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

House Natural Resources and Energy Committee January 2015

Regulatory Assistance Project

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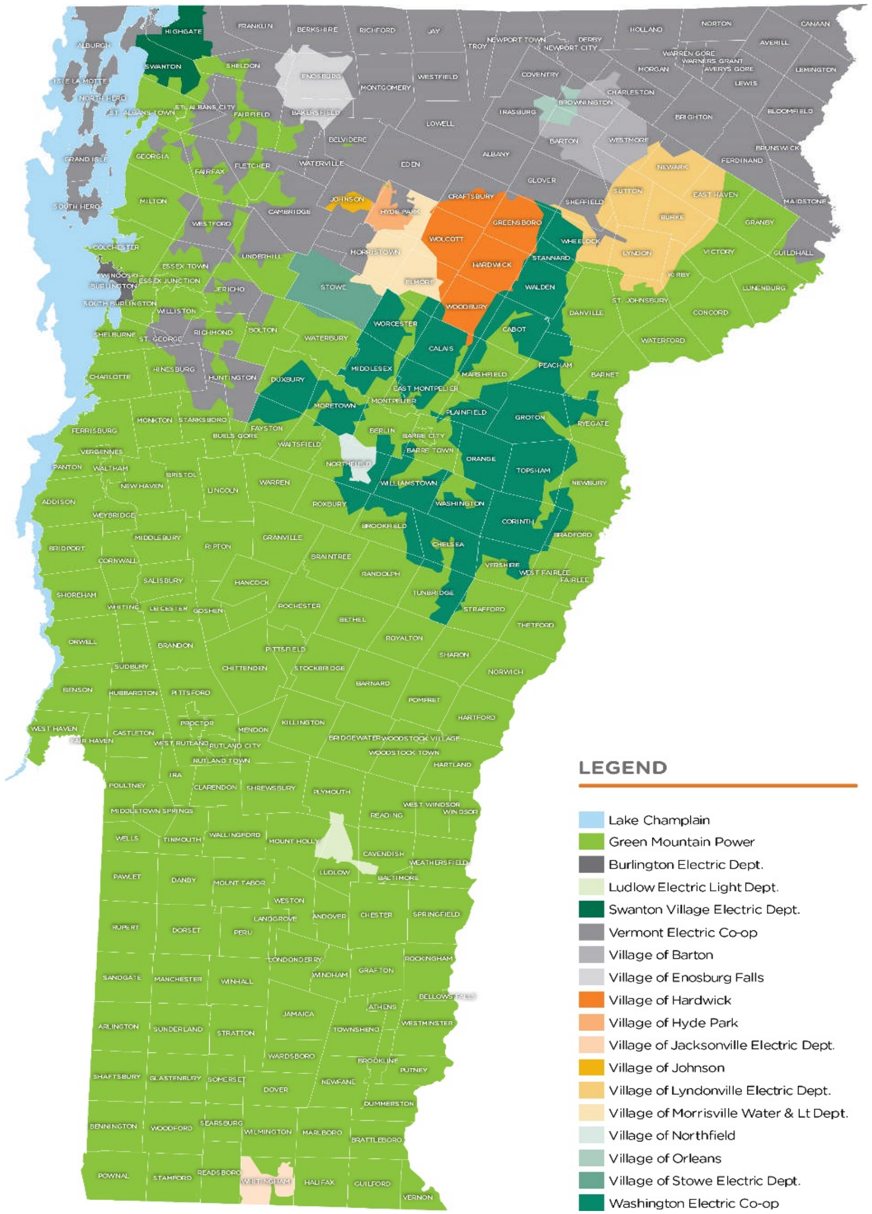
Major topics coming up

1. Evolution of industry structure in VT
2. Roles of the PSB and DPS
3. What to Build, What to Buy? – Recurring Resource Battles
4. Transmission & ISO- New England
5. Managing Environmental Impacts
6. Rate Design Challenges

Vermont’s Power Sector

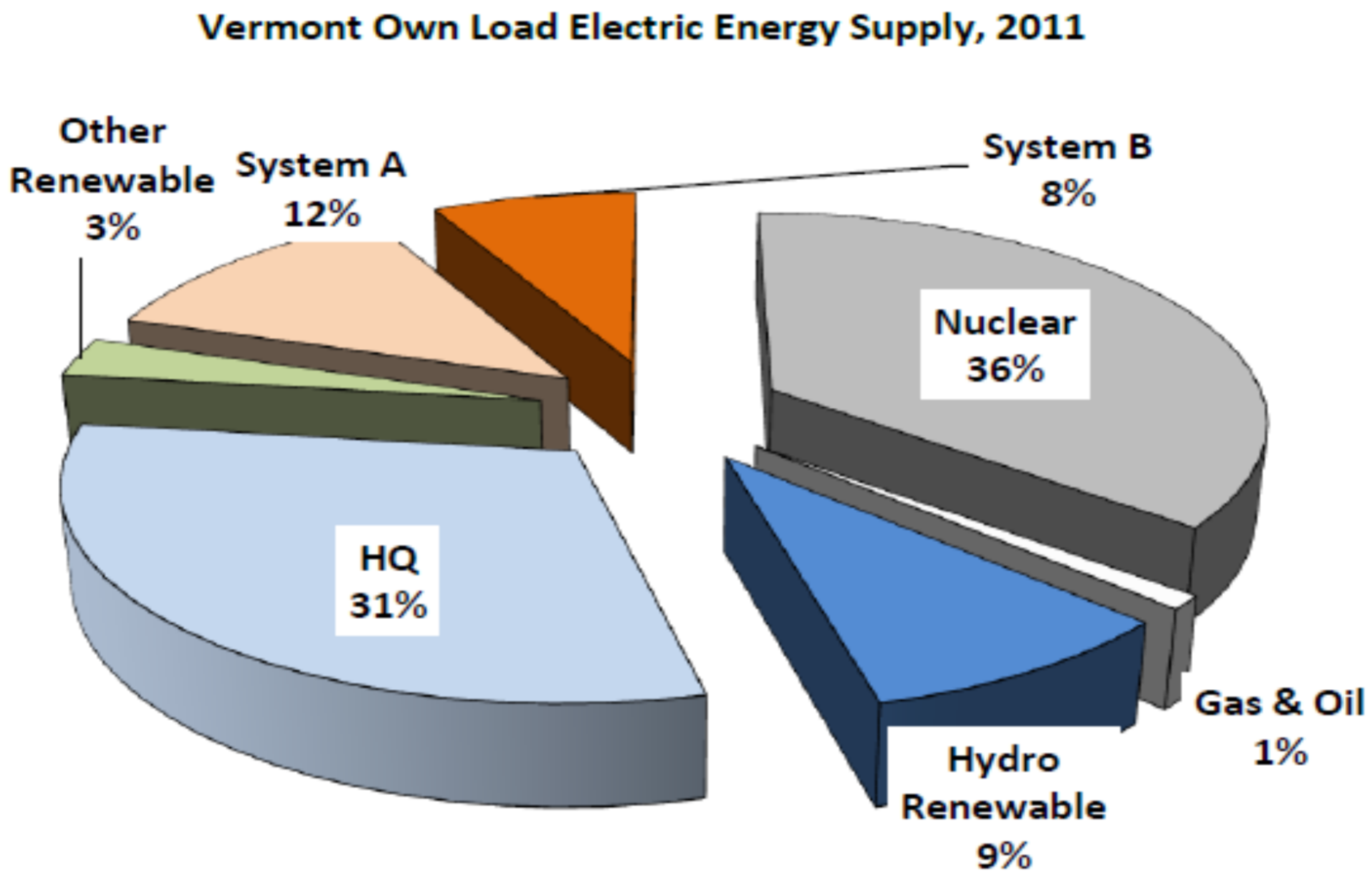
- Sales: $800 million
- GMP: 75%
- 14 Munis, 2 Co-ops
- Long history of consolidation
- There were at least 71 power and gas companies in 1912



