



Energy+Environmental Economics

Technical Support for Maryland's Energy Transition Plan US Climate Alliance & E3

Scope of Work Presentation for the Mitigation Working Group

February 16, 2021

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Agenda

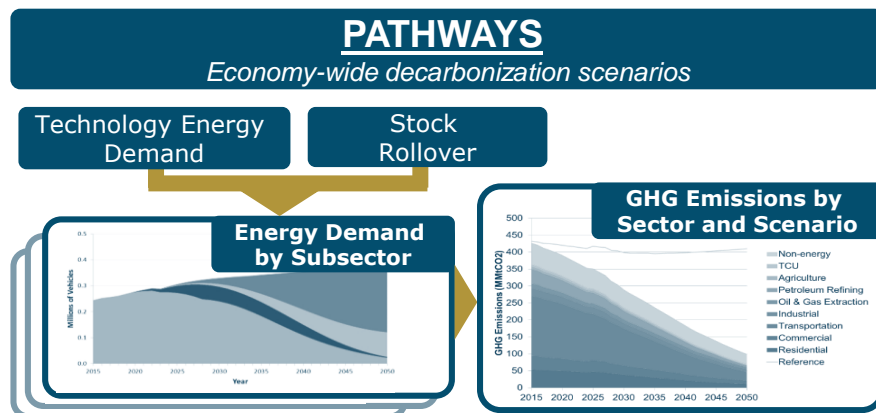
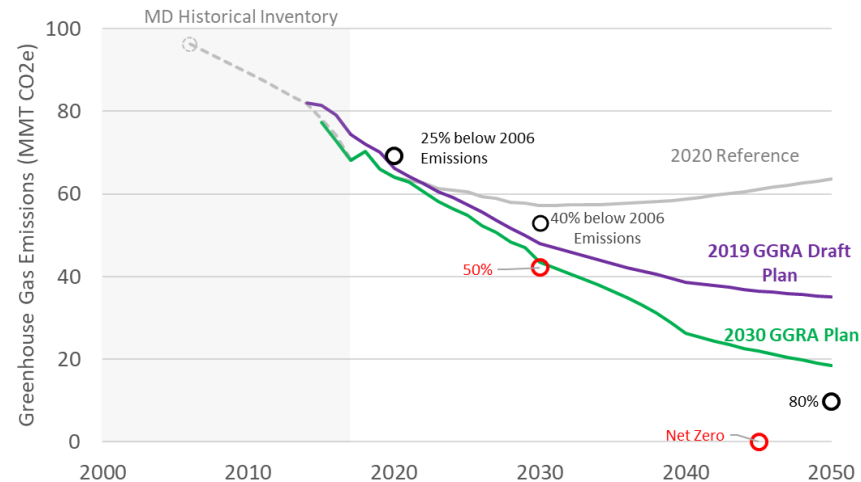
- +Background
- +Key Questions
- +E3's Analysis Plan
- +Proposed MWG's Involvement
- +Optional Scopes



Background

- + E3 has been supporting MDE's development of Maryland's statewide climate plan.
- + E3 developed a **Maryland-specific PATHWAYS model**, which considers **energy efficiency, renewables, adoption of heat pumps**, along with other measures to achieve Maryland GGRA goals.
- + E3 will leverage our experience and toolkit to support **MWG** in developing an **Energy Transition Plan** for the buildings sector.

GGRA Plan Emission Reduction Projections based on E3's PATHWAYS Analysis



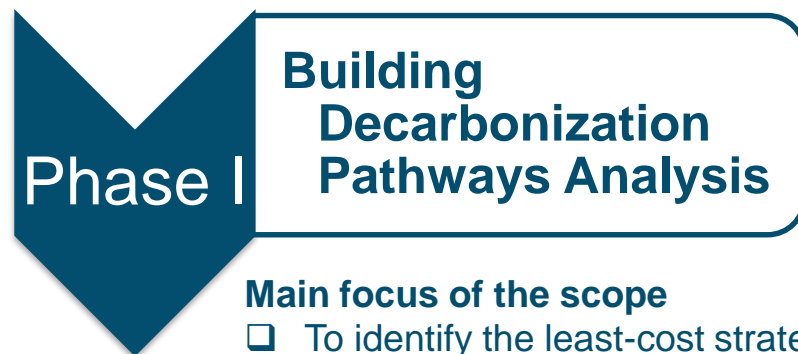


Key questions and E3's analysis plan

+ E3 identified two key questions based on MWG's requests for technical analysis to support the Energy Transition Plan

1. What are the potential pathways to achieve deep decarbonization of Maryland's buildings stock by mid-century?
2. What are the costs and benefits of each pathway, considering incremental cost to the electric system, fuel costs and heating equipment costs?

