



**Teaching Energy Efficiency Policy at the
University Level**

A California Approach to Teaching Energy Efficiency

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Topics

- Why teach energy efficiency policy?
- Who are the students?
- What do they need to learn?
 - How much technology? Economics? Policy?
- How do you keep them excited?
- Measures of success?

homeenergy.org

A Different Challenge – Training the Practitioner



The screenshot shows the homepage of homeenergy.org. At the top right, there are links for "Subscriber Login", "Donate", "About Us", "Links", and "A". The logo for "Home energy" is prominently displayed, with the tagline "The Home Performance Magazine" below it. A navigation bar contains four dropdown menus: "Home Performance", "Business Development", "Training Guide", and "Departmen". The main content area features a large article titled "Learning Applied Building Science is Still Hard to Do" in green text. Below the title, a short paragraph states: "It seems as though customers as well as contractors need to be better educated." A green arrow icon followed by the text ">> Read more" is positioned below the paragraph. To the right of the text is a photograph of a man presenting a slide titled "Identifying Heat Transfer Type - Activity" to a group of people. The slide shows a diagram of a house with arrows indicating heat flow. At the bottom right of the image, there is a pagination bar with numbers 1 through 6, where the number 2 is highlighted in green.



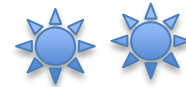
The University of California, Davis Campus

Vancouver



Sacramento

Davis



San Francisco

Berkeley

Los



Angeles



Davis: 100 km Northeast from San Francisco, 30 km west of Sacramento



Toronto

Ottawa



30,000 students: 3rd most popular UC campus (after Berkeley & UCLA)

Famous for wine, bicycles, and now energy efficiency



My Classes at UC Davis

Fundamentals of Energy Efficiency:
Understanding the Other Side of the Meter
MGT 290


Alan Meier
Fall 2013

Other courses at
Berkeley, Stanford

UC DAVIS
UNIVERSITY OF CALIFORNIA

Economics of Energy Efficiency
(and Climate Change Mitigation)

TTP 289
Winter 2014
Alan Meier



Who Are the UC Davis Students? And What Do They Want?

- Graduate students mostly
 - Engineering, Business, Chemistry, Physics, Sociology, Agronomy, Economics (**from all over the world!**)
 - Interested in sustainability, zero-energy, solar, climate change, jobs
- Teaching EE as a supplement to other specialties
- For undergraduates, the course can be transformational

My goals: show different perspectives, think differently, question authority, collect data, provide context