Vermont power sector: Other important players

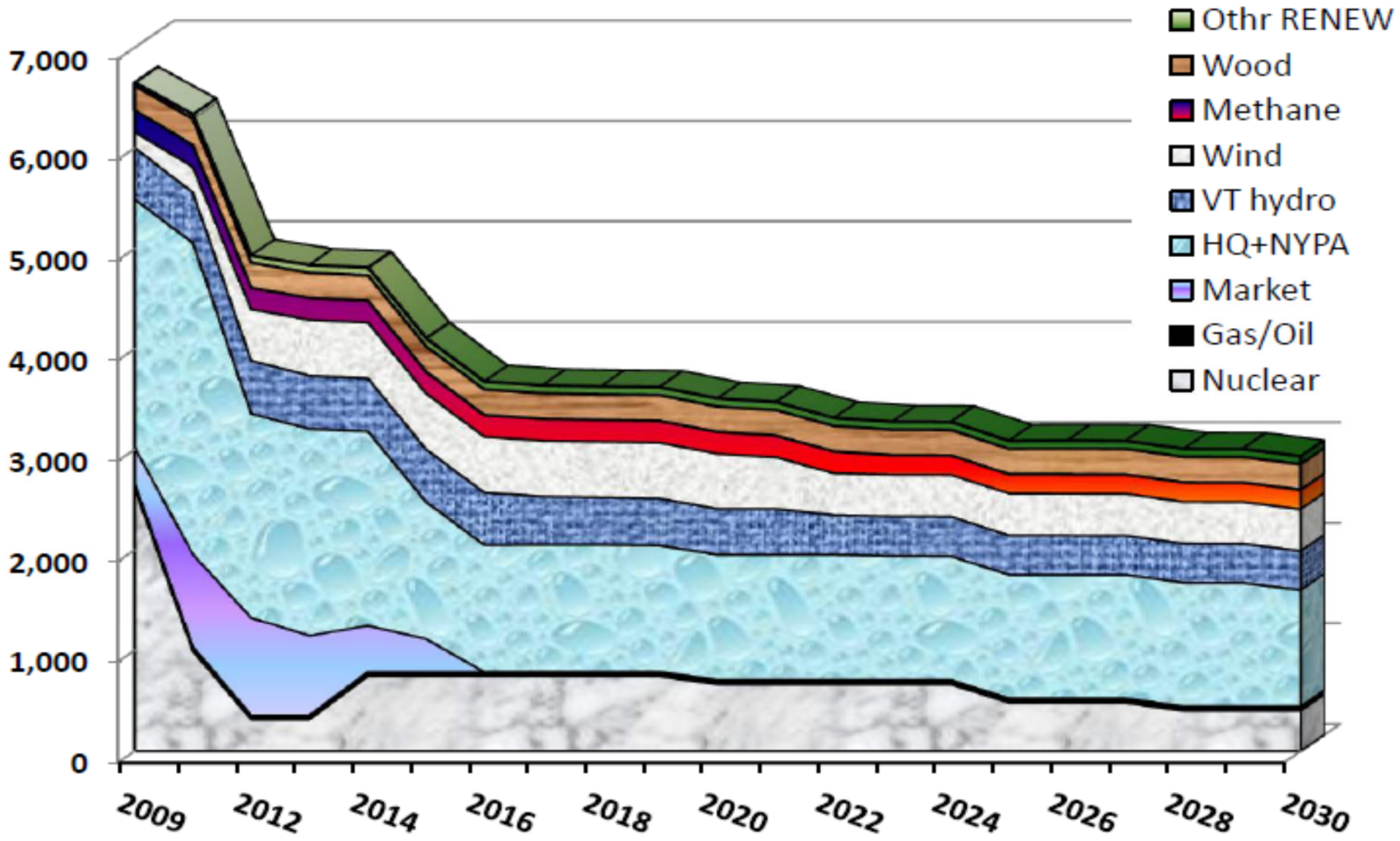
- VELCO
- NEPOOL, 1965 blackout – New England ISO
- Non-traditional suppliers: Qualifying Facilities (QFs) (aka "PURPA providers");
- PV installers, net metering providers

Vermont power sources 2011



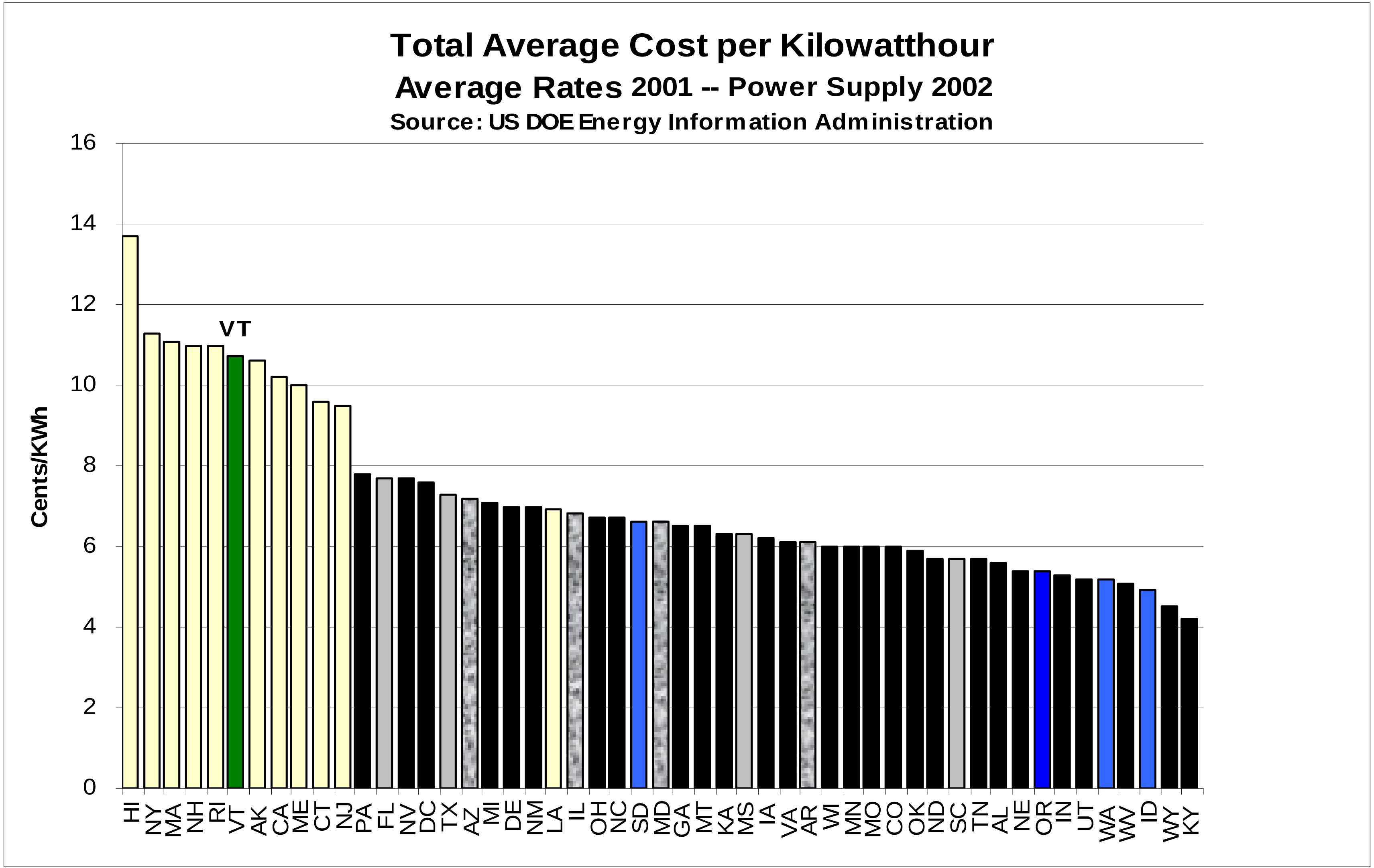
Vermont Electric Utilities By Energy Source, 2011 (in MWh)

