UNIVERZITA J. E. PURKYNĚ V ÚSTÍ NAD LABEM

TU WIEN

Czech-Austrian Winter and Summer School Promoting Renewable Energy: targets, costs, strategies, by technology 2005-2017

Martin Horák, Niko Themeßl, Kateřina Vrbková

Co-operating Universities

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Content

1. INTRODUCTION AND GENERAL INFORMATION

The economies of all democratic states, including the European ones, stand on the principle of a free market. This principle uses bilateral agreement between the buyer and the seller based on the supply and demand model. However, this model does not count on the existence of a third party, which is often called the term "public good." Under this term are included non-economic aspects such as social and ecological one. In energy branch, the natural resource market is often considered unlimited and therefore free for use. However, we only increase our debt in nature, that we are starting to pay, in the form of smog conditions or increasing concentrations of GHG in the air. To incorporate these public goods into the economic world, it is necessary to evaluate the ecological impact and motivates to reduce the waste of natural resources (Cost 2014). The subsidies aimed to motivate both producers and consumers to reduce the environmental impact especially in times of economic growth and to support the development of low-emission sources. The success of the support is often different for different countries, and therefore the goal of this project is evaluating them.

ABSTRACT

This paper deals with the summary of targets, costs, strategies, and technologies of promoting renewable energy from 2005 to 2017. This paper aims to summarize current goals in the European Union concerning the prevention of climate change. First, a short overview about subsidies and their effect on promoting renewable energy within Europe was made. We focused on international targets, as probably a first historical step in promoting renewables. The fulfillment of the targets within the Czech Republic and Austria was considered. The effectiveness and costs of promoting strategies and their effects on a market were demonstrated. In the last few years, different technologies have been applied. Their advantages/disadvantages and capital costs were discussed.

MOTIVATION

Many reasons, such as consequences of climate change, enhancement of greenhouse gas emissions or level of pollution causes the transition from energy, produced from fossil fuels to energy produced from renewable sources. However, the incorporation of these sources into an electricity market to the common ones required a certain level of support. The level of support with consideration on costs and strategies are going to be discussed.

PROBLEM STATEMENT

The scope of our work is a short overview of the relevance of promoting renewable energies. This shall be made to underline the importance of an exit from nuclear and fossil-fuel energy.

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APPROACH

This project aims to summarize current goals in the European Union concerning the prevention of climate change. There will be a focus on officially driven objectives like for example the 202020-goals and the 2-degrees-goal.

Information will be gathered about what was the target of the promotion of renewable energy from 2005 to 2017. There may be a conclusion drawn from the introduction where preventing climate change and the compliance with the 2-degrees-goal was already given attention.

2. INTERNATIONAL TARGETS

Kyoto protocol

From the historical point of view is taken as a step in reversing the inexorable increase in the emission of GHGs. The Kyoto protocol was signed in December 1997.

The emissions of the 40 countries (listed in Annex B of the protocol) are to be reduced by at least 5 % between 2008 and 2012 in comparison to 1990 level. The non-Annex B countries have no set objectives. The mitigation requirement is defined as the difference between Business-As-Usual (BAU) emissions in 1990 and the maximum emissions allowed by the protocol. The emission targets refer to six different greenhouse gases known such as carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF6). (Müller-Pelzer, 2004)

The main problem that occurred in the case of implementation of the protocol was that it should be ratified by at least 55 countries representing a minimum of 55 % of Annex B emissions in 1990. After ratification of the protocol by Russia in November 2004, the implementation was in the following year finally achieved. (Ministère de la Transition écologique et solidaire, n.d.)

The Protocol establishes three market-based mechanisms for achieving emission reductions. These were implemented to aid countries to reach reduction targets and allow credits to be gained from action taken in other countries.

- the Emission Trading
- the Joint Implementation
- the Cleaned Development Mechanism

The Emission Trading mechanism allows trading carbon credits on a global carbon market within the countries with emission targets. A party with emissions lower than its target could sell the remaining part up to the target.

The joint implementation allows for any Annex I Party to be credited for emissions reduction achieved by investing in projects located in other Annex I countries.

The cleaned development mechanism allows for any Annex I Party to be credited for emissions reduction achieved by investing in projects located in developing countries. These must be done by specific conditions dealing with the article 12 of a protocol. (Wikipedia, 2018)

The group of countries included in Annex I are members of United Nations Framework Convention on Climate Change (UNFCCC). The group of countries included in Annex B in the Kyoto Protocol is the countries, which have already agreed to a target for their greenhouse-gas emissions. It includes all the Annex I countries except Turkey and Belarus. The Kyoto protocol is nowadays ratified by 192 parties (191 states and one regional economic integration organization). The participating countries are shown in **Chyba! Nenalezen zdroj odkazů.**. The emission share of Appendix I states that have ratified the Protocol to the total emissions of Appendix I countries is 61.6%. (United Nations, 1992) The Percentage changes in emissions of GHGs for Austria and the Czech Republic according to Kyoto targets are shown in Table 1.

