbishment is often not prioritised compared to investing in a new kitchen or a new garage. The workforce in Denmark within building specialists is highly qualified and needs to obtain certain certifications to operate. This ensures a fair access to the market for new energy efficient technologies, but there is a need to speed up the process even more if Denmark should reach the energy efficiency goals of 2020.

7.3.1.2. Recommendation on stimulation policies

Energy consumption in buildings accounts for almost 40% of total energy consumption. The energy is primarily for heating, ventilation, cooling, operation and lighting. Efficiency of energy consumption in buildings plays a crucial role in achieving the political goal of being independent of fossil fuels by 2050, enabling Danish companies to engage in innovation cooperation so that the goals are achieved both in terms of the technical solutions already in the market, but also in relation to new solutions.

Thus, there is also a significant potential for energy efficiency, but also opportunities for interaction between energy supply and buildings in dealing with more fluctuating energy sources that characterize the energy supply of the future.

An analysis from Aalborg University (2016) shows that it is better to respond to reducing heat consumption in the building stock by 40% by 2050 compared with the corresponding renewable energy expansion. The reduction target of 40% corresponds to the fact that the heating consumption in buildings is to be reduced by 1% per year until 2050. The figure may change in both directions in relation to technological developments, but there is a great need to get set more focus on achieving the cost-effective energy savings that are in buildings.

Requirements for integrated energy design, i.e., where the natural passive properties of the building, which contribute to the creation of a good indoor climate and the integration of architecture, function and technology, should also be high on the agenda.

7.3.1.3. Danish WBG companies on smart houses

Please find a list below on Danish companies that work on smart homes:

- LeapCraft
- IoT Denmark
- Anyware.Solutions
- Danfoss
- Niko-Servodan
- LS control
- Greenwave systems
- NorthQ
- Velux
- Airmaster
- Flex-Control
- ShowerEcoguide
- Visility
- Betterhome ApS

- Panasonic
- Zzzero ApS

7.3.2. Barriers

7.3.2.1. Policies & regulations

In Denmark, several experts have pointed to areas that should include a new energy agreement in relation to energy efficiency in the existing building stock. These include:

- The heat consumption in buildings should be reduced by at least 40% by 2050
- Partial targets should be set for reductions in heat consumption by 2050
- A strategy should be prepared with an accompanying action plan for the energy conversion of existing buildings
- Requirements should be made for or concluded with municipalities and regions regarding the energy efficiency of their building stock
- Resources should be allocated to support the development of new business models targeted energy innovation.

In connection with the energy conversion of private housing, Varmeplan Danmark (prepared by Rambøll) has described that the distribution of net heat requirements for building categories is as follows: 64% in housing, 16% in manufacturing, construction and agriculture buildings, while the remaining 20% in trade and service. In other words, housing is one of the important segments to look at the potential of energy innovations in terms of heat. However, many homeowners lack insight into the possibilities and therefore find it difficult to get started with the necessary renovation. Therefore, it is politically decided to launch a series of initiatives that make it easy to get qualified advice on energy conversion and energy savings in private households. For example, the Danish Energy Agency has a 'consumer site' under the name: www.sparenergi.dk, where consumers can read about different initiatives in both saving energy and saving money. In addition, in Denmark, ex. a Knowledge Centre for Energy Savings in Buildings (VEB www.byggeriogenergi.dk). The purpose of the centre is to ensure greater dissemination of knowledge about energy-efficient solutions among the professional actors.

7.3.2.2. Implication barriers (e.g. infrastructure)

There is a need to disseminate information about possibilities for renovation levels based on building type. The Danish Energy Agency has launched a building guide that brings together knowledge about the 15 most common types of single family houses in Denmark and suggests their possible improvements to the energy label.

It varies by building to building, how much it costs to renew a building and how much energy can be saved. SBi had back in 2013 an investigation in which it was estimated that the cost of improving a 120 m2 detached house from energy-saving G to C would amount to approx. DKK 325.000. In the same report, it is estimated that it costs approx. DKK 100,000 to demolish a house, and construction of a new detached house of 120 m2 costs an estimated 1.5 million. As a rainfall example, it is illustrated how much weight energy savings are, respectively. renovation and demolition construction, cf. Tables 1a and 1b below.

Tabel 1a. Investerings- og energiudgifter ved grundlæggende energirenovering og nedrivning-nybyggeri. Parcelhus på 120 m2 med energimærke G

	Investering (kr.)	Energiudgift med lav energipris (fjernvarme) (kr./år)	Energiudgift med høj energipris (olie) (kr./år)
Hus med energimærke G	0	24.387	32.241
Renovering til C	325.000	9.999	13.219
Nedrivning-nybyggeri i energimærke A2015 + varmepumpe	1.600.000*	2.288	2.288

Kilde: Kim Wittchen og Jesper Kragh: "Udtjente bygninger og bygningsrenovering", SBI, 2013, egne skøn og beregninger.
* Heraf nedrivning 100.000 kr.

