



# Connecticut Department of Energy and Environmental Protection



# GC3 Analysis, Data, and Metrics Meeting

July 26, 2016  
1:30 — 3:30 p.m.



Connecticut Department of Energy and Environmental  
Protection

# Agenda

**1:30**

Review meeting agenda

*DEEP Commissioner Klee*

**1:40**

Review 2013 GHG Emissions Inventory

*Keri Enright-Kato, CT DEEP*

**2:00**

Review and discuss draft scenarios and setting mid-term targets

*Paul Miller and Jason Rudokas, NESCAUM*

**3:00**

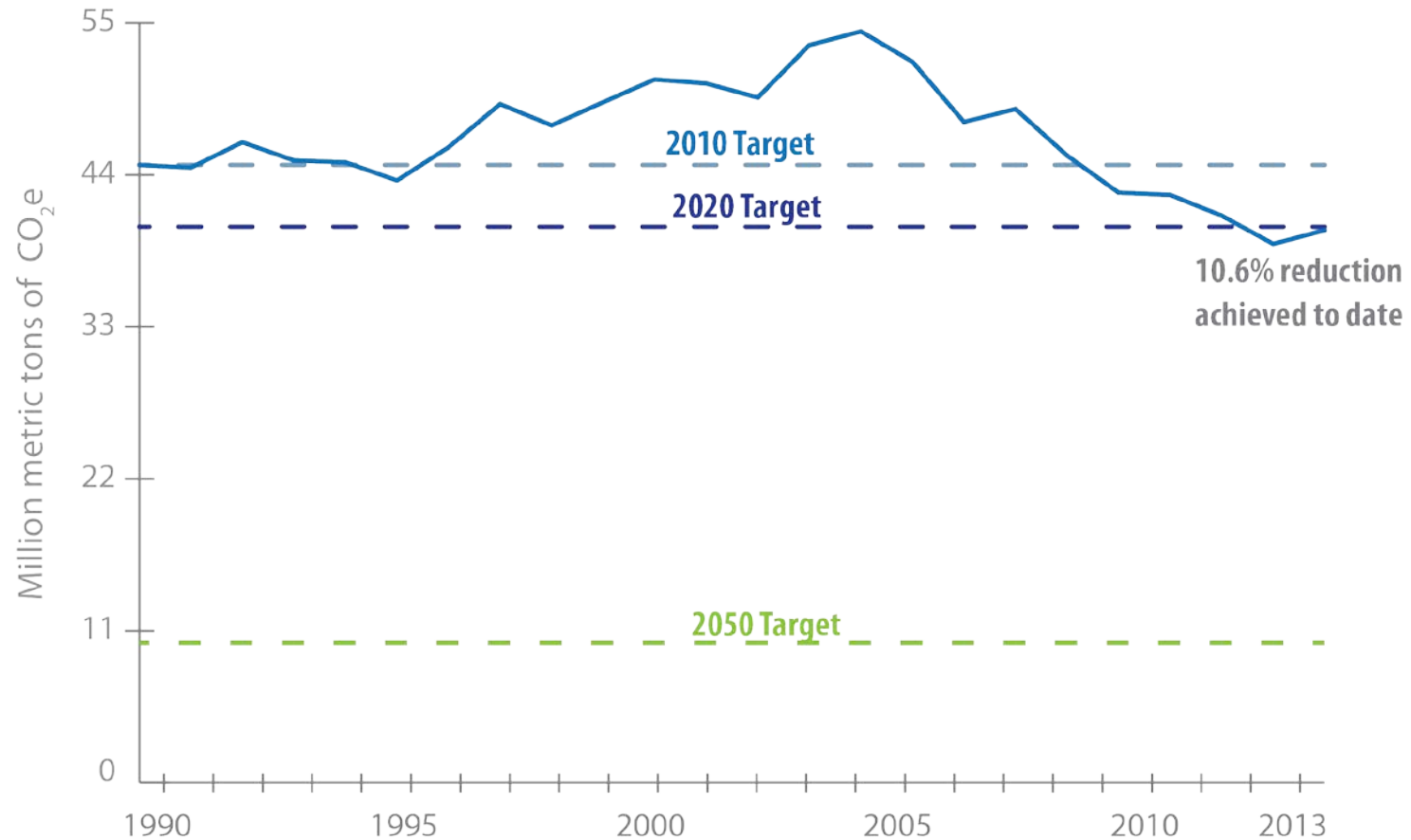
Public Comments

# 2013 Statewide GHG Emissions Inventory



Connecticut Department of Energy and Environmental Protection

## Connecticut Statewide Greenhouse Gas Emissions 1990-2013



Overall statewide emissions are 10.6% below 1990 levels. This maintains the state's efforts to meet the GWSA goal of 10% below 1990 levels by 2020. There was a slight uptick (2.5%) in emissions from 2012 to 2013.

# Inventory Methodology

- U.S. Environmental Protection Agency's State Inventory Tool (SIT).
- Solid-waste data collected by the Department of Energy and Environmental Protection's municipal waste program, data that the agency believes to be more accurate than the default SIT data.
- Consumption-based accounting approach for the electric power sector was applied.
- Energy Information Administration data on Connecticut electricity
- Regional-grid carbon intensity data developed by the Massachusetts Department of Environmental Protection which takes into account the carbon intensity of electric generation within the ISO New England grid as well as electricity imported into the region from Canada, New York, and other jurisdictions. This approach more accurately reflects the emission profile of the regional electric grid.

**ELECTRICITY**  
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State Electricity Profiles  
Data for 2014 | Release Date: March 24, 2016 | Next Release: February 2017  
Choose a Year: [Select a Year]

Connecticut Electricity Profile 2014

Table 1. 2014 Summary statistics (Connecticut)

Item	Value	Rank
<b>Primary energy source</b>		
Nuclear		
Net summer capacity (megawatts)	8,832	35
Electric utilities	161	45
IPP & C&P	8,671	12
<b>Net generation (megawatt-hours)</b>		
Electric utilities	54,693	45
IPP & C&P	33,676,989	38
<b>Emissions</b>		
Sulfur dioxide (short tons)	1,807	47
Nitrogen oxide (short tons)	8,913	45
Carbon dioxide (thousand metric tons)	7,959	41
Sulfur dioxide (lb/MWh)	0.1	46
Nitrogen oxide (lb/MWh)	0.3	44
Carbon dioxide (lb/MWh)	523	46
<b>Total retail sales (megawatt-hours)</b>		
Full service provider sales	29,354,469	37
Energy-only provider sales	12,696,169	41
Energy-only provider sales	16,656,291	9
<b>Direct use (megawatt-hours)</b>		
	837,754	30
<b>Average retail price (cents/kWh)</b>		
	17.05	3

Other state profiles:  
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**Statewide Greenhouse Gas (GHG) Emissions Baseline & Projection Update**

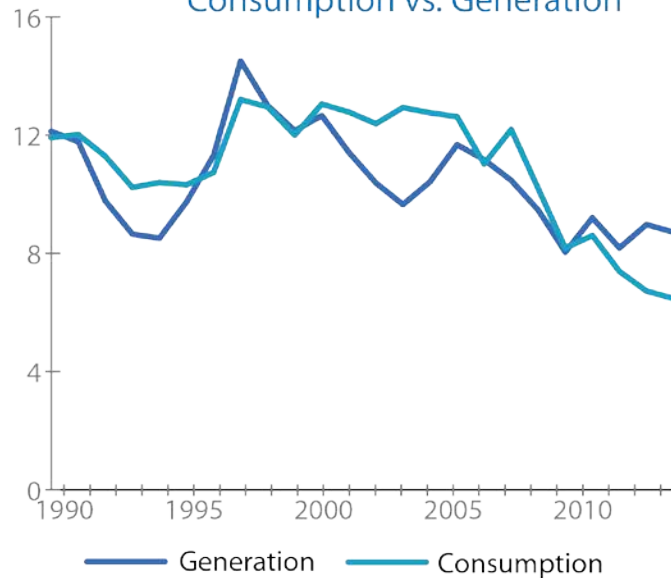
Public Comment Period:  
Ended December 23, 2015

Chapter 298 of the Acts of 2008, the Massachusetts Global Warming Solutions Act (GWSA) was signed into law in August 2008 to begin to address the challenges of climate change. The GWSA requires MassDEP to "... determine the statewide greenhouse gas emissions level in calendar year 1990 and reasonably project what the emissions level will be in calendar year 2020 if no measures are imposed to lower emissions other than those formally adopted and implemented as of January 1, 2009. This projection shall thereafter be refined to as the projected 2020 business as usual level." MassDEP published such a 1990 Baseline and 2020 BAU on July 1, 2009, which indicated "The Department recognizes that the science and practice of determining [greenhouse gas] GHG emissions is changing rapidly and that Massachusetts, being at the cutting edge of this work, should avail itself of advancements in the science to the extent possible. Therefore, MassDEP will re-evaluate the 1990 Baseline as needed (e.g., significant new data becomes available, if amendment is necessary, a full public review process will be used." Significant new data have become available, including revisions to the Global Warming Potentials (GWPs) of GHGs, improvements to data methodologies, and corrections to underlying data sources.

