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The Economic Imperative and Opportunity of Long-Term Energy Efficiency

Three Questions in Exploring the Efficiency Potential *

John A. "Skip" Laitner
Senior Fellow
American Council for an Energy-Efficient Economy (ACEEE)

Capturing the Multiple Benefits of Energy Efficiency

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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.**

First Question: Other than population, what may be the single largest contributor to economic and environmental degradation?

Answer: The large-scale and inefficient use of energy.

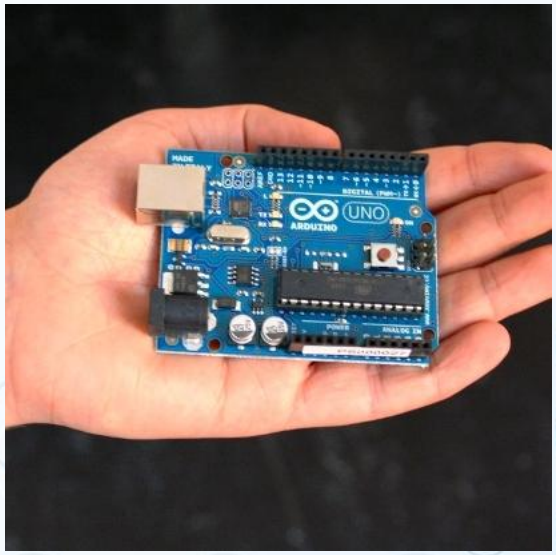
Estimate: The United States wastes ~86 percent of all the energy consumed within the economic process!

Result: That magnitude of waste imposes a large array of costs that severely constrains the economic process!

Conclusion: Perhaps the most immediate opportunity to ensure a more robust and sustainable economy within the U.S. is to quadruple or quintuple our current 14 percent level of energy (in)efficiency.

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 512 MB 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 Record Fuel Economy?

- If I were to ask what is the current record for fuel economy with a standard gasoline engine research vehicle, some in the U.S. have ventured guesses of 100 miles per gallon (mpg); and even a respectable 150 or 200 mpg.
- Many have been 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 the Federal Polytechnical School of 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, and in the spirit of Richard Feynman, it is to suggest that ***we still know so little about real efficiency opportunities that we unnecessarily limit our options by excluding possibilities in our future scenario analyses.***

Jumping to the End of the Story

The 2012 ACEEE report, *"The Long-Term Energy Efficiency Potential: What the Evidence Suggests,"* shows how reducing energy use by 40 to 60 percent – 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 insight? Instead of tiny increments, the U.S. 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-**

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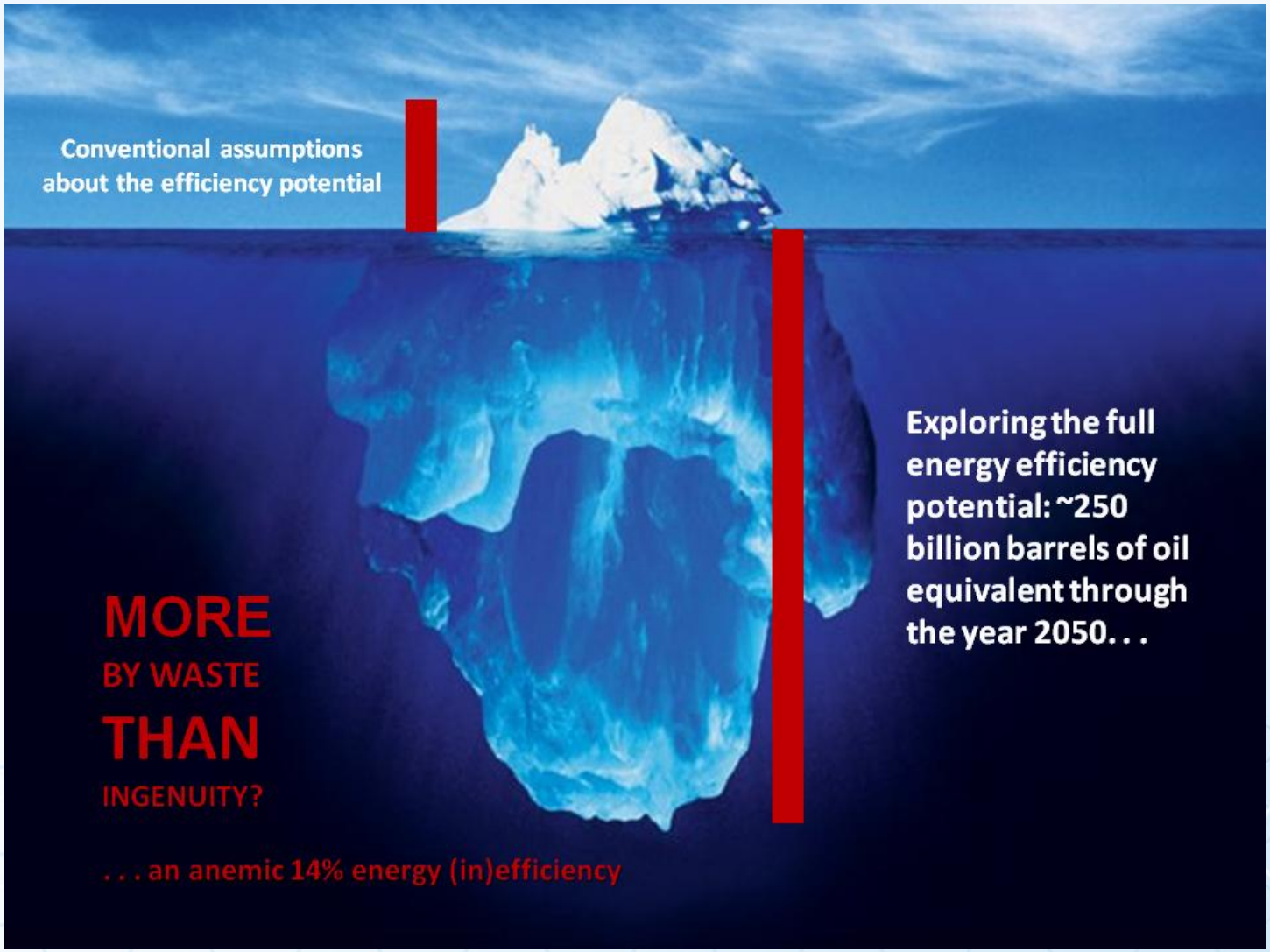

