Best Practices in Utility Demand Response Programs

With Application to Hydro-Québec's 2017–2026 Supply Plan

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Outline

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2. The Québec context for DR
3. Best practices:
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Demand response defined

The U.S. Federal Energy Regulatory Commission (FERC) defines demand response (DR) as:

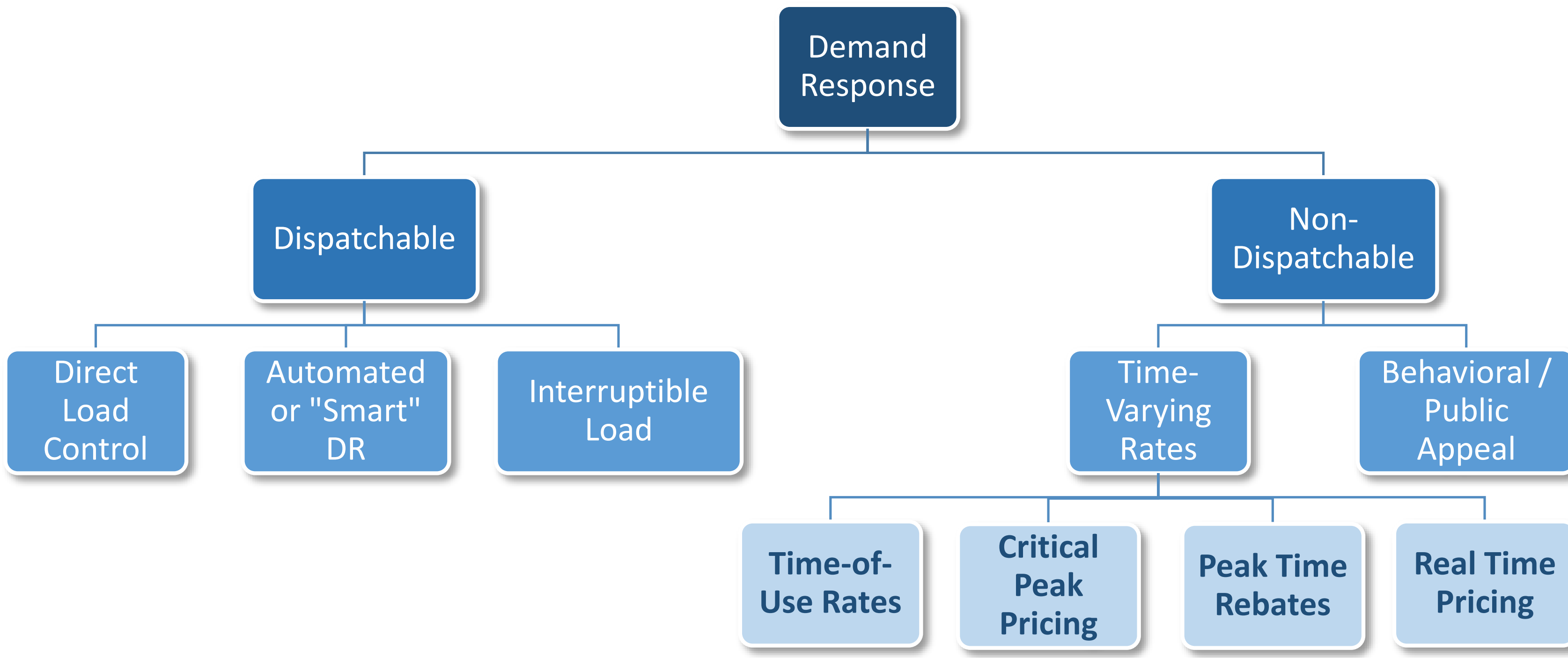
“Changes in electric usage by demand-side resources from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at times of high wholesale market prices or when system reliability is jeopardized.”

Uses of DR

- Avoid peak capacity costs by reducing peak demand
- Avoid local transmission or distribution costs by reducing local peaks or responding to contingency situations
- Increase reliability during generator or line forced outages
- Enhance grid flexibility through ancillary services, such as frequency response or load following

DR may be accompanied by shifting loads to other times or by net shedding of load

