



Federal Ministry  
for Economic Affairs  
and Energy



**MITTELSTAND  
GLOBAL**  
ENERGY SOLUTIONS  
MADE IN GERMANY

# Future Smart Grids for Renewable Energy Sources

Lars Waldmann

Consultant on behalf of the Federal Ministry  
for Economic Affairs and Energy

eclareon GmbH

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Facilitator:



# Welcome



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# Introduction



**Lars Waldmann**  
M.A. Dipl.-Oec.  
Founder / CEO

Johannisstraße 78A  
24937 Flensburg  
Telefon +49 461 99 876 486  
Mobil +49 173 6122 817  
Waldmann@ew-con.de

## International Consulting

Energy Transition Infrastructure  
Regulation and Legislation  
Strategies and Planning

Ministries  
Governments  
Administrations  
Cities and Municipalities

## Technology-Transfer

Innovation-Scouting and Projection  
Stakeholder-Dialogue  
Business Models

NGOs  
Start Ups  
Enterprises  
Associations

## Municipality Consulting

Integrated Modular Approach  
Analysis and Implementation  
Safeguarding the Future

Cities  
Utilities  
Municipalities  
Grid-Operators



# Agenda

- 
- A wide-angle photograph of terraced rice fields in a lush green valley. The terraces are filled with vibrant green rice plants, and the fields are separated by low stone or concrete walls. In the background, a dense forest covers the hills. A small wooden hut is visible on a higher terrace, and another one is in the foreground. A few people can be seen walking through the fields.
1. It's All about Sun and Wind
  2. The Future of Infrastructure
  3. Smart Electricity Grids
  4. Conclusions

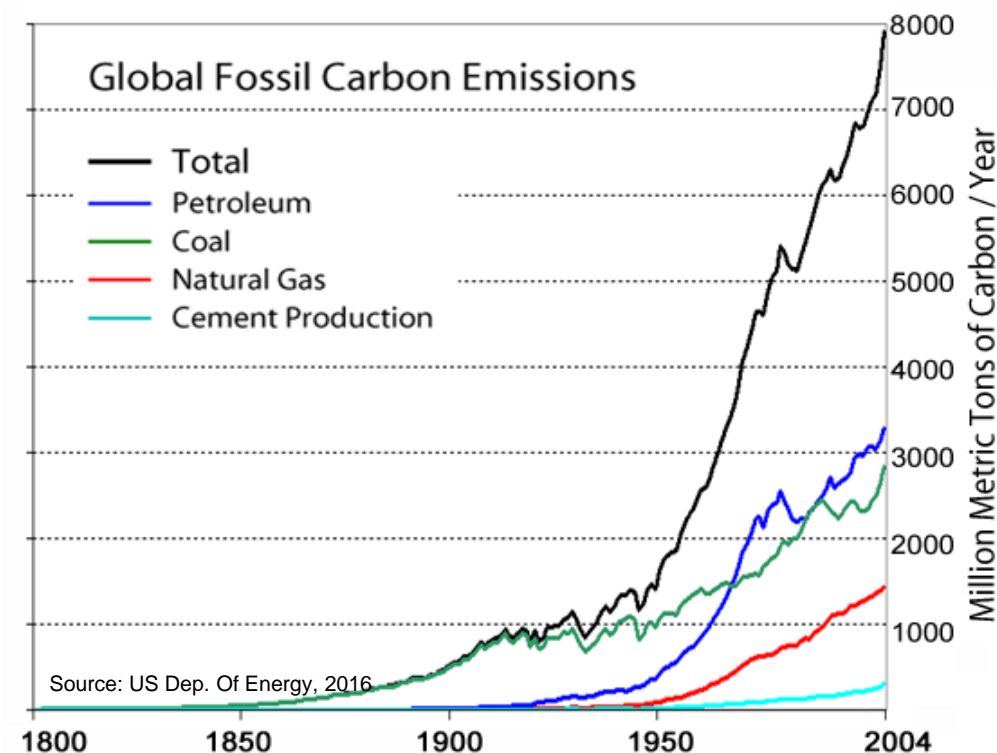
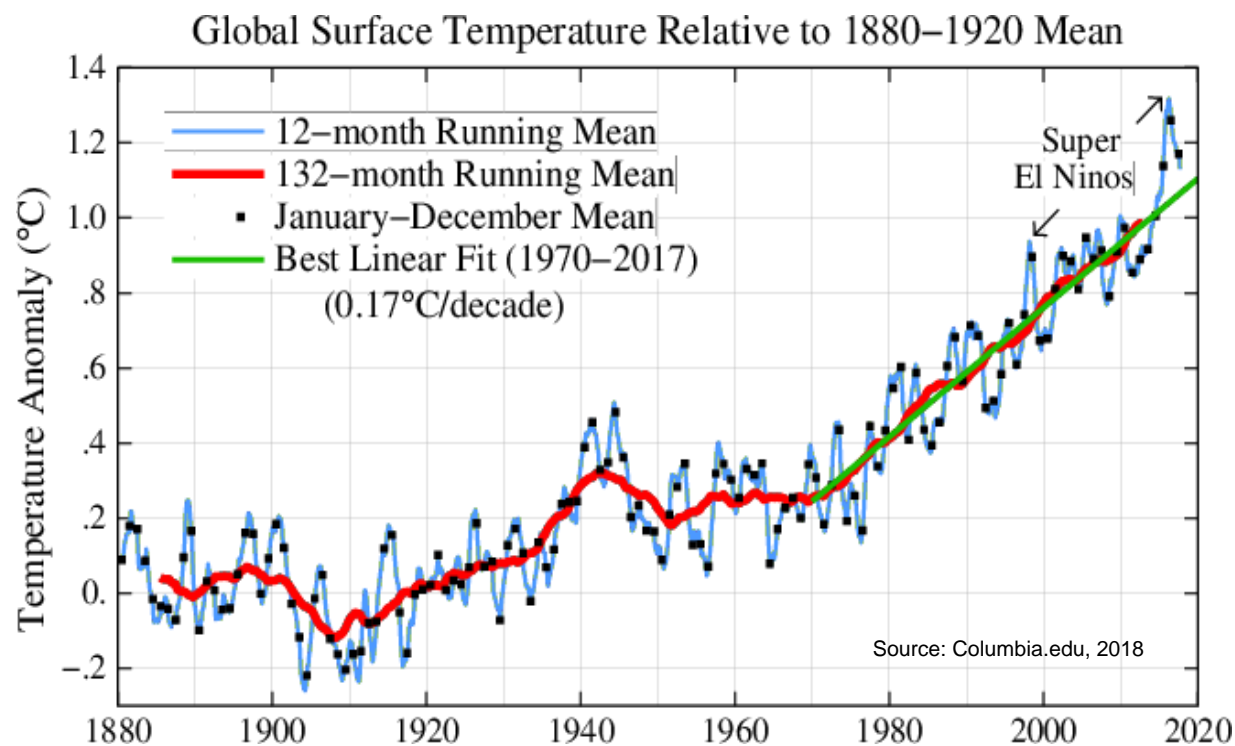


