

# Winter-summer school Prague- Vienna

## Renewable sources in Austrian- Slovak border region.

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### Abstract

In the next few years there will be a huge development of renewable energy sources (RES). This trend is expected to be the same for all European countries and this development is connected with 20/20/20 agenda of the European Union and the Action plan for each country. In Central Europe, this development can especially be observed in Austria, where water power plants or wind power plants are widely penetrated. Other countries like the former Eastern Block are developing much more slowly in the field of renewable sources; however it is possible to see a bit of improvement in this field. In this paper I am going to focus on renewable sources in a region of two capital cities Bratislava and Vienna. These two parts of this region have been developing totally differently. On the one hand, Austrian inhabitants thinking “green”, on the other hand, bad conditions of the political situation till 1989. I am going to look closer on the main differences of these parts and compare sources already in use and the future possibilities of this region.

### Introduction

The two regions of Bratislava and Vienna have been historically connected for many years. The longest division was after WW II till the year 1989. Nowadays, it is possible to observe different kind of development in the field of renewable sources of energy.

The main core of this work will be to compare action plans of these two countries and development of renewable sources. After that, I will focus on the renewable sources and sustainable development in the Bratislava - Vienna region<sup>1</sup>.

Renewable sources of energy have been used for long time in Austria, however in Slovakia the renewable sources of energy

are quite new. Thus, this is the main reason why I am going to focus on this topic.

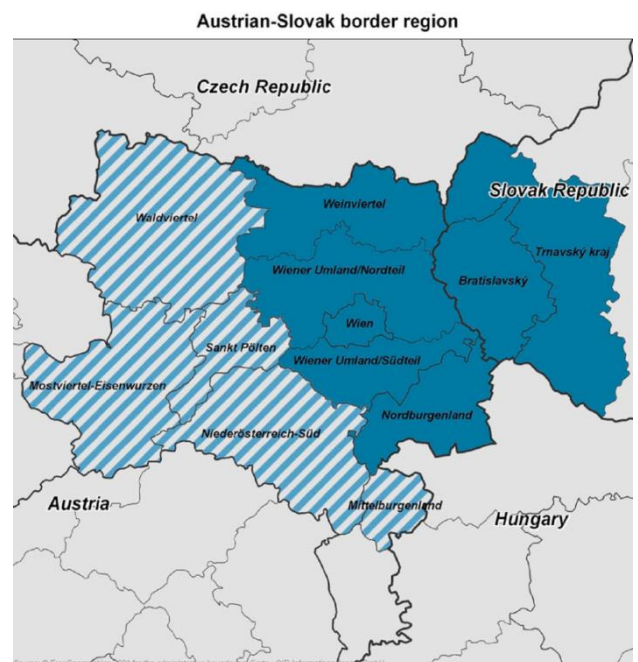


Figure 1 Map of the Bratislava - Vienna region

<sup>1</sup> Austria- Slovak border region:  
[http://www.sk-at.eu/sk-at/img/map\\_zoom.jpg](http://www.sk-at.eu/sk-at/img/map_zoom.jpg)

## Action plans<sup>2</sup>

Action plan of every member country of the European Union is closely connected with plan 20-20-20. Plan is set to reach goals in field of climatic change and energy consumption till year 2020. The goals are set to reach:

- A 20% reduction in EU greenhouse gas emissions from 1990 levels;
- Raising the share of EU energy consumption produced from renewable resources to 20%;
- A 20% improvement in the EU's energy efficiency.

According to this plan, all members of the European Union adopted Action plans which set goals to reach those overall targets. These goals are different for each country and depend on possibilities and climate of the concerned country.

