IT SOLUTIONS FOR RENEWABLE ENERGY SYSTEMS AND ENERGY EFFICIENCY

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Fraunhofer Institute for Solar Energy Systems ISE

Asia-Pacific Week Berlin 2019:
Seminar on the »Efficient use of Energy with IT«

Berlin, May 15th 2019

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AGENDA

- The need of IT solutions for energy system transformation
- Digitization of the energy system transformation – Examples
- Conclusion

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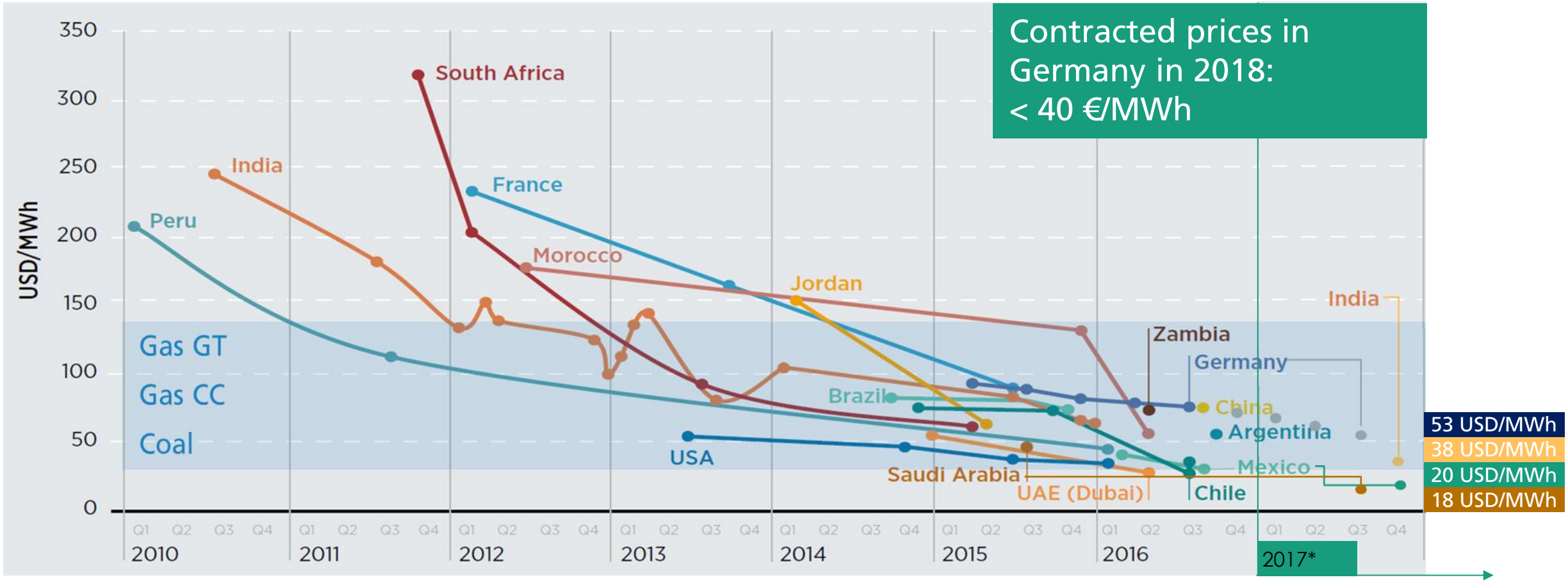
Average prices for photovoltaic electricity
January 2010 - December 2017



Source: Renewable Energy Auctions 2016, IRENA
* Source: Fraunhofer ISE

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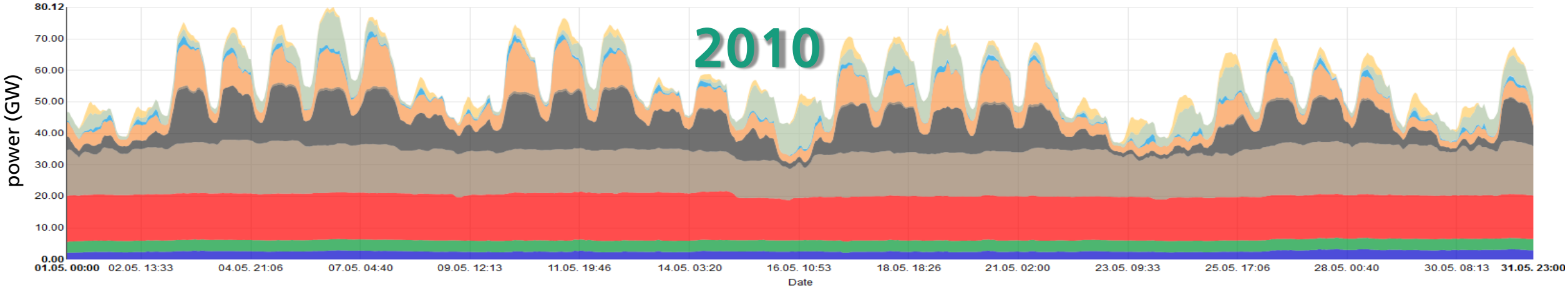
Electricity Production in Germany in May 2010 and 2018

Fraunhofer ISE Energy Charts



Stacked
Expanded
Import Balance
Hydro Power
Biomass
Uranium
Brown Coal
Hard Coal
Oil
Gas
Others
Pumped Storage
Seasonal Storage
Wind
Solar

