Electricity in Vermont: A Quick Tour of a Few Recurring Issues

House Natural Resources and Energy Committee  January 2015

Regulatory Assistance Project
Major topics coming up

1. Evolution of industry structure in VT
2. Roles of the PSB and DPS
5. Managing Environmental Impacts
6. Rate Design Challenges
Vermont’s Power Sector

- Sales: $800 million
- GMP: 75%
- 14 Munis, 2 Co-ops
- Long history of consolidation
- There were at least 71 power and gas companies in 1912
Vermont power sector: Other important players

- VELCO
- NEPOOL, 1965 blackout – New England ISO
- Non-traditional suppliers: Qualifying Facilities (QFs) (aka “PURPA providers”);
- PV installers, net metering providers
Vermont power sources 2011

Vermont Own Load Electric Energy Supply, 2011

- System A: 12%
- System B: 8%
- Nuclear: 36%
- Hydro: 9%
- Gas & Oil: 1%
- Other Renewable: 3%
- HQ: 31%

Vermont Electric Utilities By Energy Source, 2011 (in MWh)
Committed Resources: Vermont Electric Utilities (in MWh)

Source(s): Vermont Electric utilities Integrated Resource Plans (selected), PSD
How to get low rates – inherit hydro or burn coal

Total Average Cost per Kilowatt hour
Average Rates 2001 -- Power Supply 2002
Source: US DOE Energy Information Administration

Cents/KWh

VT
PSB – Institutional Aspects

• Origins in legislative attempts to regulate railroads, then Railroad Commission
• “Public good” mandate across various regulated utilities (energy, water, telco, other)
• Quasi-judicial body, 3 Members with 6-year terms, screened by the Judicial Nominating Board
• Can open investigations on its own motion
• Can proceed via rulemakings, contested cases, or via informal proceedings (workshops, stakeholder dialogues, etc.)
Department of Public Service-Roles

– Executive Branch Utility Policy
– Statewide Planning
  • And data analysis
– Public Advocacy
  • With staff experts and billback authority
– Consumer Affairs (answering the 800-line)
– State Energy Office (liaison to US DOE)
– Safety
DPS and PSB assumed current structure in 1981 – Why?

Governor Snelling instigated the change. He wanted:

– Accountability for state’s positions in regulatory matters, as the state’s top elected official
  • Rather than a special council attorney making the decisions on how to represent the state
– Bring together key utility functions for synergies post Oil Embargo
– PSB would remain independent
Vermont Regulatory Model – compared to other places

- Independence – Connecticut, China
- Elected commissioners – several states
- Consumer advocate inside the PUC – CA
- Backwards on *ex parte* – California
- Lack of authority – most of Europe
- Need for interstate regulator – EU v. US
What to build, What to buy?

“We’ve been asking the question: ‘Given this price forecast, what should we invest in?’ The real question is, ‘Given that we don’t know what prices are, what should we invest in?’”

--Lee Raymond, CEO
Exxon-Mobil (WSJ 4-8-05)
Evolution of the Vermont power mix

- Early days – hydro and Village systems
- Fossil fuels critical for growth (Moran)
- Nuclear arrives
- Canadian hydropower
- Energy Efficiency and Renewables
- Natural Gas
- “Resource of the Decade”
Energy Mix Highlights over Time

Early days of power in Vermont:

- Hydroelectric in communities
- Fossil fuel combustion critical to extend power further
  – NY hydro
Nuclear and Canadian Hydro

Nuclear arrives in the 60s with Yankee Rowe

– And becomes dominant in the 70s with Vermont Yankee
  • Helped Vermont ride through price spikes from oil embargoes of the 70s

Canadian Hydroelectric arrives in the 1970s

– Long connection with northern tier
– Matches VY for dominance with state’s Hydro-Quebec contract starting in 1985
Evolution of IRP and Efficiency in VT

• 1970s, ’80s:
  – Rising fuel prices (NE had significant oil-fired capacity)
  – Nuclear cost over-runs
  – Dissatisfaction with ex post prudence reviews
  – Flawed utility planning and poor risk management
  – Growing recognition of EE as a resource

• Mid-1980s:
  – Imminent need for new power resources
  – Recognition that §248 did not require a full IRP analysis of proposed investments/contracts
IRP and EE as a Resource

• Docket 5270 opened 2/88; Order issued 4/90
  – Required all utilities to engage in IRP and to implement programs to acquire all cost-effective EE resources, as identified by the IRP
  – IRPs to be reviewed and approved by PSB
  – Prescribed ratemaking treatment for adverse financial impacts on utilities from EE
    • Potential rewards for superior performance

• Early to mid-1990s
  – Utility EE performance varied
IRP and EE in Industry Restructuring