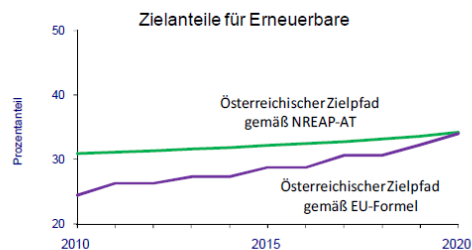
### Action Plans

The National Renewable Energy Action plan in 2010 has been created according to Directive 2009/28/EC and the template was predetermined in accordance with European Commission Decision of 30.06.2009 (2009/548/EC).

Member States are requested to set their targets for the share of energy from renewable sources in 2020 in the following sectors:

- heating and cooling

<sup>2</sup>[http://ec.europa.eu/clima/policies/package/index\\_en.htm](http://ec.europa.eu/clima/policies/package/index_en.htm)



German	English
Zielanteile für Erneuerbare	Renewables target shares
Österreichischer Zielpfad gemäß NREAP-AT	Austrian trajectory in accordance with NREAP-AT (Renewable Action Plan)
Österreichischer Zielpfad gemäß EU-Formel	Austrian trajectory pursuant to EU formula

Figure 2 Renewable energy target shares

- electricity
- transport

### Austrian Action Plan<sup>3</sup>

The Action plan sets the limit of the share of renewable energy in gross final consumption (final energy consumption of 1 100 PJ in year 2020)

- 34 % by 2020
- 16% reduction of GHG emissions in non-ETS sectors

According to figure 2, it is possible to see, that in year 2010 the share of renewable energy is around 25 %. According to the Austrian Action plan the share in the year 2005 was 24.4 % and in the year 2008 it reached 29 %.

### How to reach the goal?

Based on two conditions:

- compared to the reference scenario, which updates the previous trends, a 13 % reduction of final energy

<sup>3</sup> National Renewable Energy Action Plan 2010 for Austria

consumption is needed for the efficiency scenario to be achieved

- The volume of renewable energy in 2008 must be increased by 18 % by 2020.

### The mix of renewable energy

Various quantities of renewable energy are possible in principle in order to achieve the overall goal. Even though potential of available biomass is important for provision of cooling and heating, Sources such as water, wind and solar power are more significant. Another important achievement is to reach the 10% biofuel target.

According to figure 4 the share of renewable energy is currently at 10 % and according to the Action plan in 2005 the share was 6.7 % of final consumption of energy. Also it is possible to see on figure 4, that Slovakia produces 20 % of “green” energy. This situation is caused by large number of Hydro power plants.

### How to reach the goal?

Slovakia divided the Action plan according to EU to three sectors and set smaller goals.

- Heat and cooling: the share of renewable energy is set to 14.6 % in 2020.
  - Electricity: the share is set to 24 %
  - Transportation: the share is set to 10 %, in the Action plan there is a calculation with Biofuel of 2<sup>nd</sup> generation, which helps to reach this goal.