Types of DR

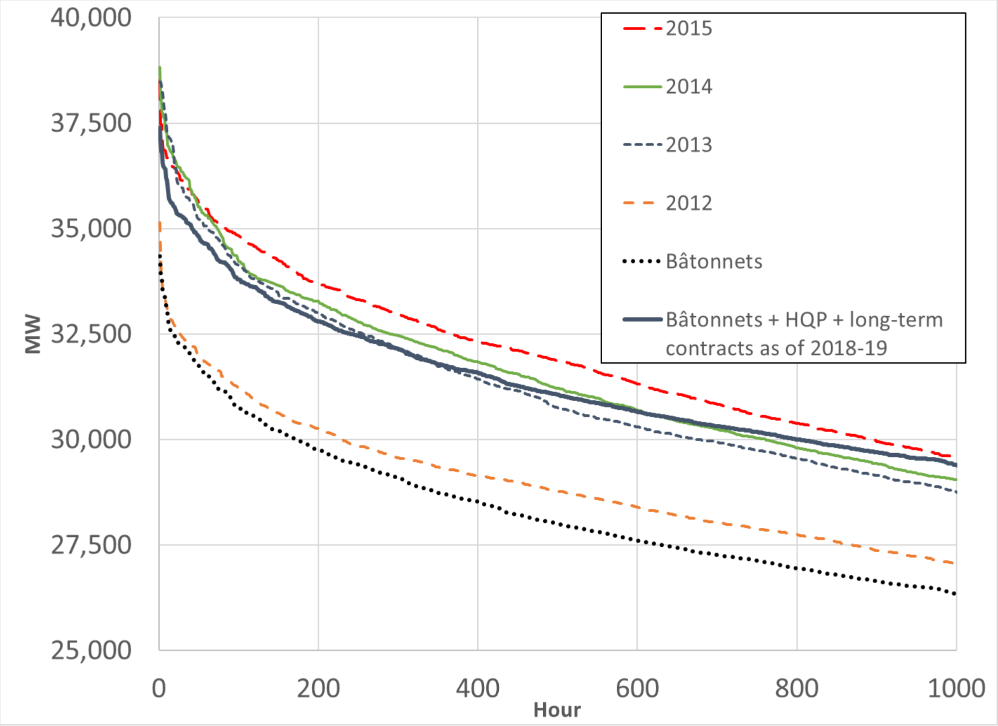

Demand Response
Dispatchable
Non-Dispatchable
Direct Load Control
Automated or "Smart" DR
Interruptible Load
Time-Varying Rates
Behavioral / Public Appeal
Time-of-Use Rates
Critical Peak Pricing
Peak Time Rebates
Real Time Pricing

Québec context for DR

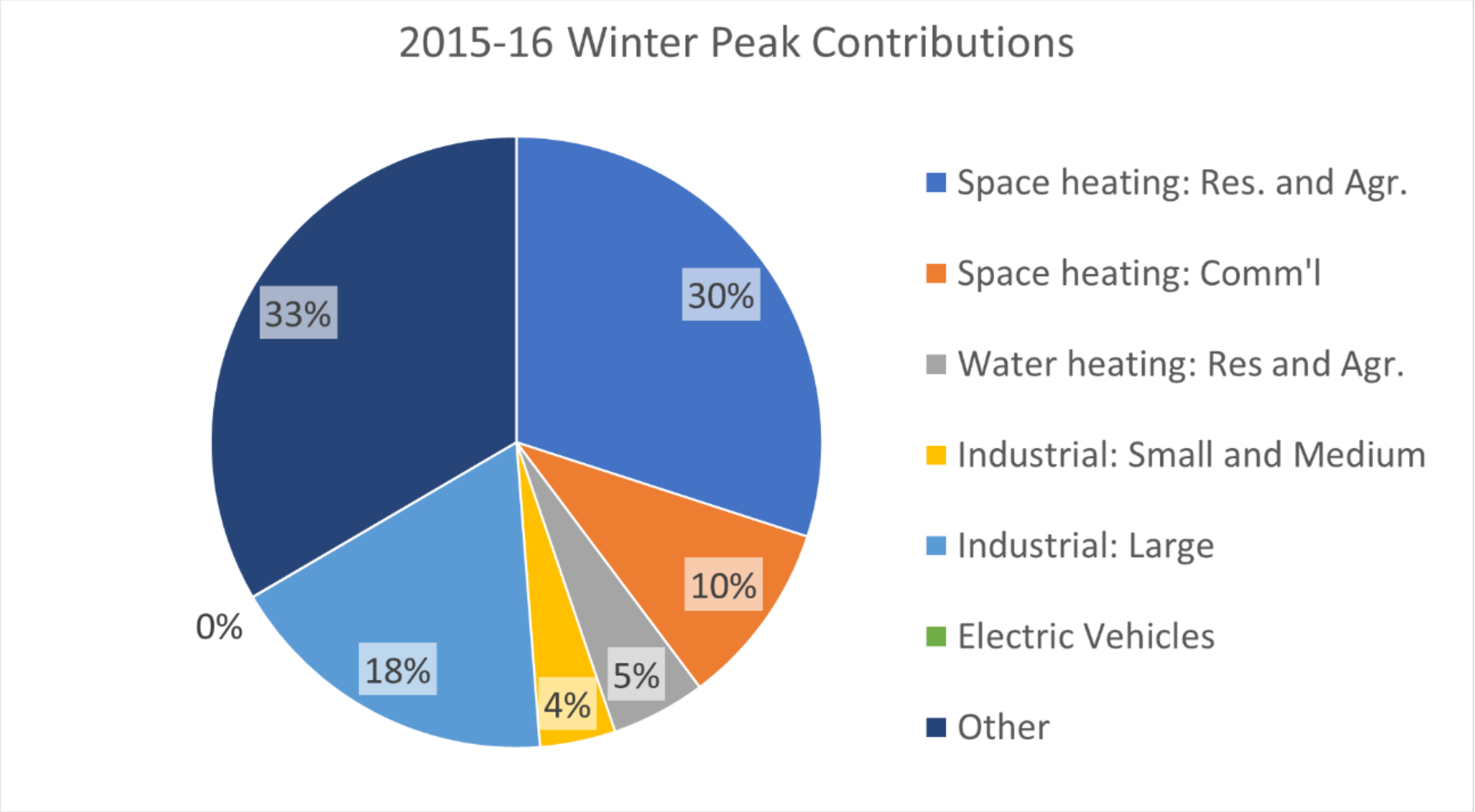
- Supply cost is nearly invariant except during peak periods
- Electric grid built to handle these same peaks
- Peaks are driven by the coldest winter weather
- Relatively low electric rates have encouraged extensive use of electricity for space and water heating
- Advanced Metering Infrastructure (AMI) has been deployed
- Québec is committed to GHG reductions, including through electrification of transportation