• 1995-96: Restructuring debate
  – Docket 5854: Report to Legislature
  – Who should deliver EE in a restructured industry?
    • PSB concluded 3\textsuperscript{rd}-party “energy efficiency utility”
      – Not government: political and budgetary entanglements
      – Not distribution utilities, given performance to date and the large number of small companies
      – 3\textsuperscript{rd} party EEU: State-wide single purpose entity
Efficiency Vermont

• 1997-1999: Docket 5980
  – 2½-year investigation
  – Board order establishment of EVT in 9/99

• 2000: EVT established
  – Performance-based contract, since morphed into performance-based franchise
Renewables, IPPs

– McNeil wood-chip generation
– PURPA and the independent power producers
  • Creative approaches by PSB and DPS
– Some utility hydro (Bolton Falls)
– Net metering
– Searsburg – notable utility-built wind project
– Hydro-Québec
– Modern wind systems
Natural Gas for Electricity

--Significant supplier of electric energy in New England

– Roughly 40% of electricity in New England is generated by natural gas

– Even though Vermont gets little electricity from these sources, natural gas remains an important backbone for the grid in which Vermont sits
The sweep of history

• Things change -- “resource of the decade”
• A Hydro and Fossil based power sector evolves to one dominated by natural gas regionally
• With nuclear power still important
• While wind and solar are growing exponentially, but remain a small fraction
• Economies of scale drove bigger plants for decades; this is now turning around
• And energy efficiency is lowering costs and minimizing supply risk
NYPA Power
Importance, we fought for it, we lost

- NYPA power is sold at cost, not at market price
  - Why? Sources are federal projects commissioned by Congress with guidance on allocation
  - Cost is very low today
  - Genesis of VELCO

- NY municipals found legal argument to take over the power Vermont had received for almost 30 years

- Today small amount of NYPA power goes only to Vt munis/coops
Searsburg

• First significant utility owned wind generation in the US in recent years
• Result of 14 years of project development effort
• Good experiment in how to “do” wind
Net Metering

• Vermont among early adopters
• Simple for consumers to use
• Industry developed promptly
  – Exponential growth, energy fraction still small
• Innovation to include farms, and groups
• Utilities learning to plan for customer generation
Connecticut River Hydro Redux

• As part of electric policy choices in Massachusetts, the owner of the Connecticut River dams put them up for sale
• They were bought by a Canadian company
• Vermont could have competed for these assets
Feed-in Tariff

• PURPA QFs were Vermont first experiment with setting a price and offering a long-term commitment to encourage renewables
• Vermont rebooted the idea by creating technology-specific contract prices for qualifying renewable forms (solar, wind, wood, etc.)
  – Greater than avoided cost?
• Room for improvement to introduce market oriented features to the feed-in tariff
Modern Wind Projects

• On Vermont scale, these provide significant energy
• Ridgelines allocated to wind is controversial
• Renewable energy credits valuable in southern New England (deliverability important)
• SPEED program also a factor
  – SPEED is an economic development initiative
  – VT utilities sell the attributes and can no longer claim them
    • Proceeds benefit ratepayers
Regional Natural Gas Dependency

• 40% of New England electricity produced by natural gas generation – alarm?
• Price volatility
• Reliability rules allow gas generators to claim capacity credit in the capacity market without firm gas supply or firm back up fuel
  – Result: “Gas versus Gas” competition = when there is a cold snap, primary heating demand spikes, not enough gas for all the gas generators, some generators suddenly unavailable when needed most
ISO-New England: Paying for Reliability

• How does the region support reliability?
• Companies own supply resources
• Transmission links can improve reliability
• Demand side also supports reliability
ISO-New England: Paying for Reliability

• What if the right answer to a reliability problem is an incremental dose of EE, DR, DG?
• FERC will not order ISO-NE to pay for the non-transmission solution(s)
  – Practice calls for cost of transmission solutions (not others) to be shared across all New England
• As a result, the region pays more for the line
• As this happens over and over, cost-effective solutions are bypassed for more costly and intrusive solutions
ISO-New England: Paying for Reliability

• Vermont policy on this is clear
• ISO-NE practice should be changed
• All substitutes should be eligible for ISO-NE tariff support, best set wins
• VELCO argues for this in ISO-NE governance
• More states would need to see how this raises costs for all and can be changed with consensus among states, which is lacking now
History Lessons – Recurring Resource Battles

- Hydro and public power battles since the 1920s
- Churchill Falls vs. Vermont Yankee
- Seabrook, Millstone, and the era of nuclear cost overruns
- NYPA and the DPS role in power sales
- Hydro Quebec, HVDC line, and utility contracts
History Lessons (2)
Challenges of today’s resource choices