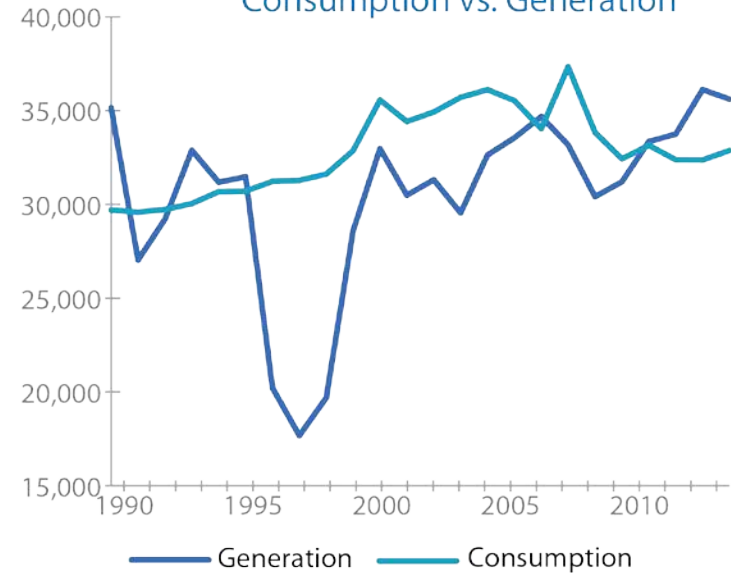
- Statewide Greenhouse Gas Emissions Level, 1990 Baseline & 2020 Business As Usual Projection Update. Includes Appendices A & B.
- Appendix C: GHG Inventory Spreadsheet (ARL Global Warming Potentials)
- Appendix D: GHG Inventory Spreadsheet (ARL Global Warming Potentials)
- Appendix E: 2001 Draft Electricity Emissions Factors (Including Imports)
- Appendix F: 2002 Draft Electricity Emissions Factors (Including Imports)
- Appendix G: 2003 Emissions from Electricity Consumed in Massachusetts
- Appendix H: 2004 Emissions from Electricity Consumed in Massachusetts
- Appendix I: 2005 Emissions from Electricity Consumed in Massachusetts
- Appendix J: 2006 Emissions from Electricity Consumed in Massachusetts
- Appendix K: 2007 Emissions from Electricity Consumed in Massachusetts
- Appendix L: 2008 Emissions from Electricity Consumed in Massachusetts
- Appendix M: 2009 Emissions from Electricity Consumed in Massachusetts

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CT Electric Sector GHG Emissions  
Consumption vs. Generation

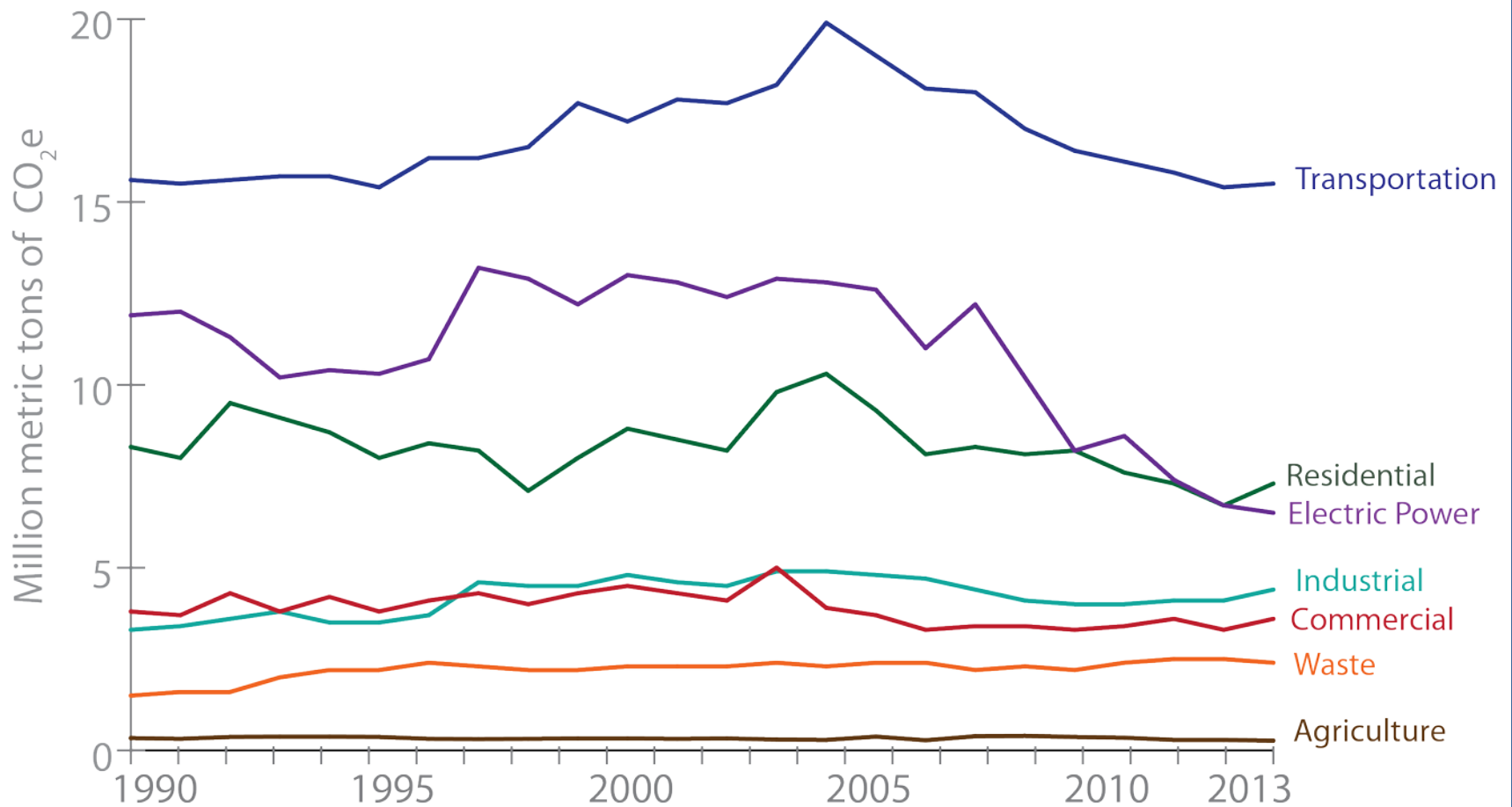


CT Electric Sector GWH  
Consumption vs. Generation



These two graphs represent a comparison of GHG emissions and GWH using a consumption-based and generation-based accounting approaches. While the consumption-based approach will be DEEP's primary method for calculating emissions from the electricity sector, the agency will continue to track emissions associated with in-state electric power generation for the purposes of comparison. The two methods produce roughly parallel estimates across the period 1990-2013: emissions peaking in the mid-1990s and then significantly declining.