Tabel 1b. Energiudgifter i forhold til investeringsudgifter ved grundlæggende energirenovering og nedrivning-nybyggeri. Parcelhus på 120 m2 med energimærke G

	Lav energipris (fjernvarme)		Høj energipris (olie)	
	Tilbage-betalingstider	Energiudgift i 20 år i forhold til Investerings-udgift	Tilbage-betalingstider	Energiudgift i 20 år i forhold til Investerings-udgift
	(år)	(pct.)	(år)	(pct.)
Renovering, G til C	23	89	17	117
Nedrivning-nybyggeri ift. gamle hus	72	28	53	37
Nedrivning-nybyggeri som alternativ til renovering	165	12	117	17

Kilde: Beregnet ud fra tabel 1a. Fx er de 23 år i første celle beregnet som 325.000/(24.387-9.999), og de 89 procent i næste celle beregnet som 20*(24.387-9.999)/325.000.

Table 9: Investment and energy costs in energy renovation and demolition

Source: https://ens.dk/sites/ens.dk/files/Energibesparelser/notat_-_nedrivning_og_nybyggeri_som_alternativ_til_omfattende_renovering.pdf

7.3.2.3. Energy efficiency

In the following we will look at the implications for energy renovation of existing buildings, new constructed buildings, the circular building and the cognitive building.

7.3.2.4. Energy renovation

Existing buildings represent a great value. Since only about 1% of new buildings are being built every year, the existing building stock will in the longer term also represent a large part of the potential for the buildings' role in the green change over renovation. By 2020, Denmark will introduce long-term energy efficiency targets in existing buildings, depending on the building type, which ensures that a total reduction of about 30-50% of energy consumption will be achieved by 2050. By renovating buildings after 2020, the same requirements for the replaced parts, as for new construction.

The public sector has a major role to play in leading it because it represents a very high demand in society. By 2018, ambitious national policies for energy efficiency of public buildings must be prepared according to EU requirements. Therefore, good examples of successful renovations are needed, which can inspire others to renovate and promote the green change. Public buildings consist of a wide range of buildings owned by both state, region and municipality, as well as the general sector, and there is a need to ensure both energy efficiency and the economy to implement energy upgrades.

It is important to point out that energy savings in the existing building are significantly cheaper to achieve when the building is still facing renovation. If the investment is expired, it is likely that cost-effective energy savings will be "locked" as the ability to achieve them will only come back many years later, for example the next time the building is about to change roofs, windows and the like.

7.3.2.5. New build

Denmark intends to maintain the current BR15 energy levels since 2020, as economic analyses have shown that further tightening is not profitable by 2020. They are supplemented by a voluntary low energy class for builders with higher ambitions in the energy field. Experience from practice shows that high energy consumption in new buildings is often due to improper operation of the technical installations, and therefore extra focus must be placed on reducing actual energy consumption. This should be done with ongoing follow-up and documentation of buildings' energy performance, increased focus on commissioning, operational optimization and user friendliness. Sharpening of component requirements may be relevant in areas where new and more efficient building materials have been created, which is expected to be the case for windows.

In 2025, focus will be on low energy consumption for several of the phases of the building. This is done by evaluating the energy framework and component requirements for possible tightening of requirements. With low operating energy consumption in buildings, the embedded energy in materials from their production is an increasing proportion. Therefore, the energy requirements with LCA requirements for the building are extended to determine the embedded energy of the materials. It is based on environmental protection declarations (EPD) for building materials that make up an important part of the entire construction.

After 2025 and by 2030 and afterwards a holistic approach in construction will be the focal point, where all parts of the construction phases will affect the total energy consumption of the building. In the use phase, low consumption is ensured with evaluation and possible tightening of both the energy framework and component requirements, which is complemented by requirements for the level of embedded energy for the production phase of materials determined by LCA for the construction work. Furthermore, the actual energy consumption for the operation of the building can be claimed.

In general, there is also an increased interest in the sustainable development of construction in Denmark. Therefore, there is a proposal that by 2020 a voluntary sustainability class for new construction for implementation in future building regulations will be developed from 2020. The aim is initially that a common understanding of the elements of sustainable construction will be developed within the building. The voluntary sustainability class is expected to be a driver for the development of new innovative solutions and products and should, in addition to the existing requirements of the Building Regulations, also include specific requirements for topics such as indoor climate, overall economy and resource consumption, and ensure assessment of the entire life cycle of the entire building. Generally, all new buildings must be delivered with an energy calculation for the building's total need for energy for heating, ventilation, cooling and hot water.