Power supply

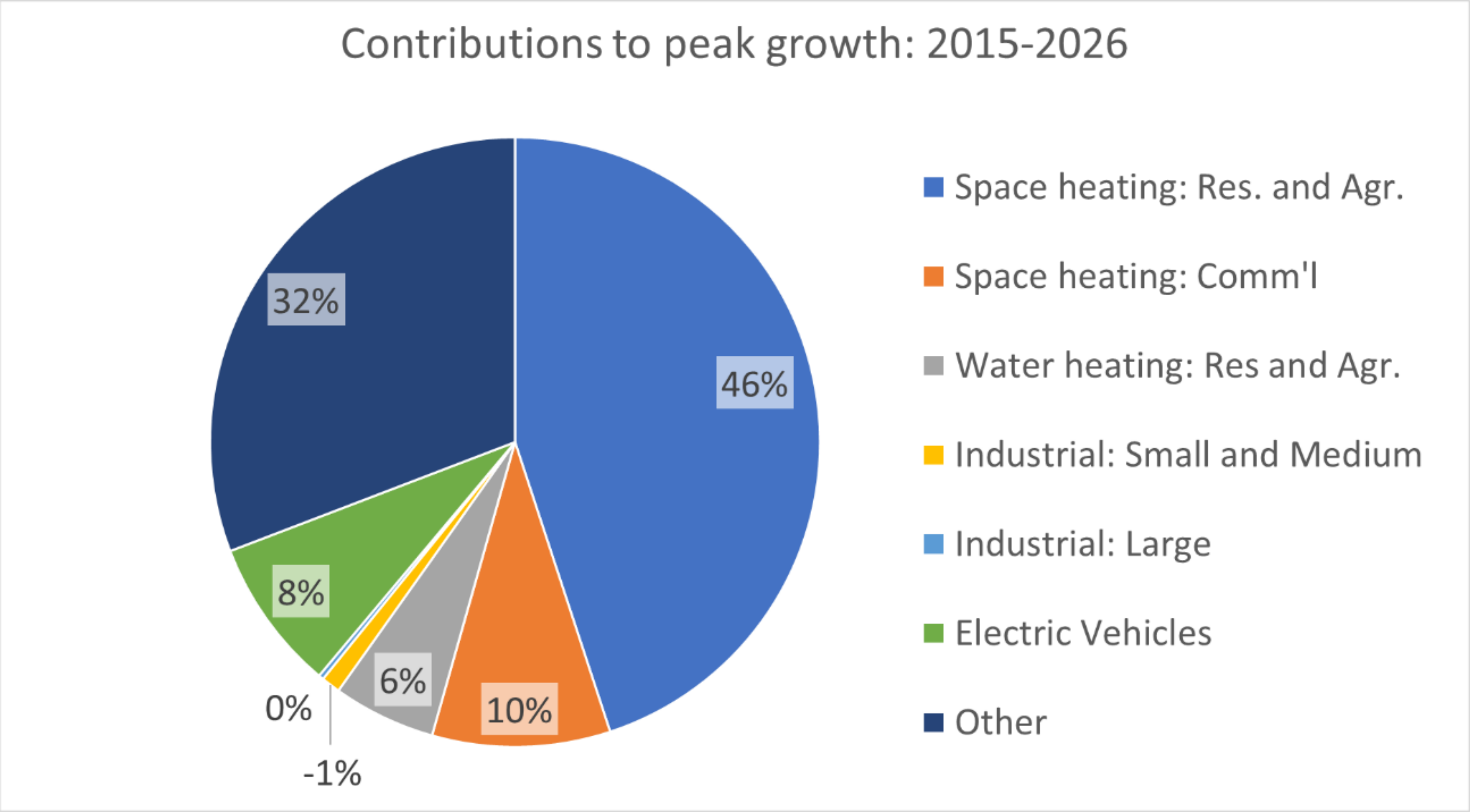
- Patrimonial supply plus long-term contracts (predominantly wind firmed with hydro)
- Exceeding the level of these long-term supplies can be expensive
- Load-duration curve for 2012-2015, along with bâtonnets and long-term contracts:



