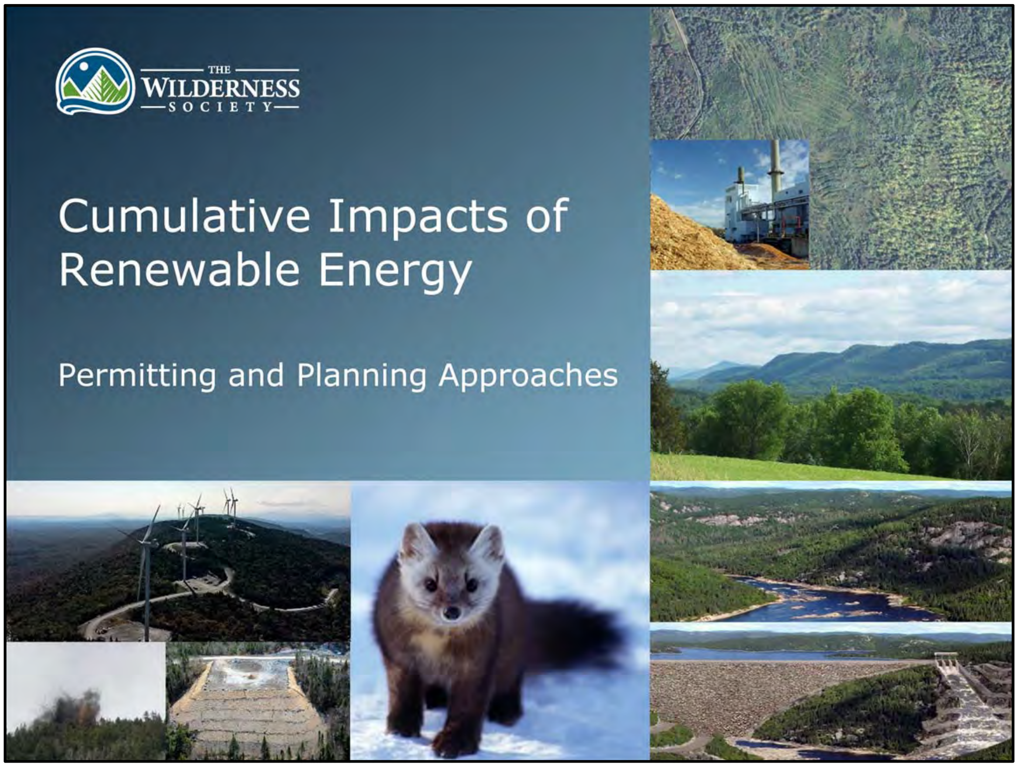

This presentation illustrates options for assessing and minimizing the cumulative impacts of renewable energy development in Vermont. We offer these ideas to Vermont's Energy Generation Siting Policy Commission in the hope that the Commission will recommend resolving many siting issues through landscape-explicit energy planning before projects ever get to the permitting stage.

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Photos, from lower left:

Wind project on Lowell Mountain ridgeline, with blasting and turbine pad.

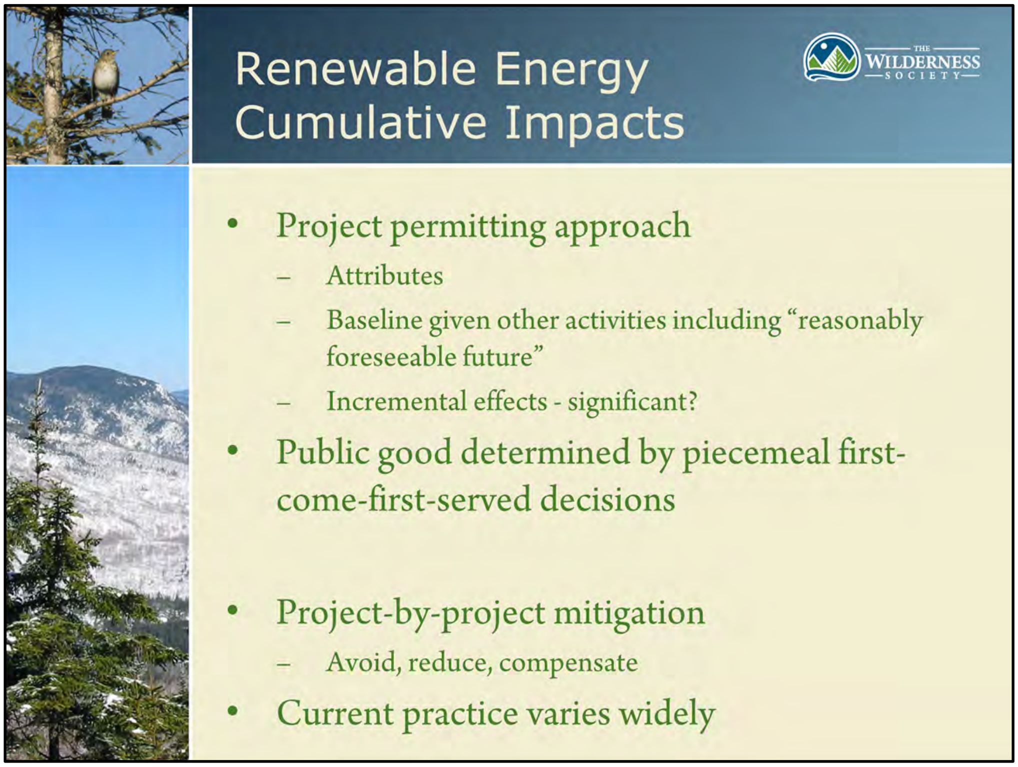
American marten, prefers mature conifer forests at mid-high elevations, making a come-back in Essex County, VT.

