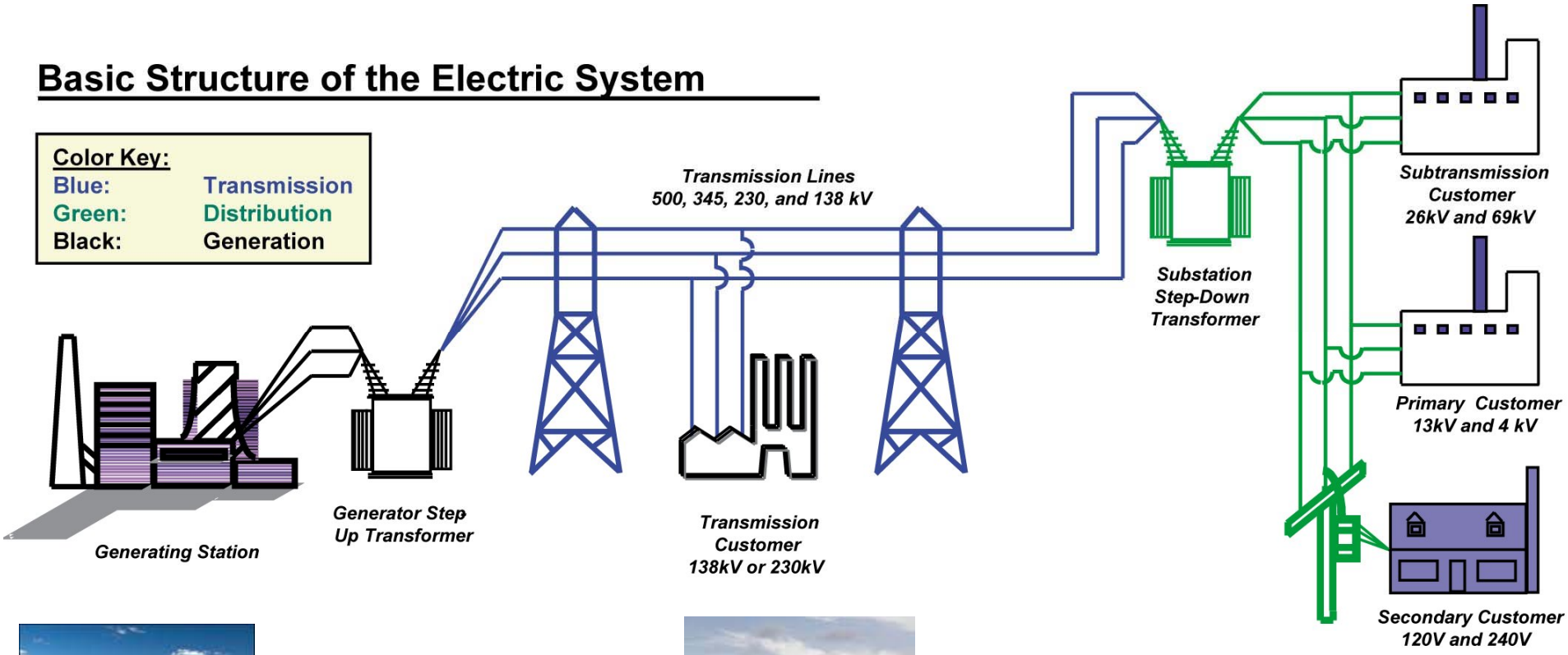
# Lessons to be Learned from Industry: Demand Research and Modeling

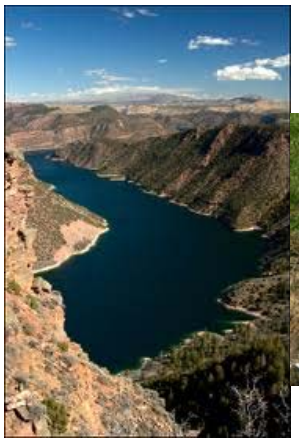
Urban Water Demand Roundtable
Arizona State University

