Initial Findings of the Climate Action Council Scoping Plan Integration Analysis

Long Island Power Authority Board of Trustees
Oversight & Clean Energy Committee

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November 17, 2021

NEW YORK STATE OF OPPORTUNITY. | Climate Action Council

Contents

NYS Climate Act

NYS Climate Leadership and Community Protection Act – *the Climate Act*

- **Among the most aggressive greenhouse gas reduction goals of any major economy:**

  40% by 2030, 85% by 2050, carbon neutrality

  70% renewable energy by 2030

  Zero-carbon electricity by 2040

- **Codifies clean energy targets**
- **First statutory Climate Action Council (CAC)**
- **Commitments to environmental justice and just transition**

The New York Times

New York to Approve One of the World's Most Ambitious Climate Plans

The state would pledge to eliminate net greenhouse gas emissions by 2050, with all its electricity coming from carbon-free sources.

New York will be required to get 70 percent of its electricity from renewable sources by 2030, and shift entirely to carbon-free power a decade later. Benjamin Norman for The New York Times

Climate Action Council Scoping Plan

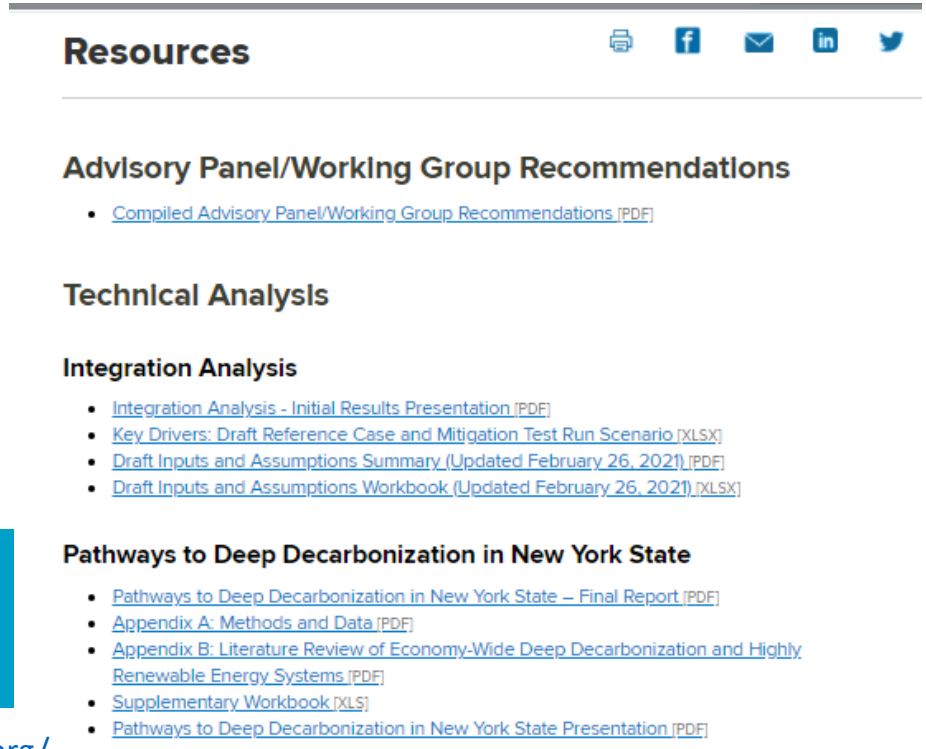
Climate Action Council Scoping Plan Resources

> For more information visit:

- https://climate.ny.gov/Climate-Resources
- https://climate.ny.gov/Climate-Action-Council/Meetings-and-Materials

https://www.nyclimatescience.org/

https://nysclimateimpacts.org/



Resources

Advisory Panel/Working Group Recommendations

- Compiled Advisory Panel/Working Group Recommendations [PDF]

Technical Analysis

Integration Analysis

- Integration Analysis - Initial Results Presentation [PDF]
- Key Drivers: Draft Reference Case and Mitigation Test Run Scenario [XLSX]
- Draft Inputs and Assumptions Summary (Updated February 26, 2021) [PDF]
- Draft Inputs and Assumptions Workbook (Updated February 26, 2021) [XLSX]

Pathways to Deep Decarbonization in New York State

- Pathways to Deep Decarbonization in New York State – Final Report [PDF]
- Appendix A: Methods and Data [PDF]
- Appendix B: Literature Review of Economy-Wide Deep Decarbonization and Highly Renewable Energy Systems [PDF]
- Supplementary Workbook [XLS]
- Pathways to Deep Decarbonization in New York State Presentation [PDF]

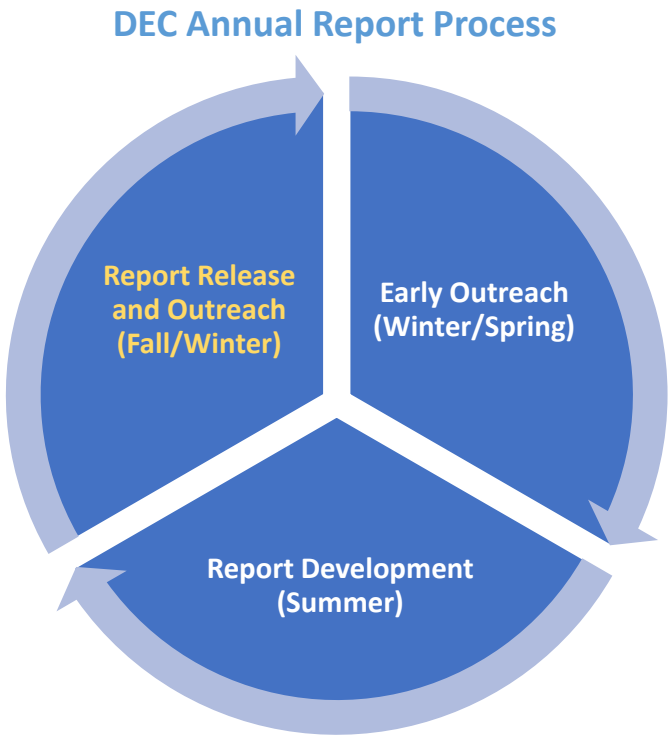
Climate Action Council Scoping Plan

- **Scoping plan will outline recommendations to achieve emissions targets, carbon-neutral economy and:**
  - **Measures to aid in just transition of workforce**
  - **Mechanisms to limit emission leakage**
  - **Measures to reduce emissions in disadvantaged communities**
  - **Measures to achieve healthy forests**
- **Process**
  - **2021**
    - **Consider Advisory Panel recommendations**
    - **Consult with Climate Justice Working Group and Environmental Justice Advisory Group**
    - **Issue Draft Scoping Plan**
  - **2022**
    - **Hold six public comment hearings on the Draft Scoping Plan**
    - **Deliver Final Scoping Plan**
  - **Update every five years.**

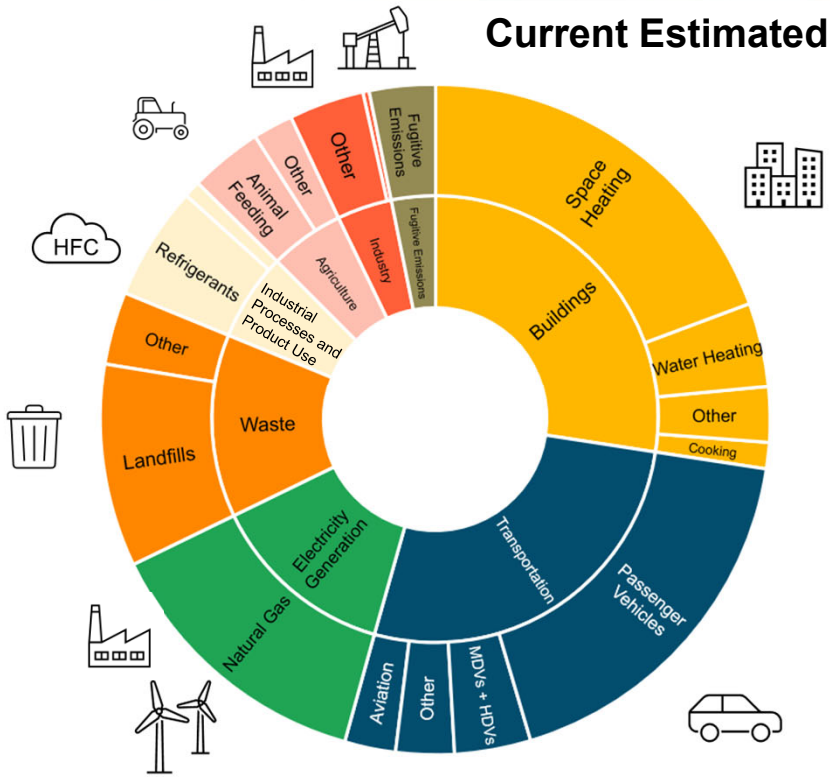
GHG Emissions

Statewide GHG Emissions Report

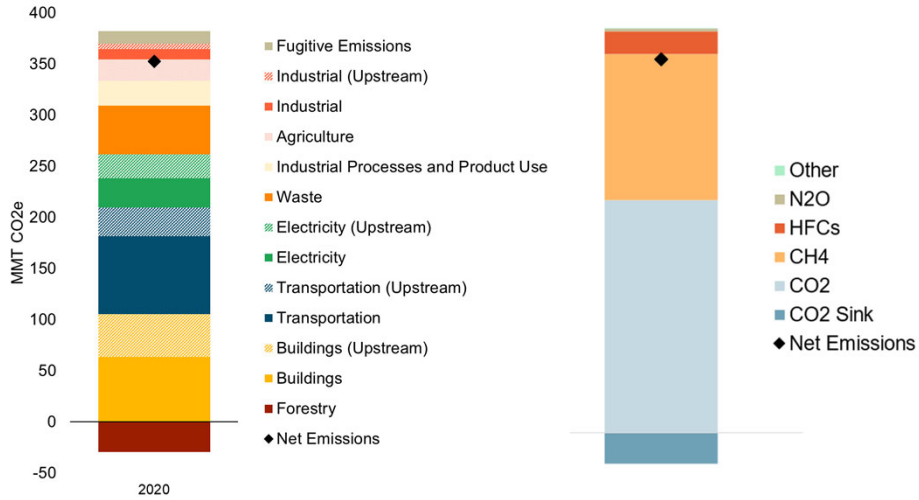
- The Climate Act requires NYS DEC to issue an annual Greenhouse Gas (GHG) Emissions Report
- 2021 report will cover 1990-2019
- Will include a special report on Agriculture, Forestry, and Other Land Use (AFOLU)



Current Emissions in New York State



Current Estimated GHG Emissions by Sector*



*Draft 2020 results in line with DEC CLCPA accounting including upstream emission factors, 20-year GWP, and estimates from NY PATHWAYS

Integration Analysis: Overview and Findings

Key Decarbonization Pathways Findings

> **Achievement of emissions reductions to meet state law requires action in all sectors, especially considering New York State's novel emissions accounting**
  - Every sector will see high levels of transformation over the next decade and beyond, requiring critical investments in New York's economy

> **Energy efficiency and end-use electrification** will be essential parts of any Pathway that hits NYS Emissions Limits
  - In all scenarios modeled, zero emission vehicles and heat pumps become the **majority of new purchases by the late 2020s**, and fossil-emitting cars and appliances are **no longer sold after 2035**
  - **1 - 2 million efficient homes** electrified with heat pumps by 2030
  - Approximately **3 million zero-emission vehicles** (predominantly battery electric) by 2030
  - **Unprecedented rate of adoption** of novel and potentially disruptive technologies and measures
  - **Consumer decision-making** plays a large role, especially important for the purchase of new passenger vehicles and heating systems for homes and businesses through the next decade

