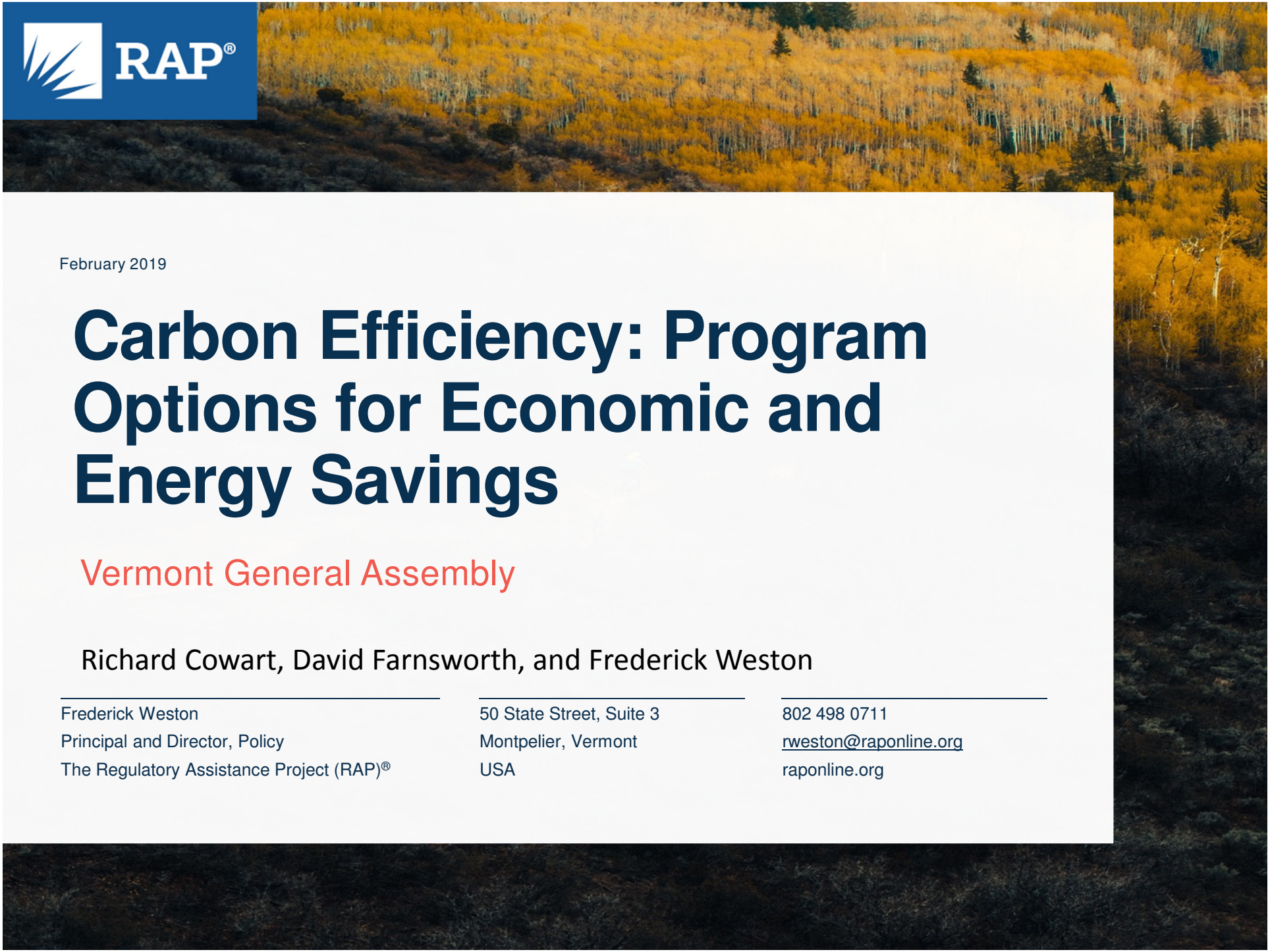

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Carbon Efficiency: Program Options for Economic and Energy Savings

