Energy Efficiency and ICT in Germany – Opportunities for New Business Ideas in the Transformation of the Energy System

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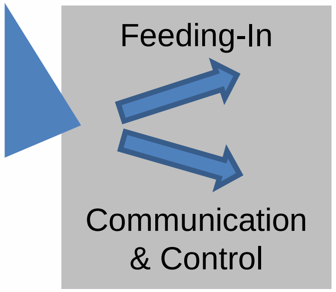
Agenda

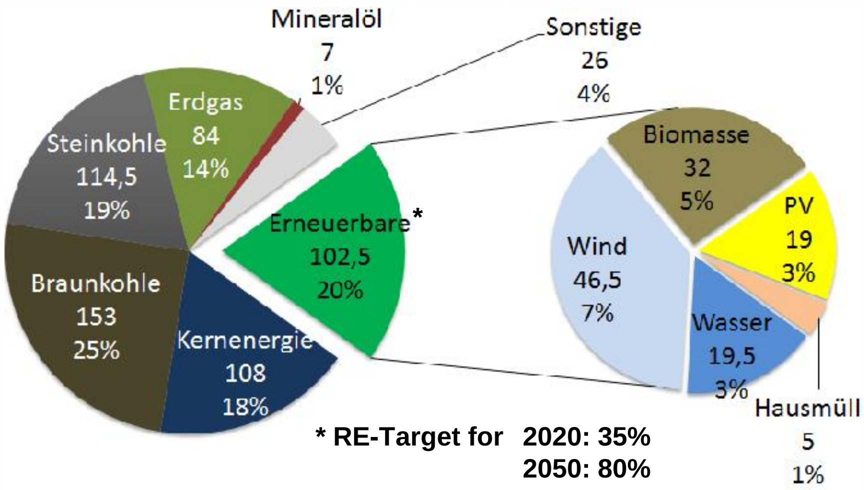
- The change of our energy system
- ICT as part of the solution – A huge challenge for the ICT industry
- Business models – enabled through ICT in the energy system
- Conclusion

Conventional Power plants (fossil und nuclear) generate electricity depending on the demand and feed into the high-voltage grid

Generation

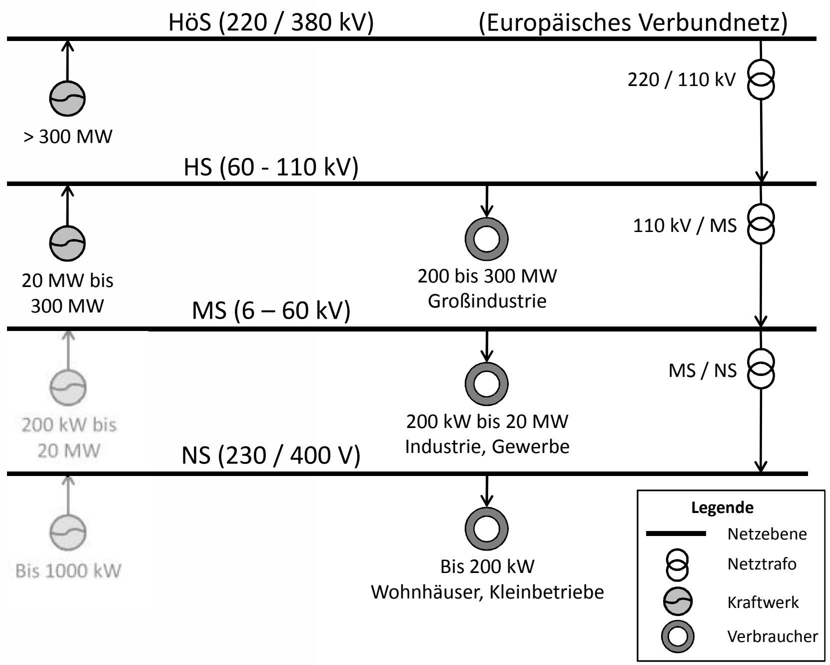


Gross Electricy Production in Germany in the year 2011 in TWh:



