Smart Micro Grids and Cellular Grids

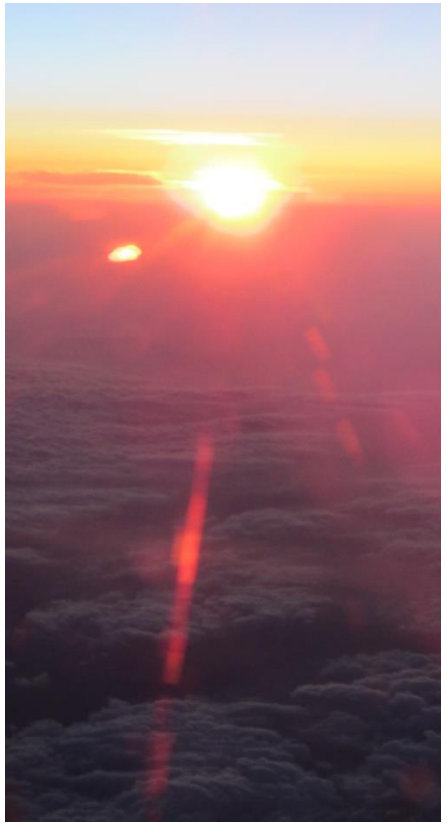
Presentation at “Sustainable Places 2016”

Anglet, 30.06.2016

Dr. Thomas Walter

SUSTAINABLE PLACES 2016
June 29-July 1, 2016
Anglet, France

Easy Smart Grid GmbH



„Leapfrogging“: Future is not the extrapolation of the past

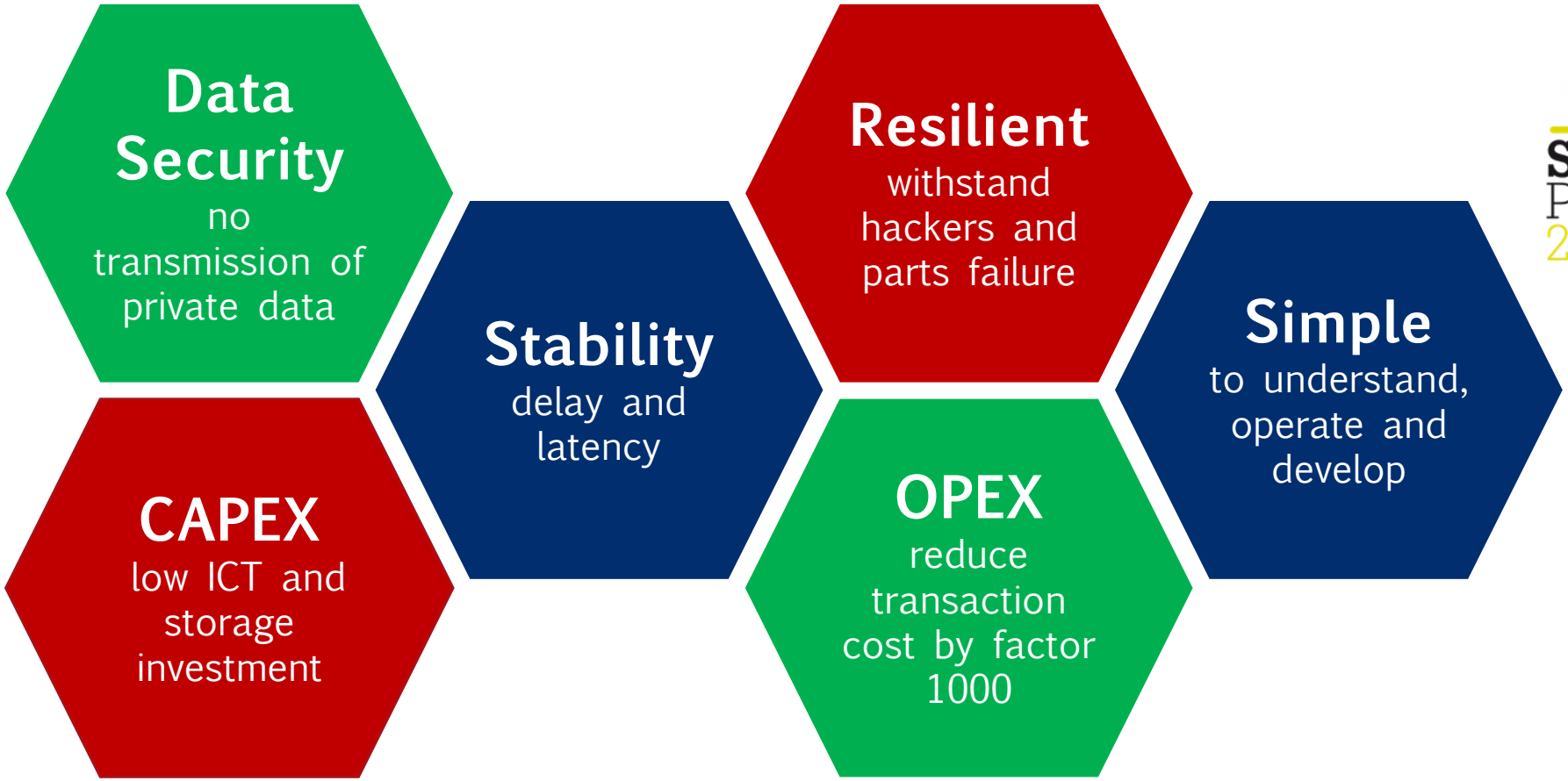
- Everybody expects a disruptive transformation of the energy system.
- A „jump“, not a „step“ to the next generation.
- Where this happened recently:
  - Cisco leapfrogged Siemens/Alcatel
    Analogue voice => Digital data
  - Apple leapfrogged Nokia
    Mobile phone => Smartphone

Source: Blog Prof. Wettengl: wettengl.info/Blog/?p=5072, Download 21.08.2015, Bullet points by Thomas Walter

Requirements are clear:
We need to improve on existing “SG 1.0”

