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Learning from Current Mistakes: Developing Slovenia's Electric Generation Infrastructure

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LEARNING FROM CURRENT MISTAKES: DEVELOPING SLOVENIA'S ELECTRIC GENERATION INFRASTRUCTURE

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Introduction

Slovenia has one of the smallest electric grids in the European Union, but the issues that the country's electricity sector faces are not trivial. The EU has imposed demanding policy pressures to produce clean and lean power while curbing demand. However, Slovenia's electricity generation sector has powerful, state-owned companies pursuing big generation projects that could become environmental and financial liabilities. In particular, an ongoing project to build a 600-megawatt (MW) coal power plant has run into financial problems and has sparked environmental concerns, raising questions about the direction in which the country's power sector is headed.

This article presents the broad background of Slovenia's electricity system before critically examining proposals for its future development. Specifically, it argues that Slovenia should make promoting small-scale renewable energy projects a long-term priority in order to avoid financial risks associated with larger projects, to help increase competition and private sector involvement in a heavily concentrated public market, and to meet present and future environmental goals mandated by the EU.

Background

Structure of the Slovenian Electricity Sector

Upon gaining independence in 1991, the Republic of Slovenia divided its state-owned electricity assets into generation companies, a transmission system operator, and a distribution system operator. Prior to acceding into the EU in 2004, Slovenia formalized this three-tiered structure of the electricity sector by adopting an Energy Act (1999). The Energy Act established a regulatory Energy Agency and paved the way to liberalizing the market. In compliance with EU Directives 2003/54/EC

and 2009/72/EC, the Slovenian electricity sector has been fully unbundled and open since 2007, meaning that generation companies cut financial ties with the transmission system operator (to ensure competitive access to the transmission grid), and households became free to select their suppliers.

Most major generation facilities (those with capacities greater than 10 MW) currently belong to the holding companies Holding Slovenske Elektrarne (HSE) and GEN Energija.[1] In 2001 the government of Slovenia merged most of the state-owned generation companies to form HSE. Then in 2006 the government took steps to privatize its generation assets and increase competition by restructuring HSE and creating GEN Energija. GEN Energija gained control of Slovenia's only nuclear power plant, Nuklearna Elektrarna Krško (NEK), which is co-owned with Croatia. Because of bilateral agreements between Slovenia and Croatia, NEK cannot be privatized. However, HSE has not yet attracted any tenders, and both companies remain 100 percent state-owned, effectively acting as a duopoly. The current ownership structure is shown in Figure 1.

As seen in Figure 1, HSE and GEN Energija control a large portion of the generation market, both in terms of installed capacity and production. As specified in the Slovenian Prevention of Restriction of Competition Act, a company has a dominant market position if its market share exceeds 40 percent or if it shares more than 60 percent of the market with one or more companies. HSE alone controls 64 percent of the production in Slovenia, while HSE and GEN Energija together control 87.8 percent of the production in Slovenia ("Report on the Energy Sector…," p. 39). The transmission system operator, Elektro Slovenija (ELES), and the distribution system operator, Sistemski Operator Distribucijskega Omrežja (Electricity Distribution System Operator) (SODO), are also 100 percent state-owned.[2] In all, the government of Slovenia owns about 80 percent of the electricity sector, which is one of the highest state ownership rates in the EU-27 (European Bank...).

Slovenia in the Regional Market and the European Union

Slovenia plays an important role in the regional and European electricity market, primarily due to its strategic location. ELES has cross-border transmission capabilities with three of four of Slovenia's neighbors: Croatia, Austria, and Italy.[3] Slovenia's importance in the European market became even more apparent in 2011, when the city of Ljubljana won the seat for the new Agency for the Cooperation of Energy Regulators (ACER). ACER's main responsibilities include coordinating national energy authorities with the purpose of creating pan-European network rules, performing consulting tasks for various EU institutions, and monitoring general trends in the markets.

Since acceding into the EU, Slovenia has faced new levels of policy pressures and responsibilities. Slovenian energy policy must conform to a wide body of EU legislation, commonly referred to as the EU Energy Community *acquis communautaire*. Two major pieces of relevant legislation include the Third Energy Liberalization Package and the EU Climate and Energy Package. The Third Energy Liberalization Package issued directives and regulations to help create a single European energy market by 2014; the EU Climate and Energy Package is discussed in detail below.

