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The Economic Imperative of ICT

*Questions, Comments, and Possible Outcomes**

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*** In the spirit and tradition of Nobel Laureate and former Caltech physicist Richard Feynman, in his 1959 visionary talk, "There's Plenty of Room at the Bottom." See, http://www.its.caltech.edu/~feynman/plenty.html.**

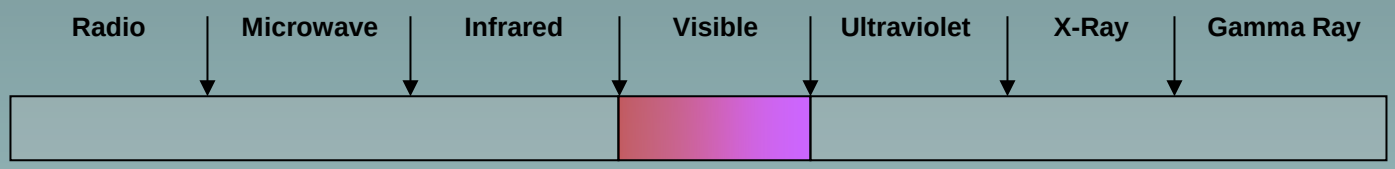
A Working Hypothesis

The economic recovery and the full development of our long-term global prosperity will not be possible without significant increases in purposeful investment and greater levels of resource and energy efficiency – enabled by interactive information technologies and systems, and motivated by informed attitudes, and more productive behaviors.

With a cautionary note (in two equations). . .

An Illuminating Thought Experiment

Let's start with the full electromagnetic spectrum, as shown below:



Not drawn to scale, but visible light is about one-thousandth of one percent of that full spectrum

Our understanding of the physical world would be considerably more impoverished if we relied only on visible light to shape our insights into the topography, morphology, and composition of the elements and materials that make up the world in which we live.

And yet, many, if not most, of our energy scenarios (and policy assessments) assume a knowledge based upon a highly limited understanding of today's data, technologies and opportunities – in effect, using only the immediately visible part of the technology spectrum – as if no other knowledge or insights were necessary to fully understand or positively shape the future. . .

Some Questions. . .

Some thought experiments, or Gedankenexperimente, to open up our thinking. . .

What is the Raspberry Pi?

- The University of Cambridge noticed that many PhD students in computer science had never mucked with the internal workings of a computer.
- Hence, the Raspberry Pi.

A credit card-sized computer that can be plugged into your TV and keyboard. It can be used for many of the things a desktop PC does, like spreadsheets, word-processing and high-definition video games.

- It now sells for $53.95 on Amazon. What might that reduction in cost and size mean for prospective improvements in energy efficiency?

What is the Social Rate of Speed?

- This question is drawn from an intriguing 1974 book, *Energy and Equity*, written by Austrian philosopher, Roman Catholic Priest and social critic, Ivan Illich.
- If the driver in a car were to go from point A to point B in 10 minutes, at, say an average speed of 30 miles per hour, but a person on a bicycle were to take 30 minutes, the immediate assumption is that the person using the car is better off.
- Updating Illich, let's unfold the larger context. The person in a car may drive, say, a total of 10,000 miles per year.
- But if we add up all the hours to pay for the car, all the hours going to court over the car, repairing the car, looking for parking spaces, and paying for streets control signal and parking lots, that might require more like 1500 to 2000 hours of time each year.
- Thus, what I call the social rate of speed might be more like 5-7 miles per hour.