Table 1 Percentage changes in emissions of GHGs for Austria and Czech Republic according to Kyoto targets (Wikipedia, 2018)

Country	Kyoto target 2008-2012	Kyoto target 2013-2020
Austria	-8 (-13)	-20
Czech Republic	-8	-20

Paris Agreement

Paris Agreement is an agreement to combat against climate change. In December 2015 was adopted under the United Nations Framework Convention on Climate Change (UNFCCC). Almost all of the parties to the UNFCCC came to Paris to promise voluntary actions to abate global warming, each choosing actions compatible with its interests. (Anthony, 2016) It sets a long-term temperature goal of holding the global average temperature increase in warming below 2 C and effort the strengthening of it addressing the limit to 1.5 °C above pre-industrial levels. (Schleussner et al., 2016)

To achieve the long-term temperature goal set out in Article 2, Parties aim to reach global peaking of GHG emissions as soon as possible, recognizing that peaking will take longer for developing country Parties. This goes together with achieving a balance between anthropogenic emissions and removals by sinks of GHGs in the second half of the century. (United Nations, 2015)

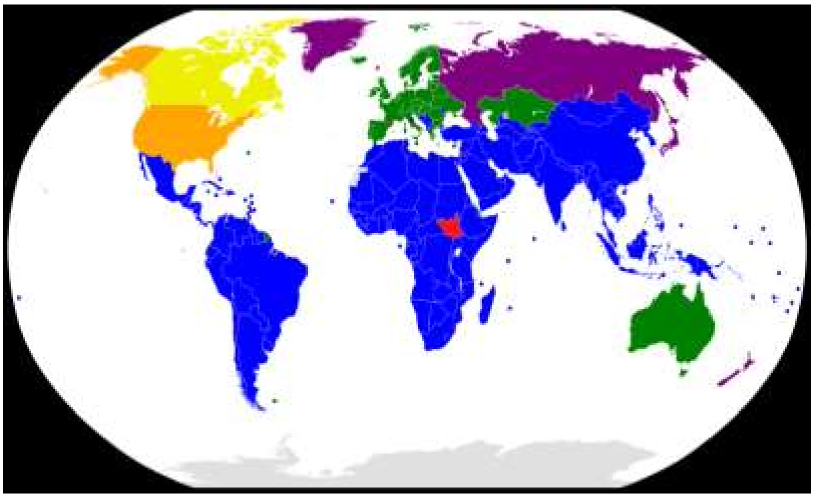

Figure 1 Schema of Kyoto protocol parties (Wikipedia, 2018)

3. Legislation in EU

Energy 2020

In November 2010 the European Council agreed on the strategy for competitive, sustainable and secure energy, so-called Energy 2020. The European Council in 2007 adopted ambitious energy and climate change objectives for 2020 – to reduce greenhouse gas emissions by 20% compared to 1990 level, to increase the share of renewable energy to 20%, and to make a 20% improvement in energy efficiency. (Energy 2020)

EU framework 2030

In October 2014, the European Council agreed on this framework for climate and energy. The new framework sets out the European Union target of at least 27% for the share of renewable energy consumed in the EU in 2030. This target is binding at EU level and will be fulfilled through individual Member States contributions guided by the need to deliver collectively for the EU. Also, the framework allows to set up more ambitious goals in the individual action plans of the states. Together with the RES level, additional targets have been established. At least 27% improvement in energy efficiency in 2030, and reducing greenhouse gas emissions by at least 40% by 2030 compared to 1990 level. This reduction should be ensured by already operating emission allowances. The criteria for the allocation of free emission allowances will be continuously revised due to technical progress in the relevant industries. The annual factor for the reduction of the maximum allowable emissions will be changed from 1,74% to 2,2% from 2021;

On several occasions, the European Council and the European Parliament has encouraged the Commission to review and develop legislation related to i.a. renewables to underpin the agreed 2030 target. The more ambition level 30% have been rejected. (Energy 2030)

EU roadmap 2050

The EU had committed to reducing greenhouse gas emissions by 80-95% to the level of 1990 by the end of 2050. The European Commission has analyzed the implications of this objective in the "Roadmap for moving to a competitive low-carbon economy in 2050". In this "energy plan by 2050", the Commission is examining the challenges posed by the achievement of the EU's decarbonization target, while ensuring the security of energy supply and competitiveness. It responds to a request from the European Council. They will continue to deliver beyond 2020 helping to reduce emissions by about 40% by 2050. They will however still be insufficient to achieve the EU's 2050 decarbonization objective as only less than half of the decarbonization goal will be achieved in 2050. This gives an indication of the level of effort and change, both structural and social, which will be required to make the necessary emissions reduction while keeping a competitive and secure energy sector. (Energy 2050).

