GWSA IAC Meeting

December 6, 2018

Massachusetts Global Warming Solutions

Agenda

- Review draft meeting minutes of October 23, 2018
- Agency updates
- Discuss the GWSA 10-Year Progress Report
- Discuss the Comprehensive Energy Plan
- Summary of projected 2050 GHG emissions in LEAP reference scenario and discussion of the 80x50 Study
- Discuss proposed IAC work plan for 2019
- Wrap up, next steps

GWSA 10 Year Progress Report: High Level Summary

Purpose & Scope

- Report on the progress of GWSA implementation and "shall include recommendations regarding such implementation."
- Evaluate how policies listed in the updated Clean Energy and Climate Plan for 2020 have reduced GHG emissions in the last 5 years and how much more reductions can be expected for 2020.

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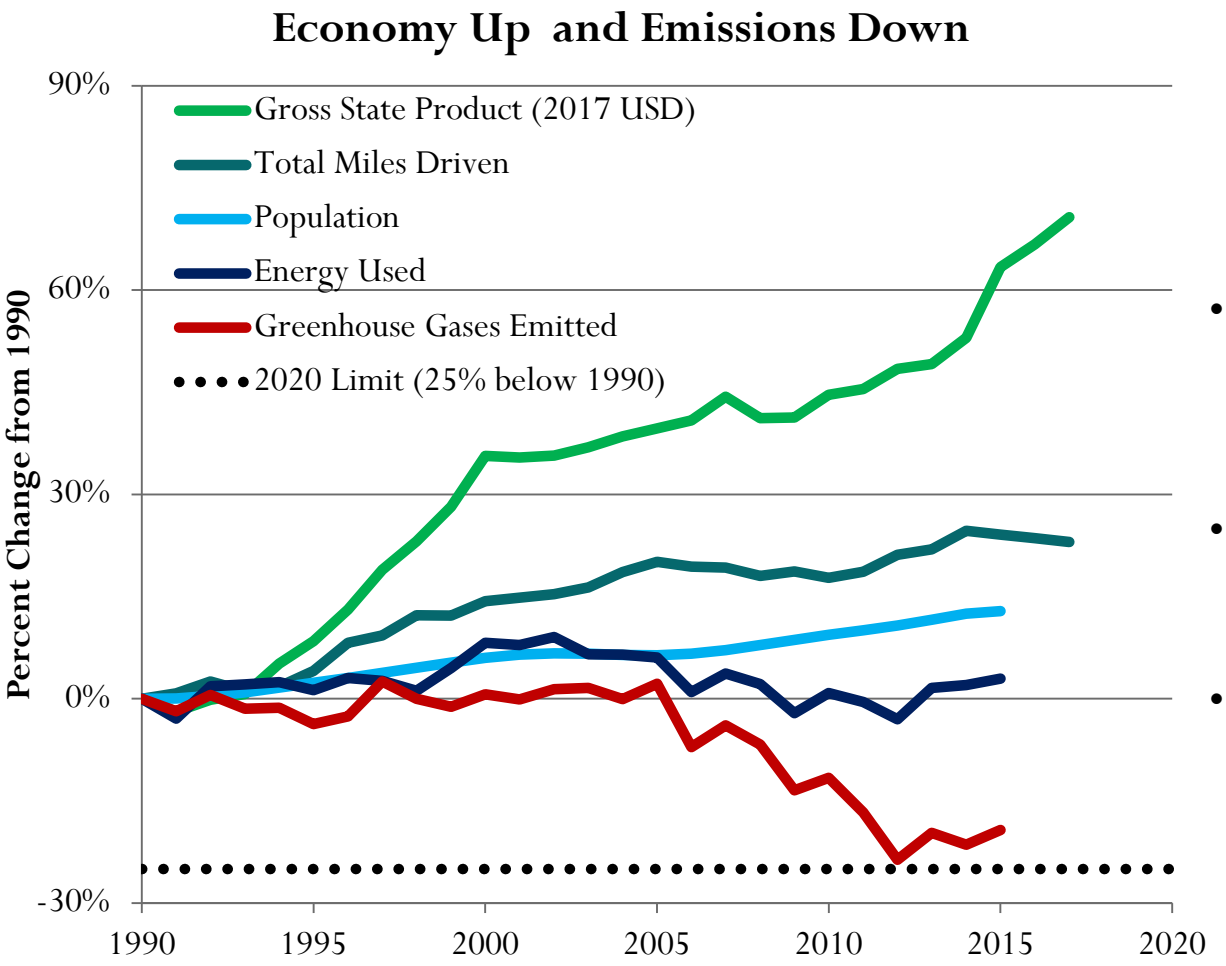
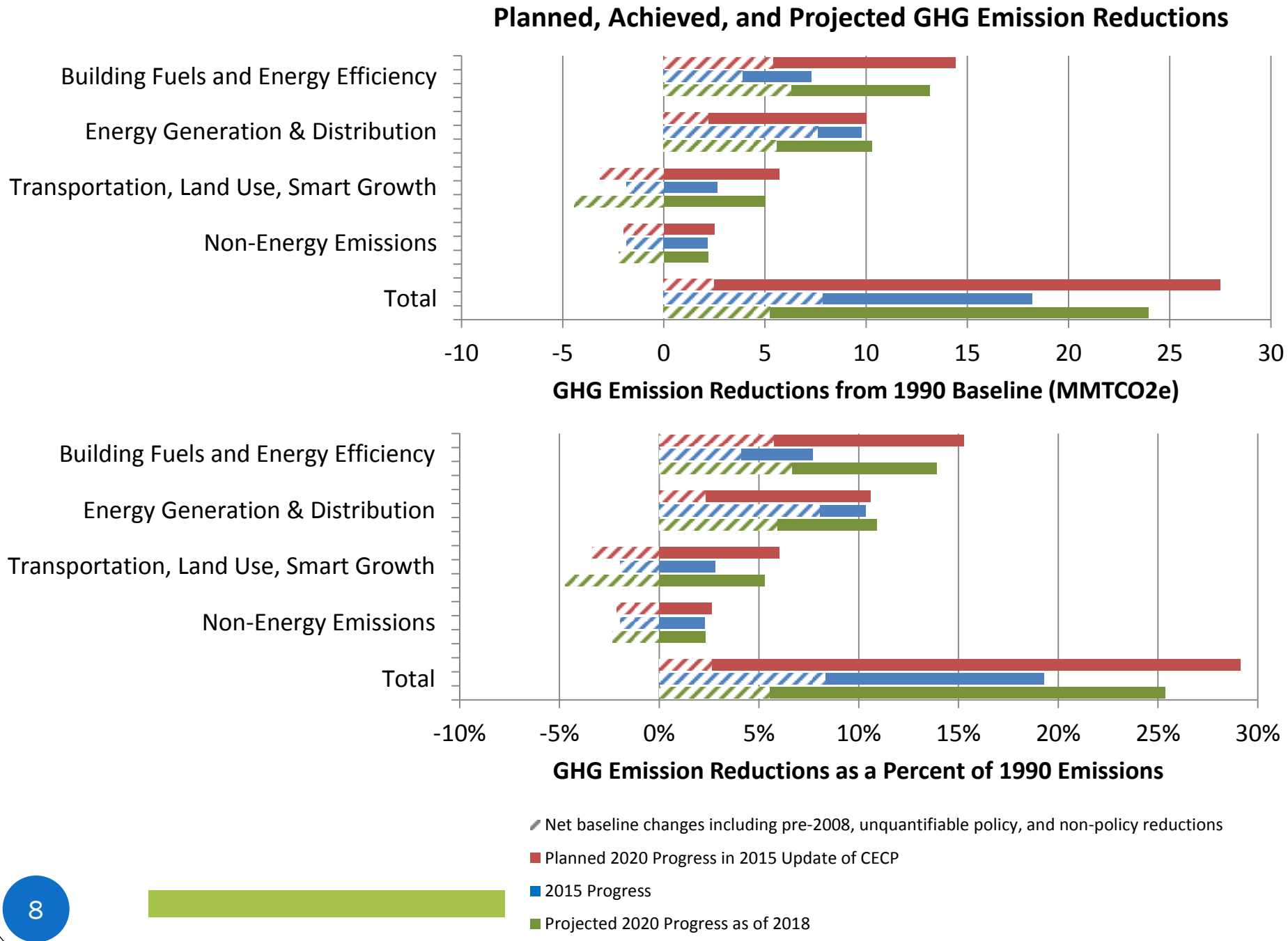
Main Highlights



- Gross GHG emissions in 2015 were 19% below the 1990 baseline.
- After adjusting for inflation, Massachusetts' Gross State Product has increased by more than $91 billion (21%), from $436 billion in 2008 to $527 billion in 2017 (all values in constant 2017 dollars; nominal value of GSP in 2008 was $385 billion).
- Gross GHG emissions decreased despite a 13% growth in population and 23% growth in vehicle miles traveled.
- Vehicle standards are lowering the carbon intensity of each vehicle mile traveled.
- Energy efficiency measures in buildings are helping to control energy demand despite increased economic growth and variable weather conditions.

Main Highlights, cont.

- **First 5 years, 2008-2013:** Building institutional capacity, coordination, collaboration, and stakeholder engagements.
- **Second 5 years, 2014-2018:** Continuing capacity-building, coordination, collaboration, and stakeholder engagements.
  - GHG reductions are now estimated for all policies in the 2015 Update of the Massachusetts Clean Energy and Climate Plan for 2020:
    - 18.2 MMTCO2e were reduced between 1990 and 2015. Approximately 10.3 MMTCO2e of that are attributed directly to the implementation of GHG mitigation policies since 2010.
    - The Commonwealth expects GHG emissions in 2020 to be 25% below the 1990 baseline.