Easy Smart Grid GmbH

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

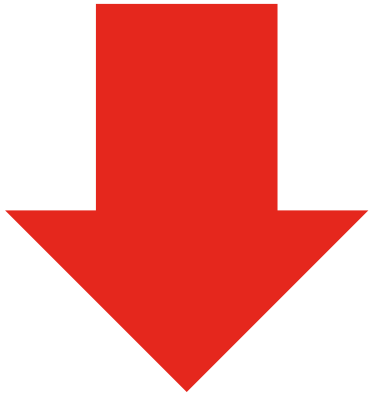


Challenge Flexibility
Why we need paradigm change

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

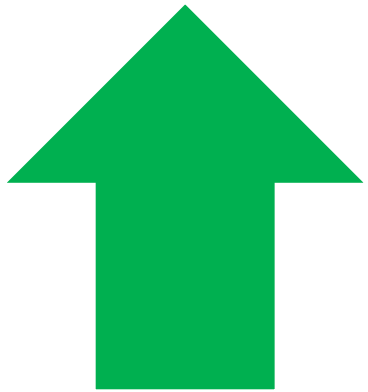
Easy Smart Grid GmbH

- Today: Central supply of **Energy** and **Flexibility**.
- Photovoltaics and wind provide **Energy**, but not **Flexibility**.
- System transformation requires **new Flexibility Sources**.
- Paradigm Change needed: **Consumption follows Production**



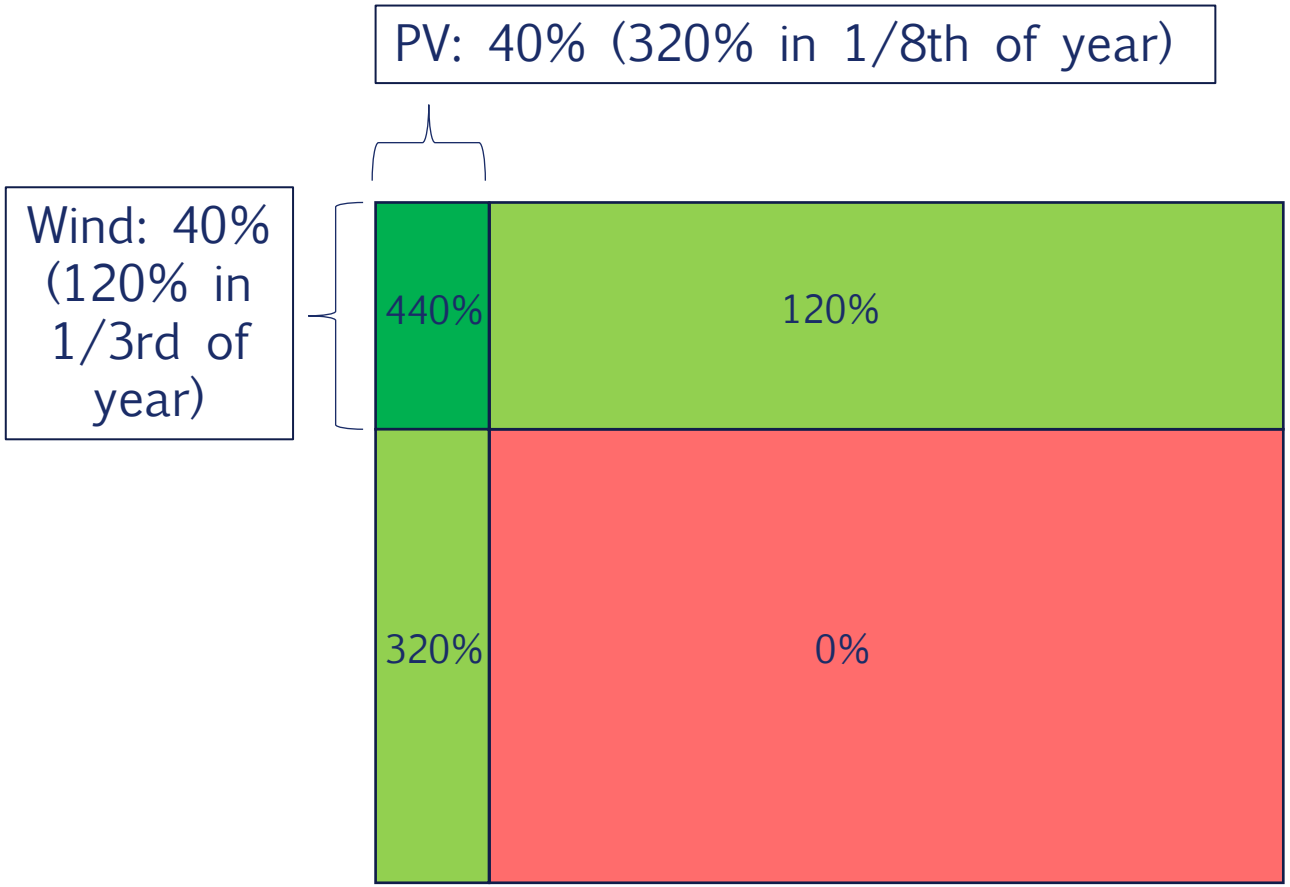
Less Fossils to balance Volatility

More Renewables, more Volatility



Challenge Flexibility
Expected Situation (K-V-Diagram)

Germany 2050: Wind and PV supply 40% each



- PV and wind are volatile.
  Annual production (8,740 hrs):

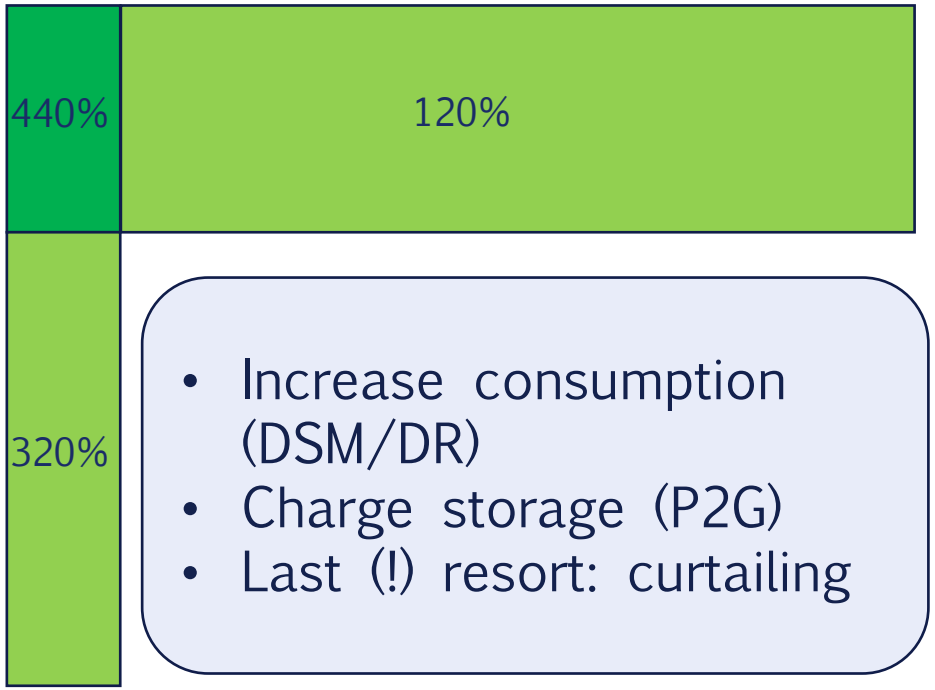
  PV ~1,100 hrs
  Wind ~3,000 hrs
- Challenge #1:
  Motivate Flexibility
  => Market design
- Challenge #2:
  Activate Flexibility
  => ICT Implementation