In 2017 published Energy Fund in Denmark with some recommended bets compared acces buildings role in the green transition. Below is a list of recommended efforts from the Energy Fund Roadmap, broken down by new buildings, existing buildings and utilities:

Anbefalinger til indsatser		2020	2025	2030
Nybyggeri	Energi	BR 15 energikrav fastholdes, evt. stramning af udvalgte komponentkrav	Energiramme og komponentkrav, evt. stramning	Evt. yderligere stramning
		Frivillig Lavenergiklasse		
		Reduktion af faktisk energiforbrug		Evt. krav til faktisk energiforbrug
			LCA opgørelse af indlejret energi	Krav til indlejret energi i LCA
	Indeklima	Indeklimakrav til alle bygningstyper	Indeklimakrav til alle bygningstyper, evt. skærpelse	Evt. yderligere skærpelse
		Vejledning og information om indeklima	Kontrol af indeklima, måling mv.	
		Krav om VOC måling		
	Miljø	Produktdata for materialer	LCA opgørelse på baggrund af EPD'er	Krav til LCA niveau
		Identifikation af kemi i byggeriet	Kemi i byggeriet, udfasning/substitution	Forbud mod farlig kemi i byggeri
		Fokus på byggepladsens energi- og ressourceforbrug	Opgørelse af energi- og ressourceforbrug på byggepladsens	Evt. krav til energi- og ressourceforbrug på byggepladsens
	Bæredygtighed	Introduktion af frivillig bæredygtighedsklasse	Opdatering af frivillig bæredygtighedsklasse	Krav om opfyldelse af bæredygtighedsklasse
Eksisterende bygninger	Renovering	Langsigtet mål for energieffektivitet afhængig af bygningstype		Krav om opfyldelse af energieffektivitet
		Nybyggerikrav til udskiftede dele	Evt. skærpede krav til udskiftede dele som for nybyggeri	Evt. skærpelse følger nybyggeriet
		Incitamenter og muligheder for renovering afhængigt af bygningstype		
		Vejledning om driften og brugernes betydning for forbrug og indeklima	Krav om minimumsniveau eller forbedring af indeklima	
		Offentlige bygninger som rollemodel for grøn omstilling	Genanvendelseskrav for affaldsmaterialer (alle bygninger)	LCA beregninger for miljømæssig betydning af renovering (alle bygninger)
Forsyning	Nettet	Langsigtede energifaktorer fastsættes ud fra ENS fremskrivning af energiforsyningen	Evt. justering af energifaktorer på baggrund af energiforsyningens udvikling	BR energikrav afkobles fra energiforsyningen
	Lokal VE	Indflydelse af lokal VE i energirammen reduceres mest muligt	Kun lokal VE anvendt direkte i bygningen indregnes i energirammen	Udbygning af lokal VE drives af teknologiudvikling og markedskræfter
	Energifleksibilitet	Analyse af behov for mulige krav til energifleksibilitet i bygninger	Bygningers energifleksibilitet udbygges og udnyttes hvor det er relevant	Yderligere fremme af bygningers energifleksibilitet overfor energiforsyning

Table 10: In 2017, the Energy Fund in Denmark published some recommended efforts compared with the role of buildings in the green transition
Source: Energy Fund in Denmark, 2017

7.3.2.6. The circular building

In order to realize a low-emission society by 2050, it is necessary to focus on both the existing and new building mass that contribute to the circular economy. Of this existing building stock, a significant part is unused, which according to CONCITO is expected to rise in the near future. Several homes in villages often lie desolate while building elsewhere in a region. New ideas for demolition and renovation can therefore ensure greater and better recycling of building materials, including through better coordination.

The decisive factor for the circular conversion is to maintain the good quality of the construction, so that durable buildings are built with proper indoor climate and that the conversion is based on facts and documentation. It is therefore important that the recycled materials have the same quality as new materials from fresh raw materials.

For example, Dansk Byggeri has documented how old windows are sold from municipal recycling sites without regard to the energy requirements of today's construction. This can help bring harmful substances into new buildings, as the paint on the old windows often has a high content of lead and other heavy metals, and PCB from the joints may be penetrated the window sill. Uncritical recycling of old windows from municipal recycling sites can bring PCBs and other harmful substances into new buildings.

Another example is pressure-impregnated wood. Projects, for example, municipalities and material producers will reuse pressure-impregnated wood collected at recycling sites. But this is highly inappropriate, as the material - which may be 40-50 years old when sent for recycling - may contain copper, chromium and arsenic heavy metals. Recycling this material will mean that the heavy metals that have been gathered heavily will be brought back in circulation again. Here it is far better to burn the wood, as practice is now. Be aware of heat plants where emissions and residues are controlled.

Another problem is that uncritical recycling of bricks and concrete can create the risk that new buildings are not so durable or strong that they meet the demands we have today.

In addition, it is important that proper environmental requirements for recycled building materials are laid down and that the necessary documentation is provided so that recycled - circular building materials meet the same requirements as current building materials.

