Building Energy Efficiency and the Smart Grid

Providing consumers with energy diagnostics, feedback, control

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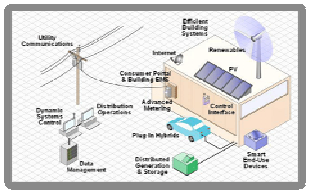

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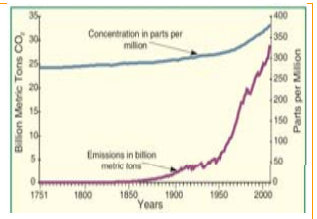


Innovative solutions required:

- By imbalanced world energy supply and demand,
- And to prevent unmanageable, irreversible climate change.

1. How Does Efficiency Stack up?
   …i.e. How ***Large, Clean, Cheap, Safe, Quick?***
2. How does Society ***make Efficiency Happen?***

MIT Energy Efficiency Strategy Project

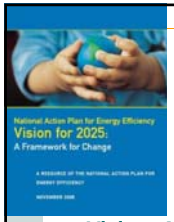
***How* will we Enable Energy Efficiency?**

US Buildings consume 71% of all electricity, 55% of all natural gas

Goal: 30% efficiency achievable by 2030 with 4 Deployment options:

Public funding models, incl. utilities:	***carrots***
Codes and Standards:	***sticks***
Data and intelligence-driven :	***information***
New Business Models:	***innovation***

Transforming the nation's consumers*: good energy decisions (ie lower discount rates) *change everything.



National Action Plan for Utility-based Energy Efficiency

Efficiency Spending increasing from $4 B in 2009 to $10 B by 2012

Vision: An Elegant Balancing Act?

- **Utility Incentives: Efficiency = Supply Resources**
- **Evaluation, Measurement, and Verification Mechanisms**

OR another way?

- **Public control of programs?**
- **Smart Grid**
- **An innovative Ecosystem for private enterprise?**
- **Codes/standards**

Do we want, trust, need utilities to do efficiency?

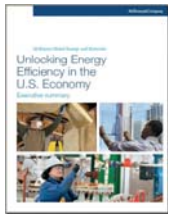
Massachusetts – 2008 Green Communities Act

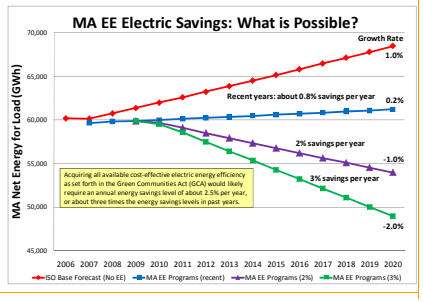
Establishes the requirement that utilities support their customers to install:

- ***All-cost effective efficiency*** **that costs less than energy supply, 1/1/2010 to 12/31/2012**
- **Target: Reduce energy needs with efficiency by 2.4% per year by 2012**
- **Utility Efficiency Budgets: $125 mm 2009 - $2 B 2010- 2012**

