



# Towards "Smart" Electric Infrastructures A Networked Dynamical Systems Approach



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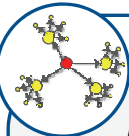
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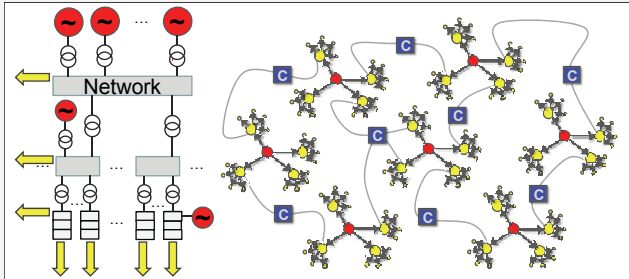
### Visiting Fellows

### Doctoral Candidates

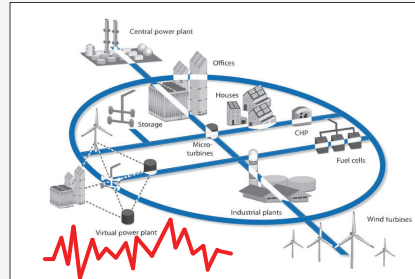


## The Rise of Complexity: Heterogeneity, Interconnection, Large Scale & Dynamics

Dealing with technological complexity:  
Feedback control and information harvesting



Energy & information networks:  
"Smart grids" enable new services....



"Putting it all together":  
...a challenging path!



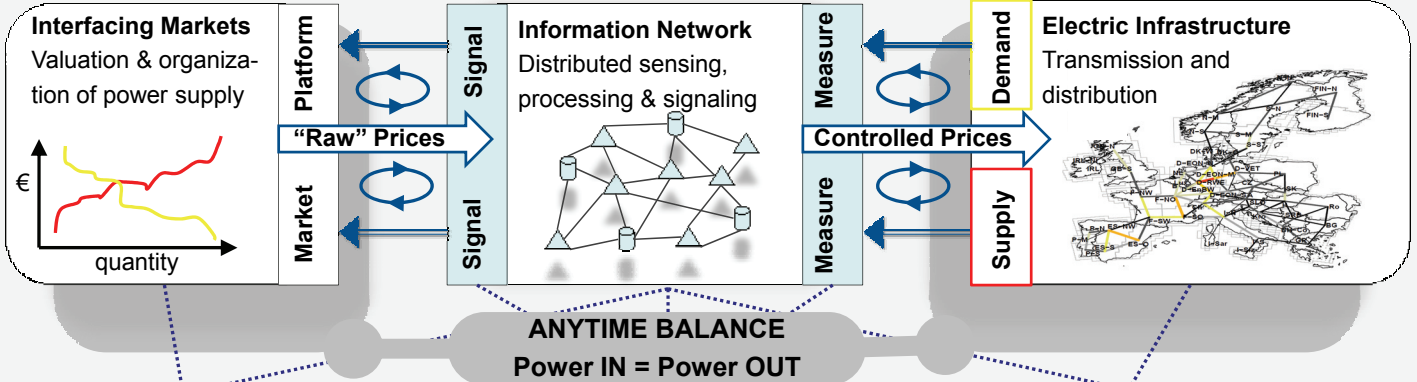
### 19th century

### 20th century

### 21st century

- Evolution of e-power grids by scaling via **modularity & interconnection**
- Scaling problem & cascading failures
- Black-outs & stability issues
- Integrating renewable energies: **intermittency & volatility**
- Operation with **energy markets**
- Integrating renewable energies: **Granularization** of control, communication
- Service-oriented **multi-agent** architectures
- Open platforms vs **cyber-attacks**

## The Quest for "Smart Architectures"



**Dynamics of e-markets**  
Combine economics & control to design well-behaved closed-loop systems

**Large-scale interconnected systems theory**  
Develop system theoretic tools from statistical mechanics and information theory

**Control, communication & optimization**  
Explore the role of network topology and communication in networked dynamical systems

## TUM-IAS Fellows Take a Leading Role in Fundamental Research on Smart Grid Technologies

### International Workshop with Leading Experts in Control, Berchtesgaden



### Direct outcome of activities supported by TUM-IAS

- Head of **IEEE Smart Grid Vision for Control Systems** group
- "Co-design of Multimodal Cyber-Physical System Architectures and Adaptive Controllers" awarded **NSF grant** among 3 out of 248 US-wide applications
- Showcasing activities in **special sessions & workshops** at high-ranked international control conferences (CDC, ACC)
- ~ **30 publications** in major international journals and proceedings