End uses contributing to winter peak

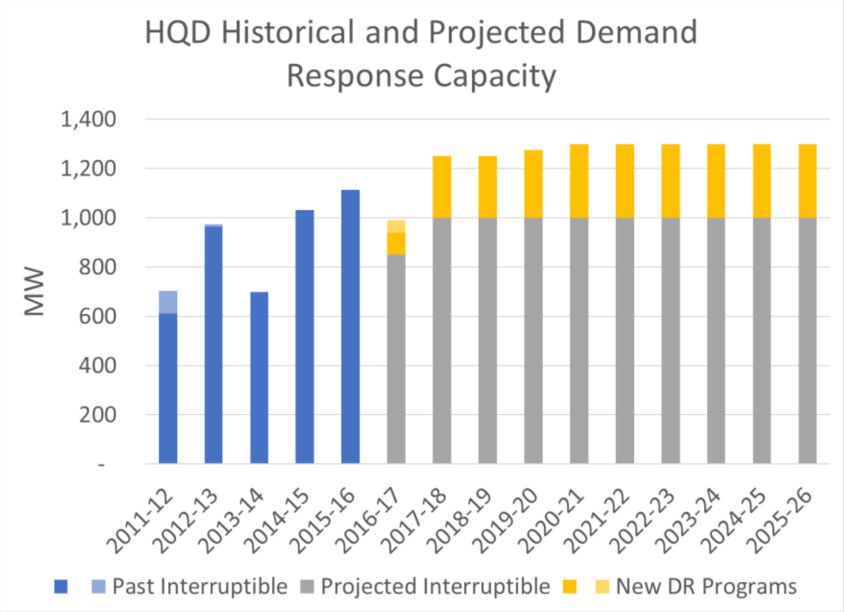


Winter peak growth, 2015-2026



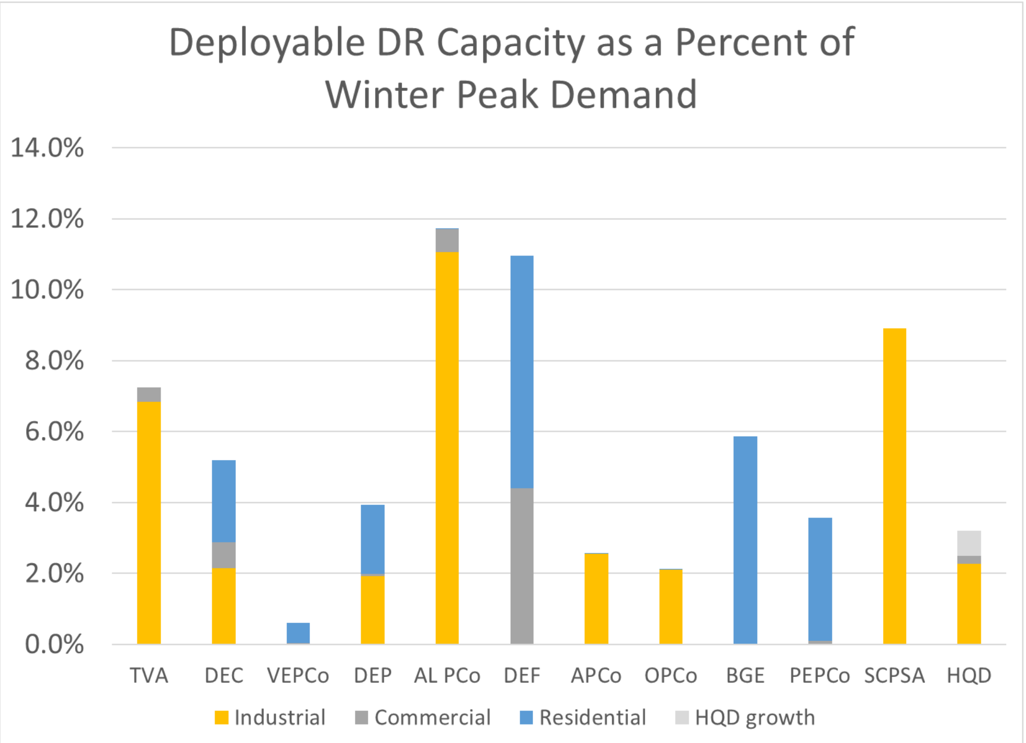
DR today and projected

- Hydro-Québec (HQD) has historically had a single class of DR programs, “interruptible electricity,” which has primarily enrolled industrial customers
- HQD has recently started a new program, “GDP Affaires,” which is intended to enroll commercial/institutional and additional industrial customers
- Other new DR programs in the plan include residential controlled or interruptible loads, but these have not been quantified and included in the projected resource



Comparison with other large utilities

- 11 large winter-peaking U.S. utilities have DR capacities between 0.6 percent and 11.7 percent of their winter peaks
- Utilities vary greatly in the sectors they harness for DR
- Weighted average cost of DR capacity is $47/kW



Wholesale market DR

- ISO New England:
  - Year-round resources required
  - Forward Capacity Market auction only
  - 2.7 percent of winter peak from 2015-16 through 2019-20
- Ontario:
  - 478 MW of winter DR cleared market auction
  - About 1 GW of industrial DR in addition
  - Nearly 7 percent of winter peak

Best practices

Distributors and system operators implementing demand response programs should:	Design programs appropriate for the jurisdiction's context and objectives
	Quantify the DR potential and develop a plan to meet it
	Take advantage of AMI, smart appliances, and other technologies
	Address a range of measures and sectors to identify and capture least-cost resources
	Effectively engage with customers and capture economies of scale with other customer engagement initiatives
	Continually assess costs and benefits and update both as circumstances change

