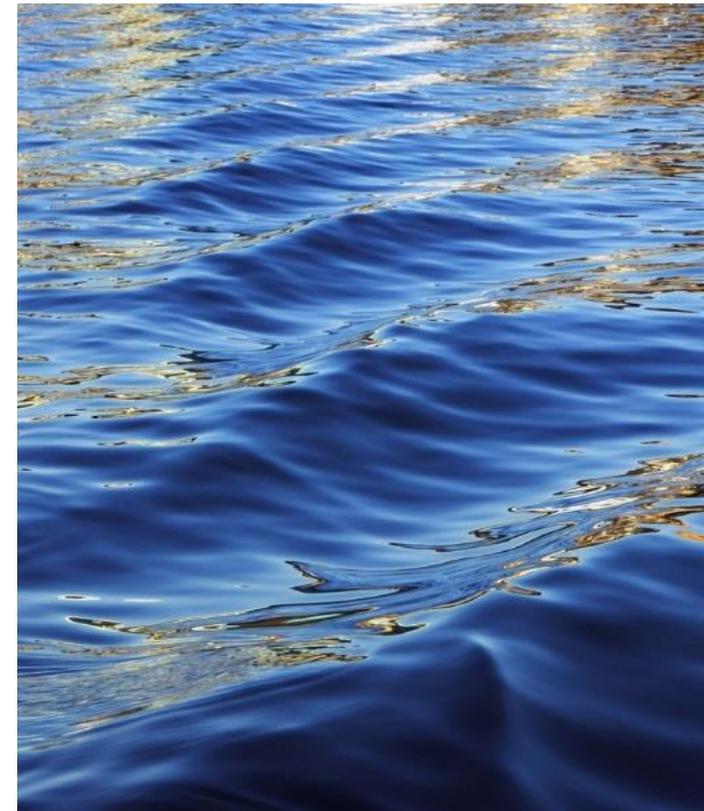
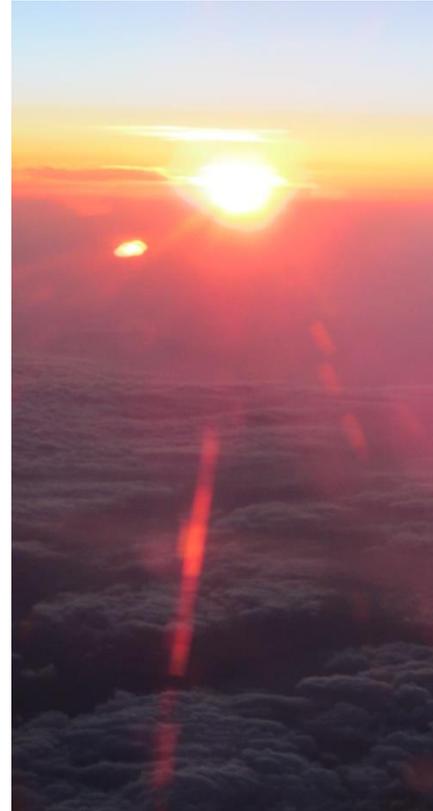




Extending electric grid physics to implement smart grid trading function

„Energy meets Economy“ at DPG Conference 2014
Dresden Apr. 2nd, 2014
Thomas Walter and Bernd Brunner



Agenda

1. New Opportunities and Challenges for Renewable Energies
2. Flexibility and Smart Grid become limiting factor
3. KISS (Keep It Simple and Stupid): „Easy Smart Grid“
4. Conclusion: Integrated view of RE, Storage, Smart Grid

New Opportunities and Challenges for RE

A new perspective: PV is a low cost replacement for Diesel Electricity

Huge Application Area:

