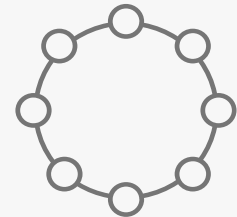


**ESTABLISHING THE FLOW – A VIRTUAL POWER PLANT FOR THE TRANSITION TOWARDS
100% RENEWABLE ENERGIES**

Jan Aengenvoort



YOU CANNOT BUILD A POWER PLANT OUT OF UNIVERSITY



OR CAN YOU?



BEING A UTILITY IN A NEW ENERGY WORLD

Decentralization

Number of Power Plants in Germany
in 1990

800

Number of Power Plants in Germany
in 2016

1,500,000

BEING A UTILITY IN A NEW ENERGY WORLD

Liberalization

Number of energy spot markets in
1990

0

Number of energy spot markets in
2017

12

BEING A UTILITY IN A NEW ENERGY WORLD

Digitalization

LTE connections worldwide in 1990

0

LTE connections worldwide in 2016

1 billion

WHAT IS A VIRTUAL POWER PLANT (VPP)?

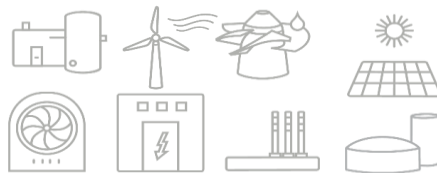
Next Kraftwerke is one of Germany's biggest power stations without owning or operating any power stations.



Sounds familiar? Think airbnb, uber, facebook. A VPP is the operator of a power plant without having any power plants! It's a platform where independent producers & consumers are connected to grid operators & markets through M2M communication

BEING DIGITAL: THINKING IN BITS AND WATTS

4,500 UNITS IN EIGHT
COUNTRIES, >3,200
MEGAWATTS



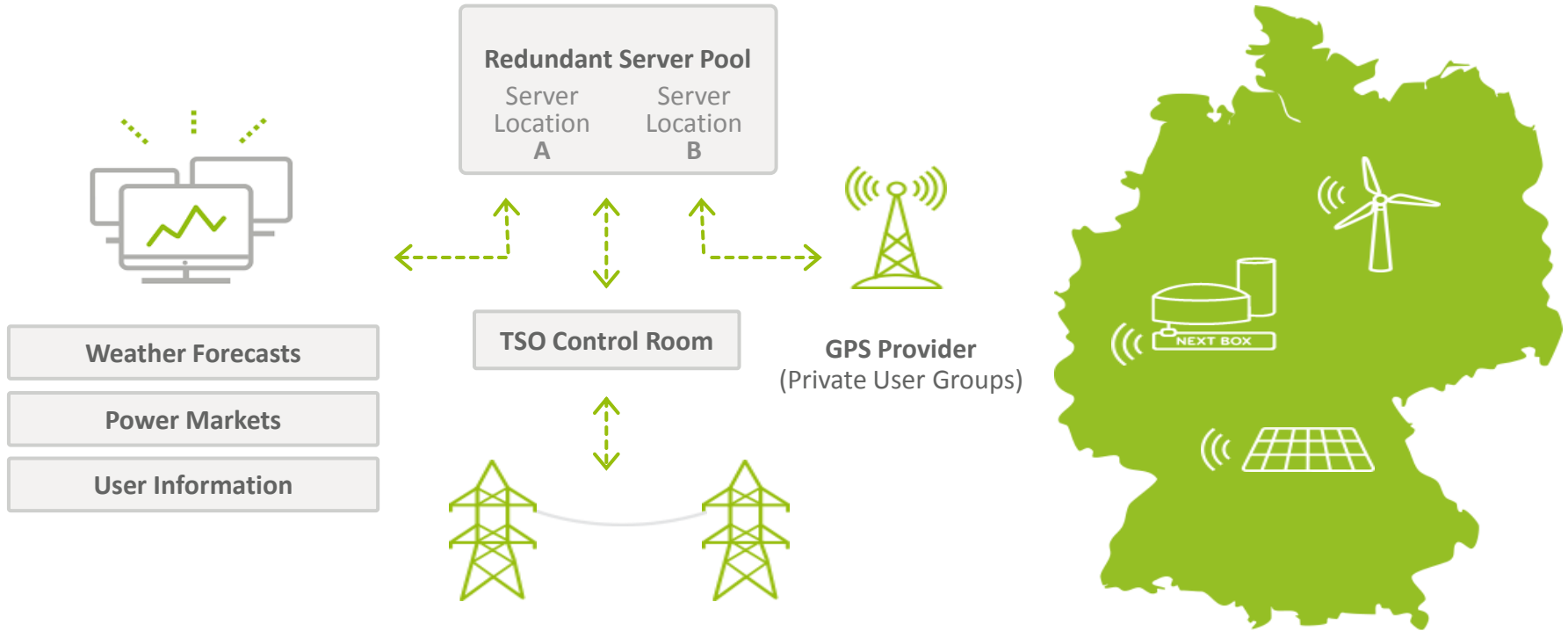
LINKED VIA THE REMOTE
CONTROL UNIT NEXT BOX