Design for context

- Design DR programs to meet the system's particular needs
- Weather driven peaks: understand the relationship between weather and load
  - VT Weather Analytics Center combines next-gen weather forecasting with distributed energy resources (DER) and demand forecasts
- Don't run a program when it's not cost-effective
  - PA legislature required utility DR to address top 100 hours of load
  - But costs are really driven only by top 30 hours
  - 100-hour programs not cost-effective and risked exhausting customers
  - ***Result***: change the program

Potential and planning

- Take a long-term perspective to allow time for least-cost programs to scale
- Best practice parallels the process used in leading energy efficiency programs:
  - Identify the cost-effective and achievable potential
  - Consider the resource in the context of supply planning
  - Engage stakeholders
  - Plan to achieve the necessary and cost-effective resource

Planning in the Pacific Northwest

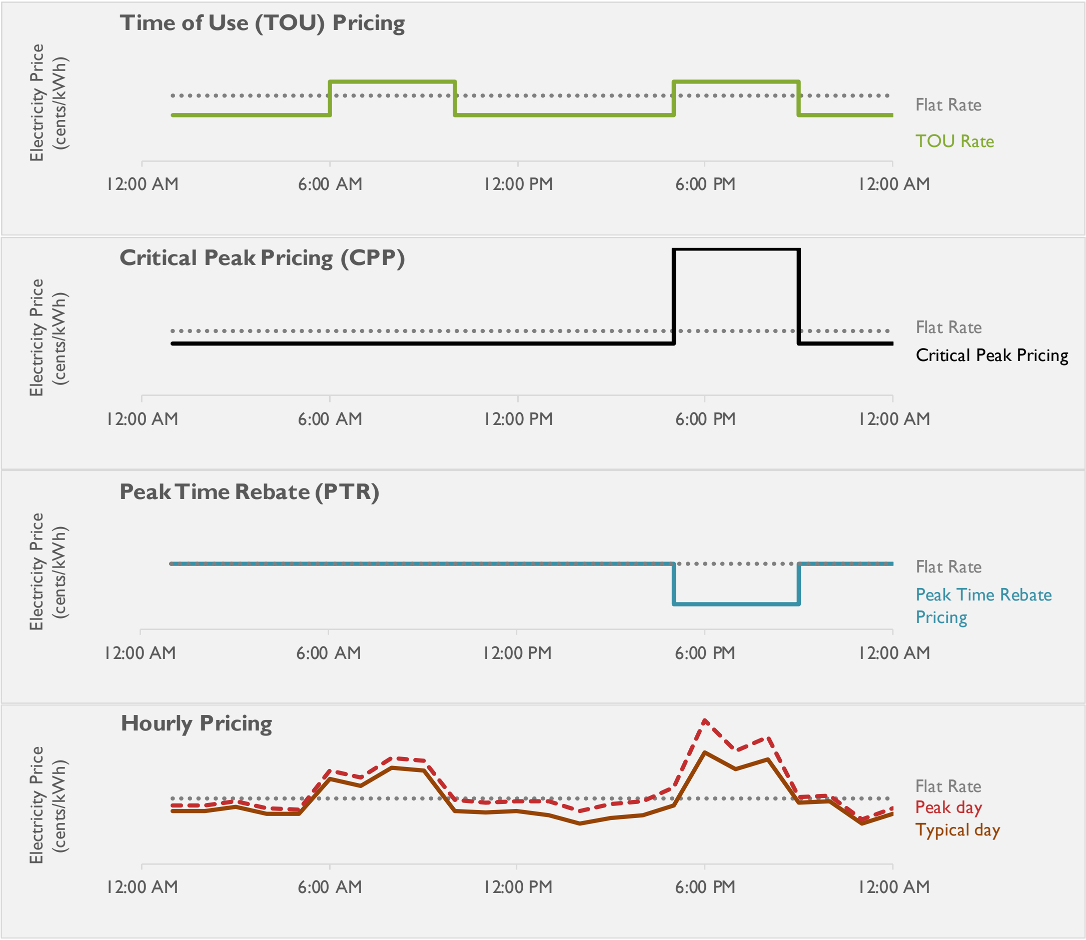
- Northwest Power and Conservation Council (NWPCC) coordinates regional energy and water resource planning with a very open stakeholder process
- Maximize use of hydro resource, integrate wind, and maintain healthy rivers
- 7th Power Plan (2015) process:
  - DR potential study (all sectors, “base” and “smart”)
  - 4,300 MW potential; 1,500 MW at less than $25/kW-year
  - NW Demand Response Project stakeholders reviewed the potential study
    - Plan establishes a formal DR Advisory Committee
  - In stochastic regional supply planning, NWPCC identified that 600 MW of additional DR is needed for least-cost capacity needs by 2021 in nearly all futures
    - Plan for this amount
  - NWPCC has to use “soft power” approach to hold utilities accountable for progress toward this goal
- Portland General Electric commissioned DR potential study in 2015, distinguishing technical from achievable potential and including AMI-enabled DR

Take advantage of technology

- Advanced metering infrastructure
    - Time-varying rates
- Networks and smart appliances/controls
- Technical standards
    - Universal Smart Network Access Port (USNAP)
    - OpenADR