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



Energy solutions
for a changing world

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

Energy solutions
for a changing world

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 3rd-party "energy efficiency utility"
      - Not government: political and budgetary entanglements
      - Not distribution utilities, given performance to date and the large number of small companies
      - 3rd 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

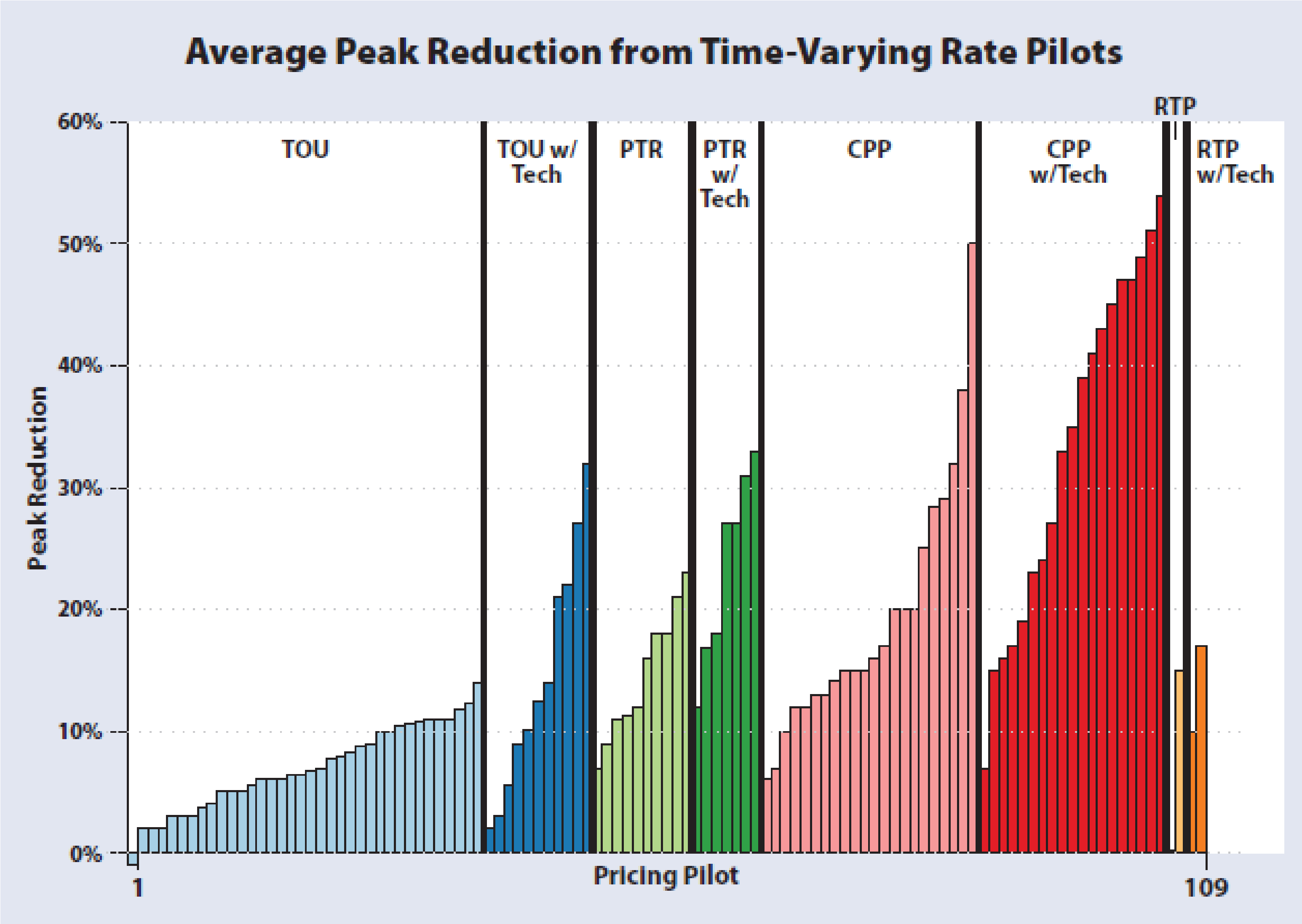
- Siting: what is the relationship between Act 250 and Section 248?
- Side visit: no jurisdiction over interstate pipelines; (Champlain Pipeline)
- Application of environmental criteria to purchases as well (Hydro Quebec)
- "Light touch" review for small renewable projects
- Climate change [comes later]

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



Source: Faruqui, *et al.* (2012). *Time-Varying and Dynamic Rate Design*. Montpelier, VT: RAP.

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**

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Climate Change and the Power Sector –

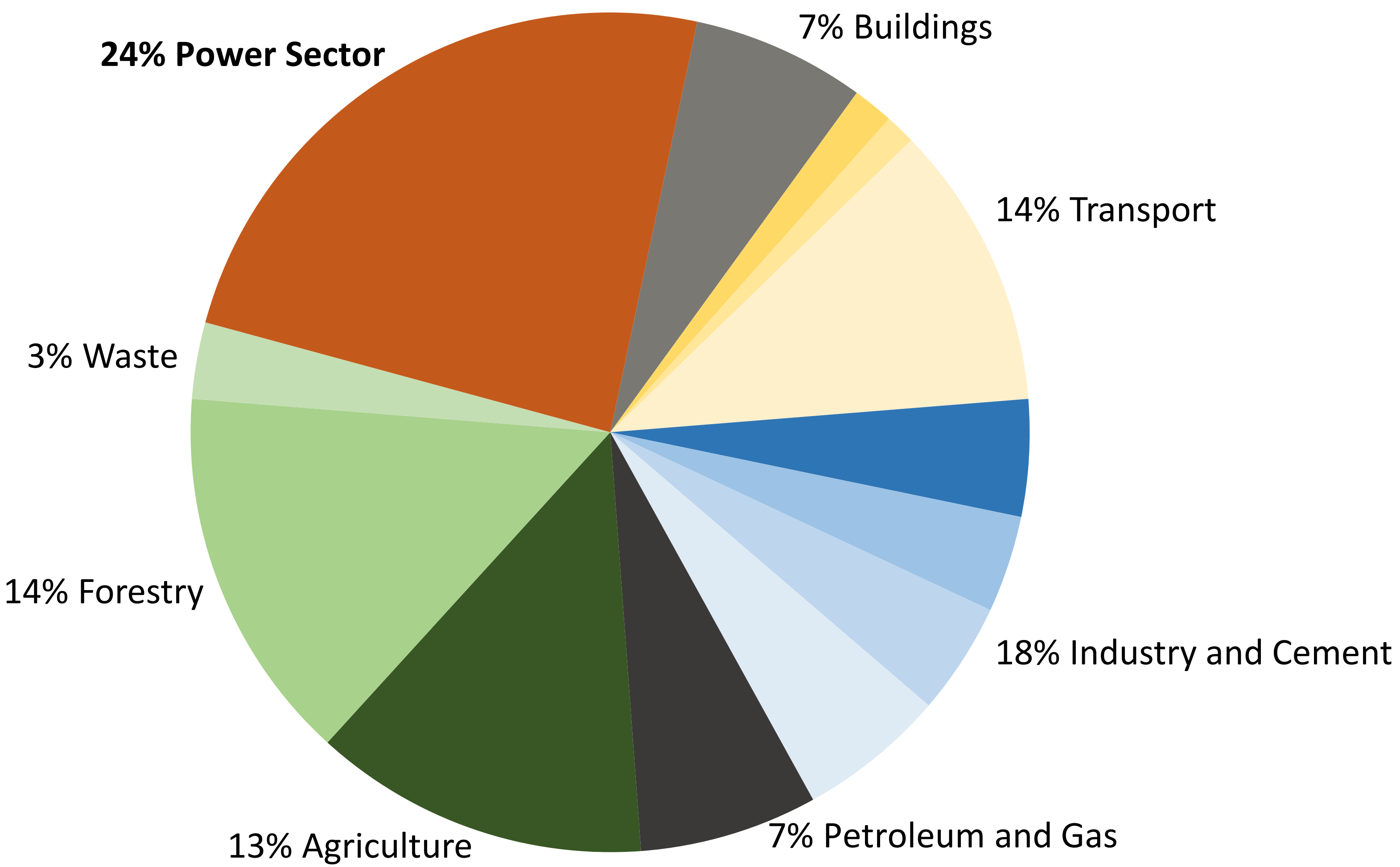
(1) The logic of carbon revenue recycling