Planned, Achieved, and Projected GHG Emission Reductions
Building Fuels and Energy Efficiency
Energy Generation & Distribution
Transportation, Land Use, Smart Growth
Non-Energy Emissions
Total
-10
-5
0
5
10
15
20
25
30
GHG Emission Reductions from 1990 Baseline (MMTCO2e)
Building Fuels and Energy Efficiency
Energy Generation & Distribution
Transportation, Land Use, Smart Growth
Non-Energy Emissions
Total
-10%
-5%
0%
5%
10%
15%
20%
25%
30%
GHG Emission Reductions as a Percent of 1990 Emissions
Net baseline changes including pre-2008, unquantifiable policy, and non-policy reductions
Planned 2020 Progress in 2015 Update of CECP
2015 Progress
Projected 2020 Progress as of 2018

	Planned 2020 GHG Emissions Reduction		2015 Progress		Projected 2020 GHG Emissions Reduction	
	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level
Building Fuels and Energy Efficiency	**9.0**	**9.5%**	**3.4**	**3.6%**	**6.8**	**7.2%**
All Cost Effective Energy Efficiency	5.4	5.8%	2.7	2.9%	5.1	5.4%
Advanced Building Energy Codes	1.5	1.6%	0.6	0.6%	0.8	0.9%
Building Energy Rating and Labeling	—	—	Cross-cutting policy; reduction reflected elsewhere.			
Expanding Energy Efficiency Programs to Commercial and Industrial Heating Oil	<<0.1	<<0.1%	Reductions to be included in All-Cost Effective Energy Efficiency			
Appliance and Product Standards	1.0	1.1%	<<0.1	<<0.1%	0.8	0.8%
Renewable Thermal Technologies	1.0	1.1%	<<0.1	<<0.1%	0.1	0.1%
Tree Retention and Planting to Reduce Heating and Cooling Loads	<<0.1	<<0.1%	<<0.1	<<0.1%	<<0.1	<<0.1%

	Planned 2020 GHG Emissions Reduction		2015 Progress		Projected 2020 GHG Emissions Reduction	
	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level
Transportation, Land Use, and Smart Growth	**5.7**	**6.1%**	**2.6**	**2.8%**	**5.0**	**5.3%**
Federal and California Vehicle Efficiency and GHG Standards (CAFE/Pavley)	3.7	3.9%	2.2	2.3%	3.7	4.0%
Federal Emissions and Fuel Efficiency Standards for Medium and Heavy Duty Vehicles	0.4	0.4%	<<0.1	<<0.1%	0.5	0.5%
Federal Renewable Fuel Standard (RFS) and Regional Clean Fuel Standard (CFS)	0.1	0.1%	<<0.1	<<0.1%	0.1	0.1%
Clean/Electric Vehicle Incentives	0.1	0.1%	Reductions included in CAFE/Pavley standards			
State Transportation Initiatives and Regulations (policy formerly called GreenDOT)	1.0	1.1%	Reductions included in CAFE/Pavley standards			
Transportation Climate Initiative	—	—	Cross-cutting policy; Reductions reflected elsewhere.			
Smart Growth	0.4	0.4%	0.4	0.4%	0.7	0.8%

	Planned 2020 GHG Emissions Reduction		2015 Progress		Projected 2020 GHG Emissions Reduction	
	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level
Electricity Generation and Distribution	**7.8**	**8.2%**	**2.2**	**2.3%**	**4.7**	**4.0%**
Coal-Fired Power Plant Retirements	2.7	2.9%	1.7	1.7%	2.7	2.9%
Regional Greenhouse Gas Initiative (RGGI)	—	—	Cross-cutting policy; reductions counted elsewhere.			
Renewable Portfolio Standard (RPS)	1.1	1.1%	0.5	0.5%	1.0	1.1%
Clean Energy Standard (CES)	—	—	0.0	0.0%	1.0	1.0%
Clean Energy Procurements	4.0	4.2%	Some reductions to be counted in RPS and CES after 2020.			
Electric Grid Modernization	—	—	Cross-cutting policy; reduction counted elsewhere.			

	Planned 2020 GHG Emissions Reduction		2015 Progress		Projected 2020 GHG Emissions Reduction	
	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level	MMTCO2e	% of 1990 level
Non-Energy Emissions	**2.5**	**2.6%**	**2.2**	**2.3%**	**2.2**	**2.3%**
Reducing GHG Emissions from Plastics Combustion	0.3	0.3%	0.1	0.1%	0.1	0.1%
Reducing SF6 Emissions from Gas-Insulated Switchgear	0.4	0.4%	0.4	0.4%	0.4	0.4%
Reducing Emissions from the Natural Gas Distribution Network	1.7	1.8%	1.7	1.8%	1.7	1.8%
Stationary Equipment Refrigerant Management	0.1	0.1%	Policy not yet pursued.			

Recommendations for how to focus efforts in the next 5 years

- Develop a roadmap for meeting the GWSA emissions limit for 2050, informed by existing analyses and the forthcoming 80x50 Study.
  - Continue addressing socio-economic equity in policy design and implementation.
  - Continue to integrate climate change mitigation and adaptation strategies and policies.
  - Explore additional land use strategies and policies and promote nature-based solutions to increase carbon sequestration and avoid GHG emissions from natural and working lands.

Recommendations for how to focus efforts in the next 5 years, cont.

- **Continue implementation of policies in the Updated CECP and additional GHG mitigation policies:**

Buildings

- Continue aggressive implementation of energy efficiency as proposed in the latest 3-Year Energy Efficiency Plan for 2019-2021 filed with DPU:
  - Achieve more aggressive gas savings goals. Increase weatherization measures to improve existing building shell efficiencies and targeted winter gas savings.
  - Achieve electric energy efficiency goals and peak demand reductions. Expand programs to include new cost-effective active demand management programs such as energy storage, residential direct load control, and C&I load curtailment programs.
  - Expand electric efficiency programs to holistically serve customers and promote fuel switching to more efficient and lower GHG emitting heating and hot water systems.
  - Serve more customers through additional efforts to serve moderate income, non-English speaking residents, renters, and small business customers.
  - Drive market/consumer demand for energy efficiency measures and fuel switching by educating consumers about the benefits of energy efficiency and creating a market incentive for consumers to invest in energy efficiency improvements through a "Home Energy Scorecard".
  - Further reduce energy demand in new buildings through promoting high efficiency building construction (such as meeting Passive House or Zero Energy standards).
- Explore possible ways to strengthen building codes that better support renewable energy, electrification, energy storage, and resiliency policy goals.

Recommendations for how to focus efforts in the next 5 years, cont.

Transportation

- Continue electrification of passenger vehicles, and promote electrification/decarbonization of freight vehicles.
- Continue to incentivize development in transit oriented development areas and other locations with low car travel.
- Explore regional collaboration to address greenhouse gas emissions from the transportation sector.

Electric

- Continue to increase cost-effective clean electricity supply to meet RPS and CES compliance obligations.
- Continue policies that support distributed resources, including considering policies that will support solar development in the Commonwealth after the SMART program concludes, especially projects that pair renewables with energy storage to align supply and demand and provide grid flexibility.
- Implement policies and programs, including the Clean Peak Standard, that incentivize energy conservation during peak periods.

Non-Energy

- Explore potential strategies to limit use and emissions of HFCs.

Cross-Sector

- Leverage and enhance data collection and analyses to help a diverse portfolio of government offices, public university campuses, and other state buildings track energy use and GHG emissions, as well as prioritize opportunities and strategies for future emissions reductions.
- Assist Green Communities to reduce their energy use by 20% within 5 years despite growth in demand for municipal services.
- Identify opportunities to engage more municipalities to participate in the Green Community Designation and Grant Program.
- Revise the MEPA GHG Policy and Protocol to finalize the land alteration protocol and the adaptation and resiliency policy.

Building Fuels and Energy Efficiency

Policies	Key Accomplishments and Highlights	Recommendations and Next Steps
All Cost-Effective Energy Efficiency	* The Mass Save® 3-year plans have saved on average over 800,000 metric tons/year since 2014. The program is on track to deliver over $18 billion in net benefits by 2020. * Electricity savings grew from under 1% of annual sales in 2009 to over 3% in 2017; natural gas savings grew from 0.5% to 1.2%.	* Continue Commonwealth's investment in all cost-effective energy efficiency and demand reduction thru Mass Save®, incl. new opportunities to increase gas energy efficiency. * Expand programs to promote fuel conversions from oil and propane heating to renewables and efficient electrification, * Focus on peak demand reduction in the summer and winter through new active demand management programs.
Advanced Building Energy Codes	* Widespread adoption of the Stretch energy code by over 249 towns and cities helped offset modest improvements in IECC model energy codes in recent years. * Sharp decline in residential construction during housing-led recession has returned to historical levels with more multi-family.	* The Baker-Polito Administration has set a goal of 135,000 new housing units by 2025 (Housing Choice Initiative). Explore how best to encourage high efficiency building construction in cost-effective manner. * Explore possible ways to drive additional efficiency in new construction and better support renewable energy, electrification, energy storage, and resiliency policy goals.
Building Energy Rating and Labeling	* DOER's 'HomeMPG' and 'Home MVP' energy scorecard pilots led to commitment to residential scorecard integration in Mass Save® programs. The Baker-Polito Administration filed proposed legislation in 2018 to require home energy scorecard disclosure during real estate transactions. * Commercial bldg. operational performance is tracked by Boston & Cambridge. DOER's commercial asset rating pilot demonstrated challenges in asset rating of diverse range of commercial bldgs.	* Create a market incentive for consumers to invest in energy efficiency improvements through a "Home Energy Scorecard".
Expanding Energy Efficiency Programs to Commercial/ Industrial Heating Oil	* The Advance Clean Energy Act of 2018 enables fuel switching to clean energy sources in all sectors, incl. heating oil in C&I sector.	* Continue to promote fuel switching in the C&I sector.
Appliance and Product Standards	* Federal standards for various household appliances and device chargers are estimated to save Massachusetts residents more than $20 million in energy costs by 2020.	* Consider state-level and regional next-generation appliance and product standards with other US Climate Alliance states.
Renewable Thermal Technologies	* The APS was modified in 2017 to provide financial incentives for renewable thermal technologies. * The Baker-Polito Administration committed $3 million for the Renewable Thermal Infrastructure Grant Program. * MassCEC launched the Heatsmart Mass program in 2017 in select communities and the Reheat Mass program in 2018 to encourage adoption of renewable thermal technologies.	* Expand utility programs to offer consumer rebate for renewable thermal technologies, especially for air source heat pumps. * Promote fuel switching through expanded public outreach efforts.
Tree Retention and Planting To Reduce Heating and Cooling Loads	* Over 19,000 trees have been planted in 14 Gateway Cities. * The Baker-Polito Administration has committed $1 million annually in planning grants, with tree retention bylaws or incentives encouraged as one of the eligible activities.	* Continue planting efforts to hit target of five trees per acre in currently participating cities. * Expand to the remaining 12 Gateway Cities as soon as feasible.

