GWSA IAC Meeting

August 30, 2018

Massachusetts Global Warming Solutions

MA Greenhouse Gas Emissions

Sharon Weber, MassDEP

Primer: GHGs, GWPs, $MMTCO_2e$

- The individual gases that contribute to total greenhouse gas (GHG) emissions in the MA GHG Inventory include:
  - carbon dioxide (CO_2),
  - methane (CH_4),
  - nitrous oxide (N_2O),
  - sulfur hexafluoride (SF_6),
  - hydrofluorocarbons (HFCs), and
  - perfluorocarbons (PFCs).

Primer: GHGs, GWPs, $MMTCO_2e$

- Not all GHGs have the same **heat-trapping capacity**. For example, one ton of methane (CH_4) is equivalent to greater than 20 tons of CO_2 with respect to their heat trapping potentials. A standard, known as the **global warming potential (GWP)**, relates the heat trapping potential of each GHG to an equivalent quantity of CO_2 over a given time horizon. Emissions are in units of **million metric tons of carbon dioxide equivalents ($MMTCO_2e$)**.

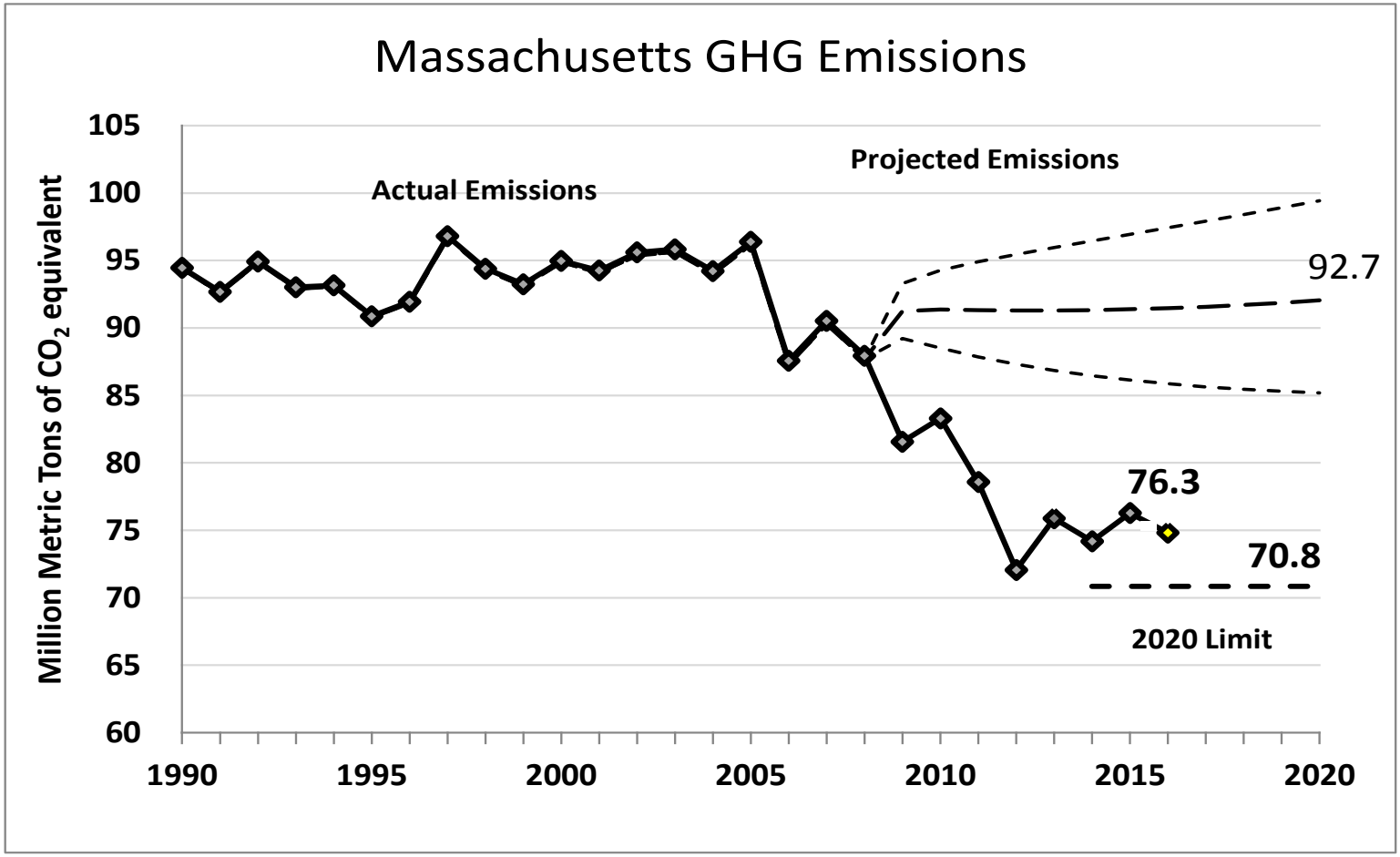
Primer: GHGs, GWPs, $MMTCO_2e$

- Current 100-year GWPs from IPCC AR4

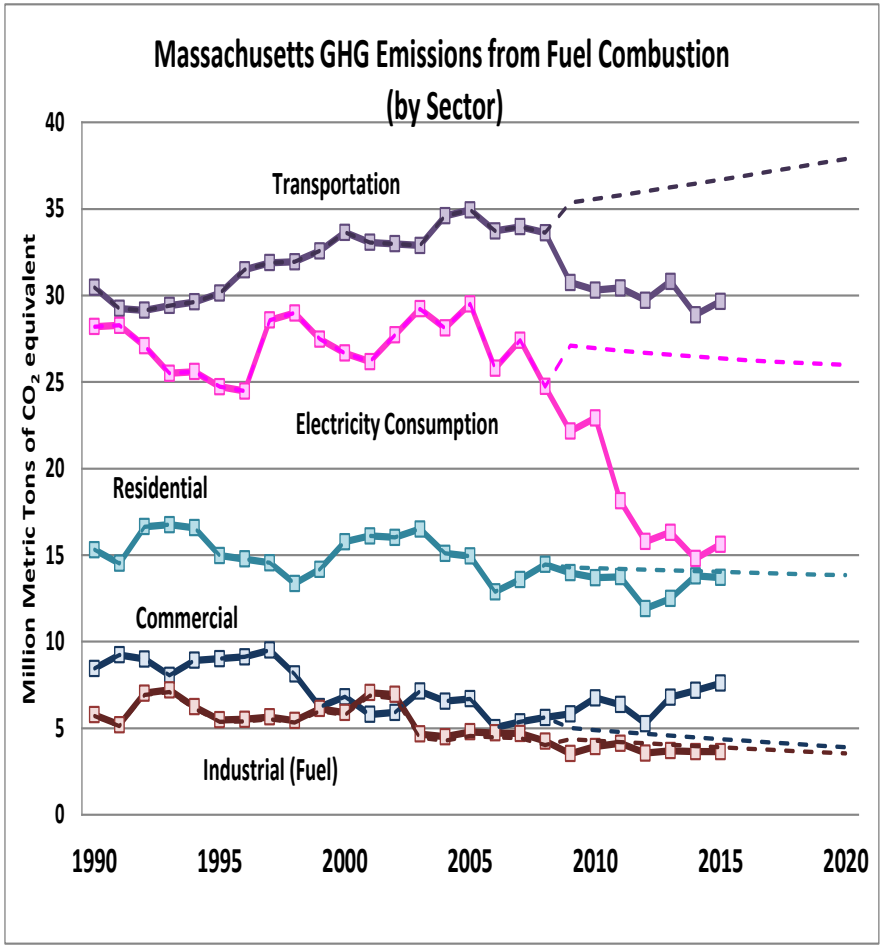
GHG	GWP
carbon dioxide (CO_2)	1
methane (CH_4)	25
nitrous oxide (N_2O)	298
sulfur hexafluoride (SF_6)	22,800
hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs)	124 to 17,700