Prof. Kenneth Gillingham

Yale SCHOOL OF FORESTRY & ENVIRONMENTAL STUDIES

# Analogies Between Electricity & Water Markets



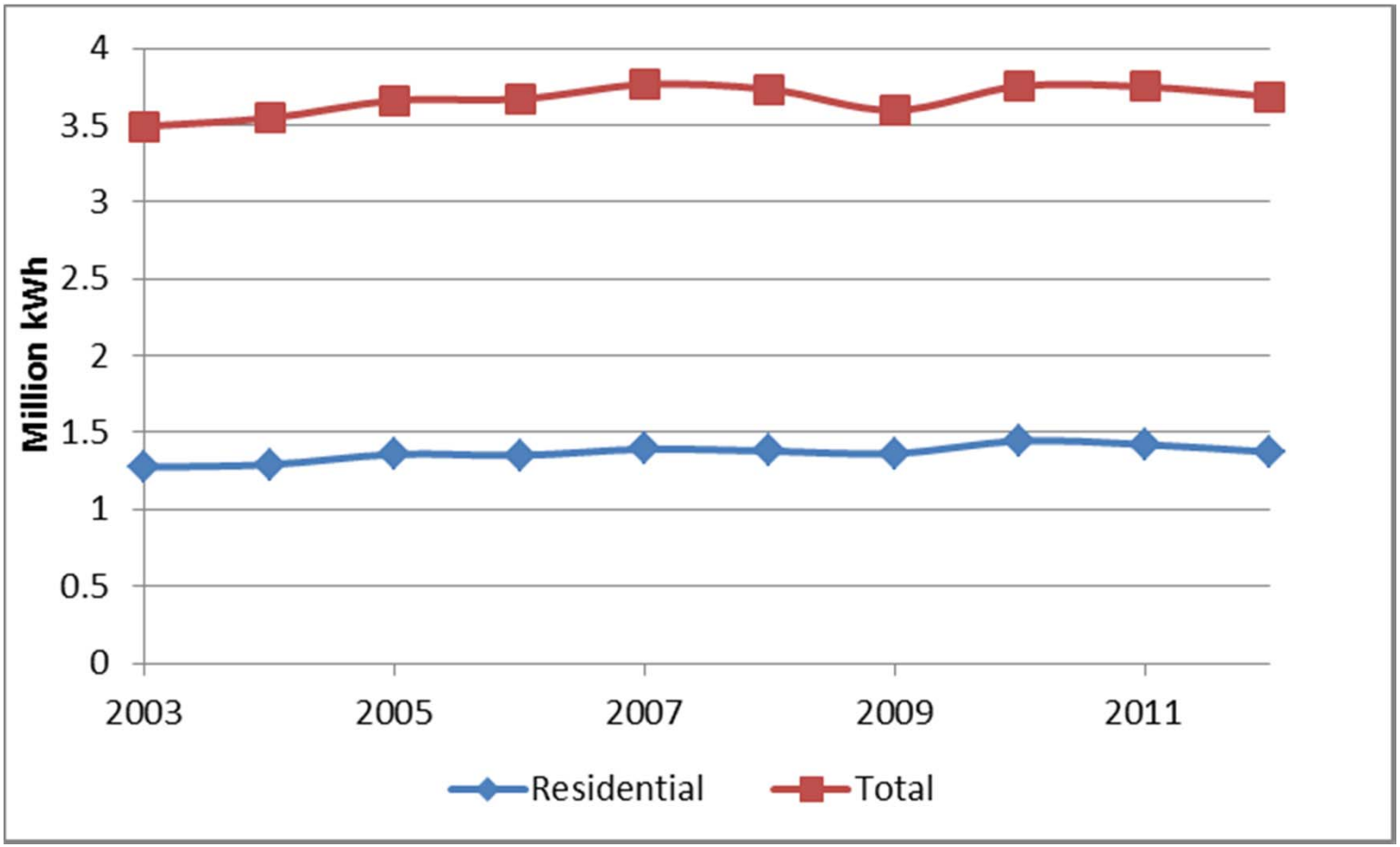
# Some Key Features of Electricity Markets