Transportation, Land Use, and Smart Growth

Policies	Key Accomplishments and Highlights	Recommendations and Next Steps
Federal and California Vehicle Efficiency and GHG Standards (CAFE/Pavley)	* The Trump Administration proposed the ''Safer Affordable Fuel-Efficient Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks'' (SAFE Vehicles Rule) in 2018. This proposed rule would weaken existing federal vehicle efficiency and GHG standards.	* California has proposed a change to its Low Emission Vehicle rules in reaction to EPA's rulemaking, in order to ensure that its standards for model years 2021-2025 are maintained. Adopt and implement California's motor vehicle emissions standards as long as those standards are at least protective as the federal standards.
Federal Emissions and Fuel Efficiency Standards for Medium and Heavy Duty Vehicles	* First-ever fuel economy standards for medium- and heavy - duty vehicles were established by EPA and NHTSA in 2011. Phase 1 of the federal heavy-duty program covers model years 2014 to 2018, expected to provide nearly $50B in fuel savings nationally. * Building on the success of the Phase I standards, EPA and NHTSA jointly finalized Phase 2 standards in 2016 for medium- and heavy-duty vehicles through model year 2027.	* Assess EPA's Cleaner Trucks Initiative (CTI), a future rulemaking announced in November 2018 to update standards for nitrogen oxide (NOx) emissions from highway heavy-duty trucks and engines, to see if GHG co-benefits will result.
Federal Renewable Fuel Standard (RFS) & Regional Clean Fuel Standard (CFS)	* Implementation of the RFS is ongoing.	
Clean/Electric Vehicle Incentives	* The MOR-EV program has provided approximately $23 million to provide over 11,300 rebates to consumers who purchased or leased plug-in electric vehicles since its start in 2014. * The MassEVIP Fleets program has funded $2.66 million for 267 EVs and 92 publicly accessible EV charging stations for MA municipalities, state agencies, and state colleges and universities. The MassEVIP Workplace Charging Program has funded $1.35 million for 543 EV charging stations at 265 separate locations.	* Allocate $16 million of Massachusetts's VW Settlement funding to projects that support electrification of the transportation network in Massachusetts, including $11 million to support the purchase of electric transit buses by the Pioneer Valley and Martha's Vineyard transit authorities and $5 million for the installation of electric vehicle supply equipment.
State Transportation Initiatives and Regulations	* MassDOT has converted tolled highways in Massachusetts to electronic tolling. * MBTA has replaced 50% of the commuter rail fleet with new hybrid diesel-electric locomotives. * MassDEP finalized regulations 310 CMR 60.05 and 310 CMR 60.06 in 2017 to address transportation emissions.	* Explore the feasibility of using zero emissions bus technology in the MBTA fleet.
Smart Growth	* EEA launched a Planning Grant Program in 2017 to help municipalities update their land use plans and regulations, favoring projects that address climate change. Over $2 million has been provided to advance 68 different planning projects. * The Baker-Polito Administration launched its Housing Choice Initiative in 2018 to promote housing production in sustainable patterns and places.	* Pursue necessary information and establishing systems to track the effectiveness of VMT reductions and changes in land use and land cover change associated with smart growth.

	Policies	Key Accomplishments and Highlights	Recommendations and Next Steps
Electricity Generation and Distribution	Coal-Fired Power Plan Retirements	* A reduction of 5.0 MMTCO2e was accomplished by 2018, but closure of Pilgrim nuclear plant in 2019 will give a net GHG reduction of 2.7 MMTCO2e by end of 2020. * MassDEP promulgated 310 CMR 7.74 in 2017 to impose annually declining limits on emissions from Massachusetts' remaining fossil fuel-fired power plants.	* Develop a Clean Peak Standard to reduce demand for oil-fired power during periods of peak electricity demand starting in 2019 and ending in 2050, as required by the Advance Clean Energy Act of 2018.
	Regional Greenhouse Gas Initiative (RGGI)	* RGGI allowance auctions have raised more than $500 million for Massachusetts. * RGGI delivered a clear "price signal" to electricity markets, which, in combination with falling natural gas prices, has reduced the regional electricity sector's emissions by more than 50% since it began in 2009.	* Participate in regional discussions on bringing in new states and planning for 2021 program review.
	Renewable Portfolio Standard (RPS)	* The Advance Clean Energy Act of 2018 raises the RPS annual incremental increase by an additional 1% for 2020-2029.	* Extend SMART Solar Program and prioritize further pairing with electric storage.
	Clean Energy Standard (CES)	* MassDEP promulgated 310 CMR 7.75 in 2017 settings a minimum percentage of electricity sales that utilities and competitive suppliers must procure from clean energy sources, beginning at 16% in 2018 and increasing 2% annually to 20% in 2020 and 80% in 2050.	* Partner with municipal light plants to advance GHG emission reductions, including review of phasing in CES. * Explore expanding eligibility to include existing (pre-2010) generators.
	Clean Energy Procurements	* Governor Baker signed the Energy Diversity Act of 2016 requiring utilities to competitively solicit and contract for 1,200 MW of clean energy generation and 1,600 MW of offshore wind. * The New England Clean Energy Connect project (delivering hydroelectric generation in New England from Quebec) and Vineyard Wind (delivering 800 MW of offshore wind) have been selected and are in contract negotiations. Both projects are expected to be online in the 2020s.	* Investigate the necessity, benefits, and costs of an additional procurement of up to 1600 MW of offshore wind, as required by the Advance Clean Energy Act of 2018.
	Electric Grid Modernization	* DPU issued an Order in May 2018 authorizing Massachusetts' investor-owned utility companies to invest $220 million in grid modernization technologies over the next three years to improve the efficiency and reliability of the electric grid.	* Facilitate stakeholder outreach and investigate investments in advanced metering infrastructure, or "smart meters."

	Policies	Key Accomplishments and Highlights	Recommendations and Next Steps
Non-Energy Emissions	Reducing GHG Emissions from Plastics Combustion	* The Massachusetts 2010-2020 Solid Waste Master Plan (SWMP), published in April 2013, sets a goal of decreasing solid waste disposal by 30 percent by 2020 and by 80 percent by 2050. * MassDEP has awarded over $7.5 million in Sustainable Materials Recovery Program Municipal Grants since 2010.	* Develop the 2020-2030 Solid Waste Master Plan, with a goal of completing the 2020-2030 SWMP by the end of 2020.
	Reducing SF_6 Emissions from Gas-Insulated Switchgear	* MassDEP amended the regulation 310 CMR 7.72 *Reducing Sulfur Hexafluoride Emissions from Gas-Insulated Switchgear* to add declining annual limits on total SF6 emissions from large electric utilities.	* Continue to implement 310 CMR 7.72.
	Reducing Emissions from the Natural Gas Distribution Network	* The replacement of aged cast-iron, wrought-iron and non-cathodically protected steel pipes has been accelerated, especially to repair natural gas leaks that pose significant public safety or environmental impact, in response to the Natural Gas Leaks Act of 2014, the Energy Diversity Act of 2016, and DPU directives.	*Expected promulgation of regulations that concern the investigation and identification of natural gas leaks that pose significant public safety or environmental impact. *Continue accelerated replacement of aged cast-iron, wrought-iron and non-cathodically protected steel pipes.
	Stationary Equipment Refrigerant Management	* Massachusetts joined other members of the U.S. Climate Alliance in committing to the Short-Lived Climate Pollutant Challenge to develop and implement state-specific strategies to reduce short lived climate pollutants, which include HFCs.	* Explore potential strategies to limit use and emissions of HFCs.

	Policies	Key Accomplishments and Highlights	Recommendations and Next Steps
Cross-Sector Policies	Leading By Example (LBE)	* Heating oil consumption at state facilities has decreased 84% from 2006 to 2017. * Electricity production from on-site solar PV and wind at state facilities has grown to 25 million kWh in 2017.	* Leverage and enhance data collection and analyses to help a diverse portfolio of government offices, university campuses, and other state buildings track energy use and GHG emissions, as well as prioritize opportunities and strategies for future emissions reductions. * Continue to pursue innovative approaches to moving away from fossil fuels and increasing building efficiencies, as well as drive further growth of renewable and alternative energy.
	Green Communities	* 27 Green Communities (out of 112 eligible communities) have reached their 20% energy reduction goal. * 210 of 351 cities and towns in Massachusetts have adopted the Stretch Code. * Green Communities have saved more than $170 million in municipal energy costs.	* Explore how best to maintain equity in opportunity for both long tenured and newly designated Green Communities. * Assist Green Communities to reduce their energy use by 20% within 5 years despite growth in demand for municipal services. * Identify opportunities to engage non-participating municipalities.
	MEPA GHG Policy and Protocol	* Over the past ten years, a total of 166 projects have completed MEPA review and made commitments to reduce GHG emissions by over 356,584 metric tons of CO2e per year. * MEPA review has secured commitments to design and construct a 750,000 sf office to Passive House standards; replace SF6 in refrigeration and utility infrastructure; and install EV charging infrastructure and reserve parking for EVs.	* Revise the MEPA GHG Policy and Protocol to finalize the land alteration protocol and the adaptation and resiliency policy. * Continue to require analysis of Passive House design in the Environmental Impact Reviews as an integrated approach to climate adaptation and to reduce GHG emissions while lowering energy costs.

Creating a Clean, Affordable and Resilient Energy Future for the Commonwealth

DOER
Massachusetts Department of Energy Resources

Comprehensive Energy Plan

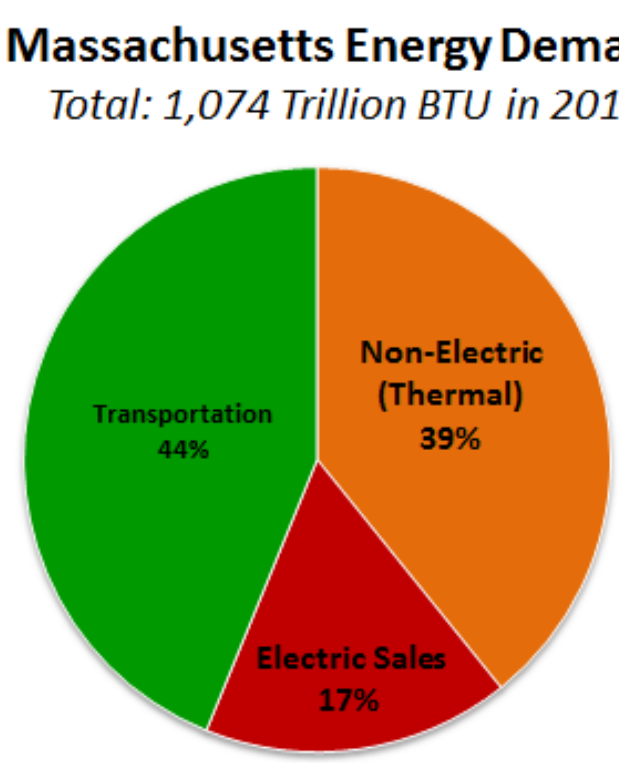
Executive Summary

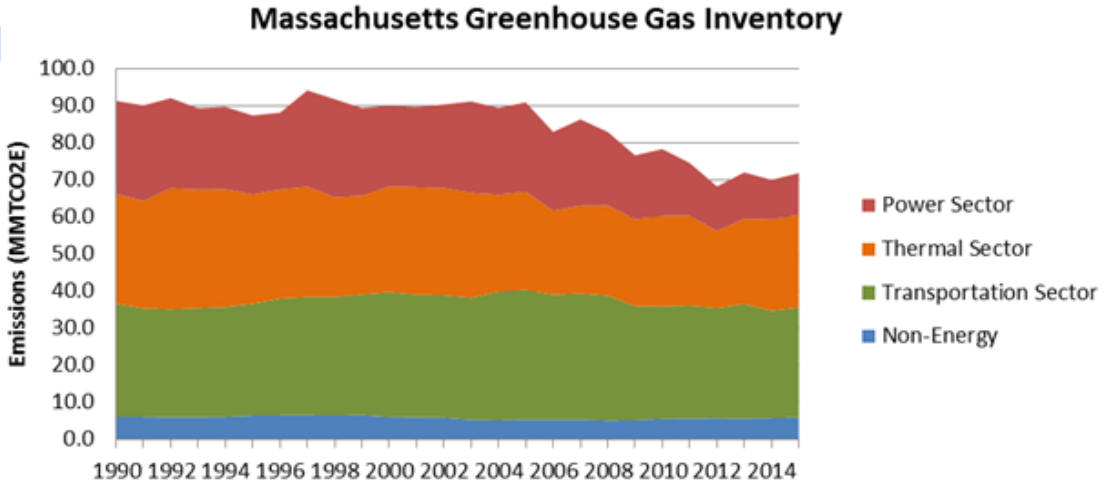
Confidential Policy Deliberative

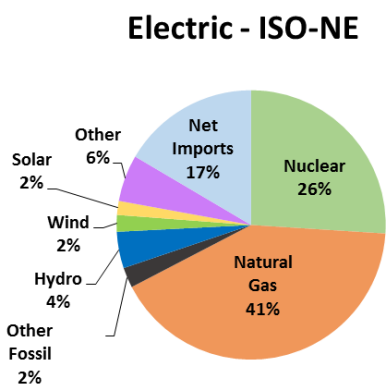
Comprehensive Energy Plan (CEP) Overview

