

BUILDINGENERGY BOSTON

The Green Upgrade Calculator: A New Economic Modeling Tool for Home Decarbonization

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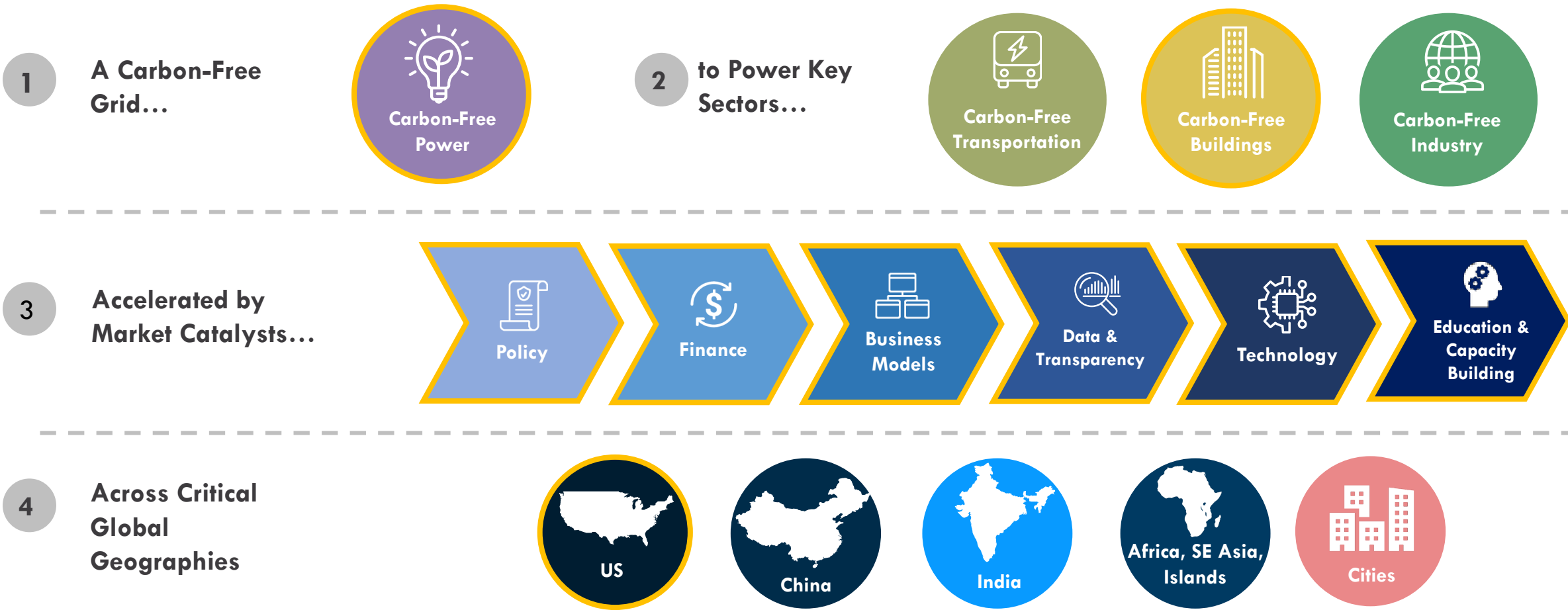
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RMI is a non-partisan, non-profit organization that works to transform the global energy system to secure a clean, prosperous, zero-carbon future for all.

Our vision includes...



Agenda

Calculator Overview

 Demo for Individual Home Analyses

 Demo for Aggregated Analyses

 Example: Contractor Experiences

 Group Discussion

1

There are various barriers to home decarbonization



Technical: Limited electrical panel capacity, longer installation timeline, limited supply, etc.