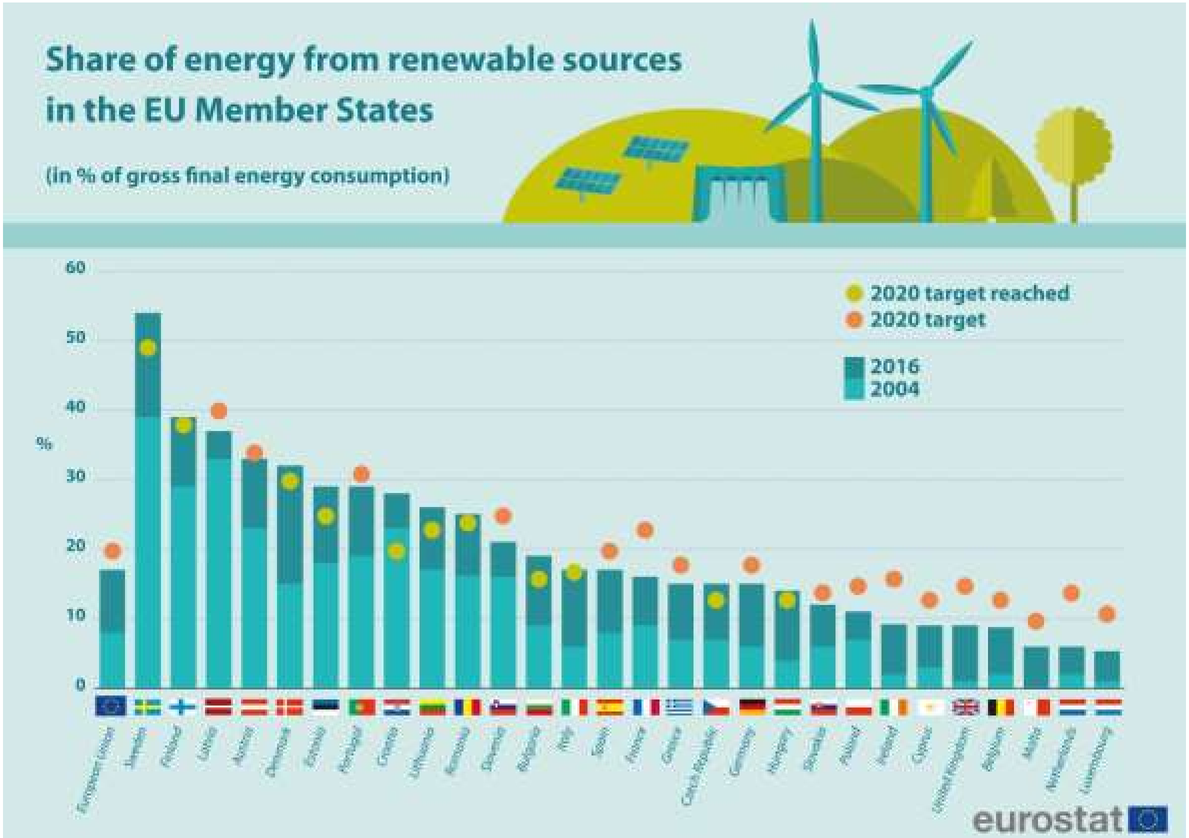

Figure 2 Share of energy from renewable sources 2004-2016 (Eurostat, 2018)

4. Subsidies

The widely used definition of subsidies is „any measure that keeps prices for consumers below market levels, or for producers above market levels or that reduces costs for consumers and producers. "

Subsidies are frequently discussed topic because, by nature, discriminate against one side of the trade. The amount of compensation is mostly determined by government directives, which can be influenced by a lobbyist or by buying voters before the elections. Other disadvantages are the flexibility of legislative processes, which may not be fast enough in contrary to technological progress.

Only energy market cannot naturally reach the desired level of renewables in the EU. That means a national support scheme may be needed to increase investment in renewable energy. If these public interventions are not carefully designed, however, they can distort the functioning of the energy market and lead to higher costs for European households and businesses.

For avoiding the pitfalls, the EU adopted guidance for EU countries about renewable energy support schemes. This guidance suggests that (Support schemes):

- financial support for renewables should be limited to what is necessary and should aim to make renewables competitive in the market
- support schemes should be flexible and respond to falling production costs. As technologies mature, schemes should be gradually removed.
- unannounced or retroactive changes to support schemes should be avoided as they undermine investor confidence and prevent future investment

EU countries should take advantage of the renewable energy potential in other countries via cooperation mechanism.

Development of policy support in The Czech Republic

2005

Approval of Act No. 180/2005 Coll. on the promotion of electricity from renewable energy sources. During the approval period, the year-on-year decline in purchase prices was limited to 5% per year. This percentage was like the German law for ground PV installation. The producer could choose either to purchase the energy or green bonus. Income tax and property tax for five years of operation were not selected.

2006

The Energy Regulatory Office (ERÚ) has announced a price for the photovoltaic power plant at CZK 13.20 per kWh (EUR 0.47 per kWh) for all power and location and 15-year period. For other RES, the purchase period was 20 years, except a small water power plants period for 30 years. In other European countries, the prices for small rooftop installation were half higher than large ground installation.

2007

The first four photovoltaic power plants with an output exceeding 0.5 MWp were launched. The total installed capacity of photovoltaic power plants reached 3.4 MWp at the end of the year. Ministry of Industry and Trade (MPO) planned at the end of 2010 the installed photovoltaic power to 10 MWp.

2008

The German law on RES support was revised, the decline in the purchase price for photovoltaics depends on installed capacity in the previous year. Between 2009 and 2011, redemption prices were to decrease by 8-11% per year. For other RESs, the decrease of 1 and / 1.5%. The Czech legislation has not responded to this change at all. Although the regulatory office (ERÚ) has divided photovoltaic power plants into two power categories (up to 30 kWp and over 30 kWp) but the purchase prices varied by less than 1%. The installed capacity reached 65 MWp at the end of the year. The MPO plan for 2010 was increased to 185 MWp.

