The transition to decentralized energy: Challenges, opportunities and progress

By

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Abstract

The European Union (EU) 2020 Energy Strategy calls for reducing the EU's greenhouse gas emissions, increasing the share of renewable energy, and achieving significant energy savings. All EU countries must also increase the share of renewable energy in their transport sectors. EU member states are at various stages of compliance. This article analyses the situations in Slovenia, Croatia, Austria, and Luxembourg. It analyses relevant governance structures in each country and identifies where regulation is conducive to the above goals and where it is acting as a barrier. Given that deregulation and decentralization are part of achieving the EU's energy strategy, the article examines where each of the four countries stands on that front and what specific initiatives and projects are underway towards greater deregulation and decentralization. Such initiatives include rollouts of smart metering systems and of electric vehicles as well as launching demand response schemes. The article also addresses relevant data protection concerns.

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I. INTRODUCTION

This article examines the state-of-the-art on energy in four European Union (EU) countries: Slovenia, Croatia, Austria, and Luxembourg. The focus is on legislation and initiatives aimed at promoting renewable energy, energy security, and tools for greater flexibility and consumer empowerment, such as smart grids and demand response mechanisms. All four jurisdictions are at varying stages when it comes to complying with the EU's 2020 Energy Strategy.[1] Slovenia was the first country in the world to be declared a green destination[2] based on the Green Destinations Criteria.[3] Its capital city, Ljubljana, was awarded the title European Green Capital in 2016[4]. As for Croatia, on 1 July 2013[5], the country became a member of the European Union and joined the EU energy market. Luxembourg has commenced a nationwide smart meter revolution. And Austria has more than tripled public funding for energy research, development and demonstration from 2007 to 2014.[6] These are a just few examples of where each country stands on achieving a 21st century approach to energy usage and generation.

Section II of the article focuses on Slovenia, Section III on Croatia, Section IV on Austria, and Section V on Luxembourg. Section VI concludes the article.

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[1] European Commission, 2020 Energy Strategy, https://ec.europa.eu/energy/en/topics/energy-strategy-and-energy-union/2020-energy-strategy.

[2] STA, *Slovenia declared world's first green country*, THE SLOVENIA TIMES (Sept. 28, 2016), http://www.sloveniatimes.com/slovenia-declared-world-s-first-green-country.

[3] The Green Destinations Standard is a system to measure, monitor and improve the sustainability of destinations and regions. It is owned by ECEAT, EUCC and Green Destinations. The Standard applies 100 criteria and 100 indicators, https://www.gstcouncil.org/green-destinations-standard/.

[4] News, *Ljubljana wins European Green Capital Award for 2016,* EUROPEAN ENVIRONMENT AGENCY (Jun. 24, 2014), https://www.eea.europa.eu/highlights/ljubljana-wins-european-green-capital-2016.

[5] Guy Delauney, *Croatia celebrates on joining EU,* BBC NEWS (Jul. 1, 2013), https://www.bbc.co.uk/news/world-europe-23118035.

[6] International Energy Agency, country profiles. See: https://www.iea.org/news/iea-praises-austria-for-well-balanced-energy-policy-but-sees-areas-for-further-improvement.

II. SLOVENIA

1. ENERGY PROFILE

Flexible, available, reliable, and affordable electric power is key to the growth and stability of contemporary states, and consequently the smart grid concept is becoming an increasingly important factor in power generation, transmission, and distribution.

1.1. Energy mix in Slovenia

In the years following the 2012 Eurozone crisis the Slovenian economy has been steadily recovering (a 4.1% in GDP for 2018 compared to the previous year) [7]. As stated by Ulicar i Bozicko, 'the country's overall energy demand is increasing and this is reflected in all energy markets'[8].

Slovenia only has one nuclear power plant (NPP)[9], the NEK (*Nuklearna Elektrarna Krško*) located in Virbia in the Municipality of Krško[10]. It was built as a joint venture[11] between Slovenia and Croatia, which were at the time both part of Socialist Federal Republic of Yugoslavia. 'Half of all electricity produced at Krško (approximately 2,983 GWh) was transmitted to the Republic of Croatia based on the bilateral treaty, yet the plant still supplied 40% of all the electricity generated in Slovenia'[12]. The various energy sources and their place in the market and electricity market are shown in Table 1.

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[7] Slovenian GDP. Country Economy, *available at* https://countryeconomy.com/gdp/slovenia?year=2018.

[8] Matjaž Ulčar, Polona Božičko, *Slovenia*, *in* ENERGY 2019 […] (7th ed. 2019).

[9] *Country Nuclear Power Profiles: Slovenia,* INT'L ATOMIC ENERGY AGENCY (2018), https://cnpp.iaea.org/countryprofiles/Slovenia/Slovenia.htm.

[10] 'The plant was connected to the power grid on October 2nd 1981 and came on-stream on January 15th 1983.' INT'L ATOMIC ENERGY AGENCY, COUNTRY NUCLEAR POWER PROFILES: SLOVENIA § 2.1.1 (2018), https://cnpp.iaea.org/countryprofiles/Slovenia/Slovenia.htm.

[11] *Id.*

[12] *Country Nuclear Power Profiles: Slovenia,* INT'L ATOMIC ENERGY AGENCY (2018), https://cnpp.iaea.org/countryprofiles/Slovenia/Slovenia.htm; AGENCIJA ZA ENERGIJO, REPORT ON THE ENERGY SECTOR IN SLOVENIA 2017 20 (2017).

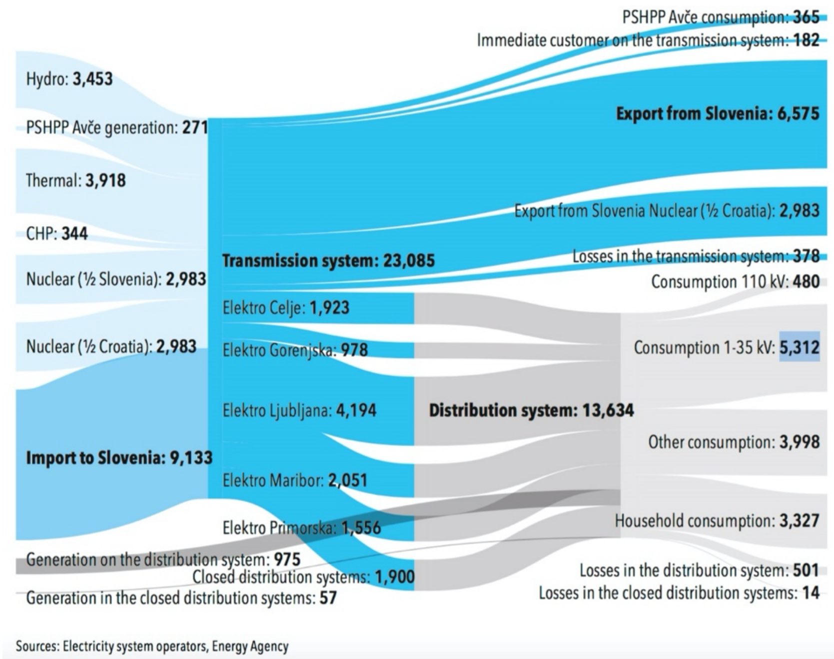
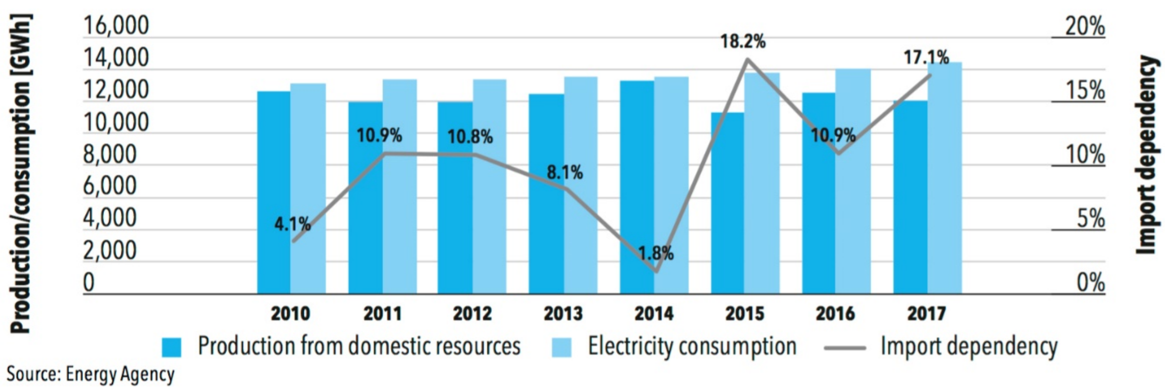


Table 1 – Balance between electricity supply and demand on the transmission and distribution system in 2017 in GWh[13]

1.1.1. Electricity

The Krško NPP still accounted for 40% of all electricity generated in Slovenia last year. The country's energy report states that 'renewable energy sources contributed 30% (hydro power, wind power, solar power, biomass) and fossil fuels provided the remaining 30% of generated electricity. Domestic production covered 82.9% of Slovenian electricity consumption and the country's import dependence was 17.1%.'[14] Table 2 illustrates the stable dynamics of production from domestic resources (82.9%) in the period from 2013 to 2017[15] and a growing dependency on imports.



[13] *Id.* at 14.

[14] *Id.* at 15.

[15] *Id.* at 16.

Table 2 – Electricity production, consumption and import dependency in the period 2013-2017[16]

According to provisional data from the Slovenian office of statistics in December 2018, 'Slovenia's net electricity production increased by 12% month-on-month to 1479 GWh' in November 2018', while total electricity production 'increased by 6 GWh to 1209 GWh.' [17] In the same period 'the output of hydro power plants increased by 70%, while the output of thermal power plants fell by 3%' Krško Nuclear Plant's electricity production dropped by 2% and fuel consumption decreased by 1%. Finally, Renewable Now[18] states that, 'Slovenia imported 560 GWh of electricity and exported 828 GWh' in November 2018.

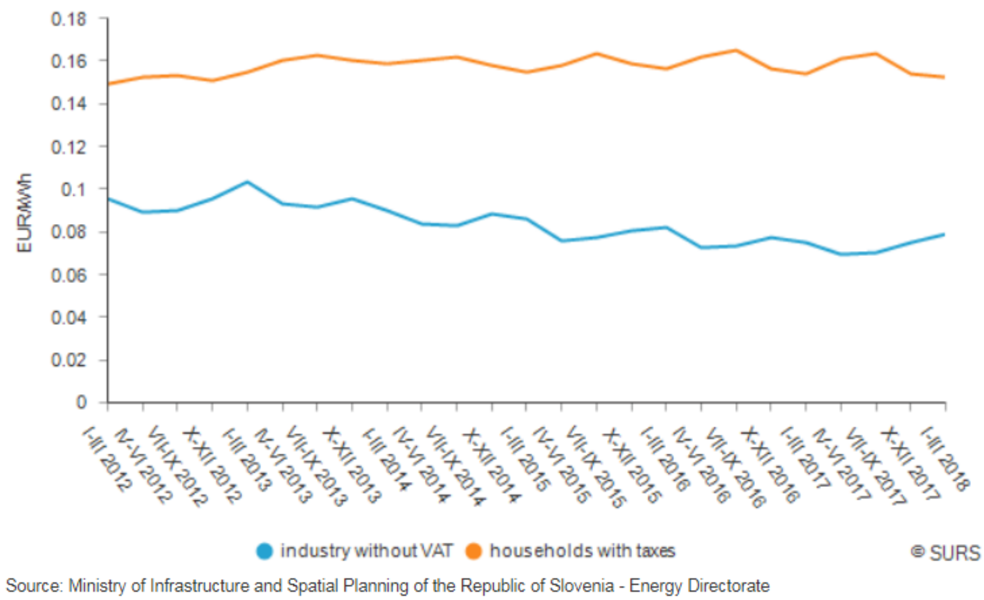


Table 3 – Electricity prices from March 2012 to April 2018, Slovenia[19]

Table 3 above shows SURS data on electricity price dynamics from 2012 to 2018 (in orange). It can be seen that the average electricity price for households in the first quarter of 2018 decreased by 1% over the previous quarter and is equivalent to 0.15 EUR/kWh[20]. The graph also shows a 5% increase in the average electricity price[21] without value added tax for industry (0.08 EUR/kWh) over the same period (in blue).

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[16] *Id*. at 23.

[17] Klaudjo Jonuzaj, *Slovenia's Net Power Output Rises in Nov*, RENEWABLES NOW (Dec. 27, 2018, 12:56 PM), https://renewablesnow.com/news/slovenias-net-power-output-rises-in-nov-637853/.

[18] *Id.*

[19] SURS Statistical Office of the Republic of Slovenia. *Prices of Energy Sources, Slovenia, 1st quarter 2018*, *available at* https://www.stat.si/StatWeb/en/News/Index/7260.

[20] *Id.*

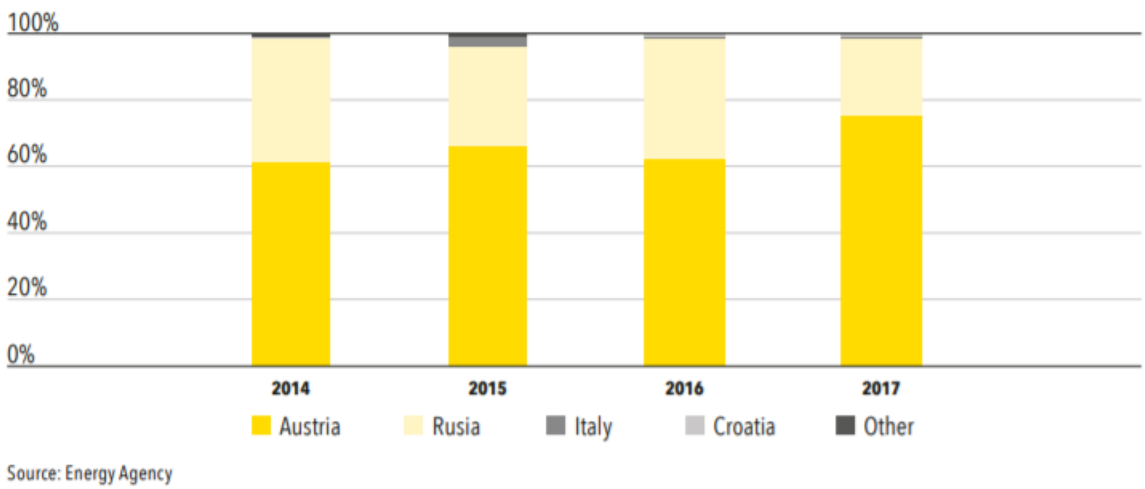
[21] *Id.*

In Slovenia there are nine companies that operate large power facilities with a capacity of over 10 MW: [22]

- Šoštanj Thermal Power Plant (TEŠ),
- Nuclear Power Plant Krško (NEK),
- Drava Electric Power Plant Maribor (DEM),
- Sava Electric Power Plant Ljubljana (SEL),
- Soča Hydro Power Plant (SENG),
- Spodnji sava Hydro Power Plants (HESS),
- Brestanica Thermal Power Plant (TEB),
- Energetika Ljubljana (JPEL),
- HSE – Energy Holding Trbovlje (HSE ED Trbovlje).

1.1.2. Natural gas

Slovenia has no domestic sources of natural gas. The same situation is true for natural gas storage and liquefied natural gas (LNG) terminals[23]. Consequently, the natural gas market is limited to imports of natural gas through neighbouring transmission systems from Austria, Italy and Croatia[24] (Table 4). Prior to independence, Slovenia had long-term contracts with natural gas producers from Russia. These contracts have either been replaced, or are in the process of being replaced with short-term contracts with gas hubs, power exchanges etc. The same graph[25] shows that 75% of natural gas was imported from Austria in 2017.



[22] AGENCIJA ZA ENERGIJO, REPORT ON THE ENERGY SECTOR IN SLOVENIA 2017 18-19 (2017).

[23] Matjaž Ulčar, Polona Božičko, *Slovenia*, *in* ENERGY 2019 […] (7th ed. 2009).

[24] *Id.*

[25] *Id.*

Table 4 – Natural gas sources in the period 2014–2017[26]

The same source reveals that natural gas consumption increased in 2017 for all consumer groups in the Slovenian market for the third consecutive year, totalling some 900 million Sm³ or 9678 GWh[27]. Volumes of natural gas distributed to consumers in closed distribution systems (CDS') rose by more than 3.6%[28]. Various factors, such as weather conditions, a reliable supply with competitive natural gas prices, favourable economic conditions, together with other factors are resulting in higher consumption. [29]

Plinovodi d.o.o.[30]**,** a private company, manages the natural gas transmission system. 2017 Energy Agency Report[31] describes the structure of the transmission system (TSO) :

'The system consists of 947 kilometres of high-pressure pipelines with a nominal pressure of more than 16 bars and 211 kilometres of pipelines with a nominal pressure less than 16 bars. The transmission system also consists of 200 metering-regulation stations, 42 metering stations, seven reducing stations, and compressor stations in Kidričevo and Ajdovščina. The Slovenian gas transmission system is connected to the gas transmission networks of Austria (Ceršak MRS), Italy (Šempeter MRS) and Croatia (Rogatec MRS) '. The border points are also relevant points of the transmission system (see Table 5). Gas trading on the wholesale market is collected at virtual points.

The same source[32] reports that distribution of natural gas is carried out as a service of general economic interest by a DSO for general consumption of gas in towns and settlements and for distribution of gas to industrial and business consumers on closed distribution systems (CDS). In 2017, 35 consumers were recorded in three CDS areas (Jesenice, Kranj and Kidričevo), a first for Slovenia. 612 GWh of natural gas were distributed to consumers in these areas. Access to CDS' is only available to customers within the closed area of these systems. [33]

[26] AGENCIJA ZA ENERGIJO, *supra* note 22, at 140.

[27] AGENCIJA ZA ENERGIJO, *supra* note 22, at 110.

[28] *Id.*

[29] *Id.*

[30] AGENCIJA ZA ENERGIJO, *supra* note 22, at 111; Plinovodi d.o.o., *Connected with Energy*, http://www.plinovodi.si/en/.

[31] *Id.*

[32] *Id*. at 112.

[33] *Id*. at.112-13.

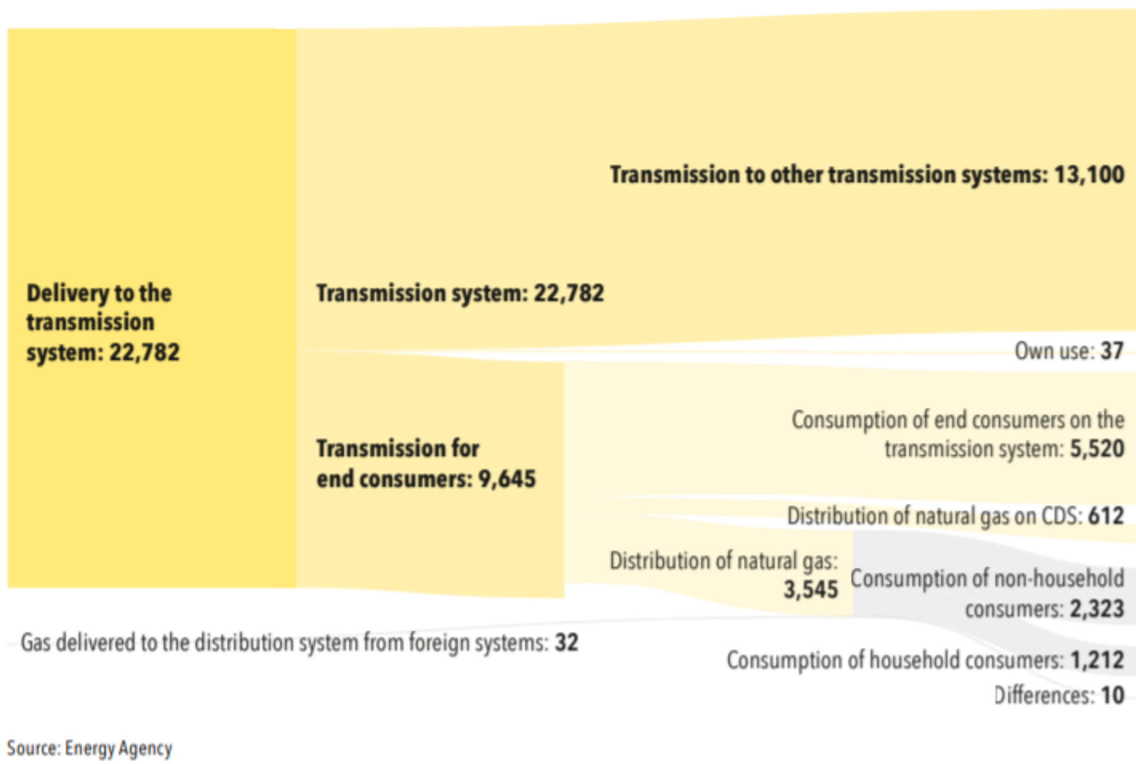


Table 5 – Delivered, distributed and consumed quantities of natural gas in 2017 in GWh[34]

Since 2016 the level of investment in gas transmission has been gradually increasing. A 2017 Report[35] indicated that TSO invested EUR 10.8m in the transmission system, 47% more than the previous year. Investments in expansion and reconstruction amounted to EUR 4.5m, and other investments totalled EUR 6.4m - or 75% more than 2016. The TSO started with the construction of the R38 Kalce–Godovič transmission pipeline, which is also intended to connect the distribution system supplying the municipality of Idrija[36]. As shown in Table 6, 'in metering-regulation station Rogatec the distribution system for the municipality of Rogatec was connected, which was previously connected to the Croatian distribution system. Renovation of the transmission pipeline M1 – crossing the Zlatoličje Channel and section of the pipeline R26 Dešen on a landslide area - was completed.' [37] When work began to enable bidirectional flow at metering-regulation station Rogatec, the preparations of projects for obtaining the status of PCI continued. The Energy Agency approved the 'Ten-Year Network Development Plan of the Gas Transmission Network for the Period 2018–2027'[38]. The Slovenian development plan is complemented by the 'Ten-Year

[34] *Id*. at 110.