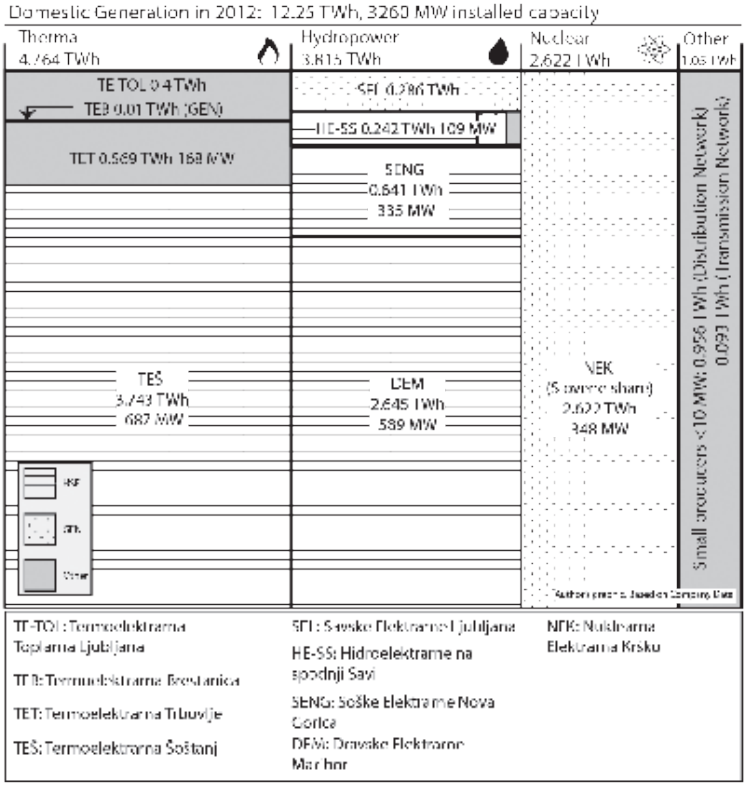
[1]HSE owns almost all major generation facilities, notably the Termoelektrarna Šoštanj and several hydropower plants on the Drava and Soča rivers through the companies Dravske Elektrarne Maribor and Soške Elektrarne Nova Gorica. Apart from NEK, GEN Energija owns a few hydropower plants on the Sava River through the company Savske Elektrarne Ljubljana and a smaller thermal power plant, Termoelektrarna Brestanica. Another hydroelectric company that operates on the lower Sava River, Hidroelektrarne Na Spodnji Savi, is co-owned by HSE, GEN Energija, and their subsidiaries. Other major generation facilities, namely Termoelektrarna Toplarna Ljubljana and the Termoelektrarna Trbovlje, belong to other government entities or private owners, respectively.

[2]ELES, founded in 1990, is responsible for the management, strategic planning, construction, and maintenance of the transmission network, as defined in the Energy Act. ELES sells electricity on the wholesale market to five regional distributors that operate under concession contracts from SODO as well as supplying a few large industrial customers directly. ELES is also responsible for matters pertaining to cross-border transmission.

[3]A long-expected 440-kV link to Hungary was finally approved in late 2012 and is scheduled for completion in 2014 (Elektro-Slovenija).

Figure 1

Installed Capacity, Production, and Ownership Structure of Major Slovenian Power Generation Companies



Sources: "Report on the Energy Sector in Slovenia for 2012" and company data.

