Energy+Environmental Economics

Building Electrification in Maryland

July 9, 2020

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Agenda

+ **Background**
  - Role of electrification in decarbonization
  - Lessons learned from other jurisdictions
+ **Building electrification in Maryland**
  - Insights from MD PATHWAYS modeling
+ **Additional resources**

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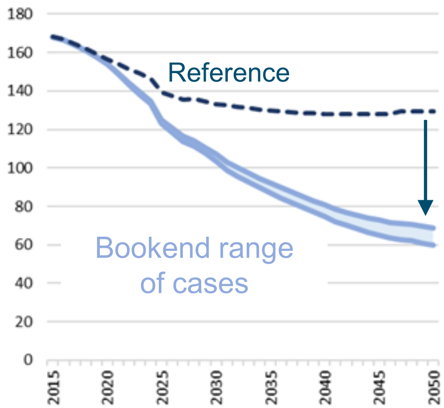
Background

Role of electrification in decarbonization

Energy efficiency & conservation

Primary Energy Efficiency (MMBtu/person-yr)

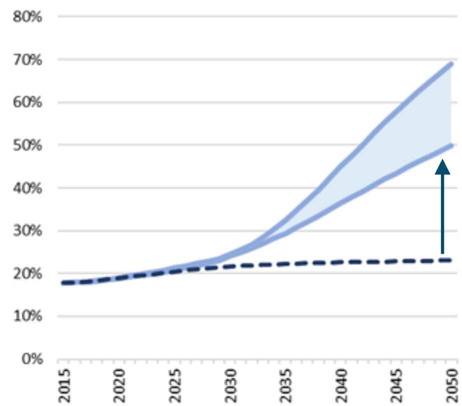


Conventional Efficiency:
- Codes and standards
- Switching to efficient devices
- Building shell improvements

Conservation:
- Behavioral conservation
- Smart growth

Electrification

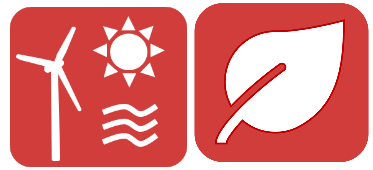
Share of Electricity and Hydrogen (% of Total Energy)



Buildings:
- Space heating
- Water heating

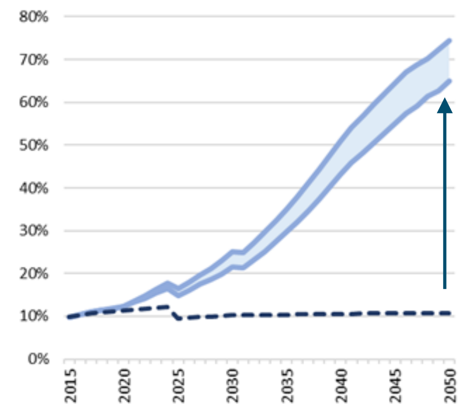
Transportation:
- Electric vehicles (BEV and PHEV)
- Public transportation

Industry:
- HVAC and boilers



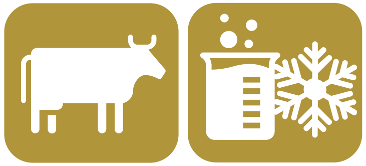
Low-Carbon Fuels

Zero Carbon Energy (% of Primary Energy)



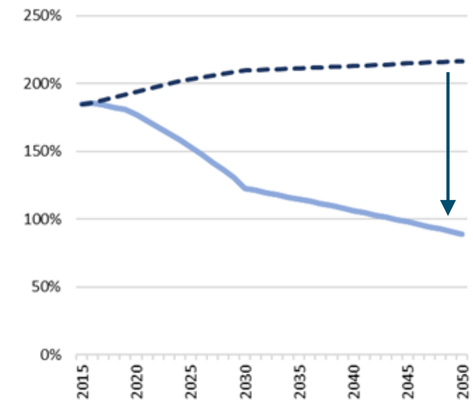
Low-carbon electricity:
- Renewables (solar, wind, hydro)
- Nuclear and CCS
- Grid integration

Low-carbon liquid and gaseous fuels:
- Biofuels
- Synthetic fuels



Reduce non-combustion emissions

Non-Combustion Emissions Relative to 1990 (%)



Methane:
- Manure management
- Methane capture at landfills and WWTP

F-Gases
- Low GWP refrigerants

Source: Mahone et al, (2018) "*Deep Decarbonization in a High Renewables Future*", California Energy Commission CEC-500-2018-012

Lessons learned from other jurisdictions

+ **E3 has been modeling statewide California decarbonization for over 10 years, but is increasingly working in jurisdictions across the U.S.**

California PATHWAYS

Analyzing strategies to meet 2030 & 2050 GHG targets (CA Air Resources Board, CA Energy Commission, CA CPUC, SMUD, SCAG, SoCalGas)

New York PATHWAYS

Evaluating variety of policy options to help NYSERDA reach 2030 and 2050 goals for electric sector and whole economy

Oregon Market Approaches to Reducing GHGs

Assessed impact of current policies on Oregon's GHG emissions and potential role of cap and trade, with OR DEQ

Maryland PATHWAYS

Analyzing impact of existing and future policies on GHG emissions in Maryland as a part of GGRA for MDE

