Younicos

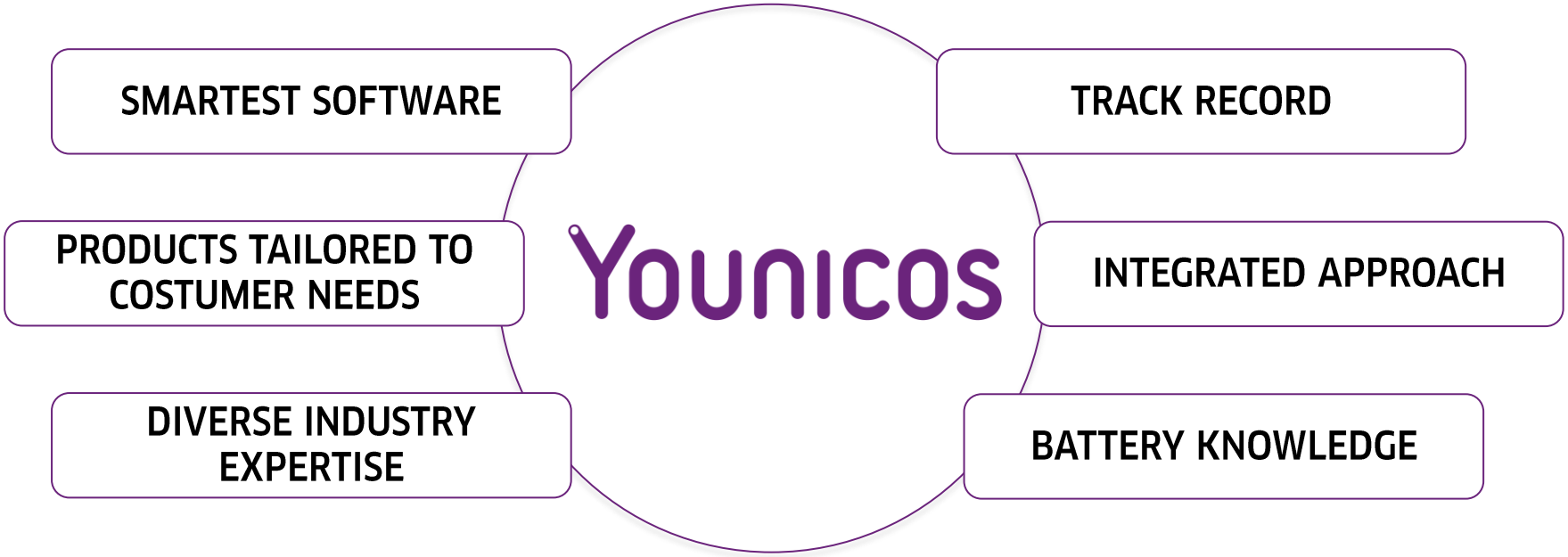
POLICIES OF THE FUTURE - WELCOME TO YOUNICOS

Younicos AG

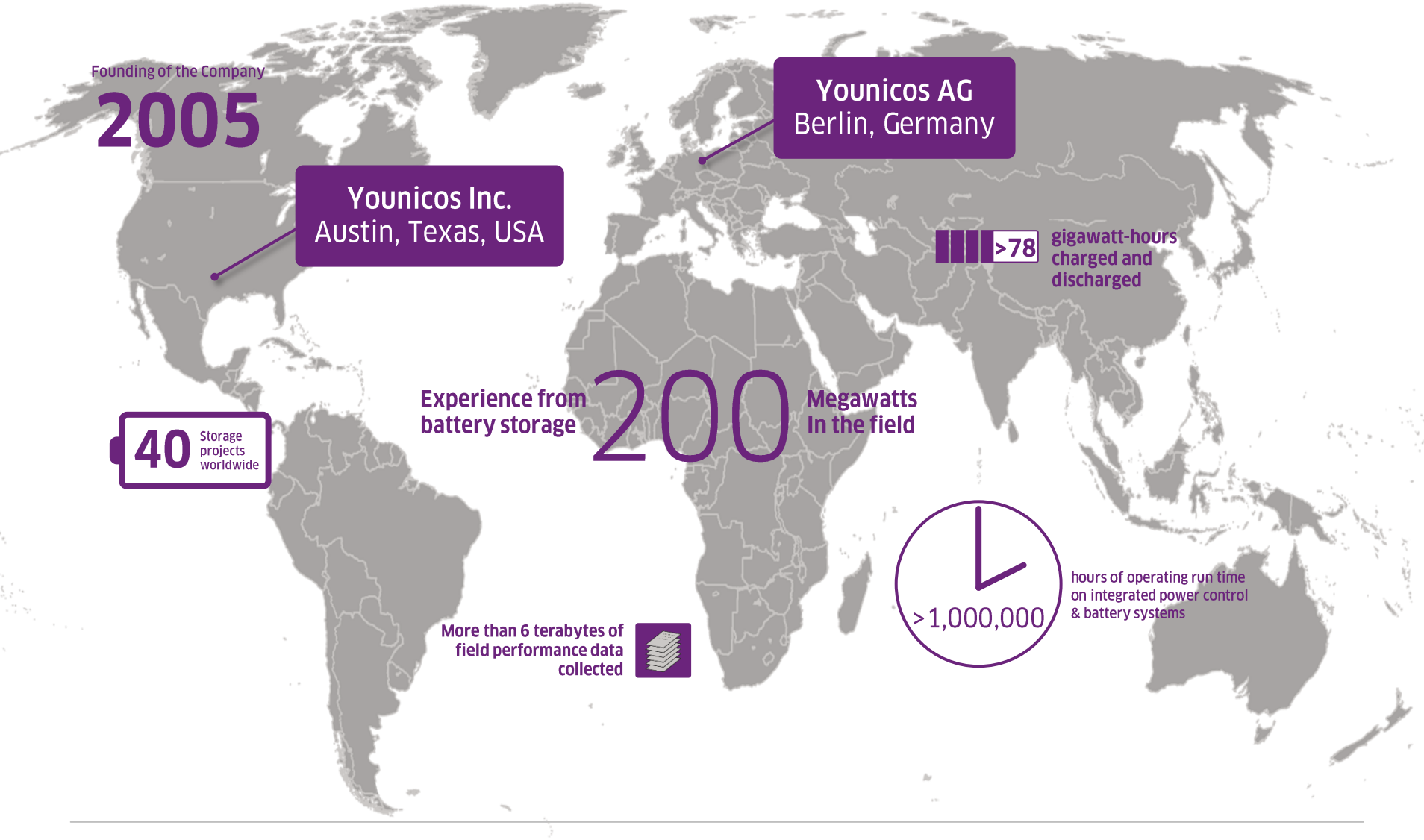
Berlin, 20. July 2017

ABOUT YOUNICOS

We are a global leader for intelligent storage and grid solutions based on battery technology.