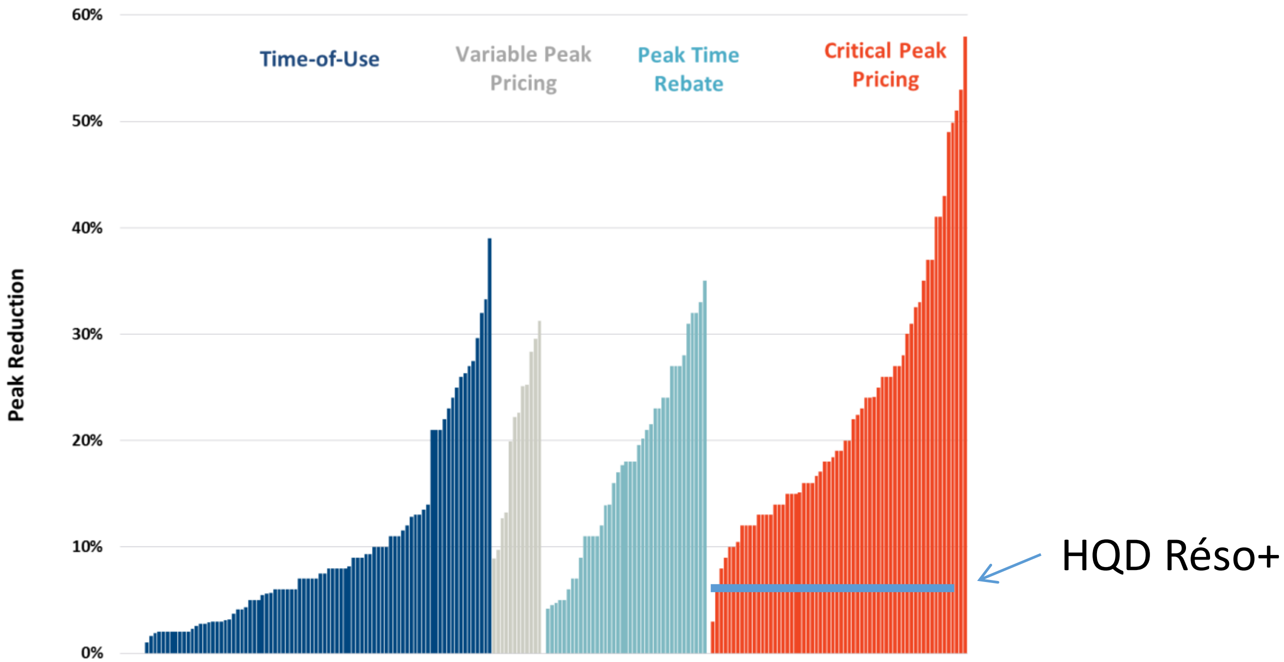
Time-varying rates

Some options enabled by AMI:



Time-varying rates

Observed peak impacts vary by the kind of rate used and across different utilities.



Source: Faruqui, Ahmad. "Arcturus." The Brattle Group

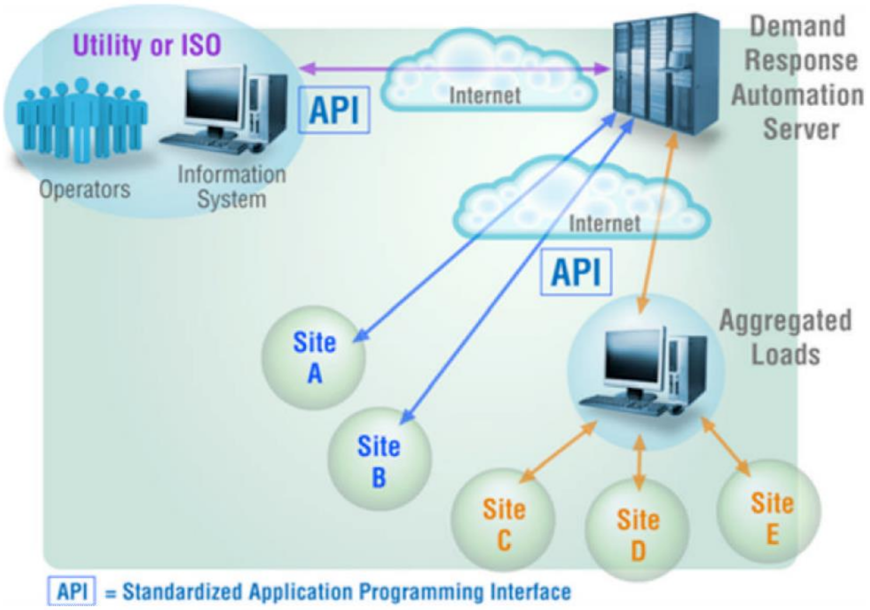
Baltimore Gas and Electric has the most extensive PTR deployment. It is now the default for their 1 million+ customers, and BGE bid the resulting capacity into wholesale markets.

