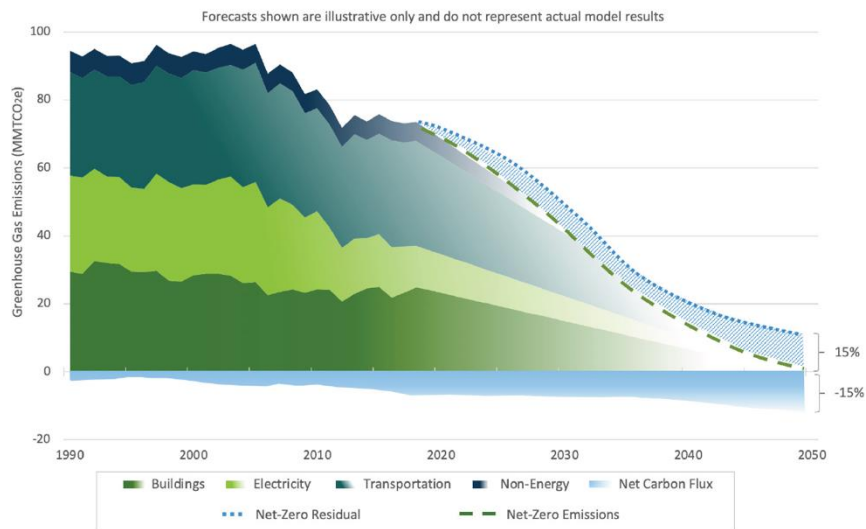


Massachusetts Decarbonization Goals

MASSACHUSETTS 2050 DECARBONIZATION ROADMAP

- 50% reduction by 2030
- 85% reduction by 2050



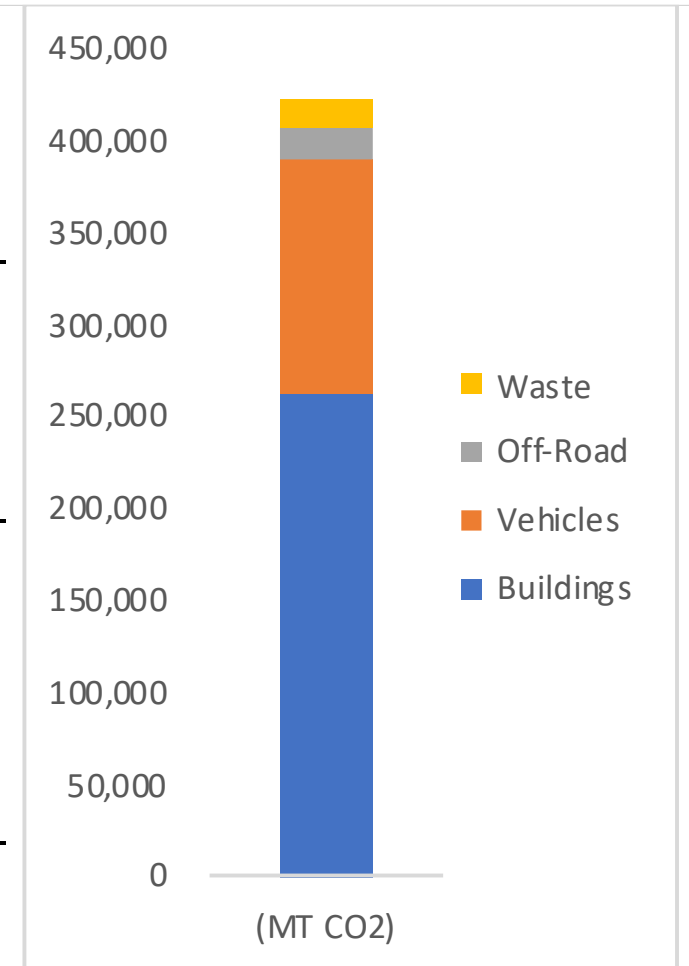
4/27/2022

MVPC/John Snell LLC

Andover's Greenhouse Gas Emissions

Community Sector	Total Carbon Emissions (MT CO2)	Emissions (%)
Buildings	263,639	58%
Vehicles	126,297	28%
Off-Road	17,794	4%
Waste	15,078	3%
Total	422,808	93%

Community Sector	Other Emissions (MT CO2e)	Emissions (%)
All sectors	30,972	7%
Total	453,779	100%



Residential and Commercial Buildings



Heat pumps are the most cost-effective decarbonization strategy for buildings



Best to install new equipment during routine home improvements or when older HVAC system is replaced