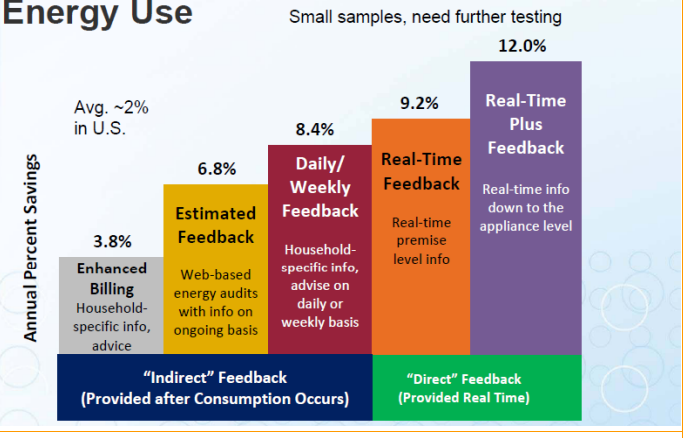
Some headwinds, some delays,

- ***but moving forward.***

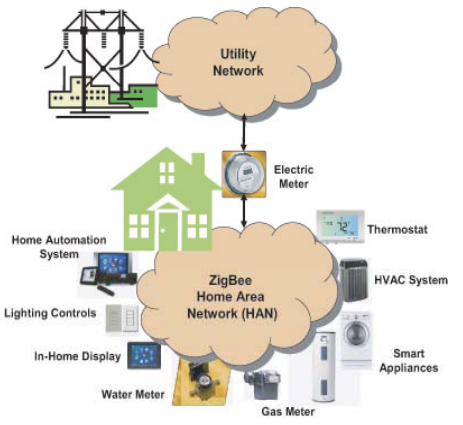


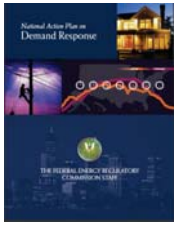


Providing Consumers with Feedback on Energy Use



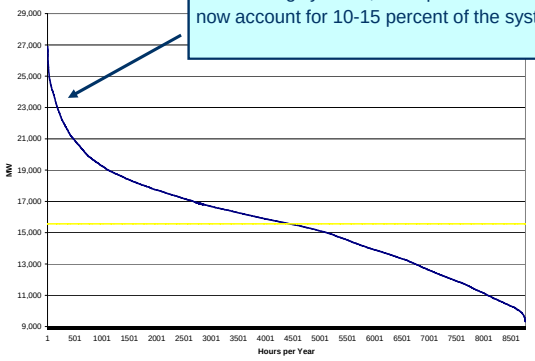
Next up – *Demand Response/Dynamic Pricing*





The Demand Response Issue: The Load Duration Curve *Continues to Erode*

With the continued penetration of central air conditioning systems, the top 60 hours of the year now account for 10-15 percent of the system peak



AMI: "Advanced Meter Infrastructure"

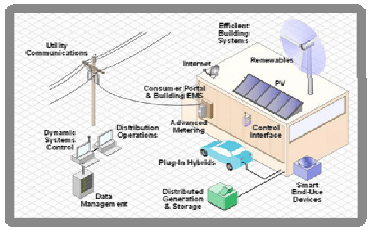
- automates the meter read process,
- increases the frequency of reads to at least hourly,
- possibly communicates two-way between utility and meter for demand response (DR) services.
- Possibly communicates between meter and home for monitoring services.
- *Widely viewed as a key node in the Smart Grid* – providing operation visibility to endpoint, aggregated neighborhood and transformer assets.

Economics:

- Costs $150-$200 per home for smart meters (plus LAN)
- 60-100% covered by operating benefits – usually *raises rates.*
- $25-$50 annual resource benefit from hourly pricing.
- Potential 2x to 4x benefits with analysis, home controls.

LAN: "Local Area Networks" within buildings

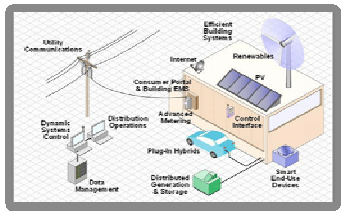
- Devices with reporting, control, on-board intelligence.
- Communications (powerline or wireless) between devices.
- Managing software process (in-home dedicated server, utility managed off-site, or Internet).
- Consumer display device (kitchen, thermostat) or multi-purpose display (TV, computer, phone).



What does the Smart Grid have to do with Energy Efficiency?

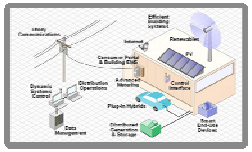
Potentially, the customer side of Smart Grid architecture may address this opportunity with three strategies:

- utility control of peak building energy use,
- time-differentiated dynamic electricity pricing, and
- more frequent and granular energy consumption data to support operational improvements and behavior change.

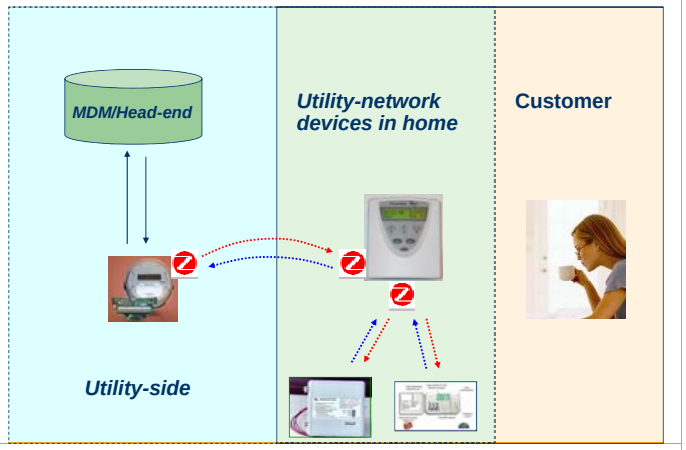


Key architecture issue:
Utility-controlled vs. *Consumer-controlled* energy networks