Before-and-after mockup up of a Hydro Quebec dam on the Romaine River.

Green Mountains ridgeline.

McNeil biomass electricity plant.

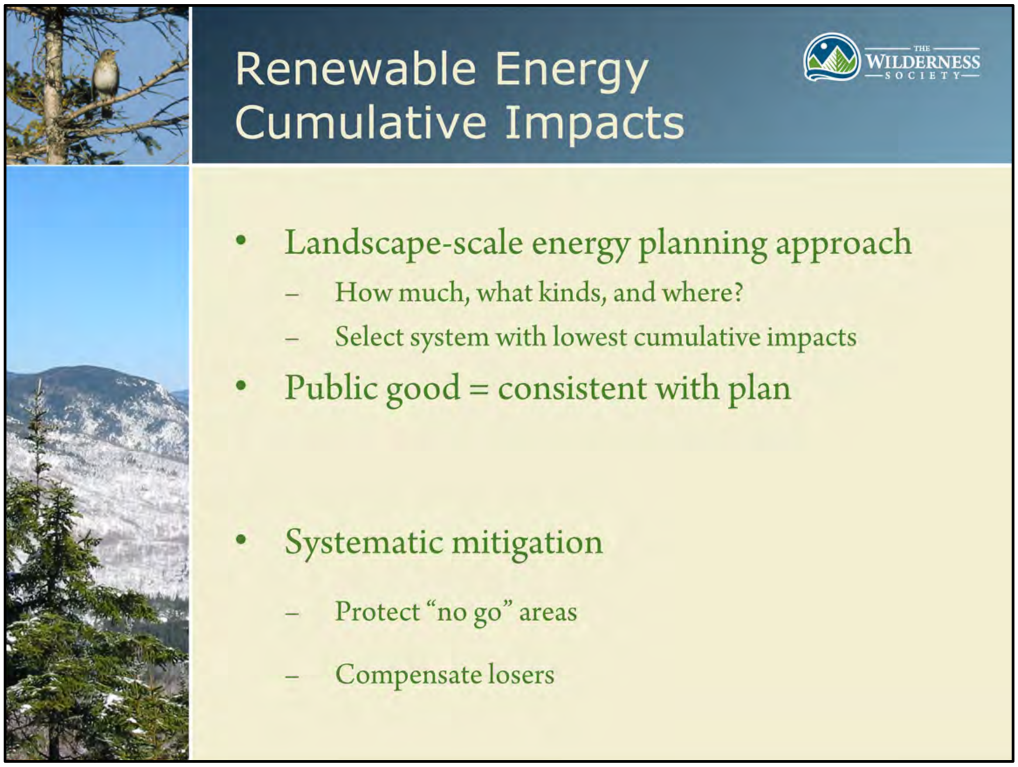
Heavily cut forest lands in the Northeast Kingdom (not necessarily harvested to supply biomass).



Cumulative impact assessments are required as part of federal environmental review under NEPA. They are meant to address incremental degradation that seems insignificant at the individual project level but adds up to substantial losses over time or across the landscape. The basic process involves listing environmental attributes likely to be affected by a project, defining baseline conditions without the project but including other activities past current and future, predicting how the project will interact with those other activities to change baseline conditions, and finally addressing significant effects by modifying or cancelling the project.

Although Vermont’s Section 248 criteria do not explicitly mention cumulative impacts, they could be incorporated by considering all relevant influences for each criterion. However, cumulative impacts assessment requires anticipating *future* actions as well as existing ones, which is challenging in the context of permit review. Without anticipating future conditions, piecemeal project-by-project decisions can continue to nibble away at important environmental values.