Vermont General Assembly

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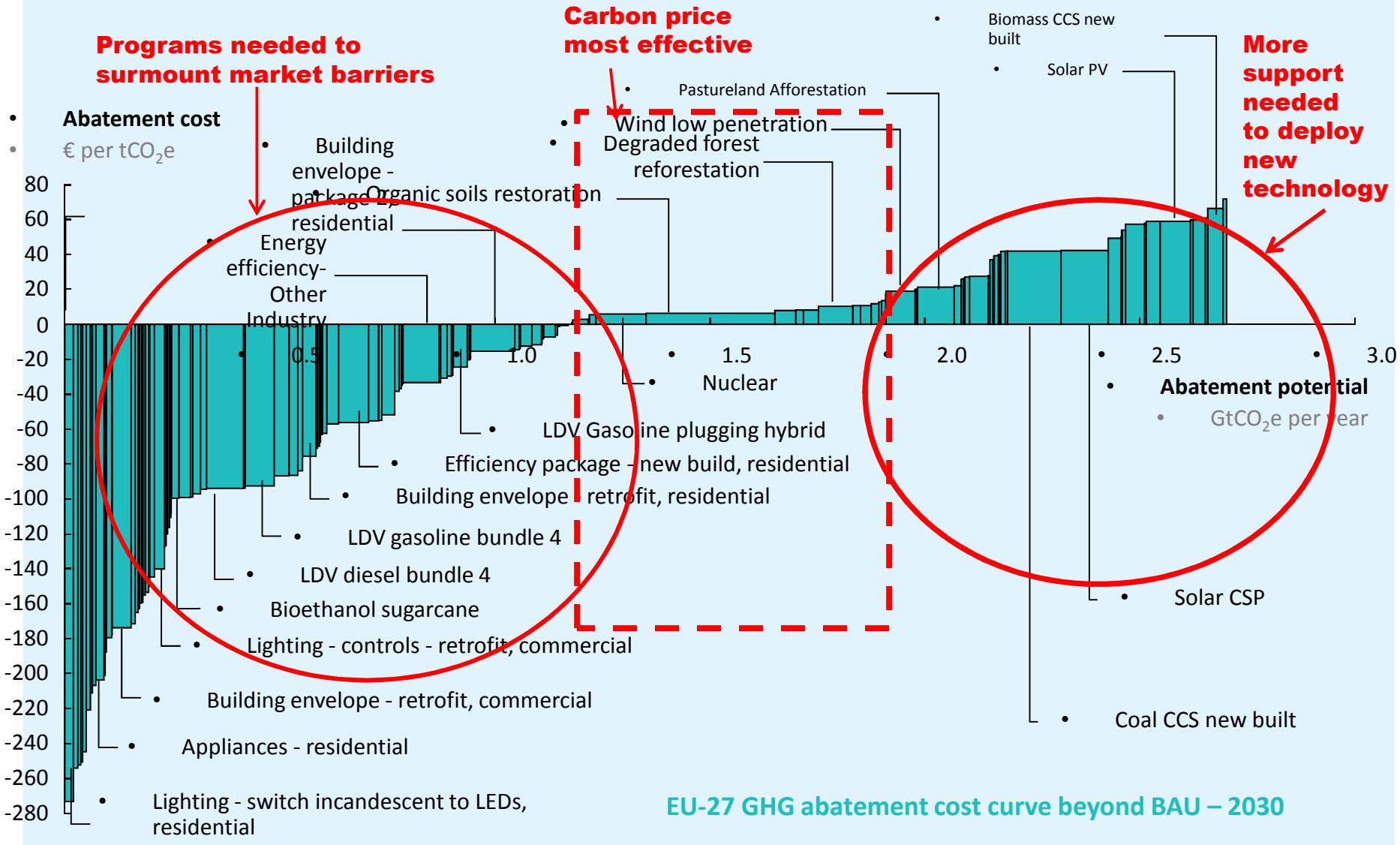
This Report

