Karlsruhe Institute of Technology

Technology for Pervasive Computing

A Control Loop Approach for Integrating the Future Decentralized Power Markets and Grids

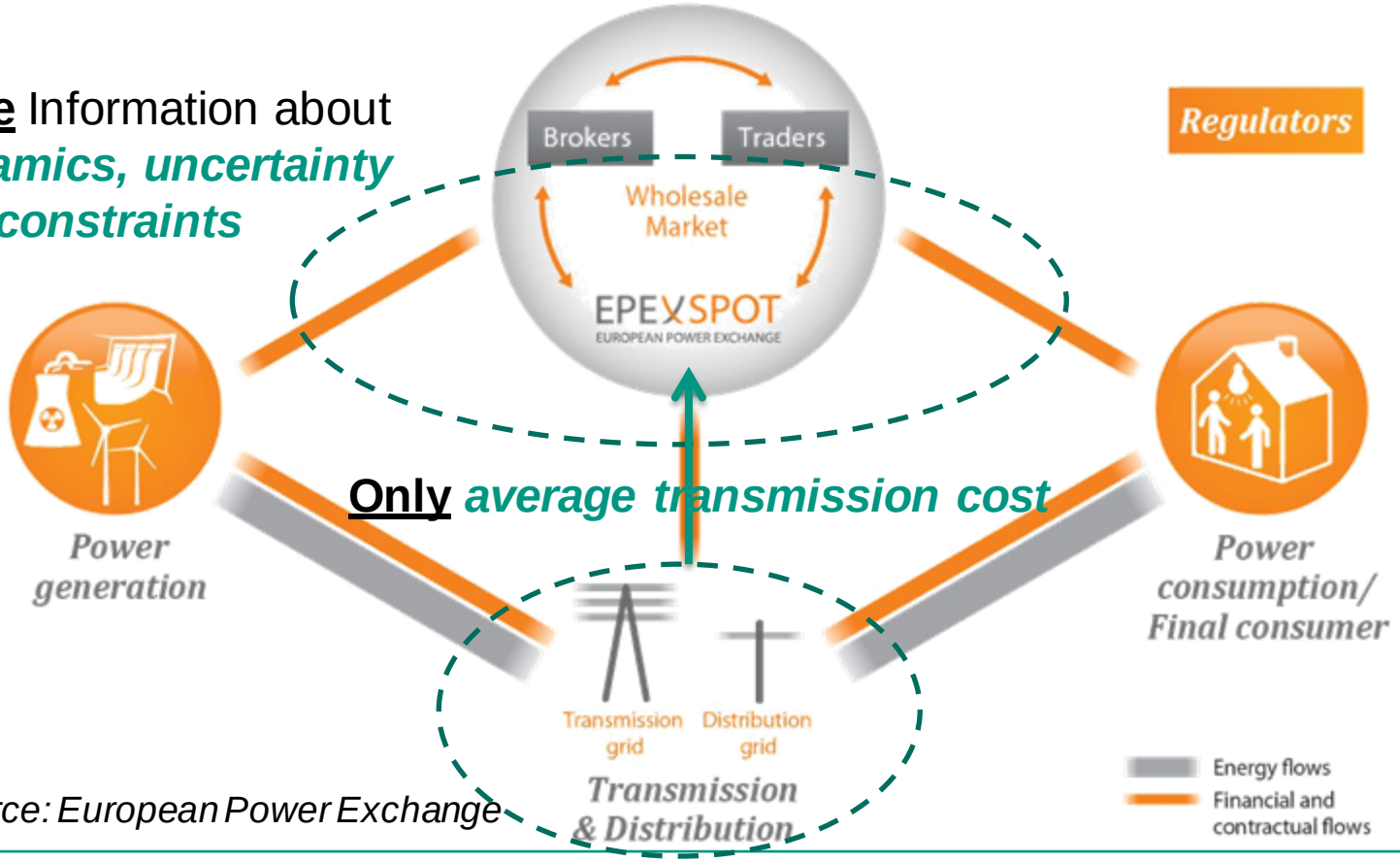
Symposium „EnergieCampus“ 2013 in Ulm

Yong Ding, Martin A. Neumann, Michael Beigl, TECO, KIT, Germany
Per Goncalves Da Silva, SAP Research, Germany
Lin Zhang, Tsinghua University

Current state of the European power market

- Liberalization and full retail competition
- Decentralized energy generation units → ***new market model***