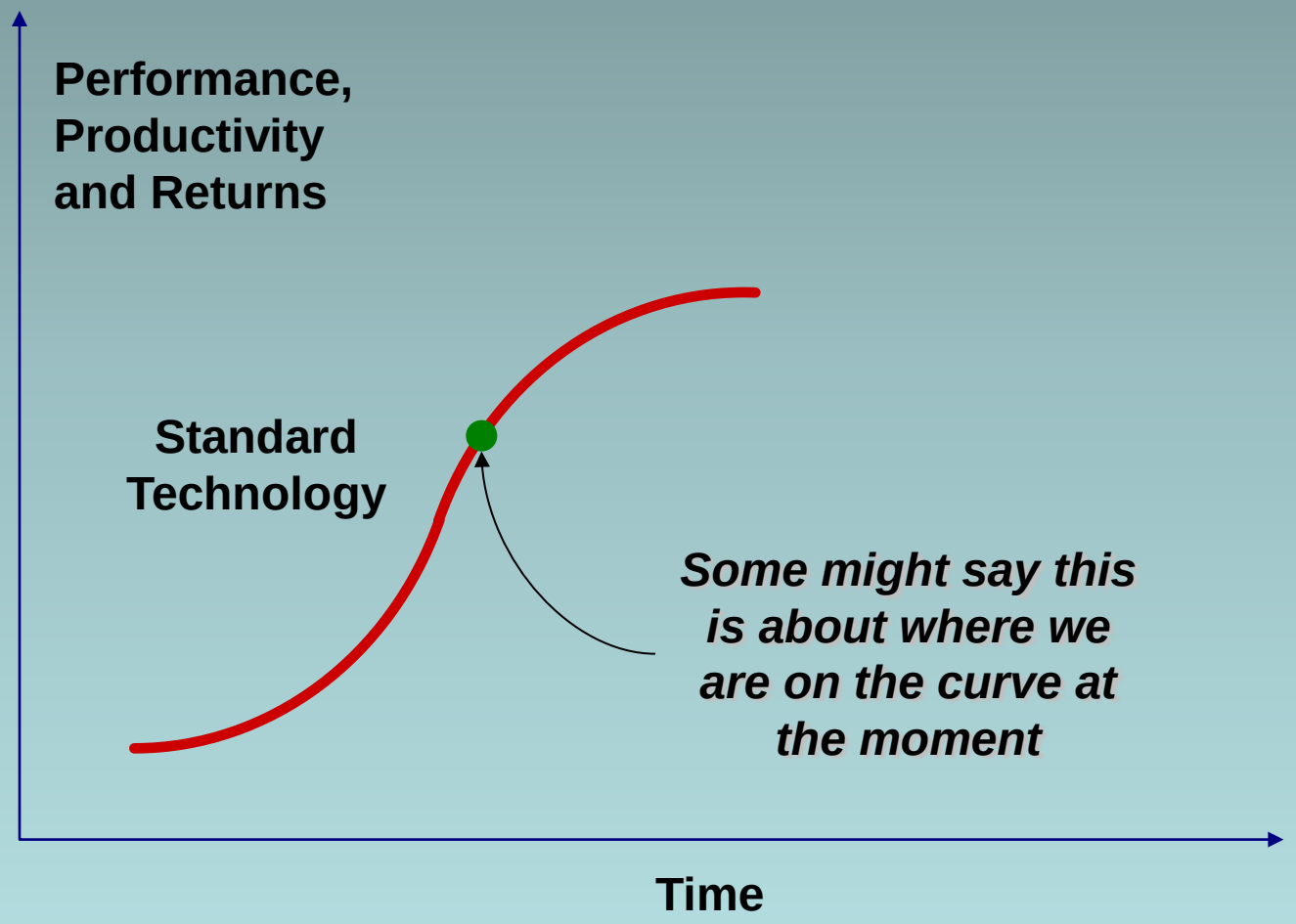
What is the Record Fuel Economy?