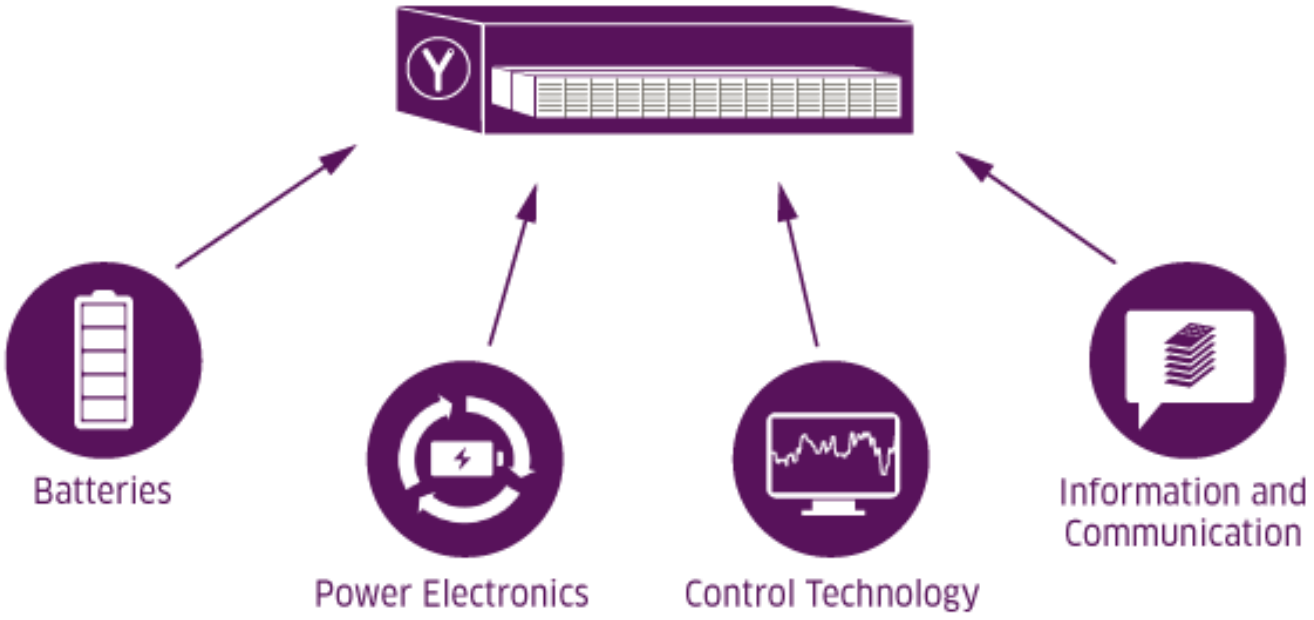


YOUNICOS AT A GLANCE



WE PROVIDE SEAMLESSLY INTEGRATED BATTERY STORAGE SYSTEMS

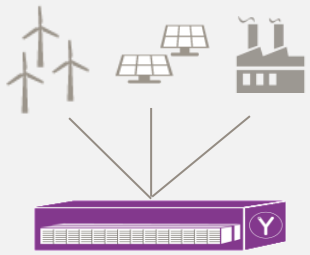
We combine battery technologies and power electronics with highly intelligent software that responds automatically within milliseconds.



OUR SOLUTIONS ARE GREAT FOR SOLVING THE ENERGY CHALLENGES OF EVERY MARKET PLAYER

Grid Tied

Power Generation



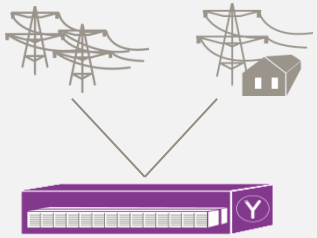
Stabilization of RE feed-in

Modeling of Power Gradients

Peak shaving

Price arbitrage

Power Transmission & Distribution



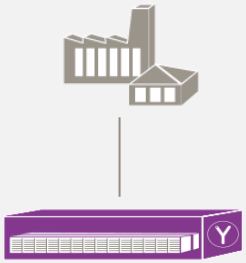
Ancillary Services, e.g. Frequency Regulation

