# GREEN PE

# O2.1 TRANSNATIONAL TECHNOLOGY AND PRODUCT ROADMAP

## A.2.1.8: REGIONAL MAPPING OF THE SECTORIAL SPECIALIZATION FOR DIFFERENT COUNTRIES/REGIONS

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# 1. Management Summary

The goal of the Green Power Electronics project is to promote the integration of advanced power electronics in the portfolio of companies in the Baltic Sea Region.

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 project activity A2.1.8 aims to make a regional analysis of relevant aspects influencing the market uptake of power electronics for green applications at each participating region or country.

This output presents the compilation of relevant factors at each region or country in the consortium.

# 2. Partner involvement

## 2.1. Technology transfer partners

Each technology transfer (TT) partner is responsible for the collection of relevant information to identify the sectorial specialization related to Green Power Electronics at their countries/regions. In Lithuania, PROTECH and KSTP should coordinate efforts to provide the Lithuanian input.

Table 1 lists the TT-partners in the consortium.

**Table 1**

| No | Acronym | Organisation | Country |
|---|---|---|---|
| PP3 | EEH | Renewable Energy Hamburg | DE |
| PP5 | Acreo | Acreo Swedish ICT | 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: Technology transfer partners*

## 2.2. Research partners

Research partners can contribute to the completeness of the information collected to identify the sectorial specialization in their countries/regions. University of Tartu might coordinate efforts with neighbouring countries to collect relevant Estonian information.

Table 2 lists the research partners in the consortium.

| **Table 2** | | | |
|---|---|---|---|
| **No** | **Acronym** | **Organisation** | **Country** |
| PP1 | SDU | University of Southern Denmark | DK |
| PP4 | CAU | Christian Albrechts Universitaet Kiel | DE |
| PP5 | Acreo | Acreo Swedish ICT | SE |
| PP6 | UL | University of Latvia | LV |
| PP8 | UT | University of Tartu | EE |
| PP9 | KTU | Kaunas University of Technology | LT |
| PP11 | WUT | Warsaw University of Technology | PL |

*Table 2: Research partners*

# Regional Roadmaps Baltic Sea Region

# 3. Latvia

## 3.1. Latvian policy and regulations

The Latvian policies and regulations are structured according to focus fields of Green PE.

**E-mobility**

To promote e-mobility the Cabinet issued a document which outlined electro-mobility development plan for years 2014-2016 [1]. 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 [2], [3], [4].


*Figure 1: Latvian Electric vehicle number plate*

For electric cars, a special design of a vehicle number plate is introduced (Fig. 1). The initial registration of electric car is free of charge [5]. The companies registered in Latvia can receive state aid for purchase of electric vehicles as well as for building electric car charging stations [6]. 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 [7]. Electric cars have the right to drive within the city public transport lanes [8]. 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.

**Renewable Energies**

The general energy development strategy is outlined in the Cabinet's order “About Energy Development Guidelines for 2016-2020” [9]. The general provisions for energy effective, safe and quality supply on reasonable price diversifying energy sources are stated in the “Law on Energy” [10]. 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” [11] relates also to renewable energies, stating that the energy should be used and managed in a way that contribute to sustainable economy and limit the climate change. At this moment there is opened one program that directly supports and promotes transition to use of renewable energy resources in the processing industry [12]. There is prepared a project of the Cabinet’s regulations (planned to be adopted in 2017) which will support use of renewable energy sources in local district heating [13]. The programmes that stimulate improvement of energy efficiency in buildings [14], [15] 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.

**Smart buildings**

The construction process is regulated by several laws and regulations which applies also to smart buildings [16], [17]. A special law is about energy performance of buildings [18]. At the moment, there are two operational programmes that stimulate investments in energy efficiency in buildings – one in residential buildings [14], the other in public buildings [15]. Although both programmes are more focused on increase of heat isolation, they set several energy saving parameter values which should 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.

## 3.2. Latvian market drivers

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, completed 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 which operates in the field of electrical engineering and electronics are united in the Latvian Electrical Engineering and Electronics Industry Association. Following is the description of the largest companies which develop and produce products with power electronics components [19]. The list is not exhaustive and reflects only small part of enterprises which operates in this field.