- If I were to ask participants in this conference what is the current record for fuel economy with a research vehicle using a standard gasoline engine, some might have ventured a guess of 100 miles per gallon (mpg); or perhaps even a respectable 150 or 200 mpg.
- I suspect many would be surprised to learn that in 2003 a French team (designers of the car, “the Microjoule”), participating in the Shell Eco-Marathon, had achieved the rather astounding result of: ***8,914 mpg.***
- In June 2005 students from our host university here today, ETH Zurich, set an even more impressive new world record for fuel efficiency: ***12,665 mpg*** — this time in a hydrogen fuel cell vehicle, also as part of the Shell Eco-marathon.
- I highlight these results, not to suggest that a standard consumer vehicle would ever achieve this level of efficiency — not in a way that is both cost-effective and comfortable; rather, it is to suggest ***even after all of the years since the 1973-74 oil embargo, we still know so little about real efficiency opportunities that we unnecessarily limit our options by excluding those possibilities in our energy future scenario.***

What is the Bekenstein Bound?

- In the spirit of Richard Feynman, this question explores what we might call “the possibilities frontier.”
- Building on the foundations of information theory advanced by MIT graduate Claude Shannon in 1948, Princeton graduate student Jacob Bekenstein proved in 1973 there was a limit to the information that can be stored in any given region of space.
- Contrary to expectation, the limit to information does not depend on volume but on surface area.
- Rough calculations suggest that the Bekenstein Bound is ~10^{70} bits/square meter.
- By comparison, today’s CD’s now cram “only” 10^{13} bits/square meter.
- In other words, we’re not even close to the physical limit, or the physical frontier.