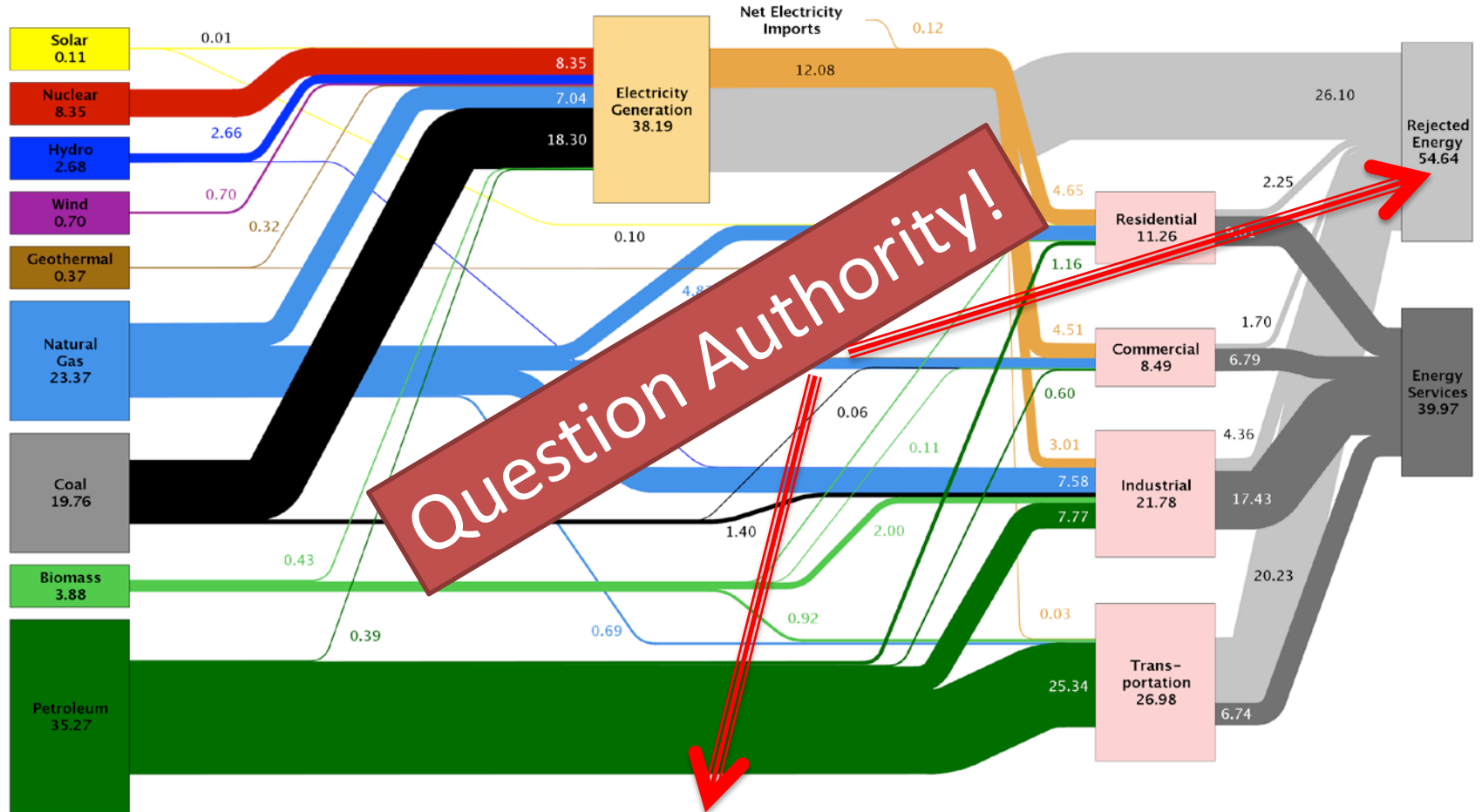
Treating Energy Demand as a Black Box

(and note the assumptions!)

https://flowcharts.llnl.gov/content/energy/energy_archive/energy_flow_2009/LLNL_US_Energy_Flow_2009.png

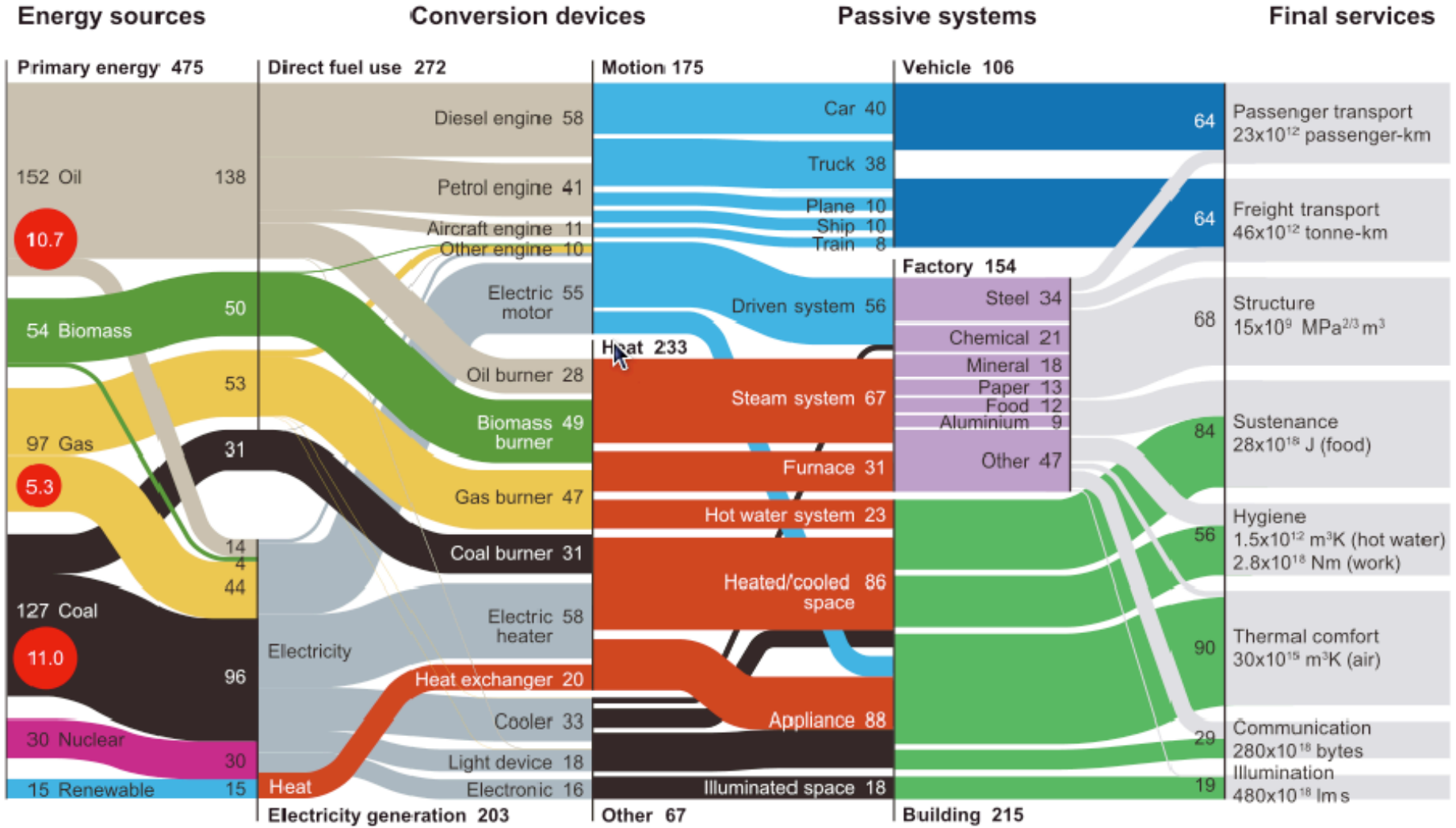


Estimated U.S. Energy Use in 2009: ~94.6 Quads



Source: LLNL 2010. Data is based on DOE/EIA-0384(2009), August 2010. If this information or a reproduction of it is used, credit must be given to the Lawrence Livermore National Laboratory and the Department of Energy, under whose auspices the work was performed. Distributed electricity represents only retail electricity sales and does not include self-generation. EIA reports flows for non-thermal resources (i.e., hydro, wind and solar) in BTU-equivalent values by assuming a typical fossil fuel plant "heat rate." The efficiency of electricity production is calculated as the total retail electricity delivered divided by the primary energy input into electricity generation. End use efficiency is estimated as 80% for the residential, commercial and industrial sectors, and as 25% for the transportation sector. Totals may not equal sum of components due to independent rounding. LLNL-MI-410527