Source: www.energy-charts.de

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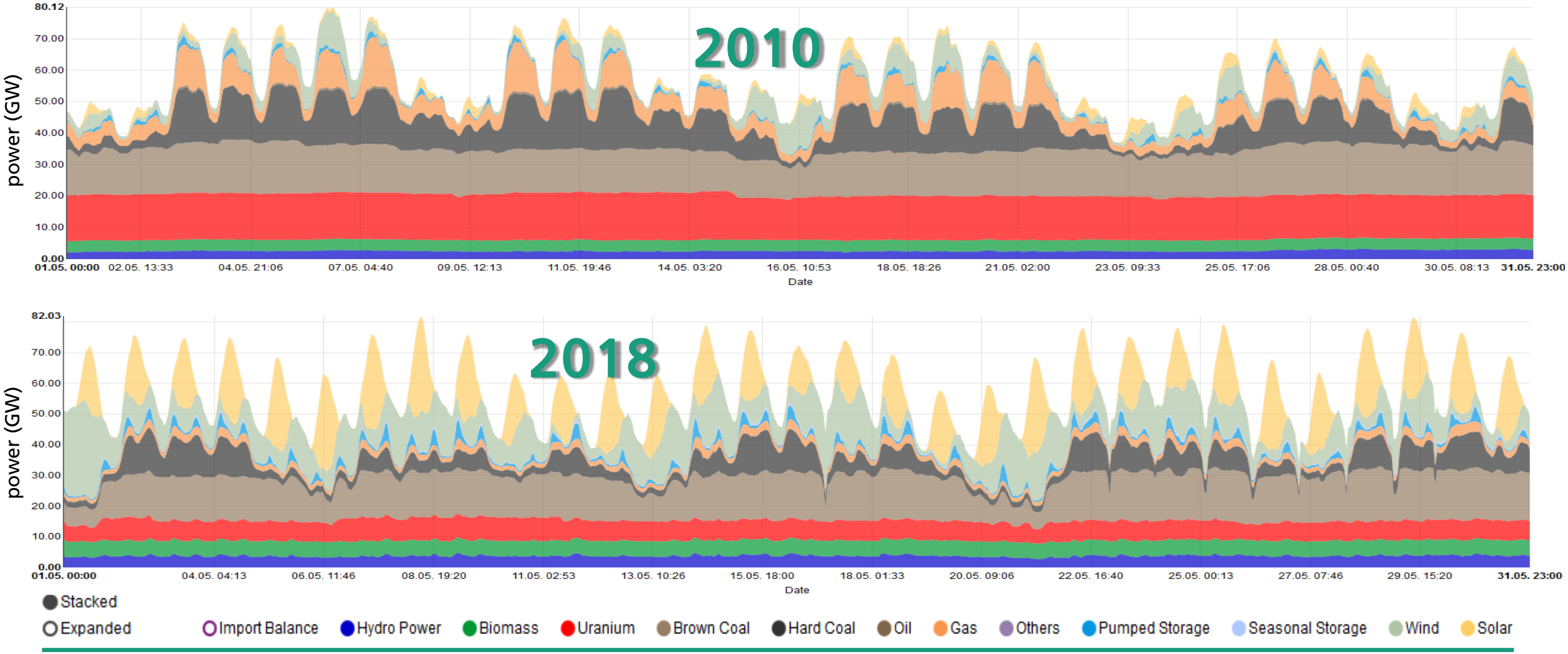

Source: www.energy-charts.de

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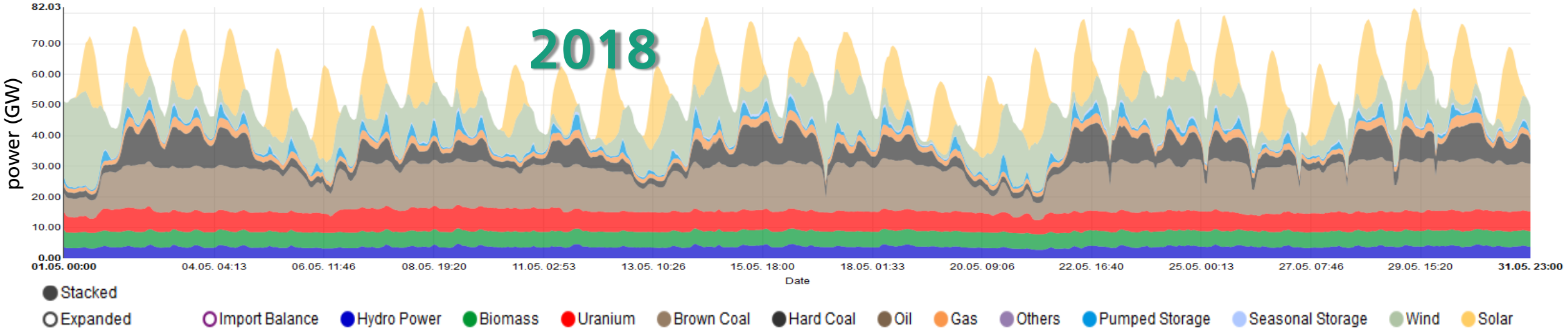
Electricity Production in Germany in May 2010 and 2018

Fraunhofer ISE Energy Charts

➔ Increased volatile production, price variations, negative residual loads, bottlenecks in transmission grids, reliability concerns (SAIDI), …



Source: www.energy-charts.de

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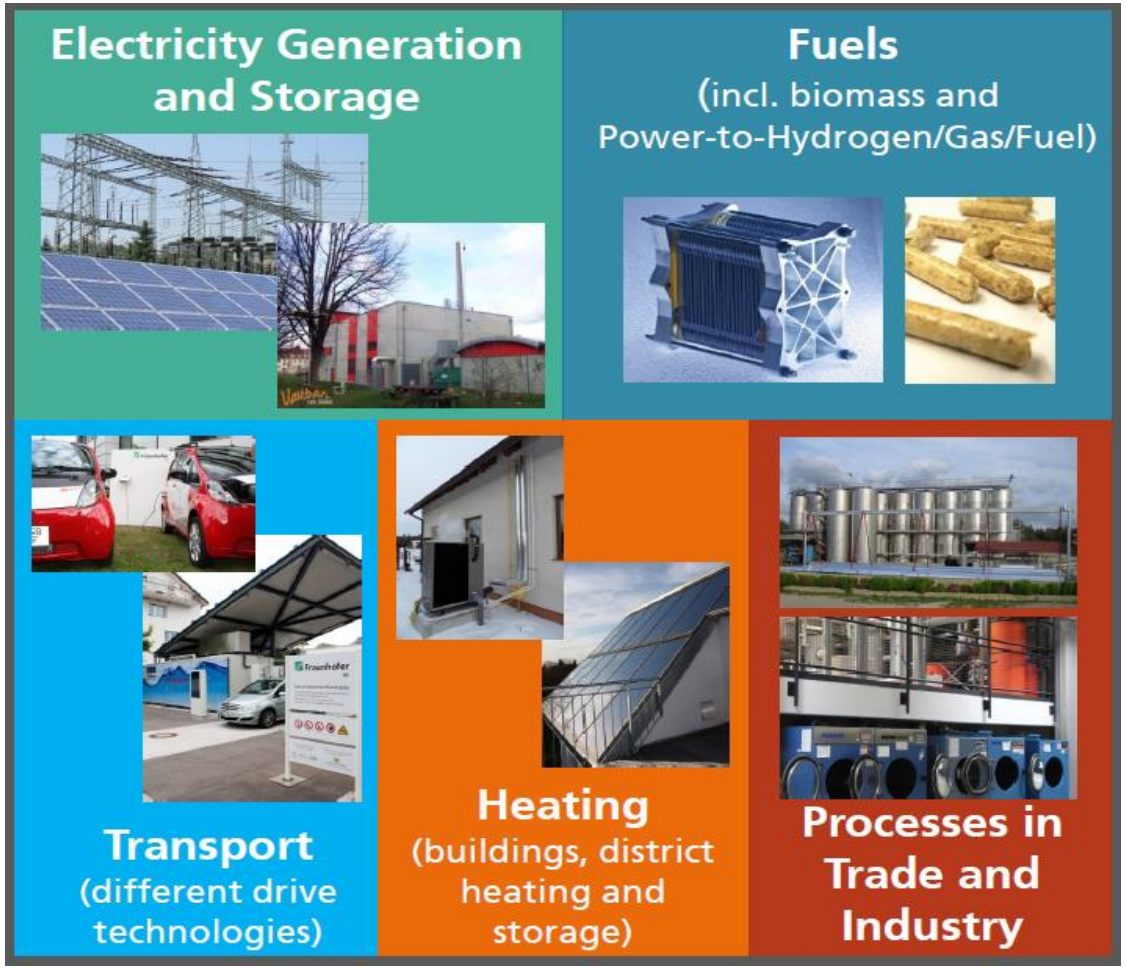
Renewable Energy Model »REMod«