# It's All about Sun and Wind



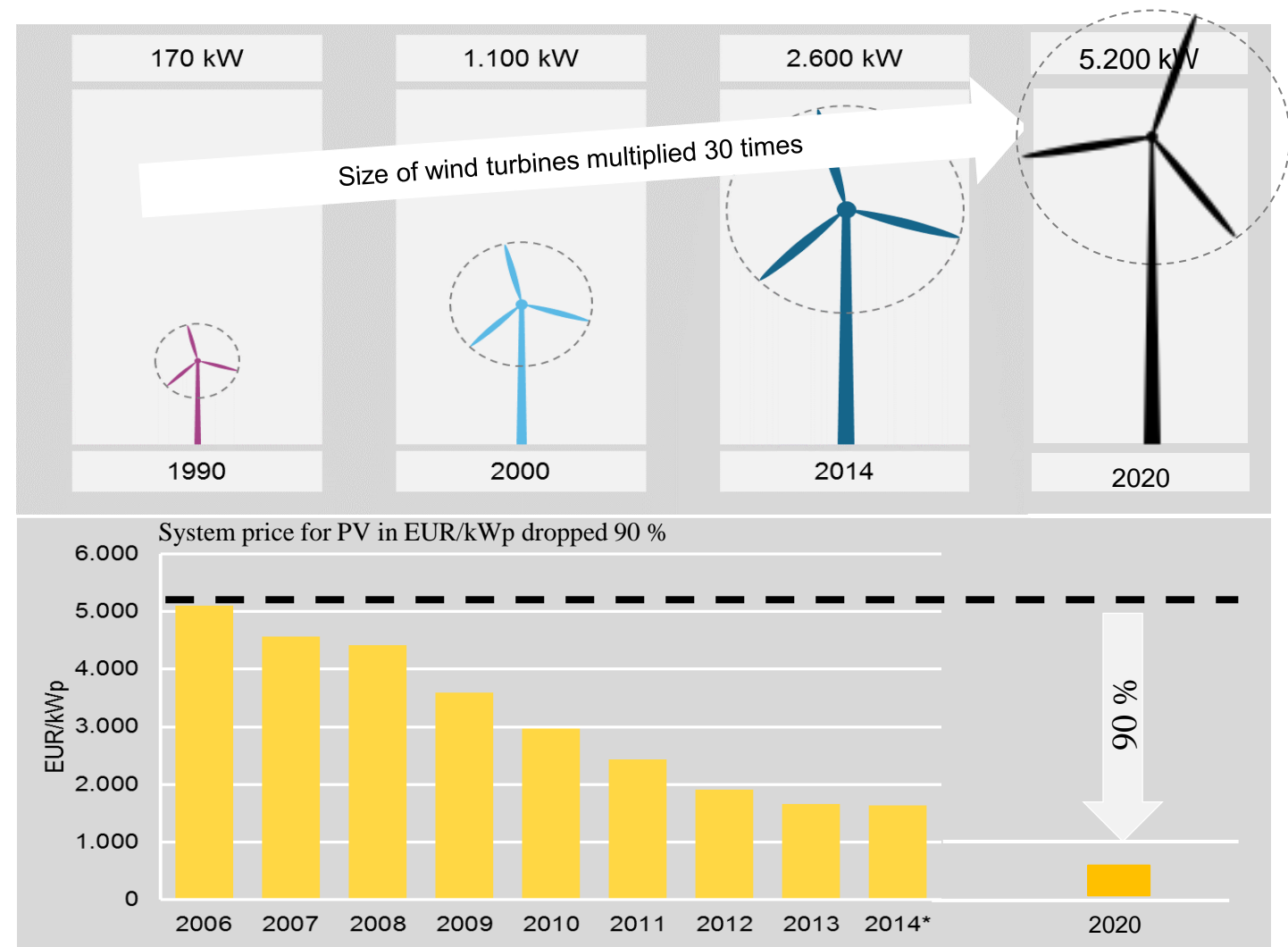
# Why we are here?

Energiewende is one necessary step to stop climate overheating. We are able to provide emission free energy access to everyone at reasonable cost.



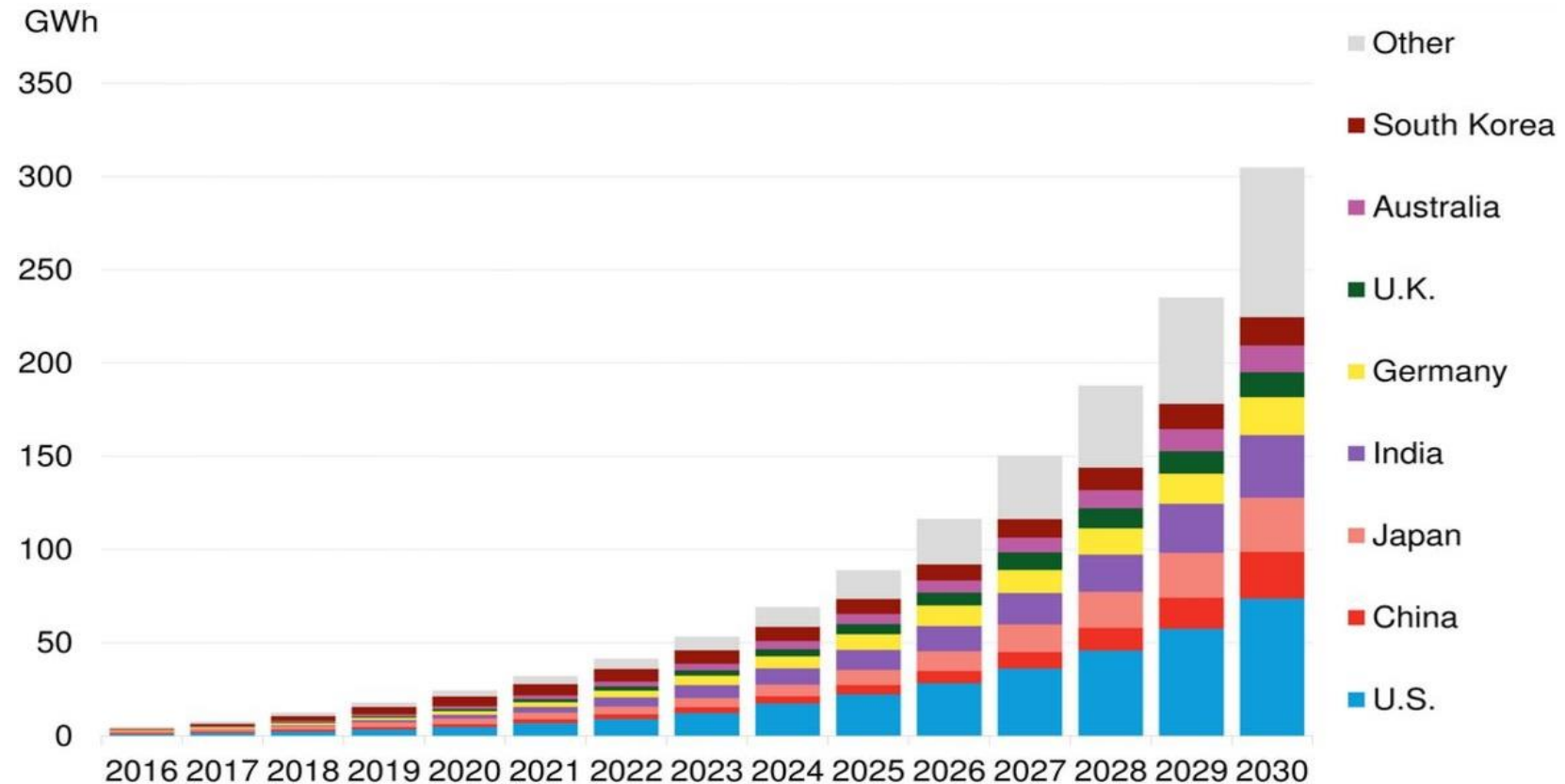
# Cost Reduction of Wind-Power and Photovoltaics

- Due to market size and technical development Wind and PV today are the most cost competitive renewable power sources.
- Price-Experience-Curve-Effects will drive down PV-costs by round 23 % per doubling of world market.
- Levelized Cost Of Electricity generation for PV in Thailand is between 1 to 2 Bath per kWh today.
- Thus PV is cheaper than new nuclear or coal fired power with 2,5 – 5,0 Bath per kWh.