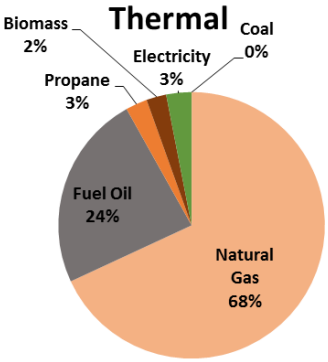
- Executive Order No. 569, *Establishing an Integrated Climate Change Strategy for the Commonwealth,* directed a **Comprehensive Energy Plan (CEP)** that includes*:*
  - Projections for energy demands for **electricity**, **transportation** and **thermal conditioning**
  - Strategies for meeting these demands in a regional context
  - Prioritizes meeting energy demand through conservation, energy efficiency, and other demand-reduction strategies
- CEP Modeling and Analysis
  - Examine impacts of policies to reduce GHG emissions on cost and reliability from now to 2030
  - Modeled under average conditions and extended cold weather conditions
- Provide policy guidance on which strategies will best balance costs, emissions and reliability

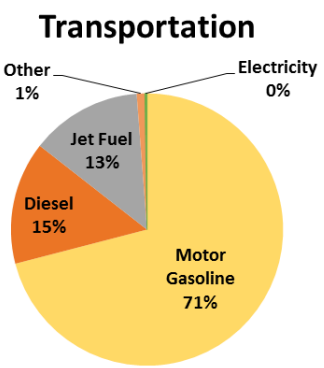
Massachusetts Energy Use and Emissions by Sector









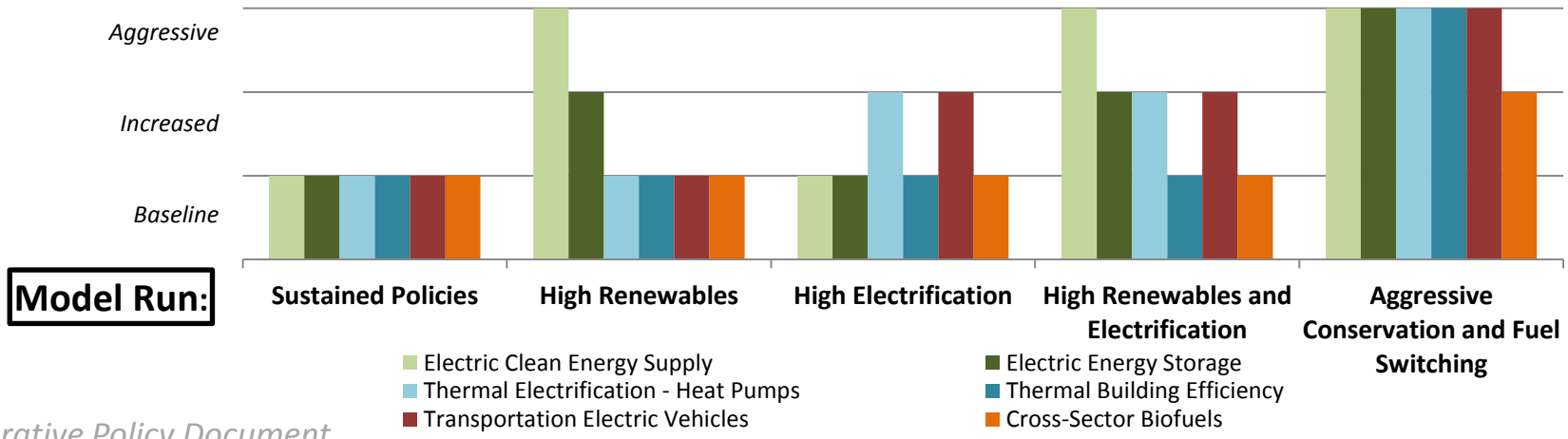


Electric generation is our smallest use of energy in the Commonwealth, but it is where we have made the greatest progress in reducing emissions

Modeling Analysis

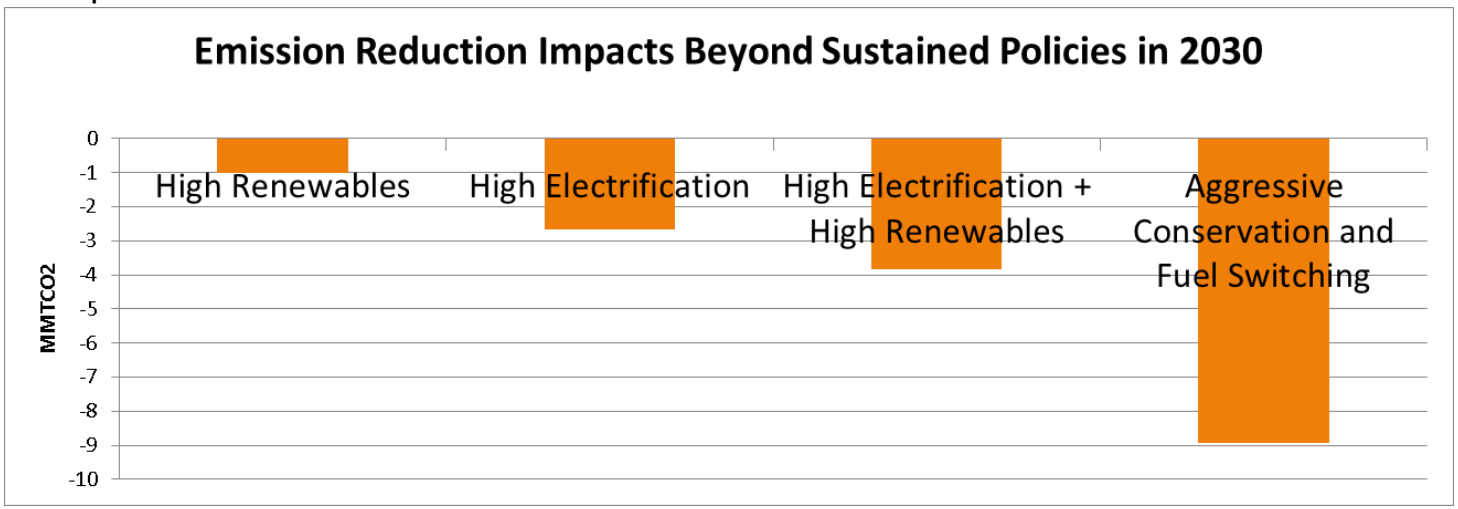
Modeled various hypothetical amounts of clean energy and demand between now and 2030 to see impact on cost, emissions and reliability:

Scenarios	Modeling Assumptions by 2030
Sustained Policies	*Assumption of what outcomes will be achieved by 2030 as a result of current policies (Pre-2018 Legislation)* 45% clean retail electricity; 500 MWh storage; 1.2 million EVs
High Renewables	*Sustained Policies with additional clean electricity:* + 16 TWh of Clean Electricity (4,000 – 7,000 MW), 65% clean retail electricity + 3x amount of energy storage (1800 MWh)
High Electrification	*Sustained Policies with increased electrification of Thermal and Transportation Sectors* + Accelerated growth in EVs (1.7 million LDV (36%) - by 2030) + 25% of oil-heated and 10% of gas-heated buildings switch to ASHP
High Renewables + Electrification	*Combine the High Renewables and High Electrification assumptions*
Aggressive Conservation + Fuel Switching	*High Renewables + Electrification scenario with:* + More aggressive fuel switching in the Thermal and Transportation sectors + 3x increase in pace of weatherization and building efficiency + 2 GW peak demand reduction



Findings: Impact on Emissions

- With sustained policies, Massachusetts estimated to achieve 35% emission reduction from 1990 levels by 2030 (~61 $MMTCO_2$); key findings for additional reductions:
  - Focusing policies primarily on the electric sector has diminishing returns, increasing rates with while realizing only modest decreases in GHG emissions
  - Electrifying the thermal and transportation sector leverages investments made in a cleaner electric grid
  - Conservation and peak demand reduction important as use of electricity for heating and transportation grows
  - Improving building efficiency is important to achieving reduced emissions in thermal sector
  - Alternative fuels, such as biofuels, can assist in transition to cleaner heating and transportation