> **Substantially reduce vehicle miles traveled** while increasing transportation access
  - Expansion of transit service structured around community needs
  - Smart growth inclusive of equitable transit-oriented development
  - Transportation demand management

Key Decarbonization Pathways Findings (cont'd)

> **Wind, water, and sunlight power the majority of New York's economy in 2050 in all Pathways**
  - Even with aggressively managed load, electric consumption doubles and peak nearly doubles by 2050, and NYS becomes a winter peaking system by 2035.
  - Offshore wind on the order of 20 GW, solar on the order of 60 GW, and 4- and 8-hour battery storage on the order of 20 GW by 2050
  - **Firm, zero-emission resources**, such as green hydrogen or long-duration storage, will play an important role to ensure a reliable electricity system beyond 2040

> **Low-carbon fuels such as bioenergy or hydrogen** may play a critical role in helping to decarbonize sectors that are challenging to electrify
  - By 2030, initial market adoption of green hydrogen in the following applications: medium and heavy-duty vehicles, high-temperature industrial
  - Additional promising end-use applications include district heating and non-road transportation such as aviation and rail

> Required transition to **low-GWP refrigerants** and enhanced refrigerant management by 2050

Key Decarbonization Pathways Findings (cont'd)

- **Large-scale carbon sequestration opportunities include lands and forests and negative emissions technologies**
  - Protecting and growing New York's forests is required for carbon neutrality
  - Negative emissions technologies (e.g. direct air capture of CO2) may be required if the State cannot exceed 85% direct emissions reductions
  - Strategic land-use planning will be essential to balance needs
- Necessary **methane emissions mitigation** in waste and agriculture will require transformative solutions
  - Diversion of organic waste, capture of fugitive methane emissions are key in waste sector
  - Alternative manure management and animal feeding practices are key in agriculture
- **Additional innovation** will be required in areas such as carbon sequestration solutions, long-duration storage, flexible electric loads, low-GWP refrigerants, and animal feeding, in concert with **Federal action** (e.g. Earthshots)
- Largest three remaining sources of emissions in 2050: **Landfills, aviation, and animal feeding**

Integration Analysis: Benefits and Cost

Integration Analysis Approach

Integration analysis will evaluate societal costs and benefits of GHG mitigation

> The pathways framework produces economy-wide **resource costs** for the various mitigation scenarios relative to a reference scenario
  - The framework is focused on annual societal costs and benefits and does not track internal transfers (e.g., incentives)

> Outputs are produced on an annual time scale for the state of New York, with granularity by sector
  - Annualized capital, operations, and maintenance cost for infrastructure (e.g., devices, equipment, generation assets, T&D)
  - Annual fuel expenses by sector and fuel (conventional or low-carbon fuels, depending on scenario definitions)
  - Does not natively produce detailed locational or customer class analysis

> Locational and customer class impact analyses would be developed through subsequent implementation processes

Integration Analysis Approach (cont'd)

Integration analysis will evaluate societal costs and benefits of GHG mitigation

> The pathways framework tracks annual greenhouse gas emissions by gas for the various mitigation scenarios and expresses changes in annual GHG emissions relative to a reference scenario

> **Value of avoided GHG emissions** calculated based on guidance developed by DEC

Integration Analysis Approach (cont'd)

Integration analysis will evaluate societal costs and benefits of GHG mitigation

> Integration analysis included **health co-benefits** analysis to estimate and quantify health benefits of mitigation scenarios relative to a reference case

> County-level analysis using EPA's CO-Benefits Risk Assessment (COBRA) Health Impacts Screening and Mapping Tool customized with detailed inputs specific to NYS and the Pathways scenarios analyzed

- Evaluates ambient air quality, based on SO_2, VOC, NO_x, and direct $PM_{2.5}$ emissions and the ensuing changes in annual $PM_{2.5}$ concentrations from 2020-2050
- Results include 12 different health outcomes, such as premature mortality, heart attacks, hospitalizations, asthma exacerbation and emergency room visits, and lost workdays

> Public health benefits from increased physical activity due to increased use of active transportation modes (e.g., walking, cycling) and accounting for changes in traffic collisions estimated using the Integrated Transport Health Impacts Model (ITHIM)

> Values from published literature on the health and safety benefits of energy system changes and weatherization programs in homes used to estimate the potential benefits of energy efficiency interventions.

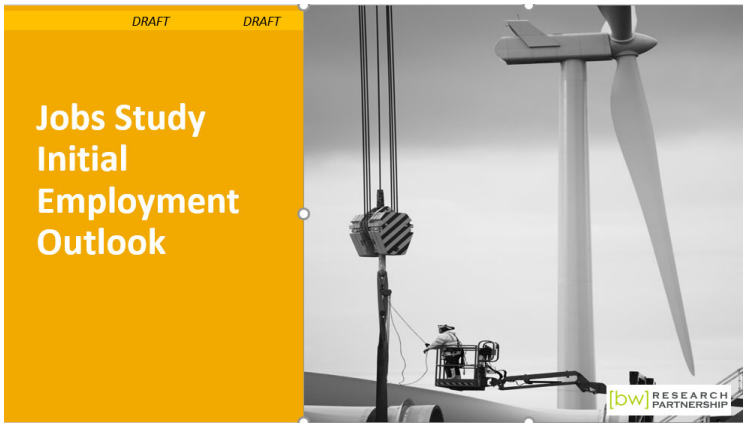
- Applied to the low- and moderate-income homes expected to have upgraded systems and weatherization

Integration Analysis Linkage with Jobs Study

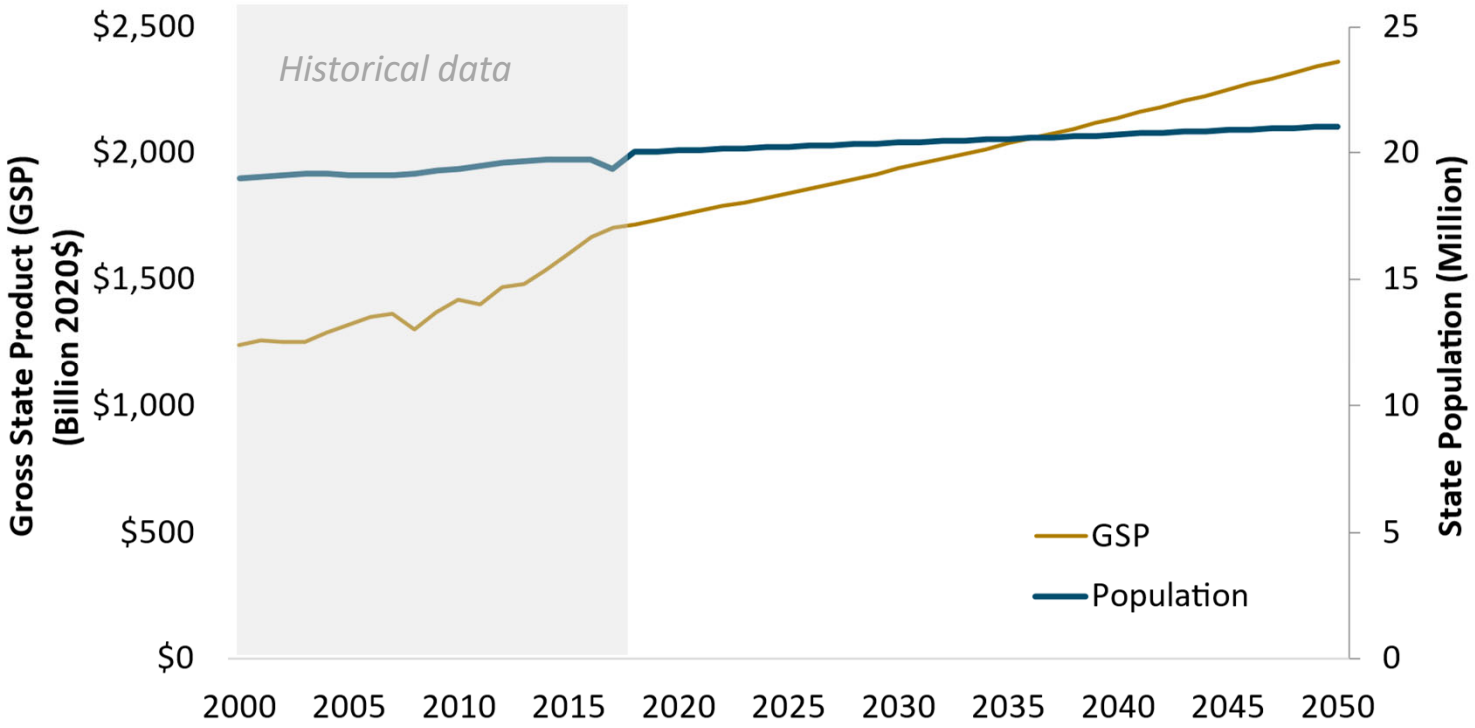
Integration analysis will serve as key input to the Just Transition Working Group *Jobs Study*

> Linkage between integration analysis and jobs study will illustrate employment benefits of GHG mitigation

> ECL § 75-0103 (8)(g) [Jobs Study to report on]…"the number of jobs created to counter climate change, which shall include but not be limited to the energy sector, building sector, transportation sector, and working lands sector."

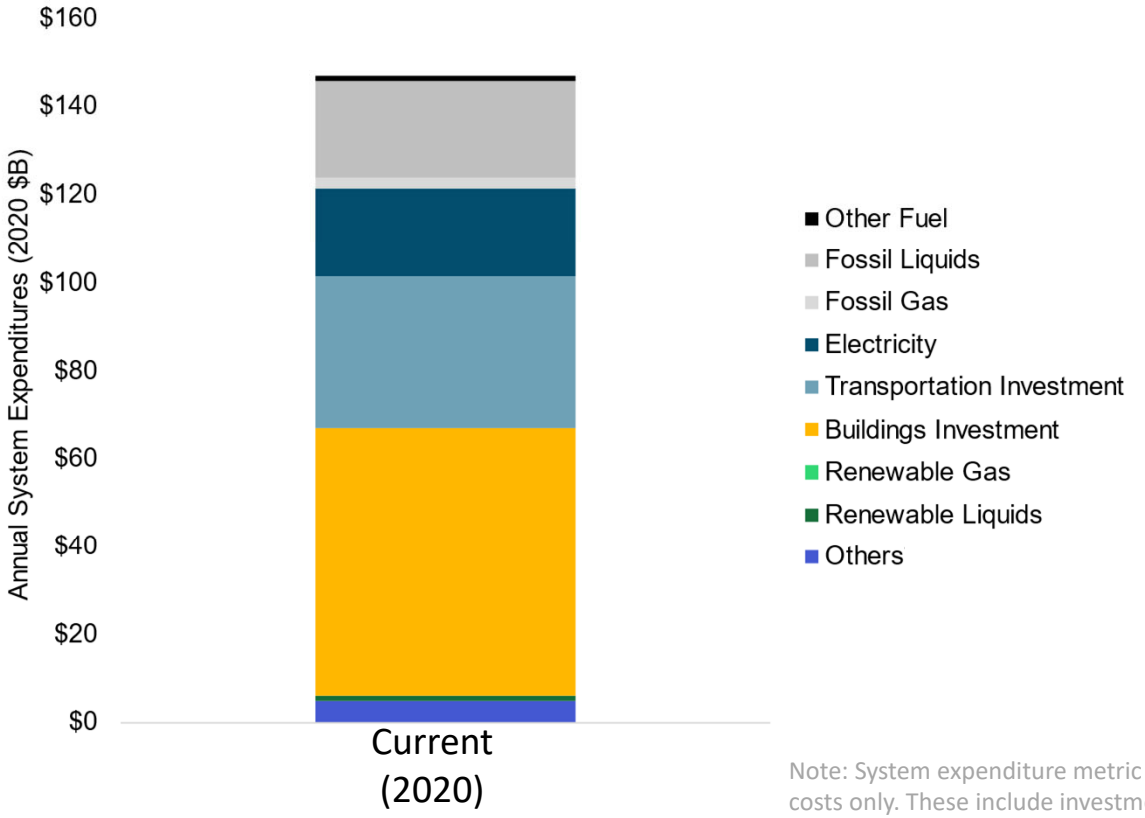


Population and Gross State Product



Sources: NYSERDA Patterns and Trends, Federal Reserve Economic Data, Cornell Program on Applied Demographics