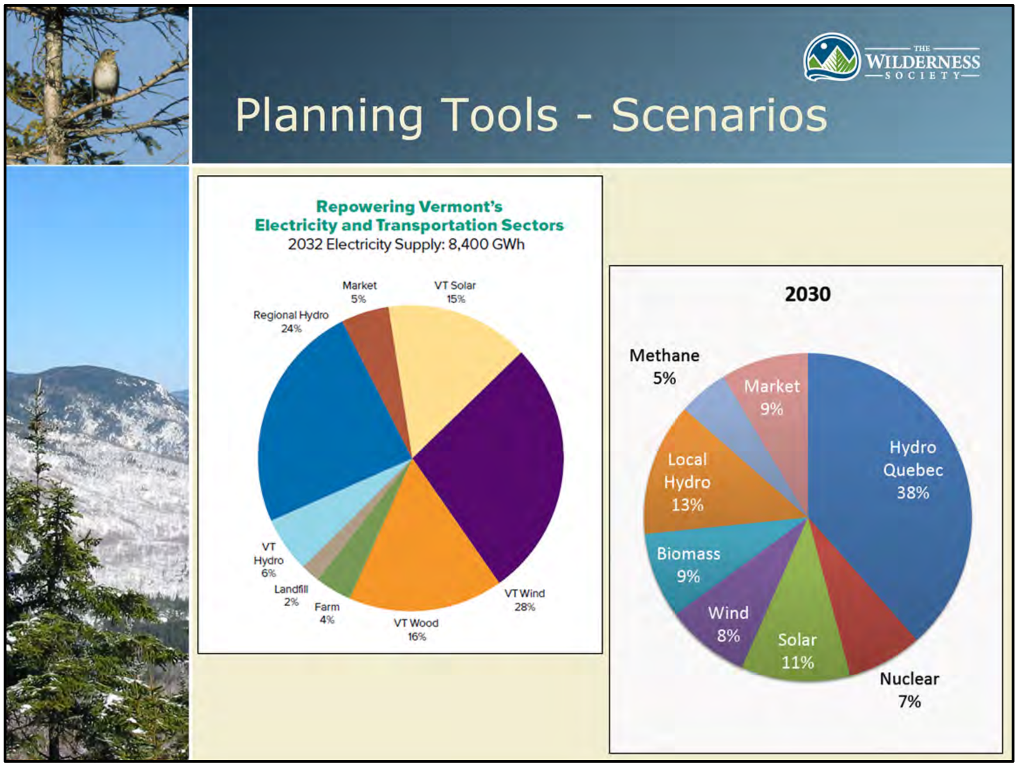
Within the permitting process, mitigation can help reduce impacts by avoiding the most sensitive sites or modifying project operations. Compensatory mitigation offsets impacts by protecting or restoring resources on-site or elsewhere, which can limit overall future cumulative impacts by permanently protecting the most critical landscape values. However, project-by-project negotiations make for uneven mitigation practice which does not always result in effective resource protection.



Given the challenges of assessing cumulative effects at the project level, they might better be addressed as part of a comprehensive planning process. Designing the *best* energy system for the long term requires a look at all energy uses, technologies and available resources, while minimizing the impacts of the entire system. Though a landscape-explicit energy plan would involve controversy and take time to develop, it could pave the way for more rapid mid-term progress through smoother permitting for individual projects.

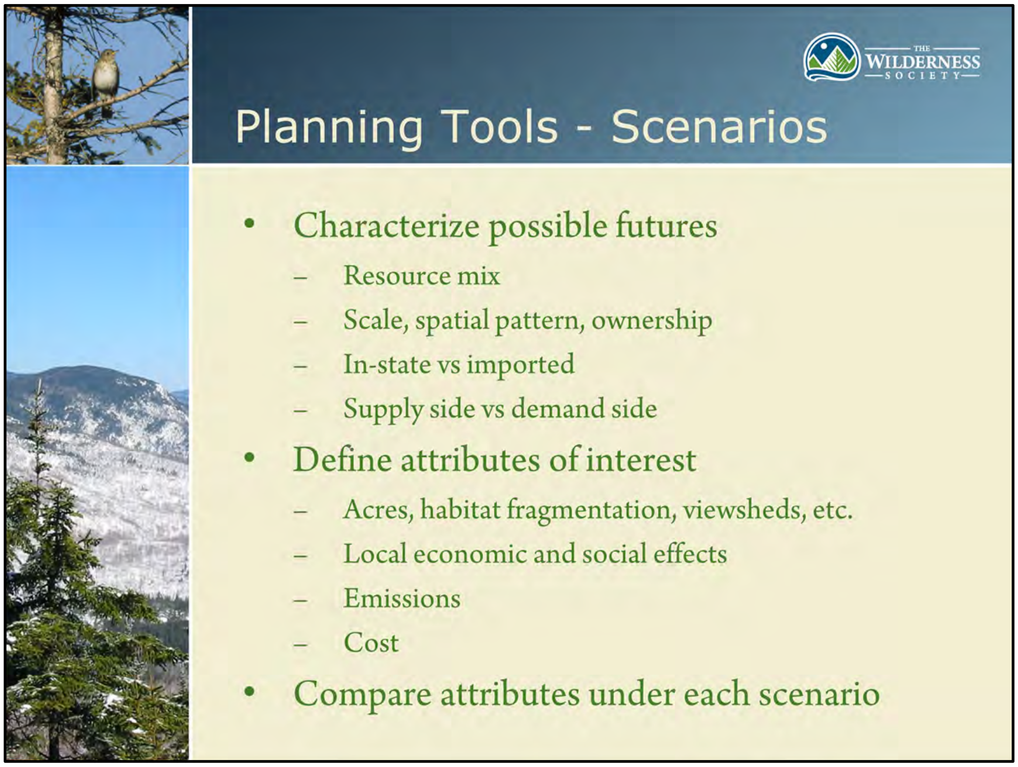
With such a plan in place, mitigation measures could be targeted to protect areas where energy development is not appropriate, and to compensate those affected where development does occur.

(For an interesting approach to energy site planning, see Scotland's wind energy planning materials at http://www.snh.gov.uk/planning-and-development/renewable-energy/onshore-wind.)

