

Energy & Utilities

# Transforming Energy Value Chain: Electric Vehicles & Smart Grid

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## The need for progress is clear.

**37%**

Projected growth in worldwide energy demand by 2030.

**170 billion**

Kilowatt-hours wasted each year by consumers.

**1/4**

Proportion of worldwide CO<sub>2</sub> emissions created by power generation, the largest man-made source.

## The opportunity for progress is clear.

**Reduction in peak loads**

**Savings in Infrastructure spending**

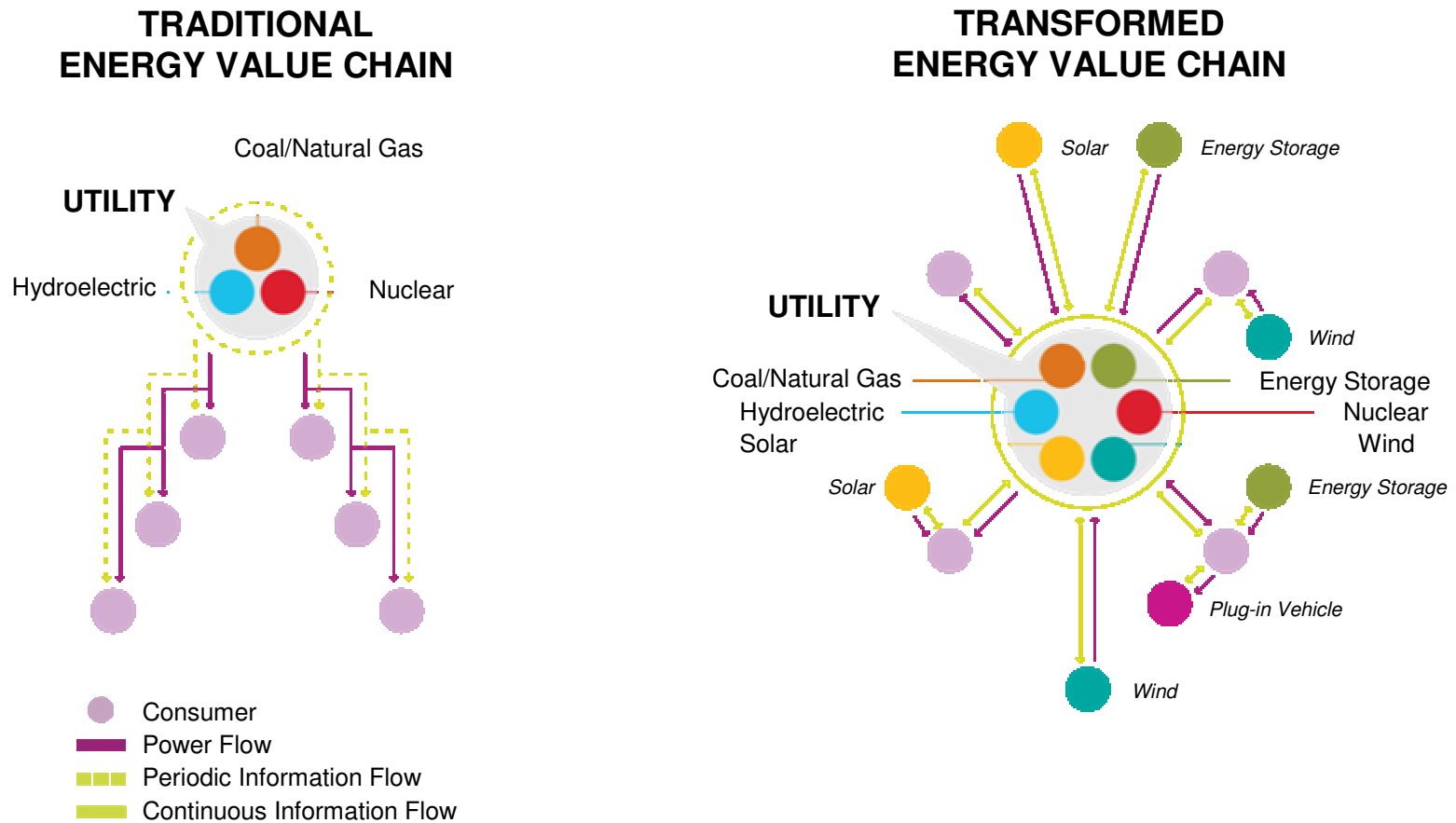
**Lower emissions**

## Drivers and challenges

- National and world wide concern on dwindling resources of Oil and Gas
- Environmental Impact of fossil fuel
- Finding clean and renewable technology
- Improving the Intelligence of Electricity Grids to optimize production and demand

Energy and Utilities market forces are creating the need for an evolution in the energy value chain.