U.S. Deep Decarbonization Pathways

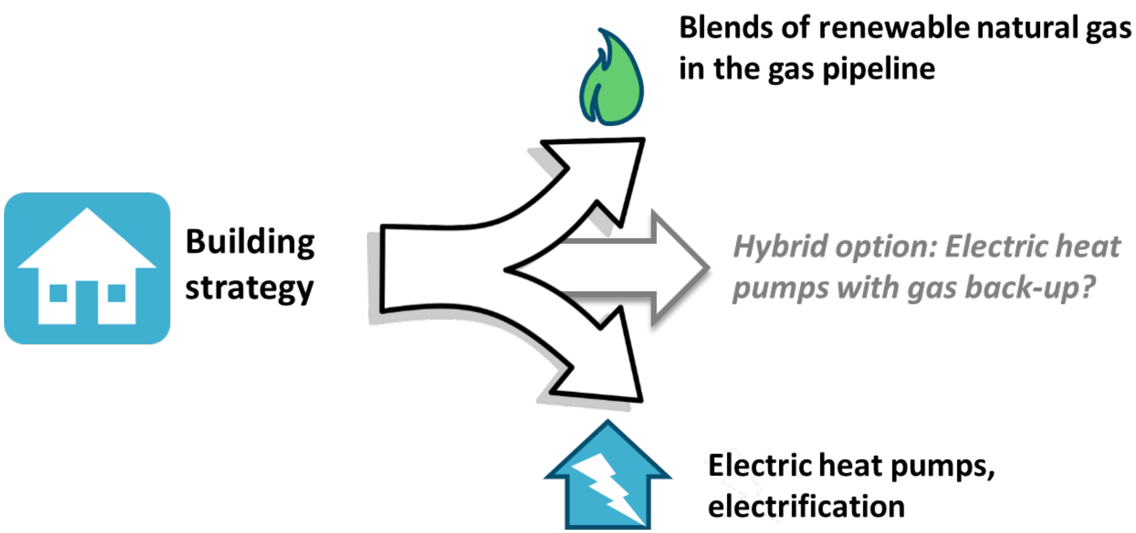
Evaluated scenarios to meet 80% reduction in GHGs in the U.S. by 2050,
part of the DDPP

Minnesota PATHWAYS

Developed scenarios for Xcel Energy's Upper Midwest IRP. Created Transportation Pathways for MnDOT

There are different strategies available to decarbonize buildings

+ There are many strategies to decarbonize buildings, including energy efficiency, low-carbon fuels, and electrification
+ Extent of low-carbon fuels will depend on sustainable biomass feedstock availability and costs to consumers

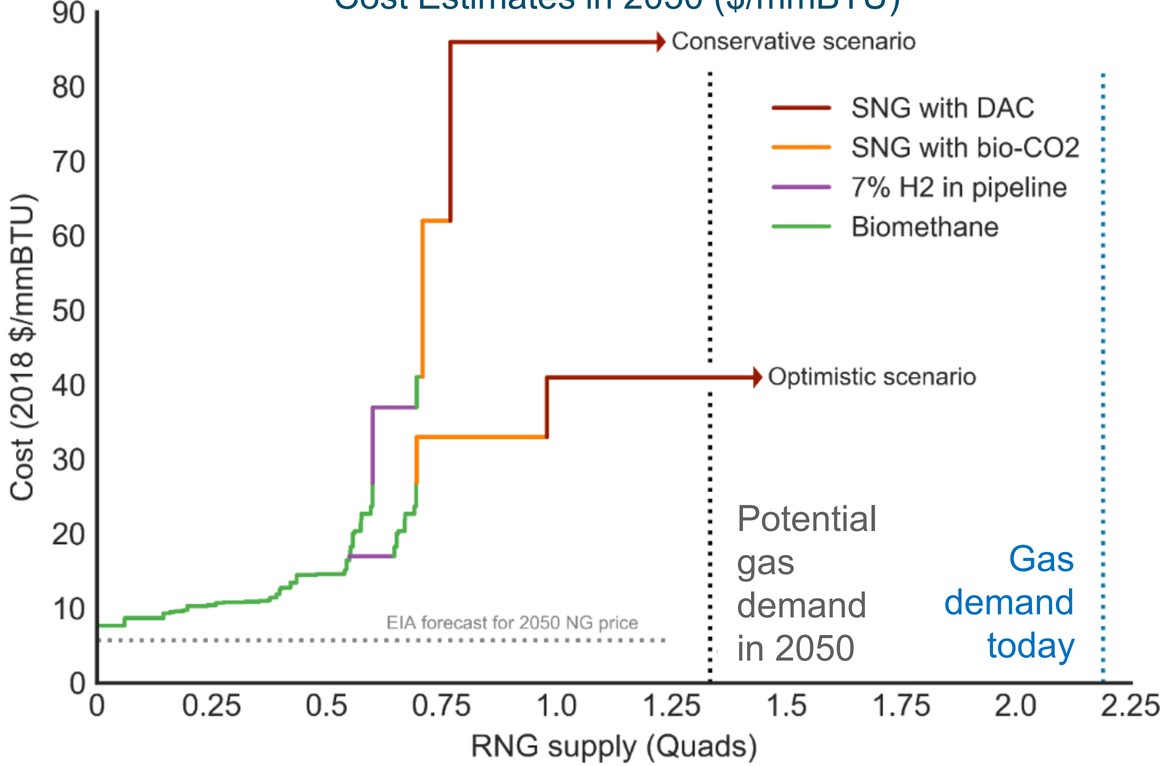


+ Extent of building electrification will depend on consumer preferences, economics, and research and development to create appropriate technologies for all building types and applications