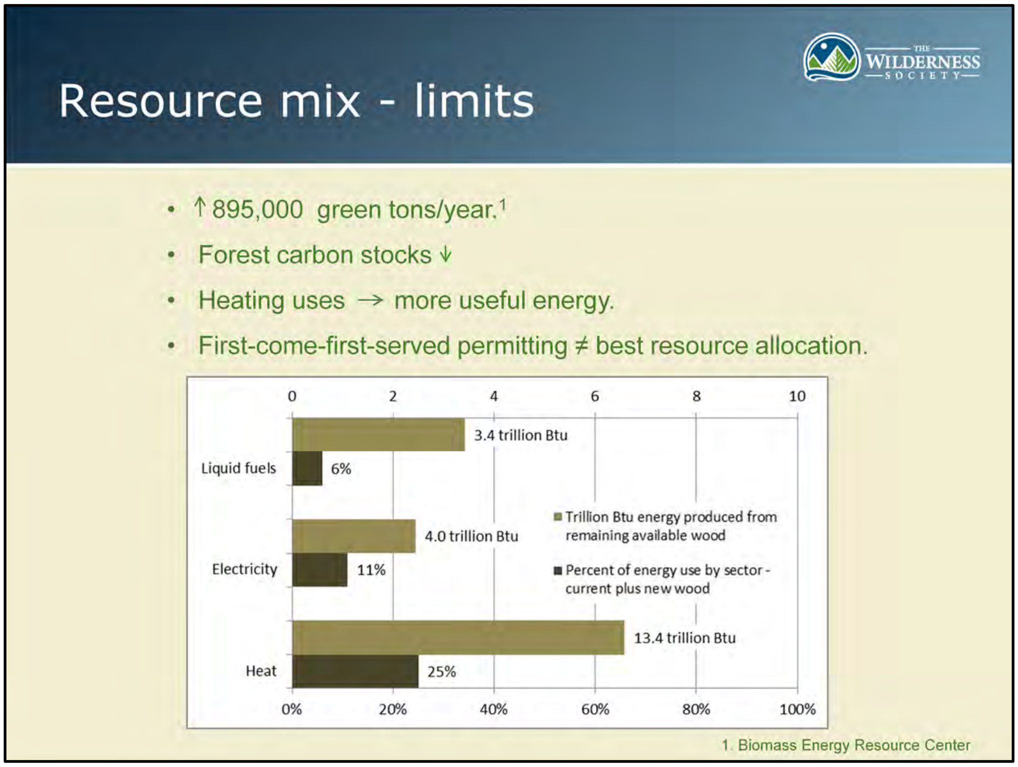


There are many different tools for assessing cumulative impacts, including quantitative projection of trends with and without a proposed project and qualitative modeling of causal connections within a complex system (see CEQ handbook at http://ceq.hss.doe.gov/nepa/ccenepa/ccenepa.htm for a summary). Here I focus on a tool known as scenario analysis, which is particularly suited to complex situations, an uncertain future, and engaging stakeholders in mutual learning.

Scenarios are hypothetical depictions of the future based on real data, limits and trade-offs. The "energy pies" proposed by competing groups are a start at defining scenarios for an energy plan, but these need to be fleshed out with a full description of costs, reliability effects, and landscape and social impacts. A realistic set of scenarios can challenge pre-conceived assumptions. Opponents of a particular technology may come to acknowledge the difficulty of meeting our goals without making room for their personal energy nemesis. Proponents may perceive a dark side to their energy star and discover alternatives with different, perhaps lower, impacts. Hopefully, all will acknowledge that putting a damper on demand is crucial if we want to preserve some remnant of the Vermont landscape we know today.

