

The transformation of distribution grids in the context of the European Energy Transformation

Ruggero Schleicher-Tappeser
sustainable strategies, Berlin

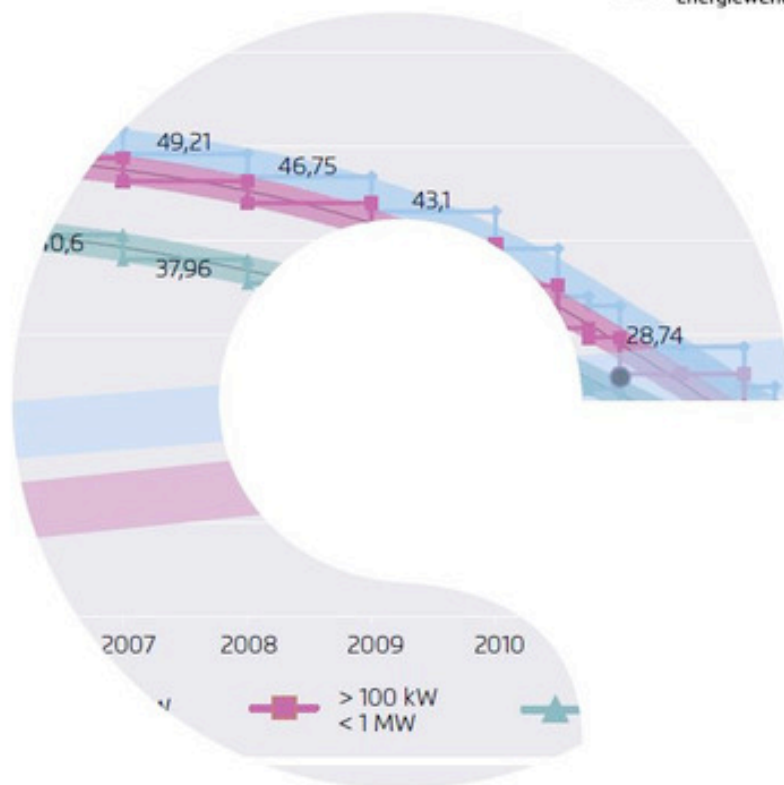
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Stromverteilnetze für die Energiewende

Empfehlungen des Stakeholder-Dialogs
Verteilnetze für die Bundespolitik - Schlussbericht

IMPULSE

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Stromverteilnetze für die Energiewende

IMPRESSUM

SCHLUSSBERICHT

Empfehlungen des Stakeholder-Dialogs
Verteilnetze für die Bundespolitik

ERSTELLT IM AUFTRAG VON

Agora Energiewende
Rosenstraße 2 | 10178 Berlin
Projektleitung: Lars Waldmann
lars.waldmann@agora-energiewende.de

KONZEPT UND TEXT

Ruggero Schleicher-Tappeser
sustainable strategies, Berlin

TEILNEHMER DES STAKEHOLDER-DIALOGS

Dierk Bauknecht, Öko-Institut e. V.
Bernhard Beck, Belectric AG
Thorsten Beckers / Nils Bieschke, TU Berlin
Christoph Dany, Stadtwerke München
Bernd Engel, TU Braunschweig / SMA AG
Michael Fiedeldey, Allgäuer Überlandwerke
Jochen Hauff, AT Kearney GmbH
Christian Held, Geode
Bernd Kördel, Epo Consult
Christoph Mayer, OFFIS e.V.
Albert Moser, RWTH Aachen
Christoph Roenick, Kisters AG
Kurt Rohrig, Fraunhofer IWES
Oliver U. Stahl, Entellos AG
Rainer Stock, VKU e. V.
Margarete von Oppen, Rechtsanwälte Geiser & von Oppen
Thomas Weisshaupt, Gemalto AG
Enno Wieben, EWE Netz GmbH
Christof Wittwer, Fraunhofer ISE
Gunnar Wrede, Younicos AG

GÄSTE

Barbie Kornelia Haller /
Maik Wiesweg, Bundesnetzagentur

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Disclaimer

Dieser Bericht ist das Resultat eines moderierten Diskussionsprozesses mit den vom genannten Teilnehmern. Er stellt nicht notwendigerweise die Meinung von Agora Energiewende dar.

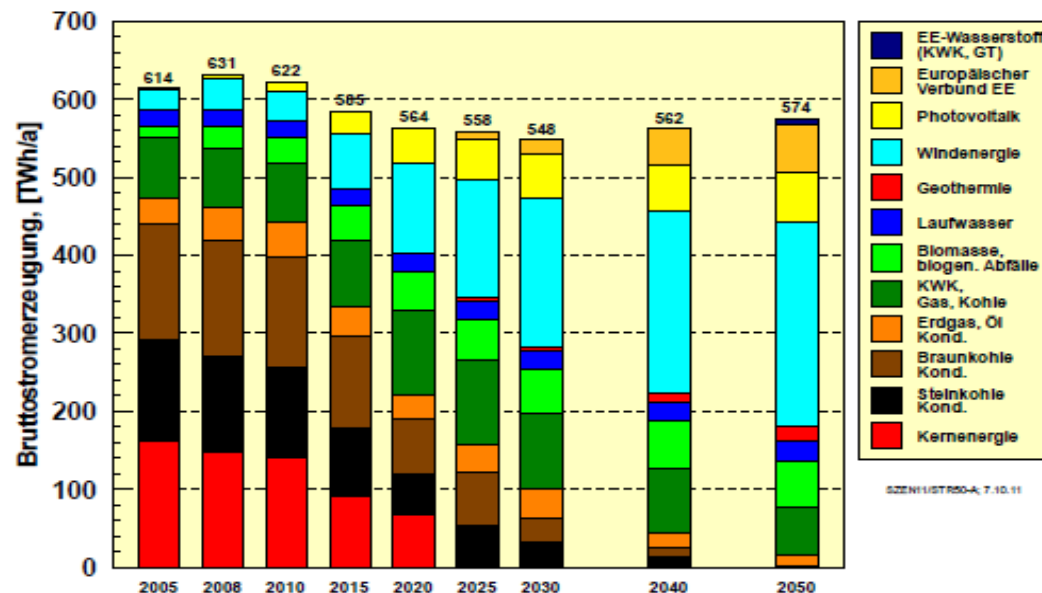
Wo möglich wurden in diesem Bericht Konsenspunkte und unterschiedliche Ansichten dargestellt. Ein solcher Bericht stellt aber immer einen lesbaren Kompromiss nach einem längeren Diskussionsprozess dar. Insofern werden nicht unbedingt alle einzelnen Handlungsempfehlungen und Aussagen von sämtlichen Teilnehmern geteilt. Zum Prozess siehe Kapitel 1 und Anhang.

Driver 1:

Politics wants renewable energies

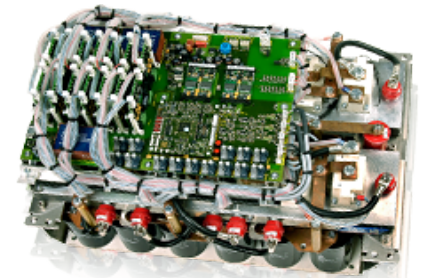
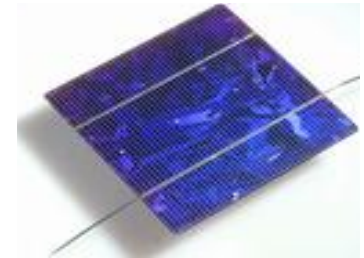
- Binding EU target for 2020: 20% of all energy from renewable sources
→ renewable share in power production must be higher
Targets for 2030: 45% Renewables ??
- Denmark:
 - 2020: 50% wind power
 - 2035: power and heat completely renewable
- Germany:
 - Reduce CO2 emissions by 80-95% until 2050