+ E3 proposes to organize the technical analysis in two phases



Main focus of the scope

- To identify the least-cost strategy to decarbonize Maryland's buildings

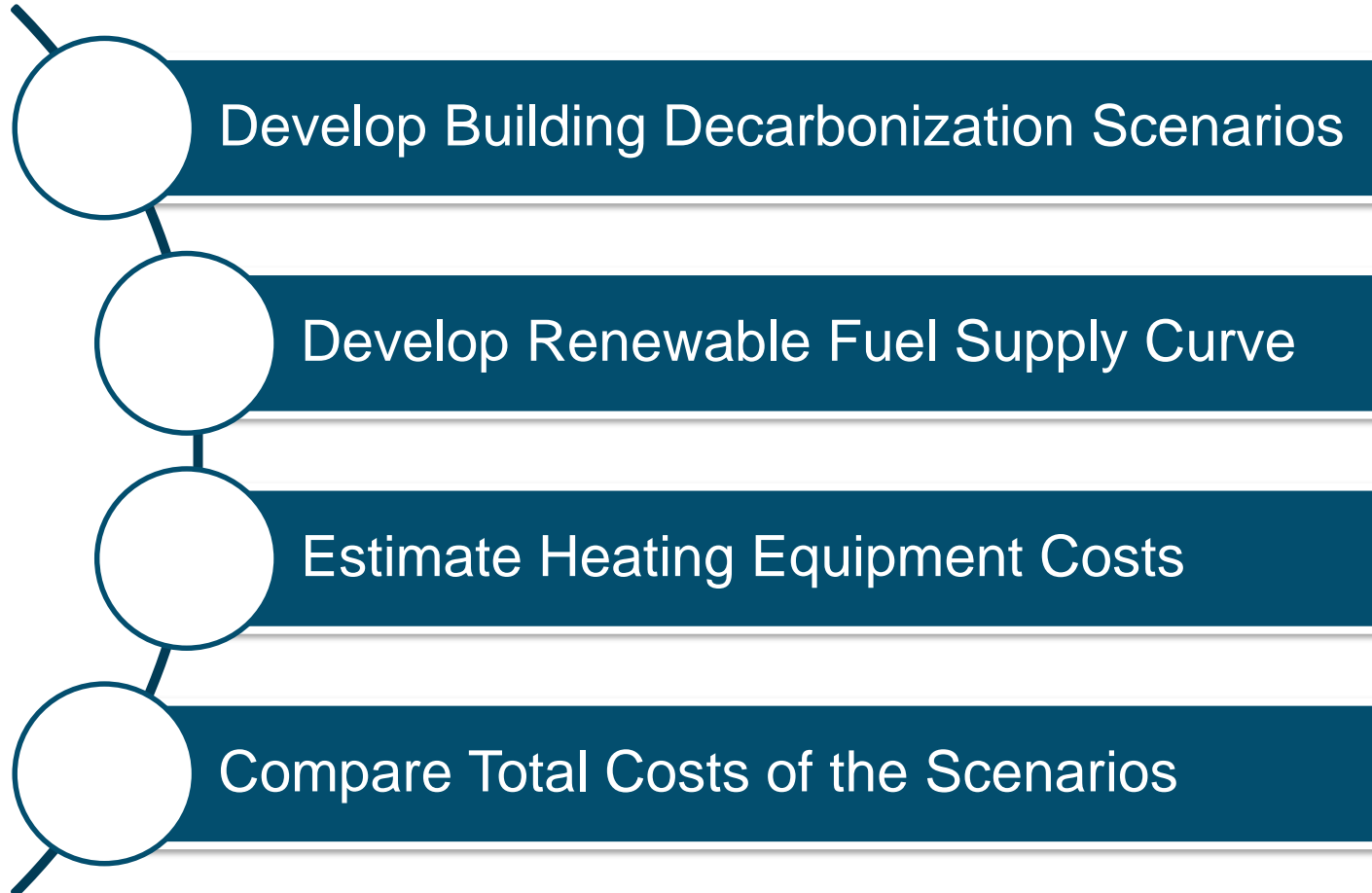


Optional if time and budget permits

- To evaluate consumer cost impacts for the various customer segments

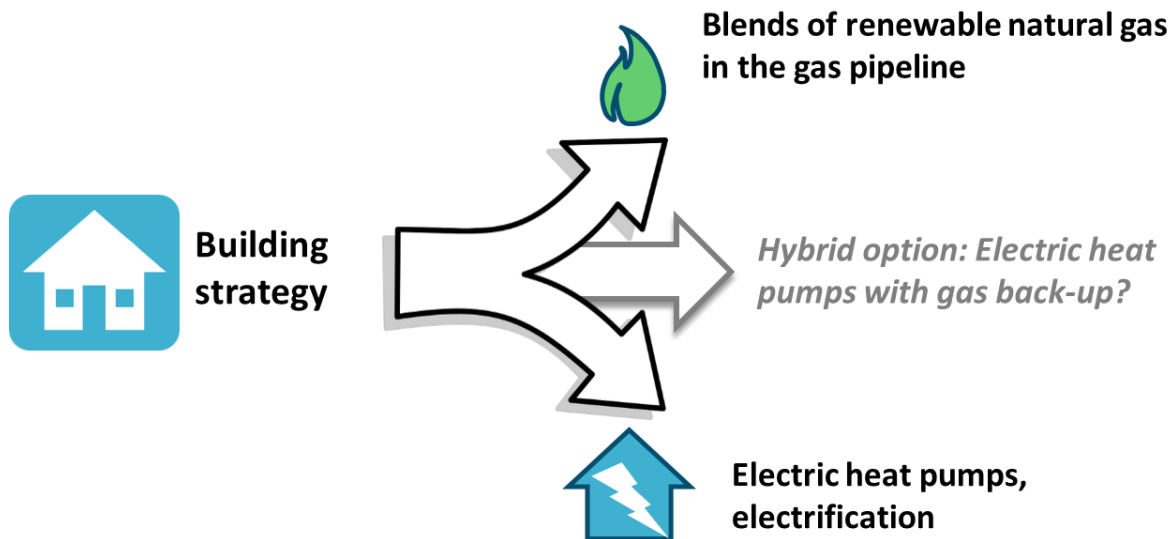


Phase I Building Decarbonization Pathways