## Connecticut Greenhouse Gas Emissions by Sector 1990-2013

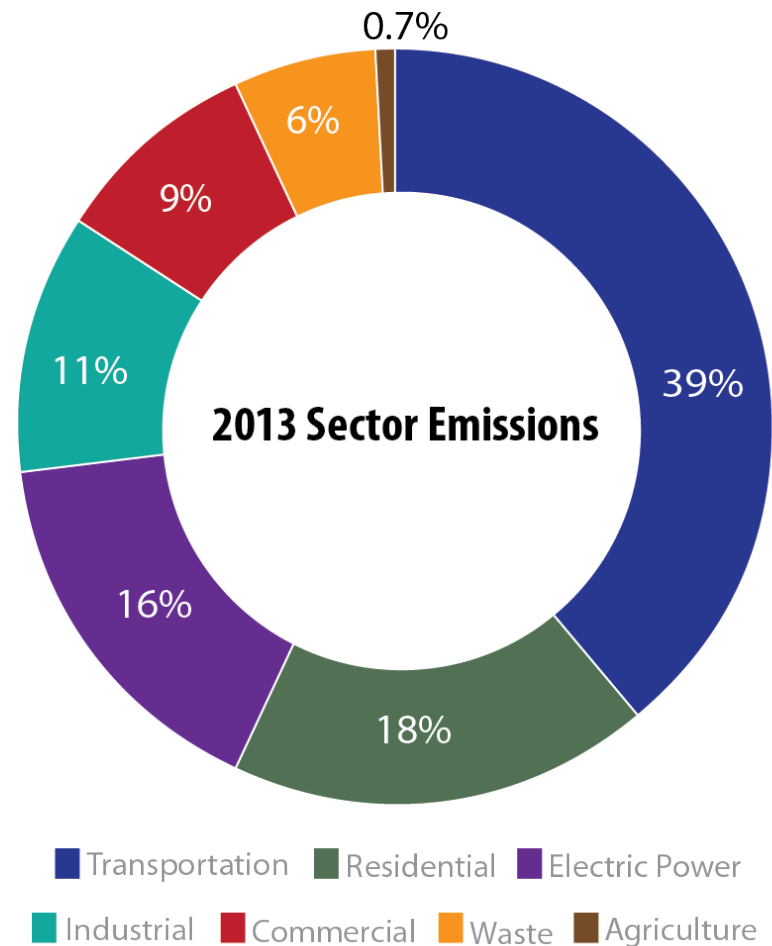


The slight increase in emission from 2012 to 2013 are attributed to increases in the residential (increased from 6.7 MTCO<sub>2</sub>e in 2012 to 7.3 MTCO<sub>2</sub>e in 2013), commercial (increased from 3.3 MTCO<sub>2</sub>e in 2012 to 3.6 MTCO<sub>2</sub>e in 2013), and industrial (increased from 4.1 MTCO<sub>2</sub>e in 2012 to 4.4 MTCO<sub>2</sub>e in 2013) sectors.



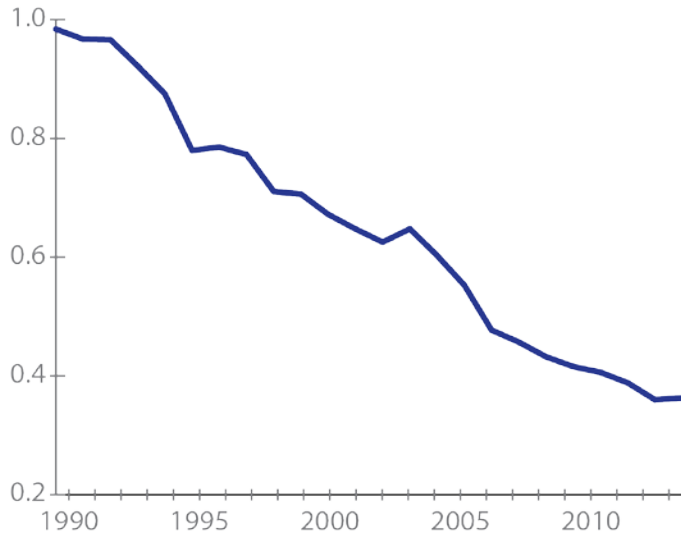
## Connecticut Emissions by Sector (MTCO<sub>2</sub>e)

	1990	2001	2013
Transportation	15.6	17.8	15.5
Residential	8.3	8.5	7.3
Electric Power	11.9	12.8	6.5
Industrial	3.3	4.6	4.4
Commercial	3.8	4.3	3.6
Waste	1.5	2.3	2.4
Agriculture	0.34	0.32	0.27
<b>Total</b>	<b>44.7</b>	<b>50.6</b>	<b>40.0</b>
<b>% change from 1990</b>		<b>-10.6%</b>	
<b>% change from 2001</b>		<b>-21%</b>	



Emissions from the transportation sector still make up the bulk of the state's emissions, representing 39% in 2013. Residential and the electric power sectors follow next at 18% and 16% respectively.

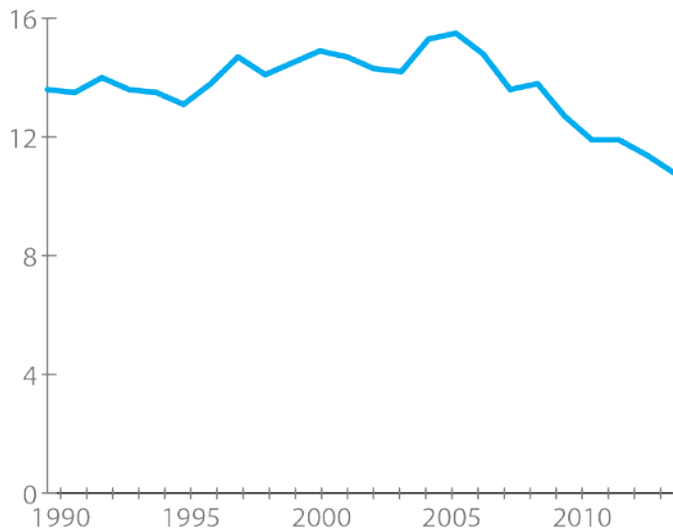
Pounds of CO<sub>2</sub>e Per \$ of CT  
Gross Domestic Product



Overall trends in the inventory demonstrate that the carbon intensity of Connecticut's economy has declined dramatically, from nearly 1 pound of CO<sub>2</sub>e per dollar of state gross domestic product in 1990 to less than 0.4 pounds per dollar in 2013. This demonstrates significant decoupling of economic activity and carbon pollution.

Connecticut's 2013 per capita emissions were 10.8 which compares favorably with surrounding northeastern states and is well below the national average of 16.7. Dropping 28 percent since 2000, GHG emissions per person have declined an average of 0.8 percent per year since 1990.

CT Tons of CO<sub>2</sub>e Per Capita



GHG emissions per capita

	2000	2006	2013
Connecticut	14.9	14.8	10.8
Massachusetts	13.0	11.8	9.7
New York	11.2	10.0	8.1
Rhode Island	11.2	9.8	9.5
New Hampshire	14.1	14.7	10.5
Vermont	11.0	10.6	8.9
Maine	17.5	15.9	12.2
California	11.2	10.9	9.2
National Average	20.7	19.6	16.7

# Review and discuss scenarios

*Paul Miller and Jason Rudokas, NESCAUM*



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# Background

- We are presenting four draft scenarios put together based on the discussion at the June 16 GC3 meeting.
- The purpose of presenting these is to foster further discussion of future mitigation scenarios and of scenario building in general.

# Mitigation Building Blocks

- State energy efficiency programs post 2025
- Expanded energy efficiency, e.g., stretch building codes
- Utility-scale renewables
- Behind-the-meter solar PV
- Electric passenger cars and passenger trucks
- Residential renewable thermal
- Commercial renewable thermal
- Short haul heavy-duty electrification
- Clean long haul & rail
- VMT reduction measures

# Mitigation Scenarios

## Scenario 1:

Pilgrim retires and is replaced with natural gas. Remaining 3 nuclear plants continue to operate through 2050. Grid evolves towards zero-carbon with utility-scale solar the dominant resource.

- Scenario 1.1 examines greater levels of energy efficiency, e.g., stretch building codes, to significantly reduce load

## Scenario 2:

All nuclear retires at the end of current license and is replaced with natural gas. Grid evolves towards zero-carbon with utility-scale solar the dominant resource.

## Scenario 3:

All nuclear retires at the end of current license and is replaced with on-shore wind. Grid evolves towards zero-carbon with roughly even split between utility-scale solar and on-shore wind.

## Scenario 4:

Scenario 1 + accelerated early deployment of mitigation technologies and measures.