System Expenditure

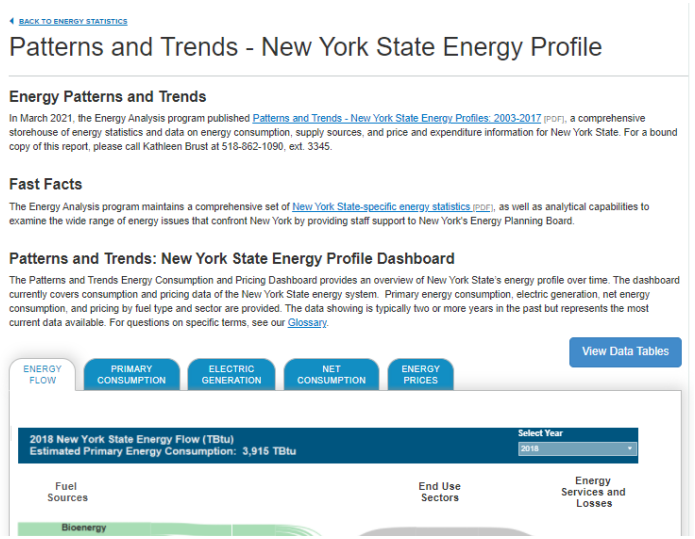


- System expenditure is an estimate of the costs related to energy consumption: this includes capital investments for energy consuming devices, fuel costs associated with energy consumption within the state, and cost to generate electricity from in-state resources and imports
- While system expenditures are significant, these make up a small share of GSP
  - 2020: 8.9%

Note: System expenditure metric does not reflect direct costs in some sectors that are represented with incremental costs only. These include investments in industry, agriculture, waste, forestry, and non-road transportation

Energy Expenditures and Opportunity

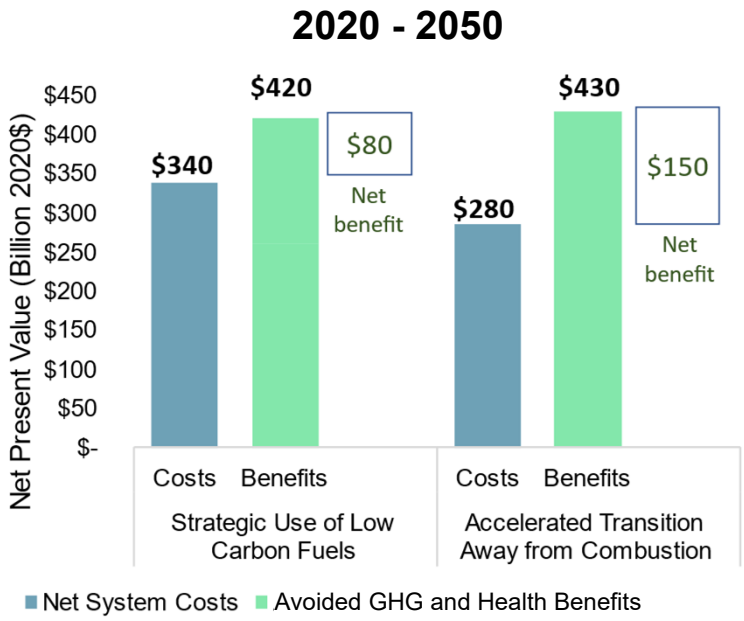
- Total **annual** energy expenditures are approximately $50 billion
  - Over half (almost $30 billion) is estimated to leave NYS
  - Petroleum fuel expenditures are the largest single category at approximately $24 billion
  - Buildings sector spends the most on energy services, followed by Transportation
- Opportunity for import-substitution through electrification, where a greater share of energy services are provided by in-state resources driving economic activity and job creation
- For more information visit: https://www.nyserda.ny.gov/about/publications/ea-reports-and-studies/patterns-and-trends



Key Benefit-Cost Findings

Cost of Inaction Exceeds the Cost of Action by more than $80 billion

There are significant required investments to achieve Climate Act GHG Emissions Limits, accompanied by even greater external benefits and the opportunity to create hundreds of thousands of jobs

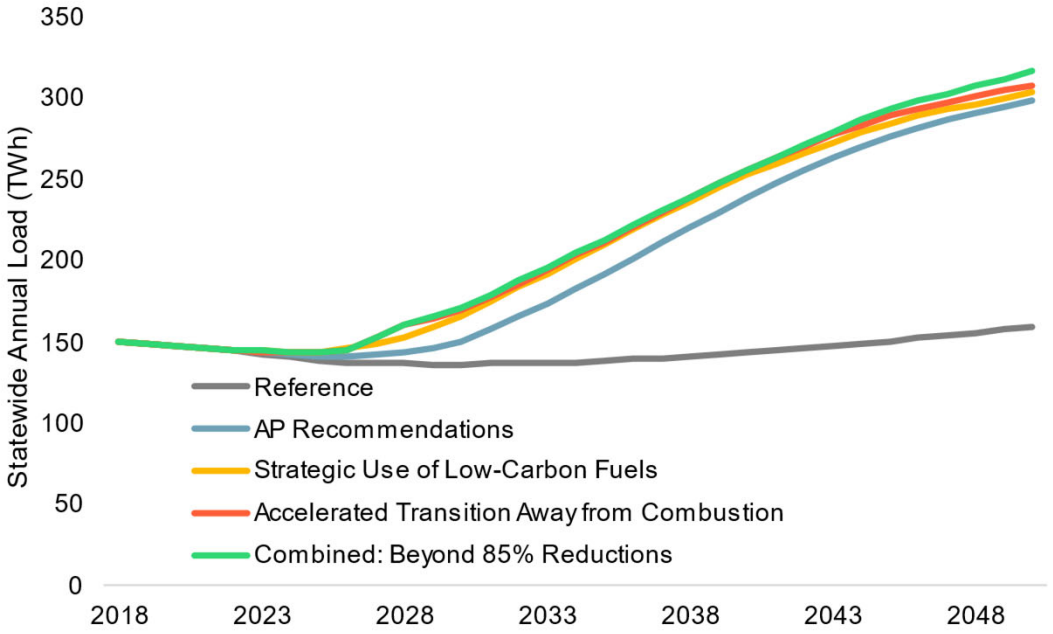


- **Net *benefits* in the range from $80-$150 billion**
  - Over this time period Business-as-Usual **system expenditure** is $2.7 trillion
  - Net system costs are an incremental 10-12%
- Costs are a small share of **New York's economy:** around 0.5% of GSP in 2030 and 2% in 2050
- As a share of overall **system expenditures,** annual costs are moderate: 7.1-8.6% in 2030 and 24-27% in 2050

Integration Analysis: Electricity Generation

Annual Load Forecast by Scenario

Buildings, Transportation, Industry, Hydrogen Electrolysis



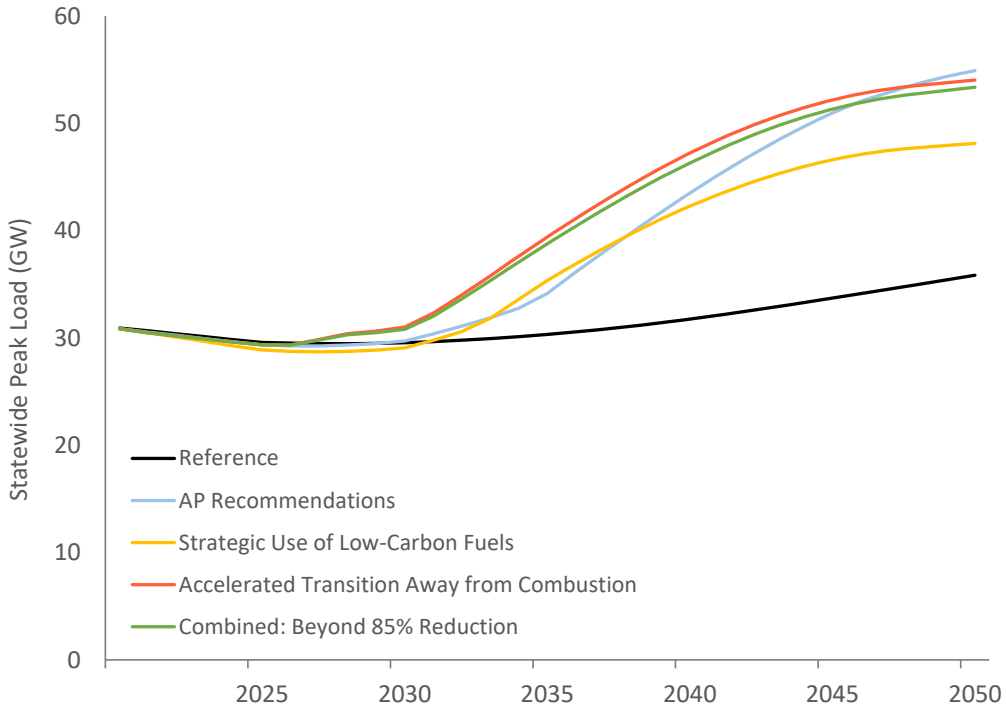
Load is exclusive of T&D losses and potential DAC loads. 2020 is a modelled year, reflecting historical trends.

