



GREEN MOUNTAIN POWER

Generating Possibilities

Distributed Generation in Vermont

ISO-NE Consumer Liaison Group
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Discussion Topics

1. Vermont context
2. Key features of Vermont DG programs
3. Value proposition for DG solar
4. Kingdom Community Wind

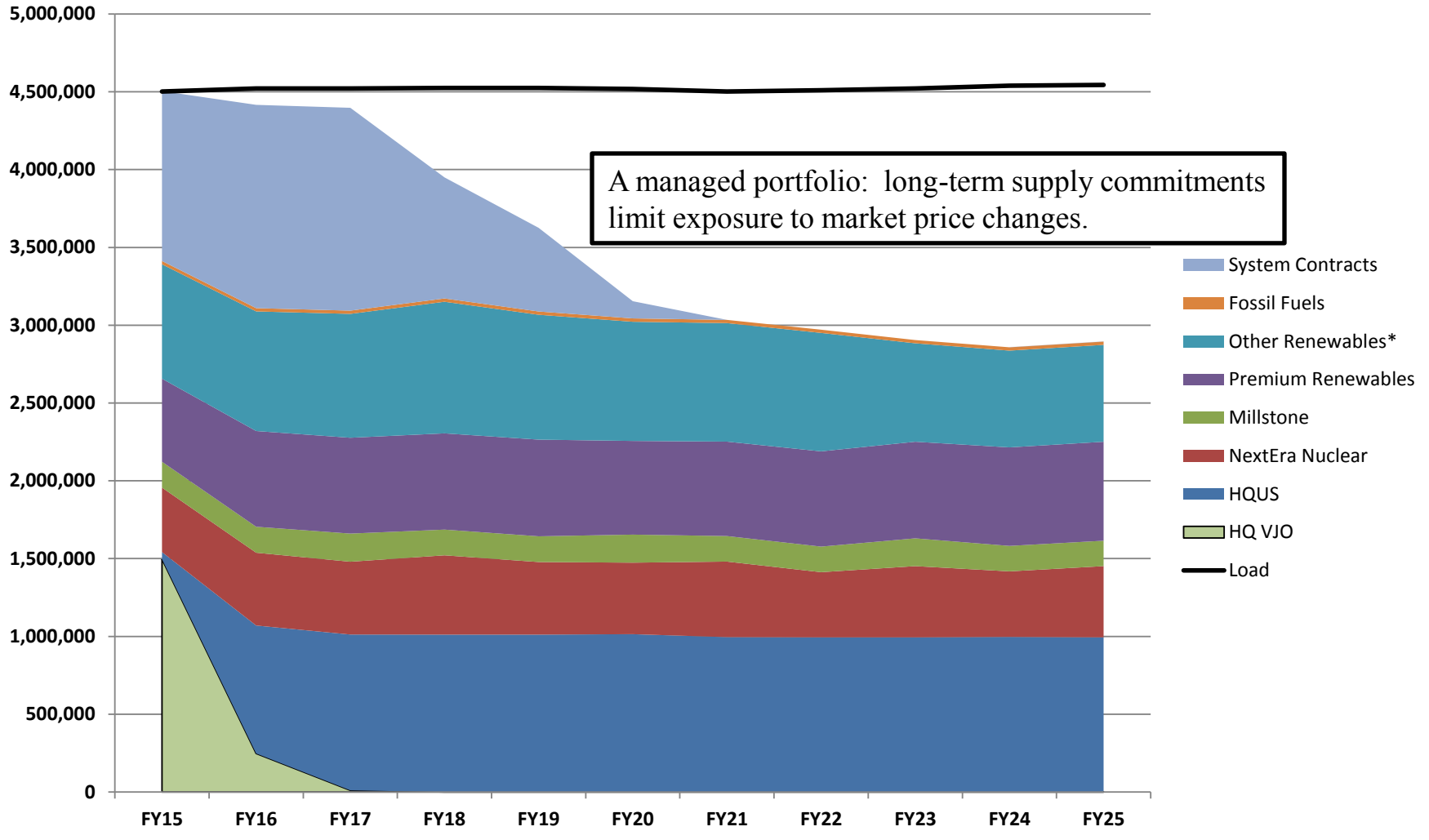
Vermont Context for DG Deployment

- Vertically integrated utilities; no retail access
- Policy context values retail rate stability
- Significant long-term contracts & utility generation ownership
- Most supply sourced from outside Vermont
 - Many DG sources; no major thermal plants
 - Largest plants are McNeil (biomass) & Kingdom Community Wind
- Desire to support deployment of renewable DG
 - Including associated economic activity
 - Long-term contracting can help