Biofuels are valuable but in limited supply

- Best uses for biofuels/RNG may include: Trucking, industry, aviation and off-road transportation
- Even assuming optimistic RNG costs, RNG will be expensive for use in most buildings

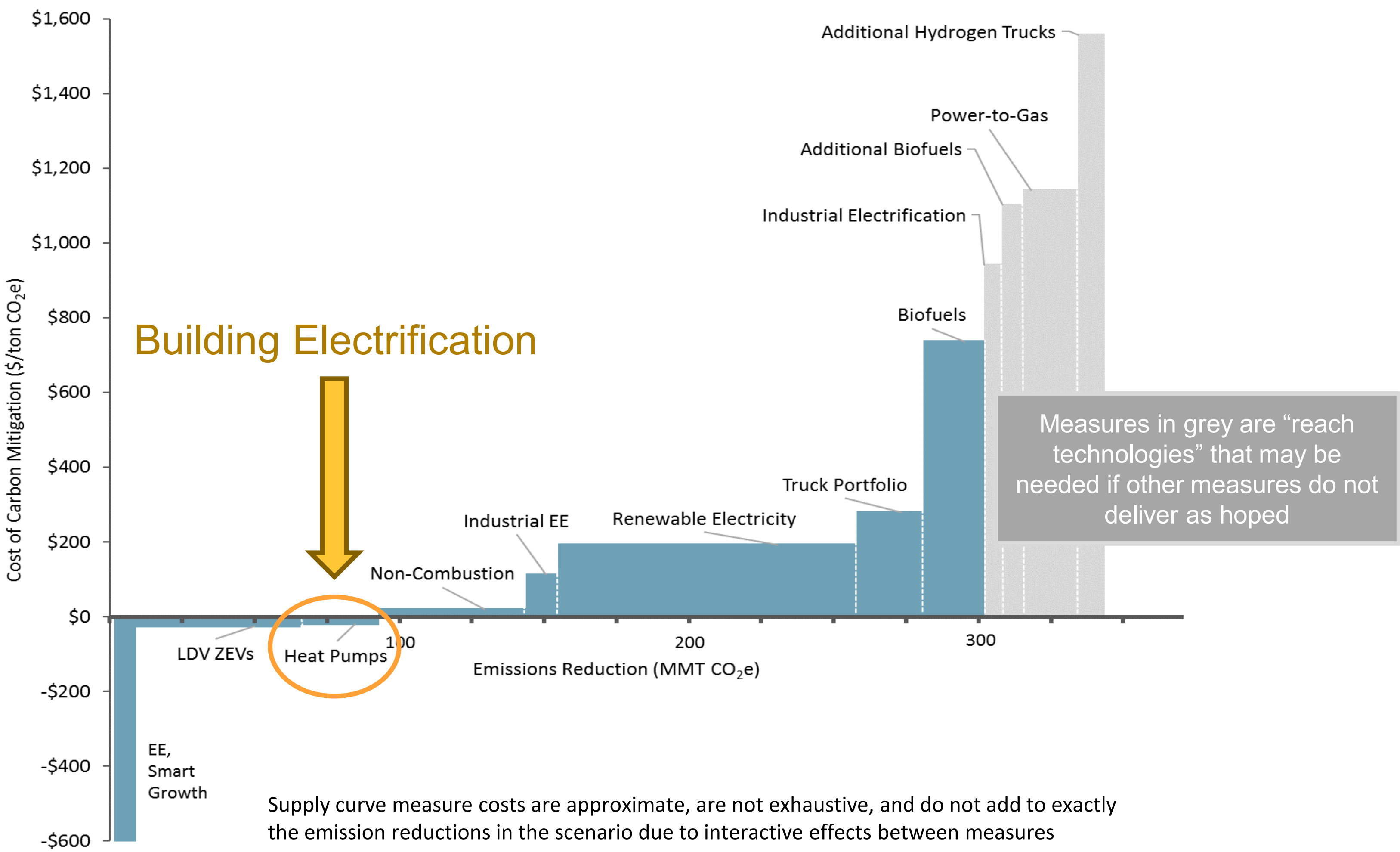
California Renewable Natural Gas Technical Potential and Cost Estimates in 2050 ($/mmBTU)



Source: E3 report on "Natural Gas Distribution in California's Low-Carbon Future" (CEC 2020). Available online: https://ww2.energy.ca.gov/2019publications/CEC-500-2019-055/CEC-500-2019-055-F.pdf

Building electrification is cheaper than other mitigation measures needed to reach 2050 goals