- Major (costly) infrastructure investments involved
  - Fixed costs

- Cost for every kWh produced
  - Variable costs

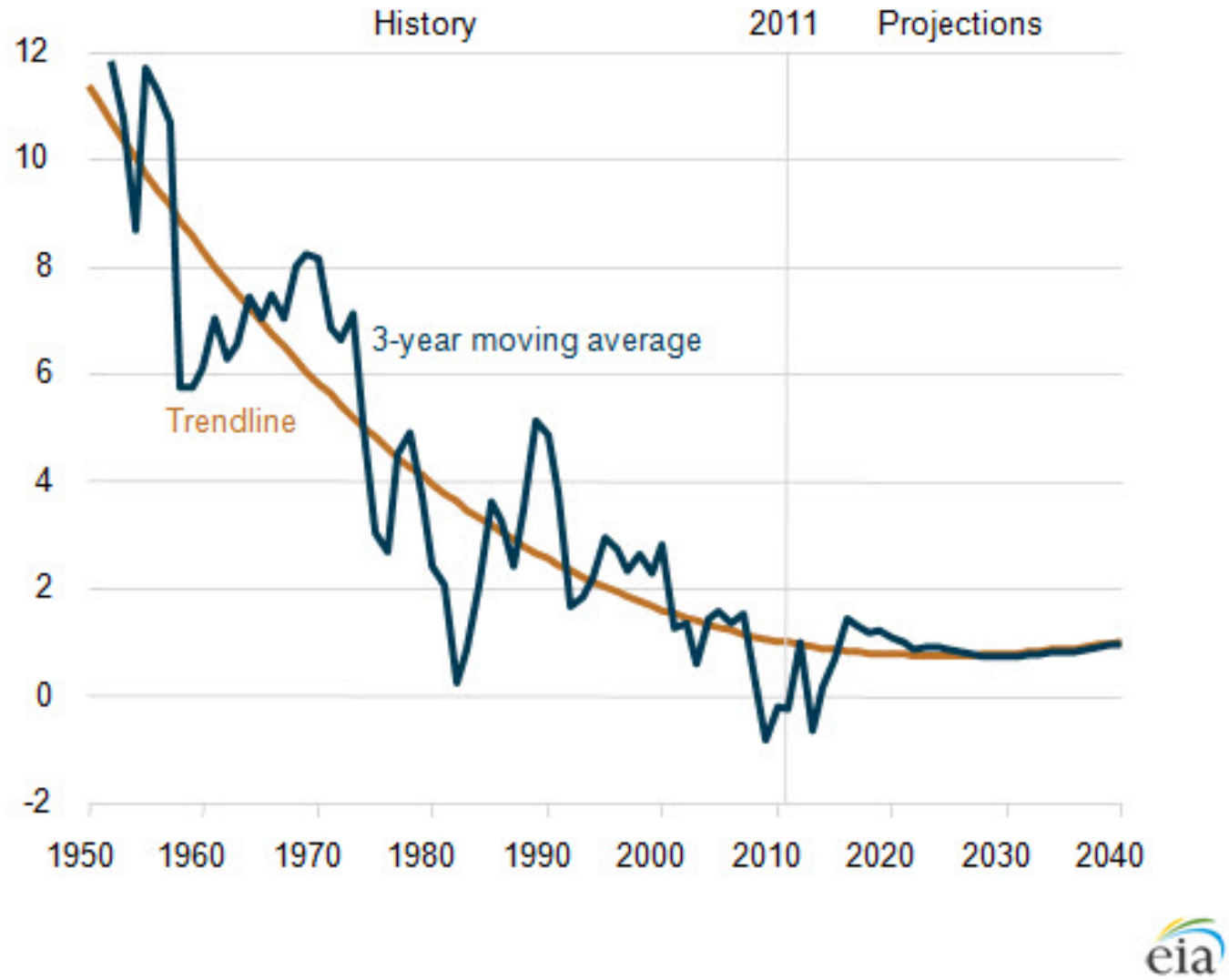
- *Declining* central generation demand in some (not all) places -