Lead scenario 2011: structure of gross power production

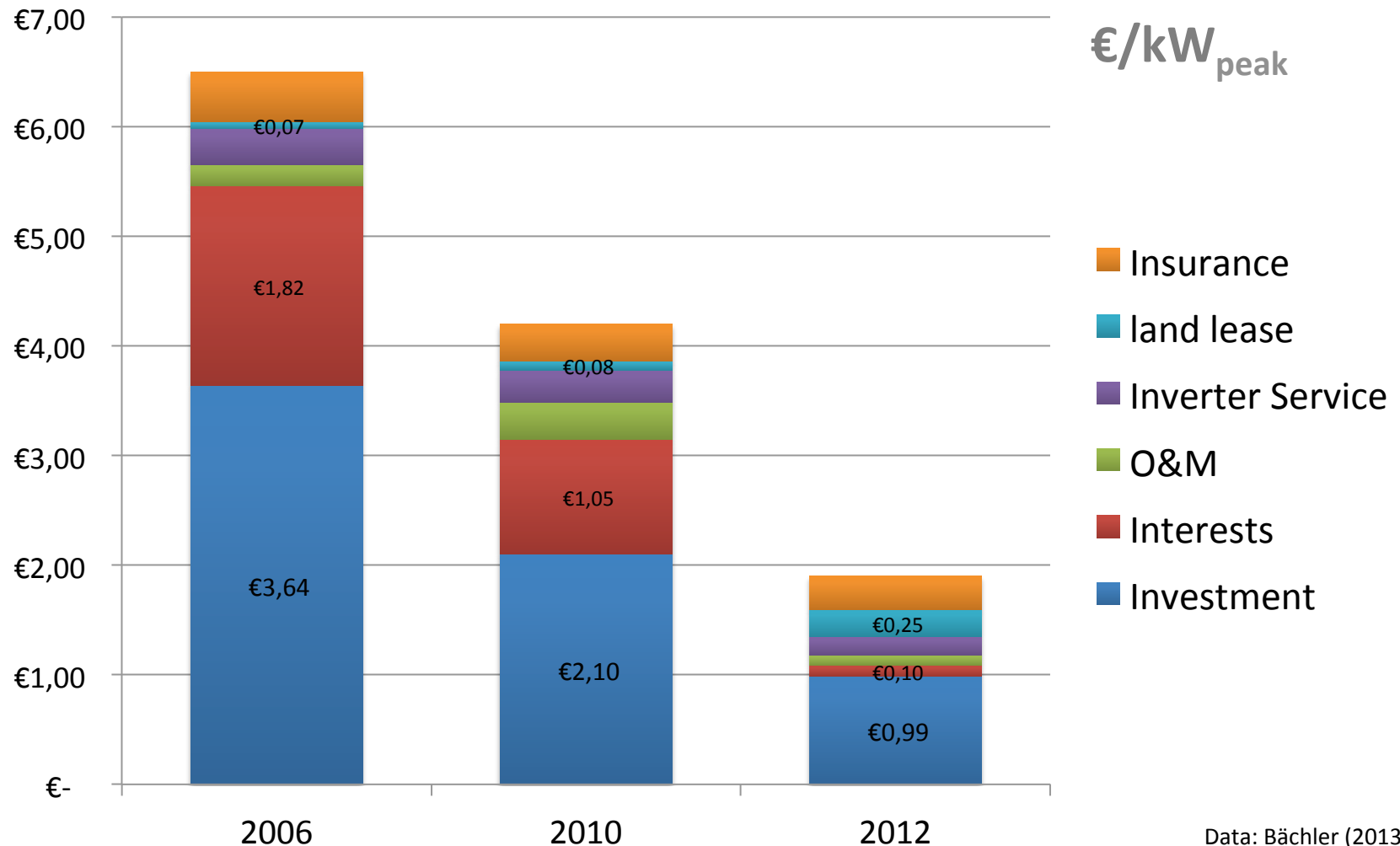


Driver 2: Breakthrough of ICT and semiconductor technologies

- PV: electricity production from solar radiation with semiconductors
 - No moving parts
 - No fuel, no operational costs
 - Mass production of standardised elements
 - High scalability, distributed application possible
- Semiconductor power electronics
 - Highly efficient converters, transformers
 - Remote control of electrical parameters
 - New options for DC applications and systems
- ICT
 - Complex control options with cheap distributed intelligence
 - Multi-level systems
 - Flexible configuration, involvement of a variety of actors
- Breakthrough of storage technologies ???



Cost of Ownership over 20 years in Germany

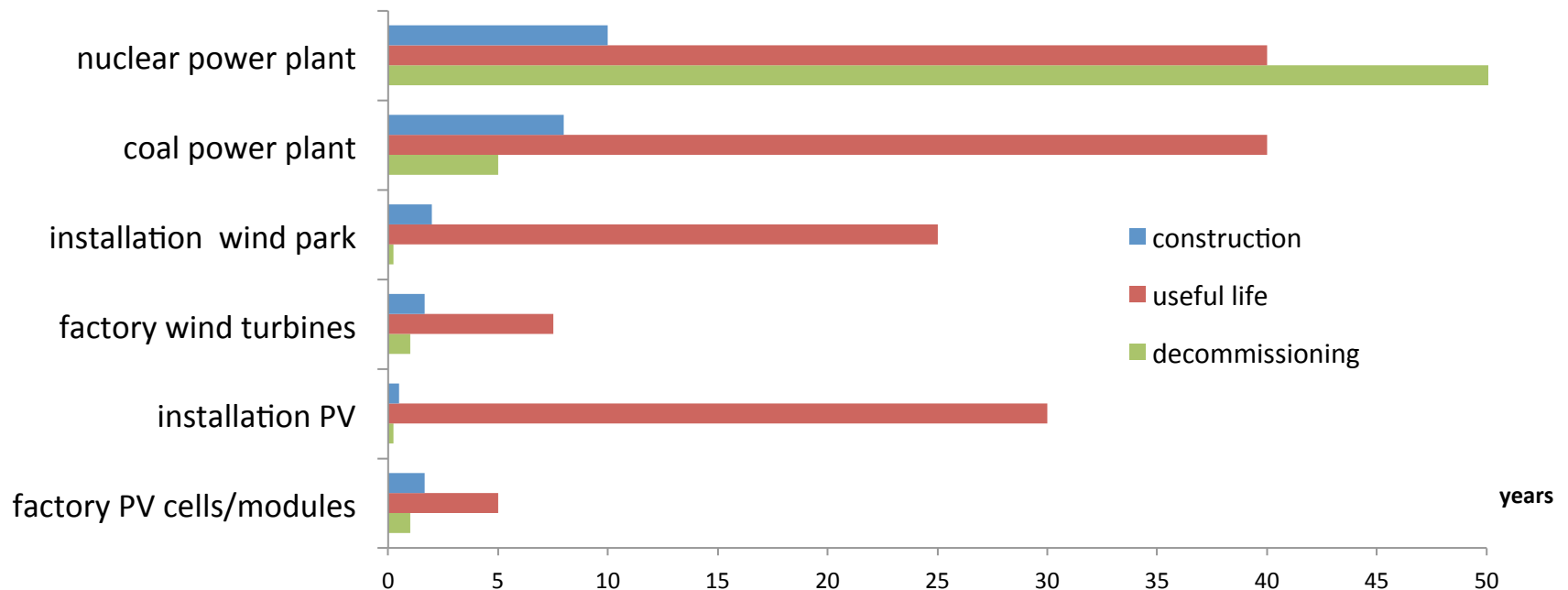


Data: Bächler (2013),
PV-magazine

Unfamiliar to business and government: 5 to 10 times shorter innovation cycles

- More rapid build-up of capacities (e.g. Dec. 2011 in Germany: 3,5 GW PV)
- More rapid decrease of costs
- More rapid transformation of the electricity sector

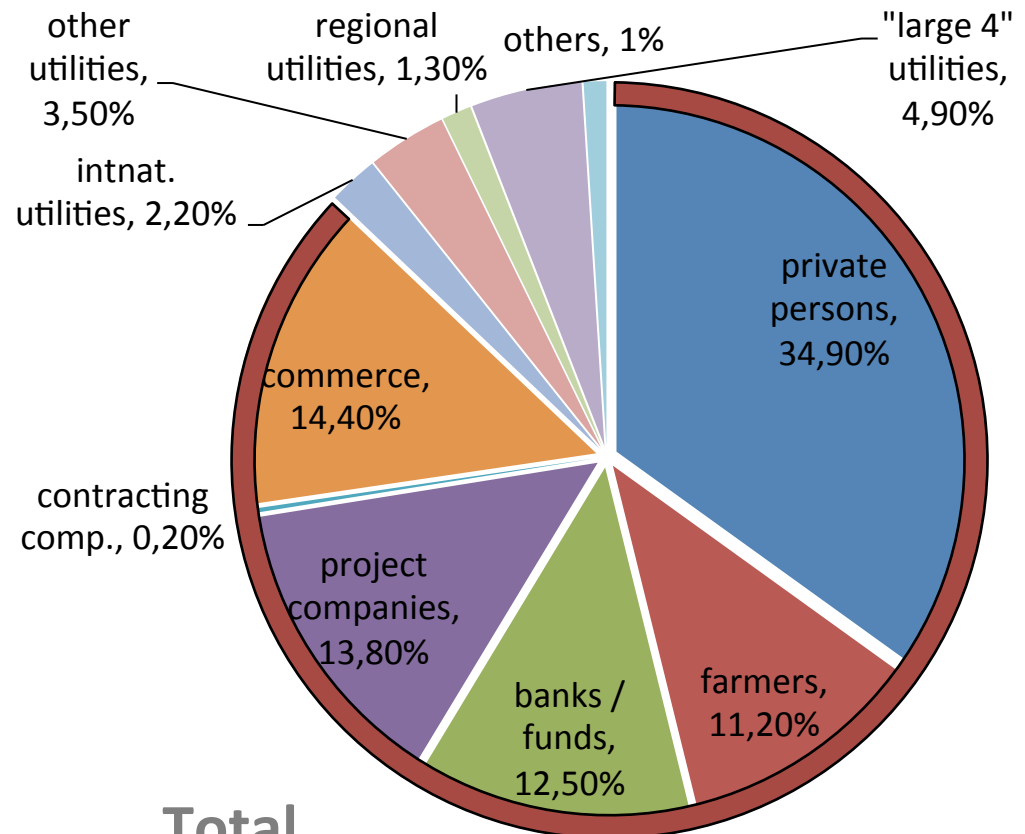
Dramatic acceleration compared to traditional energy technologies