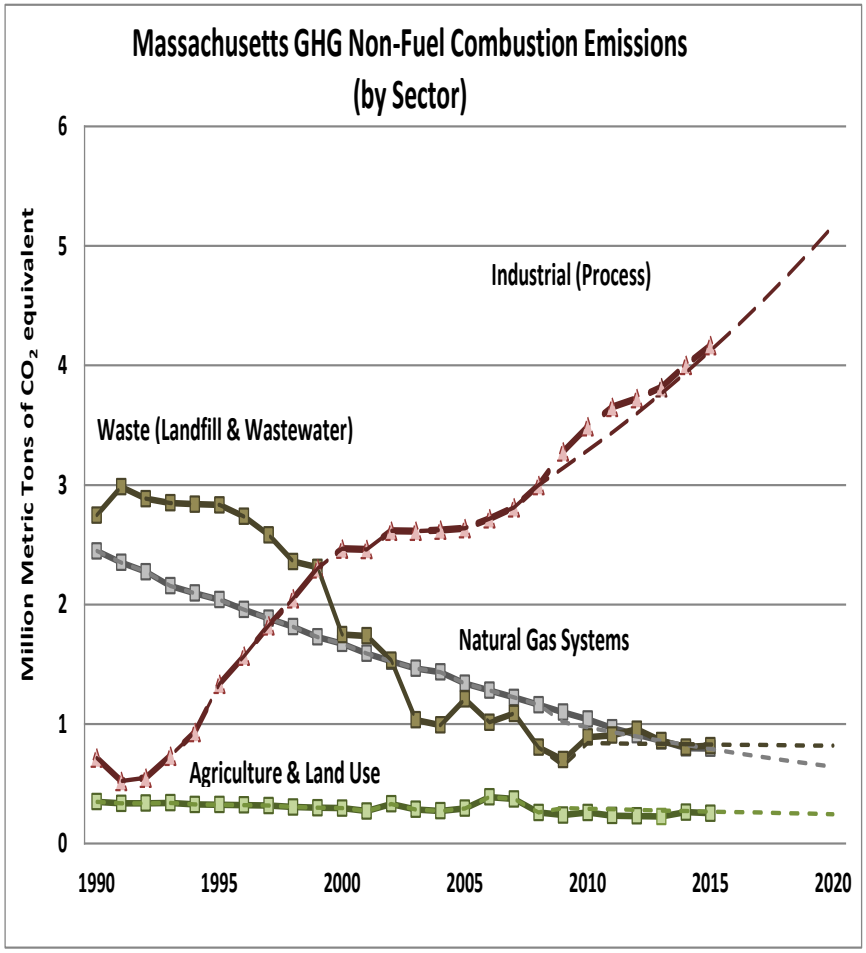
- Therefore:
  - 1 million metric tons of CO_2 = 1 $MMTCO_2e$
  - 1 million metric tons of CH_4 = 25 $MMTCO_2e$

MA GHG Inventory (complete through 2015)