Global Energy Sankey Diagram



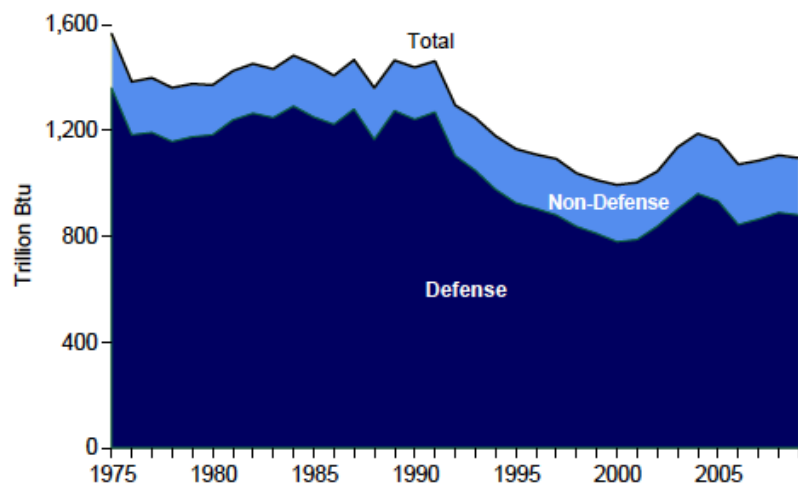
Annual global flow of energy in 2005, EJ [10¹⁸joules]

Annual global direct carbon emissions in 2005, Gt CO₂ [10⁹ tonnes of CO₂]

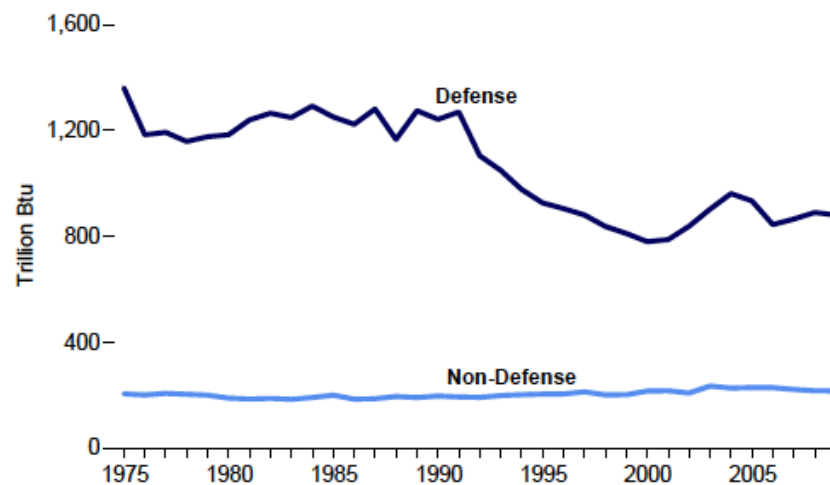
World Energy Flows Sankey Diagram, as shown on <http://aspoireland.org/2011/05/08/a-review-of-green-energy-growth-prospects-at-the-oil-economy-maxima/> Diagram originally by Cullen, J.M. & Allwood, J.M. (2010)

Breakdown by Administrative unit

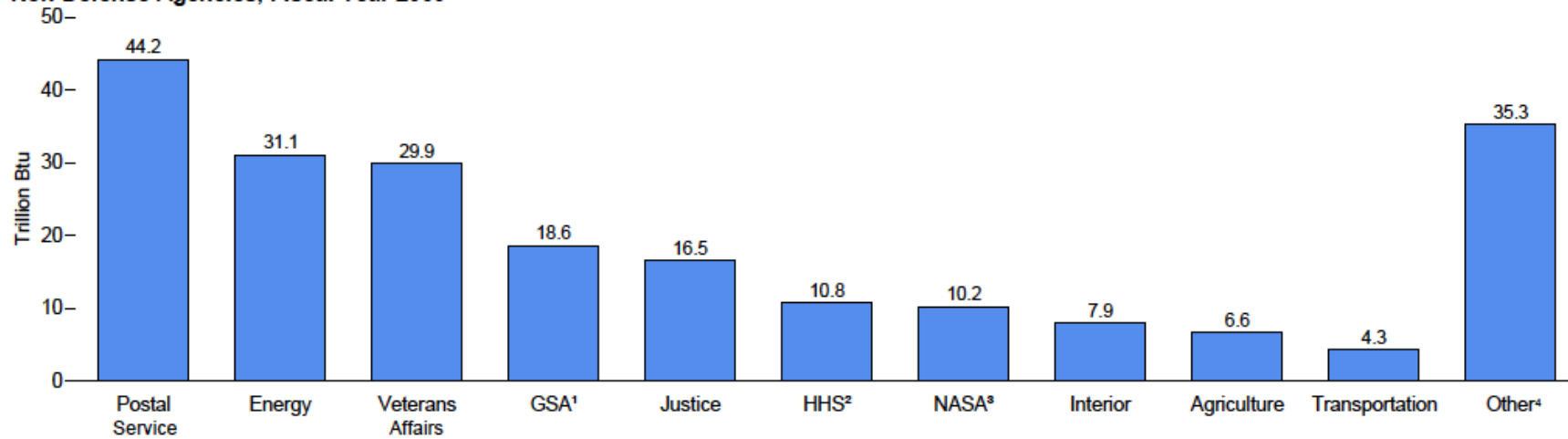
Total and U.S. Department of Defense, 1975-2009



U.S. Department of Defense and Non-Defense Agencies, Fiscal Years 1975-2009



Non-Defense Agencies, Fiscal Year 2009



¹ General Services Administration.