Challenge Flexibility
System with two states

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

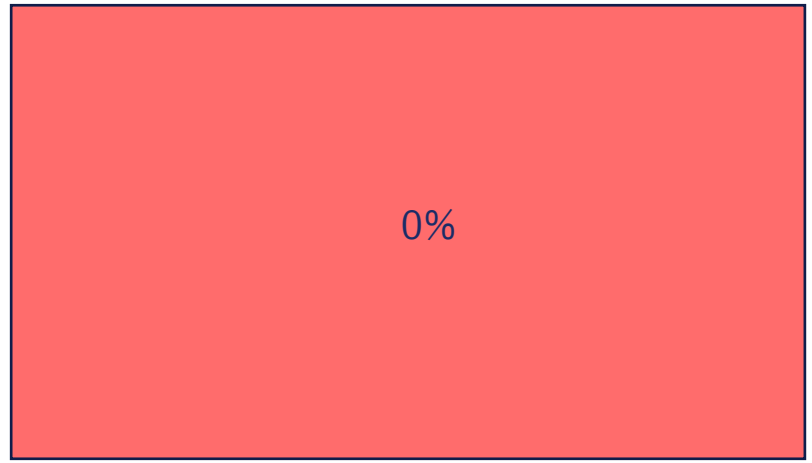
Too much wind or sun -> low price
80% of energy, 42% of time



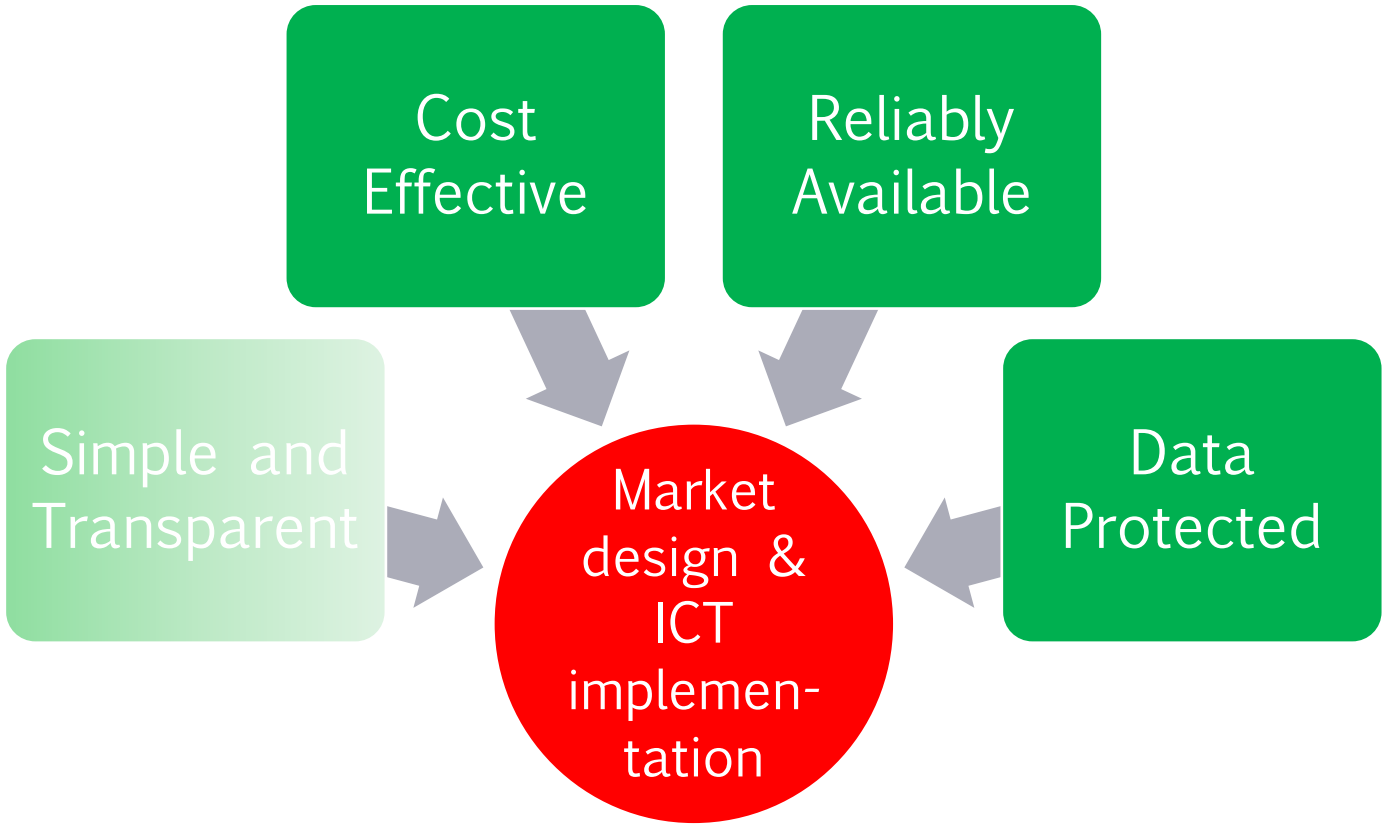
- Increase consumption (DSM/DR)
- Charge storage (P2G)
- Last (!) resort: curtailing

Too little wind or -> high price
20% of energy, 58% of time

- Reduce consumption (DSM)
- Use bio or synfuels
- Discharge storage



Customer Needs
What do customers want?