Develop Building Decarbonization Scenarios



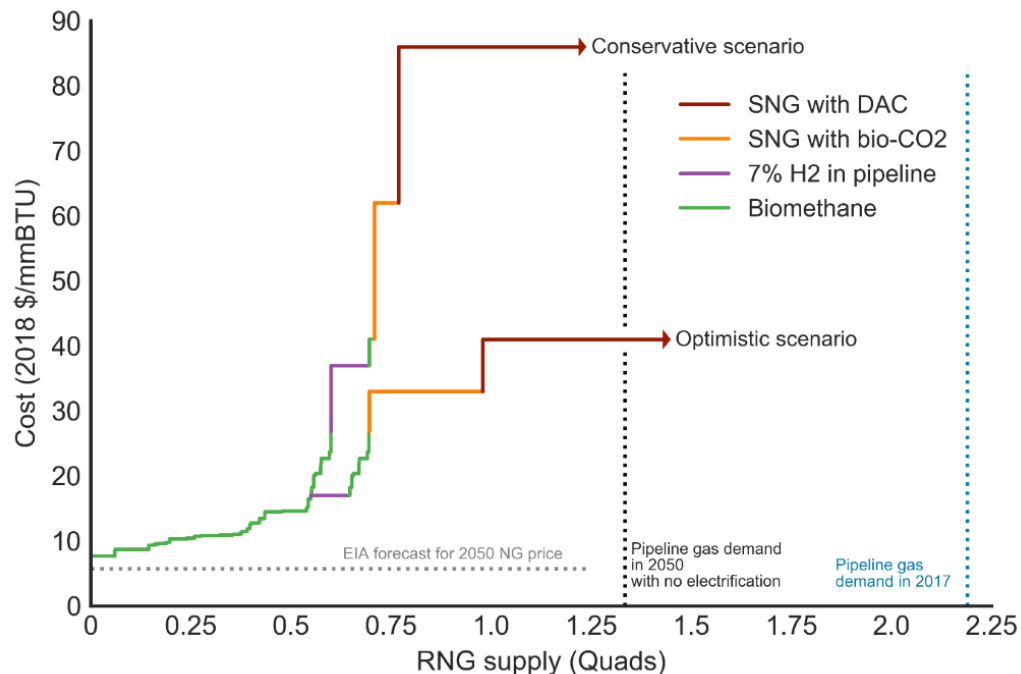
- + There are many strategies to decarbonize buildings, including energy efficiency, low-carbon fuels, and electrification
- + E3 proposes to work with a small group of MWG (technical advisory committee) to define building decarbonization scenarios informed by MWG's perspective



