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# The Technical Basis of Benchmarking, Metering, and Behavior Change

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# People Matter

“People, not machines, make the decisions that affect energy use. Insight into the human dimension of energy use is key to better understanding future energy trends and how to act effectively to manage them.”

Schipper and Meyers, *Energy Efficiency and Human Activity*. Cambridge: Cambridge University Press, 1993.

# Overview

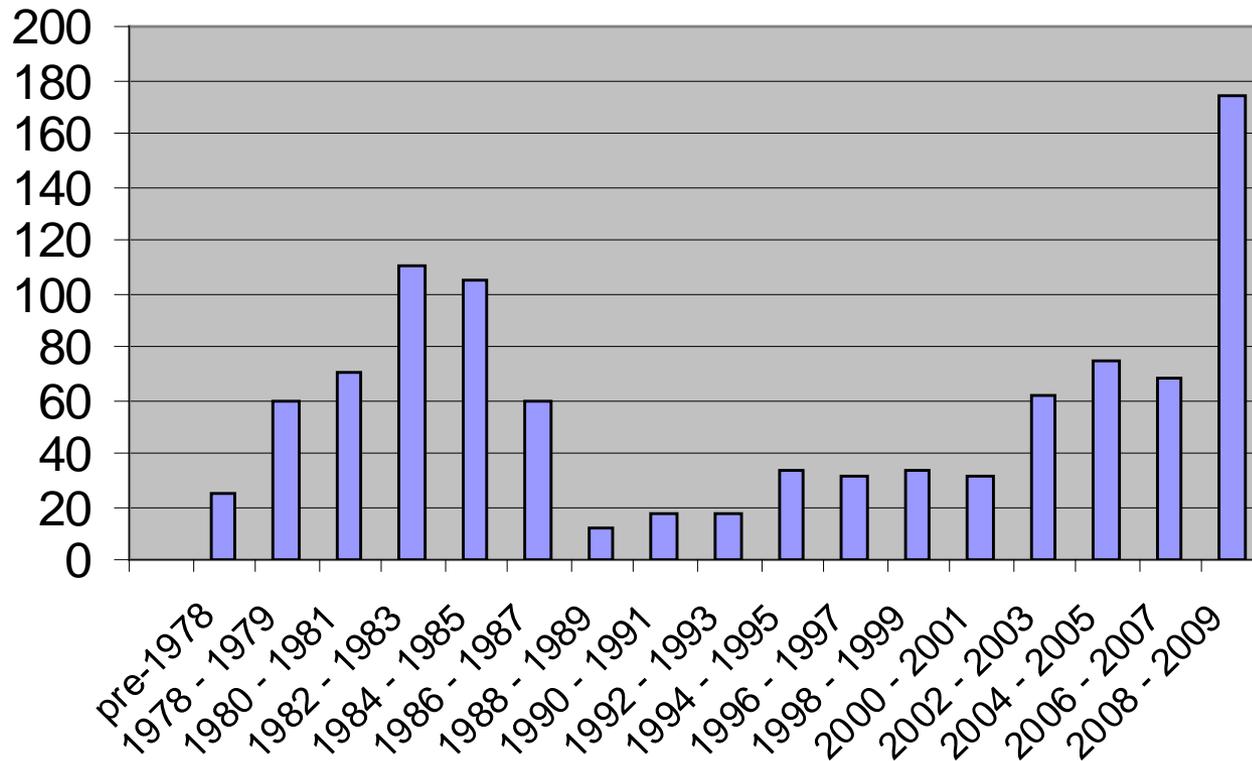
- Background on science and theory of energy and behavior change
- Benchmarking: what is it & how to do it
- Metering: application to benchmarking
- Design principles for organization and behavior change
- Applications
- Benchmarking tools

# Key Points

- Not just a technical problem
- Success takes time, persistence, and measurement
- Social science can help

# Background:

## The Science of Behavior Change



Number of research reports , 1975 - 2009

# Success Stories

- Citi Group benchmarking
  - 80M sq ft, 12,500 locations, 100 countries
  - Commitment to 10% reduction by 2011 (2006 baseline)
  - Used benchmarking to identify best practices in buildings

