



**Verified Carbon
Standard**

IMPROVING ENERGY EFFICIENCY IN HOMES THROUGH SMART THERMOSTAT OPTIMIZATION

ecobee

Project title	Improving Energy Efficiency in Homes Through Smart Thermostat Optimization
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Prepared by	Jeanny Do, ecobee Technologies, ULC – 207 Queens Quay West, 6 th Floor, Toronto, Ontario M5J 1A7

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1 PROJECT DETAILS

1.1 Summary Description of the Project

This project activity will use smart thermostats installed in homes to reduce heating and cooling usage. ecobee manufactures smart thermostats and recently developed a thermostat optimization platform titled eco+ to control these devices remotely in a manner that enhances the levels of energy savings beyond what would have occurred in the absence of this enhanced functionality. Eco+ is offered for free to both existing and new consumers and will continue to be offered for free throughout the entirety of the crediting period and any subsequent crediting period renewals¹. The energy efficiency enhancement provided by the implementation of eco+ is the project activity.

Prior to the project activity, energy usage was higher - leading to more electricity and gas consumption and greater emission as a result. This project reduces greenhouse gas emissions by reducing the electricity and gas consumed in homes as compared to the baseline, the use of an ecobee device without the enhanced thermostat optimization capability, while still offering the same level of comfort to the consumer. The energy efficiency optimizations resulting from this platform generate no additional revenue for ecobee but do represent a significant cost for the company. This approach reduces both electricity and natural gas usage in air conditioning and heating units in residential homes.

ecobee's thermostat optimization software, eco+, reduces GHG emissions by regulating the home's preferred indoor temperature by controlling the HVAC equipment. This energy efficiency enhancement uses individual customer comfort preferences, real time and historical occupancy patterns and data regarding a home's specific thermodynamic properties and HVAC system performance to create personalized, and real time optimization. The optimizations utilize occupancy sensing, which identifies when a home is vacant; machine learning, to predict temperature and customer schedules; geolocation, which determines a customer's proximity to home; and the ability to continuously adjust for indoor humidity conditions.

The project activity and primary driver of energy savings through eco+ is the patented² feature "Adjust for Humidity".

The development of this feature was informed by the principles of thermal comfort and the humidity index (i.e., humidex). Thermal comfort refers to the subjective feeling of temperature in the surrounding environment. The humidity index is a measurement that expresses how the combined effects of warm temperatures and humidity are perceived by a person. By applying these two principles, the ecobee smart thermostat and the "Adjust for Humidity" feature measures and takes into consideration the home's temperature and humidity when determining the temperature at which a customer feels comfortable.

¹ Please refer to Appendix F for ecobee's Executive Vice President's attestation that eco+ will continue to be offered for free throughout the entirety of the crediting period and any subsequent crediting period renewals.

² Trinh, K. (2021). Thermostat device with improved energy optimization. (U.S. Patent No. US20210302052A1) <https://patents.google.com/patent/US20210302052A1/en?q=US20210302052A1>

In essence, the feature takes advantage of a home's indoor humidex (a blend of temperature and moisture in the air) and automatically controls the HVAC equipment to manage the desired setpoint temperature to lower energy consumption while keeping residents feeling comfortable. It monitors these conditions around-the-clock and all year-long to deploy micro-HVAC adjustments to lower energy consumption while ensuring the home feels comfortable for its residents.

The project boundary includes the contiguous United States, and the project will be grouped by equipment type as detailed in Section 1.5.1. The total emission reductions generated during the first monitoring period of March 03, 2021 to March 02, 2023 is 390,652 tCO₂. The estimated total emission reductions are approximately 2,815,855 tCO₂ over the first crediting period (2021-2028), with estimated annual average emission reductions being 402,265 tCO₂ per year.

1.2 Audit History

Audit type	Period	Program	Validation/verification body name	Number of years
Validation	03-March-2021 to 02-March -2028	VCS	TUV SUD America Inc.	7 years
Verification	03-March-2021 to 02-March -2023	VCS	TUV SUD America Inc.	2 years

1.3 Sectoral Scope and Project Type

Complete the table below with information relevant for non-AFOLU projects:

Sectoral scope ³	Scope 3, Energy Demand
Project activity type	Grouped Project

Complete the table below with information relevant for AFOLU projects:

Sectoral scope	This is a non-AFOLU project. Not applicable.
AFOLU project category ⁴	Not applicable.
Project activity type	Not applicable.