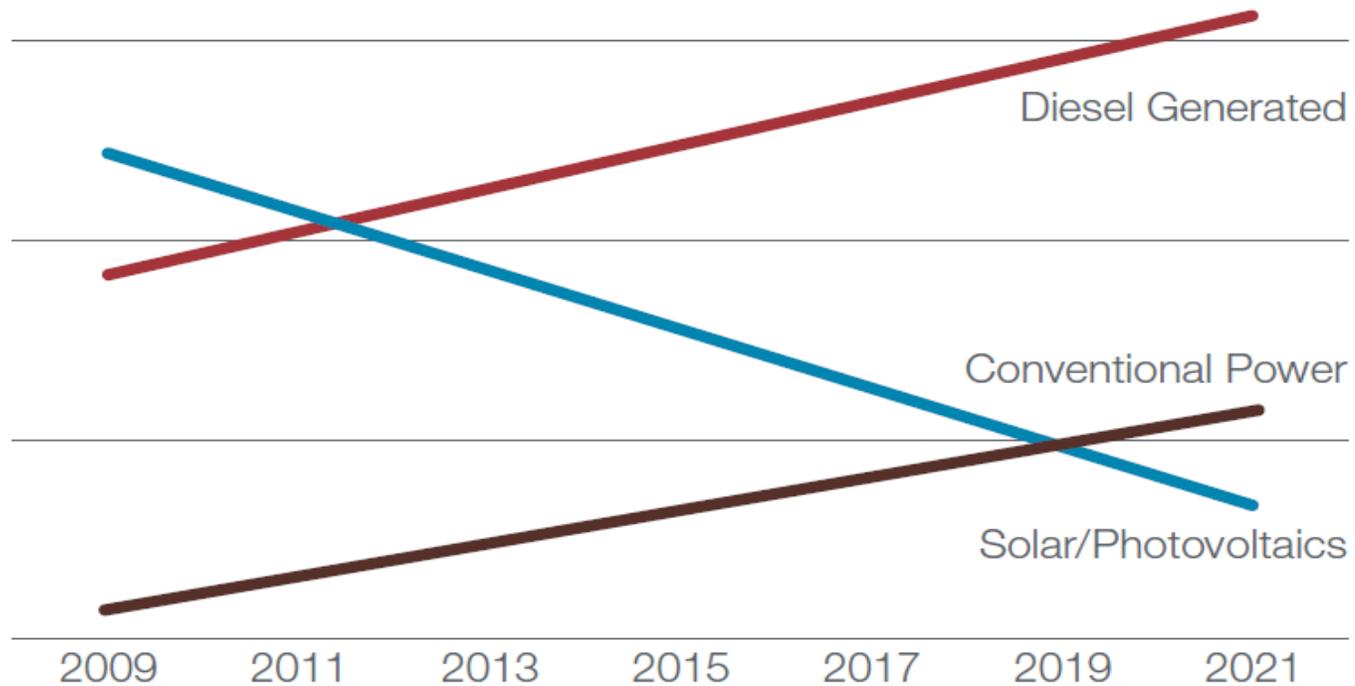
- Diesel powered grids
- RE is cheaper than Diesel already (~ 0.3 \$/kWh fuel cost)
- Ample load shift potential (desalination, pumps, cooling, refrigeration, electro-mobility)
- For high RE share: solve energy storage issue!



New Opportunities and Challenges for RE

PV beyond Grid Parity in diesel grids today, other segments (gas) will follow..