HVAC systems turn over once every 15 to 30 years



Every building should receive energy efficiency improvements



At least two-thirds should receive deep energy efficiency improvements



New and expanded financing strategies will be needed to defray upfront costs

Residential Buildings

Building Type	Homes (#)	Average Area (SF)	Average Electricity (kWh)	Average Natural Gas (therms)	Average Oil (gallons)
Single-Family- Detached	8,967	2,977	10,741	1,101	1,430
Single-Family- Attached	396	2,038	7,353	753	979
Multi-Family, 2-4 Units	789	1,191	4,297	440	572
Multi-Family, 5+ Units	2,208	849	3,063	314	408
Mobile Homes	9	1,030	3,716	381	495
Average		1,617	5,834	598	777
Total	12,369	30,325,368	109,410,959	9,225,699	2,579,324

Commercial Buildings

Facility type	Number of Employees	Total Electricity (kWh)	Total Natural Gas (Therms)	Total Oil (gallons)
Office	13,772	268,520,990		313,836
Education	2,720	53,033,480		61,983
Warehouse And Storage	1,398	27,257,649		31,858
Food Service	1,075	20,959,923		24,497
Health Care Outpatient	792	15,442,102		18,048
Lodging	753	14,681,695		17,159
Service	412	8,033,012		9,389
Mercantile Enclosed and Strip Malls	403	7,857,534		9,184
Food Sales	369	7,194,616		8,409
Public Assembly	296	5,771,291		6,745
Mercantile Retail (other than mall)	122	2,378,708		2,780
Total	22,112	431,131,000	10,690,290	503,887

Cost: \$250m to \$750m

Passenger and Commercial Vehicles



Switch light-duty vehicles to electric



Maintain and support existing public transit systems



Most vehicles will be replaced only twice between now and 2050



Most EV charging will happen at home (if off-road parking)



Medium-duty and heavy-duty vehicles will require retrofits to depots and fueling stations



Support active transportation with bike lanes and sidewalks

Passenger Vehicles

Vehicle type	Quantity (vehicles)	Average Daily Vehicle Miles	Average Fuel Economy (MPG):	Annual Vehicle Miles Travelled (VMT)	Annual Diesel/Gasoline (Gallons)
Gasoline	21,636	31.8	20.5	250,822,643	12,319,477
Diesel	234	38.7	24.1	3,307,682	188,076
FlexFuel	673	35.6	17.1	8,738,109	510,651
Hybrid	669	37.1	38.6	9,056,040	234,808
Electric	13				
		23,225		271,924,473	13,253,012

Commercial Vehicles

Vehicle type	Quantity (vehicles)	Average Daily Vehicle Miles	Average Fuel Economy (MPG):	Annual Vehicle Miles Travelled (VMT)	Annual Diesel/Gasoline (Gallons)
Gasoline	709	34.2	18.3	8,855,260	483,459
Diesel	47	23.1	11.1	396,694	35,803
FlexFuel	96	42.4	65.8	1,485,745	22,573
Hybrid	13	125.9	43.6	597,576	13,713
Electric	3				
		868		11,335,275	555,547

Electricity



Electricity generation will need to more than double



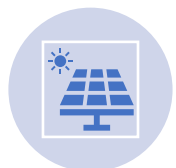
Restricting regional transmission buildout or retiring thermal generation plants may increase costs significantly