The EU Climate and Energy Package

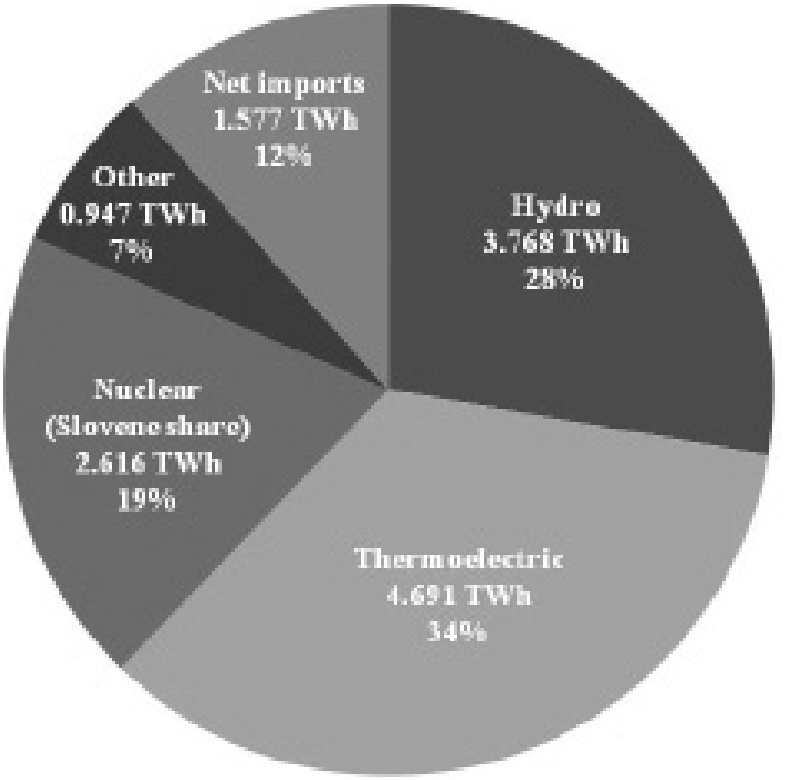
The legislation in the broad EU "20-20-20" Climate and Energy Package aims to reduce greenhouse gas emissions by 20 percent (from 1990 levels), bring the use of renewable energy sources (RESs) to 20 percent of total energy consumption, and increase overall energy efficiency by 20 percent, all by the year 2020. The EU aims to achieve these EU-wide targets by reforming its Emissions Trading System (which includes the power sector) and by setting targets for each member country regarding emissions not controlled by the Emissions Trading System, RES usage, and energy efficiency.[4]

By 2020 Slovenia is expected to increase RES usage from 16.2 percent (2005) to 25 percent and to increase energy efficiency by 20 percent, per Directives 2009/28/EC and 2012/27/EU, respectively. The 25 percent target for RESs refers to an average increase in the following three sectors: heating and cooling, electricity generation, and an obligatory 10 percent increase in transport. To meet the overall goal, Slovenia has adopted a mandatory National Renewable Energy Action Plan (NREAP) for 2010–2020 ("National Renewable..."), consequently agreeing to increase its use of RESs in electricity generation to 39.3 percent by 2020. The NREAP assesses and determines the necessary yearly quantities for RES consumption in each sector as well as proposing measures

[4]These individualized targets are based on wealth, starting points, and technical capacity. The emissions and RES targets are binding whereas the energy efficiency target is nonbinding.

Figure 2

Electricity Consumption in 2012 by Generation Type



Source: Energy Agency data.
Note: Energy Agency data consider generation and transmission losses and differ from company data, which represent gross generation

to facilitate consumption of the desired quantity of energy from RESs in future years. The target gross electrical consumption in 2020 is projected to be 15.6 terawatt hours (TWh), of which 6.129 TWh will come from RESs ("National Renewable...").

In recent years, Slovenia has steadily increased its share of RESs in electricity generation, generally in line with its NREAP projections. RES usage in electricity generation peaked at 33.8 percent in 2009, mostly due to favorable hydrologic conditions, before dropping to 32.2 percent in 2010 (Beurskens, p. 159). The target for 2012 was 4.224 TWh, or 32.3 percent of total consumption, a figure around which the sector has been hovering in recent years.

Favorable government support schemes are the primary driver of increasing renewable energy use. Slovenia has been promoting RESs with feed-in tariffs, premium tariffs, subsidies, and loans. Feed-in tariffs offer plants with capacities up to 5 MW the opportunity to sell their electricity at a guaranteed price. The premium tariff scheme allows producers with larger capacities to sell their electricity on the open market while receiving financial support based on reference costs of electricity. Occasionally, the Ministry of Spatial Planning invites tenders for subsidies of RES projects, while the Environmental Fund offers low-interest loans to RES projects, subject to funding availability (Brunec, pp. 1–2). The NREAP estimates that the cost of these support measures through 2020 will be €456.06 million ("National Renewable...").