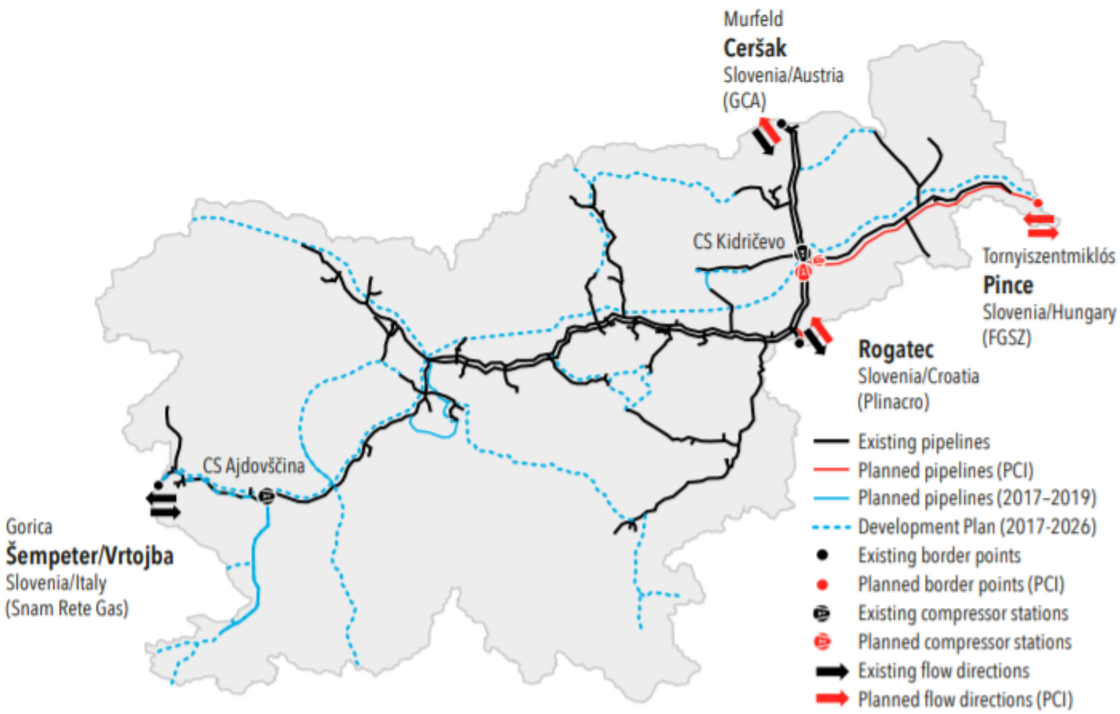
[35] *Id*. at.124.

[36] *Id*. at.125.

[37] *Id*.

[38] Plinovodi d.o.o., *Extended summary of ten-year gas transmission network development plan for the 2018 – 2027 period*, http://www.plinovodi.si/wp-content/uploads/2011/09/extended_summary_tyndp_2018-2027.pdf.

Network Development Plan by ENTSOG TYNDP2017'[39]. At the same time, the Energy Agency also approved the Investment Plan for the period 2018-2020[40].



Source: Plinovodi

Table 6 – Natural gas transmission system in December 2017[41]

Number of consumers according to consumption type	2016	2017	Index
Business consumers on the transmission system	132	135	102.27
Business consumers on distribution systems	13,724	13,782	100.42
Business consumers on closed distribution systems	34	35	102.94
Household consumers	119,583	119,678	100.08
Total	133,473	133,630	100.12

Source: Energy Agency

[39] European Network of Transmission System Operators for Gas (ENTSOG). *The Ten-Year Network Development Plan*, *available at* https://www.entsog.eu/tyndp#entsog-ten-year-network-development-plan-2020.

[40] AGENCIJA ZA ENERGIJO, REPORT ON THE ENERGY SECTOR IN SLOVENIA 2017, 125 (2017).

[41] *Id*. at 125.

Table 7 – Number of consumers according to consumption type in 2016 and 2017[42]

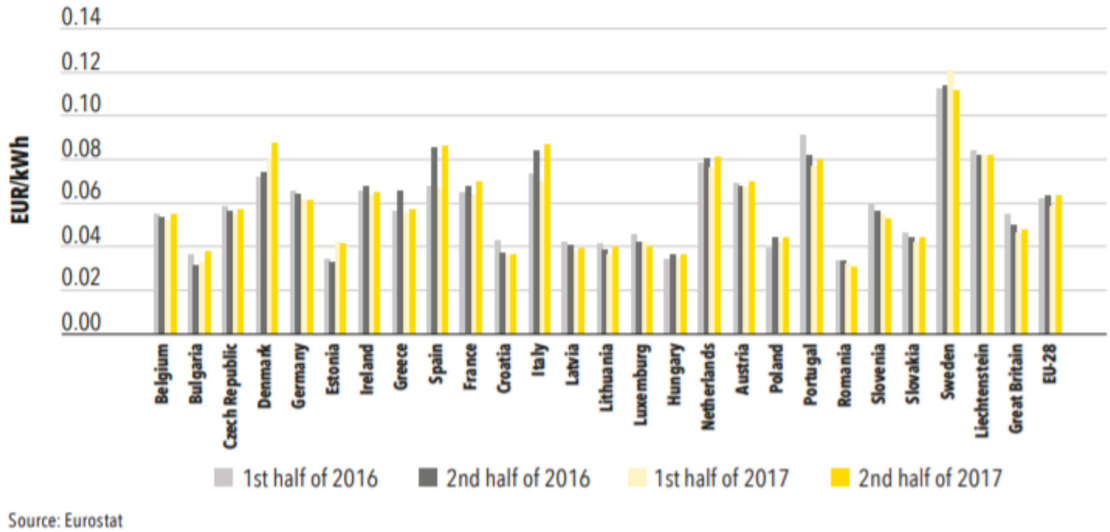
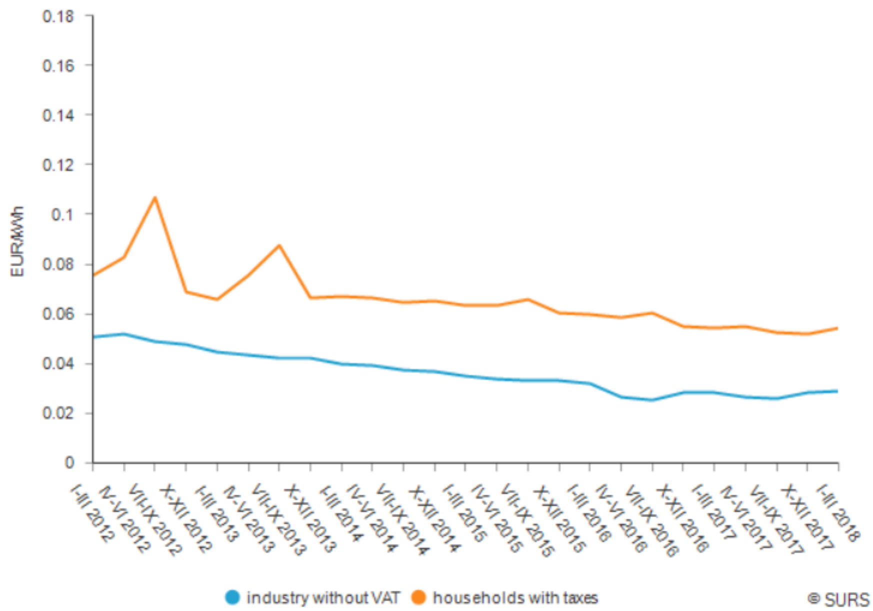


Table 8 – Final natural gas prices including all taxes and levies for typical household consumers (D2) in Slovenia and other EU countries in 2016 and 2017[43]

The figure for business and household consumers, as shown in Table 7, remained virtually static between 2016 and 2017. The final prices of natural gas dynamics for typical household consumers in Slovenia remained below the EU-28 average level, illustrated in Table 8.

[42] *Id.* at 111.

[43] *Id.* at 146.



Source: SURS

Table 9 – Natural gas prices dynamics from March 2012 to April 2018[44]

Table 9, which shows SURS data on natural gas prices dynamics over the last 6 years, reveals that the average natural gas prices for households in the first quarter of 2018 increased by 4% over the previous quarter and was equivalent to 0.05 EUR/kWh. The same period saw a 3% increase in the average electricity price (excluding value added tax) for industry (0.03 EUR/kWh).

'As a Member State of the European Union, Slovenia has committed itself to promoting the use of renewable sources for energy consumption, especially for electricity generation.' [45] This has major implications for the country's national energy policy, bringing as it does significant direct and indirect benefits. 'The EU Renewable Energy Directive 2009/28/EC sets a mandatory national target for each Member State, stating the overall share of gross energy consumption that must come from renewable energy sources by 2020. For Slovenia, this target has been set at 25%.' [46]. According to the abovementioned energy report[47], 21.8% of energy consumption in Slovenia came from RES in 2017.

'The most utilized energy source for electricity production in Slovenia is water, since there are more than 375 small hydro power plants.' [48]. It has an abundance of the resource, with 59 major rivers running across the country, of which the Drava and Sava are the most important. 'Hydro power plants (small and big) represent the highest share among RES and also for the future the highest potential in Slovenia. Beside renovation of old hydro power plants and construction of 5

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[44] SURS Statistical Office of the Republic of Slovenia. *Prices of Energy Sources, Slovenia, 1st quarter 2018*, *available at* https://www.stat.si/StatWeb/en/News/Index/7260.

[45] Matjaž Ulčar, Polona Božičko, *Slovenia*, *in* ENERGY 2019 […] (7th ed. 2009).

[46] *Id.*

[47] AGENCIJA ZA ENERGIJO, REPORT ON THE ENERGY SECTOR IN SLOVENIA 2017, 24 (2017).

[48] INTELLIGENT ENERGY EUR., SLOVENIA RES-E MAP: ELECTRICITY FROM RENEWABLE ENERGY SOURCES 7.

new hydro power plants on river Sava, the main potential is indicated on the field of combined heat and power from biomass and construction of wind power plants.'[49]

In order to incentivise auto manufacturers which have the ability to generate electricity from renewable energy sources, a feed-in tariff system is in effect in Slovenia. Held et al.[50] state that 'the Feed-in Tariff System is fully compliant with EU legislation regarding state aid, and was approved in May 2009. The 2009 Government Decree on financial support for electricity produced from RES uses the feed-in principle'. The Res-e Regions project study defines this as 'prices for individual classifications of qualified producers using different types of renewable energy sources are different and also depend on the generating capacity of the power plant. […]The government, or other competent agency, defines a buying price and obligates electrical energy distributors to buy the electricity.' [51]

The study also indicates that the region has a significant potential to harness solar energy for electricity production. However, due to high initial investment costs and a low level of system efficiency, solar power plants are expensive to construct and maintain, with these costs often making the price of solar electricity higher than that generated from any other renewable source.

1.2. Transmission System Operator

Slovenia's sole transmission system operator for electric power is ELES, a state owned company[52]. It is tasked with ensuring the efficient operation of the transmission line network and supplying electricity to consumers. Furthermore, ELES purchases and sells the electricity to the distribution companies and to the larger end-consumers. The company provides live online information on the transmission network. Table 10 illustrates sample activity of 400 kW and 220 kW transmission lines on January 9th 2019.

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[49] *Id.*

[50] Held, A., Ragwitz, M., Resch, G., Nemac, F., Vertin, K. *Feed-In Systems in Germany, Spain and Slovenia -A comparison-* December 2010, 24, *available at* http://www.mresearch.com/pdfs/docket4185/NG11/doc44.pdf

[51] INTELLIGENT ENERGY EUR., SLOVENIA RES-E MAP: ELECTRICITY FROM RENEWABLE ENERGY SOURCES 7, *available at* http://www.res-regions.info/fileadmin/res_e_regions/ULFME_Technology_map_en_01.pdf

[52] ELES – Elektro – Slovenija, d.o.o. *About the company*, https://www.eles.si/en/about-the-company.

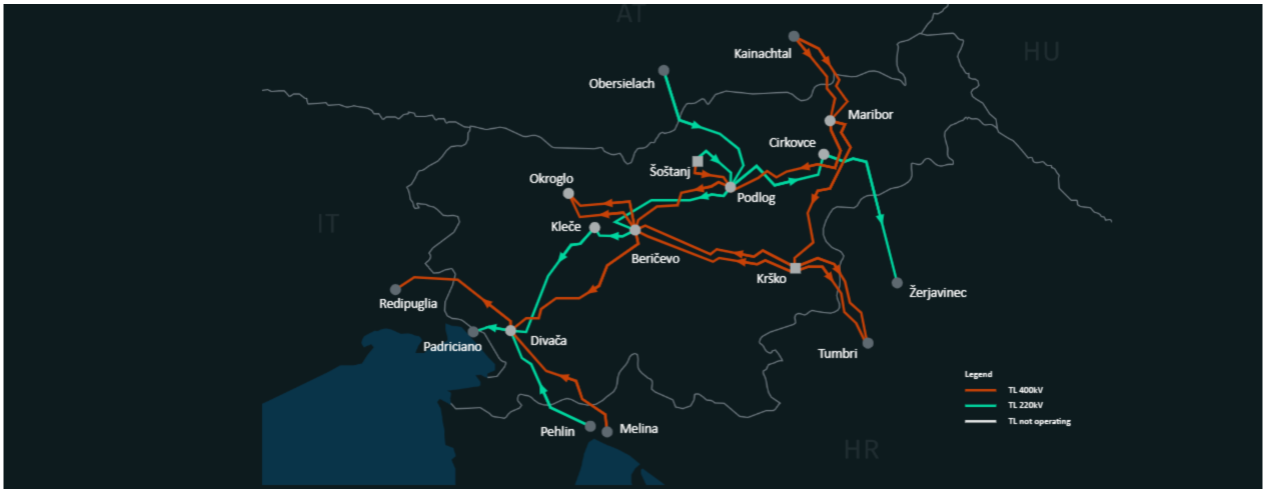

Table 10 – Transmission Network on January 9th , 2019, 17:30 (CET) [53]

The main electricity distributors in Slovenia are[54]:

- Elektro Ljubljana d.d.,
- Elektro Maribor d.d.,
- Elektro Celje d.d.,
- Elektro Primorska d.d,
- Elektro Gorenjska d.d.

SODO d.o.o.[55] is a single distribution system operator in Slovenia, established by the state in 2007 and still state-owned. It received a DSO licence from the Slovenian Energy Agency in the same year, as well as the right to distribute electricity for the next 50 years, which was explicitly identified as a public service. Five listed main distribution companies are contracted by SODO d.o.o. for the lease of infrastructure for the distribution of electricity to end-consumers in different regions of Slovenia, as detailed in the Slovenia RES-Integration report[56].

2. GOVERNANCE SYSTEM: Support schemes and selection bases

'The national legal basis for the RES and CHP support scheme is regulated by the Energy Act, the Decree on the method of determining and calculating the contribution for ensuring support for the production of electricity from high-efficiency cogeneration and renewable energy sources,8 and the Decree on support for electricity generated from renewable energy sources and from high-

[53] ELES – Elektro – Slovenija, d.o.o. *Transmission network*, https://www.eles.si/en/transmission-network.

[54] Matjaž Ulčar, Polona Božičko, *Slovenia*, *in* ENERGY 2019 […] (7th ed. 2009).

[55] *Id.*

[56] Vesna Mokorel, RES-INTEGRATION - Country report Slovenia. Integration of electricity from renewables to the electricity grid and the electricity market (2011), https://www.eclareon.com/sites/default/files/slovenia_-_res_integration_national_study_nreap.pdf.

efficiency cogeneration.'[57]. This Act details the method used for ensuring support for the production of electricity from RES and high-efficiency cogeneration.

The scheme had to comply with relevant EU legislation on state aid in order to avoid falling foul of EU principles of fair competition between member states[58]. 'The support scheme had to be harmonized with the EU legislation on state aid and was successfully notified and approved by the European Commission decision SA.41998 of October 10, 201610 as a permitted form of state aid'[59]. More than 2,500 producers (3,864 production facilities) had been included in the support scheme by the end of 2017.

'Under the initial support scheme (approved by European Commission decision no. SA.28799), operators of eligible installations were automatically entitled to the support.' [60] After January 1st 2017 all beneficiaries had to be selected through a competitive two-phase tender.

In respect of cogeneration of heat installations, the EU rules state that aid may only be granted to high-efficiency cogeneration installations as defined in the 'Guidelines on state aid for environmental protection and energy 2014–2020'. Table 11 illustrates a review of projects submitted in 2016 and 2017.

		Public tender – December 2016		Public tender – September 2017	
Technology	**renovated/new**	**number of projects**	**Installed capacity (MW)**	**number of projects**	**Installed capacity (MW)**
Hydro power plants	new	25	7.80	11	6.07
Hydro power plants	renovated	26	3.47	14	3.68
Solar power plants	new	105	12.33	84	17.00
Wind power plants	new	41	56.19	70	139.65
Power plants on wood biomass	new	39	11.89	21	13.56
Biogas power plants – waste	new	3	0.41		
Power plants using biogas from wastewater treatment facilities	new	1	0.20	1	0.20
Biogas power plants	new	3	6.03		
CHP using fossil fuels	new	26	6.67	29	9.98
CHP using fossil fuels	renovated	6	19.15	2	4.19
All submitted projects		**275**	**124.14**	**232**	**194.32**

Source: Energy Agency

Table 11 – Review of projects submitted to public tender, compiled by electricity

[57] Matjaž Ulčar, Polona Božičko, *Slovenia*, *in* ENERGY 2019 […] (7th ed. 2009).

[58] *Id.*

[59] *Id.*

[60] *Id,*

generation technology [61]

The number of completed public tenders for the support scheme are an encouraging sign, revealing a high degree of interest among potential investors to invest in renewable energy systems and cogeneration of heat installations facilities.

As for wind power plants, the construction of wind power plants in Slovenia is very complex and time-consuming due to the geographic characteristics of the country. Currently, wind power plants contribute only approximately 3MW of rated electric power in the support scheme, according to the 2017 Energy Report[62].

Nevertheless, Table 12 shows that the sector is continuing to grow and gives an indication of the huge potential for wind electricity generation in Slovenia in the coming years, in addition to projected increases in RES and CHP.

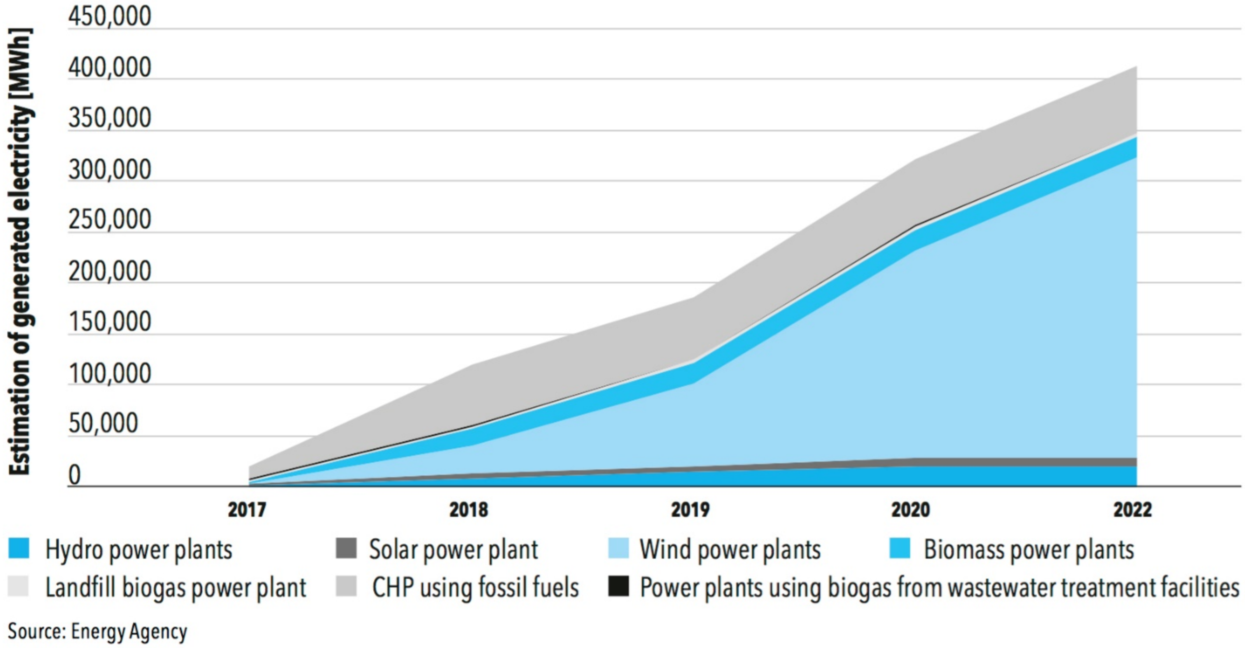

Table 12 – Estimation of the additional electricity generated by implementation of all selected projects for RES and CHP generating plants within both public tenders[63]

3. ELECTRICITY MARKET

3.1. Regulatory framework

The Slovenian Energy Agency is continuing to adhere to the guidelines it adopted on the active regulation of energy activities, and also those covering future networks. The SEA's focus is on identifying suitable solutions to improve the regulatory framework, if and where appropriate. It

[61] AGENCIJA ZA ENERGIJO, REPORT ON THE ENERGY SECTOR IN SLOVENIA 2017 28 (2017).

[62] *Id*. at 30.

[63] *Id.*

has been prioritising the introduction of smart grids to enable flexibility, accessibility, reliability of the electricity supply, and cost-efficiency. The concept of the smart grid also encompasses investment in innovative metering infrastructure. The SEA has concluded that 'pilot projects and the results of cost-benefit analysis show that the advanced metering infrastructures in Slovenia offer much more than simple measurements and the transmission of measurement data, and because of lower operational costs the introduction for all users would be a rational decision'[64].