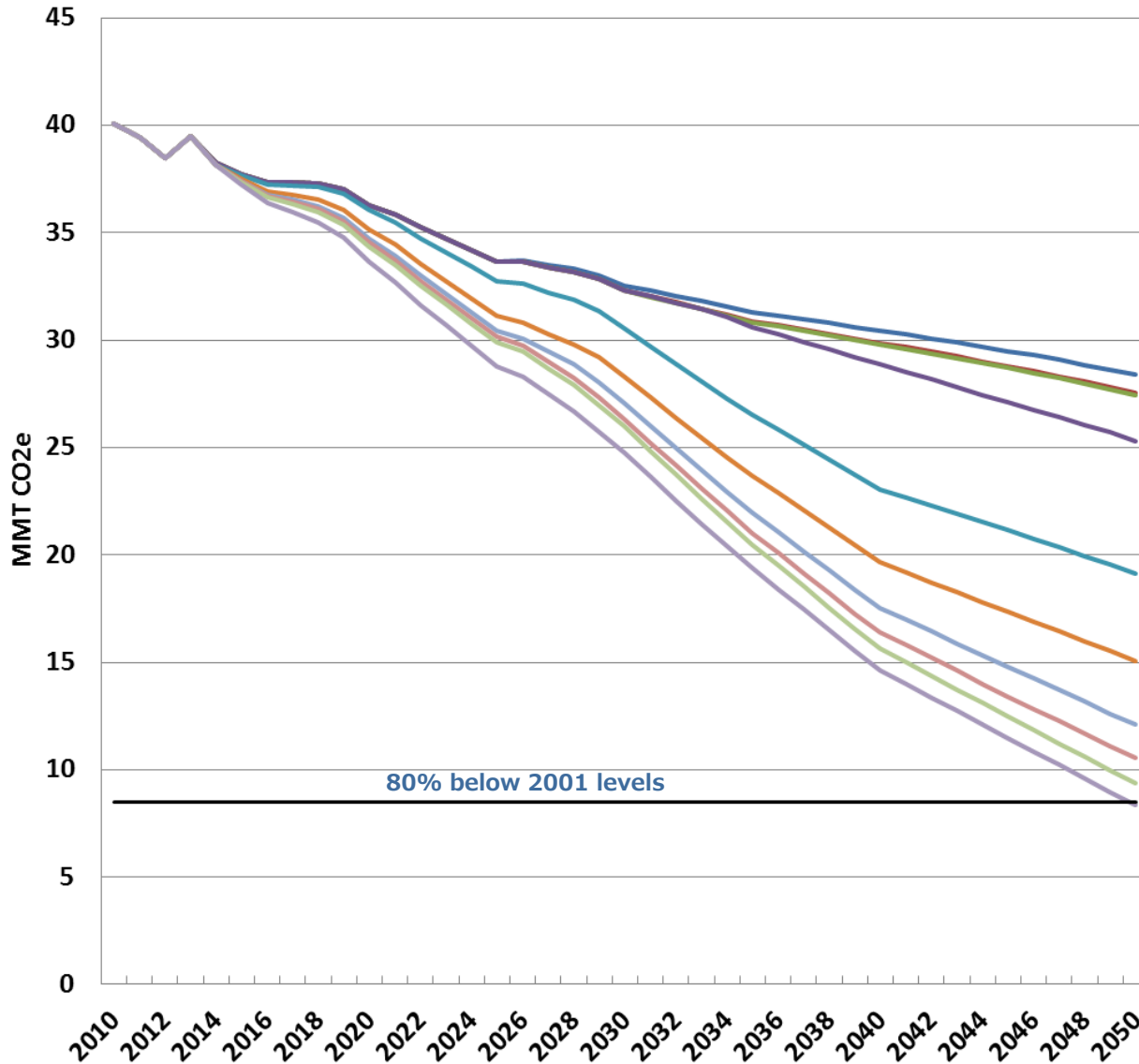
# Scenario 1

- Pilgrim retires and is replaced with natural gas. Remaining 3 nuclear plants continue to operate through 2050. Grid evolves towards zero-carbon with utility-scale solar the dominant resource.
- Mitigation building block penetration rates were set to achieve 80% reduction by 2050 and mid-range reductions by 2030
- “Reference” scenario for comparison to the other scenarios



# Mitigation Wedges – Scenario 1

Economy Wide GHG Emissions

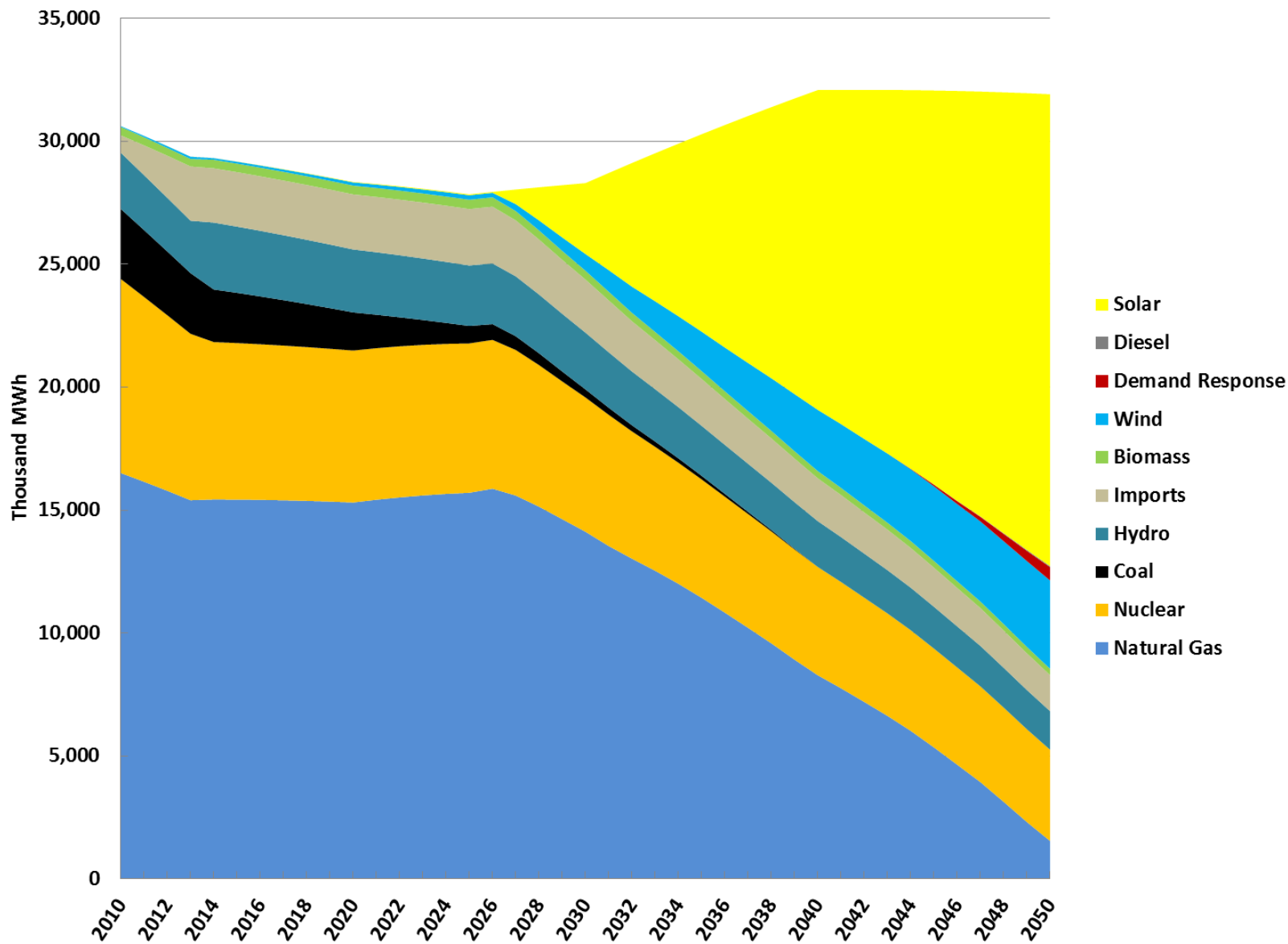


Year	% Reduction
2030	40%
2040	65%
2050	80%

- Reference Case
- State EE Programs
- Behind the Meter Solar PV
- Utility-Scale Renewables
- Electric Passenger Cars / Trucks
- Residential Renewable Thermal
- Commercial Renewable Thermal
- Heavy-Duty Electrification
- Clean Long Haul & Rail
- VMT Reduction Measures