Economic: Higher upfront costs and increased energy bill in some cases



Consumer: Lack of clear understanding of the benefits of different upgrades (economic, climate, health, etc)

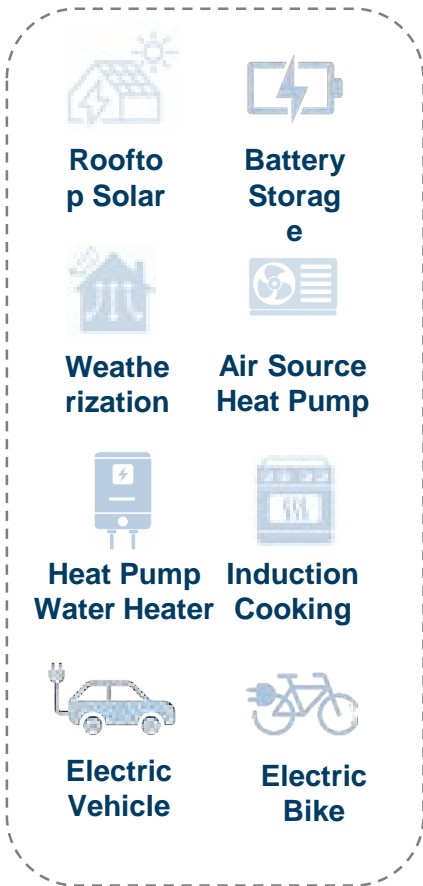


Workforce: Limited home contractors properly trained in and advocating for electrification to residents



RMI's Green Upgrade Calculator, coming April 2023, aims to address some, but not all, of these barriers

A sneak peak of the Green Upgrade Calculator: A free online tool for energy professionals to assess the economic and climate impacts of residential upgrades



The Green Upgrade Calculator has various use cases for energy professionals looking to analyze the impacts of residential upgrades, including:

1

Individual Home Analyses

Home contractors can...

- A. Modify system design and specs (e.g., hybrid vs whole-home ASHPs)
- B. Assess energy bill impacts (e.g., leverage specific utility tariffs)

Home technical advisors can...

- A. Compare contractor quotes (e.g., lifetime cost savings between two quotes)
- B. Quantify climate benefits (e.g., lifetime GHG benefit between HPWH and solar)

2

Aggregated Regional Analyses

Energy analysts can...

- A. Analyze national impacts (e.g., Home Energy Rebate programs)
- B. Analyze state policy impacts (e.g., Zero-emission equipment standard)
- C. Analyze local policy impacts (e.g., AC-to-heat pump requirement)
- D. Analyze utility regulation impacts (e.g., Clean Heat standard)

