Maryland
Department of the Environment

2019 GGRA Draft Plan Approach to 2050

Mitigation Working Group
December 17, 2019

Meeting Longer-Term Goals (2040, 2050 and Beyond)

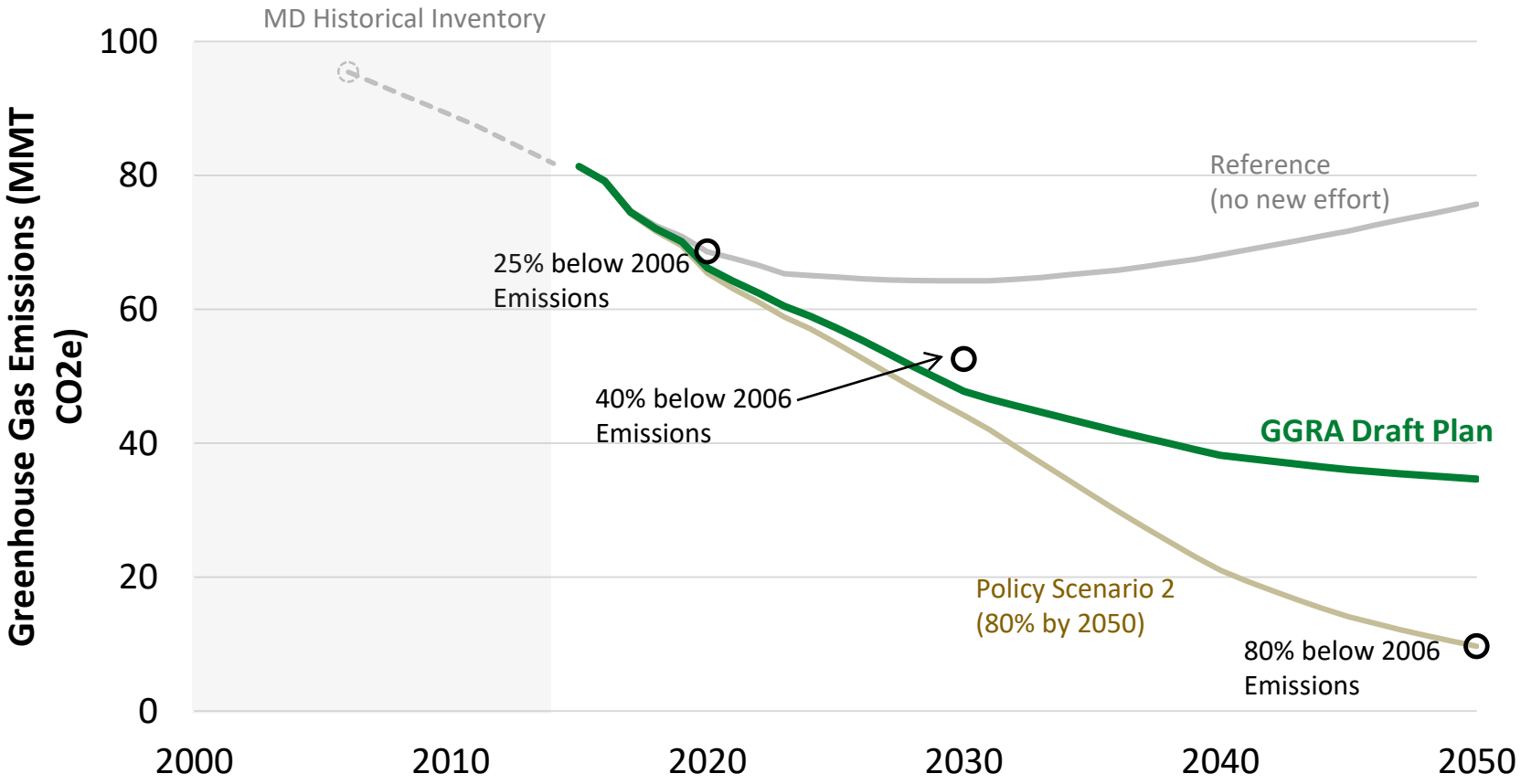
- GGRA requires incremental emission reduction steps intended to demonstrate progress towards a much deeper long-term goal.
  - 25% by 2020, 40% by 2030
  - Also includes non-binding aspirational goals of **80 percent** to **95 percent** GHG reduction in the 2050 time frame.
- The MDE modeling included analyses of 2050 and identified strategies and technologies to continue to analyze as part of the States effort to achieve deeper reductions.

