Portland State
UNIVERSITY

# NUMBERS, STORIES, ENERGY EFFICIENCY

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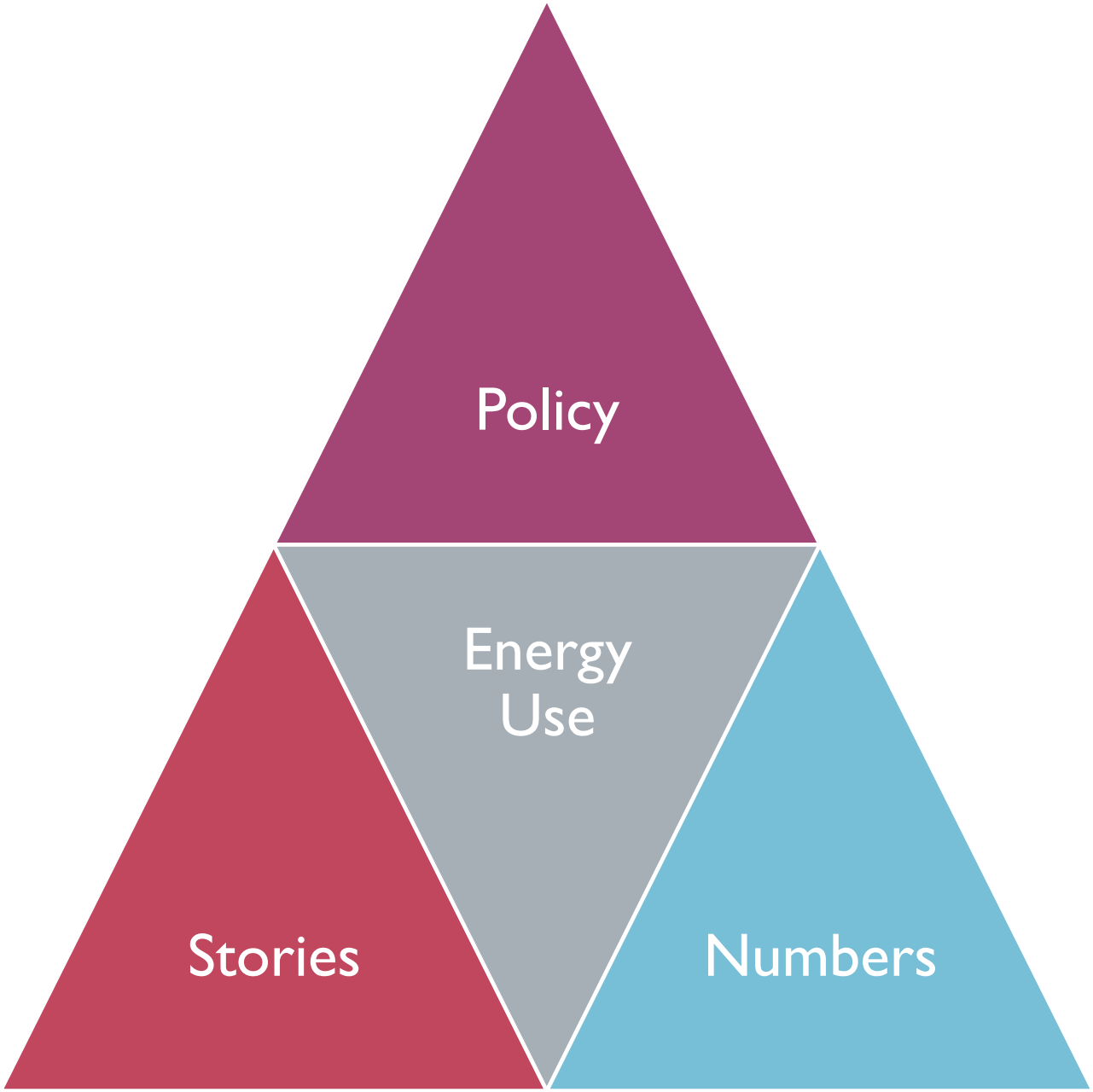
ECEEE SUMMER STUDY


Policy
Energy Use
Stories
Numbers

# CURSE OF DIVERSE

- In the beginning: précising efficient major technology for relative savings
- Transition: super-ambitious goals for absolute reductions in a diverse & dynamic world, where people are seen as part of the energy system

What are our numbers doing?

# NUMBERS

- Metrics
- Data Collection
- Statistical & Data Analysis
- Rhetorical Numbers

## Early beginnings

Photo: Matthias Kabel

**450 BC** Hippias of Elis uses the average value of the length of a king's reign (the mean) to work out the date of the first Olympic Games, some 300 years before his time.

**400 BC** In the Indian epic the *Mahabharata*, King Rtuparna estimates the number of fruit and leaves (2095 fruit and 50 000 000 leaves) on two great branches of a vibhitaka tree by counting the number on a single twig, then multiplying by the number of twigs. The estimate is found to be very close to the actual number. This is the first recorded example of sampling – "but this knowledge is kept secret", says the account.