Agenda



Calculator Overview



Demo for Individual Home Analyses



Demo for Aggregated Analyses



Example: Contractor Experiences



Group Discussion

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Agenda



Calculator Overview



Demo for Individual Home Analyses



Demo for Aggregated Analyses



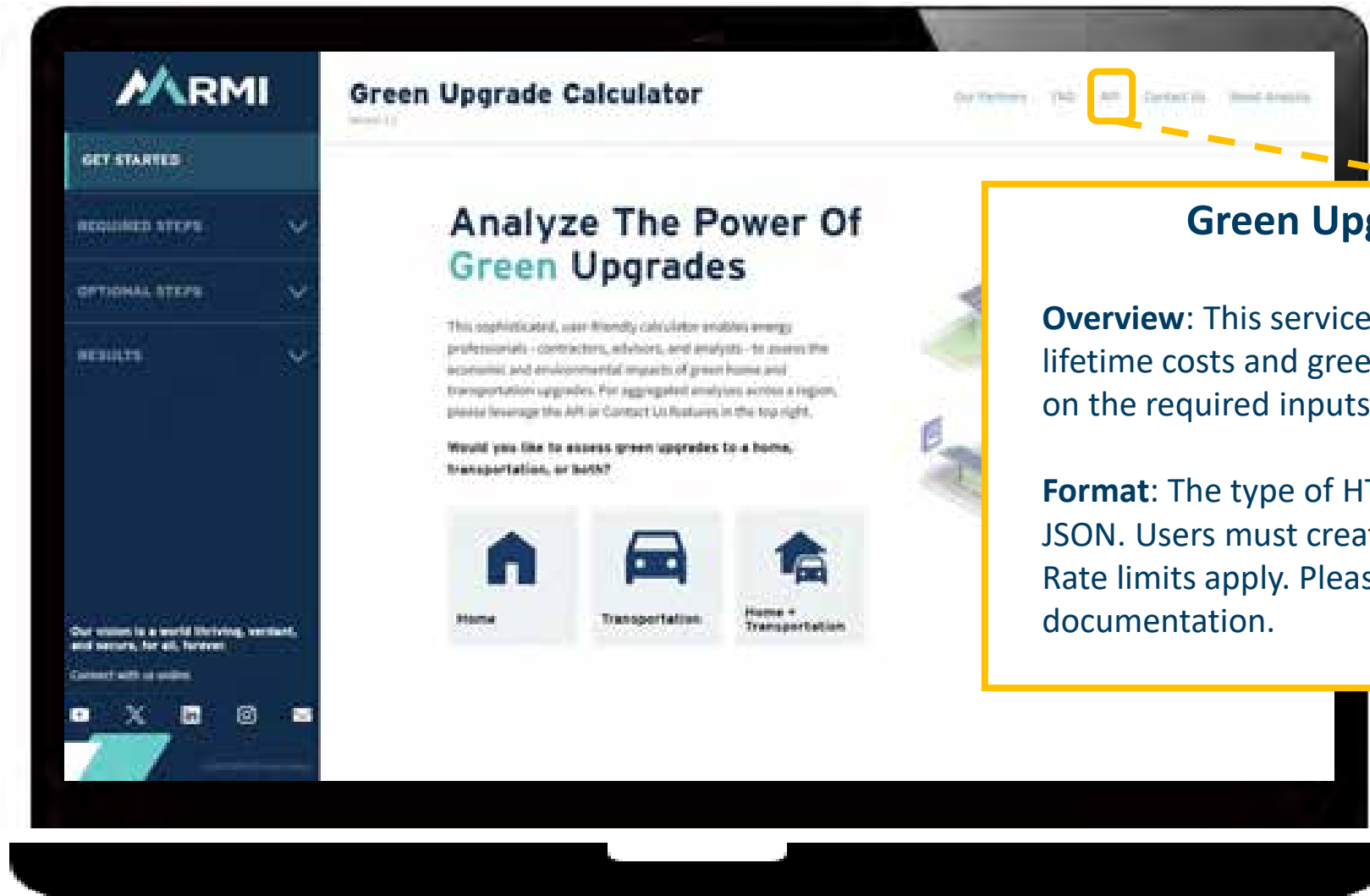
Example: Contractor Experiences



Group Discussion

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The calculator's API can be leveraged against regional building inventories to perform aggregated analyses



Green Upgrade Calculator API

Overview: This service returns the upfront, operating, and lifetime costs and greenhouse gas emissions results based on the required inputs, and any additional optional inputs.

Format: The type of HTTP requests are POST and inputs are JSON. Users must create an account to access this service. Rate limits apply. Please reference [this file](#) for full documentation.

Example #1: Using the API and building inventories to analyze residential annual and lifetime costs from a proposed policy

1. Identify the green upgrades and results to analyze based on the policy (e.g., HPWH bill savings)
2. Identify the building inventory within the identified region to analyze (e.g., EIA RECS 2020)
3. Run the API to get results for each building type
4. Calculate the aggregated values based on the weights for each building prototype