It is important to note the energy policies currently being drafted by the EU for 2030 and beyond. At the time of this writing, the legislation agreed to aim to set binding targets for all member countries to reduce EU-wide greenhouse gas emissions by 40 percent from 1990 levels and nonbinding targets to bring RES use up to an EU-wide average of 27 percent. Furthermore, the EU climate roadmap sets an ambitious goal of reducing greenhouse gas emissions by 80 percent by 2050, with most cuts coming from the power generation sector, which is expected to be virtually carbon-free (93–99 percent reduction from 1990 levels) by mid-century ("A Sectoral Perspective").

Recent Performance of the Electric Generation Sector

In 2012 Slovenia produced 12.25 TWh (company data, excluding losses[5]) of electricity (taking into account the 50 percent share of the nuclear plant NEK), using a relatively balanced share of conventional thermal, nuclear, and hydroelectric energy, as illustrated in Figure 2. The rest of the electricity generated, approximately 1 TWh, came from distributed generation (DG) facilities. DG facilities are defined as having a capacity of less than 10 MW. The total consumption, excluding losses in the system, amounted to 12.631 TWh. Slovenia thus remained a net importer of electricity, with domestic production meeting approximately 88 percent of demand ("Report on the Energy Sector…," p. 15).

Thermal Power

The largest share of electricity produced in Slovenia comes from thermal power plants, which in 2012 featured a combined capacity of approximately 1258 MW and generated 4.764 TWh using gas and domestic coal ("Report on the Energy Sector…," p. 39). Of the four major thermal power plants (Figure 2), Termoelektrarna Šoštanj (TEŠ), a subsidiary of HSE, is by far the largest. With a total installed capacity of 779 MW and annual electricity production ranging from 3.5 to 3.8 TWh, TEŠ alone accounts for about a third of Slovenia's total domestic production. The three coal-fired units currently in operation at TEŠ run on lignite from the nearby Premogovnik Velenje mine, also owned by HSE.

These three units are generally considered technologically obsolete, financially unsustainable, and environmentally unacceptable and will be shut down by 2027. In order to guarantee electricity and heat production well into the twenty-first century, HSE is currently constructing a single 600-MW lignite-fired plant, Unit 6, to replace the existing three units. In terms of cost and capacity, Unit 6 is the biggest energy project currently underway in Slovenia and has been the source of numerous controversies (discussed later).

Hydropower

In 2012, hydroelectric power plants (HPPs) produced 3.815 TWh,[6] almost a third of the electricity consumed in Slovenia. With a total installed capacity of 1270 MW, hydroelectric power represents roughly 40 percent of Slovenia's generation capacity ("Report on the Energy Sector…," p. 38). Like most RESs, hydropower output can be unpredictable, because it depends on hydrologic conditions. Hydropower in Slovenia produces significantly less electricity than thermal power plants, even though the installed capacities are similar. However, because hydropower represents Slovenia's largest renewable energy resource, there are many incentives to further develop its potential to help Slovenia fulfill EU commitments. Accordingly, approximately 750 MW of additional capacity are expected by 2022 ("Report on the Energy Sector…," p. 66).

The major HPP installations in Slovenia are owned and operated by subsidiaries of HSE and Gen Energija. The largest hydroelectric company, Dravske Elektrarne Maribor (DEM), operates on the Drava River, with a total capacity of 588.6 MW, producing approximately 80 percent of Slovenia's renewable electricity. Soške Elektrarne Nova Gorica (SENG) operates on the Soča River and its tributaries with a total capacity of 161 MW. SENG also operates

[5]Losses in 2012 were estimated to be approximately 0.875 TWh, or 6.7 percent of transmitted electricity.

[6]This figure excludes small producers with capacities <10 MW.

Table 1

Installed and Planned Capacity at TEŠ

Unit	Gross Power Output (MW)	Years of Operation
Unit 1	30	1956–2010
Unit 2	30	1956–2008
Unit 3	75	1960–2015?
Unit 4	275	1972–2015?
Unit 5	345	1977–2027?
Gas units	2 × 42	2008–2027?
Unit 6	600	2016–2054?

Source: "TEŠ Today."

the pumped storage plant Avče ("Hidroelektrarne").