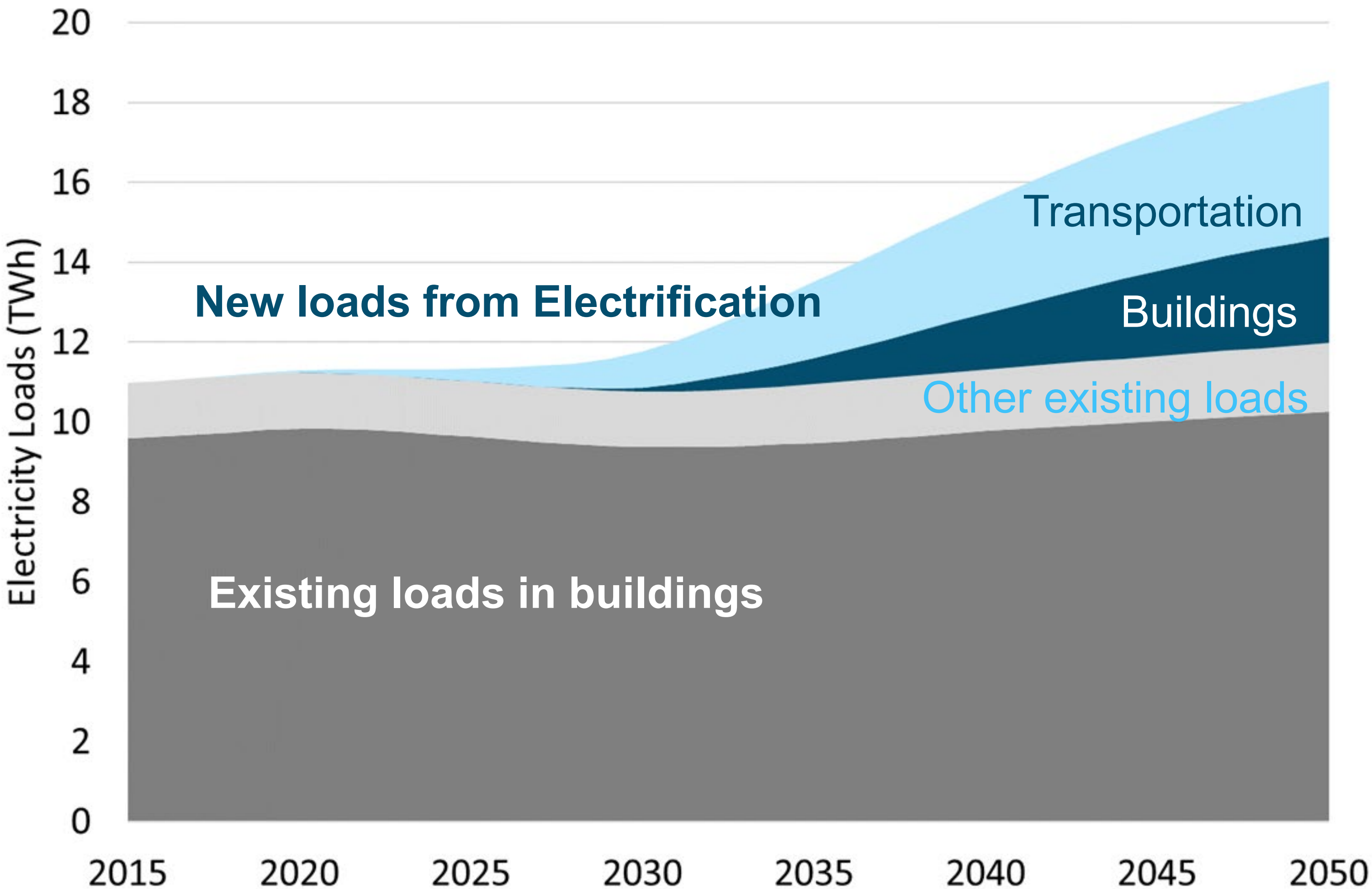
2050 $/ton in California High Electrification Scenario relative to Reference (2016$)



Source: E3 report on "Deep Decarbonization in a High Renewables Future: Updated Results from the California PATHWAYS Model" (CEC 2018). Available online: https://ww2.energy.ca.gov/2018publications/CEC-500-2018-012/CEC-500-2018-012.pdf

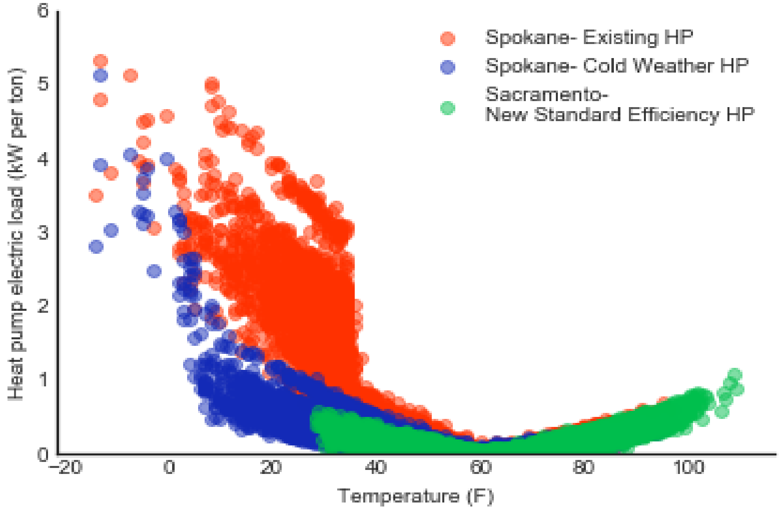
New electric loads will transform the grid