Voltage control

Black start capability

Short circuit capability

Commercial and Industrial

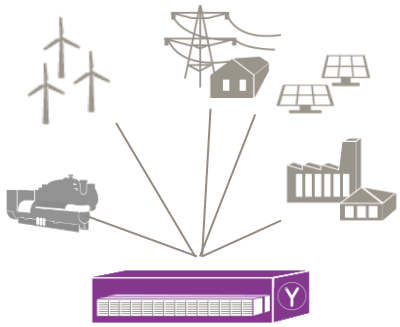


Price arbitrage

Black start capability

Short-circuit capability

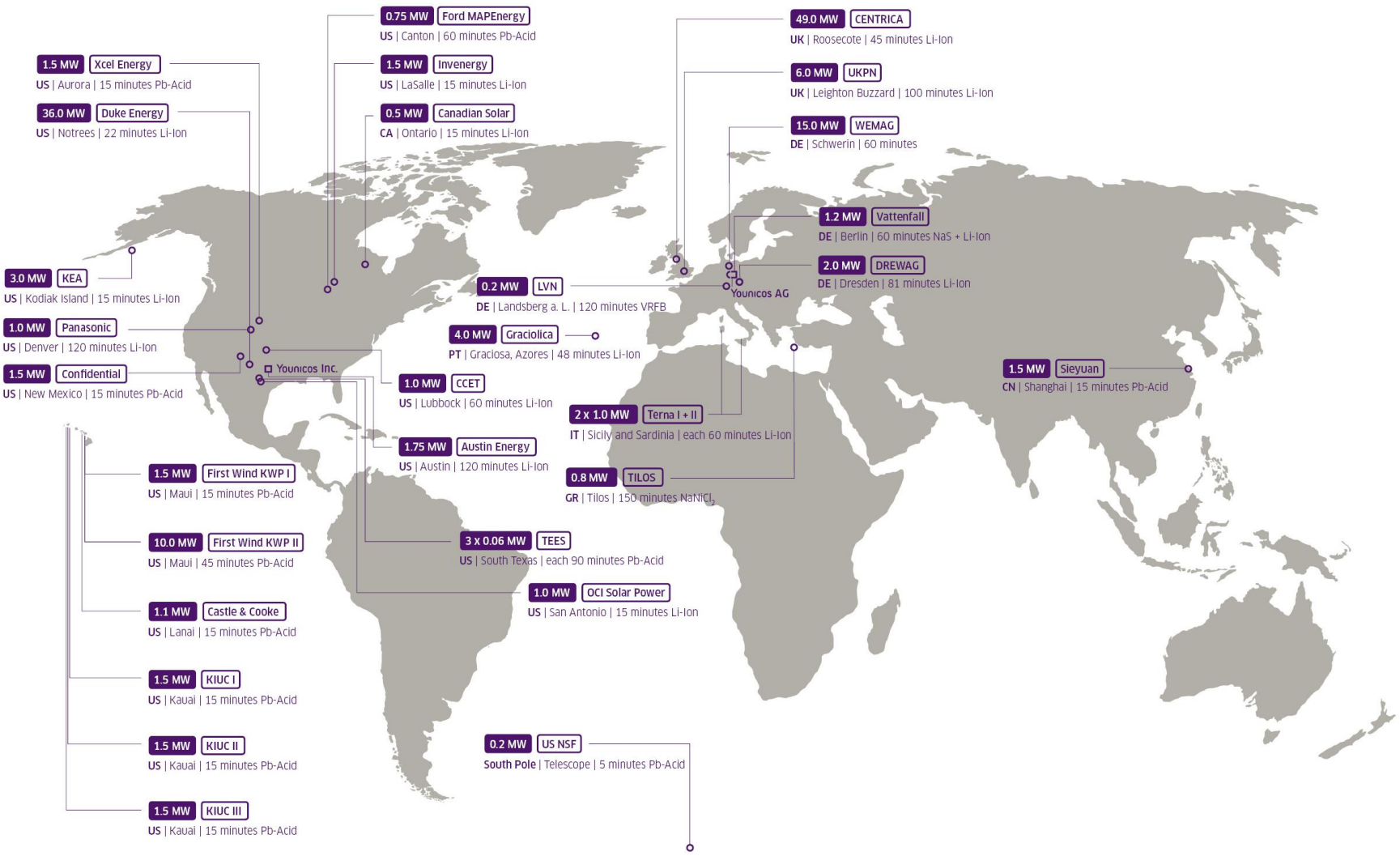
Microgrids



Diesel Abatement or 100% Renewables

Off Grid or Grid-connected

FROM SOUTH POLE TO ALASKA: EXPERIENCE FROM 200 MW IN THE FIELD

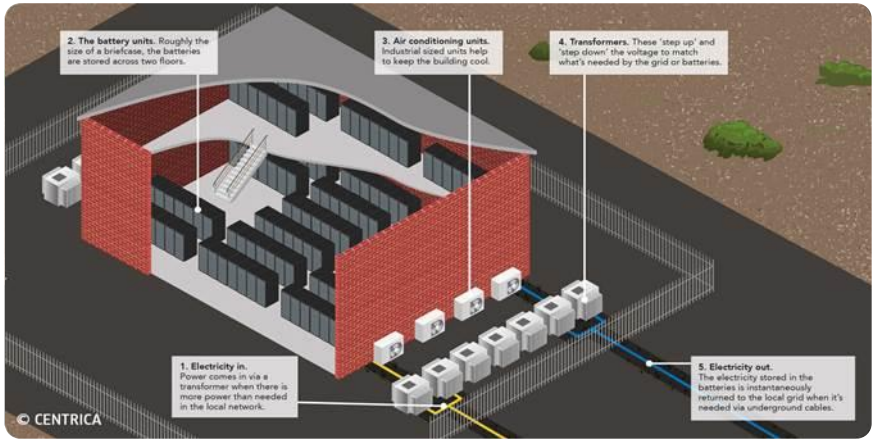


WE DESIGN AND DELIVER ONE OF THE WORLD'S LARGEST BATTERY STORAGE SYSTEMS

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



