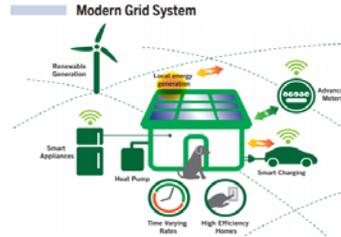




## The Future of Energy Efficiency: Intelligent Buildings at the *Edge* of a Clean Energy Grid



**Harvey Michaels, MIT Sloan Lecturer, Research Director  
Energy Management Strategy**

At BU Questrom Institute for Sustainable Energy  
Earth Week April 19, 2016

[hgm@mit.edu](mailto:hgm@mit.edu)

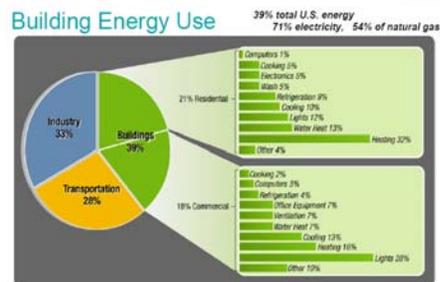


## Qu: What's Interesting about Buildings and the Energy they use?



Over time, *the answer has changed:*

- **1975: OPEC**  
→ *Building Energy Efficiency*
- **1990: Soft Energy Path**  
→ *Integrated Resource Planning*
- **2005: Smart Energy**  
→ *Demand Response, AMI, Site Solar, ICT*  
**= Intelligent Buildings**

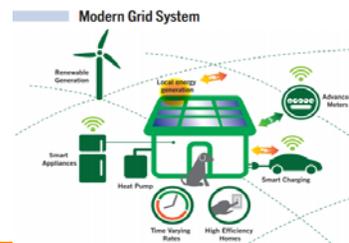
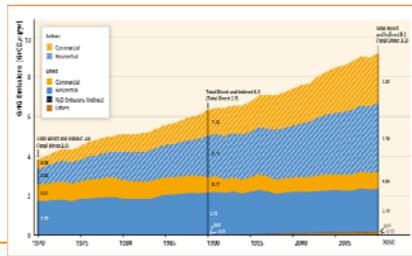


**\$25 Billion/yr!!**

## Going Forward: Intelligent Buildings are at the Center of a Climate Solution



- **1/3** - Buildings account for 1/3 of all GHG emissions.
- **2X** - Business-as-usual, building GHG's will double by 2050.
- **Half** - of emissions can be saved with positive NPV (at least).
- **All** - buildings need to integrate with intermittent renew. energy
- **Zero** - Alternatives to achieving deep gains in more than 1 billion homes/buildings - a *challenging objective*.



## Building Energy Management – 1970's to Now



- **1975** : OPEC → Building Energy Efficiency
- **1990** : Soft Energy Path → Integrated Resource Planning
- **2005** : Smart Energy → Demand Response, Site Solar, ICT
- **Next** : Climate Solution → At Scale, All Together

### Truth about Climate Change:



*Its Real, Its Us,  
Its Bad, Scientists Agree,  
There's Hope*

\* A. Lieserowitz, Yale



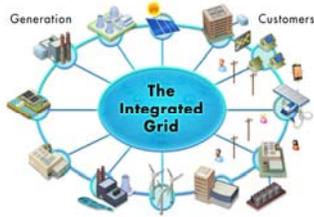
**Building Energy, Soft Energy, Smart Energy  
At Scale, All Together =**

**Intelligent Building Energy Management**

**What is it? Science and business innovations to optimize building energy use.**



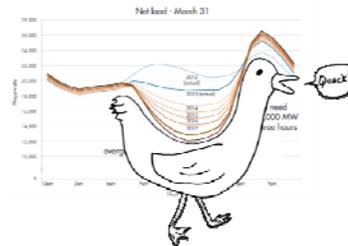
- = Building Energy Efficiency**
- + Building-to-Grid Systems**
- + Carbon-free Site Energy**
- + Smart People, Cities**



**Consumers at the Edge of a  
Connected Clean Energy Grid**



- **Climate Change-driven means:**
  - DEALING WITH: Intermittent Supply and “Duck curve” demand
  - CHOOSING: Policy/customer preferences for Site Solar, EV’s, batteries, efficient, green, modern.
- **THE PROSUMER:**  
*Decarbonization, Distributed Generation, Digitization*



## DISRUPTIVE TECHNOLOGY at the Edge of a Connected Clean Energy Grid

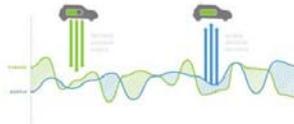


### ➤ Internet of Things, comes with everything.

- Energy - *sensible, controllable.*
- Enables Settings: *fault detection, thematic control, adaptive strategies*
- Efficiency and grid stabilization - *visible, transactable.*



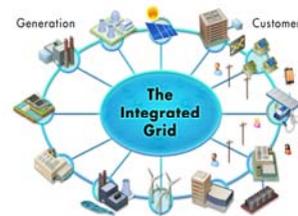
**Question: Internet of Things meets Grid of Things:  
Who owns, who controls?**



## UTILITIES at the Crossroads of Buildings, Climate, and Grid

### Distribution Utility Restructuring:

- From Monopolies → Markets



### Question: Where to get backup/insurance energy?

- Utility grid, on-premise, microgrids (real, virtual)?

**Most likely answer: *All of the Above***

- Utilities may compete post-monopoly as Comcast does:
  - FIOS, Dish/Direct, Apple TV/Amazon Fire/Netflix
  - Comcast Innovates → Xfinity, X1 : *Its Still There*
  - Utilities who embrace change – *power of incumbency.*

## Business Innovations At Scale, All Together



### All Together:

#### Building Energy Management → Full Service/Integrated:

- Building efficiency, DR/controls, Solar/batteries, energy
- Solar pull → Intelligent Buildings → Energy Efficiency

### At Scale:

#### Business, City strategies that Solve the Climate Problem employ:

- No money down, guaranteed positive cash flow.
- Easy, quick, risk free, Guilt.



**Make EM Costless, Riskless,  
Timeless, and Visible to all!**



## The Future of Intelligent Building Energy Management is bright!

### Today's \$25 B building energy industry

- Needs to be/should be \$100 B by 2020
- Needed To Solve the Solvable Climate Problem

### Opportunity:

#### Develop *much more effective* building/climate strategies

- Building Efficiency so far shows some progress, but we need *all of it*.
- Today's Prosumers want 3D's:  
*Decarbonization, Distributed Generation, Digitization*