Sources: ***The Long-Term Energy Efficiency Potential: What the Evidence Suggests*** **(2012). Washington, DC: ACEEE. http://www.aceee.org/press/2012/01/aceee-report-us-better-thinking-big-**

John A. "Skip" Laitner. 2013. "The Link Between Energy Efficiency, Useful Work, and a Robust Economy," in John Byrne and Yang-doo Wang (editors), ***Secure and Green Energy Economies*** **(forthcoming).**

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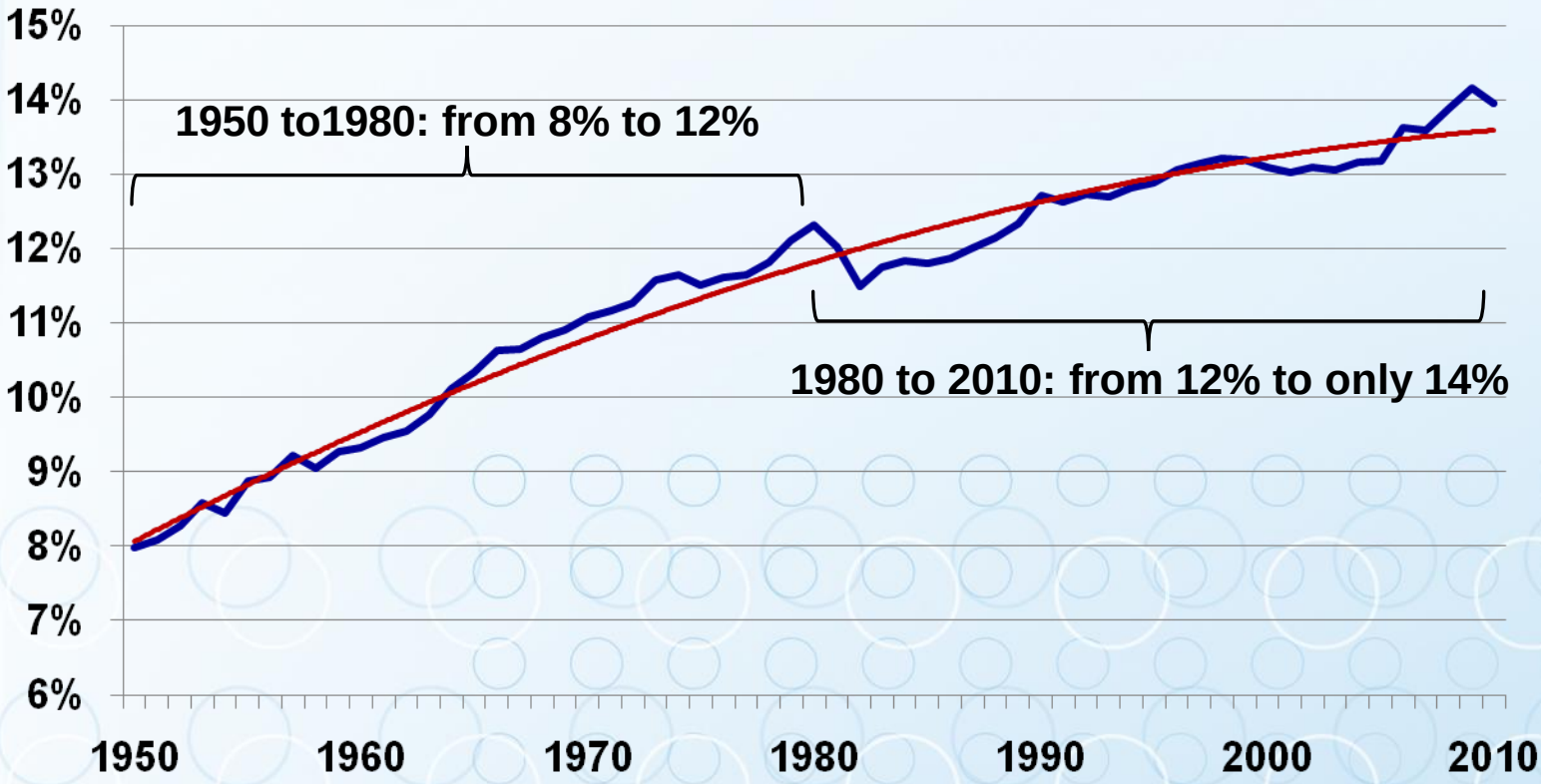
"We shape the world by the questions we ask"