² Health and Human Services.

³ National Aeronautics and Space Administration.

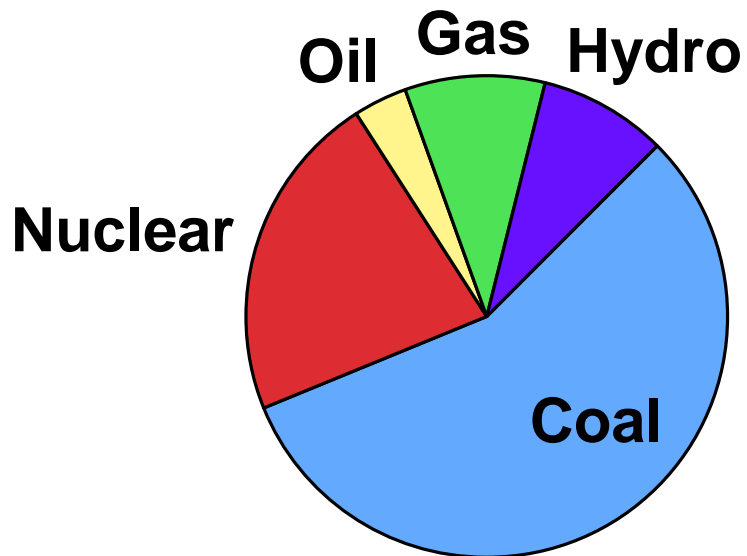
⁴ See Table 1.11 for list of agencies.

Note: The U.S. Government's fiscal year was October 1 through September 30, except in 1975 and 1976 when it was July 1 through June 30.

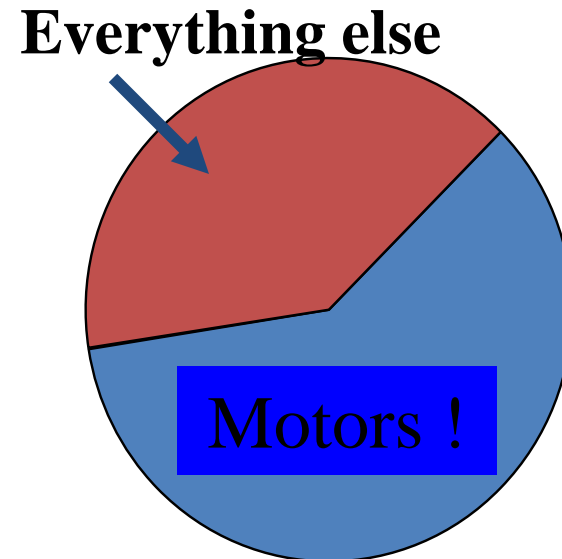
Source: Table 1.11.

Electricity (2)