Customer Needs: Transparent Market?

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

Five Time Variable Cost/Price Elements

- Day Ahead Trade
- Intra Day (Spot) Trade
- Tertiary Control Power
- Secondary Control Power
- Primary Control Power

Integrated Real Time Market

=> Four Entry Barriers to Flexibility Market

- Product Fragmentation & Fit
- Minimum Required Quantity
- Availability over Period
- Pre-Qualification

All Entry Barriers Removed

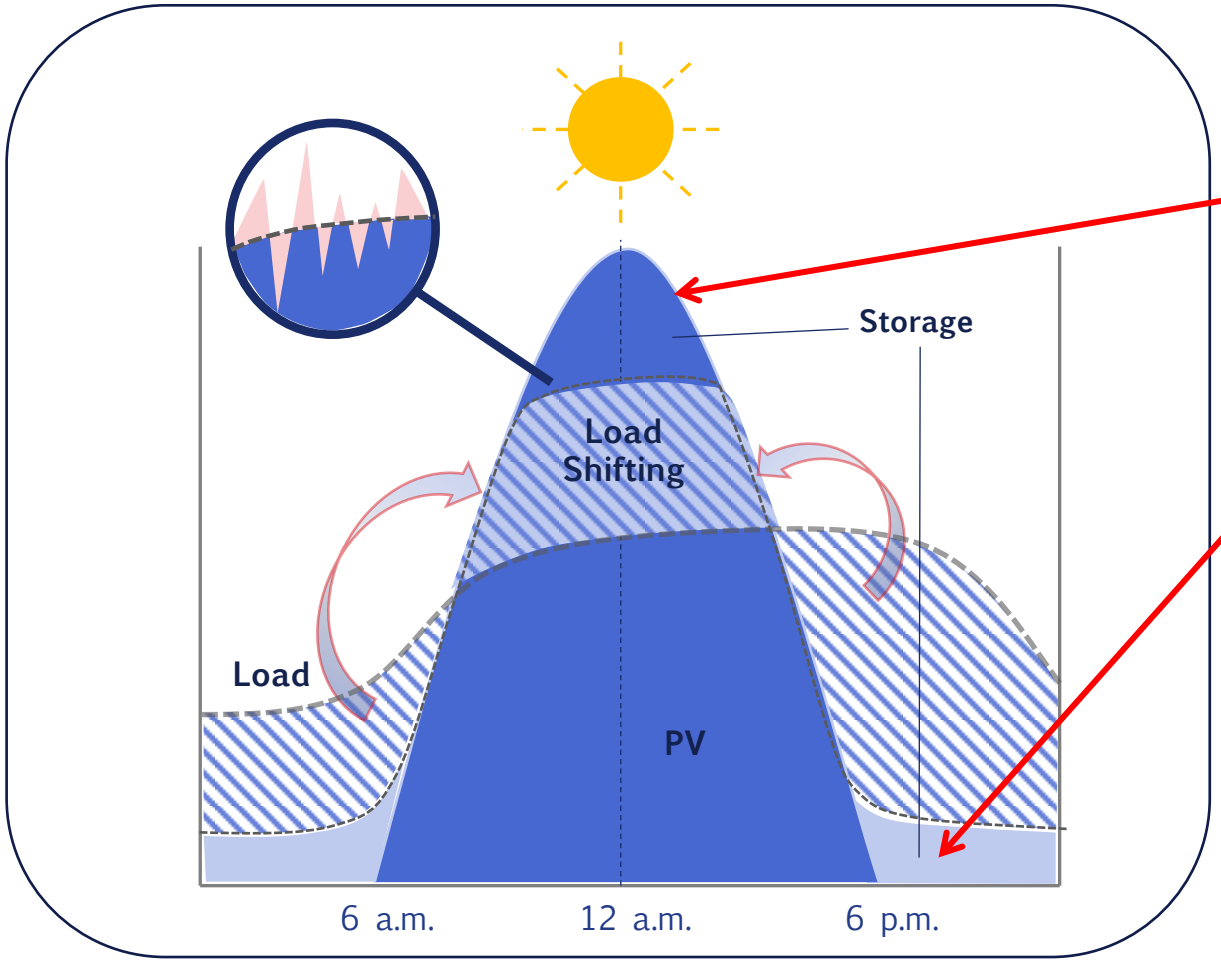
Changing Markets
Island grids transform fast

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

- Potential diesel replacement:
  > **50 GW**, equivalent to
  > **100,000,000,000 $/a**
- PV saves **0.2 $/kWh when** replacing diesel.
- **High DSM potential reduces storage investment**:
  Heating/cooling, pumps, desalination, electro mobility.
- Picture shows PV potential. Similar opportunities for wind

Demand Side Management: The cheapest Battery



Benefits:

- **Use more Renewables:** Absorb peaks, don't curtail them
- **Pay less:** For fossil energy and storage
- **Easy Smart Grid:** Coordinate DSM, flexible generation and storage

Smart Cells and Cellular Grids
Time and Place affect Price

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

Weather (local)
- Determines generation cost
- Price reflects local generation cost

Local Balancing
- Today via transmission grid
- Local balancing reduces grid extension need

Smart Grid Cells
- Self balancing
- Exchange energy & flexibility
- Islanding if disturbed

Weather (time)
- Determines generation cost
- Price varies over time

Time Shifting
- Compensate volatility
- Use all flexibility for minimum storage cost

Real Time Markets
- Full transparency
- Efficient implementation: Easy Smart Grid

Smart Cells and Cellular Grids

- Germany 2050: 80% of generation weather dependent
- Cell size determined by weather correlation (~60 km Ø)
- 126 grid cells, 635,000 inhabitants each