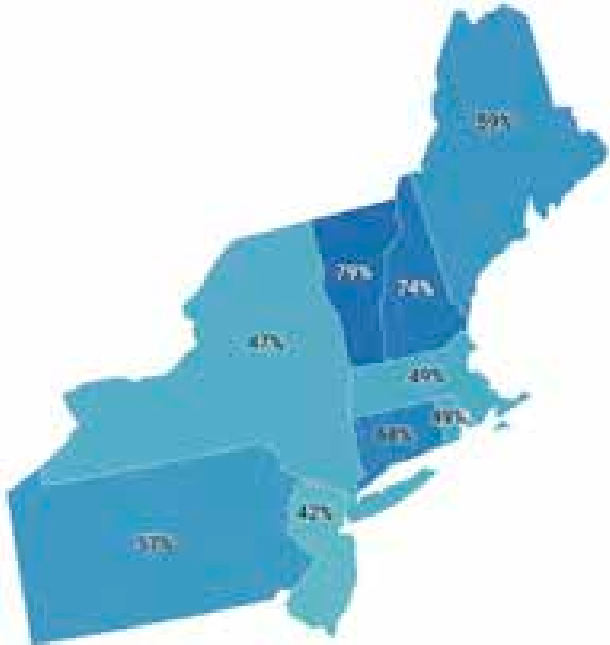
Simplified example below for a HPWH analysis for single-family detached homes in MA

Building prototype #	1	2	3	4	5	6	7	8	9	10	11	12
Home construction year	Pre-1980						Post-1980					
Current fuel	Electricity		Fuel oil	Propane	Natural gas		Electricity		Fuel oil	Propane	Natural gas	
Current water heater	Tank	Tankless	Tank	Tank	Tank	Tankless	Tank	Tankless	Tank	Tank	Tank	Tankless
Percentage of Homes	15%	2%	11%	0.3%	28%	6%	6%	1%	6%	2%	10%	3%
HPWH Annual Savings	\$910	\$860	\$330	\$400	\$70	-\$10	\$1200	\$1130	\$435	\$525	\$90	-\$20

Example #2: Using the API and building inventories to analyze the homes with lower utility bills across a region under different scenarios