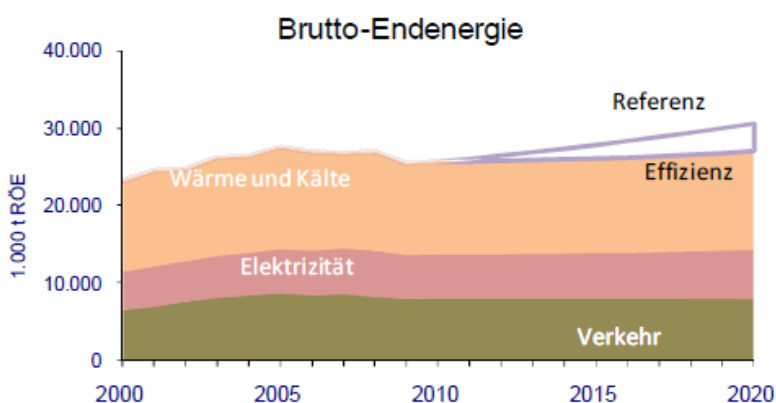


Figure 3 Scenario for the gross final consumption of energy by sector

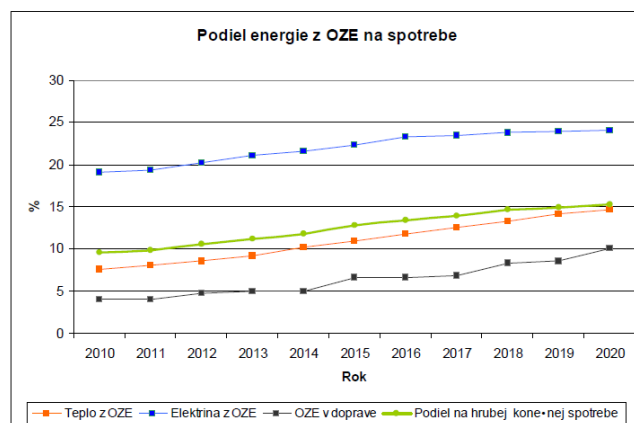
### Slovakia Action Plan<sup>4</sup>

The Action plan of the Slovak Republic sets the limit of the share of renewable energy in gross final consumption (final energy consumption of 470 PJ in year 2020)

- 14 % by 2020

### The mix of renewable energy

The most significant electricity



### Share of energy from RES in consumption

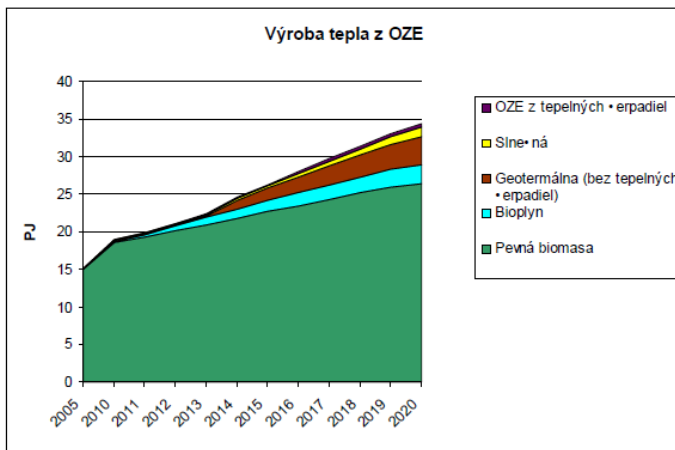
Year

- Heat from RES
- Electricity from RES
- RES in transport
- Share in gross final consumption

<sup>4</sup> National Renewable Energy Action Plan 2010 for Slovakia

Figure 4 Graphs of RES contributions up to 2020

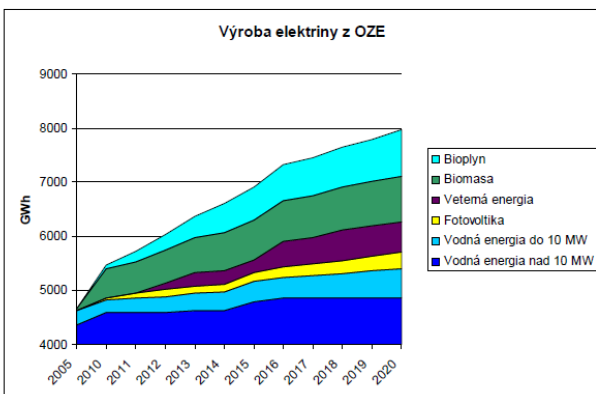
source of renewable energy in Slovakia is hydro power. On the side of heat production solid fuel is the most significant source. This trend is represented on figure no. 5 and no.6.



Production of heat from RES

- RES from heat pumps
- Solar
- Geothermal (less heat pumps)
- Biogas
- Solid biomass

Figure 5 Production of head from RES



Production of electricity from RES

- Biogas
- Biomass
- Wind energy
- Photovoltaic
- Hydro energy up to 10 MW
- Hydro energy above 10 MW

Figure 6 Production of electricity from RES

## Renewable sources of the Austria-Slovakia border region

Bratislava and Vienna are located closely to each other. Distance between these two capital cities is approximately 55 Km and both cities lie in the basin of the Danube River.