Mimimize total cost →



Strictly model-based techno-economic optimization of transformation pathways based on comprehensive simulation of energy systems (hourly time scale)

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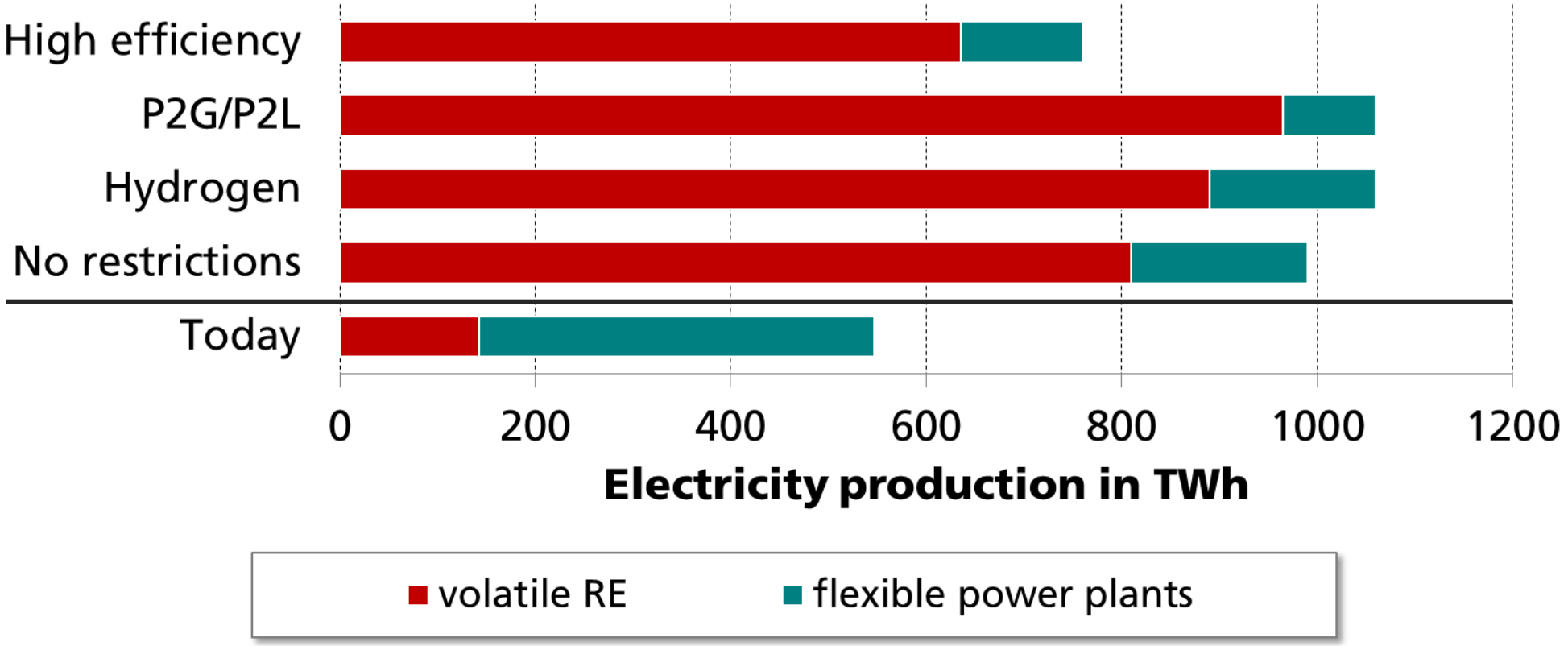
Study by the German academies of science
Investigated transformation pathways

Scenario	CO_2 goal	Major characteristics
No restrictions	Minus 85 % in 2050 (compared to 1990)	❑ No limits for direct electricity use (e.g. heat pumps, transportation)
Hydrogen		❑ Transportation with majority of hydrogen / fuel cell drive trains ❑ High fraction of H_2 in gas network
Power-to-Gas Power-to-Liquid (P2G/P2L)		❑ Transportation with majority of fuel/methane based drive trains ❑ Building heating partly based on methane ❑ Good progress in efficiency in industry
High efficiency		❑ No limits for direct electricity use ❑ Good progess in implementing high efficiency technologies ❑ Good progress in reducing energy demand