### Evolving Energy Value Chain



## EVs are being increasingly talked about .....

- 3.2 million plug-in electric vehicles on the roads by 2015 (Pike research report 2010)
- Vehicle 2 Grid capable EVs to raise grow to 1.06 million units by 2020 (July 2010 report of Zprime Research & Consulting )
- All leading car manufacturers announce electric vehicles..
- Buyers of EVs:
  - the environmentally conscious who value zero emissions
  - the economically driven who are attracted to minimal vehicle depreciation & fuel savings
  - the movers & shakers.....

## Emergence of new market dynamics..

- New players in the market place
  - System/Battery Manufacturers
  - OEMs
  - Charging station manufacturers
  - Utilities
  - Government
  - Integrators – create partnerships with Utilities, OEMs and Govts
- New Revenue opportunities for Utilities from:
  - Selling electricity (night charging at lower rates could reduce revenue!)
  - Selling charging stations
  - Installation & Maintenance of charging stations
  - Diagnostics
  - Garage Referrals
  - Other ???
- Different business models will emerge – and subsidies on EVs will play a significant role in the business model that will be accepted in different markets

## Challenges to Utilities with EVs

- Sudden spurt in unplanned demand - require significant financial resources, staff and planning to deal with that demand
- Pockets of large usage will suddenly appear that push the limits of the distribution network - suddenly, distribution transformers, capacitor banks and local substations will be undersized!
- Uncontrolled random charging can lead to neighborhood blackouts - - *the utilities will need the ability to locally disconnect*
- Consumers buying behavior
- Charging an EV can put carbon obligations on the utility. Overall carbon emissions will probably increase because of large coal capacity at night
- **Billing and settlement system for EVs and Aggregators**

**Single Transformer upgrade can cost more than the money collected over 10 EVs for 10 Years!!!**

## Opportunities for Utilities

- A Vehicle 2 Grid vehicle is one that can connect and communicate with the grid and sell Demand Response service to the Grid
- The EVs can be used both as:
  - **Frequency Regulator** - many shallow charges and discharges through a day
  - **Spinning Reserve** - a few dozen occurrences during the year, typically for 10 minutes at a time
- V2G market place is positioned for explosive growth as consumers refine their relationship with vehicles and manufacturers become creative with application of Smart Grid technologies with in vehicles
- **EVs could provide Demand Response to the tune of 10,000 MW+**

*“V2G refers to adding the capability to deliver power from the vehicle to the grid, but “V2G” is also used to imply that power flow, whether to or from the vehicle, is controlled in part by needs of the electric system, via a real-time signal”*

*[Willet Kempton, 2008]*

## Need for smarter utility grids...

- Leverage EVs as Virtual Power Plants
- Manage a fleet of EVs – to shift electrical load in time
- Excessive EV battery energy could be fed back into the electrical grid:
- Aggregate EVs and RE sources for ecological balance
- Frequency regulation and Spinning reserves (EVs can play a key role)
- Power Market Operations
- Improve resiliency in distribution networks



# **EDISON** *Electric vehicles in a Distributed and Integrated market using Sustainable energy & Open Network*

IBM Research - Zurich



## IBM as partner in the EDISON Consortium

### Project

Design of an energy system that will support a large proportion of EVs.

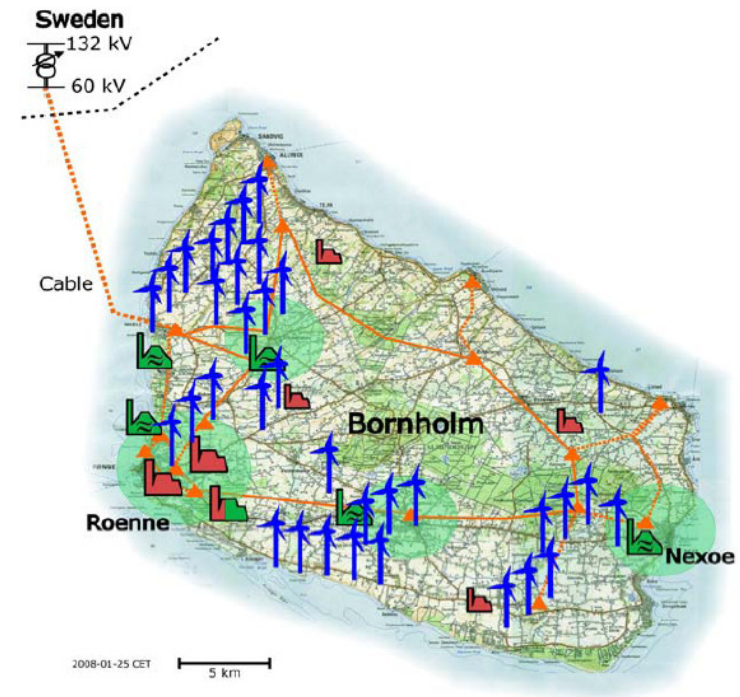
Real-life testbed on the Danish Island of Bornholm (pop. 40'000)