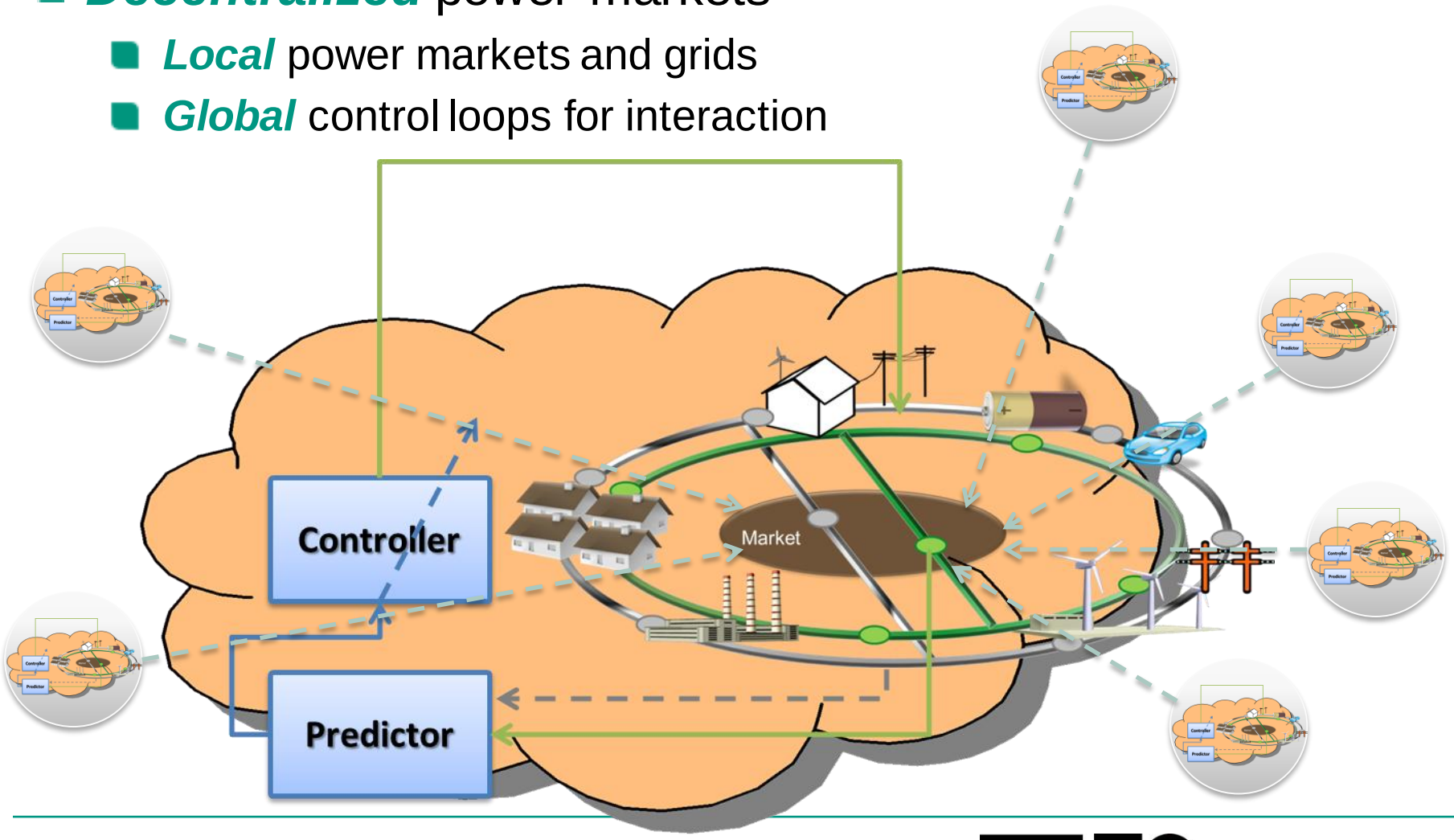
Little Information about ***dynamics, uncertainty*** and ***constraints***



Source: European Power Exchange

System Design – A Distributed Architecture

- ***Decentralized*** power markets
  - ***Local*** power markets and grids
  - ***Global*** control loops for interaction