• Searsburg and utility-scale wind
• PV and net metering
• Diversity as an issue – the challenge of too much gas-fired power
• ISO New England’s transmission expansion process; socializing reliability
Managing Environmental Impacts

• Siting: what is the relationship between Act 250 and Section 248?
• Side visit: no jurisdiction over interstate pipelines; (Champlain Pipeline)
• Application of environmental criteria to purchases as well (Hydro Quebec)
• “Light touch” review for small renewable projects
• Climate change [comes later]
Rate Design

• Vermont’s commitment to cost-based rates
  – Application of the general principle that the cost-causer should pay
  – Cost allocation among customer classes is fair, with no subsidies

• Seasonal rates
  – Why we did it, why we are glad we did, and why we removed them
  – Inherent winners and losers; a demonstration of the dilemmas facing decision-makers

• Block rates
  – DPS NYPA power
  – Inclining, declining
Rate Design

- Time-varying rates
- “Public interest” rate proposals
  - Economic development rates (new jobs vs. existing jobs)
  - Schools and hospitals
  - Low-income households
- Surcharges
- Fuel-adjustment clauses: why not and why
Major topics remaining

1. Climate change and the power sector –
   (1) RGGI and carbon revenue recycling

2. Climate change and the power sector –
   (2) Integrating renewables and the role of
   Demand Response

3. Reprise – some leading legislative
   actions in Vermont
Climate Change and the Power Sector –
(1) The logic of carbon revenue recycling
Daily Climate News -

Everything Awful
Oh God Somebody Do Something
Power Sector Contribution to Global GHG Emissions

51 Gt CO$_2$e in 2010

- 24% Power Sector
- 7% Buildings
- 14% Transport
- 3% Waste
- 14% Forestry
- 18% Industry and Cement
- 13% Agriculture
- 7% Petroleum and Gas
Carbon prices/taxes alone will deliver only a part of the abatement needed. Programs needed to surmount market barriers include:

- Abatement cost (€ per tCO₂e)
  - Building envelope - package 2, residential
  - Energy efficiency - Other Industry
  - LDV Gasoline plugging hybrid
  - Efficiency package - new build, residential
  - LDV diesel bundle 4
  - Bioethanol sugarcane
  - Lighting - controls - retrofit, commercial
  - Building envelope - retrofit, commercial
  - Appliances - residential
  - Lighting - switch incandescent to LEDs, residential

Carbon price most effective:
- Wind low penetration
- Degraded Forest Reforestation
- Organic soils restoration
- Pastureland Afforestation

More support needed to deploy new technology:
- Biomass CCS new built
- Solar PV
- Solar CSP
- Coal CCS new built

EU-27 GHG abatement cost curve beyond BAU – 2030
Where do power sector reductions actually come from?

4 main possibilities:
- Reduce **consumption**
- **Re-dispatch** the existing fleet and/or
- **Shut down** high-carbon units
- Lower the emission profile of **new generation** (including repowering)

For each opportunity, ask:

1. How many tons will it avoid?
2. How much will it cost society *(or, cost consumers per ton)*?
3. What tools – including what kind of carbon caps -- get the best results on #1 & #2?
Challenge#1: It’s hard to affect demand (enough) with carbon prices alone

- To decarbonise power while adding electric transport, BAU demand must be reduced by about 40% by 2050
- Demand for electricity is relatively inelastic
- Long-term price-elasticity of demand is about -0.2 to -0.3. (A +10% increase in price yields a 2% to 3% decrease in demand)
- BUT: the income-elasticity of demand is positive (as incomes rise, so does demand)
- What price increase would be needed to turn load growth negative in a Europe with rising incomes and modern economies?
Challenge #2: Carbon prices to generators can increase wholesale power prices with little effect on dispatch or emissions
Carbon price Can Raise Prices without Changing Dispatch or Emissions
- Dispatch depends on ‘gas Vs coal’ price & CO2 €

![Diagram showing the impact of CO2 emissions on market prices and net revenues.](image-url)
**“High cost tons” in the US context**

Study by PJM – the largest wholesale power market in the US

<table>
<thead>
<tr>
<th></th>
<th>Carbon @ $20</th>
<th>Carbon @ $40</th>
<th>Carbon @ $60</th>
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</thead>
<tbody>
<tr>
<td>Power price increase per MWh</td>
<td>$15/MWh</td>
<td>$30/MWh</td>
<td>$45/MWh</td>
</tr>
<tr>
<td>Total consumer cost increase</td>
<td>$12 billion per year</td>
<td>$24 billion per year</td>
<td>$36 billion per year</td>
</tr>
<tr>
<td>Number of tonnes reduced via redispatch</td>
<td>14 MT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consumer cost per tonne reduced</td>
<td>$850 /tonne</td>
<td>$348/tonne</td>
<td>$1440/tonne</td>
</tr>
<tr>
<td>Multiple of carbon price</td>
<td>&gt;40 times</td>
<td>&gt;8 times</td>
<td></td>
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</tbody>
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## “High cost tonnes” in EU power markets

