NixTheFix Forum:
Residential Demand Charges - Load Effects, Fairness & Rate Design Implications

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Overview

* Intro to Demand Charges
* Rationale
* Problems
  * Demand charges do not fall on the peak loads that drive investment requirements
  * Costs are driven by non-peak loads
  * Reduce incentives for solar and conservation

Rate Structures

* Customer and commodity (energy) charges
* Commodity and demand (and customer) charges
* Customer and TOU commodity charges
* Customer and variable commodity charges

Customer & Commodity Charges

* Nearly universal for residential and smallest commercial customers
* Examples:

$5/month + 10¢/kWh

$5/month + 7¢/kWh for the first 1,000, 15¢/kWh for additional kWh

Commodity & Demand (and Customer) Charges

* Common for medium and large non-residential electric customers
* Some large gas customers
* Example:

\$5/month + 8¢/kWh + \$5/kW-month

Customer & TOU Commodity Charges

- Usually optional for residential customers
- Example:

$5/month
+ 15¢/kWh on-peak (weekdays noon to 6 PM)
+ 8¢/kWh off-peak (other hours)

Customer & Variable Commodity Charges

- Emerging as option for residential customers
- Examples:

$5/month
+ 25¢/kWh super-peak (weekdays 10 AM to 8 PM,
if forecast load > 8,000 MW or day-ahead price over $100/MWh)
+ 12¢/kWh normal peak (other weekdays 10 AM to 8 PM)
+ 7¢/kWh off-peak (other hours)

Or

$5/month
+ Day-ahead price plus 20% on-peak (weekdays 10 AM to 8 PM,)
+ 6¢/kWh off-peak (other hours)

What's a Demand Charge, Anyway?

- A charge added to each monthly bill based on the *maximum rate* of energy use
  - $/kW for electric
  - $/Dth/hour of $/Dth/day for gas
- Variants:
  - Measurement interval
    - *Electric: one hour or less (e.g., 15-minute intervals)*
    - *Gas: hour or day*
  - Period for which charge is locked in (ratchet)
  - Time-differentiation

Lock-in Periods (Ratchets)

* The billing demand may be the highest usage rate in:
  * The billing month
    (you get charged in April for your max hourly use in April)
  * The previous year
    (you pay in April 2016 for max hour in May 2015–April 2016)
  * The previous peak season
    (you get charged in April 2016 for max hour in Summer 2015)
* Or set at:
  * A contract demand level previously selected by the customer or set by past loads

Time-differentiation

- Demand rate may be lower in off-peak season or hours
- Example:
    - **On-peak demand rate (max use noon–8 PM) for generation and transmission**
    - **Any excess in other hours charged at lower rate for distribution**

Where Else are Demand Charges Used?

* Not much.
  * Analogies are hard to find.
* Internet service charges vary with your contract connection speed
* Rental agencies charge more for larger (and perhaps more powerful) cars
  * Car rentals don't charge for miles plus max mph
* Demand charges are hard to explain

Where did this Idea Originate?

- Very old, predates viable TOU energy metering
- Traditional benefits for utilities (and regulators, once they started paying attention)
  - Give discounts to big energy users.
  - Benefit industrial over commercial customers.
  - Penalize self-generators by charging ratcheted demand for backup power.
- Demand charges are hard to avoid
  - Often referred to as fixed costs, like customer costs.
  - More stable revenue stream for utilities.
  - Reduces benefit of distributed generation.

What are the Problems?

* The customer's maximum load misses the maximum load on
  * Most equipment
  * The system
* Shifting load off the customer peak may shift it onto the system or equipment peak
* Equipment costs vary with more than peak demand
* Reduces energy charges
  * Reduces incentives for PV, CHP, efficiency
* Reduces customer control over bills