Physicist John Wheeler

U.S. Energy Conversion Efficiency

That is, the Ratio of Used Energy (Useful Work) to Total Energy



Source: *Ayres and Warr 2009 with data updates from 2005 to 2010 by Laitner (2013).*

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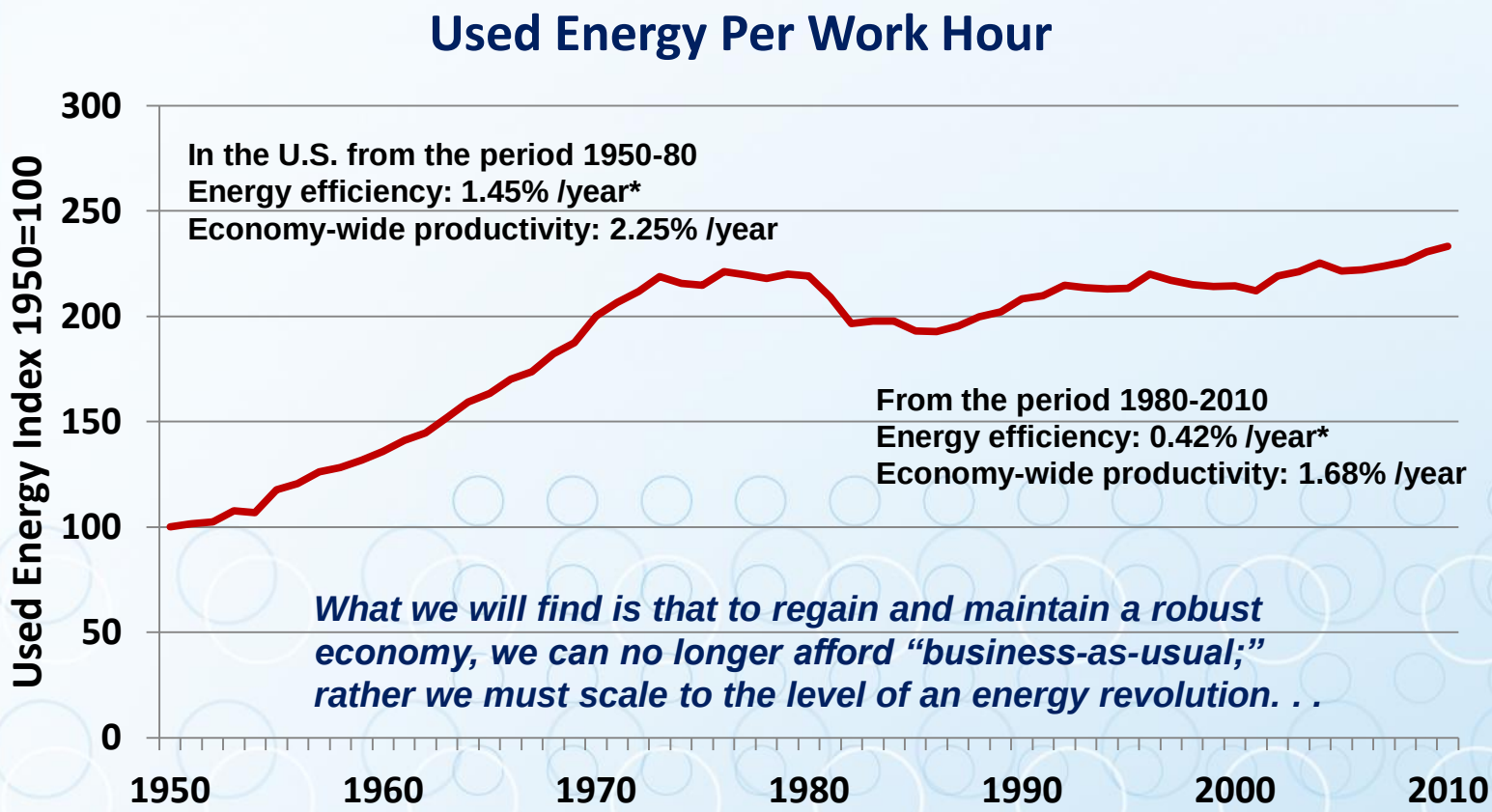
Emerging Insights in the Critical Role of "Used Energy" to Enhance Productivity