Another major hydropower company, Hidroelektrarne Na Spodnji Savi (HE-SS), is a joint venture between HSE, Gen Energija, DEM, SEL, SENG, and TEB. HSE is the majority owner, with 51 percent of the shares. HE-SS is developing the hydropower potential of the lower Sava River with a series of five new HPPs, three of which are already complete. The two remaining plants are scheduled to come online by 2018. The final nominal capacity of the five HPPs will be 186.5 MW, which HSE estimates will produce an average of 0.72 TWh annually and cover 6 percent of Slovenia's demand ("Construction of HPPs…"). However, an even bigger hydropower project is under consideration for the middle course of the Sava River. HSE plans to construct a chain of ten new HPPs with a total capacity of 295.4 MW (0.994 TWh annually) ("Annual Report…," p. 66). Although funding has been secured, the construction timeline has been pushed back at least five years, with the completion of the project unlikely before 2030 ("Construction of HPPs…"). Nevertheless, Slovenia's hydroelectric potential will continue to be developed for the foreseeable future.

Nuclear Power

The only nuclear power plant in Slovenia, the 696-MW Nuclearna Elektrarna Krško (NEK), began commercial operations in 1983. Built in former Yugoslavia, today NEK remains co-owned by Slovenia's GEN Energija and Croatia's Hrvatska Elektroprivreda, with output divided 50/50 between the two countries. Accounting for the share of production belonging to Croatia, NEK supplied about 19 percent of the electricity consumed in Slovenia in 2012 ("Report on the Energy Sector…," p. 39). NEK was built with a planned lifetime of 40 years, meaning it is scheduled for decommissioning in 2023. However, due to continuous upgrades in instrumentation, controls, and equipment, GEN Energija is confident that the lifetime of the plant can be extended to 2043.

There have also been proposals for the construction of a new nuclear power plant at Krško (NEK 2) by 2030. The nominal capacity of such a facility would be at least 1,000 MW. Currently, all feasibility and acceptability studies for this new power plant have been completed as well as several other documents necessary for decision-making purposes, including pre-investment studies, conceptual design and requirements, initial environmental assessments, and preliminary safety studies ("Update on Slovenia Nuclear…").

Small Producers Connected to the Distribution Network

In 2012 small producers generated approximately 1.049 TWh. The majority of this

came from DG, which produced 0.956 TWh with 471.19 MW of installed capacity. DG projects, unlike the large central generation plants (discussed previously), are small electric-generation installations connected to the distribution network,[7] which produce electricity that is used on-site or nearby. Most DG facilities use RESs, such as hydroelectric power, solar, or biogas/biomass, although some (approximately 40 MW) in Slovenia are cogeneration plants that use fossil fuels. Due to the favorable RES support schemes (discussed previously), installed solar capacity approximately doubled from 2011 to 2012 to 240.4 MW and produced 0.121 TWh, making up the largest share of DG by capacity ("Report on the Energy Sector…," pp. 38–39).

A Critical Examination of Generation System Development

The National Energy Program for 2010–2030

In 2011 Slovenia released a draft of its National Energy Program (NEP) for 2010–2030 ("Proposal of the...") for public review and consultation. This important planning document, prepared for the Ministry of the Economy by the Jožef Stefan Institute, will guide Slovenia's long-term developmental objectives and policies regarding the supply and use of energy in the electricity, natural gas, transportation, and heating sectors through the year 2030. Keeping in mind the close relationship between national and EU energy policy, the NEP focuses on environmental sustainability, security of supply, and competitiveness in the process of developing infrastructure of national importance. Slovenia's apparent long-term strategic goal, as made evident in the NEP, is to become a regional net exporter of electricity. This would require increases in generation capacity and market efficiency. Currently, Slovenia and all of its neighbors are net importers of electricity ("Annual Report…," p. 55).

In terms of electricity production, the NEP analyzes several combinations of generation capacity, paying attention to security of supply, competitiveness, and how well each combination would allow Slovenia to meet a host of EU requirements for 2020 and 2030. Assuming the completion of TEŠ Unit 6, the still pertinent scenarios are the base scenario, the nuclear scenario, and the natural gas scenario. The base scenario foresees the continuation of all current projects and measures, including more hydropower on the Sava River, the completion of TEŠ Unit 6, a life extension of NEK to 2043 (from 2023), and the construction of new cogeneration and gas turbine plants. The nuclear scenario builds on the basic scenario and foresees the construction of a new nuclear power plant at Krško before 2030, with a nominal capacity of at least 1,000 MW. The natural gas scenario is another variation of the basic scenario and would entail the construction of two combined gas turbine-steam cycle plants with a total capacity of approximately 800 MW by 2030.