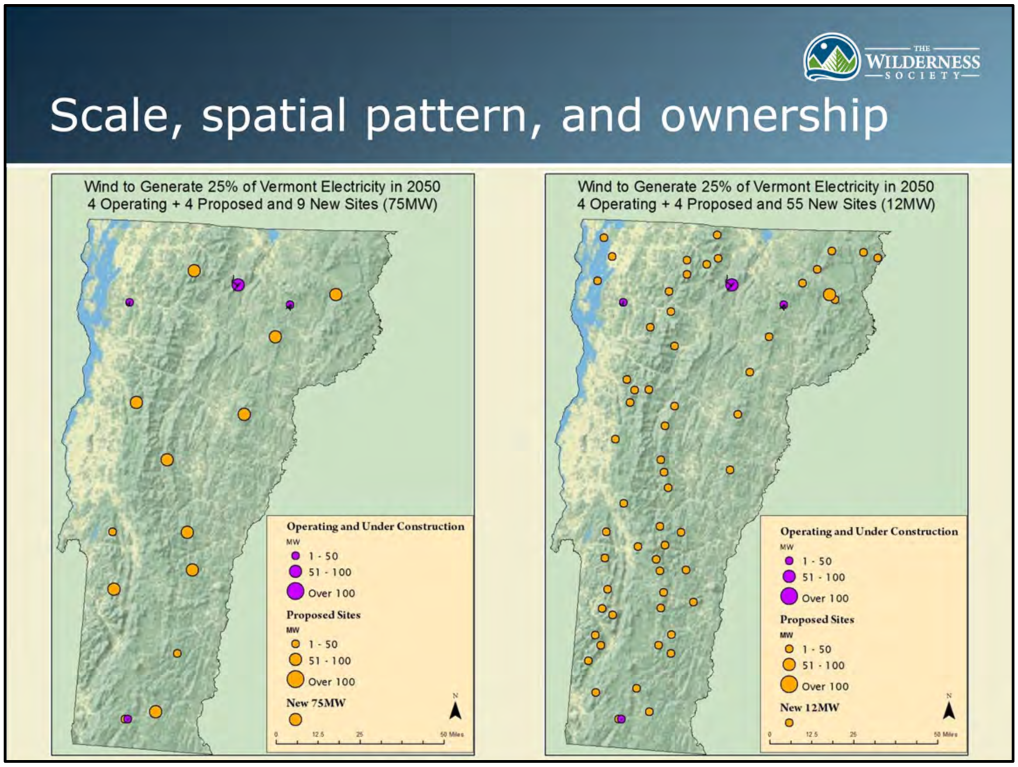


Once several contrasting possible futures have been defined, attributes of special interest might be tabulated for each scenario to facilitate comparisons. The next several slides illustrate some of the attributes that might be compared across scenarios and indicate key cumulative impact questions, with a focus on ecological values. These illustrations use 2050 as a reference year, corresponding to Vermont's 90% renewable goal, and assume a modest increase in Vermont's electricity use to ~6,900 GWh, due to effective demand-side management combined with expanded use of electric vehicles and heating.

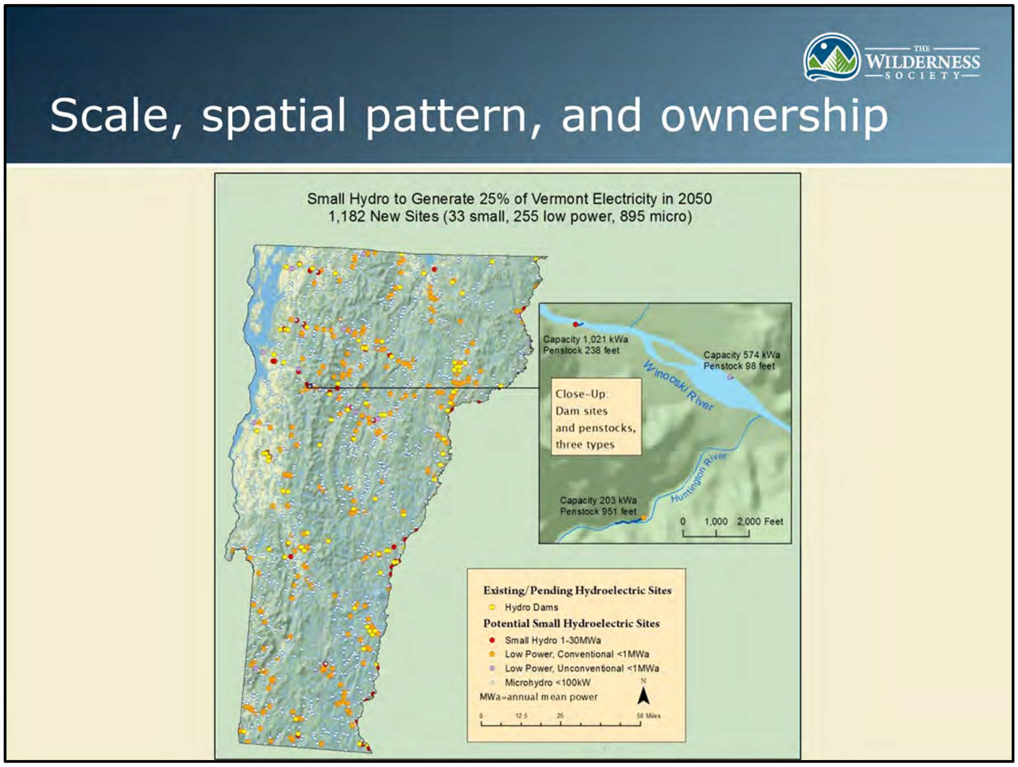


Limitations of each energy resource need to be respected when building scenarios: wind is more reliable at night when demand is low and may be curtailed by congested transmission; solar shuts down at night and under heavy cloud cover; hydro plants need to maintain minimum instream flows during hot dry summers; wood energy is less variable but is limited by ecosystem capacity, including the effect of increased harvest on forest carbon stocks. Scenarios should project realistic energy outputs that match resource capacity and include balancing power sources, storage, or demand response to deal with intermittent power or sources poorly correlated with load.