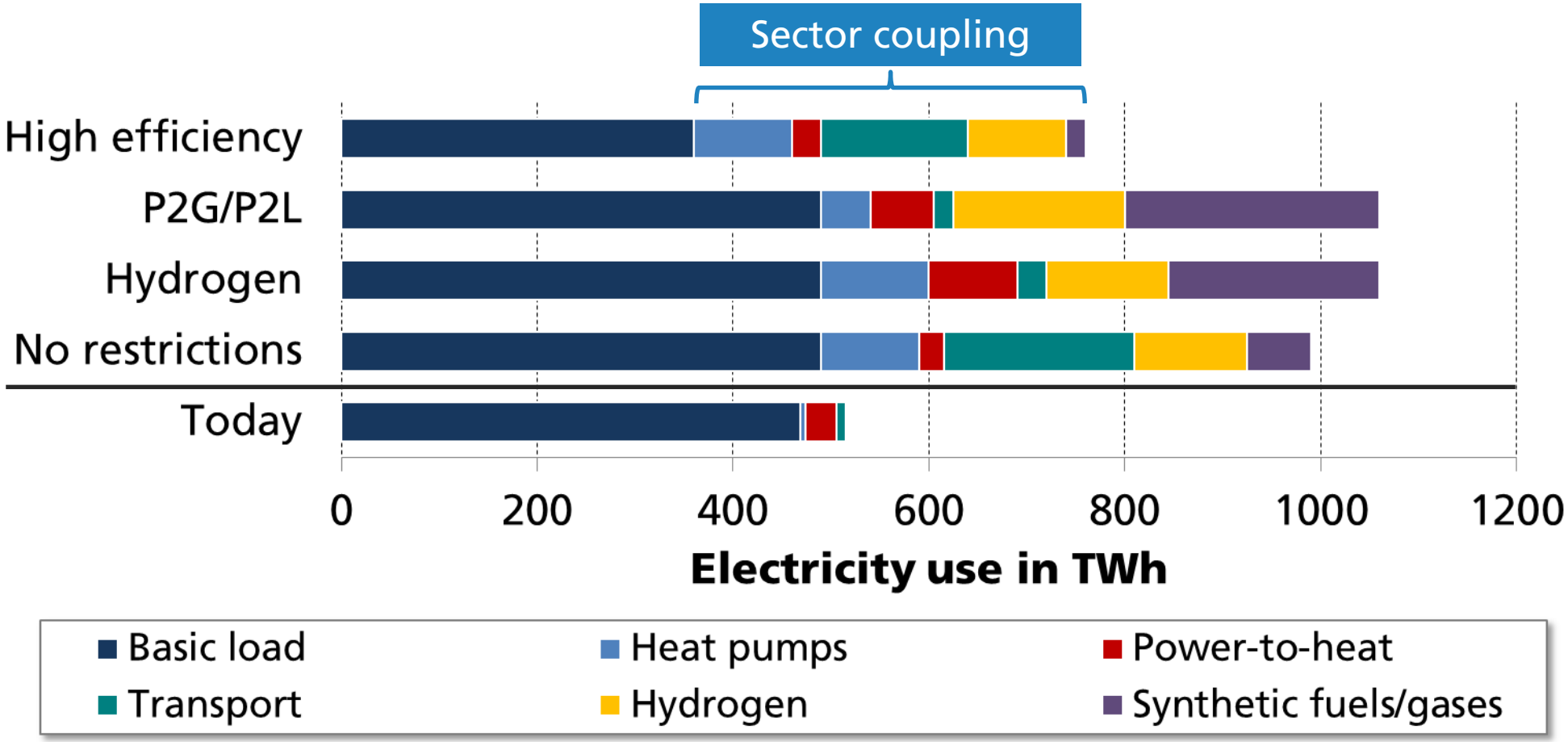
Electricity production

Annual energy in TWh in 2050 and today

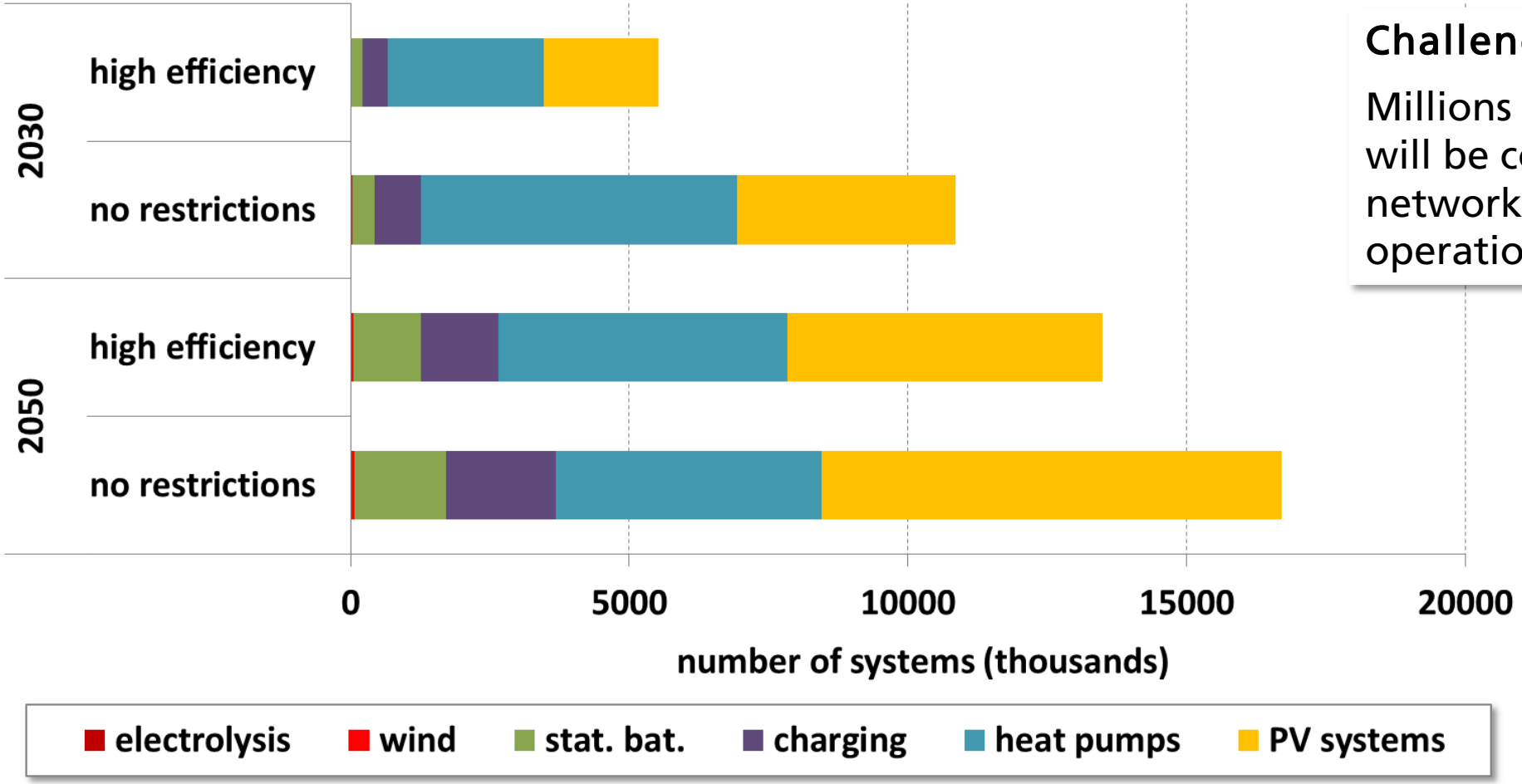


Electricity use

Annual energy in TWh in 2050 and today



Numbers of units for key components in the electricity grid

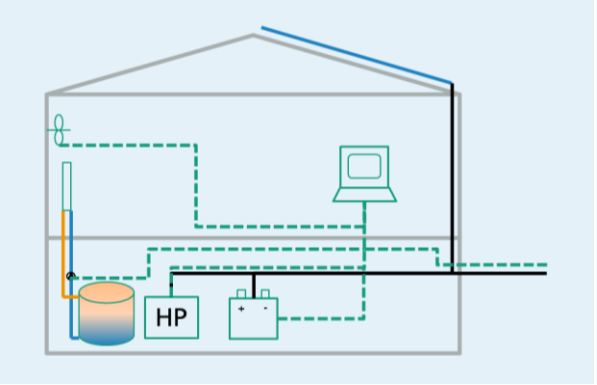


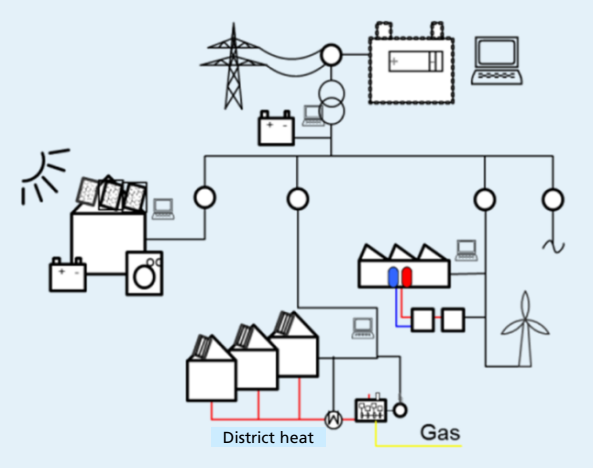
Challenge

Millions of systems which will be connected in an IT network to enable flexible operation and management

Paradigm shift in the supply model
Fluctuating renewable energies as a game changer

- High shares of **fluctuating, non-controllable renewable power** require a paradigm shift in the supply model
- Today's demand-based provision of energy by large power plants is replaced by **continuous rebalancing** between provision and use by
  - **flexible use** of generation and storage facilities,
  - **temporally adapted energy use** (demand response, load shift),