1.4 Project Eligibility

1.4.1 General eligibility

The project meets all the criteria set out in the VCS Program Guide, the VCS Standard v4.5 and the approved VCS Methodology VM0008: Weatherization of Single Family and

³ Projects, activities, or methodologies may be developed under any of the 16 VCS sectoral scopes: <https://verra.org/programs/verified-carbon-standard/vcs-program-details/#sectoral-scopes>

⁴ See Appendix 1 of the VCS Standard

Multi-Family Buildings, version 1.1, October 2012, herein referred to as “VM0008”. Of the applicable interventions, this project activity falls under Category B. The project will reduce emissions by improving the energy efficiency of homes using ecobee’s thermostats and the eco+ optimization software platform. The project activity meets all of the applicability criteria of the methodology being used with the applicable intervention falling into Category B – Efficiency enhancement of the Building Envelope and central heating and/or cooling systems. Section 2.1 of the VCS Standard v4.5 details the scope of the VCS program, including the following:

- 1) The seven Kyoto Protocol greenhouse gases (this project will reduce CO₂ as explained in Section 4 of this document)
- 2) Ozone-depleting substances (not applicable)
- 3) Project activities supported by a methodology approved under the VCS Program through the methodology and review process (this project is supported by the approved VCS methodology, VM0008)
- 4) Project activities supported by a methodology approved under an approved GHG program (not applicable)
- 5) Jurisdictional REDD+ programs and nested REDD+ projects as set out in the VCS Program document Jurisdictional and Nested REDD+ (not applicable)

Section 2.1.3 Table 1: Excluded Project Activities of the VCS Standard also outlines a number of excluded project types, such as those involving the reduction in hydrofluorocarbon-23 (HFC-23) emissions. None of these excluded activities apply to this project activity.

AFOLU project eligibility

This is a non AFOLU project. This section is not applicable.

1.4.2 Transfer project eligibility

This is not a transfer project from another approved GHG program and will remain a project with the VCS program. This section is not applicable.

1.5 Project Design

Indicate if the project has been designed as:

- ☐ Single location or installation
- ☐ Multiple locations or project activity instances (but not a grouped project)
- ☒ Grouped project

1.5.1 Grouped project design

Because this is a grouped project, the project proponent will specify the eligibility criteria for including individual homes into the project boundary. These criteria include homes (or “dwellings”) that have smart thermostats manufactured by ecobee, which have been upgraded with a thermostat optimization platform and are occupied as per the definition of “occupied” in the methodology. Environmental attributes generated by these subprojects are therefore owned by the sole project proponent as stipulated below in Section 1.8 Subprojects that do not follow this eligibility criteria will be excluded from the grouped project. New project instances must also comply with all of the applicability criteria outlined in VM0008, which are addressed in Section 3.2. of this document. Specific eligibility criteria include:

Eligibility Criteria (VCS Standard 3.6.16)	Confirmation
<i>1)Meet the applicability conditions set out in the methodology applied to the project.</i>	It will be demonstrated to the VVB that all new project activity instances meet the requirements as laid out in VM0008 Section 4 (Applicability Conditions).
<i>2)Use the technologies or measures specified in the project description.</i>	All new project activity instances will be required to use the ecobee smart thermostat eco+ energy efficiency enhancement technology.
<i>3)Apply the technologies or measures in the same manner as specified in the project description.</i>	All new project activity instances will use the ecobee smart thermostats in exactly the same manner – to reduce energy use for both heating and cooling, without reducing the overall level of service.
<i>4) Are subject to the baseline scenario determined in the project description for the specified project activity, geographic area and Same Building Stock.</i>	This will be the case for all new project activity instances within the project boundary of the contiguous USA.
<i>5) Have characteristics with respect to additionality that are consistent with the initial instances for the specified project activity and geographic area</i>	The same additionality factors, as specified in Section 3.5, will apply to all new project activity instances.

