Energy and Mobility Transition in Metropolitan Areas

GOOD GOVERNANCE FOR ENERGY TRANSITION

Uruguay, Montevideo, 05/06 October 2016

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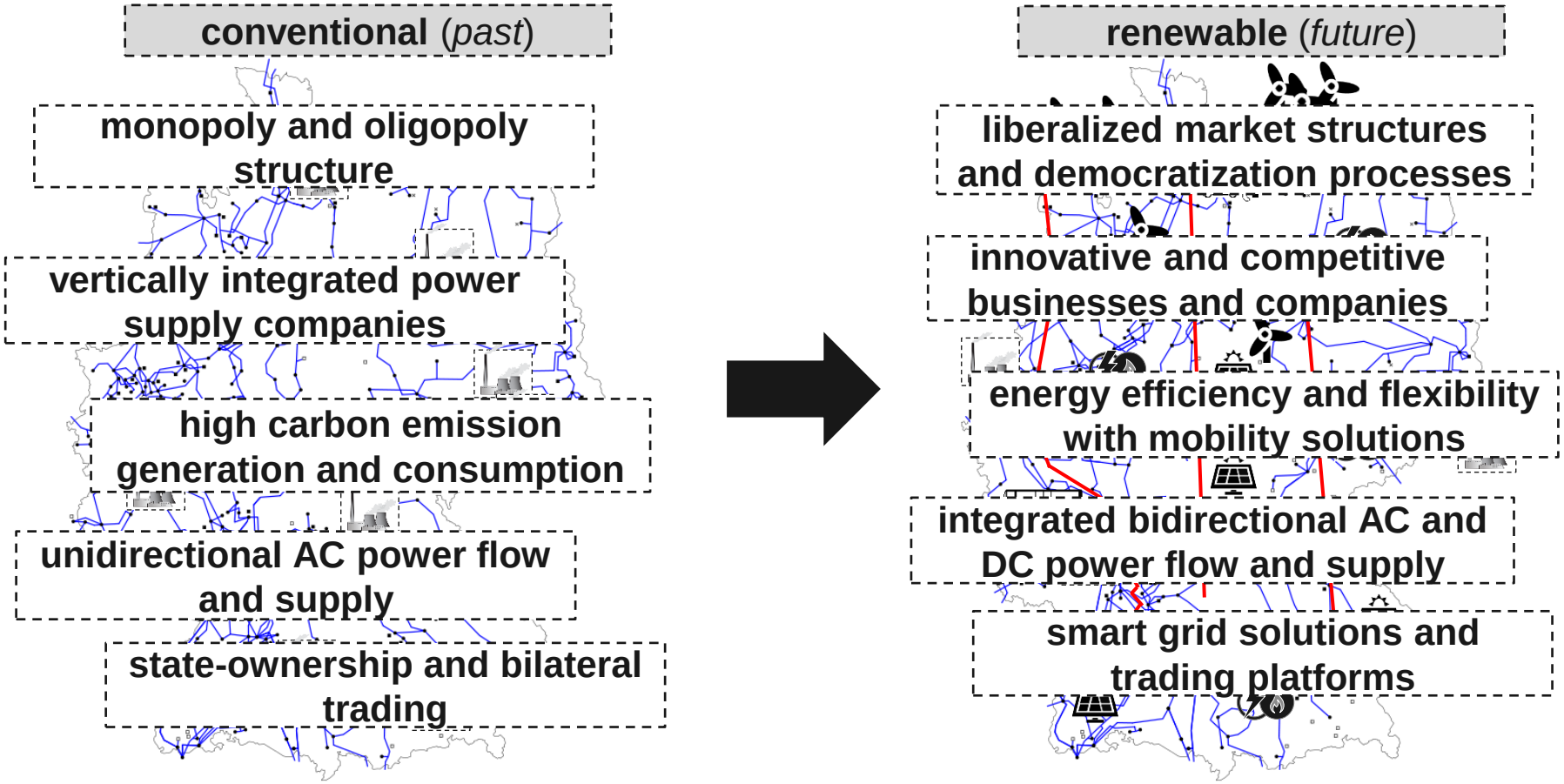


