Empowering Consumers Through Smart Technology

Experimental Evidence on the Consequences of Time-of-Use Pricing

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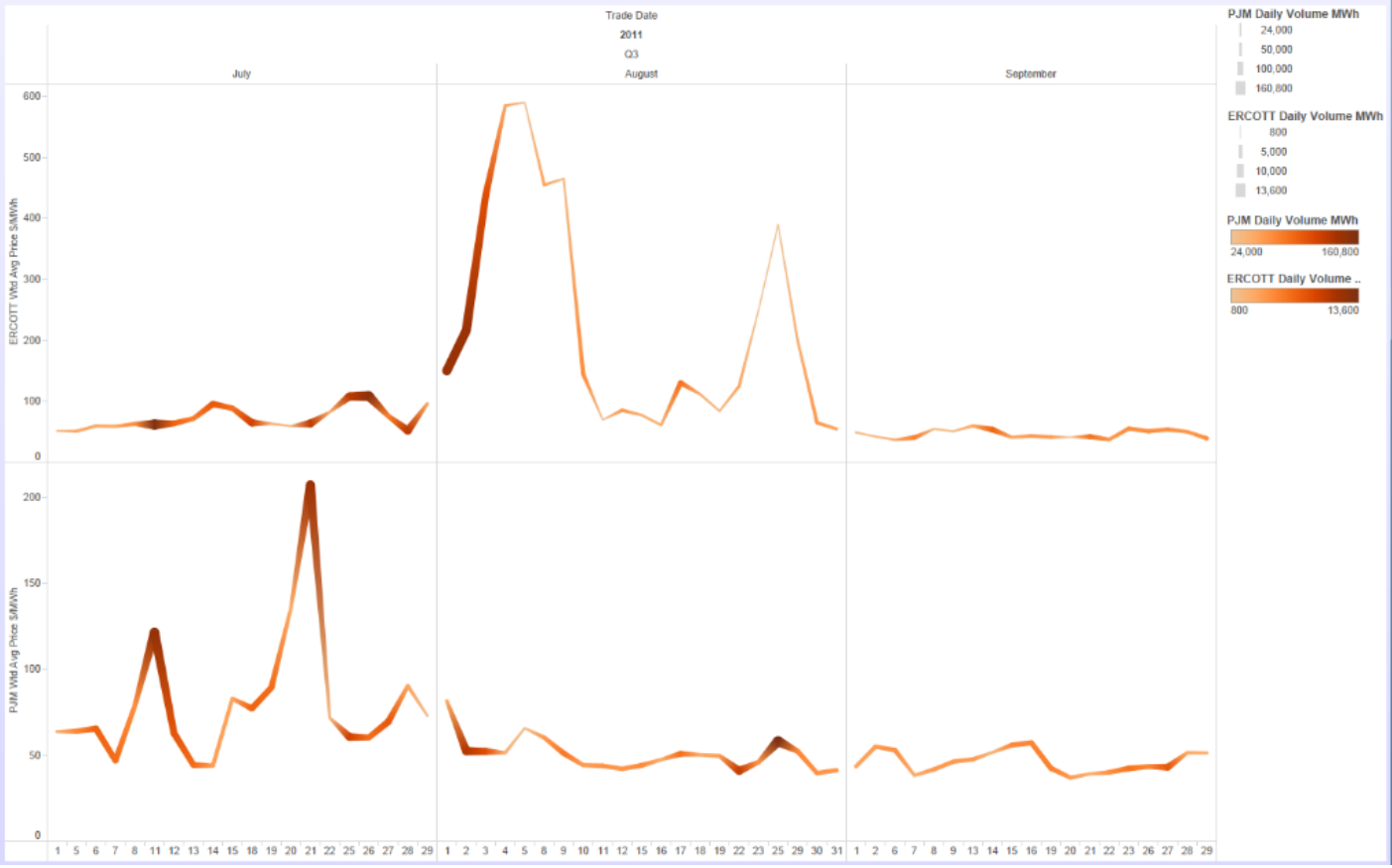
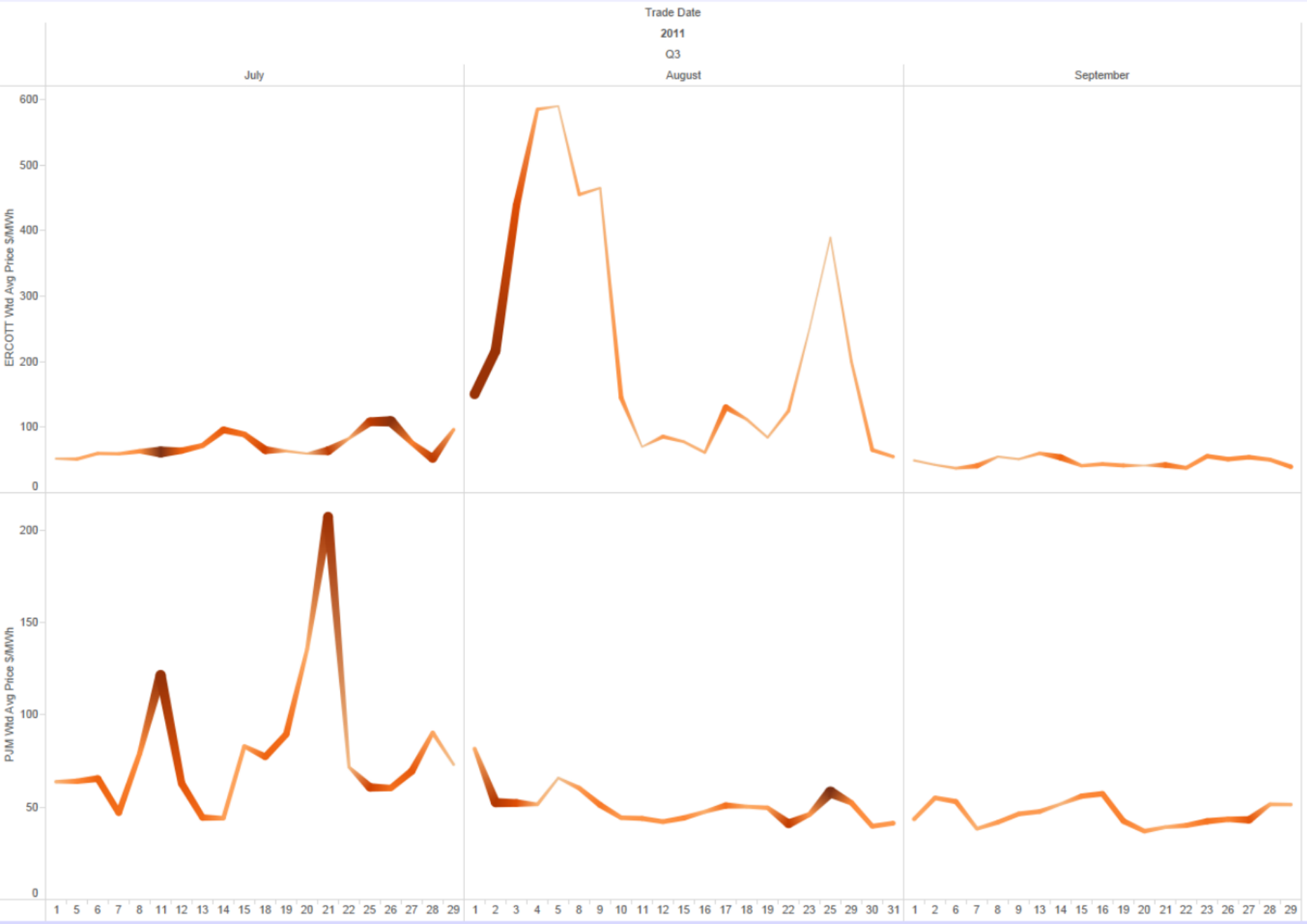
Big Data Research