According to a recent report covering the 2017-2018 period,[65] 'the adoption of further key acts for implementation of the Energy Act (and implementation of the EU Third Package of energy legislation) continued, inter alia, by adopting the following acts:'

- Rules on the balancing of the electricity market[66]
- A Decree establishing the infrastructure for alternative transport fuels[67]
- The methodology determining the regulatory framework for the electricity distribution system[68]
- The methodology for determining the regulatory framework for gas distribution[69]
- The methodology for determining network charges for natural gas distribution
- Cyber and information security provisions[70]
- A 2015 amendment which altered the tender process (from a one to two-round public tender process)[71]

The most significant amendment to the scheme is the introduction of a tender process to select its beneficiaries, and to determine the exact level of support they receive. Slovenia has introduced a two-round public tender process designed to make it more competitive and ensure that support is granted to the best-value projects. The European Commission[72] has assessed the scheme and concluded that the measure is compatible with the internal market. This measure will expire on December 31st 2019.

The legal framework for smart grid development is laid out in the Energy Act[73] ("*Energetski zakon*"). The Slovenia RES-Integration report[74] states that 'the Energy Act regulates the generation, transmission, sale, export, import and transit of electricity and the economic and technical management of the power system'. It also prescribes the main principles for the

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[64] The Energy Agency. Slovenia. *Smart Grids*. Available from: https://www.agen-rs.si/web/en/smart-grids

[65] Matjaž Ulčar, Polona Božičko, *Slovenia*, *in* ENERGY 2019 n.19 […] (7th ed. 2009).

[66] *Id.* n.21

[67] *Id.* n.22

[68] *Id.* n.23.

[69] *Id.* n.24.

[70] *Id.* n.25.

[71] *Id.* n.25

[72] *Id.*

[73] Energetski zakon – EZ-1 (Uradni list RS, št. 17/14 z dne 7. 3. 2014) (https://www.energetika-portal.si/fileadmin/dokumenti/zakonodaja/energetika/ez-1/ez-1_energy_act_proposal.pdf)

[74] RES-Integration. Country report Slovenia. Integration of electricity from renewables to the electricity grid and the electricity market. 2011. P.19. Available from: https://www.eclareon.com/sites/default/files/slovenia_-_res_integration_national_study_nreap.pdf

connection of RES plants to the grid. The same document[75] two other important legal sources are identified; the 'Regulation on general conditions for the supply and consumption of electricity valid for transmission system operator'[76] and the 'General conditions for the supply and consumption of electricity valid for the distribution system operator'[77]. Different companies are expanding the smart grid pilot in Slovenia, such as the 'New Energy and Industrial Technology Development Organisation' (NEDO), Siemens and Slovenian's own ELES.

The Slovenian Ministry of Economic Development and Technology signed a memorandum of cooperation[78] last October to expand the 'Smart Community Demonstration Project' until March 2021, aiming 'to improve security and to prevent power outages through autonomous operation during a grid failure, ensure the quality of factory electricity through voltage dip mitigation measures, and provide frequency control to electricity transmission system operators.' [79] At the signing, NEDO announced that 'the parties will integrate an advanced cloud-based energy management system with a battery energy storage system installed on consumer sites'.

Smart Energy International[80] states that the pilot is being implemented in part as a result of Slovenia's difficulties in meeting an increasing demand for energy, and 'will be used to develop a business model to expand Europe's portfolio of distributed resources integrated with the main grid.'

3.2. Energy security dimension

The integration of renewable energies into the Slovenian grid is vital to maximise utility operations, as well as to pilot and adopt new technologies and infrastructure.

As a result of the increased level of interconnections (see Figure 1), Slovenia is now more integrated into the single European electricity market; stronger coordination between energy markets is bringing tangible benefits to end-consumers. It is also helping to strengthen the Slovenian electricity price index SIPX[81].

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[75] Ibid, p.20.

[76] Uredba o splošnih pogojih za dobavo in odjem električne energije. Uradni list RS, št. 117/02, 21/03 – popr., 51/04 – EZ-A, 126/07 in 37/11 – odl. US. Available from: http://www.pisrs.si/Pis.web/pregledPredpisa?id=URED2654

[77] Splošni pogoji za dobavo in odjem električne energije iz distribucijskega omrežja električne energije. Uradni list RS, št. 126/07, 1/08 – popr., 37/11 – odl. US in 17/14 – EZ-1 Available from: http://www.pisrs.si/Pis.web/pregledPredpisa?id=DRUG2905

[78] NEDO. New Energy and Industrial Technology Development Organisation. *News List*. October 2, 2018. Available from: https://electricenergyonline.com/article/organization/33246/723619/NEDO-Amended-MOC-MOM-and-MOU-with-the-Government-of-the-Republic-of-Slovenia-to-Start-Cloud-Based-Advanced-Energy-Management-System-Demonstration-Project.htm

[79] *Id.*

[80] Smart Energy International. *Slovenia expands Smart Community Demonstration*. September 28, 2018 Available from: https://www.smart-energy.com/industry-sectors/business-finance-regulation/slovenia-expands-smart-community-demonstration/

[81] SURS Statistical Office of the Republic of Slovenia. *Prices of Energy Sources, Slovenia, 1st quarter 2018* Available on: https://www.stat.si/StatWeb/en/News/Index/7260

The frequent outages in the Slovenian electricity system - primarily a consequence of ageing infrastructure - have acted as a stimulus for the state to replace the conventional grid with smart grid technology.

On December 12th 2017, an unfortunate chain of events resulted in a tragic accident at the Baumgarten natural gas hub located on the Austrian-Slovakian border.[82] The hub suffered a fire, followed by an explosion which interrupted the supply of natural gas at the Ceršak entry point for several hours. Slovenia has no storage facilities and is highly dependent on natural gas transfer from Austria. The government responded to the accident by importing gas from Italy, which is in turn dependent on Russian supply for almost one third of its demand. The result was confusion in the market and a price rise. Consumer supply was not disturbed and the gas transmission system worked properly. However, this incident raised serious concerns relating to the security of the country's gas supply.

Figure 1 – Interconnections in the 2030 EU power system model[83]

Slovenia's primary focus is on finding innovative solutions which will lead to greater grid flexibility. It is particularly important for cross-border projects. The 'Sincro.Grid' is a smart grid investment project of pan-European importance, which is being rolled out in the territory of Slovenia and Croatia.[84] The Sincro.Grid PCI, co-financed by the Connecting European Facility

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[82] BBC NEWS. *Austria gas plant burns after deadly explosion*. (Dec. 12, 2017), https://www.bbc.co.uk/news/world-europe-42321217

[83] IRENA, *Renewable Energy Prospects for the European Union,* (February 2018), https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Feb/IRENA_REmap_EU_2018.pdf, following p. 61.

[84] SINCRO.GRID. *About the Project*, https://www.sincrogrid.eu/en/About-the-Project

fund, aims to respond to Slovenia and Croatia electricity grid's challenges.[85]

The project is predicated on the successful cooperation between the power systems of Croatia and Slovenia through the construction of the 400 kV TESLA loop.[86] Similar political transformations in the 1990's and legislative changes after 2000 in these two countries have left them with a system that was designed to operate in different conditions.[87]

There are numerous similarities between the technical deficiencies of Slovenia and Croatia. This has consequently led to a search for a joint, collaborative, solution with a focus on smart grids, between the transmission system operators (HOPS and ELES) and distribution networks (HEP – ODS and SODO) of Croatia and Slovenia (Figure 2).[88]

Figure 2 – Project partners (after image on the 'Sincro.Grid' project website).[89]

The partners in the 'Sincro.Grid' project have assembled various traditional and novel approaches in a smart grid package, which includes investment in infrastructure, technology and processes.

The transmission system operator will manage the project, with each operator having responsibility for the implementation of new technologies in their respective systems. The monitoring of the distribution grid operators will also be strengthened. Moreover, the control centres of distribution and transmission grid operators will be connected via ICT infrastructure and integration systems (primarily using the semantic Common Information Model – CIM).[90]

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[85]. INNOVATION AND NETWORKS EXECUTIVE AGENCY, *Connecting Europe Facility*, https://ec.europa.eu/inea/en/connecting-europe-facility

[86] European Union, *Candidate PCI projects in the thematic are of smart grids in view of preparing the 4th PCI list,* https://ec.europa.eu/info/sites/info/files/detailed_information_about_smart_grids_candidate_project_for_consultation.pdf

[87] *Id.*

[88] SINCRO.GRID, *Consortium,* https://www.sincrogrid.eu/en/Consortium

[89].SINCRO.GRID, *Presentation of the project at E.DSO for Smart Grids Project Committee,* (Dec. 14. 2018) https://www.sincrogrid.eu/en/News/ArticleID/139/Presentation-of-the-project-at-E-DSO-for-Smart-Grids-Project-Committee

[90] European Union, *supra* note 86

The main goal of the project is to establish operating conditions that will provide for increased generation from renewable energy sources and dispersed generation, as well as greater potential for their penetration into distribution and transmission grids in Croatia and Slovenia.[91] Consequently, it expects to increase transfer capacities through the dynamic monitoring of overhead transfer capacities (DTR).[92]

Additionally, the project aims to ensure technical control of dedicated and non-dedicated sources of reactive power and establish the control and centralized management of generation from renewable energy sources and system variables on the high-voltage and medium-voltage networks of Croatia and Slovenia.[93] Another objective of the project is to alleviate local power flows in the 110 kV grid and provide alternative ancillary services (secondary regulation) in a range of up to 12 MW.[94] The project also aims to introduce real-time control of the operational limits of network elements.[95]

Other important elements of the project focus on monitoring of distribution and transmission networks by the use of advanced tools for the assessment of operating limits (SUMO).[96] This system enables improved utilisation of the extant infrastructure, thanks to the implementation of dynamic operational limits in accordance with weather conditions.

Additional objectives include improving the monitoring of RES, the communication platform for the DSM tertiary reserve, introducing real-time control of operational limits and guaranteeing an "[a]dditional 5 MW of tertiary reserves provided through Demand Side Management by establishing a common communication platform that will allow for provision of more accurate data to the TSO".[97]

Another significant international project is the abovementioned Slovenian-Japanese Smart Grids demonstration project.[98] 'Total Slovenia' has reported that the project is entering its second phase,

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[91] *Id.*

[92] *Id.*

[93] *Id.*

[94] *Id.*

[95] *Id.*

[96] SOUVENT, A., KOSMAC, J., PANTOS, et al., *SUMO- a system for real-time assessment and short-term forecast of operational limits in the Slovenian transmission network*. Poster on First South East European Regional CIGRÉ Conference - Portoroz, Slovenia, (June. 7-8, 2016), http://hro-cigre.hr/downloads/SEERC_CD/papers/posters/P13_poster.pdf

[97] VASILJEVSKA, J., GRAS, S., FLEGO, G, *Evaluation of Smart Grid projects for inclusion in the third Union-wide list of Projects of Common Interest, (2017), https://publications.jrc.ec.europa.eu/repository/bitstream/JRC107348/jrc_smart_grid_pci_science_for_policy_report_2017_gk_final.pdf , following p. 47*

[98] Branislava Jovičić, *ELES joins Japanese-Slovenian smart grids project*. (Dec. 17, 2015), https://balkangreenenergynews.com/eles-joins-japanese-slovenian-smart-grids-project/

which focuses on smart communities. [99] It states that "the development of advanced solutions will focus on efficient energy use in urban communities, mainly in capital Ljubljana and city of Indrija, and the use of batteries for emergency situations."[100] Its main aims are to reduce investment costs and to lower costs for end-consumers.

In 2018, "grid operator ELES announced it had signed a preliminary agreement with Croatian grid operator HOPS to construct a 1.2km segment of the 400kW line 'between Cirkovce, a town near Ptuj, and Pince, a village on the border with Hungary' by 2021".[101] The project is estimated to cost between EUR 120m and EUR 130m and will be partly funded by the EU. The new line is meant to "improve the reliability of Slovenia's grid system and allow the country to access eastern electricity markets".[102] This being an international power line, operated by ELES, HOPS and Hungarian grid operator MAVIR,[103] the Slovenian operator will not be required to pay for the use of the segment located in Croatia.

D. SMART METERING SYSTEMS

The Economy Ministry is responsible for drafting legislation dealing with the national implementation of the third EU energy market package. Presently in Slovenia there is no defined legislation regarding the introduction of smart meters.

The existing legal framework does not exclude the rollout of smart meters by distribution network operators. So far, there have been no serious discussions between Slovenian stakeholders about the benefits of smart metering for different stakeholder groups. Nor have data security, privacy issues and the possibility of time-of-use tariffs been discussed in detail.

It is expected that the main policy objectives for Slovenia will be fully compliant with EU legislation. In 2008, EIMV (*Milan Vidmar Electric Power Research Institute*) carried out an analysis of the rollout of AMI-systems which evaluated the costs and benefits of the systems for household and small business customers.[104] All 890,000 measuring sites in Slovenia were analysed, with the assumption that the systems of all five Slovenian distribution network operators would be harmonised.[105] The total investment costs were assessed at the time at about EUR 235 million, which averages out at EUR 266 per consumption site.[106]

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[99] STA, *Slovenian-Japanese Energy Project Enters Second Phase, Focussing on Smart Grids* News. (May. 8, 2018) https://www.total-slovenia-news.com/business/1191-slovenian-japanese-energy-project-enters-second-phase-focussing-on-smart-grids

[100] *Id.*

[101] STA. *Slovenia set to start building power grid link with Hungary*, (Oct. 30, 2018), http://www.sloveniatimes.com/slovenia-set-to-start-building-power-grid-link-with-hungary

[102] *Id.*

[103] MAVIR. *Hungarian Transmission System Operator Company Ltd*. Available from: http://mvm.hu/mvm-group/mavir-hungarian-transmission-system-operator-company-ltd/?lang=en

[104] Omahen G., Souvent A., Luskovec B.: *Advanced metering infrastructure for Slovenia*, CIRED, 20th International Conference on Electricity Distribution, Prague, 8–11 June 2009.

[105] *Id.*

[106] *Id.*

The assessment of the advantages of the system's implementation, carried out by EIMV identified the following benefits:

- Lower costs for meter readings
- Demand Side Management (DSM)
- Combined automated meter reading for electricity, gas, water and heat
- Better information of customers about their consumption (Inhouse displays)
- Accurate monthly billing.[107]

Omahen et al.[108] noted the following additional important aspects of smart metering in Slovenia:

- Accurate data enables more cost-efficient distribution system planning
- Faster detection of power outages
- Easier integration of distributed generation
- Lower administrative costs for supplier switching
- More accurate consumption planning

EIMV calculated a net present value of approximately EUR 115m with an internal rate of return of 10.4 % and the expected payback period was around 11 years.[109]

According to a European Smart Metering Landscape Report, EIMV carried out another cost benefit analysis in 2010 for SODO d.o.o., with a more favourable outcome because of the intervening reduction in the cost of smart meters.[110] Nevertheless, for the time being, no official cost-benefit analysis has been carried out as per the requirements of Directive 2009/72/EC.[111] Whether or not this occurs is dependent on the Ministry of the Economy; they may deem the existing analysis to be sufficient.[112]

Renner et al. state that "[i]n the current legal framework, the electricity distribution system operator is responsible for the installation, calibration and maintenance of the meters as well as for invoicing.[113] There is at least one meter-reading per year for household and small business customers". Additionally, "[i]ndustrial customers and other customers with contracted power of more than 41 kW are equipped with AMR-systems . . . [t]hese meters measure the daily load profiles of the customer every 15 minutes".[114]

So far, only one of the five Slovenian Distribution Companies - Elektro Gorenjska - has decided to start a full-scale rollout of smart metering systems. The decision for the rollout was based on

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[107] *Id.*

[108] *Id.*

[109] Stephan Renner et al., European Smart Metering Landscape Report, 79 (2011), https://www.sintef.no/globalassets/project/smartregions/d2.1_european-smart-metering-landscape-report_final.pdf

[110] *Id.*

[111] *Id* at 29.

[112] *Id.*

[113] *Id* at 79.

[114] *Id.*

the first cost-benefit analysis of EIMV in 2008, after a successful small-scale pilot project. Figure 3 below provides a graphic overview of the energy value chain:

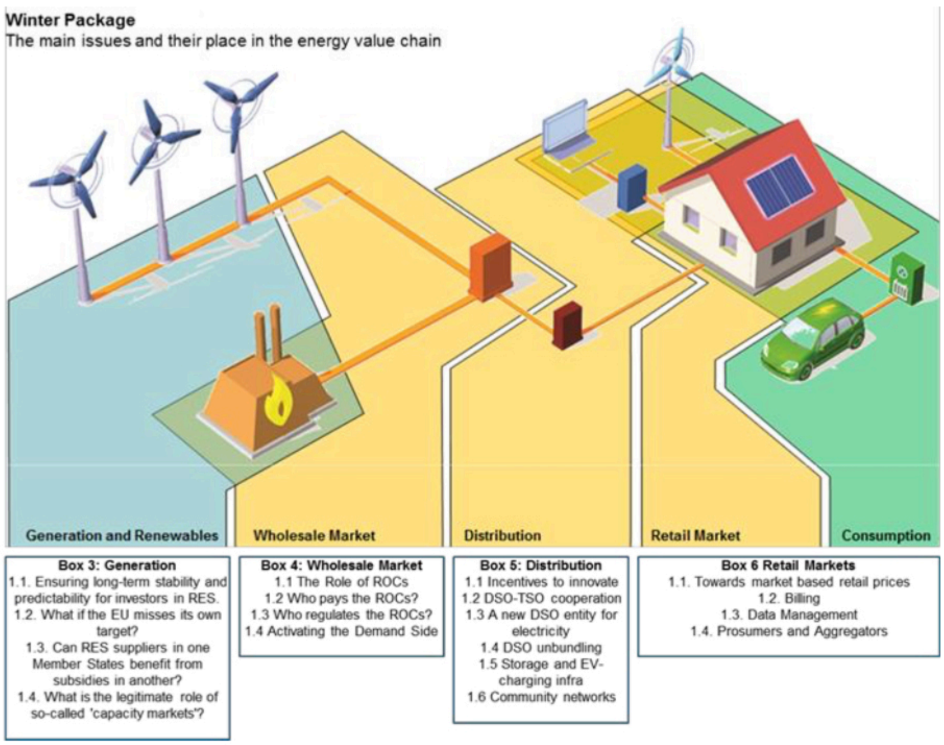

Figure 3 – Energy Value Chain: Winter Package of eight points to facilitate the transition to a clean-energy economy, 2017[115]

Slovenia has successfully corrected its imbalances. An assessment of the progress the country has made on structural reforms, carried out by EU last March, indicated that:

> Risks arising from weaknesses in the banking sector, corporate indebtedness and short-term fiscal situation have receded. Government debt peaked in 2015, but has been shrinking since then. The corporate sector underwent a substantial deleveraging after the crisis, which temporarily weakened investment and potential growth.[116]

Investment is now increasing - particularly foreign direct investment (FDI).[117] Banking sector restructuring has coincided a significant reduction in the number of non-performing loans on

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[115] L. HANCHER, B.M. WINTERS, *The EU Winter Package, Briefing Paper* (Feb. 2017), p. 6.

[116] European Commission. *European Semester Winter Package: reviewing Member States' their economic and social priorities,* P.21 (March. 7, 2018), http://europa.eu/rapid/press-release_IP-18-1341_en.htm

[117] *Id.*

corporate balance sheets.[118] There are, however, still unresolved questions concerning the pension system, healthcare and long-term care systems that remain key priorities for the state.[119]

E. DEMAND RESPONSE

One of the principal objectives of creating a single European energy market is providing reliable, affordable and simple energy services to all users. The distinction between consumer and supplier is being gradually being broken down as many consumers (including households) are becoming both energy consumers and energy suppliers. In many EU countries, large customers have been providing system operators based on demand response for a number of years. Small and mid-sized consumers are increasingly able and prepared to offer such types of services.

New energy services are carried out mainly by pooling resources (i.e. of consumers and producers), and the Slovenian Energy Agency[120] is encouraging system operators to use these services, which are provided by different market participants: suppliers; independent aggregators; energy services companies (ESCO).

As Leal-Arcas et al. point out, "[s]mart meters, sensors, and demand response mechanisms can mediate and manage the variability and unpredictability of power markets by providing both mechanisms for controlling energy use and amassing precise information on the state of the power system and the supply-demand equilibrium".[121]

Electricity production must therefore be sufficient to cover high levels of consumption at any given time. In periods of peak demand, production is also expensive. The Energy Agency in Slovenia is working on the development of programmes designed to change on-site demand.[122].This is of key importance for the use of advanced metering systems and the deployment of electro-mobility and energy efficiency.

Leal-Arcas et al. summarise the importance of smart applications for improving energy efficiency:

> Instructing the washing machine to wash the clothes at the lowest price of electricity during the day can lead to optimal results for both the consumer and the grid. Dynamic price contracts are also a useful tool for demand management. Based on their consumption patterns, consumers are encouraged to negotiate suitable contracts with electricity suppliers. From the side of utilities, well-targeted, flexible contracts should increasingly become part of their corporate strategy to cater to customers' individualized needs. Competition forces can work well in this sector and lead to a wave of easily adjustable contracts. [123]

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[118] *Id.*

[119] *Id.*

[120] The Energy Agency. Slovenia. *Pametna omrezja*. https://www.agen-rs.si/izvajalci/elektrika

[121] RAFAEL LEAL-ARCAS ET AL., *Smart grids in the European Union: Assessing energy security, regulation& social and ethical considerations*, Columbia Journal of European Law, Vol.24.2018, p. 308

[122] The Energy Agency. Izvajalci energetskih dejavnosti. Available from: https://www.agen-rs.si/izvajalci/elektrika

[123] LEAL ARCAS ET AL, *supra* note 117, at 307

In the 2016-2018 regulatory period, incentives designed to promote investment in smart grids and related markets-mechanisms in Slovenia focused on testing the effectiveness of active customer engagement, in customization programs, using dynamic tariffs. The Energy Agency approved the application of the pilot dynamic tariff to two projects: the “Flex4Frid project”[124] (distribution area Elektro Celje dd) and the “Peak equalization / the area of RTP Breg” (distribution area Elektro Maribor dd) project. A critical peak tariff, aimed at dynamically redirecting end-users from the system load during peak hours to peak load, is anticipated. This will take the availability of energy from renewable energy sources (energy generated in cogeneration of electricity, heat with high efficiency, and distributed generation of electricity) into account.

By the end of 2018, up to 10,000 household or small business customers were able to participate in programs tailored to their specific energy needs; programs implemented by distribution companies within the framework of the above projects.