PROCESSED & ORCHESTRATED
BY THE CENTRAL CONTROL
SYSTEM

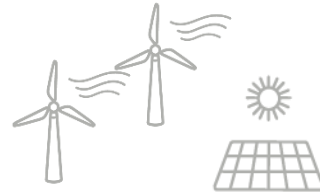


TECHNOLOGY



WHY?

KEEPING THE GRID BALANCED



Too much wind & solar on the grid



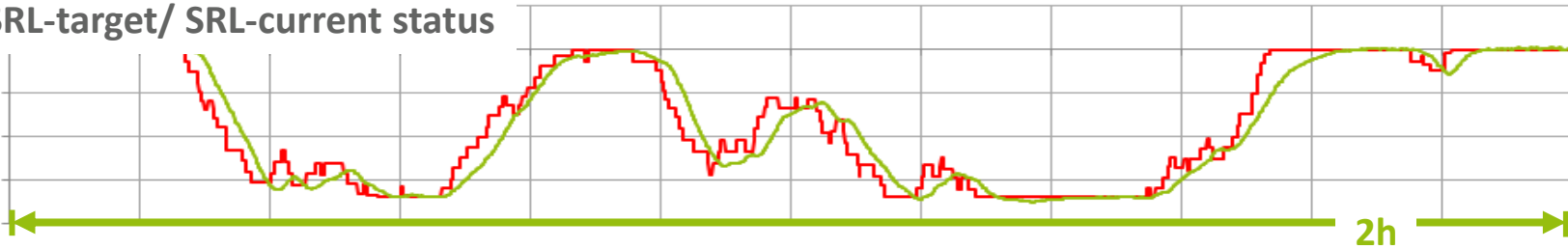
Ramping down bioenergy, hydro & CHP to stabilize grid frequency

