Energy+Environmental Economics

Maryland Pathways
Reference Scenario Presentation

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Tory Clark, Senior Consultant
Doug Allen, Managing Consultant
Amber Mahone, Director
Snuller Price, Senior Partner

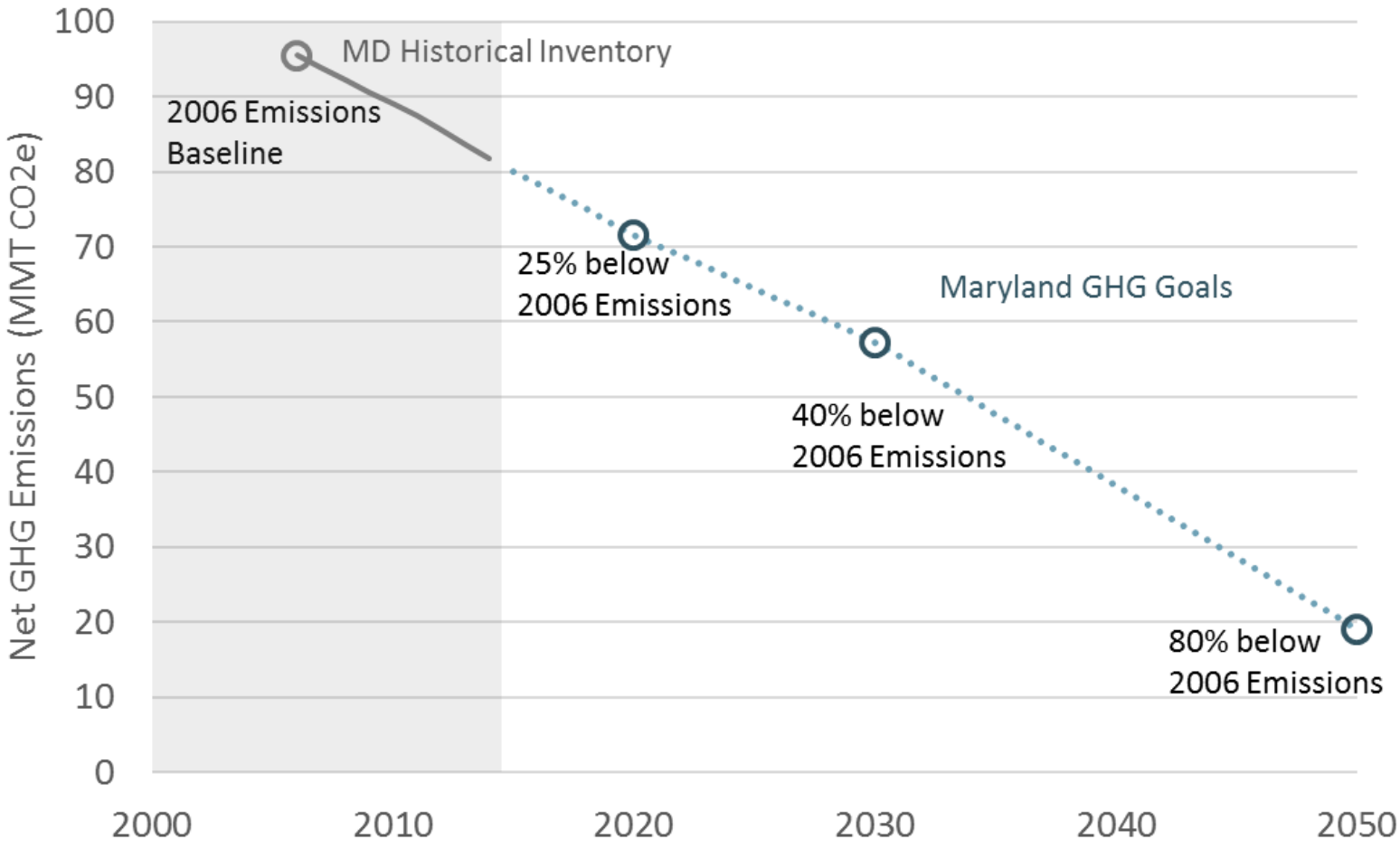
Agenda

- Background and Modeling Approach
- Scenario Assumptions
- Draft Reference Scenario Results

BACKGROUND AND MODELING APPROACH

Maryland's GHG Targets

Net GHG Emissions*



*Net emissions after sinks

Purpose of this study

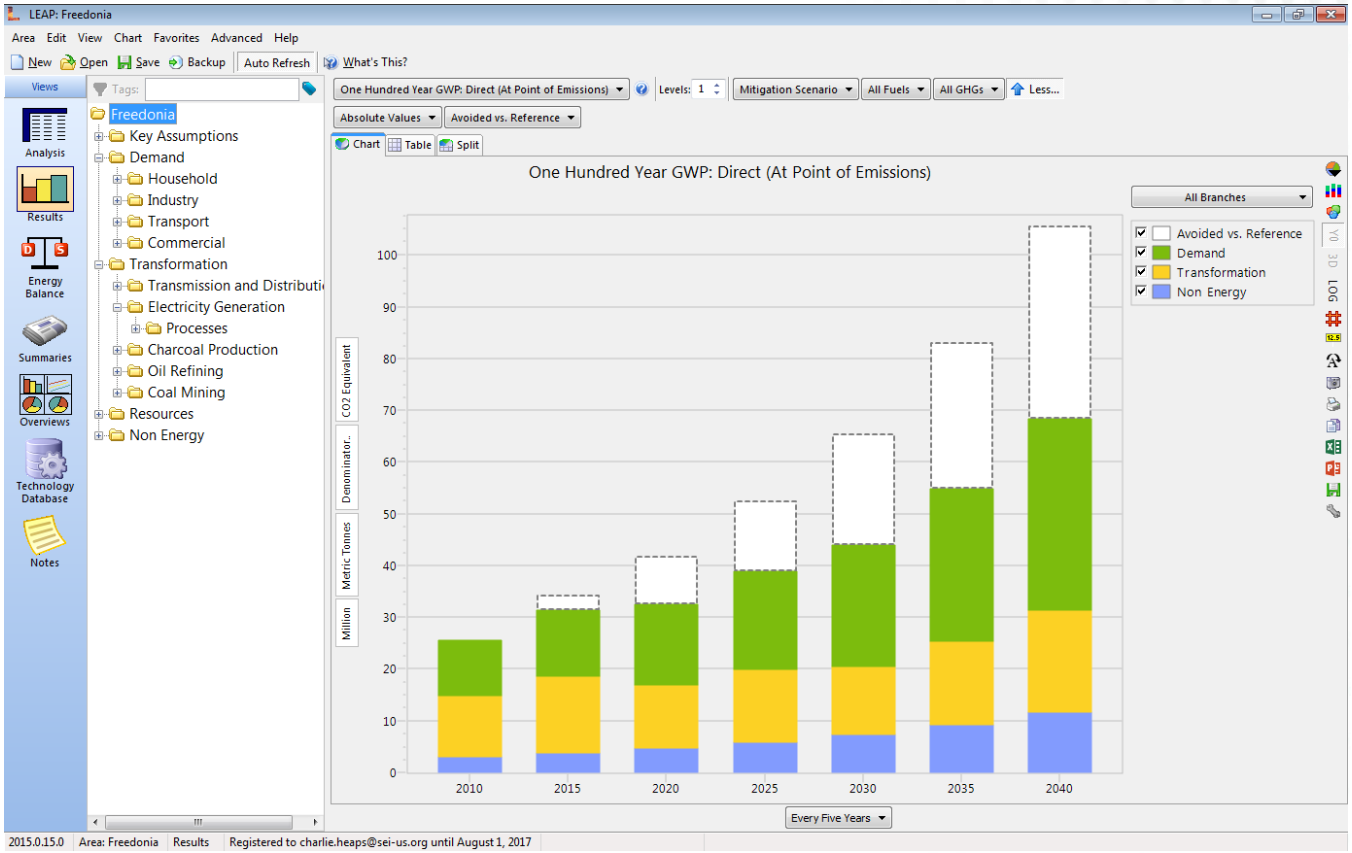
- **The goal of this project is to quantify energy and emissions impacts from Maryland's current policies in the E3 PATHWAYS model**
- **The modeling analysis will set up a framework for calculating sectoral costs of mitigation measures relative to a policy reference case**
- **The LEAP modeling framework allows for:**
  - Detailed stock rollover in residential, commercial, and transportation sectors
  - Hourly treatment of electricity sector
  - Flexible data requirements with option to model specific sectors in more detail
- **Mitigation scenarios will be modeled in 2018**