**AD 7** Census by Quirinus, governor of the Roman province of Judea, is mentioned in Luke's Gospel as causing Joseph and Mary to travel to Bethlehem to be taxed.

500 400 300 200 100 0 100 200

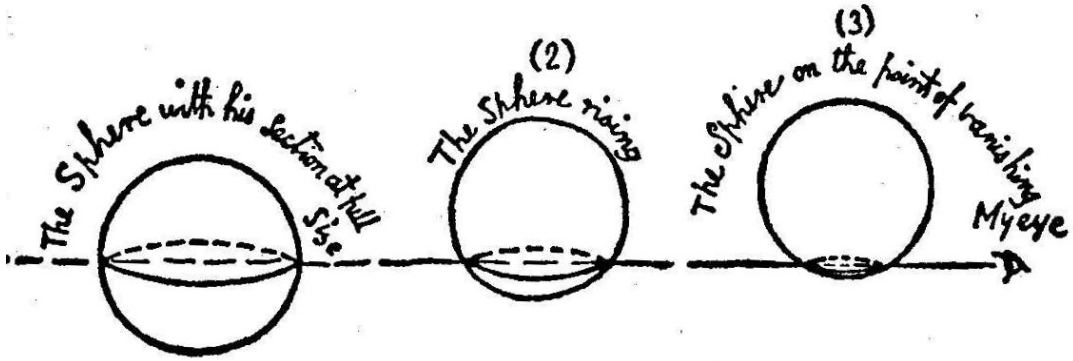
**431 BC** Attackers besieging Plataea in the Peloponnesian war calculate the height of the wall by counting the number of bricks. The count was repeated several times by different soldiers. The most frequent value (the mode) was taken to be the most likely. Multiplying it by the height of one brick allowed them to calculate the length of the ladders needed to scale the walls.

iStock/Thinkstock

**AD 2** Chinese census under the Han dynasty finds 57.67 million people in 12.36 million households – the first census from which data survives, and still considered by scholars to have been accurate.

RSS / ASA "History of Statistics Timeline" poster clip http://www.statsref.com/timeline-of-statistics.pdf

"Volkstelling 1925 Census". Source: http://commons.wikimedia.org/wiki/File:Volkstelling_1925_Census.jpg#/media/File:Volkstelling_1925_Census.jpg


(1)
The Sphere with his section at full Size
(2)
The Sphere rising
(3)
The Sphere on the point of vanishing
My eye

- Act of surveillance
- Selective, reductive, and contested
- Data are much more limited that one might at first think
- Static: difficult to capture activities, relationship, change
- Difficult to see people (except as bodies)

# FORM OF ENERGY (AND EMISSIONS) EFFICIENCY METRICS

| Dimension of Intensity Metric | Examples |
|---|---|
| Numerators: Energy or emissions units | Site electricity use<br>Total primary energy use<br>Computed GHG emissions |
| Denominators: Units of output | Per household<br>Per unit floor area<br>Per person<br>Gross Domestic Product |
| Statistical qualities | Average<br>Individual<br>Distributional (e.g., median) |
| Data source | Census, survey, etc.<br>Simulated, modeled<br>Extrapolation of empirical measurement of various sorts |
| Adjustments | Weather-normalized<br>“Typical” usage (e.g., asset ratings, "market basket")<br>Factorial decomposition |
| Realm | Single-family only<br>Program participants only<br>Year |

- Denominators are social output, legitimized
- Energy use and emissions overflow the boundaries
- Lots of options, often not evident in reporting
- Static and standardizing, may hide a lot … people are generally missing

# POLICY / STORIES

# POLICY AND ENERGY PROBLEMS

- "Difficult conditions become problems only when people come to see them as amenable to human action" … Deborah Stone

- But policy has an aversion to complex causal stories (Stone)

market barriers

systems of nudges

models that produce truths & deviances

"if you build it they will come"

"if only they had the money"

. . .


*Are our blunt force stories and data analyses getting in the way of better approaches to managing energy?*