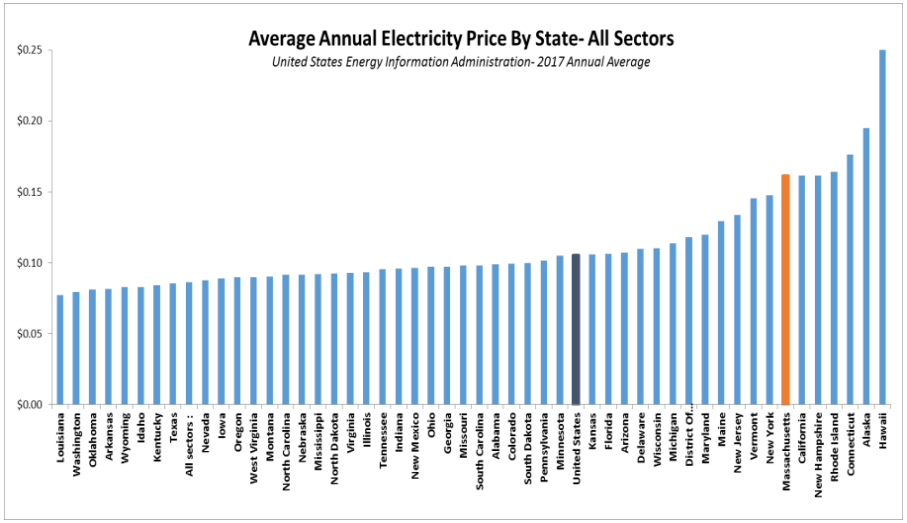


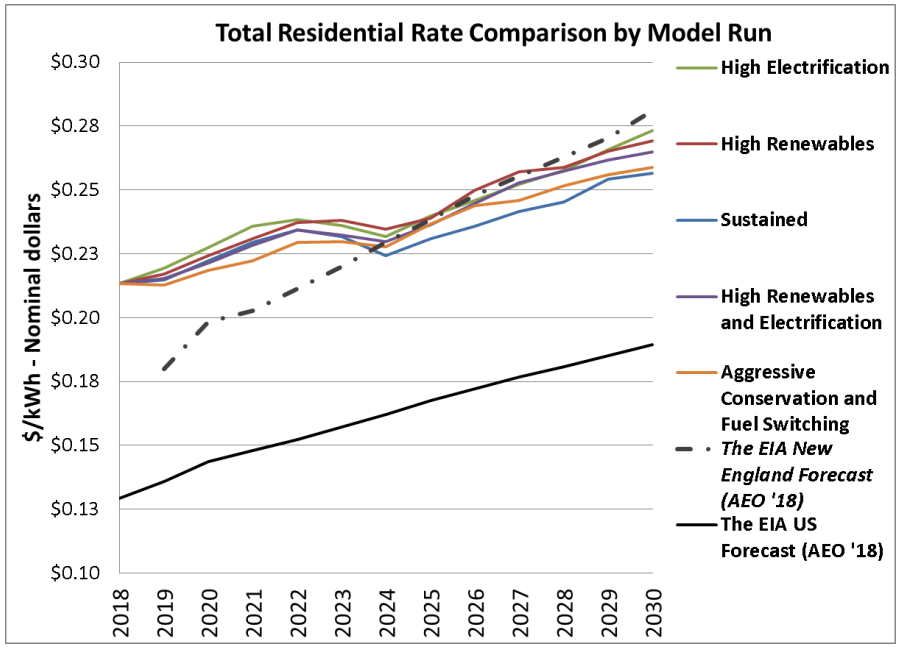
Greatest amount of emissions reductions are achieved by combining increased use of clean energy in all sectors while simultaneously decreasing overall energy consumption

Findings: Impact on Electric Rates

- All scenarios show lower retail electric rates in 2030 than projections by the U.S. Energy Information Agency (EIA), primarily due to large-scale hydro and off-shore wind procurements
- However, all other scenarios besides Sustained Policies show that additional policies aimed at the electric sector raises rates
- Energy efficiency and peak demand reduction are important for keeping electricity rates affordable, as demand for electricity in the thermal and transportation sector increases
- Finding low cost sources of clean electricity that can deliver in winter improves costs

Comparison of Current Massachusetts Electric Rates with projections for 2030



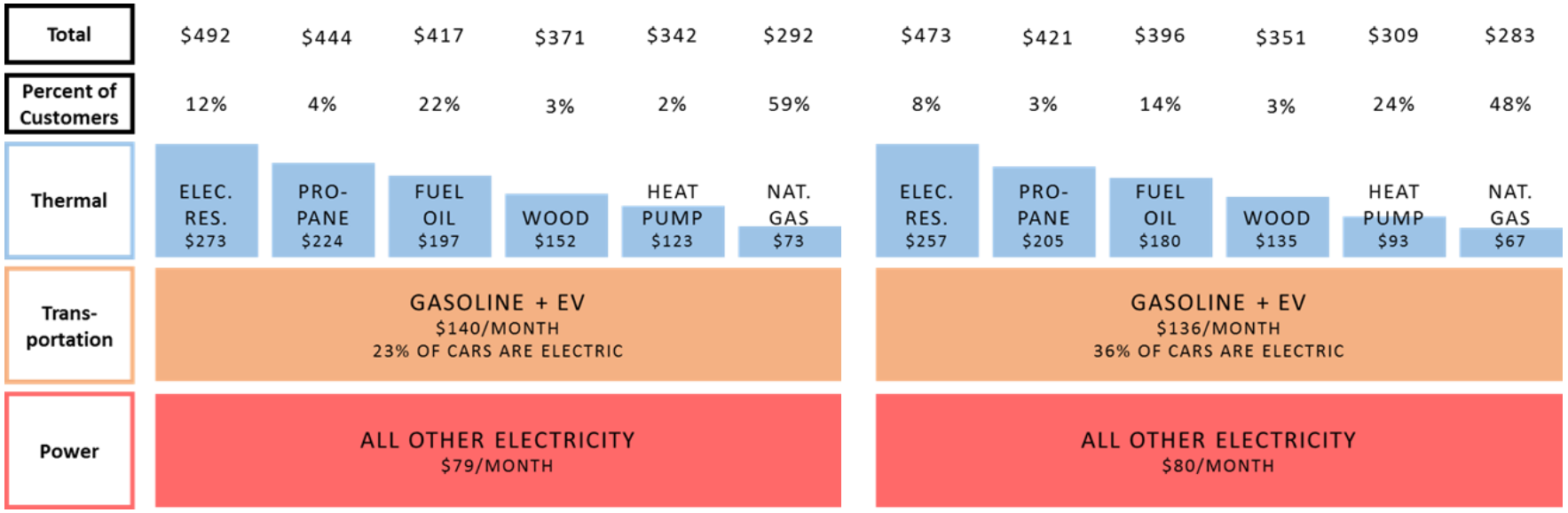


New England states have some of the highest electric rates in the nation, however Massachusetts on path to become more competitive

Findings: Impacts on Consumer Energy Bills

Sustained Policies
Average Monthly Expenditures in 2030* = **$351**

Aggressive Conservation and Fuel Switching
Average Monthly Expenditures in 2030* = **$326**

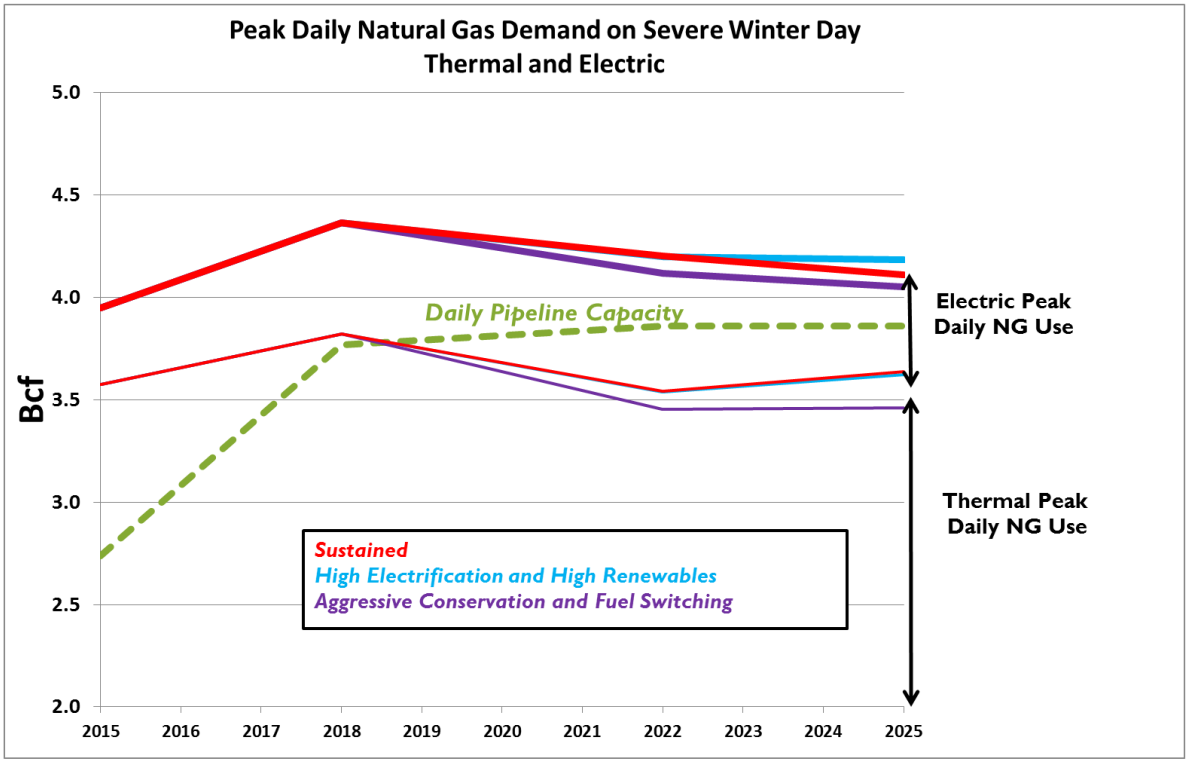


- Fuel switching from expensive fuels for heating such as electric resistance heat, propane and fuel oil to lower cost fuels, such as electric air source heat pumps and biofuels, can lower an average consumer's monthly energy bills
- Even with higher electric rates, monthly expenditures for energy are lower

Fuel switching and greater efficiency in the thermal and transportation sectors lowers consumers' monthly energy expenditures

**all values in 2018 equivalent dollars*

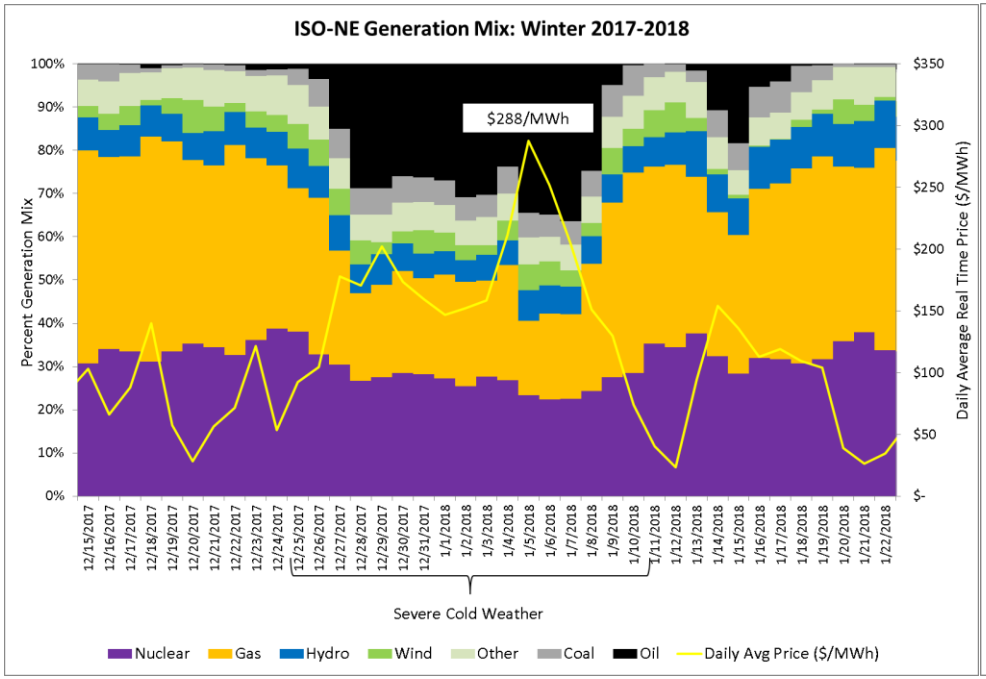
Findings: Winter Reliability and Affordability