With respect to the electricity sector as a whole, the NEP also analyses two strategies regarding questions of sustainability. Integrating the conclusions of the NREAP, the NEP addresses issues of RES development, energy efficiency at production and consumption levels, local energy supply, and the cogeneration of heat and electricity. The reference strategy ensures minimal compliancy with international obligations, whereas the intensive strategy creates a support environment to promote profitable green energy projects. In effect, the intensive strategy sets more ambitious targets for energy efficiency, the share of RESs, and the production of energy at a local level.

Every analyzed scenario and strategy fulfills all adopted international legal requirements and obligations and meets industry standards in terms of competitiveness and security of supply. With respect to the climate and the environment, the pertinent legislation includes the Kyoto Protocol and the EU Climate and Energy Package. The NEP also considers possible EU climate goals for 2050, which include a nearly complete cessation of CO2 emissions in the electricity generation sector.

In terms of sustainability, the NEP proposes the intensive strategy. Even though the two strategies do not differ significantly in 2020, the intensive strategy provides significant

[7]Small producers connected to the transmission grid produced 0.093 TWh, using a capacity of 25.6 MW.

benefits by 2030. Namely, the intensive strategy would result in a 53 percent share of RESs in electricity production versus 44 percent in the reference strategy. For large-scale electricity generation, the NEP recommends the basic and nuclear scenarios on the basis of lower supply costs and smaller emissions. The natural gas scenario provides no direct advantages over the other two scenarios except a lower initial investment cost, but it would result in a higher dependence on imports and result in greater emissions of carbon dioxide and mono-nitrogen oxides. The basic scenario adequately covers Slovenia's consumption needs through 2030, whereas the nuclear scenario designates a large share of electricity for export.

Two Ways Forward

In the most general terms, the proposals for the development of the Slovenian generation system detailed in the NEP fall into two categories: single, large, central-generation projects like TEŠ Unit 6 or the proposed NEK 2, and the numerous smaller investments such as those backed by the government RES support schemes. These categories constitute a choice that the country must make regarding the future of its electricity generation system. Slovenia can invest public money to back large projects or support the development of smaller projects and DG. Although it is important to have a diverse generation system, large projects have the potential to become financial and environmental burdens and, compared with smaller alternatives, are not as well suited to Slovenia's size and national demand. In fact, the NEP has provoked critical comments from a wide spectrum of the public, including environmental groups such as Greenpeace and foreign agencies such as the Environment Agency of Austria, for its support for TEŠ Unit 6 and NEK 2.

Unit 6 has been the source of continuous public controversy since it was proposed in 2006, even though HSE and TEŠ presented Unit 6 as an environmentally friendly and financially prudent investment. According to TEŠ, the new unit will provide Slovenia with a safe and secure supply of electricity by generating the same amount of power as the existing units but at higher efficiencies and with lower emissions. The company promises to eventually cut emissions of sulfur dioxide from 400 to 100 mg/Nm^3 and emissions of mono-nitrogen oxides from 500 to 150 mg/Nm^3 while reducing specific emissions of carbon dioxide (emissions per unit of power produced) by 35 percent ("Unit 6 of Sostanj…," p. 2). However, environmental groups have been quick to criticize this large coal project that will cover roughly a third of Slovenia's demand for electricity yet use up virtually all of the country's carbon allowances by 2050. As stated in its investment plans, TEŠ expects to operate Unit 6 until 2054, coinciding with the year that the lignite reserves at the Premogovnik Velenje mine will be depleted. From an environmental standpoint, lignite is one of the dirtiest fuels, and running the plant through the middle of the century could hinder Slovenia's ability to meet any potential new EU climate targets. As mentioned previously, the EU climate road map foresees a 93 to 99 percent reduction of CO_2 emissions from 1990 levels in the power generation sector by 2050 ("A Sectoral Perspective"). Provided that Slovenia was emitting approximately 18.5 MMTCDE in 1990,[8] the country will have to emit no more than a collective 3.9 MMTCDE in 2050 ("Greenhouse Gas Emission Trends…"). By comparison, TEŠ today emits almost 5 MMTCDE (Kovačič, p. 322), so even the 35 percent reduction in specific CO_2 emissions would result in about 3.25 MMTCDE emissions from TEŠ alone. Further environmental complaints about Unit 6 regard the lack of alternatives proposed in the investment plan and the lack of detail concerning the implementation and viability of future carbon capture and storage technologies ("Complaint: Sostanj…," pp. 9–12). Barring a shutdown of the plant before 2054, implementing carbon capture and storage technology, which remains expensive and experimental, would be the only way Slovenia could feasibly meet the proposed EU climate obligations.