F. DATA PROTECTION

The Slovenian Government is currently developing the new Slovenian Data Protection Act ‘ZVOP-2’, that encompasses the key elements of the GDPR and supersedes the current Act.[125] According to Leal-Arcas et al. "[i]t is . . . essential to redefine the risks in the operation of the power markets and their management. What is considered acceptable risk now must be adjusted to the new operating conditions of smart grids and power markets”.[126] Data protection is thus playing an increasingly important role in establishing an efficient and functional energy market.

The same is true for the cyber security essential for the development and functioning of smart grids. Network security measures and information systems are governed by the Act on Information Security,[127] which came into force in May 2018. The same paper highlights the obligations incumbent upon the operators of essential services in the energy sector, such as to:

- Take measures to manage the risks posed to the security of network and information systems.[128]
- Take appropriate measures to prevent and minimise the impact of incidents affecting the security of network and information systems.[129]
- Notify the competent authority or the CSIRT of incidents having a significant impact on the continuity of the essential services they provide.[130]

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[124] Flex4Grid. Description, https://www.flex4grid.eu/

[125] Government of Slovenia. *Predlog zakona o varstvu osebnih podatkov*, http://www.mp.gov.si/fileadmin/mp.gov.si/pageuploads/mp.gov.si/novice/2018/ZVOP-2_javna_razprava_2.pdf

[126] LEAL ARCAS ET AL, *supra* note 117, at 308

[127] Government of Slovenia. Office for the protection of classified information, http://www.uvtp.gov.si/en/legislation_and_documents/legal_acts_in_force/

[128] LEAL ARCAS ET AL., *supra note 117,* at 389.

[129] *Id.*

[130] *Id.*

G. ELECTRIC VEHICLES AND STORAGE

7.1. Electric vehicles

In a time of rising energy demand and the increasing impact of local and global pollution on the environment and the population, efficient energy use is key to ensuring better living conditions for current and future generations. The transport sector is the largest consumer of final energy and a major environmental pollutant. It thus, directly or indirectly affects the lives of every individual in modern society.

Slovenian private expenditure on transport and the hours spent in road congestion (Table 13) are less than the EU average. However, the market share of electric passenger vehicles is relatively low, and the share of renewable energy in transport fuel consumption (Table 14) is among the lowest in the EU. Slovenia, nevertheless, actively invests in research and in advanced infrastructure to facilitate the future development of electric vehicles. This is evidenced by a higher number of charging points than the EU average (Table 15).[131]

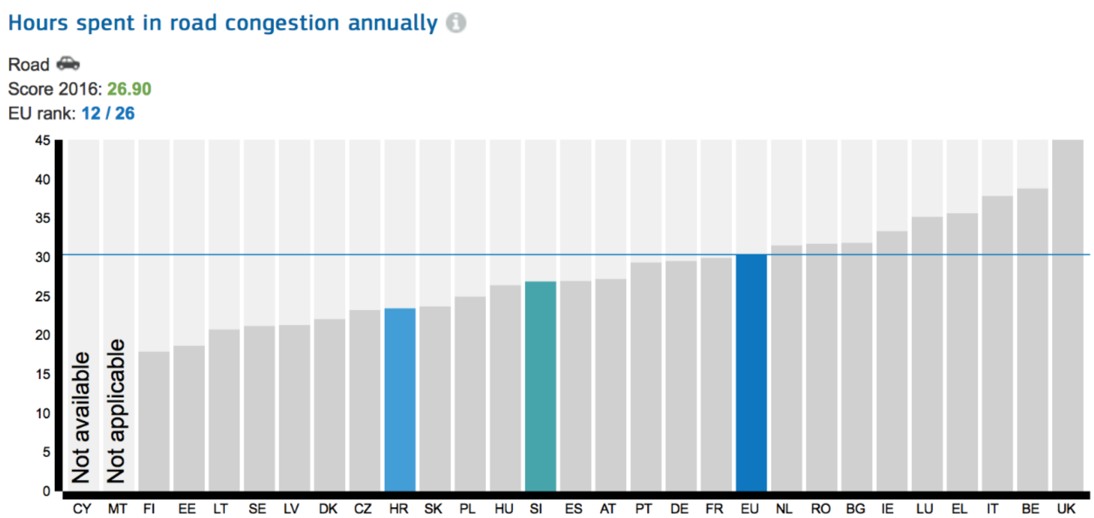

Table 13 – Hours spent in road congestion annually in Slovenia compared to Europe and Croatia[132]

[131] European Commission. *Mobility and Transport*, https://ec.europa.eu/transport/facts-fundings/scoreboard/countries/slovenia/energy-union-innovation_en

[132] *Id.*

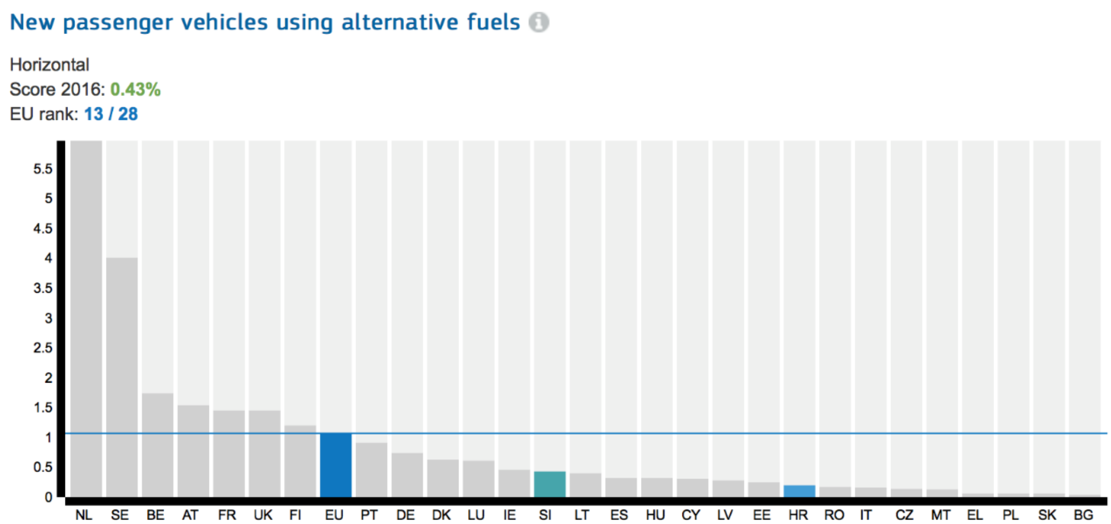

Table 14 – Slovenia's new passenger vehicles using alternative fuels compared to Europe and Croatia[133]

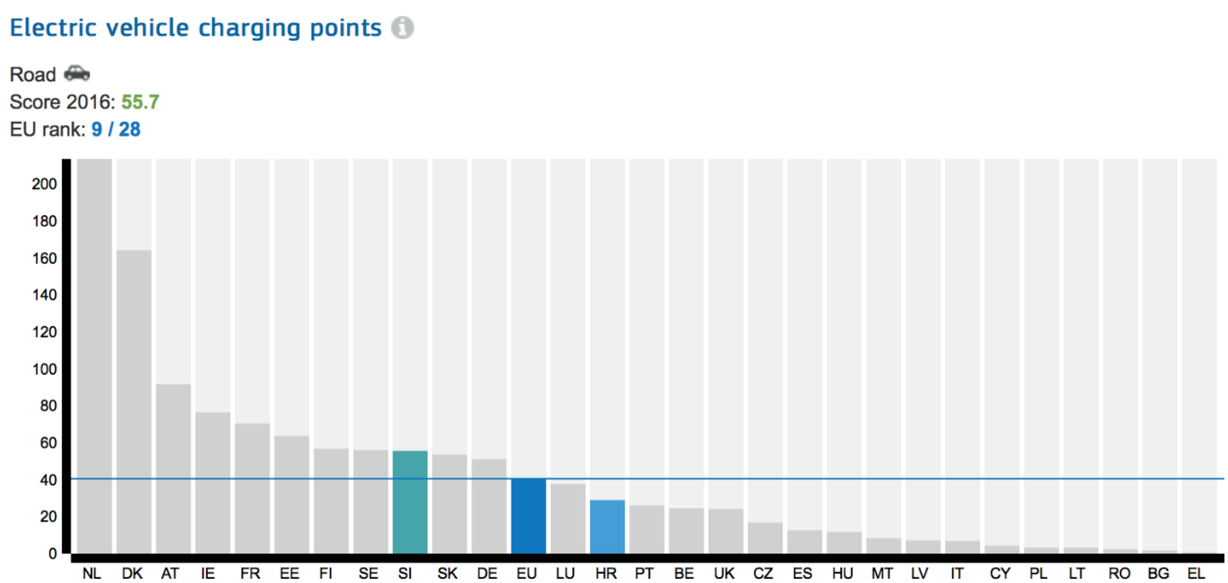

Table 15 – Electrical vehicles charging points in Slovenia compared to Europe and Croatia[134]

The rapid introduction of EVs into the transport sector could pose a major challenge to the effective

[133] *Id.*

[134] *Id.*

operation of the existing electricity grid. Without the ability to control the charging times or locations of electric vehicles, there is a real risk of the system overloading, especially at sites containing a high density of charging stations (e.g. clusters of single-family houses, garage houses, car parks) and in rural areas of the network. The Energy Agency underlines the importance of appropriate investment and/or solutions, which will be needed to counteract the deleterious effects of charging electric vehicles on the grid.[135]

To facilitate a deeper understanding of the topic, assist in the design of programs in this field and create the conditions for effective introduction of electric vehicles, the Electric Agency has conducted two cycles of a public consultation process on electric vehicles, applying the AREDOP model (Figure 4).

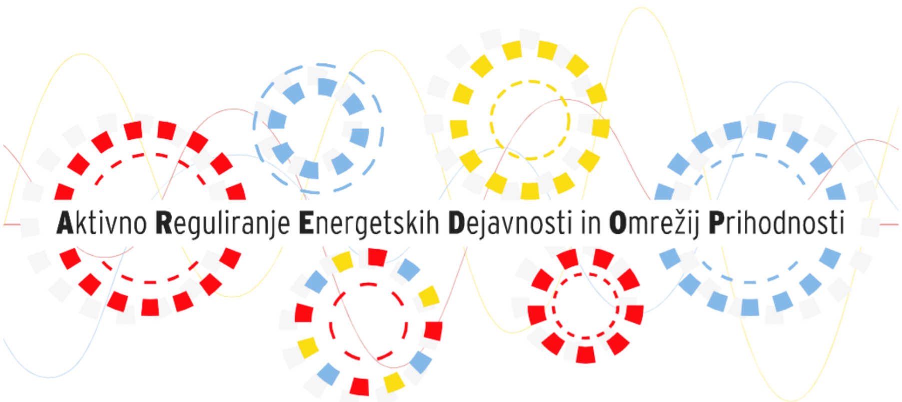

Figure 4 – AREDOP model – Document Active Regulation of Energy Activities and Future Networks[136]

The government of Slovenia has adopted a strategy that aims to boost the uptake of electric vehicles (Green Vehicle Deadline of 2030),[137] increase the use of alternative fuels in the transport sector, and reduce carbon emissions. Under the new framework, vehicular carbon emissions are being capped at 50g per kilometre and the banning of diesel and petrol cars is expected from 2030.[138]

According to Energy Agency, currently the Slovenian car ownership rate (at 523 cars per 1,000 individuals) is one of the highest in the world.[139] The Slovenian government has also set targets for electric vehicles' share of the transport mix. Under the scheme, 17% of all passenger vehicles and 12% of all vans and lorries should be electric by 2030.[140] Other targets to be achieved by 2030

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[135] The Energy Agency. Elektromobilnost, https://www.agen-rs.si/izvajalci/elektrika/elektromobilnost

[136] AREDOP - *Aktivno Reguliranje Energetskih Dejavnosti in Omrezij Prihodnostti,* https://www.agen-rs.si/documents/10926/20705/DEL_20130901_AREDOP_EDI_RazpršenaProizvodnja_V2-0_1930.pdf/37013260-4b3b-4678-a388-30a781622b12 p.1

[137] Emerging Europe. *Slovenia Sets Green Vehicle Deadline of 2030*, https://emerging-europe.com/news/slovenia-sets-green-vehicle-deadline-2030/

[138] *Id.*

[139] *Id.*

[140] *Id.*

include raising the percentage of buses powered by natural gas to 25%. The use of liquefied petroleum gas for 12% of heavy lorries is also expected.[141] In the first eight months of 2017 there were 900 registrations of electric vehicles in Slovenia, a threefold increase compared to the same period in 2016.[142]

In 2016, however, of 1,470,000 cars sold, 53% were petrol-fuelled, 46% used diesel and only 1% used liquefied petroleum gas.[143] The standards adopted by Slovenia also call for the government to expand the number of electric-vehicle charging stations in the country from 227 to 1,200 by 2020, 7,000 by 2025 and 22,300 by 2030.[144]

7.2. Storage

According to a recent CMS study, no major electricity storage projects are currently taking place in Slovenia, "with the exception of the hydroelectric pumped storage facility [in] Avče (which has a capacity of 185 MW) on the Soča River, which is (ultimately) state owned".[145] The need for electricity storage, together with potential subsidies, could generate future investment in this area. As the study points out, there have been encouraging examples of local experiments in electricity storage, such as the installation of "vanadium-flow batteries at a restaurant in the Slovenian Alps".[146]

Storage is not yet dealt with by Slovenian law, but it is mentioned in the Action Plan for Energy Efficiency over the 2014 – 2020 period.[147] The need for effective electricity storage may yet press the state into providing subsidies for their construction and operation, as could falling technology costs. These factors have the potential to encourage further investment in Slovenia at some point in the future, but regulatory obstacles, a lack of state support, and underdeveloped technology are currently a deterrent to investors.

The previously stated CMS study also mentioned that "[d]epending on [the] technology used ([e.g.] pumped storage) [the] storage of electricity might be considered as generation of electricity, meaning that [the] construction of such projects of more than 1 MW connected to public grid requires a permission [granted] by the Minister for Infrastructure".[148]

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141 *Id.*

142 *Id.*

143 *Id.*

144 Smart Energy. *Slovenia adopts framework to expand adoption of EVs*, (Oct. 17, 2017), https://www.smart-energy.com/regional-news/europe-uk/electric-vehicles-slovenia-shell/

145 CMS. *Regulatory related challenges*. *Slovenia,* https://cms.law/en/int/expert-guides/cms-expert-guide-to-energy-storage/slovenia

146 *Id.*

147 National Energy Efficiency Action Plan 2014-2020, https://ec.europa.eu/energy/sites/ener/files/documents/NEAPSLOVENIA_en.pdf

148 CMS, *supra* note 142

III. CROATIA

A. Energy profile

i. Energy mix in Croatia

Croatia produces about "half of its own electricity, depending on hydrological conditions"; almost half coming from hydropower, around 17% from oil/gas, and the rest from wind, biomass, and solar power.[149] Croatia no longer has its own coal reserves, unlike other Western Balkan countries.[150] HEP - *Hrvatska Elektroprivreda* - owns most of the country's electricity generation capacity and has a 50% stake of the Krško nuclear power plant (NPP) situated in Slovenia.[151] Krško NPP contributes to Croatia's electricity supply but is categorized as an import in statistics.[152]

The country's advantageous meteorological conditions offer the possibility of meeting a large part of its electricity needs through the harnessing of wind and solar power.

Croatia has access to rich sources of renewable energy, but according to a recent report it "has not developed a new energy strategy since the overly ambitious and outdated 2009 plan, so there has been no systematic debate about the country's energy direction in recent years."[153] Following EU State aid rules, "Croatia has now switched to auctioning and feed-in premiums rather than feed-in tariffs,"[154] but as of May 2018 has not yet approved the supporting legislation that would enable the system to function.

Croatia's potential for energy efficiency improvements is very considerable, especially in the energy efficiency of the residential sector.

Its geographical position creates specific potential for RES. There are around 50 inhabited islands. They could be energy self-sufficient from locally available renewable energy sources. Detailed studies carried out for the three islands in the North Adriatic, and three in the south Adriatic Sea have identified "the importance of building smart energy systems on the Croatian islands order to increase penetration of renewable energy sources and make local transport more sustainable".[155] The country would benefit from expanding the proportion of energy it derives from RES, and developing energy storage, hydrogen and electric vehicles in order to devise better strategies for building smart energy systems.

Natural gas

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[149] Bank Watch. *Energy sector in Croatia*, https://bankwatch.org/beyond-coal/the-energy-sector-in-croatia.

[150] *Id.*

[151] *Id*.

[152] *Id.*

[153] ZELJKO SERDAR, *The energy sector in Croatia, (June.10, 2018), https://solarserdar.wordpress.com/2018/06/10/europe-2020-indicators-croatia/*

[154] Bank Watch, *supra* note 146

[155] PFEIFER, A., BOŠKOVIĆ, F., et al., *Building smart energy systems on Croatian islands by increasing integration of renewable energy sources and electric vehicles*. 2017 IEEE International Conference on Environment and Electrical Engineering and 2017 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe),https://ieeexplore.ieee.org/document/7977401/authors#authors

Croatian gas sector market is significantly related to its geopolitical relations. By joining the European Union, Croatia has started the process of gradually liberalising the market for gas, particularly in the areas of supply and distribution, in which 100 firms currently operate. The key aim of liberalization is to abolish state monopolies. This objective is to be met through the introduction of market pricing mechanisms, which is expected to ensure higher standards of service, more competitive pricing, and a more secure gas supply. A study of the gas sector indicates that as a result of the liberalization of the country's gas supply, the overall "market share of private firms has increased, whereas firms with minority state ownership have gradually been squeezed out of the market".[156] The final prices of natural gas dynamics in Croatia remained below the EU-28 average level, illustrated in Table 16.

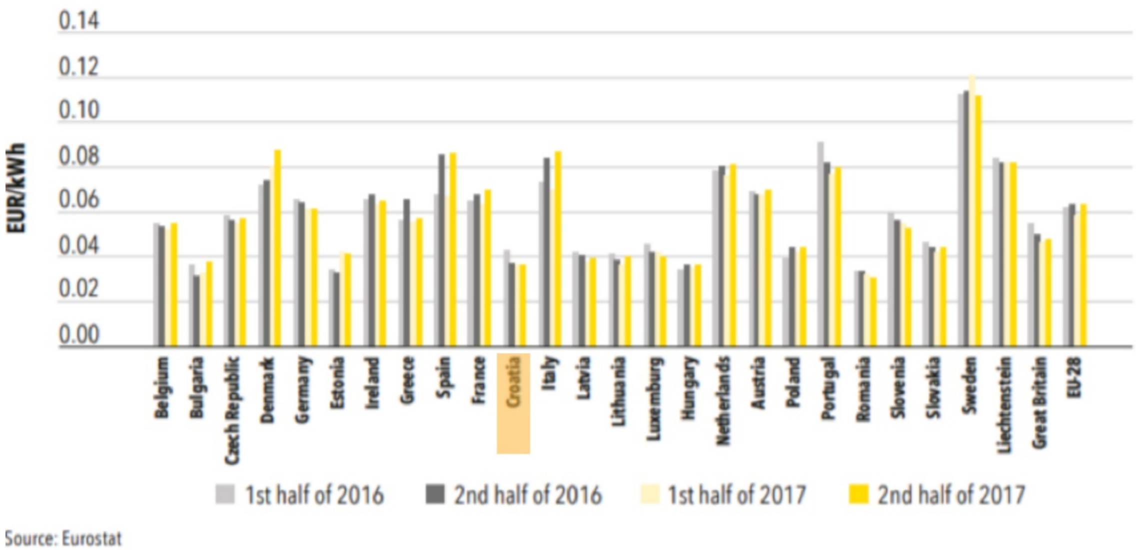

Table 16 – Final natural gas prices including all taxes and levies for typical household consumers (D2) in Croatia and individual EU countries in 2016 and 2017[157]

1.2. Transmission System Operator

The key market actors include the following companies and organizations[158]:

- The Croatian Energy Regulatory Agency (HERA) [159]
- The Croatian Transmission System Operator (HOPS) [160]
- Croatian distribution system operator (HEP-ODS) [161]

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[156] IJF. FISCUS. *The Gas Sector in the Republic of Croatia – Liberalisation and Financial Operations.* N°3 (October 2016). https://www.ijf.hr/upload/files/file/ENG/FISCUS/3.pdf, page 1

[157] Energy Agency, *Report on the energy sector in Slovenia*, (2017), pp.146, https://www.agen-rs.si/documents/54870/68629/a/78f74b68-dbfc-415e-ab88-882652558d94.

[158] ERRA. Energy Regulators Regional Association. *Activity Report 2016*, https://erranet.org/erra-activity-report-2016/

[159] HERA. Hrvatska energetska regulatorna agencija, https://www.hera.hr/hr/html/index.html

[160] HOPS. Hrvatski operator prjenosnog sustava, https://www.hops.hr/wps/portal/hr/web

[161] HEP-ODS. Operator distribucijskog sustava. Available from: https://mojamreza.hep.hr/#!/login

- The Croatian energy market operator (HROTE) [162]

Figure 5 illustrates transmission activity of 400 kW (in red), 220 kW (in green) and 110 kW (in black) in December 2018.