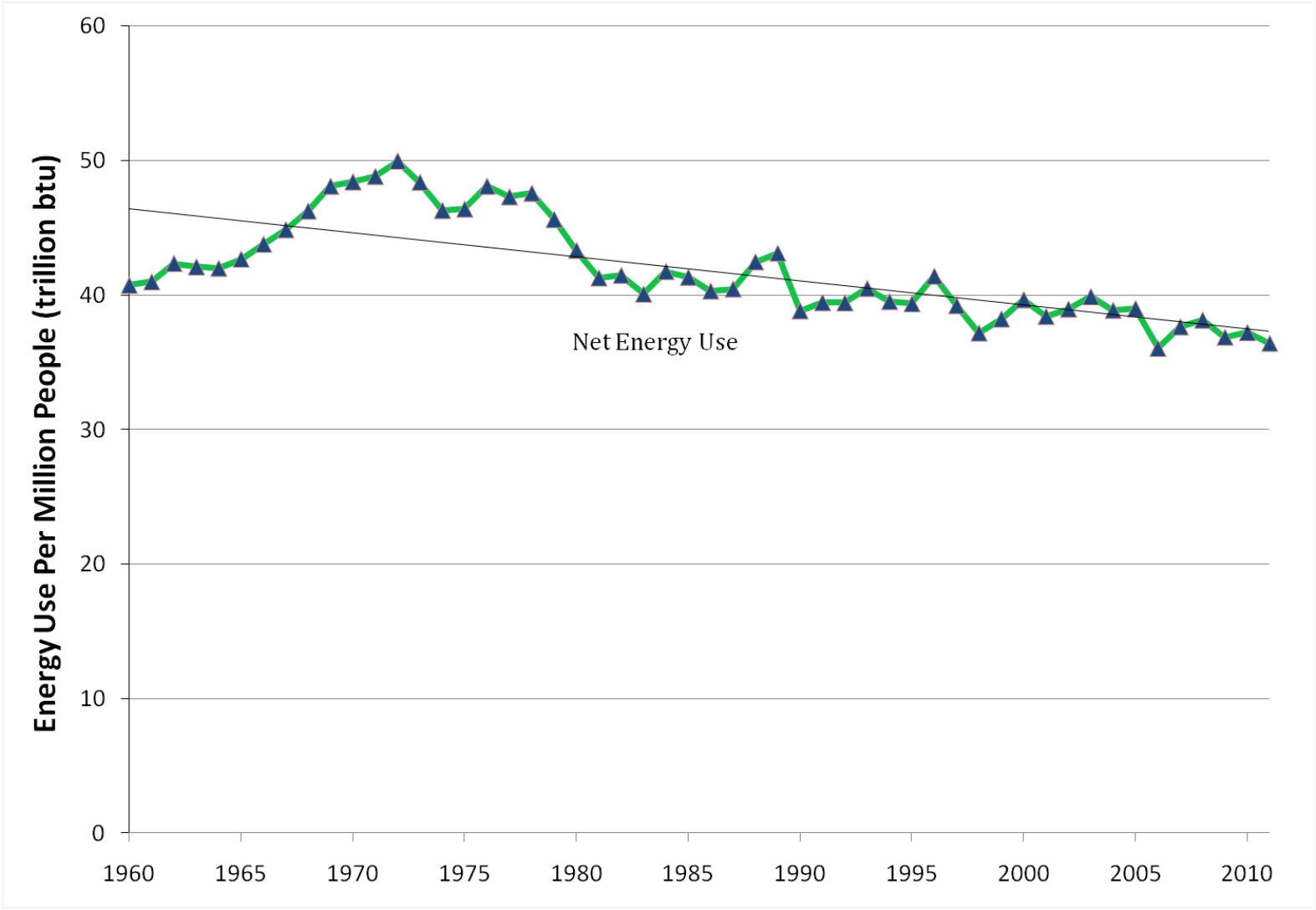
*Can we more effectively admit structure, complexity & the less-quantifiable?*