Cost and Benefits: RES Support Scheme versus TEŠ Unit 6

[8]Million metric tons of carbon dioxide equivalent (MMTCDE) refers to a theoretical amount of CO_2 needed to absorb the same amount of heat as the total amount of all greenhouse gas emissions in question.

In contrast to large-scale projects like Unit 6, small-scale capacity increases, which often use renewable energy and are backed by private initiatives, rarely provoke controversy. In order to obtain a rough estimate of the relative financial performance of each of the two approaches to developing the generation system, the projected cost of the RES support measures presented in the NREAP can be used as a reference. Comparing the RES support scheme in the NREAP and Unit 6 in terms of their respective costs and benefits suggests that promoting small-scale renewable energy projects makes economic sense. Executing the NREAP will result in an additional 557 MW of renewable generation capacity by 2020, comparable to the 600 MW capacity of Unit 6 ("National Renewable..."). However, due to varying maintenance requirements, distributed RES facilities can operate for a greater number of collective operating hours than a single plant like Unit 6. This means that the completed RES installations will produce an estimated 6.126 TWh annually whereas Unit 6 will produce only 3.5 TWh (6650 h/year) ("Annual Report…," p. 64). The two approaches to developing the generation system diverge further when examined in financial terms. The €456.06 million in paid RES support predicted by the NREAP is significantly less than the estimated €1.44 billion cost of Unit 6. Unit 6 is backed by state-backed loans from the European Bank for Reconstruction and Development and the European Investment Bank together worth €650 million, with an additional €100 million syndicated to commercial banks (Guay et al., 2014). Furthermore, the NREAP foresees several positive effects on the Slovenian economy resulting from the RES support schemes, which include a potential €1.3 billion in private spending and investments, up to 339 permanent jobs, and 10,603 person-years of employment during development ("National Renewable...").

These figures contrast sharply with Unit 6's predicted financial performance, which has always been questioned. Only now as construction nears completion are the consequences becoming clear. The current cost is almost double that in the original budget, and the investment plan has been amended five times, with constantly changing projections regarding the internal rate of return, the price of coal, and the cost of carbon credits. Although the project will create 200 permanent jobs, Unit 6 is now predicted to operate at an annual loss of €50 million if completed by 2015 due to the aforementioned miscalculations (Guay et al., 2014). After numerous debates and uncertainties, Slovenia will complete the project, because not doing so would result in even greater losses. Overshadowing the financial controversy have been allegations of corruption in awarding construction contracts. At the time of this writing, HSE is facing cash-flow problems and is behind on payments to contractors.

The TEŠ Unit 6 project, with its environmental and financial troubles, is a product of the high rate of government ownership of a highly concentrated generation sector and does not set a good example for the future of Slovenia's generation system. Instead, Slovenia should support smaller RES projects and back away from additional larger state-funded projects such as NEK 2. Generally, gradual, smaller-scale RES investments pose a lesser financial risk, can increase competition and private-sector involvement in a heavily concentrated public market, and promote green job creation, while enabling Slovenia to meet EU climate targets. In particular, increasing RES usage will help offset the environmental and financial effects of TEŠ Unit 6.