Driver 3: New actors in the game

- Classical utilities have only a small share in renewable electricity generation
- Over 1 million solar power installations in Germany
- Local and regional initiatives and cooperatives
- **New actors** have other decision criteria and profit expectations
- Revival of municipal utilities with new business models
- IT and communication industries

Ownership of renewable power generation in Germany 2012



Total
72,9 GW

Drivers for change → Challenges in the electricity system

External Drivers

Politics calls for
renewables

Generation
change in
technology

New actors use
distributed RES

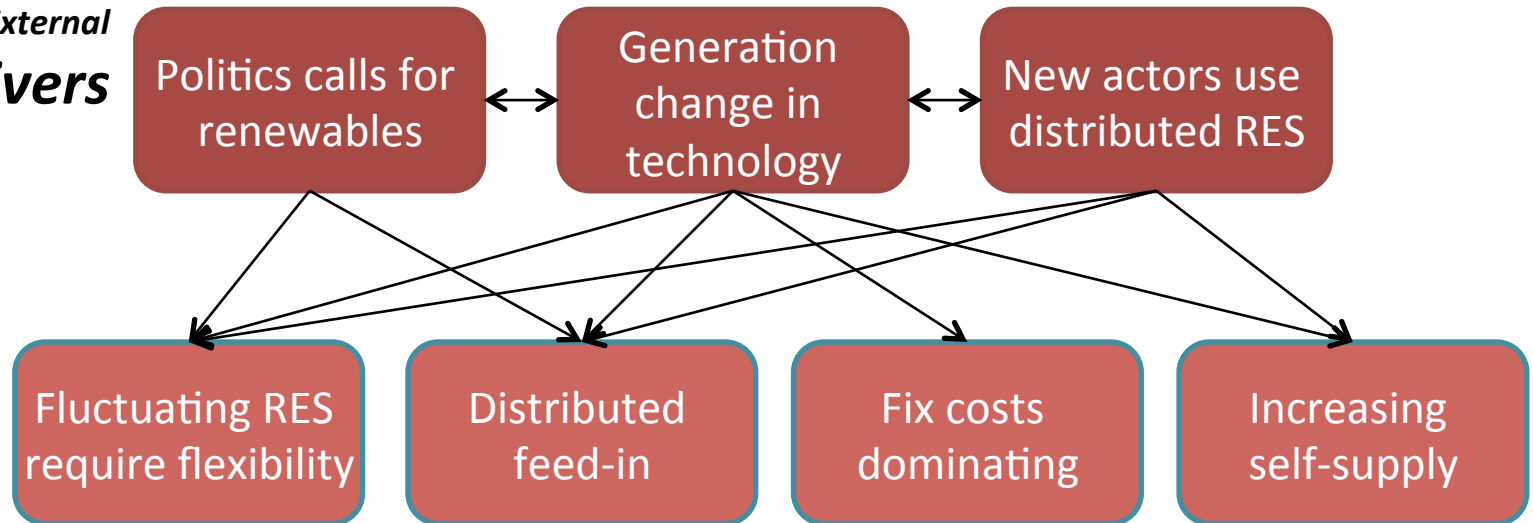
Challenges in the electricity system

Fluctuating RES
require flexibility

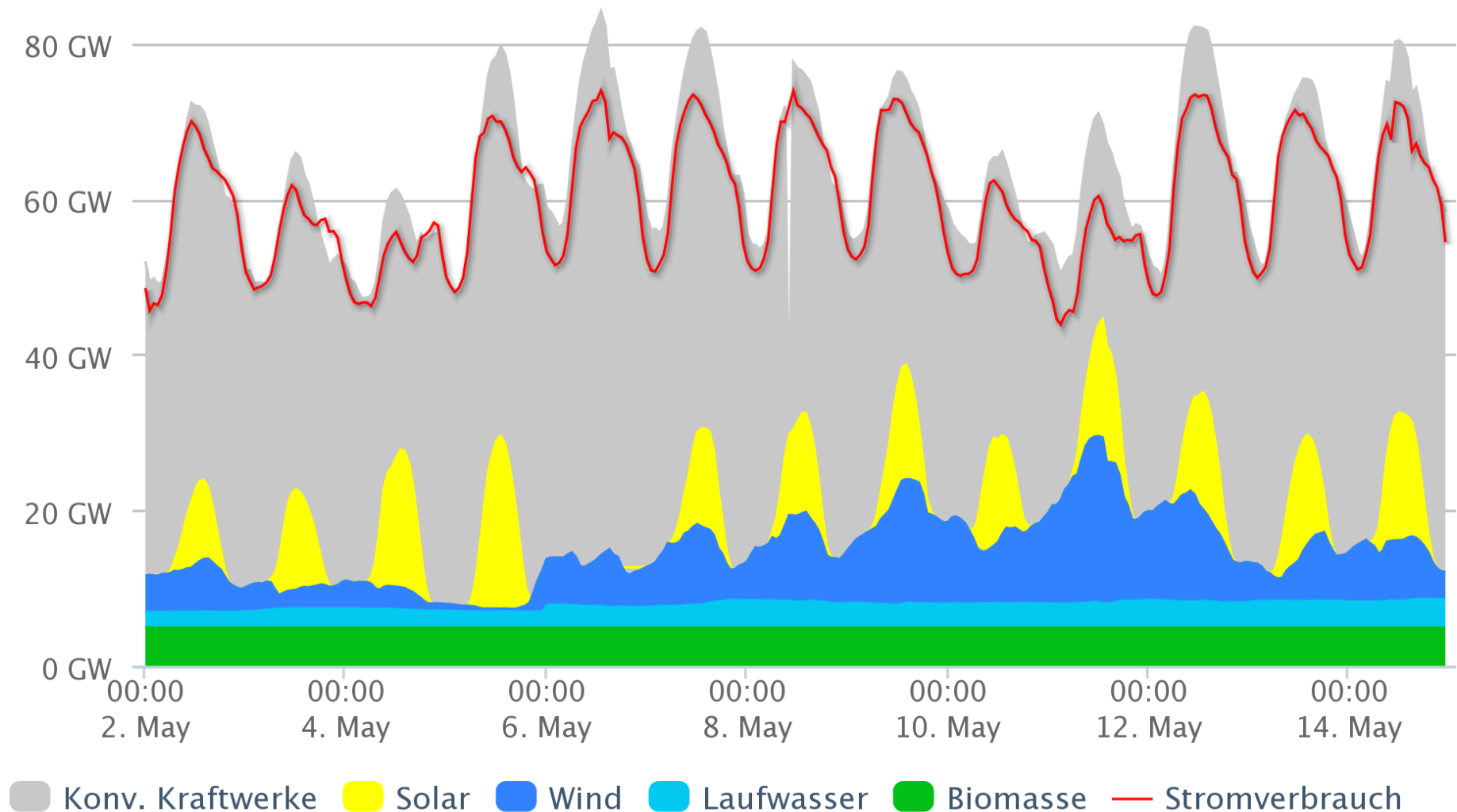
Distributed
feed-in

Fix costs
dominating

Increasing
self-supply

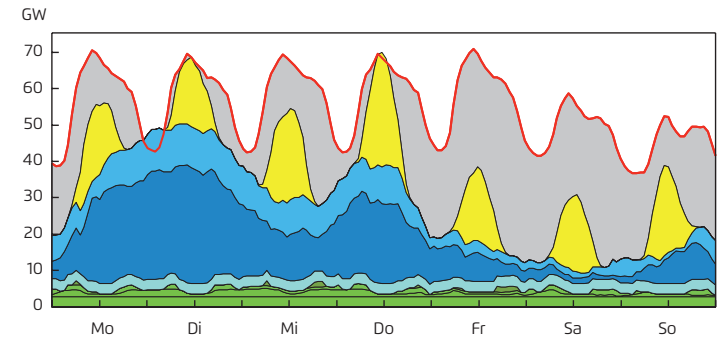


Germany: 28,5% renewable electricity in Q1-2, 2014



Challenge 1: Fluctuating generation

Four basic options for more flexibility

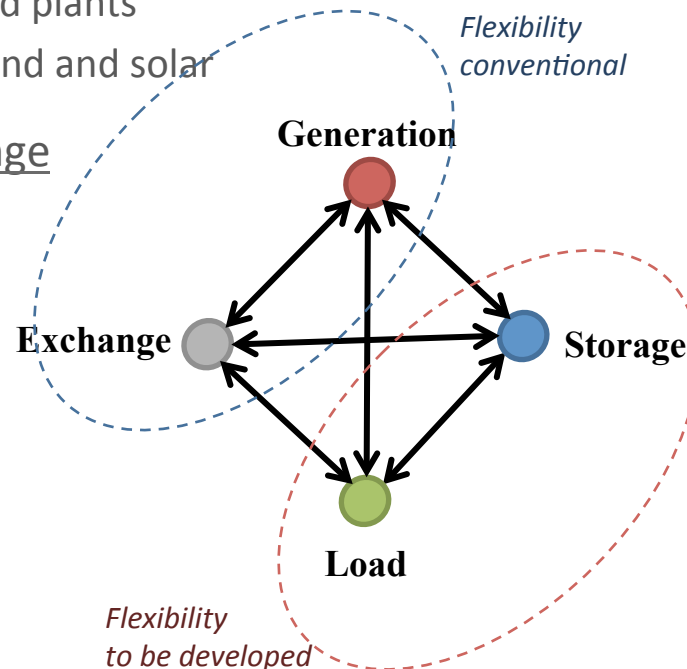


1. Flexible generation

- flexible fuel-based plants
- curtailment of wind and solar

2. Increased exchange

- grid expansion
- on all levels



3. Power storage

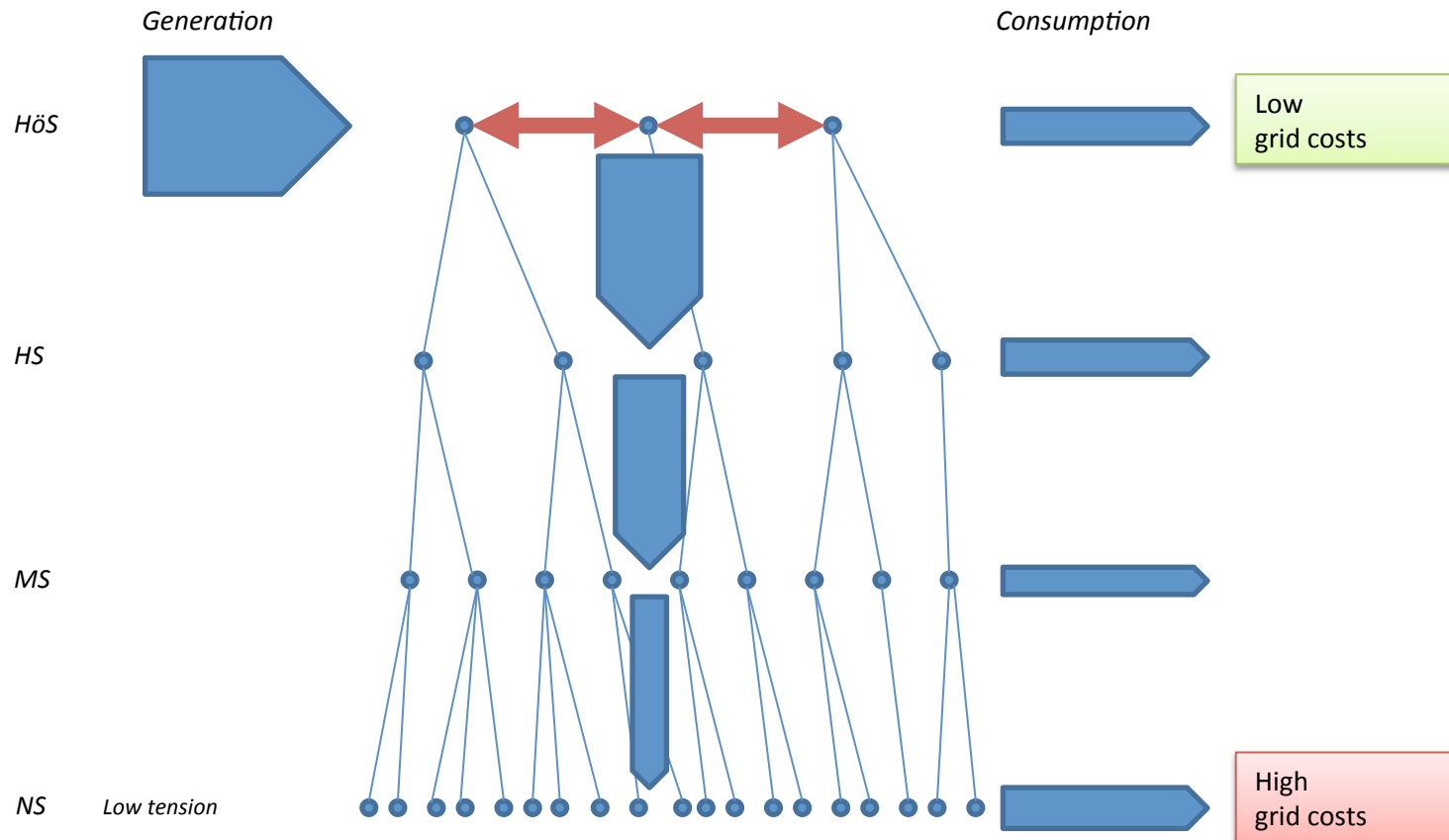
- requires cheaper storage
- in proximity of generation or consumption