# EXAMPLE ONE: TRENDS

MACRO –LEVEL EXAMINATION OF PAST ENERGY USE

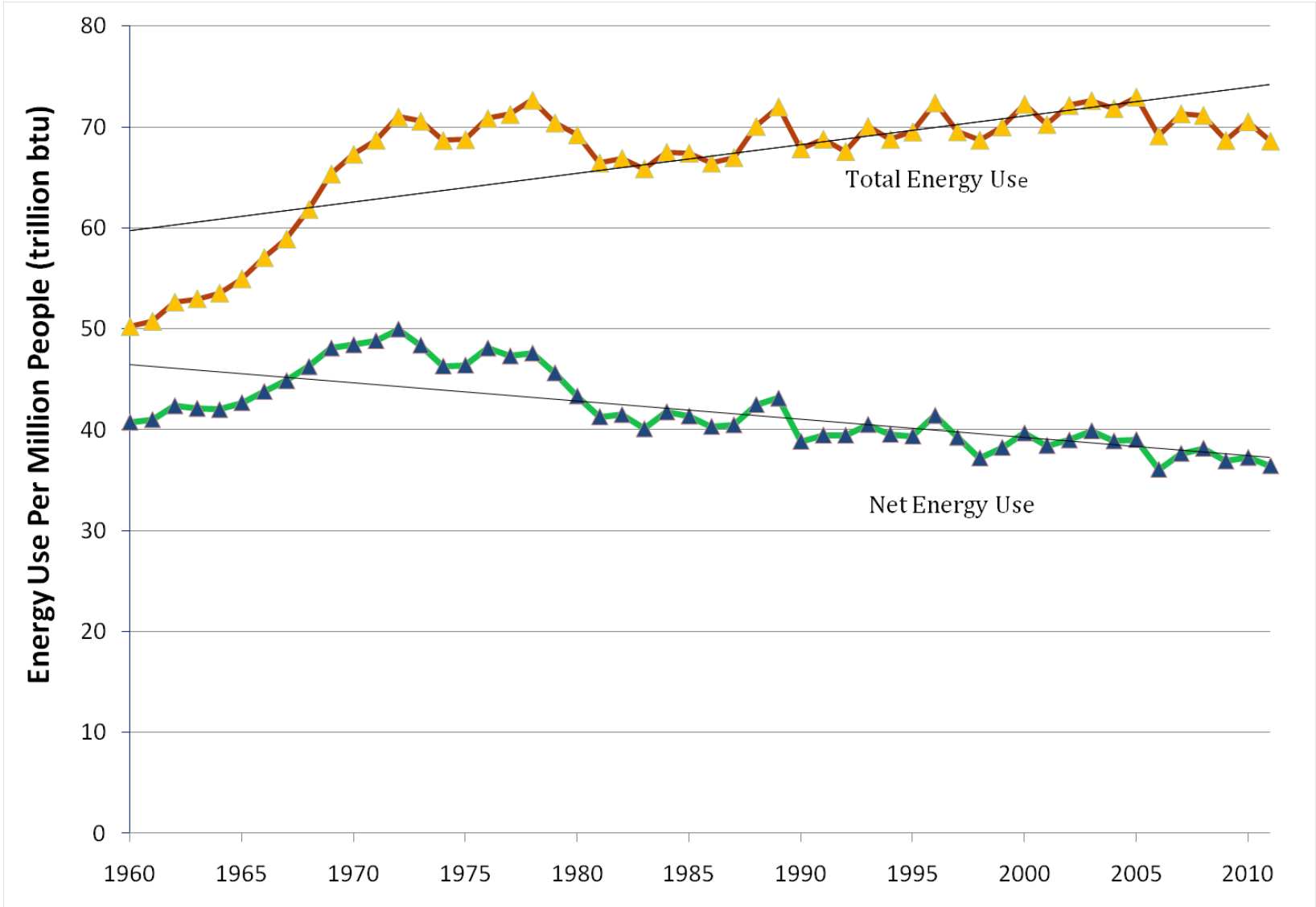
ILLUSTRATING THE LEVEL OF THE PROBLEM

# US RESIDENTIAL ENERGY USE :V1




Data Source: US Energy Information Administration

# US RESIDENTIAL ENERGY USE:V2




Data Source: US Energy Information Administration

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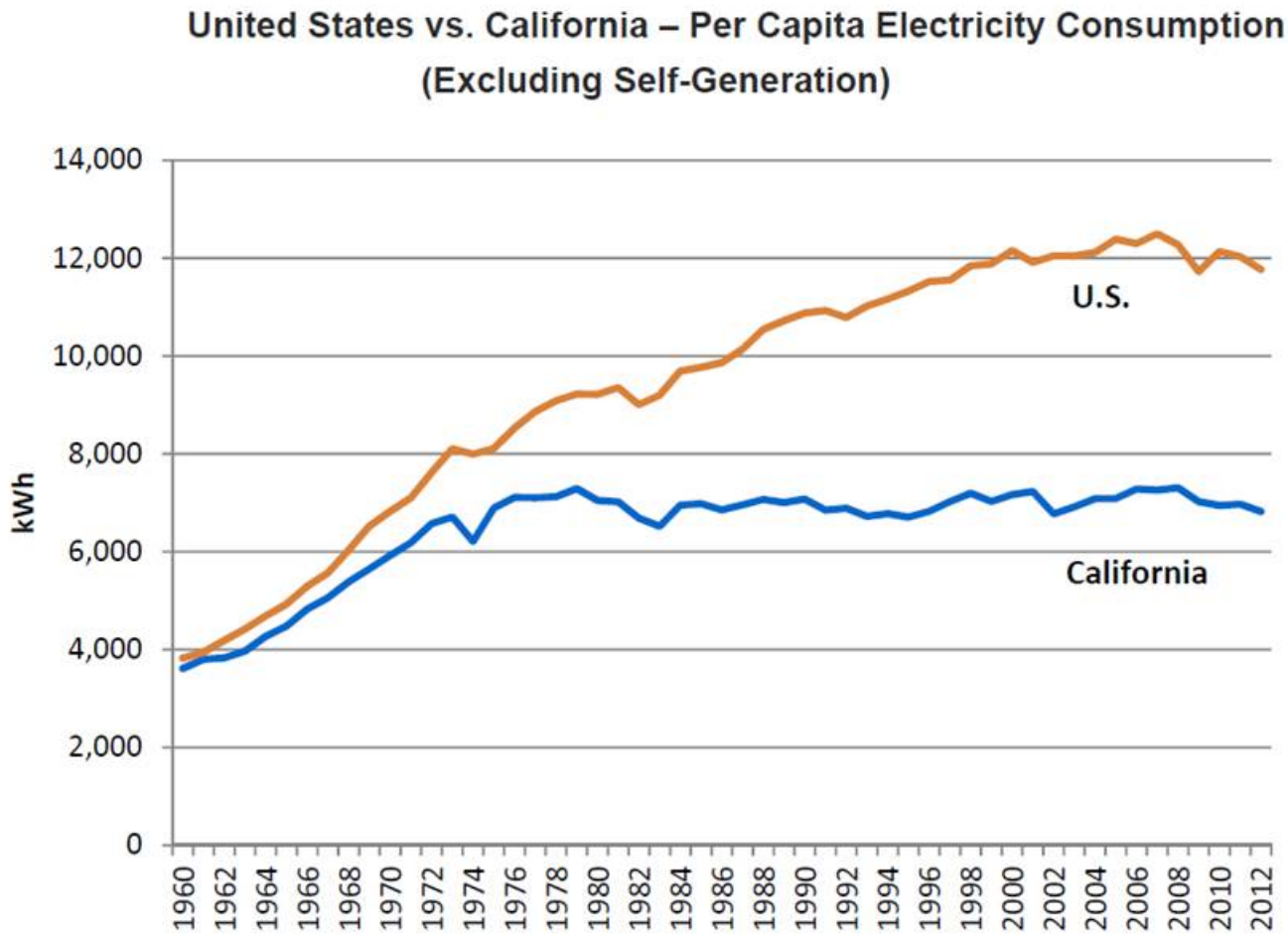