An enterprise which should be noticed specially is JSC Rīgas elektromašīnbūves rūpnīca (RER), which design and produce original power electronics elements using them in production of various products. It is 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 (Fig.2), as well as electrical equipment and motors for general industrial purposes.

*Figure 2: 750 kW DC/AC converter for dump trucks asynchronous motor drive*

Energolukss, Ltd. is a full-service company providing emergency power supply solutions. It is the Latvian market leader in sales and rental of generating set as well as one of the major players in power electronics repairs and maintenance. Energolukss provides delivery, installation, maintenance, repairs and rental of equipment as well as manufactures switchboards and designs wiring diagrams. It also designs the electrical diagrams for emergency power supply networks, delivers of any kind of power supply equipment, voltage

and current converters and inverters, welding equipment and generating sets including full technical support.

Hanzas Elektronika (HansaMatrix brand), Ltd. offers a one-stop shop for complete electronic manufacturing services, including product design support, industrialization, and manufacturing processes, from PCB assembling to complete box building, logistics and after-sales support. All the facilities are brand new, equipped with state-of-the-art assembling technology and world-class verification and traceability IT solutions. The company has a very strong engineering workforce, including R&D, component, new product introduction, maintenance, and quality engineering teams. HansaMatrix has high competence in the volume manufacturing of high complexity PCBAs, as well as box building and various types of conformal coating and encapsulation of electronic circuits.

JSC SAF Tehnika is among the world's top microwave carrier-class point-to-point data transmission equipment manufacturers and distributors. Originally incorporated and having its headquarters in northern Europe, SAF Tehnika has become a global company within just a decade, covering all relevant market segments in more than 130 countries worldwide. SAF products are ISO 9001:2008 certified and correspond to major industry standards such as ETSI, FCC and Industry Canada. The company's product portfolio covers most licenced and licence-free frequency bands within the range of 300MHz-42GHz with capacities up to 1 Gigabit full-duplex.


*Figure 3: Of-road race car with electric drive*

In the field of e-mobility operates the most popular in Latvia company "Drive-eO" under the leadership of the former racing car pilot A. Dambis. They have developed racing cars with electric drive for Dakara off-road race (Fig. 3) and for the Pikes Peak International Hill Climb competition (Fig. 4). In the smaller scale also operates a new company "Blue Shock Race" developing electric drive for go-karts (Fig.5) and bicycles as well as recently established company - Electric Mobility, Ltd., whose business profile is engineering and production of light electric vehicles - electric scooters, controllers for LEVs (light electric vehicles), wireless solutions for electrical drives and electric motors.


*Figure 4: Supercar designed for the Pikes Peak International Hill Climb*

*Figure 5: Variety of go-karts for sports and entertainment*

In the educational of society in e-mobility topics actively is involved in the Road Traffic Safety Directorate (CSDD). It is possible to get detailed information about various aspects of e-mobility on the WEB-site “E-transport” [20]. Predicting the increase of number of electric vehicles it is planned till January, 2021 to complete the development of the network of rapid electric charging stations. They will be located on TEN-T roads as well as in national and regional centres and on connecting roads [21]. The location of rapid electric charging stations can be found on the website which is regularly updated [22].

Potential drivers in implementation of the Green PE project outcomes are listed in the Table 2.

## 3.3. Latvian implementation barriers

The main barriers for wider implementation of e-mobility in Latvia are relatively high price of electric cars (in comparison with conventional cars) and small number of electric car charging

stations. The first barrier is especially important taking into account relatively small income for majority of population. According to the Road Traffic Safety Directorate data until the July 1, 2016 in Latvia were registered only 295 electric vehicles, including 227 cars. The operation of these vehicles depends on accessibility of electricity supply (charging) points. At the end of 2016 there were 16 electric vehicle charging stations in Latvia. The electric vehicle charging stations are located mainly in Riga or near Riga (Fig. 6) which is an obstacle to use electric cars in remote regions.