Grouped projects provide for the inclusion of new project activity instances subsequent to the initial validation of the project, therefore all new project activity instances will:

Eligibility Criteria (VCS Standard 3.6.17)	Confirmation
<i>1)Occur within one of the designated geographic areas specified in the project description</i>	All new project activity instances will be within the designated geographic area of the contiguous USA, as specified in the project description.

2)Conform with at least one complete set of eligibility criteria for the inclusion of new project activity instances.	All new project activity instances will comply with the eligibility criteria for inclusion outlined in table above: 1) Meet the applicability condition set out in VM0008 Section 4 (Applicability Conditions) 2) New project activity instances will use the ecobee smart thermostat eco+ Adjust for Humidity energy efficiency enhancement technology 3) New project activity instances will use the ecobee smart thermostat in exactly the same manner – to reduce energy use for both heating and cooling without reducing the overall level of service 4) Subject to the same baseline scenario as determined in the project description, within the project boundary of the contiguous USA and of Same Building Stock 5) Subject to the same additionality factors, as Specified in Section 3.5 and will apply to all new project activity instances.
3)Be included in the monitoring report with sufficient technical, financial, geographic and other relevant information to demonstrate compliance with the applicable set of eligibility criteria and enable sampling by the validation/verification body.	All new project activity instances will be: 1) Reported in the monitoring reports 2) Compliant with all applicability conditions set out in VM0008 and found in PD Section 3.2 3) Have sufficient technical information to perform emission impact quantification, analysis and enable sampling by VVB 4) Be within the project geographic boundary of the contiguous USA
4)Have evidence of project ownership, in respect of each project activity instance held by	All new project activity instances included from the respective start date of March 03, 2021 and later

<i>project proponent from respective start date of each project activity instance.</i>	will remain under ecobee's ownership as ecobee is the sole project proponent and sole owner of all carbon offsets generated from the project activity. As noted in PD Section 1.8, ecobee has the right to claim ownership over environmental attributes from eco+ through the following clause in its <i>Terms of Service for ecobee Remote Applications, Including eco+ Section 6 (g)</i> "ecobee shall be eligible to claim any qualifying environmental attributes, benefits, credits, awards or bounties from Program Administrators resulting from savings gained by the benefit of eco+"
<i>5)Have a start date that is the same as or later than the grouped project start date</i>	All new project activity instances will have a start date that is later than the initial grouped project start date of March 03, 2021.
<i>6)Only be eligible for crediting from the later of start date of project activity instance or the start of the verification period in which they were added to the group project, through to the end of the total project crediting period</i>	All new project activity instances will be eligible for crediting from the later of start date of project activity instance or the start of the verification period through to the end of the project crediting period. The validation and crediting period is March 03, 2021 to March 02, 2028.
<i>7)Not be or have been enrolled in another VCS project</i>	All new project activity instances will be confirmed to not be or have been enrolled in another VCS project.
<i>8)Adhere to the clustering and capacity limited requirements for multiple project activity instances set out in VCS Standard 3.6.8 – 3.6.9</i>	Per 3.6.8, all new project activity instances that are within 10km from each other will be included in a singular project as all new project instances are of the same project activity and owned by the same project proponent. Per 3.6.9, methodology VM0008 does not impose a capacity limits on project activity. This is not applicable to this grouped project and new project activity instances.

1.6 Project Proponent

Organization name	ecobee Technologies, ULC ("ecobee")
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Contact person	Tamara Dzubay
Title	Sr. Director, Energy Sales
Address	207 Queens Quay West, 6 th Floor, Toronto, Ontario M5J 1A7
Telephone	(630) 269-1779
Email	tamara.d@ecobee.com

Organization name	ecobee Technologies, ULC (“ecobee”)
Contact person	Jeanny Do
Title	Energy and Emerging Markets Specialist
Address	207 Queens Quay West, 6 th Floor, Toronto, Ontario M5J 1A7
Telephone	(416) 827-0229
Email	jeanny.d@ecobee.com

1.7 Other Entities Involved in the Project

Organization name	Demand Side Analytics, LLC (“DSA”)
Role in the project	Evaluation, measurement and verification experts enlisted to perform quantification analysis of GHG emission reductions of project activity
Contact person	Jesse Smith
Title	Partner
Address	691 John Wesley Dobbs Ave NE Suite V3, Atlanta, GA, 30312 USA
Telephone	(770) 401-9018
Email	jsmith@demandsideanalytics.com