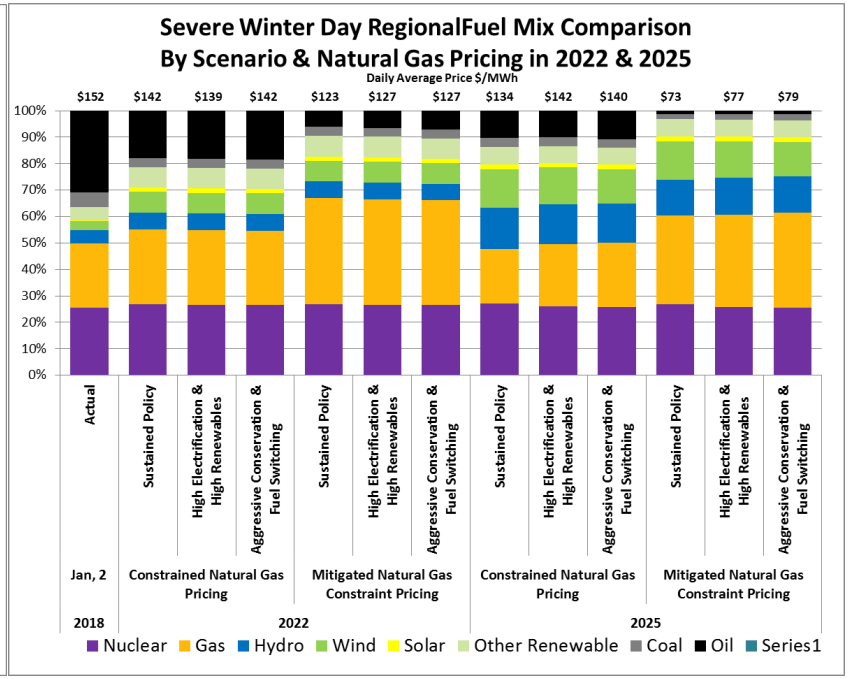


- In all scenarios modeled, the region will continue to rely on higher cost stored fuels such as liquefied natural gas (LNG) and high emission fuel oil.
- State policies that reduce natural gas demand, such as increasing clean energy supply and reducing thermal sector demand, reduces but does not eliminate reliance on oil and LNG

Region remains at risk for price spikes and emission increases during extended cold periods

Findings: Winter Reliability and Costs





- The added costs from a winter event **increase retail rates in subsequent years** across all classes of ratepayers
- The **combination** of the current large-scale **procurements** (83D and 83C) and **mitigating natural gas constraints** reduces reliance on stored fuels in a winter event, which could save 2 cents/kWh in all hours, or approximately $900 million annually if extended cold weather occurs
- **Mitigating natural gas constraints could decrease emissions 5-8%** during a winter event
- **Reducing demand in the thermal sector** (heating and cooling) reduces cost and emissions for consumers, while improving winter reliability

Mitigating natural gas constraints to lessen reliance on oil generation in the electric sector reduces the cost and emission impacts from an extended cold period

Policy Priorities and Strategies

for a clean, affordable, resilient energy future

Thermal Sector

- Leverage investments made in the clean energy sector through **electrification**
- **Promote fuel switching** in the thermal sector from more expensive, higher carbon intensive fuels to lower cost, lower carbon fuels such as electric air source heat pumps and biofuels
  - Reduce use of expensive and high emission heating fuels such as fuel oil, propane, and electric resistance heat
- Reduce thermal sector consumption
  - Explore possible ways to strengthen **building codes** to drive additional efficiency in new construction
  - Increase **weatherization** measures to improve building shell efficiencies and targeted **winter gas savings** through the MassSave efficiency programs
  - Promote high efficiency building construction, such as **passive houses**, to further reduce energy demand from the thermal sector
- Drive market/consumer demand for energy efficiency measures and fuel switching
  - Educate consumers about the benefits of energy efficiency and create a market **incentive for consumers to invest** in energy efficiency improvements through a "**Home Energy Scorecard**"
  - Address the **split incentive** between landlords and renters for investments in energy efficiency
- Invest in R&D for **clean heating fuels**, such as renewable gas and biofuels, that can utilize investments already made in heating infrastructure

Policy Priorities and Strategies

for a clean, affordable, resilient energy future

Electric Sector

- Prioritize electric energy efficiency and peak demand reductions
  - Implement policies and programs, including the **Clean Peak Standard**, that incentivize energy conservation during peak periods.
  - Develop policies to **align new demand** from the charging of EVs and heating/cooling with the production of clean, low-cost energy.
  - Include cost-effective **demand reduction** and **additional energy efficiency initiatives** in our nation-leading energy efficiency programs and plans
  - Utilize our successful **Green Communities** programs and **Leading By Example** programs to continue to make state and municipal infrastructure clean and efficient
- Continue to increase cost-effective renewable energy supply
  - Investigate policies and programs that support **cost-effective clean resources** that are **available in winter** to provide both cost and emission benefits to customers
  - Evaluate or expand **continued policies to support distributed resources,** including distributed solar and storage development in the Commonwealth after the SMART program concludes, to continue lowering costs while providing benefits to ratepayers

Policy Priorities and Strategies

for a clean, affordable, resilient energy future

Electric Sector

- Support grid modernization and advanced technologies
  - Promote cost effective **microgrids** to provide greater overall grid resiliency and reduce transmission and distribution costs from building out the grid to meet new demand
  - Review existing and possible new policies to **support new technologies**, including energy storage, that can **align supply and demand** and provide grid flexibility
- Examine potential strategies to lower the price of natural gas and **mitigate natural gas constraints**
  - Encourage **contracting with LNG supply ahead of the winter** to ensure LNG supplies are available to be used by gas-fired generation
  - Work with federal officials to explore modifying the **Jones Act** to facilitate shipping of LNG from domestic sources
  - **Reduce thermal and electric sector demand** to reduce the region's demand for natural gas

Policy Priorities and Strategies

for a clean, affordable, resilient energy future

Transportation Sector

- Increase the **deployment of EVs** and charging infrastructure.

- Support development of **liquid renewable fuels** to provide alternative transportation fuels.

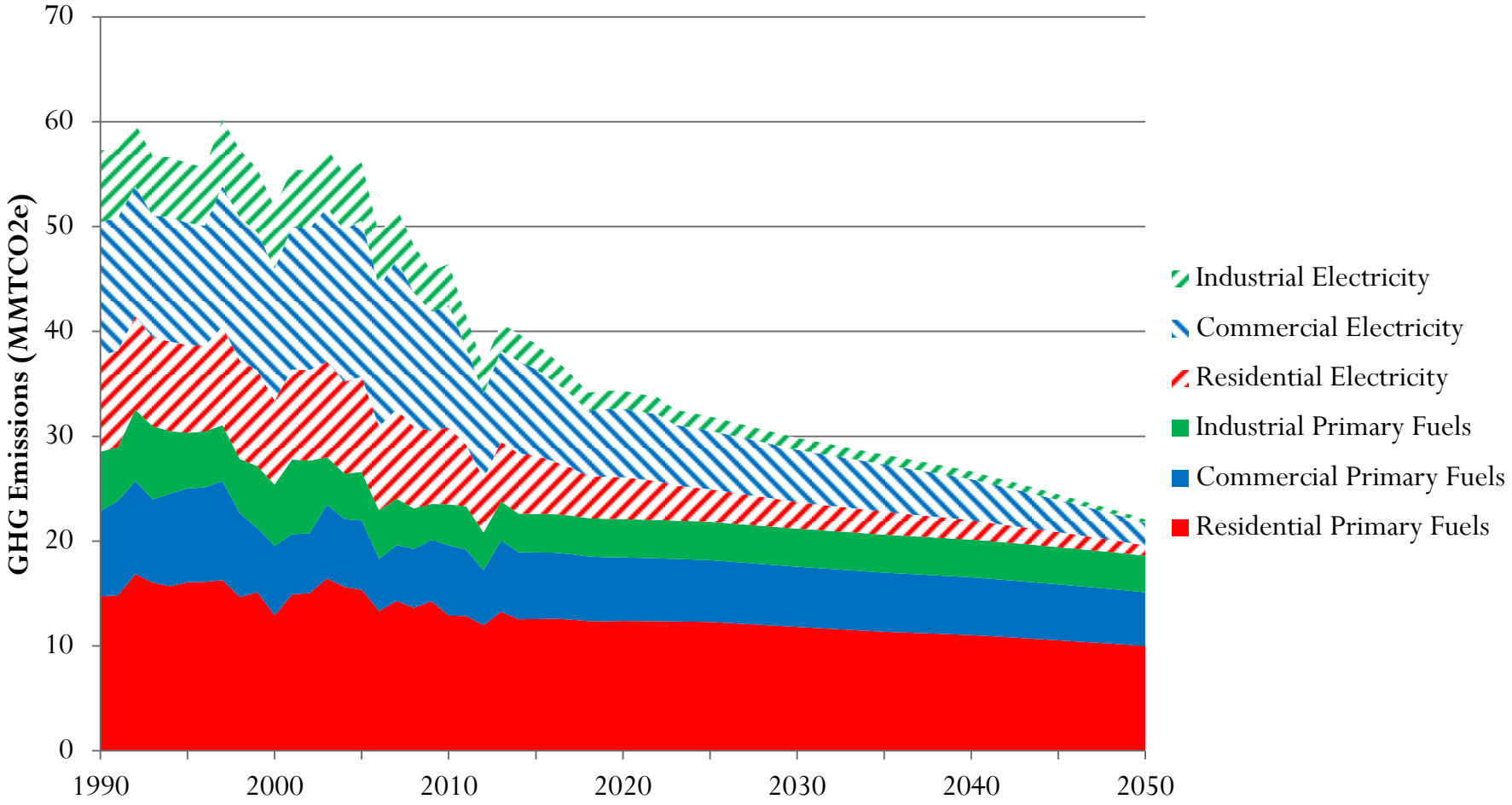
Awaiting policy recommendations from the Commission on the Future of Transportation – Dec 2018

