Benchmarking of energy strategies of municipalities and regions

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ABSTRACT: Many municipalities and regions work out their own energy strategies for the energy transition. Joining them together should lead to a national strategy, which supports a successful energy transition. It is not a simple problem to benchmark a local energy strategy, because the potentials of renewable energies, population density and the grade of industrialization, … vary in a wide range. In this work a method of benchmarking was developed: After elaborating a scenario for the energy transition for Austria in hourly resolution, certain characteristic values concerning the grades of usage of potentials for renewables sources, efficiencies were calculated. These values are used for benchmarking a local energy strategy. This method of benchmarking energy strategies was realized in RESYS-Tool – a web-tool which supports the development of energy scenarios.

1. INTRODUCTION

The transition from a fossil-based to a renewable-energy-based energy system is a central target of climate and energy policy.

Two important challenges (besides others) are connected with this transition:

1. Renewable energy sources which are harvested locally and fluctuate in their intensity have to contribute to an energy system that has to work stable as a whole (which means that fluctuating energy demand has to be met by fluctuating energy production in combination with sufficient energy storage capacity).
2. Different regions have different renewable energy potentials – e.g. for cities it is practically impossible to meet their energy demand by locally produced renewable energy which means that they have to import energy from their surroundings respectively from less densely populated (rural) regions.

RESYS-tool (www.resys-tool.at), developed by an inter-disciplinary consortium contributing to this paper, allows designing customized energy transition strategies for municipalities and regions. One special feature of the RESYS-tool is the generation of dynamic profiles for energy demand and production for each hour of the year based on reference weather data sets and empirical profiles for specific demands. Energy demand and potentials of renewable energies are estimated with high accuracy from basic statistical data, which are easily available in every municipality. By comparing energy demand and energy production a rather detailed calculation of energy storage resp. import/export of energy can be achieved.

2. HOW TO EVALUATE ENERGY STRATEGIES – THE RESYS-BENCHMARKING METHODOLOGY

Figure 1 depicts future energy scenarios of "Enviroland" and "Envirotown" (the real names are changed, Enviroland represents a rural region in Austria, Envirotown represents an Austrian town) . At first glance the Enviroland-scenario seems to be more suitable for a future without fossil and nuclear energies because there is a surplus of energy the whole year over. May the Enviroland-people claim that their energy strategy is better than the one of Envirotown? In fact Enviroland people buy products produced in Envirotown and many Enviroland people have a job in Envirotown. Both need energy in Envirotown. Additionally there are fu-

ther interconnections with other parts of Austria and abroad. How can we benchmark these and a lot of similar facts in a fair way?