  - **strong coupling** of the sectors electricity, heat and transport,
  - integration of modern **forecasting methods for generation and consumption**
- **Extensive use of techniques and methods of digitization** is mandatory for success of organization and **management** of an increasingly complex system



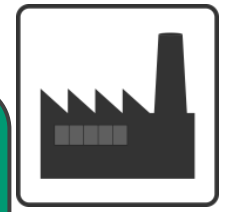


Digitization in the energy system
Fields of application

Generation
- production forecast
- virtual power plants
- predictive maintenance

Sector Coupling
- Power
- Heat & cold in building sector
- Process heat
- Transportation

Energy end-use
- demand forecasts
- load management
- optimized operation



Grids
- real-time data
- automated M & C
- management of system services

Trade & Distribution
- virtual market places
- peer-to-peer
- trade in system services
- time-variable tariffs

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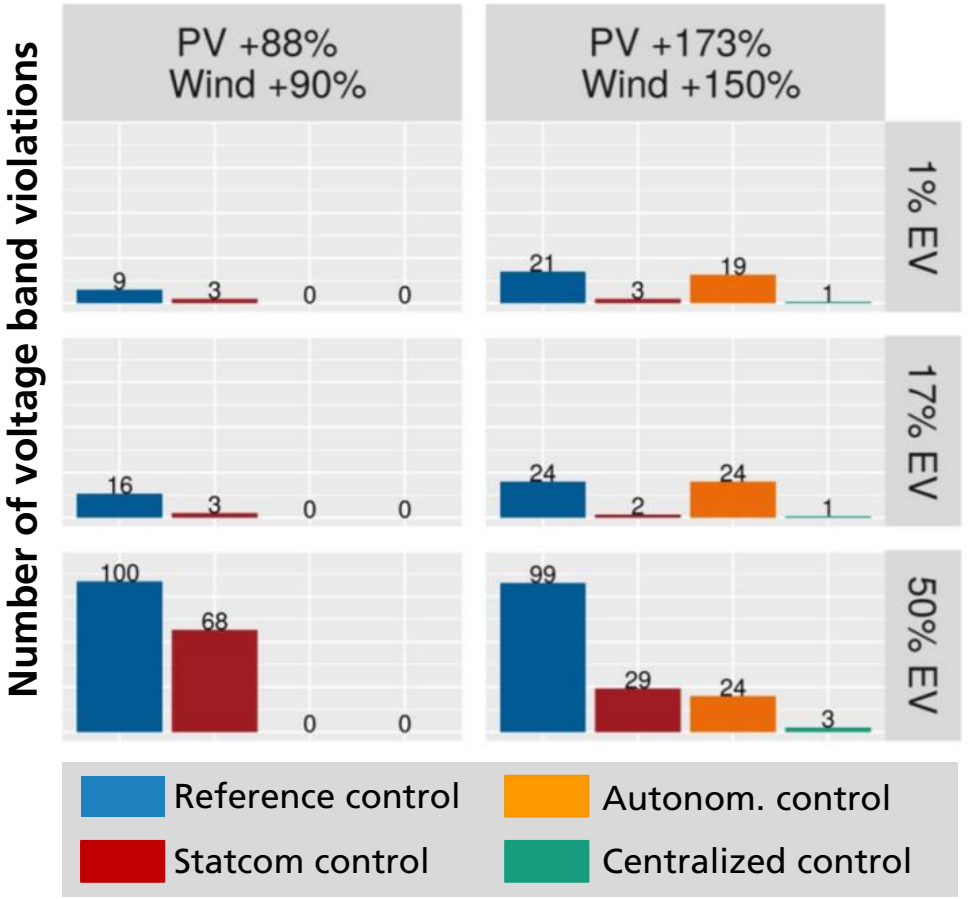
Example: medium & low voltage grid in northern Germany