4. Demand side management

- requires incentives and learning
- Lowest system level

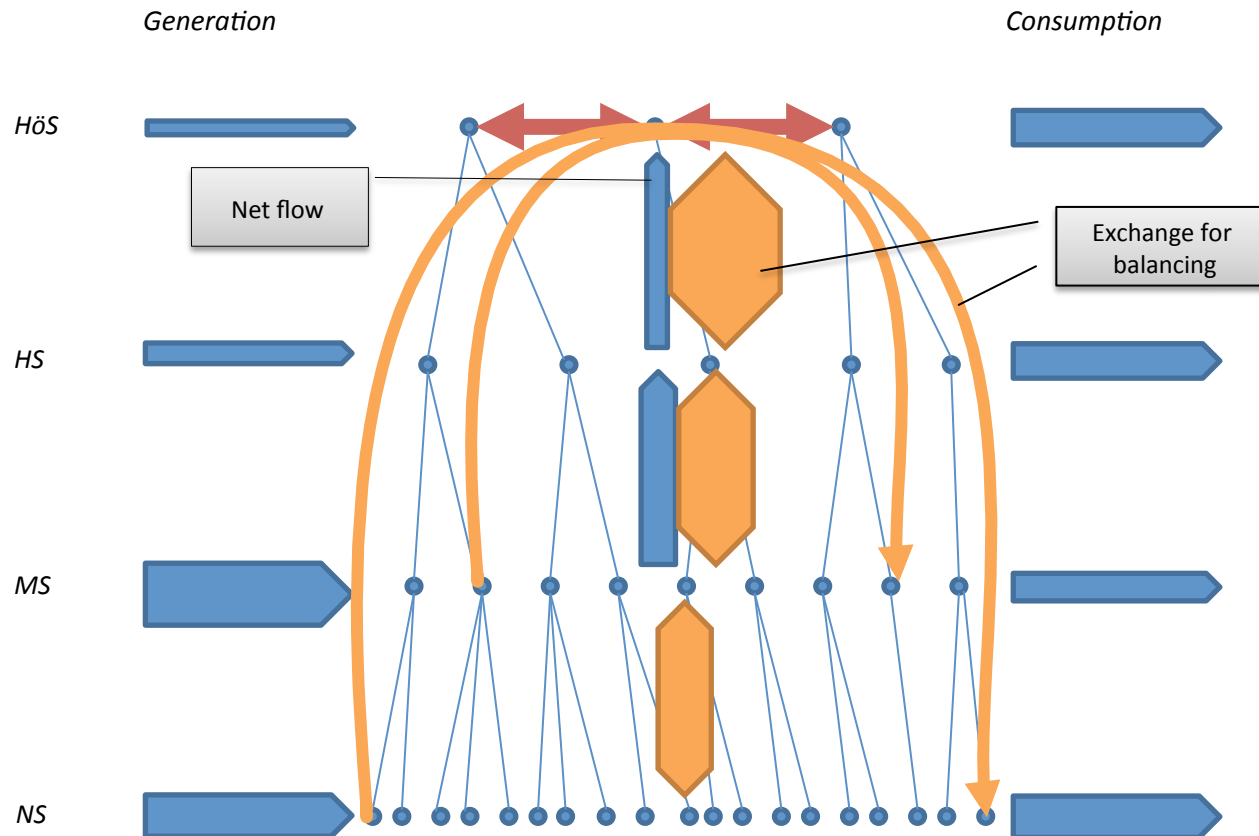
Challenge 2 – distributed generation

From centralised to distributed generation: the old system



Central generation, central balancing

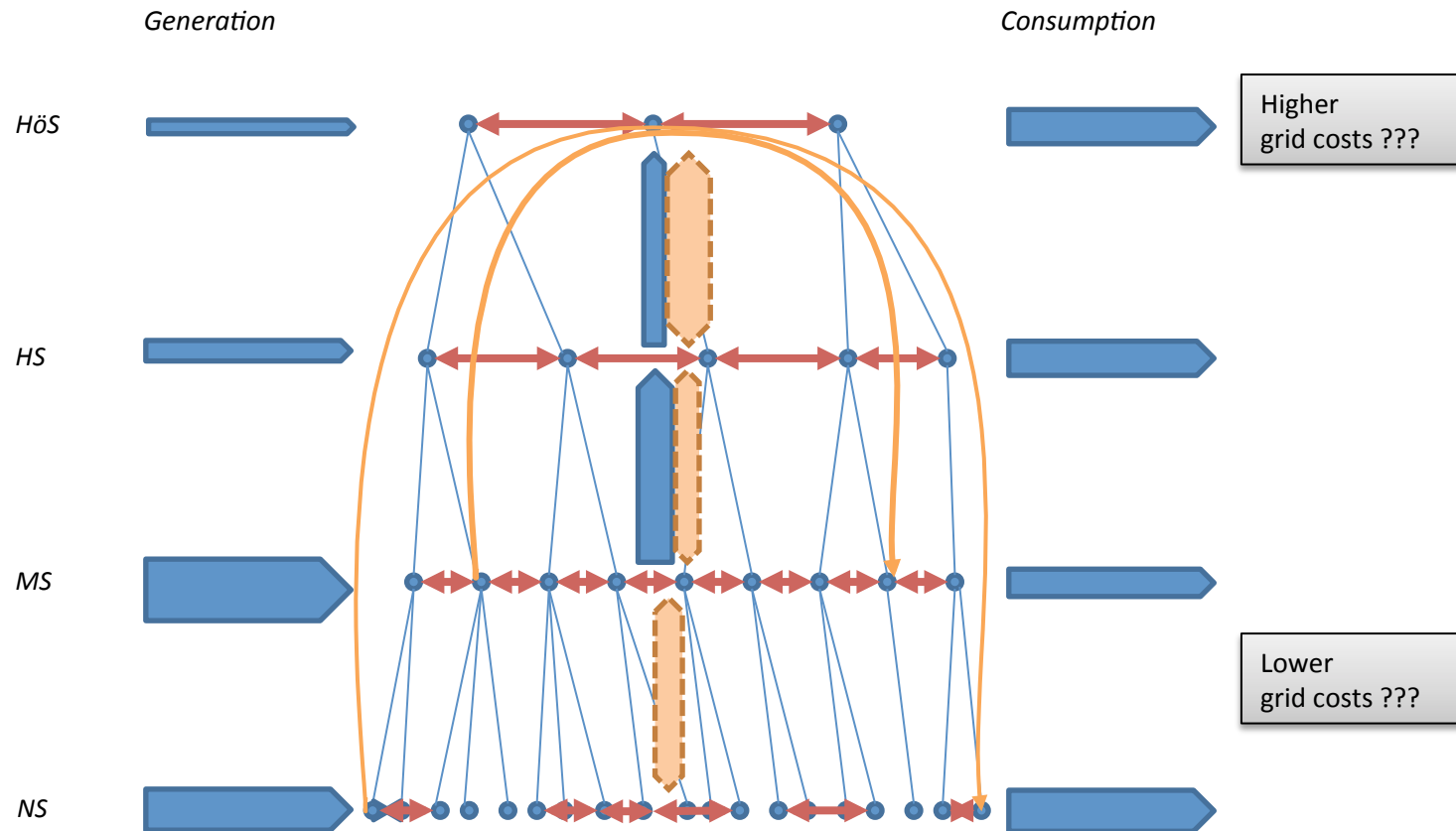
From centralised to distributed generation: new generation pattern – old logic?



Distributed generation, centralised balancing

- Partially reversed flows
- Reduced net flows
- Balancing requires strong exchange between levels

From centralised to distributed generation: active distribution grids



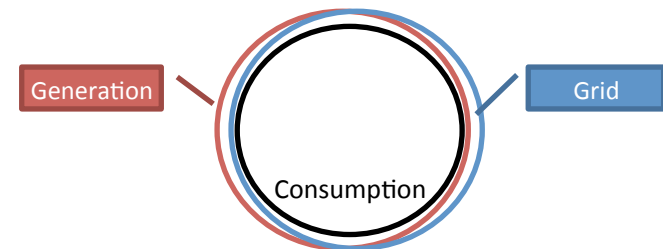
Distributed generation, balancing on all levels

- Active balancing on lower levels can significantly reduce the need for exchange
- This, however, requires new frame conditions

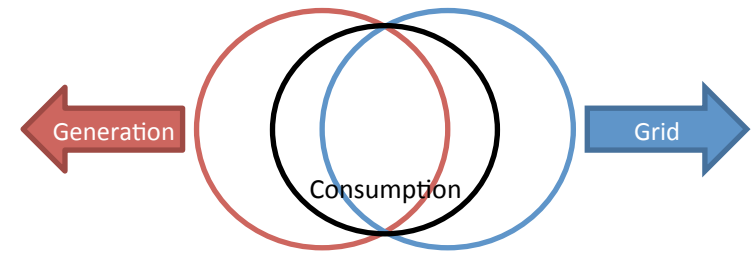
Liberalisation & Unbundling: Problematic disregard for spatial patterns

- Newly created markets entirely based on characteristics of traditional technologies