# U.S. Electricity Demand Over Time



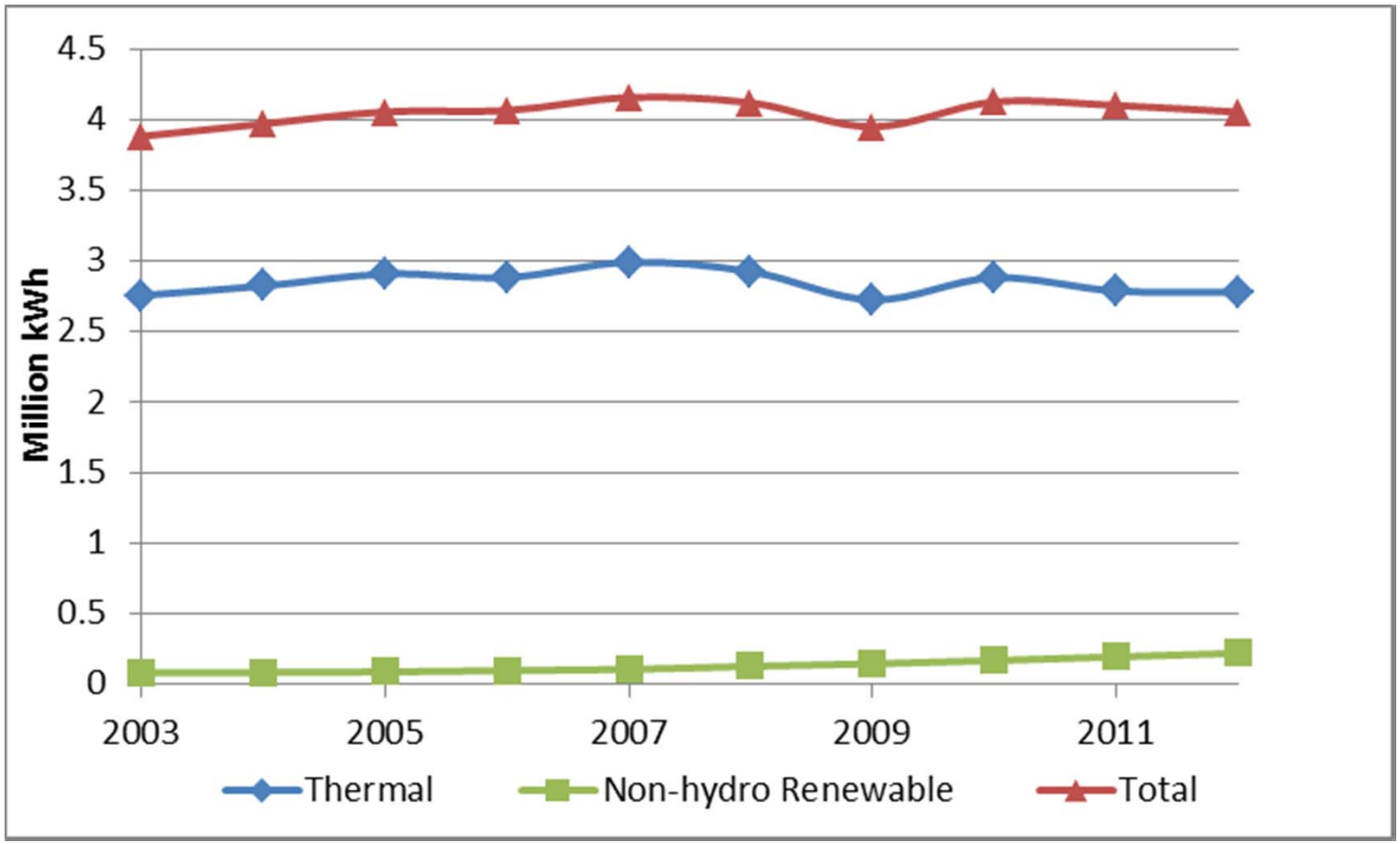

Source: EIA (2013)

Figure 75. U.S. electricity demand growth, 1950-2040
(percent, 3-year moving average)