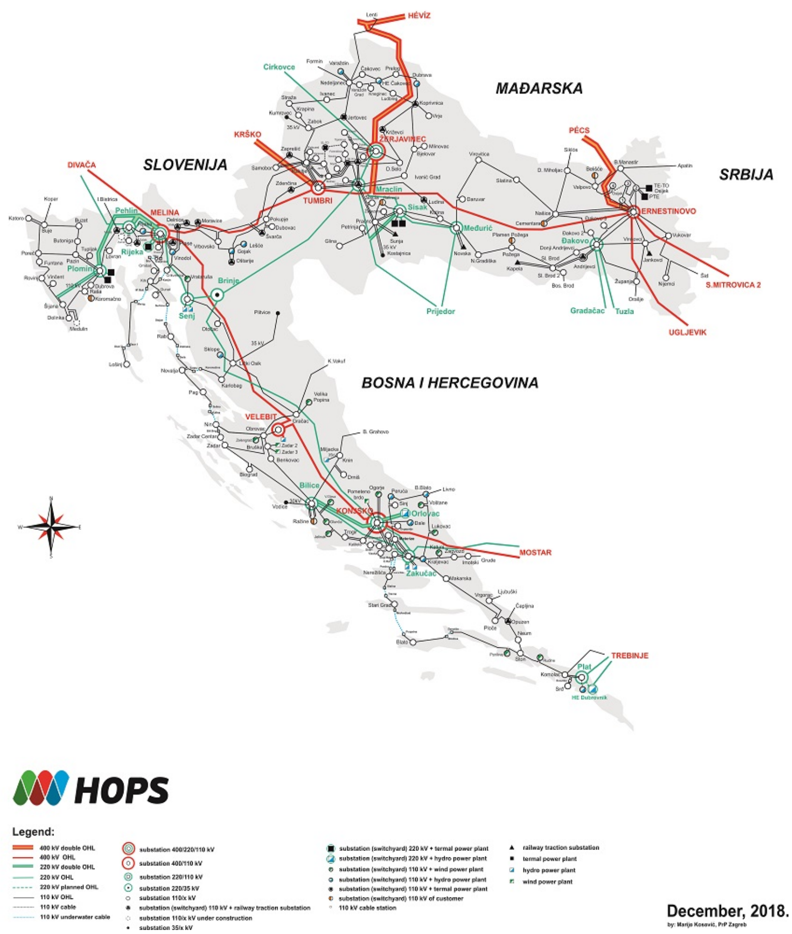

Figure 5 – Croatian Transmission Network, HOPS, December 2018[163]

B. GOVERNANCE SYSTEM

The general guidelines of Croatia's government policy in relation to the electricity sector are set out in their Energy Development Strategy.[164] At the time the Strategy was adopted (June 2009), Croatia's main aim was to adjust and prepare the energy sector in general - including the electricity sector - for accession to the EU and participation in the single EU market, but at the same time to

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[162] HROTE. Hrvatski operator trzista energije, https://www.hrote.hr

[163] HOPS – Hrvatski operator prijenosnog sustava d.o.o. System scheme, https://www.hops.hr/wps/portal/en/web/hees/data/present

[164] Energy strategy of the Republic of Croatia, https://www.mzoip.hr/doc/energy_strategy_of_the_republic_of_croatia.pdf

protect Croatia's national interests. A state-energy regulation study states that, "[t]he strategy is to achieve a balance between the liberalization of the electricity market and necessary government intervention, to enhance energy efficiency and to use more alternative energy sources and technologies that protect the environment. Croatia's further aim is to achieve security of supply (especially in import of electricity), competitiveness in the international market and sustainable energy development.[165]

Consequently, the study identifies that "although the main principles remain, the Strategy is not entirely in line with the current market and some of its goals will be difficult to attain. As a result, the government has adopted several national action plans modifying aims set by the Strategy , implementing specific measures for the realization of EU and national energy targets."[166]

By joining the EU energy market, one of Croatia's obligations – as part of its accession process – was the incorporation of the EU Third Energy Package.[167]

The foundation of the Croatian Power Exchange (CROPEX)[168] in 2015 represented a major step towards further liberalization and the improvement of the Croatian power market. It has met all the basic legal requirements in accordance with the 'EU CACM Regulation for the implementation of cross-border market coupling'. At the same time, as stated at the launch of CROPEX, ". . . the beginning of Intraday trading has significantly improved the preconditions for the expected full implementation of the market integration of the renewable energy by the EKO balance group leader in accordance with the applicable Croatian laws and regulations."[169]

C. ELECTRICITY MARKET

3.1. Regulatory framework

Croatia adopted new legislation governing the activities and functioning of the electricity sector in line with EU legislation in 2013. [170] It was consequently amended via the Energy Act [171],the Energy Activities Regulations Act[172] and the Electricity Market Act[173]. An energy Regulation study indicates[174] that these acts incorporate respective EU directives, in particular Directive

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165 IVANA MANOVELO, MIRAN MAĆEŠIĆ, ,*Electricity Regulation in Croatia,* (Nov. 6, 2018), https://www.lexology.com/library/detail.aspx?g=63fb2d8e-0ba7-467b-aa88-9409740c454b

166 *Id*.

167 The latest round of EU energy market legislation, known as the third package, has been enacted to improve the functioning of the internal energy market and resolve structural problems.

168 CROPEX. *Hrvatska burza elektricne energije*,https://www.cropex.hr

169CROPEX., *CROPEX Intraday market successfully launched*, (April. 26, 2017) https://www.cropex.hr/en/news/129-cropex-unutardnevno-tr%C5%BEi%C5%A1te-uspje%C5%A1no-pokrenuto-2.html

170 IVANA MANOVELO, *supra* note 162.

171 Official Gazette of the Republic of Croatia. Nos. 120/12, 14/14, 95/15, 102/15 and 68/2018

172 Official Gazette of the Republic of Croatia. Nos. 120/12 and 68/2018. https://www.ecolex.org/details/legislation/law-on-regulation-of-energy-activities-lex-faoc105025/?

173 Official Gazette of the Republic of Croatia. Nos. 22/13, 102/15 and 68/2018

174 Electricity Regulation. Croatia. Macetic, M. (November 2018), https://gettingthedealthrough.com/area/12/jurisdiction/80/electricity-regulation-croatia/

2009/72/EC[175], 2009/28/EC[176] and 2005/89/EC[177] and a number of EU regulations. Croatia has been a party to the Energy Community Treaty[178]. The Croatian Constitution states that international agreements take priority over domestic laws and form an integral part of Croatian legislation.

Further relevant statutory instruments and regulations include:

- Act on the Regulation of Energy Activities[179]
- Act on the Electricity Market[180]
- Act on the Gas Market[181]
- Act on the Oil and Oil Derivatives Market[182]
- Act on Production, Distribution and Supply of Thermal Energy[183]
- Act on Energy Efficiency[184]
- Rules on the balancing of the electricity market
- A decree establishing the infrastructure for alternative transport fuels
- The methodology for determining the regulatory framework for the electricity distribution system

The Croatian Electricity Market Act regulates six electricity activities: "generation, transmission, distribution, supply, retail and electricity market organisation."[185] Traditionally, all these activities were carried out exclusively by the Croatian national electricity utility, HEP[186]. The process of liberalization, which opened up much of the electricity sector to market competition, led to certain electricity activities becoming market activities, while others remained within HEP's exclusive remit.

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[175] Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0072

[176] Directive 2009/28/ EC of the European Parliament and of the Council of 23 of April 2009 on the promotion of the use of energy from renewable sources and amending and subsequently repealing Directives 2001/77/EC and 2003/30/EC, https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=celex%3A32009L0028

[177] Directive 2005/89/EC of the European Parliament and of the Council of 18 January 2006 concerning measures to safeguard security of electricity supply and infrastructure investment, https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32005L0089&rid=7

[178] Official Gazette, International Treaty Series No. 6/06

[179] Official Gazette of the Republic of Croatia No. 120/12

[180] Official Gazette of the Republic of Croatia No. 22/13

[181] Official Gazette of the Republic of Croatia Nos. 28/13,14/14

[182] Official Gazette of the Republic of Croatia No. 19/14

[183] Official Gazette of the Republic of Croatia Nos. 80/13,14/14,102/14

[184] Official Gazette of the Republic of Croatia No. 127/14

[185] Electricity Regulation. Croatia. Macetic, M., https://gettingthedealthrough.com/area/12/jurisdiction/80/electricity-regulation-croatia/

[186] *Hrvatska elektroprivreda* (HEP Group) https://www.hep.hr/about-hep-group/2502

HEP Group consists of *Hrvatska elektroprivreda dd* (HEP dd), the parent company as well as several subsidiaries[187], each of which performs regulated and market activities.

A recent research into electricity regulation in Croatia indicates that "in August 2018, there were 52 registered electricity generation undertakings, 17 suppliers, and 33 retail undertakings."[188] Although the number of registered electricity undertakings has been growing continuously HEP's retains a dominant position within the market. This is changing, however, as a result of new market entrants. German RWE and Slovenian GEN are active in the Croatian market, particularly the supply market, and their low prices have forced HEP into cutting its own prices.

3.2. Energy security dimension

To construct and operate generation facilities two types of authorisations are required: licences for the performance of electricity generation activities and energy authorisation for the construction of new generation capacities.

The licence for electricity generation is issued by the Croatian Energy Regulatory Agency[189] in accordance with the Rules on Energy Licences and Maintenance of Registry[190] of Issued and Revoked Energy Licences[191].

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[187] HEP d.d. owns following subsidiary companies:

HEP-*Proizvodnja d.o.o*. (HEP Generation) http://proizvodnja.hep.hr

HEP-*Operator distribucijskog sustava d.o.o*. (HEP DSO) https://www.hep.hr/ods/

HEP *Elektra d.o.o*. http://www.hep.hr/elektra/

HEP-*Opskrba d.o.o*. https://www.hep.hr/opskrba/

HEP-*Trgovina d.o.o*. (HEP Trade) https://www.hep.hr/hep-group-companies-2506/hep-trgovina-d-o-o-2575/2575

HEP-*Toplinarstvo d.o.o*. (HEP District Heating) http://www.hep.hr/toplinarstvo/

HEP-*Plin d.o.o*., (HEP Gas) https://www.hep.hr/plin/

HEP-*Opskrba plinom d.o.o*. (HEP Gas Supply) https://www.hep.hr/plin/o-nama/djelatnosti-hep-plina/opskrba-plinom/1535

HEP ESCO d.o.o. https://www.hep.hr/esco/

HEP-*Upravljanje imovinom d.o.o*. (HEP Asset Management) https://www.hep.hr/drustva-hep-grupe/hep-upravljanje-imovinom-d-o-o/191

Plomin Holding d.o.o. https://www.hep.hr/drustva-hep-grupe/plomin-holding-d-o-o/1412

Program Sava d.o.o. (Programme Sava Ltd) http://zagrebnasavi.hr

HEP-*Telekomunikacije d.o.o*. (HEP Telecommunications) https://www.hep.hr/hep-group-companies-2506/hep-telekomunikacije-d-o-o-2578/2578

[188] Electricity Regulation. Croatia. Macetic, M. Available from: https://gettingthedealthrough.com/area/12/jurisdiction/80/electricity-regulation-croatia/

[189] HERA. Croatian Energy Regulatory Agency. Available from: https://www.hera.hr/en/html/index.html

[190] HROTE. *Hrvatski operator trzista energije.* Available from: https://www.hrote.hr/market-participants

[191] Official Gazette Nos. 88/15, 114/15 and 66/2018

In a study of electricity regulation in Croatia[192] is stated that the energy authorisation for the construction of generation capacity is granted by the Ministry of Energy. [193] Other construction, location and environmental licences are issued by authorised administrations or ministries in accordance with relevant legislation. If and when it finds it is necessary, the government may decide on the construction of additional electricity generation facilities through a public tender procurement process in the interests of safety of supply.

The same study points out "under the Electricity Market Act, HOPS must provide non-discriminatory access to the transmission grid according to the regulated third-party access regime." [194] Any new generator should consequently file a request for connection to the transmission grid, which HOPS must accept if all the prerequisites set out in the General Conditions for Grid Usage and Electricity Supply[195] and the Grid Code are met. HOPS may not deny access to a new generator based on possible future network limitations or additional costs related to an increase in network capacity. "Upon issuing consent for connection to the grid, an agreement is concluded between HOPS and the new grid user. A new generator whose access to the grid is denied may appeal against HOPS' decision to HERA." [196]

Croatia has been party to the treaty establishing the Energy Community since 1 July 2006[197], which enabled the country to become part of the European energy market. It also allows a single mechanism for cross-border transmission or transport of interconnected energy for the whole of Europe.

In accordance with the terms of the Energy Community Treaty, the HOPS has adopted the 'Rules on Allocation and Use of Cross-border Transfer Capacities'[198]. Croatia is currently focusing on finding innovative solutions to achieve greater grid flexibility (Figure 6). This is of particular relevance for cross-border projects.

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[192] Electricity Regulation. Croatia. Macetic, M. Available from: https://gettingthedealthrough.com/area/12/jurisdiction/80/electricity-regulation-croatia/

[193] Republika Hrvatska. *Ministarstvo zaštite okoliša i energetike*. Available from: https://www.mzoip.hr/en/ministry.html

[194] Electricity Regulation. Croatia. Macetic, M. Available from: https://gettingthedealthrough.com/area/12/jurisdiction/80/electricity-regulation-croatia/

[195] Official Gazette No. 85/15. http://www.pristupinfo.hr/wp-content/uploads/2014/03/ZPPI-procisceni-tekst-eng.pdf

[196] Electricity Regulation. Croatia. Macetic, M. Available from: https://gettingthedealthrough.com/area/12/jurisdiction/80/electricity-regulation-croatia/

[197] Eur-Lex. *The Energy Community Treaty*. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=LEGISSUM%3Al27074)

[198] HOPS. *Rules on allocation and use of cross-border transmission capacities*. Available from: https://www.hops.hr/wps/wcm/connect/3da9ec34-91b9-465e-855b-b16316f8fd95/Rules.pdf?MOD=AJPERES

Source: IRENA and University College Cork based on ENTSO-E (2016). Background map: OpenStreetMap®

Figure 6 – Interconnections in the 2030 EU power system model after fig. 19 in Renewable Energy Prospects for the European Union, February 2018, p. 61[199]

In the Sincro.Grid project,[200] Croatia and Slovenia worked on the development of a shared smart grid, with extensive collaboration between the transmission system operators (HOPS[201] and ELES) and distribution networks (HEP – ODS[202] and SODO[203]). The Croatian and Slovenian partners

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[199] IRENA. Renewable Energy Prospects in the European Union. Available from: https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2018/Feb/IRENA_REmap_EU_2018.pdf

[200] SINCROGRID. *Project*. Available from: https://www.sincrogrid.eu/

[201] HOPS Ltd. *Croatian Transmission System Operator*. www.hops.hr

[202] SODO d. o. o., *Electricity distribution system operator*., www.sodo.si

[203] HEP-Operator distribucijskog sustava d.o.o. www.hap.hr/ods

(Figure 7) in the 'Sincro.Grid' project have assembled various traditional and novel approaches in a smart grid package, which includes investment in infrastructure, technology and processes.
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Figure 7 – Project partners (after image on the 'Sincro.Grid' project website)[204]

The main goal of the project is to "establish operating conditions that will provide for increased generation from renewable energy sources and dispersed generation, as well as greater potential for their penetration into distribution and transmission grids in Croatia and Slovenia." [205] Consequently, it expects to increase transfer capacities through the dynamic monitoring of overhead transfer capacities (DTR).

3.3. Renewable energy

Croatia's natural features and geographical position make the use of alternative energy sources viable. The exploitation of these resources is embedded in one of the country's principal strategies for the future of energy development[206]. In 2013 Croatia adopted a 'National Action Plan for

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[204] SINCROGRID. *Project*. Available from: https://www.sincrogrid.eu/en/News/ArticleID/139/Presentation-of-the-project-at-E-DSO-for-Smart-Grids-Project-Committee

[205] ELES. *SmartGrid Project. Goals and positive effects.* Available from: https://www.eles.si/en/sincro-grid-project/goals-and-positive-effects-of-the-project

[206] Energy strategy of the Republic of Croatia, Available from: https://www.mzoip.hr/doc/energy_strategy_of_the_republic_of_croatia.pdf

Renewable Energy Sources until 2020'[207] for the realisation of 'EU targets (20-20-20)' [208] and a national energy strategy. Presently, Croatia has already reached its 20% target.

A recent research on Energy Regulation in Croatia [209] details the provisions of the Energy Act [210], which "also expressly states that use of alternative energy sources and CHP is in Croatia's interest" while the Electricity Market Act stipulates that "any generator that uses renewable energy sources may be awarded eligible producer status". The new 'Act on Renewable Energy Sources and High Efficient Cogeneration' [211] (RES Act), effective from 1 January 2016, harmonises national and EU legislation[212] in the field of renewable energy, and introduces a market premium as the new incentive model. Feed-in tariffs have only been retained as an incentive model for smaller plants (up to 30kW).

D. SMART METERING SYSTEMS

The implementation of a smart metering system is still in development in Croatia. "The electricity distribution subsidiary of Croatian state-owned power utility HEP, HEP ODS, has to replace all existing electricity meters with new smart meters by 2030 at its own expense. In the next five years, HEP ODS must install smart meters for customers with connection power greater than 20 kW and within ten years for all business customers with connection power less than 20 kW." [213] According to the Balkan Green Energy News[214] about 4.3 million smart meters are currently installed and "by the 2021 about 35 million smart meters at more than 95 % of the measuring points' are planned."

Pandžić et al.[215] have examined the liberalisation of electricity markets in Croatia, noting the ongoing "embedding and development [of] remote metering points reading systems." The same report also states that the Croatian System "contains technology which allows, on demand or by

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207 Fourth National Energy Efficiency Action Plan of the Republic of Croatia for the period from 2017 to 2019. Available from : https://ec.europa.eu/energy/sites/ener/files/hr_neeap_2017_en.pdf

208 RECS International, European 20-20-20 Targets. Available from http://www.recs.org/glossary/european-20-20-20-targets

209 Electricity Regulation. Croatia. Macetic, M. Available from: https://gettingthedealthrough.com/area/12/jurisdiction/80/electricity-regulation-croatia/

210 Official Gazette 120/12, 14/14 and 95/15

211 Official Gazette No. 100/15, 123/16, 131/17

212 Directives 2009/28/EC and 2012/27/EU

213 Balkan Energy. HEP ODS to install smart meters to all consumers by 2030 – Croatia, May 2018. Available from: http://balkanenergy.com/hep-ods-install-smart-meters-consumers-2030-croatia-4-may-2018/

214 Balkan Green Energy News. Croatian HEP and French EDF want to establish cooperation in smart meters area. August 2017. Available from: https://balkangreenenergynews.com/croatian-hep-and-french-edf-plan-to-establish-cooperation-in-smart-meters-area/

215 Pandžić, H., Bošnjak, D., Kuzle, I., Bošković, M., Ilić, D., *The Implementation of Smart Metering Systems for Electricity Consumption in Croatia*, 17th Symposium IMEKO TC 4, 3rd Symposium IMEKO TC 19 and 15th IWADC Workshop Instrumentation for the ICT Era Sept. 8-10, 2010, Kosice, Slovakia Available from: https://www.researchgate.net/publication/277248058_The_Implementation_of_Smart_Metering_Systems_for_Electricity_Consumption_in_Croatia

predefined schedule, automatic readings of electricity consumption data, control values, events and alarms.”

Croatian electric power companies are exploring the possibilities for cooperation with international partners for further strengthening smart metering systems.

5. DEMAND RESPONSE

As a recent study points out, “demand response is not yet properly regulated in Croatia.”[216] The electricity market remains concentrated in the hands of relatively few players and the liberalisation process has been proceeding slowly, although recent years have shown improvements towards a market for Demand Response.

The market is inching towards full liberalisation and consumers have demonstrated a greater willingness to switch suppliers despite price regulation - Energy Community Regulatory Board 2012[217]. Croatia is moving away from bilateral contracts.

Demand response is still not supported by a relevant statutory instrument, but there is a current focus on increasing unbundling and removing price regulation.

6. ELECTRIC VEHICLES AND STORAGE

6.1. Electric vehicles

Croatia has started to open its rail freight market to competition. The passenger segment, however, remains a state monopoly. The EC Mobility and Transport study[218] noted that in July 2017 Croatia has received consistently high scores relating to “its transposing of transport related EU directives into national law.” There has been a recent uptick in the share of employment in high growth transport enterprises following the preceding year’s downturn.

On average, Croatian private expenditure on transport and the average number of hours spent in congestion (Table 17) are significantly less than the EU median. However, the share of renewable energy in transport fuel consumption (Table 18) and the market share of electric passenger vehicles (Table 19) are among the lowest in the EU.