 - Large scale, highly centralised power generation
 - Considerable variable costs (fuel)
 - System governance on the top level, dumb distribution
- Intrinsic consideration of spatial aspects by the old monopolies was abolished
 - Growing role of non-spatial markets
 - More and more non-spatial balancing groups
 - Separate decision making for grid development and generation investments
 - → Increasing divergence of grid pattern & generation pattern → more grids needed
- New technologies exacerbate this tendency
→ COPPER-PLATE APPROACH GETS INCREASINGLY UNSUSTAINABLE

Coherent Planning by Monopolies



Liberalisation: different Criteria



- ❖ **Technicians call for cellular structures and tendentially to go back to integrated area monopolies**
- ❖ **Economists insist on competition, but tendentially are stuck with old centralistic market structure**

→ **New Approaches are necessary**

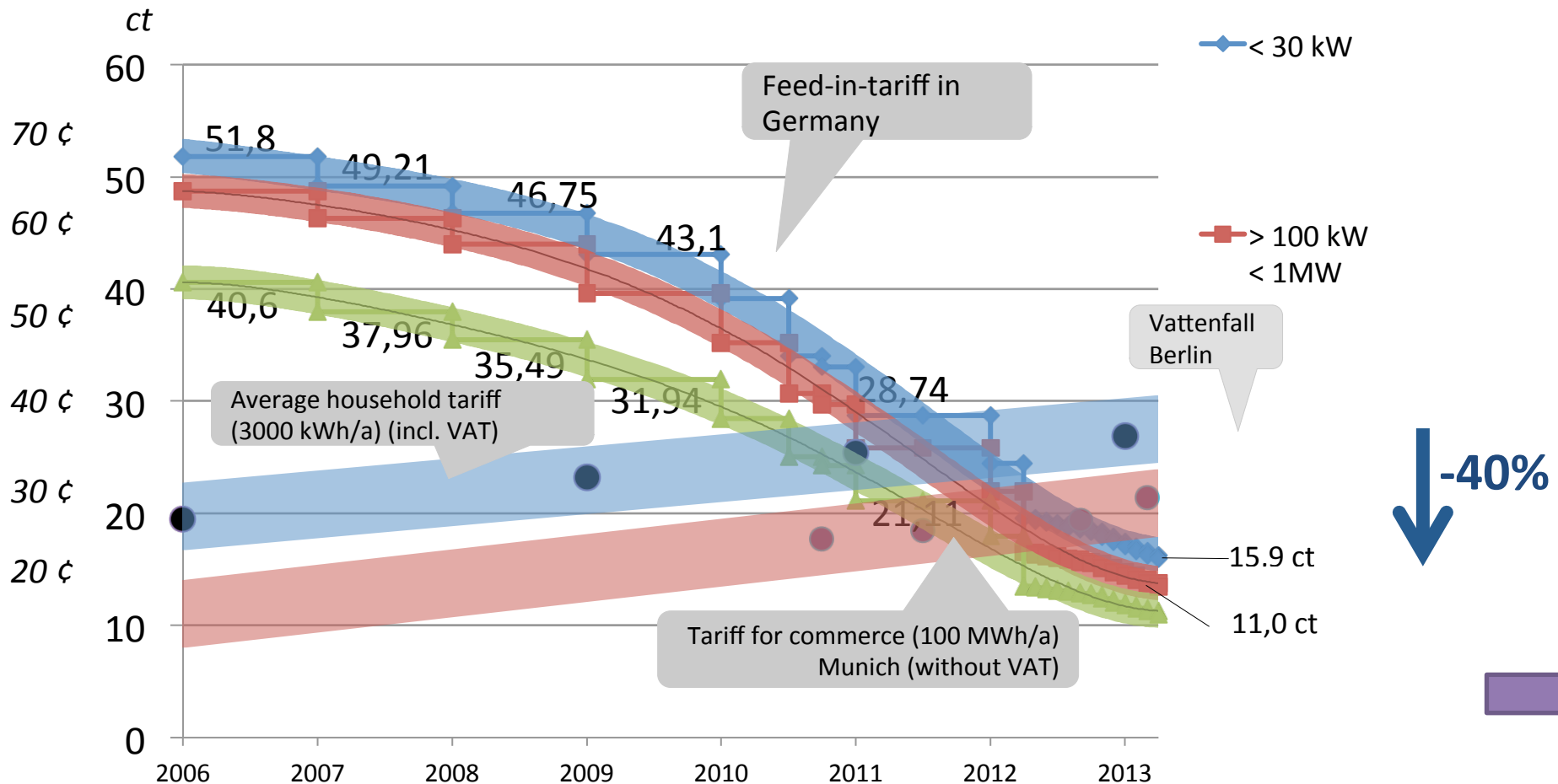
Challenge 3:

Renewables have nearly no variable costs

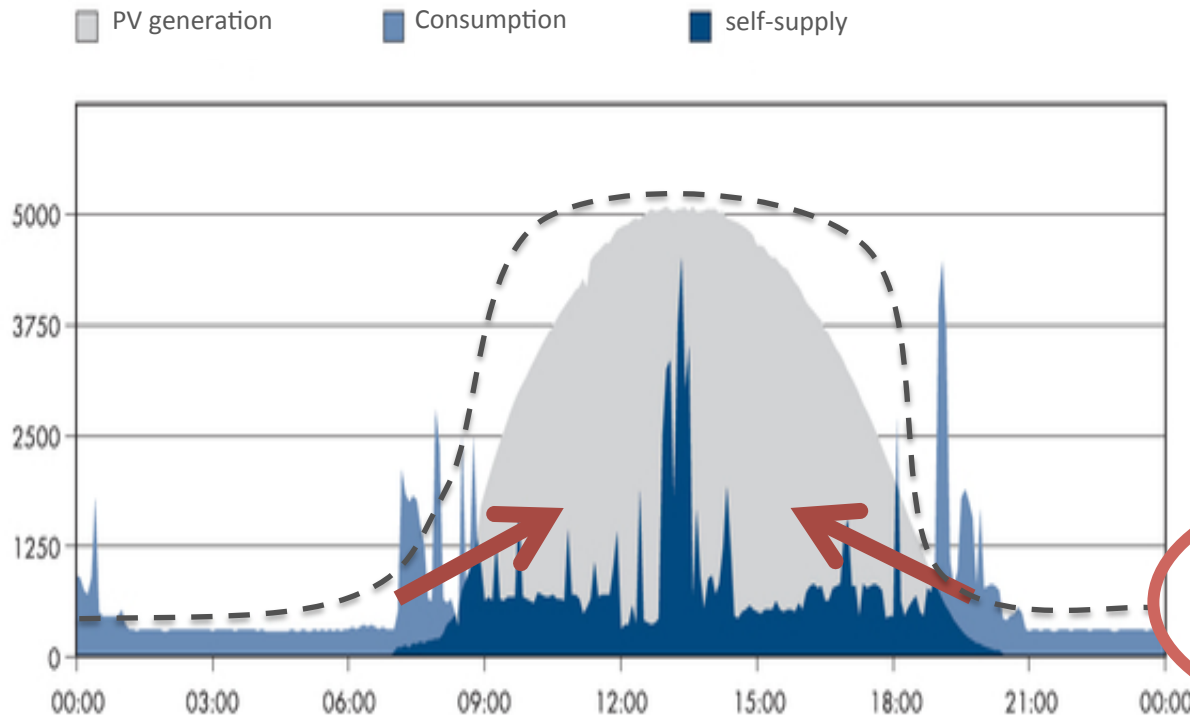
- Present energy only markets have been designed for electricity generation with fuels and high variable costs
- Growing share of renewables drives spot market prices down
→ generation cannot cover costs through these markets
- Electricity supply becomes all infrastructure:
long-term investments in grids & generation
 - Public infrastructure (similar to water supply?)
 - Private long-term consumer goods (similar to houses?)

Challenge 4 – Self-Supply

Power from the roof cheaper than from the grid



Self supply boosts interest in energy management



Shifting loads into sunshine hours

- Storing electricity
- Shifting loads
- Coupling with heat and mobility markets
- **Flexibility of user system increases massively**

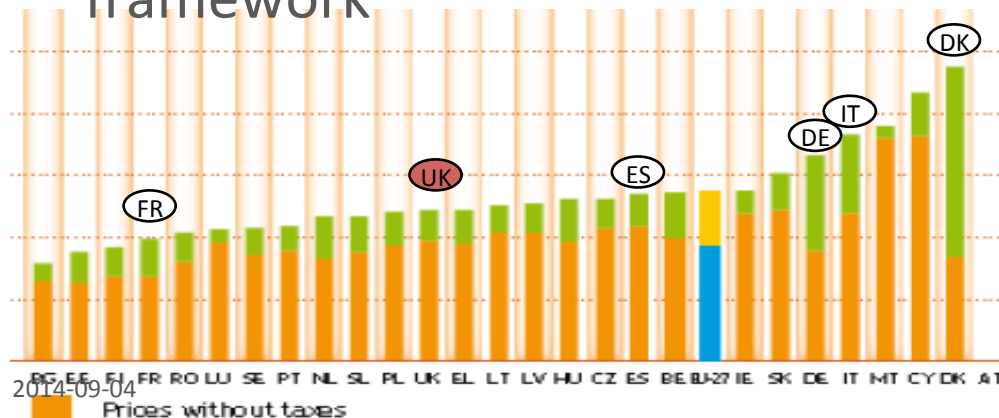
Private household cloudless summer day, 4 persons, PV system 5 kW_p
Without additional measures self-supply only ca. 30%

Commerce: Consumption mainly during sunshine hours

Should be used
for increasing
flexibility of the
whole system

Boom of self-supply to be expected: industry, small business, residential

- Inquiry on captive power generation in German industry:
 - 13% of have it, mostly conventional
 - additional 16% are planning, mostly RES
- Cost advantage interesting in growing number of countries
- Also self-supply with CHP increases
- Uncertainty about future regulatory framework



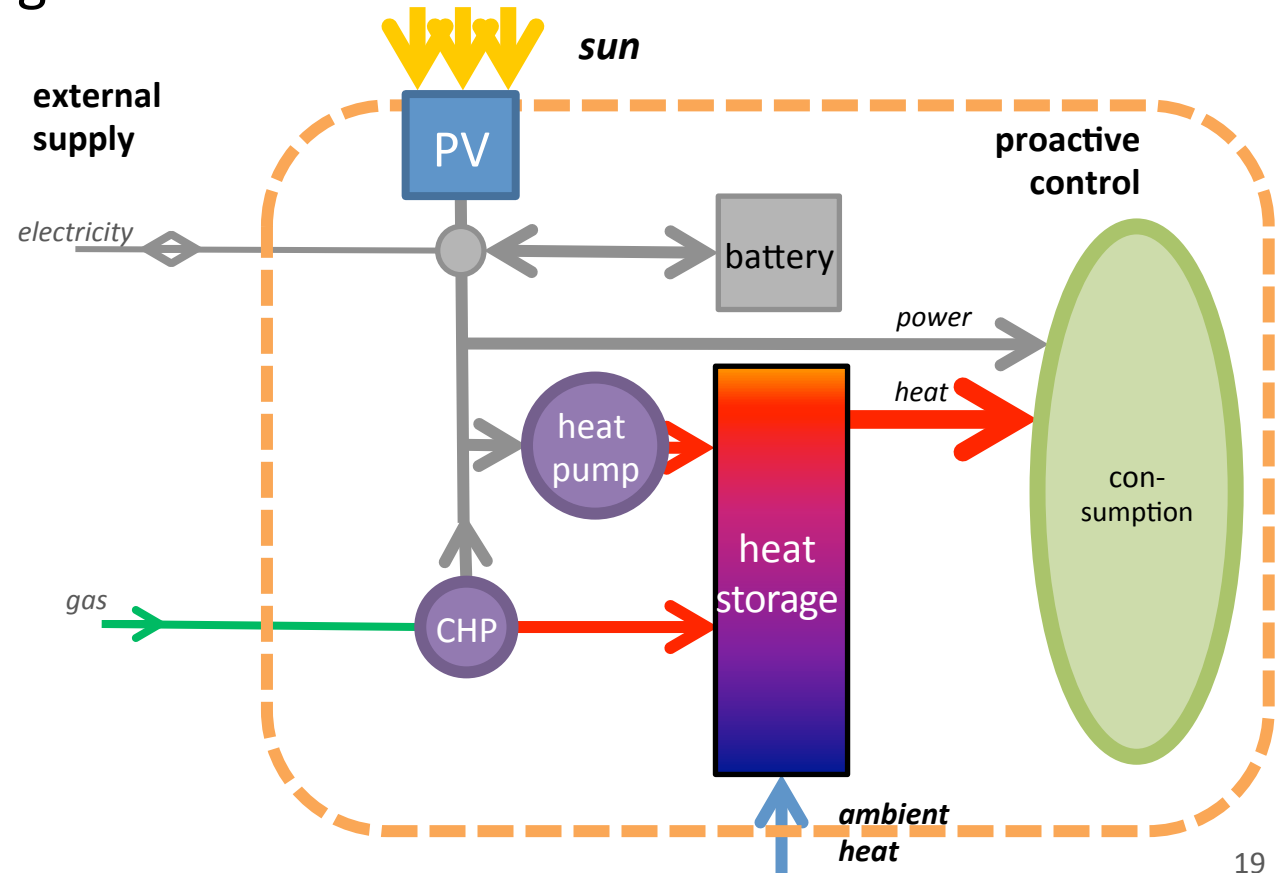
Belgium: Audi factory:
3,5 MW rooftop PV plant for self-supply