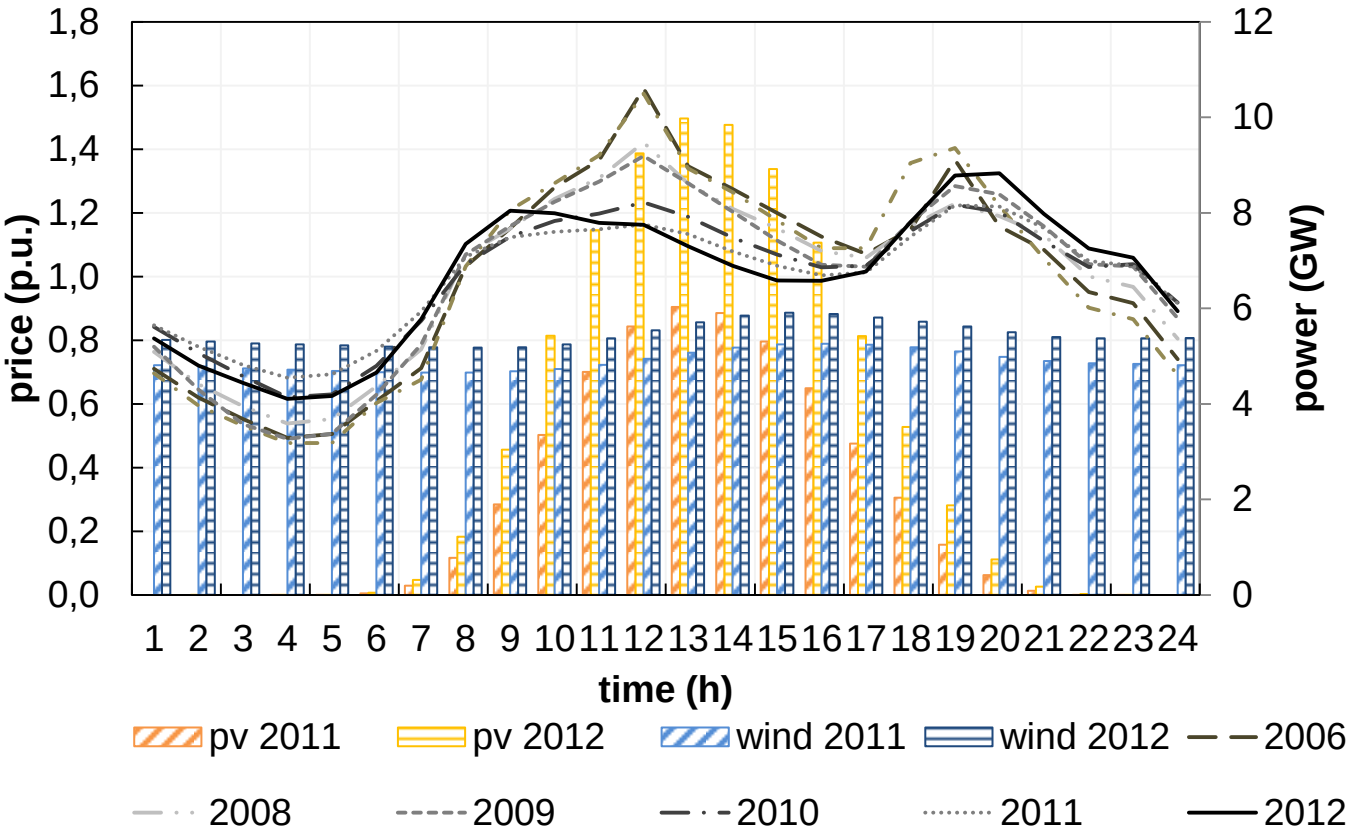
2000 *2015* *2020* *2030*

Passing of EEG; Renewable electric energy share: ~6 %	Renewable electric energy share: ~33%	Goal for RES: ~35 % share of electric energy	Goal for RES: ~50 % share of electric energy

Renewable Energy Sources Act (EEG) to encourage the development of renewable energy sources (RES) and share in the gross energy demand in Germany.