Source: Based on U.S. Energy Information Administration, Population U.S. Census Bureau (Sources [1]-[9]), as modified by California Energy Commission, Demand Analysis Staff in February 2013.

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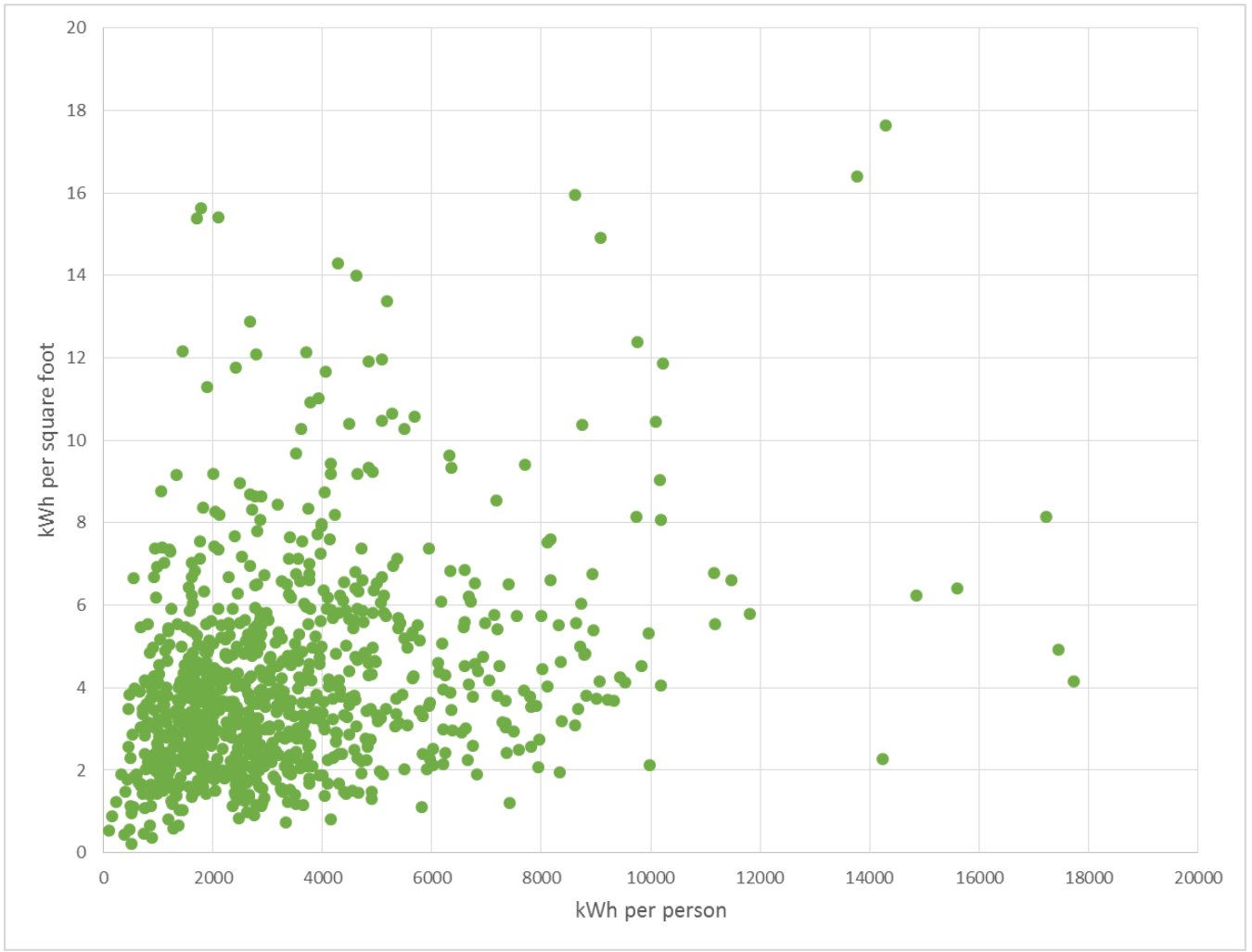
Source of image: http://switchboard.nrdc.org/blogs/dgoldstein/can_it_be_cheap_and_easy_to_so.html