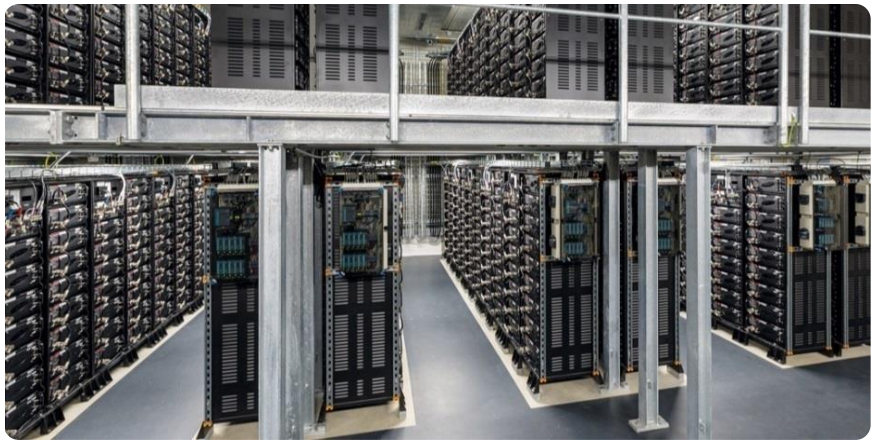
WE HAVE BUILT THE FIRST COMMERCIAL STORAGE PROJECT IN EUROPE

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

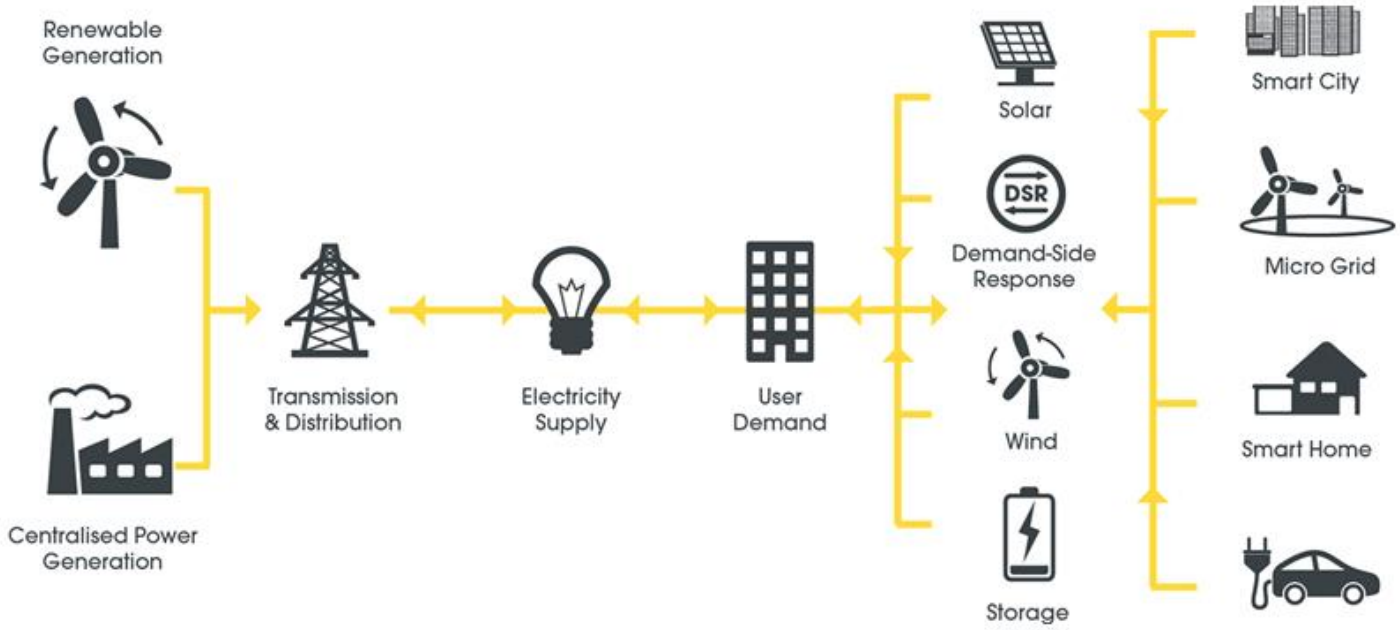
Graciosa (Azores), Portugal

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

TRANSFORMATION OF THE ENERGY SYSTEM I

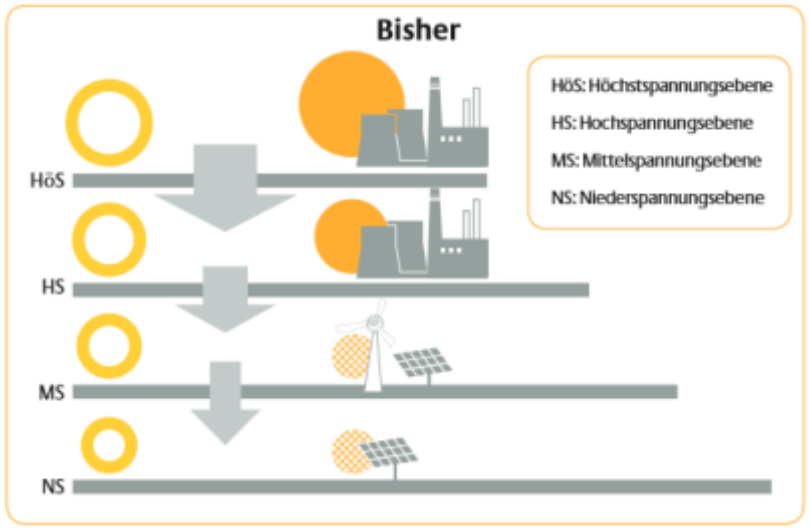


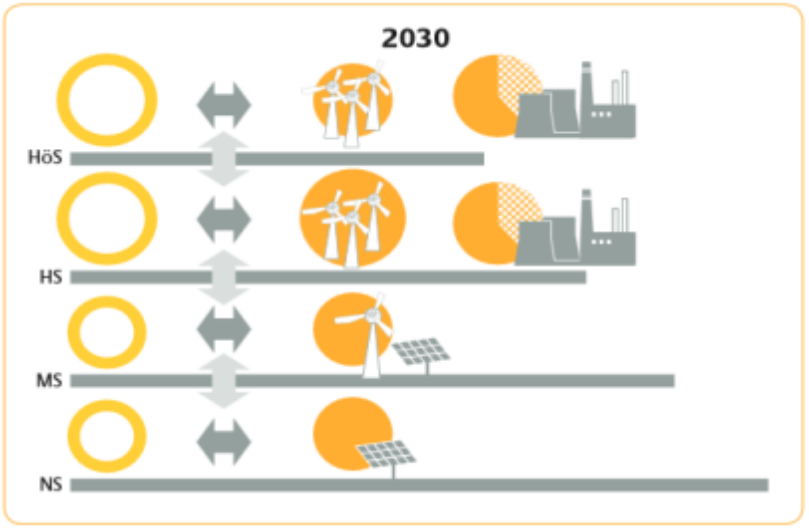
→ Renewables are the main driver and various technologies introduce new flexibility options into the energy system of the future