System Peaks & Customer Peaks

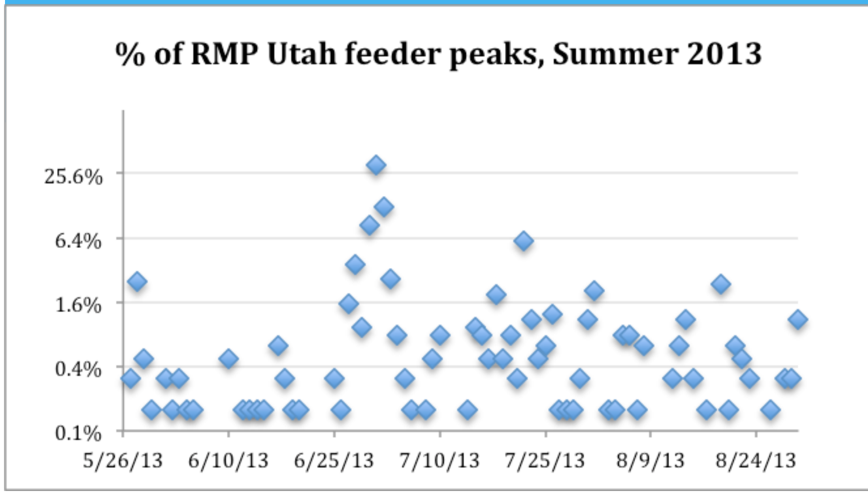
- Sum of residential customer max loads is much larger than
  - Residential class peak
  - Residential contribution to system peak
- Example
  - **Northeast Utilities Overhead Distribution Standards (1999)**

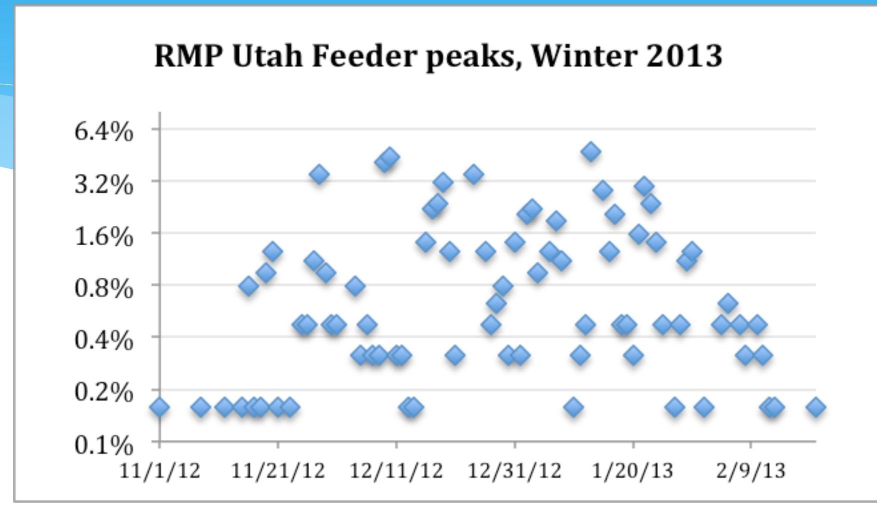
    Diversity = Group max demand ÷ Sum of customer max demands

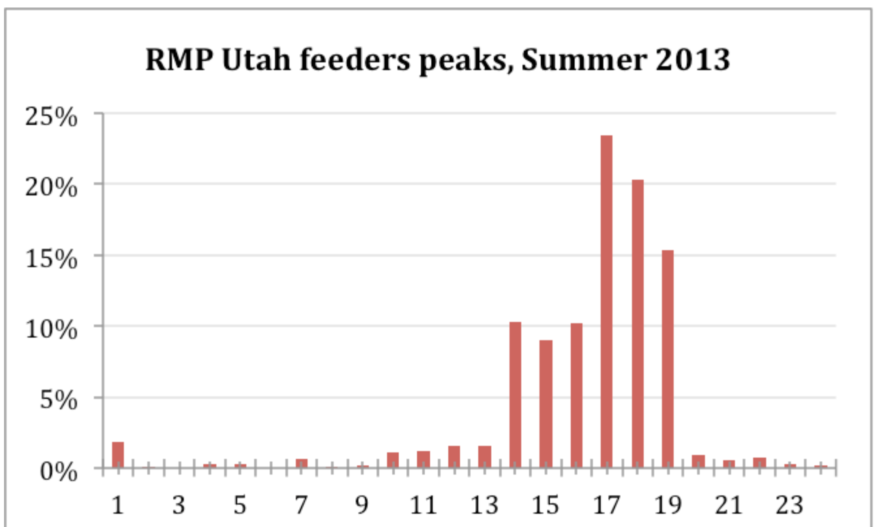
Homes	2	3	4	5	6	7	8	9	10	11	12	>12
Diversity	0.68	0.58	0.52	0.49	0.47	0.45	0.44	0.43	0.42	0.42	0.41	0.40