2009

There is a sharp decline in the prices of photovoltaic panels, which began at the end of the previous year. The downfall was caused by market constraints in Spain, the price pressure of Chinese producers and a sharp increase in solar silicon production, which led to a significant reduction in its price. An increase in the production of solar silicon was expected a year later. In the Czech Republic, at the turn of 2008 and 2009, the panel prices were overshadowed by a much faster depreciation of the crown. Therefore, it did not take effect until the second quarter of 2009. Estimation of installed capacity varied between 36 MWp to 100 MWp.

The most daring estimates of the installed capacity at the end of September 2009 ended at 300 MWp at the end of 2009. This uncertainty might be the reasons for the postponement of the amendment to Act No 180/2005. It did not seem to be critical.

2010

Reality surpassed all expectations, in February 2010 the ERÚ announced the final installed capacity at the end of 2009 - 463 MWp. Real panic began because it turned out that photovoltaic power plants could be built faster than anybody could imagine. Act No. 137/2010 Coll. Modify the earlier law and null the purchase price from projects with a payback on investment in less than 11 years. The law comes into force from 2011.

2012

Approval of an Act No.165/2012 Coll. The Law on Supported Power Resources (POZE), Act. No. 180/2005 has been canceled. For the determination of the purchase price, the condition of a 15-year return on investment and the annual reduction of more than 5% only in case of the return on investment falls below 12 years. The new law also adds the opposite limit, when the redemption price must not be increased by more than 15% per year. The maximum possible amount applicable to both forms of support is limited to CZK 4.5 per produced 1 kWh. Also, the purchase price is paid by the so-called obligatory buyer (i.e., for 2014 to E.ON Energie and ČEZ Prodej, s.r.o and Pražská energetika, as), including VAT. On the other hand, the green bonus is paid by the market operator (OTE a.s.). Because green is considered as payment of the aid, it does not apply to the VAT scheme. The guarantee is not changed. (Development of subsidy, 2011)

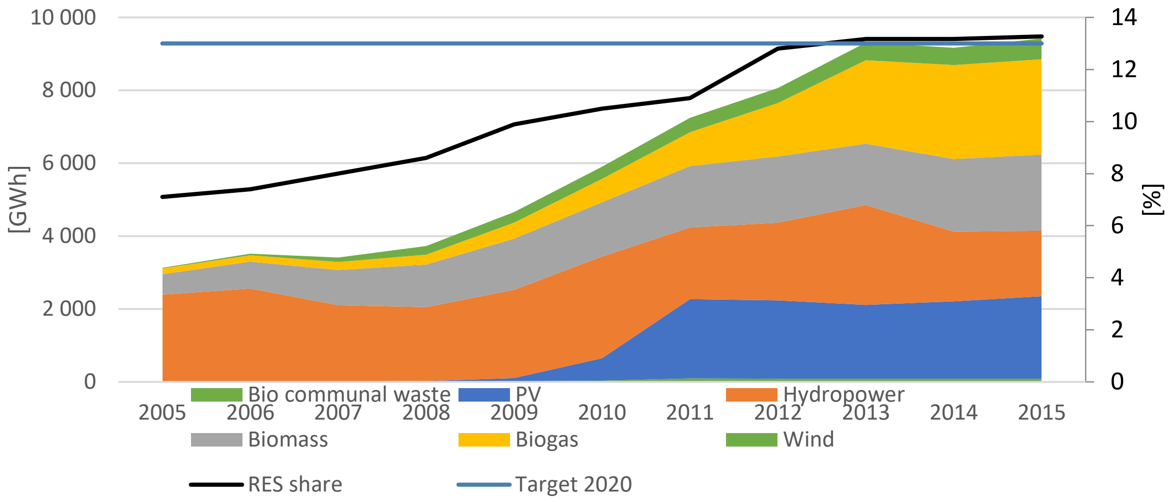

Figure 3 Development of installed power in RES (Shares, 2016)

Development of policy support in Austria

2005

The energy efficient housing programmes – a Constitutional treaty between Austrian federation and länder was applied. This support is still in force with annual funding of 2 billion euros. The objectives were replacement of fossil fuel heating system by heating from renewables especially from solar or biomass sources.

2007

Three policy support schemes were applied such as Austrian climate change strategy, Climate, and energy fund and Targets for renewables 2007-10. The first two are still in force, the last one already ended. The Austrian climate change strategy was adopted in 2002 so only a modified version came into force to ensure the fulfillment of Austrian Kyoto protocol target. The climate and energy fund got support about circa 500 million euros in the field of research and development on sustainable energy technologies, the enhancement of energy efficiency, public transport and mobility as well as a technology deployment and diffusion. In the next year subsidized this program PV installations up to 5 kW. The targets for renewables covered increase of renewables, the share of electricity from renewables, use of alternative fuels, double use of biomass and others.

2008

The green electricity act – 2008 and 2009 amendments from this year is already superseded by green electricity act 2012. The target for the share of electricity from renewable sources was increased to 15% by 2015. That should be achieved through the installation of 700 MW of wind and hydropower and 100 MW of biomass.