Daily Climate News -

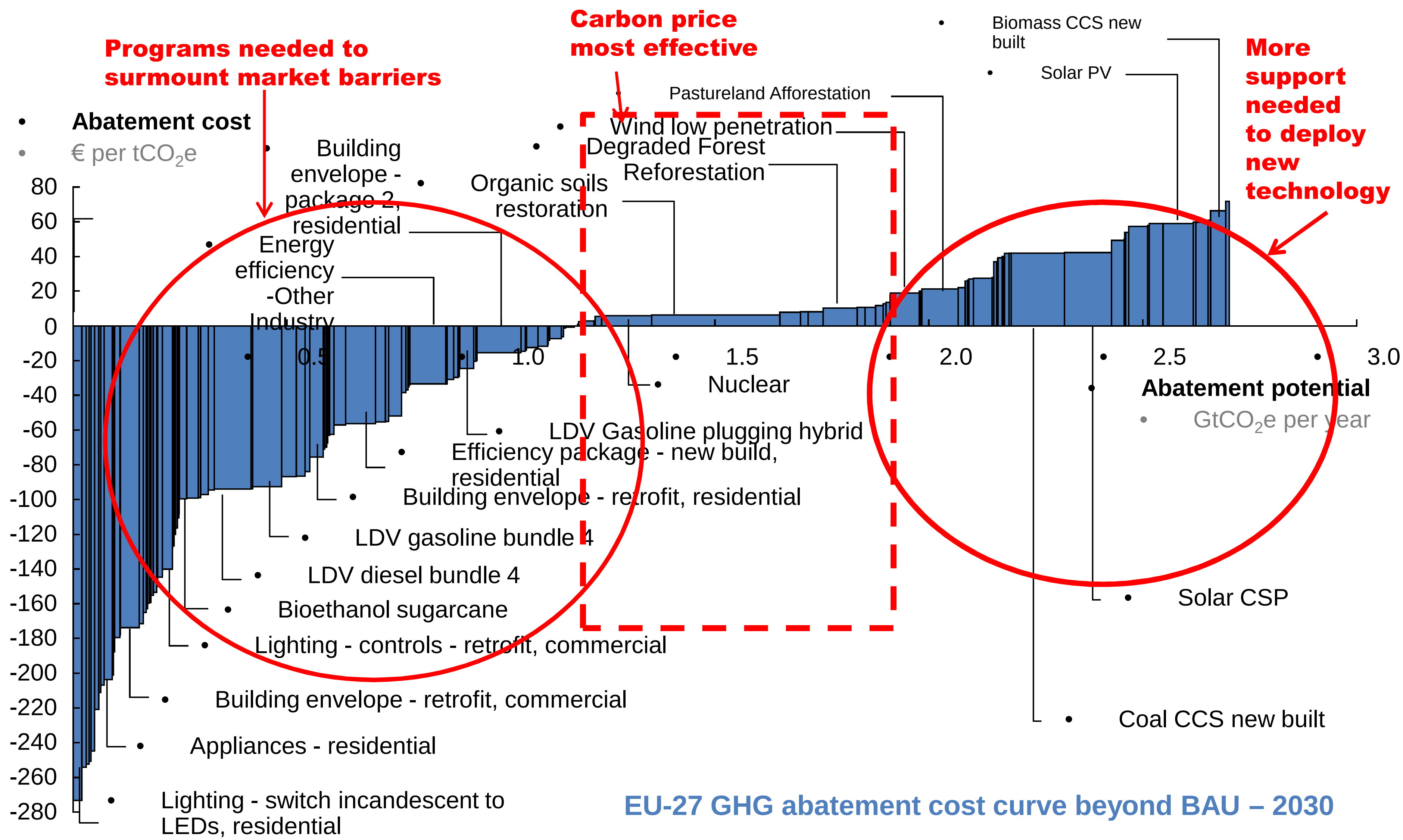
Energy solutions
for a changing world

Power Sector Contribution to Global GHG Emissions

51 Gt CO_2e in 2010



Carbon prices/taxes alone will deliver only a part of the abatement needed



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)

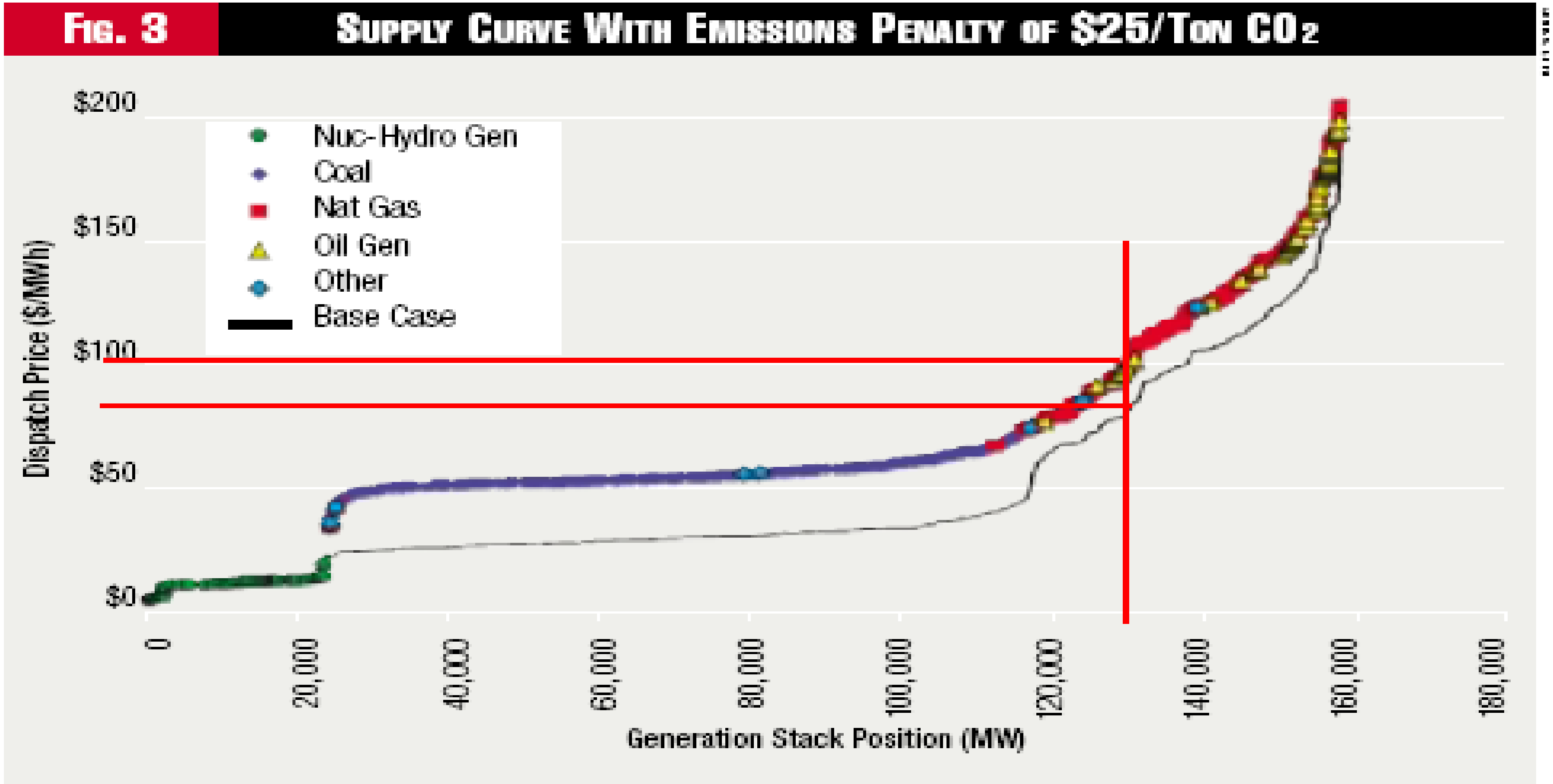
For each opportunity, ask:

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 ?