ASHP+HPWH

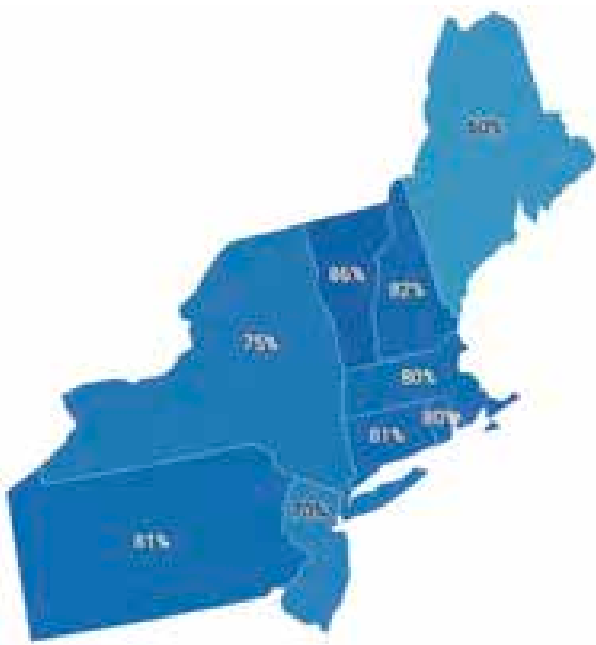
Northeast Avg: 52%



Source: RMI Green Upgrade Calculator

Hybrid ASHP+HPWH

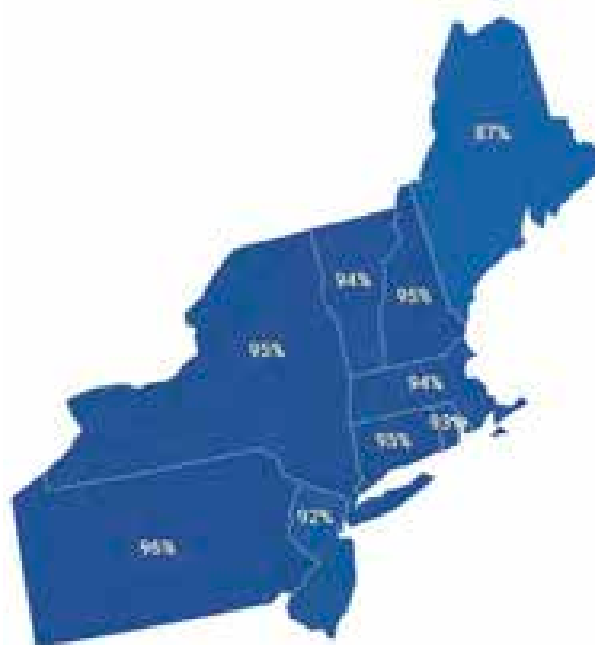
Northeast Avg: 77%



Source: RMI Green Upgrade Calculator

Hybrid ASHP+HPWH+Weatherization

Northeast Avg: 94%



Source: RMI Green Upgrade Calculator

Note: Hybrid ASHP only applies to gas-powered homes.

Note: Weatherization (adding insulation and sealing air leaks) only applies to homes built before 1980.

Agenda



Calculator Overview



Demo for Individual Home Analyses



Demo for Aggregated Analyses



Example: Contractor Experiences



Group Discussion

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Abode Background

Utility Efficiency Programs

Mass Save® Home Performance Contractor Lead Vendor - National Grid & Eversource

- Trade ally management
- 50K home energy assessments
- 18K weatherization installations
- 10K quality assurance (QA) inspections

Municipal Light Plant Weatherization Quality Assurance

- Trade ally management
- Virtual and in-home QA inspections



Electrification & Decarbonization

Overall Customer Support

- 775 Quotes Compared for Air Source Heat Pumps
- Nearly 10,000 heat pump consultations

MassCEC & City of Boston Decarbonization Programs

- Technical lead consultant
- Implementation for single-family and triple-decker pilot

Energize ConnecticutSM and Mass Save® Heating Cooling Support, and Clean Heat Rhode Island lead vendor

- Statewide customer consultation services
- Heat Pump Installer Network (HPIN) management

Municipal Light Plant Community Heat Pump Support

- 18 communities



Barriers contractors face in home electrification

- **Still a specialized marketplace**
 - "PEMDAS" of electrification
 - Project costs and timeline
 - Decarbonization 'GC'
- **Transparency of heat pump performance**
 - Analysis/Comparison tools bridging the gap
 - Not on the contractor's radar? Interaction between gre upgrades
- **Comfort-level with savings analysis & design**
 - Performance of legacy equipment vs heat pumps
 - Limitations of the available equipment



Helping homeowners make informed decisions

Page 1: Summary

Equipment Summary

Qualified Product Lists

- Highlights equipment that meets rebate requirements

Operating cost

- Estimated annual heating and cooling cost

Change in Operating Cost

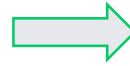
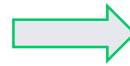
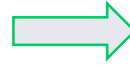
- Change relative to estimated existing operating cost

System Fit Score

- Explained on the next slide

Environmental benefit/CO2 reduction

- % change in CO2



HEAT PUMP QUOTE REVIEW



412 Evans Rd., Providence, RI

Percent of home to be conditioned by heat pumps: **100%**

Primary Motivation: **Reduce Environmental Impact**

Current Setup

Electric Rate: **\$0.24 per kWh**

Electric Utility: **Nikola Electric**

Heating Fuel and Distribution: **Oil / Hot Water**

Sustainable Comfort HVAC

Warm Better LLC

Clean Power HVAC

Equipment	Sustainable Comfort HVAC	Warm Better LLC	Clean Power HVAC
	8 x Indoor Units 3 x Outdoor units	8 x Indoor Units 3 x Outdoor units	8 x Indoor Units 3 x Outdoor units
	Ductless	Ductless + Ducted	Ducted

Each system contains a variety of indoor and outdoor units. The type of ducting will depend on the layout of your current house.

Rebates	CleanHeatRI	CleanHeatRI	Check with Contractor
Eligible	Yes	Yes	No
Net cost after rebate	\$22,509	\$42,245	\$36,941

The check if each system is eligible for rebates, and the estimated net cost of the system after rebates. Be sure to check with your contractor to verify rebate eligibility.