CONTROL RESERVE IN A VPP

Processing a Secondary Control Reserve Call Within the Pool

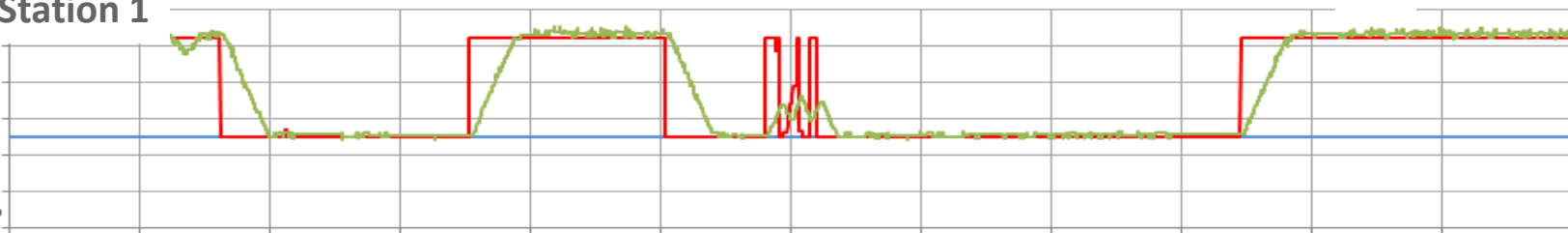
Pool SRL-target/ SRL-current status

0 MW



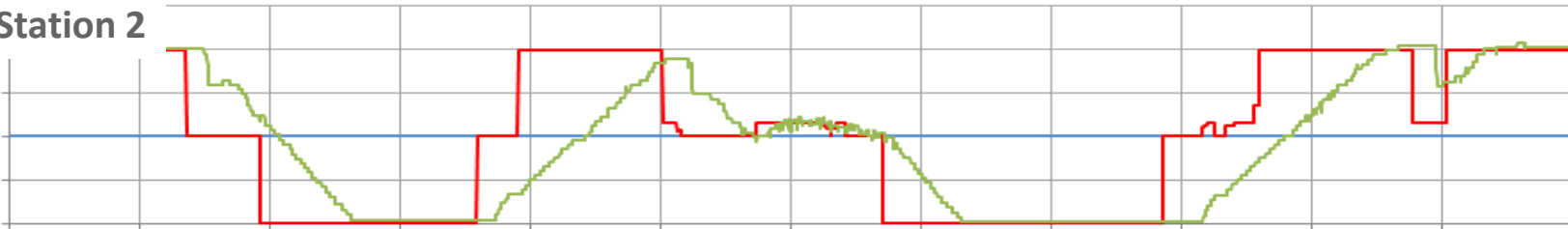
Station 1

P_{AP}
0 kW



Station 2

0 kW



WHO WE ARE WORKING FOR

Forecasting, trading, and dispatching of renewable energies

- Peter Hecht, Mittelfranken
- Installed capacity: 1.18 MW
- Medium capacity: 530 kW
- Gas tank: 2.500 m³
- Products: Trading; R2-; R2+
- VPP: 283 units in R2+ & 1880 units in R-



WHY?