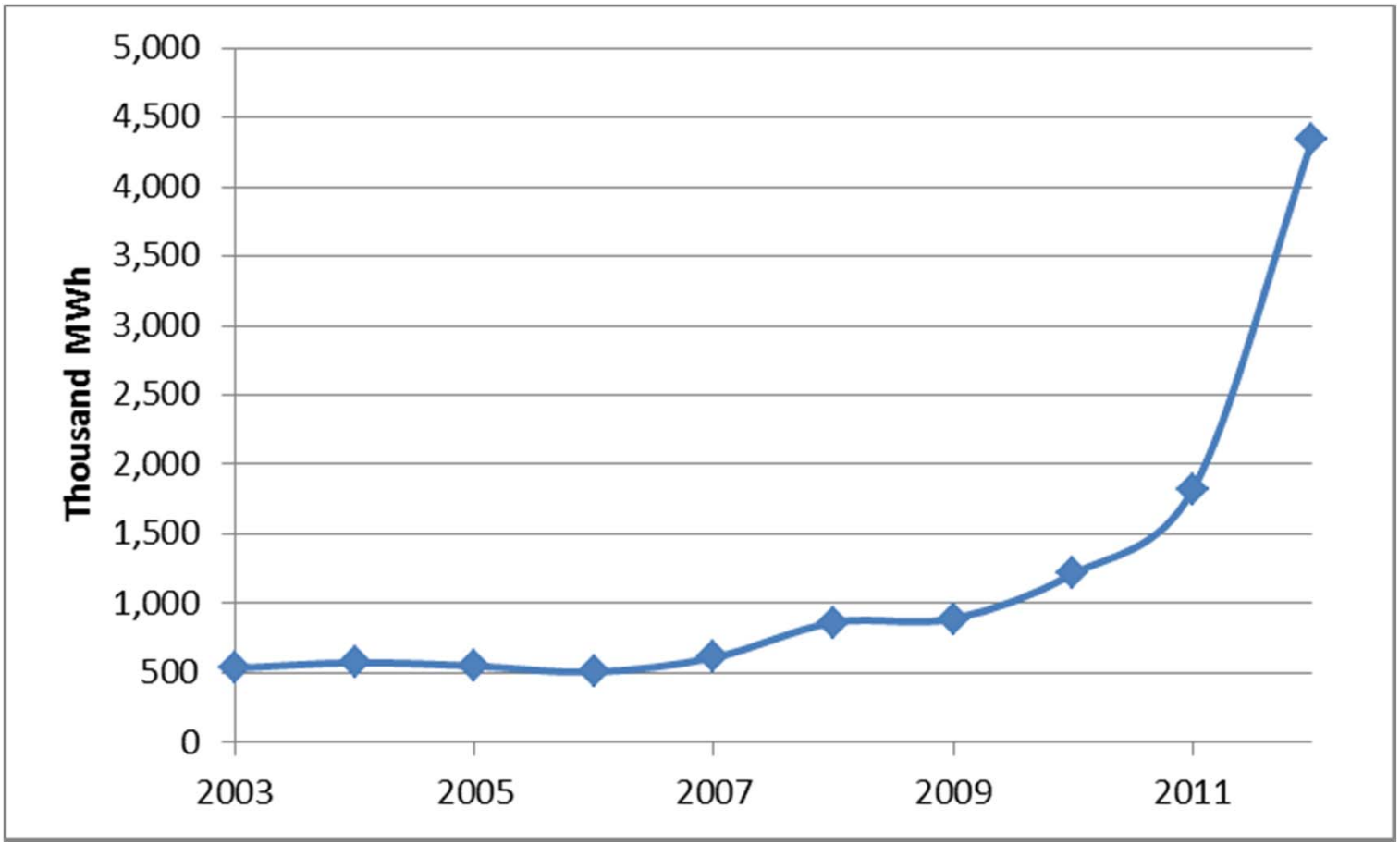

Source: EIA (2013)

# U.S. Electricity Generation: Still Dominated by Central Generation




Source: EIA (2013)

# But Moving Towards Distributed?
# Solar PV Production

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# What Can We Learn From Electricity?

Electricity is not quite the same, but electric utilities have been thinking about this issue for a long time

A standard electricity bill says a great deal…

Your Account Information

*Customer Name Key:* **GILL**
KENNETH GILLINGHAM
211
109 CHURCH ST
NEW HAVEN, CT 06510

| | |
|---|---|
| Account Number: | 010-0001043-9379 |
| Meter Number: | 014001640 |
| Trans and Dist Rate: | RT - Residential Time of Day |
| Generation Rate: | Standard Service |
| Billing Period: | 2/07/13 - 3/10/13 |
| Statement Date: | 3/12/13 |
| Next Meter Reading *(on or about)*: | 4/09/13 |