What is Pathways modeling?

- Bottom-up, user-defined, non-optimized scenarios test "what if" questions
- Economy-wide model captures interactions between sectors & path-dependencies
- Focus is on comparing user-defined policy and market adoption scenarios and tracking physical accounting of energy flows within all sectors of the economy
- Can include accounting of GHG emissions associated with energy and non-energy/non-combustion activities
- Typically involves one counterfactual scenario (e.g. "reference" or "baseline") and one or more mitigation scenarios

PATHWAYS in LEAP

- Long-range Energy Alternatives Planning system (LEAP) developed by the Stockholm Environment Institute (SEI)
- www.energycommunity.org

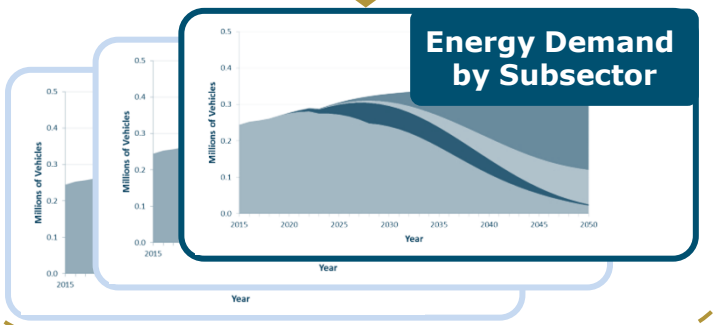


Basic Energy Modeling Framework

Integrated Emissions Analysis

Technology Energy Demand

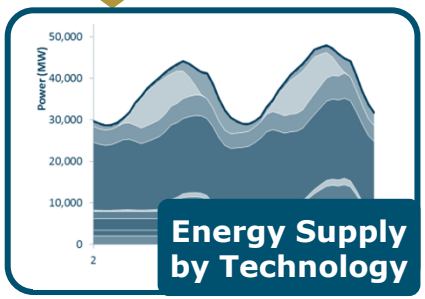
Scenario assumptions over time



Energy Demand by Subsector

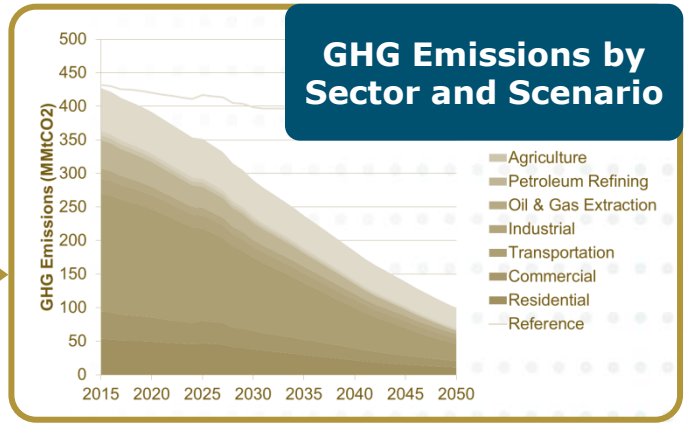
Electricity Supply

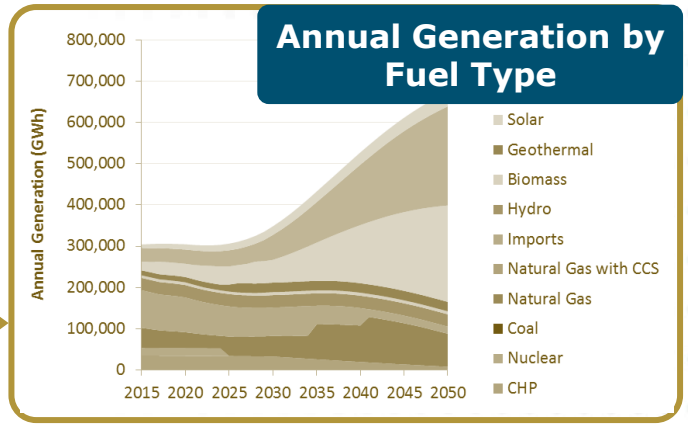
Pipeline Supply and Other Fuels



Energy Supply by Technology

Sample Outputs:





SCENARIO ASSUMPTIONS

Composition of Maryland's GHG Emissions

- **Largest categories of GHG Emissions in Maryland are**
  - Electricity Generation
  - Transportation
  - Buildings

MD 2014 GHG Emissions

*Industry includes emissions from direct energy combustion; Industrial Process emissions include non-combustion categories such as cement and refrigerants

Reference Policies

- **Key Policies Address Largest Categories of Emissions**
  - Renewable electricity
    - 25% RPS by 2020
    - RGGI
  - Clean transportation
    - ZEV Mandate and CAFÉ Standards by 2025
  - Energy efficiency
    - EmPOWER efficiency goals (electric and natural gas)