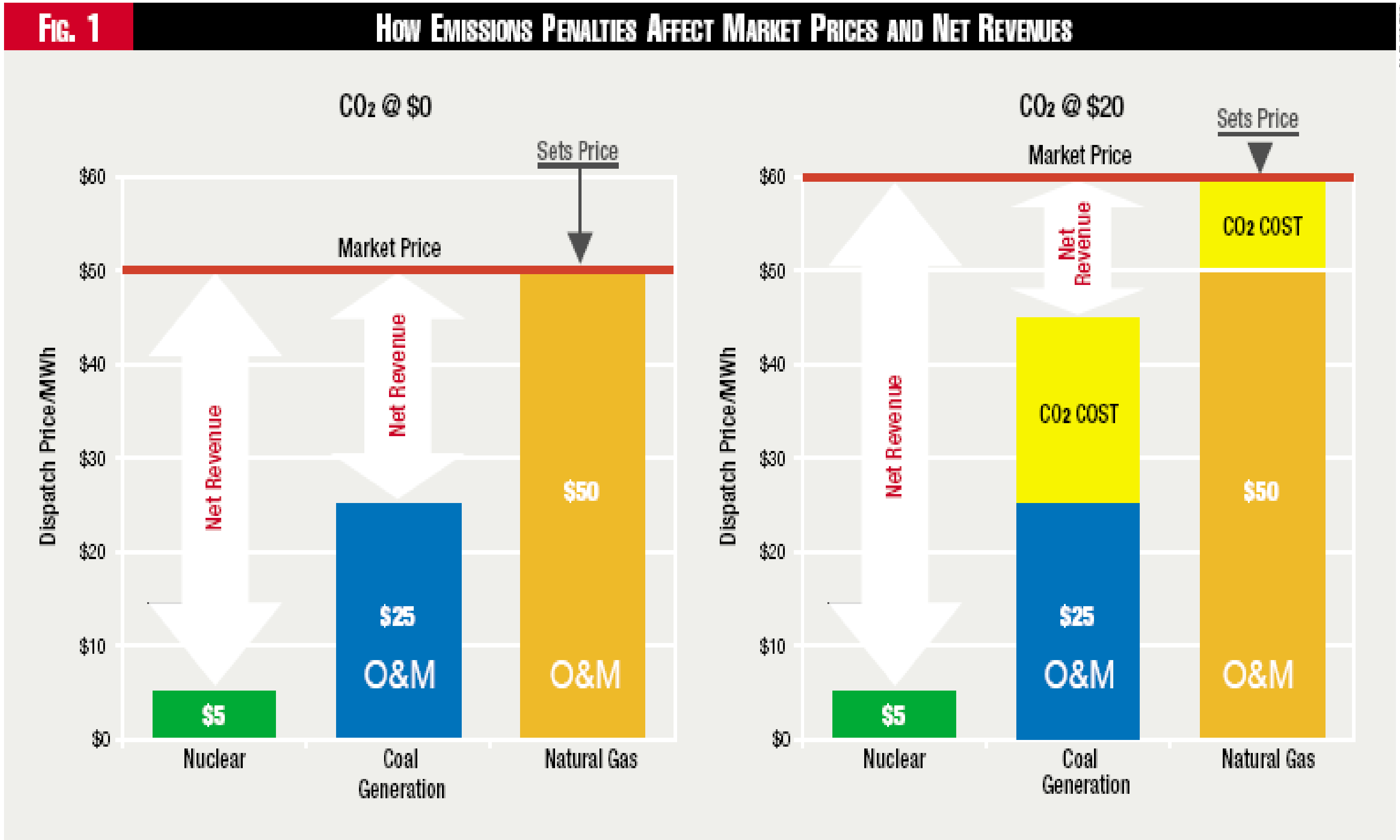
Challenge#1: It's hard to affect demand (enough) with carbon prices alone

- 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 & CO_2 €



Source: "The Change in Profit Climate" -- Public Utilities Fortnightly May 2007 --Victor Niemeyer, EPRI

"High cost tons" in the US context

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

	Carbon @ $20	Carbon @ $40	Carbon @ $60
Power price increase per MWh	$15/MWh	$30/MWh	$45/MWh
Total consumer cost increase	$12 billion Per year	$24 billion per year	$36 billion per year
Number of tonnes reduced via redispatch	14 MT		
Consumer cost per tonne reduced	$850 /tonne	$348/tonne	$1440/tonne
Multiple of carbon price	>40 times	>8 times	