2009

Ökostromverordnung 2009 (2009 feed-in tariffs for green electricity) was adopted. In the next years were then superseded by version 2010 and afterward by version 2012. Within this economic instrument, new feed-in tariffs for renewable electricity were determined. Another economic instrument, which was adopted, was Combined heat and power law with the objective of promoting new and modernized plants for public district heating. If it leads to energy and CO2 emissions savings, these new plants can receive in the final consequence an investment subsidy.

2010

In 2010 three policy supports were implemented, which are still in force. The national renewable action plan was an obligatory plan set under the EU Directive 2009/28/EC with the description, how the 2020 targets are going to be reached. The goal of the energy strategy of Austria is to stabilize the final energy consumption and reduction of greenhouse gas emissions. Austria energy strategy, on the other hand, deals with the concrete measures for reaching a 2020 target drawn up and discussed by 180 representatives.

2011

Klimaschutzgesetz KSG ("law for climate protection") is policy support to determine Austrian climate change strategy.

2013

Investment Subsidy for Solar PV installations <5kWpeak (PV/BIPV 2013) were adopted. The total received amount for a small PVs was 36 million EUR. Another Investment subsidy for large solar thermal plants was applied with the 5 million EUR budget. These could be exploited only with the minimum size from $50m^2$ up to $2000m^2$.

2016

A green book for an integrated energy and climate strategy with some analyses of the current situation was published. This opened a discussion about the expectations of reaching the 2030 and 2050 targets. (IEA, © 2018)

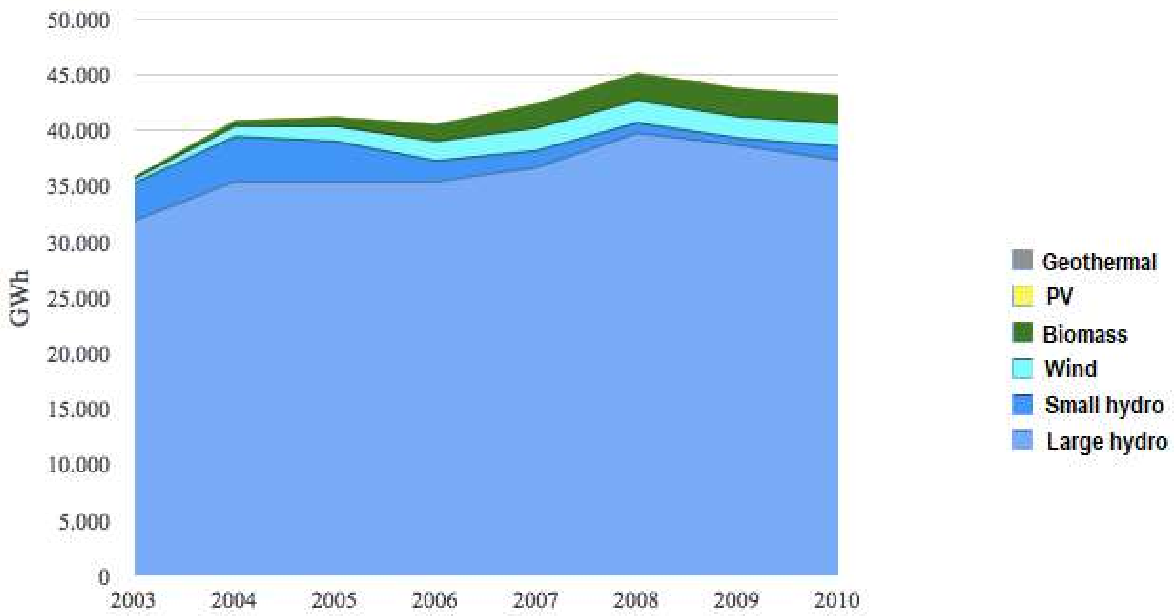

Figure 4 Development of installed power in RES in Austria (E-Control, 2018)

5. Strategies:

The different strategies for promoting renewable energy which has been used in the years from 2005 to 2017 will be discussed.

Quota

The quota system is a policy instrument and is characterized by selling a certain amount of electricity from renewable energy sources. The selling of it takes place on a total energy market. The market part, which operates with the electricity from renewable energy sources is protected from the rest, but still, there is a close connection between them. A Tradable green certificate is a market tool for how could be targeted for renewable electricity generation achieved. Quota can be laid down on both production and consumption (van Dijk et al., 2003)

Feed-in tariff

This promoting strategy is electricity producers have revenue from fix amount of kWh. This fixed amount is independent of costs. The mechanism provides a long-term contract with renewable energy producers, typically based on the cost of generation of each technology.

Green bonus

This promoting strategy is based on the getting extra money for all power that power plant produce. This bonus is not related with the purchasing the energy. Therefore the producer must ensure the purchasing energy via another trader or in the stock exchange. This strategy naturally supports to consume generated power by own and reduce the electricity bill. (every cent saved is earned) In the Czech Republic, the amount of green bonus is annually revised by the Energy Regulatory Office.