# Electricity Generation – Scenario 1



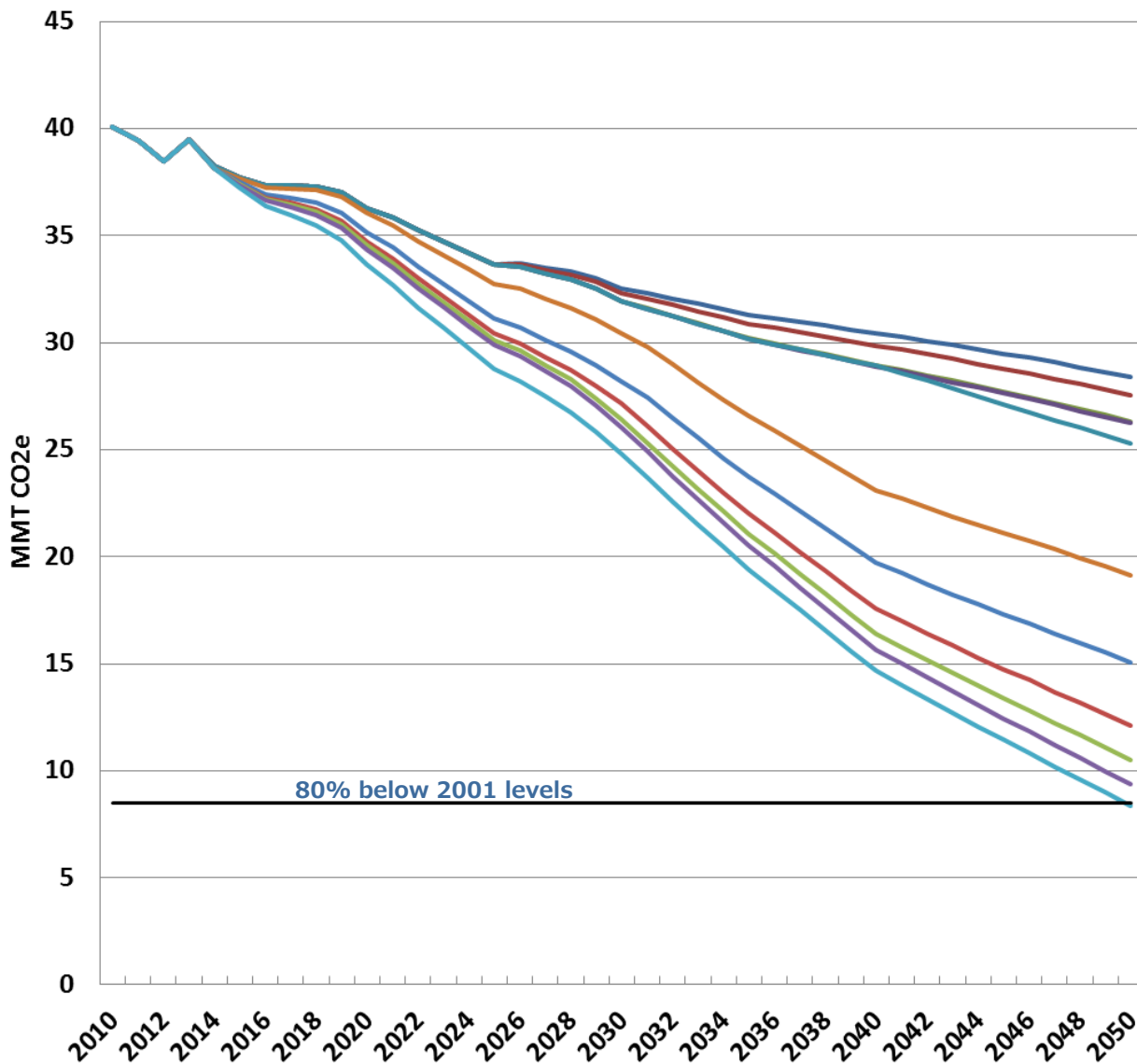
# Scenario 1.1

- Pilgrim retires and is replaced with natural gas. Remaining 3 nuclear plants continue to operate through 2050. Grid evolves towards zero-carbon with utility-scale solar the dominant resource.
- Mitigation building block penetration rates were set to achieve 80% reduction by 2050 and mid-range reductions by 2030
- Deep electric energy efficiency significantly reduces load



# Mitigation Wedges – Scenario 1.1

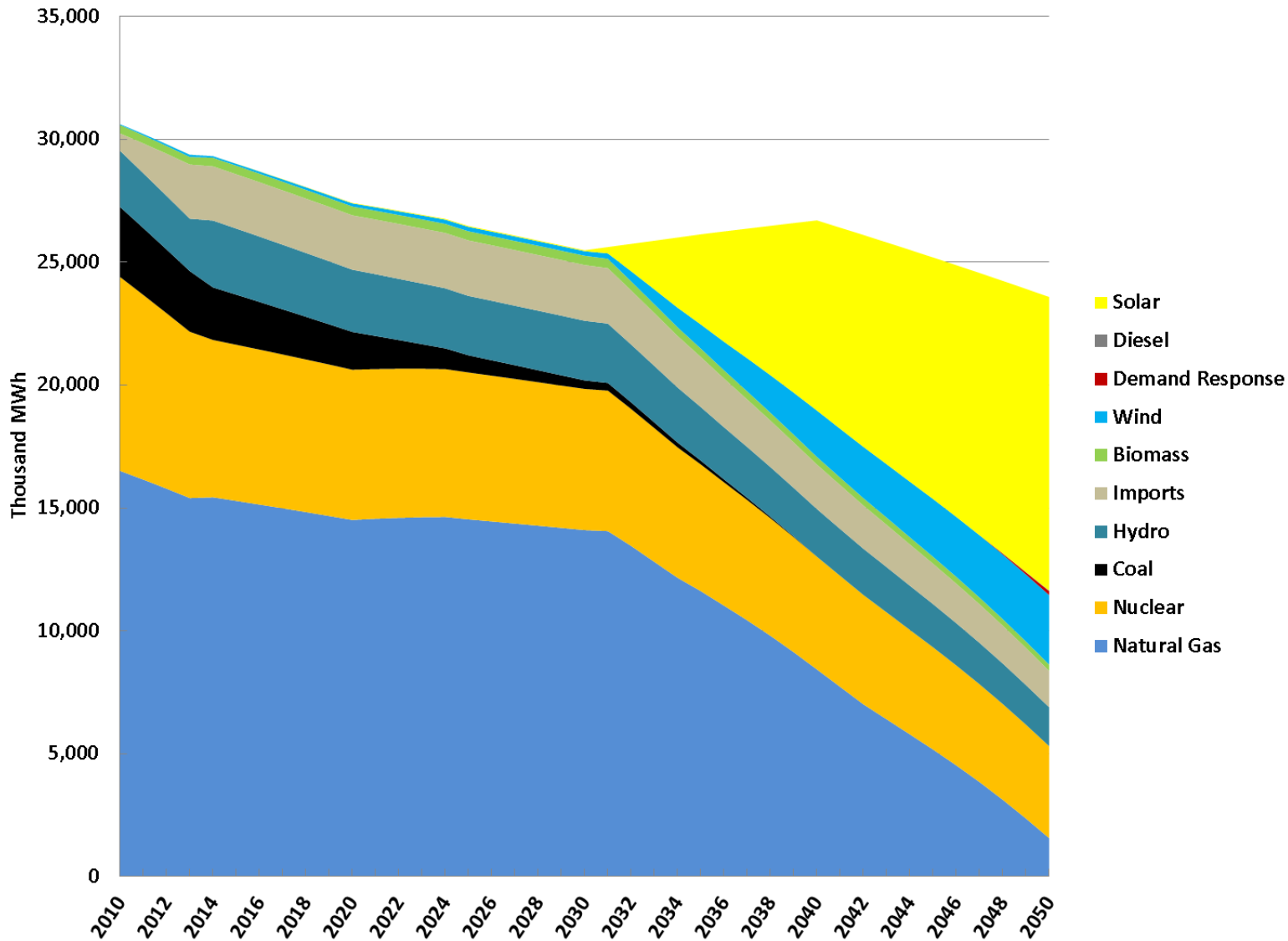
Economy Wide GHG Emissions



Year	% Reduction
2030	40%
2040	65%
2050	80%

- Reference Case
- State EE Programs
- Expanded EE
- Behind the Meter Solar PV
- Utility-Scale Renewables
- Electric Passenger Cars / Trucks
- Residential Renewable Thermal
- Commercial Renewable Thermal
- Heavy-Duty Electrification
- Clean Long Haul & Rail
- VMT Reduction Measures