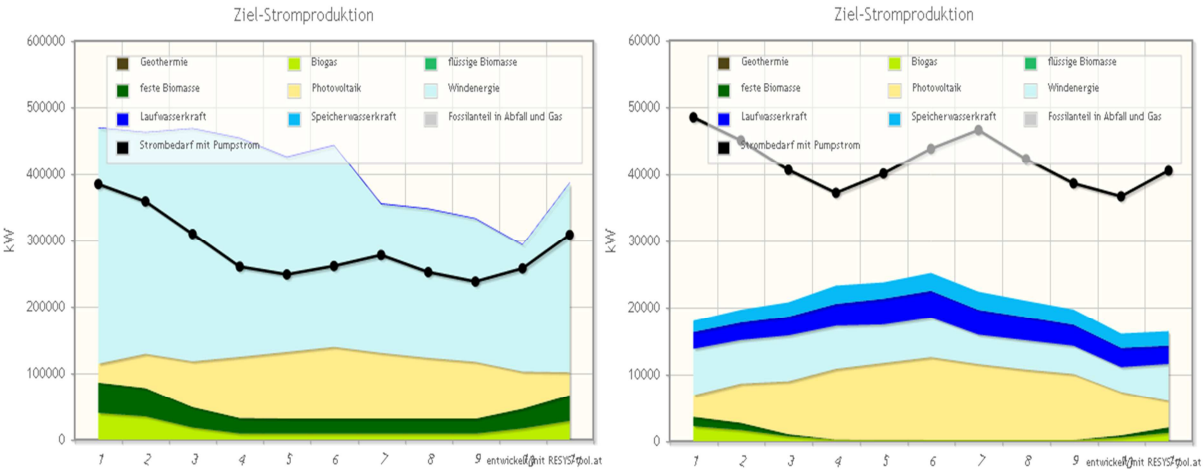

Figure 1: Demand (black line) and production of energy for Enviroland (left) and Envirotown (right) for the future year 2050. Which energy strategy is the better one?
Enviroland: 277.569 inhabitants, area of 3963km². Envirotown: 34.678 inhabintants, area of 84km².

RESYS-tool helps its users to benchmark energy transition strategies. The benchmark methodology is based on an energy strategy which provides a 100% renewable energy supply for the whole of Austria in every hour of the year (A2050 strategy). It is not important and not necessary that every region (village, town) is self-sufficient regarding energy. But it is important that every region contributes its share to the common energy strategy of Austria in a fair way.

The RESYS-benchmarking is processed in two steps:

1. Working out an Austrian energy strategy and a calculation of characteristic values for energy production, efficiency, mobility, etc. These values are called benchmark values in the further description.
2. Benchmarking: Calculation of the characteristic values of a local energy strategy and comparing them with the benchmarks.

2.1 THE RESYS-ENERGY STRATEGY OF AUSTRIA - A2050

The RESYS-Team worked out the A2050 strategy based on the following facts:

- 100% renewable energy supply based on the study of Streicher et al. [1] and the Austrian Windatlas [2]
- All realized (pumped) hydro storage power stations are used for balancing production and demand. But no expansion is assumed (see Figure 3)
- No expansion of agricultural areas for producing bioenergy (priority of food production)
- Achieving a good balance of exploiting renewable potential and reducing the energy demand by efficiency and sufficiency.

The course of energy production and demand in Figure 2 shows that there is an energy surplus of about 23.000 GWh/a. This surplus is used to produce liquid fuels [3] for mobility applications, which cannot be powered with electricity (planes, tractor, trucks).

Main benchmarks issue the grades of exploiting the potentials of renewable ressources and energy effiency.