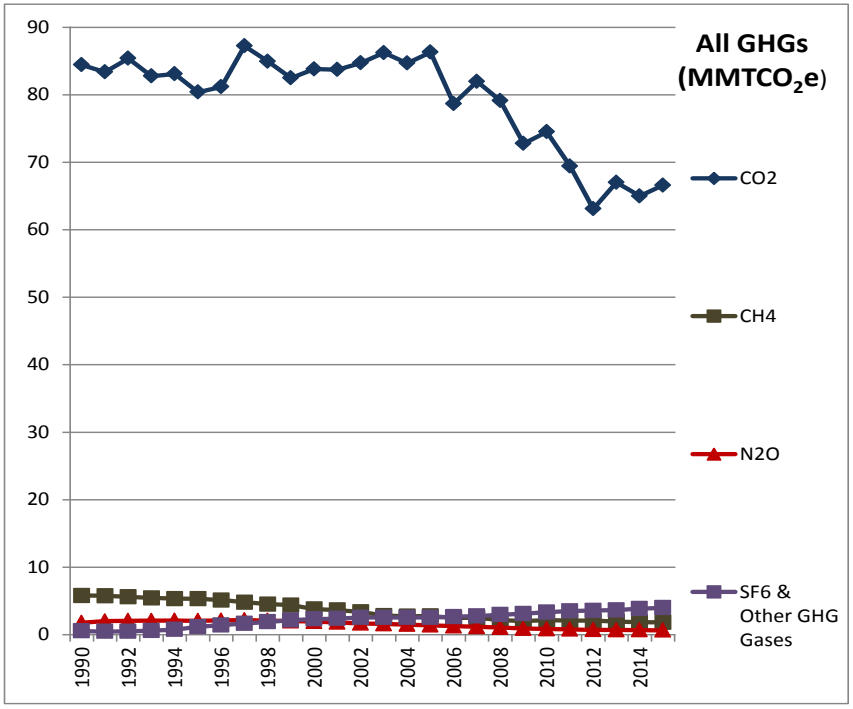
MA GHG Inventory divided by Sectors

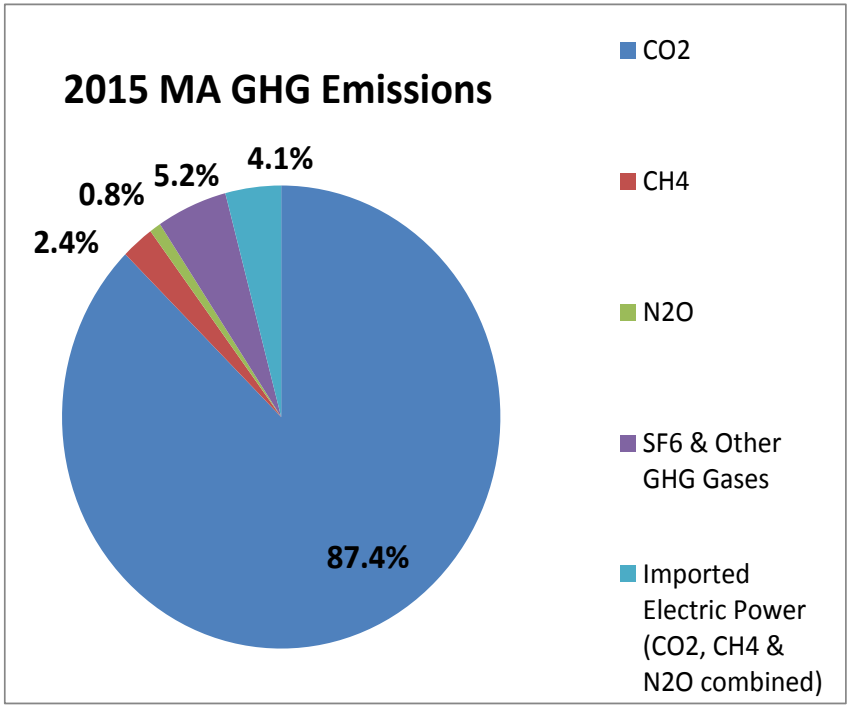




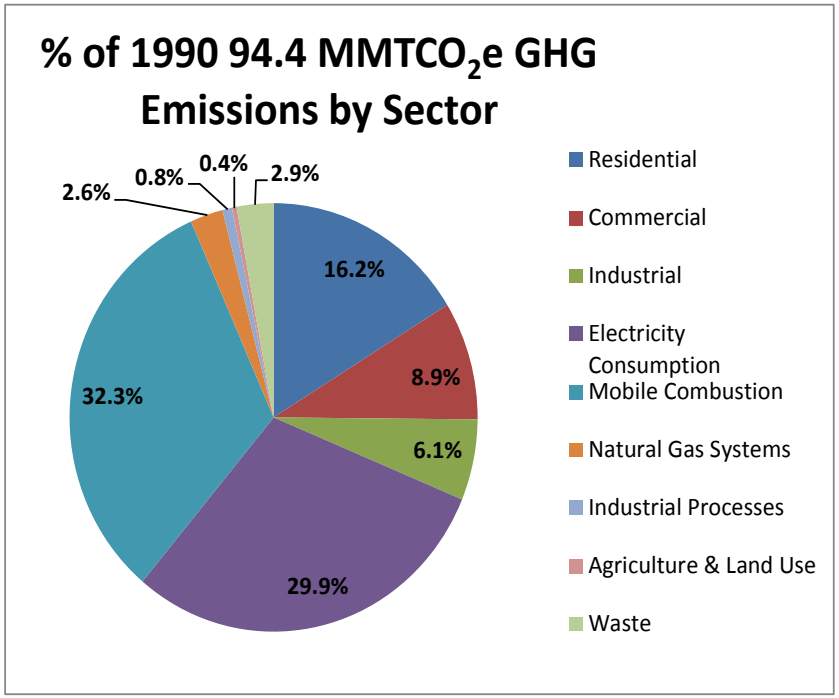
2015

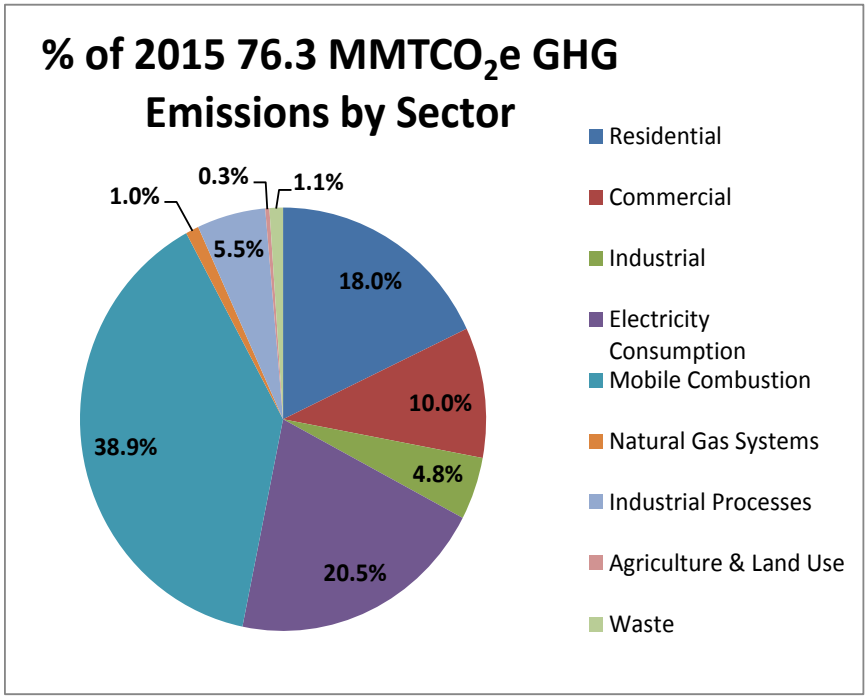
MA GHG Inventory



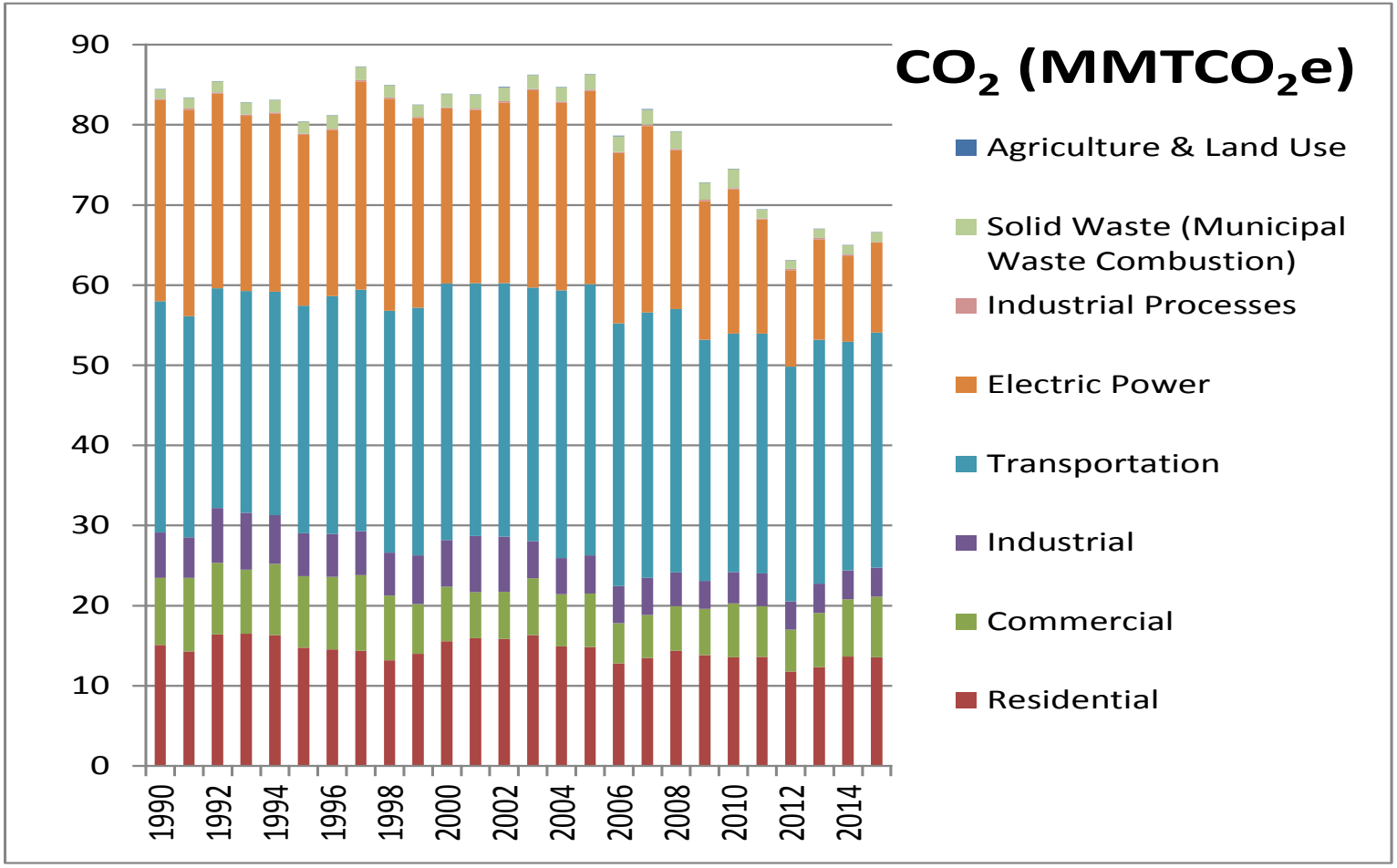


1990 and 2015 GHG Emissions by sector

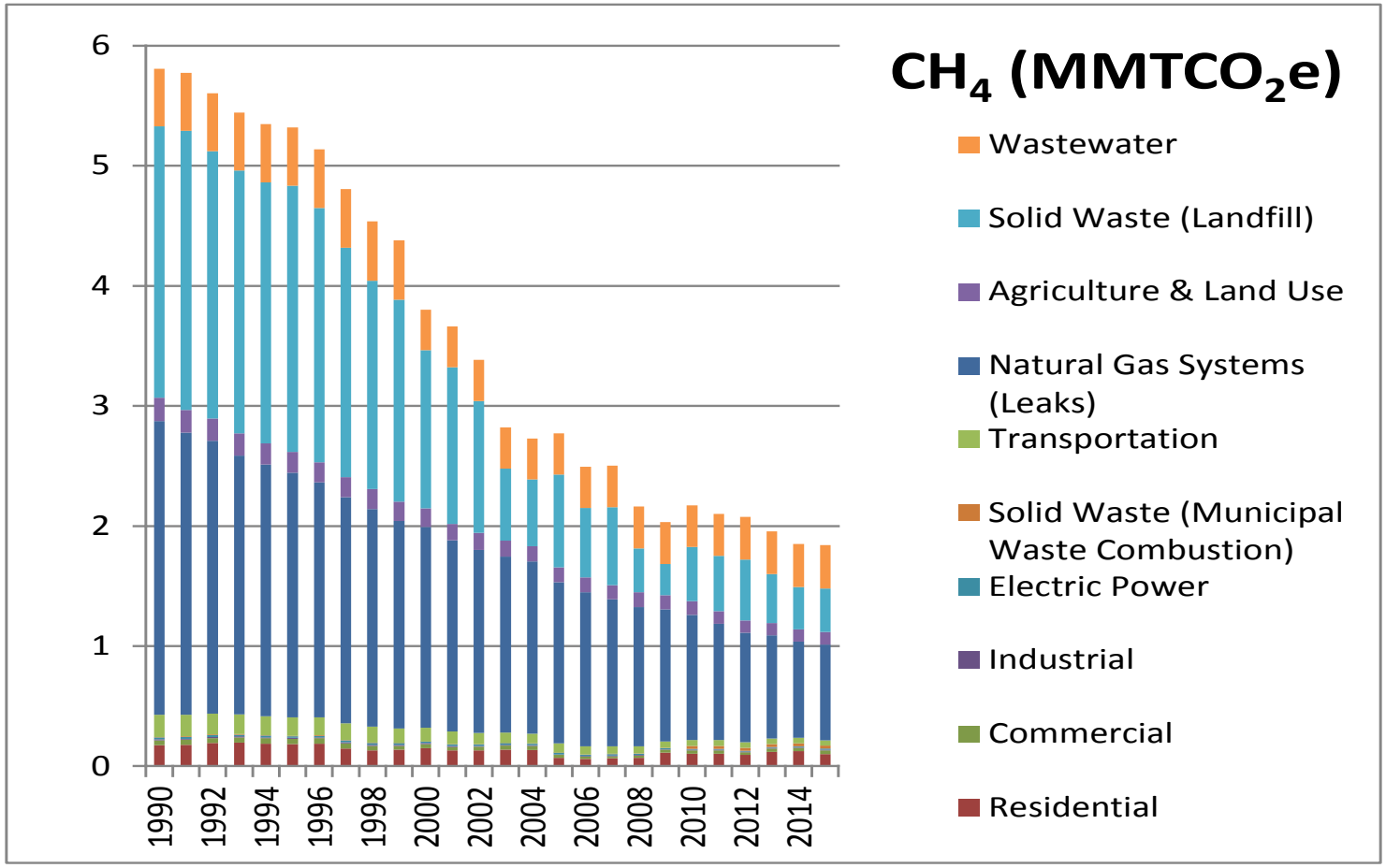




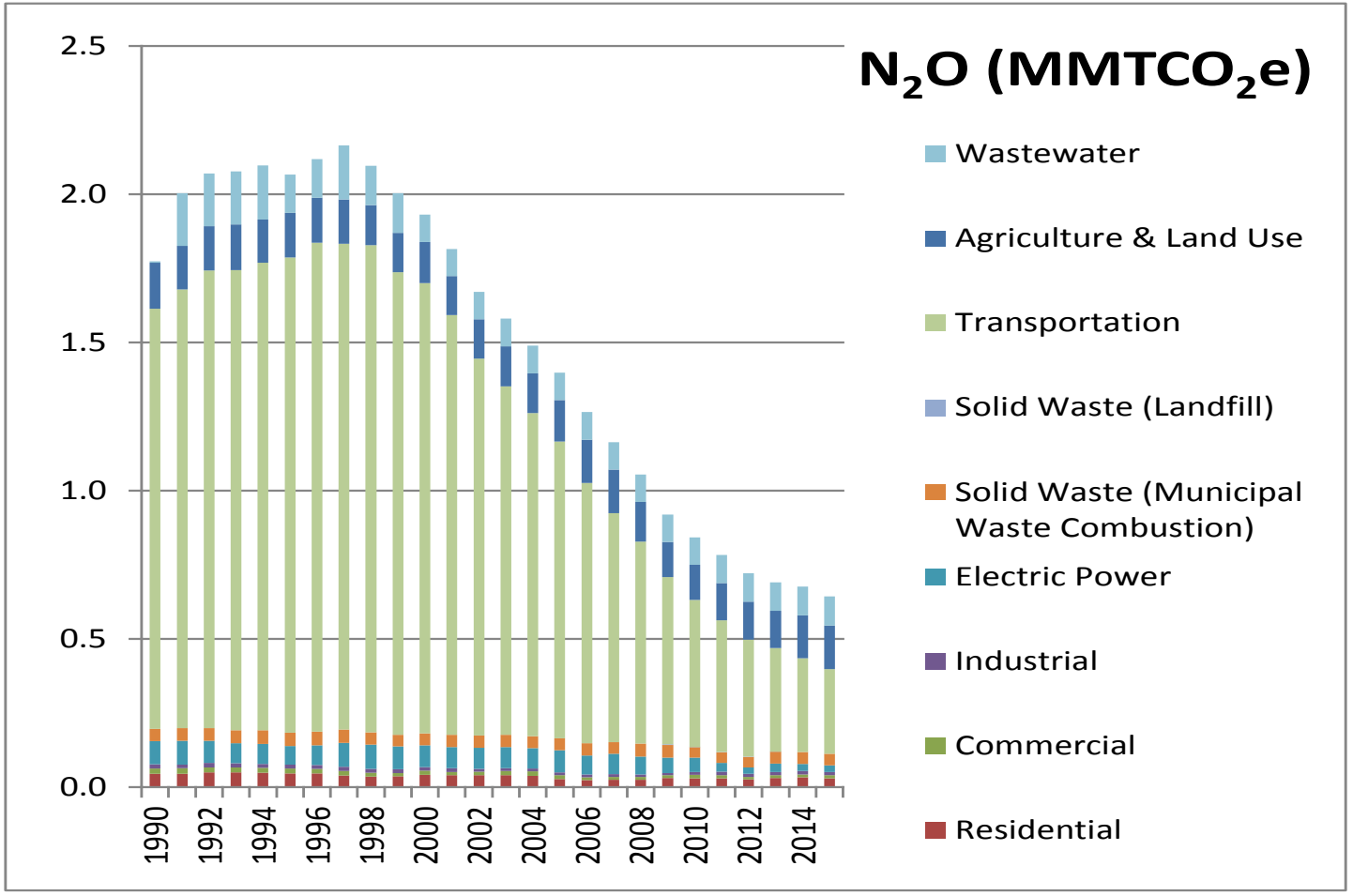
MA GHG Inventory Trends: Carbon Dioxide (CO_2)



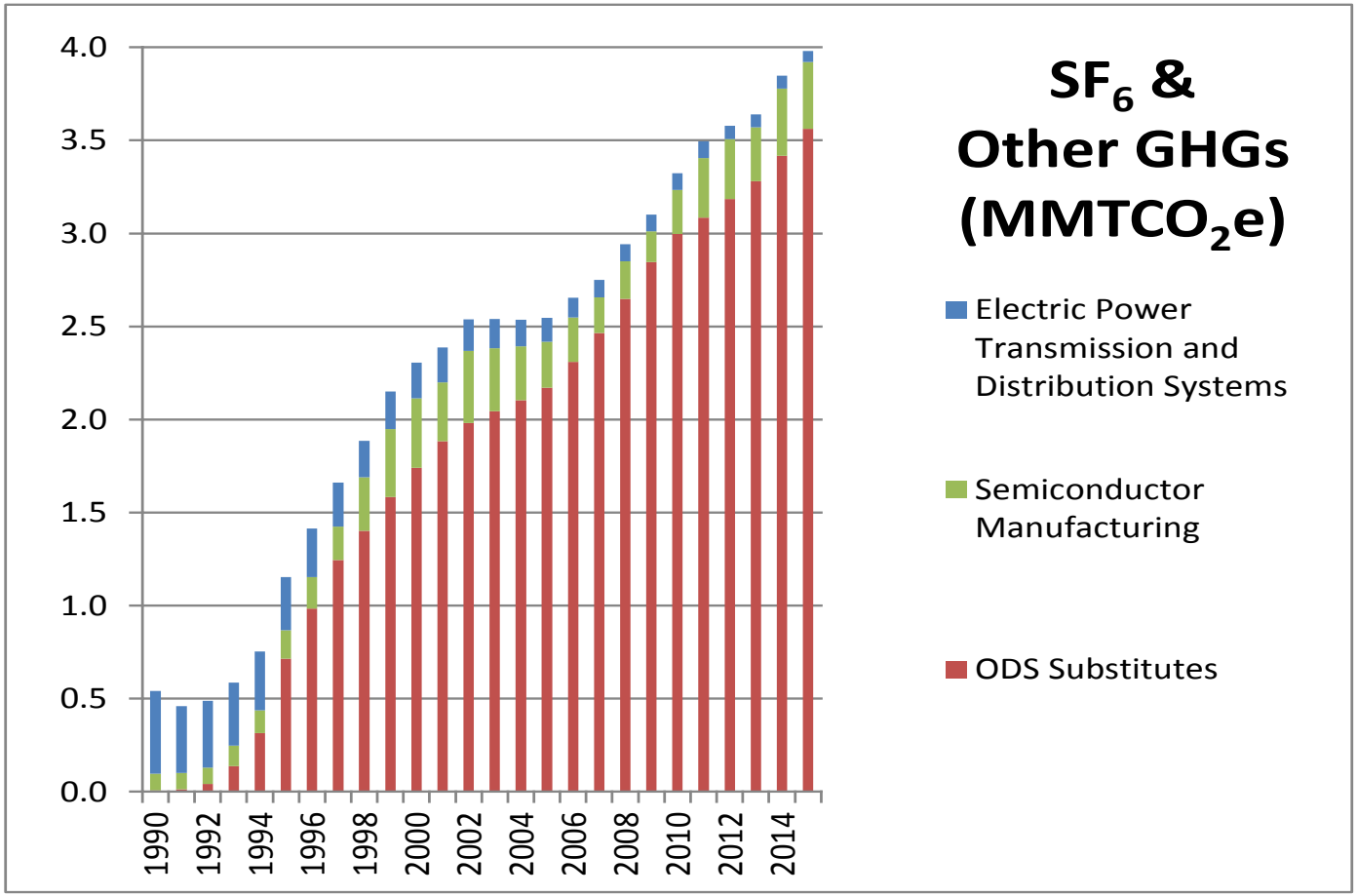
MA GHG Inventory Trends: Methane (CH_4)



MA GHG Inventory Trends: Nitrous Oxide (N_2O)



MA GHG Inventory Trends: Sulfur hexaflouride (SF_6), hydroflourocarbons (HFCs) and perflourocarbons (PFCs)



DATA SOURCES

- US Energy Information Administration (EIA)
  - State Energy Data System (SEDS) annual data
  - Annual Survey Form EIA-923 (utility) and (older, non-utility) EIA-867 combustion data
- US Environmental Protection Agency (EPA)
  - State Greenhouse Gas Inventory Tool (SGIT) modules