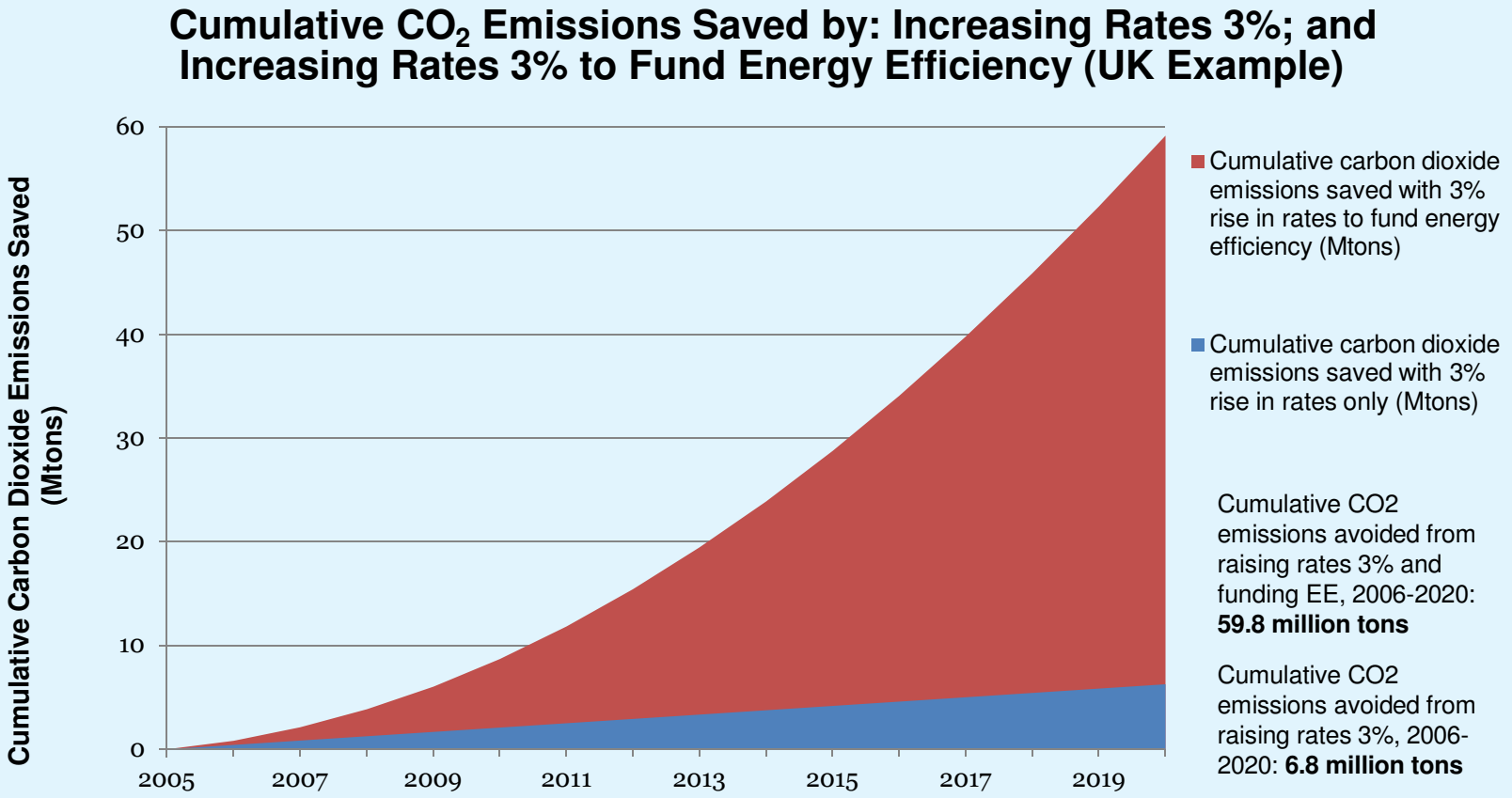
- JFO requested review of the RFF study
- RAP commissioned two expert studies:
  - One on energy savings in housing and public buildings by the Energy Futures Group (EFG)
  - A second on low-carbon transportation, by M.J. Bradley & Associates (MJBA)
- Our conclusions are based on these analyses and our own work on these issues globally

Efficiency is the Overlooked Resource



EU-27 GHG abatement cost curve beyond BAU – 2030

Efficiency Programs Save 9x More Carbon Per Consumer GBP Than Carbon Taxes Or Prices