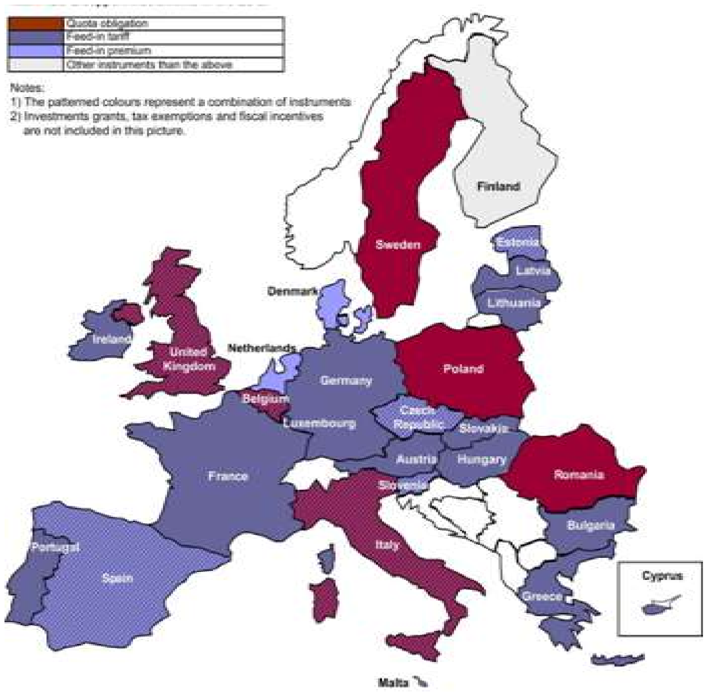

Figure 5 Main RES-E support instruments in the EU-27 (Ferroukhi & al., 2013)

6. COSTS:

Different promoting strategies such as Tradable Green Certificates or Feed-in-Tariffs are being used (more or less) successfully but seem to have very different effects on a market. Hence, the use of both promoting strategies during the time from 2005 until 2017 is going to be compared to each other focusing not only on the costs but also on the positive and negative effects which occurred. In general, the market driven by any promoting strategy is an artificial market. (Haas, et al., 2011) To make the electricity (produced from the renewable energy sources) competitive with the electricity, produced with conventional generation technologies, some financial support is required. Therefore, such an introduction of promoting a strategy to a market cause additional cost. This must be paid by electricity customers. The acceptance of such a promoting strategy by electricity customers is necessary. (Haas, et al., 2011) If we focus on a sample of a quota-based market, where the targets have to be annually reached, is this for consumers such as unpleasant situation. The objective for the policymakers in the future is then to minimize the additional costs. (del Río & Cerdá, 2014)

Consideration of TGC on costs

In the case of trading the commitments through the quotas, the costs effectiveness of gaining the commitments increase. Taking into consideration the price of green certificates on the market it is mainly influenced by the target and commitment ambition.

The positive impact on the costs, which means the decreasing of the costs value, have the trading of the green certificate. They stimulate the rival between renewable energy producers. The government also profits from the quotas in the case of reducing costs. The costs are just allocated to utilities. To not discriminate one technology from the others, the quota is laid down on supply. That can ensure a mix of technologies, where the effectivity of the costs of each technology could play a main role. The negative things related to required ensurement of the technology mix can lead to the lower cost-effectiveness of the whole system. (van Dijk el al., 2003) Revenue is obtained from the selling of electricity as well as from the selling the green certificates. This system means that producers profits from two different streams. As was already written, the distributors of electricity on the quota-based market have to annually share some green certificates to avoid penalty from noncompliance. (del Río & Cerdá, 2014)

Consideration of Feed-in tariffs on costs

The question still is, what is the effectiveness of a quota system. The main scale, which determines it, is the height of the penalty on eventual noncompliance. In the case of permitted import, the effectiveness of a quota on consumption is on the boundary of the market dependent. From experience is evident, that the introduction of levels of support and the height of the penalties enhanced the effectiveness of the instrument. For that reason, the quota can be taken as the most effective promoting strategy in reaching policy targets. (van Dijk et al., 2003)

Feed-in tariffs seem to be cost-effective thanks to the stable investment place and sureness of contract conditions. (Cory, et al., 2009) According to A.L. van Dijk et al. (2003, p. 26):

> *The costs of feed-in tariffs are commonly allocated over market players so that cost-effectiveness for government is high. Good contacts with market parties are necessary to gain insight into actual costs. This is necessary to set a tariff that does stimulate investments but at the minimum support level*.

Consideration of Green bonus on costs

The annual green electricity bonus must at least cover the difference between the redemption price and the expected average hourly electricity price on the OTE daily market. The annual green bonus scheme assumes that the manufacturer will find the consumer (trader) himself for the electricity it produces and will treat the third party with a question of imbalances. The electricity supplied is then sold at a market price reflecting the quality of the electricity (supply diagram, controllability, reliability). The green bonus is an addition to the market price and is set as the difference between the purchase price and the market price estimate for the given type of RES. (Green bonus, 2012)

7. Technologies

Photovoltaic:

The functional principle of a Photovoltaic (PV) systems is based on electronic semiconductors which consist of two so-called energy bands, the valence band, and the conduction band. The two energy bands show different energy levels and are separated by the band gap, which depends on the used materials of the energy bands. Materials are chosen by the number of electrons which are free to be used to transfer energy. When radiation energy reaches the solar penal, electrons from the valence band are being lifted in the conduction band through the band gap. Connecting the generated poles closes the electric circuit, and electric energy can be used. (PV system, undated)

Advantages and Disadvantages of Photovoltaic:

PV-Systems make it possible to sustainably produce electric energy in decentralized units as well as in central power plants. Especially decentralized units bring many advantages as the chance for the electric energy to be consumed directly. If direct usage is not possible in the moment of generation, the energy can still be transformed to heat in an electric boiler or be stored in various battery systems and electric vehicles.