[216] Bertoldi P., Boza-Kiss B., Zanchella P. Demand response status in EU Member States. July 2016. Available from https://www.researchgate.net/publication/305315798_Demand_response_status_in_EU_Member_States

[217] Procedural Act No 02/2012 of the Energy Community Regulatory Board Available from: https://energy-community.org/dam/jcr:5004fb43-65bb-4983-af19-d44787d63b5a/PA_2012_02_ECRB_network_code.pdf

[218] European Commission. *Mobility and Transport*. Available from: https://ec.europa.eu/transport/facts-fundings/scoreboard/countries/slov

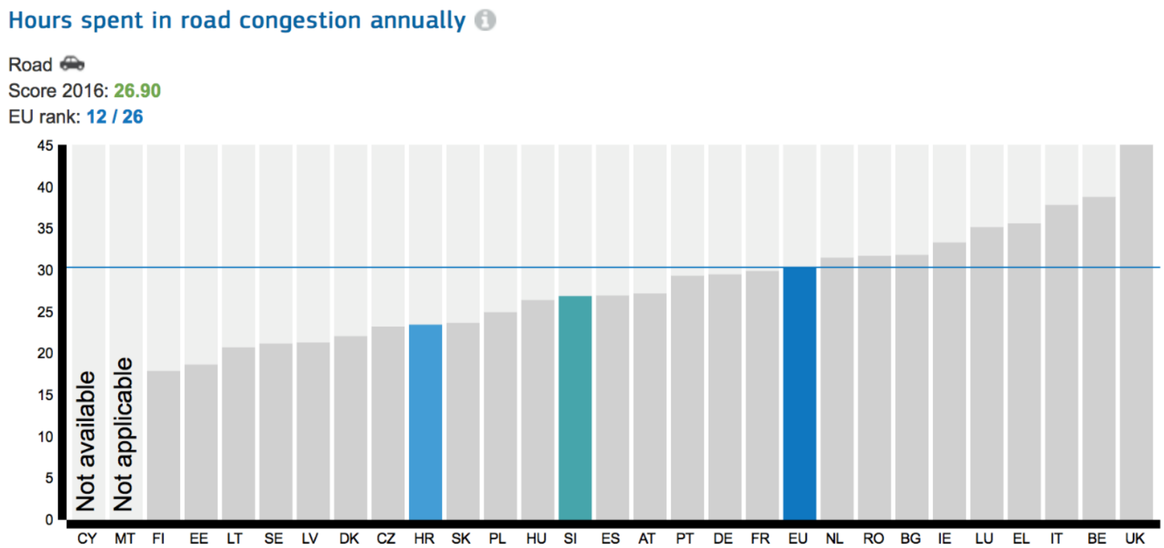

Table 17 – Hours spent in road congestion annually in Croatia compared to Europe and Slovenia[219]

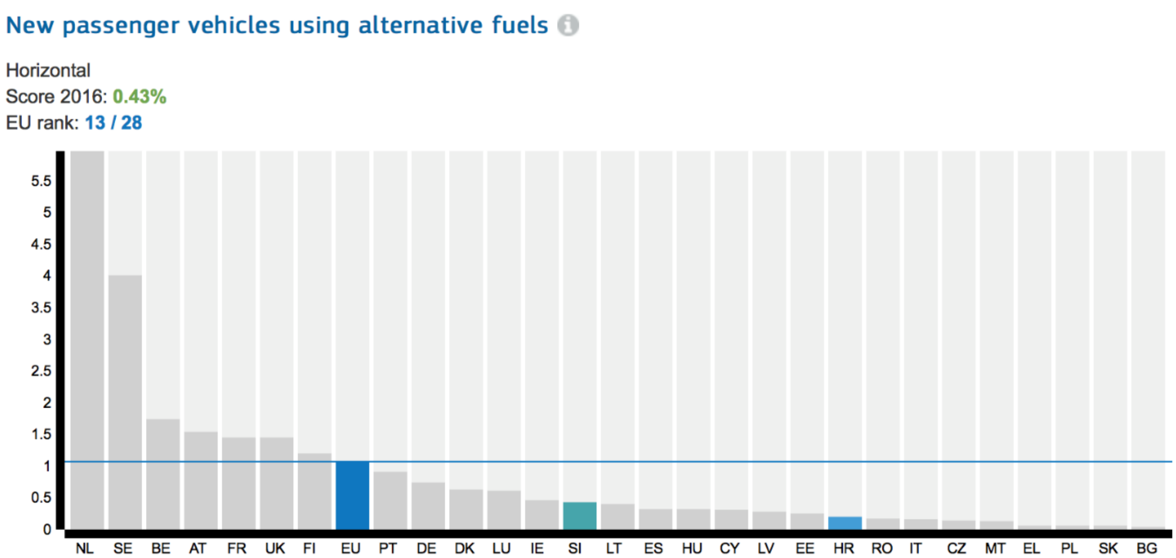

Table 18 – Croatia's new passenger vehicles using alternative fuels compared to Europe and Slovenia[220]

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[219] Idem.

[220] Idem.

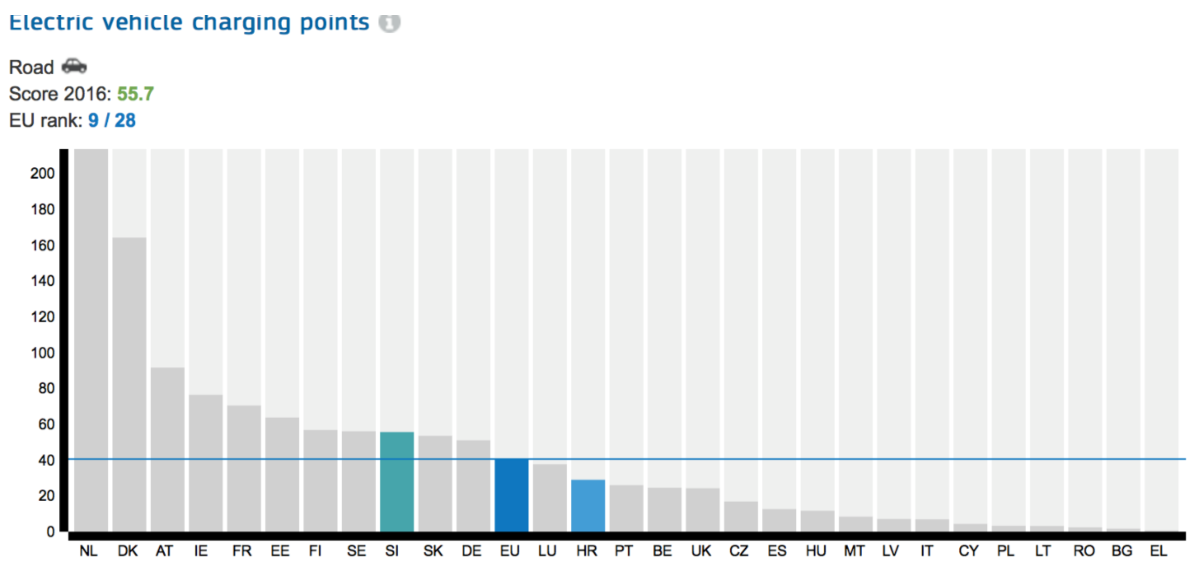

Table 19 – Electrical vehicles in Croatia compared to Europe and Slovenia[221]

The Balkan Green Energy News[222] reported that "Croatia will get, 133 electric and 1 plug-in cars, 224 electric bikes and 56 electric motorcycles" as a result of the incentives provided by the Croatian Environmental Protection and Energy Efficiency Fund, shown in Figure 8.

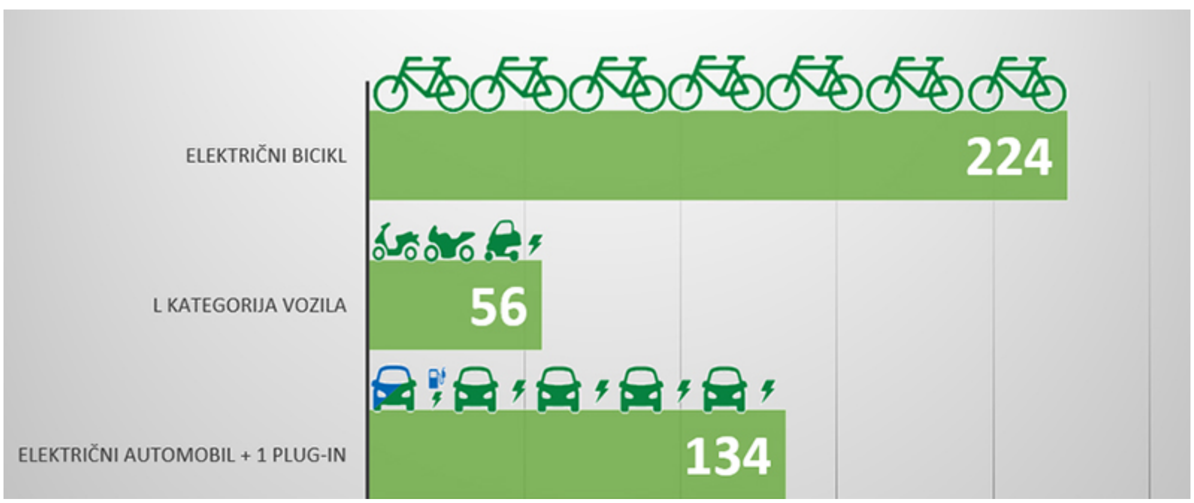

Figure 8 – Results of the public call for co-financing of eco-vehicles by number of requests[223]

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[221] Idem.

[222] Balkan Green Energy News. Number of electric vehicles in Croatia to rise by 64% this year. June 2018. Available from: https://balkangreenenergynews.com/number-of-electric-vehicles-in-croatia-to-rise-by-64-this-year/

[223] 'Environmental Protection and Energy Efficiency Fund'. Balkan Green Energy News. Number of electric vehicles in Croatia to rise by 64% this year. June 2018. Available from https://balkangreenenergynews.com/number-of-electric-vehicles-in-croatia-to-rise-by-64-this-year/

Depending on the type of vehicles, they can be financed with loans or through leasing agreements. Incentives for purchasing EVs are rare in the Balkan region. Croatia has dedicated incentives for citizens and businesses interested in buying electric vehicles. Albania, Kosovo, Macedonia, Bosnia and Herzegovina, Montenegro, and Serbia do not currently offer them, in contrast to their EU neighbours. In July 2017, Total Croatia News[224] announced that HEP had installed 46 'ELEN' charging stations in Croatia and plans to install the first high-power fast-charging stations for electric vehicles.

6.2. Storage

Electricity storage is not specifically regulated or supported by Croatian law. The RES Act[225] prescribes that renewable energy demonstration projects shall not be supported through market premium or feed-in tariff incentive models, but rather through general research and development and innovation support programmes.

IV. AUSTRIA

1. ENERGY PROFILE

In 2015, Austria's final energy consumption amounted to 27.3 Mtoe – a 14% increase compared to 2000. The main drivers for the increase are a rise in final energy consumption in the transport sector (+29%) and in the industry sector (+21%) over this period. Final consumption also rose in the agricultural sector (+4%) and the services sector (+2%). However, final consumption of households, which is adjusted for climatic corrections, recorded a 3% lower consumption in 2015 than in 2000. In 2015, the transport sector had the highest share of final energy consumption with 33%, followed by industry (30%), households (24%), services (11%) and agriculture (2%)[226].

The Austrian energy efficiency index for the whole economy (ODEX) improved by 18% between 2000 and 2015, which is the same level as for the European Union. The average improvement rate was 1.3% per year. Most of the efficiency improvements were achieved in the residential sector, for which efficiency increased by 31%, compared to 27% for the European Union. The least efficiency progress was recorded in the transport sector, where energy efficiency recorded 10%, which is 3% less than the EU. Efficiency in industry in Austria rose by 15%, which is 5% less than the EU as a whole[227].

The Austrian energy market has drastically changed as a result of deregulation at the turn of the

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[224] Total Croatia News. More Electric Vehicle Charging Stations Coming to Croatia. April 2018. Available from https://www.total-croatia-news.com/business/27742-more-electric-vehicle-charging-stations-coming-to-croatia

[225] Act on Renewable Energy Sources and High-efficiency Cogeneration (Zakon o obnovljenim izvorima energije I visokoucinkovitoj kogeneraciji). Official Gazette 100/15 and 123/16. Available from: https://narodne-novine.nn.hr/clanci/sluzbeni/2015_09_100_1937.html

[226] OECD Austria: Country Health Profile 2017

[227] Energy Efficiency Trends and Policies in Austria, Austrian Energy Agency 2018

century. The focus on market economy structures required reorganising the grid in both legal and practical aspects. Transmission system operators found themselves having to reform their ownership by reorganising themselves as independent systems operators (ISOs) or independent transmission operators (ITOs).

Despite the liberalisation of the electricity market, the transmission and distribution grids are closely supervised by regulatory bodies; Energie-Control (E-Control) is largely responsible for the balance of supply and generation in accordance with the country's competition rules. The state still maintains at least half of shares in Austrian electricity companies.

Hydroelectric power is the country's main energy source, but it maintains a strong emphasis on renewable energy – such as wind, geothermal and photovoltaic. The country relies upon hydroelectric power plants, 68% of the country's electricity is sourced this way. In total, 75% of electricity consumption is produced by renewable sources.[228]It leaves the country with roughly 10% having to be produced by fossil fuels.[229] Germany and the Czech Republic make up 15.5% of Austria's electricity imports[230].

Energy Security is a complex concept that has been best categorised by Cherp and Jewell in their 4 As: Availability, Accessibility, Affordability, and Acceptability. They have argued the possibility of adding climate change as a fifth. The recommendation has been to focus on the context of its use rather than focus on its applicability in its purest meaning[231].

The International Energy Agency (IEA) concluded that Austria' energy securitisation at this point in time is robust. However, it has also called for greater production in domestic gas and an expansion of its activities into the wider European energy market.[232] The reason is Austria opts for an energy policy focused on efficiency and renewable energy.

Furthermore, there are two problems: it relies on energy imports for industry, transport and agriculture; it continues to be a growing consumer of energy without balancing its net import percentages. The conclusion is that Austria will remain an importer of energy for the foreseeable future. It remains a concern not only in meeting sustainable development goals as well as cheaper electricity for consumers, imports rely on a healthy trade relationship premised on a stable political situation. This has led to calls to abandon the country's no-nuclear policy, however, it remains a minority few among the public and their representatives. The same position is held towards exploiting shale gas.

The IEA suggests Austria strengthens its integration of electricity and natural gas markets.[233]

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[228] Energy Efficiency Trends and Policies in Austria, Austrian Energy Agency 2018

[229] Austria: Total Energy Consumption by Fuel - European Environment Agency 2018

[230] Wagner, B. 'A review of hydroelectric power in Austria: past, present and future' 2015

[231] Cherp, A., Jewell, J. 'The concept of energy security: beyond the four As' Science Direct 2014

[232] IEA Review of Austria's Energy Policies' 2014

[233] OECD/IEA 2014.

However, there are substantial difficulties in doing this. For example, Germany has made the intention of building technological barriers between its own electrical infrastructure and Austria's. Although it may seem to be a politically motivated move, that is not the case. Germany finds itself supporting Poland's outdated grids – which cannot absorb Germany's production. Germany's higher production is the result of new strategy of moving away from nuclear power by using wind energy plants in the northern part of Germany. This has ultimately resulted in higher costs and to cover for this expenditure, the policy has been implemented to push Austria to buying additional capacity on the stock exchange. These additional costs will set Austria back €100m.[234] Austria may find itself having to spend even more of its budget in updating its own grids, just as Poland. Martin Graf, the CEO of "e-control" has called for more than €5bn in investment to avoid the disaster of blackouts.[235]

2. GOVERNANCE SYSTEM

The Austrian Constitution requires the regulation of electricity be divided between the central government and the federal states. There is no state autonomy concerning this element of legislation; the state enacts law in accordance with federal law. The Federal Electricity Management and Organisation Act 2010 (EJWOG 2010) and state-level law give guidance to the regulatory bodies of the Austrian electricity market. The primary objectives of the EJWOG are:

- To provide affordable and high-quality electricity.
- To ensure the market remains in compliant with EU law.
- To ensure power-heating is used and that a legal framework is maintained to push to use of sustainable energy.
- To ensure to the involvement of public service bodies in matters pertaining to electricity.

E-control is a public institution that is fully independent – at least in principle. It is made up of three bodies: managing board, regulatory commission and supervisory board that oversee the regulation of the electricity market.

3. ELECTRICTY MARKET

The overwhelming production of electricity is produced by Verbund-Gesellschaft. Provincial state entities make up the bulk of what is left of production. The primary distribution system operators (DSOs) were former provincial state entities and now they are key players in the generation and supply markets. [236]

3.1 TSOs

The transmission system operators (TSO) combine the responsibilities of network operator and transmitter of power. The main TSO is the Austrian Power Grid (APG), which is classified as an ITO as it owns and operates virtually all transmission grids in the country.[237]

3.2 DSOs

[234] Kishko, I. 'Electric Shocks From Germany' 2015

[235] Pohoryles, R. 'Combing Energy Security with Energy Safety and Energy Efficiency' ICCR Foundation 2015

[236] E-Control 'The Austrian Electricity Market' 2013

[237] EU Country Reports, 2014

Distribution system operators (DSOs) work in compliance with contracts established between producers and withdrawers in exchange of payment for system charges by the regulator. Network stability is of upmost priority and have the power to take any action necessary to maintain it and are required to consistently look for innovative ways of maintaining the network. The DSOs have the following responsibilities to:

- Finalise contracts with consumers.
- Ensure consumers receive electricity.
- Keep record of consumption and find patterns.
- Share data with the clearing and settlement agent.

There are more than 130 DSOs[238].

3.3 SUPPLY

Customers now have the choice to choose between suppliers and pay an energy tariff to the supplier and a tariff to the DSOs. Suppliers have the following responsibilities[239]:

- Finalise contracts with consumers.
- Share consumption forecasts.
- Correctly bill their customers for consumption.

The liberalisation of the market as imposed 'unbundling' requirements on suppliers:

- Freedom from instructions.
- Autonomy in investment matters.
- Independence from other business enterprises.
- Transparency.

With respect to the autonomy of a company, a stock company is the most preferred business structure. Transmission system operators must be unbundled or works as independent operators. [240]

3.4 OWNERSHIP

After the Second World War, politicians came to the conclusion that the public must maintain ownership in the energy sector and as a result, the government created Verbund-Gesellschaft and the nine provincial electricity suppliers. The second nationalisation law was amended in 1987 and it stipulates:

Austria shall own 51% of Verbund-Gessellschaft and 51% of share capital of the nine provincial

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[238] E-Control 'The Austrian Electricity Market' 2013

[239] E-Control. Monitoring Report - Versorgungssicherheit Strom. Vienna: Energie-Control Austria; 2013. p. 13.

[240] Getting The Deal Through: 'Gas Regulation' 2018

supplied must be owned, either directly or indirectly, by regional bodies.[241]

4. SMART METERING SYSTEMS

4.1 OVERVIEW

Austria is working towards smart meter coverage of 95% of households by 2019, equivalent to 5.7m end points[242]. Austrian DSOs are at the heart of deployments, both from an installation and data collection perspective. Distribution companies are working within a tightly regulated framework to produce a smart meter rollout that meets Austrian requirements. After the country mandated smart gas and electricity meters - following a favourable cost-benefit analysis - industry association Österreichs Energie laid out a set of guidelines for DSOs to follow.

Minimum requirements of the Austrian smart meter rollout are high security and privacy standards - smart meters can only transmit the overall electricity consumption of a household, not individual devices in a bid to protect personal data. Meters must also have a customer interface and a remote ability to make daily meter readouts available to consumers via a consumption visualization portal. Another mandatory function of Austrian smart meters is a breaker to allow the DSO to disconnect and reconnect the customer, in part to meet the DSO's need to manage changes in household tenancies.

Austria has advanced its electrical infrastructure by moving to used G3-power line communication for transmission. It allows for a greater amount of data to be transmitted and also protects the network from sudden changes, which helps it meet the demands of the regulatory bodied.

4.2 LANDIS+GYR PROJECTS

Energy management company Landis+Gyr has been working within Austria's regulated energy market by helping Netz Burgenland to go from pilot rollout to large-scale deployment. Netz Burgenland, a fully owned subsidiary of Energie Burgenland, is one of Austria's seven largest electricity DSOs and has more than 200,000 metering points in its network.

Landis+Gyr began a partnership with the eastern Austria energy company in 2015 with a pilot of 3,000 G3-PLC communicating meters and the head end system - "as a way to validate performance and build up IT systems to support the business processes", says Landis+Gyr Austria country manager Helmut Scherzer.

A further 18,000 metering points followed in early 2016 and then in December 2016, Landis+Gyr secured a contract for the remaining 180,000 metering points as a part of the complete advanced metering infrastructure (AMI) solution. Commenting on the rollout so far, Peter Sinowatz, Managing Director of Netz Burgenland, says: "After 15,000 installed devices, the balance sheet looks very good. The smart meter installation is straightforward, and the customers are fundamentally positive about the new technology." Sinowatz adds: "We are currently replacing about 3,000 meters a month. And over the year the deployment will ramp up to more than 6,000 a

[241] Section 5(1), nationalisation law (as amended), Federal Law Gazette No. 321/1987)

[242] Balmet, D., Petrov. K. 'Regulatory Aspects of Smart Metering' ERRA Licencing and Competition Committee' 2010

month."[243]

Landis+Gyr's Scherzer says the experience of working closely with Netz Burgenland since 2015 has highlighted two key learnings for a successful smart meter project. First, the vendor-utility relationship has to be an open partnership with a clear alignment of mutual expectations between the DSO and the technology provider. And second, the importance of pilots in allowing the DSO "to prepare and understand the complexity that's needed to integrate a head end system into third party systems". "A pilot reveals how all utility processes are affected by smart meters," says Scherzer," and offers the chance to address vulnerabilities before a mass-scale deployment."[244]

In Upper Austria, policy has moved to making greater use of photovoltaics. This will be achieved by implementing the 2030 Energy Strategy – R&D projects supported by numerous federal departments to create pioneering energy systems. This will be achieved by analysing consumer behaviour and finding a way to simply the demand and supply coordination in photovoltaic systems.

4.3 OTHER PROJECTS

The European Union requires all households are connected with smart meter technology by 2020 Energie AG Oberösterreich is responsible for the rollout of 100.000 units. The EU requires all households have smart meters installed by 2020. Energie AG Oberösterreich will ultimately move to installing smart meters for 500.000 customers. These smart meters will record the consumption of electricity and natural gas and then transmit that data to the grid operator. The objective is to replace a quarter of a million electricity meters with smart meters by 2025.[245]

4.4 APPLICABILITY

Smart meter rollouts are part of a utility's need to scale up for the future as well as lay a digital energy platform for further use cases such as load management and home automation. As Brunner et al. point out[246], smart meters collect data that can then be used to review customer satisfaction as well as which energy saving strategy is working best. The cost of the smart-meter rollout will be placed upon customers, however, the sheer number of customers it will affect means that the burden can be shared, resulting in an incremental rise price. There is equal benefit for the entire country.

There are basic benefits for consumers in the form of operational savings, cheaper energy costs as a result of renewable energy use, efficient management of the network and fewer incidents of fault and fraud. The fact that there is greater access of information from generator to customer will only enhance the regulation, transparency and reliability of the service.

There is concern pertaining to the impact of EU policy on smart metering and its relationship with

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[243] Landis+Gyt 'Austria's smart meter rollout: A case study of meeting local regulations [2017]

[244] Ibid.

[245] Federal Ministry Republic of Austria: Transport, Innovation and Technology – Energie Systeme der Zukunft 2018

[246] Brunner, K.-M., Christianell, A., and Spitzer, M., 'Fuel poverty. A case study of vulnerable householdsin Vienna, Austria. Proceedings of the European Council for an Energy-Efficient Economy' 2011

households and fuel poverty. [247] The introduction of this technology could potentially damage households in the short term and therefore consideration of their circumstances will be necessary. However, the benefits are fast. The simplest digital meter can offer accurate billing information. The European Commission require monthly billing be sufficient enough that a consumer can regulate their own levels of consumption (EC, 2010)[248].. This is welcome news for Austria, where mandatory meter reading could extend to nearly two years. There is anxiety with estimated billing, however, smart meters allow customers to receive in-depth information in the form of graphics to explain their consumptions and ways in which they can reduce costs.

