Towards an End-to-End Smart Grid -
How to foster competition and innovation.

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An End-to-End Smart Grid: Capabilities Perspective

An electricity network that cost efficiently can integrate the behavior and actions of all users connected to it – generators, consumers and those that do both – in order to ensure a sustainable power system with low losses and high levels of quality, security of supply and safety.

The new power consumer will:
- be better informed
- more active and participative
- respond to real-time price signals
- have alternatives of supply
- have efficiency-increasing management options
- more participative and active role of power consumers
- be offered innovative energy-related services and applications.

Source: ERGEG (2010)

An End-to-End Smart Grid: Architectural Perspective

The Smart Meter Technology bridges the communications gap between customer’s premises and the remaining electricity network.

For a profitable Business Case the full SMT’s potential has to be leveraged; Demand Response is the key.

Source: Kranz et al. (2010), Haney et al. (2009)

Present value costs and AMI-benefits (EU)

U.S. Demand Response Potential

Source: Faruqui et al. (2009), FERC (2010)
A Smart Grid Ecosystem: Expect the unexpected!

A national Smart Grid policy should encourage tens of thousands of entrepreneurs to innovate - using new technologies and business models - to create a wide variety of in-building energy management and information services.

FCC (2010)

Applications Layer

Communications Layer

Power Layer

R&D as percentage of revenue

Gas and Electricity Decoupling in the US

These innovations are unlikely to come from incumbent utilities

Most state regulatory regimes include inherent disincentives for energy efficiency. Some regulatory innovations, such as decoupling, are aimed at taking away disincentives, rather than creating incentives. We’re working to change that paradigm, by encouraging our regulators to allow utilities to earn a return on their investments in saving watts, just as they would for generating watts. This new paradigm would give us an incentive to fully develop all economically sound energy efficiency programs.

Jim Rogers, CEO Duke Energy

The evolution of industries - Domination by birthright?

Experiences from other industries

Observations on EU-metering markets

- Pre-existing firms in related industry have advantage in new ones.
- Lots of small scale entry and exit
- Entrants take 5-10 years to become large
- Incumbents do not respond to entrants immediately
- Technological and regulatory changes facilitate entry
- Government policies can promote learning by new entrants (Japanese TV producers)

- Mostly incumbents are in charge of rolling out the new metering infrastructure
- So far mandatory roll-outs seem to work better than competitively organized ones due to incumbents’ “split the difference” policy
- In some liberalized markets costs for metering services have risen considerably
- Extreme reluctance from other sectors
- As a reaction to the slow diffusion, the Netherlands switched from a liberalized to a regulated metering market

As incumbents have incentives and opportunities to deter entry by raising rivals’ costs,

Technology will play a key role in evolution

Important role for regulation and competition policy


The Ladder of Investment or Stepping Stones Approach has proved to be successful in the Telecoms Sector

Political controversy to one side, new technology should not be allowed to obscure an old truth. The basic problem is a rerun of the issues for rails and telecommunications: can outsiders connect to the network?

Richard Epstein, Professor of Law

Non-discriminatory access to meter data in as near to real-time as possible is a prerequisite for an innovative ecosystem to emerge

Access

<table>
<thead>
<tr>
<th>Use of data</th>
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<tbody>
<tr>
<td>Cloud</td>
</tr>
<tr>
<td>Fossil fuel operation, billing issues, loss detection, customer service, process automation, customer switching, power quality monitoring</td>
</tr>
<tr>
<td>Supplier</td>
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<tr>
<td>Trading, forecasting, trading</td>
</tr>
<tr>
<td>Generation (distributed)</td>
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<tr>
<td>Information, control, decision making</td>
</tr>
<tr>
<td>End customers and other third parties</td>
</tr>
<tr>
<td>Energy efficiency measures, input to home and building automation</td>
</tr>
<tr>
<td>Government, Meter quality monitoring, Body or Regulators</td>
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</tbody>
</table>

Source: Bundesnetzagentur (2009)

Open and non-proprietary standards, interface specifications, and communication protocols will
Concluding remarks

- As long as regulation does not provide the right incentives, incumbents will have an interest to discriminate against independent service providers.
- Institutional and regulatory barriers are much more important than problems raising the necessary capital.
- Regulators have to establish favorable and reliable conditions for entrants.
- Encourage market entry by low entry barriers.
- Evolution may take years for entry to be significant.
- However new entrants should shake industry.
- Market potential for new services and applications is enormous.

Thanks.

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SM basis for SG, but only if the Communications Infrastructure is scalable to new applications

Anticipated Smart Grid Benefits

Supply
- Optimization of facility utilization and reduced need for excess capacity provided by peak load power plants
- Improved connection and operation of generators of all sizes and technologies
- Reduced environmental impact of the whole electricity supply system

Electricity Network
- Preventive maintenance and remote grid management through better monitoring and control features
- Increased degree of automation and "self-healing" responses to system disturbances
- Effective incorporation of DER and PHEVs

Demand
- Provide consumers with greater information and alternatives of supply
- Increased responsiveness and flexibility of demand
- Enhanced efficiency by better management options and greater awareness about energy consumption
- More participative and active role of power consumers
- Enable innovative services and applications

Peak Demand

Influence on Load Curves

Peak clipping
- Reduction of consumption in peak load periods

Valley filling
- Increase of consumption in low load periods

Load shifting
- Shift of consumption in low load periods

CO2 Savings Potential of Smart Grids

Advanced Meter Penetration

Source: Climate Group (2008)
Growing electricity demand... but the fraction coming from renewable sources is projected to rise sharply—as is total demand.

Annual U.S. electricity sales (in billions of kilowatt hours)
- Total
- Renewable

CURRENT PROJECTIONS

25% by 2025
10% by 2025

Wind Availability in the U.S.