Looking at this from the electric grid point of view, the feeding in of energy to the grid is mostly seen as a disadvantage because production is volatile and can therefore not be forecasted precisely. Hence, it needs very complex mechanisms and actions from the different operators to destabilize the grid (Quaschning, V., Weniger, J. and Tjaden, T., 2014).

Capital Costs of Photovoltaic:

PV is taking center stage in large part due to the already achieved cost reductions and the potential for further cost reductions. Globally, the average capital cost has fallen by almost 60% in the past years. The average capital costs for utility-scale PV-Systems in 2015 were globally about 1.700 $/kW with the lowest costs in Germany at about 1200 $/kW. (World Energy Outlook, 2016)

Wind-Power:

Wind-Turbines are designed in many different ways to efficiently produce electric energy by using the power of the wind. Mostly horizontal runners are being used. The principle is to use the energy provided by the wind to run the rotors of the turbine. These rotors are connected to a generator over a gearing mechanism. As the wind drives the rotor, the generator produces electric energy. The amount of energy being produced depends on the speed of the wind, where the speed of the wind affects the produced energy by the factor of three (Hau, E., 2017).

Advantages and Disadvantages of Wind-Power:

Wind-Turbines can produce electric energy not just during the day but also at night. Even though the production of wind-power is volatile, the production often happens in times where there is no sun shining and therefore evens out the unsteady production of PV to some extent. Even though there are some disadvantages in wind-power like noise emissions or the potential hazards for birds, it will be one of the key technologies for the energy transmission. Another advantage is that wind power can not only be used onshore but also offshore which gives wind power very big development potential. (A new institute, undated)

Capital Costs of Wind-Power:

Wind power has, as well as PV, achieved cost reductions in recent years. Capital costs for onshore wind power stood on average at about 1.500 $/kW in 2015. Offshore wind power represents only a small share of today´s wind power market. This is mainly due to the higher capital costs which were at about 4.500 $/kW in 2015. (World Energy Outlook, 2016)

Bioenergy:

Biomass, including all sorts of energy crops products arising from these biomass-sources, are one of the most important factors to successfully manage the energy transmission. The way out of the fossil age is also a way towards electrification. It needs a bridging solution until power grids become more advanced and therefore the production (and storage) of electricity can serve our demand for energy entirely. Bioenergy can be one of the key energy sources to make a smooth transition of today's energy system possible while at the same time reducing our CO2 emissions due to the carbon-neutrality (Thrän, D., Seitz, S.T., Wirkner, R. and Nelles, M., 2016)

Advantages and Disadvantages of Bioenergy:

As bioenergy, we see all kinds of energy products which can be generated by different plants. The classical type of bioenergy is biomass. Growing as trees or crops, biomass can be seen as a domestic energy source in many regions. The local production and consumption of bioenergy bring valuable economic advantages because bioenergy production lowers the demand for energy sources which have to be imported. Furthermore, bioenergy can be stored and transported. Hence, the energy production from bioenergy sources can supply a base load when used in power plants. Though, bioenergy is mainly used to produce heat. The production of electricity by using bioenergy is only of secondary importance. Whatever energy is finally produced from biomass, there are always emissions being released. When burning biomass, emissions being released can be complex and problematic, even though the burning of biomass is known to be carbon neutral. (Creutzig, F., et.al 2015)

Capital Costs of Bioenergy:

Investing in a biomass boiler costs two- to five times more than a comparable natural gas boiler, due to the engineering complexity of biomass systems and lower economies of scale in production. In numbers, bioenergy-based power plants were around 2000 $/kW. Depending on the density of the heat requirement in a given area, the use of bioenergy to provide heat is done most efficiently by using district heating, supplied by combined heat and power plants. The capital costs of such installations are predicted to decline by 10-20% depending on the location and market size. (World Energy Outlook 2016)

Hydropower:

Hydropower is a flexible technology that can provide power in different scopes, from single homes to regional scales. There are four broad types of hydropower.

- Run-of-river hydropower uses the flowing water from a river through a turbine. Typically a run-of-river-plant will have little or no storage capacity, but continuously provide a base load of electricity.
- Storage hydropower is typically used in large systems due to a dam to store water in a reservoir. By releasing water from the reservoir through a turbine, electricity can be produced. Storage hydropower provides base load as well as the ability to be shut down and started up at short notice according to the demands of the system (peak load).
- Pumped-storage hydropower provides peak load supply by water which is cycled between a lower and upper reservoir. Energy for the pumps is being used at times of low demand. When electricity demand is high, water is released back to the lower reservoir through turbines to produce electricity.