Another important benefit is the presence of an in-home display system. This can help families organise their activities in conjunction with live reporting of the consumption. The displays can show in real-time how much gas, water, heat and electricity are being used. For example, a customer can easily read how much it will cost them to have a shower as opposed to a bath. Time-varying tariffs is a direct product of smart-metering. It allows a consumer to record during regular intervals their amount of usage (e.g. every 30 minutes).

4.5 PRICING

There is now the ability to switch between credit and repayment. This is especially helpful for places that require air-conditioning at certain times during the year. This gives TOU tariffs the ability to move away from the static status and become more flexible in their estimations. A more complex form of pricing is real-time pricing (RTP) which is a sophisticated method premised on variable pricing. This has been made specifically for 'non-biddable' sources as renewable source (wind, wave and solar) or when there is uncertainty surrounding usage during the winter period. In this situation, customers can contribute to generation in order to meet demand by balancing the network. The third form of pricing, critical peak pricing (CPP), can be implemented for exceptional situations. This could be when supply is considerably high in a blazing summer season or a bitter winter period. Customers will usually be informed of this prior to its implementation.

Smart metering allows for different forms of pricing and helps manage load reduction and storage problems during peak times. Households could opt to use heating containers in such scenarios and may receive incentives in the form of favourable tariffs to do so. [249]

4.6 DATA CONCERNS

There are privacy concerns surrounding smart meters, even though many countries who have adopted the technology early on, such as Italy and the Scandinavian countries, have done so without much controversy. The most obvious concern being with whom this data will be shared, [250] but beyond a guarantee and regulatory oversight, the trade-off seems fair. The utility will be used to offer tailored tariffs which will ultimately be of benefit to the customer. Moreover, customer feedback could help with diagnostics.

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[247] Darby, S. 'Metering: EU policy and implications for fuel poor households' 2011.

[248] EC, 2010b. Interpretative note on Directive 2009-72/EC concerning common rules for the internal market in electricity.

[249] Darby, S. 'Metering: EU policy and implications for fuel poor households' 2011.

[250] KEMA, 2011. Smart meters in the Netherlands. Revised financial analysis and policy advice. /http://smartgridsherpa.com/wp-content/uploads/2011/05/ 10-1193-Final-report-smart-metering-EZ.pdfS.

It is primarily with the issue of marketing do concerns relating to confidentiality arise. The public's perception of the government through its regulatory bodies will go a long way towards its acceptance. The public's perception of the energy sector is even more pertinent. The UK regulator Ofgem conducted a survey of 100 customers and found that they all shared concerns about unwanted commercial intrusion. However, most customers accepted the trade-off to be fair and that the data is essential to the government and suppliers to deliver the best possible service. There were slight concerns about 'spying'[251]

4.7 DIRECT LOAD CONTROL

Direct load control (DLC) provides the consumer with remote control of their electrical appliances. This technology is especially common in warmer climates which despite Austria's year-long cool climate, can from time to time move to sweltering condition. Remote control electrical space and water hearing could benefit households by balancing its use between peak times and storage periods. This, nonetheless, poses risks as it provides the customer the opportunity to substitute demand or storage capacity for more favourable prices. It will be beneficial to low-income customers but there is room for exploitation. Ultimately, there has been little research done into this theory, but it is worth bearing in mind. Even so, very few would be able as they lack the know-how to switch between load and storage and then negotiate spot prices.

4.8 PROSUMERS

Smart metering has helped households benefit from microgeneration but the fuel poor in Austria have found difficulty in finding a door to microgeneration. The introduction of feed-in tariffs across the EU may help improve that situation by implementing community access schemes but the difficult in its access may result in weakened impact.[252]

There is a strong argument that those with little access to energy or affordable energy will benefit mainly from heat as opposed to electricity with respect to feed-in tariffs. There is not yet substantial evidence for this, but mere instillation ease does not qualify it. Smart metering's skilful installation, ease of maintenance, good feedback systems and institutional backing give rise to the idea that it would work better for the fuel poor, but it is a complex development that has not yet given conclusive results. [253]

5. DATA PROTECTION

5.1 CURRENT LAW

The new Regulation (EU) 679/2016[254] on the processing of personal data, General Data Protection Regulation (GDPR), will apply from 25th May 2018.The Austrian Data Protection Act 2018 will seek to apply the regulation domestically. However, GDRP does not support legal entities and

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[251] https://www.ofgem.gov.uk/sites/default/files/docs/2011/07/panel-report-2011_0.pdf

[252] Baker, W. and White, Z., 2008. Toward sustainable energy tariffs. A Report to the National Consumer Council by the Centre for Sustainable Energy. CSE, Bristol.

[253] Bergman, N., Eyre, N., 2011. What role for microgeneration in a shift to a low carbon domestic energy sector in the UK? Energy Efficiency 4, 335–435. doi:10.1007/s12053-011-9107-9.

[254] REGULATION (EU) 2016/679 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL OF 27 APRIL 2016

therefore basic protection under section one of the Data Protection Act 2018 is necessary. In order to bridge this divide, trade secrets for business are protected by Directive 2016/943/EU – Trade Secrets Directive[255]. The Austrian legislature has yet to implement measure to meet the 9 June 2018 deadline.

5.2 SMART GRIDS

Baloglu and Demir (2014) published a study on the relationship between data protection and smart-grid metering infrastructure.[256] They investigated the electric industry's move towards smart grid metering and data gathering and concluded, "Privacy concerns emerge due to the data engineering and data mining techniques which analyse large volumes of private data rapidly. The electric power industry has to cooperate with information technologists to adopt cyber security into the smart grid to maintain the reliability because reliability requires security. Sender authentication and privacy preserving of consumer data are two major security problems in smart grid communication. Applications and services should be designed in a way to operate efficiently without intruding on the privacy of consumers." [257]

The current methodologies combine monitoring power consumption in household appliance with regular interval readings. The concern is that the collection of data from a personal setting such as what time you sleep or what time you go to work can give rise to a variety of purposes, including robbery or even assassination. There must be strict oversight in ensuring this data is used solely for smart grid applications and must be encrypted.

5.2.1 SECURITY

Liang et al. conducted a study in 2012 into cyber security surrounding smart grid technology. They concluded that tackling privacy issues may require adopting anonymous and camouflage communication technologies.[258] In the same year, Yan et al. conducted further research into security challenges and solutions in the same field. They offered several existing solutions that have already been applied to real homes and industries but have also added seven encryption and anonymisation techniques.[259]

A year later, Wang and Lu (2013) conducted a similar study. Their conclusions were similar to those of Yan et al, explaining the smart grid is a demanding environment for security and reliability.
The authors provide an in-depth analysis of cryptographic authentication and key management. The trade-off between latency and privacy remains a point of contention in smart grid security, especially in wireless communications. If secure communication is increased and maintained, security of privacy will work in tandem with it[260]

[255] Directive (EU) 2016/943 of the European Parliament and of the Council of 8 June 2016 on the protection of undisclosed know-how and business information (trade secrets) against their unlawful acquisition, use and disclosure.

[256] Baloglu, U., Demir, Y. 'Lightweight privacy-preserving data aggregation scheme for smart grid metering infrastructure protection" International Journal of Critical Infrastructure Protection, 2018

[257] C. Hawk and A. Kaushiva, 'Cybersecurity and the smarter grid', The Electricity Journal, 2014, 27(8), pp.84–95.

[258] Liang, X., Barua, M., Lu, R., Lin, X., & Shen, X. S. (2012), HealthShare: Achieving secure and privacy-preserving health information sharing through health social networks. Computer Communications, 35(15), 1910–1920.

[259] Yan, Y., Qian, Y., Sharif, H., & Tipper, D. (2012). A survey on cyber security for smart grid communications. IEEE Communications Surveys & Tutorials, 14(4), 998–1010. http:// dx.doi.org/10.1109/SURV.2012.010912.00035.

[260] Wang, W., & Lu, Z. (2013). Cyber security in the Smart grid: Survey and challenges. Computer Networks, 57(5),

In 2014, Komninos et al. commented on the current security goals that must to be tackled and what sort of potential pitfall may exist between current Smart Home technology and its interaction with smart grid entities. They also tackle multiple privacy preserving methods based again on encryption and anonymization. The conclusion was that a legal framework specifically aimed at potential abuse of privacy in the smart grid network as essential. It will help organise management and aggregation components mechanisms in the most effective way.

5.2.2 PRIVACY

Erkin et al. (2013) focus their study on data aggregation. They present the existence of complex systems that can disseminate reading and deliver a more acute prediction between an appliance being turned on and off. They suggest using cryptographic protocols related to hardware limitation and signal processing as a way to secure privacy. [261]

Finster and Baumgart deliver high quality methodologies toward tackling the issue of consumer privacy. They introduce two terms that must be solved first: billing and operations in smart meters. They argue of a trade-off between sampling frequency attribution and exactness against privacy. They categorise the different methods to accentuating this trade-off using aggregation, cryptography, imprecise data etc. [262]

The aforementioned studied do not cover the more recent, state of the art methods that have been introduced since 2015. Nonetheless, the concerns persist and a detailed analysis on the taxonomy of the state with respect to preserving privacy in smart grids.

5.3 CHALLENGES

Ferrage et al. summarised the main trend and directions for both industry and academia with respect to privacy in smart grid technology as follows: "Privacy preserving schemes that are applied on smart grid mostly use cryptography as a basic countermeasure; most of the proposed privacy-preserving schemes do not encounter sufficiently key-based attacks but focus on data-based attacks; a smart grid is constituted from several different systems (smart meters, electric vehicles, etc.)"[263]The challenges in the future will range from detecting new attacks to privacy for the Internet of Things (IoE) and with it, further research must be conducted, especially as more and more countries add smart grid technology to their infrastructure.

6. DEMAND RESPONSE

6.1 MECHANISMS

Marcus Meisel et al.[264] conducted a thorough examination into the demand response mechanisms

1344–1371. http://dx.doi.org/10.1016/j.comnet.2012.12. 017.

[261] Erkin, Z., Troncoso-Pastoriza, J. R., Lagendijk, R. L., & Perez-Gonzalez, F. (2013). Privacy preserving data aggregation in smart metering systems: An overview. IEEE Signal Processing Magazine, 30(2), 75–86. http://dx.doi.org/10.1109/MSP.2012.2228343.

[262] Finster, S., & Baumgart, I. (2015). Privacy-aware smart metering: A survey. IEEE Communications Surveys & Tutorials, 17(2), 1088–1101. http://dx.doi.org/10.1109/ COMST.2015.2425958.

[263] Ferrage, M. et al. 2018 'A systematic review of data protection and privacy preservation schemes for smart grid communications' Science Direct.

[264] Meisel, M., Ornetzeder, M., Schiffleitner, A.,Leber,,T, Haslinger, J. Pollhammer,, K. (2013). Demand Response for Austrian Smart Grids.

in place and being developed in Austria. In order to assess the possible success and implication of each mechanism, a short description and assessment is provided. They judged them across four criteria: load management potential; sustainability, market potential in 10 years, degree of innovation.

Mechanism	Explanation	Load Management Potential	Sustainability	Market Potential	Degree of Innovation
Microgrid for buildings with photo voltaic generation	The risk of unpredictable overload.	Low to Medium If it is coupled it with renewable energy then it has greater promise, otherwise it is lacking. There is a delay in installing thermic storages and may not be in place for another decade or so.	Medium to high This scenario presents environmental promise and ability to merge into the grid.	Medium to high As a result of costs decreasing in PV, high disaggregation rates are very much possible.	Medium It is medium for office buildings but low for households.

Mechanism	Explanation	Load Management Potential	Sustainability	Market Potential	Degree of Innovation
Microgrid for municipalities	Rural municipalities are greater in	Medium to High It is very pragmatic as a result of	Medium to high The scenario helps to	Medium It depends on the market and the costs	Medium It has already been implemented in certain

	number and ensuring they share smart grid technology is essential.	belonging within an energy balancing group thereby making it easily able to connect with renewable sources.	integrate REs into the grid, enables more decentralized generation without the need for reinforcing the existing grid infrastructure, and uses existing infrastructure versus new devices.	it undertakes in implementing the technology.	areas.

Mechanism	**Explanation**	**Load Management Potential**	**Sustainability**	**Market Potential**	**Degree of Innovation**
Battery grid - coupling of existent accumulators	All chargers need to be plugged into a separate power outlet of a second controlled power circuit feeding electricity on a demand-supply basis.	Low The scenario could contribute to overall grid stability and prevent blackouts.	Low to Medium Infrastructure needs and material costs are low, and the sum of devices connected to the grid could shift loads.	Low Depends on reasonable business models (e.g. special tariffs, products bundling, etc.)	High Not done yet.

Mechanism	**Explanation**	**Load Management Potential**	**Sustainability**	**Market Potential**	**Degree of Innovation**

Wireless Charging	An owner of such a system could offer the charging device as a service to keep cost of purchase for the user at an extremely affordable level to gain importance.	Low Depends on mass adoption and participation.	Low New infrastructure needs to complement additional devices and clear any electrical smog.	Low Similar to battery grid scenario.	Low to Medium High for wireless charging part, low for the service part.

Mechanism	**Explanation**	**Load Management Potential**	**Sustainability**	**Market Potential**	**Degree of Innovation**
Re-use of batteries	Reuse of batteries can drastically improve the ecological balance.	Medium It depends on the market and state with respect to electrical vehicles and state of the art batteries.	Medium Positive effects depend on available battery technology. There is concern how old batteries can be processed and how efficient new batteries can be.	Medium Depends very much on market penetration of electric vehicles and/or new battery technologies and on recyclables.	High Not done yet.

6.2 EU REVIEW

The European Union conducted an assessment into the status of Demand Response in respective Member States and its conclusions for Austria was the following:[265]

6.2.1 LESSONS LEARNED

- Despite the liberalisation process was completed rapidly, Austria remains a small market and competition is limited. DR can bring new actors and enhance the liquidity of the market.

- Although apparently Austria will not face capacity issues in the near term, the infrastructure may be stressed by consumption trends, delocalised generation and increased share of renewables: DR can play a vital role.

- Transparency and participation are at the basis of the new regulatory framework that will allow evolving from generation-driven electricity markets to actor-neutral products and services markets. The close cooperation of all actors, TSOs, DSOs and all the stakeholders, and particularly with the future (new) market participants, shall enforce a consistent transition.

6.2.2 RECOMMENDATIONS

- Encourage new market participants: New participants provide more liquidity to all markets. For that, existing and potential barriers shall be removed and prevented; information shall be provided to all participants and participation of customers and pools shall be supported.

- On the regulatory front, a common level playing field for all participants should be designed as well as a technical entity in charge. Technical requirements to participate in the markets shall be adapted to all participants including DR. Bidding sizes shall be adapted to DR.

- The entire process should be carried out transparently and in consultation with all parties involved, including TSOs, DSOs, and market operators.

- Specific products, considering e.g. revised time slices, lower minimum

Demand Response shares promise in that it can possibly maintain the balance between supply and demand in area of large density and it can achieve this through renewable source. However, to achieve this, further developments around DR scenarios are necessary. The current scenarios provide policy makers, industry experts, and inventors the chance to analyse growth to and fill the technological gap but in order to do this, they will have to explore more scenarios by surveying manufacturers, financiers, regulators and focus groups. This will combine social, ecological,

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[265] Bertoldi, P., Zancanella, P. Boza, B. 'Demand Response Status in EU Member States' JRC Science for Policy Report 2016

technological and economic factors for future implementation. The goal should be to develop every aspect of demand side management.

7. ELECTRIC VEHICLES

7.1 OVERVIEW

Figures compiled by Verkehrsclub Österreich (VCÖ), an Austrian campaigning organisation that promotes sustainable mobility, found that Austria has the highest share of electrical vehicles in the European Union. They have shown that EV cars have doubled in 2015, with a total of 3,826 being registered in 2015. This means that 1.2 percent of Austria's newly made cars are electric, more than France and the Netherlands.[266]

Within Austria, the state of Vorarlberg had the highest share of new electric cars, ahead of Salzburg (1.5 per cent) and Styria (1.3 per cent). Vorarlberg register 355 new electric cars, three times more than the whole of Poland. Austrian sustainable mobility and transport experts say that tax incentives, in force since last year, have contributed significantly to the higher numbers. They add that a new e-mobility package launched by the Austrian federal government on 1 March could trigger a new surge in registrations[267].

7.2 TAXATION

At this current time, there are three forms of taxation with regards to passenger automobile transport:

- Normverbrauchsabgabe (NoVA): An upfront fuel consumption tax.
- Motorbezogene Versicherungssteuer: An engine tax
- Mineralölsteuer (MöST): Fuel tax.

The taxes are levied as a percentage of the car's value and the car's fuel economy – this is achieved using a bonus/malus system in relation to CO2 emissions. Electrical vehicles, however, receive 500 EUR bonus whereas cars outside this remit are charged 20% VAT, including fuel tax. EV cars are exempt from engine related tax in Austria, whereas diesel and gasoline have 20% VAT, respectively[268].

Gass et al. (2012) reviewed policy instruments geared towards promoting Electric Vehicles. They compare total costs of ownership (TCO), including charges and taxes as well as recycling and disposal. Three alternatives measures have been assessed to promote EV until 2015 and beyond:[269]

- Policy makers should support research and development into R&D and implement stringent framework for a sustainable transport system.
- CO@ and NoVA taxes must be exempt for electrical vehicles.

[266] VCÖ Report: 2012

[267] Ibid

[268] Linszbuer, W. 'Austria: Electric Vehicle Taxation' Austrian Vehicle Industry Association 2017.

[269] Gass, V., Schmidt, J., and Schmid, E. 'Analysis of alternative policy instruments to promote electric vehicles in Austria' World Renewable Energy Congress 2011.

- A low upfront cost to make up for the loss in exempted taxes.
- Policy makers should provide an infrastructure for large-scale adoption of EV.

8. STORAGE

As part of Smart Grids, storage facilities can help to ensure a reliable energy supply even if an increasing share of fluctuating sources of energy is integrated into grids. Via the strategic process, Smart Grid 2.0, the Federal Ministry for Transport, Innovation and Technology (bmvit) is actively supporting this development in collaboration with the stakeholders from the energy sector, industry and research. The aim is to jointly evaluate the results obtained so far from research and demonstration, and to derive medium-term strategies and concrete plans of action for Austria from these.[270]

Energy generation and consumption can be harmonized in grids by means of options for rescheduling loads and/or changing the rate of supply from generation facilities in response to an external signal (so-called "flexibilities"). Flexibility options including tying in energy storage devices – such as classical pumped-storage power stations or power-to-gas facilities. Batteries in electric-powered vehicles can also serve as storage devices and help to reschedule loads if they are charged appropriately. The system can also be made more flexible overall by means of active distribution grids (e.g. with controllable substations). Linking the sectors electricity, heat and natural gas together in hybrid networks and systems has considerable potential. Utilizing power-to-heat or power-to-gas technologies can turn heat or natural-gas storage facilities into functional energy storage, making the energy system much more flexible than would be possible purely with electrical load rescheduling.

With the study "Stromspeicher 2050" by Vienna University of Technology on behalf of the Climate & Energy Fund, a first-ever analysis was performed of how the demand for electricity storage will develop in the Austrian and German electricity system up to 2030 and 2050 as the share of renewables in power generation increases. A number of scenarios were simulated, leading to a reduction in carbon-dioxide emissions of 76 % to 90 % for the sectors power generation, space heating, hot water and car traffic. With the aid of HiREPS, a simulation model with hourly resolution developed by the Energy Economics Group at Vienna University of Technology, the technical feasibility of a large proportion of electricity from renewables and the cost-effectiveness of flexibility options have been successfully simulated. The simulations show that expanding storage facilities, plus power-to-heat and managed charging for electric cars, can contribute to integrating a large proportion of electricity from renewables cost-effectively.[271]

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[270] https://www.energy-innovation-austria.at/wp-content/uploads/2016/05/eia_02_16_E_fin.pdf

[271] Totschning, G. Hirner, R. Kloess, M. 'Assessment of pumped storage needs and alternative integration measures of renewable in Austria and Germany' Institute of Energy Systems and Electric Drives 2015

V. LUXEMBOURG

1. ENERGY PROFILE

Luxembourg is not like Qatar or Kuwait, where the country's respective wealth is a direct result of its natural resources. Luxembourg does not refine petroleum, it does not export any fossil fuels. As a result of its size, it has the highest ratio of consumption in the European Union – 61% of its electricity consumption is imported.[272] Much like Austria, its power generation depends upon hydropower – Luxembourg also uses gas. In 2010, the country consumed more than double the EU average, making it the third highest consumer by capita in the European Union. With respect to electricity, total output equalled 689 MW in 2012. This excludes pump storage which is located in Vianden and is a part of the Amprion electricity grid. In the Creos zone, total output is 313 MW, which is a significant increased to what it was in 2011 (264 MW). This is in large part due to the increasing use of photovoltaic plants and wind power. [273]

Luxembourg is in a key geographical and economic area of Europe by virtue of being in-between the Netherlands and Belgium. As a result, the energy balance has been centred on transport and is demonstrated by the fact that in 2000, 1.93 Mtoe was required and in 2015 2.43 Mtoe. This is obviously due to increase economic activity in the country and an increased population. However, despite this, the energy sector has decreased its share in the energy balance by implementing structural changes and improving efficiency.[274]

1.1 RENEWABLE ENERGY

As many of its European neighbours move towards diversifying their energy portfolio by venturing into renewable energy, Luxembourg remains hindered in its ability by virtue of its physical size. The country simply does not have access to major reservoirs or geothermal energy. The country does not have the necessary meteorological environment to welcome other renewable sources, such as solar, wind and biomass energy – at least not on any significant scale. Moreover, it does not have the space to create installations for energy crop production. Its bleak renewable future was confirmed by the National Renewable Energy Action Plan (NREAP) by predicting, rather generously, that 11% of energy consumption shall be as a result of renewable energy.[275] In 2010, wind power covered just 1.1% of energy use. The fact that it falls among countries that have been welcomed into the EU relatively recently and with countries that have gained independence within the last 40 years is a testament to its situation – countries such as Slovakia and Slovenia generate less electricity from wind power. Ireland, on the other hand, can produce more than half of its electric output on wind power alone if conditions are at optimal levels. [276]

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[272] European Energy Network [2013]: Available at: http://www.enr-network.org/

[273] Luxembourg: Energy Efficiency Report [2013]. Available at: http://www05.abb.com/global/scot/scot380.nsf/veritydisplay/5210f680e6b18129c1257be80054e4b7/$file/Luxembourg.pdf

[274] ODYSSEE-MURE 'Luxembourg, Energy Profile' [2018]

[275] European Environment Agency 'National Renewable Energy Action Plan' [2011]

[276] ILNAS [2013]: Standards Analysis - Energy Sector - Luxembourg. Available at: http://www.ilnas.public.lu/fr/publications/normalisation/etudes-nationales/standards-analysis-energy-sector-october-2013.pdf

1.2 FUTURE

The Luxembourg government recognise that this is deeply concerning, especially for a country with as much wealth as it. Policymakers seek to improve security of supply by setting up interconnectors with neighbouring countries. At present, natural gas resources are entirely dependent on imports and by moving to partnerships with neighbouring countries would ease current concerns. The relationship between the European Union and Russia remains deeply unstable, making it even more imperative for Luxembourg to secure its energy future.