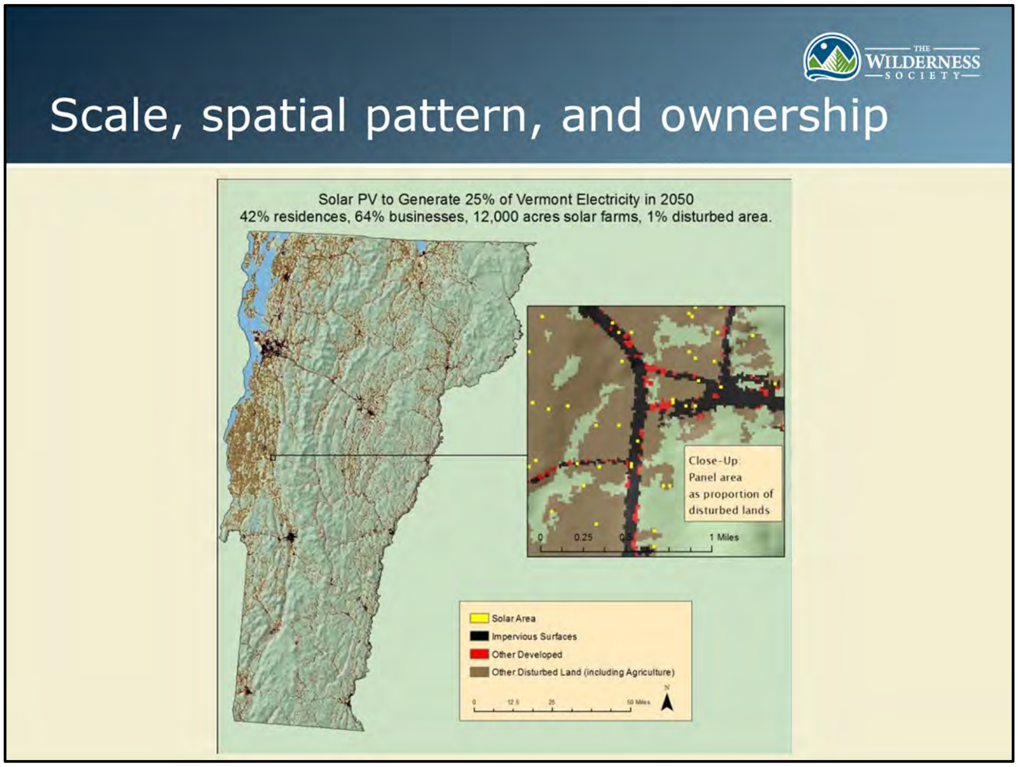
Because several energy uses compete for a limited wood supply, scenarios should incorporate all sectors to highlight the consequences of different allocations. Vermont already uses nearly 1 million green tons of wood for heating each year (with the highest residential wood heat rate in the nation at 15% of households) and roughly ½ million green tons for electricity (at McNeil and Ryegate). If all remaining available low-grade wood were used for energy, heating uses would generate more usable energy than transportation fuels or electricity due to more efficient energy conversion. Without anticipating future uses, permitting first-in-line wood energy projects could block later adoption of better alternatives.



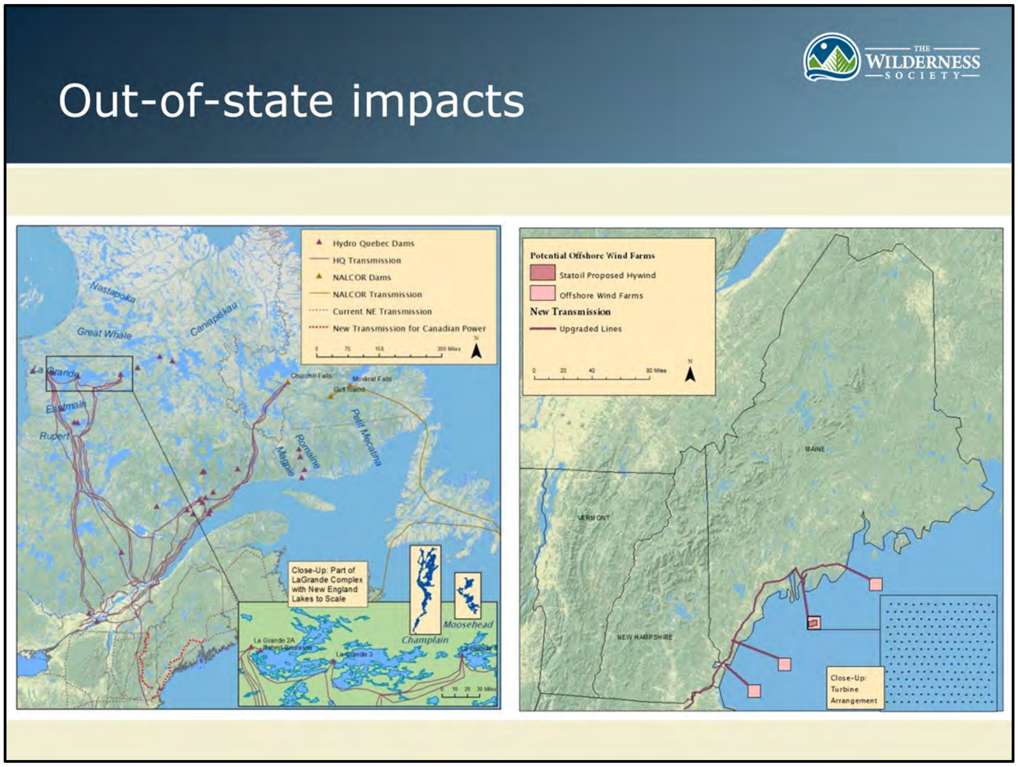
Maps provide an intuitive sense of landscape impacts for contrasting scenarios. The next few slides show patterns of disturbance across the landscape. As these maps show, scale matters - a few large wind sites will have very different impacts from multiple small ones, even if both affect similar acreages. Small projects might spread across a broader landscape, but may have less intensive local effects, with more micro-sites in already disturbed areas, smaller viewsheds, narrower access roads, and shorter transmission connectors. Smaller projects owned by municipalities, coops, or individuals might also be easier to permit thanks to direct local benefit. On the other hand, scattered smaller projects may mean that nearly every Vermont resident, and most of our wildlife, live near a wind turbine.