1.8 Ownership

ecobee will be the sole project proponent and will be the sole owner of all carbon offsets generated from this project activity.

ecobee has the right to claim ownership over the environmental attributes from eco+ through the following clauses in its *Terms of Service for ecobee Remote Applications*⁵, Including eco+ Section 6 (g). *“So long as it does not conflict with any incentives provided to you under S.6(f)., ecobee shall be eligible to claim any qualifying environmental attributes, benefits, credits, awards or bounties from Program Administrators resulting from savings gained by the benefit of eco+.”*

Additionally, ecobee includes the following clause in its Standard Software Agreement, Schedule B, s. 1.4, *“Both parties agree that ecobee shall be eligible to claim any qualifying environmental attributes, benefits, credits, awards or bounties from third parties resulting from customer incremental savings gained by the benefit of eco+ or other software upgrades that are outside the scope of the services stipulated in this Schedule B.”*

1.9 Project Start Date

Project start date	03-March-2021
Justification	The start date of the project activity is 03-March-2021 which is when ecobee completed version 1 of the phased roll out of eco+ as an energy efficiency enhancement upgrade. Below is evidence of the rollout schedule and e-mail campaigns that were deployed to customers: 1.ecobee’s Product Team internal release plan and timeline of eco+ roll out. See line 4 where eco+ (“8.3”) was released to all customers at 100%.

⁵ For more details, please see <https://www.ecobee.com/en-ca/privacy-policy/#Privacy-Policy-and-Legal>.

OOTB Release plan



Owned by Valentin Randon (Deactivated) ...
Last updated: Mar 02, 2021 • 1 min read • 30 people viewed

Definitions

- V1: includes mobile setup changes. Does not include FW changes
- V2: includes FW changes (manufacturing build)

Timeline

	Date	Milestone
1	Feb 17th	all <u>OOTB</u> work part of Codefreeze for 8.3 Mobile release
2	Feb 24th	Beginning of progressive roll out of 8.3.
3	~~Feb 24th~~ March 4th	Beginning of A/B test. Update: Android only
4	March 3rd	8.3 released at 100%.
5	March 8th	start of FW rollout for V2
6	March 12th	Beginning of progressive roll out of 8.4 iOS users will now be part of the A/B test.
7	~~March 17th~~ March 26th	Provided A/B test is conclusive: Feature rolled out to 100% users
8	April 19th	V2 rolled out to 100% users

2. ecobee's Marketing Communication team's e-mail campaign tracker of eco+ introduction e-mail completing in March 2021.