Time-of-Use Pricing (TOU)

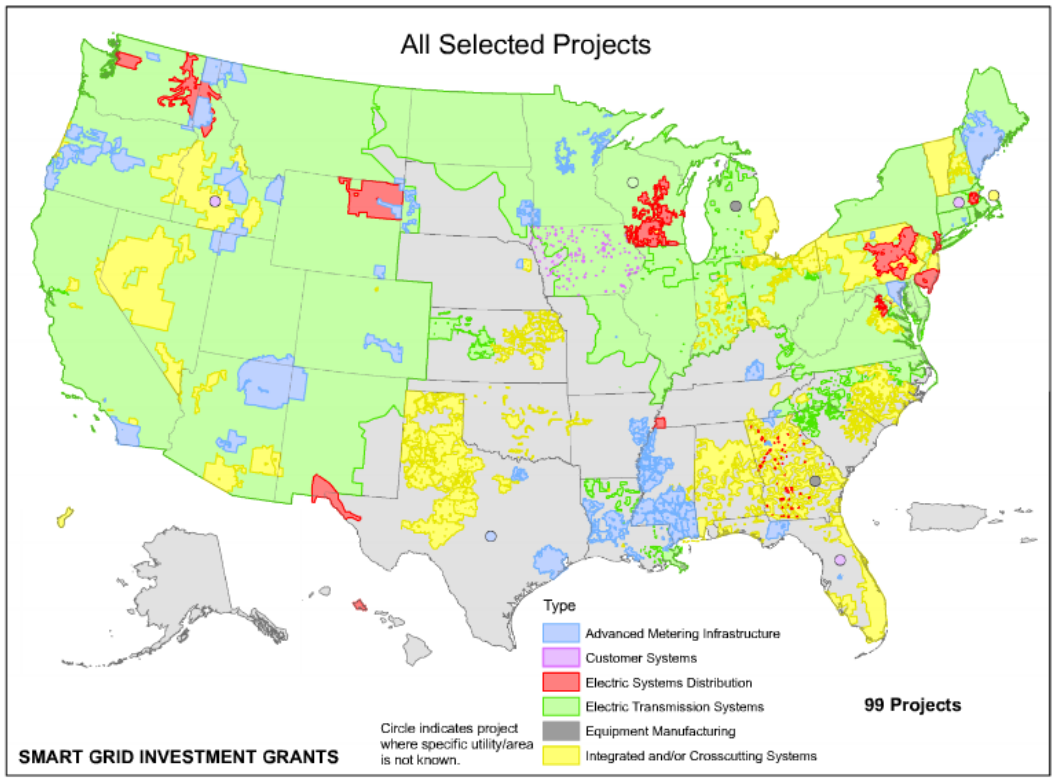
- Price signals should reflect marginal costs (Boiteux, 1960)
- Electricity is not (economically) storable
- Mismatch between wholesale and retail prices
- Inefficient allocation of resources, blackouts

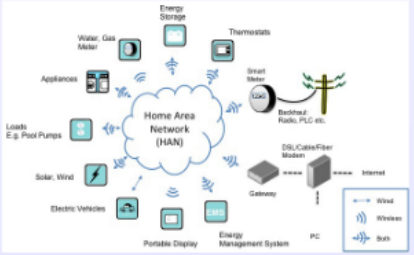


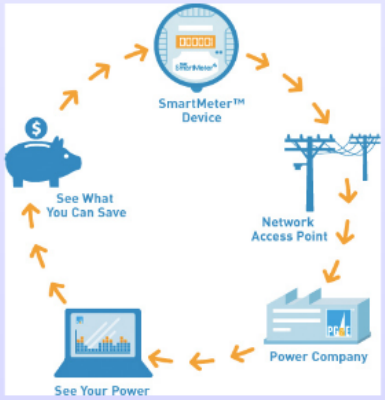

Trade Date
2011
Q3
July
August
September
ERCOTT Wtd Avg Price $/MWh
PJM Wtd Avg Price $/MWh
PJM Daily Volume MWh
24,000
50,000
100,000
160,800
ERCOTT Daily Volume MWh
800
5,000
10,000
13,600
PJM Daily Volume MWh
24,000
160,800
ERCOTT Daily Volume ..
800
13,600