80x50 Study: Proposed Scope

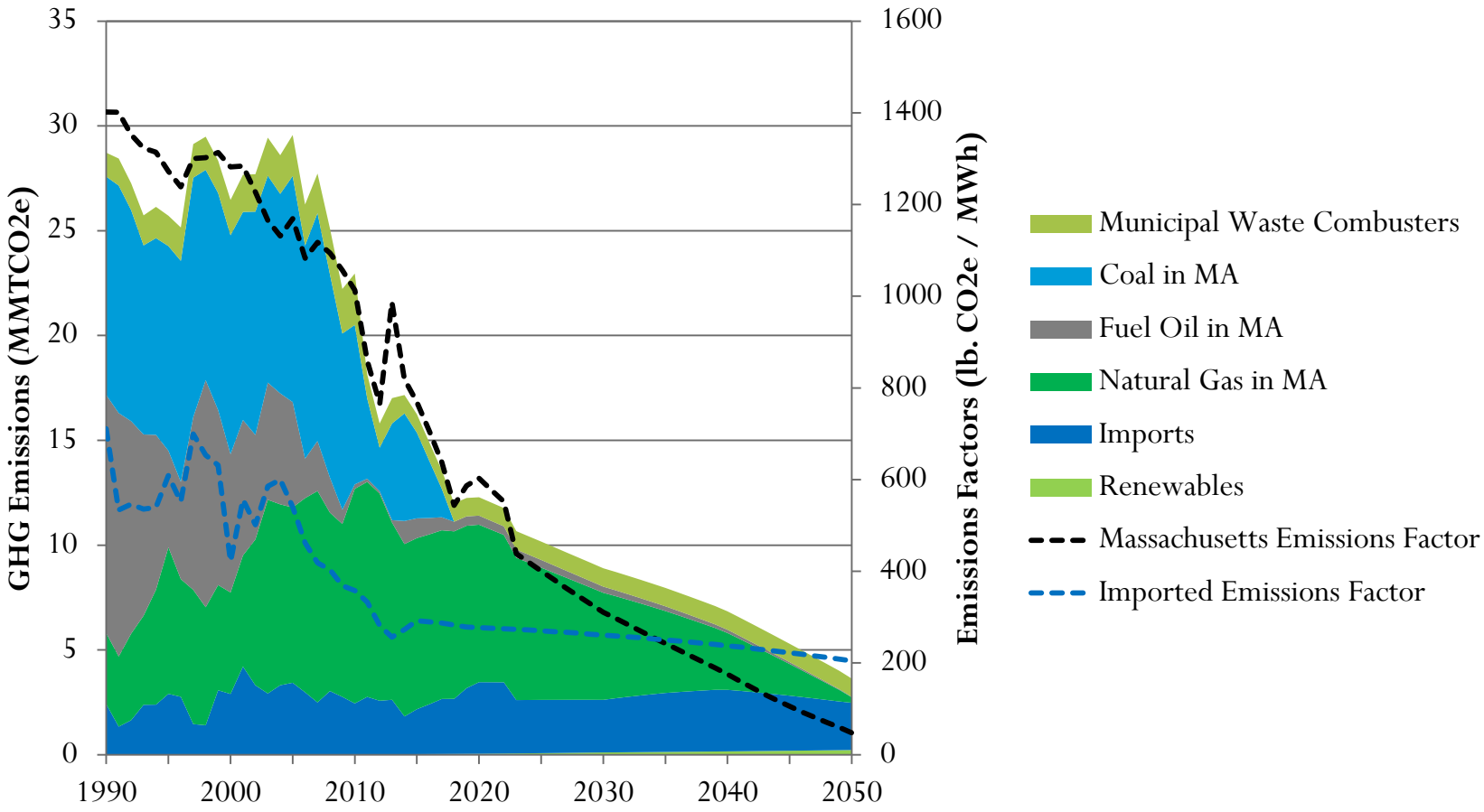
Preparation Thus Far

- Analysis of projected GHG emissions through 2050 under a reference case where only currently existing policies are on the books (i.e. no new policies) – COMPLETED but will be continually updating.
- Review of existing 80x50, deep decarbonization, and net-zero studies – ONGOING

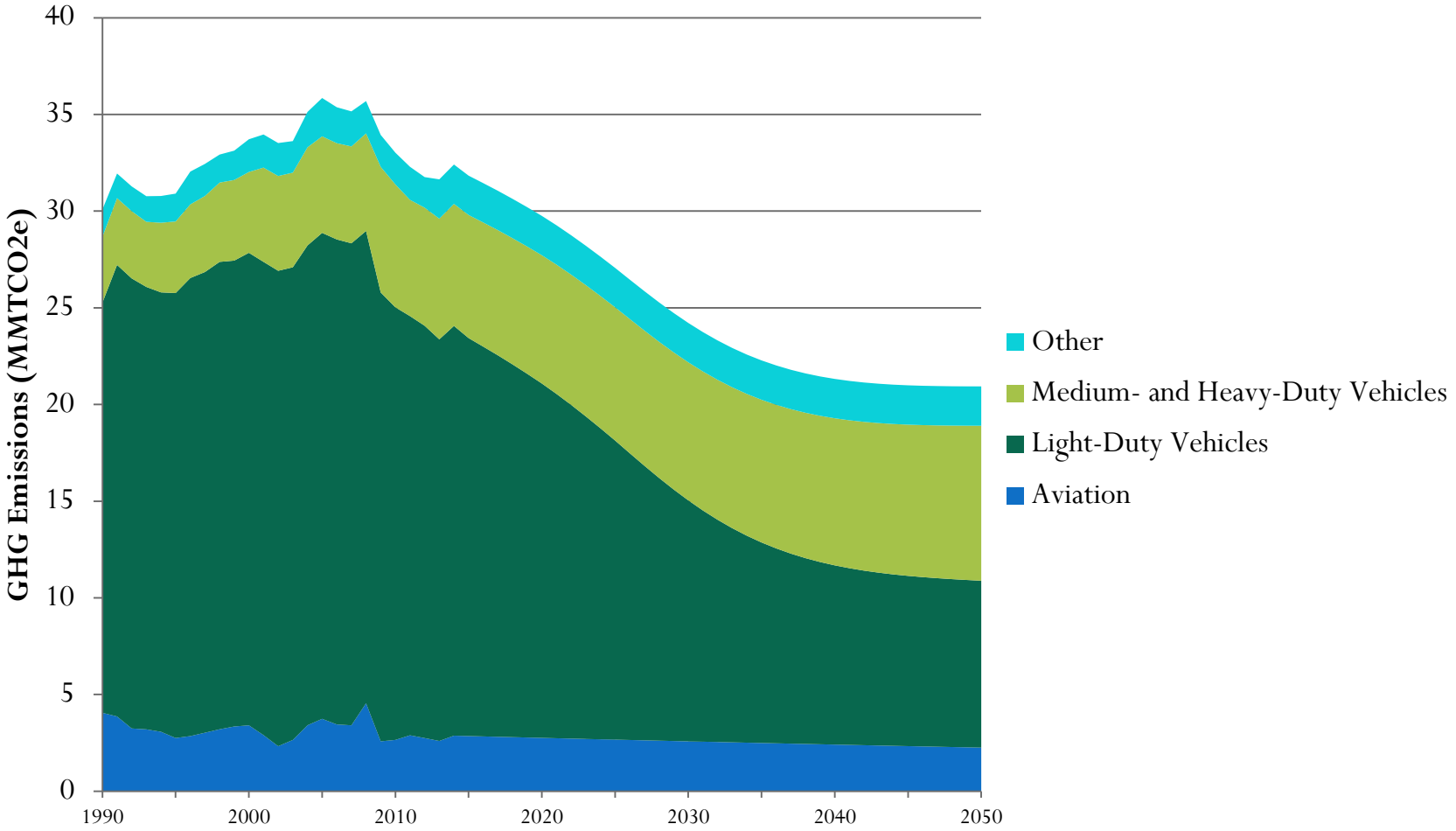
Buildings Sector GHG Emissions (Reference Case in LEAP)



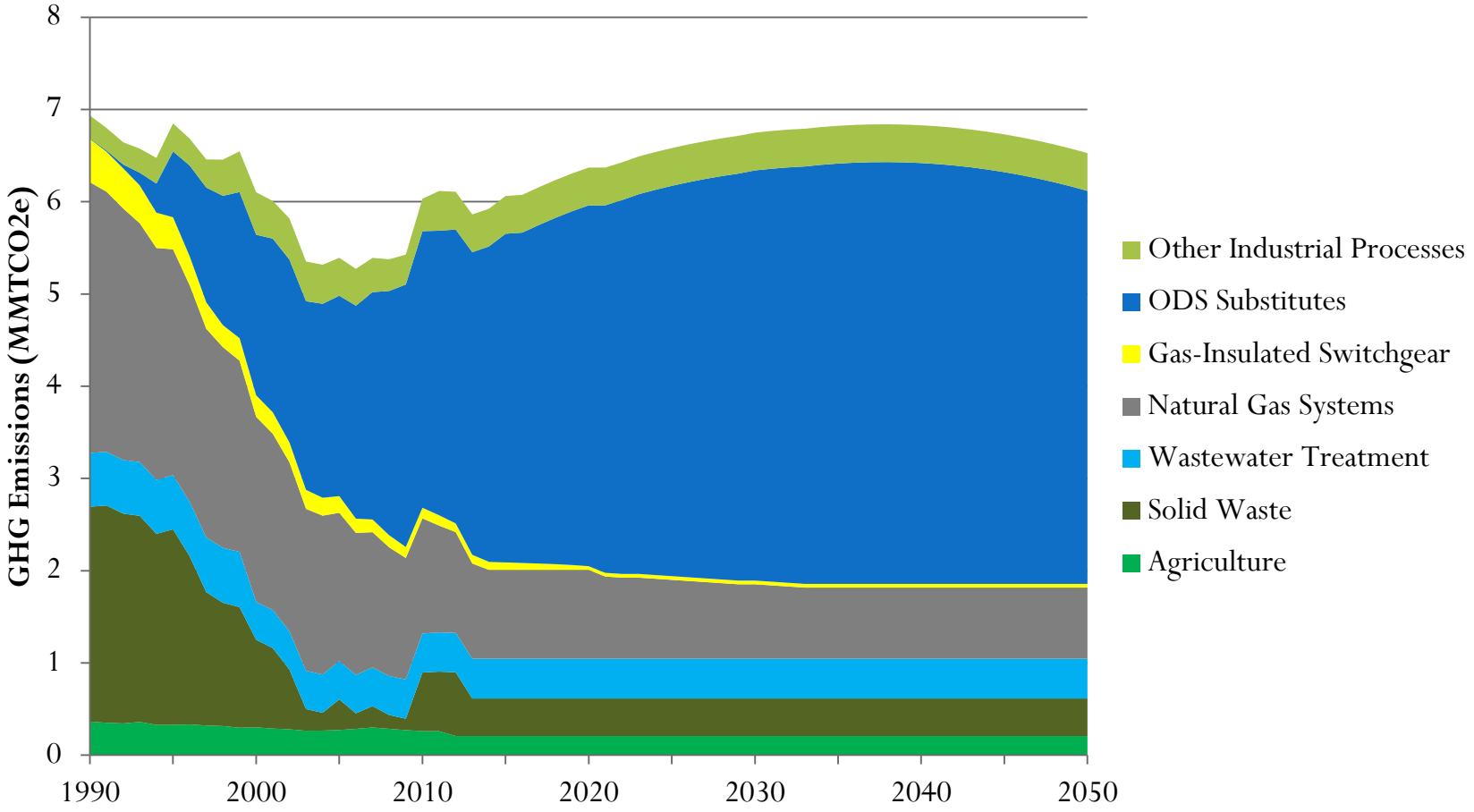
Electric Sector GHG Emissions (Reference Case in LEAP)