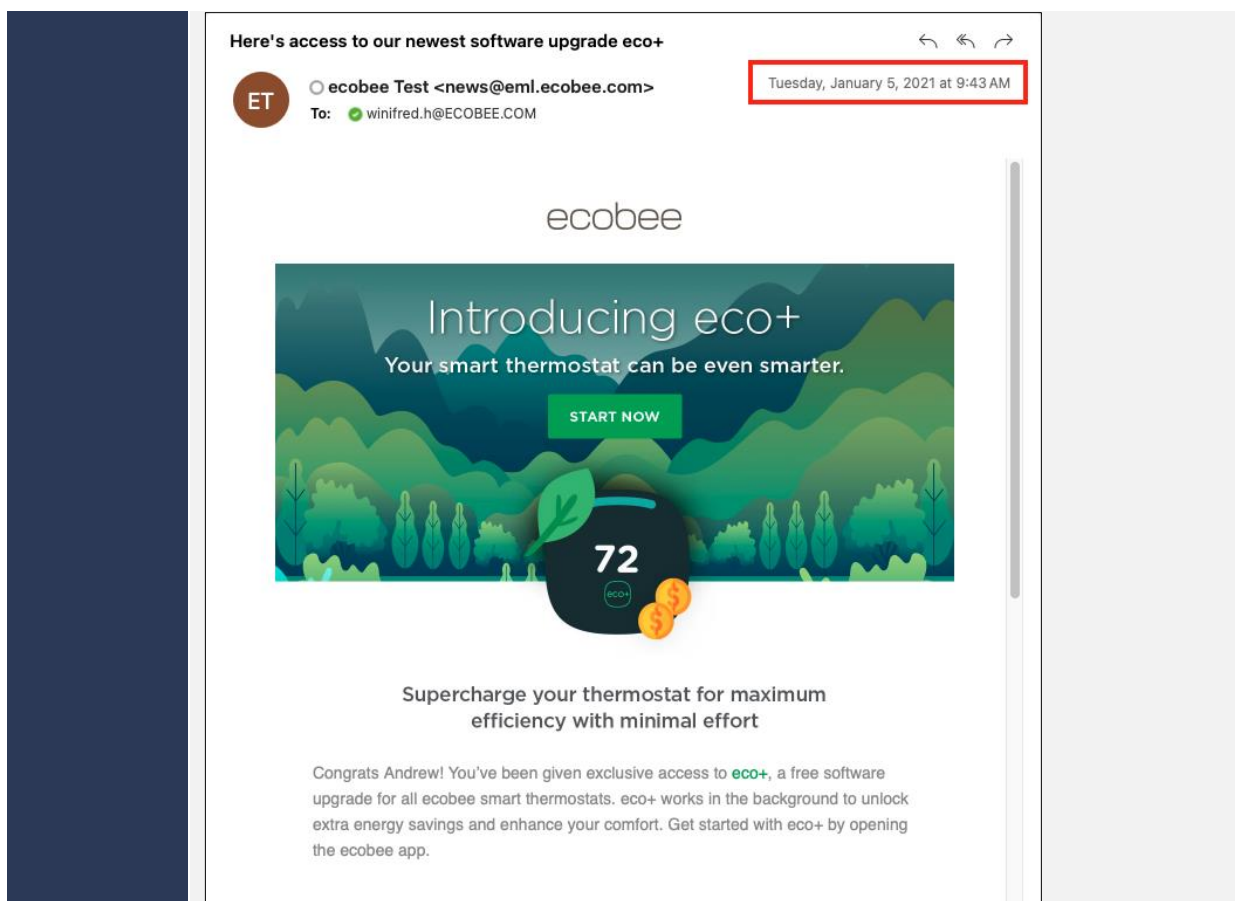
My Tracking > 1. Production > 2021 > Energy Services > eco+ Feature Announcement

 Move
  Delete
  Pause Send
  Resume Send
  Cancel Send
  Compare Email Sends
 Showing: 2021-01-01 to 2021-03-02

☐	Job ID	Name	Date/Time Sent
☐	7464	2021-01-05_BCH_NRG_ecoplus_FeatureAnnouncement	2021-03-02 2:16 PM
☐	7350	2021-01-05_BCH_NRG_ecoplus_FeatureAnnouncement	2021-02-23 5:52 PM
☐	7311	2021-01-05_BCH_NRG_ecoplus_FeatureAnnouncement	2021-02-18 10:10 AM
☐	6980	2021-01-05_BCH_NRG_ecoplus_FeatureAnnouncement	2021-02-02 4:57 PM
☐	6973	2021-01-05_BCH_NRG_ecoplus_FeatureAnnouncement	2021-01-28 2:06 PM
☐	6972	2021-01-05_BCH_NRG_ecoplus_FeatureAnnouncement	2021-01-28 2:04 PM
☐	6932	2021-01-05_BCH_NRG_ecoplus_FeatureAnnouncement	2021-01-22 5:59 PM
☐	6743	eco+ Feature Announcement email - Generic - USCAN - wBlogarticle	2021-01-05 3:31 PM
☐	6742	eco+ Feature Announcement email - Generic - USCAN - wBlogarticle	2021-01-05 3:31 PM
☐	6741	eco+ Feature Announcement email - Generic - USCAN - wBlogarticle	2021-01-05 2:55 PM
☐	6740	eco+ Feature Announcement email - Generic - USCAN - wBlogarticle	2021-01-05 2:54 PM
☐	6739	eco+ Feature Announcement email - Generic - USCAN - wBlogarticle	2021-01-05 2:24 PM
☐	6738	eco+ Feature Announcement email - Generic - USCAN - wBlogarticle	2021-01-05 2:08 PM

3. eco+ introduction e-mail template sent to customers. The e-mail campaign introducing customers to eco+ was completed on March 2, 2021.