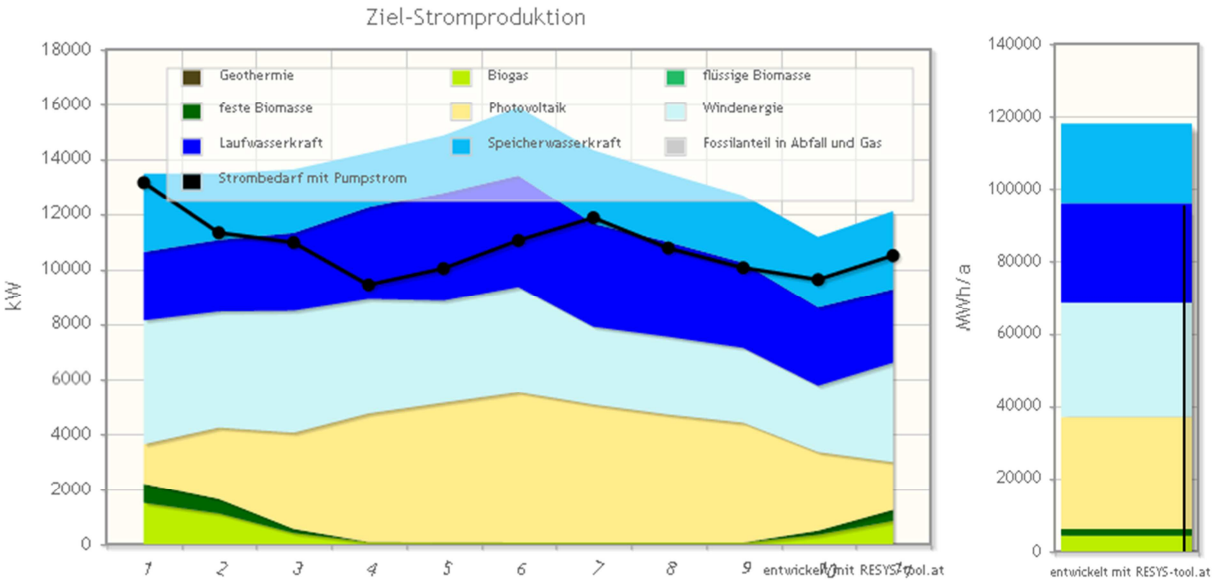

Figure 2: Demand (black line) and Production of energy in the A2050 energy strategy of Austria. Energies in GWh/a: geothermal 4 – biogas 4291 – biomass 1863 – solar 30.845 – wind 31.765 - water 27.360 – storage water 14.644 (netto) + energy from pumping 7286

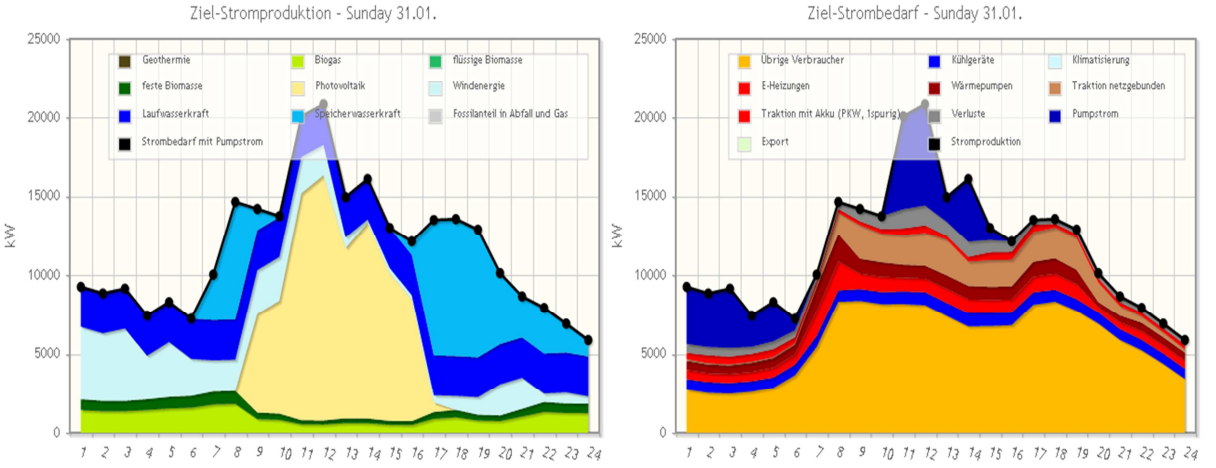

Figure 3: Demand (black line) and production of energy on Jan 31st in scenario A2050. In the first 6 hours and from 10 to 16 o'clock energy is stored. In other times of the day energy from the storage is needed.

2.2 BENCHMARKING OF A LOCAL ENERGY STRATEGY

A local energy strategy in RESYS is worked out by determining the technologies to exploit potentials of renewable energies and by estimating the reduction possibilities in energy demand, for instance by changing the modal splits in the mobility sector, etc. Then RESYS-Tool calculates the same key values as in the Austria energy strategy A2050 for both RESYS-scenarios (actual scenario and the future –scenario). The results of the comparison are shown in tables and diagrams (example in Figure 4). There are a lot of such benchmarks, but only some are evaluated with a scientific method.