OFFERING FLEXIBLE RATES



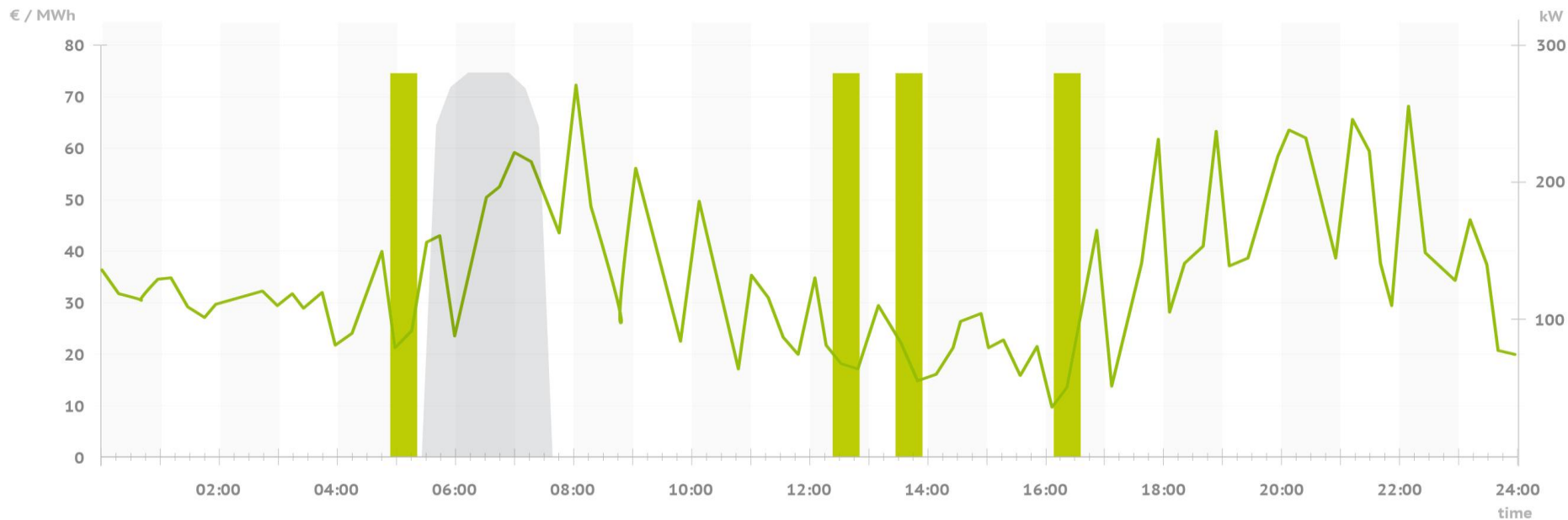
Low prices on the energy exchange



Ramping up energy consumption

FLEXIBLE RATE IN A VPP

Demand Side Management with Flexible Electricity Rate



Power consumption before optimization

Power consumption after optimization

DE-EPEX Intraday 1/4h

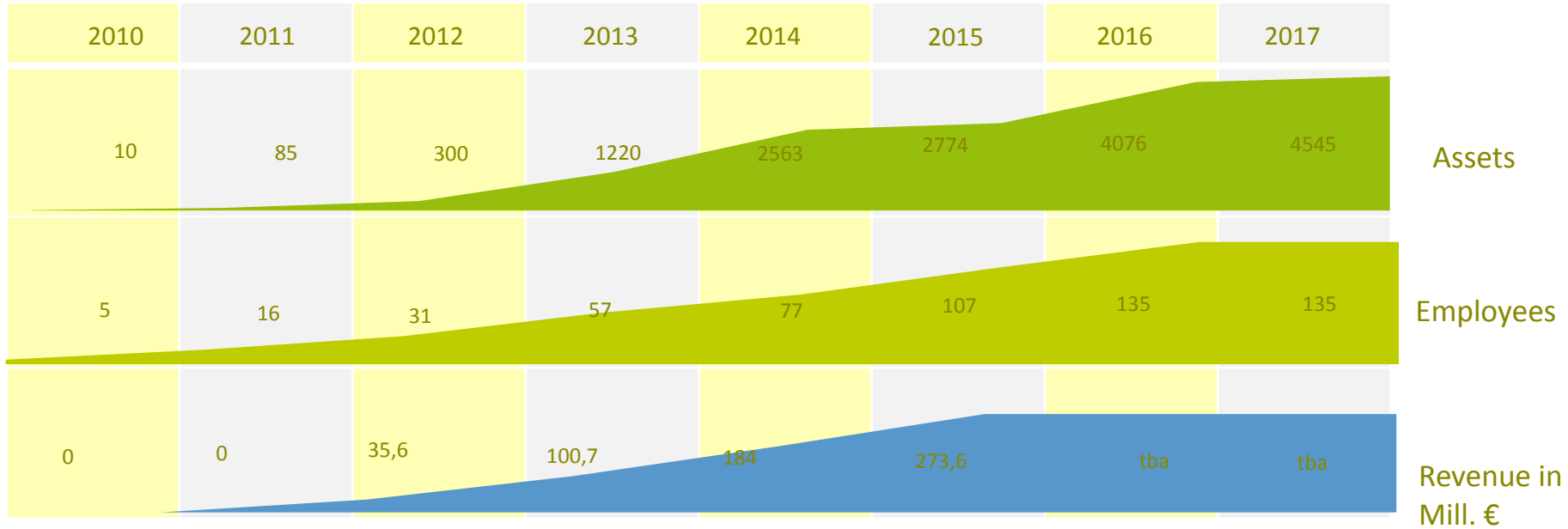
WHO WE ARE WORKING FOR

Offering flexible rates to power consumers

- › Deich- & Hauptzielverband, Dithmarschen
- › Flexible power rate „Best of 96“
- › Power delivery with reference to quarter-hourly prices on the energy exchange
- › Levy pumps are running when power is cheap (= a lot of wind & solar in the system)
- › >500 commercial & industrial power consumers amounting to >150 GWh in 2017



COMPANY DEVELOPMENT



DIGITAL, FLEXIBLE, SUSTAINABLE

THE GOAL

Making 100% renewable energy possible

THE PATH

Digital, Flexible, Sustainable

THE STATUS

One of the largest Digital Utilities in Europe

THE TEAM

More than 130 employees with a broad academic background

Jan Aengenvoort

Head of Communication & Market Research

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