Renewable energy deployment affects the price evolution in the wholesale market has declined significantly by approx. 51% between 2008 and 2014

Ratio of average auction prices on day-ahead market



year	daily average price (EUR/MWh)
2008	63.51
2010	58.59
2012	43.59
2014	33.01

-51%

Fig.: Ratio of Average Auction Prices on Day-Ahead Market, Partially Offsetting the Increased EEG Surcharge with Delivery in the German/Austrian Market Zone

Composition and utilization of power plant portfolio in Germany changes continuously with the presence of distributed and renewable energy sources

Impacts and changes in terms of guaranteed power plant capacity

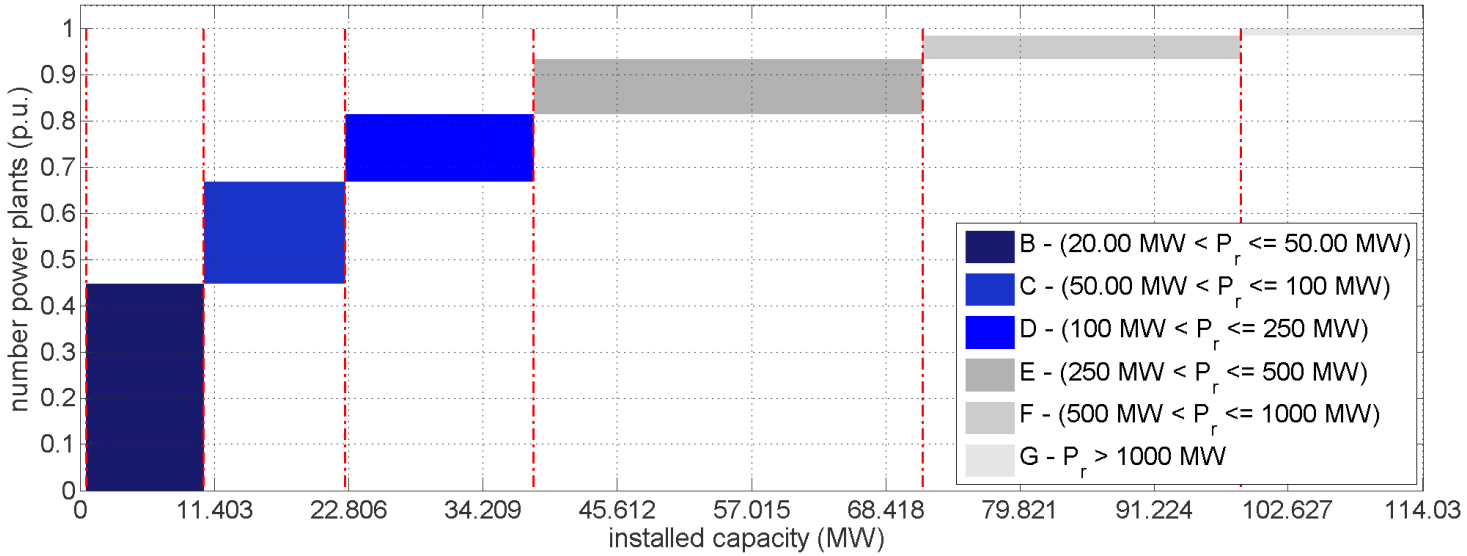


Fig.: Cluster analysis of power plant portfolio in Germany for listed power plants > 20 MW installed capacity 2014.

- Reduction of the available capacity of conventional power plants due to the shut-down of coal and nuclear plants between 2005 and 2014
- Decreasing utilization (full-load-hours) of conventional power plants, need for business evaluations and justification of past and future investments (lifetime cycle)
- Mitigation of increasing imbalances through more flexible and cost-efficient power supply-and-demand balancing solutions

Enhanced engagement and technological innovations has led to a more far-reaching set of challenges towards energy and mobility system transformation

Frameworks and driving forces

Environmental Awareness

Reducing Emissions and Mitigating Global Warming

Air and Water Pollution, Energy Independence

Energy Prices

Price Evolution of Commodities, e.g. Oil, Coal, Gas,
Renewable Energy Subsidies, eMobility Promotion

