

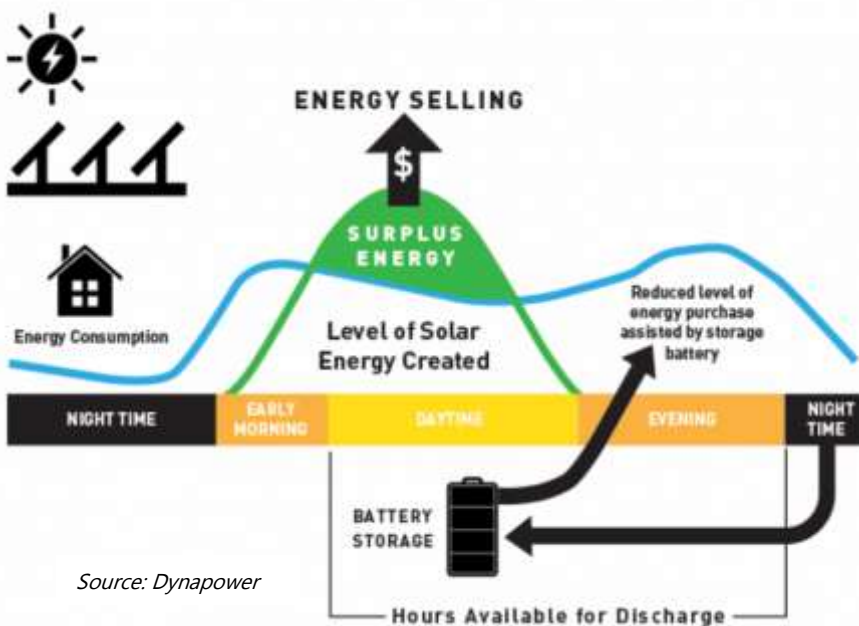
# Renewable Energy Storage

## Benefits of Energy Storage

- ✓ Increases grid resiliency, integrity, and stability
- ✓ Helps residents and businesses manage electricity use, lowering electric costs
- ✓ Lowers costs to ratepayers by reducing electricity demand during peak periods when additional supply is needed
- ✓ Helps avoid costly distribution and transmission infrastructure upgrades, reducing costs to ratepayers
- ✓ Provides backup power when the grid is offline
- ✓ Replaces fossil fuel powered backup generators
- ✓ Reduces greenhouse gases
- ✓ Maximizes use of VT produced renewable energy
- ✓ Supports economic growth
- ✓ Proven technology already deployed around the world

*Energy storage provides an intelligent buffer between generation and demand that provides grid operators an essential tool for a **reliable, resilient, and flexible power grid**. While transmission provides energy where it is needed, energy storage provides energy when it is needed.*

*- Babu Chalamala, Energy Storage Program Manager, Sandia National Laboratories*



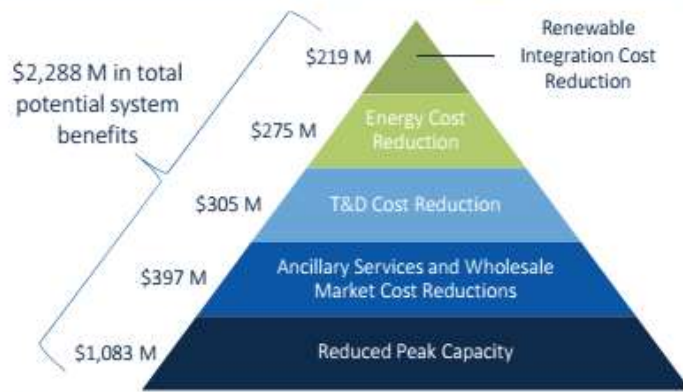
Electric vehicle batteries could charge during off peak times, and provide energy back to the grid during peak periods.

*Massachusetts “State of Charge” study found that energy storage could deliver **billion\$ in benefit\$** to Massachusetts, **lower peak demand by 10%**, and **reduce more than a million metric tons of carbon dioxide emissions over ten years**.*

## Energy Storage in Other States

- ✓ California (2010), Massachusetts (2015), and Oregon (2015) enacted laws requiring utilities to provide storage.
- ✓ Eversource (ISO New England’s largest utility) is making a \$100 million commitment to energy storage.
- ✓ New York, Maryland, Hawaii, and California offer incentives for energy storage.
- ✓ At least 7 states are currently considering legislation to study, further incentivize, or require utilities to adopt energy storage (MD, HI, NV, NJ, NY, MA, MN).

### Potential System Benefits Highlighted by State of Charge



Source: State of Charge Report – Massachusetts Energy Storage Initiative



Grassroots Solar Sonnen Battery










Northern Reliability Project

### Storage Pilots in Vermont

- ✓ Northern Reliability built 10 storage units supporting VTA operations for remote cellular and broadband resiliency after Hurricane Irene.
- ✓ Grassroots Solar and GMP are installing storage at Emerald Lake State Park in East Dorset, to take the park off the grid. The cost is estimated to be 20% less than that of rebuilding the distribution line.
- ✓ Green Mountain Power customers may lease a Tesla Powerwall battery for their home from GMP, providing 4 – 6 hours of backup power.
- ✓ The Stafford Hill Solar Farm installed by groSolar, Dynapower, and GMP in Rutland was named by the U.S. Department of Energy as the first utility microgrid in the country, powered by solar energy coupled with storage. In 2016, the project saved GMP \$200,000 in one hour.

## Electricity Storage Technologies

 <p><b>Battery storage</b> They include lead-acid, lithium-ion and sodium-sulphur designs.</p>	 <p><b>Pumped Hydro</b> Pumping water up to a reservoir and, when electricity is needed, releasing it through turbines.</p>	 <p><b>Compressed air energy storage</b> Storing air at high pressure, often underground, before using it to generate electricity via a turbine.</p>
 <p><b>Pumped heat electricity storage</b> Pumping heat away from a cold, gravel-filled container into a hot one. Reversing this drives a pump, which generates electricity.</p>	 <p><b>Liquid air electricity storage</b> Cooling air to temperatures below -196°C, where it turns into a liquid. When heat is reintroduced, it gasifies, expands and turns a turbine.</p>	 <p><b>Flywheel and Supercapacitor</b> They can be used to recover energy from braking in cars and trains or to ensure that power for large energy consumers is not interrupted by providing short bursts of back-up electricity.</p>
 <p><b>Hydrogen</b> Storing energy that can be released by burning it or through a fuel cell chemical reaction.</p>		

Source: Inline Policy

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