## Previous Charges & Credits

| | | | | |
|---|---|---|---|---|
| Amount of Previous Bill | 2/08/13 | $ | 86.50 | |
| Payment Received. Thanks! | 2/08/13 | $ | 86.50 | cr |
| **Balance Forward** | | $ | **0.00** | |

## New Charges & Credits

POD 3000000003763 (CYCLE 04)

| | | | |
|---|---|---|---|
| Current Supplier: THE UNITED ILLUMINATING COMPANY | | | |
| Generation Services Charge on-peak | 48 kWh X $.102770 | $ | 4.93 |
| Generation Services Charge off-peak | 428 kWh X $.067770 | $ | 29.01 |
| **Total Generation Services Charges** | | $ | **33.94** |
| Transmission per kwh on-peak | 48 kWh X $.071016 | $ | 3.41 |
| Distribution Basic Service | | $ | 15.85 |
| Distribution per kwh on-peak | 48 kWh X $.048995 | $ | 2.35 |
| Distribution per kwh off-peak | 428 kWh X $.048995 | $ | 20.97 |
| Combined Public Benefits Charge | 476 kWh X $.007142 | $ | 3.40 |
| Competitive Transition Assessment per kwh | 476 kWh X $.015222 | $ | 7.25 |
| Non-Bypassable FMCC per kwh on-peak | 48 kWh X $.024977 | $ | 1.20 |
| Decoupling Adjustment | 476 kWh X $.000000 | $ | 0.00 |
| **Total Delivery Charges** | | $ | **54.43** |

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# Key Features of Electricity Pricing

1. Generation service charges are separate from delivery charges
   - Delivery charges are sometimes fixed “network access” charges
   - Generation service pricing is based on variable cost of generation

2. Time-varying tariffs/Critical peak pricing
   - Higher charges on-peak than off-peak
   - In some cases: higher charges during critical times

# Demand Estimation in Electricity Markets

Two Potential Goals:

(1) Forecasting baselines

(2) Simulation of policy interventions

Much sophisticated demand modeling in energy markets

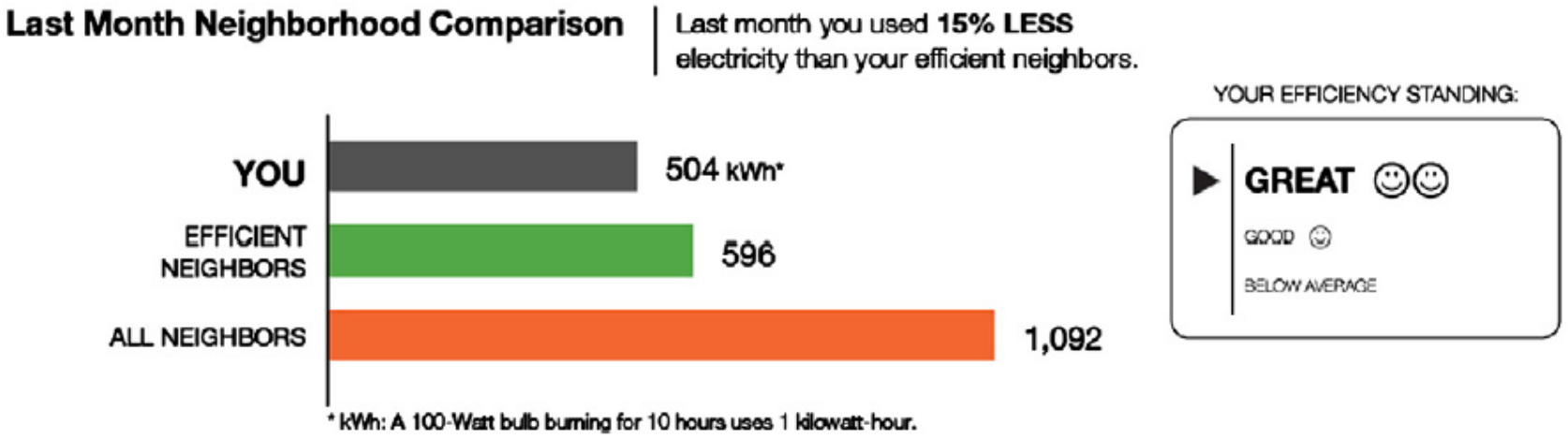
We can think about energy demand response as having a short-run and long-run component

- Buying more efficient durable goods: long-run
- Using what you have a bit less: short-run

# Nothing More Fun Than Estimating Demand Response!

Often we are interested in learning how demand changes along with different policies

- Change tariffs
- Implement critical peak pricing
- Information campaigns
  - E.g., OPower (WaterSmart):



# What Does it Take to Estimate Demand?

Two Primary Methods:

1. Use historical changes in policy
2. Experiment: perform carefully designed pilots!

Take Reiss and White (2008): How promptly do consumers react to price changes and public pressures?