Source: Open Energi

TRANSFORMATION OF THE ENERGY SYSTEM II

Location of provision of ancillary services chances to all levels





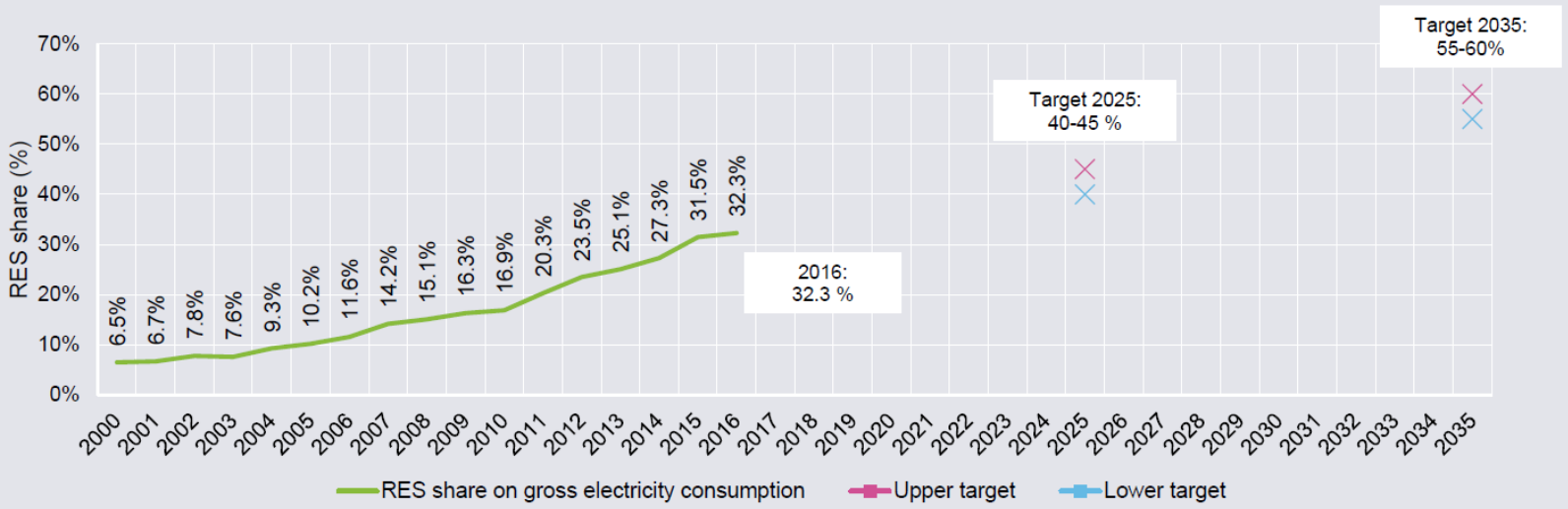
→ Ancillary services are provided on all voltage levels

→ Partially all ancillary services will have to come from the distribution grid

source: dena-Study Systemdienstleistungen 2030

THE CHALLENGE OF ENERGIEWENDE IN GERMANY

Share of renewables in gross energy consumption, 2000–2016, together with 2025 and 2035 targets

