Energy Efficiency:
Imagine the Possibilities

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Asking the Right Questions

• Physicist and now Princeton Emeritus Professor John Wheeler once commented:

  “We shape the world by the questions we ask.”

• Hence, if we are failing to ask the right set of questions, then we may very well end up with less than the best set of answers.
Working Definition: Energy Efficiency Investments

• The cost-effective investment in the energy we don’t use to produce our goods and services.

• Examples include:
  – New electronic ballasts and lamps, sensors, building and piping insulation, and heat recovery systems installed to primarily save energy
  – Information and communication technologies (ICT) whose secondary value increases overall energy productivity
  – Combined heat and power (CHP) and recycled energy systems with efficiencies of 70-90 percent, or more
  – Investments in the more innovative, high value-added industries and services that power structural change, but in ways that also lower our overall energy-intensity

• The common denominator in all these examples is productive investment and informed behavior – and now, increasingly enabled by smart materials, semiconductor devices, technology systems and infrastructures.
An Opening Commentary

- Energy efficiency is the farthest reaching, least-polluting, and fastest growing energy success story of the last 40 years.
- Energy efficiency has met 75 percent of the new demands for energy-related goods and services since 1970 while new energy supplies have met only 25 percent of those demands.
- But energy efficiency is a highly invisible success story.
- At the same time, we are in the midst of an economic quandary that may be severely impacted by energy and climate constraints, as well as by growing demands from developing economies.
- Yes. . . “Science and technology can create much better choices.” (DOE Secretary Chu 2009)
- **But we won’t get there unless we bring both people and imagination into the process.**
Creating an Energy Revolution

A revolution doesn’t happen when society adopts new tools, it happens when society adopts new behaviors.

Clay Shirky, Digital Guru
The Scale of the Energy and Climate Imperative

![Graph showing historical trends and future forecasts for total primary energy use from 1990 to 2050. The graph includes a forecast for normal innovation showing an increase and a forecast with changed behaviors and expanded levels of innovation showing a decrease.](image-url)
A Key Insight: Purposeful Effort is Required if We are to Respond to the Twin Imperatives

Performance, Productivity and Returns

Standard Technology and Effort

Some might say this is about where we are on the curve at the moment

Time
A Key Insight: Purposeful Effort is Required if We are to Respond to the Twin Imperatives

But, new innovations, new social norms, and a new appreciation of possibilities are all required to leverage the full range of opportunities and productive investments.
Exploring new possibilities at a substantially larger scale. . . .
The Acciona Zero Emissions Building in Spain

Why is it a zero emissions building?

The head office of ACCIONA Solar is a ‘zero emissions’ building due to:

- The saved energy through the bioclimatic and eco-efficient characteristics of the building
- and the energy produced by renewables

allows a CO₂-free balance, the main greenhouse gas causing global warming
Planned Retrofit of the Willis (formerly Sears) Tower in Chicago

A MODERNIZED ICON

HOW
Modernization + green strategies
- Exterior Wall
- Mechanical Systems
- Daylighting
- Green Roofs
- Water Savings
- Operations and Maintenance
- Solar Hot Water
- Wind Turbines
- Vertical Transportation

WHY
Conserves more than 68,000,000 kilowatt hours per year or:
- 5,000,000 fewer miles of highway driving
- 50,000 fewer barrels of crude oil
- Electricity for 2,500 average Chicago homes
- 10,000,000 light bulbs saved

Source: Courtesy of Adrian Smith and Gordon Gill Architecture, Chicago, IL
And the Retrofit as a Symbiotic Catalyst for a New Zero Energy Building

- **Sky Deck**: envision the future
- **Solar Hot Water**: conserve heat energy
- **High Rise Green Roof**: conserve heat energy
- **Wind Turbine Lab**: demonstrate technologies
- **Exterior Wall**: improve performance and interior comfort
- **Urban Garden**: engage the public realm
- **Cultural Exhibits**: enhance the visitor experience
- **Physical Plant**: optimize shared efficiency
- **Art Wall**: inform the public
- **Solar Deck**: capture solar energy through building integrated photovoltaics
- **Conservatory**: experience landscapes
- **Building Integrated Wind Turbines**: harness wind power
- **Light shelves**: increase natural daylight
- **Intelligent Facade**: enable interior comfort and energy performance
- **Sky Garden**: ventilate the interiors
- **Atrium Light Well**: distribute daylight
- **ECO-Gardens**: provide habitable green space

Source: Courtesy of Adrian Smith and Gordon Gill Architecture, Chicago, IL
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And What of Historical Building Retrofits (an Idea in Italy)?

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And Finally: A Fully Integrated Buildings-Systems Retrofit?

Multi-directional ‘flows’

End user real time information & participation

Seamless integration of new applications

Central & dispersed intelligence

Central & dispersed sources

Smart materials and power electronics

Bi-directional power and information flows

Source: Courtesy of Pier Nabuurs (KEMA – The Netherlands)
The Good News About the Transition to a More Energy Productive, Climate-Friendly Economy

• It is does not have to be about ratcheting down our economy;
• Rather, it can be all about:
  – using innovation and our technological leadership;
  – investing in more energy productive behaviors and technologies (including both existing and new opportunities); and
  – developing new ways to make things, and new ways to get where we want to go, where we want to work, and where we want to play.
• The opportunities for a robust, smart energy future are there – but revolutions don’t happen without people and imagination.
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