*Figure 6: Location of the electric vehicle charging stations*

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

There are no specific programmes that support investments in smart buildings. In Latvia, 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.

| Table 1 | | |
|---|---|---|
| Ref. | Document name in Latvian | Document name translation 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 "Veicināt energoefektivitātes paaugstināšanu valsts un dzīvojamās ēkās" 4.2.1.2. pasākuma "Veicināt energoefektivitātes paaugstināšanu valsts ēkās" pirmās projektu iesniegumu atlases kārtas īstenošanas noteikumi” | Implementing rules for the first call 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 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" |

*Table 3: Translations to English from Latvian of reference documents*

| Table 2 | | |
|---|---|---|
| Renewable Energy | e-mobility | Smart houses |
| 1.JSC LATVENERGO (wind and solar energy, wood products)<br>2. Institute of Physical Energetics (smart grids) | 1.JSC RER (traction drive)<br>2. Drive-eO (sport cars)<br>3.Blue Shock Race (go-karts)<br>4.Electric Mobility (light vehicles)<br>5. EMI (charging stations) | 1. FONONS (heat pumps)<br>2. Mikrotīkls (control systems)<br>3. NAMCOS (control systems)<br>4. JSC SAF Tehnika (microwave info- carrier) |

*Table 4. Potential drivers in implementation of the Green PE project outcomes*

## 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>.

# 4. Poland

## 4.1. Polish policy and regulations

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 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

Electricity from renewable sources is promoted through a quota system, tax relief and subsidy and loan schemes. Heat generated from renewable energy sources is supported through three subsidy schemes and a loan scheme. Renewable energy in transport is promoted through a biofuels quota obligation. Electricity distributors are legally obliged to acquire a minimum amount of renewable energy (for the 2015 year this was 14%).

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.

The following legislations that shape uptake of power electronics: **RES, energy law, act on energy efficiency, environmental protection policies, construction law, telecommunications law, act on development of telecommunications services and networks**, and many others, discourage business from investing in digitisation and innovation. 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.

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'

## 4.2. Polish market drivers

The main market drivers for the market uptake of the advanced power electronics would be:

• switch to (low-carbon) environmental policy

• further availability of EU funds (subsidies) for innovation investments

• 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

• intensive development of the sector of storage technology and energy storage management

• 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

• increase in competitiveness in the energy market, forcing a shift towards innovation

• 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

## 4.3. Polish implementation barriers

On the national level, the uptake of power electronics is slowed down by the lack of necessary legal regulations that would define the shape of market mechanisms. Due to the current legislative philosophy, the law is lagging behind the reality, and regulations are drafted only if there is a pressing, current need to do so. For this reason, the law needs to be amended constantly, which, when combined with the practice of ongoing regulation, leads to overregulation, increasing incoherence and legal chaos.

The main implementation barriers for the market uptake of the advanced power electronics 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

• 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

• low domestic demand for products related to power specialisation (lack of investment in SMEs, farms and households)

• 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

• lack of standards regarding communication and transmission of information in power grids

• focus on nuclear power as a solution to the Polish energy problems and reliance on foreign technologies

• 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

## 4.4. Poland. List of literature

See examples below according to Harvard System of Referencing

(http://libweb.anglia.ac.uk/referencing/harvard.htm):

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)

Paiz - Legal framework for renewable energy projects in Poland

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)

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

# 5. Lithuania

## 5.1. Lithuanian policy and regulations

NATIONAL STRATEGY FOR ENERGY INDEPENDENCE. In this strategy, the most important aim of expected energy policies and actions – Lithuania's energy independence by 2020 assurance, strengthening Lithuania's energy security and competitiveness. Lithuania's energy independence will ensure the freedom to choose the type of energy resources and their supply sources.

**Lithuanian energy sector until 2020.**

- The strategy provides essential tasks and solutions for renewable energy increase, environmental protection and greenhouse gas reduction areas.
- In electrical energy sector the main attention is assigned to the implementation of the strategic projects and decisions that will have a crucial impact to achieve Lithuania's energy independence. This is assurance of competitive local electricity production capacity:
  - Increasing the scale of electricity production from renewable energy resources.
- In the natural gas sector, there will seek to reduce natural gas consumption by replacing them with renewable energy sources in the long term.
- In the oil sector, there will seek to change the oil products to renewable energy sources and increase competition in the Lithuanian market.
- By 2020 not less than 23 % of final energy consumption will consist of renewable energy resources (not less than 20 % in the electricity sector, not less than 60 % in the central heating sector, not less than 10 % in the transport sector).