- Size: Investment plans have the objective of 200'000 EVs on the road in Denmark in the coming years (10% of total number of cars).
- Focus on leveraging EVs to support political objective of increasing share of renewable energy in total consumption.
  - Vehicle-2-grid is part of long-term objectives.

**Policy-maker involvement.** Public co-financing (5 million Euro).

- Sponsored by Connie Hedegaard, Danish Minister of Climate and Energy, host of the 2009 UN Climate Summit (COP15).
- Policymakers willing to maintain tax exemptions for EV's.

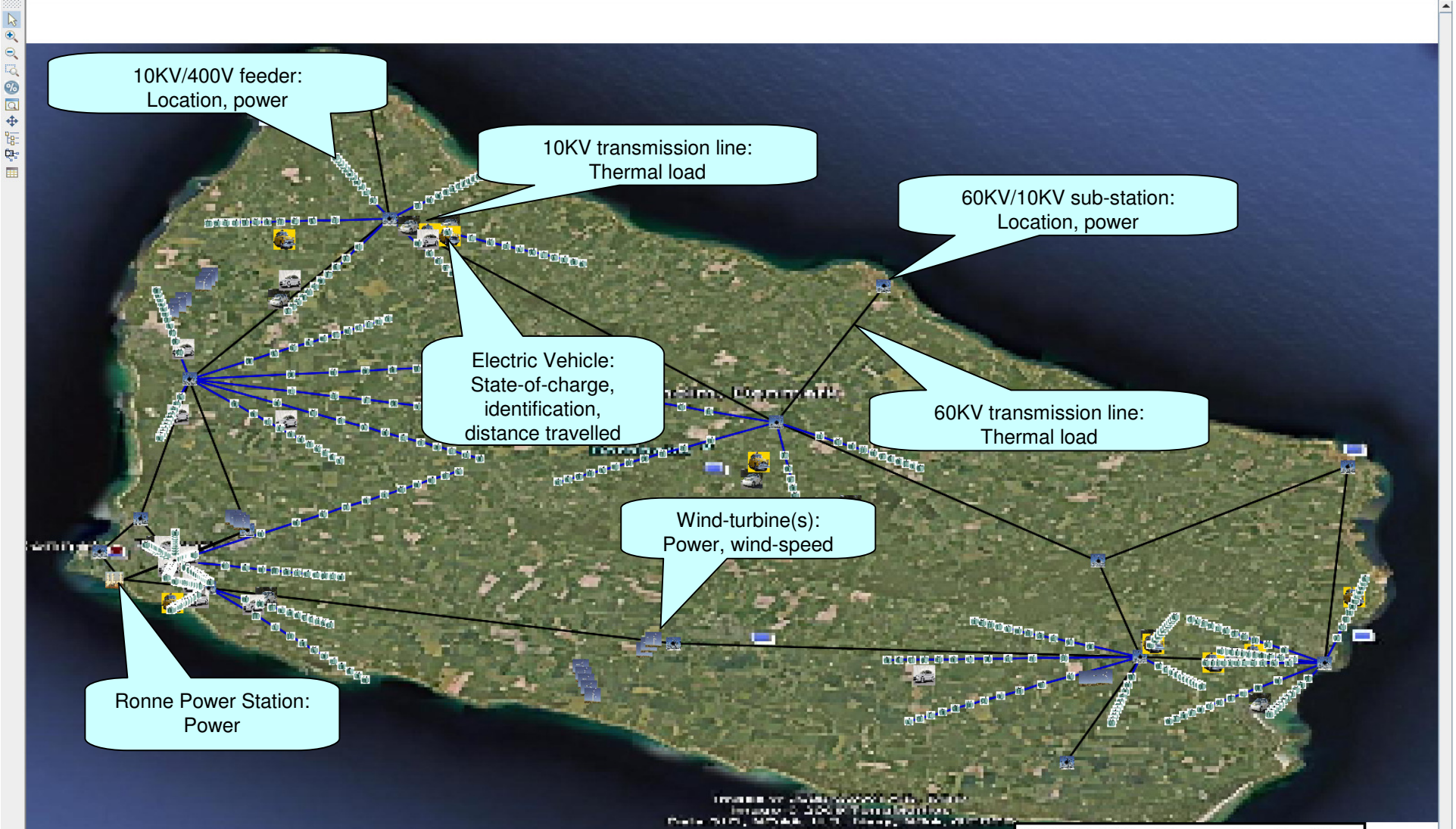
**Project partners:** IBM, Denmark's largest energy company DONG Energy and member of the IBM Global Intelligent Utility Network Coalition, the regional energy company of Oestkraft, Technical University of Denmark, Siemens, Eurisco and the Danish Energy Association