> The load increase in 2050 relative to today for each scenario is:
  - Reference: 7%
  - Scenario 1: AP Recommendations: 103%
  - Scenario 2: Strategic Low Carbon Fuels: 105%
  - Scenario 3: Accelerated Transition Away from Combustion: 108%
  - Scenario 4: Beyond 85% Reduction: 114%

> Electrolysis to produce hydrogen is a significant share of load, reaching almost 44 TWh of load by 2050 in the Strategic Use of Low Carbon Fuels scenario
  - Electrolysis produces hydrogen needed in transportation, industry, and electricity generation
  - 50% of hydrogen demands are assumed to be produced in-state

Peak Load Forecast

Without Accounting for Flexible Loads



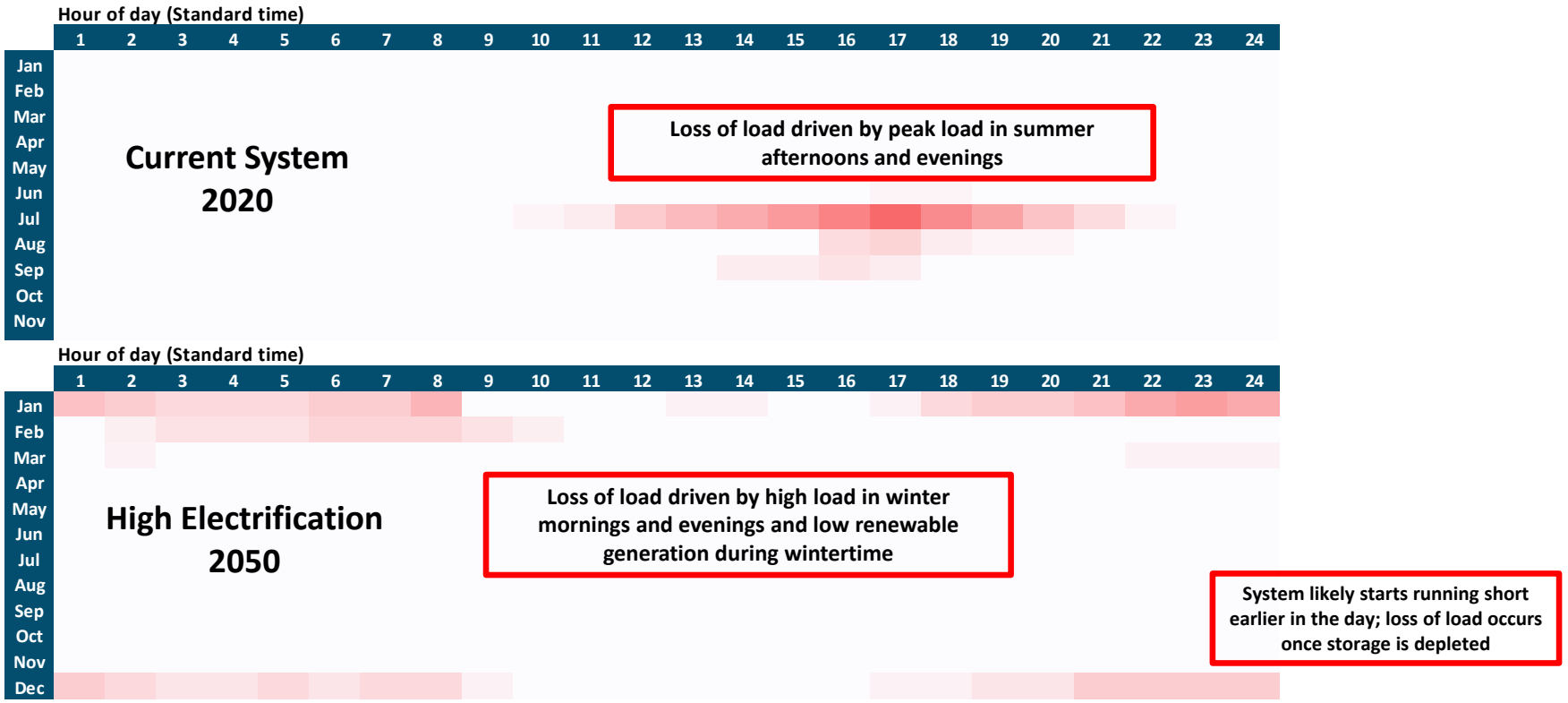
Note: peak forecast does not include the impacts of load flexibility. Flexible loads are accounted for when developing electric sector resource portfolios. 2020 is a modelled year, reflecting historical trends

> All Mitigation scenarios shift from summer to winter-peaking by 2035

> The peak load increase in 2050 relative to today for each scenario is:

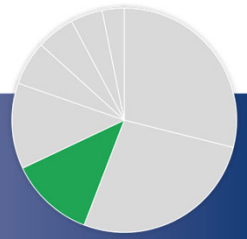
- Reference: 16%
- Scenario 1: AP Recommendations: 77%
- Scenario 2: Low Carbon Fuels: 56%
- Scenario 3: Accelerated Transition: 75%
- Scenario 4: Beyond 85% Reduction: 73%

Impacts of Electrification



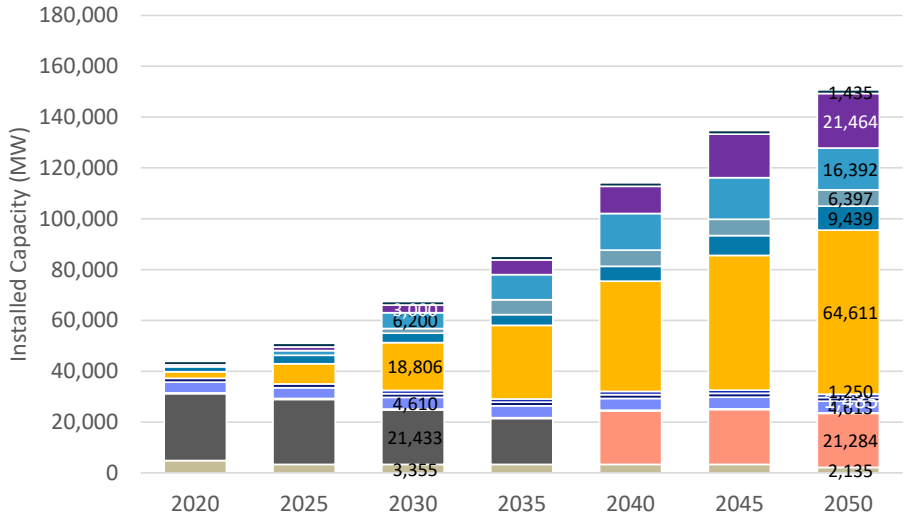
Electricity Generation

Scenario 2: Strategic Use of Low Carbon Fuels

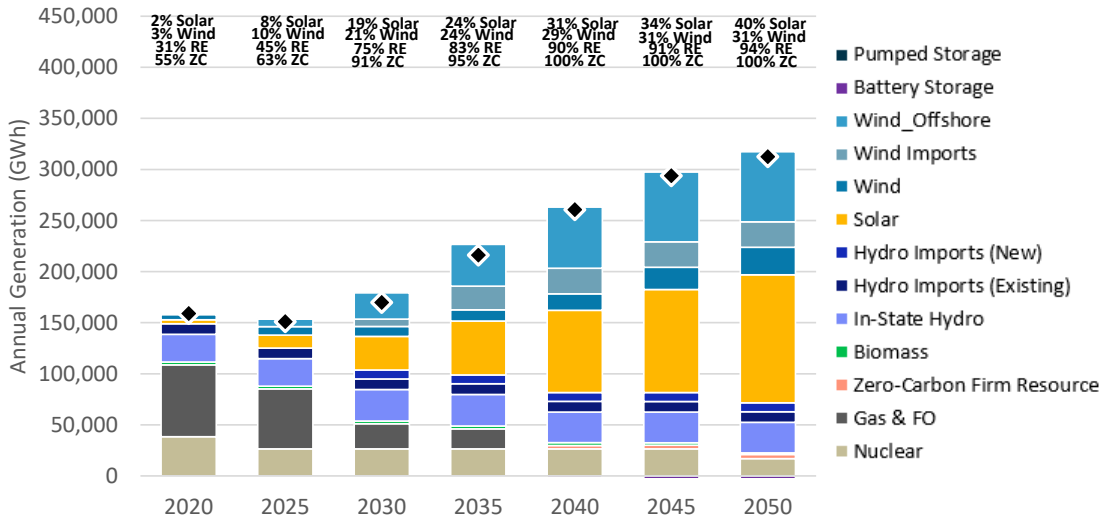


- > Load increases to over 300 TWh by 2050 due to high levels of electrification, coupled with electrolysis loads (40 TWh) to meet hydrogen demand
- > 65 GW of solar, 16 GW of land-based wind and 16 GW of offshore wind are added by 2050 to provide zero-carbon supply
- > 21 GW of battery storage helps with balancing renewables, including 1.4 GW of 8-hour storage
- > 21 GW of zero-carbon firm capacity is required to maintain reliability during periods of low renewables