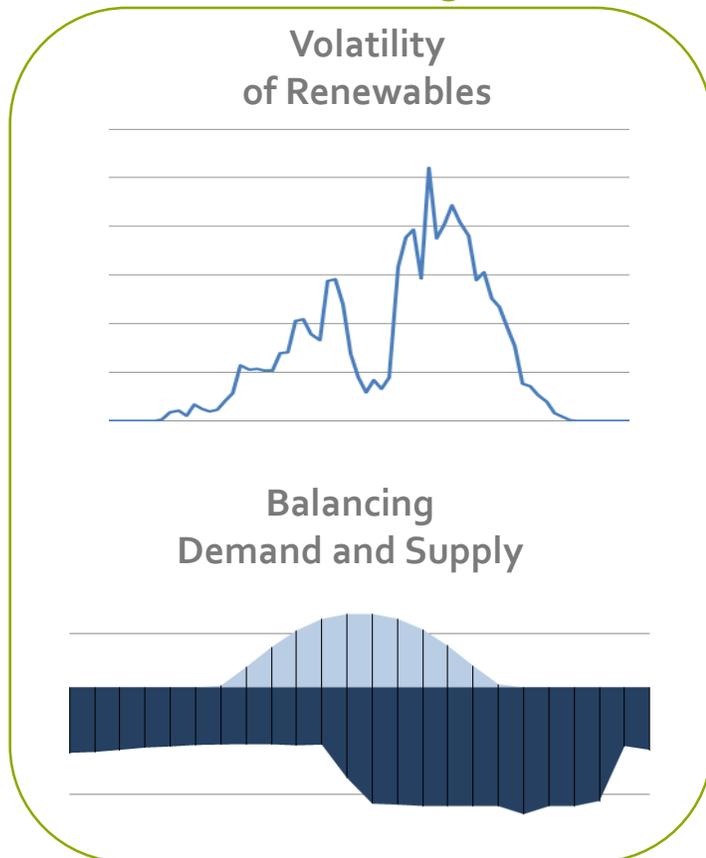
Energy Price Trend



New Opportunities and Challenges for RE

Grid balancing and stability become key from about 20% RE share

Challenge



Storage type 1

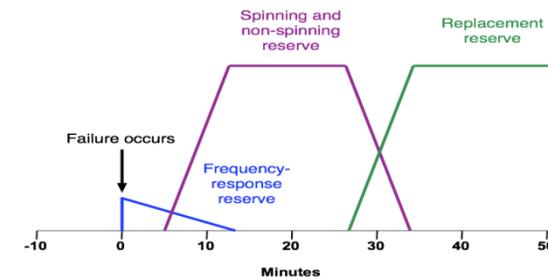


Storage type 2

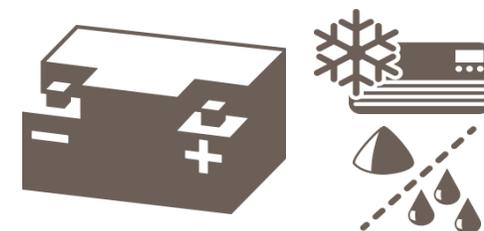


Solution

Spinning Reserve
(short term <minute)



Storage & DSM¹
(long term >hour)



¹ DSM = Demand Side Management

Smart Grid Research: we have to wait

From a Status Review by European Electricity Grid Initiative (EEGI)



MAPPING AND GAP ANALYSIS



	T1	T2	T14	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T15	T16	T17	TD 1	TD 2	TD 3	TD 4	TD 5
Hardware	-1	-1	3	1	1	1	1	-1	-1	-1	-1	-1	-1	3	-1	2	-1	2	1	-1	-1
Software tools	2	2	3	2	2	2	3	2	2	3	3	2	2	2	3	-1	2	2	2	3	-1
Integration into the system	3	3	-1	2	2	2	3	2	2	3	2	2	2	2	2	2	2	3	2	3	3
Market Design	-1	2	-1	-1	-1	-1	-1	-1	-1	-1	3	3	3	-1	-1	-1	-1	3	3	-1	-1
Cost-benefit analysis	-1	2	3	2	2	2	-1	-1	-1	2	3	2	2	2	2	2	-1	3	3	-1	3
Regulation of grid services	-1	-1	3	2	-1	2	-1	1	-1	3	3	2	3	-1	-1	3	2	3	3	3	3
Stakeholders involvement	-1	3	3	-1	-1	1	-1	-1	2	2	3	2	2	-1	-1	-1	2	2	3	2	3
System reliability	-1	3	3	2	3	3	3	3	-1	3	3	2	2	2	3	2	2	3	2	3	-1

Not relevant	
Ready to deploy at large scale	
Need more demonstration or pilot project to validate the maturity	
Need moderate development	
Require more research (work with research institutes)	

Flexibility and Smart Grid are major cost elements

Generation cost (Maldives)

Diesel	0.50 \$/kWh
← Value of flexibility of diesel electricity →	
PV	0.25 \$/kWh

Storage cost

Battery	0.20 \$/kWh
Cooling	0.00... \$/kWh
Desalination	0.00... \$/kWh
E-mobility	0.00... \$/kWh

Flexibility cost (Smart Grid Transaction)

Merit order of Flexibility emerges:

- Batteries and other flexibility sources compete on price
- Shiftable loads are integrated as „Virtual Storage“
- Smart Grids provides means and motivation to mobilize cheap flexibility from Cooling, Desalination, Electric Vehicles...