Purposeful Effort is Required to Respond to the Economic and Climate Imperatives



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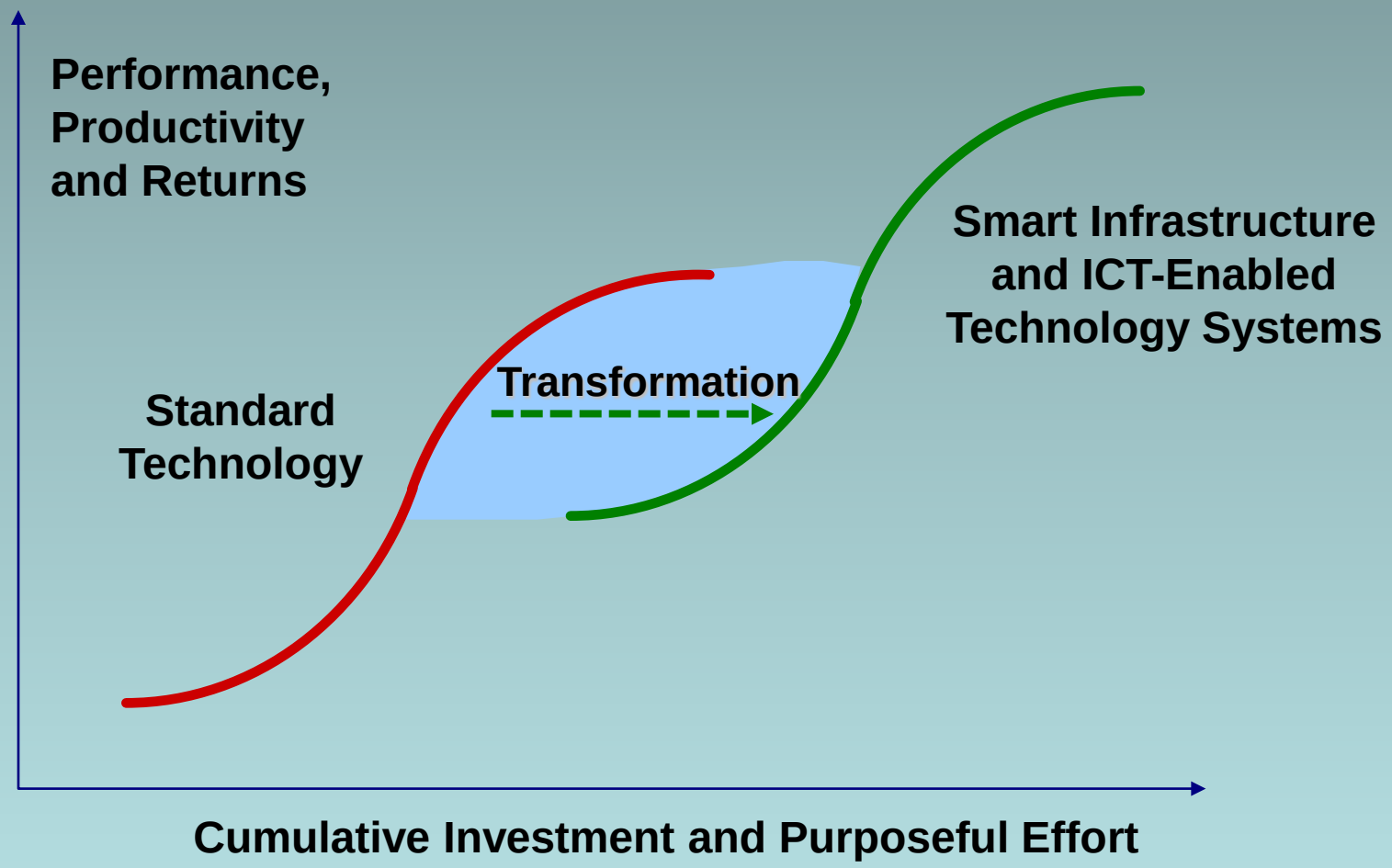
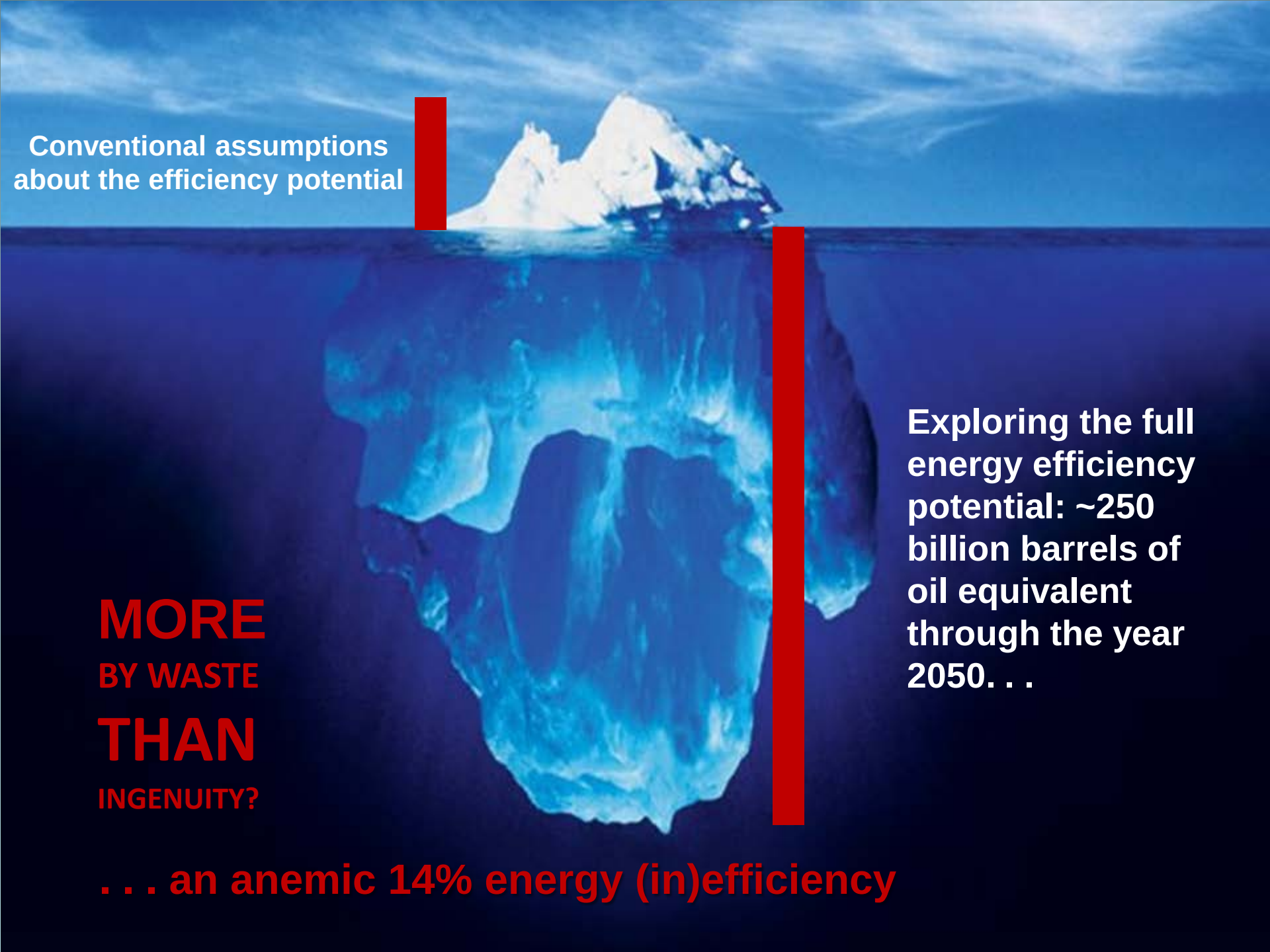