Green Mountain Power

Projected Energy Resources Compared to Load

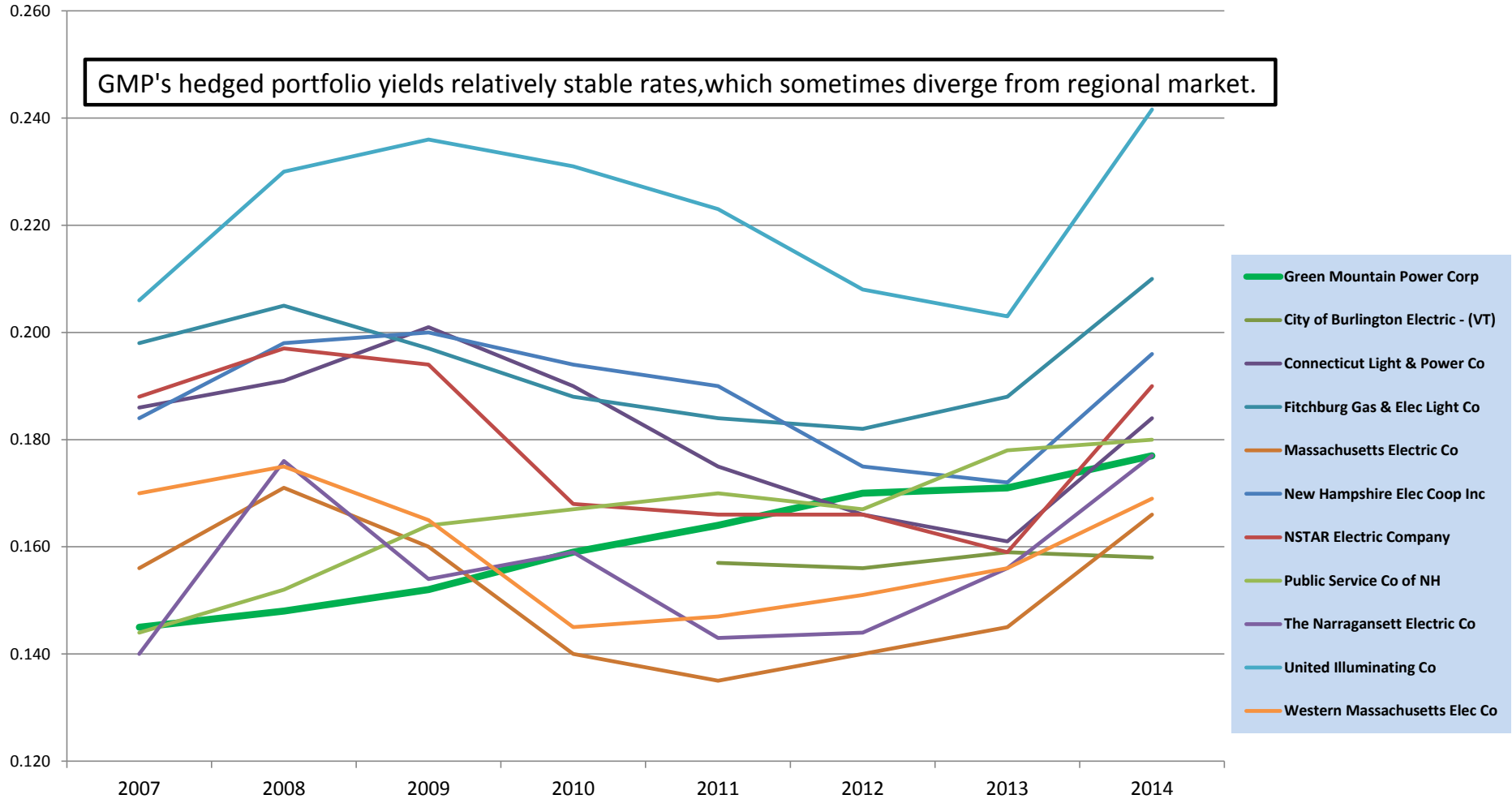
Fiscal Years 2015 to 2025



Note that GMP's ultimate fuel mix could differ from this illustration. For example, if GMP sells RECs (e.g., from the premium renewable category), the associated energy would be depicted as New England "system residual."

Illustrative Residential Rate Trends

(EIA data; partial year 2014)



Vermont Renewable Programs

- VT SPEED (new renewable) goal: 20% by 2017
 - Renewable project development (contracts & ownership), not consumption
 - Utility-scale projects and DG projects are eligible
 - Utilities are generally expected to sell the associated RECs
 - For GMP, currently \$30M/year of revenue to reduce retail rates
 - But cannot claim this power as renewable supply to its customers
- SPEED Standard Offer
 - Long-term PPAs, solicited annually (presently 5 MW/year)
 - Mostly solar PV so far; allowances for other technologies
 - Solar pricing has declined greatly (30 cents/kWh >> 12 cents/kWh)
 - Recent pricing competitive with larger new renewables (e.g., utility-scale wind)
- Net Metering
 - Solar “adder” above retail electric rate
 - Current total pricing = 19 to 20 cents/kWh (for first 10 years)
 - Group/virtual net metering is allowed
 - Maximum project size = 500 kW
 - “Net Metering 2.0” docket to review program features for 2017+