Conclusions from 2050 Analysis in GGRA Draft Plan

- Identified several measures and technologies to monitor as they become available & economical.
- Many should be deployed in the future.
- Many policies cannot be precisely specified multiple decades out.
- Difficult to demonstrate positive economic impacts with new or speculative technologies, whose cost is very high, and very uncertain.

Long Term Goals

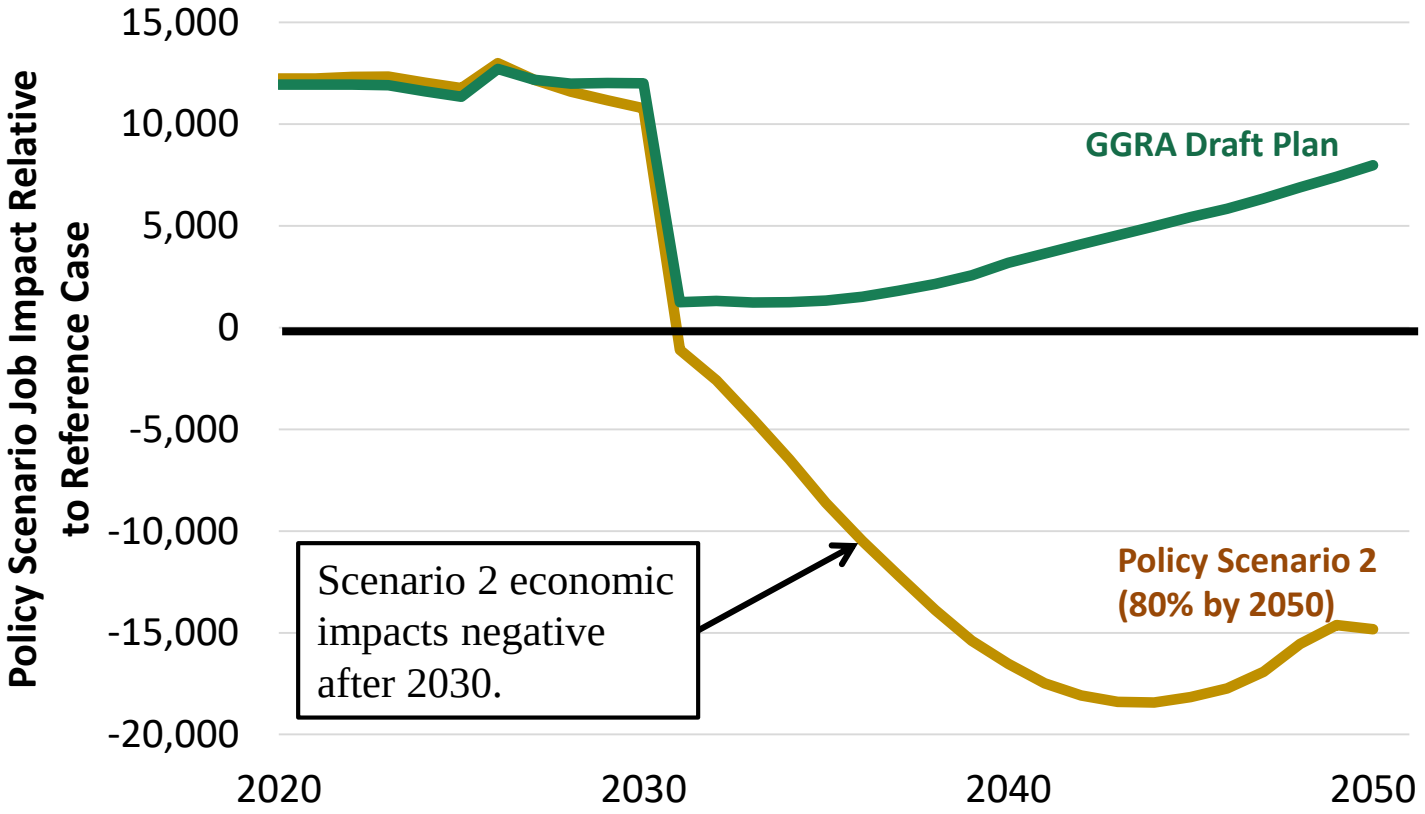
MDE analyzed a scenario that achieves 80% reduction by 2050 ("Scenario 2")



Important long-term measures included: renewable natural gas, other advanced biofuels, electric or other zero-emission heavy trucks and non-road vehicles.

