ADRES
Autonomous Decentralized Regenerative Energy-Systems

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Abstract

The energy supply of today and in the future have to cope important challenges like increasing import dependence, resources shortage as well as environmental and climatic effects. So that these problems can be solved lastingly, it requires a change of the power supply infrastructure. Therefore the energy services should be fulfilled regionally to make regenerative energy resources available in the future. This causes however substantially changed basic conditions. Due to the limited offer of regional resources the energy must be produced and consumed in an efficient way.

In this contribution we want to present the project ADRES-Concept. Our goal is it to develop and test an autonomous decentralized regenerative energy-system in a holistic concept. The major columns are improving the efficiency, the use of renewable energy sources and an innovative grid management. The autonomous, regenerative energy region reaches the self-sufficiency in consequence of high efficiency. The regional resources wind power, solar thermal power, geothermal power, biomass, photovoltaic and water power fulfil all the energy needs. We do not want to answer the question “How much is necessary for the fulfilment of the need?”, but “How little energy is necessary for a full supply without noticeable comfort loss?”

1 Energy vs. power autonomous system

1.1 Initial situation

Past research work in the area of the energy-autonomy can show already very good results. There are some regions in Austria where an energy-autonomy can be already achieved over the year for energy services (electrical power, heating, mobility). However they proceed from present efficiencies of consumption and try to fulfil this existing consumption in sum over the year by available regenerative production. Additionally there are a lot of innovative solutions of partial aspects to improve the entire energy-system. Our point of view is the overall system.
Complete autonomy means that the generation have to be equal to the demand at each time. That is to say the ADRES System have to be a completely isolated "island grid". Therefore the results of the European research project "More Microgrids" are to be mentioned.

1.2 The „new“ approach

The vision of ADRES is an autonomous system with regional supply by renewable resources. The “new” approach is: “Not the increasing demand determines the production, but the renewable resources must be sufficient for the covering of the necessary energy services”.

First of all it is necessary to reduce today’s energy consumption within the ranges household, building and mobility drastically. Only by reaching the highest possible efficiency a complete fulfilment of all energy services of a region by only using renewable resources can be ensured.
The goal is to keep the balance between locally available renewable energy and total consumption. See in addition the description of the principle in illustration 1.

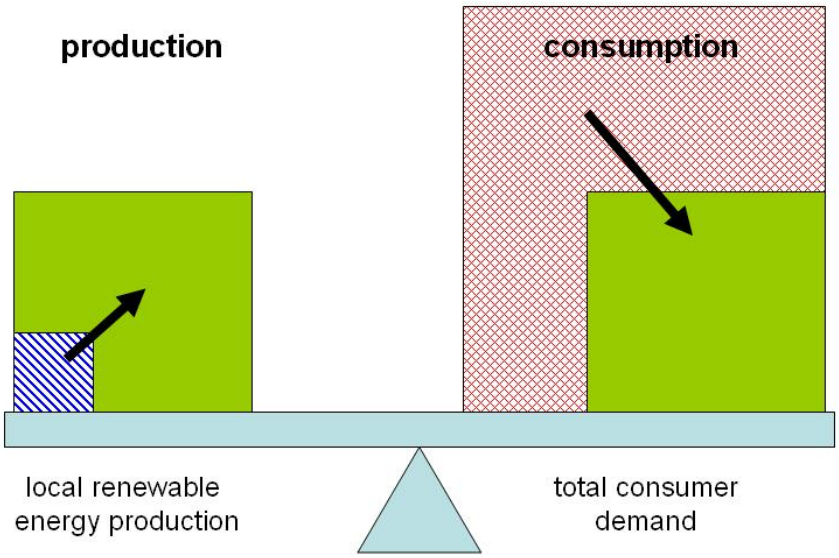

Fig. 1: reaching the balance

This balance can be achieved easily over a larger period (e.g. one year). For the independent ADRES area however a balance in real time must take place. This requires the possibility of intermediate storage from surplus energy during periods with e.g. good wind conditions and an intelligent control mechanism. The safe and robust operation of the system as well as the adherence to all technical borders is necessary. So it is possible to avoid any incidents such as “Blackouts”. Schematically the way to power-autonomy is illustrated in figure 2.