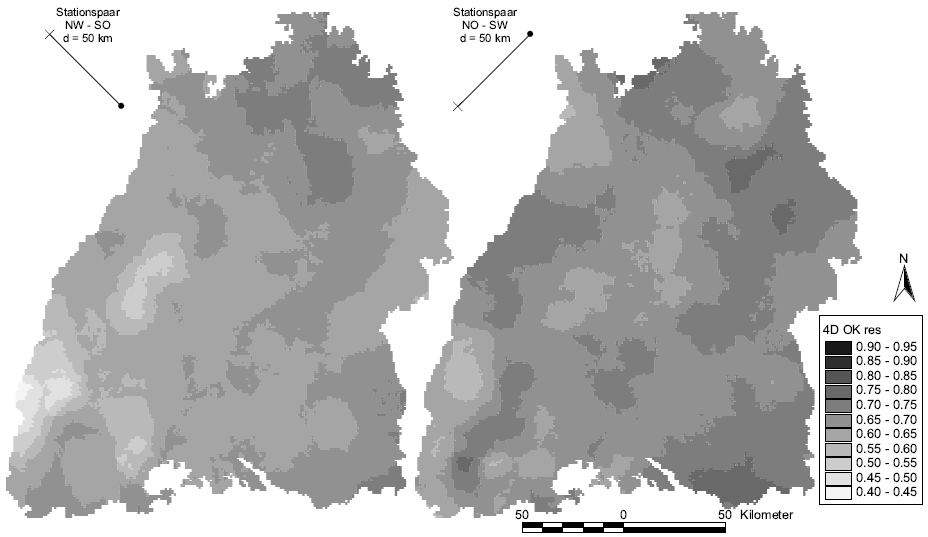


Abbildung 3.7.: Regionalisierte Korrelation zwischen Station und 50 km entfernter Station mit vierdimensionalem Ordinary Kriging der Residuen unter Verwendung eines dreiparametrigen exponentiellen und sphärischen Variogramm (Modell 7 in Tabelle 3.1.

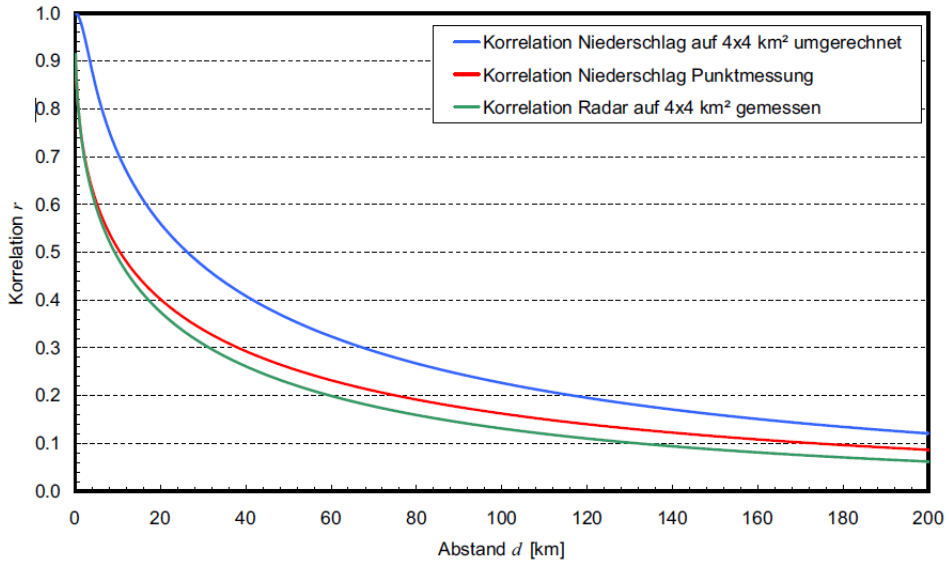


Abbildung 3.12.: Korrelation der Niederschlagspunktmessungen, der Radarmessungen und der auf die Fläche der Radarraster umgerechneten Niederschlagsmessungen.

Source of graphics: Dissertation Jürgen Brommundt, 2008 Institut für Wasserbau Uni Stuttgart, Download 20.08.2015, http://elib.uni-stuttgart.de/opus/volltexte/2008/3470/pdf/Brommundt_170_online.pdf

Smart Cells and Cellular Grids Pioneers: Islands

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

- Gran Canaria (800,000 inhabitants, 55 km Ø)
- Renewables reduce fossil subsidy needs (Spanish Islands: 13 bill €/year)

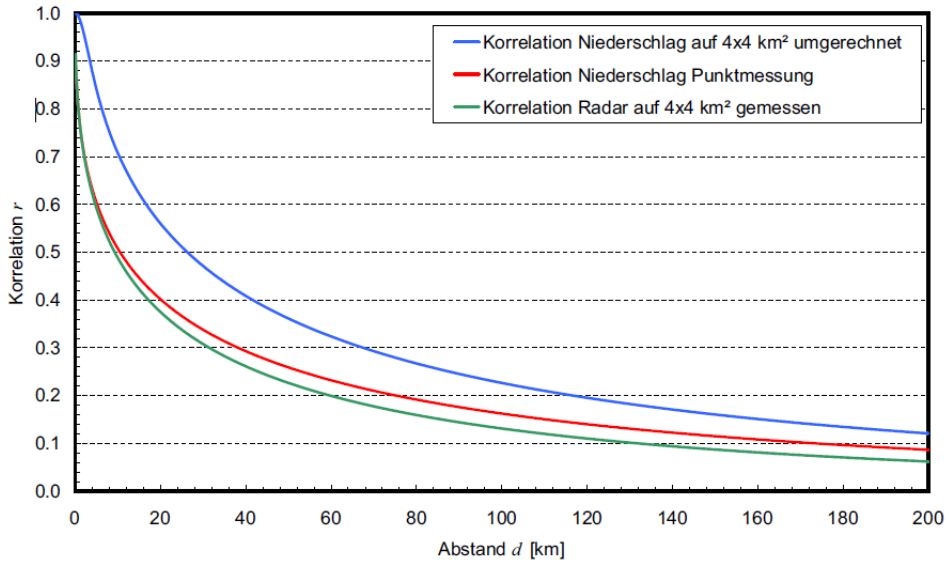


Abbildung 3.12.: Korrelation der Niederschlagspunktmessungen, der Radarmessungen und der auf die Fläche der Radarraster umgerechneten Niederschlagsmessungen.

Source of graphics: Dissertation Jürgen Brommundt, 2008 Institut für Wasserbau Uni Stuttgart, Download 20.08.2015 http://elib.uni-stuttgart.de/opus/volltexte/2008/3470/pdf/Brommundt_170_online.pdf, Google Maps

Smart Cells and Cellular Grid New Roles for Players?