Develop Renewable Fuel Supply Curve

- + E3 has worked in other jurisdictions on costs and potential to produce **zero-carbon fuels**, which include **biofuels, synthetic fuels and hydrogen**.
- + E3 will develop one renewable fuel supply curve for Maryland reflecting our best knowledge, due to budget limit.

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>



Estimate Heating Equipment Costs

- + E3 will develop a high-level estimate of **heating equipment costs** for **representative applications** in Maryland.
- + The MWG can provide cost information about Maryland heat pump applications as available from its members
- + The cost estimate will include **upfront all-in capital costs** and **operating costs**

Key Sectors



Residential



Commercial

Key Types of Heating Equipment



Gas or Oil
Furnace/Boiler



Hybrid System



Heat Pump HVAC



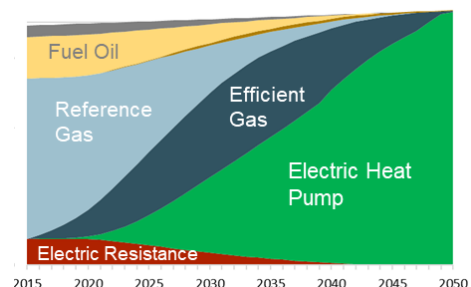
Compare Total Costs of the Scenarios

+ Total costs will include **incremental electric system costs, fuel costs and heating equipment costs.**

+ **Incremental electric system costs**

- E3 will estimate peak load impact using the RESHAPE model
- E3 will build a spreadsheet for a high-level view of **incremental energy and capacity costs** for the electric system

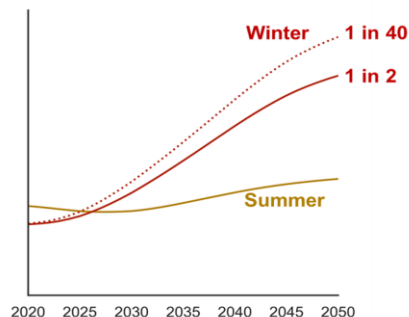
E3's PATHWAYS Model
End-use Electrification Trajectory



E3's RESHAPE
Model



Change of Summer and Winter Peak Electric Loads due to building electrification





Proposed MWG's Involvement

+ Scenario Definition

- E3 suggests meeting with a technical advisory committee of the MWG to present a straw proposal of the scenario definitions and receive feedback.