Generation

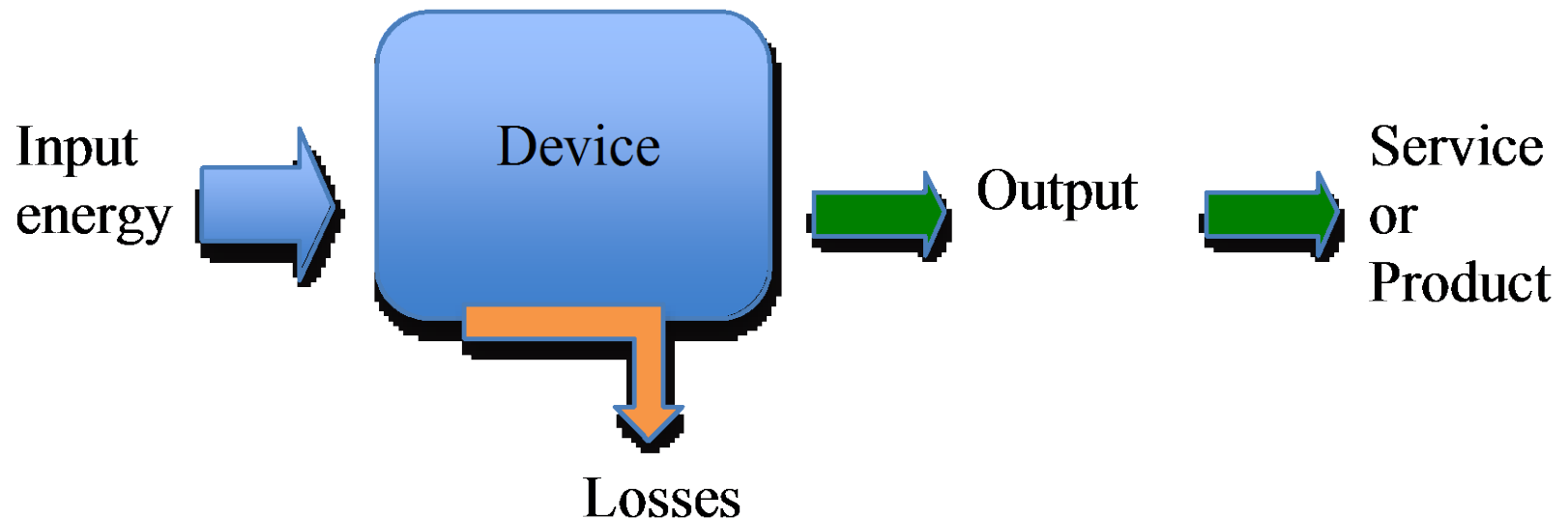


Use



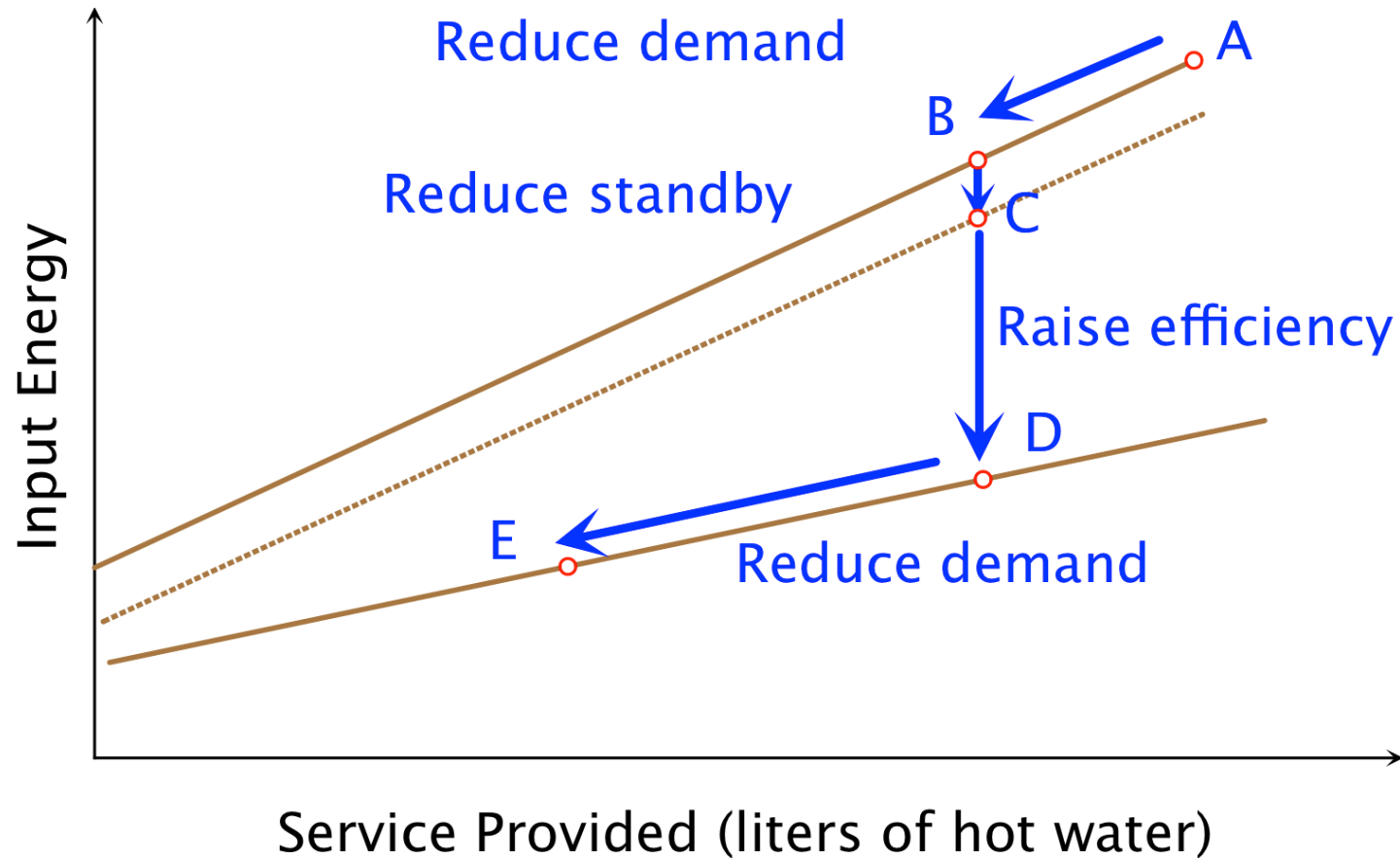
I ask the students to guess: they are never right!

A device transforms energy into a useful output, service, or product



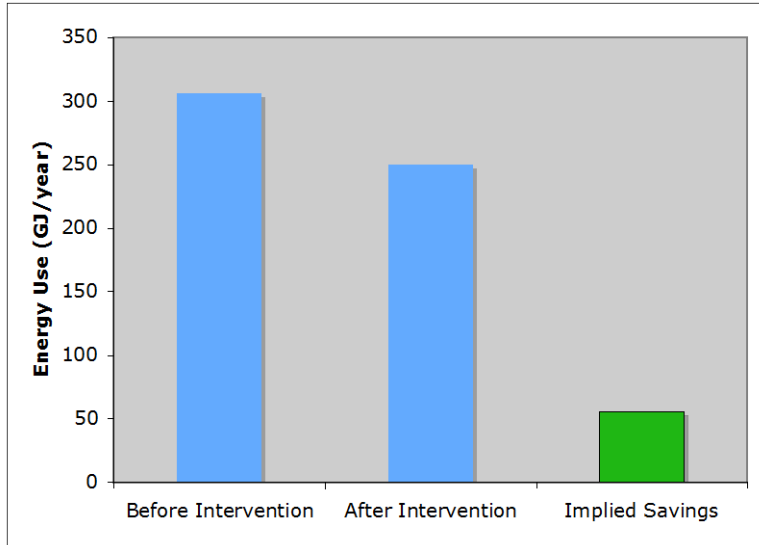
Students need to understand that people want services, not energy