Carbon emissions from the electricity system will need to approach zero



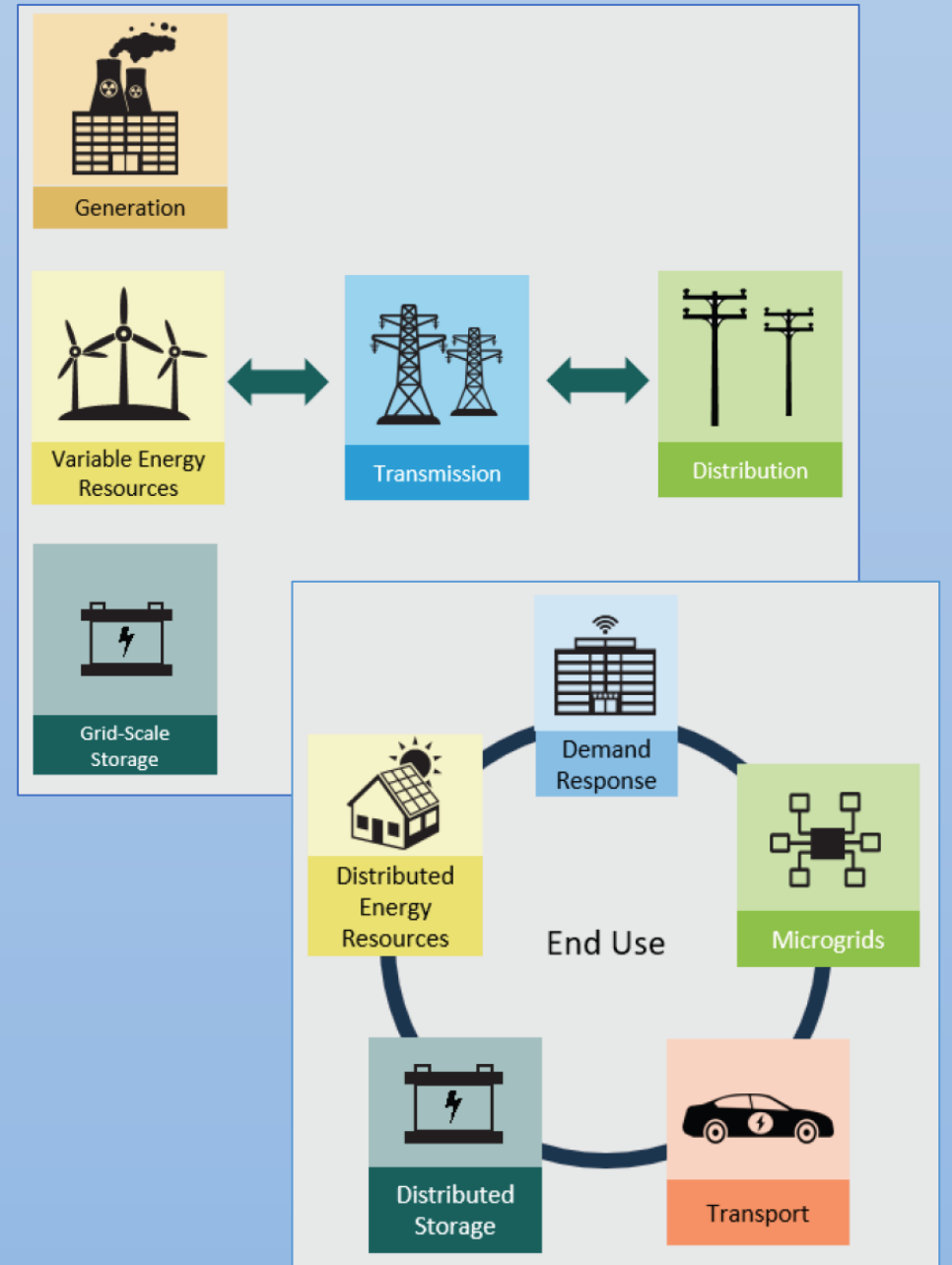
Offshore wind and solar must be deployed at scale (15-20 GW of each)



