Forecasting the Geographic Distribution of Demand Reductions from Energy Efficiency

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Capturing Value from Energy Efficiency





ENERGY SAVINGS:

Using less energy results in a direct cost savings to customers each month on their bill.

T&D SAVINGS:

If load reduction is coincident with the network peak, investments in distribution assets can often be deferred.

LINE LOSS SAVINGS:

Delivering less energy avoids losses in the wires.

CAPACITY SAVINGS:

If load reduction is coincident with the system peak, fewer new power plants may be needed to supply peak demand.

ENVIRONMENTAL BENEFIT:

Burning less fuels reduces emissions of CO2 and other pollutants.

Capturing Peak Demand Benefits

- Most utilities forecast coincident EE savings at the system level to avoid new peak generation capacity
  - But to our knowledge none forecast savings below this level (e.g., substations) in order to avoid new T&D capacity
- To avoid new T&D load relief projects:
  - We must know where the demand reductions will occur (geographic distribution)
  - We must know when the demand reductions will occur (coincidence)
  - We must know far enough in advance (projects can have long lead times)
- We believe that regulators will increasing pressure utilities to capture these T&D benefits
  - But regulators likely underestimate the forecasting challenge and risks

Con Edison's Experience
Targeted DSM

- Con Edison's "Targeted DSM" program has attempted to use EE proactively to reduce demand on specific circuits since 2003
- Contracted demand reductions in targeted networks included in 10 year peak load forecast, but…
  - No geographic uncertainty (ESCOs credited only for projects in targeted networks)
  - No coincidence uncertainty (ESCOs only allowed to include measures that would reduce consumption during the relevant network peak)
  - Only risk is ESCO non-performance: mitigated contractually via liquidated damage provisions that offset the costs of handling last minute capacity shortfalls

Con Edison's Experience
EEPS

- Arrival of EEPS programs in 2008 complicated things
  - Multiple program administrators (Con Ed, NYSERDA, NYPA)
  - Regulatory uncertainties (timing of approvals, alterations ordered)
  - Market uncertainties: program ramp rates, macroeconomics
  - Uncertainty about the market penetration of new programs in different networks
  - Difficulty estimating the overall coincidence between widely varying measures from multiple EE programs and 91 different network peaks
- But impacts were impossible to ignore
  - EEPS expected to result in 800 MW of load reductions (6% of peak) over 5 years
  - Including this in the peak load forecast eliminated $1 billion of load relief work over the 10 year planning horizon (at least on paper)

Decision was made by the CEO to include EEPS demand reductions in forecast

Example: Ten Year Peak Load Forecast
Substation "A"

(in MW)	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Forecast	197	199	202	204	207	209	212	213	215	216
Less DSM	*(1)*	*(3)*	*(5)*	*(7)*	*(9)*	*(10)*	*(10)*	*(10)*	*(10)*	*(10)*
Net Demand	196	196	197	197	198	199	202	203	205	206
Capacity	200						250			

- Without DSM: demand is expected to exceed capacity by 2012
  - Capital investment needed to expand capacity.
  - Depending on the engineering solution, several years of lead time may be needed
  - Procurement/construction may start long before the impacts of EE are apparent.
- With DSM in forecast: project is deferred until 2016

Forecasting Approach

- Allocate expected energy savings to networks for each program
  - Con Edison has 91 networks/load areas, each with differing customer composition
  - Challenge is to estimate the geographic distribution of program participants by network (relative market penetration)
- Convert expected energy savings to coincident load reductions
  - Program goals are expressed in energy—not demand—savings
  - Programs measures have differing load curves; networks peak at differing times
  - Account for the variability of real outcomes (distribution uncertainty)
  - Grid reliability requires that the variance of the geographic distribution be estimated

Allocating Energy Savings

- Program targets expressed as annual energy savings (kWh)
  - Started with realistic estimates of expected program achievements
- Used prior year consumption by service class as a proxy function
  - Built matrix of consumption by service class and network from billing data
- But EE market segments not constructed along service class lines
- Had to regroup service class consumption to match program market segments using market research data (available to borough level)
  - Single (1-4) Family Residential
  - Multi (5+) Family Residential
  - Small Commercial
  - Large Commercial
  - NYPA and Electric Heating (no savings mapped here)