# The Energy Storage Market Development

- The global energy storage market will double six times between 2016 and 2030
- Rising to a total of 125 GW and 305 GWh in 2030



Facilitator:

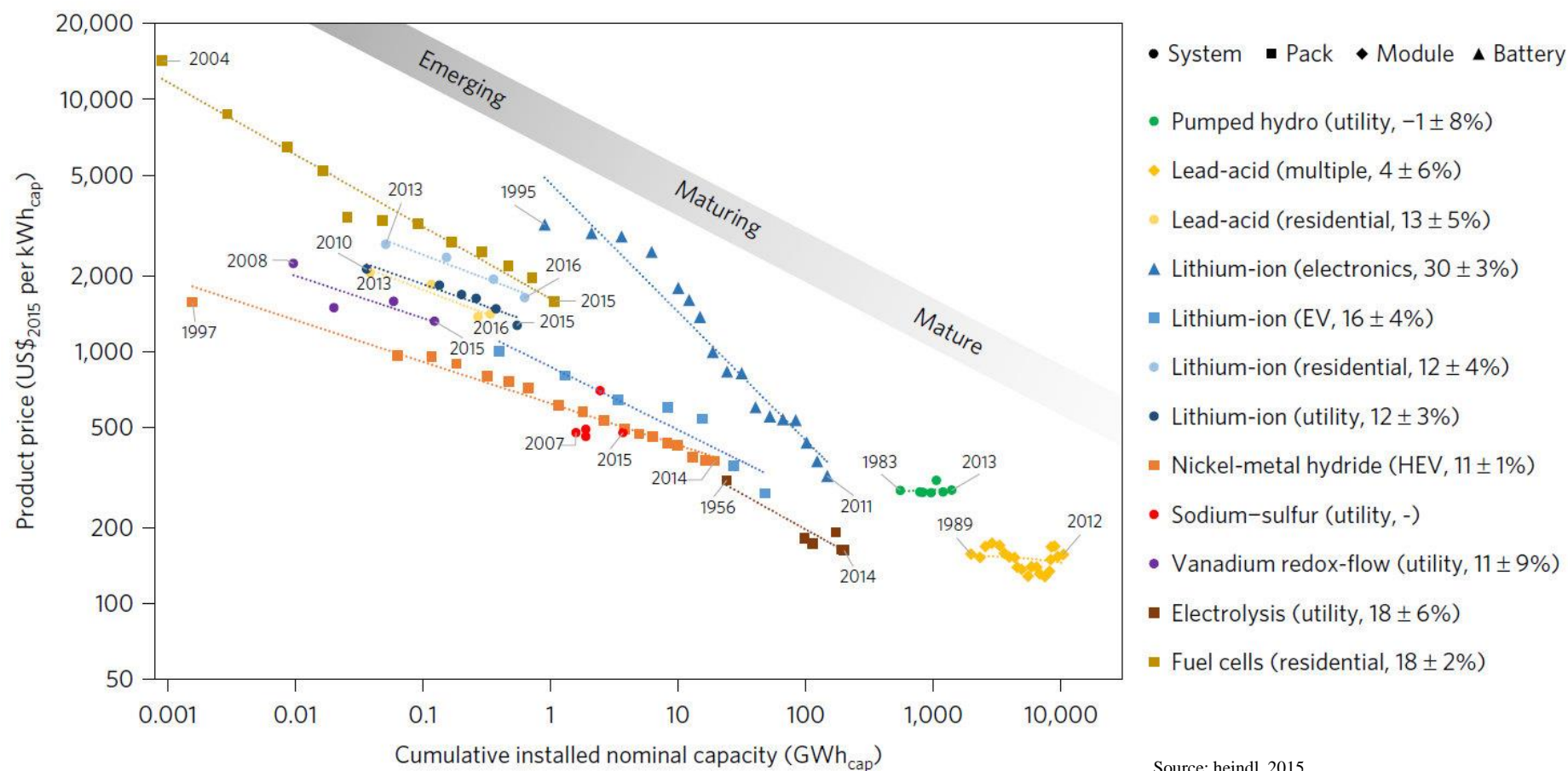


Source: Bloomberg New Energy Finance, 2018



# Cost Curve of Storage Technologies

Market growth translated with the cost curve lead to storage TCO at 0,15 - 0,10 EUR/kWh in 2020