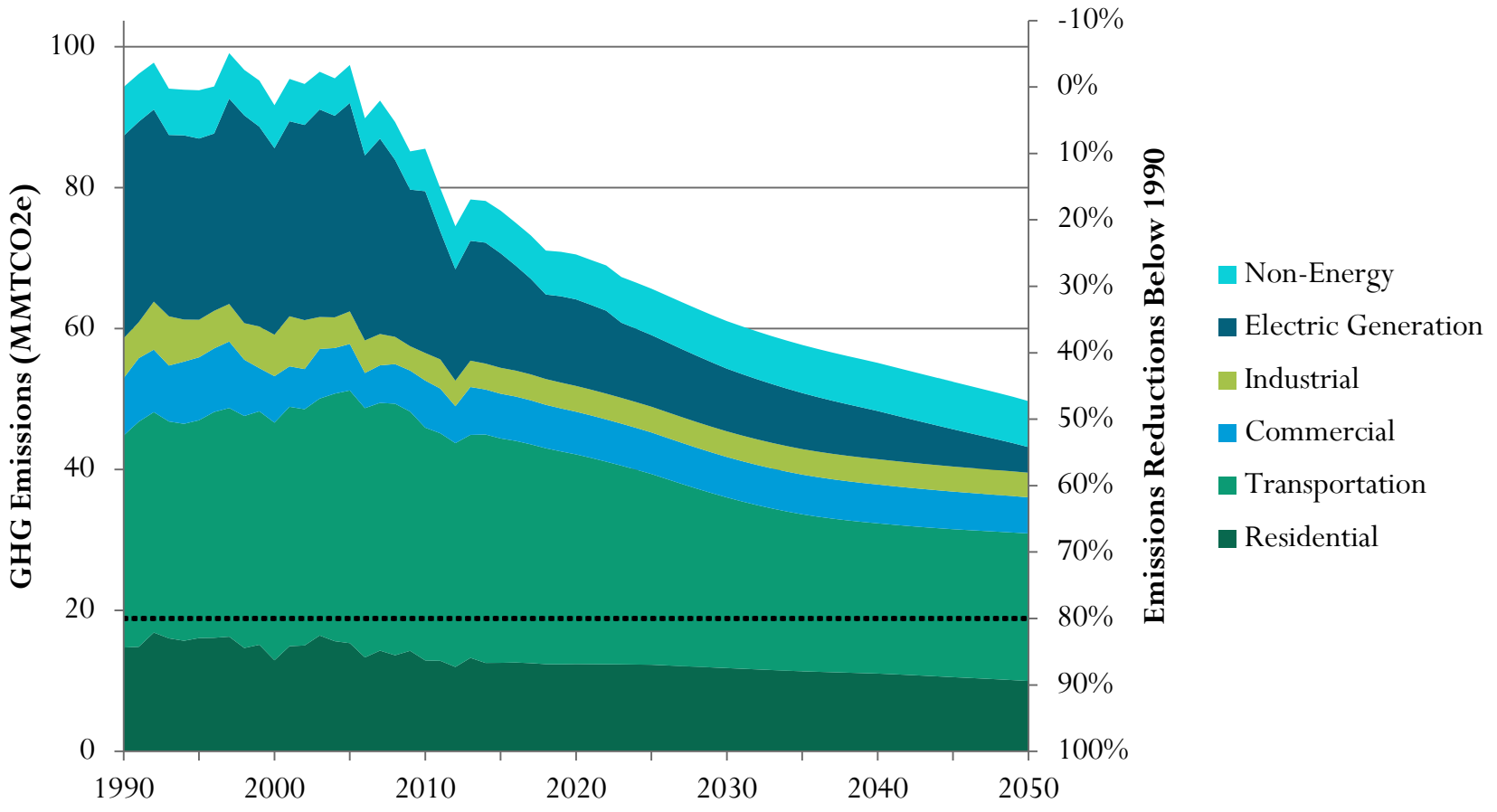
Transportation Emissions (Reference Case in LEAP)



Non-Energy GHG Emissions (Reference Case in LEAP)



Economy-wide GHG Emissions (Reference Case in LEAP)



Other Decarbonization Pathway Analyses: Technical Pathways

Study	Electricity	Buildings		Transportation	
		Residential	Commercial	Light-Duty	Heavy-Duty
National Grid 80x50 (NE region)	Effectively carbon-zero	45-50% reduction		Effectively carbon-zero	
Rhode Island	75-86% renewable generation	81% heating load met by heat pumps	67% heating load met by heat pumps	76% of all on-road VMT electrified E-78 in gasoline	B-31 in diesel
Hydro-Quebec (NE region)	90%+ reduction in carbon intensity	85% residential heat pumps	-	~100% ZEVs	
California	95% renewable generation	100% residential heat pumps		100% ZEVs (15% hydrogen)	MDVs: 75% ZEVs, 25% hybrid diesel & CNG HDVs: 40% ZEVs, 25% hybrid diesel, 35% CNG
Pennsylvania (zero-emissions pathway)	100% renewable generation	100% heat pumps	100% heat pumps	100% electric vehicles	100% renewable

Other Decarbonization Pathway Analyses:
Policy & Infrastructure Discussion/Assumptions

Study	Electricity	Buildings	Transportation	Economy-Wide
National Grid 80x50 (NE region)	* Support R&D for battery storage and synthetic fuels * Storage infrastructure * Procurements and installations	* Regulations to encourage oil and propane conversions to GSHPs * Building codes incentivizing oil-to-gas * Additional incentives for green gas and electrification * Use existing pipelines to deliver biofuels	* Rebate program (cost/funding an issue) * Proliferation of user-friendly charging infrastructure	* Economy-wide carbon pricing * Develop facilities to produce biofuels from excess renewable electricity * Create a new regulatory framework for a new utility-customer relationship
Rhode Island	* Regional market pricing; regional adoption of clean energy, not just deployment within state borders	* Allow electrification of heating to qualify as under the RI's EE program * Increase the existing statewide bioblend standard	* Promote and invest in alternative modes of transportation * Encourage federal R&D for biofuels statewide bioblend standard * Incentivize the adoption of electric vehicles and charging infrastructure	
Hydro-Quebec (NE region)	* Procure large hydro and offshore wind resources			
California	* Increase the RPS to 50% by 2030 * Renewable energy tariffs * Regional cooperation (Energy Imbalance Market) * Fuel cell storage technology	* Evaluate and set targets for the electrification of space and water heating in residential and commercial buildings * CALGreen Code provisions mandate installation of PEV charging infrastructure in new residential and commercial buildings	* Reliable incentives * Charging infrastructure * Advanced Clean Cars program * Biofuel R&D * Separated ZE/NZE freight lane * ZE/NZ road pricing * ZE/NZE storage and distribution infrastructure	* Cap-and-trade program * Support more compact development patterns
Pennsylvania (zero-emissions pathway)	* Ease permitting and siting regulations on renewable energy * Remove tax credits for fossil fuel extraction – give to renewables. * Ease interconnection barriers	* Green building incentives (rebates, tax credits, expedited permitting and reduced inspection costs) * Discourage or increase the cost of natural gas, etc.		

Goals for MA's 80x50 Study

Scenario analysis

Technical pathway analysis

Policy analysis

Roadmap to 2050

2030 Plan

IAC Input on Guiding Questions for Analyses

1. What are 3-4 plausible cross-sectoral futures in 2050 that should be analyzed and incorporated into the planning process of GWSA compliance?
   - Incorporate the 3 main variables of fuel price, technology growth and deployment, and land use development. Examples:
     - Low fuel price and high interest rate and cost of borrowing
     - Low technology growth due to high production cost and/or other factors outside state control
     - Regional population growth and development patterns that may:
       - increase energy demand and/or challenge the infrastructure needed to support such demand;
       - degrade the capacity of natural and working lands to sequester carbon and avoid further GHG emissions.

IAC Input on Guiding Questions for Analyses, cont.

2. What are the projected energy demands through 2050 and when and where will they likely to occur?
   - Focus on electrification of end uses in the Buildings and Transportation Sectors, as identified/recommended by the CEP.
   - Incorporate all energy conservation measures whenever and wherever feasible, as recommended by the CEP.
   - Factor in drivers of price and non-price behavioral change
   - Include spatial analysis of projected energy demands.
3. What are the necessary infrastructure to effectively support and manage such demand, and what is the most strategic and cost-effective implementation timeline?

IAC Input on Guiding Questions for Analyses, cont.

4. What emissions limit should the EEA Secretary set for 2030 (and maybe 2040)?
5. What suite of policies/strategies should the Commonwealth implement to best meet the GWSA emissions limits, balancing cost, socio-economic equity, and non-GHG benefits?
   - Use criteria in Section 5 of GWSA to evaluate potential policies.
   - Acknowledge uncertainties from federal, regional, and municipal actions.
   - Incorporate stakeholder feedback on potential policies.
6. What land use policies/strategies and nature-based solutions can the Commonwealth implement to sequester carbon emissions and avoid further GHG emissions?
   - Include spatial analysis of where future development may occur and the projected GHG emissions and carbon sequestration from natural and working lands.

IAC Input on Guiding Questions for Analyses, cont.

7. Other?

Proposed IAC Work Plan for 2019

Date	IAC Meeting Focus	IAC Preparation for Meeting
Dec. 6, 2018	• Discussion of IAC work plan for 2019 • Additional feedback on 10-Year Progress Report. • Discussion of the Comprehensive Energy Plan (CEP). • Summary of projected 2050 GHG emissions in LEAP reference scenario and discussion of 80x50 Study.	• Be prepared to provide comments and feedback on the Progress Report, CEP, and 80x50 Study.
February 2019	• Discussion of IAC working groups' recommendations of policies for 2030 (which could be included for analysis in the 80x50 Study). • Presentation and discussion on the Commission on the Future of Transportation report	• Finalize each working group's recommendations of policies for 2030. • Provide feedback on proposed framework for how the working groups should format and submit their recommendations. • Read the Commission on the Future of Transportation report to inform discussion at the meeting.
April 2019	• IAC adoption of working groups' recommendations of policies for 2030 (which could be included for analysis in the 80x50 Study). • Announcement of selected consultant team for 80x50 Study. • Presentation and discussion of 2030 Plan development and timeline.	• Review each working group's recommendations of policies.
June 2019	• Presentation of 80x50 Study's final scope and timeline.	
August 2019	• Discussion of how best to incorporate socio-economic equity in climate policy development and evaluation.	• Read relevant documents to inform discussion at the meeting.
October 2019	• Discussion of how best to incorporate public health impact (i.e. air pollution co-benefits) in climate policy development and evaluation	• Read relevant documents to inform discussion at the meeting.
December 2019	• Feedback on some preliminary results of 80x50 study	