Agreements

Ratification of Climate Change Agreements, e.g. Kyoto, Doha, Paris

Environmental Constraints and Development of International Standards

Power Grid

Cross-Border and Time-Zone Exceeding Power and Energy Transfer

Energy Supply of Isolated Areas

Utilities need to position themselves to play a key role in new businesses and become drivers for innovation in the energy and mobility transition

Market overview and actors in Germany

Fleet Operators

4,6M Commercial Cars
2,1M Utility Vehicles

Campus Areas

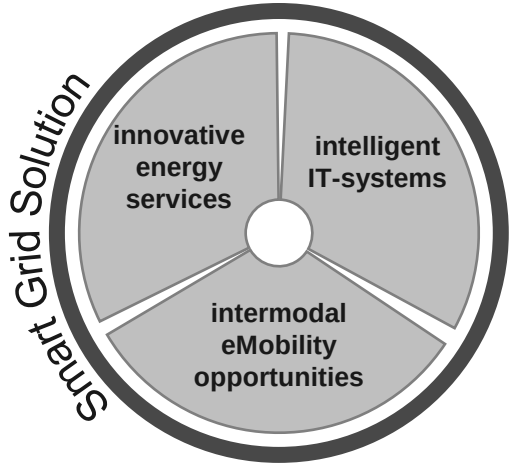
400 Campuses

Mobility Hubs

2.000 Facilities

Residentials

2.000 Companies
2,2M Apartments

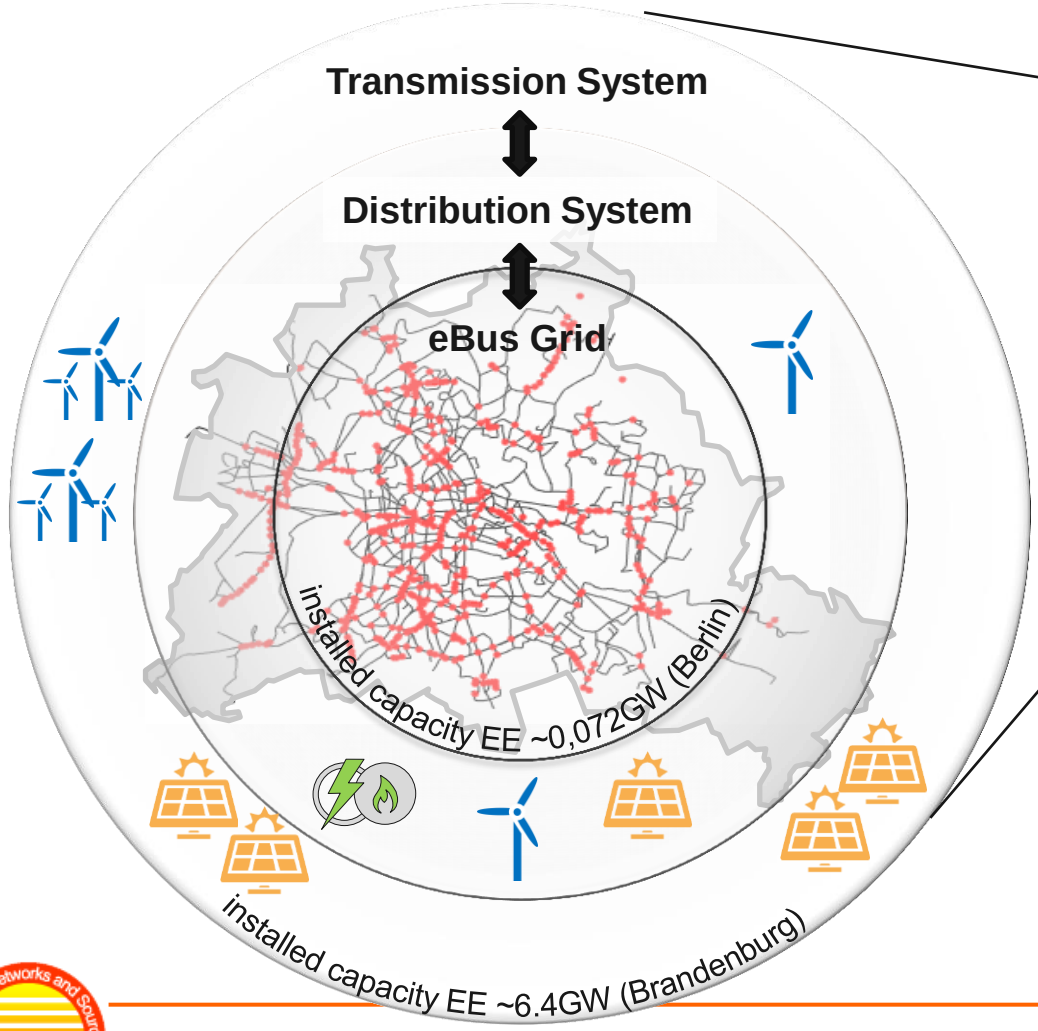


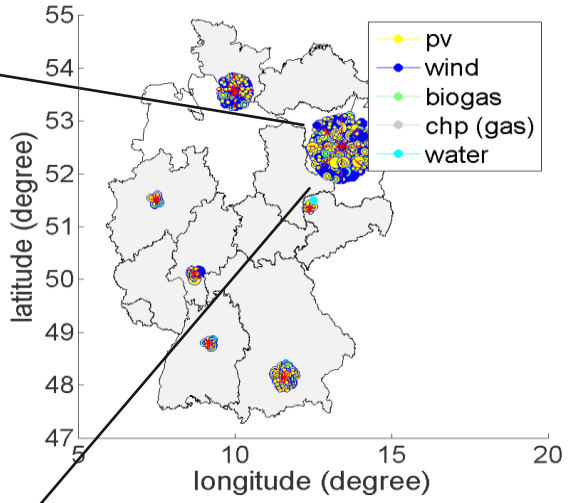
Actors and Customers

- central role of railway stations and airports in the development of local smart grids
- municipal and private utilities provide robustness and flexibility in power supply
- transmission and distribution system operators manage balancing groups and grid operation
- Adaption of energy supply to the user behavior of municipal, small and medium-size enterprises

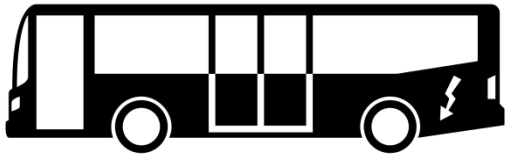
Proliferation of electric vehicles provides a unique opportunity to develop integrated energy and transport systems