Long Term Challenges

Scenario 2 identified important long-term measures that should be re-evaluated as technologies mature, but are currently expensive.



These measures may be necessary for deeper reductions, and may be cost-effective when the time comes. In the meantime, the Draft Plan focuses on measures necessary for 2030.

Policy Scenario 2 Measures

Compared to The Draft Plan ("PS4")

Near Complete Electrification:

- Accelerated light duty ZEV sales by 2030 (same 100% by 2050 as PS4)
- Accelerated heavy duty EV and Diesel Hybrid Sales (95% by 2050)
- Electrification of non-road vehicles (50% construction EVs by 2050)
- Aggressive building electrification (95% Heat Pump sales by 2050)

Near Complete Decarbonization:

- Continued RGGI cap decline through 2050 (90% reduction 2020-2050)
- Aggressive deployment of renewable natural gas and advanced biofuels (25% biomethane by 2050 and 63% renewable diesel by 2050)
- More aggressive energy efficiency (100% efficient appliance sales by 2030; additional savings in industrial sector)

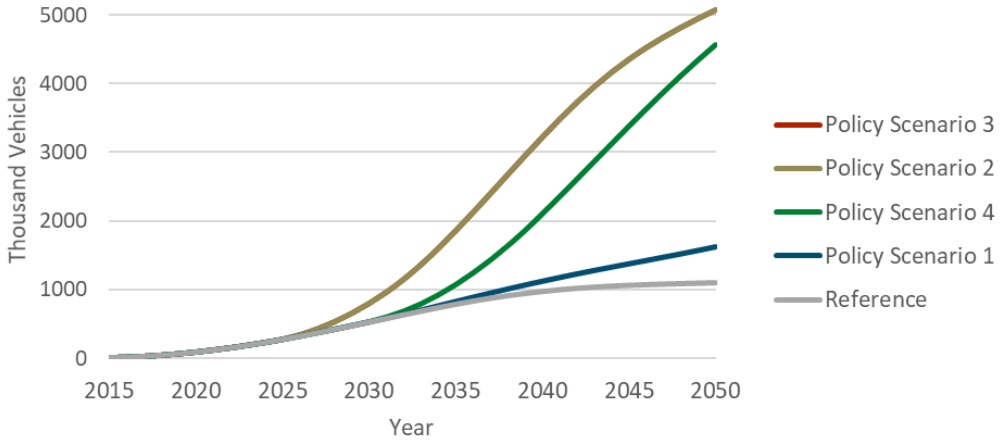
Policy Scenario 2 Measures

Light Duty and Heavy Duty ZEVs

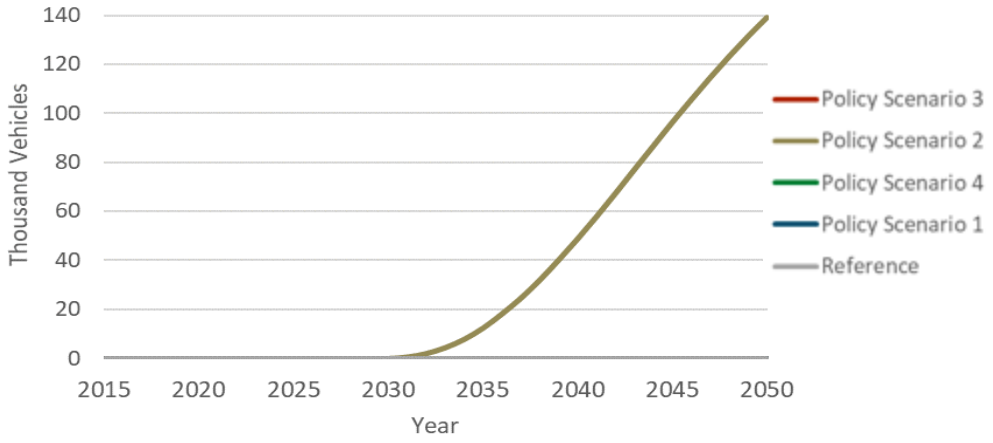
Increased Sales of ZEVs

- New sales of LDV EVs and PHEVs gradually increase to 50% by 2030 and 100% by 2050
- 270,000 ZEVs by 2025, 800,000 ZEVs by 2030, 5,000,000 ZEVs by 2050
- Combined Electric and Diesel Hybrid HDVs sales increases to 40% by 2030, 95% by 2050
- 5,700 HDV EVs by 2030, 72,000 EVs by 2050
- 5,700 Diesel Hybrid by 2030, 83,000 by 2050