*** RE-Target for 2020: 35%**
2050: 80%

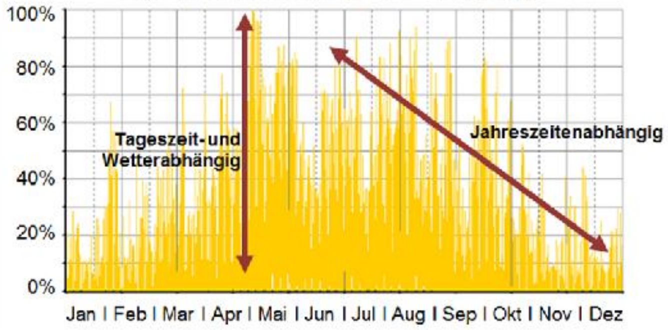
Voltage levels of the electricity grid



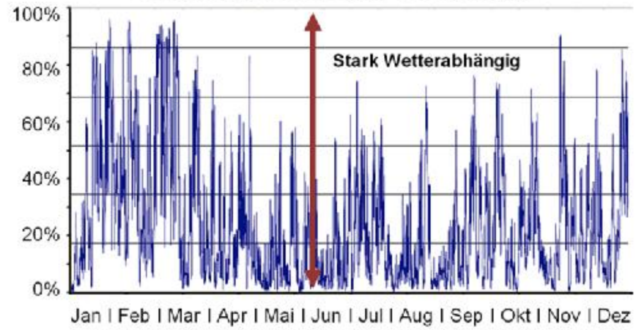
Sources: AGEB (2012), BMWiBMU (2010), Römer (2010)

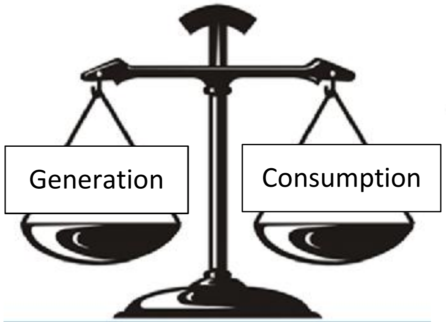
The feed-in of renewable energies into the distribution grid and increasing non-controllable volatility of the generation leads to increasing strain in the grid

Schwankende Leistung - PV-Erzeugung

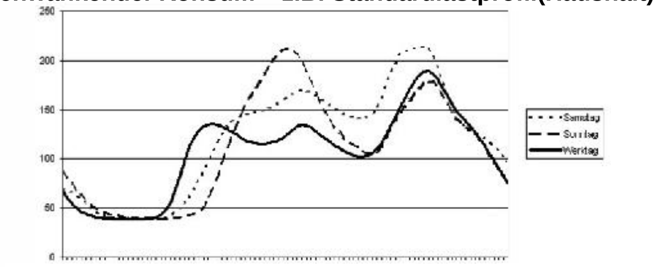


Schwankende Leistung - Windenergie



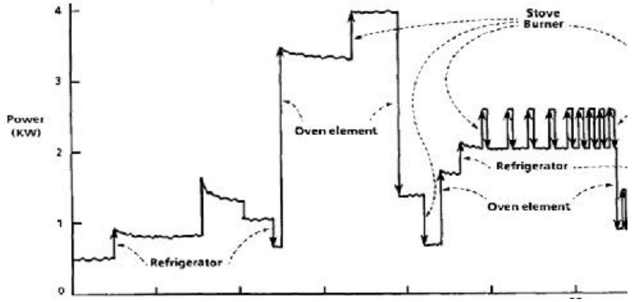


Schwankender Konsum – z.B. Standardlastprofil(Haushalt)



Unregelmäßige Schwankungen [1 Tag]

Schwankender Konsum – z.B. Einzelner Haushalt



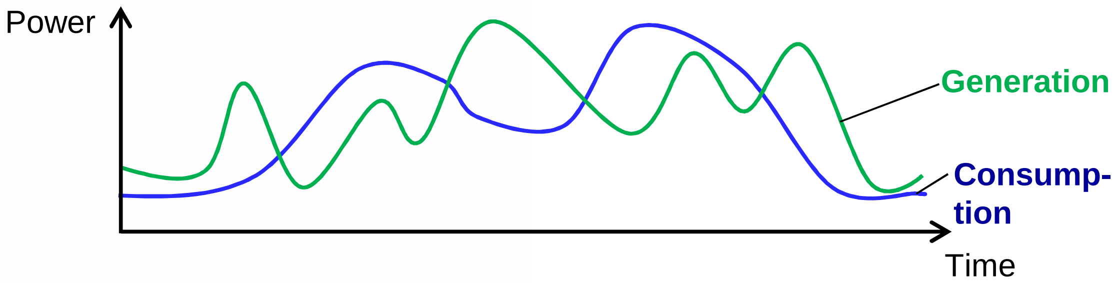
Unregelmäßige Schwankungen [1 Stunde]

- At the moment, it is not possible to store a huge amount of electric energy in an economically efficient way. Thus, the following equation needs to be fulfilled in every second: **Generation = Consumption**
- With heavily increasing **volatility** in electricy generation, the consumption needs to be adapted often and in a significant way
- This is an **enormous challenge** for the energy supply industry

Image Source: Hart (1992)