Jumping to the End of the Story

The new ACEEE report, *"The Long-Term Energy Efficiency Potential: What the Evidence Suggests,"* shows how slashing U.S. energy consumption by 40 to 60% – all done through highly cost-effective efficiency investments – could generate up to 2 million jobs while saving all residential and business consumers a net $400 billion per year, or the equivalent of about $2,600 per household annually.

The key insight? Instead of tiny increments, the US will be better off '*Thinking Big*' about energy productivity and energy services, rather than relying on the usual set of very costly and conventional energy resources.

Source: *The Long-Term Energy Efficiency Potential: What the Evidence Suggests* (2012). Washington, DC: ACEEE. http://www.aceee.org/press/2012/01/aceee-report-us-better-thinking-big-


Conventional assumptions about the efficiency potential
Exploring the full energy efficiency potential: ~250 billion barrels of oil equivalent through the year 2050. . .
MORE
BY WASTE
THAN
INGENUITY?
. . . an anemic 14% energy (in)efficiency

Just One of Many Examples: Optimizing the U.S. Traffic Signals

- There are an estimated 272,000 traffic signal systems throughout the United States today.
- Stop and start driving and poorly timed signals cause unnecessary fuel consumption on our nation's highways.
- Retrofitting these systems with smart sensors and dynamic programming techniques can improve traffic flow that, in turn, can reduce highway fuel consumption by 5-10% per year.
- The cost? About $10-12 per household. The savings? About $150 per household per year – and possibly more!
- ICT and smart infrastructure can be a critical enabler.

Developing Intelligent Efficiency

- Not yesterday's idea of real energy efficiency, but interconnected systems – what we can call "Intelligent Efficiency" – could reduce energy use by about one-fourth of today's levels, while still maintaining jobs and a robust economy.
- With new information technologies and advanced sensors and controls, for example, both Schneider Electric and Rockwell Automation offer services to manufacturing firms that can reduce electricity use by up to 40 percent and reduce oil and gas requirements by up to 35 percent.

Source: ***A Defining Framework for Intelligent Efficiency*** **(2012). Washington, DC: ACEEE.**
http://www.aceee.org/press/2012/06/aceee-major-new-us-energy-find-could

Yet, we must also explore the behavioral elements as a means to reinvigorate the economic imperative of energy efficiency. . .

Why? Because the mere availability of smart technologies does not ensure any particular or any desired outcome!

So This Critical Observation

- Yes. . . “Science and technology can create much better choices.” (Former DOE Secretary Chu 2009)
- *But we won’t get there unless we bring people back into the process.*

Or More Prosaically. . .