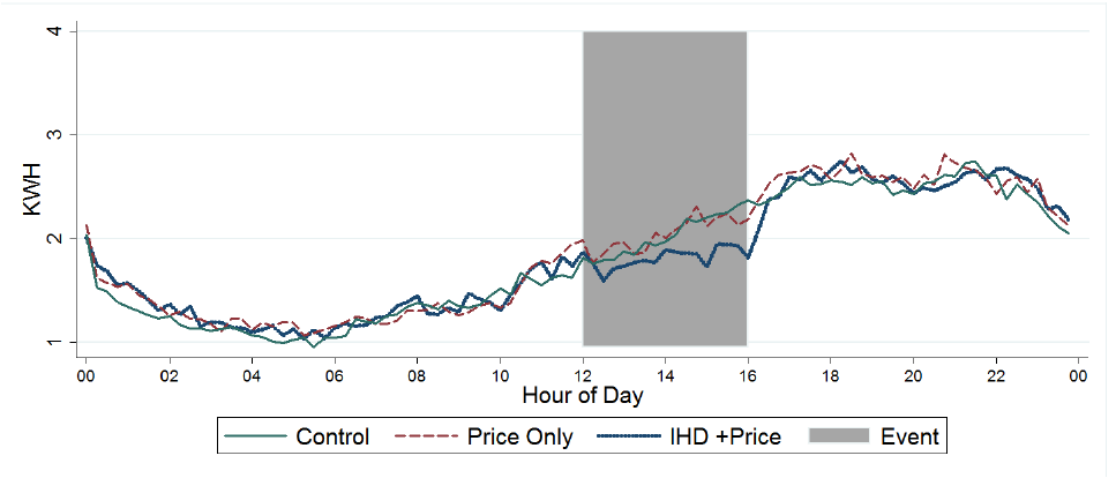
- Use utility billing data from tens of thousands of households in San Diego during the CA electricity crisis
- Find average household electricity use fell by 13% in 60 days, but (largely) returned to former levels with price caps

# Estimating Demand Response with Field Trials

Jessoe and Rapson (2013): How does providing different types of information affect demand?

- Worked with utility in CT to design randomized field trials.
- Performed estimation using thousands of billing records
- Estimated effect of feedback devices etc.
  - Informed households are three standard deviations more responsive to price increases

Figure 1: July 21, 2011: 4hr $0.50 increase, day-ahead notice

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# Questions for Water Demand Research and Policy

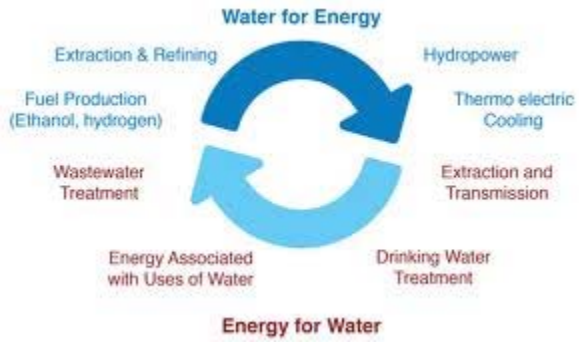
Some key policy/research questions:

- What water tariff structure makes the most sense given the cost structure of water provision/processing?
- How does water demand respond to different pricing and information policies? Efficiency standards?
  - Short-term (reducing use)
  - Long-term (changing water-using durables)

We can look at analogous situations in electricity for ideas…

# Water-Energy Nexus

- Water provision/treatment requires energy
- Energy production typically requires water
- Reducing water use may require energy




I find this a particularly interesting and important research area

- Trade-offs in the context of hydroelectric generation
- What is the substitutability between water and energy?
- How do they relate during heat waves?