A Service Plot for Water Heating



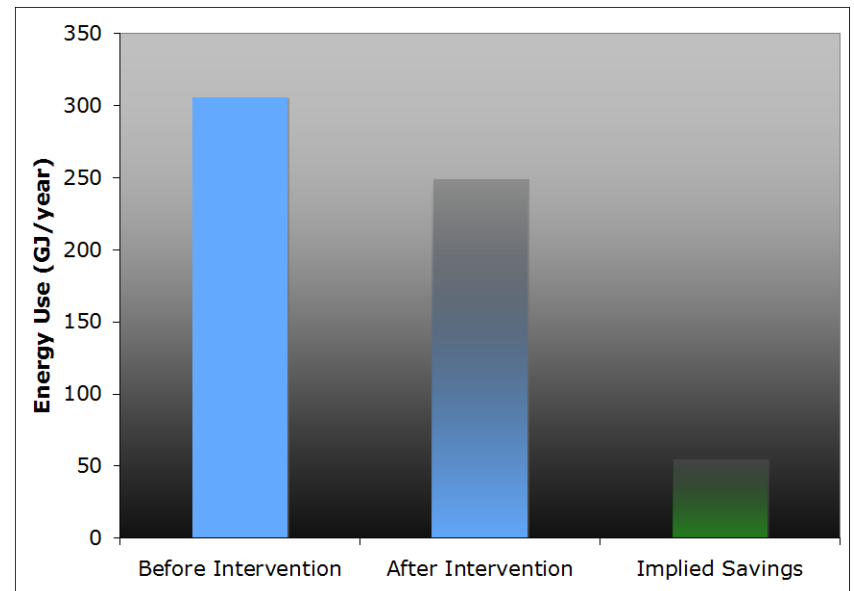


Ideal Conditions



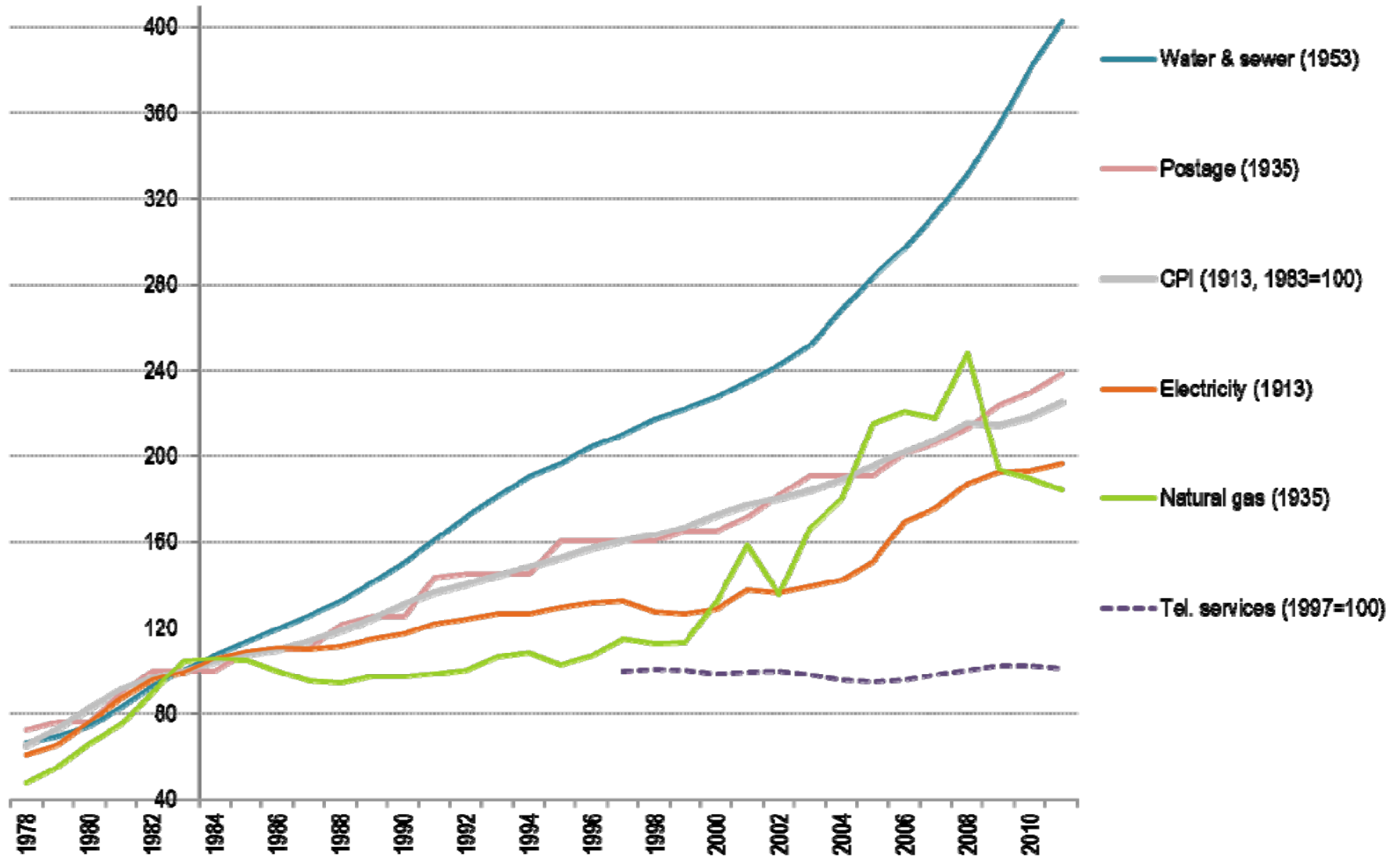
Estimation of Energy Savings

More Common Situation
("the fog of uncertainty")



How Are Energy Costs Changing Compared to Other Utilities?