Scenario Assumptions

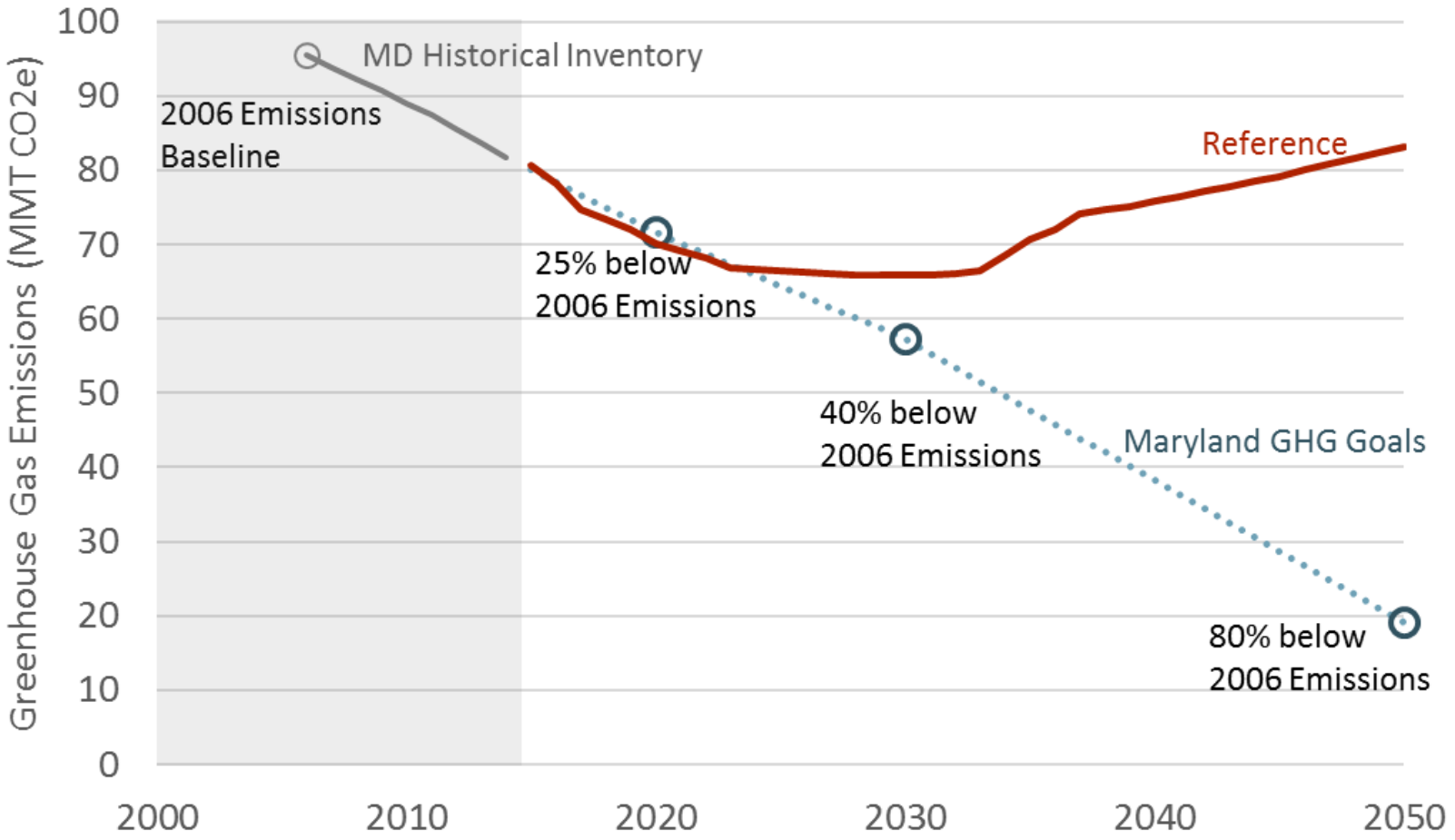
	Reference Scenario (Existing Policies)
Renewable Portfolio Standard	25% RPS by 2020
RGGI	30% cap reduction from 2020 to 2030
Nuclear power	Assume Calvert Cliffs retires in 2034/2036 at end of license, and is replaced with NGCC/imports
Existing coal power plants	IPM planned retirements (670 MW of coal by 2023)
Rooftop PV	Moderate growth from current levels of 200 MW (2% a year; 400 MW in 2050)
Energy Efficiency (Res., Com. & Industrial)	Calibrated to EmPOWER filing targets 100% of sales are high-efficiency by 2023, 5% residential behavioral conservation, 10% reduction below baseline for non-stock sectors
Electrification of buildings (e.g. NG furnace to heat pumps)	None
Transportation	Federal CAFÉ standards for LDVs by 2026, Meets ZEV mandate by 2025 (270,000 ZEVs)
Other transportation sectors (e.g. aviation)	AEO 2017 reference scenario growth rates by fuel
Industrial energy use	AEO 2017 reference scenario growth rates by fuel
Biofuels	Existing ethanol and biodiesel blends, but no assumed increase
Other (fossil fuel industry, industrial processes, agriculture, waste management, forestry)	Assume held constant at MDE 2014 GHG Inventory levels

Key Drivers
2015-2050

Sector	Key Driver	Compound annual growth rate [%]	Data Source
Residential	Households	0.73-0.53%	Maryland Department of Planning (varies over time)
Commercial	Households	0.73-0.53%	Maryland Department of Planning (varies over time)
Industry	Energy growth	Varies by fuel	EIA AEO
On Road Transportation	VMT	1.7%	Maryland DOT
Off Road Transportation	Energy growth	Varies by fuel	EIA AEO
Electricity generation	Electric load growth	0.5% average 2015-2030	Built up from Pathways demands in Buildings, Industry, Transportation