* Here energy efficiency refers to the conversion of total primary energy (exergy) to useful work.
Source: Laitner 2013 (forthcoming).

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Given the Huge Energy Inefficiencies: The New Normal in the U.S. Economy?

Period	The Average Annual Growth Rate by Period of Time		
	Population	Productivity	GDP
1950 to 1980	1.34%	2.25%	3.63%
1980 to 2010	1.04%	1.68%	2.73%
2010 to 2040*	0.94%	1.38%	2.33%

The worrisome element. . .

* Drawn from a 2012 long-term forecast by Moody's Analytics

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A Thought Experiment: the Economic Imperative of Energy Efficiency

- If just a 0.3 percent decline in the U.S. economy-wide productivity, the difference could mean a Gross Domestic Product (as measured in 2005 dollars) that is $2.5 trillion or 8 percent smaller by 2040.
- Over the period 2012 through 2040, a less robust economy implies ~$6 trillion in fewer investment dollars and government revenues. Fewer resources to solve problems.
- More critically it means perhaps 15-18 million fewer jobs.
- Yet, the evidence suggests that energy efficiency remains the most vital opportunity to return economic activity to a greater level of robustness – should we choose to invest in that opportunity.

Energy Efficiency?

Offering just three of so many different examples, if we're willing to really look!

And imagining industry more as a source of multiple innovations than as a consumer of energy

Optimizing our Nation's Traffic Signals

- There are an estimated 272,000 traffic signal systems throughout our country 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 so that we reduce our highway fuel consumption 5-10% per year.
- The cost? About $10-12 per household. The savings? About $150 per household per year – and possibly more!

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Developing Intelligent Efficiency

- Interconnected systems – what we might now 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

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Improving Electricity Generation

- Our current system of generating and delivering electricity to U.S. homes and businesses is an anemic 33% efficient.
- For every three units of coal or other fuel that we use to generate the power, we manage to deliver only one unit equivalent in the form of electricity to homes and businesses.
- What the U.S. wastes in the generation of electricity alone is more than Japan needs to power its entire economy.
- More astonishing is that our current level of (in)efficiency is essentially unchanged since 1960, when President Dwight D. Eisenhower spent his last year in office.
- With more efficient power plants and distributed generation we can boost that to nearly 50% efficiency, saving about 10 quads of energy – about the amount South Korea now uses.

Perhaps Four Additional Tasks

- 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."*
- *And so the need to think through at least 4 additional tasks:*
  - Explore efficiency gains beyond improvements in individual devices, looking to include both system and infrastructure improvements – in effect, promoting productive changes in the built environment;
  - Examine the full costs of energy services, including non-energy costs and benefits associated with efficiency improvements;
  - Review rebound and the full macroeconomic impacts through the lens of exergy, useful work, and conversion efficiency; and
  - Expand the assessment for a more proactive review and change in the human, behavioral, and cultural dimensions of energy use.
- As Henry Ford once said, *"Thinking is the hardest work there is which is the probable reason why so few engage in it."*

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

John Maynard Keynes

Contact Information

John A. “Skip” Laitner
Senior Fellow, American Council for an Energy-Efficient Economy
Principal, Economic and Human Dimensions Research Associates
Tucson, Arizona
m: (571) 332-9434
Email: EconSkip@gmail.com

And also see our eBook:

Karen Ehrhardt-Martinez and John A. “Skip” Laitner, Editors. 2010.