Source: heindl, 2015

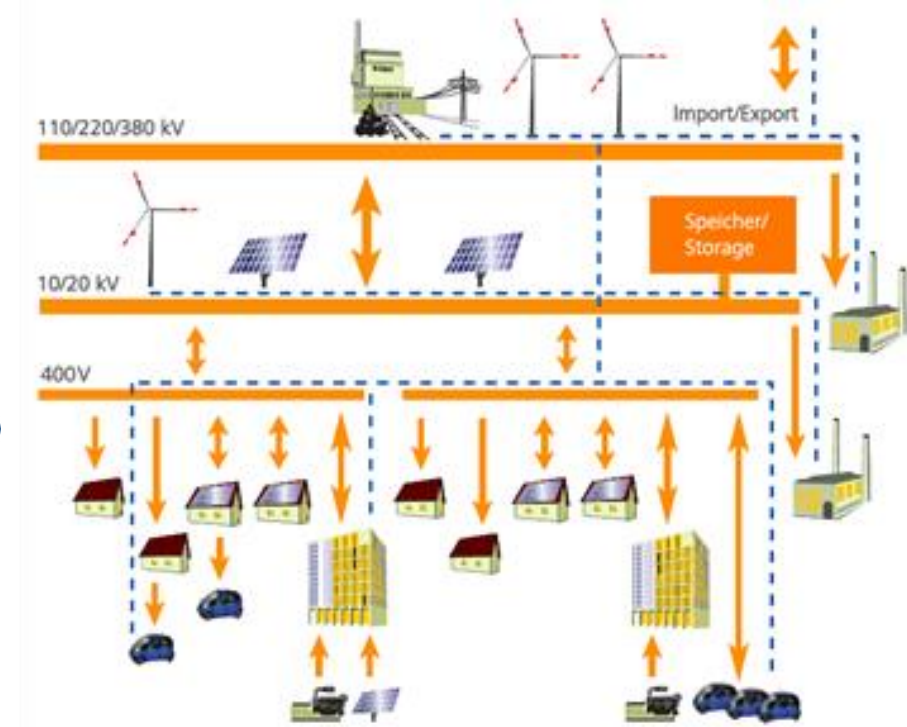
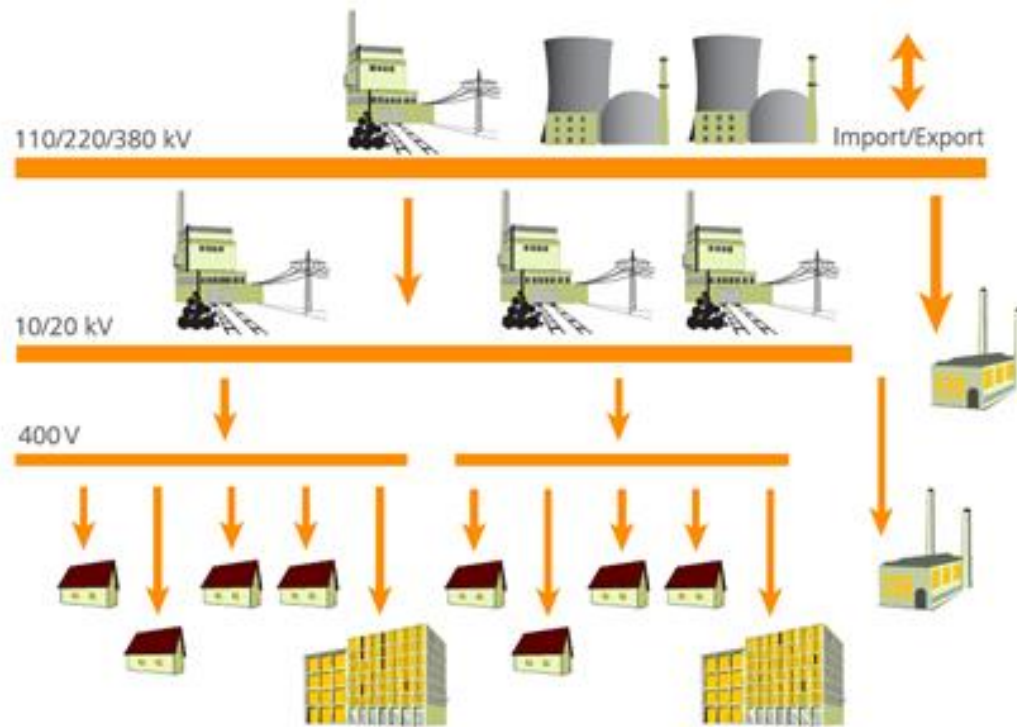
# The Future of Infrastructure





# The Energy Transition

Distributed energy generation and consumption turns the grid upside down and terminates the one-way-street.