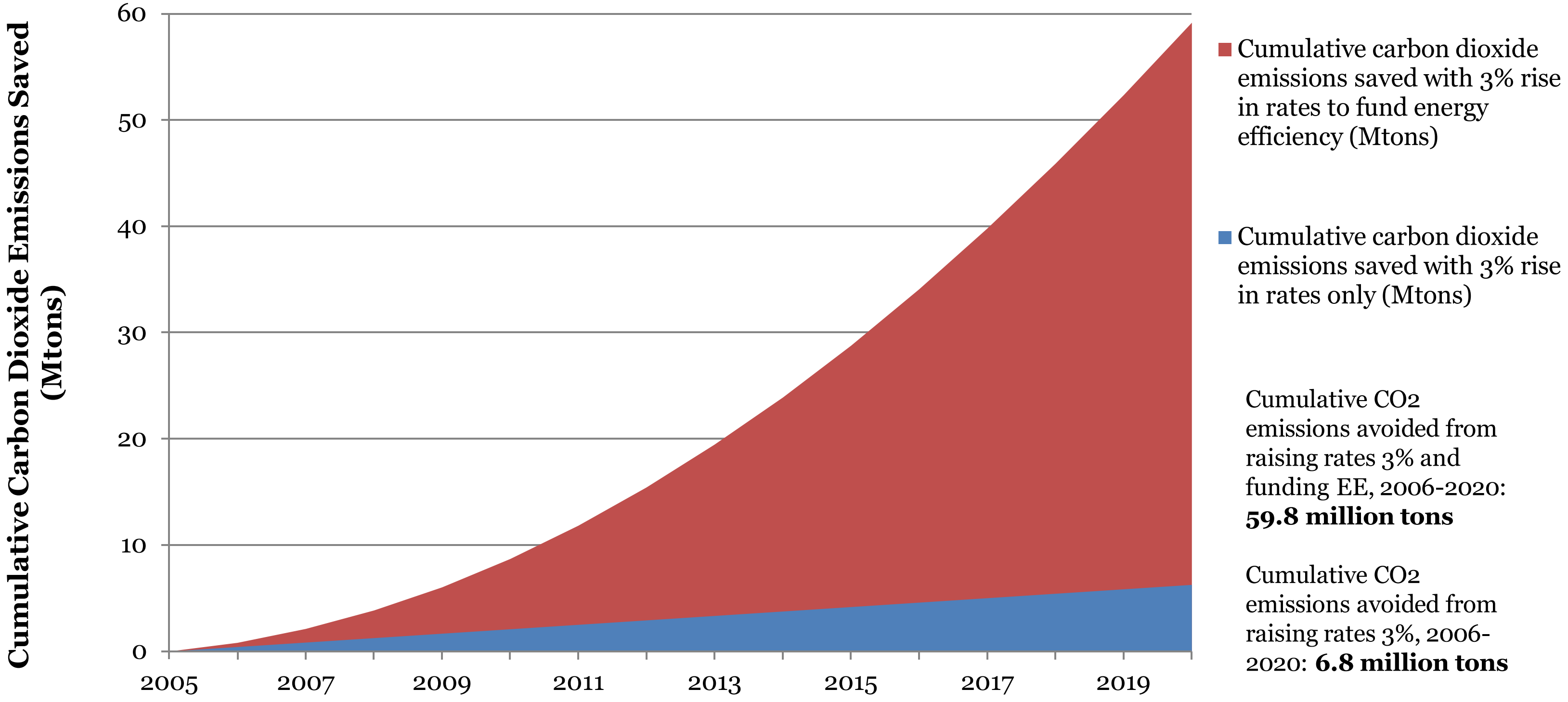
"High cost tonnes" in EU power markets

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

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 CO_2 Emissions Saved by: Increasing Rates 3%; and Increasing Rates 3% to Fund Energy Efficiency (UK Example)

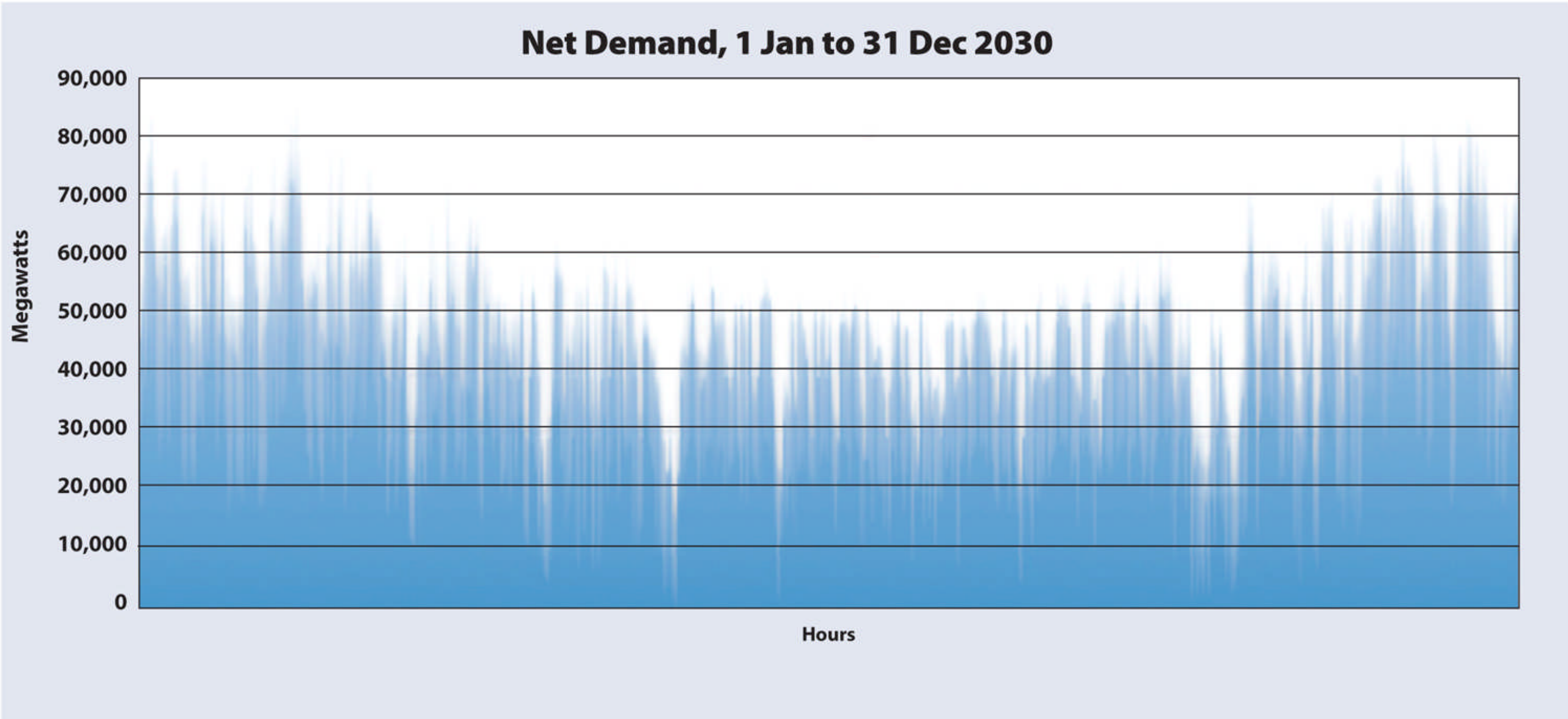


Carbon Revenue Recycling: Carbon revenues are a powerful tool to leverage carbon price

- 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) CO_2 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

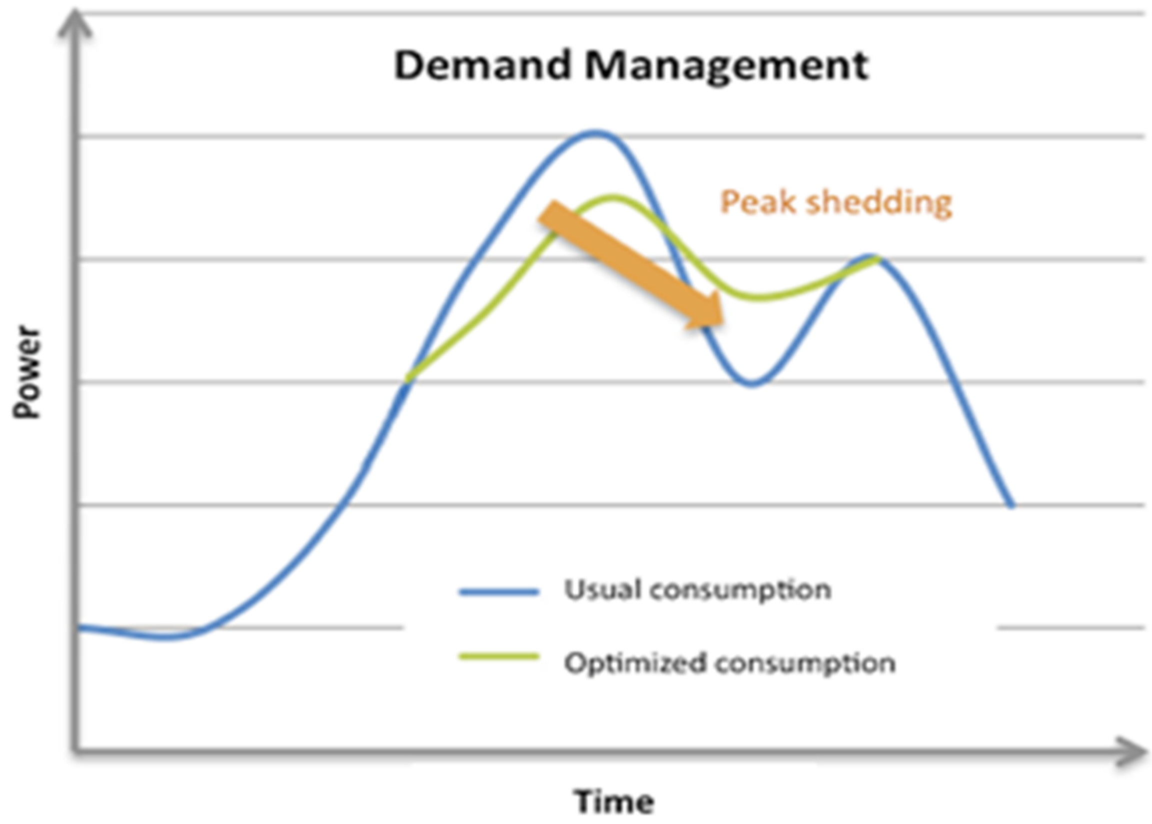
Climate change and the power sector (2): Integrating renewables