KISS: „Easy“ Smart Grid

A Real Time Price for Electricity in Mini Grids:

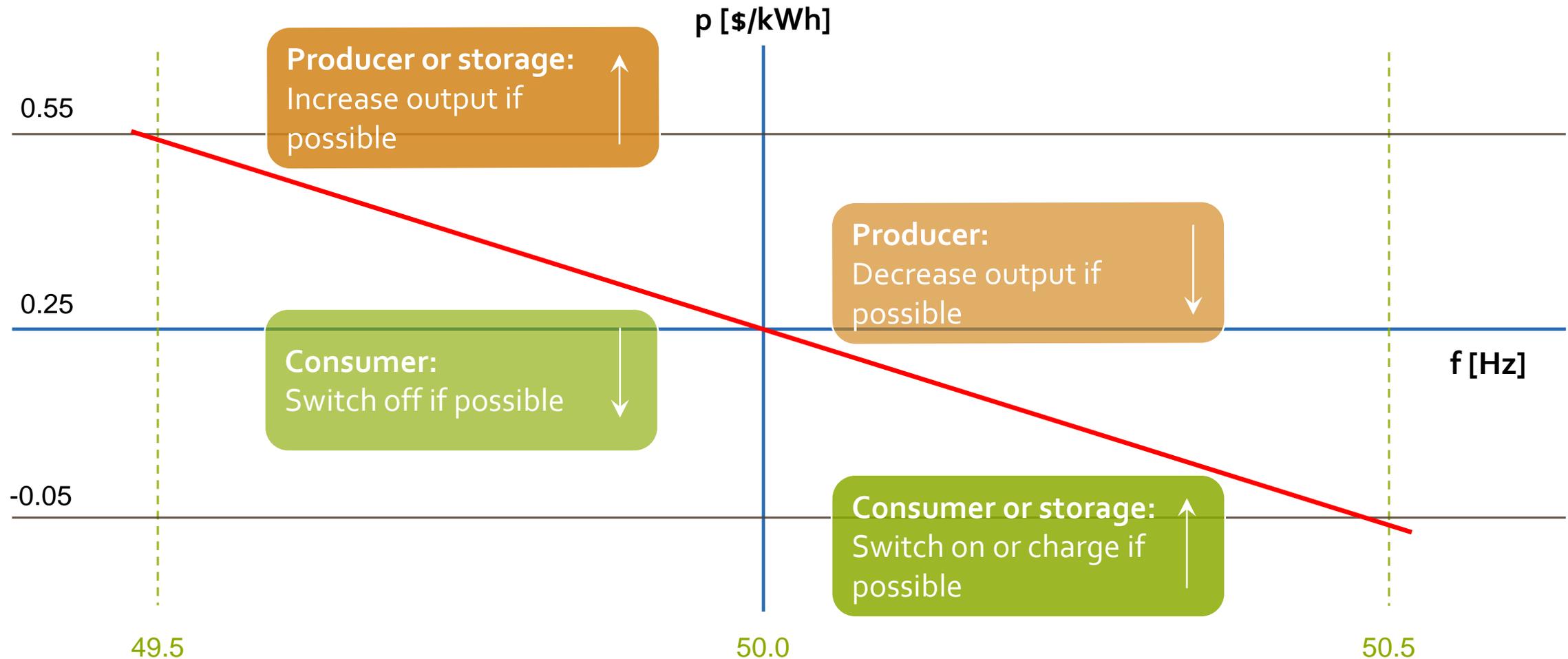
- If generation < load: Increase price until balance is reached
- If load > generation: Reduce price until balance is reached
- Flexible generators: Shift generation to high price times
- Flexible consumers: Shift consumption to low price times
- Storage: Charge at low price, discharge at high price

How to implement?

- „Big Data“ (classic IT technology to calculate balance and communicate price)
or
- „Easy“ Smart Grid (grid physics knows and communicates balance itself)