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 power plant (LPP). Other development scenarios focus on renewable energy source power plants, cogeneration power plants 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. 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 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 produced 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 Law on RES Lithuania currently use FiT system and auctions for wind and biogas energy prodcers. For fotovoltaic FiT system was used until 2012 but now is closed. Net metering system for prosumers from 2014 is implemented.

Important role for RES regulation play also Law on Electricity where tehnical requirements for RES producers are described.

## 5.3. Lithuanian implementation barriers

The main obstacles in development of RES are bureaucratic barriers: for final start of action of power station is necessary to prepare 24 documents and it takes up to 6 month 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 system is allowed only for public entities and only up to 50 kW; limit for private prosumers - 10 kW. Still there is no permissions to construct off shore wind farms even onshore sites are already completed. There is some support for RES using income of LT from selling of green certificates, but system is very complicated and not stable therefore lose it attractiveness.

## 5.4. Lithuania. List of literature

# 6. Sweden

## 6.1. Swedish policy and regulations

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.

### PV support

In Sweden, there are several 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.
Currently the subsidy is at the level of 20 % of the total PV investment, material, work etc. included.

- **"ROT"**

(ROT = repair and maintenance, remodeling and extension) grant.
ROT can be used for the work-part of the PV installation. The level is currently at 30 %.

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 has to 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 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 fee**

Network companies cannot charge for entry subscription or replacement of electricity meters for the photovoltaic systems less than 43.5 kW, and the property is a net consumer annually. The subscription 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.

- **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.
A 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 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;

ROI today for PV micro-producer installations are in the order of 10-11 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 only one form of subsidy of wind power, 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, is 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.

**E-mobility**

“Bonus Malus” ruling is proposed by politicians to be introduced.

Eco-friendly vehicles with low emissions of carbon dioxide, a bonus at the moment of purchase, while the vehicles with high emissions of carbon dioxide have higher taxes for the first three years. It is proposed in a memorandum to the Ministry of Finance.
The proposals are part of an agreement between the government parties and the Left party before the budget proposal for the 2018th

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 will be affected by the new system are new cars, light trucks and light buses.

The memorandum contains, for example, the following proposals:

• The maximum bonus amount of 45 000 SEK given to cars that emit zero grams of carbon dioxide. The minimum bonus of 7500 SEK given to cars that emit no more than 60 grams of carbon dioxide. Gas cars get a bonus of at least 7500 SEK.

• For petrol and diesel light vehicles proposed an elevated vehicle tax (malus) during the first three years. For vehicles that run on ethanol or gas other than LPG is no malus charged.

• For vehicles not covered by the bonus-malus system the limit is reduced for when the carbon dioxide is charged to what a vehicle combined fuel releases of carbon dioxide per kilometer in addition to 95 grams, meaning a vehicle tax will be increase for most vehicles.

Supermiljöbilspremie, (Super green car rebate) is currently at a level of 40 000 SEK for All Electric vehicles.

**Charging Infrastructure**

Support for installation of charging infrastructure is provided by the Swedish Energy Agency and the Environmental Protection Agency.

The funding can be applied for from the “Klimatklivet “ ( climate stride).
All types of organizations, companies, municipalities, foundations and associations housing associations can search from climate stride. Support for the charging stations must be no more than 50 percent of the investment cost.
For charging stations for normal charging the funding may not amount to more than SEK 20 000 per charging position.
The funding is not aimed for individuals, but it is possible to seek a tax deduction for the installation of a charging point in a private home.

## 6.2. Swedish market drivers

## 6.3. Swedish implementation barriers

## 6.4. 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.

# 7. Denmark

## 7.1. Danish Policy and 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 renewable energy sources by exploiting the synergies between its different parts. Generally, it can be described as two phases:

Phase 1) Focusing on exploiting renewable energy 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 renewable energy 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 renewable energy 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[1]. This is considered an important driver for renewable energy in Denmark.

