How Do Technology and Pricing Impact Consumer Behavior?

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Fully Engaging Demand:
What We’ve Learned from the Olympic Peninsula Demonstration
Olympic Peninsula Demonstration

Invensys

Clallam PUD & Port Angeles
n = 112, 0.5 MW DR

IBM

Market

MW

$0

12

18

24

Internet broadband communications

Sequim Marine Sciences Lab
0.3 MW DR
0.5 MW DG

Johnson Controls

Clallam County PUD Water Supply District
0.2 MW DR

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0.3 MW DR
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Testing Market-based Customer Incentives

Virtual distribution feeder (in software) as if all resources co-located on a single feeder

Real-time (5-min.) market clearing — real cash deposits & shadow billing

Demand response equipment to automate response based on customer preferences

Load Behavior

Power Price

Contract Offers

Contract Accepted

Fixed CPP/TOD Real-Time

CPP/TOD

Customer contract choice
Olympic Peninsula Demo: Key Findings (1)

Customers can be recruited, retained, and will respond to \textit{dynamic pricing} schemes \textbf{if they are offered}:

\begin{itemize}
  \item Opportunity for significant savings (~10\% was suggested)
  \item A “no-lose” proposition compared to a fixed rate
  \item Control over how much they choose to respond, with which end uses, and a 24-hour override
    \begin{itemize}
      \item prevents fatigue: reduced participation if called upon too often
    \end{itemize}
  \item Technology that automates their desired level of response
  \item A simple, intuitive, semantic interface to automate their response
\end{itemize}

\begin{tikzpicture}
  \node at (0,0) {More Comfort};
  \node at (2,0) {More Savings};
  \draw[->] (0,0) -- (2,0);
\end{tikzpicture}

\textbf{Translates to control parameters:} \quad K, T_{max}, T_{min} \text{ (see Virtual Thermostat)}
Significant demand response was obtained:

- 15% reduction of peak load
- Up to 50% reduction in total load for several days in a row during shoulder periods
- Response to wholesale prices + transmission congestion + distribution congestion
- Able to cap net demand at an arbitrary level to manage local distribution constraint
- Short-term response capability could provide regulation, other ancillary services adds significant value at very low impact and low cost)
- Same signals integrated commercial & institutional loads, distributed resources (backup generators)
Load Shifting Results for RTP Customers

- Winter peak load shifted by pre-heating
- Resulting new peak load at 3 AM is non-coincident with system peak at 7 AM
- Illustrates key finding that a portfolio of contract types may be optimal – i.e., we don’t want to just create a new peak
Potential for Demand Response to Help Manage the Large Infusion of Wind Power Implicit in a Carbon Strategy

*Regulation:* one or more fast-responding power plants continually throttle to match normal fluctuations in load

Highest cost generation in markets (zero energy sales, wear & tear, fuel consumption)

Fluctuations in wind farm output greatly exacerbate need for regulation, reduce cost effectiveness of wind power at high penetrations
How Can We Engage Demand Response in a Fully Regulated Utility Environment?

- Keep regulated, “flat” rates for small customers
- Lay the financial “cards” on the table:
  - Determine *actual costs to serve* customers, *by time & by location*
  - *Reveal to customers the marginal value* of reducing their demand
  - *Offer to share* the benefits they create through incentives
  - *Buy them controls to automate* the response & savings they desire
  - *Keep it simple*, transparent, *customer in charge* of all response
  - Remaining share of benefits to *reduce rates for all customers*
- Design revenue-neutral, fully-regulated incentives (no windfalls, no risk)
  - Pay-for-curtailment (measurement & analysis intensive to compare actual to “baseline”)
  - Price-based programs* (simple: pay for what you use) debited from a *declining balance incentive account*

* Note: *time-based retail price signals or incentives do not require deregulated wholesale markets*
What is a *Declining Balance* Approach?

How it works from customer perspective:

- Pay fixed rate bill as usual
- Receive up-front incentive deposited in internet holding account in customer name—potential to save $ is explicit
- Incentive deposit can be designed or adjusted to be revenue neutral for current average customer load shape
- Debited a TOU/CPP or real-time-price based “shaping charge” against their holding account
- Periodically receive a check for the unspent balance in their account—clear, tangible reward distinct from bill
- Account cannot go below zero—ensures “no losers” proposition, lowers risk of trying something new
What are the Advantages of this Approach?

▶ Looks like payment for curtailment to customers, regulators
▶ Avoids complexity of customer baseline—*none required by pricing schemes*
▶ No losers (holding account cannot go negative)—*eliminates risk for customers* (and regulators)
▶ Up front payments can be
  ▪ revenue neutral or revenue positive, course corrected over time to maintain targets
  ▪ individually tailored to each customer (e.g., a fraction of previous year’s bill, and/or based on AMI data)
▶ Engages customers in dynamic pricing, where demand response can be fully employed, all the time, to provide maximum value
Going Beyond the Traditional Benefits of Demand Response is Simply Good Business

► Obtain the broadly recognized, “traditional” benefits of demand response (DR):
  ■ Minimize need for new generation & transmission capacity
  ■ Manage demand on peak days
  ■ Mitigate wholesale price spikes

► Maximizing return on the strategic DR investment is simply good business:
  ■ Utilize demand for ancillary services
  ■ Defer distribution capital investments
  ■ Leverage network to obtain & measure efficiency/carbon benefits

Engaging DR continually rather than intermittently brings many additional benefits
Questions/Comments

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