Like wind, hydro generation balances high single-site impacts for large projects against less-intense but landscape-wide effects for small ones. New hydroelectric dams are very unlikely in Vermont, but there is potential at existing dams or for small run-of-river projects that divert only a portion of stream flow or install turbines directly on the streambed. Vermont's hydro infrastructure already provides about 11% of the state's electricity, or 9% of projected 2050 use. Additional small sites could potentially generate another 22% or so of 2050 need, but that level of production would take more than 1,000 facilities state-wide.



Like small wind or hydro, solar PV is well-suited to a distributed approach, but in this case the resource is available almost anywhere on the landscape so structures can be located in already-developed areas near electricity users. Panels covering just 1% of disturbed lands in the state could meet 25% of the state's 2050 needs. One possible blueprint would involve panels on 113,000 residences (~42%) + 45,000 business/public buildings (~64%) + 12,000 acres of free-standing solar farms. Though ecosystem impacts may be minimal, solar development does affect aesthetics and may encroach on farmland so scenarios should include those attributes.

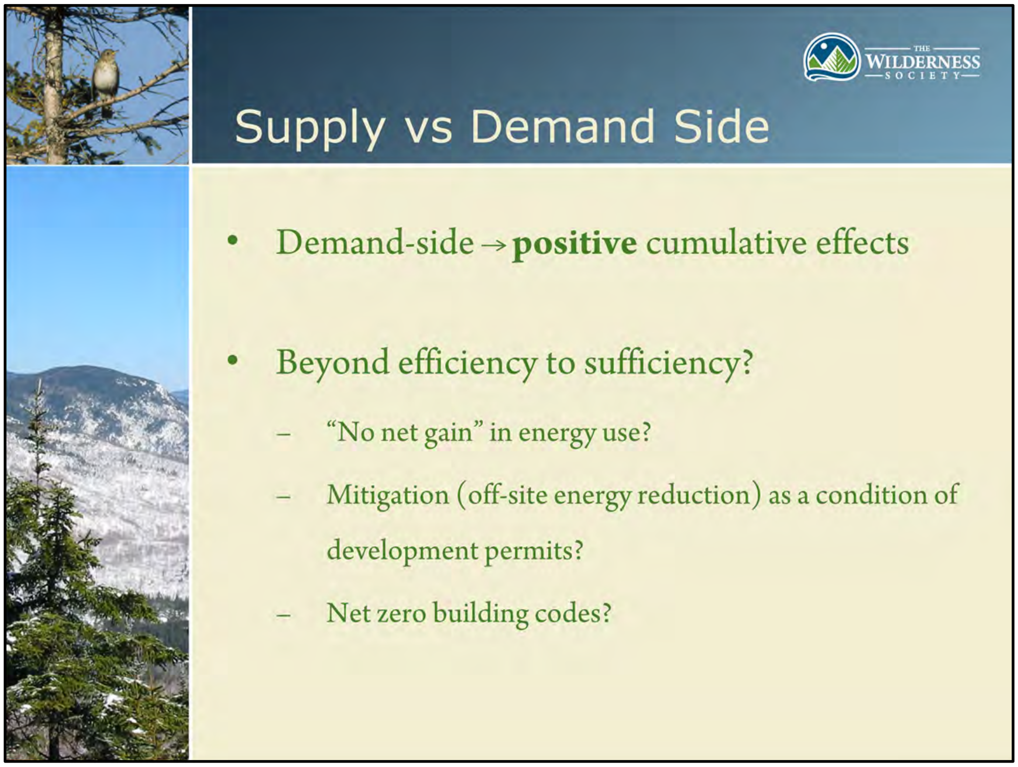


Many of Vermont’s policies incentivize in-state energy development, but for such a small state regional resources may be an important part of our energy mix. The Public Service Board considers out-of-state impacts only to the extent that they affect the public good of Vermont.