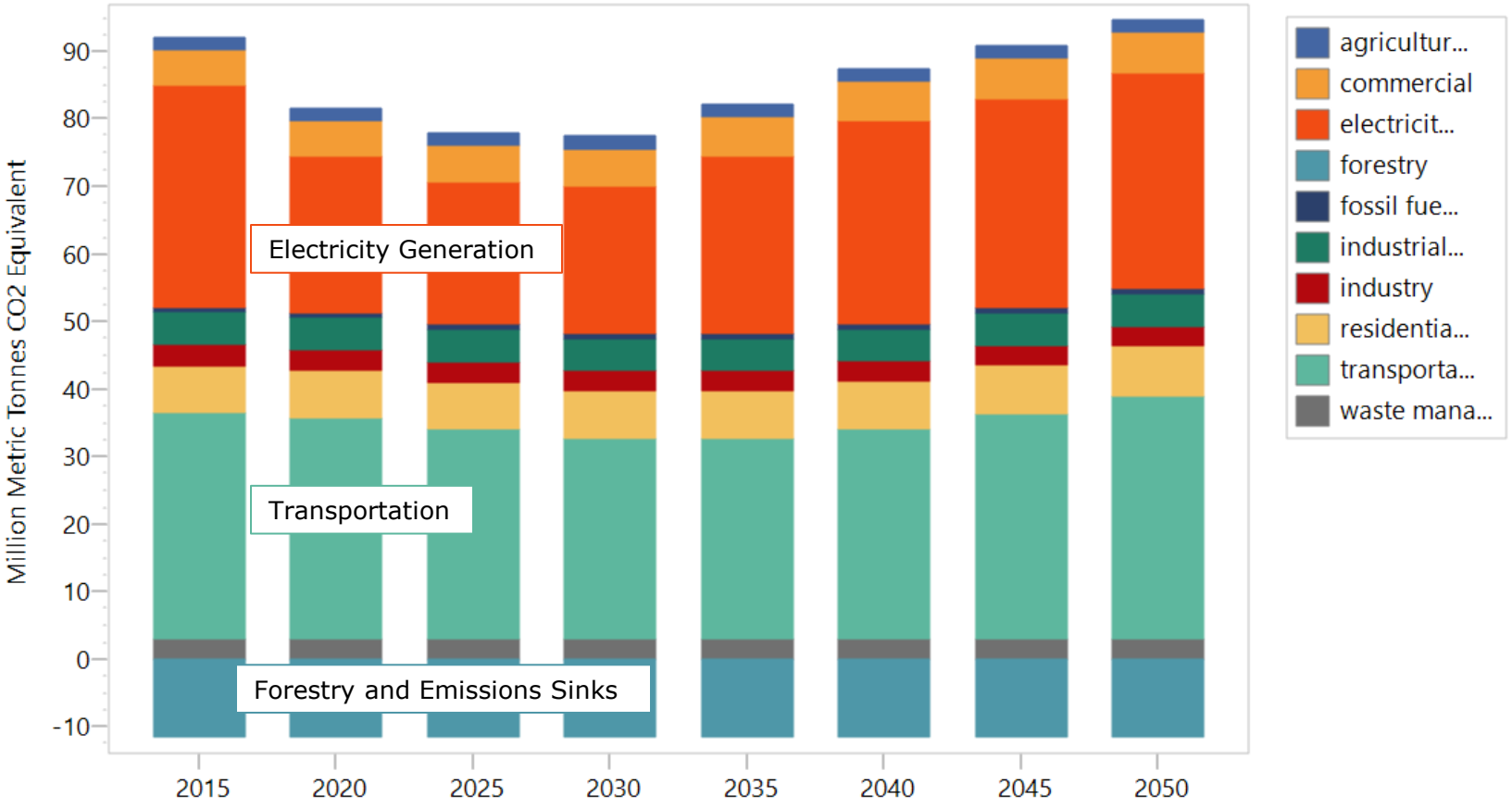
REFERENCE SCENARIO RESULTS

Reference Scenario
Total Net GHGs*

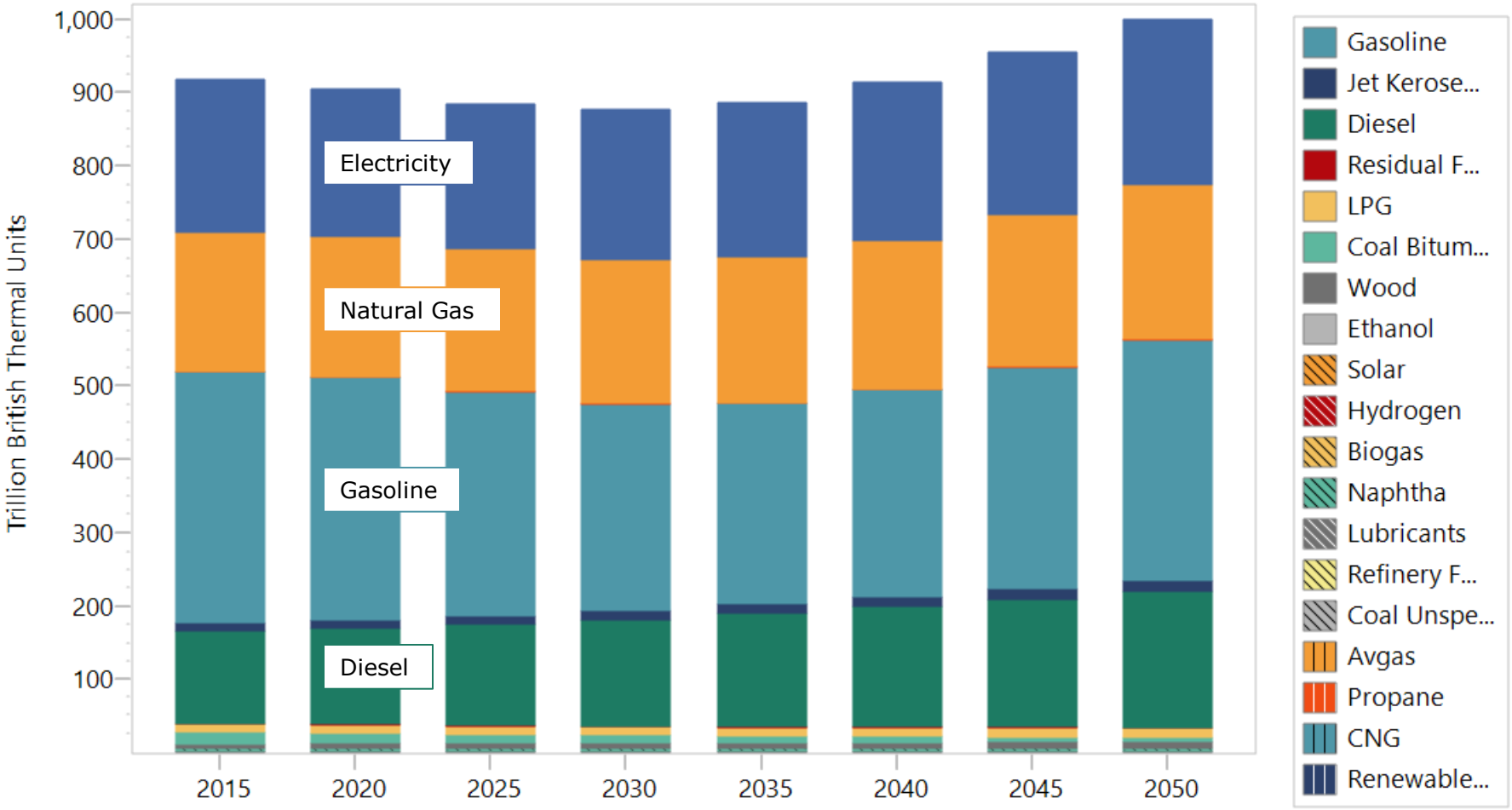


*Net emissions after sinks

Reference Scenario
Total emissions by sector

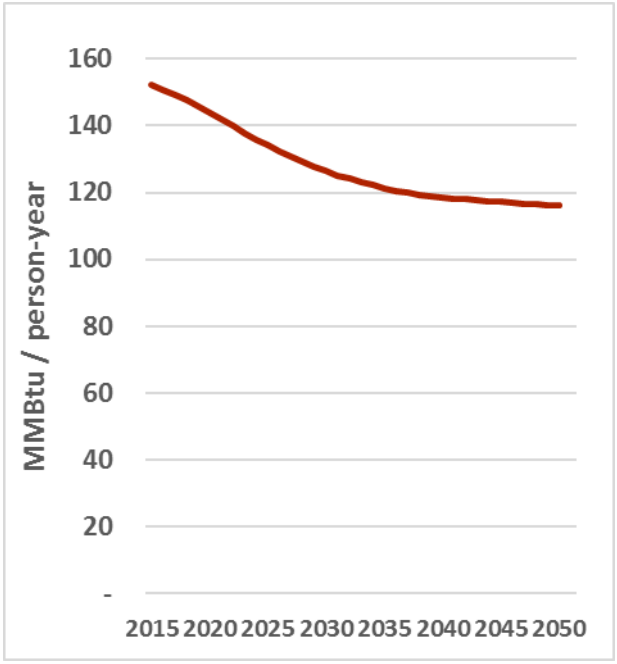


Reference Scenario
Total energy by fuel

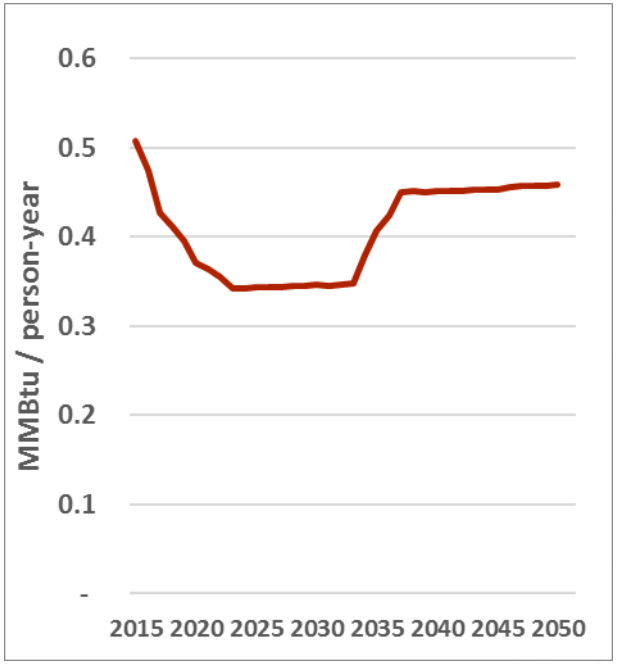


Key Metrics: 3 Pillars of Decarbonization