Proposed Bill H.40 (“RESET”)

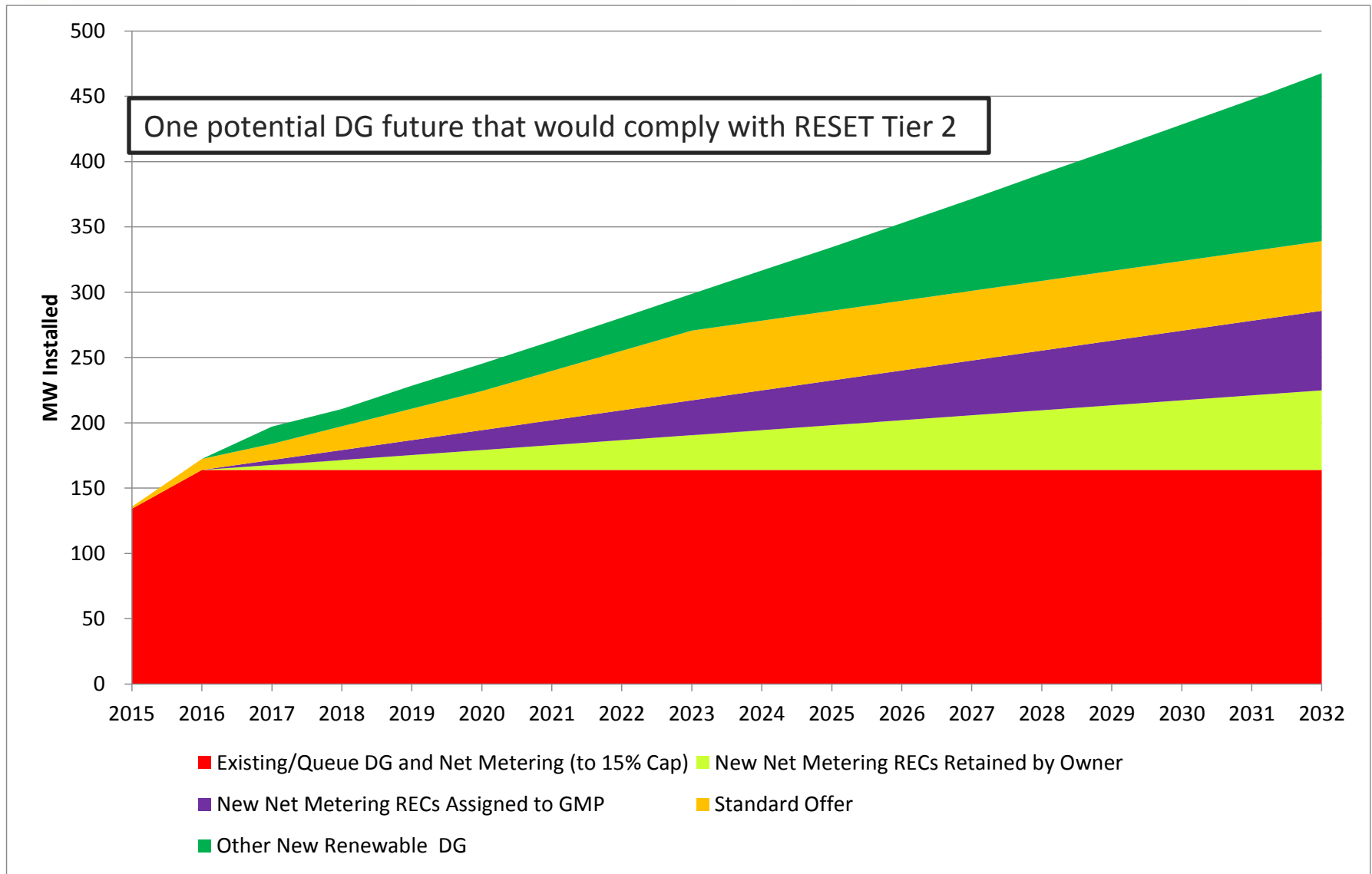
Under consideration, a new renewable framework:

- Tier 1 = Total Renewables Requirement
 - 55% of sales in 2017, increasing to 75% in 2032
 - Renewables broadly defined (including existing)
- Tier 2 = DG carve-out (counts toward Tier 1)
 - 1% of sales in 2017, increasing to 10% in 2032
 - Plant size 5 MW or less, instate only
 - Net metering can count, if customers assign attributes
- Tier 3 = Energy Transformation
 - Customer-facing measures that lower costs and GHG emissions
 - Ex: efficiency, EVs, heat pumps above baseline path
 - 2% in 2017, increasing to 10% in 2032