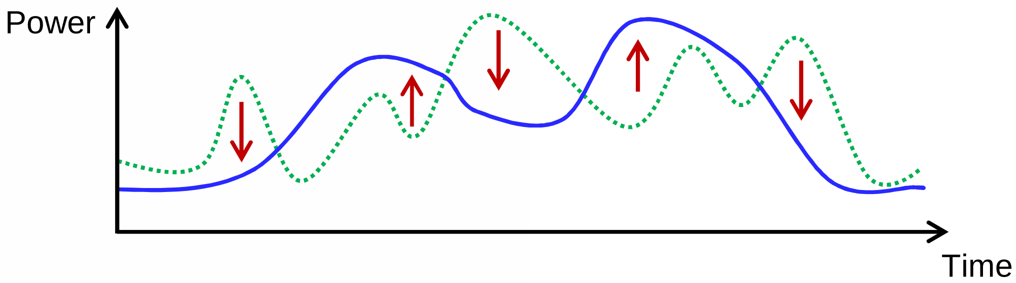
There are two approaches to handle volatility – Besides the adjustment of the generation, it is possible to adjust the consumption

Basic problem of volatility: Independent fluctuation of consumption and generation from renewable energies



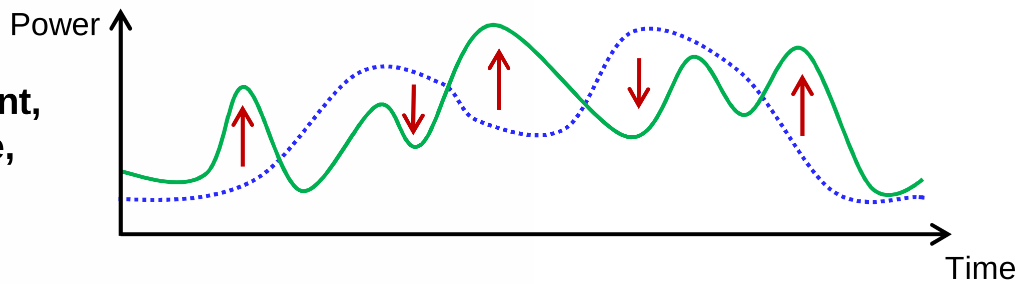
1

consumption-oriented generation:
e.g., pumped-hydro, batteries, e-mobility (with feeding-back), …



2

generation-oriented consumption:
e.g., demand side management, flexible prices, virtual storage, E-Mobility (intelligent charging), microgrids, …



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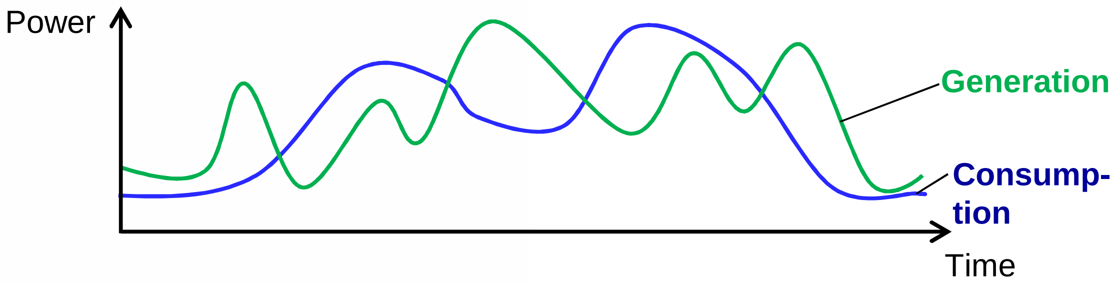
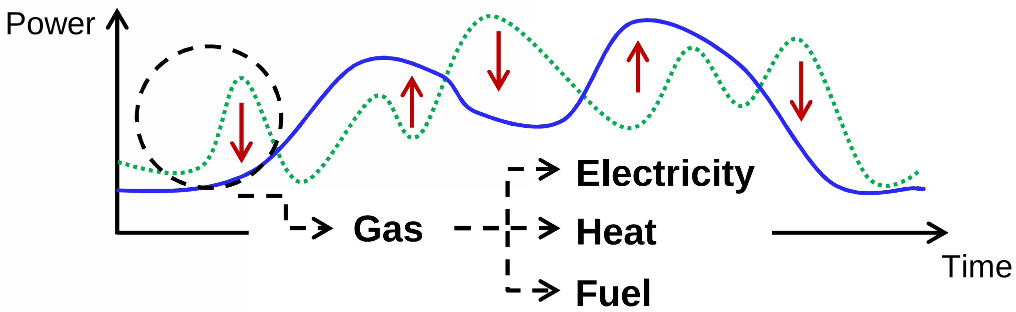


1 **consumption-oriented generation:**
e.g., pumped-hydro, batteries, e-mobility (with feeding-back), …