**IBM's contribution:** Development of management system to control charging of cars in accordance with the availability of wind energy while enabling optimal use of the electricity grid.

Unnamed (1) - Bornholm Simulation

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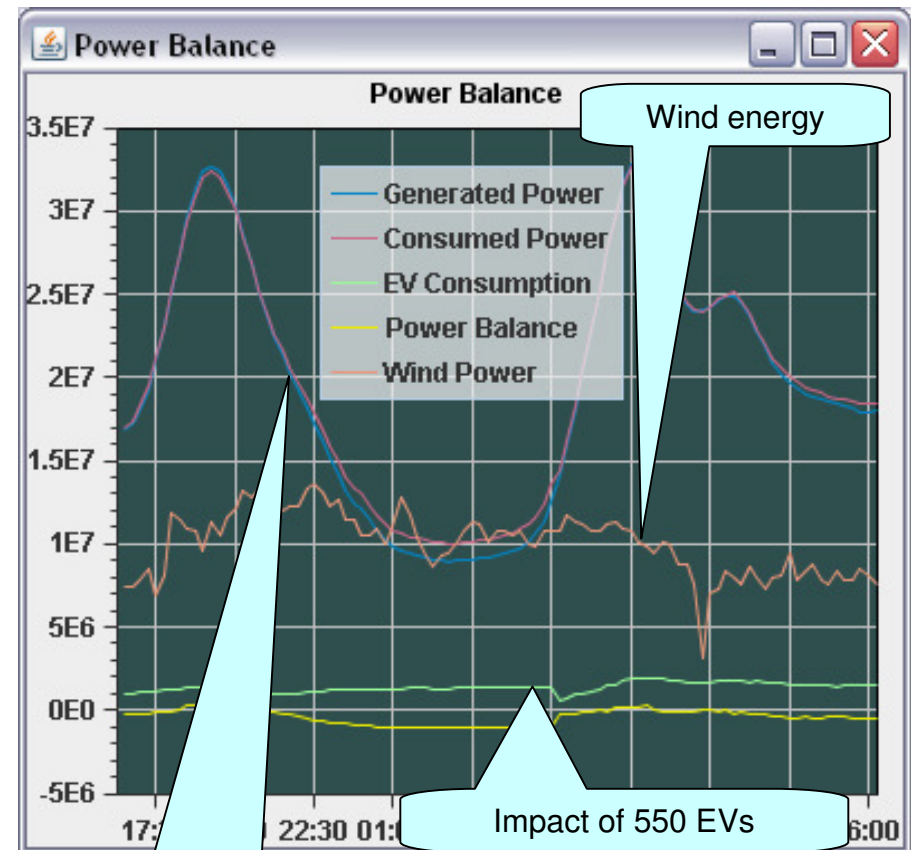


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## Preliminary Results

- **Bornholm** (a Danish island) electricity grid simulated.
  - See **EDISON** project
- **Traffic mix** (commuters, taxis, family cars) integrated into simulation.
- We can evaluate the state of the grid and EVs.
  - Thermal load on transmission lines
  - Power load on transformers
- Optimization of interaction EVs and electrical grid
  - Linear program, quadratic
  - Non-linear optimization: optimal control
  - Netflow optimizations: grid constraints!
- use real-world wind-data & prices



## Here is how we'd summarize

- The future is close but not here...
- Mass roll-out of EVs starting .., but charging must be properly managed
- Growing renewable production but distributed dynamics challenge grid
- Find the optimal match of battery technology and grid services
- It's a disruptive change ...
- Well aligned with IBM's Smarter Planet initiative

**THANK YOU**

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