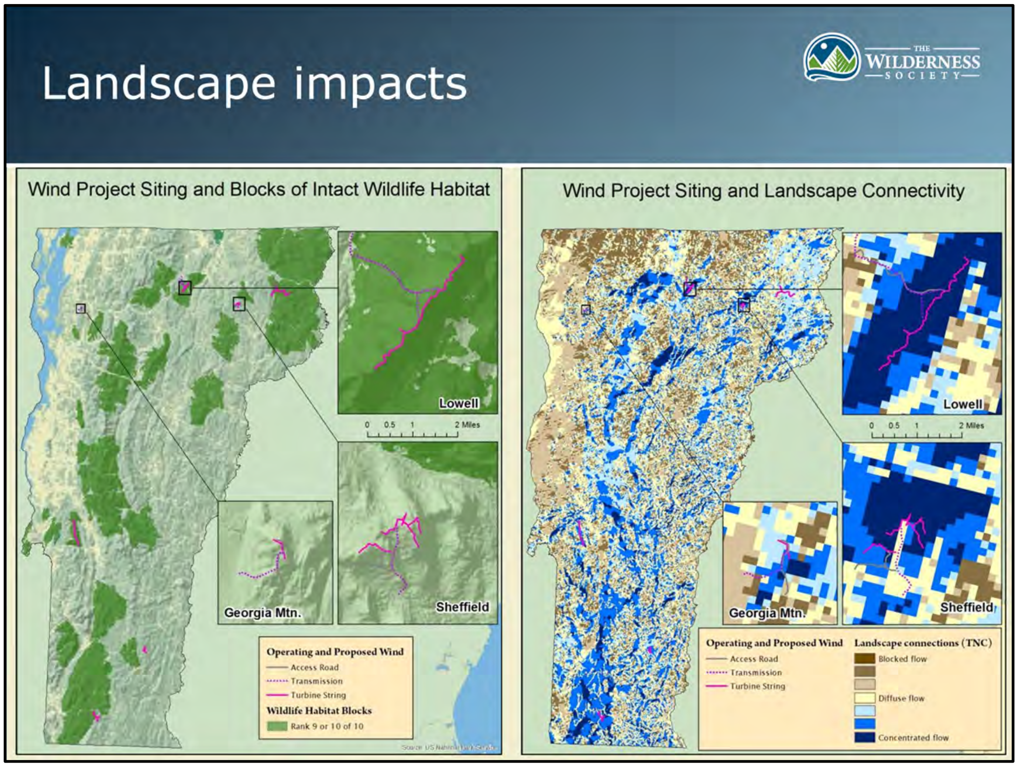
In its review of the most recent Hydro Quebec (HQ) PPA, the PSB concluded that no environmental impacts from dam construction in Quebec can be attributed to Vermont’s use of that power, because the new contract is smaller than the expiring one and represents a small portion of total HQ capacity (about 0.5%). Any future increase in Vermont’s use of HQ power could lead to a different conclusion about cumulative impacts.

(As an aside: Vermont’s decisions may exert influence disproportionate to our small direct impact. Vermont’s reductions in greenhouse gas emissions have symbolic value beyond their tiny direct contribution. Likewise, cancelling or limiting HQ power purchases, when combined with similar actions by other states, could discourage further HQ expansion. Conversely, Vermont’s acceptance of HQ power as renewable encourages new investment with the expectation that other states will follow our lead.)

Another potential future resource is offshore wind from New England coastal waters. Four large offshore wind farms, as proposed by the DeepC Wind Consortium of Maine, could provide 25% of the electricity for Vermont, New Hampshire and Maine combined, and a single offshore wind farm with 152 5-MW floating turbines could provide 25% of Vermont’s needs. A landscape planning approach might anticipate emerging opportunities with lower overall environmental impacts, rather than assuming that the first-proposed projects are the best solution available.



Positive cumulative effects should be considered alongside *negative* ones, and for demand-side approaches most landscape effects tend to be positive. Thanks to Vermont's energy efficiency leadership, demand-side solutions are already incorporated in Criterion (b)(2) of Section 248. However, the piece-meal project-level approach has led the PSB to conclude that every recently proposed project is necessary, because current demand-side solutions cannot meet the entire need for renewable power. In contrast, cumulative effects analysis embedded in a comprehensive plan that fully accounts for environmental, social, and transmission costs might suggest more ambitious demand-side measures as part of an optimal energy system. These might include options that reduce energy *use* rather than simply increase *efficiency* of use.



This final set of maps illustrates how specific landscape metrics might be used to assess cumulative impacts across scenarios. They display two environmental attributes for which cumulative impacts may be reaching a critical threshold in our state - large blocks of habitat (mapped by Vermont ANR and others) and connectivity between them (mapped by The Nature Conservancy, using a model that resembles current flowing along paths of least resistance). Because of Vermont's dispersed development pattern wildlife habitat in our landscape is already fragmented, and even small additional losses could reduce the ability of natural systems to adapt as the climate shifts.

Of three wind projects recently sited in northern Vermont, the Lowell project clearly had the greatest impact on both core habitat and connectivity. Turbines in Sutton, originally proposed as part of the Sheffield project, would have extended northeast into the concentrated flow corridor shown on the right-hand map, so modifications to the original project because of town opposition also reduced its ecological impact. Such small adjustments may be helpful at the project level, but total cumulative impact could be limited much more effectively through a state-wide planning process that guides development toward low-impact sites.

Over the next decade or so, Vermont has a historic opportunity to design a future energy system that not only weans us from destructive and unreliable fossil fuels, but also strengthens our social fabric and protects our treasured landscape. Improving the permitting process will help at the margin. But engaging Vermonters more broadly in brainstorming and weighing trade-offs will get us to our goal with less collateral damage to people and place.