  - GHG Facility Reporting Program (beginning 2010)
- MassDEP
  - GHG Facility Reporting Program (2010-2015)

Website links

- **MA GHG Inventory**

  https://www.mass.gov/lists/massdep-emissions-inventories#greenhouse-gas-baseline,-inventory-&-projection-

- **MA CECP for 2020**

  https://www.mass.gov/files/documents/2017/01/uo/cecp-for-2020.pdf

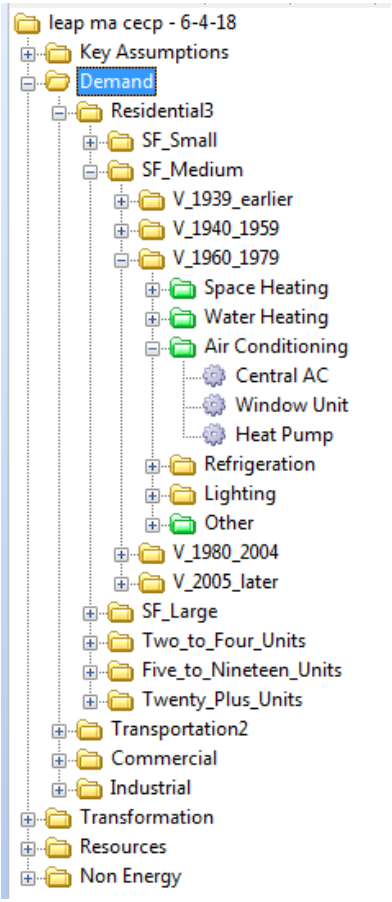
Electricity Projections: Reference Case

Benjamin Miller, EEA

Reference Case

- Reference Case is a scenario consisting of only existing policies
  - Aims to answer: Without new policies, what will GHG emissions in MA be like in 2050?
- Includes some global assumptions about ongoing non-policy trends, some examples:
  - Decrease in annual HDDs as the climate warms.
  - Gradual changes in housing stock as population grows and new housing units are built.
  - Ongoing macro-level trends in energy demand and consumption
    - But no direct policy-driven changes, except what is already established.