# Electricity Generation – Scenario 1.1



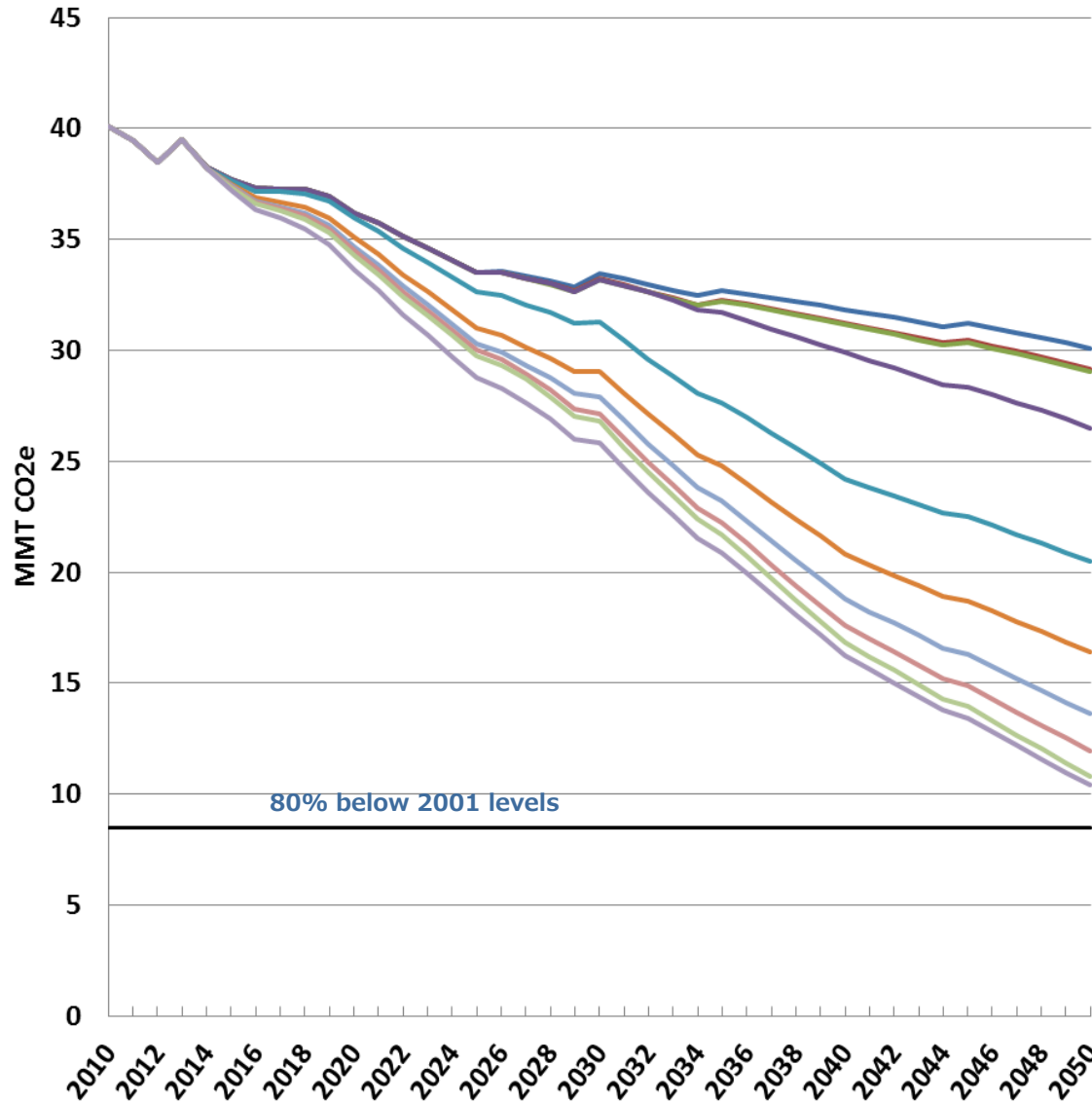
# Scenario 2

- All nuclear retires at the end of current license and is replaced with natural gas. Grid evolves towards zero-carbon with utility-scale solar the dominant resource.
- Mitigation building block penetration rates were the same as scenario 1.



# Mitigation Wedges – Scenario 2

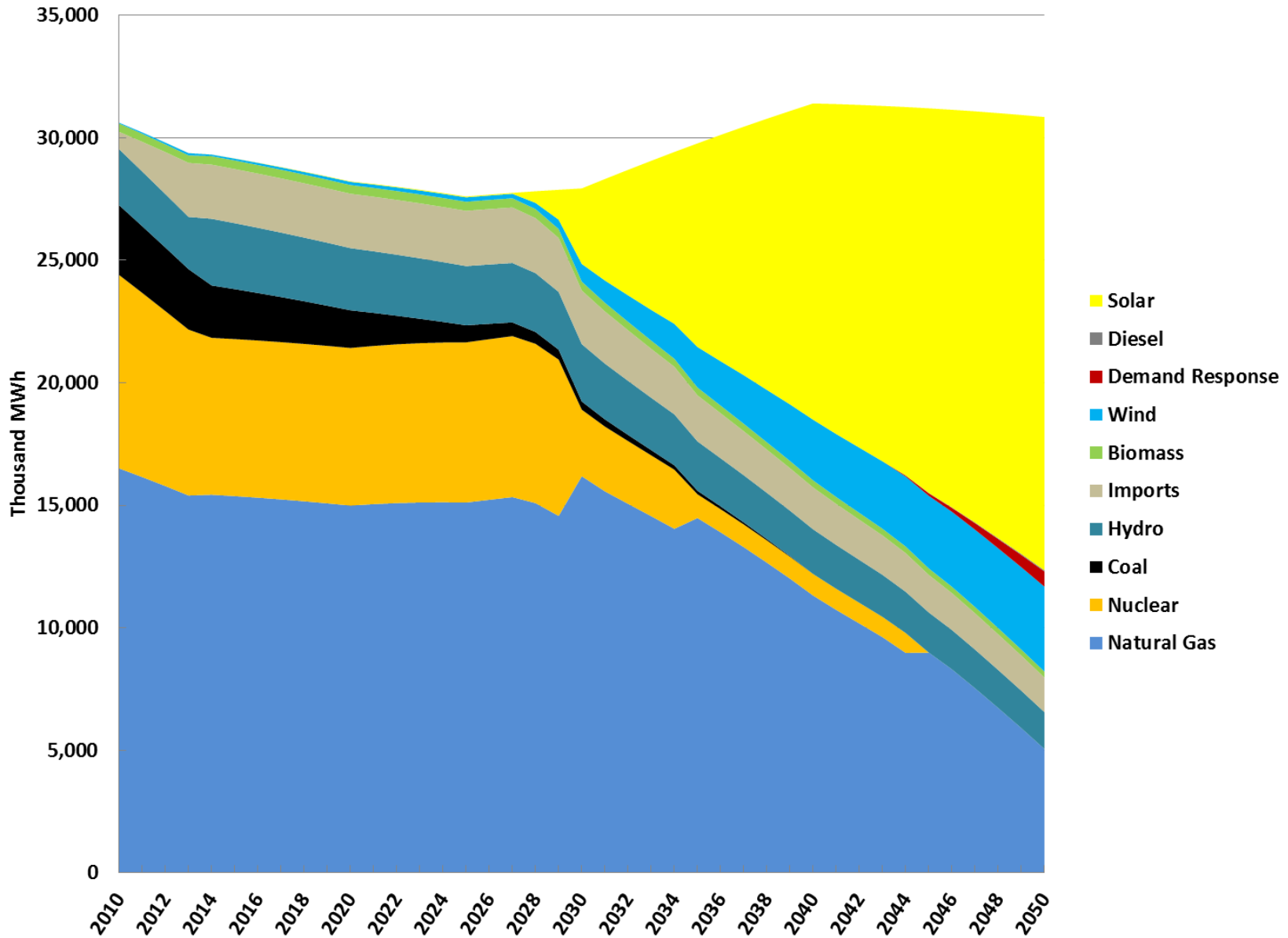
Economy Wide GHG Emissions



Year	% Reduction
2030	38%
2040	61%
2050	75%

- Reference Case
- State EE Programs
- Behind the Meter Solar PV
- Utility-Scale Renewables
- Electric Passenger Cars / Trucks
- Residential Renewable Thermal
- Commercial Renewable Thermal
- Heavy-Duty Electrification
- Clean Long Haul & Rail
- VMT Reduction Measures