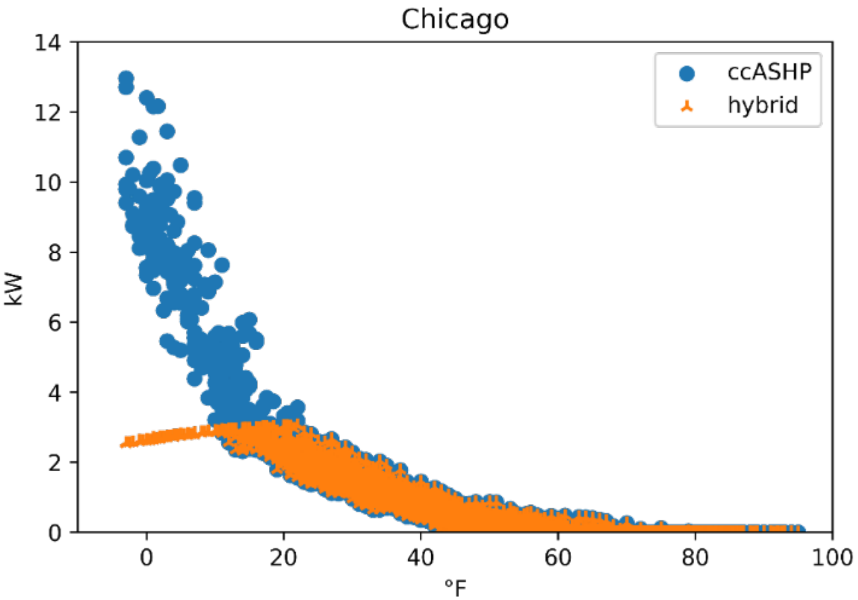
Example from Sacramento Municipal Utility 2018 IRP:
Total electricity loads projected in PATHWAYS 80x50 Scenario



Grid impacts from building electrification vary based on climate & technologies

- **Electricity demands from heat pumps are tied to outdoor temperatures; electric demands increase as temperatures drop**
  - Grid impacts will depend on heat pump technologies, use of back-up heat or hybrid systems, as well as grid management solutions
- **Colder climates may become winter-peaking electric systems, mild climates may continue to be summer-peaking systems**





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Building Electrification in Maryland

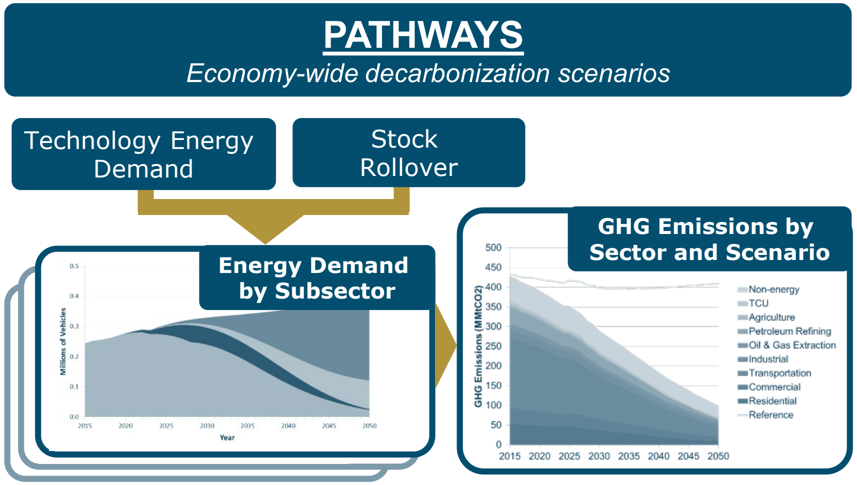
PATHWAYS Modeling Approach

+ Economy-wide infrastructure-based GHG and energy analysis

- Captures "infrastructure inertia" reflecting lifetimes and vintages of buildings, vehicles, equipment
- Models physical energy flows within all sectors of the economy
- Allows for rapid comparison between user-defined scenarios
- Tracks electrification load shapes by sector and end use

+ Scenarios test "what if" questions

- Reference or counterfactual scenario for consistent comparison in future years
- Multiple mitigation scenarios can be compared that each meet the same GHG emissions goal



MWG Scenario Policies and Measures

Electricity Generation

- 50% RPS by 2050, 75% RPS and 100% zero-emissions electricity by 2040
- All in-state coal-fired power plants are retired by 2030
- No new natural gas power plants built after 2020
- Increased net metering cap to 3 GW by 2030
- Accelerated RGGI cap (50% reductions by 2030, 100% reductions by 2040, vs. 2020)

Transportation

- CAFE Standards improving through 2026
- Aggressive zero-emission vehicle sales
- Low LDV VMT growth rate (0.6% per year)