ZEV Stock (LDVs)



EV + Diesel Hybrid Stock (HDVs)



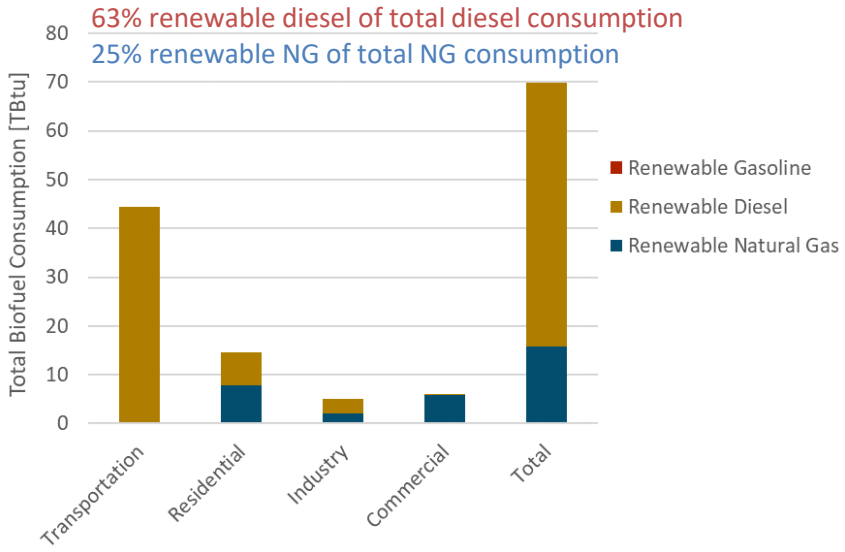
Policy Scenario 2 Measures
Renewable NG and Advanced Biofuels

- E3 performed biofuel feedstock analysis for supply and cost of biofuels
- Deployed to reduce non-electrified transportation and building emissions to hit 80-by-50

Quantity and market-clearing price of biofuels in Policy Scenario 2

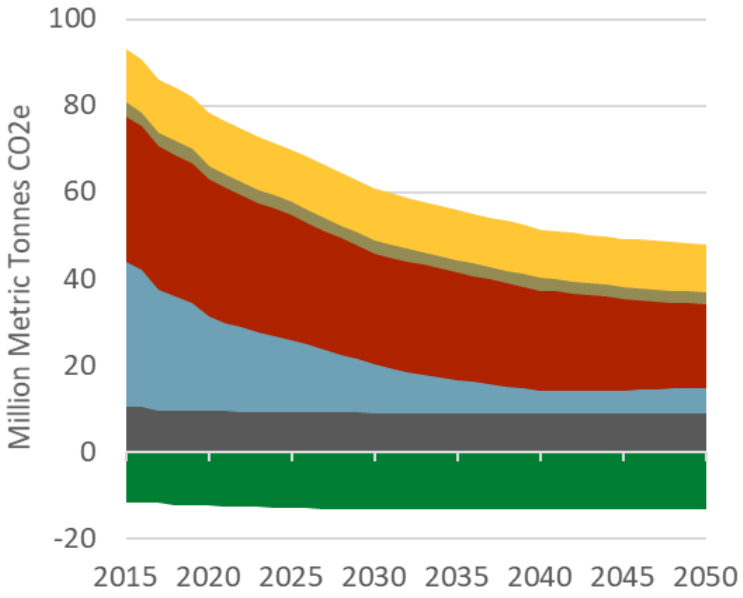
Year	Final Fuel	Projected Quantity (TBtu)	Projected Price of Biofuel (2017$/MMBtu)	Projected Price of Fossil Fuel (2017$/MMBtu)
2050	Renewable Diesel	56	$42.8	$28.1
2050	Renewable Natural Gas	17	$16.5	$5.1