Trends in consumer prices (CPI) for utilities

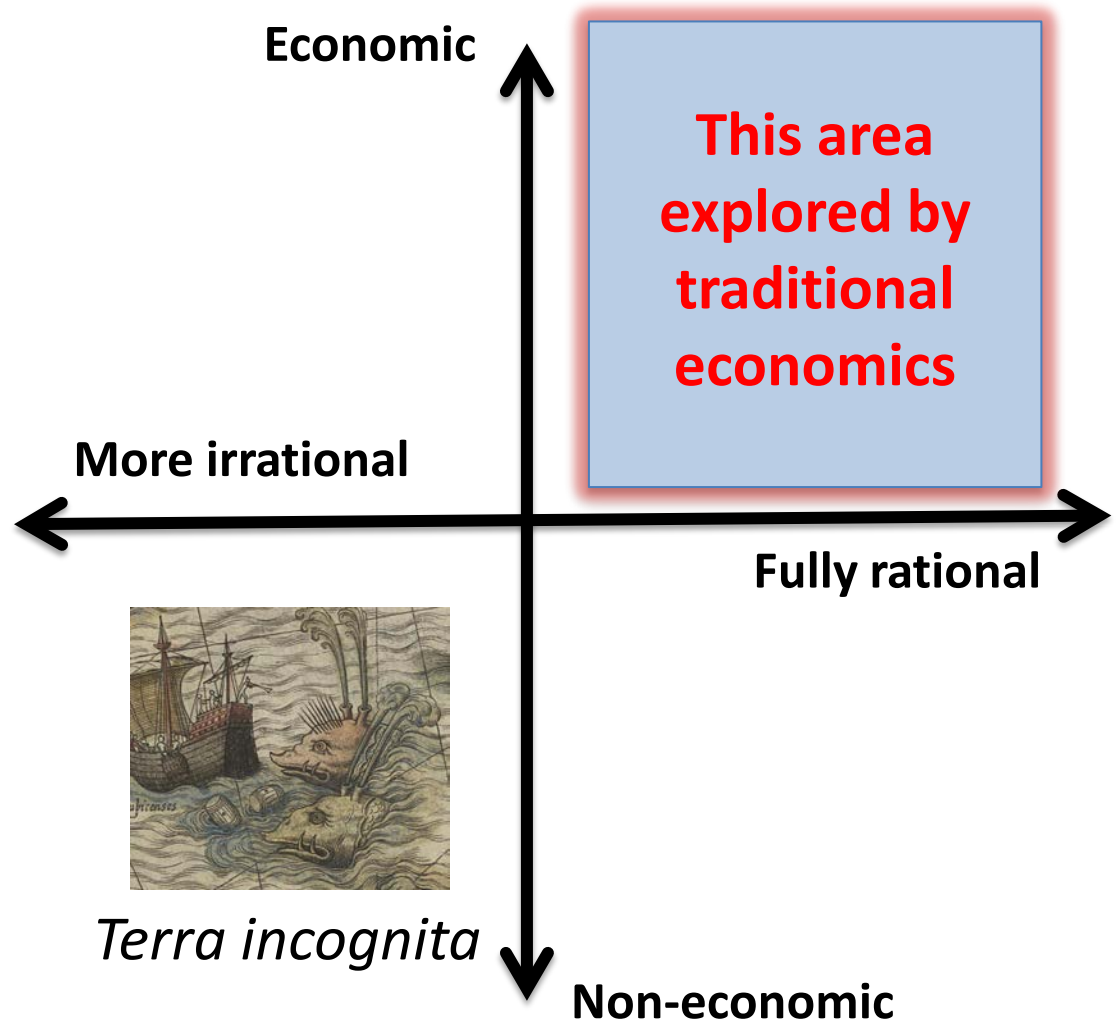


Beecher IPU-MSU

Source: Beecher, Institute of Public Utilities, MSU [2012]

Quadrants of People's Motivations

What kind of economics should we talk about?



COOLBIZ

クールビズ

Prime Minister Koizumi
wearing CoolBiz



COOLBIZとは？

2005年春、環境省は、地球温暖化対策の一環として、夏のオフィスの冷房温度を28度としても涼しく快適に格好良く働けるビジネススタイルの一般的な愛称を公募しました。審査委員による選考の結果、選ばれた愛称が「COOLBIZ(クールビズ)」です。当社は、シャツで応援しています。

Different approaches to energy efficiency



冷房は28℃に設定しよう

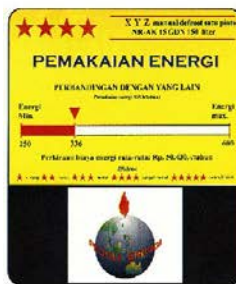
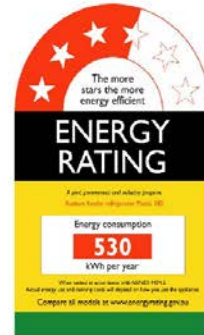
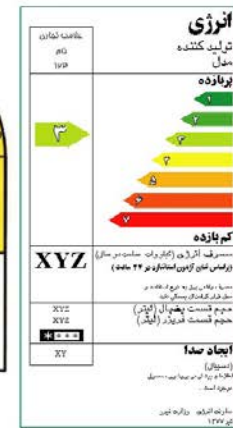
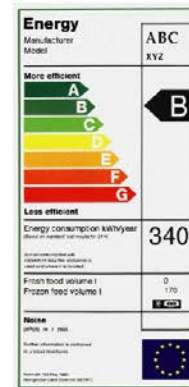
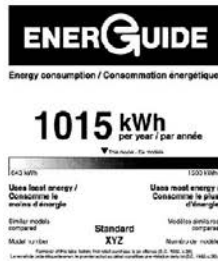
チーム・マイナス6%