The test e-mail dated January 5, 2021 displays the content that customers would have received throughout the e-mail campaign period.



1.10 Project Crediting Period

Crediting period	☒ Seven years, twice renewable ☐ Ten years, fixed ☐ Other (state the selected crediting period and justify how it conforms with the VCS Program requirements)
Start and end date of first or fixed crediting period	03-March-2021 to 02-March-2028 (7 years)

1.11 Project Scale and Estimated GHG Emission Reductions or Removals

Indicate the estimated annual GHG emission reductions/removals (ERRs) of the project:

- ☐ < 300,000 tCO₂e/year (project)
☒ ≥ 300,000 tCO₂e/year (large project)

Estimated emission reductions were also calculated using average emission rates from EPA's eGRID emission factors. Please see *Section 4.4 – Estimated GHG Emission Reductions and Carbon Dioxide Removals* for more details.

Calendar year of crediting period	Estimated GHG emission reductions or removals (tCO ₂)
03-March-2021 to 31-December-2021	159,642
01-January-2022 to 31-December-2022	224,899
01-January-2023 to 31-December-2023	334,005
01-January-2024 to 31-December-2024	399,069
01-January-2025 to 31-December-2025	453,639
01-January-2026 to 31-December-2026	523,699
01-January-2027 to 31-December-2027	604,578
01-January-2028 to 02-March-2028	116,325
Total estimated ERRs during the first or fixed crediting period	2,815,855
Total number of years	7 years (2021-2028)
Average annual ERRs	402,265

1.12 Description of the Project Activity

Background of ecobee Technologies ULC

ecobee is a developer of smart home products, including smart thermostat technology for homes and buildings. A smart thermostat is a device that regulates a home's temperature by controlling HVAC systems and allows users to designate a schedule through home and away set points. A smart thermostat is Wi-Fi-enabled and connects with a mobile application on a smartphone or tablet, allowing users to monitor and control their heating and cooling remotely. This connectivity enables manufacturers to add and adjust features and user settings.

Building on this core functionality, ecobee has developed an advanced thermostat optimization platform called eco+, to make personalized, automated adjustments to the set point of HVAC systems through special features that offer energy efficiency enhancement. The energy efficiency optimizations use individual customer comfort preferences, real-time and historical

occupancy patterns, and data regarding a home's specific thermodynamic properties and HVAC system performance to create personalized, real-time optimization. The optimizations utilize occupancy sensing, which identifies when a home is vacant, learning algorithms that use machine learning to establish customer schedules and temperature preferences, geolocation, which determines a customer's proximity to home, and the ability to adjust for indoor humidity conditions. This advanced software helps people lower their energy use without sacrificing comfort.

Background of eco+ and features

This project activity will cover devices equipped with eco+ which enables additional functionality resulting in personalized energy efficiency optimization that will further reduce heating and cooling usage in the home beyond what would happen in the absence of this energy efficiency enhancement⁶. Enabling this additional functionality has both one-time and on-going costs that ecobee has to incur. To further demonstrate the significant cost of developing and sustaining on-going implementation and maintenance of the software, ecobee has provided the VVB with details on cost and expenses incurred and same can be shared with Verra upon request. ecobee does not generate additional revenue through offering this service and has attested that eco+ will remain free to end users throughout the crediting period and any subsequent crediting period renewals⁷.

Upon enabling eco+, customers are prompted to select their desired balance of comfort and energy savings. Then, eco+ tailors an algorithm unique to the customer for the energy optimization that best represents both their comfort preferences and the thermal profile of the home⁸.

Energy Efficiency features like "Adjust for Humidity", "Smart Home and Away", and "Schedule Assistant" are designed to help ecobee customers lower their overall heating and cooling energy consumption.

- Adjust for Humidity – a patented⁹ technology that accounts for fluctuations in indoor humidity to ensure customers' homes always feel like the temperature they have set on their thermostat. This keeps their home energy efficient and comfortable even in periods of unusually high or low humidity.
- Smart Home & Away – automatically adjusts temperature for energy savings when residents leave home and restores to preferred comfort settings when they return.