Installed Capacity

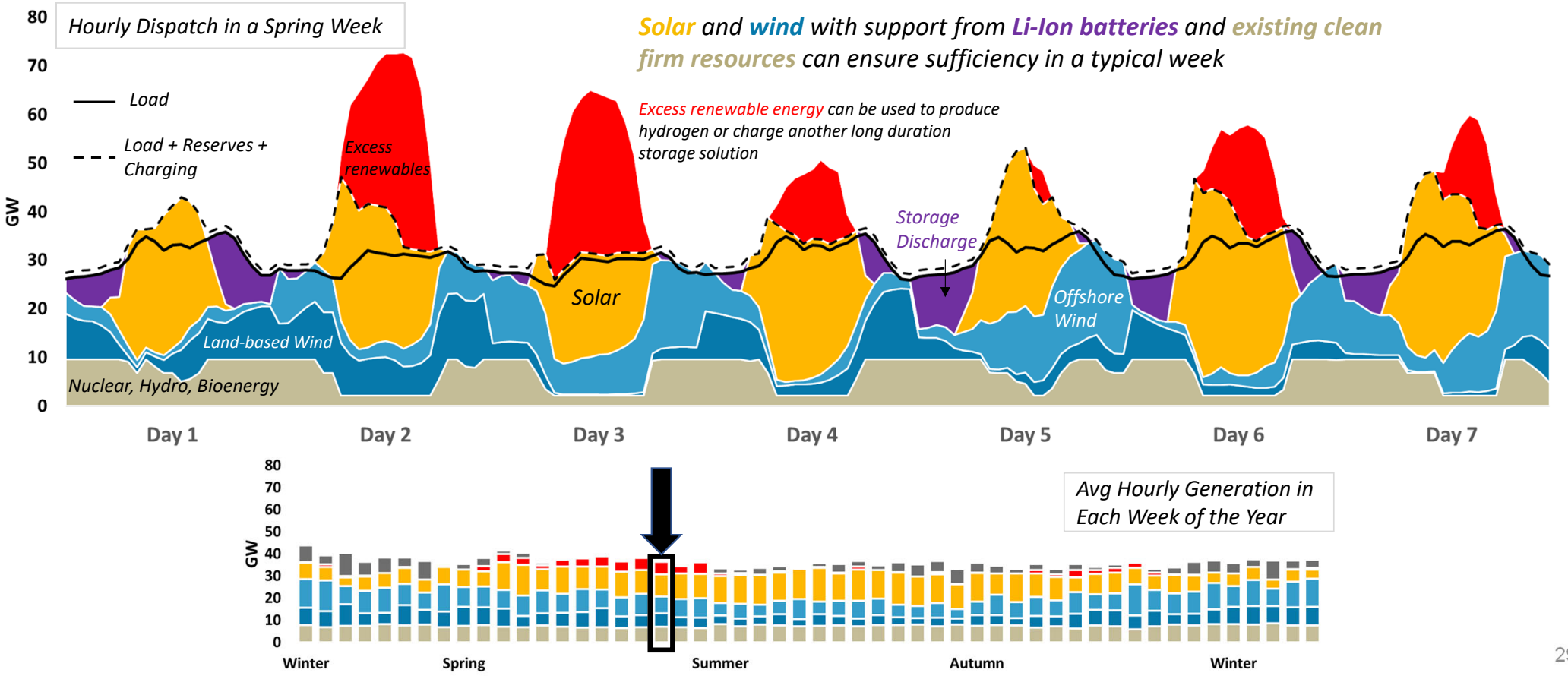


Annual Generation



Typical Spring Week in 2050

Scenario 3

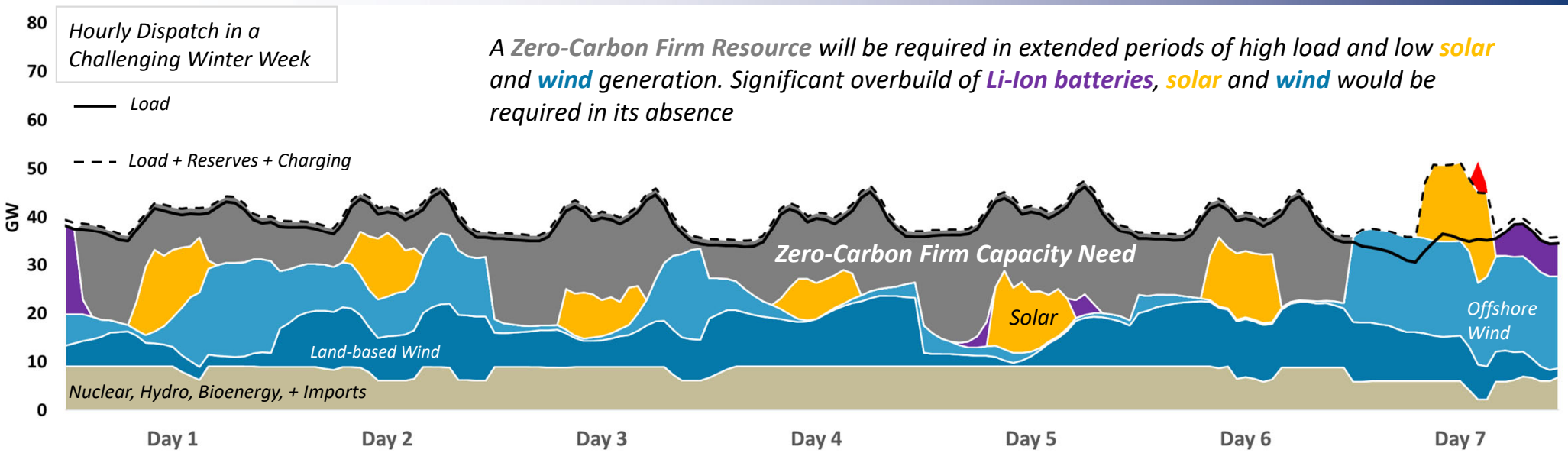


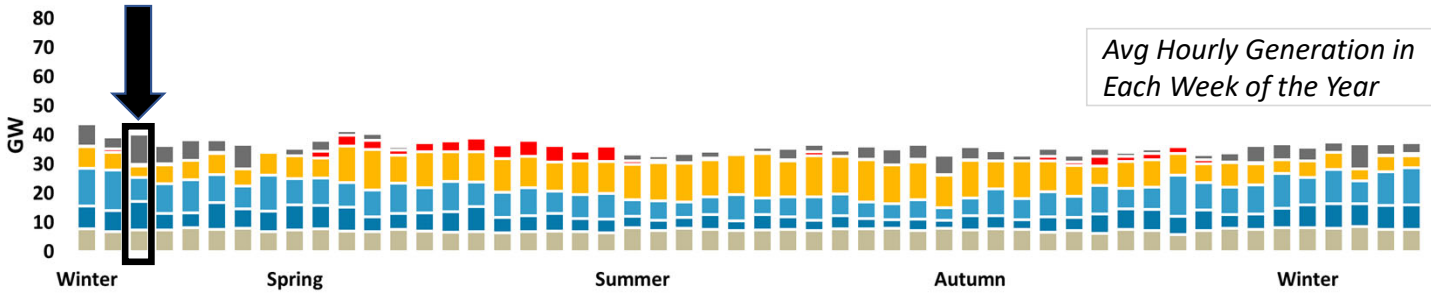
Multi-Day Reliability Needs in 2050

Scenario 3

Hourly Dispatch in a Challenging Winter Week

*A **Zero-Carbon Firm Resource** will be required in extended periods of high load and low **solar** and **wind** generation. Significant overbuild of **Li-Ion batteries**, **solar** and **wind** would be required in its absence*





Avg Hourly Generation in Each Week of the Year

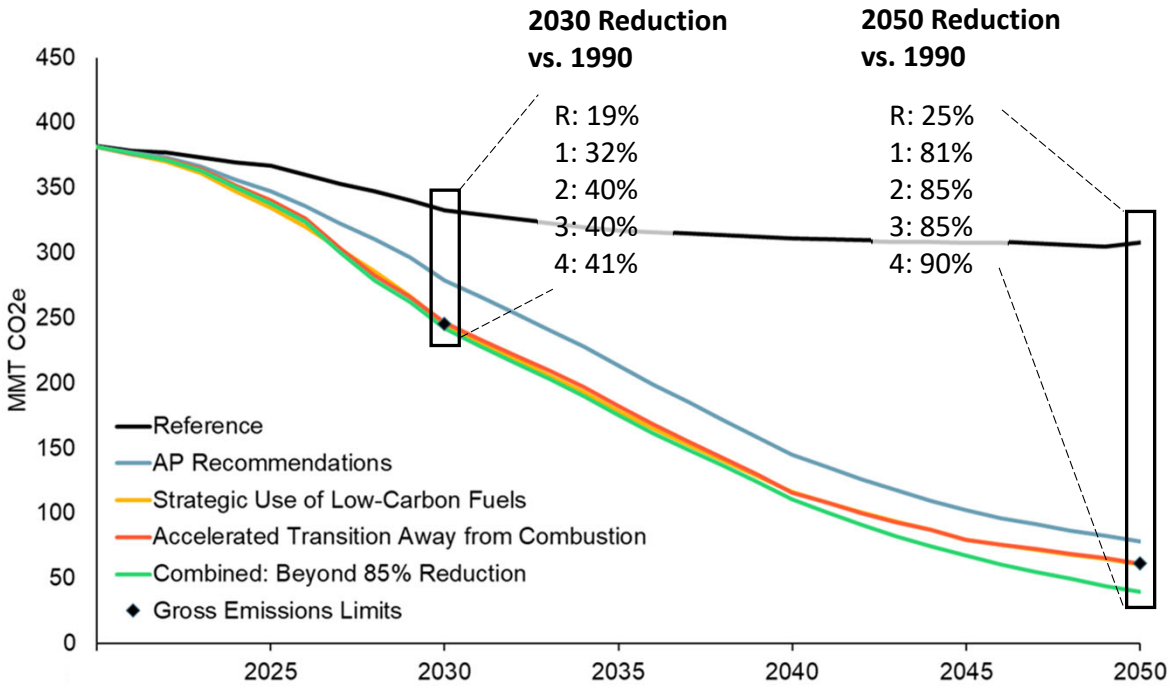
Integration Analysis: Economy-wide Results

Scenario Overview

> Initial Scenarios
  - Reference Case
    - Currently implemented policies
  - Scenario 1: Advisory Panel Recommendations
    - Aggregate impacts of recommendations from Advisory Panels

> Scenarios that meet or exceed GHG emission limits, achieve carbon neutrality by midcentury
  - Foundational themes across **all** mitigation scenarios based on findings from Advisory Panels and supporting analysis
    - Zero emission power sector by 2040
    - Enhancement and expansion of transit & vehicle miles traveled reduction
    - More rapid and widespread end-use electrification & efficiency
    - Higher methane mitigation in agriculture and waste
    - End-use electric load flexibility reflective of high customer engagement and advanced techs
  - **Scenario 2: Strategic Use of Low-Carbon Fuels**
    - Includes the use of bioenergy derived from biogenic waste, agriculture & forest residues, and limited purpose grown biomass, as well as green hydrogen, for difficult to electrify applications
  - **Scenario 3: Accelerated Transition Away from Combustion**
    - Low-to-no bioenergy and hydrogen combustion; Accelerated electrification of buildings and transportation
  - **Scenario 4: Beyond 85% Reduction**
    - Accelerated electrification + limited low-carbon fuels; Additional VMT reductions; Additional innovation in methane abatement; Avoids direct air capture of CO2

GHG Emissions by Mitigation Scenario



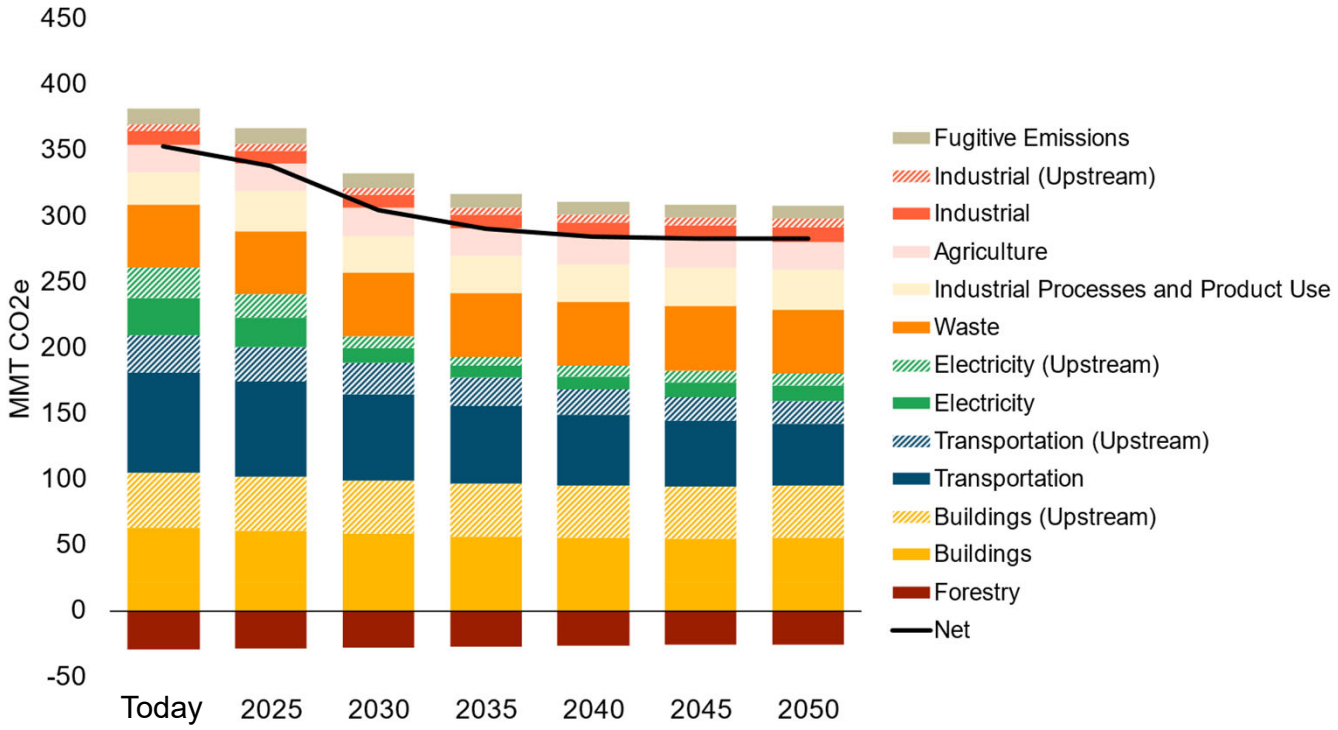
#	Remaining GHGs by Scenario [MMT CO2e]	2030	2050
R	Reference	332	311
1	AP Recommendations	276	72
2	Strategic Use of Low-Carbon Fuels	246	61
3	Accelerated Transition Away from Combustion	246	61
4	Beyond 85% Reduction	242	40
◆	Gross Emissions Limits	246	61