In order to ensure successful circular restructuring in the construction sector, it is therefore important that:

- ensure documentation of the quality and purity of the circular construction
- create a link between demolition and construction of new buildings
- think the circular into a life-cycle perspective.

According to Ingeniøren, the construction sector accounts for 40% of Denmark's total resource consumption and 30%. of waste production, the circular economy has its justification

7.3.2.7. The cognitive building

Big data is the new “black” and broad coverage of collecting, analysing and interpreting vast amounts of data that can be 'collected' from a building in operation. However, we must remember that it is human behaviour that, after all, determines whether a building is also operating energy-efficiently - that is, whether there is a lot of data available or not. Often people - whether it is a larger public building, in homes or companies, is not aware of the possibilities for all this data, and the risk is therefore that wrong decisions or actions are taken based on data that comes for the buildings' intelligent systems. This challenge must be solved to allow for the operation of optimal buildings where the 'self-thinking' (cognitive) buildings and the people who are users use and operate the building as optimally as possible.

When the term 'the cognitive building' is used, on:

- Home automation systems using energy technologies operated as one system that is possible to optimize on
- IoT - Internet of Things, connectivity between devices and systems and adaptive learning equipment
- Big data, development of new product service systems in business modelling using data and digitization technologies.

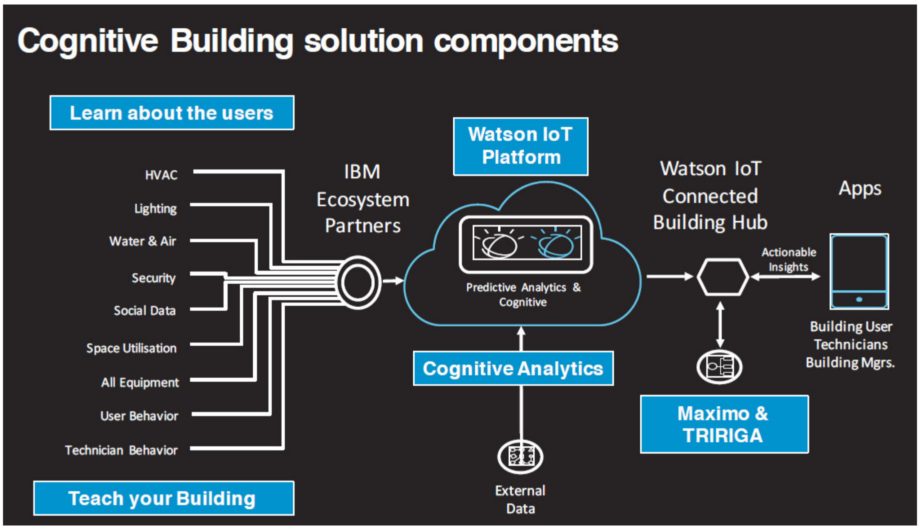

Figure 15: Cognitive building solution components

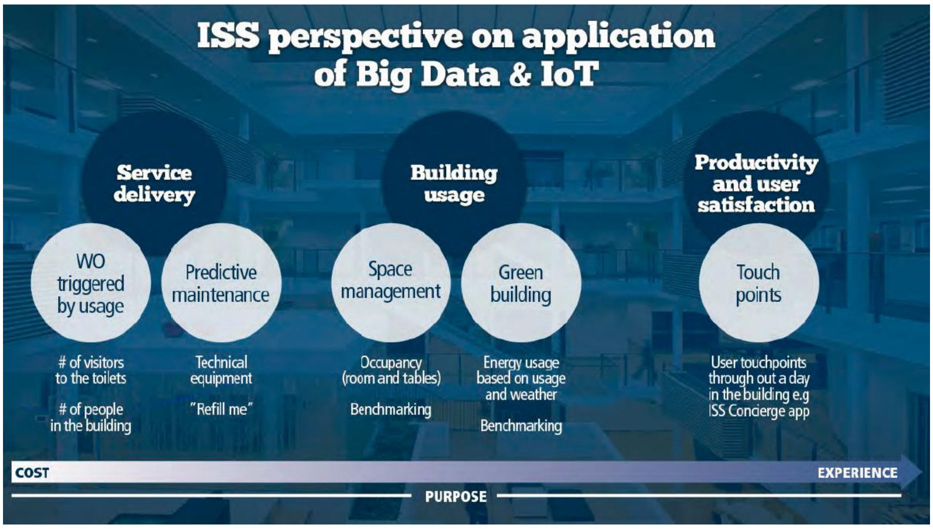

Figure 16: ISS perspective on application of Big Data and IoT

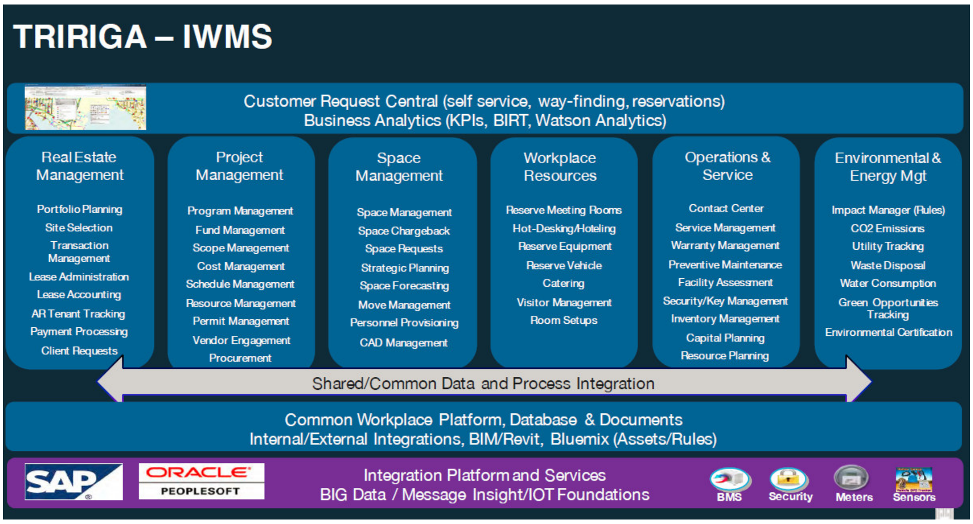

Figure 17: TRIRIGA - IWMS

Inspiration: Kim Escherich | @kescherich IoT Innovation Architect
Kim Escherich; IBM Analytics; Internet of Things Innovation Architect

In the future, it is likely that demand for 'self-thinking' buildings will be high. To achieve this, many of the existing data must be utilized. It is often data that is already available (big data phenomenon) but, as 'just not yet', is optimally utilized in connection to the operation of the building, incl. The considerations the building should be run on to 'work' optimally both in connection to the users, as well as energy performance.

7.3.2.8. Noise emission