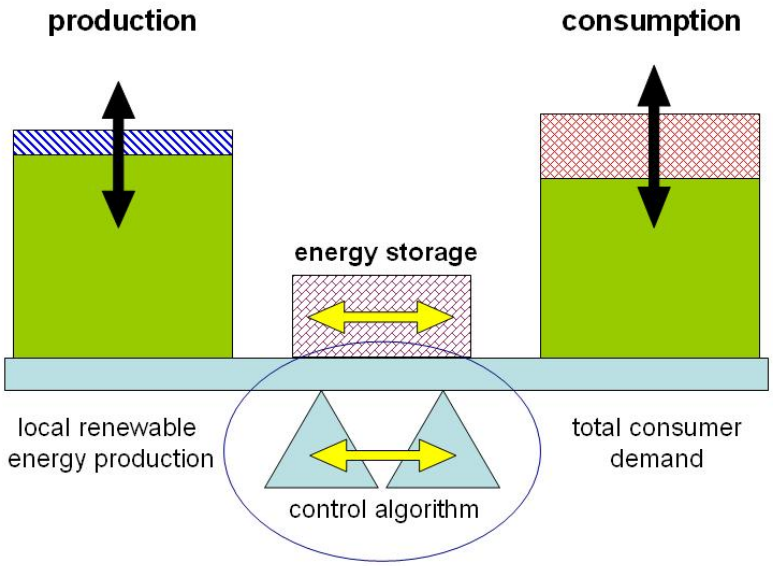

Fig. 2: power-autonomy

2 Implement the strategy

The following figure illustrates the three major columns of ADRES. There are also some details considering renewable energy, efficiency improvement and intelligent energy system. The optimal interoperation of these three parts results in the best possible solution.

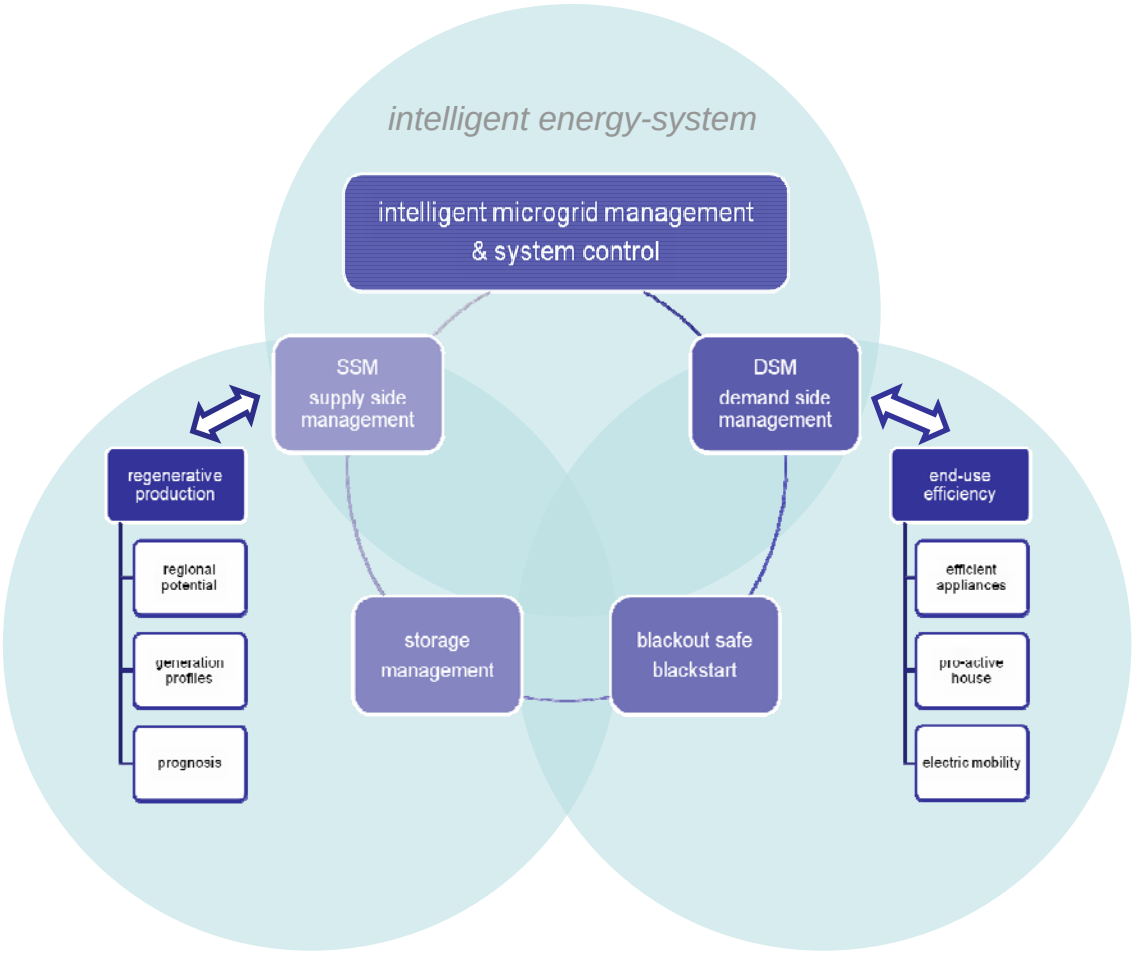

Fig. 3: ADRES overview

The optimal overall system depends on the interaction of these aspects. Some details are explained in the following sub items.