2 **generation-oriented consumption:**
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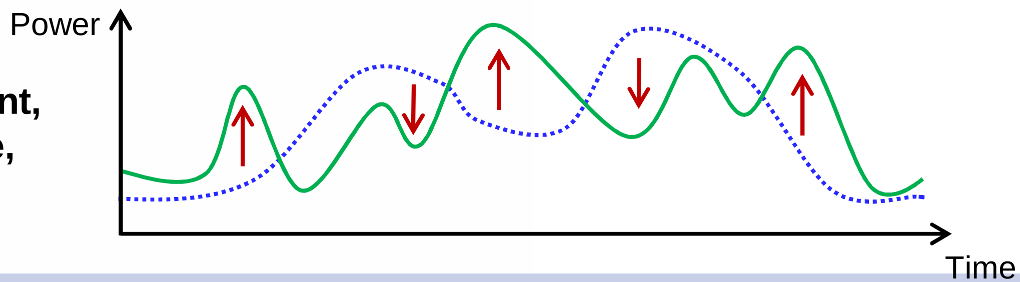


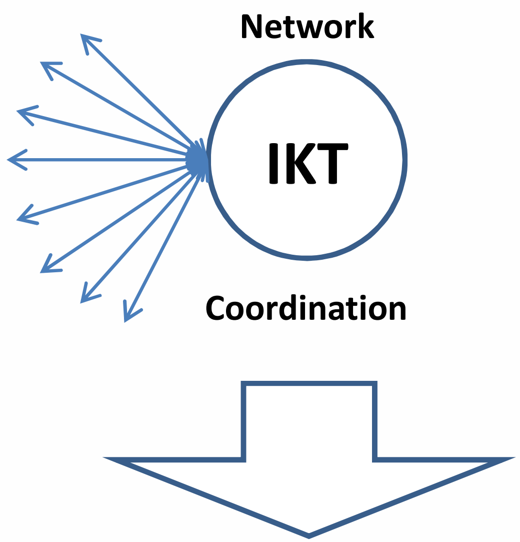
Power-lead hybrid grids: Conversion of electric energy in another grid-bound form of energy (integrated coordination with the gas grid)

ICT is a central part of most approaches to solve the challenges of future energy systems

The energy system of the future will be a combination of many solution components

Solution components

- Pumped-hydro (limited potential)
- Extension of power lines (cost-intensive)
- Smart metering
- Flexible tariffs
- Microgrids
- Demand side management
- Electric mobility
- Virtual power plants
- Decoupling of generators
- Battery systems
- Power-to-Gas
- …



Interconnectedness and coordination between all solution components necessary

Controlability also necessary in the distribution grid

EENERGY **Smart Grid**

Paradigm Shift: From demand-oriented generation to generation-oriented consuption

Huge challenges for the ICT industry

The challenge for the ICT industry is to fulfill the numerous requirements of the future energy grid

E-ENERGY **Smart Grid** = Energy system + Information and communication technologies

requires

- Standardized interfaces
- Standardized compontents
- Data / privacy protection
- Reliability
- Availability
- Confidentiality
- Integrity
- Open data platform to enable new services
- Enabling of forcasting / prognosis services
- Operating safety
- …

- Coordination of a significantly bigger number of actors in a complex energy system
- IT-Security
- Data transfer across company borders
- Interoperability of components from diverse manufacturers and companies
- Scalability of systems
- Real-time requirements
- End-to-End QoS-Requirements
- Services for authorization, authentication and finding and access to resources
- …

Besides the challenges, the combination of ICT and the energy system offers numerous new business opportunities

EENERGY **Smart Grid** = Energy system + Information and communication technologies

enables

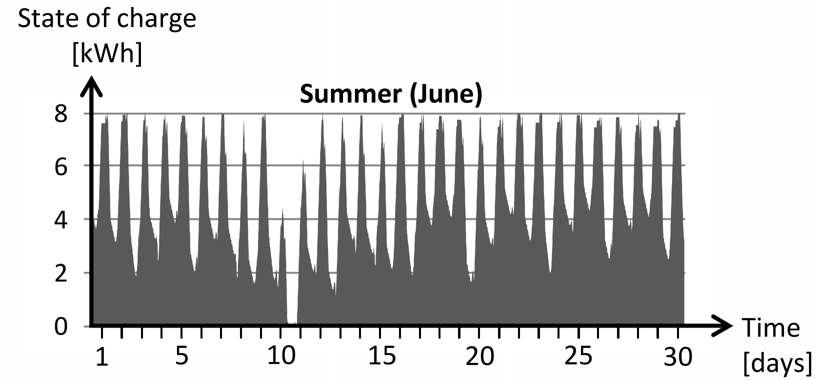
Countless new innovative eEnergy Products and Services