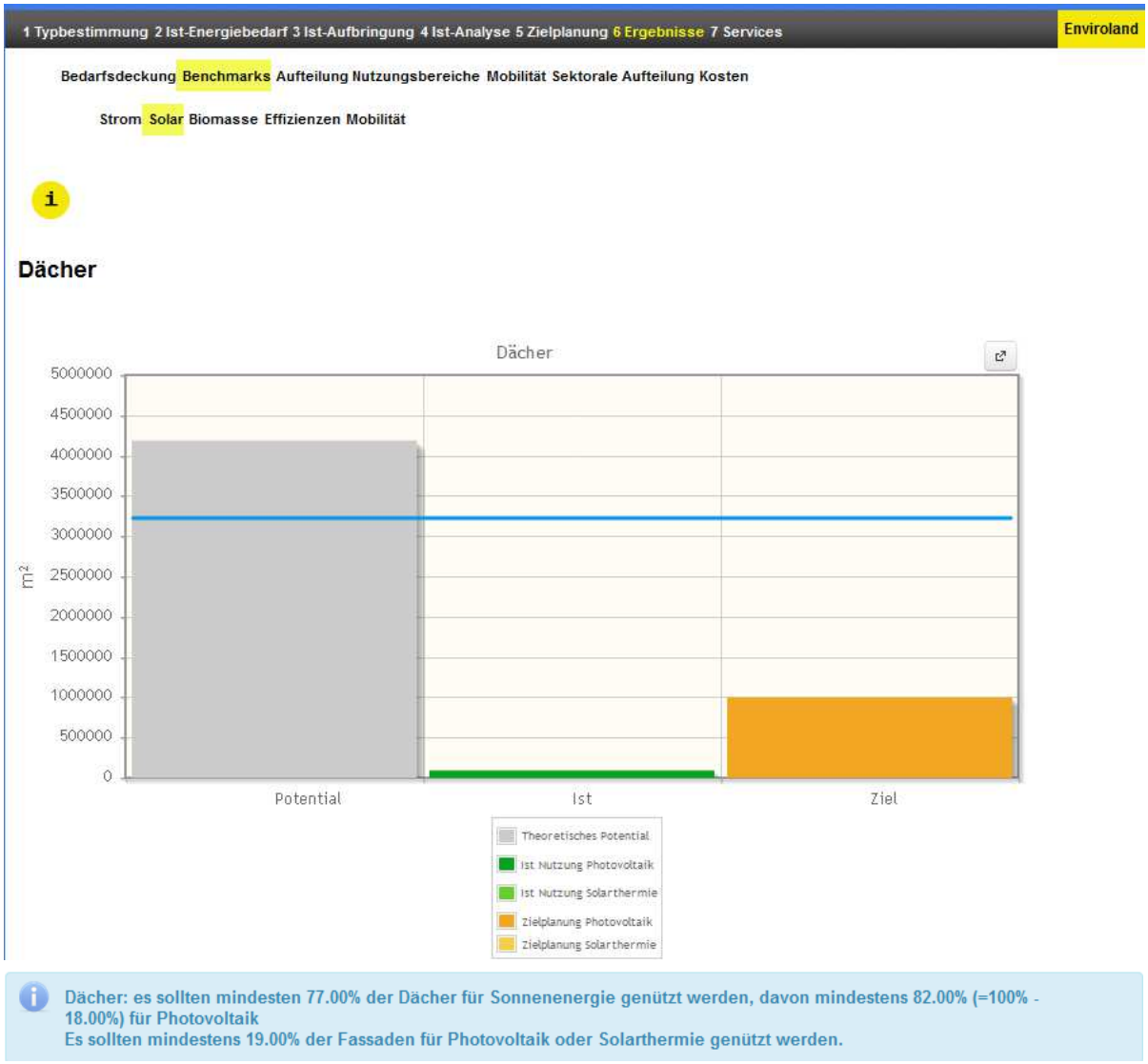

Figure 4: Benchmark for the use of roofs for heat and electricity from solar energy. The blue benchmark-line is the aim of a good energy strategy. The gray column is the potential of roofs, the green "IST" is the actual use, the orange colored represents is the future use. This "Ziel"-value fails the benchmarks. Therefore the user gets the information in the blue frame.

