POLICIES OF THE FUTURE
- WELCOME TO YOUNICOS

Younicos AG

Berlin, 20. July 2017
ABOUT YOUNICOS
We are a global leader for intelligent storage and grid solutions based on battery technology.
YOUNICOS AT A GLANCE

Founding of the Company: 2005

Younicos Inc.
Austin, Texas, USA

Younicos AG
Berlin, Germany

Experience from battery storage: 200

- 40 Storage projects worldwide
- More than 6 terabytes of field performance data collected
- >1,000,000 hours of operating run time on integrated power control & battery systems

- >78 gigawatt-hours charged and discharged

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WE PROVIDE SEAMLESSLY INTEGRATED BATTERY STORAGE SYSTEMS

We combine battery technologies and power electronics with highly intelligent software that responds automatically within milliseconds.
OUR SOLUTIONS ARE GREAT FOR SOLVING THE ENERGY CHALLENGES OF EVERY MARKET PLAYER

**Grid Tied**
- Power Generation
  - Stabilization of RE feed-in
  - Modeling of Power Gradients
  - Peak shaving
  - Price arbitrage
- Power Transmission & Distribution
  - Ancillary Services, e.g. Frequency Regulation
  - Voltage control
  - Black start capability
  - Short circuit capability
- Commercial and Industrial
  - Price arbitrage
  - Black start capability
  - Short-circuit capability

**Microgrids**
- Diesel Abatement or 100% Renewables
- Off Grid or Grid-connected
FROM SOUTH POLE TO ALASKA: EXPERIENCE FROM 200 MW IN THE FIELD
WE DESIGN AND DELIVER ONE OF THE WORLD’S LARGEST BATTERY STORAGE SYSTEMS

Barrow-in-Furness, Cumbria, UK

**Roosecote Battery Park**

- 49 MW/24.5 MWh
- Lithium Ion
- Frequency response, Provision of capacity, Triad avoidance
- Younicos designs and delivers the battery park
- Commissioning: Q4/2018
- Client: centrica

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WE HAVE BUILT THE FIRST COMMERCIAL STORAGE PROJECT IN EUROPE

Schwerin, Germany

**Schwerin Battery Park**

- Originally 5 MW/5 MWh
- Extension to 15 MW/15 MWh in 2017
- Lithium Ion
- Primary frequency response
- Younicos delivered turnkey battery power plant
- Commissioned: 06/2014
- Client: WEMAG
AN ISLAND POWERED BY WIND AND SUN

Graciosa (Azores), Portugal

**Graciosa Battery Park**

- 4 MW/3.2 MWh
- Lithium Ion
- Diesel substitution, grid stability services e.g. voltage and frequency control
- Younicos delivered turnkey battery power plant
- Commissioning: 02/2017
- Client: Graciolica
THE CASE FOR STORAGE IN THE TRANSFORMATION OF THE ENERGY SYSTEM
Renewables are the main driver and various technologies introduce new flexibility options into the energy system of the future.

Source: Open Energi
Location of provision of ancillary services chances to all levels

→ Ancillary services are provided on all voltage levels
→ Partially all ancillary services will have to come from the distribution grid

source: dena-Study Systemdienstleistungen 2030
THE CHALLENGE OF ENERGIEWENDE IN GERMANY

The increasing share of renewables in Germany is mainly driven by fluctuating solar and wind generation.

The high share of fluctuating renewables creates challenges in the integration into the energy network.

Source: Agora
RENEWABLE SHARE IN GERMANY: 30% IN 2016

Renewable Targets: 40-45% in 2025 and 55-60% in 2035

Source: Agorameter
AND THE PROBLEM STARTS RIGHT HERE

Renewables in Germany in May 2016

Source: Agora
Batteries offer higher efficiency in the provision of frequency containment.