Biofuels consumption by sector in PS2 in 2050

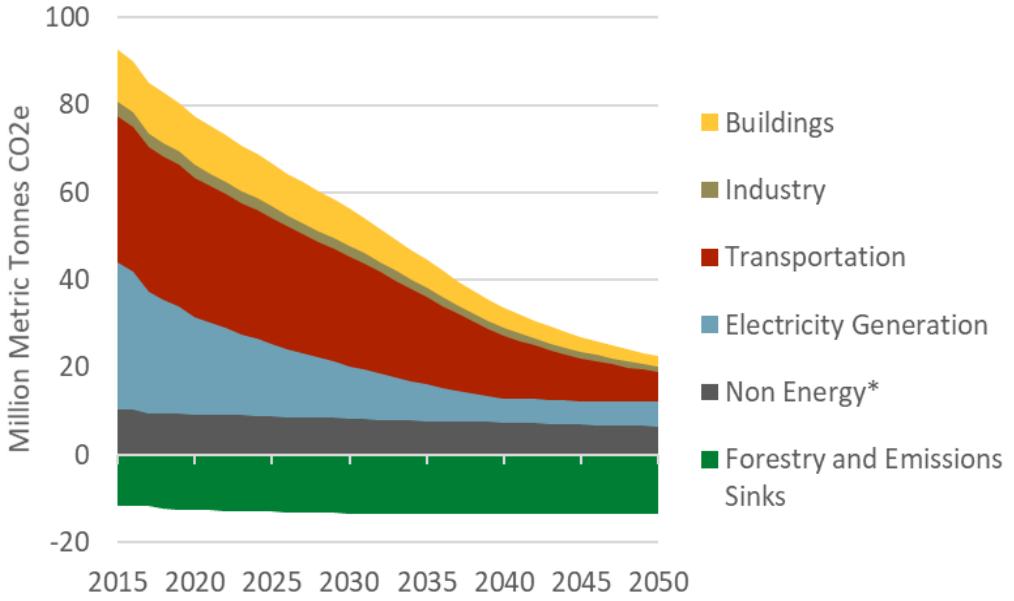


Total GHG Emissions by Sector

Draft Plan (Policy Scenario 4)



Policy Scenario 2



- Additional efficiency, electrification, and biofuels further reduce transportation and building GHGs.
- But they violated economic impact restrictions, given current high cost of many measures (esp. new technologies).
- Some also very uncertain to achieve given currently available policies (e.g. even more LDV EVs).
- **That doesn't mean we shouldn't pursue those measures in the future.**

*Non Energy includes Agriculture, Waste Management, Industrial Processes and Fossil Fuel Industry emissions

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Appendix: E3 Biofuels Methodology