AR5, 20-yr GWP

2020 is a modelled year, reflecting historical trends

Emissions by Sector over Time

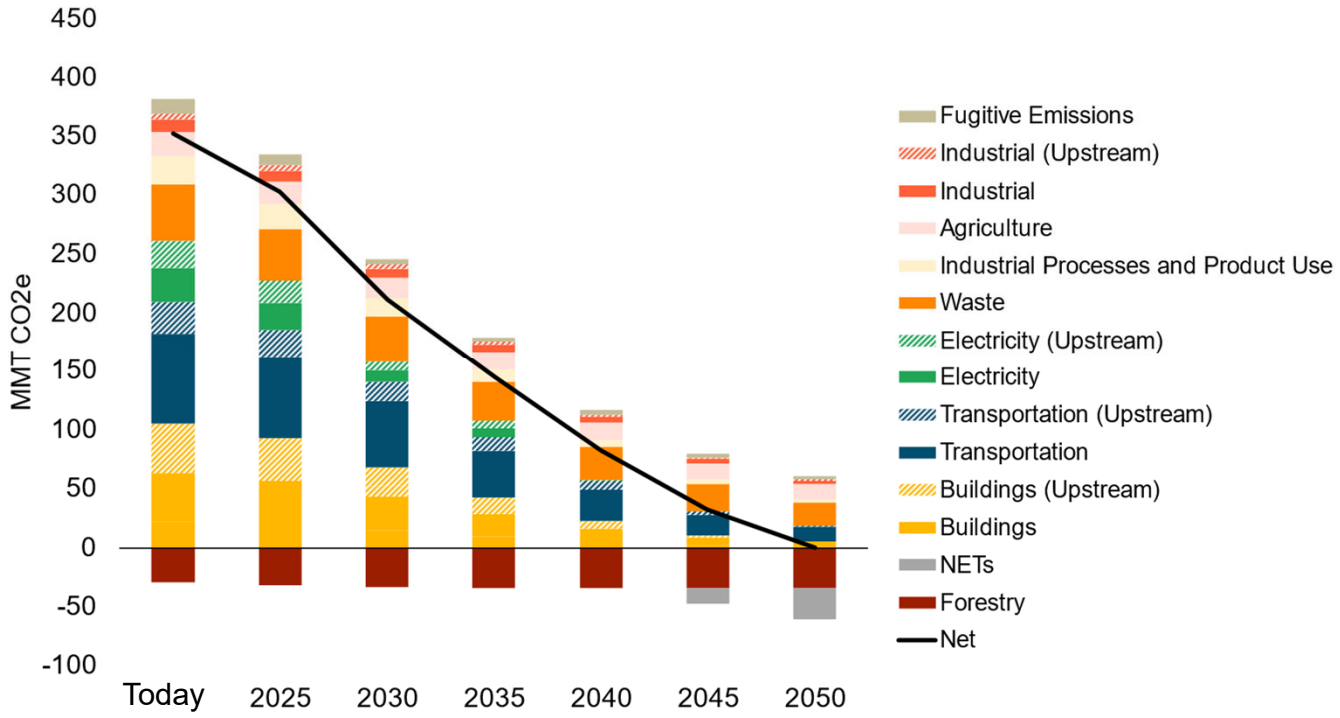
Reference Case



2020 is a modelled year, reflecting historical trends

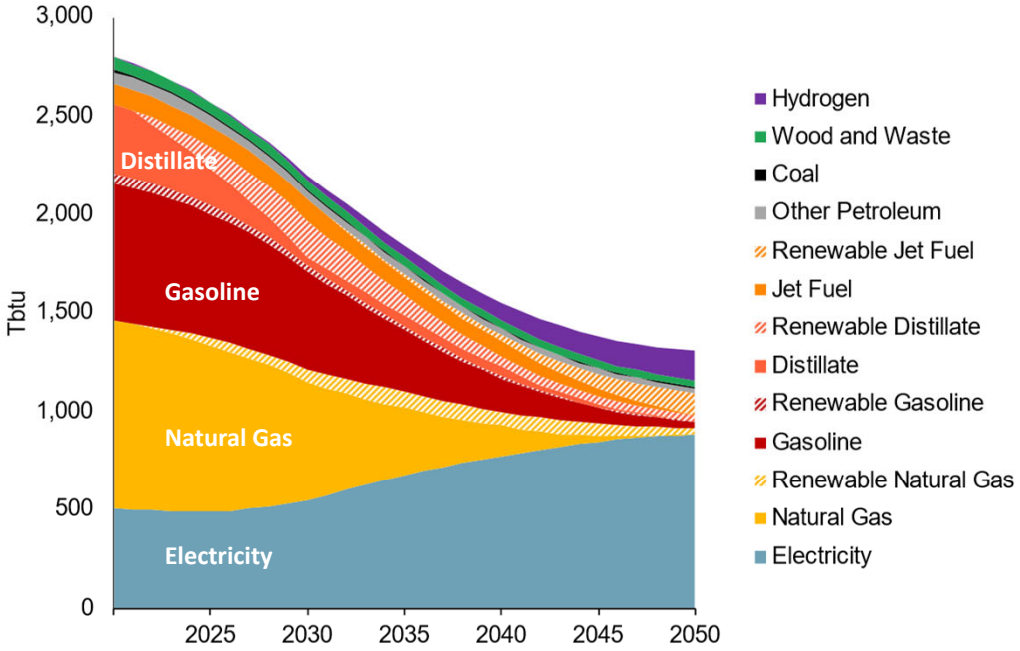
Emissions by Sector over Time

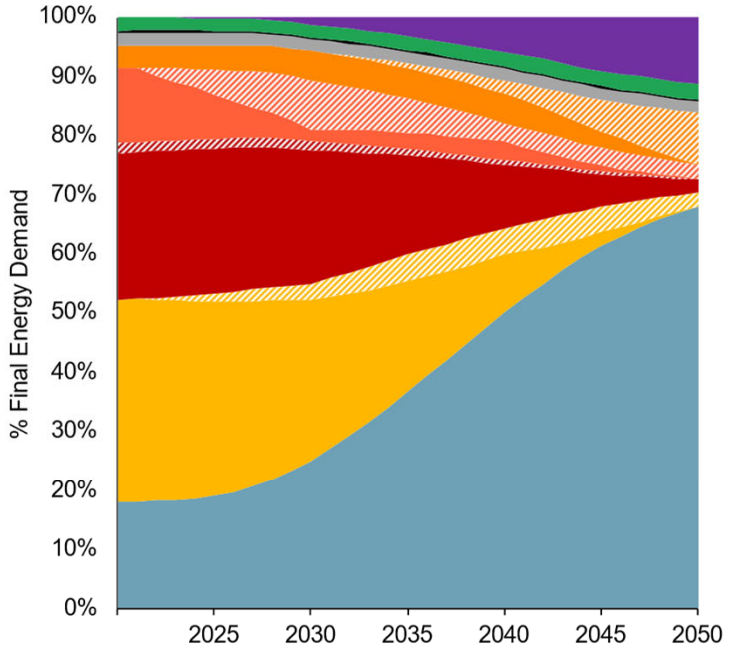
Scenario 2: Strategic Use of Low-Carbon Fuels



2020 is a modelled year, reflecting historical trends

Total Energy by Fuel
Scenario 2: Strategic Use of Low-Carbon Fuels





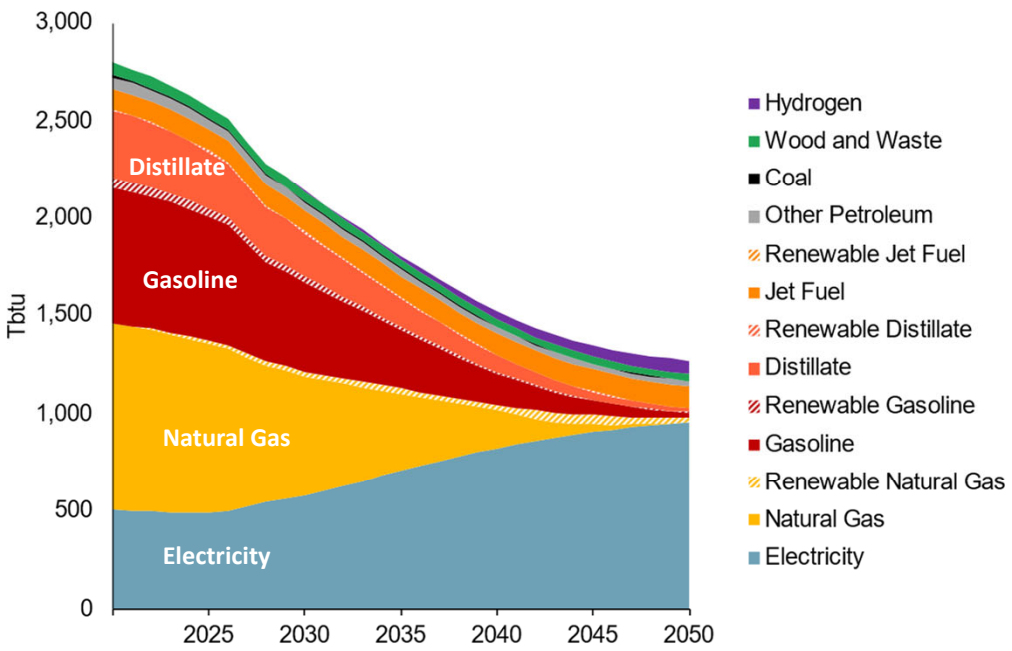
Hydrogen: 11%

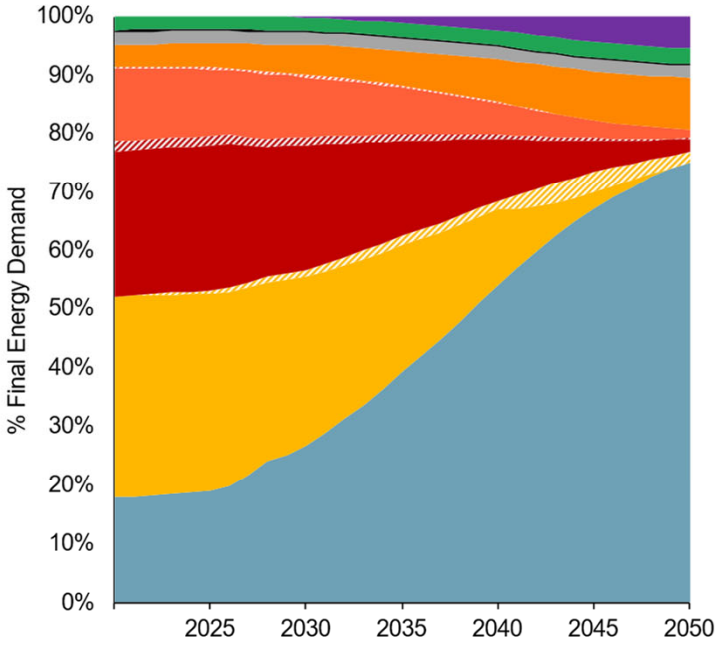
Bioenergy: 14%

Electricity: 68%

Includes energy use from transportation, industrial, commercial, and residential sectors.
2020 is a modelled year, reflecting historical trends