From the geographical point of view, both regions are almost the same. As was already mentioned, both cities lie on the same river. The Danube River has been forming this region to big lowland so both regions have the same conditions.

### Austrian borderline region

Austria has long history of renewable energy, and also thinking of inhabitants is in

line with this trend.

Hydro energy is the source with the biggest influence, which is given by location of Alps.

### Hydro power

The Vienna region has possibilities to use hydro power plants on the Danube River. Three big hydro power plants and one smaller are located in this region. (on figure no.7 from top in order)<sup>5</sup>

- Altenwörth
- Greifenstein
- Nußdorf
- Freudenau

<sup>5</sup> <http://www.verbund.com/cc/en/about-us>

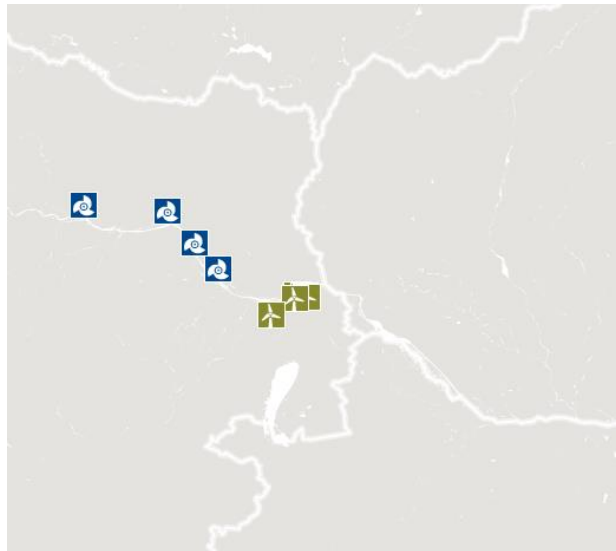


Figure 7 Hydro power plant and Wind power plant owned by Verbund

**Basic information:**

**Altenwörth:**

Beginning of operation	of <b>1976</b>
Type	Run-of-river
Country, State	Austria: Lower Austria
Waters	Danube
Capacity	328 MW
Annual generation	1.967.600 MWh

Table 1 information about Altenwörth hydro power plant

**Greifenstein**

Beginning of operation	<b>1985</b>
Type	Run-of-river
Country, State	Austria: Lower Austria
Waters	Danube
Capacity	293 MW
Annual generation	1.717.300 MWh

Table 2 information about Greifenstein hydro power plant

**Nußdorf**

Beginning of operation	2005
Type	Run-of-river
Country, State	Austria: Vienna
Waters	Danube
Capacity	5 MW
Annual generation	28.141 MWh

Table 3 information about Nußdorf hydro power plant

**Freudenau**

Beginning of operation	1999
Type	Run-of-river
Country, State	Austria: Lower Austria
Waters	Danube
Capacity	172 MW
Annual generation	1.052.000 MWh

Table 4 information about Freudenau hydro power plant

Overall capacity of these four power plants is more than 700 MW, which represent a bigger block of nuclear power plant and production of 4700 GWh representing huge part of renewable sources in this region.

**Solar power**

Austria is located in the temperate climate with solar radiation between 1000 kWh/m<sup>2</sup> in valleys up to 1800 kWh/m<sup>2</sup> in a top of the Alps (according to figure 8).

Total capacity of all solar power plants is almost equal to Freudenau hydro power plant with amount of 173,8 MW in 2011. However, during the year 2011 power plants with capacity over 80 MW were built. Bu this source still has only minor representation in the mix of renewable sources.

In the region of Vienna according to figure 8, solar radiation is around 1200 kWh/m<sup>2</sup> up to 1500 kWh/m<sup>2</sup>. For an effective process of producing electricity this average radiation is too small and outcome from power plants is not as high as it could be in places with higher solar radiation such as Spain, Italy or Cyprus.