Energy+Environmental Economics

Biofuels Modeling and Assumptions

Prepared for the Maryland Department of Environment

November 8, 2019

Tory Clark
Charles Li

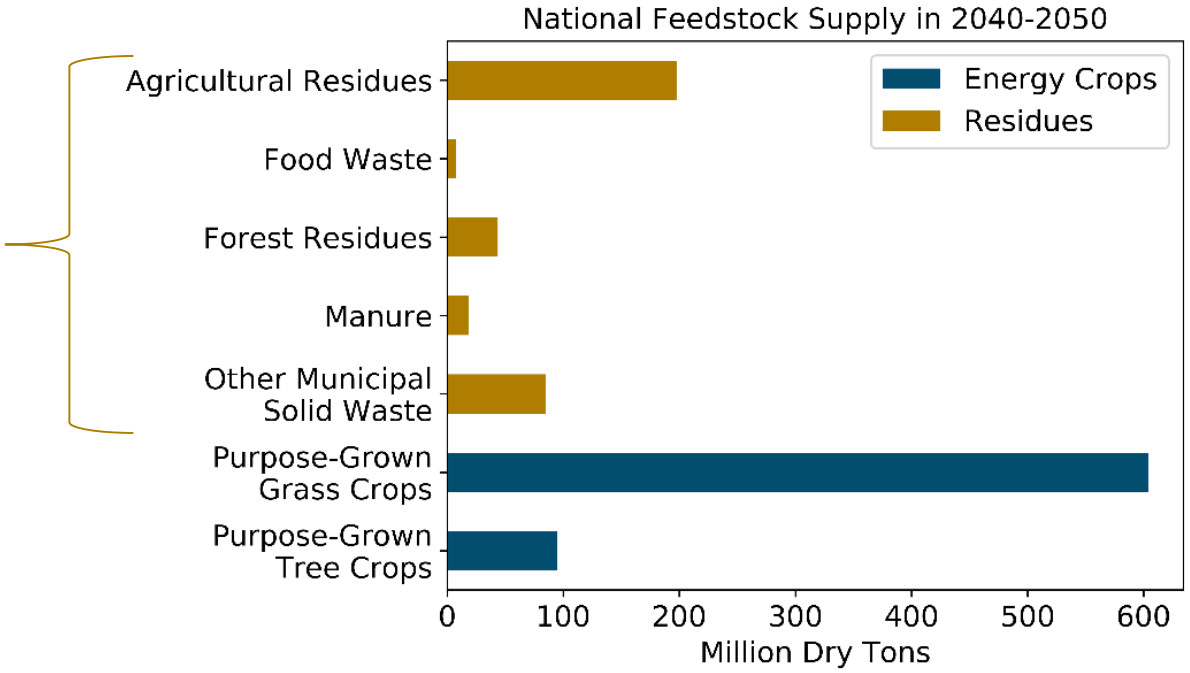
Biofuels Measure Summary

- **Policy Scenario 2 assumes that Maryland will pursue advanced biofuels in addition to conventional biofuels in the federal renewable fuel standard.**
- **We use county-level biomass feedstock data from the 2016 Billion-Ton Report by DOE**
  - Estimates the potential biomass available in the US based on current and future production capacity, availability, and technology
  - Concludes that US has the potential to produce at least one billion dry tons of biomass resources (composed of agricultural, forestry, and waste products) without adversely affecting the environment.
- **Policy Scenario 2 includes using population-weighted share of US supply of wastes and residues, starting in 2031. As a result,**
  - **63% diesel will be replaced by renewable diesel by 2050**
  - **25% natural gas will be replaced by renewable natural gas by 2050**

Feedstock Potential

- **The Billion Ton Study includes two major categories of feedstock:**
  - **"Residues" include feedstocks such as agricultural residues, forest thinnings, and food waste**
  - **"Energy Crops" include dedicated land to grow high-energy crops or new forests for conversion to biofuels. *These have been excluded for this analysis due to land-use concerns***