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

Cell/Micro Grid	Neighbours	Transmission Grid

· 0-2.5 GW generation (Avg. power need *4)
· Exchange for energy and flexibility
· System and balancing services Island-/Black Start modes
· Grid and Market integrated (c/f NY „REV“)
	· Energy exchange (Δ Price)
	· Flexibility exchange (Δ Price)
	· Access to Neighbour n+2
	· Special zones: Areas where energy production or consumption dominates
		· „Motorway“ HVDC for Large Area Integration
		· Weaker role in balancing
		· Coupling special zones:
		  · Offshore, „Desertec“
		  · Large Consumers „NRW“ (energy intensive area in Germany)

Smart Cells and Cellular Grids
Balancing by “transactive principle”

Generation < load	*Increase* price until rebalanced
Load < generation	*Reduce* price until rebalanced

Flexible generators	Shift generation to *high price* times
Flexible consumers	Shift consumption to *low price* times
Storage devices	Charge at *low*, discharge at *high* price

Example „ECOGRID“ – A Real Time Market on Bornholm Island/DK

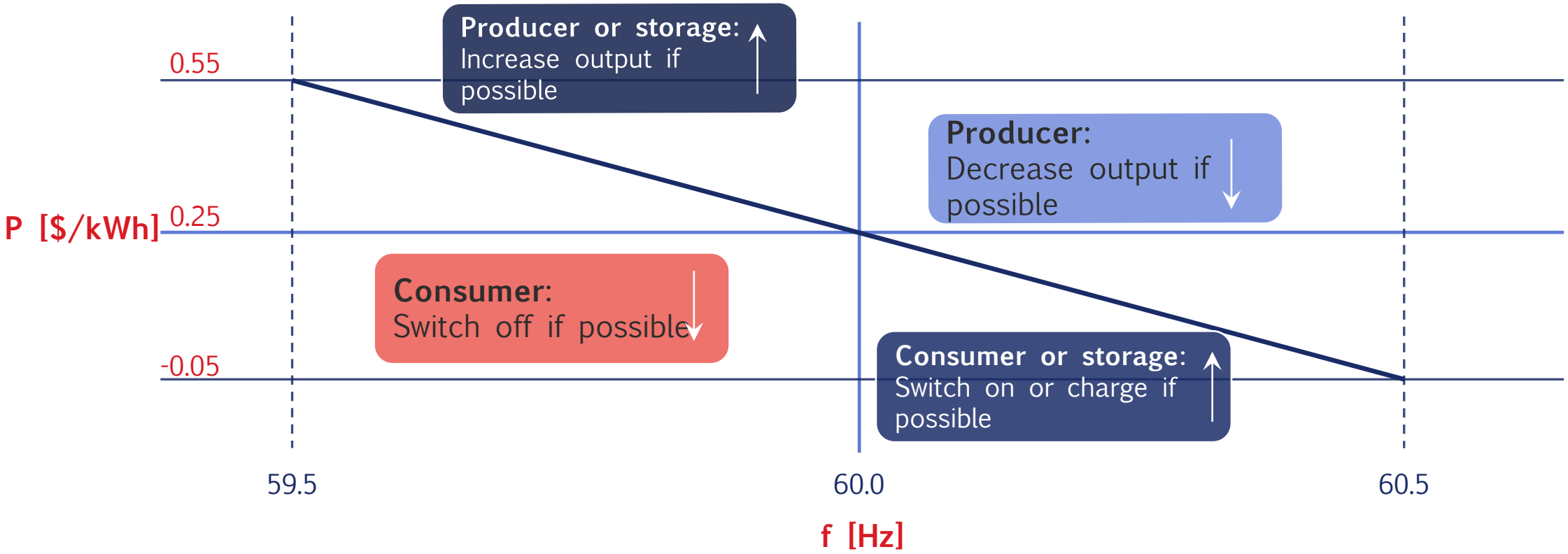
- ICT investment over 10 M€ (collect, process and communicate data)
- CHP (Combined Heat and Power plants) react to price update (5 Min.)