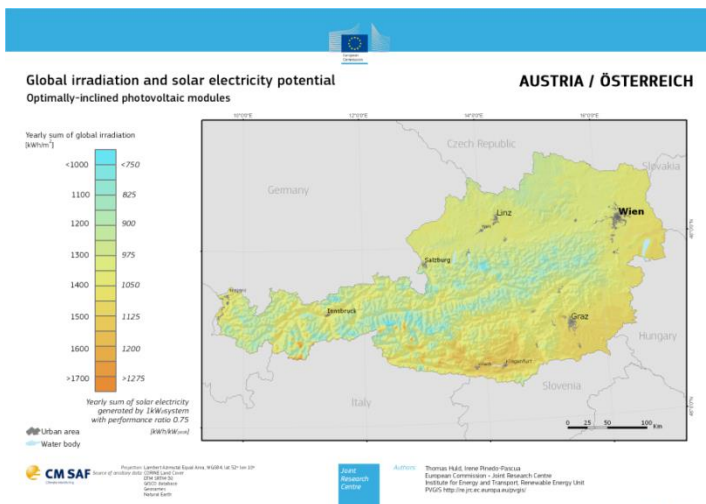


Figure 8 Solar radiation map Austria

## Wind power

Comparing to Solar power, Wind power in Austria has better conditions. The best conditions are in the Alps. However, another region of Austria also has good conditions for wind power plants (figure 9 Wind map of Austria).

The total capacity of all wind power plants in Austria is up to 1400 MW<sup>6</sup>. Production capacity:

- End 1997: 20 MW
- End 1999: 42 MW
- End 2001: 94 MW
- End 2003: 415 MW
- End 2005: 819 MW
- End 2007: 982 MW
- End 2009: 995 MW
- End 2011: 1,084 MW
- End 2012: 1,378 MW

<sup>6</sup>[http://www.thewindpower.net/country\\_en\\_13\\_austria.php](http://www.thewindpower.net/country_en_13_austria.php)

Vienna region and borderline region is region with the highest density of the wind power plants. The reason for this is the average wind speed of 5m/s up to 7 m/s. According to figure 10<sup>7</sup> most of the power plants are situated in the borderline with Slovakia.

## Wind map Austria

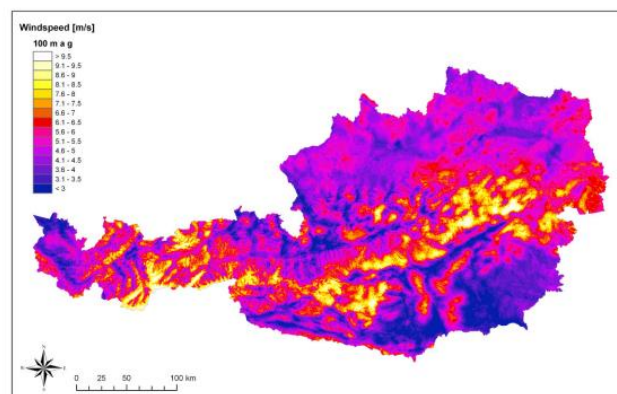


Figure 9 Wind map Austria



Figure 10 Location of Wind power plants

<sup>7</sup>[http://www.thewindpower.net/country\\_maps\\_en\\_13\\_austria.php](http://www.thewindpower.net/country_maps_en_13_austria.php)

## Slovak borderline region

Renewable sources of energy are quite new in Slovakia (except hydropower which has long history). Boom of the renewable sources began with 20-20-20 plan and financial support of the Slovak Government.

## Hydro power

Hydro power plants are the biggest source of renewable energy in Slovakia with the longest history. First hydropower plants were built at the end of 19<sup>th</sup> century and beginning of 20<sup>th</sup> century. With installation capacity approximately 2600MW and outcome of 4300 GWh (year 2012) they are creating 18 % share of all production of electricity in Slovakia. The potential of hydro power plants is now approximately at 58 %, but in Slovakia there is no place for big dams and this potential is hidden in small hydro power plants, which are now supported by the government.