⁶ ecobee thermostat models compatible with eco+ include: Smart Thermostat Premium, Smart Thermostat Enhanced, SmartThermostat with voice control, ecobee4, ecobee3 lite, and ecobee3. eco+ and the Adjust for Humidity feature are not compatible with the original thermostat model ("SmartSI") which make up less than 10% of the existing ecobee smart thermostat population and are no longer manufactured.

⁷ Please refer to Appendix F for a copy of the attestation from ecobee's Executive Vice President.

⁸ The eco+ platform consists of three (3) categories of algorithms: 1) Demand Response (DR) – Presented to users as Community Energy Savings (CES), this feature shifts cooling loads away from peak hours when the electrical grid is most constrained through customized pre-cooling of the home and temporary temperature setbacks during system peak hours; 2) Time-of-Use Optimization (TOU) – For ecobee customers whose electricity rate varies by hour of the day, the TOU algorithm shifts energy use from high price hours to lower price hours while maintaining the desired comfort levels through customized pre-cooling and temporary temperature setbacks. ecobee is not seeking to generate carbon offsets from the these categories. The third category which includes Energy Efficiency (EE) is the added functionality that will be the primary project activity.

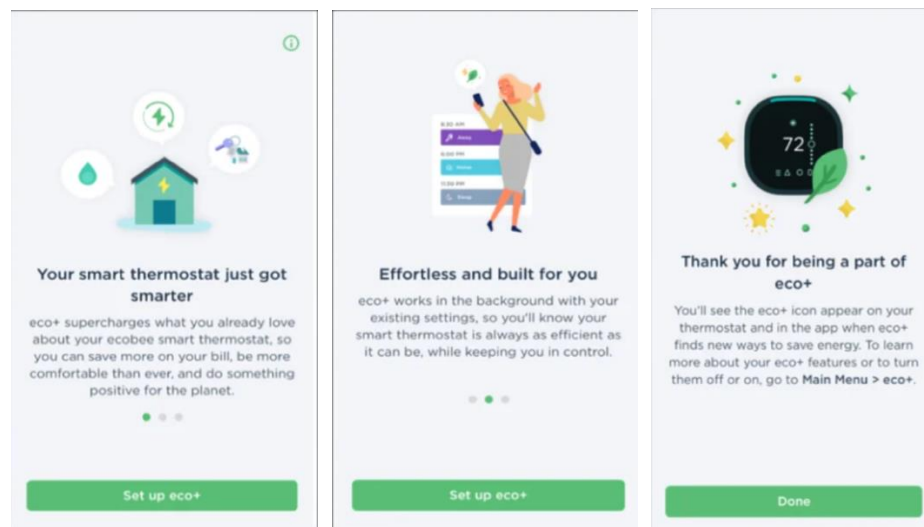
⁹Trinh, K. (2021).Thermostat device with improved energy optimization. (U.S. Patent No. US20210302052A1)
<https://patents.google.com/patent/US20210302052A1/en?q=US20210302052A1>

- Schedule Assistant – recommends updates to users’ thermostat schedules to match their occupancy patterns.

Prior to the full rollout of eco+, there was a beta trial (between March 2019 and August 2020) to a subset of approximately 241,000 existing ecobee customers. During the beta trial, upon completing the firmware upgrade, customers had eco+ available to opt-in. Customers that accepted the eco+ offer had the feature enabled (or toggled ‘ON’) and customers that did not accept the offer had eco+ disabled (or toggled ‘OFF’).

After the beta trial, ecobee completed an over the air phased roll out of eco+ to existing eligible thermostat customers by March 03, 2021 during which eco+ was presented as a default firmware upgrade. See Figure 1 below.