Total Energy by Fuel
Scenario 3: Accelerated Transition Away from Combustion





Hydrogen: 5%

Bioenergy: 2%

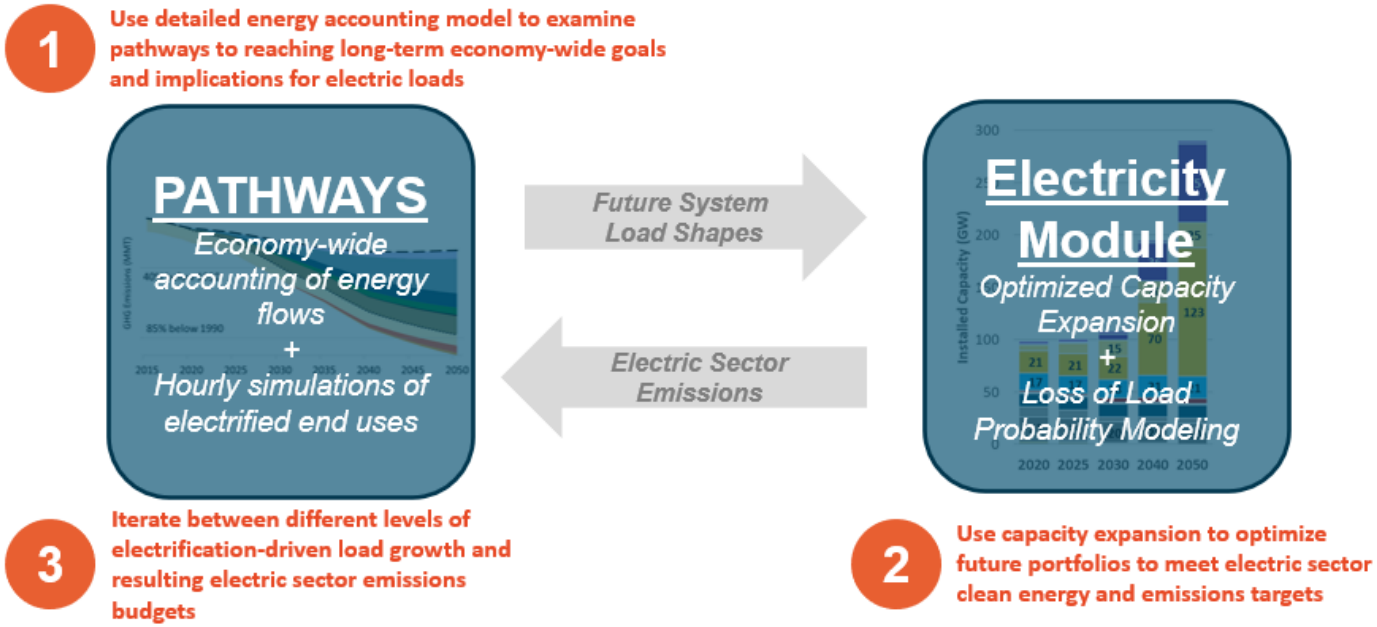
Electricity: 75%

Includes energy use from transportation, industrial, commercial, and residential sectors.
2020 is a modelled year, reflecting historical trends

Integration Analysis: APPENDIX

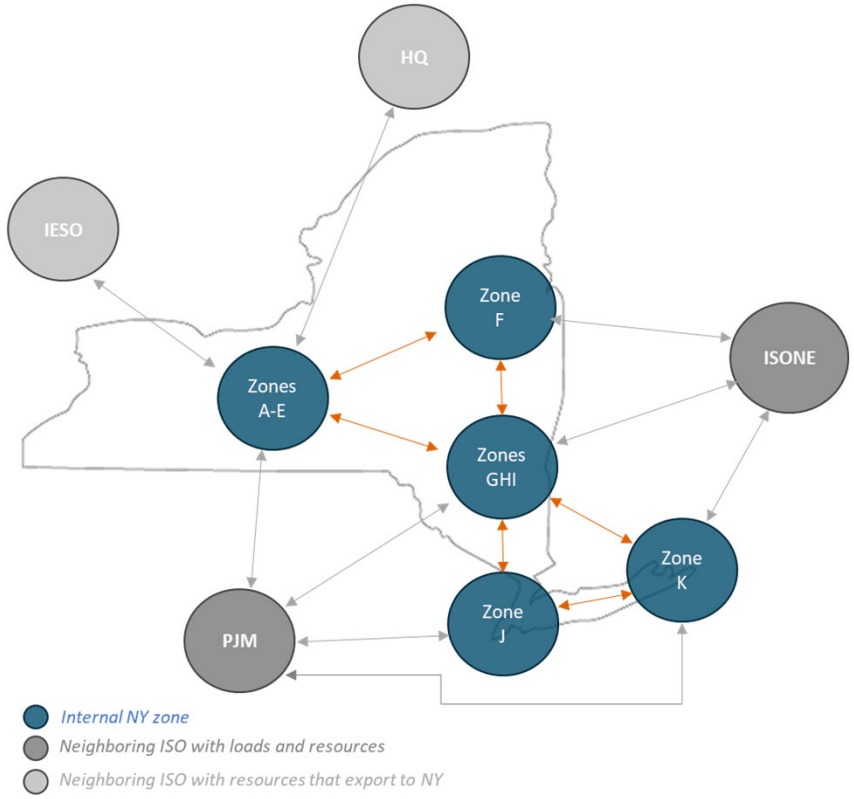
Integration Analysis Framework

> Analytical framework combines a detailed accounting model of energy supplies and demands across the entire economy with an optimized capacity expansion model in the electric sector



Representation of NY Electricity System

- New York RESOLVE model contains representation of 5 areas within NYISO to capture key transmission constraints as well as local capacity requirements
- Model also contains high-level representation of loads and resources within neighboring regions
  - Transmission constraints within neighboring regions are not considered
  - For HQ and IESO, the model solely captures generation resources available to export into NY
- RESOLVE optimizes *investments* to meet New York policy and reliability requirements while optimizing *operations* over the entire system
  - There is no endogenous capacity expansion for neighboring regions; resources are exogenously added to meet those regions' policy and reliability requirements



Greenhouse Gas Accounting

> Many states and the federal government account for GHGs using current IPCC protocol, which advises 100-year year Global Warming Potentials (GWPs) from the IPCC AR4, accounts for biomass (e.g. wood, biodiesel, renewable natural gas) as carbon neutral, and includes direct emission factors.

> The Climate Act takes a different approach, accounting for pollutants on a 20-year lifetime, including emissions from biogenic CO2, and including impacts of upstream emissions from fossil fuels

- **GWP**: "set greenhouse gases on a common scale using the carbon dioxide equivalence metric (CO2e) and the 20-year Global Warming Potential (GWP20) of each gas, which the Department derived from the IPCC Fifth Assessment Report (AR5)." [1]
- **Biogenic CO2**: "On [the basis of gross GHG emissions limits], the carbon dioxide released from the combustion of plant material has the same effect as carbon dioxide emitted from the combustion of fossil fuels;" [2]
- **Upstream emissions**: "include certain emission sources that are located outside of the State borders [...] including emissions associated with imported electricity and fossil fuels." [3]

Pollutant	20-yr GWP (AR5)	100-yr GWP (AR5)
CO2	1	1
CH4	84	28
N2O	264	265

[1] ECL 75-0101(2). https://www.dec.ny.gov/docs/administration_pdf/revisedris496.pdf
[2] ECL 75-0107. https://www.dec.ny.gov/docs/administration_pdf/pubcomment496.pdf
[3] ECL 75-0101(13). https://www.dec.ny.gov/docs/administration_pdf/revisedris496.pdf

GHG Accounting: Impact to Fuels

> Under the prior IPCC accounting, renewable fuels acted as net-zero replacements of fossil equivalents. Under the updated CLCPA accounting, a renewable fuel can only avoid roughly 20%-40% of a fossil fuel's emissions because it only avoids the upstream emissions associated with the fuel.

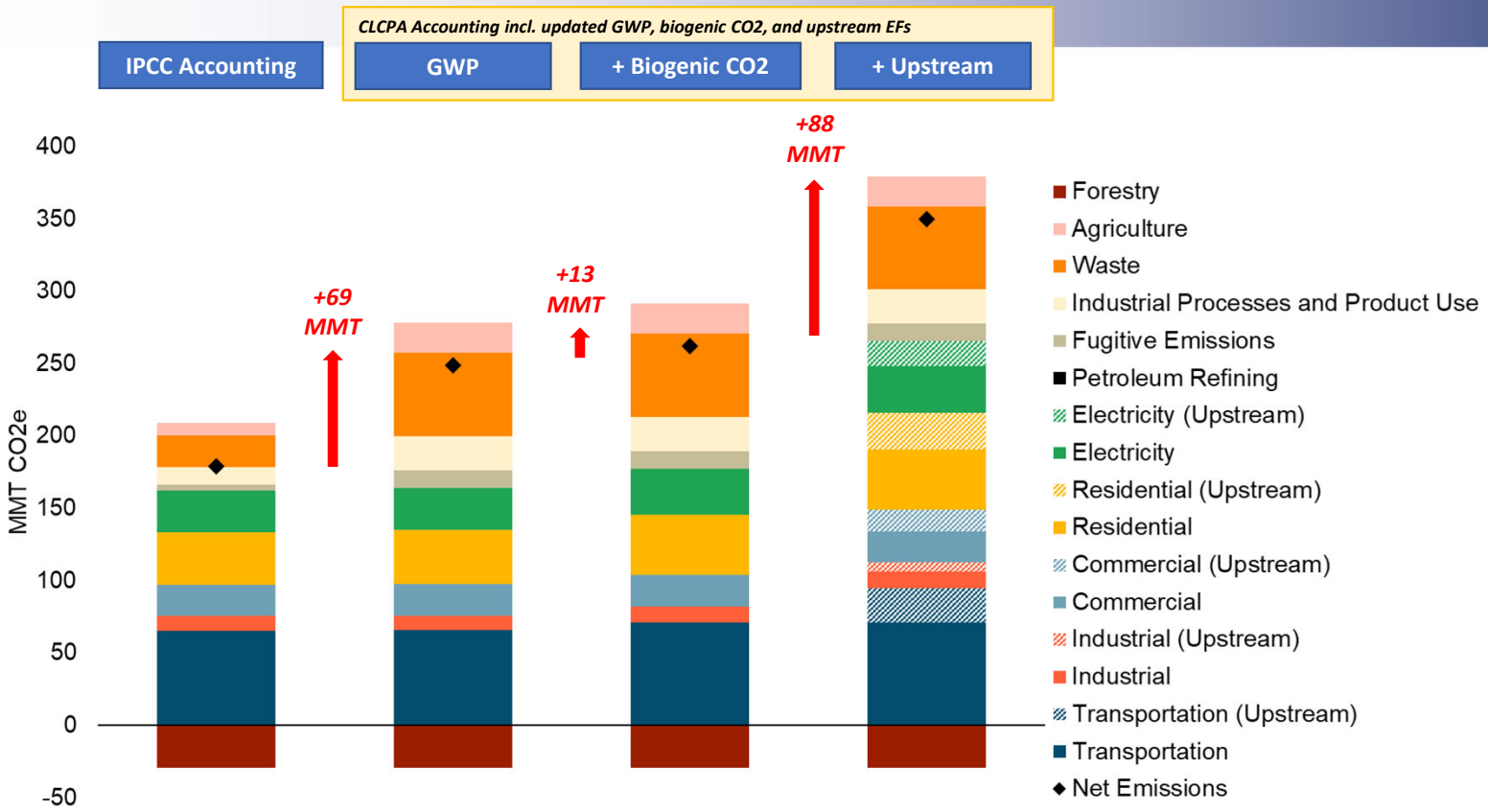
	June 2020 Accounting [1]	Draft CLCPA Accounting [2]
	Emission factor, lbs/mmbtu CO2e (100-yr GWP, combustion emissions only)	Emission factor, lbs/mmbtu CO2e (20-yr GWP, upstream emissions included)
Natural Gas	117	182-**215 ***
Renewable Natural Gas	*~0*	*117*
Distillate Fuel	163	219
Renewable Diesel	*~0*	*163*
Gasoline	160	227
Renewable Gasoline	*~0*	*160*
Jet Fuel	161	204
Renewable Jet Fuel	*~0*	*161*