Adaptive distribution grid operation – avoiding voltage band violations

- Voltage band violations depend on expansion of fluctuating RE, electric vehicles (EV), heat pumps and on control concept
- Local node control is not sufficient for scenarios with more PV, EV, HP
- Digitization and shared (centralized) control avoids LV/MV grid reinforcements

➔ Strongly increased installation of renewable energies and electric vehicles possible without extensive grid extension



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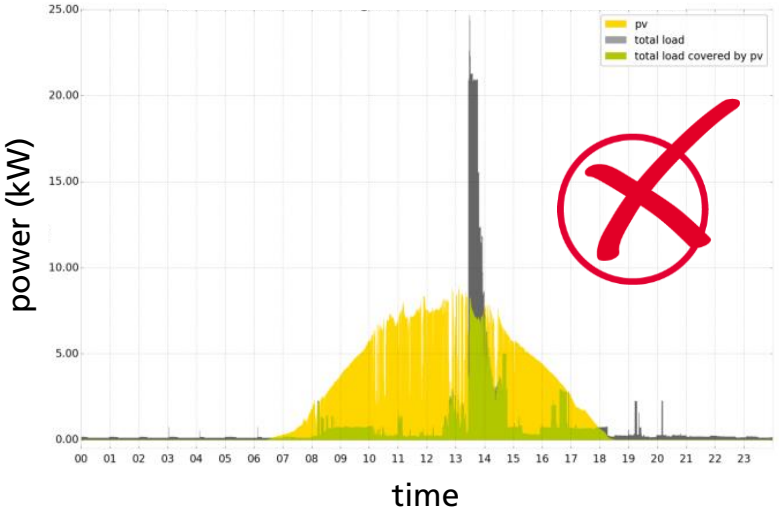
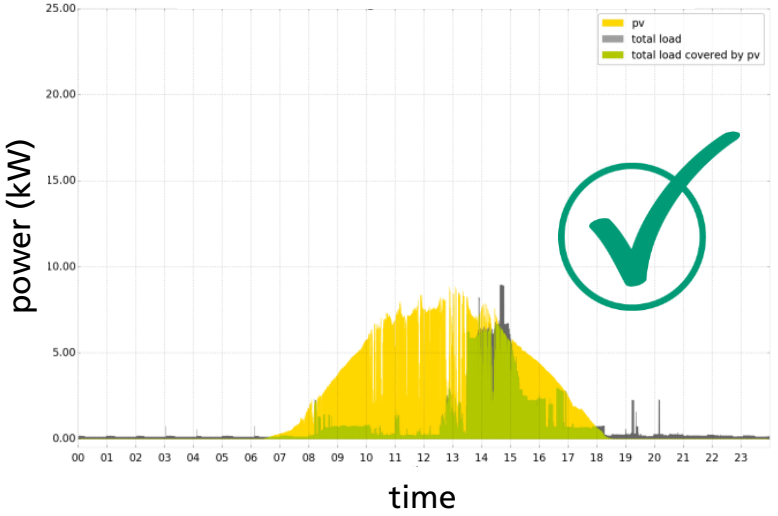
Example: Consumption

Empowering grid and infrastructure

- Peak management on grid level, ensuring grid stability
- Home energy management and smart charging: Charging can be aligned with local photovoltaic power generation
- Forecast-based energy management algorithms for optimal charging strategy
- Maximizing self-consumption and grid stability

example day: 26.03.2016





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Example: Prosumers

ENIT - Energy management for industrial companies

Spin-off of Fraunhofer ISE

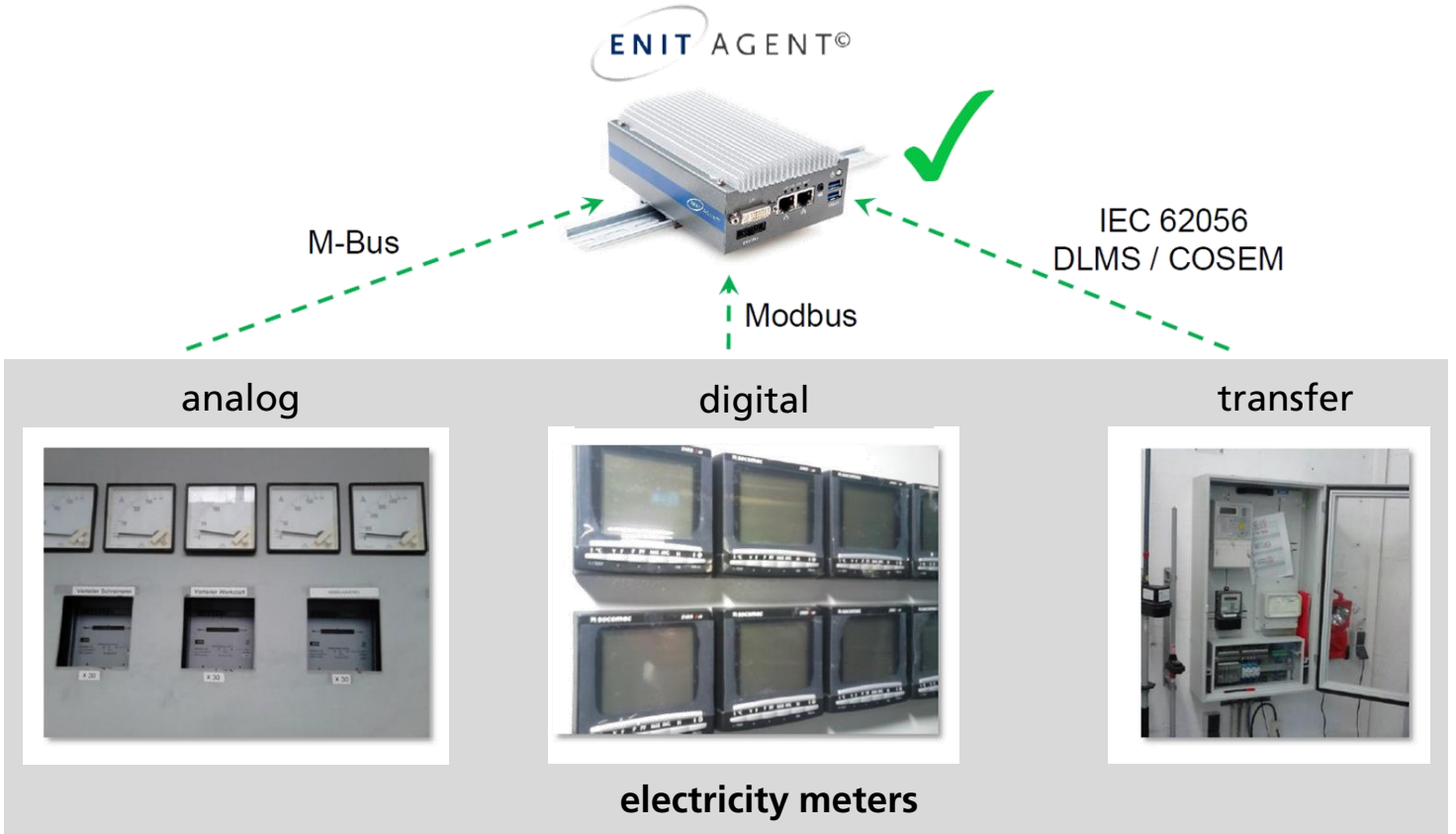
Monitoring and control systems for decentralized energy systems:

- transparency about electricity, heat and gas consumption
- intelligent system control and more efficient operation
- tailored to the needs of small to medium-sized companies

➔ **peak load reduction**

➔ **fault detection**

➔ **integration of energy data into controlling / ERP systems**



ENIT SYSTEMS

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Example: Prosumers
mondas - Intelligent system monitoring

Spin-off of Fraunhofer ISE

Application in solar parks, combined heat and power plants, compressed air systems, heat transfer stations and building services engineering:

- Merge plant data
- Systematic and automated error analysis
- Predictive maintenance
- Derivation of concrete instructions for action

➔ **Reduced maintenance effort**

➔ **Optimization of operation**

➔ **Increase customer satisfaction**

mondas®

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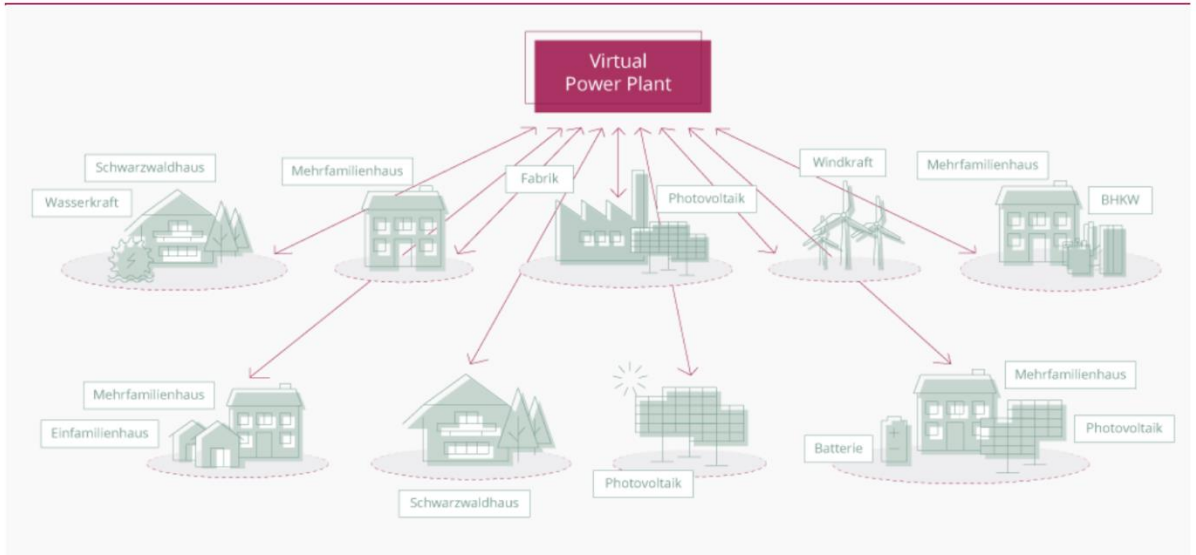
Example: Prosumers

Oxygen Technologies – IoT platform for decentralised energy plants

Spin-off of Fraunhofer ISE

IT connectivity and data-handling for actors of the energy system:

- equipment manufacturers
- end customer/prosumer
- power distributor
- network operators
- balancing group manager



➔ **Short term: Direct marketing of decentralized energy plants through Virtual Power Plants (VPP)**

➔ **prosumer-to-prosumer energy trading system based on a Fair Merchant Mechanism (FMM)**