# Electricity Generation – Scenario 2



# Scenario 3

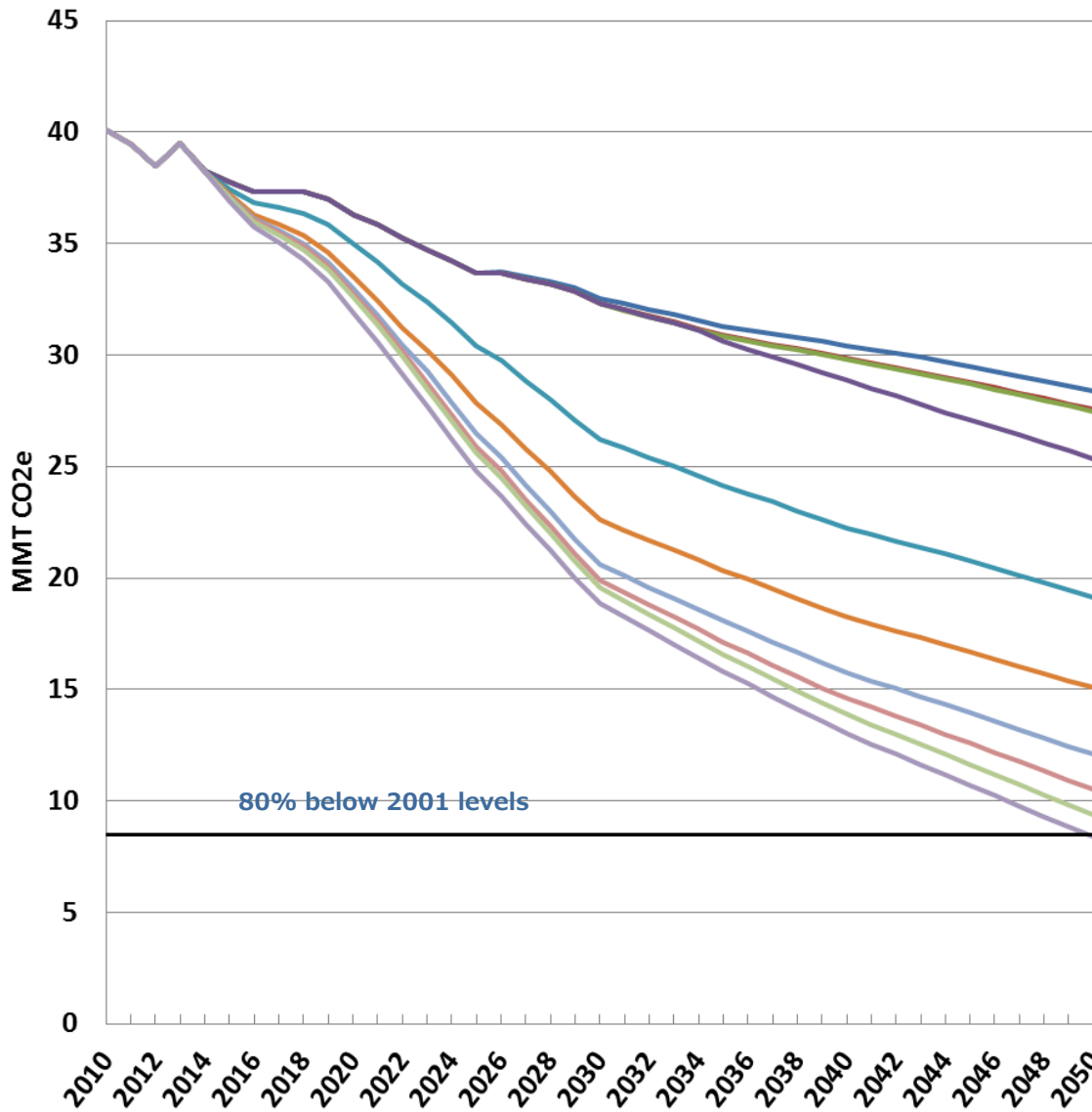
- All nuclear retires at the end of current license and is replaced with on-shore wind. Grid evolves towards zero-carbon with roughly even split between utility-scale solar and on-shore wind.
- Mitigation building block penetration rates were the same as scenario 1.





# Mitigation Wedges – Scenario 3

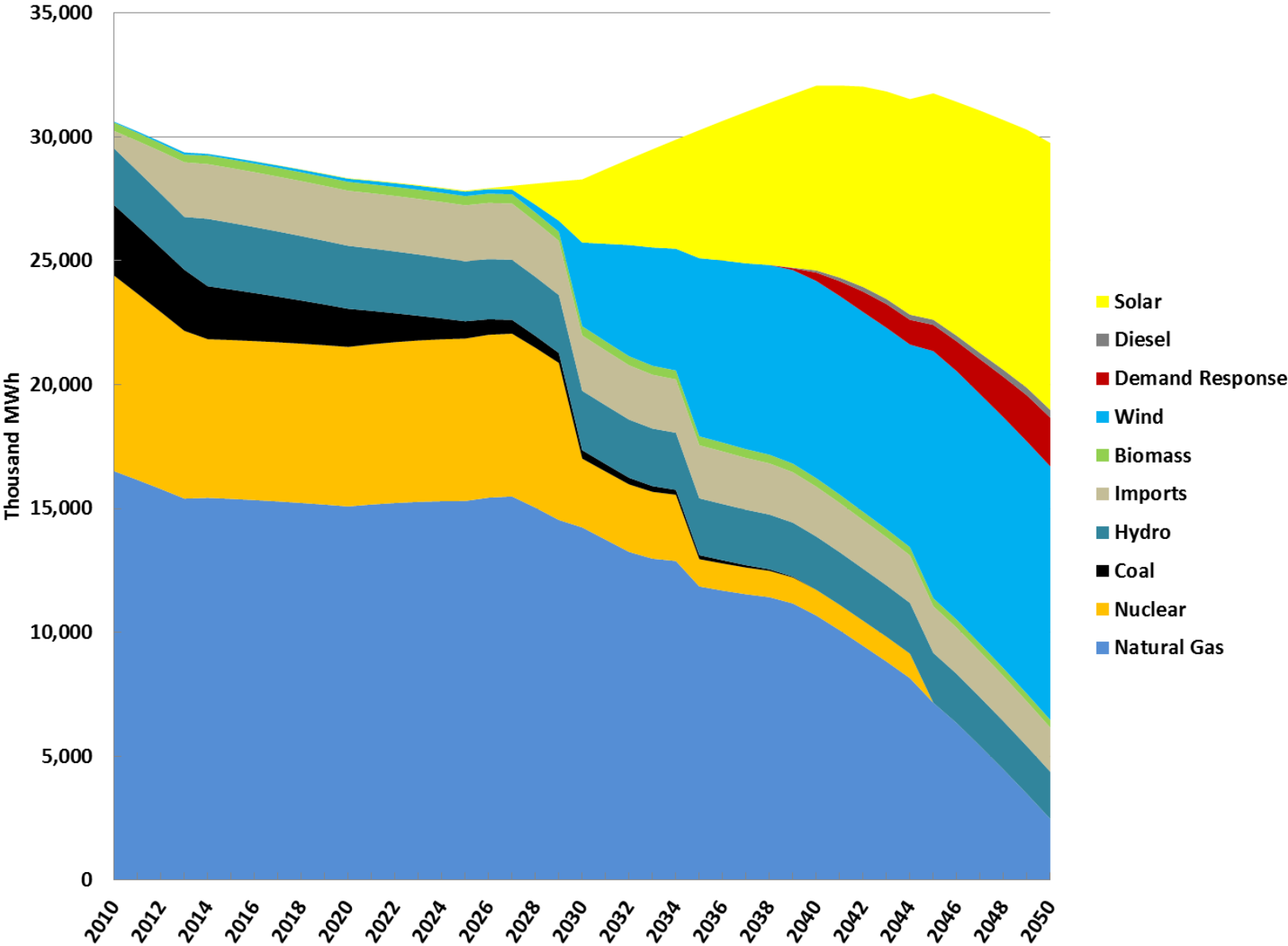
Economy Wide GHG Emissions



Year	% Reduction
2030	40%
2040	63%
2050	80%

- Reference Case
- State EE Programs
- Behind the Meter Solar PV
- Utility-Scale Renewables
- Electric Passenger Cars / Trucks
- Residential Renewable Thermal
- Commercial Renewable Thermal
- Heavy-Duty Electrification
- Clean Long Haul & Rail
- VMT Reduction Measures