[1] Although CO2 emissions from biogenic fuels were counted as 0 in prior analysis, emissions were *near-zero* on a CO2e basis due to small direct impacts from CH4 and N20

[2] Data based on "Upstream Fuel Cycle Emission Approaches and Sensitivities" (https://www.dec.ny.gov/docs/administration_pdf/upstreamerg.pdf) and CLCPA Integration Analysis Draft Input Assumptions Workbook, with E3 draft assumptions for how to treat bioenergy accounting for the CLCPA

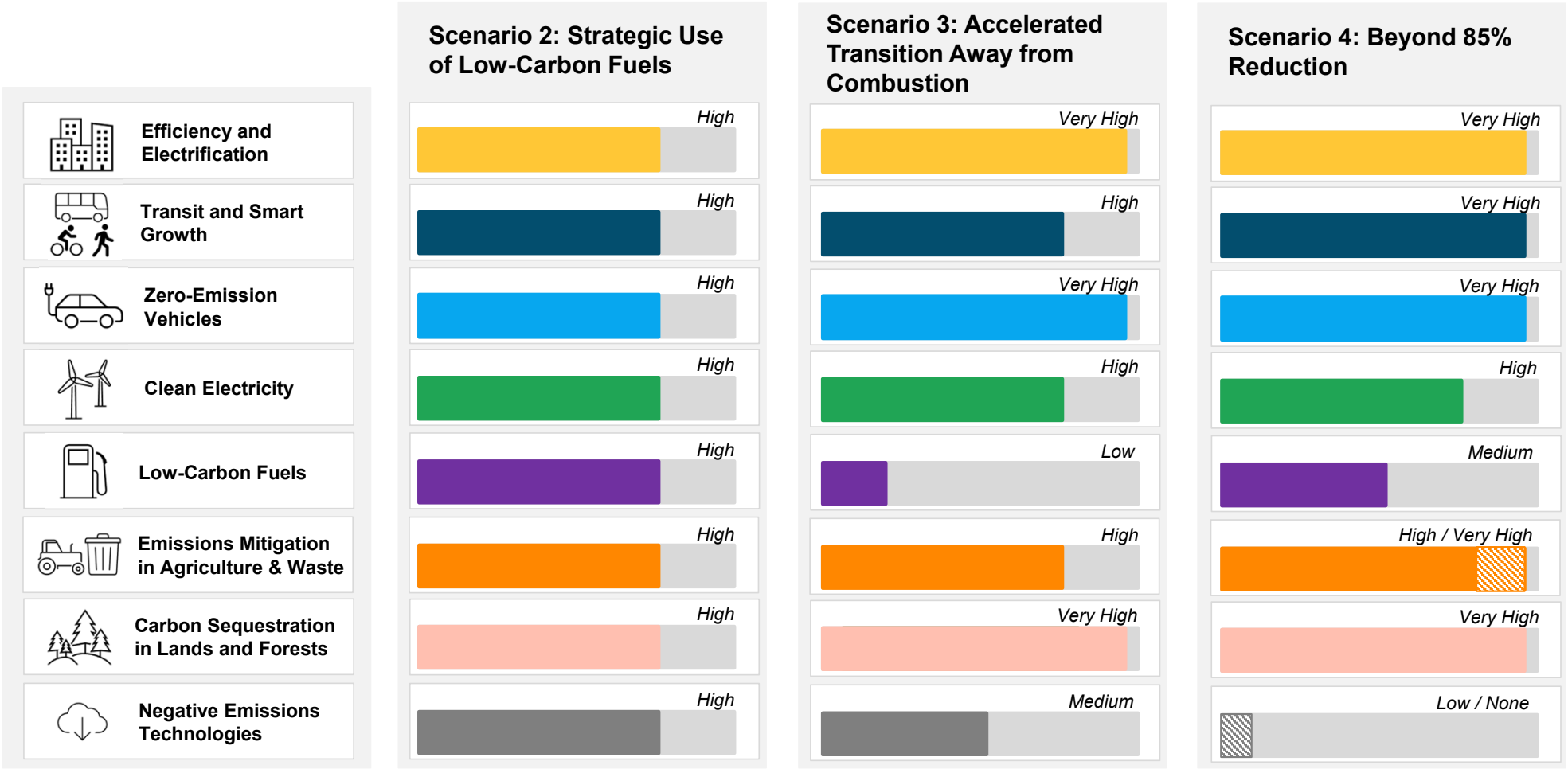
* Note that emissions from in-state natural gas infrastructure is accounted for separately in the analysis. If added to this calculation, upper range would be 235 lbs/mmbtu CO2e

Current Emissions Under Multiple Accounting Frameworks



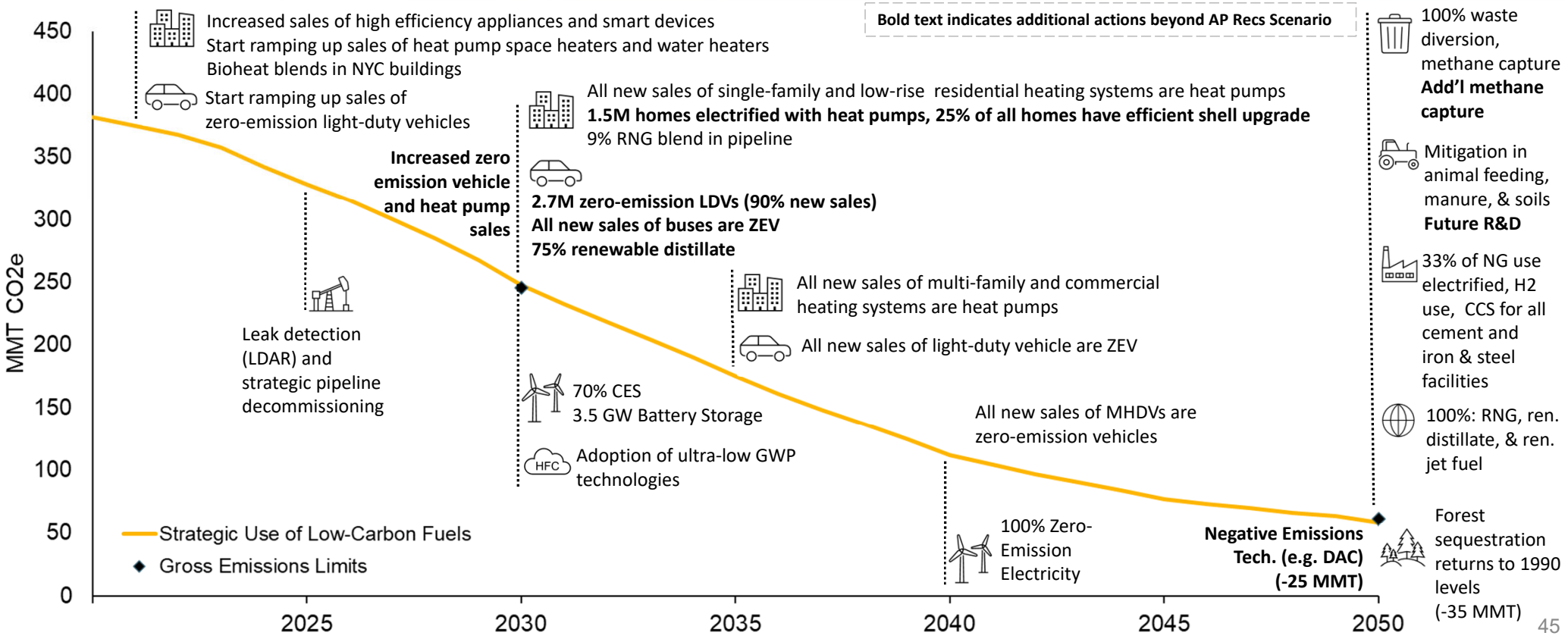
Current emissions are estimated from NY PATHWAYS model year 2020, accounting changes are additive in each bar (e.g. biogenic CO2 also includes GWP changes), GWP changes are AR4 100-yr to AR5 20-yr

Level of Transformation by Mitigation Scenario



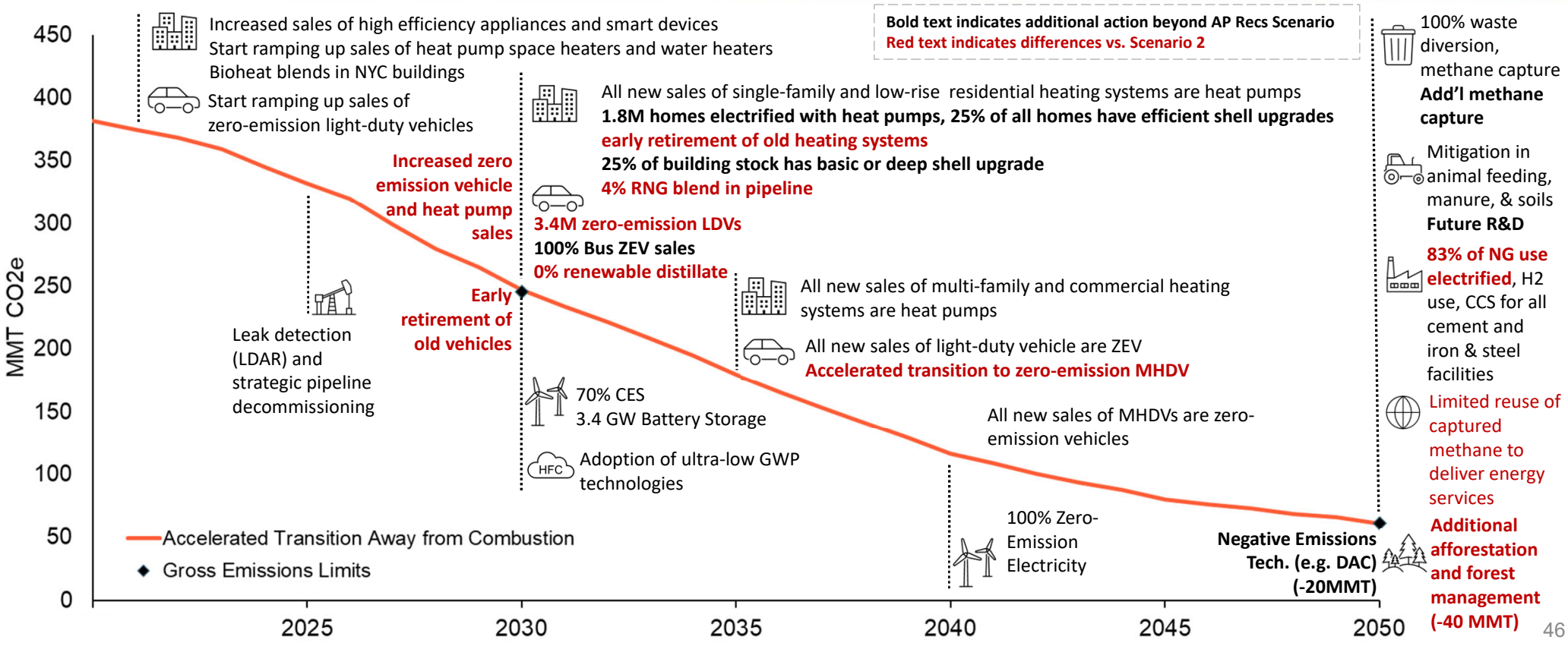
Scenario 2 at a Glance

Strategic Use of Low-Carbon Fuels



Scenario 3 at a Glance

Accelerated Transition Away from Combustion



Scenario 4 at a Glance

Beyond 85% Reduction