# Layers of a Common Grid

## High Voltage Level

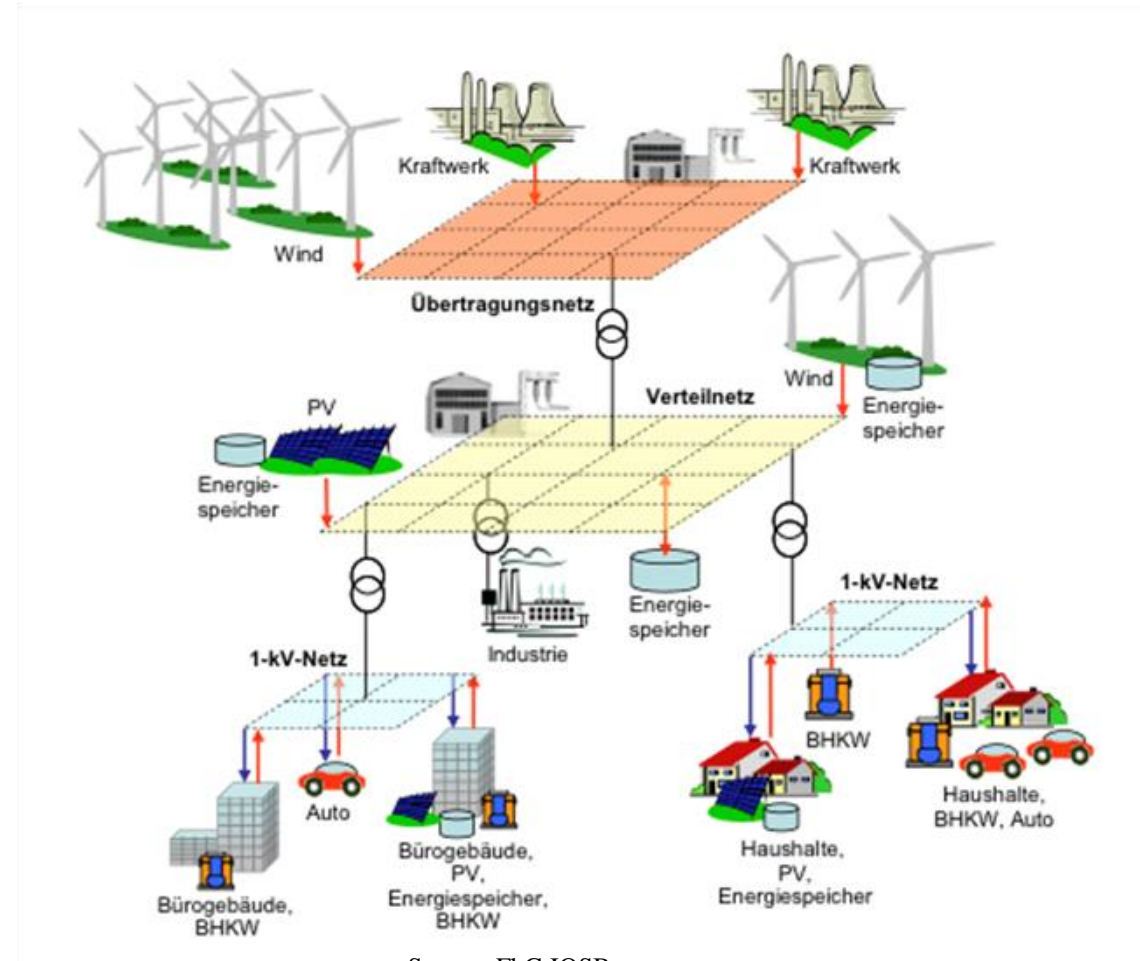
- Transmission Lines

## Medium Voltage Level

- Distribution System

## Low Voltage Level

- Local Connection Points



Source: FhG IOSB

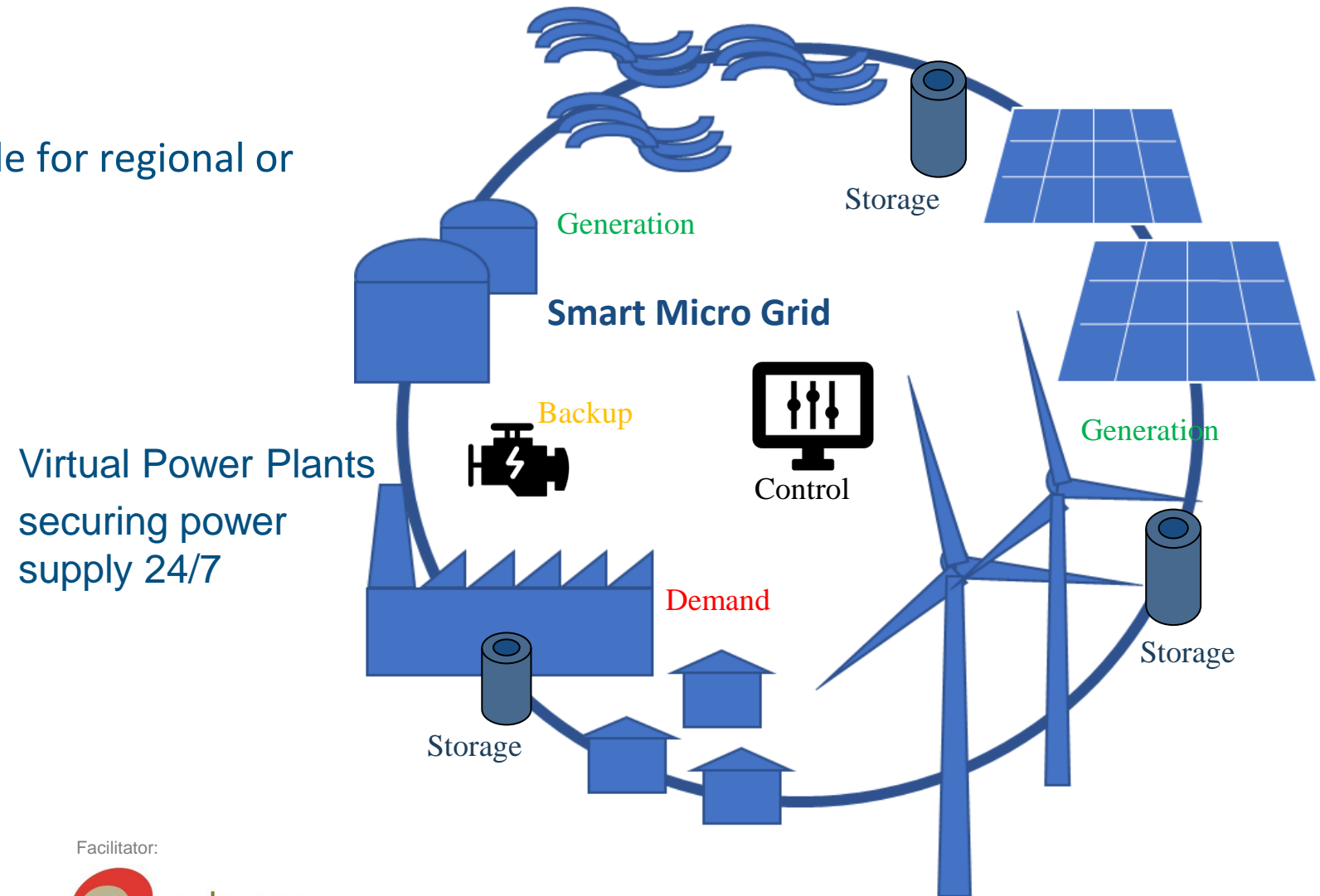


# Smart Electricity Grids



# Components of a Smart Micro Grid

- Smart Micro Grids are suitable for regional or local power supply
    - Mining
    - Industrial Zones
    - Harbours
    - Plantations
    - Factories
    - Airports
    - Hotel-Resorts
    - Remote Villages
- Virtual Power Plant  
securing power  
supply 24/7

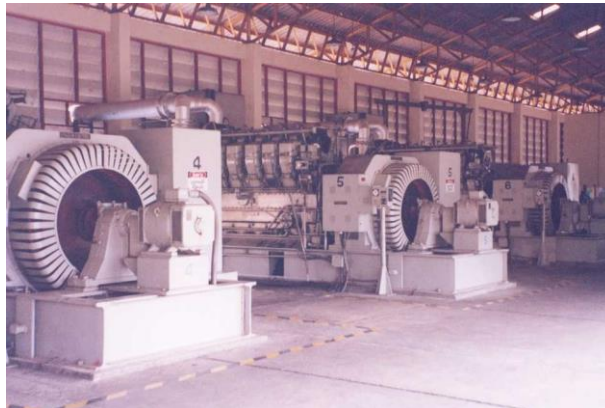




# EGAT Smart Grid Project - Mae Hong Son

Phase I accomplished by RWE Solutions in 2004

- 500 kW RWE Schott Solar PV Panels
- 1800 kW Diesel-Generators from the 1950ies
- 3 MWh Battery Storage Hoppeke
- Central Control Centre RWE Solutions
- 22 kV Distribution Grid



# Micro Grids for Wind and PV



Micro grids usually are disconnected to the public grid.