チーム・マイナス6%とは？

深刻な問題となっている地球温暖化。この解決のために世界が協力して作った京都議定書が平成17年2月16日に発効しました。世界に約束した日本の目標は、温室効果ガス排出量6%の削減。これを実現するための国民的プロジェクト、それがチーム・マイナス6%です。



Energy Labels Around the World



- > 60 countries operate product efficiency programmes
- Currently national schemes tailored for local markets & suppliers
- Now greater recognition of global markets & world suppliers

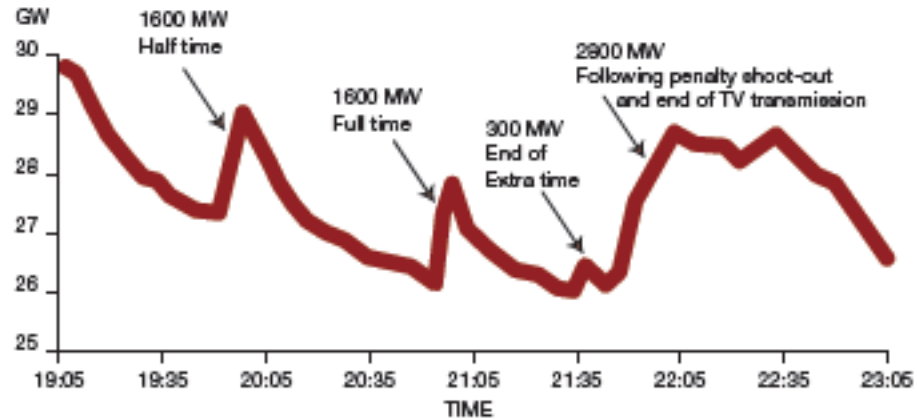
Source: Australian Greenhouse Office 2005



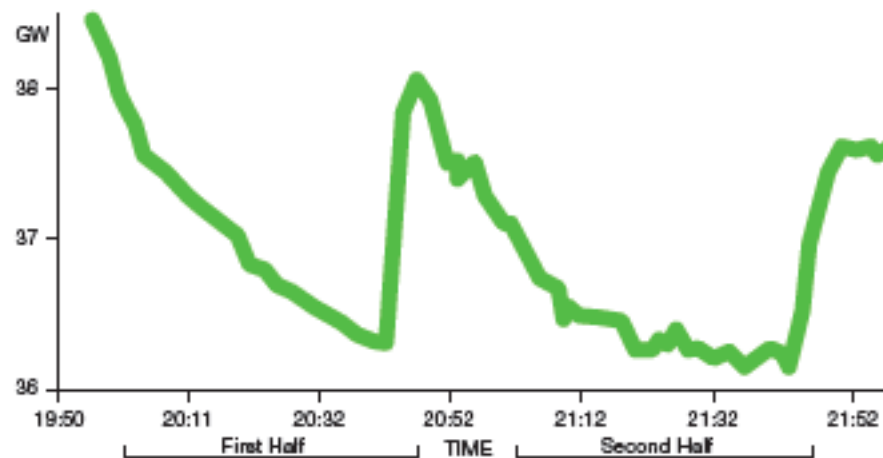
TV Pick-Ups

Electricity Demand and the Behavior of the Masses

England Vs Germany 1990, World Cup Semi-Final, Kick Off 19:00



England Vs Sweden 2006, World Cup 2006 First Round, Kick Off 20:00





Most Students Enjoy Measuring Things

In fact, it's sometimes their favorite part of the class!



With luck they also learn the difference between energy and power.

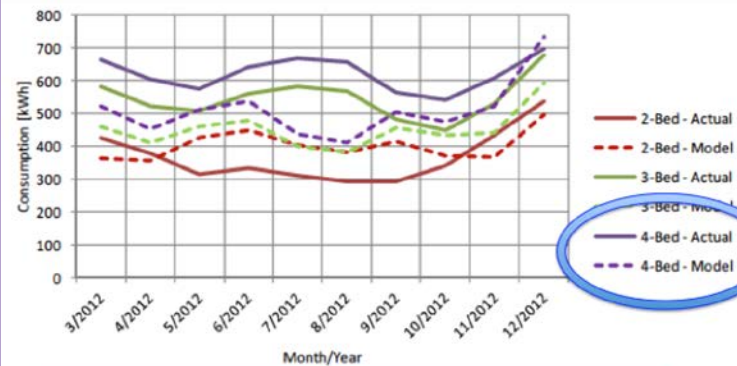




West Village at UC Davis: America's First Net-Zero Energy Community

Use the
Community as
a Lab

Apartment Electricity Consumption



Actual energy use is much higher than assumed in models.



Topics for Discussion

- Why teach energy efficiency? Policy?
 - In what Department(s)?
- Who are the students?
- What do they need to learn?
 - How much technology? Economics? Behavior? Policy?
- How do you keep students excited?
- Measures of success?

Course Summary for “Fundamentals”

1. The demand-side perspective
2. Energy is transformed into services
3. Service plots and impacts of energy-saving measures on demand, standby, efficiency
4. Direct energy savings
5. Indirect energy savings (and increases)
6. Changing rules of game
7. Estimating energy use and savings