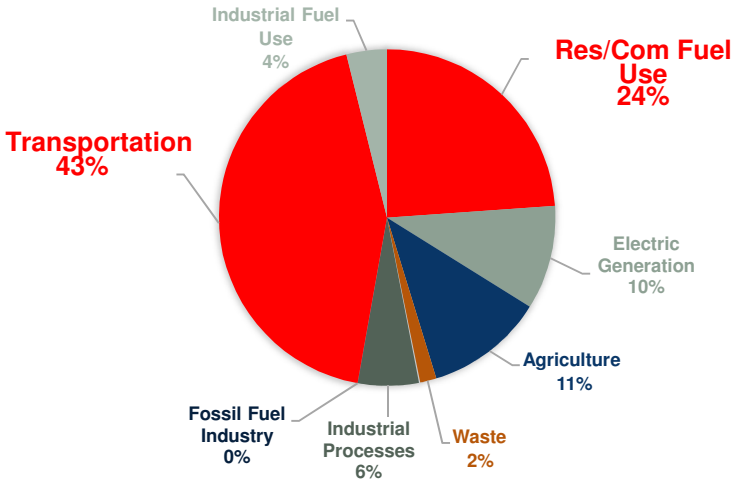


Vermont Succeeds with Efficiency First

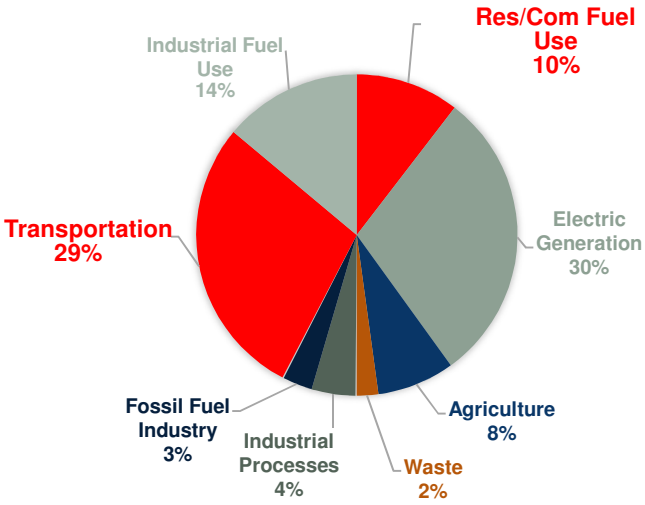
- Vermont pioneers – Sec 248; EE dockets; Efficiency Vermont
- Efficiency now avoids 20% of total power demand (EVT + utility programs to date)
- Larger than solar, wind, biomass, methane generation
- Has generated $2.5 billion in electric energy savings
- Avoiding carbon emissions at better than zero cost

Now for the hard part

VERMONT GHG EMISSIONS



U.S. GHG EMISSIONS



Transportation and heat = 67% of GHG emissions in Vermont, only 39% in US

Vermont's Fossil Energy Bill

- $500 Million for fossil heat & $1.5 Billion for gasoline and diesel fuel

$2 Billion = 35,000 HH

More than 2X the entire Ag economy

The total income of 35,000 average VT families

Carbon Efficiency Questions:

1. How many tons will it save?

2. How fast?

3. How much will it cost the public per ton avoided?

4. Is it fair? Does it advance energy justice?

Transportation Carbon Mitigation Two Scenarios

- Business as Usual Assumptions
  - No change to current CAFE standards and
  - No standards or policies designed to reduce the carbon intensity of traditional liquid fuels; and
  - Relatively low levels of EV adoption.
- 80x50 Assumptions
  - Annual increases in new vehicle fuel efficiency beyond current standards;
  - Annual reductions in the carbon intensity of liquid transportation fuels; and
  - Significantly higher levels of EV penetration than in the baseline case.
  - Does not reflect enhancements to public transportation or other policy action to limit expected increases in personal-, medium-, or heavy-duty vehicle miles traveled.

Low-Carbon Transportation — 3 Strategies Studied

1. Significant electrification of vehicles including (a) light-duty, (b) medium-duty, and (c) heavy-duty vehicles;
2. Increased efficiency in remaining new conventional vehicles; and
3. Greater use of bio-based renewable fuels in conventional vehicles.

Good News: Light-Duty EVs in Vermont

- Light-duty EVs can become cost competitive with conventional vehicles in roughly the next ten years @ approximately $16 per metric ton (MT) of GHG avoided.
- Through 2050, the required public support could be as low as $3/MT.
- To put Vermont on this path to electrifying light-duty vehicles, investment of $70 million (2018$) will be required over the next ten years, while after 2030, required investment would be only another $3 million.