12% energy reduction (sustained)

# Success Stories ?

- Jack Davis Bldg
  - 150K sq ft govt bldg
  - Prompts and real-time feedback

12% reduction

Lack of persistence

# Success Stories ?

- Malone base comparison study
  - Military housing at Ft Lewis and MCAS Yuma
  - Energy and water use conservation
  - Use of information and persuasion w/o economic incentive

10 – 12.7% reduction over 6 – 12 months

Unknown persistence beyond

# Energy Myths

- Everyone needs (and *wants*) more information
- Providing information about personal energy use will change behavior
- Most people have a pretty good idea of where energy is being used
- Saving energy = Saving money = Motivation

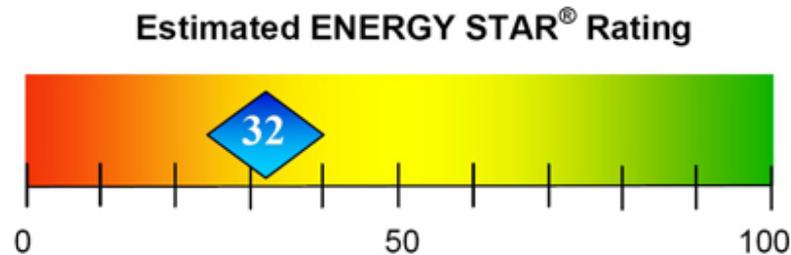
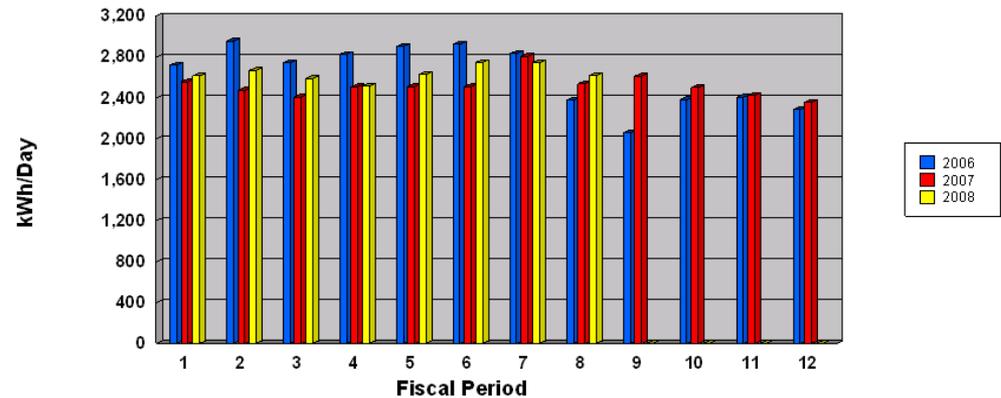
# Benchmarking

- Reference point
- Benchmark encompasses *energy consumption & organization practice*
- Benchmarks require common units of measure

|   |   |  |
|---|---|--|
|    | <b>Scope 1&amp;2 GHG Emission Reduction Target</b><br>Submitted comprehensive inventory as 2008 baseline for Scope 1&2 GHG Reduction Target of 21% by 2020'   | <br>Score: <b>GREEN</b>   |
|    | <b>Scope 3 GHG Emission Reduction Target</b><br>Submitted comprehensive inventory as 2008 baseline for Scope 3 GHG Reduction Target of 7% by 2020'  | <br>Score: <b>GREEN</b>   |
|    | <b>Reduction in Energy Intensity</b><br>Reduction in energy intensity in goal-subject facilities compared with 2003: 15.9% and on track for 30% by 2015   | <br>Score: <b>GREEN</b>   |
|    | <b>Use of Renewable Energy</b><br>Use of renewable energy as a percent of facility electricity use:<br>Total of 9.2% from renewable electricity sources including at least 2.5% from new sources (thermal, mechanical, or electric) | <br>Score: <b>GREEN</b>   |
|   | <b>Reduction in Potable Water Intensity</b><br>Reduction in potable water intensity compared with 2007: 14.1% and on track for 26% in 2020  | <br>Score: <b>GREEN</b>  |
|  | <b>Reduction in Fleet Petroleum Use</b><br>Reduction in fleet petroleum use compared to 2005: 2.9% and not on track   | <br>Score: <b>RED</b>   |
|  | <b>Green Buildings</b><br>Sustainable green buildings:<br>5.46% of buildings sustainable<br>8.71% GSF of inventory sustainable  | <br>Score: <b>GREEN</b> |