LEAP: A quick primer

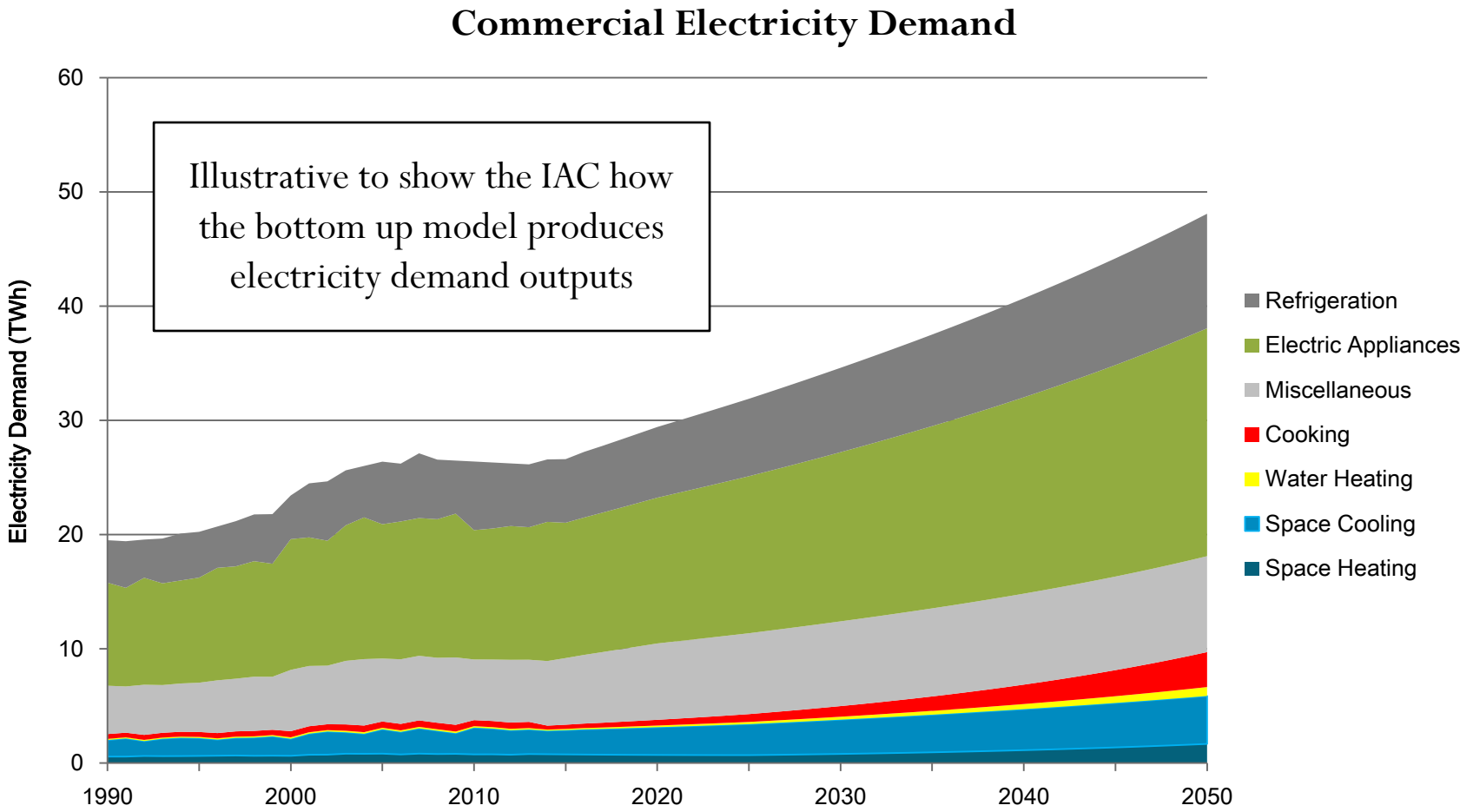


- Not a model – an energy accounting tool
  - Variables, data, assumptions, and computations are kept in open-source transparent manner.
  - Sums up demand across a tree-like structure
    - Can get very complicated very fast.
    - Lots of places for inputs and interactions.
  - "Transformation" spins up energy supply module to meet demand.
    - Time-slicing available to model energy demand on an hourly basis, but, for now, annual consumption is fine.

Major Demand Drivers (Reference)

Sector	Category	Reference Assumptions
Residential	Overall demand	Driven by population & housing growth; some baseline energy intensity assumptions for housing stocks.
	Space heating, direct electric	All forecasted growth converted to heat pump.
	Space heating, heat pumps	Linear forecast (25% penetration by 2050)
	Secondary space heating	Insignificant use of cooling-sized heat pumps for partial space heating load.
	Lighting	100% energy efficient bulbs by 2030.
	Refrigeration	100% EnergyStar certified by 2030.
	Air conditioning	Expansion of both central air and heat pumps.
	Water heating	Increases modestly.
Commercial	Electric space heating	Increases modestly.
	Electric water heating, cooking, and miscellaneous	Increases modestly.
	Electric appliances	Exponential forecast computed historical trend of demand growth
	Refrigeration	Linear forecast (increases).
Industrial	Electricity	Remains constant from 2015 levels
Transportation	EV adoption	Follows LEV regulations through 2025, reaching 160,000 by 2025 before growth slows, only reaching about 1 million vehicles by 2050.

Sample Reference Outputs



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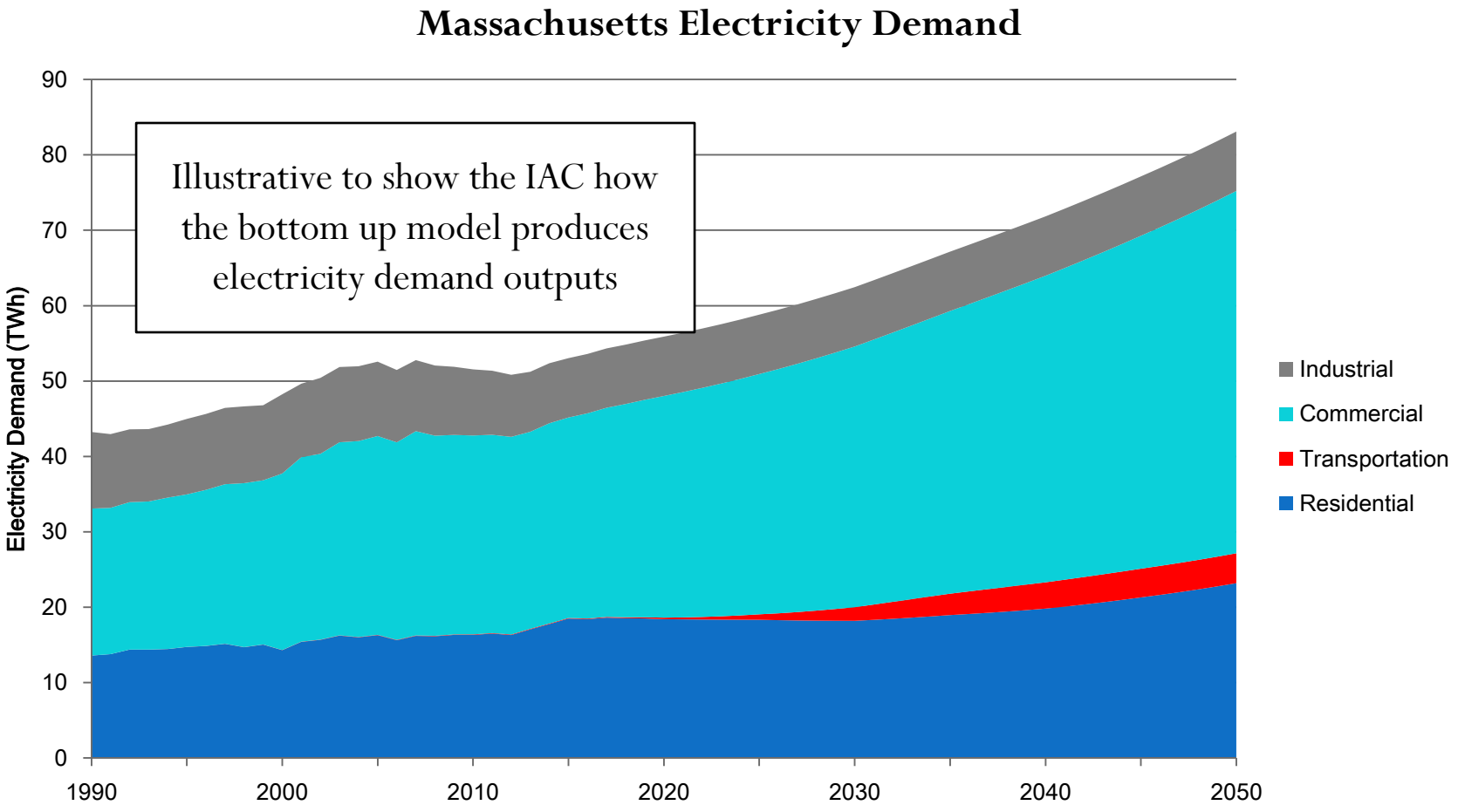
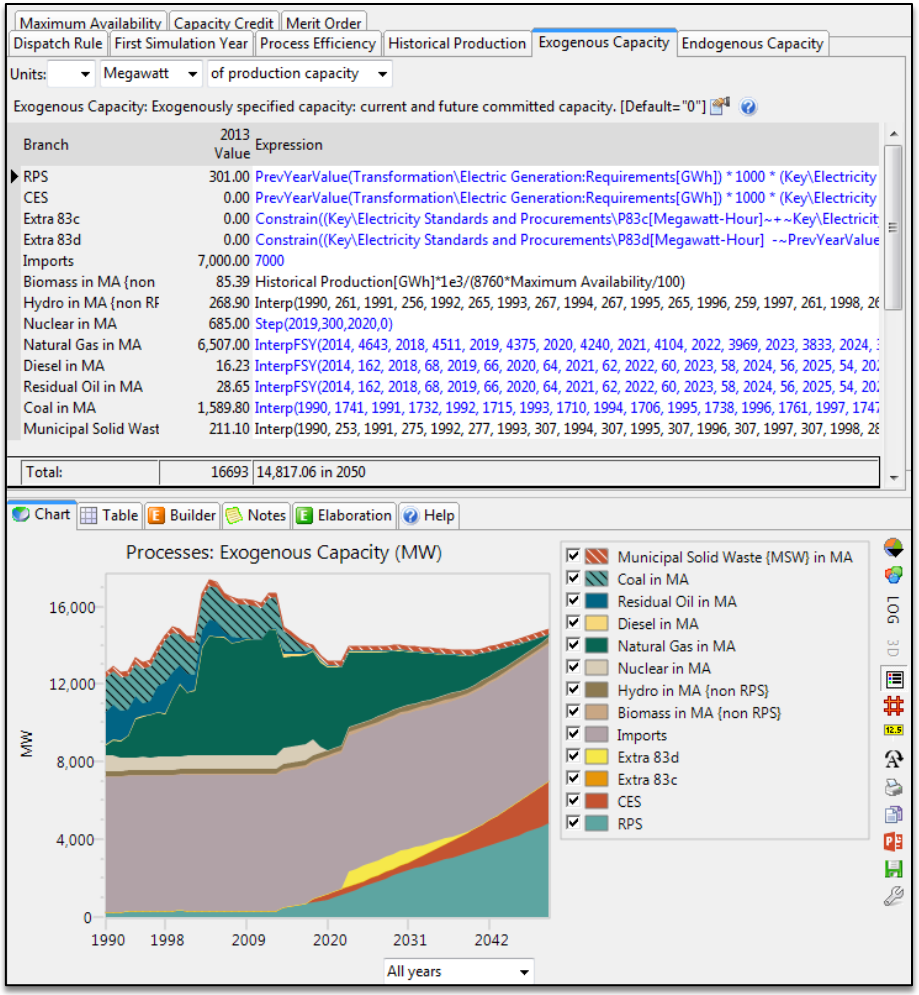