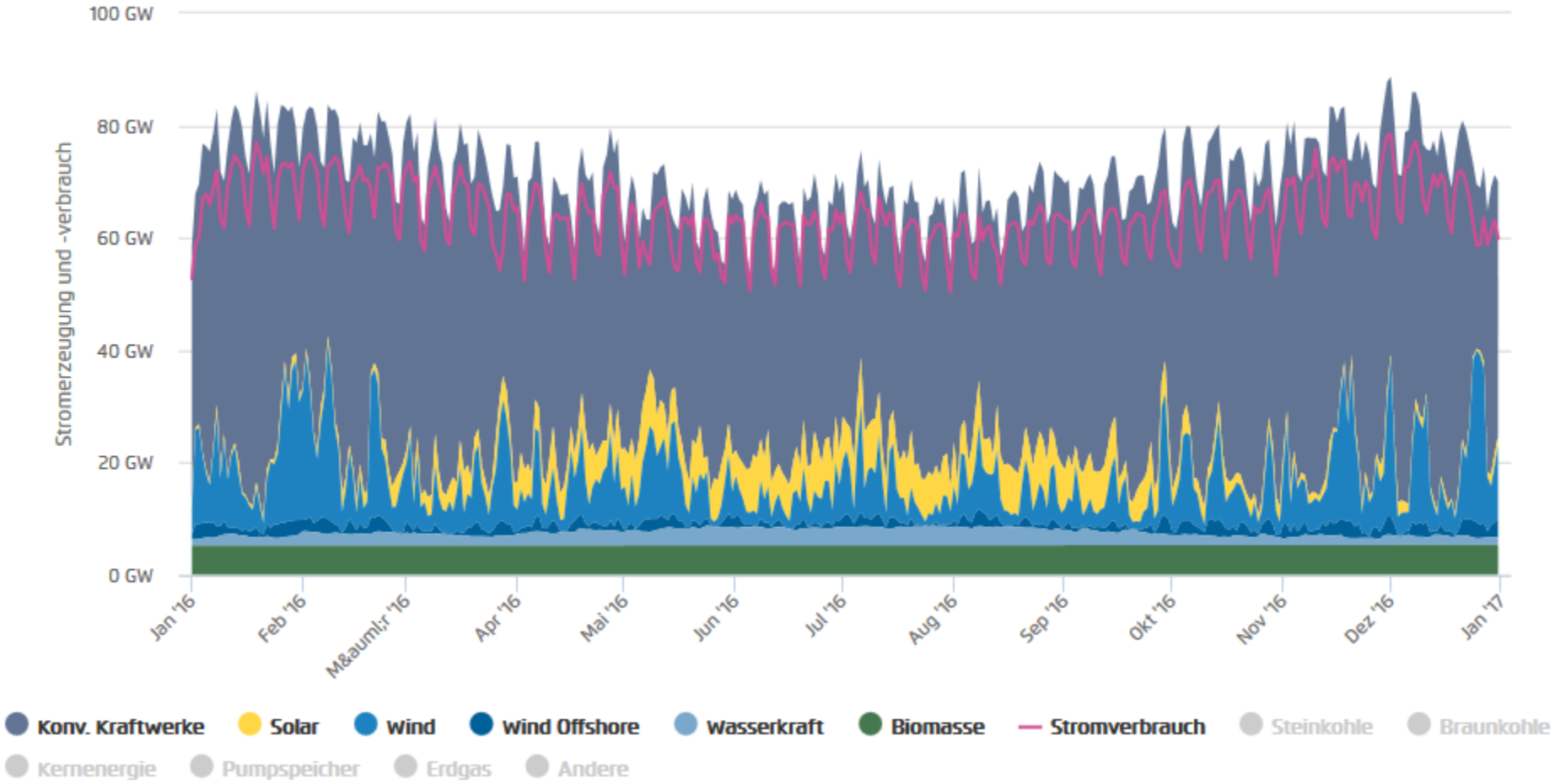


AG Energiebilanzen 2016a

→ 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

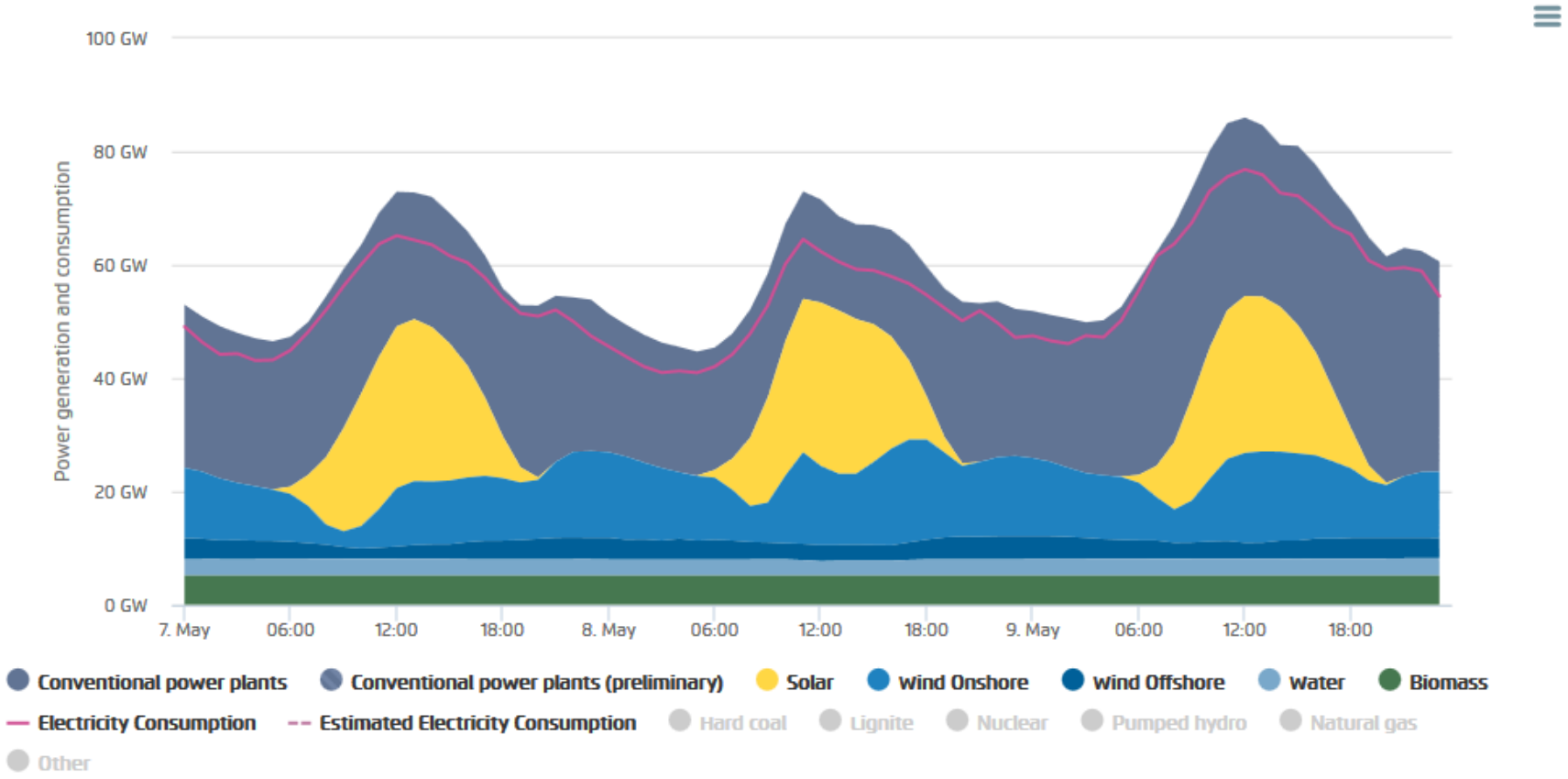


Renewable Targets: 40-45% in 2025 and 55-60% in 2035

Source: Agorameter

AND THE PROBLEM STARTS RIGHT HERE

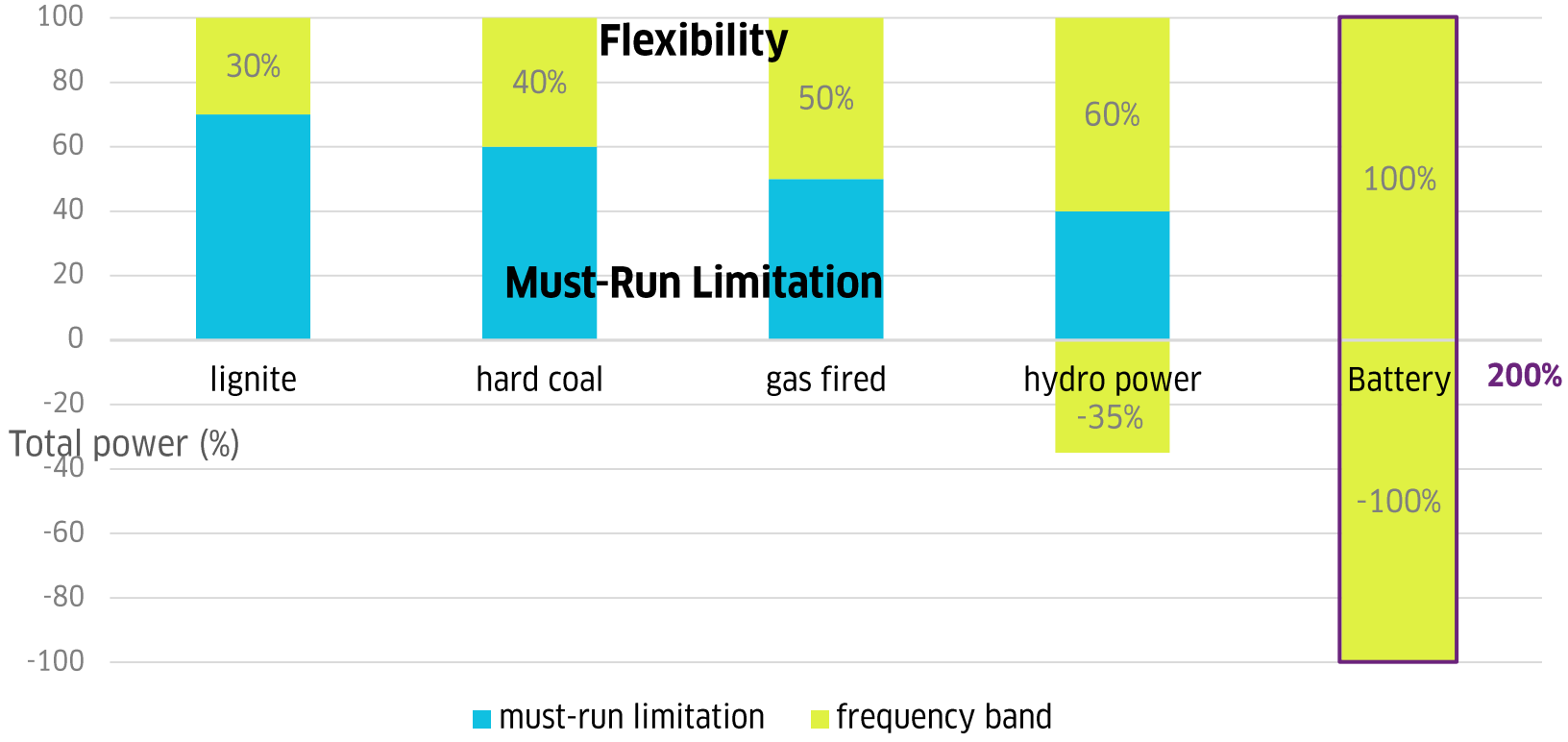
Renewables in Germany in May 2016