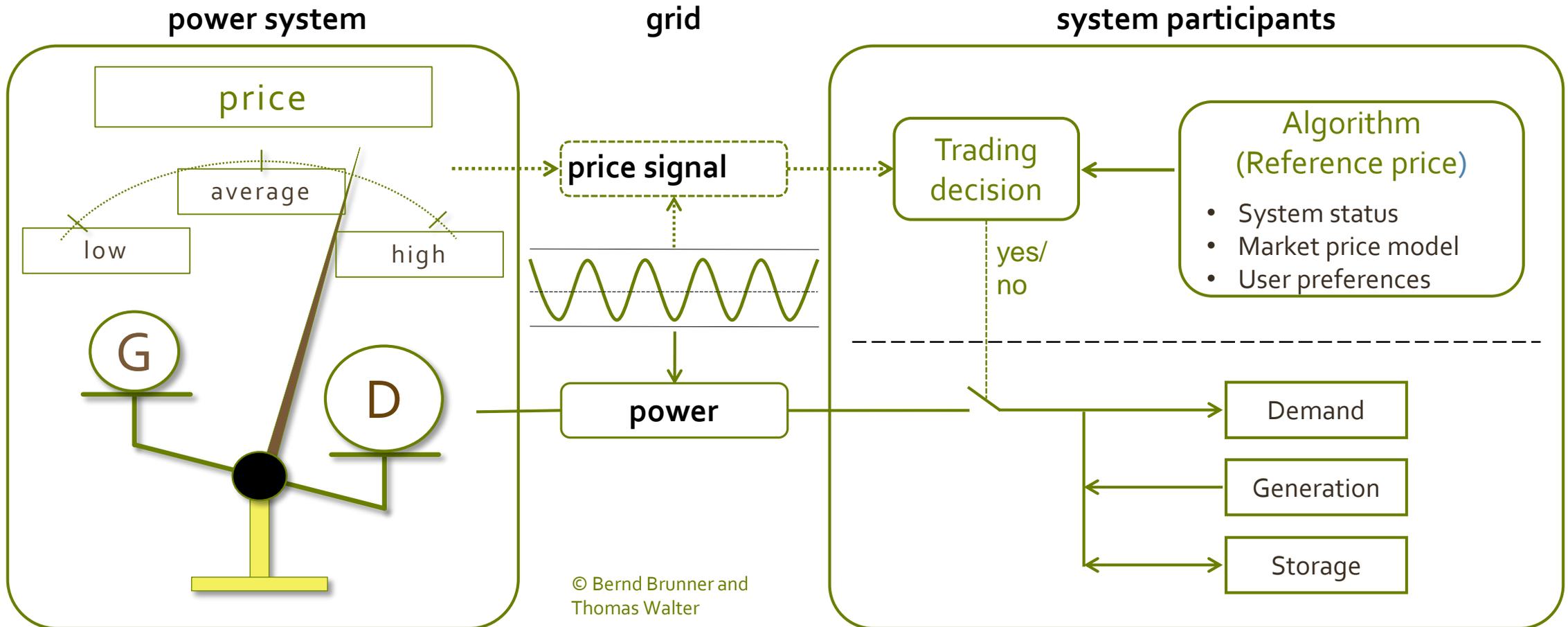
KISS: „Easy“ Smart Grid

Grid frequency is used for technical control and also provides real time price

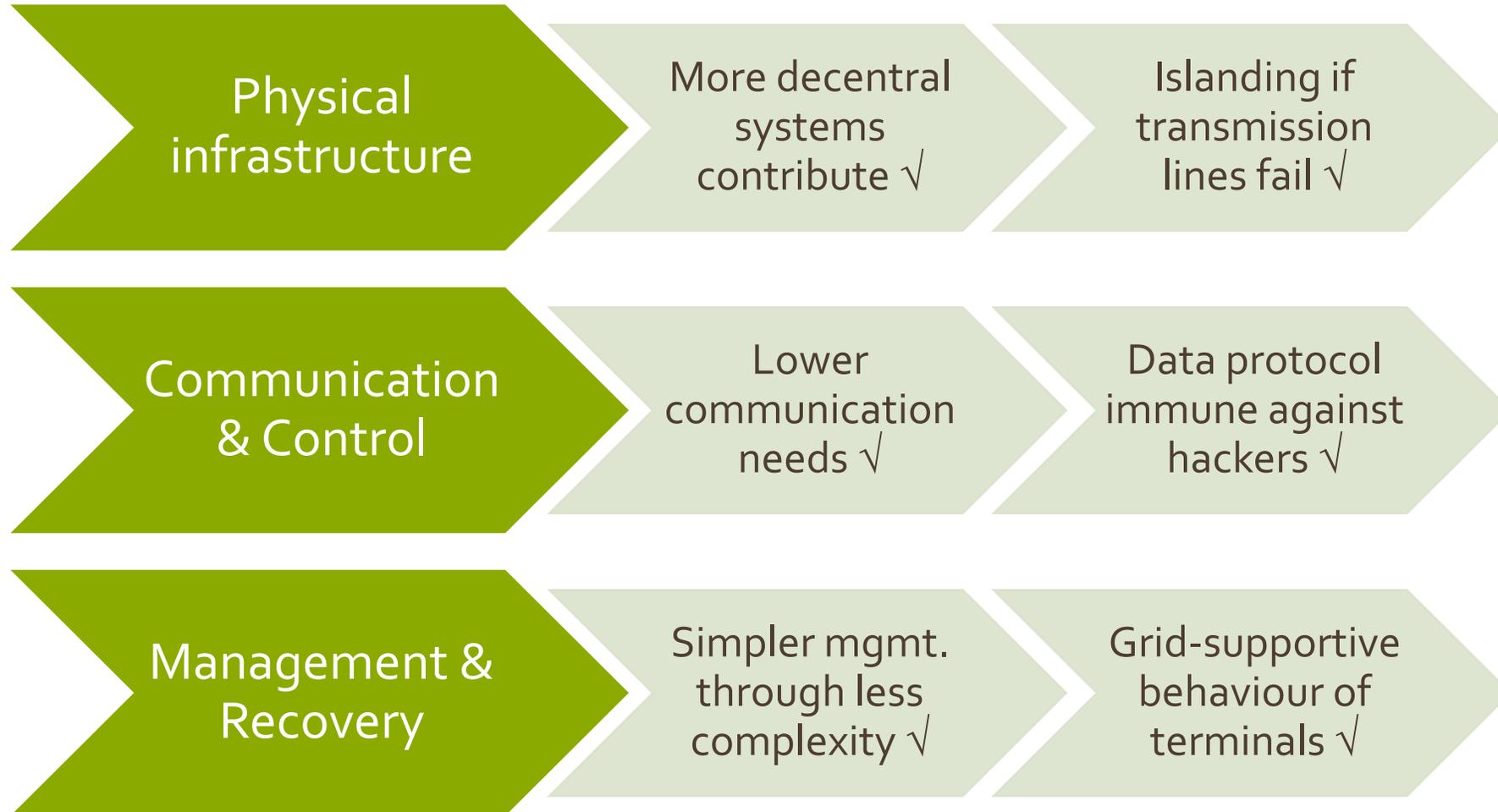


KISS: „Easy“ Smart Grid

Smart Grid: Real Time Energy Trading with “Near Zero” Transaction Cost

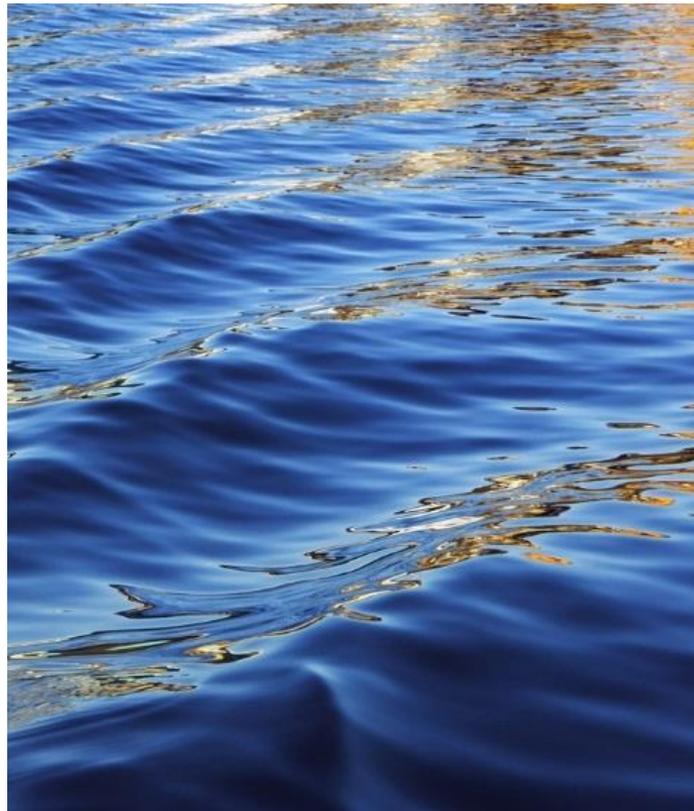


ESG makes Grid and Smart grid robust



Integrated view of RE, Storage, Smart Grid

- ✓ Large application potential, triple win (suppliers, operators and customers)
- ✓ Easy Smart Grid provides technical and commercial platform for all players
- ✓ Intelligent mini grid technology could be basis for cellular „traditional“ grids
- ✓ Saved cost of fuel and storage will drive rollout
 - substantial reduction of GHG emission is an additional benefit
- ✓ Your inputs and contributions are most welcome



Thank you for your interest!

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