Talking to smart appliances

- Home networks
  - Wifi thermostats can receive DR signals from the utility over the internet
  - Example: ConEd (New York City) offers rebate in exchange for two-year enrollment allowing utility thermostat control up to 10 times/year
- A standard for appliances: Universal Smart Network Access Port (USNAP)
  - Standard port with some market adoption
  - Vision: “USB for utility control of appliances”
  - Allows a manufacturer to build one appliance that can work with a variety of utility programs and technologies

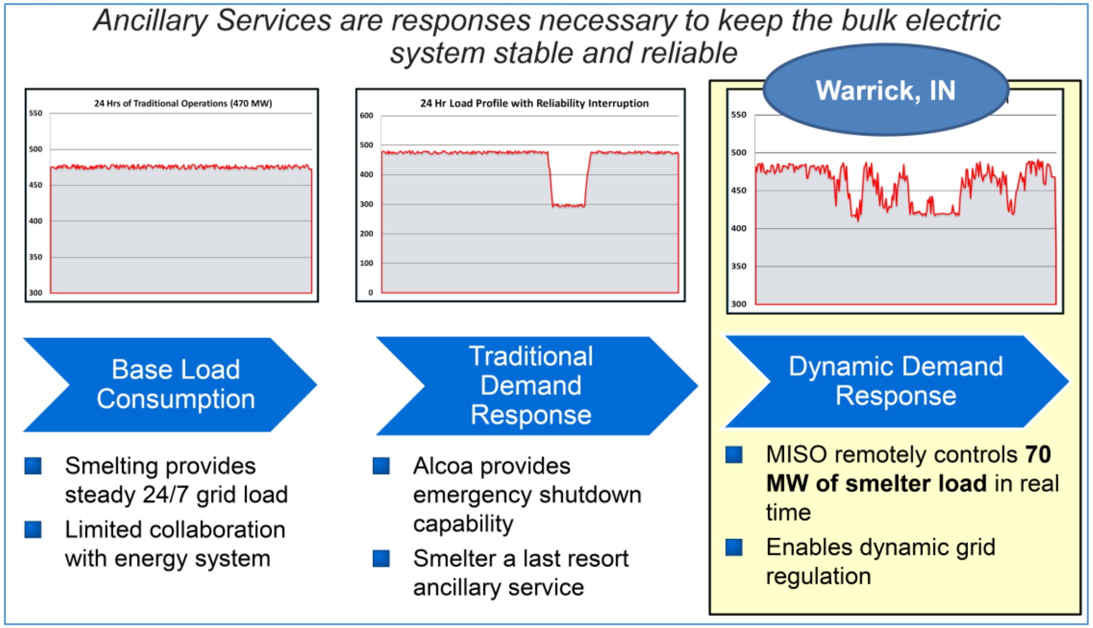
Automated DR communications

- OpenADR
  - Communication standard for automated demand response (Auto-DR)
  - Allows utility, aggregators, and loads to know they are all “talking the same language”
- Required for lighting and HVAC in large new construction in California



DR Measures

- Heating, ventilation, and air conditioning (HVAC)
  - Historically the province of direct load control
  - Smart thermostat programs (incl. “bring your own thermostat” options) rising
  - Utility adjusts the temp. setting or limits the % of time the system can run
- Interruptible loads
  - Evolving from historical role (emergency and peak DR only) to dynamic loads supplying ancillary services
  - Alcoa:



DR Measures: Water heating

- Thermal “battery” – time-shiftable load
- Range of dynamism:
  - Scheduled – planned load shape
  - One-way (individual or bulk)
  - Smart/two-way
- Great River Energy (Minnesota cooperative)
  - 665k customers
  - 200k participate in DR of some sort and 100k in water heater program
    - 67k in scheduled thermal storage: Electricity supplied only 11pm to 7am
    - 40k in peak shaving: Off for 5-7 hours when called
  - Four decades of consistent water heater programs
  - Customer engagement focused on new construction and equipment replacement
  - Two-way communication coming with AMI over the next decade
- Program implementers I talked to are not concerned about legionella

DR Measures: Electric storage

- Provides multiple sources of value
  - Host: reliability
  - Grid: regulation, capacity, capital deferral
- Implementation options include:
  - Utility-scale at substation level
  - Distributed behind-the-meter
- Green Mountain Power (Vermont):
  - Utility-owned and controlled Tesla PowerWalls, available to customers for daily fee
    - Or customers can buy and receive a monthly credit for utility controllability
  - Located at residences
  - Customer gets uninterruptible power (and integration with solar PV)
  - Utility can control battery at monthly and annual peaks

DR Measures: Electric vehicles

- Small load now, but one of the few end uses that could significantly drive up electric demand over the coming decades
- Storage/flexibility inherent in hardware
- But human systems need to be designed to harness that flexibility
  - *Behavior*: Set the car <u>not</u> to charge the moment you get home
  - *Pricing*: Send a price signal to favor low-cost times (and avoid peaks)
  - *Control (V1G)*: Utility communication to car or charger to curtail load when asked
  - *Vehicle-to-grid (V2G)*: Injection from the car into the grid upon request or in exchange for a price
- Programs may address fleets differently from individual owners
- Generally in pilot stages in leading EV markets: California, Europe

Customer engagement

- Behavioral DR
  - AMI enables measuring the impact of individualized appeals for reductions on peak days
  - Opower saw 3.4 percent effect in Glendale, CA
- Working with energy efficiency programs
  - Often EE programs are the home of utility engagement with customers on demand-related issues
  - Build DR into EE measure implementation (e.g., building or factory control systems)
- Aggregators
  - Can shift and customize the risk-reward balance for different customers
  - Have DR expertise that utilities may lack
  - Active in vertically integrated and wholesale market contexts