LEAP: Electricity Sector Dispatch

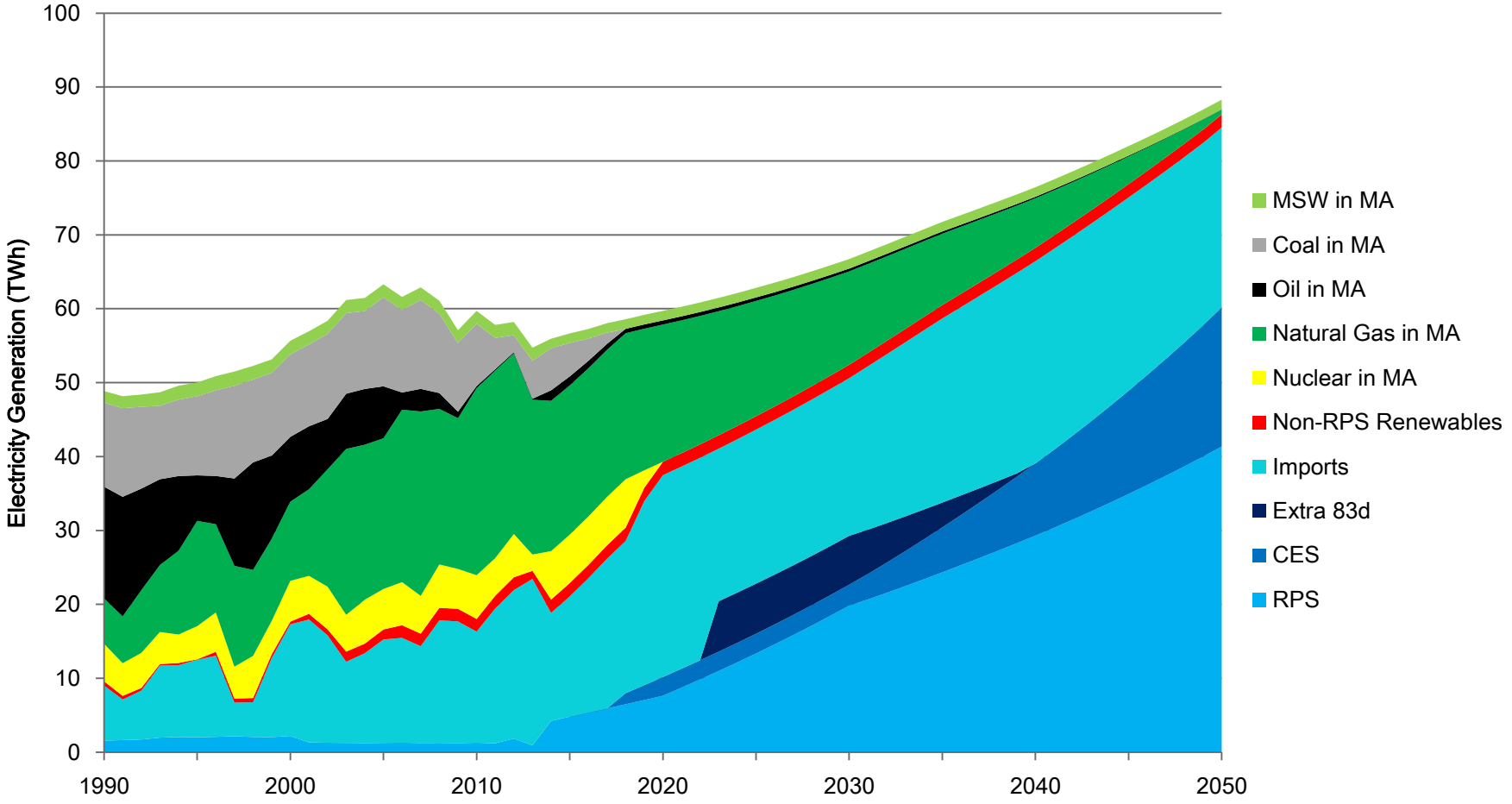
- Electricity sources programmed in with nameplate capacities, average availabilities (annual), efficiency factors, etc.
- Electricity dispatched to according to a merit order.
- Imports set with an arbitrarily large capacity and fill in any residual needs.



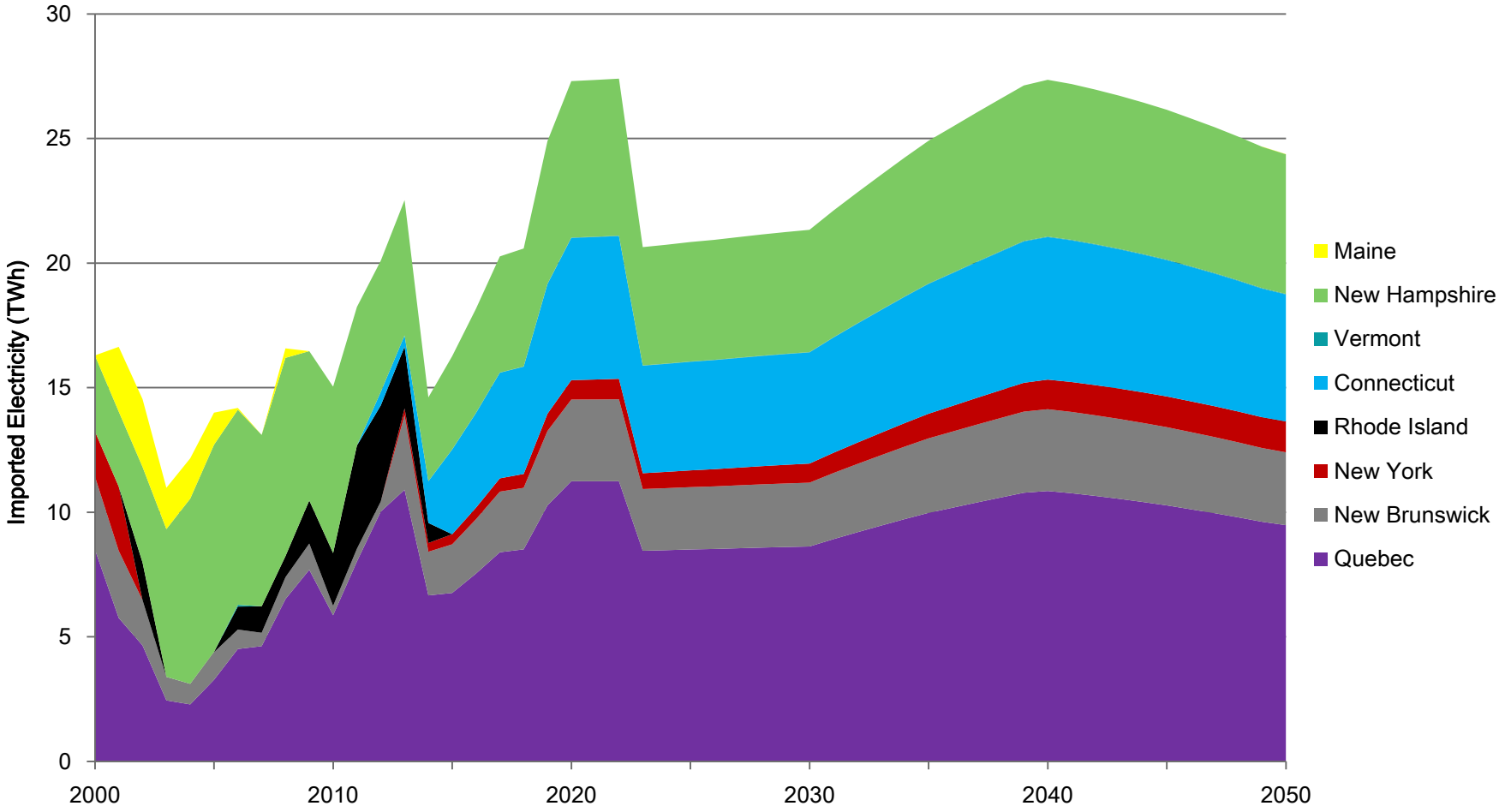
Major Assumptions and Drivers (Reference Case)