- Easy to tell very different stories with similar data
  - Only a specialist will know
- Even basic trends are suspect for general conclusions
  - Down slopes shouldn't automatically be attributed to efficiency
- Macro-level examinations of the past are rare
  - Can we learn more about the future, and the structure and level of future uncertainties, by attention to history?
- How much is reluctance to report scientifically ( complex, ambiguous, negative) getting in the way of better research & policy?

# EXAMPLE TWO: DEFINING ENERGY EFFICIENCY

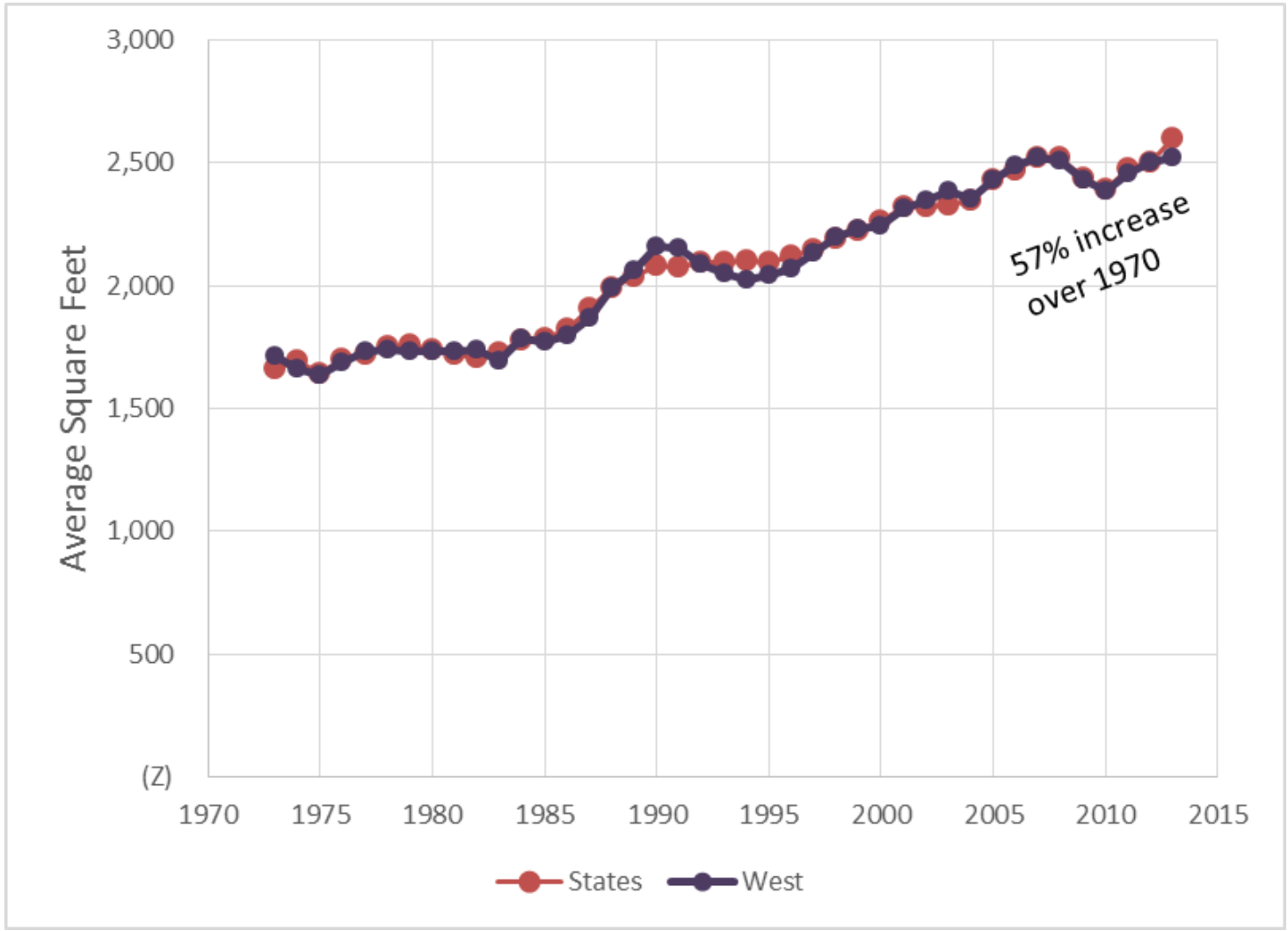
WHAT YOU COUNT AFFECTS WHAT YOU GET

# Per Floor Area vs. Per Person Energy Use Metrics



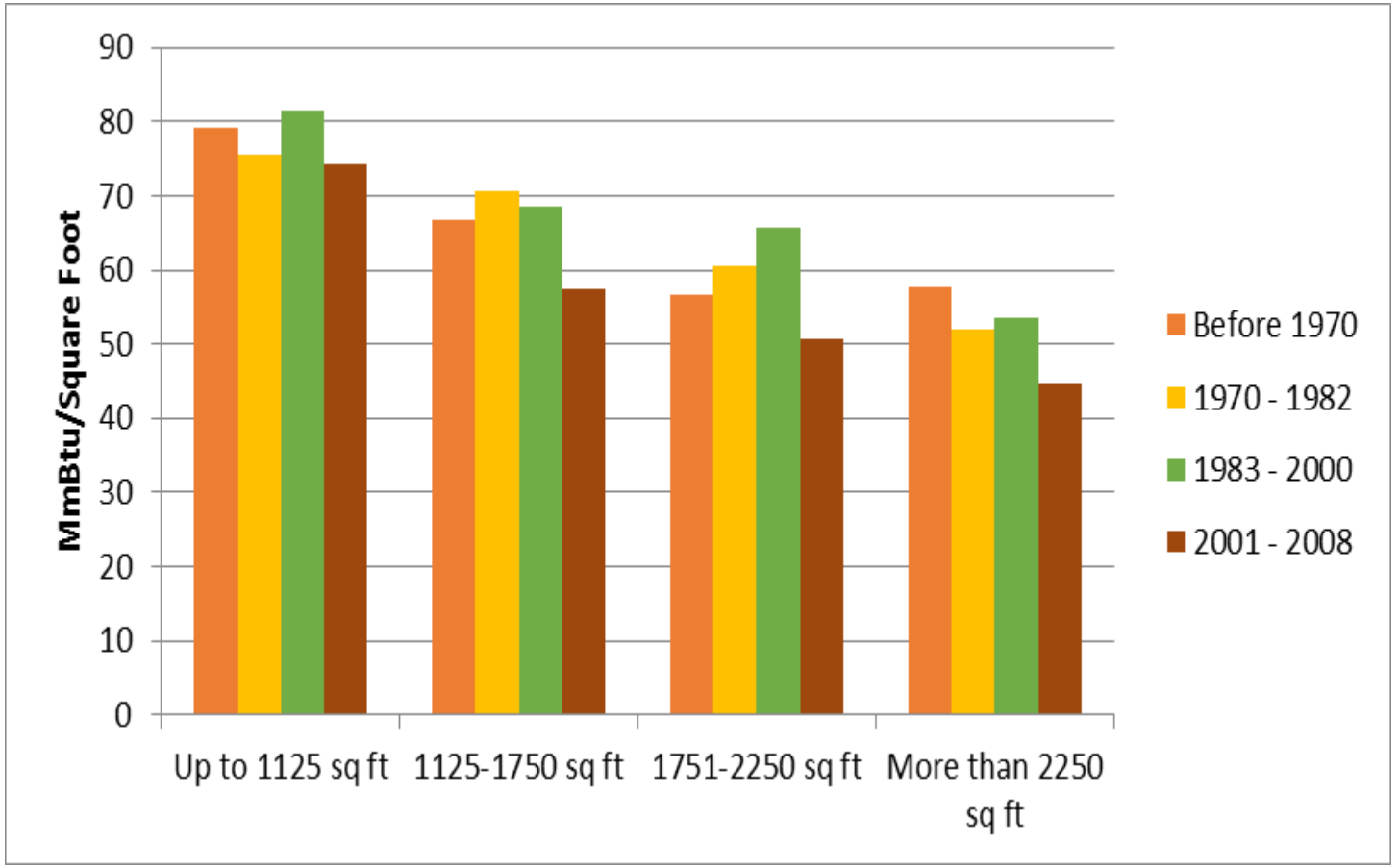

California Single Family Homes 2009

# Increasing Floor Area in Newly-Constructed U.S. Homes



# Energy Intensity by House Size and Year Built

Single-Family Homes Using Natural Gas Heating

