VERBUND Green Power GmbH

Renewable Assets as an Integrated Part of the Electricity System

Thomas Burchhart
Integrating RES in the Electricity Networks and Balancing Mechanism in MEDREG and ECRB Regions

15th of April 2021
VERBUND at a Glance

96 % production from renewable sources
approx. 392,000 residential customers –
market leader in the industrial customer segment
approx. 3,000 employees

127 hydro power plants
No. 1 in climate change mitigation
among European power supply companies

Austria’s leading electricity company
first green bond in German-speaking Europe

strategic focus on Austria and Germany
largest hydro power producer in Bavaria

51 % owned by the Republic of Austria
more than 2,000 apprentices trained
in the past 60 years

Austria-wide charging infrastructure
for electric vehicles
energy related products and services

social responsibility: € 1.8 million support for
„VERBUND-Stromhilfefonds“ of Caritas
since 2009
market leader in marketing of flexibility and
green electricity in Austria and Germany

environmental measures -
€ 280 millions to be invested until 2025
environmental management – top-10-position of 160
energy companies analysed by oekom research
VERBUND - Highlights

- Integrated utility with generation, transmission, trading and sales of electricity
- 127 hydro power plants in Austria and Germany (Bavaria) – approx. 8,2 GW
- 31 TWh total production
- >104 TWh trading volume, active in 10 European countries
- 3,500 km of line length of the Austrian transmission grid
VERBUND 430 MW Wind and PV Assets

- **EUD**
  - 0,4 MWp

- **Schönkirchen**
  - 11,4 MWp

- **Ludmannsdorf**
  - 1,3 MWp

- **Bruck, Hollern, Petronell**
  - 106 MW
  - 44 WTG

- **Eillern, Stetten**
  - 86 MW
  - 21 WTG

- **Casimcea**
  - 226 MW
  - 88 WTG
Wind Energy as Integrated Part of the Electricity System

**Yesterday**
- Energy production from renewables

**Pushing renewables**
- Fixed feed in tariffs
- Full maintenance contracts

**Today**
- Market integration of renewables

**Exploring market integration**
- Trading on the electricity stock exchange
- Insourcing maintenance activities

**Tomorrow**
- Grid stability through renewables

**Utilising full renewable potential**
- Provision of negative control power
- Excess energy for sector coupling
Wind Energy in Romania
Green electricity law (Legea 220/2008) to promote wind energy was ratified in year 2008

Highlights (end 2016)

- ~1.200 WTGs in operation
- 2.978 MW total installed wind capacity
- 8,8* TWh annual energy production (6,9% of the annual production)
- 5,6 billion Tons CO₂ avoided per year
- ~1.000 employees in wind sector

*…Production from renewables (Wind+Solar)
Wind Energy in Romania

Full market integration of wind energy
- Energy is sold on the stock exchange (OPCOM)
  - Provision of day – ahead power performance forecasts and intraday to TSO
  - Power curtailments can be requested by the TSO
  - Intraday market with low liquidity
  - Reduction of balancing costs by short term market
- Reserve of pos. balancing energy of 1%
- Retrospective changes of the promotion system with massive impact on the revenues

<table>
<thead>
<tr>
<th>Quota obligation system</th>
<th>= Energy price/MWh</th>
<th>+ Green certificate(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Incentive system for renewables, quota obligation for selling of renewable energy; can be met by purchasing green certificates by the energy seller</td>
<td>Selling of the produced energy on the stock market</td>
<td>▪ Different number of certificates for different RES technologies ▪ Retrospective changes of the system</td>
</tr>
</tbody>
</table>
Market Situation in Romania

Characteristic Week (2016)

- Balancing energy market not symmetrical
- High costs for deficit energy and low prices for exceeding energy
- No GCs for exceeding energy

### Average Market Prices in Year 2016

- Avg. OPCOM Day Ahead
- Avg. ELECTRICA Exc.
- Avg. ELECTRICA Def.