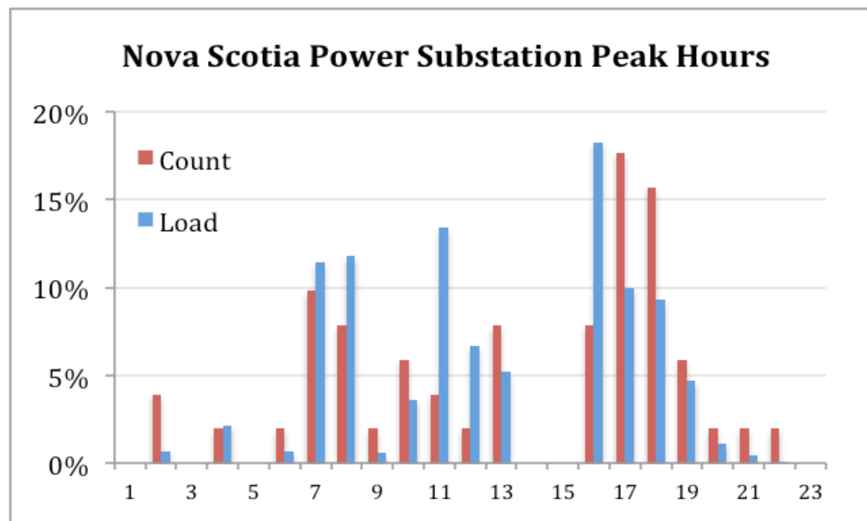
True for non-residential, too

Times of Equipment Peaks









Utility Equipment Driven by Different Loads

* Generator
* Transmission
  * Lines
  * Substation
* Distribution substation
* Feeder
* Primary lateral
* Line transformer
* Service drop
* Customer

Equipment Loads & Customer Diversity

* Service drop
  * Usually 1 customer
  * Can be dozens in apartment building, several for small commercial
* Line transformer
  * Sometimes 1 customer in remote rural areas
  * Typically several in suburban areas
  * Hundreds in urban networks
  * Residential may share with commercial
* Primary lateral
  * Dozens to hundreds of residential customers
  * More sharing with commercial
* Feeder
  * Hundreds to thousands of customers, all classes
  * More than one feeder may serve a customer

Equipment loads & typical customer diversity (cont.)

* Distribution substation
  * Thousands of customers, all classes
* Transmission lines and substations
  * Tens or hundreds of thousands of customers
  * Each customer served by many lines and substations
* Generation
  * Millions of customers
  * Each customer served by hundreds of generation units

Equipment Costs are Driven by Loads other than Peak

* Line transformers and substation transformers:
  - Transformer is a chunk of iron wrapped in copper wires
  - As power flows through wires, they heat up
  - Heat losses rise as square of power flow
    Doubling load quadruples heat loss
  - The metal core retains heat, transformer is compact, loses heat slowly
  - Hot insulation breaks down
    Long and frequent high loads kill transformers early
    Or requires larger transformers
* Underground lines:
  - As power flows through cables, they heat up
  - Heat losses rise as square of power flow
  - Earth is a pretty good insulator; heat builds up around cables
* Overhead Transmission lines:
  - Heating and sag

Equipment Costs are Driven by Loads other than Peak (cont.)

* Transmission generally:
  - Carry power from many generators, to many load areas, often in both directions
  - The same line may carry power

    north in the winter,
    south in the summer;
    from areas with excess baseload in off-peak hours
    from areas with excess peaking capacity on-peak
    from wind-rich areas in windy hours, but back in low-wind hours
    from hydro-rich areas in the spring flood, but back in low-water months (and years)
    [and so on for various patterns of generation availability]
* Generation:
  - High loads (not just the peak) contribute to need for capacity for reliability
  - Total capacity need driven by loss-of-load probability
  - Long hours of load contribute to economic justification for more expensive baseload, renewables

Reducing incentives for PV, CHP, efficiency

- Billing demand may not be affected by PV
  - One warm sticky evening with AC and lighting and frig
- Billing demand may not be affected by CHP
  - One high-load hour without a thermal load for the CHP
  - Even a brief CHP shut-down can trigger a higher billing demand
- Many efficiency measures will reduce billing demand, but:
  - Some measures (set-back thermostats, variable-speed drives) may *increase* billing demand
  - Lower energy charges make bill savings smaller, less certain
  - Customers are encouraged to focus on minimizing maximum demand, shifting load, not conserve

Reduces Customer Control Over Bills

- Timing of maximum demand is hard to guess
- Brief, randomly-timed demand spikes are hard to control

Alternatives to Demand Charges

* TOU energy charges
* Variable energy pricing
* Include probability of contributing to T&D cost drivers