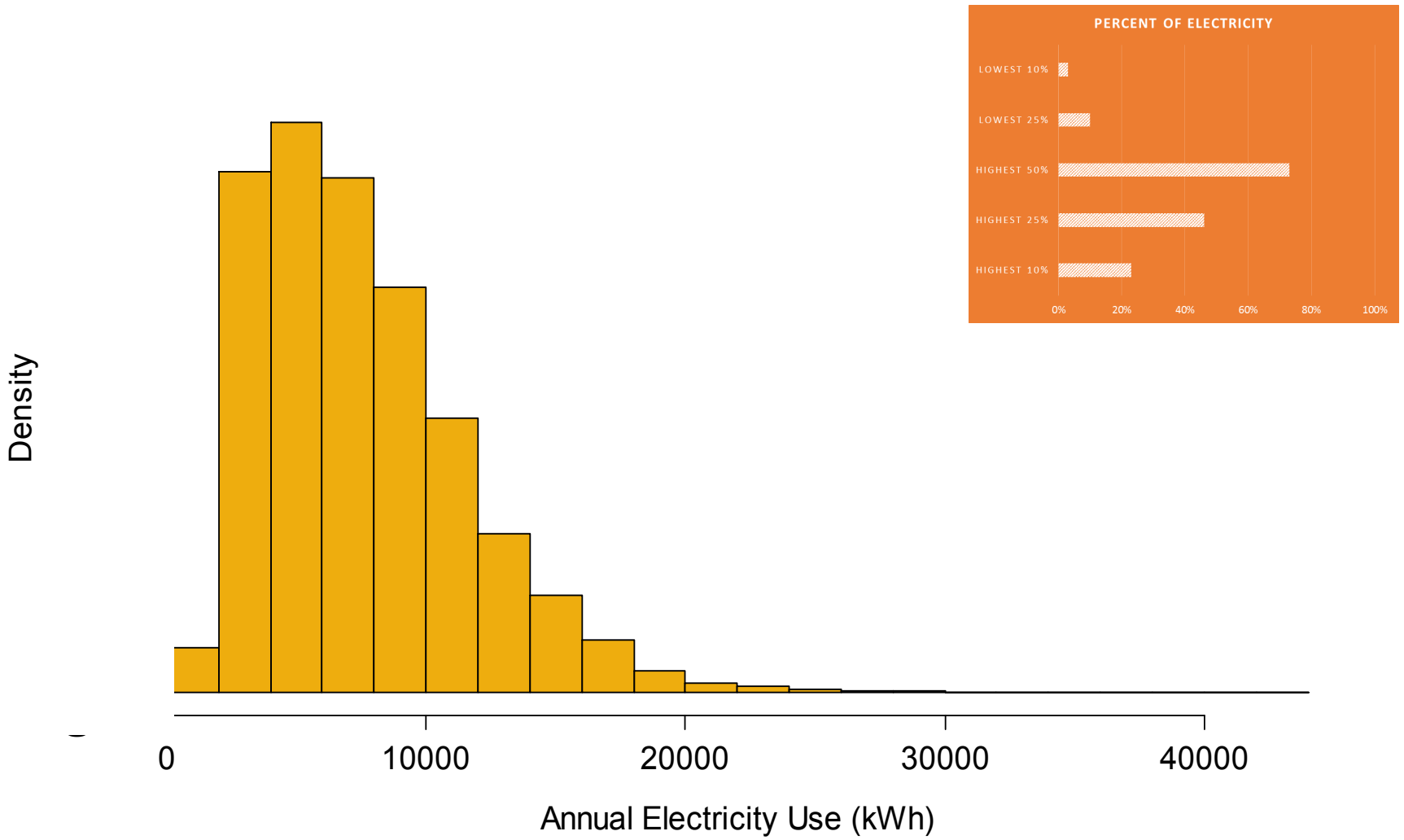


- Energy intensity (per unit floor area) decreases over time: the newest houses have the lowest energy use intensity

- House size also increases over time

- Newer homes have the highest energy use on average

- Decomposition into two dimensions says something quite different than one-dimension story
  - Already close to data limits … low resolution
  - Focus on what's to learn rather than failure/success


PERCENT OF ELECTRICITY
LOWEST 10%
LOWEST 25%
HIGHEST 50%
HIGHEST 25%
HIGHEST 10%
0%
20%
40%
60%
80%
100%
Density
0
10000
20000
30000
40000
Annual Electricity Use (kWh)

# SUMMARY AND CONCLUSIONS

- Quantification reduces the complexity of real world processes
- In focusing attention on certain aspects, other opportunities are missed
- People are often the most difficult to see
- Role of evaluation and learning can be strengthened
- Quality of statistical and data analyses is often lax: rally for a more sophisticated data science and open discussion of concerns, problems
  - Not about unachievable statistical ideals
  - Careful interpretation of models and their output
- Make room for qualitative knowledge to complement, structure, support , (and sometimes substitute for) quantitative data

1. Numbers about energy use are often less reliable than they seem

2. Much more attention to analysis, collection, and interpretation will be required if we are serious about meeting the goals we say are required

3. …. as well as recognizing what we can't know and learning how to better deal with change, uncertainty, and low-resolution data

4. Work on how to develop appropriately complex combinations of stories and numbers to inform communications, programs, policies, technologies, evaluations, and discoveries