Annual Heating & Cooling Cost	Sustainable Comfort HVAC	Warm Better LLC	Clean Power HVAC
	\$2,600	\$2,190	\$2,300

This is an estimate of the heating and cooling costs for one year of operation.

Change in Annual Heating & Cooling Cost

Sustainable Comfort HVAC	Warm Better LLC	Clean Power HVAC
-7%	-14%	-10%

This is an estimate of how much your annual heating and cooling costs for each new system will change compared to your current heating/cooling system.

System Fit Score (out of 10)	Sustainable Comfort HVAC	Warm Better LLC	Clean Power HVAC
	6.0	7.5	6.5

The System Fit score provides an high-level estimate of how well each system meets your heating and cooling needs.

Environmental Benefit / CO2 Reduction

Sustainable Comfort HVAC	Warm Better LLC	Clean Power HVAC
20%	40%	32%

This is an estimate of the environmental benefit that will occur by changing from your existing system to the new system.

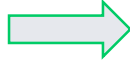
System Fit Score

- Evaluated based on analysis of six key measures of performance
- SCOP, Capacity maintenance, Aux electric resistance, Sizing for heating, Cycling temperature, Cooling turndown ratio



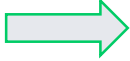
Equipment Visual

- Visual summary of the quoted equipment



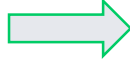
System Sizing

- Sizing relative to the estimated heating load



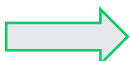
Cost to Purchase and Annual Heating and Cooling Cost

- Compared to current heating and cooling costs



Other Considerations

- Dynamic list of considerations based on performance data and analysis results



Sustainable Comfort HVAC

System Fit Score

The system fit score evaluates how the system will perform:

- Over an entire heating season
- While heating at more mild temperatures and at the coldest temperatures we regularly experience during the heating season
- While cooling at average temperatures

Which taken can together can impact operating cost, CO2, and indirectly comfort

6.0
out of 10

Equipment

Combination of Ductless and Ducted

2x Indoor Heat, 1x Indoor Heat, 3x Indoor Cooling, 3x Outdoor

System Sizing

The green area represents the sizing range for your home's heating needs based on the usage data you provided