As for the renewable energy, it makes no sense in talking – in broad terms – about the noise emissions for smart houses. One can of course say that noise levels have to be reduced and considered, when demolishing and construction of smart houses.

7.4. Denmark. List of literature

Ref.	Danish Title	English title
[1]	Aftale mellem regeringen (V) og Socialdemokratiet, Dansk Folkeparti og Radikale Venstre om de fremtidige afgiftsvilkår for elbiler og brændselscellebiler. 2015. Folketinget	Agreement between the government and supporting parties on registration fees on electrical cars. 2015. The Danish Parliament
[2]	Lov om ændring af registreringsafgiftsloven, brændstofforbrugsafgiftsloven og forskellige andre love. 2015. Folketinget	Law on the registration fees and the law on the fuel consumption tax. 2015. The Danish Parliament
[3]	Lovforslag L61 om afgift på el-biler og plug in hybrid biler er vedtaget. 2015. Folketinget	Law L61 on registration fees concerning electrical and hybrid vehicles. 2015. The Danish Parliament.
[4]	N/A	Denmark’s National Energy Efficiency Action Plan (NEEAP). 2015. The Danish Ministry of Energy, Utilities and Climate
[5]	Aftale om den danske energipolitik 2012-2020. 2012. Folketinget	Agreement on the Danish Energy Policy 2012-2020. 2012. The Danish Parliament.
[6]	Bekendtgørelse om energispareydelser i net- og distributionsvirksomheder. 2016. Energi-, Forsynings- og Klimaministeriet.	Declaration on energy efficiency measures in utilities. 2016. The Danish Ministry of Energy, Utilities and Climate
[7]	http://www.energihjem.dk/tilskud-til-energirenovering/	http://www.energihjem.dk/tilskud-til-energirenovering/ Knowledge platform for refurbishment of private buildings. 2017
[8]	Lov om ændring af ligningsloven og kildeskatteloven (genindførelse af boligjobordningen) 2013, Skatteministeriet	Law on subsidies for energy refurbishment. 2013. The Danish Tax Agency
[9]	Bekendtgørelse om tilskud til energieffektive og intelligente bygninger. 2016.	Declaration on subsidies for energy efficient and intelligent buildings. 2016. The Danish Ministry of Energy, Utilities and Climate
[10]	N/A	Mathiesen, B. V., et.al. (2015). IDA's Energy Vision 2050: A Smart Energy System strategy for 100% renewable Denmark. Department of Development and Planning, Aalborg University.
[11]	Bekendtgørelse om obligatorisk energisyn i store virksomheder.	Declaration on obligatory energy screening in large enterprises. 2014. The Danish Ministry of Energy, Utilities and Climate
[12]	Energieffektive teknologier – National kortlægning af virksomheder indenfor forretningsområdet. 2016. Region Syddanmark	Energy Efficient Technologies – National roadmap of companies within the business area. 2016.The Region of Southern Denmark