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>

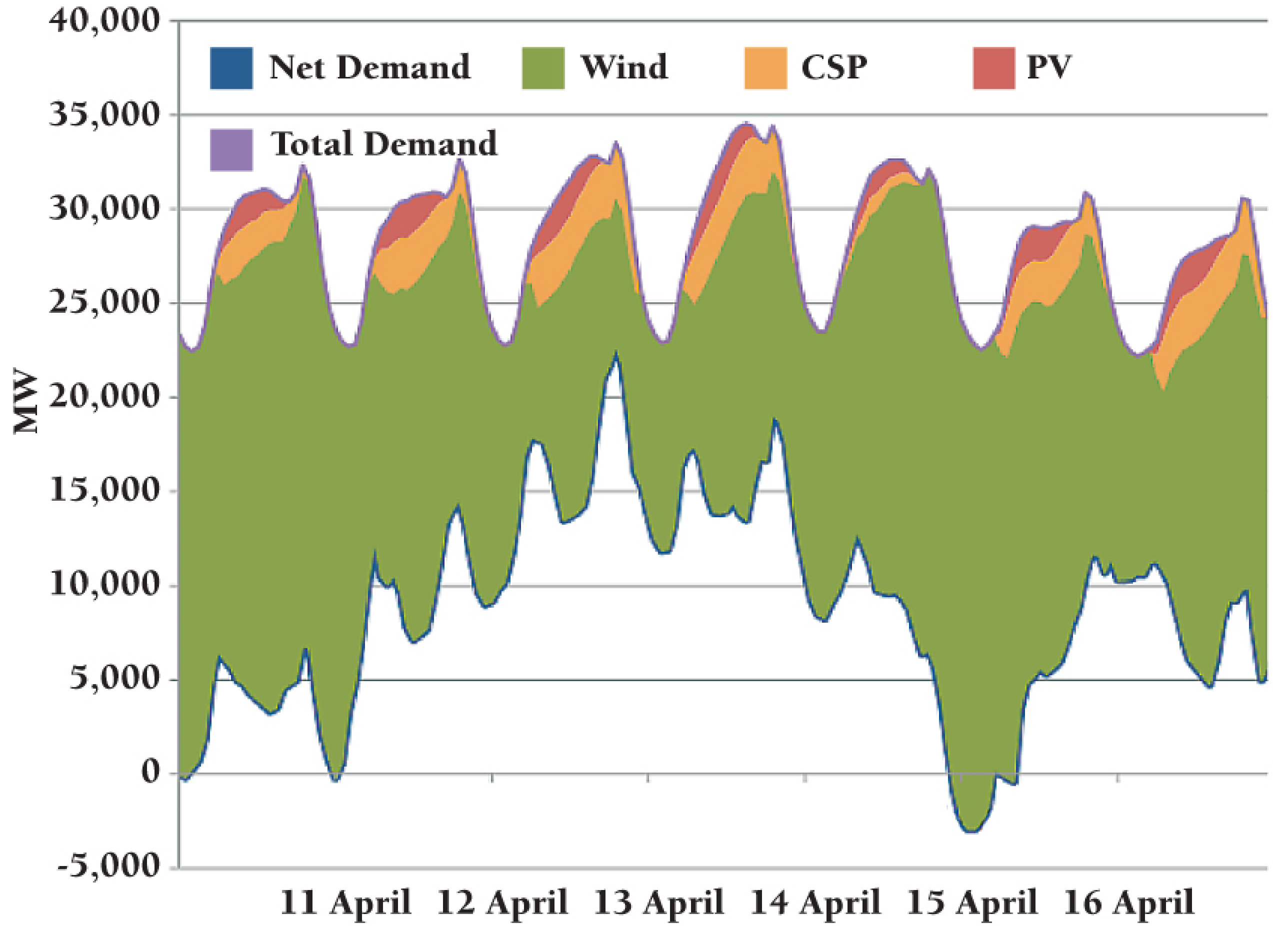
Traditional DR: Peak Shaving



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



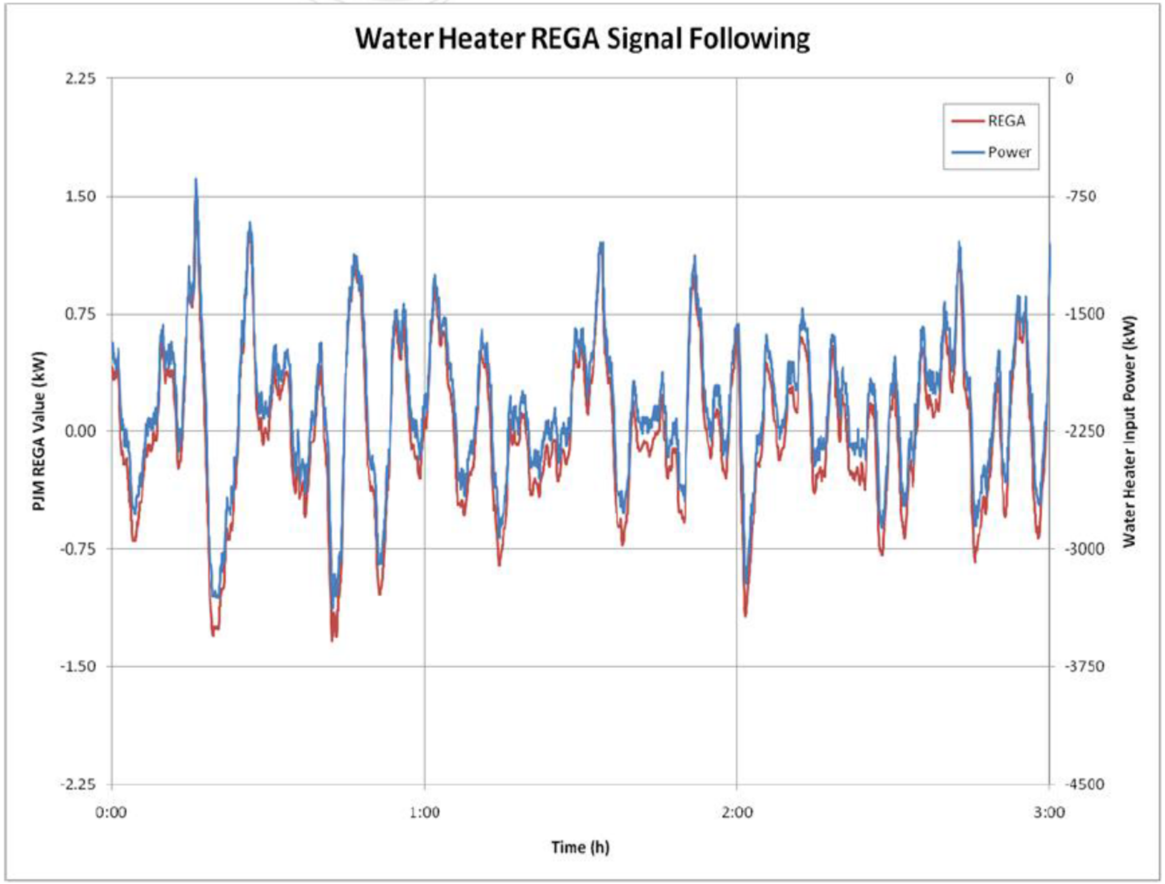
“If a problem cannot be solved, enlarge it”
-- Dwight Eisenhower