5 Potential Heating Efficiency Programs Analyzed

- Residential **low-income weatherization** of oil- and propane-heated homes
  - ~ 44% of the market over ten years – 18,000 units
- Residential **non-low-income weatherization** of oil- and propane-heated homes
  - ~ 45% of the market over ten years – 50,000 units
- Installing **cold climate heat pumps** in homes heated with oil or propane;
  - ~ 50% of the market over ten years – 75,000 heat pumps
- Switching **heat pump water heaters** into homes whose water is heated with oil or propane;
  - ~ 28% of the market over ten years -- 35,000 heat pumps
- Retrofitting **schools with wood pellet boilers** to displace oil heat.
  - ~ 50% of the market over ten years – 90 schools

Heating Programs: Costs & Benefits

Measures	Total Cost Perspective				Program Cost Perspective			
	NPV Costs	NPV Benefits	NPV Net Benefits	BCR	NPV Costs	NPV Benefits	NPV Net Benefits	BCR
Efficiency								
Non-low income weatherization	$281	$348	$67	1.24	$159	$348	$189	2.19
Low Income weatherization	$152	$195	$42	1.28	$152	$195	$42	1.28
Electrification								
Cold Climate Heat Pumps	$306	$316	$10	1.03	$167	$316	$149	1.89
Heat Pump Water Heaters	$27	$49	$22	1.81	$30	$49	$19	1.62
Biofuels								
Wood Pellet boilers for schools	$20	$46	$26	2.26	$16	$46	$30	2.84

Ten-year programs
Costs and benefits in millions 2018$
NPV = present value (2018)

Heating Programs: Carbon Reductions & Costs/Ton Avoided*

Measures	Lifetime CO2 Reduced from Measures Installed over 10 Prog Yrs (Metric Tons)	Average Annual Program Budget (millions of 2018 $)	Levelized $/Ton of Lifetime CO2 Reduced (Total Cost Perspective)	Levelized $/Ton of Lifetime CO2 Reduced (Program Perspective)
Efficiency				
Non-low income weatherization	1,458,078	$18	($75)	($212)
Low Income weatherization	817,850	$18	($84)	($84)
Electrification				
Cold Climate Heat Pumps	1,795,531	$19	($8)	($119)
Heat Pump Water Heaters	314,094	$3	($97)	($83)
Biofuels				
Wood Pellet boilers for schools	340,222	$2	($131)	($152)

***Note: since energy savings exceed costs for all 5 programs, the carbon savings are better than free.**

Heating Programs: Summary

Vermonters will save $954 million over the lives of these measures. Public program costs will total $524 million.

	Total Cost Perspective				Program Cost Perspective			
	NPV Costs	NPV Benefits	NPV Net Benefits	B/C Ratios	NPV Costs	NPV Benefits	NPV Net Benefits	B/C Ratios
Totals, All Programs	$786	$954	$167	1.21	$524	$954	$429	1.82

Millions of $ (2018)

Average Program Costs Per Ton of CO_2 Avoided (2018$)

WCI Carbon-Pricing Only	$403
Light-Duty Vehicle Strategies	$16
Buildings & Heating Strategies	-$142

Conclusions

- Urgency: a 2030 roadmap is needed
- Good news: Vermont's history of creative, resourceful leadership
- Initial steps now:
  1. Expand the **Weatherization Assistance Program**
     - Focus first on low-income housing – 750 units per year out of 50,000 units is not enough
     - Fossil fuels should contribute to efficiency at a level closer to power and gas
  2. **Thermal efficiency** in housing is also a priority – leverage existing institutions to drive change faster
  3. Continue and expand support for **advanced wood heat** for Vermont schools

Conclusions

- Support a strong regional **Transportation Climate Initiative** – and have a backup plan for vehicles
- Start now with a program for **low-income and working families**' access to low-emissions cars – e.g., used EVs, PHEVs, hybrids

Additional Resources

- *Ensuring Electrification in the Public Interest*
- *Beneficial Electrification of Space Heating*
- *Beneficial Electrification of Water Heating*
- *Beneficial Electrification of Transportation*
- *Affordable Heat: Whole-Building Efficiency Services for Vermont Families and Businesses*
- *The carbon floor price – a hammer in need of a toolbox*
- *Carbon caps and efficiency resources Vt Law Rev 2008*

About RAP

The Regulatory Assistance Project (RAP)® is an independent, non-partisan, non-governmental organization dedicated to accelerating the transition to a clean, reliable, and efficient energy future.

Learn more about our work at raponline.org