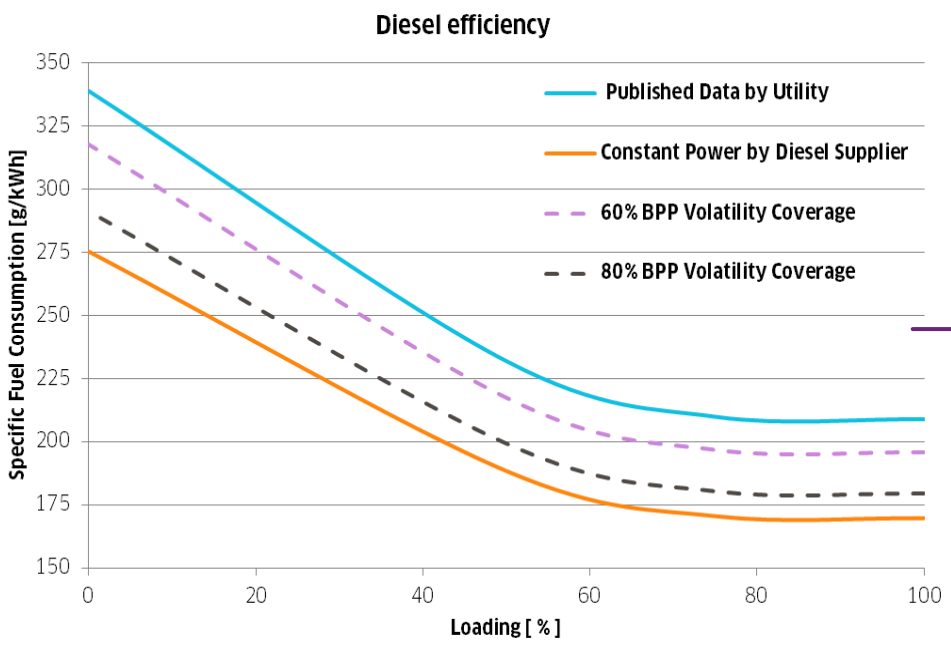
Source: Agora

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)



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

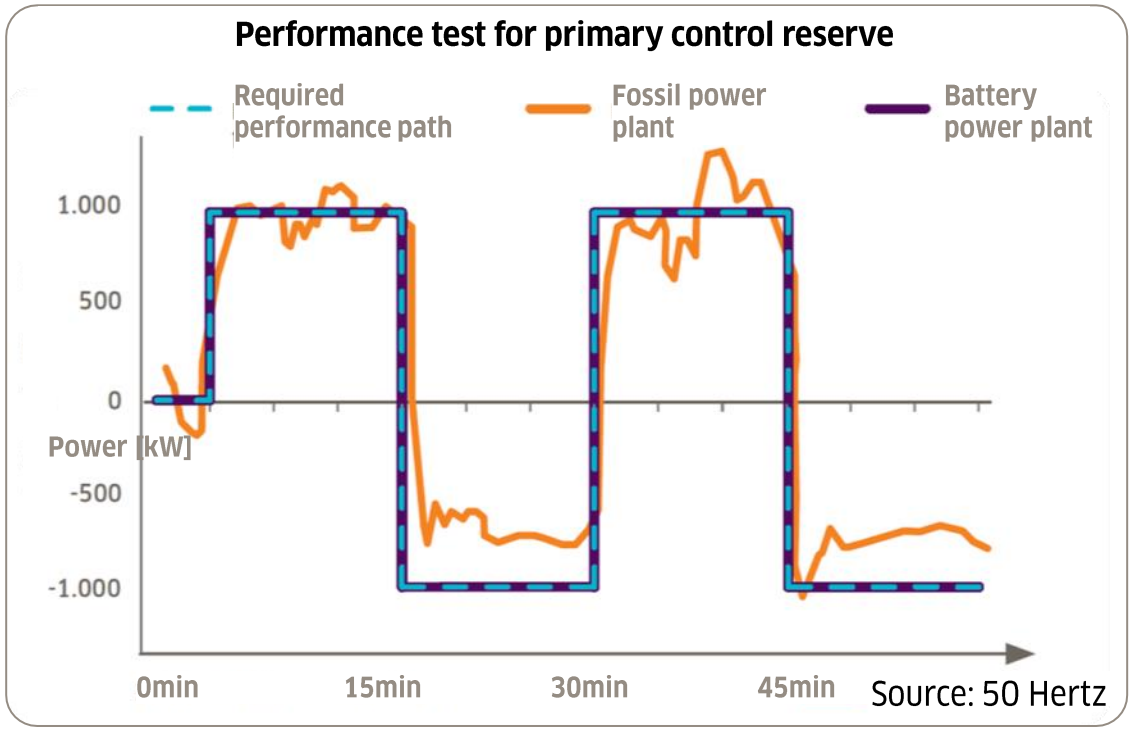
Improve grid stability & power quality

- 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

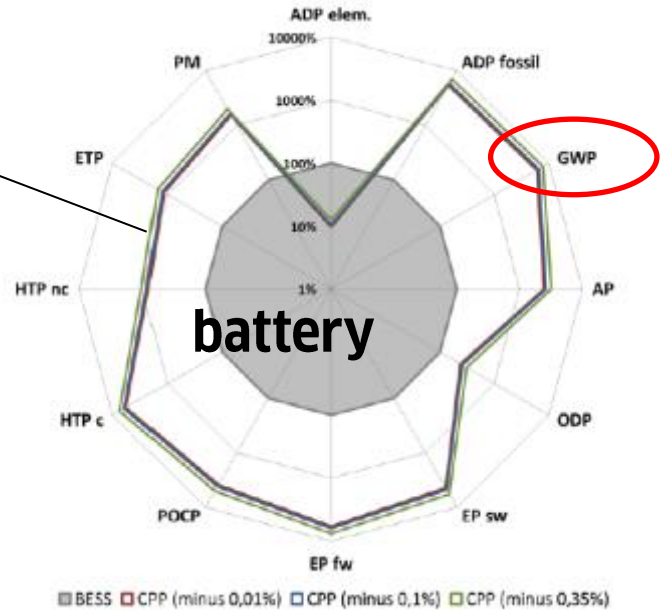
*Battery power plant's response time< 5 ms