Control bands of different power plants in % of overall power
(Frequency Containment Reserve and Frequency Restoration Reserve)

- Lignite: 30% flexibility, 0% must-run limitation
- Hard coal: 40% flexibility, 0% must-run limitation
- Gas fired: 50% flexibility, 0% must-run limitation
- Hydro power: 60% flexibility, -35% must-run limitation
- Battery: 200% frequency band

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BATTERIES OFFER HIGHER EFFICIENCY TO DIESEL GENERATORS

Increase generator efficiency
- Operate generators at optimal loading
- Reduce cycling of generators

Reduce operating costs
- Use less fuel to serve same load
- Cut O&M expenses

Improve grid stability & power quality
- Millisecond response to frequency events
- VAR support to keep power factor constant

Integrate renewable generation
- Smooth volatility to keep grid stable
- Reduce curtailment
BATTERIES ARE MORE FLEXIBLE AND ACCURATE THAN CONVENTIONAL POWER PLANTS

Faster and more accurate response of batteries make balancing more efficient and lowers the need for frequency regulation

*Battery power plant's response time< 5 ms

Source: 50 Hertz
ECOLOGICAL BALANCE OF BATTERY STORAGE: BATTERY VS. COAL PLANT

Comparison for the provision of frequency containment reserve

Coal plant

Battery

Global warming potential of coal plants exceeds that of battery plants by a factor of up to 90

Batteries help to reduce emissions and pollution from the energy sector

*FZ Jülich (2015): Life Cycle assessment of primary control provision by battery storage systems and fossil power plants
BATTERY ENERGY STORAGE – A NEW ENABLER IN THE OLD REGULATORY FRAMEWORK

Across the unbundled energy sector

Across different grid-levels

Storage technology can be employed in different applications and on different grid levels, which constitutes a challenge in today’s regulatory framework.
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## ENERGY STORAGE FOR COMMERCIAL & INDUSTRIAL APPLICATIONS

<table>
<thead>
<tr>
<th>Customer challenge</th>
<th>Younicos ESS solution</th>
<th>Value to customer</th>
</tr>
</thead>
<tbody>
<tr>
<td>Control energy usage to reduce your energy bill</td>
<td>• Peak Shaving/ Demand Charge Management - reduced grid fees</td>
<td>• Reduce energy bill and protection from future price increases</td>
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<tr>
<td></td>
<td>• Energy shifting - Avoidance of periods of highest energy costs</td>
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<tr>
<td>Secure power to your site</td>
<td>• Back-up power</td>
<td>• Protection of critical processes and equipment from power interruptions</td>
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<td></td>
<td>• Black-start capability</td>
<td>• A cleaner, more reliable and cheaper to operate alternative to diesel, with opportunity to generate additional savings</td>
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<tr>
<td>Generate more of your own energy and reduce costs and carbon</td>
<td>• Increase self-consumption of on-site generation, storing excess power and discharging when needed</td>
<td>• Reduce energy bill &amp; CO2</td>
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<tr>
<td></td>
<td>• Export connection constraints</td>
<td>• Enhance attractiveness of returns for installed on-site renewables</td>
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<tr>
<td></td>
<td>• Need to increase Return on Investment (&quot;ROI&quot;)</td>
<td>• Install larger systems on limited connection capacity</td>
</tr>
<tr>
<td>Provide grid services to generate new income, or stack with other benefits to</td>
<td>• Grid balancing services e.g. Enhanced Frequency Response or Primary Control Reserve</td>
<td>• Generate new income and combine with other applications to enhance ROI and limit risk exposure to one application</td>
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<tr>
<td>increase ROI</td>
<td>• Grid Investment deferral</td>
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</tr>
<tr>
<td></td>
<td>• High returns on investment required to compete with alternative options</td>
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<tr>
<td></td>
<td>• Rising energy bills</td>
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<td>• Carbon targets/ obligations</td>
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TECHNOLOGY CENTER AND DIFFERENT PROJECTS GENERATED GROUNDBREAKING INSIGHTS

**Lesson learnt I : Storage needs**

- Without storage, grid instabilities start at 15% RE share on total annual consumption
- 1 hour of storage capacity is enough to reach 50% annual RE penetration
- 4 hours of storage capacity are enough to reach 70% RE annual penetration

**Lesson learnt II : Leveraging Renewables with battery storage**

- The rotating masses can be switched off
- A grid with less inertia requires faster regulation

**Switching off conventional generation is the leverage to high Renewable Energy penetration**
FURTHER QUESTIONS?
WE ARE LOOKING FORWARD TO HEARING FROM YOU!

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