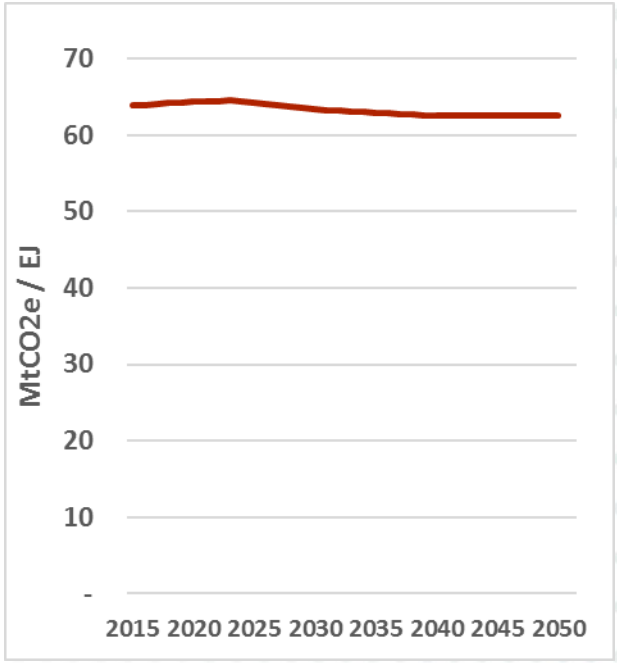
(1) Energy Efficiency
[Energy Consumption per person]



(2) Clean Electricity
[Metric ton/MWh]



(3) Clean Liquid and Gaseous Fuels
[Million Metric tonnes / EJ]



Reference Case

Modeling of 3 Key Policies

- **Renewable electricity**
  - 25% RPS by 2020
  - RGGI
- **Clean transportation**
  - ZEV Mandate and CAFÉ Standards by 2025
- **Energy efficiency**
  - EmPOWER efficiency goals