Benchmarking the usage of biomass for energy production is not a simple problem. Biomass-benchmarking is done with 17 different kinds of biomass-potentials. There are minimum values for using biogenic waste, greenings, etc. and maximum values to limit the technical possibilities for their usage or to limit biomasses which interact with the production of food.

Figure 5: Excerpt of the benchmarking of biomass. The user intended to use more waste from parks as it is possible to collect with usual technologies. So RESYS warns the user.

3. RESULTS

In **Fehler! Ungültiger Eigenverweis auf Textmarke.** several benchmarks are listed. Actually only a few indicators are used for benchmarking. The others (red values in the benchmark-column) are calculated from the A2050-senario but there is a need of proving the values in scientific works. The further usage of RESYS-tool with different types of regions will show if it is possible to assess more benchmarks. We believe that some benchmarks should accept different values for different kinds of regions (especially for mobility benchmarking).

Table 1: This is an excerpt of benchmarks in RESYS-Tool with the respective values for the regions Enviroland and Envirotown. All green marked cells indicate areas of good performance whereasthe red cells indicate areas with potential for improving. In the column "Benchmark" there are many red values - these values are not assessed yet.

Description of Benchmark	*Unit*	*Benchmark*	*Enviroland*	*Envirotown*
grade of exploiting renewable energy potential				
wind	%	>40%	32,5%	62%
solar - roofs	%	>77%	23,9%	90%
solar - facades	%	>19%	5,6%	21%
efficiencies - housing				
space heating demand	MWh/inhabitant	<3	4,98	2,26
domestic hot water demand	MWh/inhabitant	<0,75	0,80	0,57
electricity without .heating and mobility	MWh/inhabitant	<2	1,84	2,01
specific heated floor area	m²/inhabitant	53	42,8	
efficiencies non-housing				
space heating	MWh/work place	<1	3,97	1,01
hot water	MWh/work place	<0,71	1,05	0,72
process heat	MWh/work place	<0,66	1,15	0,71
electricity without .heating and mobility	MWh/work place	<7,77	8,75	7,81
efficiencies heat production:				
share electricity of total demand		>22%	18,6%	30,1%
share heat from electricity of total demand		>42%	53,2%	59,9%
COP for low-temperature-heat from electricity (heat pumpes and direct heat)		>1,95	2,861	1,95
Combined heat and power (CHP): ratio unused_heat : used_heat		4%	37,7%	0%

mobility: personal transport				
specific energy demand	Wh/person.km	<148	400	148
spec. annual energy demand	MWh/inhabitant	<1,85	4,05	1,85
annual demand liquid fuels	MWh/inhabitat	<0,70	3,88	0,67
share electricity of total demand	%	>59%	94%	55,5%
mean value of person per passenger car		>1,6	1,24	1,8
share public transport of total personal transport	%	>50%	18,2%	51%
share air travel of total personal transport	%	<5%	8,7%	4,7%

In our example for benchmarking the two strategies of Enviroland and Envirotown, Envirotown has a very good strategy. Although Enviroland will produce more renewable energy as it demands, it is not enough to fulfill the renewable strategy of Austria; that means Enviroland gets more benefit from the other regions in form of products, jobs, … than it pays back with its surplus of energy. Enviroland has to deliver more energy to other regions.

4. CONCLUSIO

The simple benchmarking algorithm in RESYS-Tool is suitable for evaluating regional energy strategies. With an increasing number of municipalities in the data base, we will get a better background for working out certain benchmark-values or new types of benchmarks.

In the actual version RESYS-Tool uses Austria as the superior area which should become energy self-sufficient.

In a future version RESYS-Tool should work with the European area. This is not only necessary for non-Austrian users; but there will also be an energy exchange with other nations. The aim is that the whole world uses only renewable energy resources.

REFERENCES

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