Ref.	Danish Title	English title
[13]	N/A	The Energy Technology Development and Demonstration Programme – strategy 2017-2019. 2017 The Danish Energy Agency
[14]	N/A	Guidelines for Grand Solutions. 2017. Innovation Fund Denmark.
[15[	N/A	www.eon.dk. 2017. Eon Denmark
[16]	N/A	www.drivenow.dk 2017. Drive Now Denmark
[17]	N/A	www.tadaacar.dk 2017. Tadaa Car sharing services
[18]	Forslag til folketingsbeslutning om klimatiltag via omstilling af transportsektorens energiforsyning	
[19]	Elbiler – Notat fra COWI	
[20]	Energistyrelsens arbejde med fremme af elbiler ved Specialkonsulent Michael Rask, Energistyrelsen, 2014	
[21]	Elbiler en vej tl grønnere transport opgør med de mange myter om elbiler af Det Økologisjke Råd	
[22]	44% Wind — Denmark Set New Wind Energy Record In 2017 (https://cleantechnica.com/2018/01/06/44-wind-denmark-smashed-already-huge-wind-energy-records-2017/)	
[23]	Energy Policies of IEA Countries; Denmark 2017 Review	
[21]		

8. Germany

Last update: 2018-08

Germany	E-mobility	Renewable energy	Smart houses
Drivers	- Financial public measures (e.g. purchase incentives, charging infrastructure, public procurement of electric vehicles) - Expansion of the charging infrastructure - Electric scooters-/car-sharing within city area - Electric post and parcel deliverage - Increasing level of electric bicycles/pedelecs through financial incentives - Indivual parking with charging options - Increasing number of charging points	- Federal legislation through law and regulations - Reduction of greenhouse gas emissions until 2050 - Decommissioning of nuclear power plants by 2022 - Expansion into international markets - Public funds for the utilization of renewable energy in process on industry level - Ongoing construction of new offshore wind turbines - German "Energiewende" as best practise/pilot model for internationals	- Energy consumption in buildings - Integrated energy design - Increasing comfort and safety - Potential cost reduction in long-term
Barriers	- High purchase cost - Small growing number of electric vehicles - Low number of charging points within rural area - Diverse plug- and payment options - Quick charge of a battery. - High production price - Electricial infrastructures in parts not designed for private/home charging	- Stagnation of national renewable extension plan such as onshore wind energy - Implication barriers through grid infrastructure - National supply and demand of renewable energy dislodged	- High implementation costs in existing buildings - Several public construction projects as pilots - Limited long term gains after additional investment - Low level of awareness of the benefits of using SH technology

Germany	E-mobility	Renewable energy	Smart houses
Energy efficiency	- Costs per kilometre are lower compared to conventional cars. - Storing excess electricity generated - Possible return of electricity to the grid discussed	- Lowering of energy consumption at end user level - Leveling demand peaks through storage solution - Convertion of gained wind energy into gas or heat	- Usage of sustainable eco-material within new build and renovation - Increase of housing construction in general with more efficient ressources - Energy framework and component requirements
Noise emission	- Reduction of noise from noise reducing pavements	- Small increase in the noise level from wind turbines - Noise reduction resulting from the progressive elimination of internal combustion engines	- In particular no noise emission from smart housing in general

Table 11: Summary Germany

The German government throughout the last 20 years has enforced several acts and laws in order to back the sustainable development in the different renewable energy application fields from the side of the regulator and different ministries. These fields of application correspond to the areas of application represented in the Green PE project. There follows an overview.

8.1. E-mobility (GER)

As the future of mobility is electric and electro-mobility is an important element of a climate-friendly energy and transport policy, the Federal Government is planning to establish Germany as one of the leading markets in the field with at least one million vehicles by 2020.

Figure 18: Charging station for e-cars
Source: Michael Flippo / Fotolia.com

Germany should be maintaining its world-leading position in exports as well in the field of electric mobility with highly innovative products. In order to accelerate the development of the market for electro-mobility, the Federal Government decided on 18 May 2016 to adopt a package of measures with an investment volume of one billion euros.

Three financial measures are in the foreground: temporary purchase incentives, expansion of the charging infrastructure and public procurement of electric vehicles.

A purchase bonus, the so-called environmental bonus, is paid for new vehicles with a list price of up to 60,000 euros. The total funding amount is set at 1.2 billion. Federal subsidies are subsidized by the manufacturer. Since July 2016 car buyers have been able to submit their applications to the Federal Office of Economics and Export Control.

In order to improve the loading infrastructure, the Confederation provides 300 million euros for fast-loading infrastructure and for standard infrastructure. The aim is to ensure that at least 20 percent of the vehicles in the Federal Motor Vehicle fleet are to be used in the Federal Republic of Germany [BMWI 1 2016].