The main source of hydropower in the region of Bratislava is the same as in Austria: Danube River. In this part of river there are two bigger and two smaller dams.

- Gabčíkovo
- Čunovo
- Mošov
- Malé Gabčíkovo SVII



Figure 11 Map of hydropower plants in the Bratislava region

## Basic Information:

Gabčíkovo:

River	Danube
Capacity	720 MW
Annual generation	2 158 557 MWh
Beginning of operation	1992

Table 5 information about Gabčíkovo hydro power plant

Čunovo:

River	Danube
Capacity	24,28 MW
Annual generation	145 726 MWh
Beginning of operation	1997

Table 6 information about Čunovo hydro power plant

Mošov:

River	Danube
Capacity	1,22 MW
Annual generation	5 492 MWh
Beginning of operation	1994

Table 7 information about Mošov hydro power plant

Malé Gabčíkovo SVII

River	Danube
Capacity	1,04 MW
Annual generation	3 552 MWh
Beginning of operation	1994

Table 8 information about Malé Gabčíkovo SVII hydro power plant

Overall capacity of these plants is over 700 MW which is almost the same as in Austria, however, building of another hydropower plant called Nagymaros have been planned in the Danube River (together with Hungary and now it is an international case)

## Solar power

Slovakia is located in the temperate climate with solar radiation between 1100 kWh/m<sup>2</sup> in valleys and in the North up to

1400 kWh/m<sup>2</sup> in a top of the High Tatras and in the South of country (according to figure 12)

Capacity already installed in Slovakia is approximately 500 MW, which represents the capacity of one reactor of Nuclear

## Wind power

In Slovakia, wind power has minor position in the field of renewable sources.

In this time, the installed capacity of wind power plant is less than 4 MW (three power plant), which is not representing possibilities of the Slovak Republic. According to the Action plan 350 MW with annual generation 560 000 MWh should be installed in Slovakia by 2020

According to figure 14, western part of Slovakia, especially Bratislava region has good conditions for wind power, but it is not used properly yet.

Global irradiation and solar electricity potential  
Optimally-inclined photovoltaic modules

SLOVAKIA / SLOVENSKO

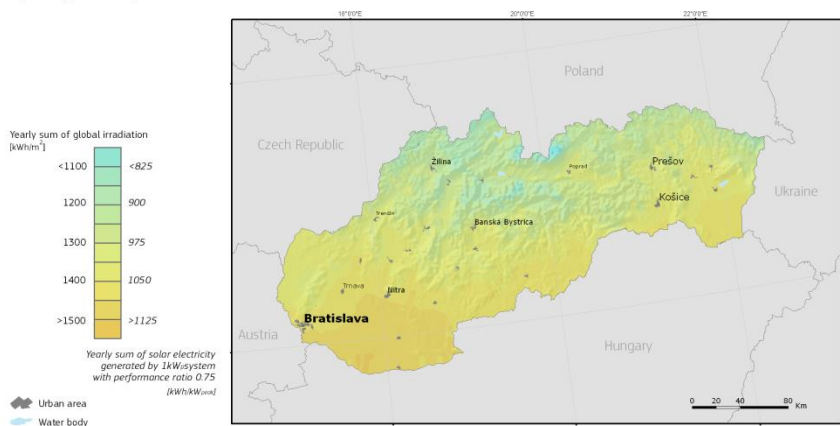


Figure 12 radiation map Slovakia

power plant. This big capacity is caused by financial support granted by the Slovak government.