Easy Smart Grid allows Efficient "Transactive" Control

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

1. Fix needed price range, 2. Fix frequency range. 3. Combine



Easy Smart Grid
Focus on value added

SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH

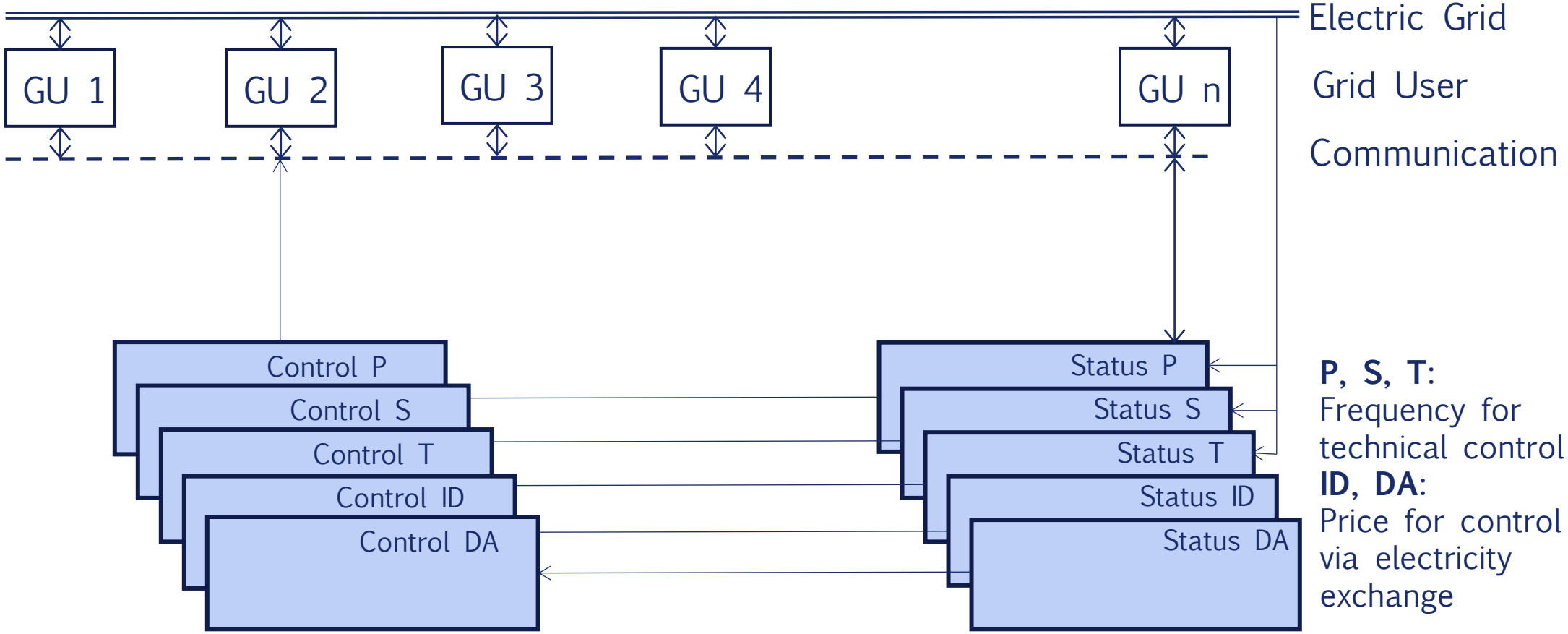
Not needed

- Measure net generation/consumption (AMI)
- Communicate net balance from all grid users (AMI)
- Compute overall balance and price
- Communication and processing latency
- Communication of price to all grid users (AMI)

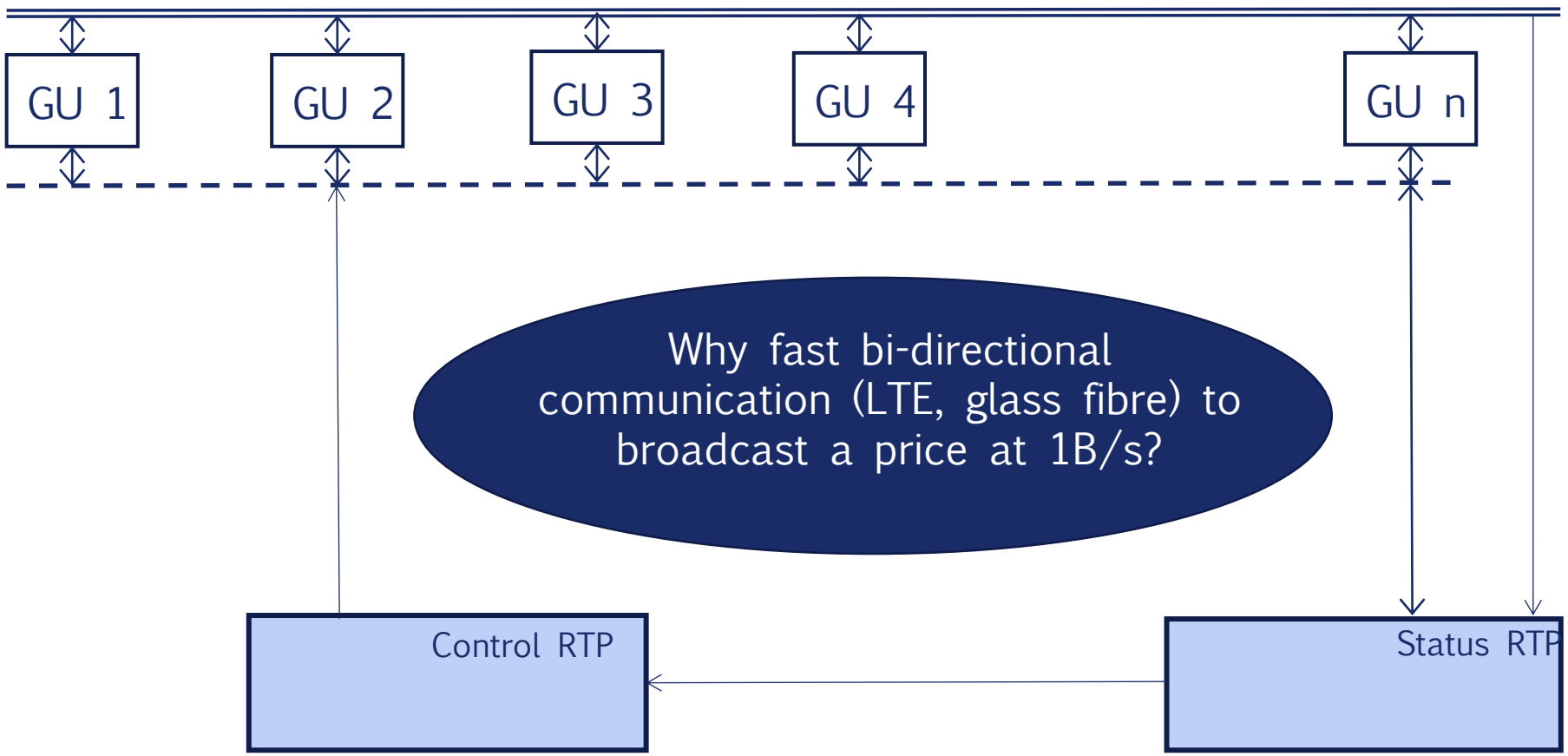
Still needed

- Electricity meter (but no RT communication need)
- Rotating mass (physical and virtual)
- Storage (much less, use customer flexibility instead)
- System supervision (limit to „system critical“ users)