# Electricity Generation – Scenario 3



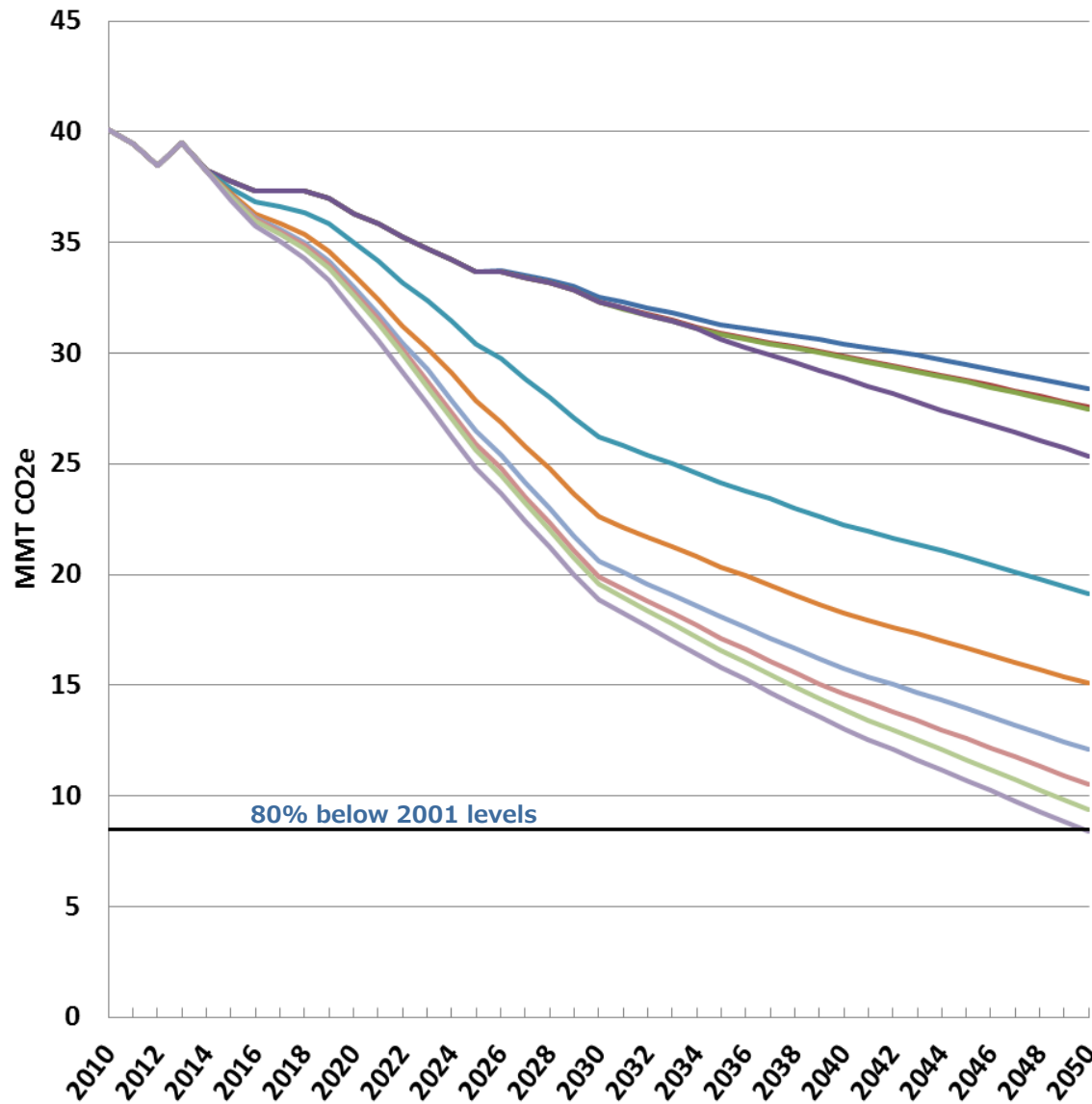
# Scenario 4

- Pilgrim retires and is replaced with natural gas. Remaining three nuclear plants continue operating through 2050. Grid evolves towards zero-carbon with utility scale solar the dominant resource.
- Mitigation building block penetration rates in 2050 are the same as scenario 1 and adjusted in 2030 to achieve a 55% reduction relative to 2001.



# Mitigation Wedges – Scenario 4

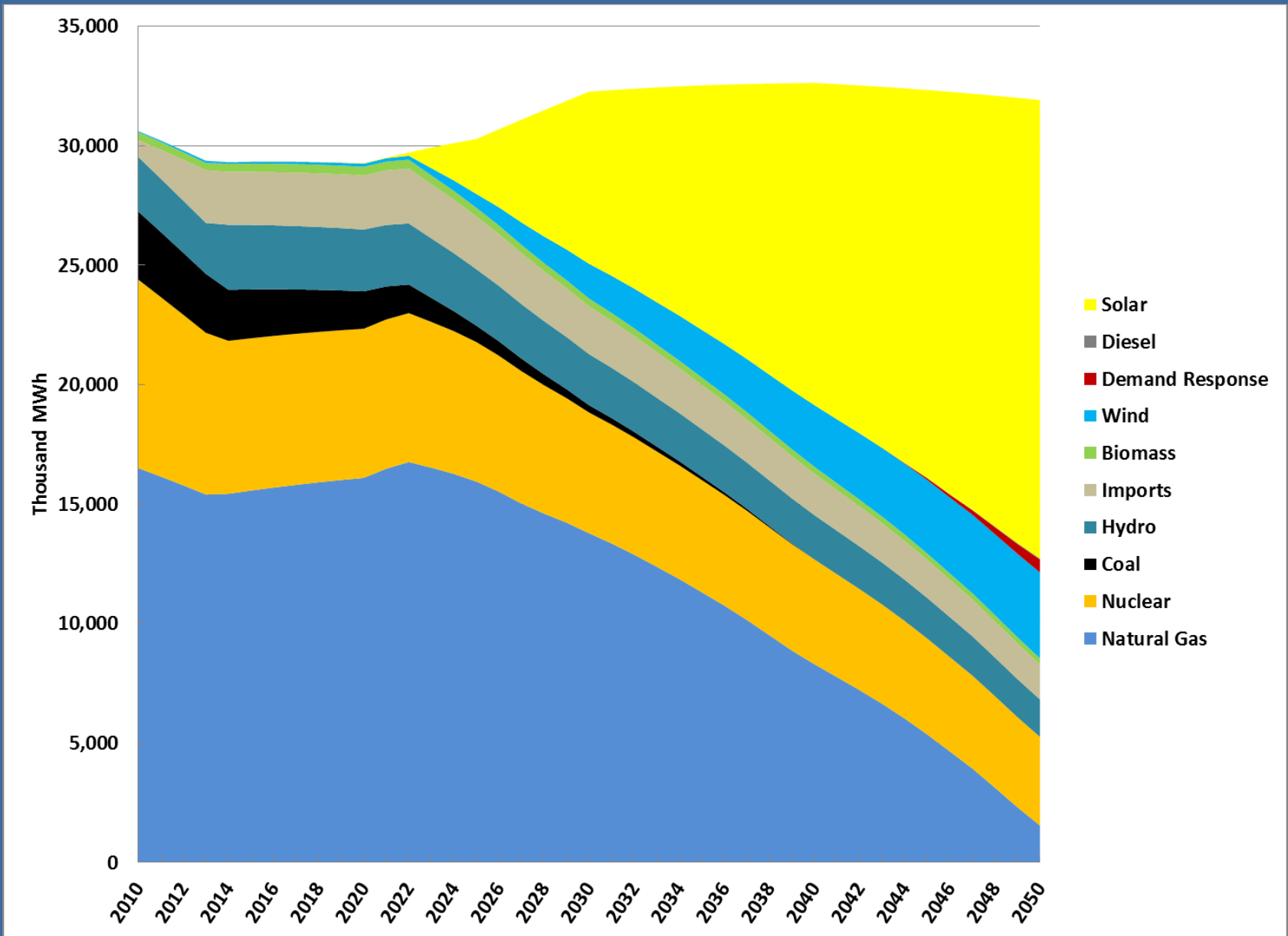
Economy Wide GHG Emissions



Year	% Reduction
2030	55%
2040	69%
2050	80%

- Reference Case
- State EE Programs
- Behind the Meter Solar PV
- Utility-Scale Renewables
- Electric Passenger Cars / Trucks
- Residential Renewable Thermal
- Commercial Renewable Thermal
- Heavy-Duty Electrification
- Clean Long Haul & Rail
- VMT Reduction Measures

# Electricity Generation – Scenario 4



# Mitigation Wedges – Scenario 4

## Electric Vehicles

	2015	2030	2050
Moderate rate of Electrification for Passenger Cars and Passenger Trucks			
# of BEV + PHEV + HEV	2,902	559,443	2,184,529
% of Fleet	0.1%	25%	79%
Accelerated rate of Electrification for Passenger Cars and Passenger Trucks			
# of BEV + PHEV + HEV	2,902	1,532,388	2,184,529
% of Fleet	0.1%	67%	79%

## Residential Ground and Air Source Heat Pumps

	2015	2030	2050
Moderate Penetration of Residential ASHP & GSHP			
# of Devices	2,934	289,920	847,293
% of Total Heating Devices	0.3%	30%	87%
Accelerated Penetration of Residential ASHP & GSHP			
# of Devices	2,934	579,840	703,485
% of Total Heating Devices	0.3%	60%	72%

- The accelerated penetration scenario was set up to achieve a 55% reduction by 2030.
- The tables are a way of comparing the difference from a technology deployment point of view between a 40% and 55% reduction by 2030.
- Early and drastic changes in technology choice would be needed for a 55% reduction.

# Public Comments



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