Figure 13 Map of Solar power plant in the Bratislava region

Mean annual wind speed (60 m above the ground)

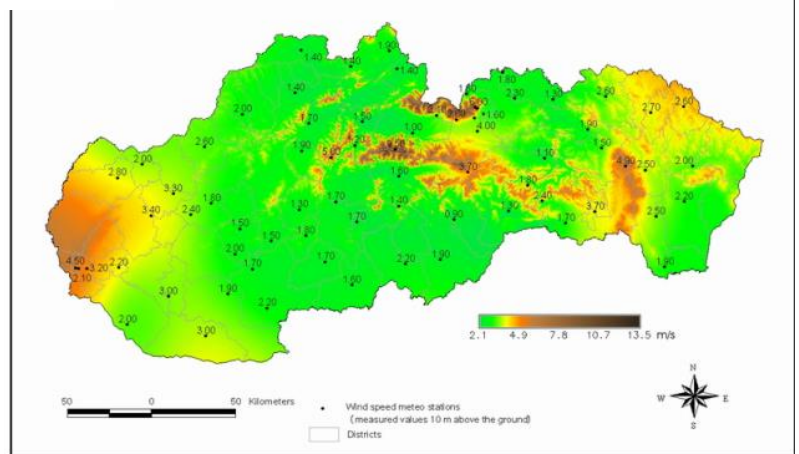


Figure 14 Wind map Slovakia

## Comparison

According to research which I did, it is obvious that both regions have almost the same conditions. Of course, there are some differences. In comparison of these two regions in solar power, Bratislava region



has bigger capacity than Vienna, but conditions are the same for both region.

In the field of hydro power it is almost the same, but I think Austria has better position than Slovakia because of longer flow of Danube and location of the Alps.

However, Austria is leading in the way of wind power. The installed capacity is hundred times bigger than Slovak capacity. But according to figure 9 and 14 border line region of Bratislava has better condition because of higher average of wind`s speed. Especially in this sector different development in the field of renewable energy is visible.

### **Conclusion**

In this paper I was focusing on renewable sources of energy in the Region of Bratislava and Vienna. Both regions were connected in the past. But in the second part of 20<sup>th</sup> century were these two regions separated, which is possible to see on the development of renewable sources.

The development and usage of renewable sources in the borderline region of Austria and Slovakia is totally different.

Common development is just visible in the field of hydropower. In another two mentioned field the development is absolutely different.

The field of wind power has strong support in Austria (as all “green” sources) and it is leading despite worst conditions than Slovakia has. But this situation is caused by different development and policy in the past and in my opinion the difference will not be so visible in the near future.

Another field is the field of solar power where Slovakia has higher installed capacity. This situation is not caused by “green” thinking of the Slovak people or businessmen but more or less by wrong application of a support to renewable sources.

### **Bibliography:**

- 1)  
Web page of the Slovak-Austrian cross-border cooperation program  
available online:  
<http://www.sk-at.eu/>
- 2)  
Web page of the EU energy and climate package  
available online:  
[http://ec.europa.eu/clima/policies/package/index\\_en.htm](http://ec.europa.eu/clima/policies/package/index_en.htm)
- 3)  
National Renewable Energy Action Plan 2010 for Austria  
Available online:  
[http://ec.europa.eu/clima/policies/package/index\\_en.htm](http://ec.europa.eu/clima/policies/package/index_en.htm)
- 4)  
National Renewable Energy Action Plan 2010 for Slovakia  
Available online:  
[http://ec.europa.eu/clima/policies/package/index\\_en.htm](http://ec.europa.eu/clima/policies/package/index_en.htm)
- 5)  
Verbund, electricity company  
Available online:  
<http://www.verbund.com/cc/en/about-us>
- 6)  
The windpower.net  
Available online:  
<http://www.thewindpower.net>
- 7) Slovenské elektrárne ENEL,  
electricity company

Available online:

<http://www.seas.sk/sk/uvodna-stranka>

8) Photovoltaic Geographical Information System (PVGIS)

Available online:

<http://re.jrc.ec.europa.eu/pvgis/>