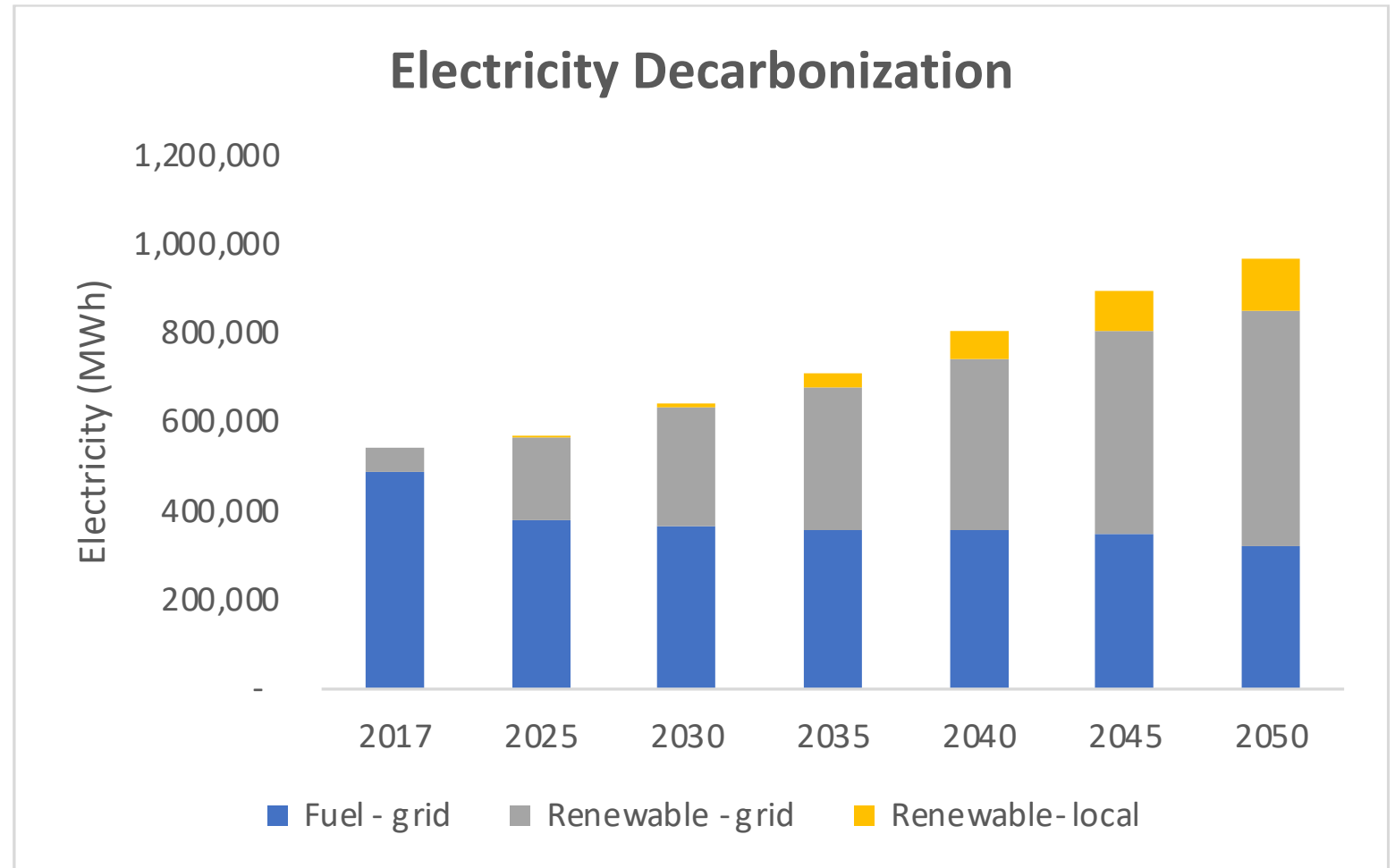
Strategically placed solar installed locally will have distribution system benefits



Reliability resources (load management & bulk storage) will be needed



Andover's Electricity Use and Sources Forecast



Andover's Solar PV Potential

Facility name	Available Roof Area (SF)	Available Land Area (Acres)	Estimated Solar PV Peak Output (kW)	\$3,496 < 250 kW Roof (\$)	\$5,000 < 1 MW Parking (\$)	\$1,500 <1 MW Ground (\$)	\$1,200 >1 MW Ground (\$)	Total Solar PV (\$)
Single-Family- Detached	2,669,476		8,064	28,189,533				28,189,533
Single-Family- Attached	80,705		244	852,239				852,239
Multi-Family, 2-4 Units	93,970		284	992,317				992,317
Multi-Family, 5+ Units	187,459		566					-
Mobile Homes	927		3	9,789				9,789
Parking lots		10.0	1,316		6,578,947			6,578,947
Parking lots		10.0	1,316		6,578,947			6,578,947
Parking lots		10.0	1,316		6,578,947			6,578,947
Commercial PPA		150.0	19,737				23,684,211	23,684,211
Commercial PPA		150.0	19,737				23,684,211	23,684,211
Commercial PPA		150.0	19,737				23,684,211	23,684,211
Commercial PPA		150.0	19,737				23,684,211	23,684,211
	3,032,537	630.0	82,898	\$30,043,879	\$19,736,842	\$0	\$94,736,842	\$144,517,563

Natural Gas



Widespread electrification will disrupt natural gas distribution markets



Blending large volumes of biogas or synthetic methane will increase prices



A shrinking number of customers will bear the cost of maintaining the gas distribution pipelines



Retiring segments of the distribution system will require retiring consumers' HVAC equipment early



Higher costs cannot be borne by the consumers least able to pay



Steps must be taken to provide for an orderly and equitable transition



Three Key Questions

How much will people do on their own?

- Homes
- Businesses
- Transportation

How much regulation will be required?

- Federal
- State
- Municipal

How much will it cost and who pays?

- Equitable utility grid upgrades
- Equitable transition from oil/natural gas
- Equitable financial opportunities and shared cost

Next Steps

Any questions about this information?

Break out groups

- Residential buildings
- Commercial buildings
- Vehicles/ Mass Transit/ Active Movement

Report back

- Thoughts and suggestions
- Additional questions/ research required