OXYGEN TECHNOLOGIES

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The concept of Smart Cities

Challenges and trends

Urbanization

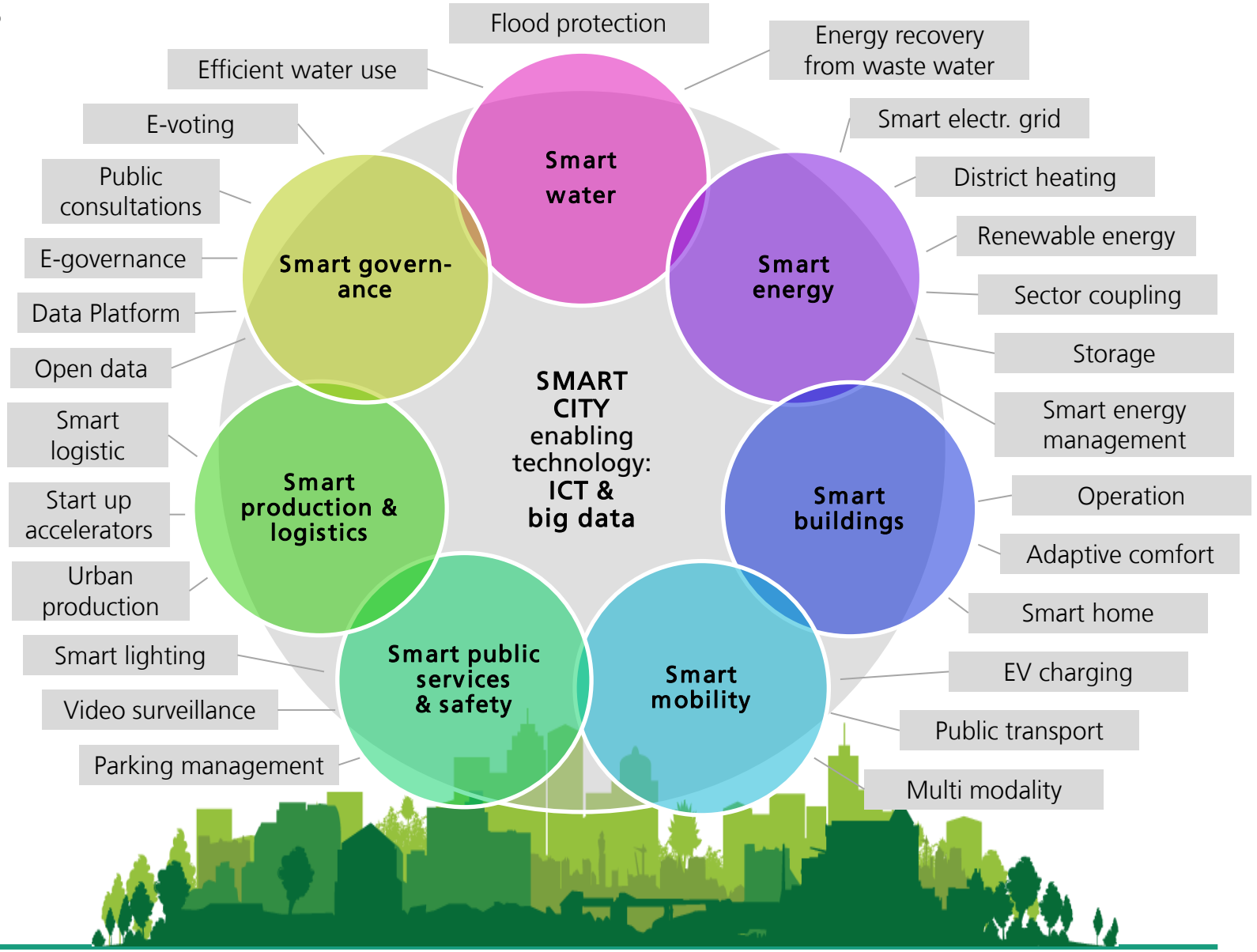
- Growing density of people
- Growing mobility, congestions & air pollution

digitization

- New business models
- New services

Climate change

- Decarbonization of the energy system
- Resilience of city infrastructure



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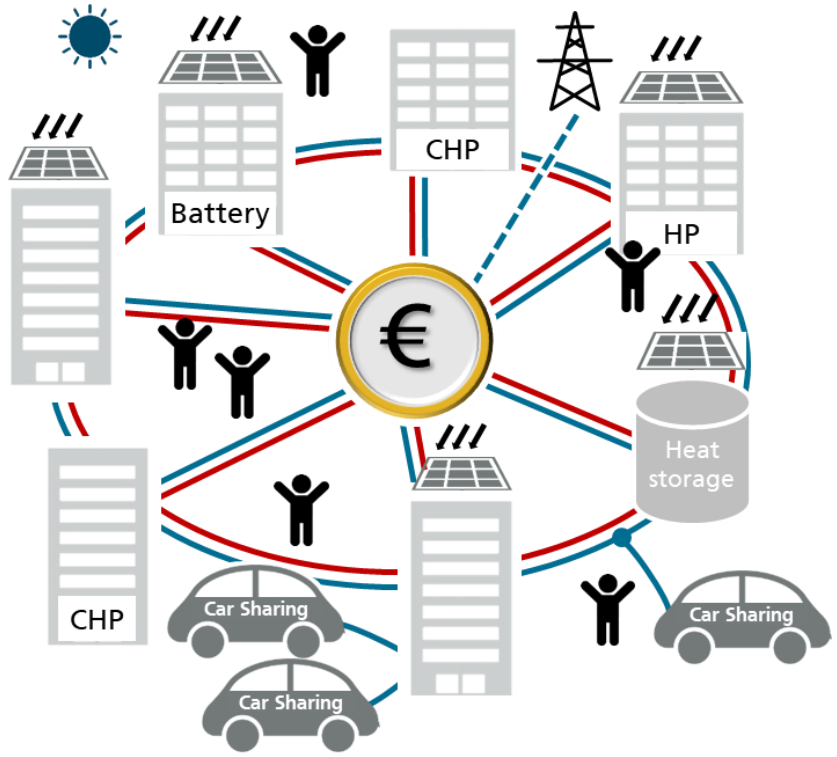
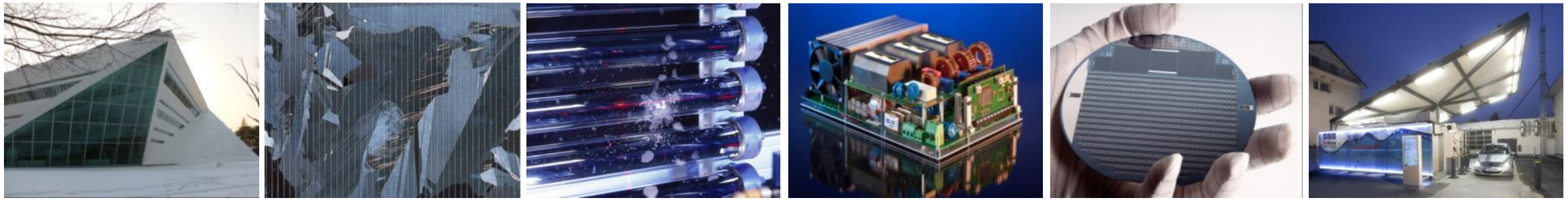
Conclusion

- **Digitization as enabler**
  - Domination of the complex system and the complex interaction of a variety of technical components in the system and market involvement
  - Efficient, intelligent use of infrastructure and hardware
- **… and as driving force**
  - New technological possibilities are emerging in the application, offering new services and opening new business models
- **Challenge**
  - Make sure that digitization helps in achieving the goals of the energy transition



CHP = combined heat & power

Thank you for your Attention!



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