Low-Tech Storage: Water Heaters Can Provide Rapid Response Frequency Regulation

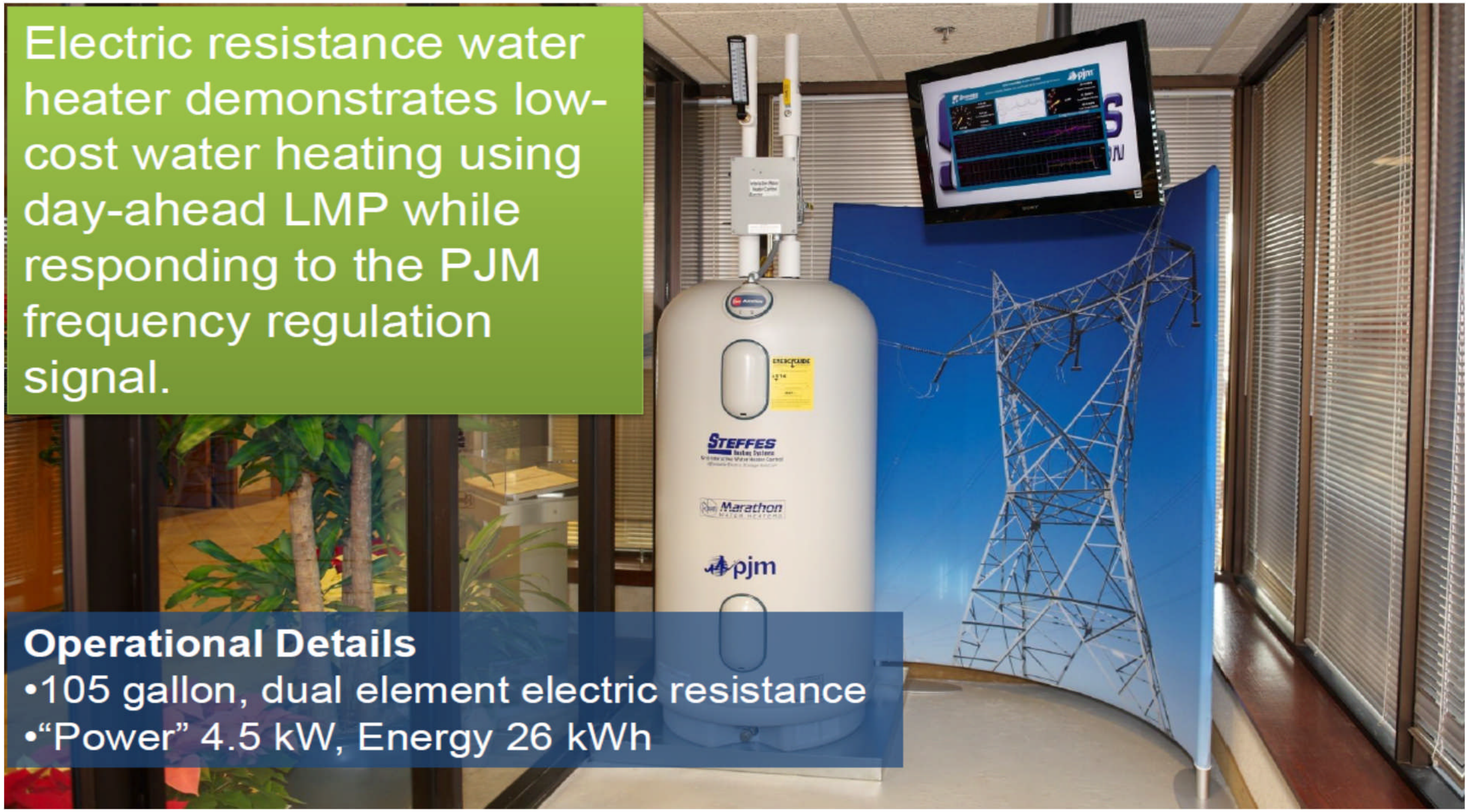
PJM pilot water heater -- January 14, 2011; Midnight to 3:00 a.m.

- 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.

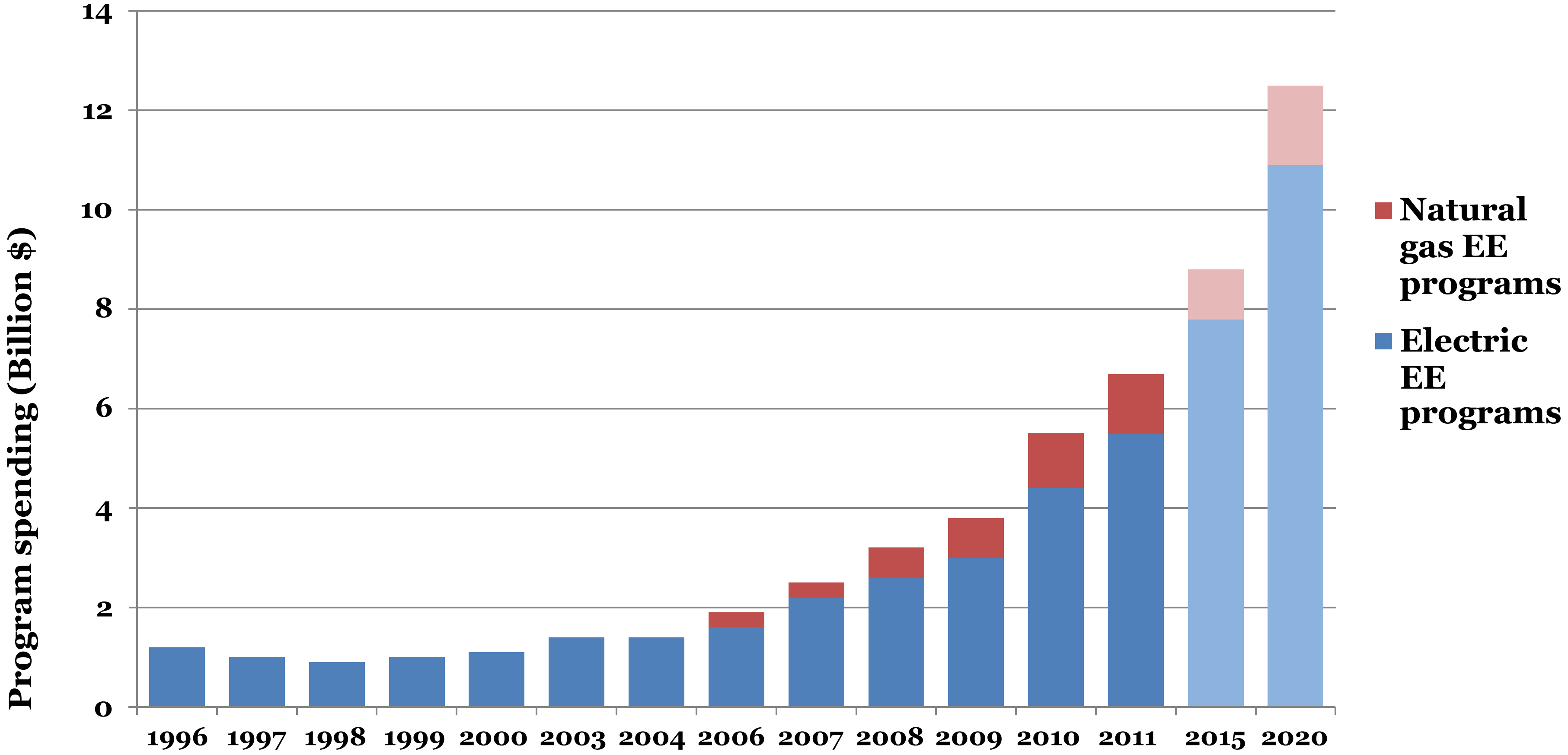
Operational Details

- 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

Sources: ACEEE, The 2010 State Energy Efficiency Scorecard, October 2010; CEE, *State of the Efficiency Program Industry*, December 10, 2010, and March 14, 2012; LBNL, *The Shifting Landscape of Ratepayer-Funded Energy Efficiency in the U.S.* , 2009.

Questions?