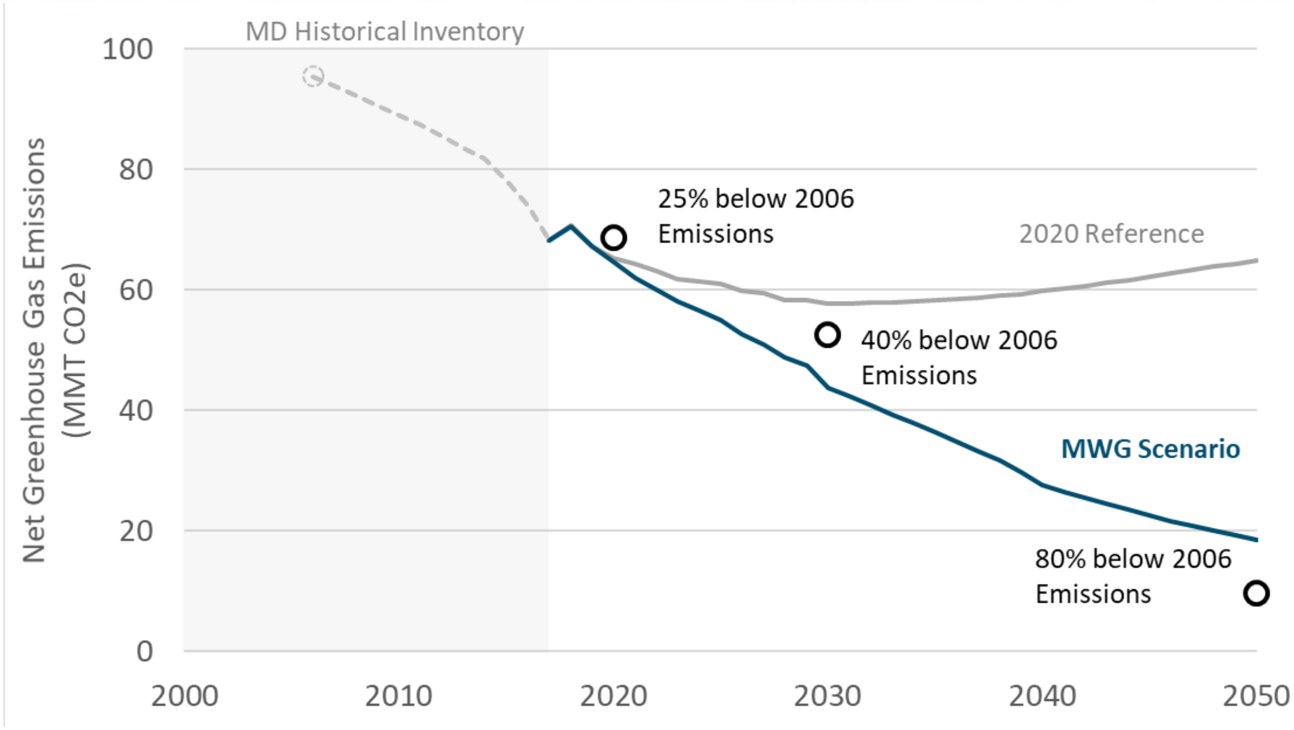
Buildings and Industry

- Increased EmPOWER efficiency goals by 2023 and beyond
- Aggressive building electrification for new construction and retrofits

Other

- Methane measures in manure management and enteric fermentation
- Increased forestry sinks by 10% by 2030 (vs. 2017)

Total Net GHG Emissions
MWG Scenario

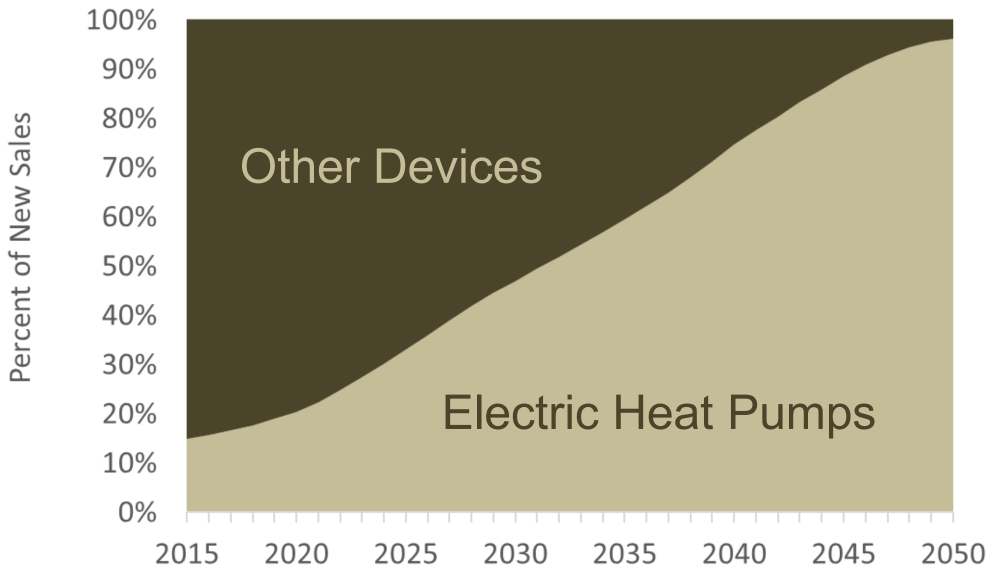


+ The MWG scenario overachieves the near-term GHG targets and is close to meeting the 2050 GHG target.
+ It overachieves the **2020 GHG target by 3.9 MMT CO2e**, and **the 2030 GHG target by 8.7 MMT CO2e**
+ It gets close to the **2050 GHG target**, but there is still **a gap of 8.9 MMT CO2.**