8.2. Renewable Energies (GER)

Germany has set itself ambitious targets: by the year 2050, it wants to largely avoid greenhouse gas emissions. This is reflected in the primary law for this sector the **Renewable Energies Law (EEG)**. However, since renewable energies are handled between different sectors, the technologies and their market requirements are reflected in other laws as well, see the following. By 2022, the German nuclear power plants will be gradually decommissioned. In order to further expand the transmission and distribution network, to design it in a more citizen-friendly way and to make the electricity network fit for the new tasks, the three laws on the Modification of Provisions of the Law of Energy Construction, the Law for the Digitization of the Energies and the Amendment to the Incentive Regulation crucial steps were taken [BMWI 2 2016].

Four laws form the basis for a coordinated, accelerated and transparent network expansion:

<u>Energy Industry Law (EnWG)</u>

Within the framework of its provisions, the EnWG ensures continually inter alia a transparent and coordinated grid expansion for the German high-voltage grid. The determination of the power dissipation requirement is carried out in a multi-stage process.

<u>Network Expansion Acceleration Law (NABEG)</u>

The NABEG facilitates the planning of network expansion projects which affect several German federal states or exceed national boundaries. The transition from state to federal planning allows a streamlining of the procedures and prevents the fragmentation of the responsibilities.

<u>Federal Requirement Plan Law (BBPlG)</u>

The central instrument for the expansion of electricity networks on the transmission grid is still the Federal requirement plan. It identifies the most urgent expansion projects on the basis of the network development plan and the offshore network development plan.

<u>Energetic Power Extension Law (EnLAG)</u>

Necessary and priority projects, which remain in the responsibility of the federal states, are included in addition to the federal requirement plan also to the energetic power extension law.

8.3. Smart Houses (GER)

Since 1st January 2016 new provisions of the Energy Saving Ordinance (EnEV) came into force. According to the EnEV 2016, the energy consumption of new buildings has to be significantly reduced substantially.

The goal of the German government, the reduction of non - renewable primary energy until 2050 by 80 % compared to 2008 will be supported by two essential changes in the building status: the use of renewable energy / decarbonisation and energy efficiency.

The strategy of the federal ministry of economics and energy (BMWI) includes the energetic modernization of the building envelope and the installation engineering as well as the use of new, efficient technologies to reduce the final energy consumption in buildings.

In terms of "smart buildings", the BMWI relies on intelligent measuring systems and meters. These can become an important building block for power generation if the legal framework provides a cost-benefit-oriented rollout with a standardized and widely applicable technology. In this context, the Smart Meter Gateway is designed as a standard communication solution for the power stations. Up to 2032, all metering points should be equipped with intelligent meters for consumers.

Installation is carried out step by step. Pioneer (from 2017) is the group of power consumers in the range greater than 20,000 KWh / year, followed (from 2019) by the group of electricity consumers in the range 10,000 to 20,000 kWh / year. Afterwards (from 2021) the group of the electricity consumers follows in the range 6,000 to 10,000 kWh / year [BMWI 3 2015].

8.4. German market drivers

1) The progressive climate change can only be stopped if greenhouse gases are consistently conserved in all areas, whether it be electricity, heat or transport. Renewable energies offer the right solution, because they reliably supply energy and cause only minimal CO2 emissions.

2) Dwindling fossil resources make the energy supply more and more uncertain and expensive. Renewable energies, on the other hand, are based on almost inexhaustible resources. They ensure permanent and secure energy.

3) The economic and financial crises have shown that investment in cutting-edge technologies is necessary. Renewable energies bring the decisive innovations for sustainable economic growth. They therefore secure future-proof jobs Germany. According to a study, 230.000 new jobs could be created by 2050, if the political course is set for this.

4) Renewable energies are generated regional and decentral. That means that homeowners, traders, farmers etc. can become electricity producers as well as citizens, who are joining cooperatives together or buying shares in citizens' solar schemes or funds.

5) Renewable energies are domestic resources. Their use reduces dependence on oil and gas supplies from politically unstable regions such as Russia.

6) Renewable energies are becoming increasingly favorable. Solar power plants will deliver the most favorable electricity in many parts of the world in a few years.

7) The German population's approval of renewables is still very high: 93 percent consider the increased expansion of renewable energies to be important to extremely important. This is the result of a representative survey from August 2015. 77 percent believe that renewable energies contribute to a secure future of the next generation [BEE].

8.5. German market barriers

Necessary for the achievement of the energy transition are not only investments in renewable energy plants, modern electricity grids, storage facilities and production technologies, but also the homes need to be rehabilitated for less heating energy need. Investments of up to 550 billion euros are required for energy generation by the middle of the century, as being calculated in the scenarios in the energy concept of the Federal Government.