Smart Cells and Cellular Grids
Today: Five parallel Control Loops

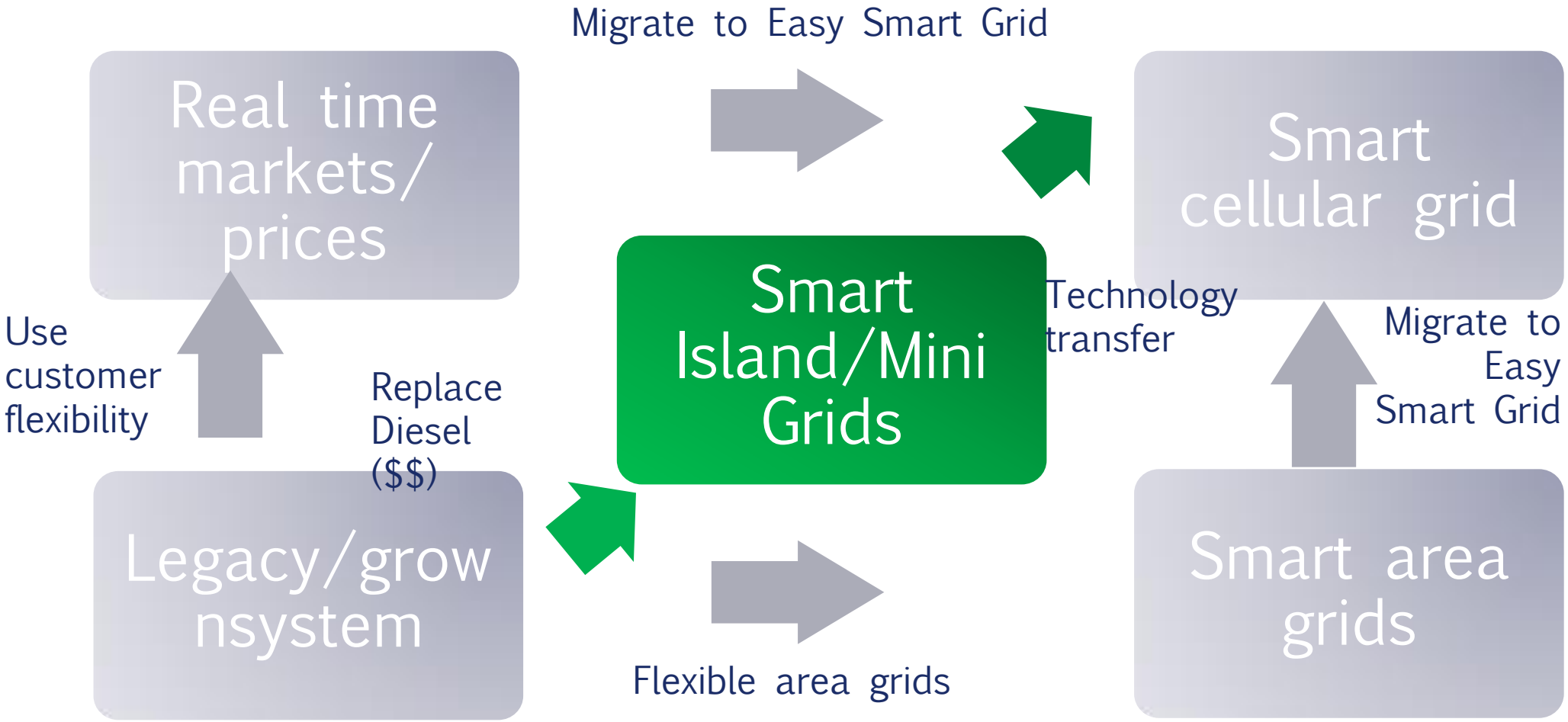


Smart Cells and Cellular Grids
Realtime Market: One control loop



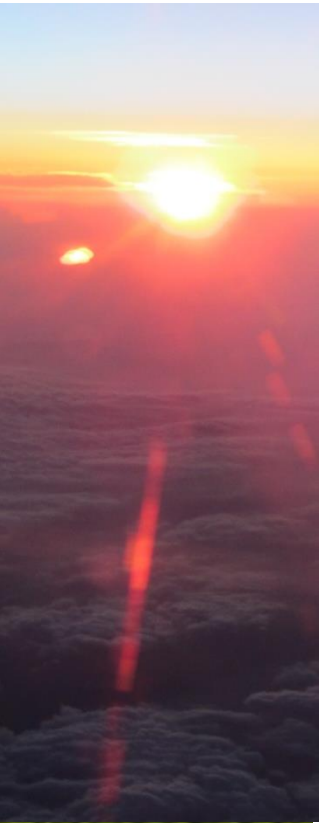
P, S, T, ID, DA: Integrated into Real Time Market
Important: Real Time Prices (RTP) today not „in real time“. Control Power may still be needed?

Smart Cells and Cellular Grids Opportunities of Transformation



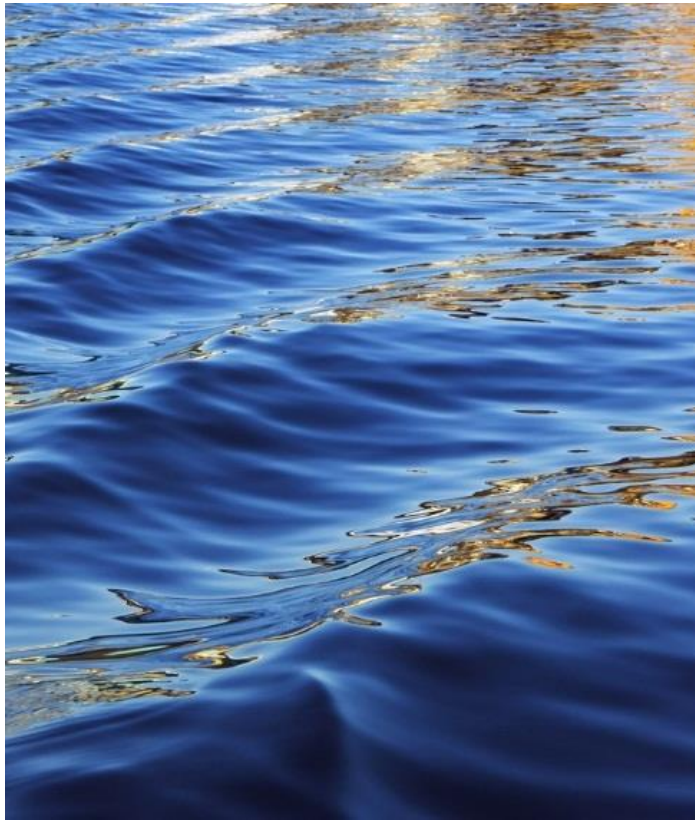
SUSTAINABLE PLACES 2016 June 29-July 1, 2016 Anglet, France

Easy Smart Grid GmbH



Thank you for your interest and questions!

Thomas Walter
Easy Smart Grid GmbH
thomas.walter@easysg.de
+49 171 229 4629
www.easysg.de



Discussion Questions

- What should stop us from implementing real time markets?
- What would be the value of aggregators in a real time market?
- Who would be intested to ensure the energy system works the most efficient way possible?
- Who would be made responsible for (non)performance of a complex IT/Big Data system (e.g. a huge blackout)?