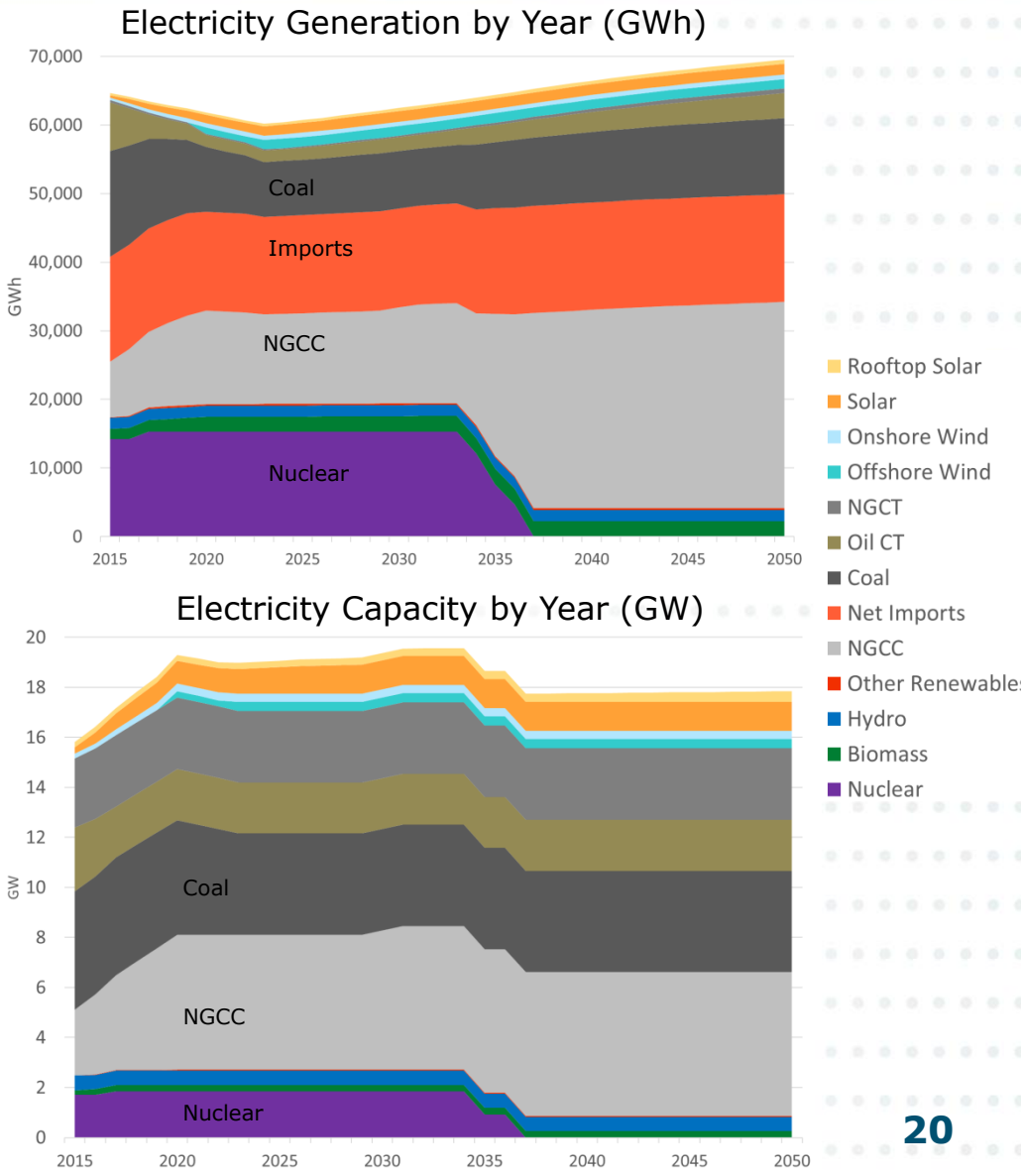
Renewable Electricity Generation

+ Existing Powerplant Retirements

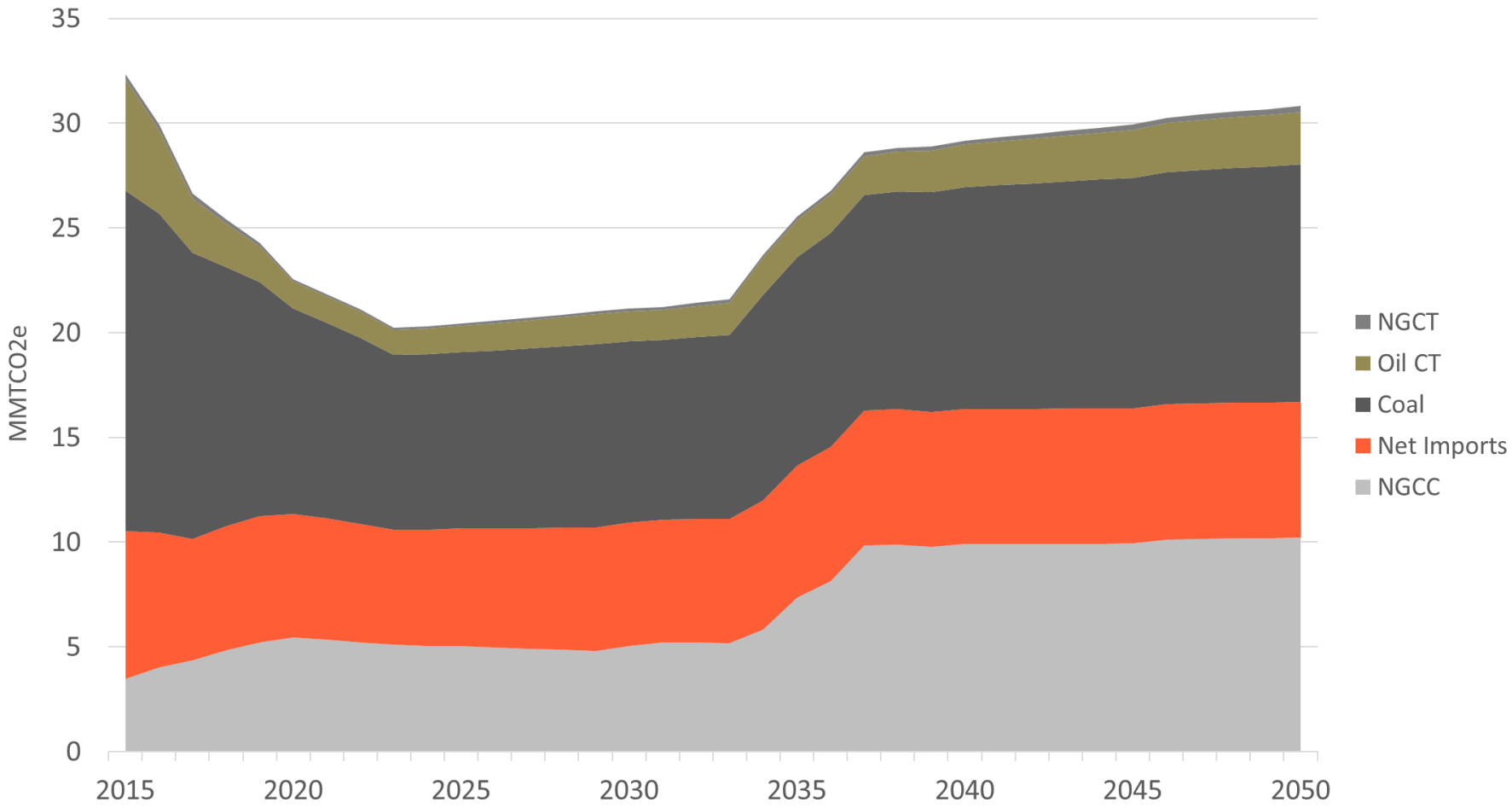
- 670 MW of coal retired by 2023
- Calvert Cliffs nuclear units retire in 2034/2036 at end of license

+ RPS

- New Solar and Wind are built to meet MD's RPS of 25%
- Other Tier 1 RECs are sourced from PJM region



Electricity Sector Emissions



Clean Transportation

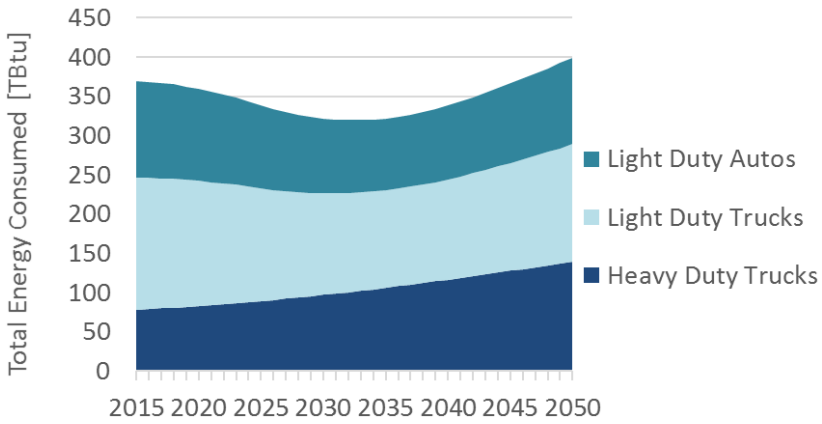
+ LDV Café Standards

- Results in significant reduction in total energy consumption for LDVs
- On-road average MPG becomes 33 mpg for LDA; average new LDA vehicle VMT is 56 mpg (including ZEVs)

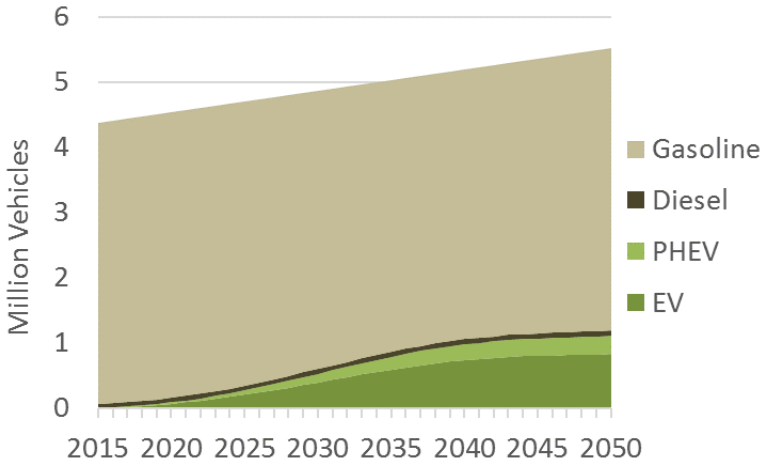
+ ZEV MOU

- Assumed 15% of new LDV sales were Electric and 5% of new sales were Plug-in Hybrid Electric by 2030
- Results in 270,000 ZEVs on the road by 2025