### Market Value Wind Energy 2016 (RON/MWh)

<table>
<thead>
<tr>
<th></th>
<th>Romania</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean ROPEX/Day-Ahead</td>
<td>149.82</td>
</tr>
<tr>
<td>Profile Value Wind 0% Error</td>
<td>133.57 (-11%)</td>
</tr>
<tr>
<td>Specific Balancing Energy Costs</td>
<td>23.3</td>
</tr>
</tbody>
</table>

- a...cost for excedent energy (lost revenue)
- b...cost for deficit energy

- T1 a<b -> Night
- T2 a>b -> Day
Forecasting and Day-Ahead Scheduling

Power forecasts are weighted according to the performance (neural) during certain "Wetterlagen" (weather conditions). The weighting is done in a module that considers various input data:

- Meteorology and/or power forecast (v, °, ρ, P, ...) on turbine level or grid point
- Consideration of wake effects
- Transformation of weather data into power output
- Adaption to turbine level (learned power curve)

The input data includes:

- Provider 1: e.g. v, °, ρ
- Provider 2: e.g. P on turbine level

The module takes into account different percentages for each forecast:

- 14% Power Forecast 1
- 73% Power Forecast 2
- xx% Power Forecast 3

There is also a downtime schedule (O&M) with availability information for different turbines:

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Availability</th>
</tr>
</thead>
<tbody>
<tr>
<td>01.09.2011 10:00-12:00</td>
<td>0</td>
</tr>
<tr>
<td>01.09.2011 12:00-13:30</td>
<td>1</td>
</tr>
</tbody>
</table>

Optional modules include:

- Nowcasting Module
- Strategic Forecast Module

Live data is provided by SCADA systems.
How to Increase the Market Value of Wind?

1. Reduction of balancing energy costs
   - Continuous improvement of the prediction quality
   - **Reduction of systematic** errors and **general optimization** of individual forecasts by consideration of “real” data
   - Implement **dynamic weighting** dependent on historic performance of single forecasts during characteristic weather classes (“Wetterlagen”)
   - Implement **strategic forecasting** as 2nd optimization step
   - Formation of **one balance group** including all Romanian assets (= One Dispatchable Unit, spatial smoothing)
   - Improvement the **quality of planned maintenances** (=scheduled downtimes) together with the OEM

2. Increase revenues
   - Develop a marketing strategy dependent on local market characteristics to be able to apply potentials and risks in a most effective way (hedging, providing ancillary services, combined offers to end customers (electricity + GC))
Reduction of OPEX

Reduction of maintenance and repair costs
- Within the full maintenance contract
  - Confront the OEM with detailed analysis results on a regular basis
    - Reaction times
    - Weaknesses of WTG components -> retrofits
  - Negotiation about alternative maintenance concepts

Reduction of costs for technical operations
- Insourcing of the operation of the substations
- Insurance contract: establishing a risk community
- Reorganization of the security services
Wind Energy in Austria
Wind Energy in Austria

Green electricity law (Ökostromgesetz) to promote wind energy was ratified in year 2002

Highlights (end 2016)

- 1.191 WTGs in operation
- 2.632 MW total installed wind capacity
- 5,8 TWh annual energy production (9,3% of the annual demand)
- 3,7 billion Tons CO₂ avoided per year
- ~5.000 employees in wind sector
The Austrian Green Electricity Promotion System

The Austrian clearing and Settlement Agency **OeMAG** is responsible for closing subsidy contracts, purchasing of the energy, allocation to traders, balancing energy management, clearing and billing.

Revenue situation of the Austrian wind farms

<table>
<thead>
<tr>
<th>VERBUND</th>
<th>Type</th>
<th>Commissioning year</th>
<th>Feed in tariff</th>
<th>End of tariff</th>
</tr>
</thead>
<tbody>
<tr>
<td>WP Bruck an der Leitha</td>
<td>5 x E66</td>
<td>2000</td>
<td>75,8 €/MWh</td>
<td>2010</td>
</tr>
<tr>
<td>WP Hollern</td>
<td>9 x E66</td>
<td>2004/05</td>
<td>78,0 €/MWh</td>
<td>2017</td>
</tr>
<tr>
<td>WP Petronell-Carnuntum</td>
<td>11 x E66</td>
<td>2004/05</td>
<td>78,0 €/MWh</td>
<td>2017</td>
</tr>
<tr>
<td>WP Hollern II</td>
<td>5 x E101</td>
<td>2014</td>
<td>95,0 €/MWh</td>
<td>2027</td>
</tr>
<tr>
<td>WP Petronell II</td>
<td>7 x E101</td>
<td>2014</td>
<td>95,0 €/MWh</td>
<td>2027</td>
</tr>
<tr>
<td>WP Bruck-Göttlesbrunn</td>
<td>7 x E101</td>
<td>2015</td>
<td>95,0 €/MWh</td>
<td>2028</td>
</tr>
</tbody>
</table>