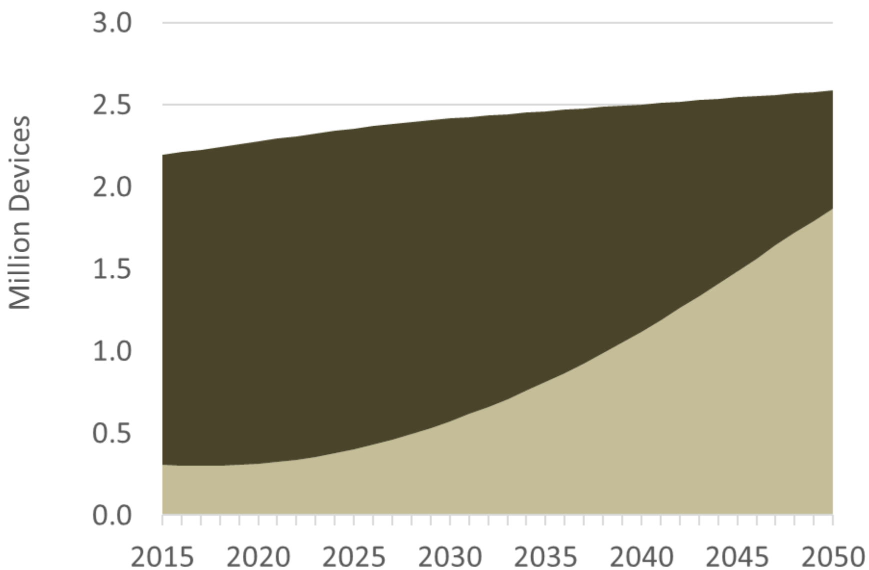
Building Electrification
MWG Scenario

+ **Building electrification adoption increases steadily after 2020; electric appliance sales share reaches 90% by 2050**
+ **MWG Scenario achieves 100% electric heat pump adoption in all new construction by 2025 and retrofits reach ~1.3 Million by 2050**

Residential Space Heaters (Sales Share)



Residential Space Heaters (Total Stock)



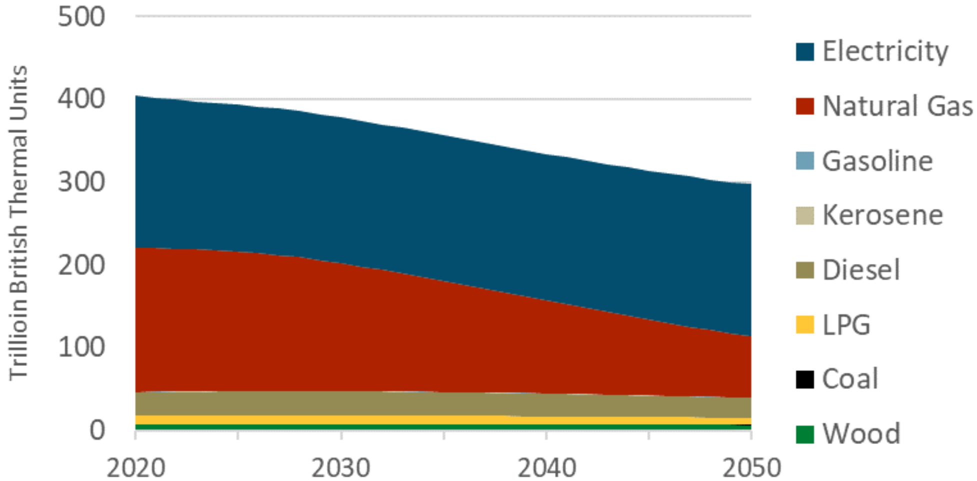
Building Energy and Emissions
MWG Scenario

+ **Appliance efficiency and electrification drive down total energy consumed in buildings, even as population grows**

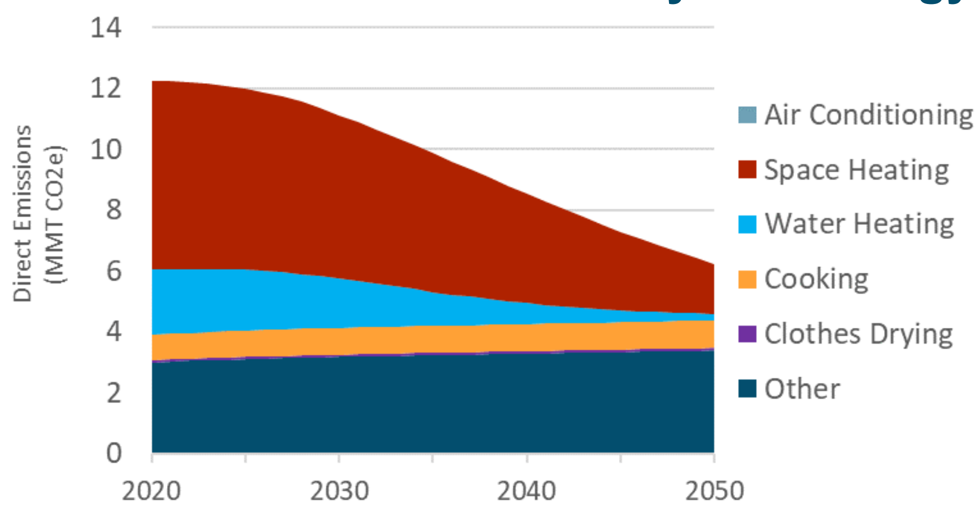
+ **Building electrification results in significant reduction of emissions in space and water heating**

+ **The MWG Scenario achieves 41% reductions by 2050 (relative to 2006)**
  - Note that emissions in buildings grew from 2006 to 2020, so in 2030 emissions are 6% higher than in 2006