eMobility in embedded metropolitan areas





Berlin Metropolitan Area: 52°31´N, 13°24´O, inhabitants ~6M, metropolitan area ~890km², peak load ~ 2.4GW, annual energy demand ~ 11TWh$_{el}$, 40TWh$_{th}$, vehicles ~1,3M incl. ~1.500 public busses[1)]



1) public buses: 55.454.000 l/a (diesel)

Research Campus Mobility2Grid investigates the realization of sustainable energy and mobility development in urban areas

Smart grid implementations

- In Berlin for example, one of the main smart grid implementations is the EUREF-Campus supported by TU-Berlin

Fig.: Overview EUREF-Campus

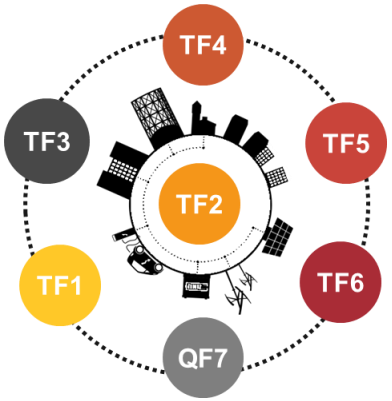


Fig.: Research Areas

Fig.: eMobility with Renewables

- Involved partners cooperate in long term public-private partnerships, exchange ideas and explore viable solutions for future smart city realizations
- Local research and development on sustainable energy and mobility concepts within smart grid environments strengthen the cross-partner innovation efforts

research areas: TF1 Acceptance and Participation, TF2 Smart Grid Infrastructures, TF3 Interconnected e-Mobility,TF4 Bus and Commercial Transport, TF5 Education and Knowledge, TF6 Digital Spaces, QF7 Operation and Commercial