People-Centered Initiatives for Increasing Energy Savings

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

www.aceee.org/node/9275

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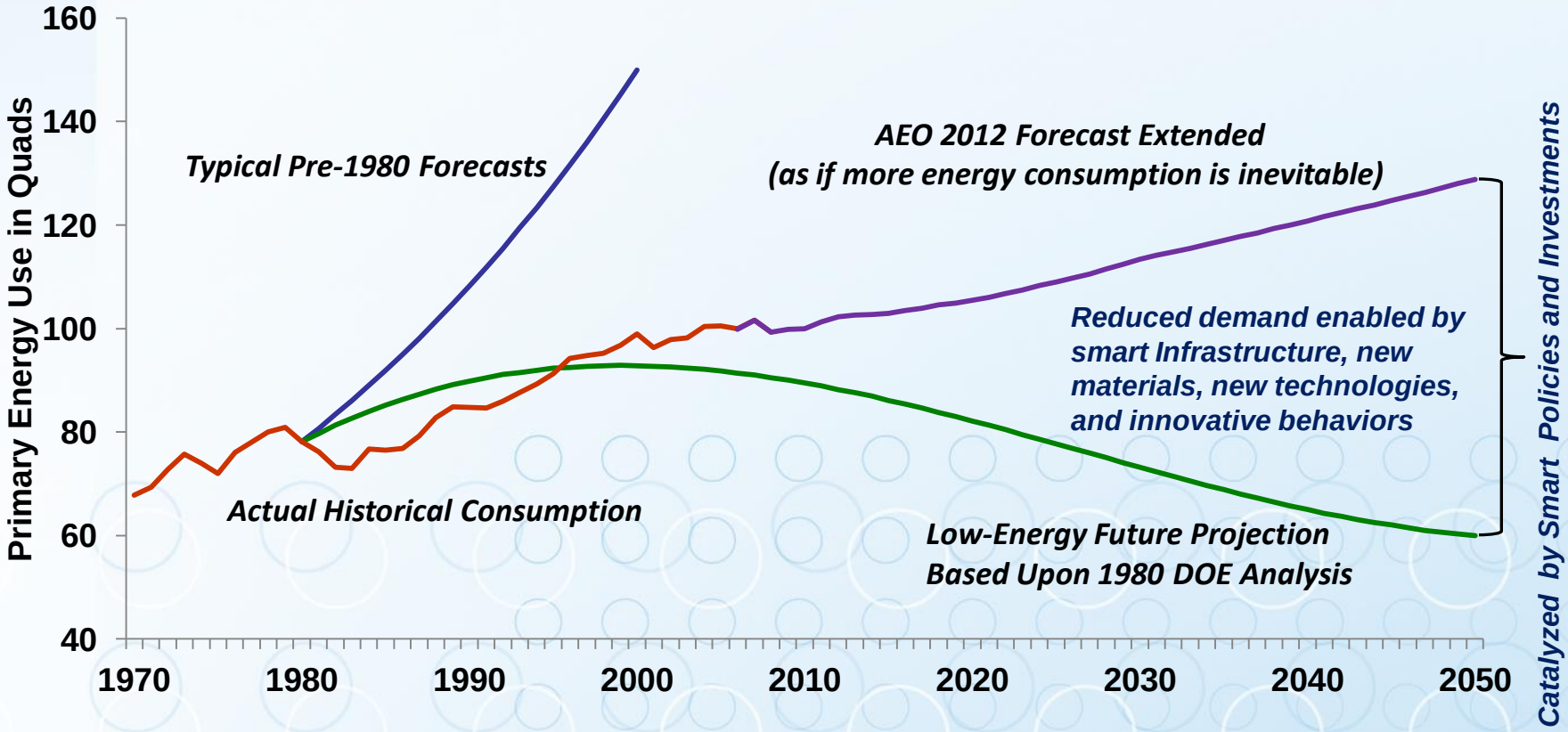
Supplemental Slide: The Energy Efficiency Resource Is Larger than Generally Believed



Sources: DOE 1980 Policy Analysis, Annual Energy Outlook 2012, and the January 2012 ACEEE report, *The Long-Term Energy Efficiency Potential: What the Evidence Suggests*. Washington, DC: ACEEE. http://www.aceee.org/press/2012/01/aceee-report-us-better-thinking-big-

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