+ Interim Check-in with the Buildings Subgroup

- E3 suggests meeting with the Buildings Subgroup to report progress and present preliminary results

+ Final Presentation to the MWG



Optional Scopes

+Phase I Optional Scope:

- Workshop on Scenario Design
- Deep Dive into Renewable Fuel Supply Curves
- Gas and Electric Rate Impact Analysis

+Optional Phase II Scope:

- Maryland Building Characterization
- Detailed Heat Pump Cost Estimate
- Consumer Cost-Effectiveness Analysis



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Thank You

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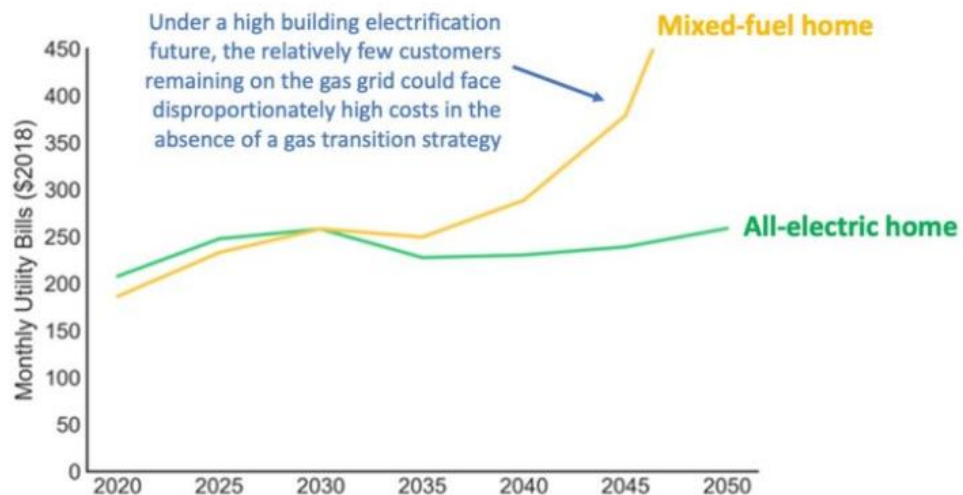
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Appendix



Gas and Electric Rate Impact Analysis

- + E3 can evaluate the customer bill impact comparing between an all-electric home vs a mixed-fuel home.
- + We can also compare the bill impacts among the building electrification strategies.





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



Detailed Heat Pump Cost Estimate

Example of installed equipment capital cost data developed for this analysis: Single family HVAC heat pump retrofit, 1990s vintage, CZ06

+E3 can work with a professional cost estimator to create a detailed dataset of heat pump costs that differentiate home types, vintages, climate zones, etc.

3 Vintages	Single family 	Low-rise multi-family 
Retrofit (Pre-1978) (No insulation, single pane windows)	1,400 sf	8 units (780 sf/unit and 960 sf/unit)
Retrofit (1990s) (T24 building code 1992 construction)	2,100 sf	6 units (1,500 sf/unit)
New Construction (2019 T24 building code)	2,700 sf	8 units (780 sf/unit and 960 sf/unit)