A half billion euros equates to annual additional investments of up to 15 billion euros or 0.5 percent of the gross domestic product. According to the calculations for the energy concept, almost 90 % of the living space needs to be energetically renovated by 2050 [BUND 2016].

However, the yield of the energy transition is modest compared to the cost of its generation. The costs for the energy transition are also reflected in the German electricity prices, which are among the highest in Europe. The levy for the promotion of electricity production from renewable energy sources is are added to the electricity prices as the EEG-levy.

This levy amounts per year to over 20 billion euros, which has to be borne by all electricity consumers [HB 2016].

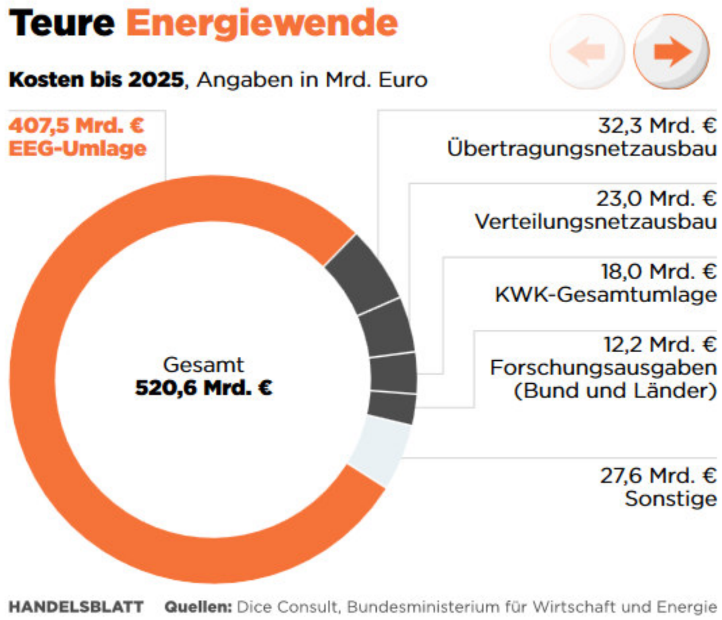

Figure 19: Overview of cost to implement the “Energiewende” in Germany

Source: http://www.handelsblatt.com/unternehmen/energie/kosten-fuer-energiewende-strompreise-geraten-ausser-kontrolle/14667630.html

In addition, it needs to be taken into account that there more and more arises a demand for connecting the different energy domains, which refers to sector coupling. This task leads to an even more complex procedure and handling of the energy transition in Germany and requires high-tech components and materials i.e. PE reliable enough to handle the heavy load shifts.

8.6. Germany. List of literature

[BMWI 1 2016] https://www.bmwi.de/Redaktion/DE/Artikel/Industrie/rahmenbedingungen-und-anreize-fuer-elektrofahrzeuge.html

[BMWI 2 2016] https://www.bmwi.de/Redaktion/DE/Dossier/netze-und-netzausbau.html

[BMWI 3 2015] https://www.bmwi.de/Redaktion/DE/Downloads/E/eckpunkte-fuer-das-verordnungspaket-intelligente-netze.html

[BEE 2017] https://www.bee-ev.de/home/publikationen/sieben-gruende-fuer-erneuerbare-energie/

[BUND 2016] https://www.bundesregierung.de/Content/DE/StatischeSeiten/Breg/Energiekonzept/0-Buehne/ma%C3%9Fnahmen-im-ueberblick.html

[HB 2016] http://www.handelsblatt.com/unternehmen/industrie/kosten-fuer-energiewende-strompreise-geraten-ausser-kontrolle/14667630.html

Project Facts

- 17 project partners: research institutions, companies and technology transfer organisations
- Duration from 2016 to 2019
- Budget: EUR 3.1 mllion
- European Regional Development Fund
- Interreg Baltic Sea Region Programme
- Led by University of Southern Denmark

Project Partners

- University of Southern Denmark (Denmark)
- Applied Research Institute for Prospective Technologies (Lithuania)
- Christian Albrechts Universität Kiel (Germany)
- CLEAN (Denmark)
- Converdan A/S (Denmark)
- Kaunas Science and Technology Park (Lithuania)
- Kaunas University of Technology (Lithuania)
- Latvian Technological Center (Latvia)
- NATEK Power Systems AB (Sweden)
- Polish Chamber of Commerce for Electronics and Telecommunications (Poland)
- Renewable Energy Hamburg (Germany)
- RISE Research Institutes of Sweden AB (Sweden)
- Sustainable Smart Houses in Småland (Sweden)
- Ubik Solutions OÜ (Estonia)
- University of Latvia (Latvia)
- University of Tartu (Estonia)
- Warsaw University of Technology (Poland)

green power electronics
innovation via new materials

Interreg
Baltic Sea Region

EUROPEAN UNION
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