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

Clay Shirky

NYU Telecommunications Professor

How Important is Behavior?

People as Problem?

Or. . .
People as Solution?

Buildings would work perfectly if it weren't for the people in them.

-- Anonymous, ACEEE Summer Study Conference, circa 1993

The Foundation of an Energy Revolution

- Engaging and empowering the entire population to adopt new behaviors, and to create a dynamically new energy culture.
- In short, we need to get people to do things differently.
- How do we do that?

Managing an Invisible Resource

- Unlike previous eras – today's energy resources are invisible.
- People no longer cut wood or shovel coal.
- Electricity enters our homes in seamless and silent ways.
- Our only means of assessing our level or impact of energy consumption is the utility bill that we pay each month, or the bill we pay with each fill-up of the gas tank.

➔ **So the very first step is feedback – a mechanism to make energy visible, a tool for learning, and a means of generating confidence and effective response.**

How do we Engage People?

INFORMATION…providing information about energy consumption, technologies, programs, priorities, and amount of savings achieved.

Energy Consumption Feedback

Residential Feedback

Savings: 4-12%

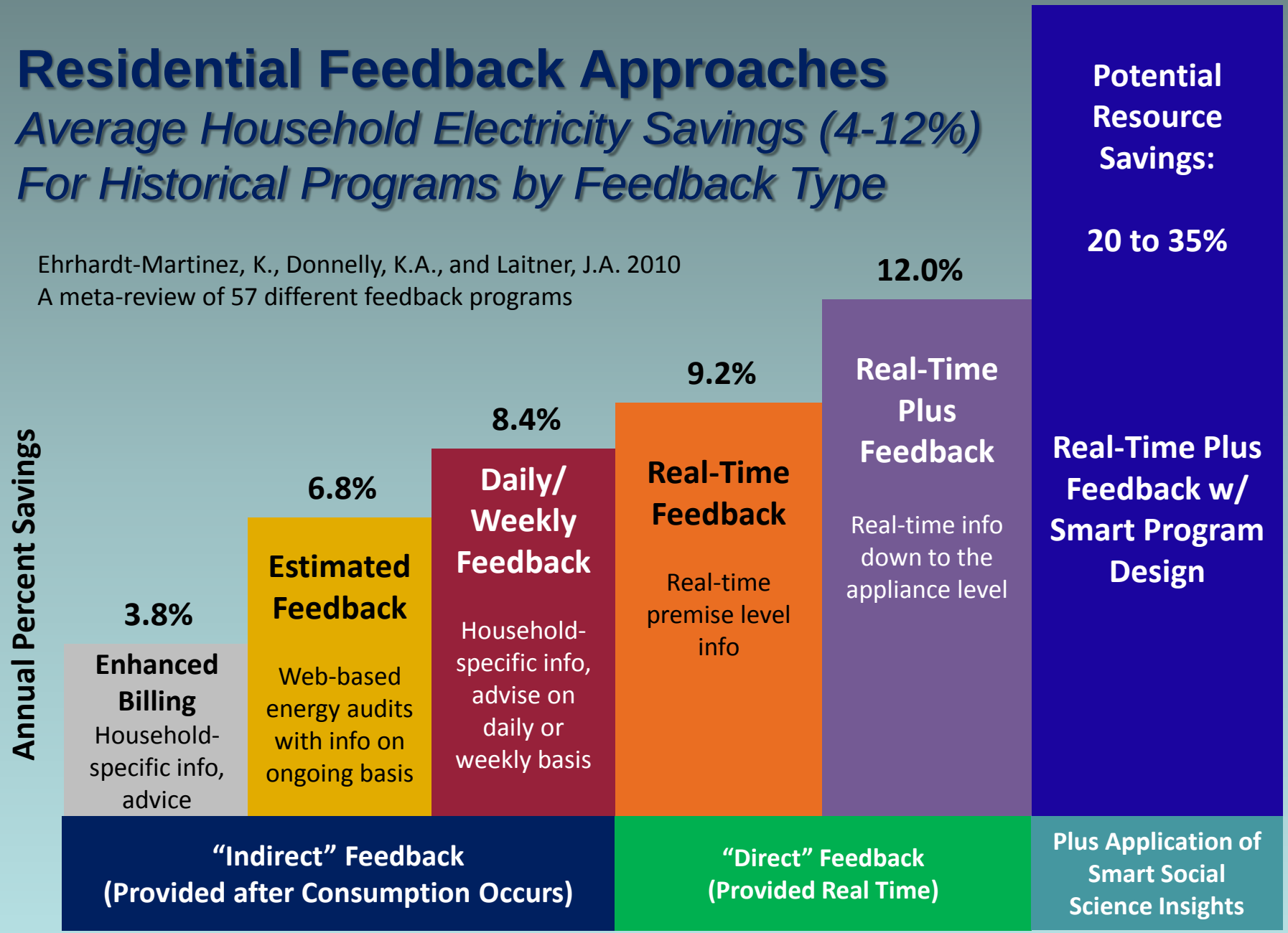
Savings: 20%

Cisco Mediator

Residential Feedback Approaches

Average Household Electricity Savings (4-12%) For Historical Programs by Feedback Type

Ehrhardt-Martinez, K., Donnelly, K.A., and Laitner, J.A. 2010
A meta-review of 57 different feedback programs



Three Targets/Mechanisms of Change

Using not just existing or new technologies, but also new insights from the Social Sciences to understand:

1. How to make energy feedback systems more effective, on-going, and over a long period of time;
2. Ways to elevate the impact of the scale and design of smart infrastructure at community and social levels; and
3. The relationship between feedback, measures of confidence and effectiveness, and other factors that will drive deep building retrofits and other large-scale efficiency improvements.

All enabled by Information and Communication Technologies

With This One Very Big Caveat. . .

Work = (1 – Waste)

Where:

"1" is the full array of all possibilities;

"work" is the set of net positive social, economic, environmental benefits; and

"waste" is the opportunity squandered by individuals, businesses, government – and society more generally. . .

With a Second Caveat on What I Call the "GDP Sweetspot"

To ensure long-term sustainability. . .

The rate of rate of annual global energy efficiency improvement must be:

Desired GDP Growth Rate + ~(0.5 to 1.0%)

Perhaps Our Ultimate Economic and Energy Efficiency Resource?

- Recalling the comment of early Twentieth Century UK essayist, Lionel Strachey, who remarked: *“Americans guess because they are in too great a hurry to think.”*
- Jerry Hirschberg, founder and former CEO of Nissan Design, who noted that: *“Creativity is not an escape from disciplined thinking. It is an escape with disciplined thinking."*
- And Henry Ford once said, *“Thinking is the hardest work there is which is the probable reason why so few engage in it.”*

The Five Key Take-Aways

- The energy efficiency resource is larger and more necessary to develop than is generally understood.
- Informing, engaging, motivating, and empowering consumers is a critical first step for large-scale savings.
- For real, deep, and lasting change, a layered approach to changing behavior is important – using multiple methods and means of reaching people, as individuals, but also as family members, neighbors, and co-workers!
- Not discussed, but also the need for new business models that shift from the sale of commodities to providing value-added services, and do so in ways that save money while generating positive returns for investors.
- There will be losers! How do we make losers into winners?

The difficulty lies not with the new ideas, but in escaping the old ones. . . .

John Maynard Keynes

For further information and citations to the resources and references cited:

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See our eBook on the behavior resource:

Karen Ehrhardt-Martinez and John A. "Skip" Laitner, Editors

People-Centered Initiatives for Increasing Energy Savings

Washington, DC: American Council for an Energy-Efficient Economy

www.aceee.org/node/9275

See also my *Desert Year* Blog:

Running with the Lizards and Doing a 180 on Energy

http://www.realclimateeconomics.org/wp/archives/1261