Total Energy Consumption by Vehicle Class

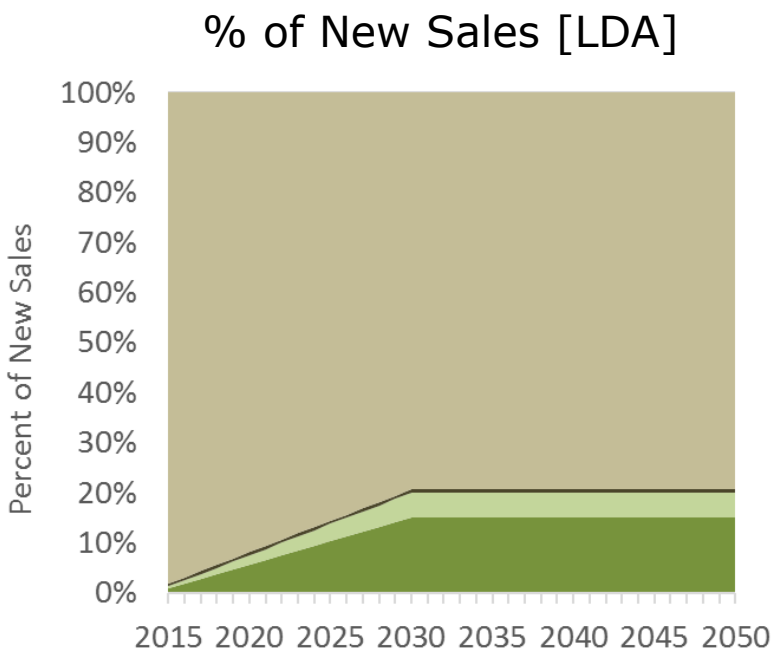


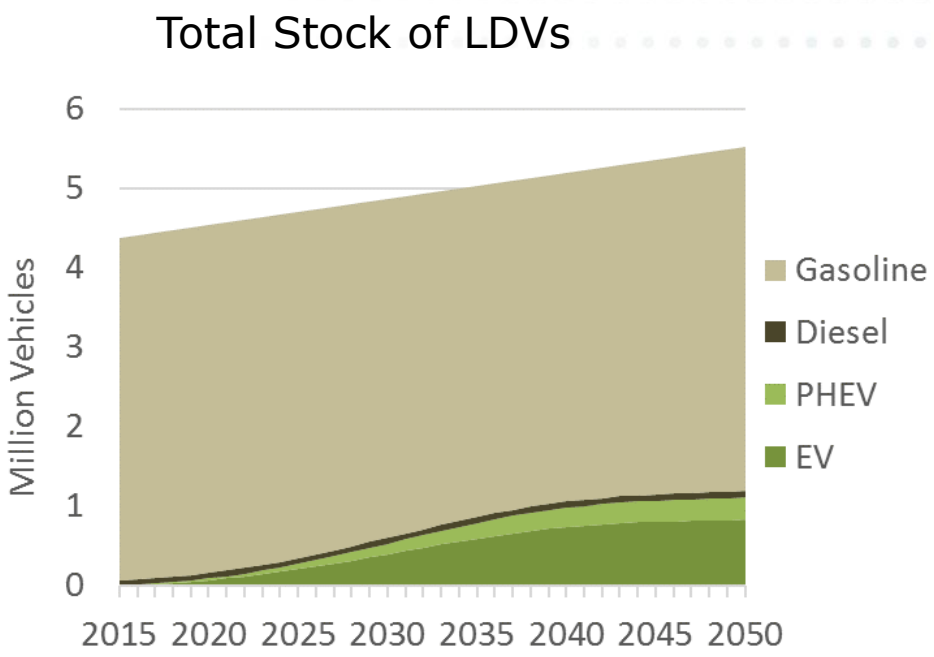
Stocks of Light Duty Autos and Trucks



Stock Rollover Example
Light Duty Vehicles

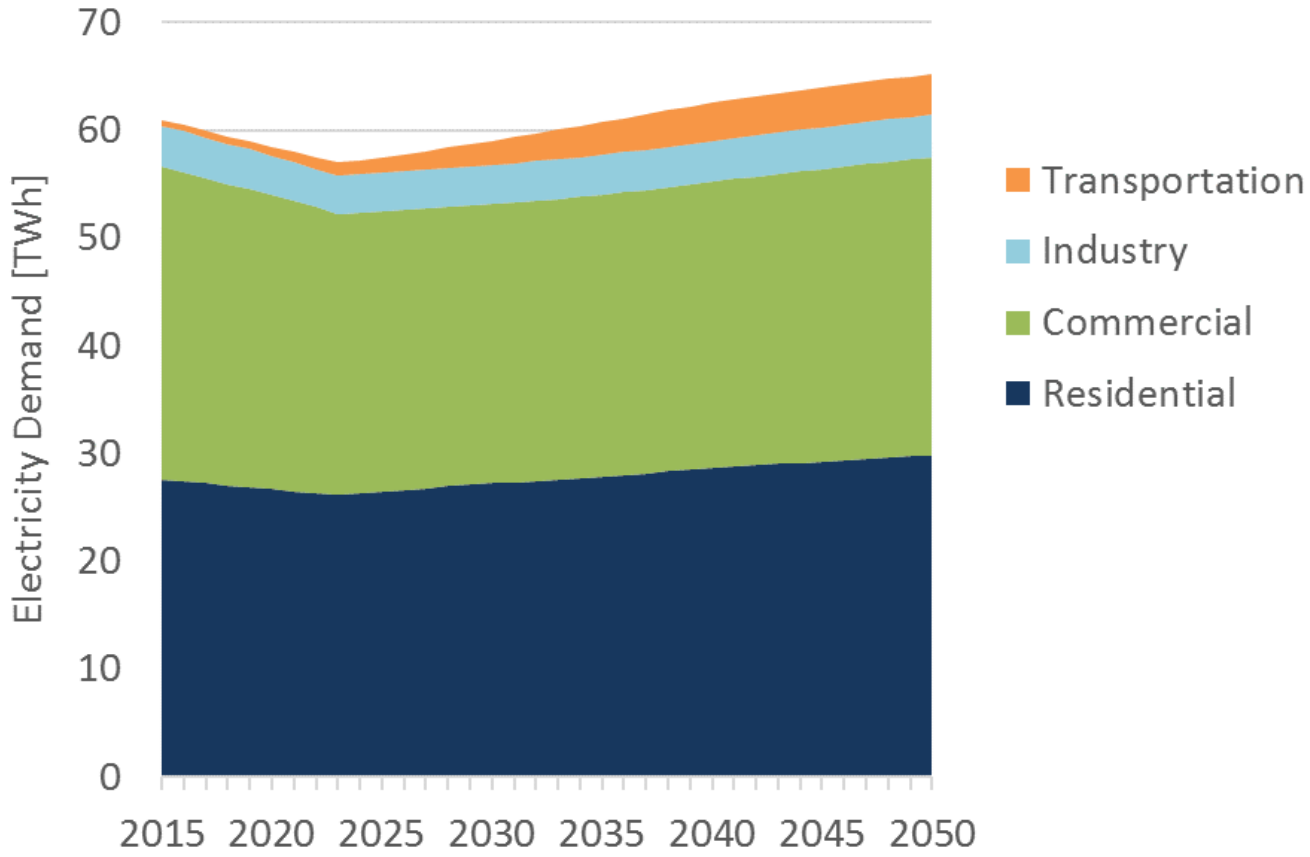
- Stock sectors are modeled by a targeted percent of new sales
- As vehicles retire at end of useful life (~15 years), they are replaced with new mix of vehicles
- Stock rollover means that new stocks lag behind sales