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

### 7.1.1. E-Mobility

Denmark has a well-developed charging infrastructure (figure 1) for electrical vehicles due to several foreign providers (Eon 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 and 2) a stable energy supply.

Electrical cars were exempt for registration fees until December 2015 when the government decided to, at first, to abolish the exemption completely but in 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.

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].

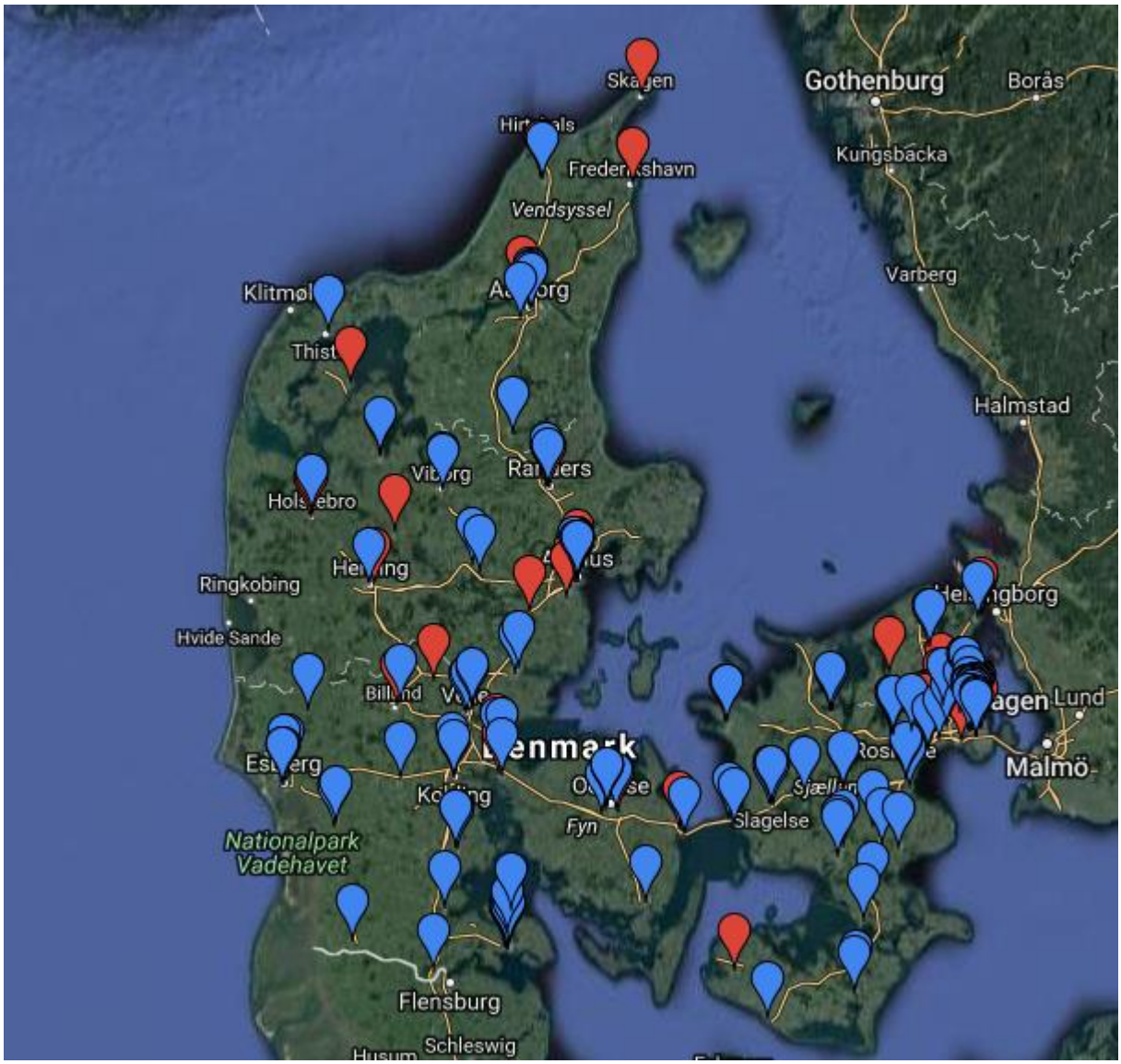



*Figure. Overview over charging stations in Denmark. The red is operated by Eon and the blue is operated by Clever. Source: [www.elbilerne.dk](http://www.elbilerne.dk)*

### 7.1.2. Renewable Energy

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 renewable energy, 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 renewable energy 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].