Cost-benefit analysis

- Reflect policy goals in choice of cost-effectiveness screening test and its components
  - Societal or utility perspective?
  - Include environmental externalities? Customer costs?
- Quantify avoided costs
  - Vary by deployment strategy, measure characteristics
- Take a longer-term perspective
  - Programs need time to ramp up
  - Customers make investments based on a program design
  - Average over volatility in markets

Application to Québec: Planning

- HQD has made strides by including in the Supply Plan the expected growth in current programs. It falls short in recognizing the impacts of additional programs over the coming decade.
- An improved planning approach could take a structure like this:
  - Conduct potential studies on a regular basis (e.g., every three years in preparation for the Supply Plan), including assessment of the *achievable* potential and of *avoided costs*.
  - Determine an appropriate fraction of the cost-effective DR resource to pursue in the long term, informed by the size of the utility's peak demand gap.
  - Identify a program portfolio that can cumulatively generate that amount of demand response, favoring programs that can ramp more quickly or whose impacts are more assured.
  - Taking into account the pace of program development and roll-out, map out the amount of demand response achievable in each year over the course of the Supply Plan and include that resource as the planned DR resource in the Supply Plan.
- The Régie should consider adopting a requirement for "all reasonably available cost-effective demand response" or a similar such goal.

Application to Québec: Planning

- Expect consistent planning between load and DR forecasts:
  - 189 MW of new peak load from EVs by 2026, but no projection of DR using that resource.
  - HQD should assess the potential and include all cost-effective EV demand response in the Supply Plan and then commit to developing the tools necessary to achieve that savings over the coming decade.
- Stochastic planning for supply might be particularly useful in the Québec context because of the impact of weather variability and the patrimonial supply construct.
  - Different DR strategies might, for example, enable more robust use of the patrimonial supply in the face of year-to-year load variability

Application to Québec: Avoided Costs

- Québec has a particularly complicated structure in which to calculate avoided costs.
- Designing demand response and other load control as tools to make the deviations from the patrimonial “bâtonnets” more predictable, and quantifying the benefits, will be a fascinating challenge.
- As load rises, the relationship between load and the patrimonial supply structure also changes, so avoided costs must be re-evaluated on a regular basis as part of the planning process.
- HQD should revise (and regularly update) its approach to calculating avoided costs to (a) account for the differences in avoided costs in relation to HQD’s peak hours and (b) enable calculation of customized avoided costs for different DR interventions.
- In order to best match DR potential with avoided costs, HQD may require more extensive data and models regarding the load shapes of different classes or sectors of customers than it currently possesses.

Application to Québec: Peak rates or rebates

- Interruptible load programs are effectively a kind of peak-time rebate.
  - Rates M, G-9, and L, as well as *GDP Affaires*
- Rate DT is a "temperature-peak" price rate, not a "grid-peak" price rate.
  - HQD is piloting utility signal and behavioral approaches
- CPP pilot (Réso+) showed 6 percent effect. This would be a 1 GW resource if it scaled to all residential and agricultural customers.
- Daily TOU rate is not justified.
- Peak-time rebate could harness the "behavioral" savings from the 2012 DR potential study and mitigate EV impacts.
- HQD should build on its 2008–2010 TOU and CPP pilot by testing new PTR or CPP programs, grounded in updated and more granular avoided costs.
  - If they prove promising and cost-effective, HQD should then introduce them as general opt-in or opt-out options to all customers.

Application to Québec

- Pilots to programs
  - HQD is developing or piloting a number of promising avenues for new DR programs or technologies
  - As these programs become ready to move from pilot to implementation, it is important that HQD move with all due haste to launch programs and capture the cost-effective potential.
  - Encourage HQD and the Régie to move the water heater program into implementation as quickly as possible, recognizing the role of other stakeholders.
  - To grow the resource, HQD should consider enlisting the assistance of third-party DR experts and aggregators.
- Use standards
  - HQD can shape and lead the market to adopt standards
  - Benefit from standards-compliant technologies developed elsewhere
  - Examples for consideration: USNAP into 3-element water heaters; integrate OpenADR into EE engagement with building and facility owners

Application to Québec: Engage customers

- Quantify impacts
  - Estimate the impacts of public appeals
  - As HQD expands its DR offerings, it should employ best practices in evaluation, measurement, and verification of programmatic impacts
- Couple with EE programs
  - HQD has improved its programs by including power management for winter peak as an eligible measure in its industrial retrofit EE program
  - HQD should build on this example and integrate DR into its other energy efficiency offerings where cost-effective opportunities exist

Application to Québec: Engage customers

- Flexible program design
  - More options for how to participate should increase participation
  - HQD has experienced this recently, with changes in the interruptible load program driving increased participation and giving HQD confidence that this program can grow from 850 MW to 1,000 MW
  - Encourage HQD to continue to diversify offerings or make them more flexible, especially for commercial and industrial customers
  - Aggregators:
    - Provide greater flexibility for customers while providing a structured service to HQD
    - Can combine smaller loads, increasing the size of the participant population
  - *GDP Affaires,* which has many of these characteristics, has been a success to date

Merci