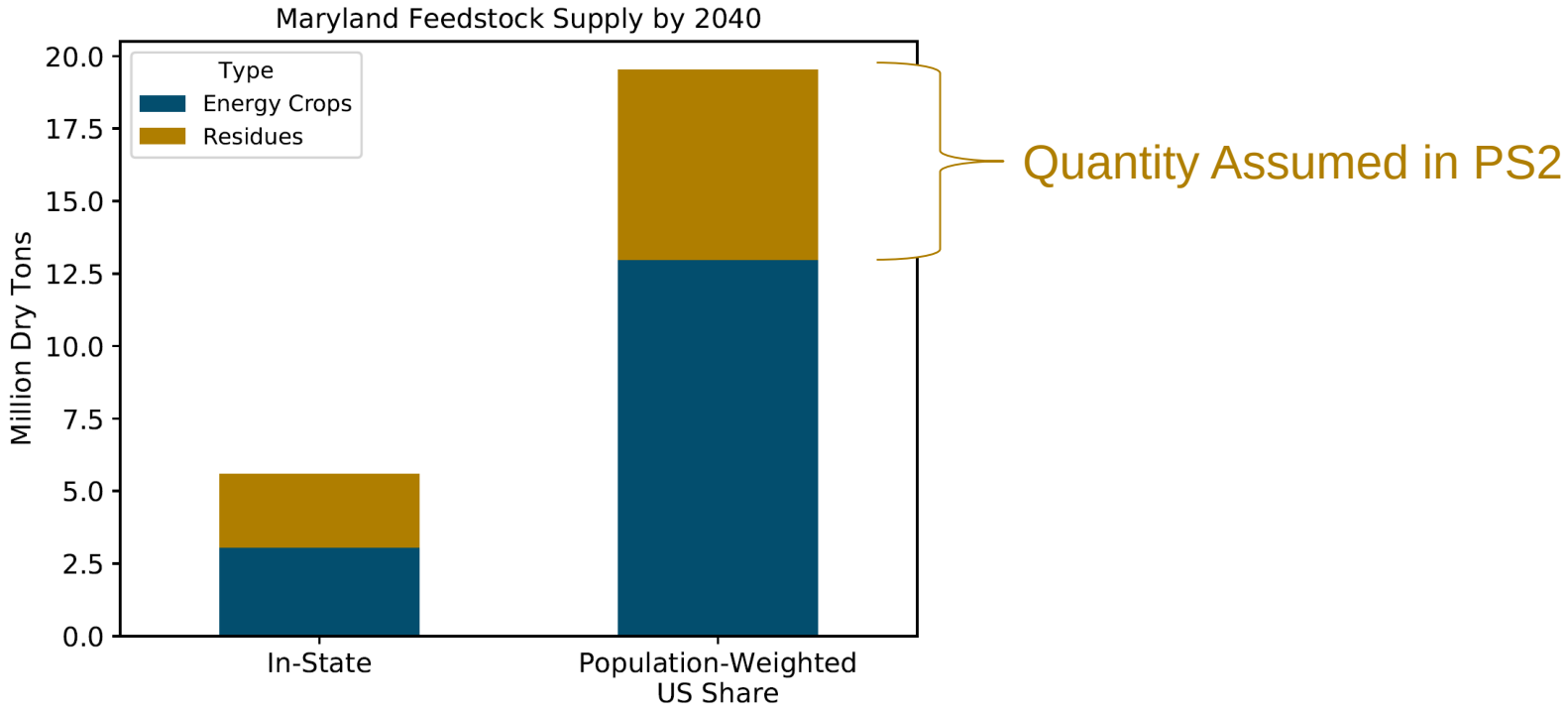
Categories Included in PS2



Source: DOE, 2016. Billion Ton Update

Maryland Biomass Feedstocks

- Policy Scenario 2 assumes that Maryland has access to its population-weighted share of the national "Residue" feedstock categories
- Maryland has limited in-state biomass resource potential
- Using the population-weighted share of the US supply (1.9%), MD has access to more than 2x the in-state potential of residues and wastes



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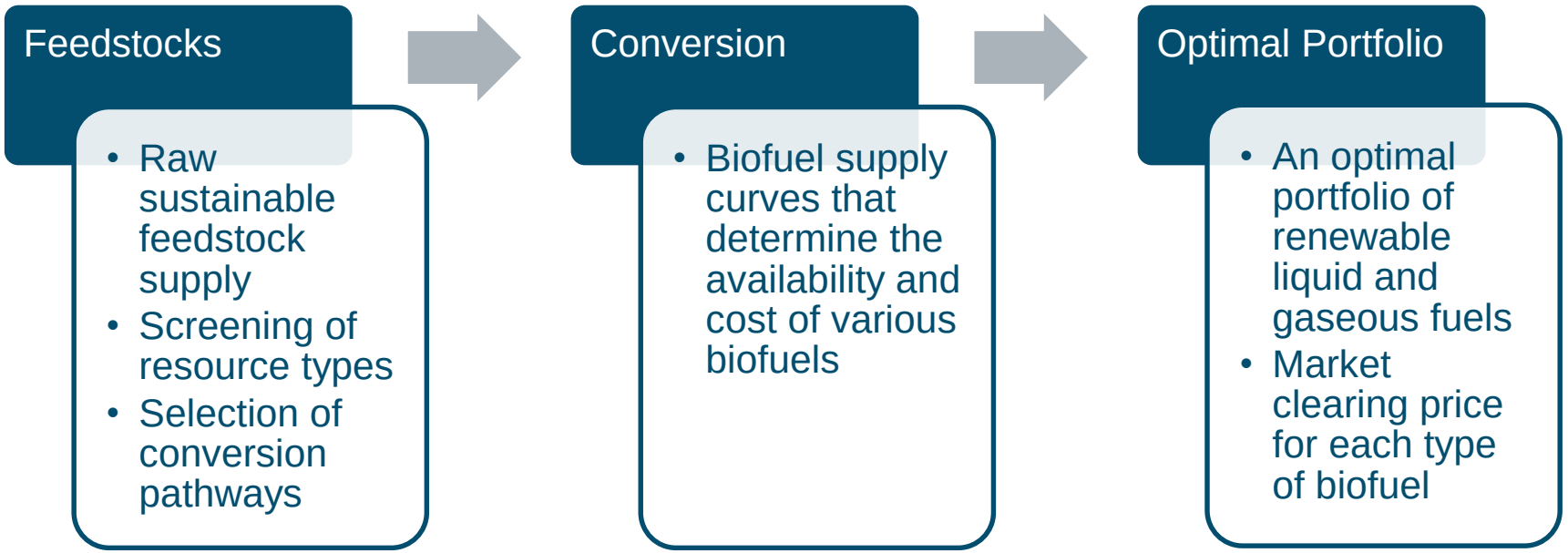
Overview of Biofuels Modeling Approach