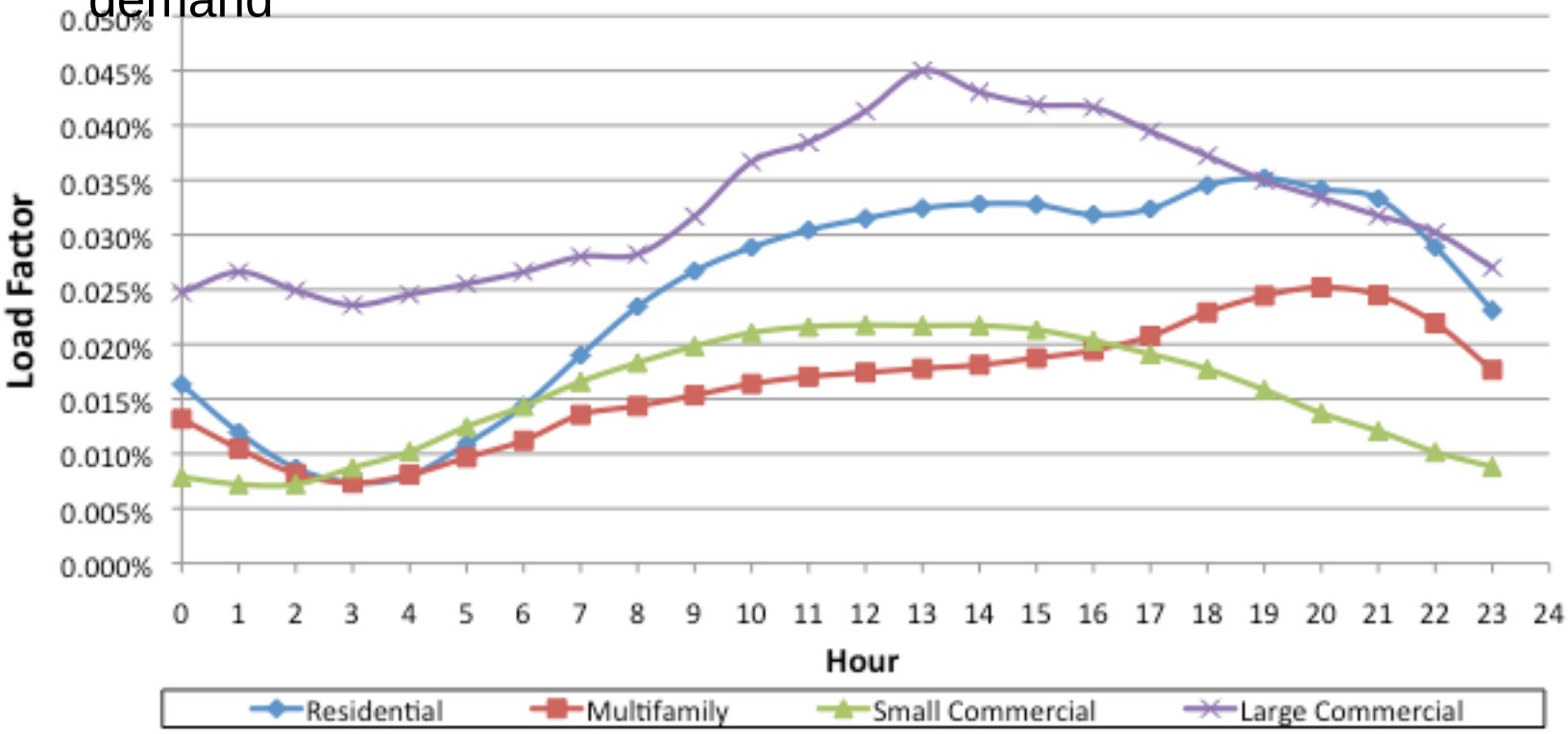
Example: Regrouping SC-1 (Residential)

Borough	SC-1 (1-4 Family)	SC-1 (Multi-Family)	SC-1 (Commercial)
Manhattan	8%	91%	1%
Brooklyn	64%	33%	3%
Queens	75%	24%	1%
Bronx	40%	58%	2%
Westchester	85%	14%	1%
Staten Island	95%	4%	1%

- Issues
  - Boroughs are not uniform (e.g., South Bronx is more like Manhattan, North Bronx is more like Westchester County) but only averages are available

Converting to Demand Reductions

- Generated 8760 load curves by program using Cadmus Portfolio Pro
  - Same tool used to design the programs
    - Sampled curves at each network's peaking hour to convert to demand