Impacts of Vehicle Electrification

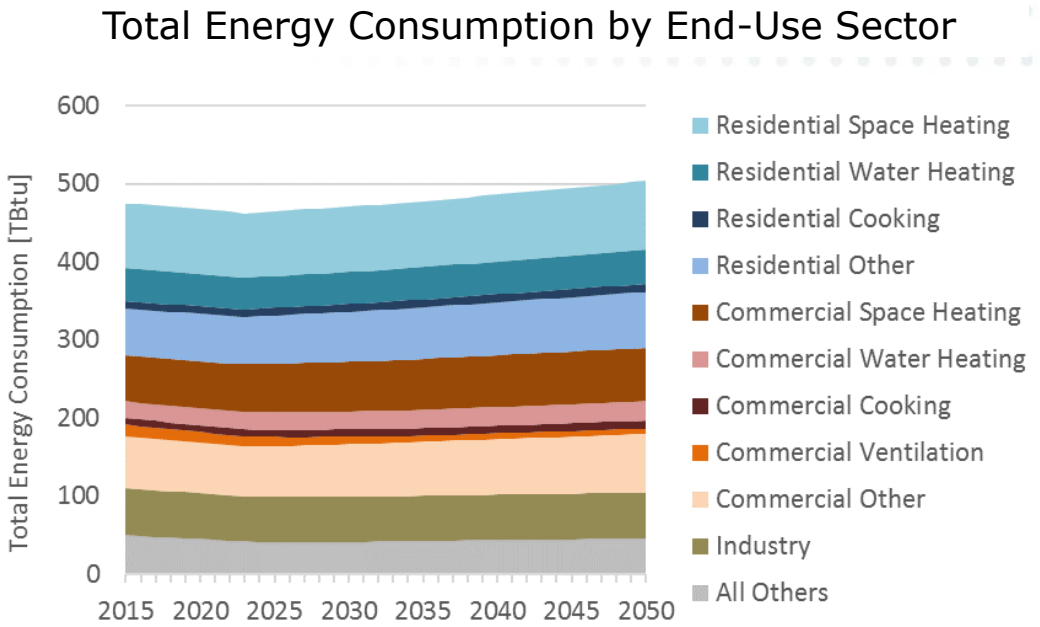
- **Electric energy efficiency impacts total load in early years, but is overtaken by underlying building energy growth and vehicle electrification**



Energy Efficiency

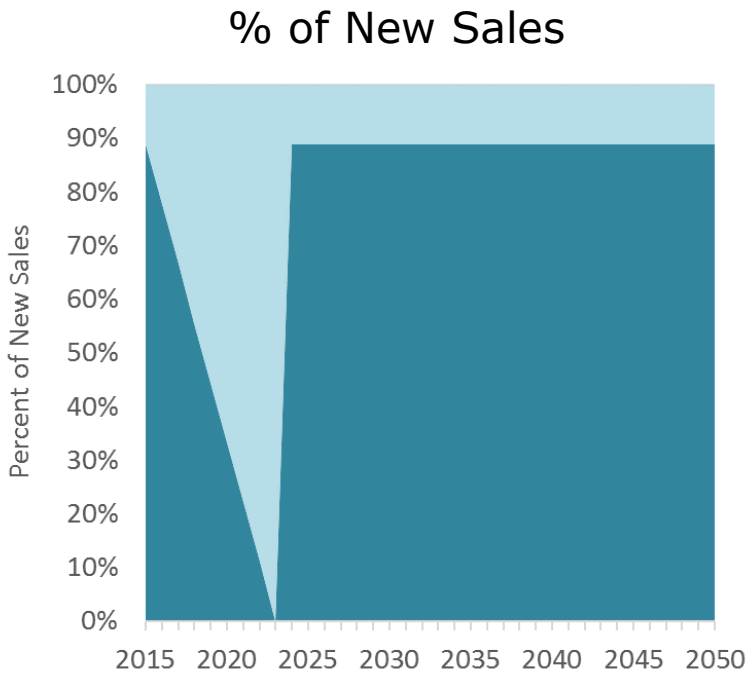
+ Aggressive Building and Industry Efficiency meets EmPower Goals

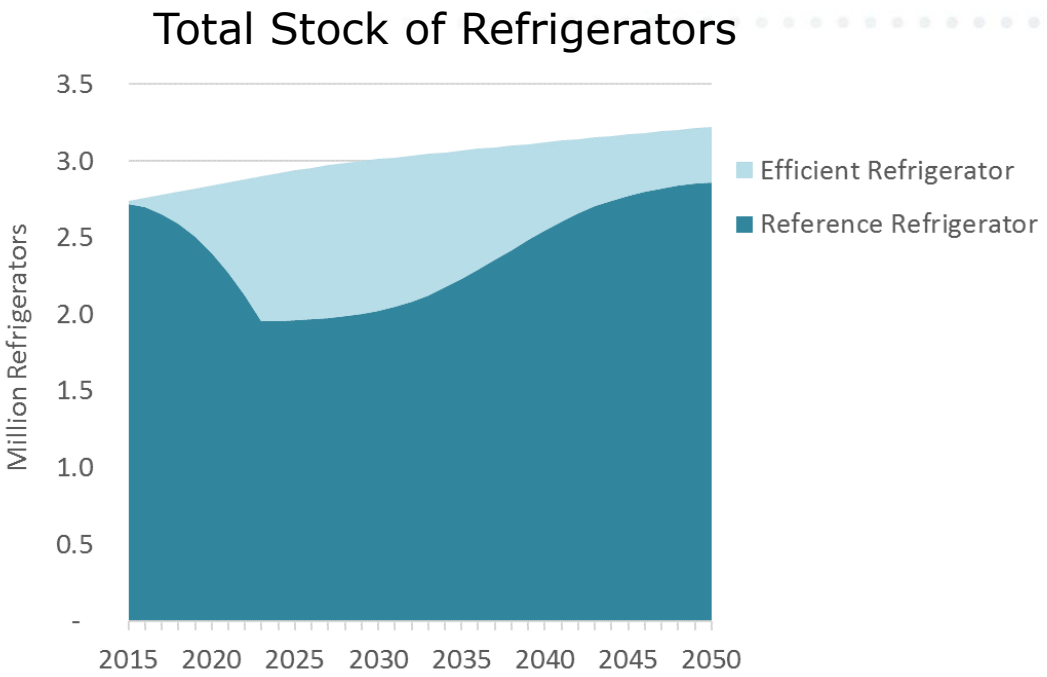
- 100% sales of efficient devices for all stock (e.g. EnergyStar) by 2023
- 5% behavioral conservation in residential lighting, space heating, water heating (reduction in energy services demand)
- 10% below Baseline counterfactual for non-stock sectors
- Reduction in transmission and distribution losses through CVR and other measures



Stock Rollover Example
Residential Refrigeration

- **EmPOWER goals represent increased sales of more efficient devices in residential and commercial buildings in 2015-2023**
- **In 2024, when current regulations expire, sales go back to 2015 sales levels**





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Thank You!

Energy and Environmental Economics, Inc. (E3)
101 Montgomery Street, Suite 1600
San Francisco, CA 94104
Tel 415-391-5100
Web http://www.ethree.com