20% 40% 60% 75% 100%

Cost to Purchase

\$34,720
Cost to Purchase

- **\$12,211**
Estimated Rebates

= **\$22,509**
Cost after Rebates

Annual Heating & Cooling Cost

Current System: \$1,100
This Heat Pump: \$2,000

Annual CO2 Production

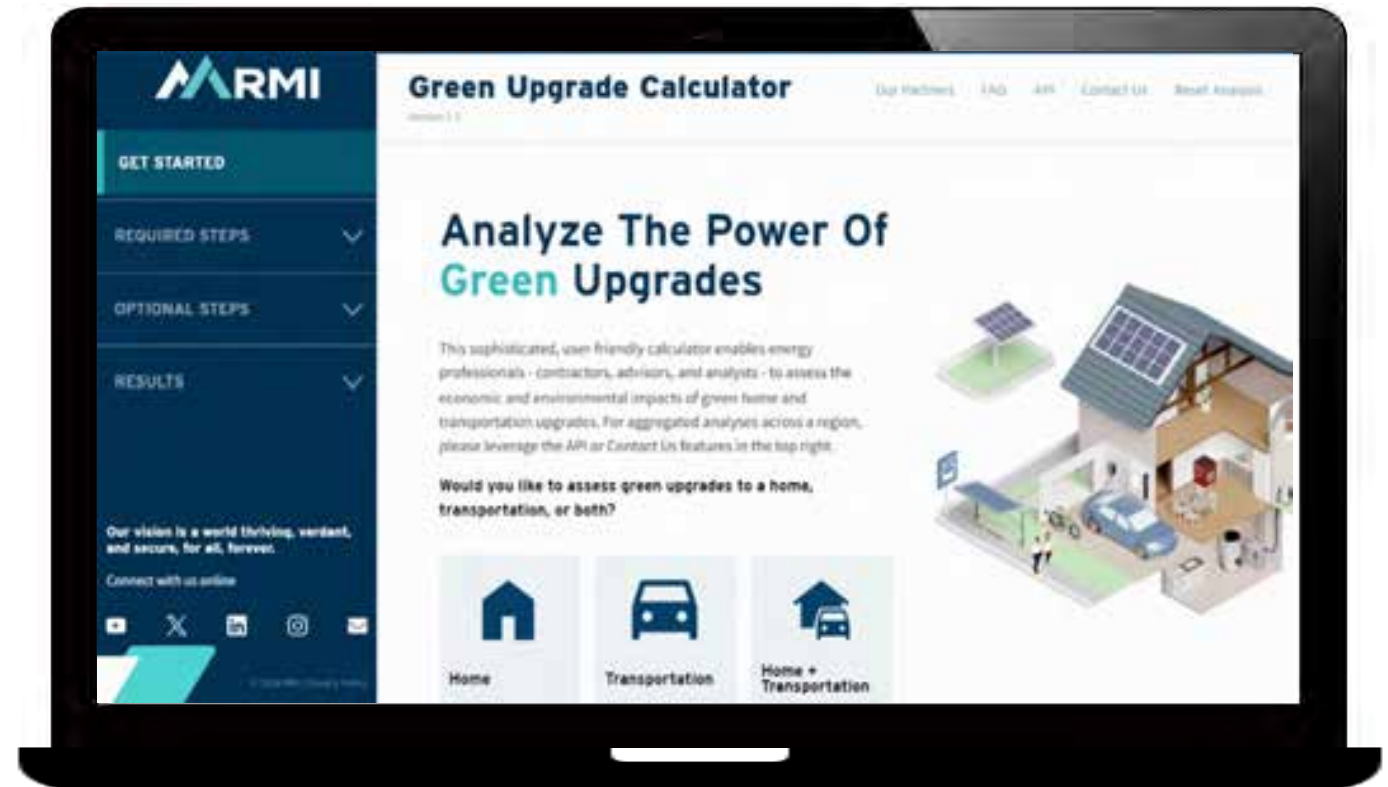
Current System: 4,000 lbs
This Heat Pump: 2,700 lbs

Other Considerations

- Includes multiple outdoor units, which can provide improved control and resilience.
- Estimated seasonal heating performance is average compared to commonly installed heat pumps in the northeast.
- Estimated to reduce CO2 emissions by 30% compared to your current heating system.
- Customers who have auxiliary electric heat may experience spikes in energy costs at low temperatures when auxiliary heat is used. We encourage you to ask your contractor to design the system so that auxiliary heat is used as little as possible or only in emergencies.
- This equipment appears to be oversized more than normal. If you choose this option, we recommend discussing the option of downsizing equipment with your contractor.

RMI's Green Upgrade Calculator addresses key contractor barriers

- Provide clarity in a specialized marketplace
 - Differentiate conventional fossil fuel & AC systems from decarbonization pathways
- Build confidence for in-industry professionals and their clients
- Numerous real-world opportunities



Real world opportunities

- **Green Upgrade Calculator**

- Building performance contractors, GCs, HVAC contractors, distributors
 - Sales tool
 - Model/evaluate commonly sold products
 - Internal training tool

- **How this breaks down barriers**

- Reduce the complexity of entry for contractors into decarbonization
- Flattens the learning curve
- Help mitigate poor outcomes and confusion for all stakeholders



Agenda



Calculator Overview



Demo for Individual Home Analyses



Demo for Aggregated Analyses



Example: Contractor Experiences



Group Discussion

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Group Discussion

- 1. Take 5 minutes at your table to discuss the following question**
 - A. Where do you see this being most useful in your work?
 - B. What are your top suggestions to make it more useful?
 - C. How can this calculator standardize data analysis in the industry?
- 2. Tables will then report out their answer to the group**