RPS	Requirement, including new 2% increase from 2020 through 2029, fulfilled.
CES	Requirement, now smaller due to RPS increase, fulfilled.
MLPs	14% of production assumed to be exempt from RPS and CES through 2050.
MWCs	Generation remains at 2015 levels.
Coal	Retired in 2017.
Nuclear	Retired in 2019.
Oil	Generation declines as RPS, CES increase, cap-and-trade limits decrease.
Natural gas	Generation declines as RPS, CES increase, cap-and-trade limits decrease.
83c	1600 MW, phased in over the 2020s, entirely subsumed by RPS requirements.
83d	9.5 TWh switch flipped on in 2023; partially subsumed by CES requirement, but some extra production logged in the 2020s and 2030s.
Imports	Takes up any residual demand not met by in-state production. Bulk emissions factor assigned based on projected import mix, individual EFs remain unchanged from present values.

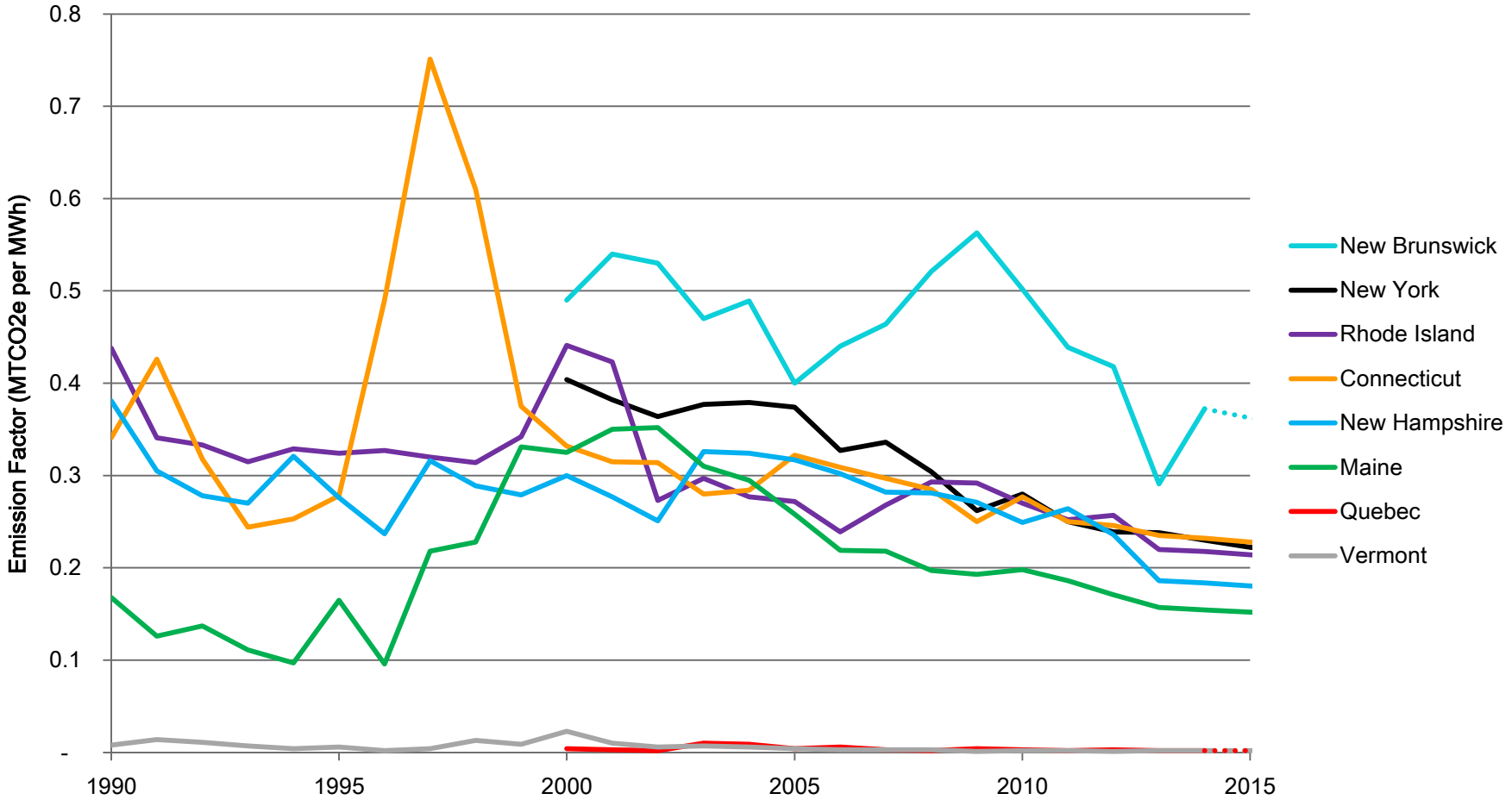
Projected Generation (Reference)



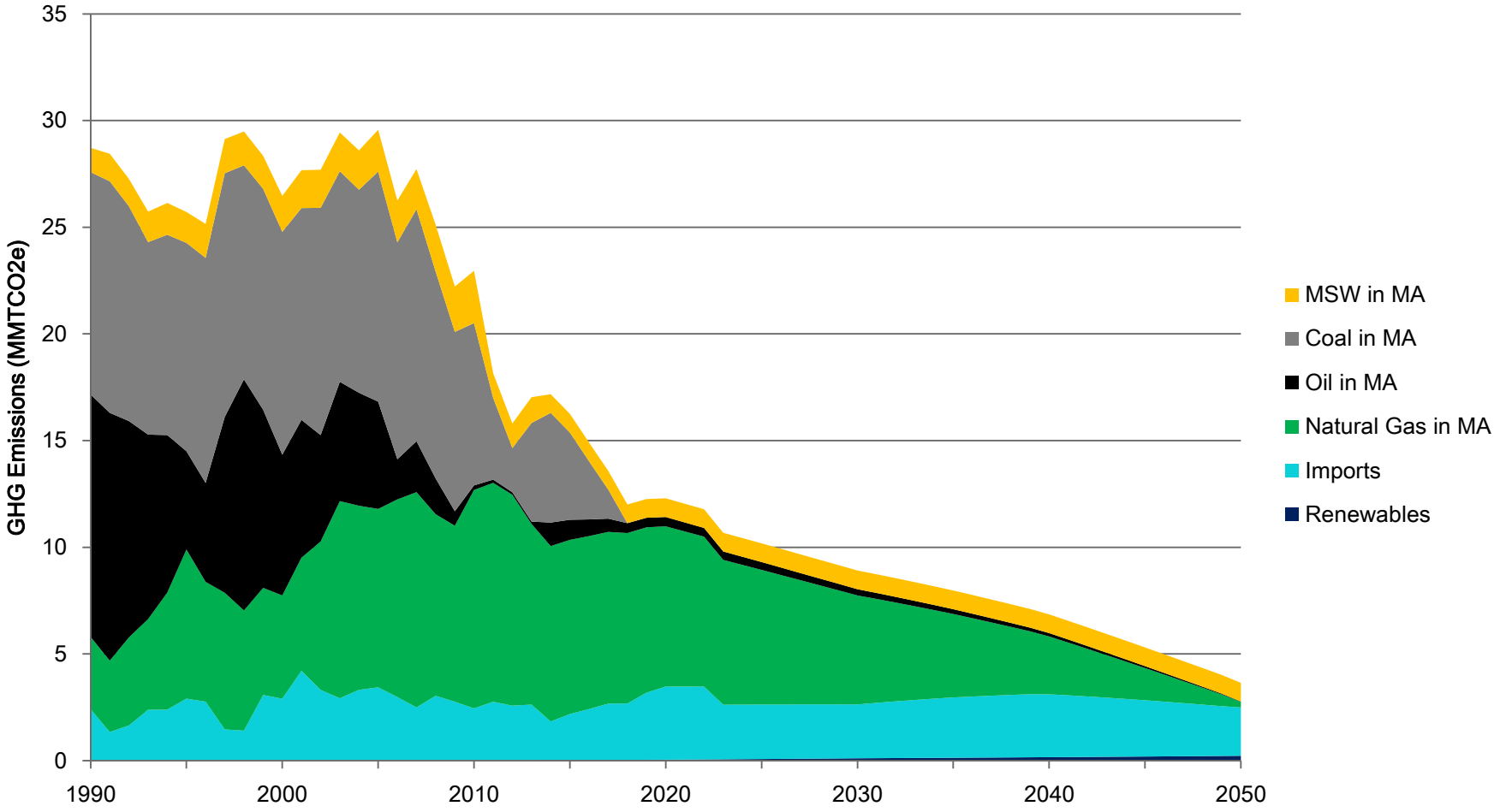
Historical & Projected Imports



Historical Imported EFs



Projected Electricity Sector Emissions (Reference)