- End of tariff for Bruck an der Leitha after 10th year of operation, Hollern and Petronell after 13th year
- After the 10th year of operation WP Bruck was traded by OeMAG connection tariff (**Marktanschlussstarif**)
OeMAG- Connection Tariff

Development after fixed feed in tariff

Declining market prices for energy and high costs for balancing energy within the Ökostrom balancing group cause declining revenues of over 80%.
# Full Maintenance Contract vs. Service Contract

| Costs | Full maintenance contract  
ENERCON-EPK (*Enercon Partner Konzept*) | Insourced maintenance with  
Service- and support contract |
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<tr>
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</thead>
<tbody>
<tr>
<td></td>
<td>• Increasing remuneration with operational year</td>
<td>• Lump sum + costs for spare parts, consumables and repair works + personnel costs and tools for repairs</td>
</tr>
<tr>
<td></td>
<td>• Remuneration quite high after 15\textsuperscript{th} year of operation</td>
<td></td>
</tr>
</tbody>
</table>
| Economic risk | • Availability warranty  
• Power performance warranty  
• Sound power level warranty | • Risk for component failures and downtimes of the WTG is borne by the operator  
• Alternative: MB & BU-insurance |
| Advantages | • Remuneration independent from number and type of failures and component exchange rates | • Remuneration independent from number and type of defect WTG components |
Wind Power @ VERBUND Grow Up

Development of an internal Service Organization

• Self-maintenance of 25 WTGs by five technicians since mid of 2016
  • Responsible for inspections, scheduled maintenances and repairs
• Professional training at the OEM and training on the job together with service technicians of the OEM
• Establishment of a new office and warehouse near the wind farms
• Implementation of safety regulation, working orders, electrical norms, ISO 14001, waste management…
Cost Savings through Repair of Defect Components

Different philosophies between the OEM and VERBUND

• Repair strategy OEM:
  • Goal: High time based availability
  • Exchange of complete printed circuit boards (PCB) and major components
  • Check and repair at internal service centres

• Repair strategy VERBUND:
  • Goal: High monetary availability
  • Repair time during times with low revenues not critical
  • Cost effective repair at PCB level
  • Repair of single components on PCB to save money
Market Situation in Austria

Correlation of the OeMAG wind forecast deviation and the deviation of the control zone

2011: Correlation 0.30

2015*: Correlation 0.59

*) January to September 2015

Source: www.apg.at/de/markt
Not only revenues (and penalties) on the spot market count but also balancing efforts have to be taken into account.
Participation in Tenders for Control Energy to Increase Revenues

How and to what extend can wind energy participate?

- Prequalification according to framework conditions in Operation Handbook ENTSO-E, Policy 1 mandatory
- Long term control power products (secondary control) difficult to offer due to volatile wind production
  - Fall back hydro power plants for reserve capacity (Synergies within VERBUND)
- Prequalification for negative reserve power only
- Wind energy capable for tertiary control power
  - Minimum bid of 5 MW
  - Tendering of 4 hour time slices
  - Capacity charge and commodity price
  - Provision of service within 15 min
Conclusions and Outlook
Conclusions and Outlook

• Type of promotion system has high impact on the market integration of wind energy

• Reduction of OPEX as key element to become economically competitive with other generation units
  • Full maintenance contracts are comfortable but very expensive
  • Responsibilities of operators have to be increased once cost reduction should take place
  • Insourcing of complete maintenance activities as ultimate step to build up know how of your own assets

• Continuous monitoring and improvements of power production forecasts are mandatory
  • Strong correlation between balancing energy costs and characteristic weather classes
  • Optimization steps may vary significantly dependent on the specific market situations

• Utilising full renewable potential can be an advantage
  • Provision of negative control power
  • Excess energy for sector coupling
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