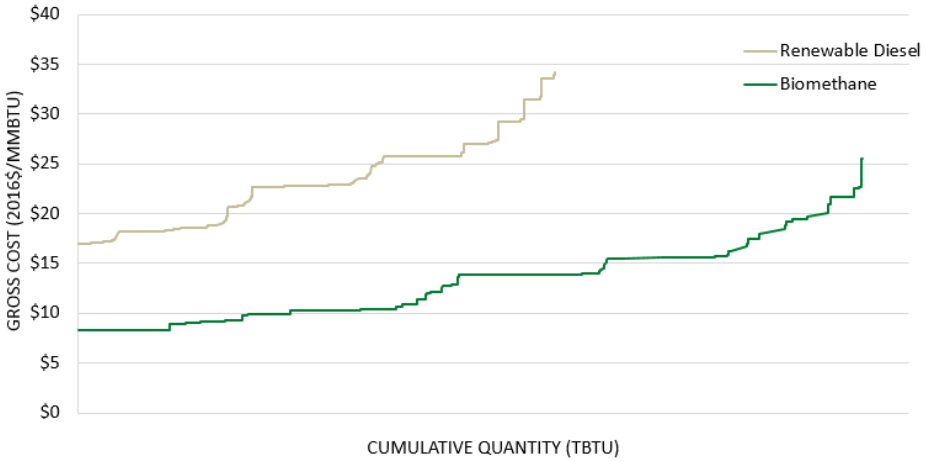
- **E3 has developed a biofuels optimization model that selects a least-cost portfolio based on available sustainable feedstocks and selected conversion pathways.**
- **The lowest-cost biofuels portfolio meets a pre-defined demand for renewable jet kerosene, renewable diesel, and renewable natural gas.**



Conversion

- **Biomass feedstocks are assumed to be converted to biofuels through one of many conversion processes:**
  - Gaseous biofuel conversion through anaerobic digestion (e.g. manure) or gasification of wastes and residues
  - Liquid conversion through hydrolysis or pyrolysis of wood and cellulose
- **Each feedstock conversion process has an assumed overall energy efficiency and levelized process conversion costs**
- **The model generates a supply curve for each type of biofuels**

Illustrative Biofuels Supply Curves (Biomethane vs. Renewable Diesel)



Costing

- **Included Costs:**
  - Raw feedstock
  - Preparation
  - Conversion
  - Transportation
  - Delivery
- **Fuel demands from PATHWAYS are used as inputs to determine the quantity and market-clearing price for each type of biofuels.**
- **We assume a regional market for biofuels that assumes a market-clearing price will need to be paid to lower cost producers in order to bring higher cost producers into the market.**

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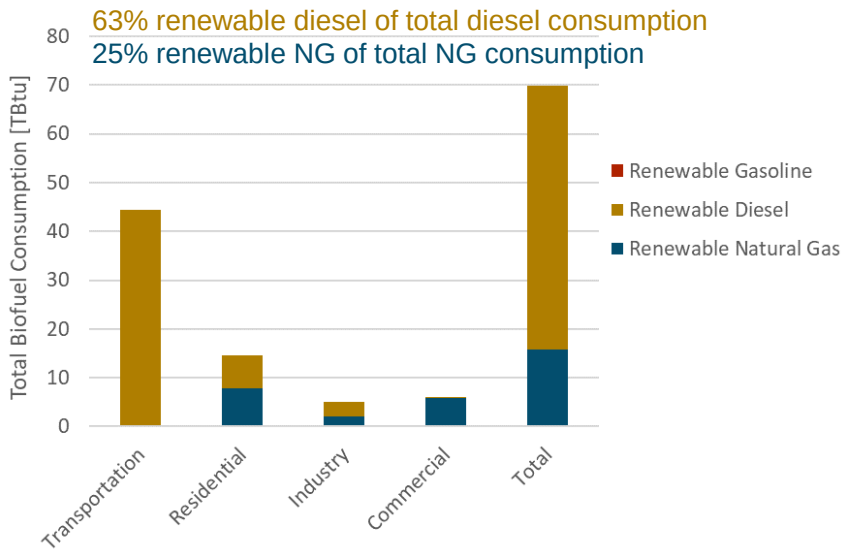

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Thank You

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