# Benchmarking Approaches

- Past performance
- Industry average
- Best in class
- Best practices



# Metering

- Can provide
  - Dashboards
  - Energy management systems
- Varying levels of precision
- Data needs vary by audience
- Metering can and should support evaluation



# Organizational & Behavioral Barriers

- Inertia
- Salience
- Mental effort
- Normative comparison
- Future discounted
- Transaction costs
- Usability



# Program Design Principles

- Social Network & Communications
- Multiple Motivations
- Leadership
- Commitment
- Feedback
- Infrastructure
- Empowerment
- Continuous Change

# Potential Application (1)

- Reduce vehicle idling
  - Saves fuel
  - Behavioral intervention
  - Can be supplemented with technology



- Myths
  - Starting consumes more than idling
- Barriers
  - Inertia
  - Salience
- Design Principles
  - Social Network
  - Feedback
  - Commitment
  - Empowerment

# Potential Application (2)

- Renewable Integration
  - Saves fuel
  - Behavioral intervention:  
Load shifting

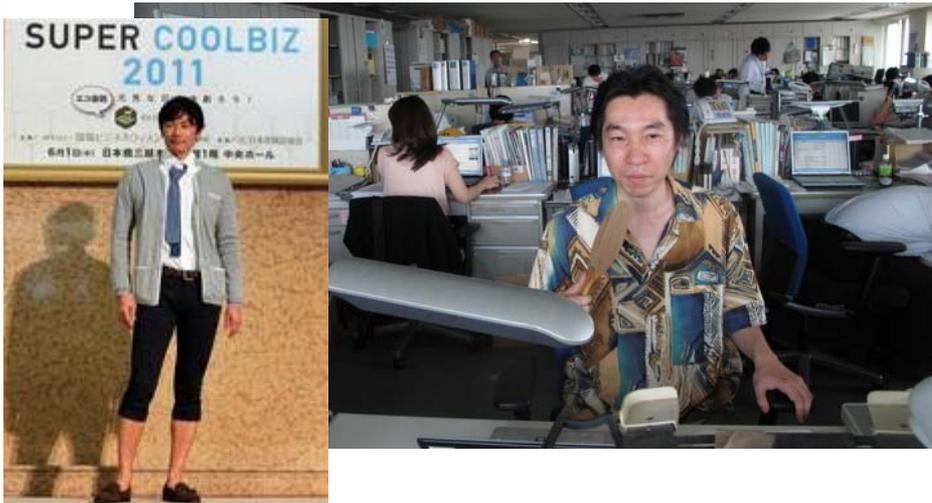


- Myths
  - Intermittency makes power source less desirable
- Barriers
  - Transaction costs
  - Usability
- Design Principles
  - Social Network
  - Feedback
  - Infrastructure
  - Commitment
  - Empowerment