Purpose: Autonomous Energy Supply

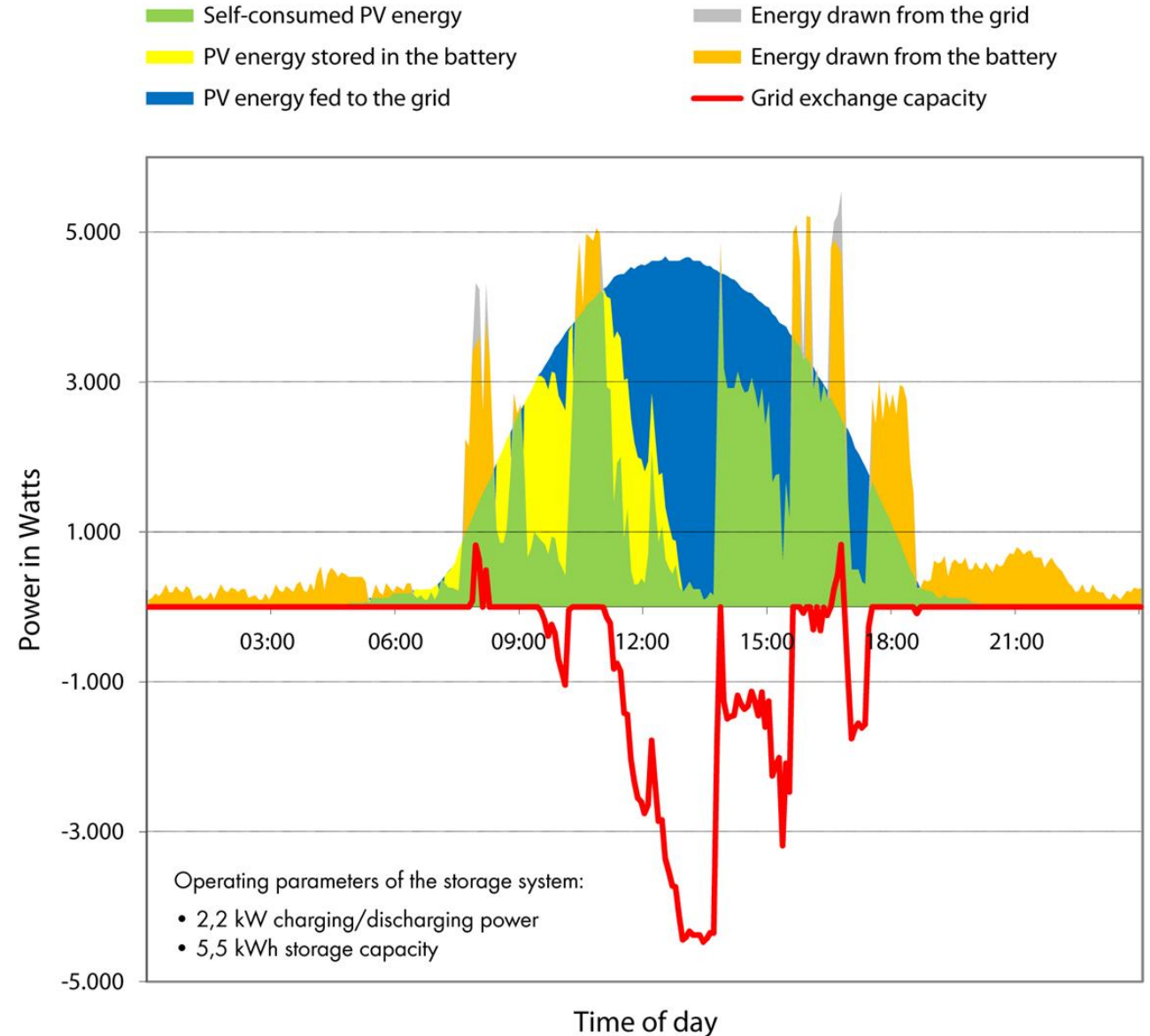
Source: SMA Solar Technology AG

Facilitator:



# Volatility and Flexibility

- Wind and Solar generation depend on weather conditions
- Demand and Supply must meet exactly round the clock
- Flexibility is the new currency in future electricity systems
- Good forecast is key to maintain the system efficiently



# The Future of Smart Micro-Grids are Smart Cities

- In the last five years only Berlin Grid connected over 300 new micro grids into the public grid



Facilitator:



Source: Solar Micro Grid, 2018



# Conclusion

- 
1. Wind and Sun are the Future Energy Sources
  2. Micro Grids Secure Energy Supply 24/7
  3. Flexibility and Smart Control are the Future of Infrastructure

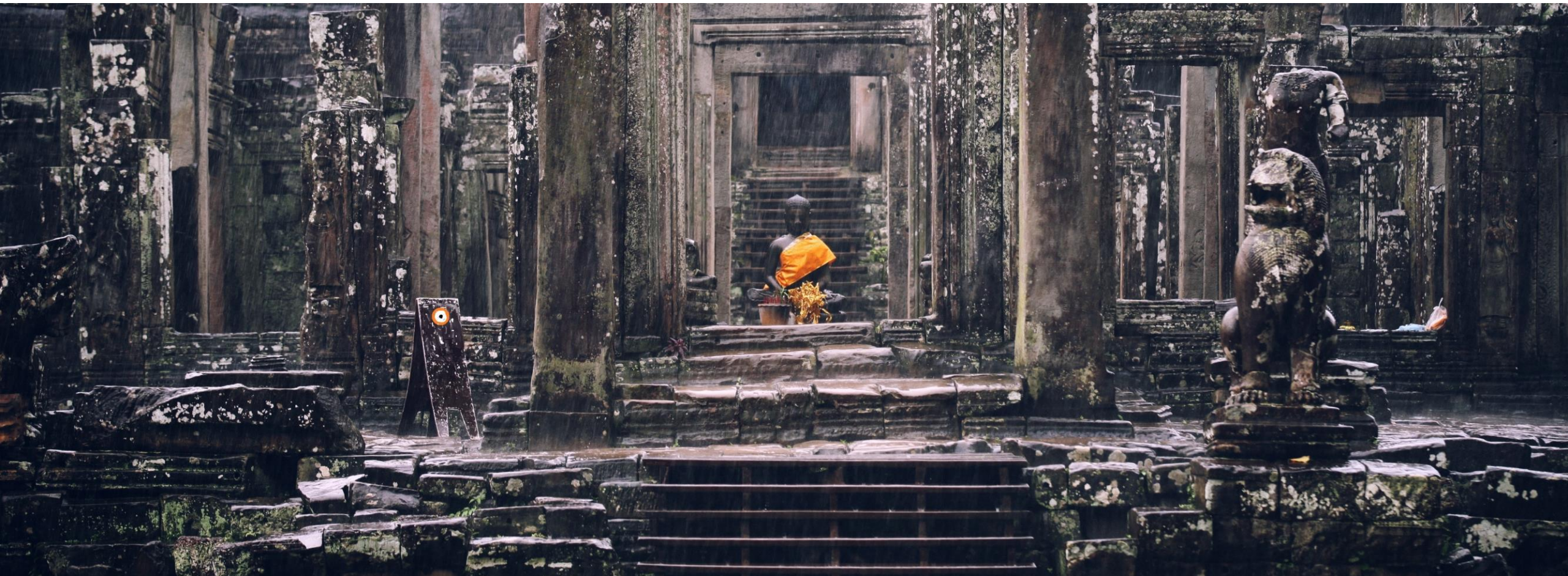


Thank you very much for listening!





# Backup





# Traffic Light System

## **GREEN (market phase)**

- flexibility is offered by sales/ aggregators for market and system oriented portfolio optimization and for balancing

## **YELLOW (phase of interaction)**

- flexibility is requested by distribution system operator on a contractual basis to avoid economic inefficient grid expansion

## **RED (secure phase)**

- flexibility is controlled by distribution system operator also without contractual basis to preserve a secure grid operation





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# Why not just stay with the grid?

Keeping the lights on during a power outage is usually the selling point of a micro grid.

- **Ten value streams** for power grids that can be delivered by micro grids.
- Grid-tied micro grids have much more to offer than resiliency, **especially micro grids with battery banks.**
- These services offer real value, can be stacked, and could flip the economics in favor of micro grids.