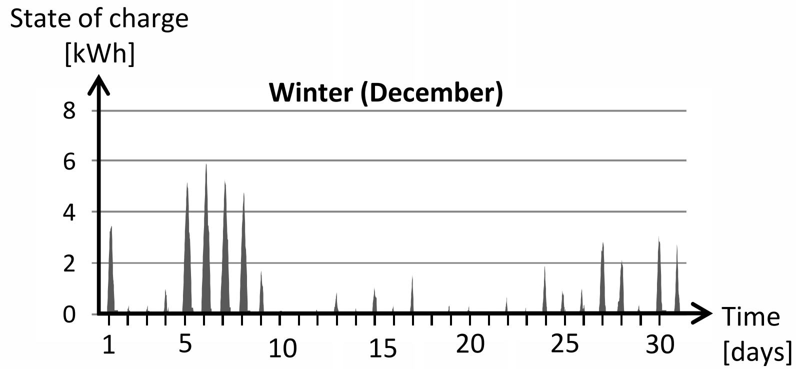
- Providing an overview of the customers energy consumption
- Combined energy storage systems
- Balancing energy via virtual power plants
- Recommendation services for new energy saving devices
- Offering of special green tariffs
- Enabling customers to control their household devices by smart phones
- Using storage systems for a variety of services
- …

- Storing wind energy when prices are low and feed electricity back into the grid in times of low production
- Direct Marketing of power from small photovoltaic power plants
- „Intelligent“ devices: automated control of devices like heat pumps and refrigerators depending on electricity prices
- Recomending systems for tariffs
- Using electric cars as mobile storages
- …

In the near future ICT and flexible tariffs can increase the degree of storage utilizati and thus the profitability of solar batteries for solar home systems

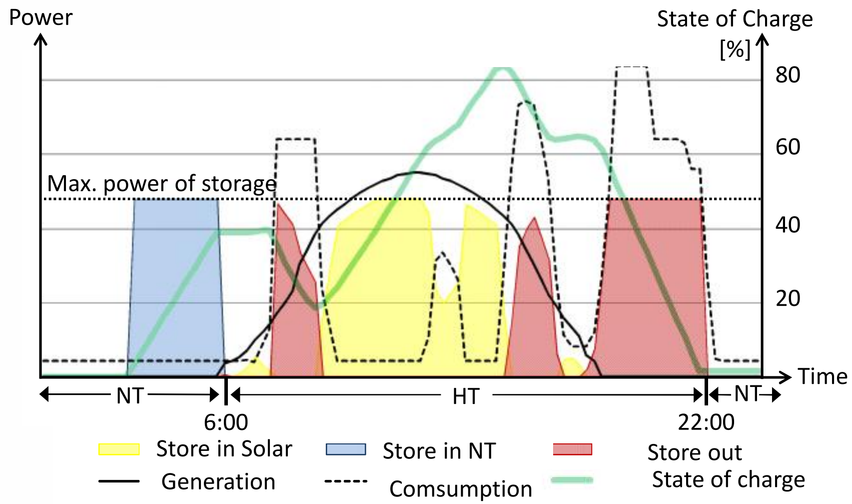
1. Business model example





Idea:

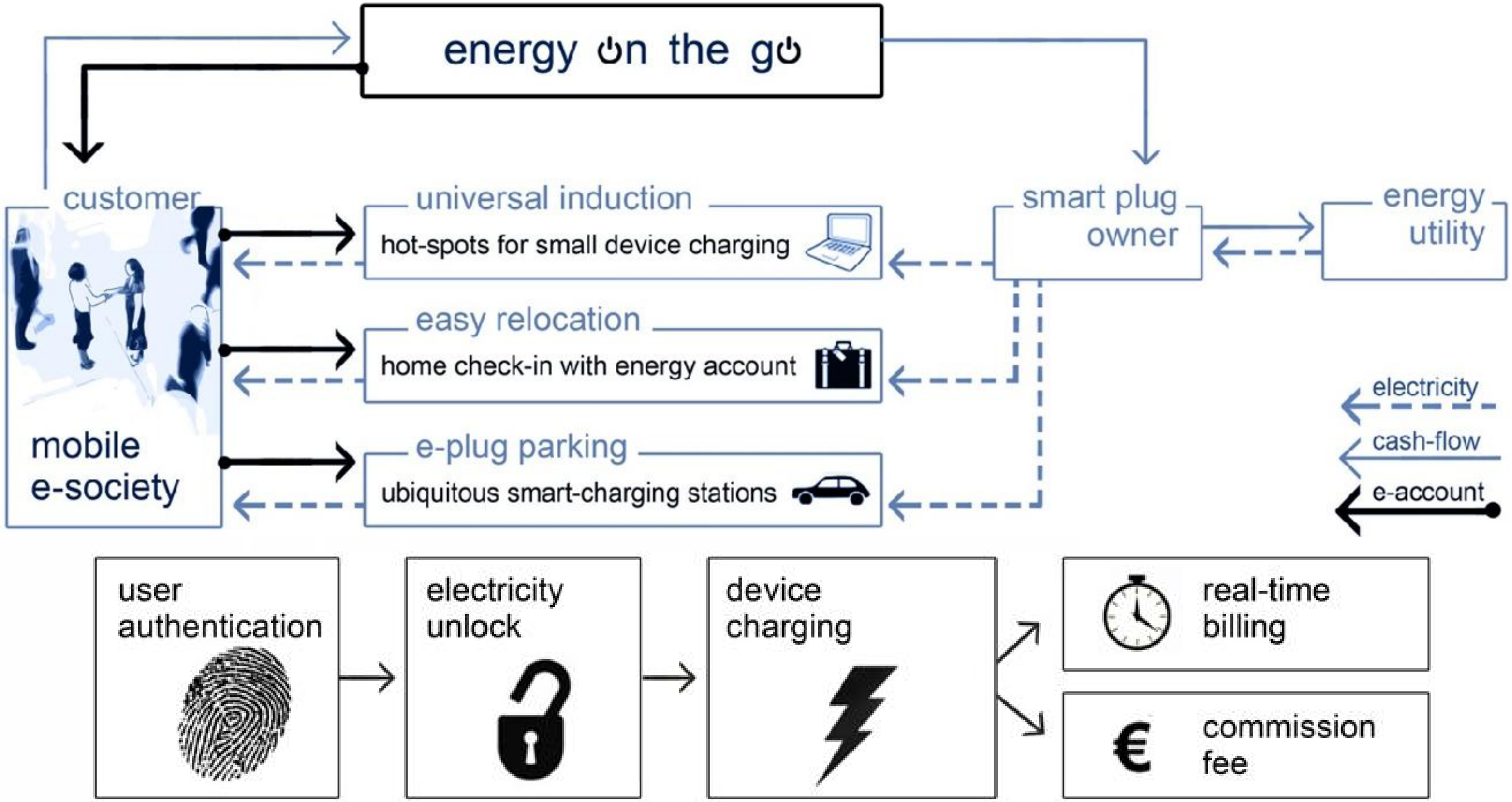
Do not only store solar energy, but as well cheap energy from the grid at times of overproduction as we will have time variable electricity tariffs (EnWG).