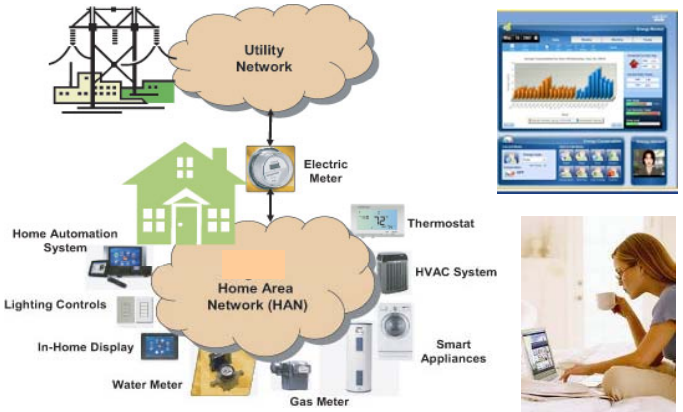
- ***Who will deliver*** **the Smart Grid technology and services that will impact the consumer directly:**
  - ***regulated utilities or firms competing in unregulated markets?***
- ***Who will control*** **the "smarts":**
  - ***utility or consumer, or some combination?***
- ***And how do choices impact energy*** **and the likelihood that innovative business models will get to scale?**

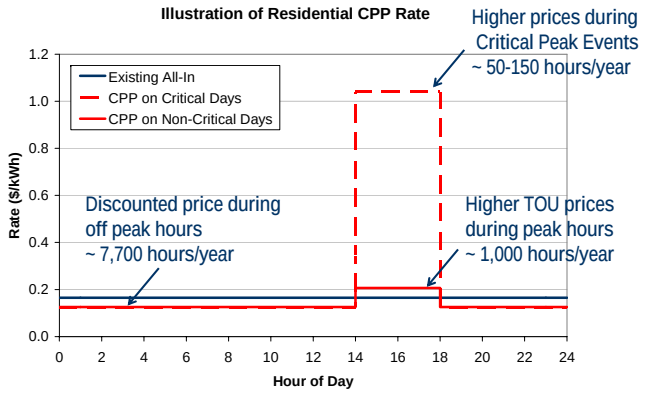

Utility Private Network Architecture – utility provides meter-to-devices communication and control



Customer Side of Smart Grid = *Responsive Energy*
Providing consumers with energy diagnostics, feedback, control



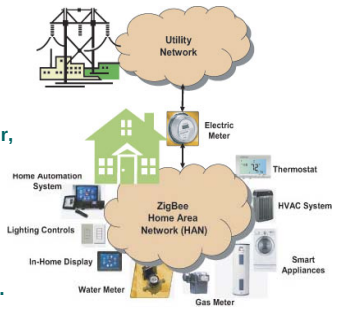
AMI needed for Time-Dependent (dynamic) Pricing



Consumer-responsive Architecture =
Providing consumers with energy diagnostics, feedback, control

refers to systems for optimizing consumers' end-use needs (especially air conditioning, heat, hot water)

- ***based on weather, schedules, and time differentiated costs.***



Time-differentiated rates are more fair, and some would argue inevitable.

Customer Responsive Systems work 24/7,

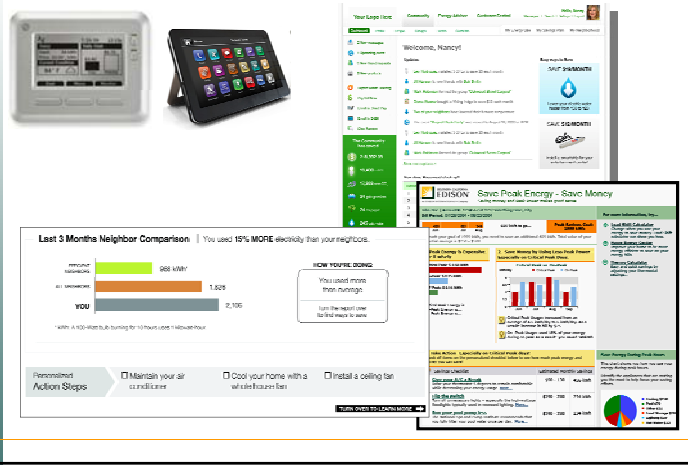
- **providing efficiency as well as peak demand response.**

Smart Grid/AMI Granular Energy Data:
- energy diagnostics, feedback, control

Behavior impacts of smart grid-based information options *may be as high as 30%:*

- **Daily**
- **End-use**
- **Carbon Footprint?**
- **Collective Action?**
- **Fault-detection**
- **Thematic Control – *make me green***
- **Control Precision**
- **Adaptive Control Strategies**

·Only at the *very beginning* of adding inference/diagnostics to the Energy Internet



Key Hypothesis:
***Utilities create the enabling conditions* for market-based systems**

- **To accomplish this, utilities, regulators should focus on:**
  - ***consumer-centric architectures* for appliance control,**
  - ***Open and public architecture* for AMI communication,**
  - ***Encouraging a broad ecosystem of content providers, including utilities.***

- **2013 – How will efficiency look – when the politics change?**
- **Smart meters and dynamic pricing – will we move forward?**
- **The nation's consumers – will we innovate, educate, and support good energy decisions? (ie lower discount rates)**

- **We can do this – *but can we do it in time?***