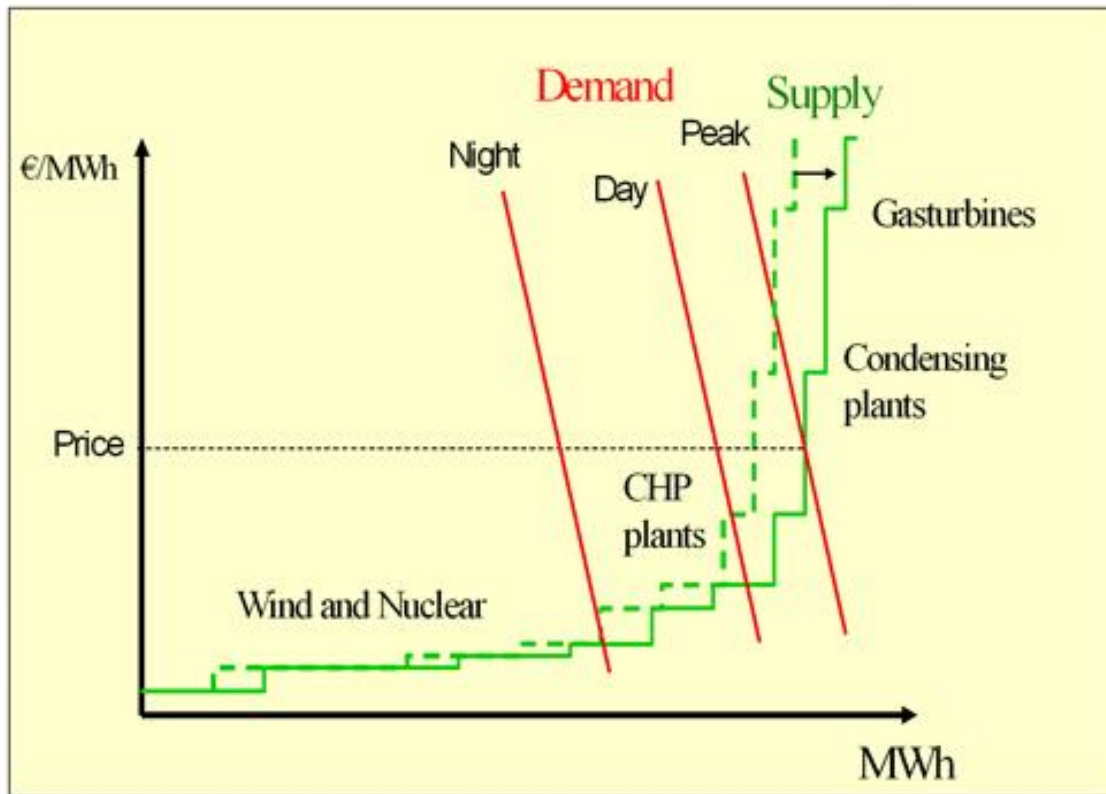


# Value Streams for connected Micro Grids

1. Energy Arbitrage
2. Frequency Regulation
3. Spin/Non-Spin Reserves
4. Black Start
5. Resource Adequacy
6. Distribution Deferral
7. Transmission Congestion Relief
8. Transmission Deferral
9. Increased Self-Consumption
10. Backup Power



# 1. Energy Arbitrage – Buy Low, Sell High



The wholesale cost of energy is increasingly volatile. Micro grid battery systems can exploit this by loading up when cheap energy is available.

During peak periods, grid operators pay power generators a premium to meet increased demand.

## ***BARRIERS:***

Microgrids don't always have access to wholesale markets.

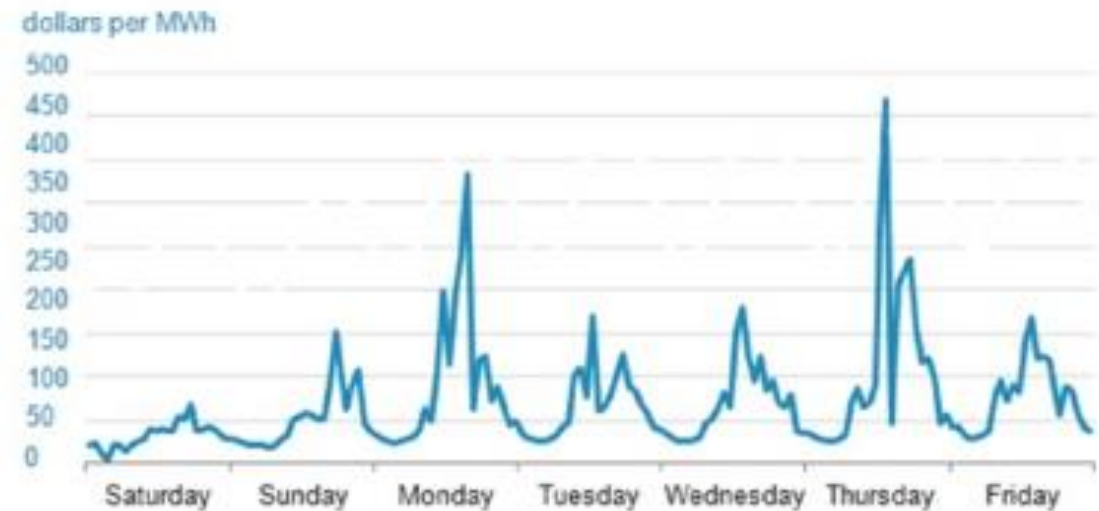


## 2. Frequency Regulation – Maintain Balance

The grid requires power supply to be perfectly aligned with demand at all times. This requires a generation source with an immediate and automatic power response to changes to demand on a moment-to-moment basis.

Frequency regulation maintains the quality and reliability of the grid.

**Figure G: Real Times electricity prices in the PJM Interconnection**  
Saturday, July 13-Friday, July 19 2013

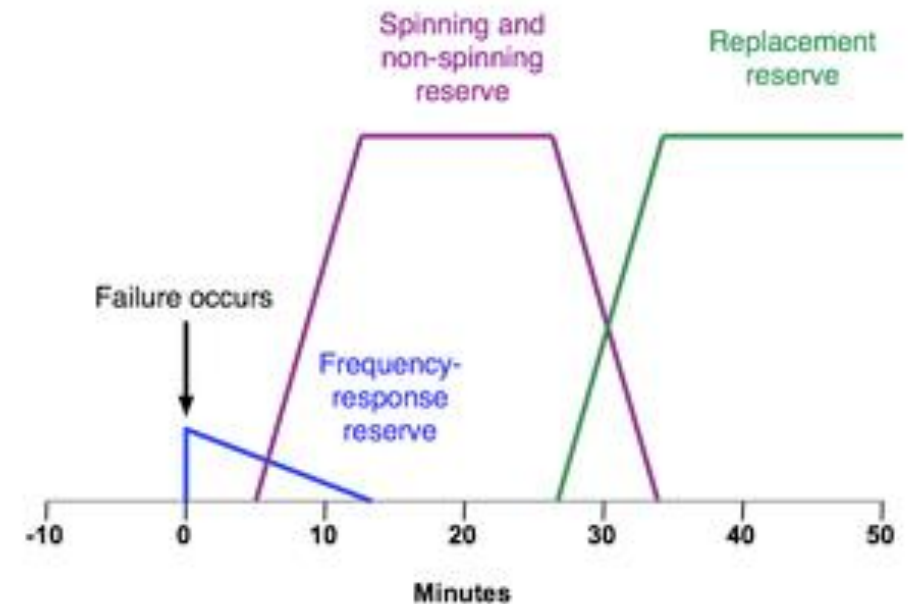


### 3. Spin/Non-Spin Reserves – Plan for the unexpected

Grid operators know that power generators will occasionally fail, so they prepare with backup generators that are ready to go. Spinning reserves are ready to go immediately while non-spinning reserves require a short period of time. In addition to extra battery capacity, a micro grid may have a backup generator that can serve this role.

#### ***BARRIERS:***

Participating here could limit the micro grids ability to perform its primary function of maintaining power during a grid failure. Non-spinning reserves may be needed when the microgrid needs to ‘island.’