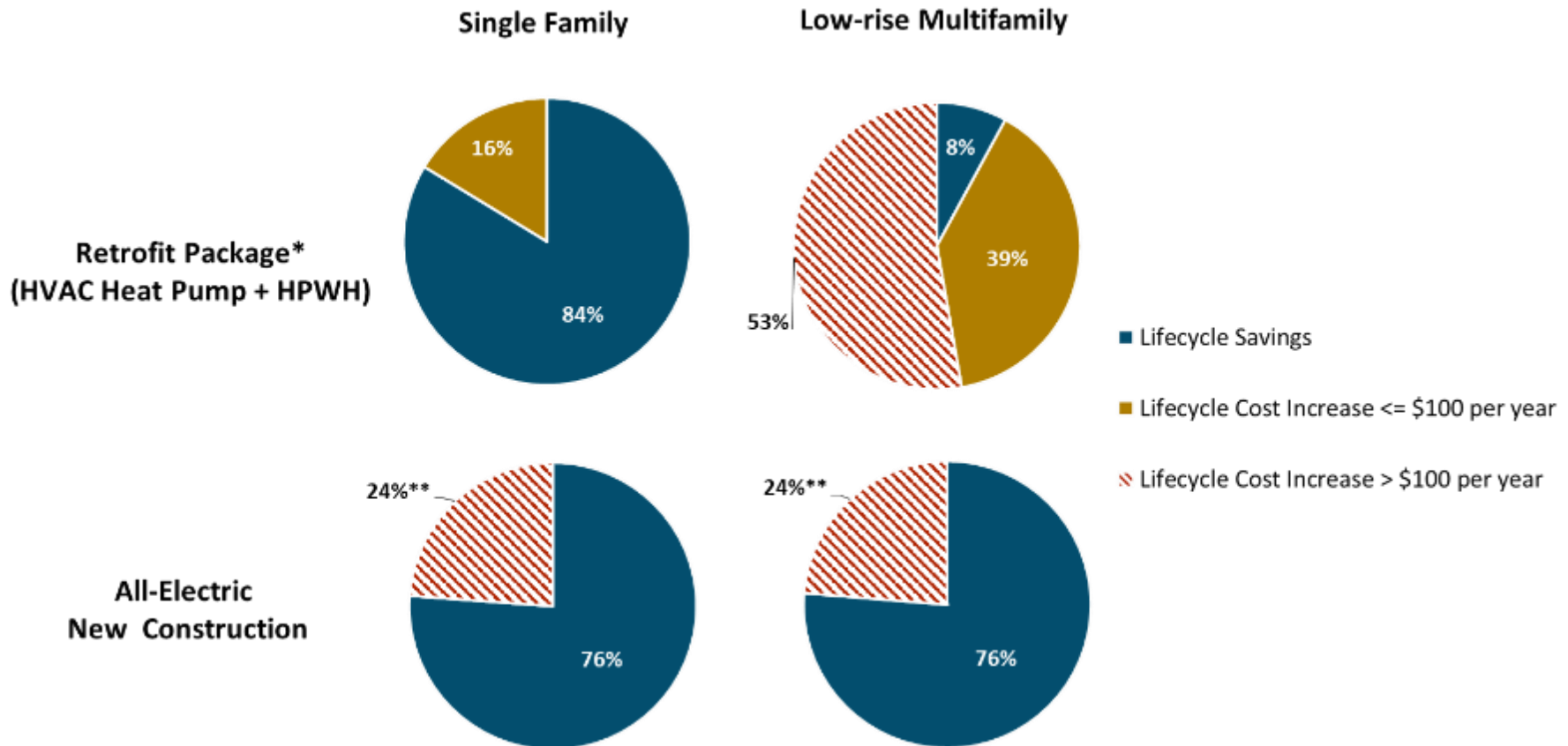
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<https://www.ethree.com/e3-quantifies-the-consumer-and-emissions-impacts-of-electrifying-california-homes/>

Demolition	
Remove existing furnace	
Labor	680
Disposal	500
	1,180
Installation	
Furnace	<i>Included in heat pump</i>
New Furnace, equipment price	
<i>Heating included in split system heat pump</i>	
Miscellaneous supplies	
Labor	
Air Conditioner	
New Air Conditioner, equipment price	\$ 5,400
<i>Ducted split heat pump AHU in attic,</i>	
<i>3-ton 18 SEER/14 EER, 10 HSPF, two-</i>	\$ -
Concrete pad, precast	\$ 100
Refrigerant piping and refrigerant	\$ 400
Miscellaneous supplies	\$ 400
Labor	\$ 1,360
Controls	
Thermostat & wiring	\$ 400
Gas and Electrical Supply	
New electrical circuits to equipment	\$ 190
Panel and main service modification	<i>Not required</i>
Gas supply piping	<i>Not required</i>
Labor	\$ 340
Ductwork modifications	\$ -
Miscellaneous supplies	\$ 250
Labor	\$ 680
	\$ 9,520
Subtotal	\$ 10,700
	\$ -
General Conditions and Overhead	\$ 1,605
Design and Engineering	\$ 1,231
Permit, testing and inspection	\$ 169
Contractor Profit/Market Factor	\$ 274
Recommended Budget	\$ 13,979



Example of consumer cost-effectiveness analysis

Lifecycle Costs of Building Electrification



* We assume that all consumers in retrofit homes have or would install air conditioning in the mixed fuel baseline.

** This category corresponds to buildings modeled in San Francisco (Climate Zone 3) that we assumed would not install air conditioning in the gas baseline home. 100% of all-electric new construction single family and low-rise multifamily homes that include air conditioning show lifecycle savings.

Full report and more information can be found here:

<https://www.ethree.com/e3-quantifies-the-consumer-and-emissions-impacts-of-electrifying-california-homes/>