Sources: Römer (2010), Römer und Lerch (2010)

Energy on the go – An ICT-based integrated energy accounting management system provides customers with mobile access to energy everywhere

2. Business model example



Source: Result of a CDTM Trend Seminar project/ For further information see CDTM Trend Report "Smart Grid Infrastructures"

Partnerkraft – The mobile application as interface between customer and operator of a virtual power plant

3. Business model example

Functions & Interactions

- Using the calendar the customer adjusts the availability of the generation plant that is part of a virtual power plant
- On the smart phone she always gets an overview of her electricity production and her revenues

Source: Result of a CDTM Managing Product Development project

Core aspects

→ Profitability

→ Transparency

→ Ease of Use

Griddle – A software solution for microgrids in office buildings that involves and activates the employees

4. Business model example

Functions & Interactions

- Push Notifications
- Remote Control
- Gaming-Elements via points and award system
- Transparency through individual consumption

→ Aktivität & Motivation

- Visualization of the microgrid's status quo
- Pull Notifications
- High visability with large displays

→ Bewusst machen

Core aspects

→ Profitability

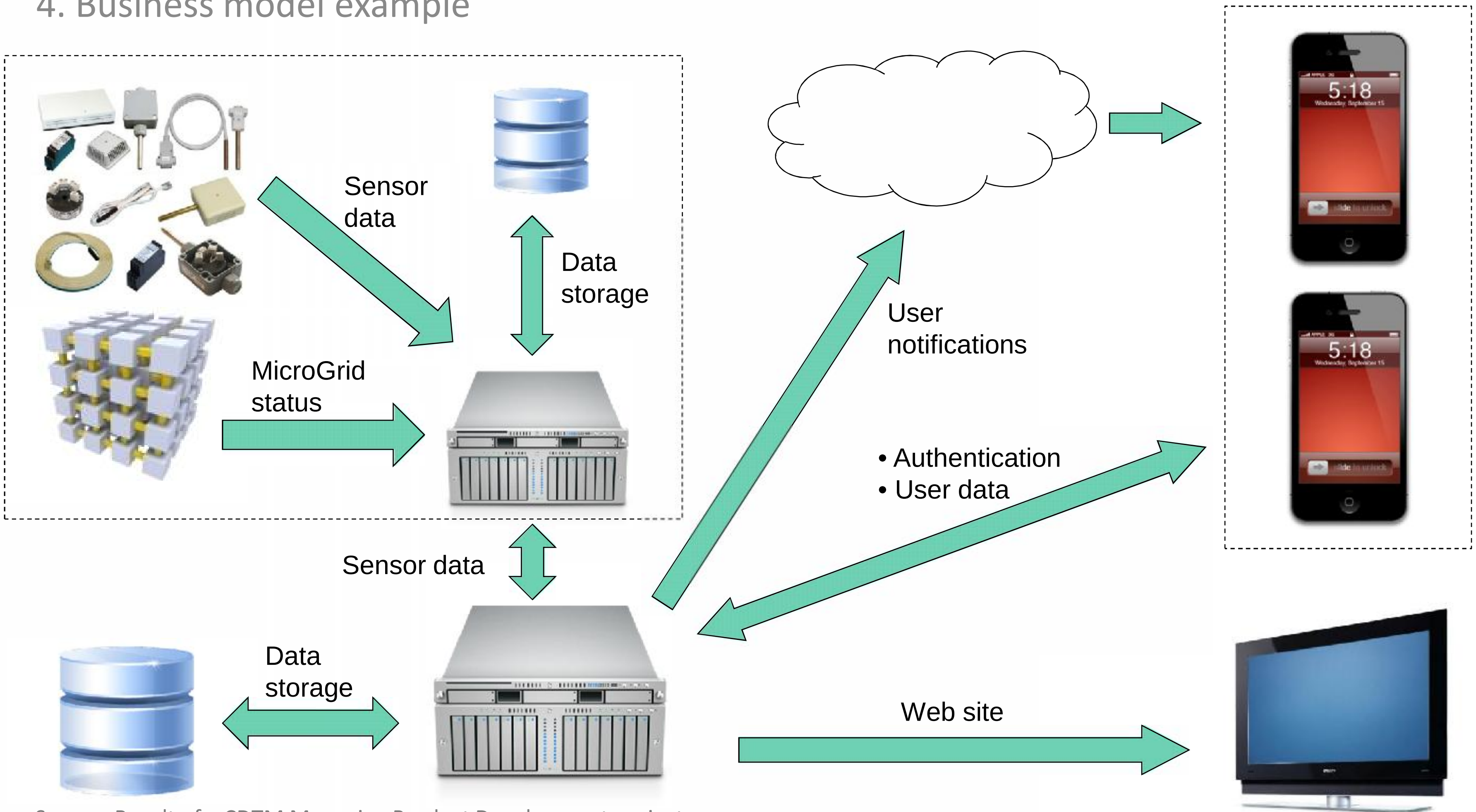
→ Transparency

→ Ease of Use

Source: Result of a CDTM Managing Product Development project

Prototype concept – ICT is key in the implementation of the griddle business idea

4. Business model example



Source: Result of a CDTM Managing Product Development project

There is a wide variety of different storage technologies – But: the currently installed capacity in the german electricity grid is very limited

5. Business model example

Storage capacity of the natural gas grid:

200 TWh

- **Installed storage capacity of all pumped-hydro plants in Germany:**

  0,04 TWh

"To shift fully to renewables, Germany needs to boost storage capacity by a factor of 500."
(The Economist, 2011)

*"**Konventionelle Stromspeichermöglichkeiten**, wie z.B. Pumpspeicher-kraftwerke oder Batterielösungen **können**, bezogen auf den Jahresverbrauch an Strom in der BRD, **eine Stromproduktionslücke nur im Minutenbereich ausgleichen**"*

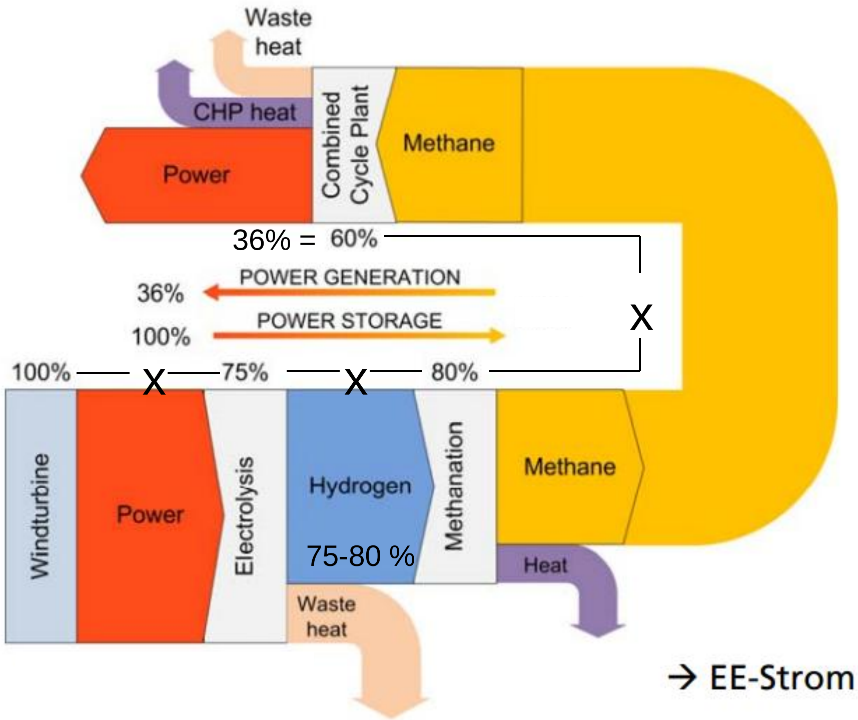
(Volk, 2011)

Hybrid grids: The storage capacity of the natural gas grid is a multiple of all currently available storage capacities in the electricty grid