Smart Meters

- Partly as a result of over $3 billion in federal funding resulting from the American Reinvestment and Recovery Act, by the end of 2011 over 493 US electric utilities had over 37 million advanced metering infrastructure (AMI) installations.
- Remove technological limitations to TOU pricing by enabling real-time two-way communication







Policy Obstacles to TOU Adoption

- Joskow and Wolfram (2012) - a number of “unresolved issues” remain regarding our understand of how consumers respond

Enabling Technology

- Consumers need technology to provide them with information on price and quantities (Alcott, 2011; Faruqui and Palmer, 2012; Jessoe and Rapson, 2013)
- Providing consumers with this technology is costly
- Behavioral questions remain: information versus automation?

WHO'S AT YOUR FRONT DOOR? GOOGLE

A $3 billion thermostat any idiot can install

CNN's Jarrett Bellini was assigned to buy a Nest, install it, and report back. If he weren't electrocuted in the process, that is. WATCH

More: **Google's plot to take over your digital life • Today, the Nest -- tomorrow, the world! • How the Nest thermostat was created • Tony Fadell on why he sold Nest to Google • Wait a second -- Google owns WHAT?**

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Nest Gives Google Its Next Big Data Play: Energy

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When Google bought Motorola in 2012, its mandate was to get more millions people on the mobile web. Now with its $3.2 billion purchase of Nest Labs, Google could get millions of homes connected to a different kind of web: an energy management system powered by Big Data.

Nest thermostat – Consumer Electronics Show – CES 2013 – Las Vegas [Photo credit: David Berkowitz]

The sexy world of smart homes aside, one easily overlooked but important part of Nest's business is energy management. Though the company has booked an estimated $275 million in sales from its Leaning Thermostat since the device first went on sale, the company launched this small but growing revenue stream for itself seven months ago, a lucrative service it sells to energy utilities that helps them better manage the energy demand of households.

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More Unresolved Issues ...

... Additional Policy Obstacles

Load Shifting Recent literature finds peak load reductions from critical events (Wolak, 2006; Allcott, 2011; Jessoe and Rapson, 2013; Ito, Ida and Tanake, 2013), but NO evidence of load shifting to off-peak hours

- Graff-Zivin, Kotchen, and Mansur (2012) show that generation mix leads to spatio-temporal heterogeneity in marginal CO2 emissions
- The overall environmental benefit of TOU pricing depends on the relative changes in load at different points in time.

Distributional Impact Major concern for regulators

- What is the impact of TOU pricing on different demographics, e.g. poor, elderly?
- How does responsiveness vary across low and high electricity households?

Experimental Design

Prices

Control

Flat rate of 8.4¢/kWh for the first 1400 kWh used and 9.68¢/kWh for usage over 1400 kWh per month

Treated Groups

- Off-peak: 4.2¢/kWh
- On-peak: 23¢/kWh.
- Critical peak: 46¢/kWh.

On-peak: 2-7pm weekdays
Off-peak: other hours and weekends
Critical Peak (CPP): occurred on 7 days in the sample, lasting between 2-8 hours

Web portal

In-home display

Programmable communicating thermostat

Experimental Design

Technology

Control	Standard rate and no technology (554 HH)
Portal	TOU+Web portal (327 HH)
Portal+IHD	TOU+Web Portal+In-home display (254 HH)
Portal+PCT	TOU+Web Portal+Programmable communicating thermostat (305 HH)
All	TOU+Web Portal+In-home display+Programmable communicating thermostat (252 HH)
Total	1682 HH
Observations	11,377,806 observations on household electricity consumption at 15 minute intervals for June-September 2011