2.1 Increasing efficiency of all energy services

The consumption is not accepted as given. Moreover it has to be reduced in all ranges by efficiency measures.

There is a huge potential in the field of household appliances. The possible development paths for energy efficiency as well as dynamic load profiles are investigated. Therefore it is necessary to classify the appliances according the requirement to the availability.

Further on the electrical and thermal consumption of the buildings in general have to be reduced. In dynamic simulations of building concepts (e.g. plus energy buildings) the interactions between buildings, household applications and user behaviour are considered.

In addition also the power requirement of the mobility should be investigated. An interesting example is the “vehicle to grid” scenario. That is to say one can use the battery in an electric car like distributed and mobile energy storage units.

2.2 Regenerative production

One of the major tasks consists of finding the optimal energy-mix for the different regions. On this topic there have been done a lot of research work in Austria. We want to use and if necessary improve the results for ADRES.

On the one hand it is necessary to provide a high quality prognosis of fluctuating generation like wind or solar power. The present prognosis for Austria should be optimized for locally limited areas. Therefore it is important to investigate which additional meteorological data will be necessary. An intraday optimization with “nowcasting” procedures should be implemented.

On the other hand you have to look for existing as well as new energy transformation technologies. As a result of an evaluation of e.g. new CHP applications one can find the best solutions with highest total efficiencies.
The classical unit commitment procedure of operational planning from seasonal to quarter-hourly in cascading form has to be adapted for ADRES. The time intervals should be compatible with the potential of Demand Side Management (DSM) as well as the defaults of the storage system. The challenge is the description and solution of a complex multiple goal optimization problem with very large forecasting deviations.

The regional available renewable energy sources match the demand of all energy services.

2.3 Intelligent grid management

The management of the energy system is analyzed in two levels. As a start a pre-balancing of energy demand and production (e.g. photovoltaic) in the house is practicable. A major goal is the implementation of an energy balancing tool. The efficient energy consumption of the houses in a settlement and the available renewable energy generation should be balanced.
The overall system of production, transformation, storage and consumption should be optimized to fulfil all energy needs. The timescale reaches from seasonal to daily and in some cases to hourly. After the simulation and optimization of the balancing tool it will be applied on defined ADRES areas.

A frequency based control algorithm is used to reach the power-autonomy. Therefore the category of appropriate household appliances will be influenced to match the actual stochastic generation. By means of technical stability analyses and dynamic simulations the borders for the “island operation mode” are determined. If this works satisfactory the capacity of storage systems can be reduced substantially.

The results can be transferred later also to other autonomous systems like the electrical systems in automobiles or at ships.

3 Conclusions

The goal of ADRES is it to develop and test an autonomous decentralized regenerative energy-system. The research work on ADRES is spread up into three steps. The first step is to investigate the “ADRES-Concept” by simulation and optimisation in three main areas. These are end-use efficiency (electrical, thermal, mobility), the exclusive use of renewable energy sources and an innovative grid management. The autonomous, regenerative energy region reaches the self-sufficiency in consequence of high efficiency. The regional resources in the different ADRES areas fulfil all the energy needs.

The consortium of the actual research project ADRES-Concept is listed below.

- TU Vienna, Institute of Power Systems and Energy Economics
- TU Vienna, Institute for Thermodynamics and Energy Conversion
- Arsenal Research
- VERBUND - Austrian Power Grid AG
- Infineon Technologies Austria
- EVN Netz GmbH
- EnergieAG OÖ
- Wienenergie Stormnetz GmbH
- BEWAG Netz GmbH

Unfortunately it wasn’t possible to present the first results of the project ADRES-Concept in this contribution. Cause of some delays in the proposal evaluation and approval it wasn’t practicable to start before April, 2008.

The next step after ADRES-Concept will be ADRES-Transfer. For this project it is intended to increase our consortium. However with some additional industrial partners the results of ADRES-Concept will be improved and transferred into products and solutions.

The final step will be ADRES-Real. It is intended to find up to three different regions in Austria where the system or parts of it can be implemented and tested.

4 Acknowledgement

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Responsible Ministries:

The project “ADRES-Concept” will be founded by the “Klima- und Energiefonds” which was originated by Austrian government.