Large projects yield more generation capacity compared with small RES investments, but they come with disproportionately larger financial risks. Given the serious financial situation of Unit 6 (discussed previously), a new nuclear facility would be even more costly and financially insecure as well as completely unnecessary to meet future domestic energy demands. NEP projections show that Slovenia can export electricity with no additional nuclear facilities. Constructing NEK 2 would result in significant overcapacity, especially if NEK receives a lifetime extension past 2030 (Lechtenböhmer et al., p. 11). If built, NEK 2 would result in a net export of up to 10.2 TWh ("Proposal of the...," p. 152). Given the large start-up and operational costs associated with nuclear power plants, Slovenia would have to rely on decades of high output and stable base load electricity prices in the regional market in order to make NEK 2 profitable. These market conditions are far from guaranteed. Austria is

seeking to limit imports of nuclear energy, and Slovenia's neighbors will be increasing their own share of RESs in the coming years. An increased share of DG RESs in the region will cause the price of base-load electricity to fall, because RESs provide more flexible and more easily dispatched electricity (Lechtenböhmer et al., p. 12). These factors pose significant financial risks that could reverberate through the Slovenian economy.

Furthermore, big-budget projects like Unit 6 are a product of the current two-pillar market structure, characterized by large, state-owned utilities, which operate in an increasingly concentrated market with little room for private competition. Given the lack of success in privatizing HSE, a good way for Slovenia to increase private sector involvement and competition is to promote small RES projects such as DG, which are well suited to private investment. Supporting DG projects is in Slovenia's favor. DG increases the use of RESs while improving the efficiency of the entire system by reducing transmission and distribution losses. DG projects also improve the security of electricity supply while deferring expensive transmission system upgrades (where DG is more cost effective).

Financial questions aside, such large projects, which have decades-long operational lives, may not be appropriate for meeting demand and may also crowd out investments in RESs and associated balancing infrastructure due to Slovenia's small size. Supporting and investing in RESs conveys several economic benefits, such as those discussed by the NREAP. However, increasing the share of RESs and DG presents a challenge to the distribution system operator because it creates a fluctuating and distributed electricity supply, with voltage often dependent on environmental conditions. Balancing such a supply of electricity requires an infrastructure different from that used in the traditional top-down approach to electricity production. To effectively address these issues, the distribution system operator must invest in networked metering technologies, known as smart grids, as well as virtual power plant technologies that allow electricity from DG installations to be fed into the grid smoothly. These technologies have the opportunity to be a significant economic driver but unfortunately do not feature prominently in the NEP. However, Slovenia is investing in smart meters, which allow near–real time communication between the meter and the distribution system operator to enable dynamic pricing to help match supply and demand. The NEP expects that the distribution system operator will provide 100 percent of electricity customers with smart meters by 2016 ("Proposal of the...," p. 95).

Slovenia can invest more in RESs than are specified in the NEP and in the smart grid infrastructure required to manage these sources. Photovoltaic installations are predicted to gain popularity in Slovenia as associated costs continue to decline in Europe. The 240 MW of installed solar capacity in 2012 already exceeds the 2020 NREAP target of 139 MW and is well on the way to meeting the NEP target of 337 MW ("Global Market Outlook…," p. 28). Furthermore, while the NEP predicts hydropower to generate 5 TWh in 2020, an increase from 3.8 TWh in 2012, HSE estimates that more than half of Slovenia's hydroelectric potential remains unexploited (Kovač).

Conclusion

Even though the policy pressures after 2020 remain uncertain and the long-term climate goals may or may not be met, increasing RES usage should remain a long-term priority for Slovenia. Slovenia can lead the EU by example by aggressively developing its renewable energy resources to create an environmentally conscious and financially viable electricity sector. Slovenia's electricity system is one of the smallest in Europe, meaning that even modest investments in RESs contribute significantly to overall generation capacity. After 2020, the country can develop more RESs than is currently specified in the NEP. This will require additional investment in active-grid technologies as well as political willpower if the EU backs away from binding RES requirements for 2030. Larger RES projects, such as the planned hydroelectric installations on the Sava River, can be combined with smaller DG projects to develop a diversified generation system. Increasing the share of RESs in electricity generation will also decrease the need for future problematic investments like Unit 6 or NEK 2, while promoting smaller DG projects will

help increase competition and innovation in a highly concentrated market. Even though TEŠ Unit 6 was a product of this market structure, it should be the last of its kind in the future of Slovenia's electricity generation sector.

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