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Carbon price 20 Euros</th>
<th>Carbon price 40 Euros</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Event/Result</strong></td>
<td><strong>No demand response</strong></td>
<td><strong>Price-elasticity -.2</strong></td>
</tr>
<tr>
<td>(a) Power price increase</td>
<td>€ 10.9 /MWh</td>
<td>€ 23.2 /MHz</td>
</tr>
<tr>
<td>(b) Total sales</td>
<td>3016 TWh</td>
<td>2881 TWh</td>
</tr>
<tr>
<td>(c) Total Cost increase</td>
<td>€ 33 Billion</td>
<td>€ 66.8 Billion</td>
</tr>
<tr>
<td>(d) Emission reduction</td>
<td>133 Mt (all due to redispach)</td>
<td>363 Mt (165 Mt from dispatch, 198 Mt from demand response)</td>
</tr>
<tr>
<td>(e) Consumer cost per tonne reduced</td>
<td>€ 248 per tonne</td>
<td>€ 184 per tonne</td>
</tr>
</tbody>
</table>

Source: Sijm, et al, The Impact of the EU ETS on Electricity Prices, Final Report to DG Environment, December 2008 (ECN-E-08-007)

[Row (e) is a RAP calculation based on Tables in the report, as shown.]
Efficiency Programmes Save 9x More Carbon Per Consumer GBP Than Carbon Taxes Or Prices

Cumulative CO₂ Emissions Saved by: Increasing Rates 3%; and Increasing Rates 3% to Fund Energy Efficiency (UK Example)

- Cumulative carbon dioxide emissions saved with 3% rise in rates to fund energy efficiency (Mtons)
- Cumulative carbon dioxide emissions saved with 3% rise in rates only (Mtons)

Cumulative CO₂ emissions avoided from raising rates 3% and funding EE, 2006-2020: **59.8 million tons**

Cumulative CO₂ emissions avoided from raising rates 3%, 2006-2020: **6.8 million tons**
Carbon Revenue Recycling: Carbon revenues are a powerful tool to leverage carbon price

- Key idea: Sell allowances, invest carbon revenue in low-cost carbon reduction -- especially EE
- **Northeast US: 9 RGGI states** now dedicate >80% of allowance value to clean energy (~55% to EE)
- **Even with low (~$3/ton) CO2 prices**, RGGI has raised over $500 Million for EE programs – avoiding CO2 at a cost of (minus) $-73 per ton!
- **So far**: Adding $1.6 Billion to the regional economy, and supporting 16,000 new jobs
- Political lesson: RGGI renewed 2013, cap lowered
- **Germany, France, Czech Republic** – have programs and/or plans to invest substantial carbon revenues in EE
Climate change and the power sector (2): Integrating renewables
The Challenge of Renewables’ Variability

Net demand = gross demand minus demand effectively served by low-marginal-cost, variable RES supply. <Southern UK 2030 w 28% PV & wind>
Traditional DR: Peak Shaving

Source: www.ijenko.com
Challenge #3: Variable Renewable Power --
Net demand is more volatile than overall demand, and lacks a repeatable daily pattern.

A challenging week for West Connect, USA, assuming 35% wind penetration.
“If a problem cannot be solved, enlarge it”
-- Dwight Eisenhower
Low-Tech Storage: Water Heaters Can Provide Rapid Response Frequency Regulation

PJM pilot water heater -- January 14, 2011; Midnight to 3:00 a.m.

- PJM Frequency Regulation Signal
- Water heater power consumption +/- 2.25 Kw base point
Demand Response via Thermal Storage

Electric resistance water heater demonstrates low-cost water heating using day-ahead LMP while responding to the PJM frequency regulation signal.

Operational Details
• 105 gallon, dual element electric resistance
• “Power” 4.5 kW, Energy 26 kWh
Finale: Recent Legislative Milestones

• Balance between legislative policy-making and inappropriate detailed interventions
• Some leading modern examples:
  • Least-cost utility planning
  • All-fuels charge and weatherization
  • Decision not to adopt retail competition
  • Creation of the Efficiency Utility
  • SPEED and Net Metering
  • Alternative regulation
  • RGGI and “carbon revenue recycling”
U.S. Utility EE Program Spending Now Over $7 Billion/Year and Still Growing

Note: 1993 - 2008 represents spending; 2009 represents spending among CEE members reporting to CEE; 2010 and 2011 represent budgets of CEE members reporting to CEE; 2015 and 2020 represent LBNL "high case" projections
Questions?