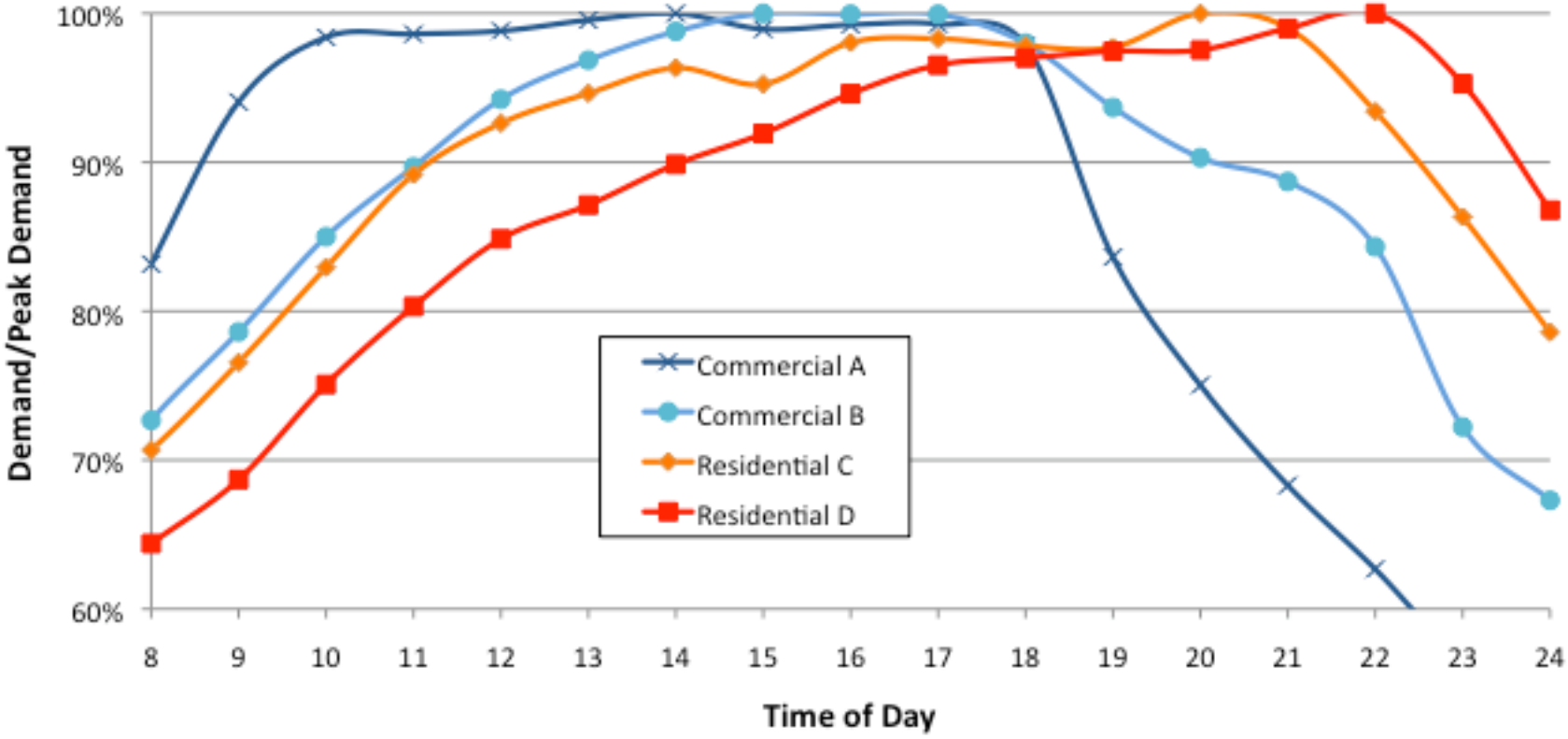


Addressing Variability

- Demand reductions to this point are expectation values (P50)
  - In half of the networks, actual demand reductions will be higher, but…
  - In half of the networks, actual demand reductions will be lower
- System planners need higher reliability (P90 or P95)
  - But this requires knowledge of the variance of the geographic distribution!
  - Until this can be measured, we reduced the expectation values by 50%
- Note that this reduction is not applied to the system forecast

Discussion

- Important to allocate energy savings before converting to demand
  - Networks load profiles are very different



Issues...Future Work

- Will the EE market penetration mirror consumption patterns within each segment?
  - Probably true for large enough aggregations of demand over the long term
  - Better than using past performance (distributions may shift as areas saturate)
  - But there will be short term variability (e.g., implementation contractors preferentially targeting areas for a variety of business reasons)
- Major weakness is the lack of market research data at network level
  - Demographics vary within boroughs, even in Manhattan
  - Con Edison working to extend market data to network level
  - Extension to secondary circuits (below network level)
  - Not currently attempted as random variability becomes overwhelming (e.g., a circuit could serve a single customer or single building)
  - (But they can be targeted!)

Public Utilities Fortnightly Paper

See August 2011 PUF for the full paper:

http://www.fortnightly.com/exclusive.cfm?o_id=759