### 7.1.3. Smart Buildings

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 4$^{th}$ year [11]

## 7.2. Danish market drivers

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 specialisation 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)

The findings of the analysis showed that there is (see table 1:

- 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)
- 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)

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:

- 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]

## 7.3. Danish implementation barriers

As mentioned in section 3.2, 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 has 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].

Denmark has a highly-integrated energy system that is slowly transforming into an infrastructure that can handle the fluctuating reality of renewable energy sources. 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 % renewable energy is storage solutions in order to store especially the wind energy. 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]

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.

## 7.4. Tables Denmark

| Table 1 | | | | | |
|---|---|---|---|---|---|
| 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 4: The market overview for energy efficient technologies in Denmark and specifically in the Region of Southern Denmark* [12]

| Table 2 | | |
|---|---|---|
| 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] | | 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] | | 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 |
| [13] | | The Energy Technology Development and Demonstration Programme – strategy 2017-2019. 2017 The Danish Energy Agency |
| [14] | | Guidelines for Grand Solutions. 2017. Innovation Fund Denmark. |
| [15[ | | www.eon.dk. 2017. Eon Denmark |
| [16] | | www.drivenow.dk 2017. Drive Now Denmark |
| [17] | | www.tadaacar.dk 2017. Tadaa Car sharing services |

*Table 5: Translations to English from Danish of reference documents*

# 8. Germany

## 8.1. German policy and regulations

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 GPE project. There follows an overview.

### 8.1.1. E-mobility

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.

**TAKEN FROM: © Fotolia.com/Michael Flippo**

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].

### 8.1.2. Renewable Energies

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:

**Energy Industry Law (EnWG)**

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.

**Network Expansion Acceleration Law (NABEG)**

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.

**Federal Requirement Plan Law (BBPIG)**

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.

**Energetic Power Extension Law (EnLAG)**

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.

### 8.1.3. Smart Buildings

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].

## 8.2. 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].

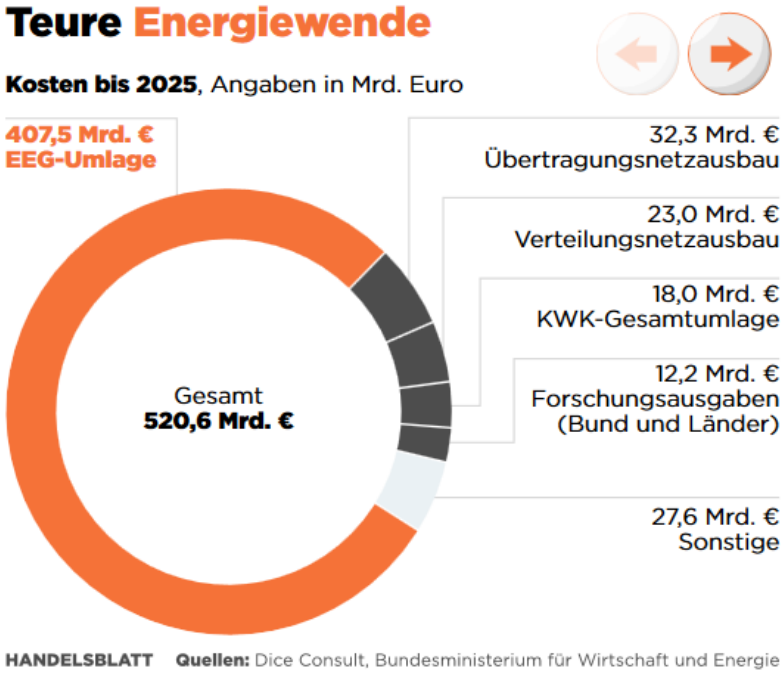
## 8.3. German market barriers

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 percent 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].

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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.

**Sources:**

[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