1.3 ENERGY SECURITY

In the 2016 OECD report of Luxembourg, oil and gas account for 86% of total primary energy supply (TPES). With no internal production of oil and gas, the country is fully dependent on imports. Oil consumption is dominated by the transport sector and is heavily dominated by diesel oil (88%). Natural gas account for over 90% of the country's electricity production and 45% of it is used by the transformation sector. Oil refineries are centred in Antwerp in Belgium, only 255 km from Luxembourg City. The rest of its oil, roughly 20%, is shared between Germany, France and the Netherlands. The distribution of oil is mainly transported by road, rail and barge, but aviation kerosene is supplied by pipeline. [277]

1.3.1 OIL

The permits for storage depots that allow for Luxembourg to store oil will expire this year which will force the country to become even more dependent on stocks abroad. If the country does not act urgently, it will cause significant disruption to logistics in the country which may lead to labour strikes or devastating problems if weather conditions turn dangerous for fuel delivery. [278] At present, the government has implemented the creation of new storage capacity, equating to 480,000 m3. [279]

1.3.2 GAS

Luxembourg's main gas supplier is Norway, which provides half of its imports. As for the Russian Federation, it provides a quarter. There are eight companies that supply gas to customers, including four integrated distribution system operators. SOTEG provides all gas to the four suppliers.

The transmission system operators (TSOs) are E.ON (20%), ArcelorMittal (20%), Cegedel (19%), Saar Ferngas (10%) and state-owned SNCI (10%). In 2009, SOTEG merged with Cegedel and Saar Ferngas to form Enovos International SA in order to solidify Luxembourg's energy security. [280] The country lacks a demand restraint programme and there is no policy to ensure users swap in the event of an energy shortage. Legislation has moved towards ensuring network operators and suppliers and wholesale customers ensure supply is maintained year-round as insurance as the country seeks ways to secure its energy security future.

2. GOVERNANCE SYSTEM

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[277] Luxembourg OECD Report [2016]

[278] International Energy Association OECD – Energy Supply Security [2014]

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tional En

The ILR (Institut Luxembourgeois de Régulation) is the primary regulator for the energy and gas market. It is independent and does not receive funding from the state. It is instead funded by operators, who are also under the regulatory purview of the ILR. It gives rise to a conflict of interest by the state feels it is better if the ILR remains as independent as possible. Further, it monitors competition by ensuring no operator holds a dominant position. The ILR also sets the method by which tariffs shall be calculated and regulates access to the network. [281]

The duties of the Institute include:

- Overseeing and making sure the energy market is functioning as efficiently as possible.
- The market is maintaining a base service that is in the interests of consumers.
- Promoting competition by avoiding discriminatory measures against new entrants into the market.
- Providing a market that delivers choice and range for consumers at fair and competitive prices.

The supply and demand of electricity is overseen by the Government Commissioner for Energy. It is the only arm of the government that takes an active role in energy regulation and the Commissioner reports to the ILR biennially. [282] In 2012, after the government feared exploitation and distortion of its vertical integration, it added an additional criterion to the Institutes jurisdictions. It can now monitor communication practices of operators. Operators must keep their activities between the distribution and supply branches of the operator. [283]

3. ELECTRICTY MARKET

3.1 OVERVIEW

The heavy reliance on imported oil is best explained by truckers taking advantage of low excise taxes compared with border countries. The way in which Luxembourg maintains its obligations to the IEA and EU in terms of oil stockholding is by ensuring importers provide stock worth of 90 days of deliveries relative to domestic consumption. The country keeps more than three quarters of storage capacity outside the country. [284]

The natural gas market is vertically structured and is dominated by a small number of companies. Creos Luxembourg S.A owns and runs the transmission system and is the dominant supplier in the market. The state itself owns 40% of the company through shares and the Société Nationale de Crédit et d'Investissement. The company which dominates the rest of the market is the Société de Transport de l'Electricité. The rest of the market is owned by municipalities. [285]

3.2 WHOLESALE MARKETS

In Institut Luxembourgeois De Regulation's 2012 report identified the market to have 278.496 customers consuming 6.36 TWh of energy. Their consumption is spread between 11 different suppliers. The Institute has found difficulties in analysing the activity of suppliers in residential

[281] ILR [2012]: National Report.

[282] Ibid.

[283] Institut Luxembourgeois De Regulation [2012] National Report

[284] OECD Report 'Fossil Fuel Support Country Note' [2016]

[285] CREOS [2010]: Creos Annual Report 2010: Available at: http://www.paperjam.lu/sites/default/files/fichiers_contenus/rapports_annuels/2013/creos_2010_en.pdf

areas and small private sector areas. In terms of industrial consumers, there has been a significant shift as rate of supplier change has increased to 15.4 %. In the natural gas sector, national consumption was 13.6 TWh, which compared to the previous year, is an increase of just 0.2%. There is now roughly 287.043 Nm3/h which is shared between eight suppliers on the national market, three in the residential market and seven in the industrial market. [286]

As opposed to other countries in Europe, there is no transmission capacity limit. As a result of efficient cross-border network, Luxembourg can trade on the German exchange as it is integrated with the German prize zone. Moreover, there is no major market for natural gas as much of the supply is imported and as a result, the market price is set by the price of neighbouring countries. The Institute does not regulate cross border transaction prices on wholesale electricity or natural gas. In terms of competition in the markets, the 2012 report identifies the presence of multiple foreign supplies and therefore prices are maintained as foreign supplies compete between themselves. The Institute did not report any abuses of the market by a dominant entity. [287]

3.3 RETAIL MARKETS

There are 11 companies, 7 of which are active in the residential sector but all 11 are active in non-residential markets. It has an unusually high number of players in its market for a country of its size. As a result, there is not enough to be shared between companies. In the natural gas market, growth is far slower than the electricity market. In 2012, the rate of switching between providers was 9.7% in volume terms and 0.22% by customers. Business customers have a higher switching rate compared to residential customers. In the industrial sector, the rate is 15.4% and in the natural gas sector, it is below 0.1% and only 29 switches between all categories. [288]

4. SMART METERING SYSTEMS

Luxembourg is implementing a nationwide smart-meter revolution. This revolution is headed under the title 'Project Scope'. Its purpose is to have all citizens using smart meters in gas and electricity. The project began in July 2016 and will conclude in December 2019 for electricity and 2020 for gas. The project is funded by all DSOs in the electricity and gas sectors. The long-term benefits shall be customers awareness in relation to their consumption, better analysis for the smart grid, more data for DSOs for investment and planning, and greater value-for-money tariffs and better forecasting. [289]

There are risks involved, the primary of which concerns engineering standardisation as well as general concerns such as costs, customer apprehension and technical issues. These concerns are offset by standardisation bodies, transparency and public bodies. All data collected will be transported to individual data contractors and an enhanced security system shall ensure end-to-

[286] Institut Luxembourgeois De Regulation [2012] National Report

[287] Ibid.

[288] Ibid.

OECD – Energy Supply Security [2014]

Directive' [2015]

end security.[290]

5. DEMAND RESPONSE

The regulatory bodies have their method for calculating network tariffs outlined in the Protection of Persons with regard to the Processing of Personal Data Act 2002. [291] It stipulates that customers ought to participate towards improving the overall efficiency of the system, including Demand Response. Network tariffs must take into consideration savings achieved from demand side and demand response measures. They must also take into consideration savings procured from the cost of delivery or investment in the grid to maintain optimal operation.

Article 27 of the amended Act now stipulates the demand response duties (via Article 27 and 33) concerning the electricity and gas markets, respectively. They are now obligated to treat suppliers of demand response services without prejudice and solely on their ability to meet technical requirements that are inherent in the operation of networks.

Article 54[292] also requires regulatory bodies encourage demand response in wholesale and retail markets. Similar to the duties imposed in providers, the regulatory bodies must enforce upon network operators a duty to support access and participation of demand response mechanisms in all system service markets. In doing so, the regulatory body shall outline the technical requirements for achieving this and must include participation of aggregators.

6. DATA PROTECTION

The European Union's most recent and wide-ranging legislation pertaining to data protection is Regulation 679/2016[293], the General Data Protection Regulation (GDPR). This has been in effect since 25th May 2018. It outlines an entirely new raft of rules concerning data collection and retention for Member States. The rules apply to all smart grid providers. Luxembourg's National Data Protection Commission (*Commission Nationale pour la Protection des Données*) (CNPD) outlined ten guiding principles for the electricity market to ensure it is compliant with the Regulation: [294]

- **Legitimacy**: The processing of data must be made on reasonable and justifiable grounds.
- **Purpose**: The controllers of data must present the purpose in explicit terms and must be processed for those terms alone.
- **Necessity and proportionality:** The processing of data must be conserved to accomplishing its stated goals and must demonstrate a direct and clear link between

[290] Press Release [2015] https://www.prnewswire.com/news-releases/sagemcom-delivers-1st-multi-energy-solution-for-luxembourgs-smart-metering-roll-out-518178871.html

[291] Coordinated Text of the Law of 2 August 2002 on the Protection of Persons with regard to the Processing of Personal Data, available at https://cnpd.public.lu/dam-assets/fr/legislation/droit-lux/doc_loi02082002_en.pdf

[292] Ibid.

[293] Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data.

[294] National Data Protection Commission // Luxembourg, at https://cnpd.public.lu/en.html

process and outcome.

- **Accuracy of data:** The data cannot be unreliable or inaccurate as it risks harming the person to whom the data relates. If any data is found to be inaccurate, it must be corrected or deleted.

- **Fairness:** The collection of data must be performed on good faith. This means the person to whom the data concerns must be aware of it and aware of the reasons as to why it is being processed. The principle of trust is emphasised here.

- **Security and confidentiality:** The data must be protected, especially in the hands of a subcontractors. The data must remain confidential and stored in a reliable and secure place. If there is non-compliance, the entity processing the data shall be held responsible.

- **Transparency:** The natural or legal person who wishes to process personal data must inform the data subject as soon as it is collected, or if the data is passed on to third parties. If the data is passed onto third parties, the person to whom the data relates must be made aware of this. There must be complete transparency relating to the handling of data at every stage.

- **Sensitive data is subject to more stringent protection:** Sensitive data must be given the highest form of protecting and authorisation for such data must be gained from the CNPD.

- **Surveillance is strictly limited by law:** Authorisation by the CNPD is in principle required before technical means can be used to monitor persons (such as video cameras, computerised tracing, and so on). Express authorisation from the CNPD is required to monitor persons, such as in CCTV cameras or computer tracing etc.

- **Advertising/marketing:** Use of personal data for advertising or marketing purposes requires permission. If the data will be used for marketing purposes, it will need further permission.

This area of law and technology is new and it will take a few years before an assessment can be made on its application.

7. ELECTRIC VEHICLES

7.1 ROLLOUT

A study into the introduction of electric vehicles in Luxembourg, a strategy for a standardised system for charging was prepared.[295] The electricity market, suppliers and distributers must work in conjunction with each other to establish a national charging infrastructure based on a common central unit. This will allow the consumer to choose freely their electricity suppliers. The

[295] Schwartz and Co, Etude technico-économique pour la mise en oeuvre nationale de l'électro-mobilité au Luxembourg *'Technical and economic study on the nationwide implementation of electromobility in Luxembourg'* [2011].

distribution system operators (DSOs) will be responsible for the practical elements of maintaining the infrastructure as it pertains to setting up and operation. The Grand-Ducal Regulation of 3rd December 2015 aims to establish by 2020 800 public charging stations and two exclusively reserved for electric vehicles. The first of these have already been set up and the government is looking to establish charging stations on motorways and key locations throughout the country.[296]

7.2 REFORM

In order to achieve its goal of having a nationwide grid for electric vehicle charging, the government of Luxembourg has enacted the following:[297]

- The 'elektromobilitéit.lu' platform focus is on promoting electromobility. Contributions are made from all stakeholders from electricity suppliers to car manufactures to research centres.
- Until the end of 2014, the purchase of an electric vehicle was supported by a EUR 5000 subsidy. From January 2017, electric vehicles for private use is entitled to the same subsidy.
- By 2016, 150 charging station have been set up for the public.
- There have been many pilot projects for 'car-sharing' with electric cars in places like Carloh and Nordstadt.
- As the country has significant cross-border transport, there is a view of creation intermodal platform across main access routes at border points.

8. STORAGE

Policymakers are considering a highly ambitious plan of achieving a fully clean energy reliant economy by 2050. Deputy Prime Minister, Etienne Schneider strongly endorsed the Ministry for Economic and Chamber of Commerce's 475-page proposal: *The 3rd Industrial Revolution Strategy Study for the Grand Duchy of Luxembourg*,[298] He said it 'constitutes a general direction for future development of the country'[299]

The team explains this herculean effort will require the cooperation of all sectors in Luxembourg and will rest on communications technology and clean mobility. With respect to energy, the study made four recommendations:

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[296] Government of the Grand Duchy of Luxembourg Ministry of Economy, *Fourth National Energy Efficiency Action Plan* Luxembourg [2017].

[297] Ibid.

[298] Accessed at http://www.troisiemerevolutionindustrielle.lu/

[299] https://www.greentechmedia.com/articles/read/the-plan-for-an-energy-internet-revolution-in-luxembourg#gs.XzyLSbL1

1. Improving efficiency and focusing all efforts on technological efficiency.
2. Greener alternatives to oil
3. Replacing consumption of energy with renewable sources upto 70%
4. Decreasing the share of imports.

They also promote the creation of a legal framework that will promote self-consumption and moving to 100% electric vehicles. The authors predict "The phase-in and integration of the Renewable Energy Internet and the generation of near-zero marginal cost renewable energy in Luxembourg will enable every business, neighbourhood, and homeowner to become a producer of electricity," and that the transition will result in an increase in "aggregate efficiency and productivity, and an equally dramatic reduction in ecological footprint and the marginal cost of doing business,"[300]

Luxembourg has set aside $2.2 billion but the International Energy Agency argues only a fifth of that goes towards productive work. It has concluded a mix of policy and price variance as well as investment incentives could lead to a 30% reduction in energy requirements and achieving this will boost economic growth by way of job creation. [301]

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[300] Ibid.

[301] Ibid.

VI. CONCLUSION

Since the beginning of the 21st century there has been a marked change in Slovenian energy policy. Energy governance has been decentralised and new actors have emerged. The Slovenian electricity sector, in line with an EU-wide trend, has undergone a major transition, as vertically structured electricity companies which controlled production, transmission, distribution, and supply activities, have seen their services unbundled.

In the current energy mix, nuclear power still provides around 40% of all electricity generated in Slovenia, with RES (hydro power, wind power, solar power, biomass) delivering approximately 30% of the country's energy needs. Fossil fuels provide the remaining 30% of generated electricity. The Slovenian energy sector is facing challenges that can only be overcome by the sustainable use of natural sources. It is crucial that this is achieved whilst also simultaneously fostering competitiveness and maintaining the security of the country's energy supply. The increasing adoption of renewable resources is extremely encouraging, and there is substantial scope for further reducing the use of fossil fuels through their replacement in the energy mix by RES'. Renewables play a key role in decarbonisation, improving energy efficiency, and involving more end consumers in energy management - some of whom are also becoming producers.

Smart grids are vital to realising the vision of a more environmentally sustainable energy market, offering unparalleled flexibility, and end-user participation. Recent years have seen significant developments with the launch of numerous international projects. One of the most important smart grid projects currently underway is the 'Sincro.Grid', which is being rolled out in Slovenia and Croatia. Interconnectivity is thus key: Slovenia's heightened integration in the single European electricity market has facilitated improvements in monitoring and in meeting EU environmental targets.

Over the last few years the Slovenian retail electricity market has become markedly more competitive, and the liquidity of wholesale markets has improved. It is important to note that although the main transmission and distribution operators remain fully state-owned, there are more market participants. The competitiveness and efficiency of the electricity and natural gas markets has increased in tandem with consumption increase, itself a consequence of Slovenia's robust economic growth.

Prior to independence, Slovenia had long-term contracts with natural gas producers from Russia. Those contracts are now being replaced with short-term contracts with gas hubs and power exchanges. Public tenders for investors to submit projects for production facilities for electricity generation from RES and CHP to enter the support scheme are carried out as part of a competitive selection process. All support schemes are fully compliant with EU legislation regarding state aid. The implementation of the EU Third Package was enabled through the passing of the Energy Act. The actual realisation of these projects also depends on spatial planning and obtaining environmental permits.

As already mentioned, Slovenia's most utilised energy source for electricity production is water. Hydro power plants make up the lion's share of RES's currently being used, and hydropower also has the greatest potential for further exploitation as an energy source. The on-going renovation of ageing hydropower facilities and the construction of five new plants on the river Sava is indicative of the importance of hydropower in the RES mix. Aside from hydro, the principal renewable energy sources in the country are biomass and wind, with the latter having the potential to provide both heat and power.

Slovenia is working to hit the European Commission targets by 2020, and in the period 2005–2017 the growth in the share of energy from RES in total gross consumption and changes in RES per individual sectors indicate that progress is being made. However, Slovenia's energy policy requires the implementation of additional measures if those obligations are to be met by 2020, as well as the objectives set out by the EU and in the Paris climate change agreement. Presently there is no defined legislation on smart-metering and storage, but other key EU-compliant objectives have been established in law.

In giving consumers a greater degree of autonomy to exercise their rights it is possible to observe increased awareness– through switching suppliers, for example, in which the decision to change is driven not only by price, but also by other factors such as the supplier's flexibility. Digitisation of energy management and an open market allow consumers to participate to become more self-sufficient and active in the management of energy, both in production and in demand response.

To conclude on Slovenia, the future operation and management of Slovenia's energy network, in which near-permanently dynamically unbalanced smart grids will play a major role - requires close cooperation and convergence between the power systems and data analytics communities. In the area of energy efficiency, suppliers of energy products will be obliged to implement measures for achieving energy savings. The present situation and the development of the electricity and natural gas market, the effort to attain key objectives in the areas of renewable sources and cogeneration, and energy saving strategies focusing on the efficient use of energy and heat supplies are all positive indications of Slovenia's commitment to combatting climate change – both directly and indirectly. Together they form a solid foundation for making decisions in national energy policy and decisions related to the development and further investment in the power sector.

As for Croatia, in recent decades there has been a marked change in Croatian energy policy. Energy governance has been slowly moving towards liberalisation and decentralisation, and new actors have emerged, though the sector is dominated by a relatively small number of players.

In line with EU legislation, Croatia adopted new legislation that governs the activities and functioning of the electricity sector. According to the Croatian Constitution, international agreements take priority over domestic laws and form an integral part of Croatian legislation.

The lack of incentives for renewable energy production made the development of the renewable energy market less dynamic. One of the reasons that the government - and the public - are more sensitive to introducing new incentives is that the previous renewable support scheme resulted in significant financial obligations on the part of the state, and therefore higher electricity bills for end-consumers.

Electricity suppliers' obligations on the regulated purchase price for renewables was postponed from 2017 until 2019. The electricity market remains concentrated and the liberalisation process has been proceeding slowly, although recent years have shown improvements towards a market for Demand Response. This is not yet supported by legislation, however. Consumers are displaying a greater willingness to switch suppliers in spite of price regulation.

The country is also moving away from only bilateral contracts. Additionally, the foundation of the

Croatian Power Exchange represented a major step towards further market liberalization.

Croatian electric power companies are exploring the possibilities for cooperation with international partners for further strengthening smart metering systems. Croatia is concentrating resources on achieving a greater degree of grid flexibility. 'Sincro.Grid', an EU-funded project, is being rolled out in Slovenia and Croatia and is one of the most important smart grid projects aimed at integration into the single European electricity market. Electricity storage is not specifically regulated or supported by Croatian law. Croatia has dedicated incentives for citizens and businesses interested in buying electric vehicles.

Croatia's potential for energy efficiency improvements is considerable, especially in the residential sector. While it has made progress in developing innovative energy systems, many additional possibilities for energy efficiency could nevertheless be explored. Considering the country's meteorological and geographical advantages, solar thermal is a promising candidate as a future RES driver. Croatia's unique chain of islands also offer significant potential for harnessing renewable energy resources.

Croatia would benefit from increasing the share of energy derived from renewable energy sources, and developing energy storage, hydrogen and electric vehicles for building better strategies for building smart energy system.

As for Austria, it remains ahead of many EU countries in supporting the rollout of smart technology as well as promoting research and development in this area. It will be interesting to commence a review of policies in 2020 to see how energy efficient and independent the country has become and to what extent has it implemented EU Regulations in order to meet the overall sustainable development objectives of the EU, UN and the Paris Agreement 2015. The future of smart grids hinders on pricing, load management, risk and social and economic factors. The evidence suggests that it is in the consumer's interest to accept this technological revolution.

Regarding Luxembourg, its vast resources and economic growth allow it to experiment and promote innovative ways to revolutionise its energy grids. The country has certainty made a progressive and leading effort in making its technological infrastructure energy efficient. The future of smart grids may help it become more energy dependent using renewable energy resource, however, it is unrealistic to presume Luxembourg will cease being so being so heavily dependent on imports for energy.