Germany: ALDI Süd:
> 100 food retail stores with PV :
own consumption 90%, self-supply 50%



Integrated heat and power supply: cheap heat storage increases flexibility

- Particularly interesting for large office and residential buildings
- Regulatory obstacles can be overcome
- District heating



High potential for self-supply threatens financiability of the system



Estimating the self-supply potential in Germany:

Roof areas
„well suited“
for PV

20%

of electricity
consumption

PV on nearby
surfaces

10%

of electricity
consumption

CHP

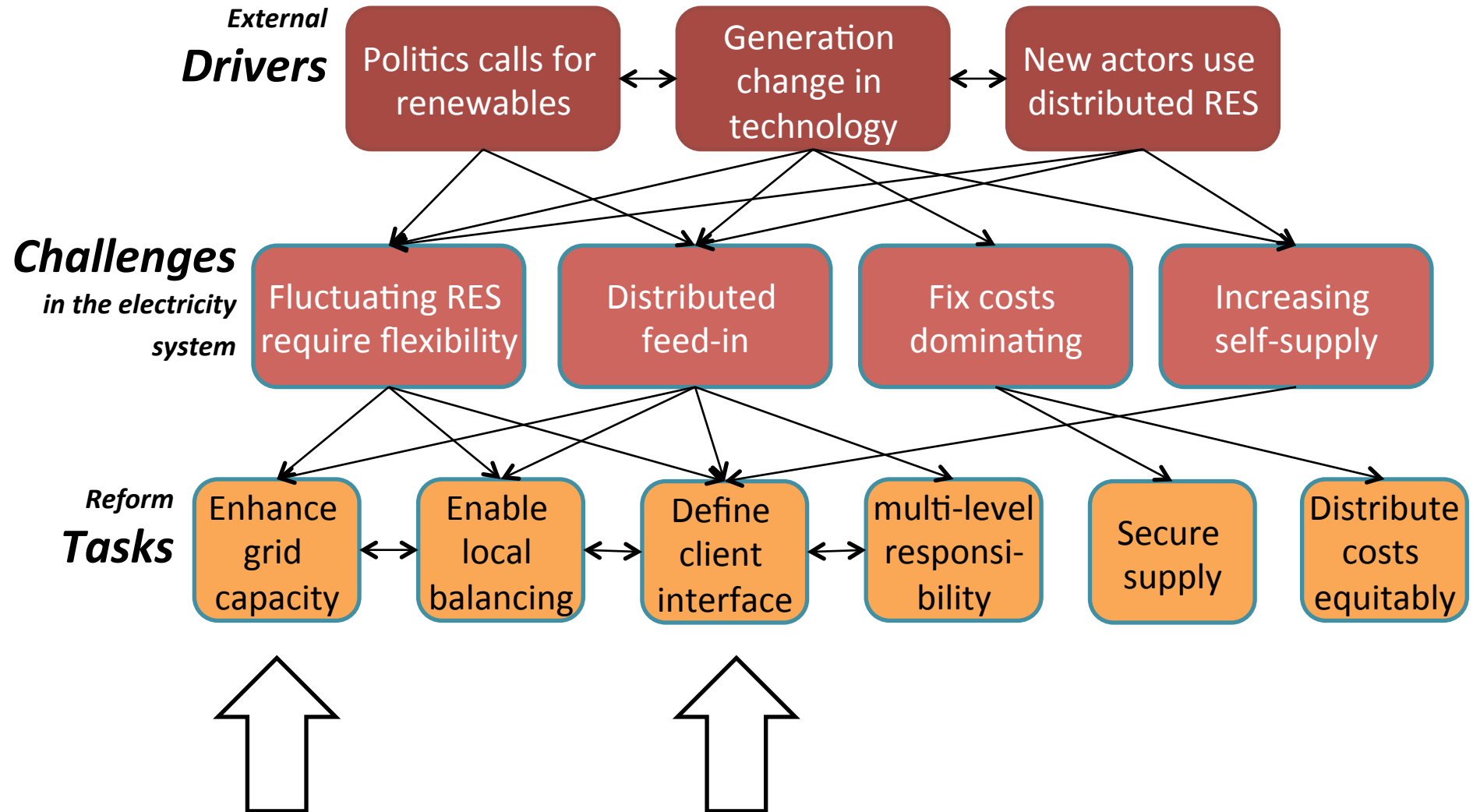
10%

of electricity
consumption

50% of electricity consumption is
directly used by industry and does not
flow through distribution grids

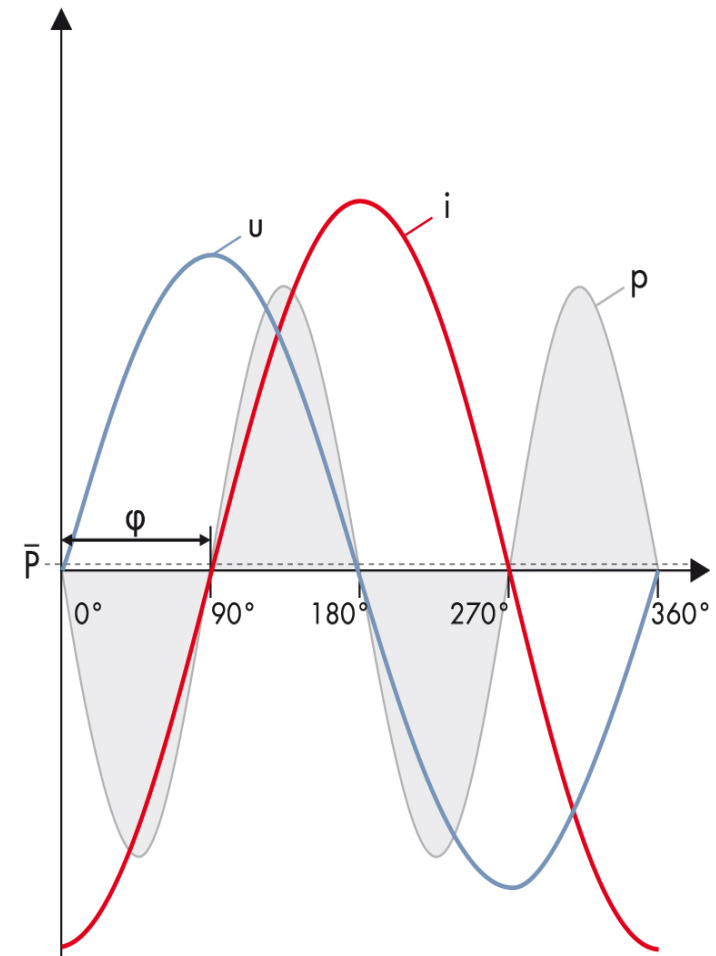
- Electricity sales flowing through distribution grids could drop considerably
- New tariff structures are needed

Drivers → Challenges → Tasks



Task 1: Intelligent grid capacity management in distribution grids

- In a series of regions in Germany reverse flows are already frequent
- Reverse flow in distribution grids can cause capacity problems
- **Adding conventional hardware to remove bottlenecks can be costly**
- **Over 80% of these costs can be saved by intelligent grid capacity management**
- Most capacity problems are caused by voltage problems as voltage patterns change. Two strategies can be combined to avoid them:
 - Controlling reactive power in the distribution grid
 - Installing controllable local network substations where this is not sufficient
- Peak shaving can be the next step, grid pricing
- Approaches differ strongly concerning the required information exchange



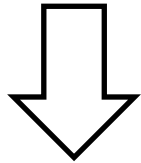
Task 2: Enable local balancing

- Delimitation ancillary services / volume market
- Local selling models
- Structuring of the balancing groups
- Grid fees
- Local markets

Task 3: Interface public system / client: external control or autonomy of the consumer?