Also, offshore hydropower is used to produce electricity by using the tidal currents or the power of waves. The offshore hydropower, compared to the other types, are less established. (Types of hydropower, 2018)

Advantages and Disadvantages of Hydropower:
Hydropower plants are sources of clean energy which require only minimal replacements due to the simple installation. Hence, these facilities are capable of providing power for a long period. The different types of hydropower plants can provide baseload energy as well as peakload energy. As for disadvantages, environmental damage and high capital costs have to be named. (Gulliver John, Arndt Roger, Hydropower Engineering Handbook, 1991)

Capital Costs of Hydropower:
For recently completed projects, the global average capital costs for large hydropower plants were around 2000 $/kW. Depending on the scale of the project, costs can vary strongly. Even though hydropower projects can come up with very high investment costs, they can still be profitable due to the low maintenance and operating costs.

Geothermal Energy:

Geothermal energy is the heat being contained in the Earth´s interior. This heat is present in huge, practically inexhaustible quantities. Some areas of the Earth´s crust are accessible by drilling. Geothermal utilization is divided into the categories of electric energy production, and direct energy uses. First, heat energy can directly be used if the local temperatures are high enough. If the temperatures of the ground do not match the needed temperature level, heat pumps can be used to lift the temperature.

Secondly, the conventional electric power production which is limited to fluid temperatures above 150°C, but lower temperatures can be used in Organic Rankine Cycles by using refrigerants different from water which show lower boiling points than water. (Barbier, E., 2002)

Advantages and Disadvantages of Geothermal Energy:
Geothermal energy can be used in more or less inexhaustible quantities. Both heat and electricity can be produced by using geothermal energy while at the same time the carbon emissions are low. Though, it has to be said that the construction of geothermal power plants can be very complex and therefore investment costs can become high. (Lexikon, 2015)

Capital Costs of Geothermal Energy:
The average costs for geothermal projects are about 2600 $/kW and therefore comparatively expensive. If drilling is not necessary for the use of geothermal energy (for example in family houses), costs of geothermal projects can become lower. Nevertheless, high capital costs do not necessarily mean that a project is expensive when considered over the lifetime.

CONCLUSIONS

In this paper are summaries of targets, costs, strategies, and technologies for promoting renewable energy from 2005 to 2017. The goals set by the European Union aim to make a general framework for reducing the impact of human activity on the environment. The following 2020 target is already met by The Czech Republic, Austria is close to meet. Therefore, the debate over the 2030s is underway. According to the latest EU negotiations, the value of the RES share should be at 32% level.

Currently, three types of support schemes are used to increase the share of energy from RES; quota, feed-in tariff, and green bonus. The use of these subsidies within countries is shown in Figure 5. Each of these subsidies has some weaknesses. Effectivity of quota system is depended on the consistent enforcement of penalties in case of purchasing an insufficient number of green certificates. The weakness of the feed-in tariff is at fixed prices. Due to technological developments, the cost can vary greatly. The example may be the development of solar power plants in the Czech Republic called a so-called solar boom. This situation could be avoided by using a pessimistic scenario of technological price developments and fixing the purchase price on the 15-year return on investment condition with more frequent revisions. The most suitable method seems to be a green bonus that amount is annually reviewed. The obligation to purchase electricity is left to a producer who can use his intermittent resource for his own needs and still receive support.

The last section of the paper deals with the most common technologies used for RES. The problem of building new energy sources is not only economic but also social. Like as other conventional sources there is the phenomenon "not in my backyard." Wind and hydroelectric power plants often cause protests among residents who reject the degradation of local nature.

Each source can generate only part of the energy from the maximum installed power. From this perspective, the construction of hydropower and biogas stations are the most advantageous. Both resources require high initial investment but high efficiency. On the other hand, photovoltaics requires lower initial investment but less efficiency. For illustration, Figure 6 shows the difference between RES share of installed power and gross output.

In the future, we should look for a solution both to increase the share of RES, but also save energy. To be attentive to nature and not just to profit.

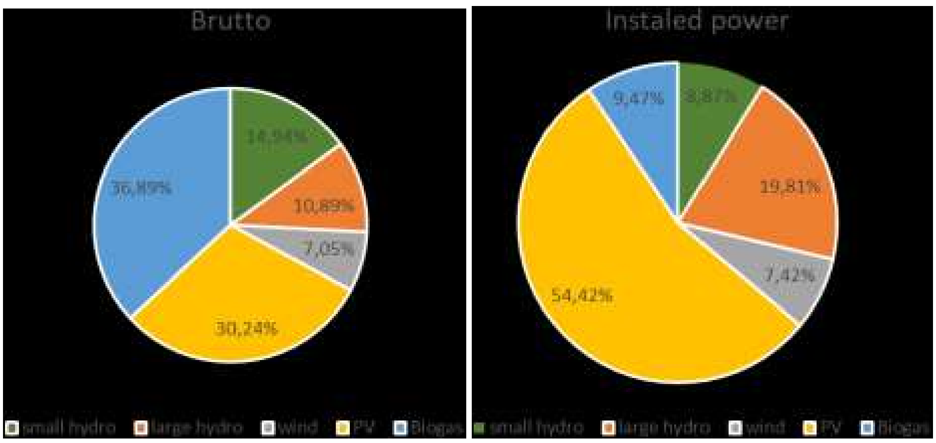

Figure 6 Effectiveness of energy production

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