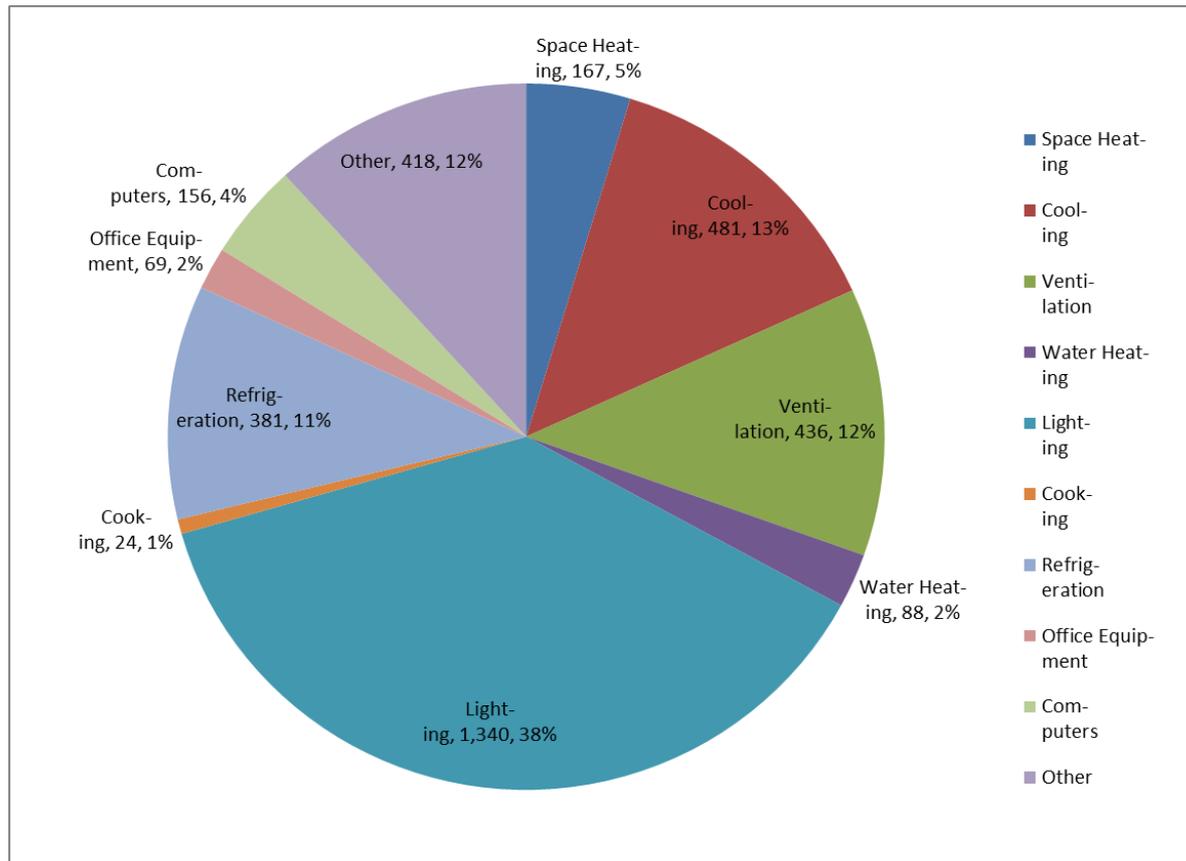
# Potential Application (3)

- Increase thermal range
  - Behavioral intervention
    - Adaptation to new setpoints
    - Clothing changes

- Myths
  - Universal band of comfort
  - A/C on high is more efficient
- Barriers
  - Hassle costs
  - Usability
- Design Principles
  - Social Network
  - Feedback
  - Infrastructure
  - Commitment
  - Empowerment



# End Use Data Needed



Percentage of total electricity used in US commercial buildings by end use: BTU, % total (2003)

# Some Benchmarking Tools

- ENERGY STAR's [Portfolio Manager](#): Compare energy performance of facilities to similar buildings nationwide. [LBNL Action-Oriented Benchmarking System](#):
- [Energy IQ](#): A web-based implementation of the LBNL AOB System for non-residential buildings.
- [Cal-Arch](#): a tool for benchmarking whole-building energy for California commercial buildings

# How to Apply in Organizational Settings

- Use existing data sources/expert knowledge to identify critical end
- Identify low-cost/no-cost behavioral interventions applicable to end uses
- Understand the operational/logistical barriers/myths to implementation
- Select interventions with high likelihood of adoption and payoff based on initial site surveys
- Implement-measure-modify as required
- Expand to more challenging end uses