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

DOER
Massachusetts Department of Energy Resources

Comprehensive Energy Plan

Updates to IAC

August 30, 2018

Overview of Stakeholder Process

- Three Meetings
  - Boston on July 17,
  - Westborough on July 18, and
  - Westfield on July 19
- Introduction to the goals and process of the CEP
  - "Commonwealth's energy **demands** for electricity, transportation, and thermal conditioning"
  - "strategies for **meeting these demands** in a regional context"
- Feedback from stakeholders on
  - Assumptions about supply and demand drivers included in the CEP modeling
  - Challenges and possible policy pathways
- DOER received 76 written comments, reviewed for report
- Leading into the 2030 CECP and 80 x 50 Study

Overview of Scenarios

- Modeling Assumptions
  - Project different possibilities for Massachusetts' energy future through modeling
  - Analyzing multiple scenarios to understand how different policies ***drive differences*** in costs, reliability, and emissions
- Key Levers
  - Efficiency
  - Renewables
  - Electrification (electric vehicles, heat pumps)
- Key Differences from LEAP Analysis
  - 2030 vs. 2050
  - True electric sector modeling
  - Market costs
  - Updates from new legislation

Modeling

- Electric Sector
  - Synapse and the Encompass Model
    - Production-cost and capacity-expansion model
    - Includes costs, scheduling, environmental compliance, etc.
    - Unit-specific and regional
  - Renewable Energy Market Outlook model and Sustainable Energy Advantage
    - Scenario-specific renewable energy build-outs
    - Renewable energy certificate (REC) and clean energy certificate (CEC) price forecasts

Modeling

- Thermal and Transportation Sector
  - Synapse and Multi-Sector Emissions Model (M-SEM)
    - State-specific information on energy use and emissions in the electric, residential, commercial, industrial, and transportation sectors
    - Energy Information Administration's (EIA) State Energy Data System (AEO) and Annual Energy Outlook 2018

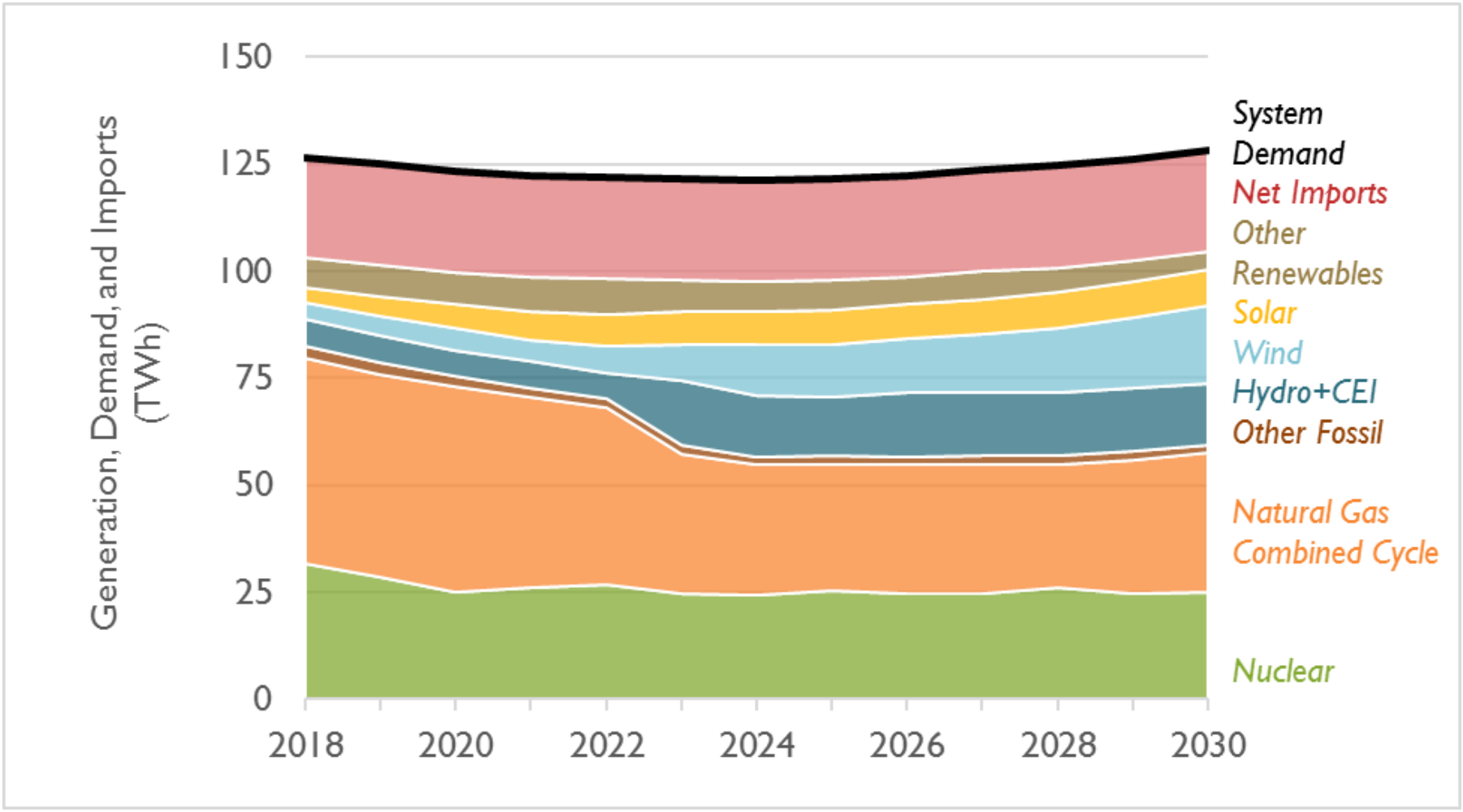
Building the Sustained Policies Scenario Electric Sector

- Demand
  - Drivers
    - Population and GDP
    - ***Energy efficiency*** programs and new codes and standards for lighting and appliances
    - ***Electrification***
  - Assumptions
    - ISO-NE 2018 CELT Report: projections of annual electricity sales from 2018 to 2027
    - Annual projection of the impacts of energy efficiency
    - Current deployment of heat pumps
    - 160,000 electric vehicles in MA specifically by 2025

Building the Sustained Policies Scenario Electric Sector

- Supply
  - Pre-2018 Legislation RPS and CES – 1% and 2% increases
  - 83D (hydroelectric) and 83C (offshore wind) as filed
  - Additional offshore wind in CT and RI
  - Additional demand met by the results of the EnCompass modeling

Sustained Policies – New England



80x50 Study

Hong-Hanh Chu, EEA

Overview

- Long-range comprehensive study outlining strategies to achieve 80 percent reductions by 2050.
- Tentative scope:
  1) 2-6 cross-sectoral scenarios that outline plausible futures for the Electric, Buildings, Transportation, Land use, and Non-energy sectors in 2050.
  2) GWSA compliant emissions reduction pathway for each plausible scenario.
  3) Viable suite of recommended policies (including market-based mechanisms and with a specific focus on policy solutions for the Transportation sector) and when to implement them in each plausible scenario.
  4) Stakeholder process to gather feedback on potential policies including those impacting freight, land use and zoning, and the low-income and rural communities.

Overview

- Key Analyses:
  - Energy demand in each sector and across-sectors
  - Energy supply and cost
  - Key actors and decision points, strategic transitions
  - Drivers of price and non-price behavioral change
  - Indirect benefits and social-economic equity concerns of potential policies
- Main Variables:
  - Technology growth and deployment
  - Land use development (where people live and work, commercial centers)
  - Fuel price

Process

- Connection to existing studies and efforts:
  - Incorporates results and recommendations from the Comprehensive Energy Plan, Commission on the Future of Transportation, and State Hazard Mitigation and Climate Action Plan.
- Connection to ***Clean Energy and Climate Plan for 2030***:
  - Emissions reduction pathways to 2050 in various plausible scenarios could inform what GHG emissions limits the EEA Secretary should set for 2030;
  - Recommended policies and implementation timeline could inform what policies should be included in the CECP for 2030 that would allow us to achieve the emissions limits in 2030 and put us on a path toward 80% reduction regardless of what scenario we may encounter in 2050.

Process

- Timeline:
  - Stakeholder feedback on study scope, today and Fall 2018
  - RFR or RFQ posted, Winter 2018/2019
  - Consultants contracted, Winter/Spring 2019
  - Stakeholder engagement throughout
  - Study concludes, Summer 2020
- IAC involvement:
  - Feedback on scope of study
  - Additional feedback as the study progresses
  - Recommendation of strategies and policies for consideration in the study and CECP for 2030