Sources: Economist (2011), Volk 2011, Sachverständigenrat für Umweltfragen (2010)

There is a wide variety of different storage technologies – But: the currently installed capacity in the german electricity grid is very limited

5. Business model example



Low efficiency

75 – 80 %	to H2
60 – 65 %	to methane
35 – 40 %	to electricity
50 – 60 %	to CHP

→ EE-Strom wird zur Primärenergie

Efficiency:	**Medium-Low**
Investment:	**High**
Storage capacity:	**Very high**

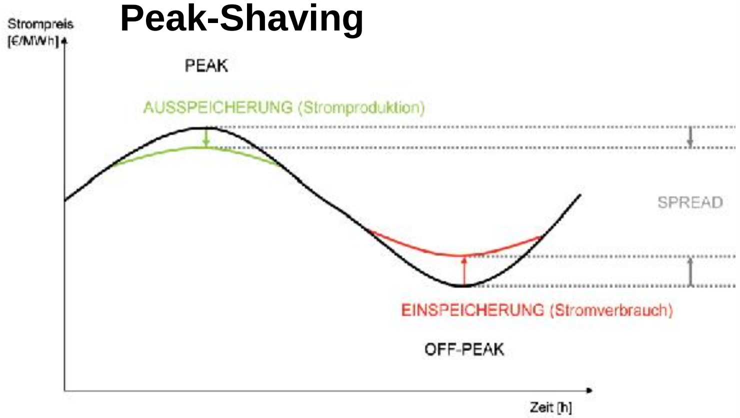
Hybrid grids are especially interesting for long-term storage and in comparison to an alternatively necessary shutdown of renewable energy power plants

Source: Jentsch , Sterner, Specht (2010) Image adapted from Jentsch, Sterner, Specht (2010)

There is a wide variety of different storage technologies – But: the currently installed capacity in the german electricity grid is very limited

5. Business model example

Peak-Shaving



- **Target: Maximization of intertemporal arbitrage**
- **Storing in of low-priced electricity**
- **Storing out at situations of high electricity prices**
- **Exploiting as balancing energy seems more attractive**

Because of the low PtG-efficiency the use of PtG-storage (with current electricity prices) is from an economic perspective not attractive.

Example from the persepctive of an industry player as operator

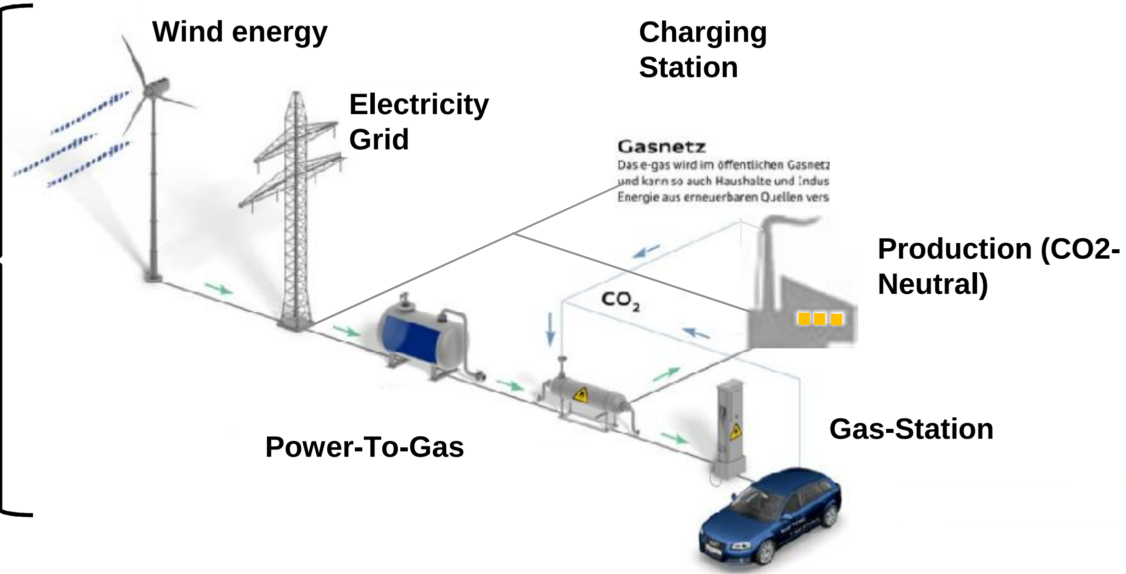


Image adapted from http://www.audi-balanced-mobility.de

Conclusion

ICT will be an important **part of the future energy grid**

ICT and the energy sector have to fulfill **numerous complex requirements**

Huge opportunities for **countless new business models** for smart grids

New business models need to be **transparent and economical**

New systems need **interfaces with good usability**

Users like to stay in **control of their data and devices/facilities**

Smart grids have to create **benefits for all involved stakeholders**

Thank you for your attention

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