RESET: Thematic Directions

- Promotes very substantial in-state DG
 - Challenging, but achievable with focus & innovation
- Tier 3 aims at all fuels, not just electricity
- Supportive of Vermont's Comprehensive Energy Plan goals (i.e., 90% renewable by 2050)
- Cost containment
 - Significant new requirements, growing gradually
 - Some compliance flexibility provisions (e.g., banking)
- Would end the SPEED framework
 - Renewable consumption requirements (via RECs), not counting renewable generation
 - More clarity, alignment with neighboring RPS programs
 - Enable Vermont utilities to remain REC sellers and buyers

Illustrative Build-out of DG Capacity



Context: GMP's recent annual peak load has been roughly 760 MW.

Value Streams From DG

- Wholesale market products
 - Energy, Capacity, RECs
- Potential additional value for “load reducers”
 - Displacement of RNS transmission charges
 - Additional capacity value (if output at ISO summer peak is high)
- Sum of these: estimated 12 to 15 cents/kWh levelized
 - Comparable to recent prices for some utility-scale solar PPAs
- Potential additional values in some locations
 - Reduction in local T&D losses
 - Deferral of T&D capital investments
 - Bulk (VELCO), or GMP
 - Support grid resiliency (particularly if combined with storage)
- Societal values (not monetized in market products)
 - Externalized cost of GHG emissions
 - For some technologies (e.g., digesters), local waste management

Increasing DG Penetration: Potential Challenges

Benefits and costs of DG can be very location-specific. The following are challenges that are likely to arise in some cases, and will need to be managed as DG penetration increases:

- Loading of T&D equipment
 - Ex: distribution circuit becomes export-constrained
- Review of protective devices & regimes
- Voltage fluctuations
 - Quick changes in DG output
- Unintended islanding
- Interconnection queue dynamics
- Also, intermittence of aggregate DG output
 - Fluctuation in GMP's net power supply costs

Management of DG Penetration

- Thoughtful system impact studies
 - Identify required upgrades & protection regimes
 - Leverage smart meter data, where applicable
- Develop screening tools (e.g., solar mapping)
 - Help projects find areas where interconnection cost is likely low; avoid high-cost areas
- Utilization of advanced inverter features
 - Ex: to control “up” ramp of solar production
- Strategic deployment of distributed storage
- Responsive demand
 - Controllable end uses that can decrease/increase consumption very quickly

Choreography: A Rutland Case Study

- A collaboration with NRG and Spirae
- Focus on local distribution circuit “ER-51”
 - About 4 MW of load, mixed residential & commercial
 - Stafford Hill project (2 MW PV, 4 MW storage, co-located)
 - 1 MW+ of other solar PV
 - About 150 controlled electric water heaters
 - Emergency shelter (high school)
- Grouping & management for multiple operating modes
 - Frequency regulation
 - Peak management
 - Reduction of capacity & transmission expenses
 - Part of an “NTA” reliability plan to defer local transmission investment
 - Smoothing solar output
 - Microgrid (part of circuit)
- Tools, experience, lessons to inform broader application

DG Value Proposition: Themes to Watch

- Cost trends for all-in cost of solar PV
 - To what degree will recent gains (performance, delivered price/kWh) continue?
 - Federal tax incentives (e.g., 2017 ITC expiration)
- Availability & permitting of low-cost sites
- Management of local interconnection queue
 - And allocation of system upgrade costs
- Solar penetration could shift system peak hours
 - If ISO/VT peaks shift to evening hours, diminishing capacity/RNS value for future solar volumes

Kingdom Community Wind

- 63 MW plant, COD late 2012
 - 21 Vestas turbines, 3 MW each
 - 8 MW to Vermont Electric Cooperative via long-term PPA
- A significant part of GMP's owned generation fleet
 - Projected all-in cost (25 years): roughly 9.5 cents/kWh
 - Potential for additional customer value thereafter
- Projected average capacity factor about 34%
 - 3.5% to 4% of GMP energy needs; weighted to winter months
 - Production to date has been consistent with this
 - Output was curtailed by ISO-NE during significant hours in 2013, due to northern VT contingency exposures
 - Since installation of a local reactive device, curtailment has not been a major factor

Some Take-Aways

- Vermont context is unique in several respects
- DG can make sense for several reasons
 - Part of a low-cost portfolio strategy
 - Local NTA and grid resiliency
 - Consistent with our customers' preferences
- Vermont DG & renewable programs have been relatively low-cost
 - Substantial project development, limited retail rate impact
- Vermont renewable policy will soon evolve significantly
 - RESET would institute renewable consumption requirements, and require large amounts of local renewable DG
 - Implementation appears challenging, but achievable
 - Pricing & other features of net metering