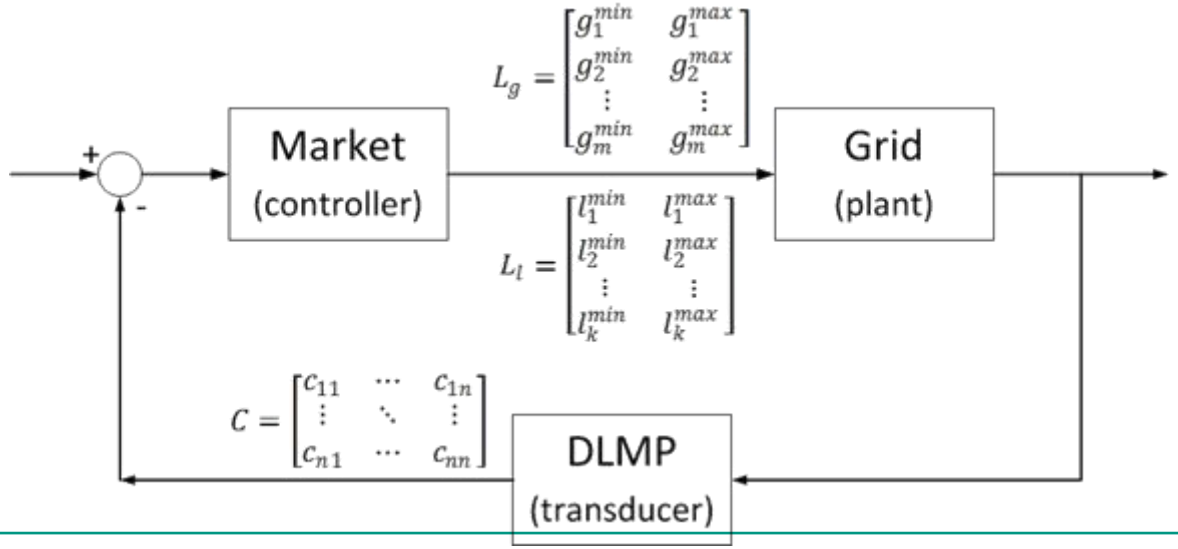


System Design – A Dynamic Equilibrium

- Generating ***coefficient matrix*** C for a market update

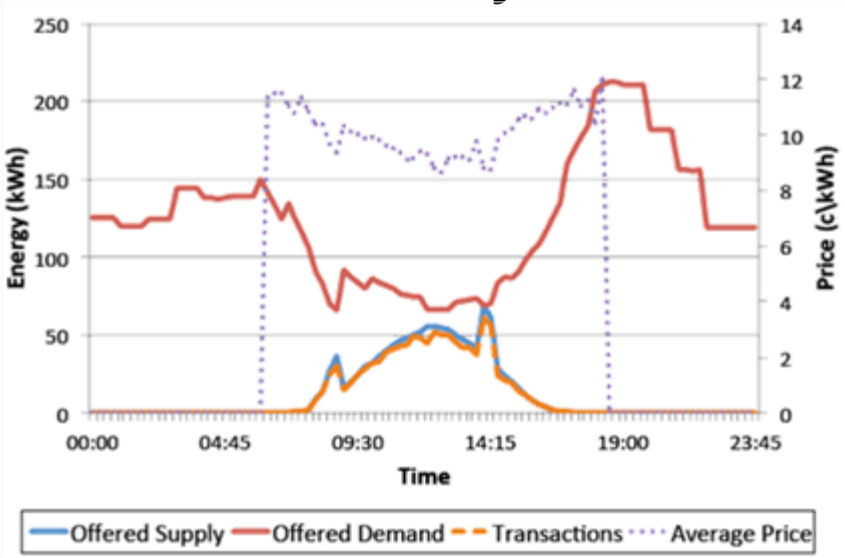
$$C = \begin{bmatrix} 0 & \cdots & \frac{\left|LMP_1{}^P - LMP_N{}^P\right|}{LMP_N{}^P} \\ \vdots & \ddots & \vdots \\ \frac{\left|LMP_N{}^P - LMP_1{}^P\right|}{LMP_1{}^P} & \cdots & 0 \end{bmatrix}$$

- C matrix as feedback signal for integrating market and grid



First Evaluation

- Trading outcomes for one day of NOBEL market operation



- A ***market*** operating ***simulation*** on a power system …
  - IEEE 14-bus system with 14 prosumer households
  - In each timeslot, half buyers and the other half sellers
  - Transaction comparison without and with power system constraints C
  - 100% power traded, dropped to 89%

Conclusions and Future Work

- A control loop approach …
  - Power grid and market interaction
  - An OPF-based power system model
  - The NOBEL market model
  - A LMP-based coefficient matrix
  - Initial experiments shown a feasible adaptation

- ***Future work***
  - Co-simulation of distributed power grids and markets
  - System plant extension with power market
  - Control loop stability evaluation with real world data on both

That's All

- *Thank You!*
- *Questions?*