Direct control by utility/DSO

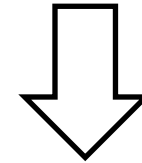
- Calculable reaction
- Immediate response
- Short-term control concept



- High data volume exchange
- High requirements for technical interface (smart meters)
- Data security issues
- Local optimisation more difficult

Control over price signal

- Price signal from supplier
- Manual or programmed reaction
- Contracts / learning of bulk effects



- Low requirements for data exchange: only price signals and cumulated consumption / supply
- Market design needs to deliver time and location dependent price signals, stronger dependency on kW
- Combines with decentralised grid stabilisation concepts

Task 4: Multi-level responsibility

Top-down supply system (central control)

load generation storage balancing

nuclear
coal
lignite

hydro &
storage

generation

load storage

industry

industry

household

commerce

services

consumers



Multi-level exchange system (subsidiarity, shared responsibility)

load generation storage balancing

offshore
wind

storage

International exchange

offshore
wind

hydro &
storage

industry

wind
PV
biogas

storage

industry

wind
PV
biogas

storage

Distribution Grid

PV

household

PV

commerce

PV

services

prosumers

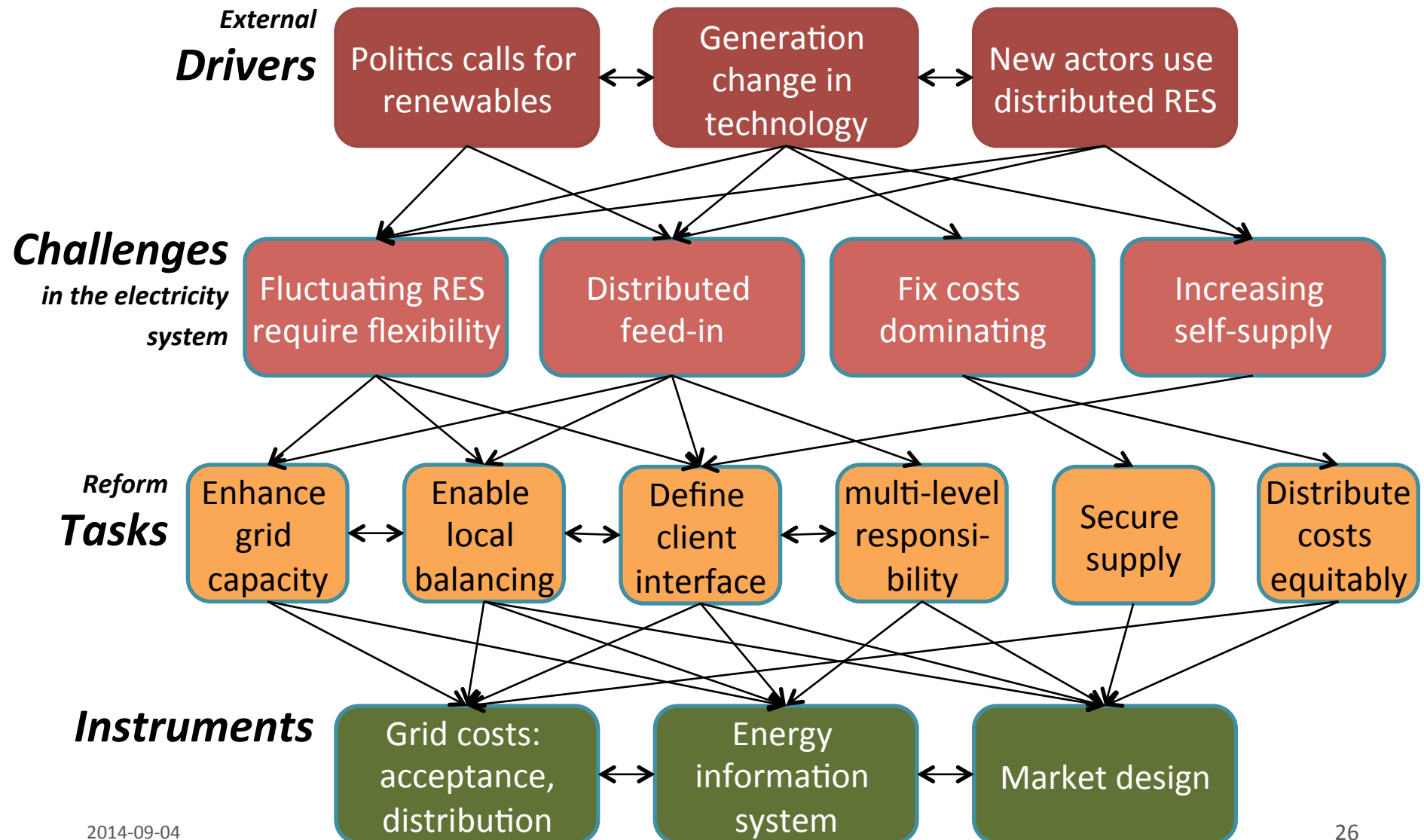
generation

load storage

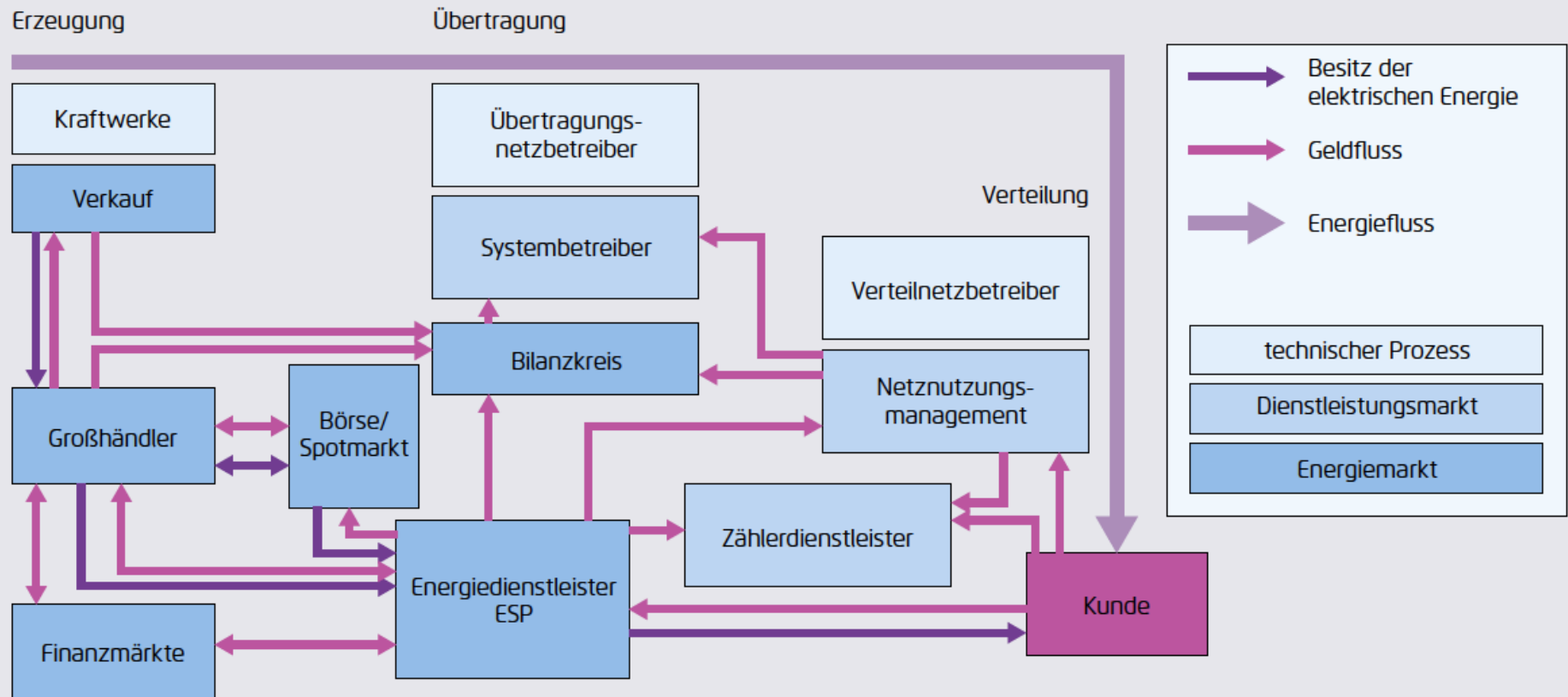
generation

load storage

Drivers → Challenges → Tasks → Instruments



Strong interests in a complex system: Lack of Transparency, Conflicts, Resistance to change



Outlook

- Turbulent change of the electricity system
- Increasing costs of the public system
- Increasingly interesting private solutions
- Strong efforts needed for adapting the system to new challenges, maintaining a reliable, affordable, public system
- Who pays the bill for the transformation?
- Public debate more and more confused
- Transparency !

Thank you

Ruggero Schleicher-Tappeser
sustainable strategies
www.schleicher-tappeser.eu