## 4. Black Start – It takes electricity to make electricity



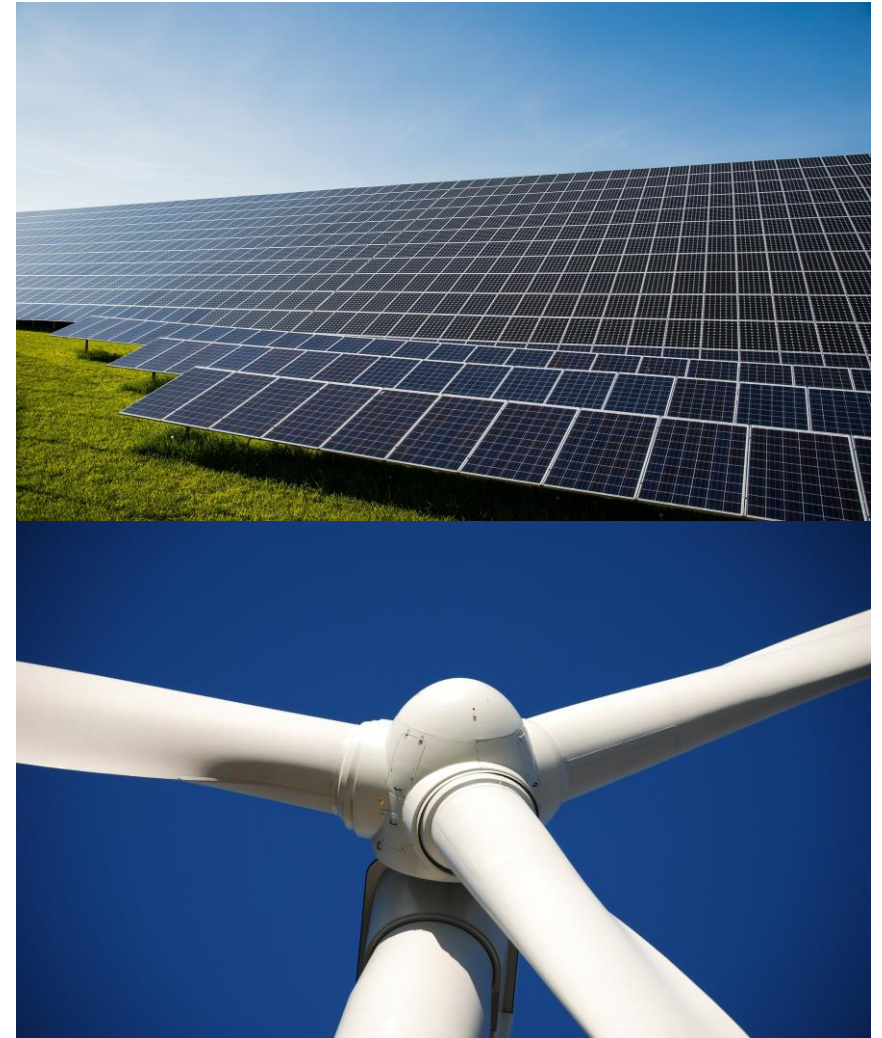
Microgrids can be valuable for helping the bulk grid restore power after a power outage. After shutting down, most large generators need outside electricity to restore their operations. Microgrids can use excess capacity, or temporarily dedicate everything for that purpose.



# 5. Resource Adequacy

## Utility Service

Microgrids can be built in areas where the grid is having trouble meeting demand. Instead of investing in more large scale generators, it may be beneficial to reduce demand by putting certain areas on their own micro grids.



## 6. Distribution Deferral

### Utility Service

Microgrids that contain distributed resources such as solar PV, micro turbines or battery storage can delay and eliminate the need for upgrading distribution assets.



Source: pro video / Vattenfall



# 7. Transmission Congestion Relief

## Utility Service

Grid operators may charge high fees to utilities for using congested transmission corridors during certain times of the day. Microgrids deployed downstream of the corridor and potentially supply additional power to the grid during those periods.



Source: Stadtwerke Nürtingen

# 8. Transmission Deferral

## Utility Service

Congested transmission corridors can delay or eliminate the need for upgrades by deploying micro grids at strategic locations downstream of the congestion.

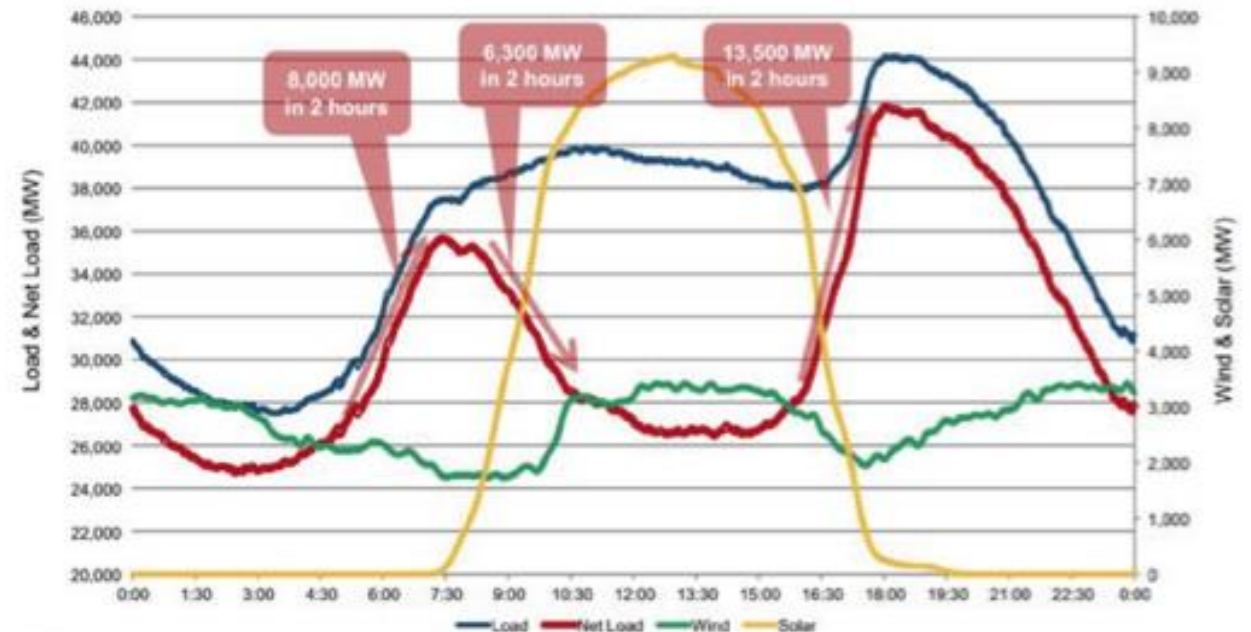


# 9. Increased PV Self-Consumption

## Customer Services

When penetration levels rise, the value of solar energy decreases to the grid. Micro grids can fully utilize solar PV with an appropriately sized battery bank. In fact, solar PV with an adequate battery bank alone is able to participate in nearly every potential value stream.

Figure E: CAISO Load, Wind & Solar Profiles - high Load Case  
January 2020





# 10. Backup Power

## Community Service

Keeping the lights on during power outages is usually the primary purpose for having a microgrid. Keeping businesses open, hospitals running, and critical infrastructure maintained during power outages has tremendous economic and social value.



# Regulatory barriers

There are many regulatory barriers that could prevent micro grids from providing their potential value.

- The biggest impediment is that batteries are often not given an equal playing field with large central generators.
- Additionally, if an asset provides value to multiple stakeholders, regulation currently makes it difficult or impossible for the utility to be compensated.

Regulations often make it difficult or impossible for a utility to collect revenue from a behind-the-meter energy storage asset. Micro grid value is determined on regulation allowing fair access to markets.



# Thank you very much!