Future innovation drivers originate from outside the industry, utilities need to position themselves to play a role in new businesses

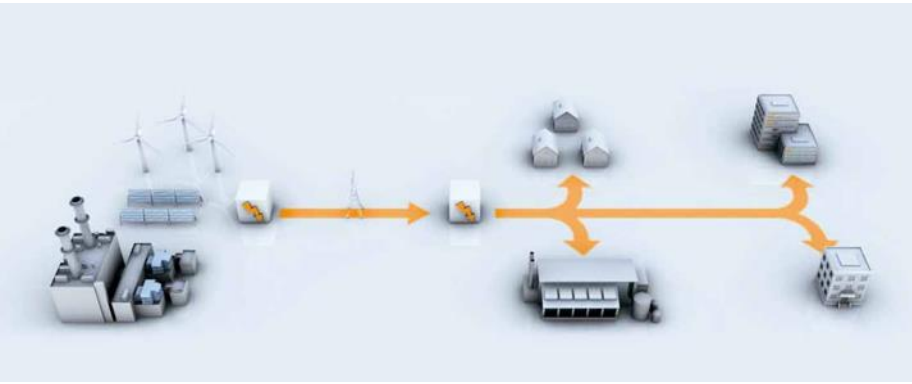
Concluding remarks

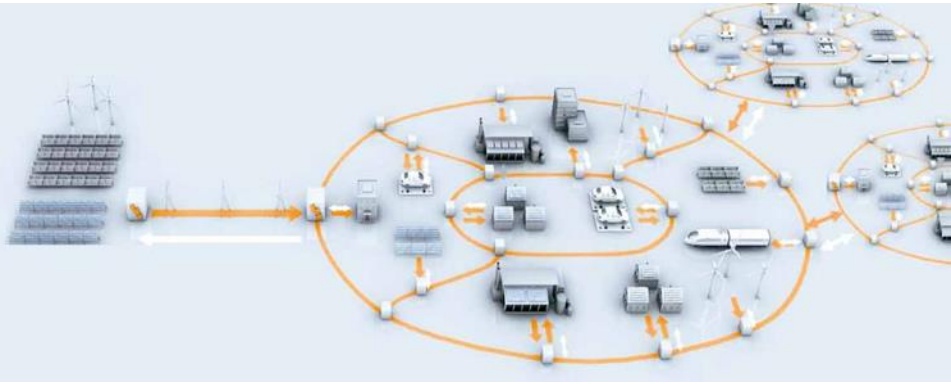
efficient grid expansion and provision of flexible operation

e.g. cross-border trading, time zone exceeding power exchange, power system resiliance

plug-and-play integration of decentral energy resources including electric vehicles

e.g. scalable IT-infrastructure, interoperability standards development, cloud-based applications





optimized portfolio management and reliable control algorithm

e.g. analytic data service, real-time forecast and control, secure and reliable power supply

self-sufficient energy supply and appro-priate market participation opportunities

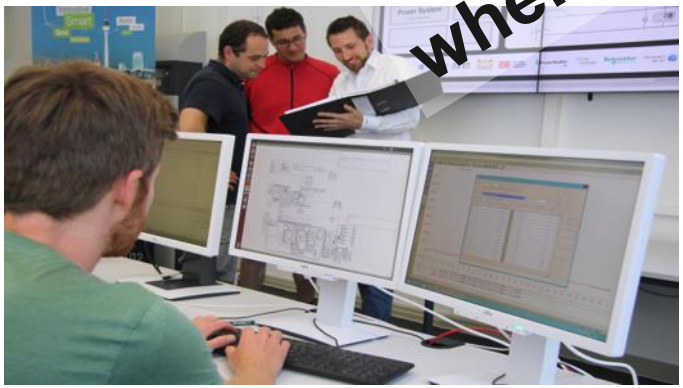
e.g. Virtual Power Plant, Microgrid, Smart Home, Prosumer Community

…

”renewable energy resources in smart grid infrastructures”

Smart Grid Realizations - where we are TODAY …

‘’mobility concepts with autonomous driving functions in urban areas”



‘’adaptive optimization of energy systems in real-time environments”

Thank you for your attention

Gracias por su atención

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