Total Energy by Fuel



Total Direct Emissions by Technology



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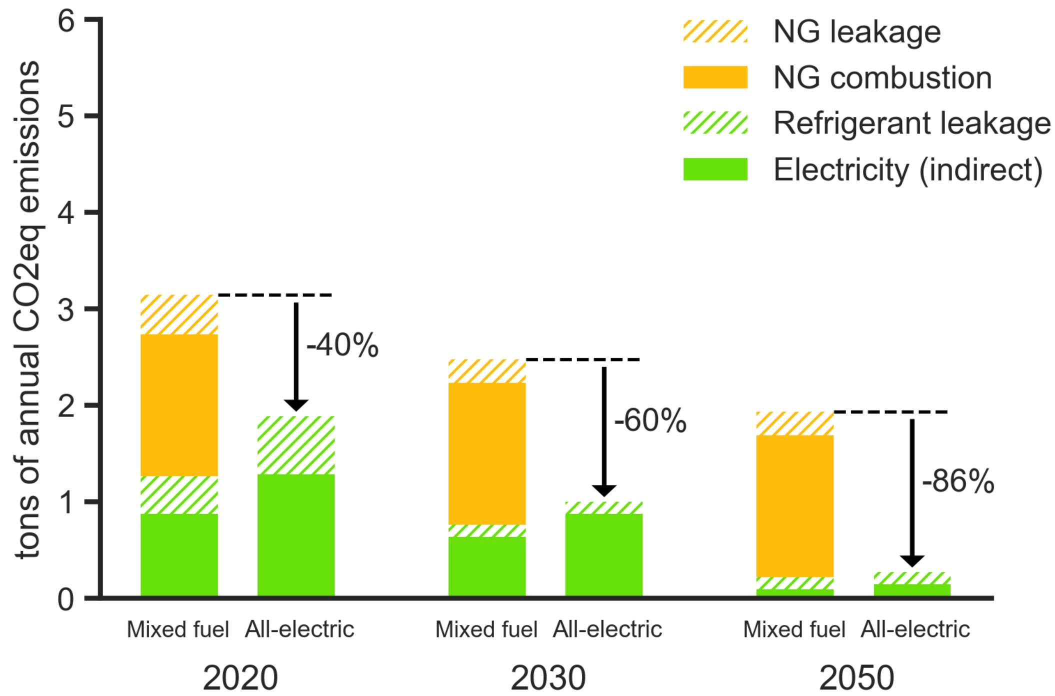
Additional Resources

Residential Building Electrification

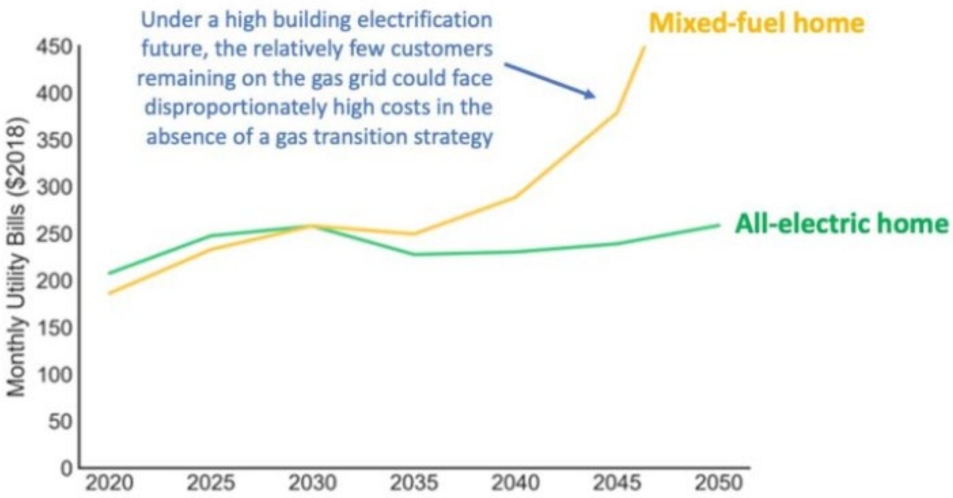
- Building electrification is a relatively low-cost, low-risk way to reduce California's building-related GHG emissions.
- E3's study examines costs, savings, and emissions for electric and gas appliances in six different home types in geographical areas covering over half the state's population.
- Methane leakage and refrigerant gas leakage are also estimated over time



Full report and more information can be found here: https://www.ethree.com/e3-quantifies-the-consumer-and-emissions-impacts-of-electrifying-california-homes/

California Natural Gas Distribution

- E3 evaluated two strategies for reducing carbon emissions from California buildings: building electrification and renewable natural gas.
- E3 found that building electrification is likely to be a lower-cost and lower-risk strategy for reducing carbon emissions from buildings in California.
- E3 also found that, particularly under a high building electrification future, customers remaining on the natural gas system could face disproportionately high costs in the absence of a gas transition strategy.



Full report and more information can be found here: https://www.ethree.com/at-cec-e3-highlights-need-for-gas-transition-strategy-in-california/

Other resources

- **RMI, 2018. The Economics of Electrifying Buildings**
  - Investigates cost-effectiveness of building electrification in four regions: Oakland, CA, Houston, TX, Providence, RI, and Chicago, IL
  - https://rmi.org/wp-content/uploads/2018/06/RMI_Economics_of_Electrifying_Buildings_2018.pdf
- **E3, 2019. Peak Heat and the Capacity Benefits of Energy Efficiency**
  - Explores electric grid impacts of building electrification in the northeast
  - https://drive.google.com/file/d/12N6XonG8mb_mR2fauDOFemEgMahGqVFB/view