ECOLOGICAL BALANCE OF BATTERY STORAGE: BATTERY VS. COAL PLANT

Comparison for the provision of frequency containment reserve

coal plant

$ADP_{elem.}$	Abiotic Resource Depletion Potential (mineral)
ADP_{fossil}	Abiotic Resource Depletion Potential (fossil)
GWP	Global Warming Potential
AP	Acidification Potential
ODP	Ozone Depletion Potential
EP sw	Eutrophication Potential (saltwater)
EP fw	Eutrophication Potential (fresh water)
POCP	Photochemical Ozone Creation Potential
HTP c	Human Toxicity Potential (carcinogen)
HTP nc	Human Toxicity Potential (non carcinogen)
ETP	Ecotoxity Potential
PM	Particulate Matter



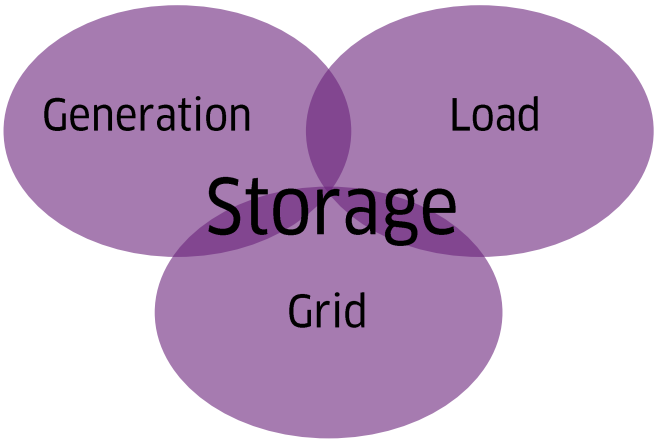
global warming potential of coal plants exceeds that of battery plants by a factor of up to 90

Batteries help to reduce emissions and pollution from the energy sector

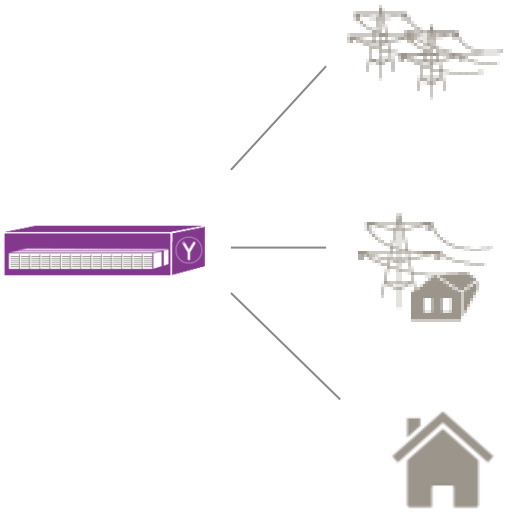
*FZ Jülich (2015): Life Cycle assessment of primary control provision by battery storage systems and fossil power plants

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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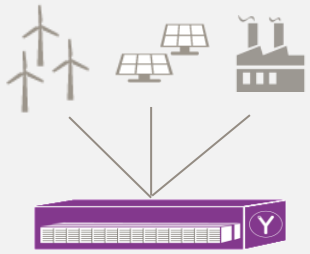
Grid Tied

Power Generation



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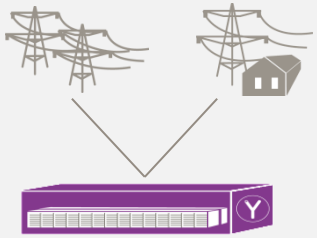

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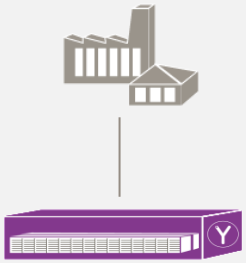

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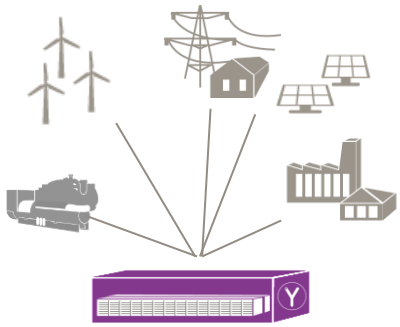

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ENERGY STORAGE FOR COMMERCIAL & INDUSTRIAL APPLICATIONS

	Customer challenge	Younicos ESS solution	Value to customer
Control energy usage to reduce your energy bill 	• Rising energy bills	• Peak Shaving/ Demand Charge Management – reduced grid fees • Energy shifting - Avoidance of periods of highest energy costs	• Reduce energy bill and protection from future price increases
Secure power to your site 	• Supply interruption presents risk of process & equipment damage • Ageing diesel back-up that are unreliable and expensive to run & maintain	• Back-up power • Black-start capability • Voltage Control & Power Factor Correction	• Protection of critical processes and equipment from power interruptions • A cleaner, more reliable and cheaper to operate alternative to diesel, with opportunity to generate additional savings
Generate more of your own energy and reduce costs and carbon 	• Rising energy bills • Carbon targets/ obligations • Export connection constraints • Need to increase Return on Investment (“ROI”)	• Increase self-consumption of on-site generation, storing excess power and discharging when needed	• Reduce energy bill & CO2 • Enhance attractiveness of returns for installed on-site renewables • Install larger systems on limited connection capacity
Provide grid services to generate new income, or stack with other benefits to increase ROI	• High returns on investment required to compete with alternative options	• Grid balancing services e.g. Enhanced Frequency Response or Primary Control Reserve • Grid Investment deferral	• Generate new income and combine with other applications to enhance ROI and limit risk exposure to one application

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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