Figure 1. In-app screens introducing eco+

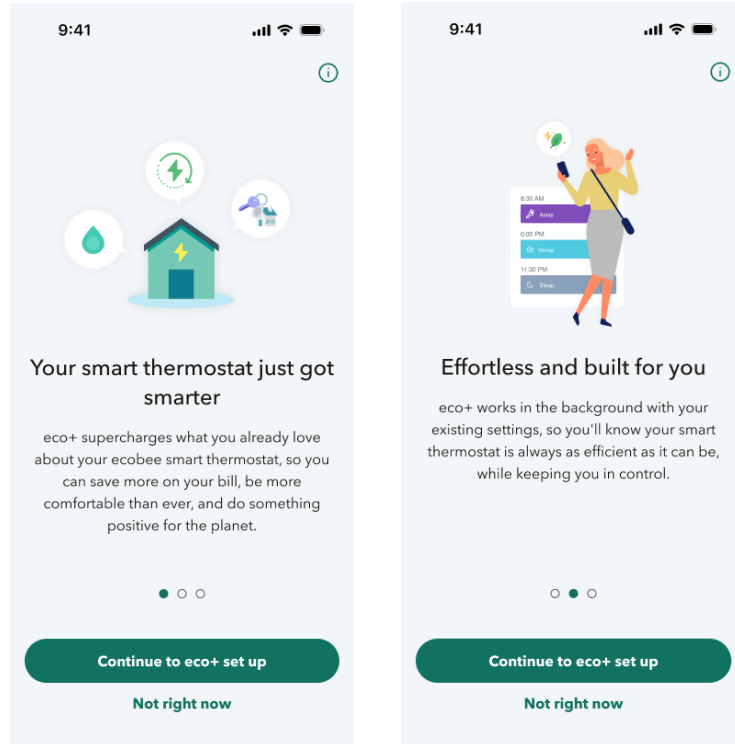


As of March 03, 2021, eco+ and Adjust for Humidity feature is toggled ON by default.

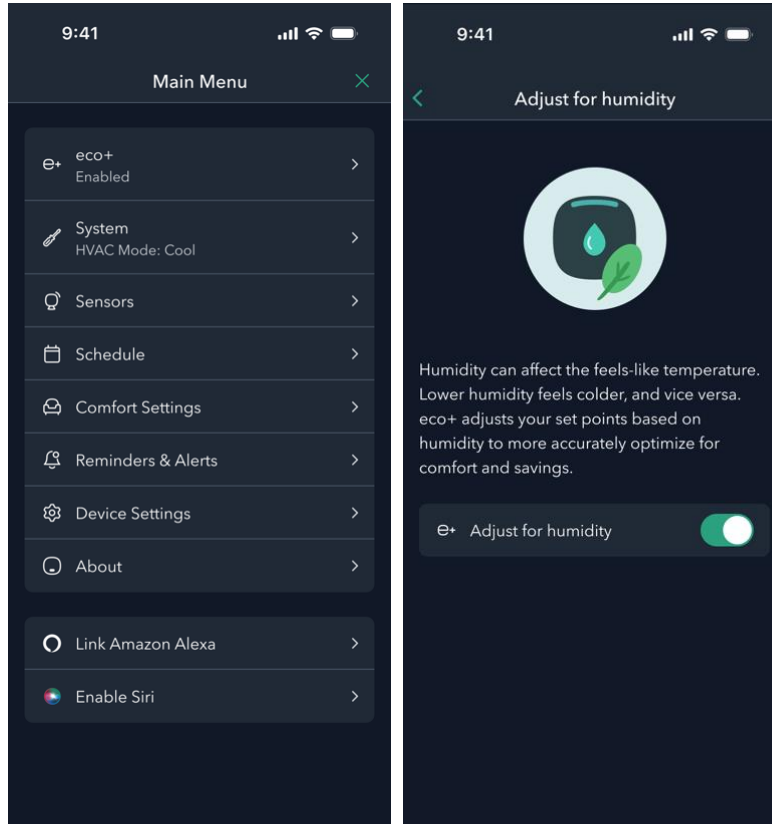
New customers that purchased an ecobee smart thermostat device manufactured in May 2021 or after received eco+ embedded (ie., pre-downloaded) on the firmware and had eco+ and ‘Adjust for Humidity’ toggled ‘ON’ by default after completing the new device registration process. Customers that purchased a smart thermostat device manufactured before May 2021 received an over-the-air firmware upgrade to download first as part of initial device registration process. Upon installing an ecobee smart thermostat device, customers are directed to the ecobee mobile app to complete device registration and are presented with the suite of eco+ features that are available. ‘Adjust for Humidity’ is an optional feature and is toggled ‘ON’ by default at the point of device registration. Customers can access the eco+ and ‘Adjust for Humidity’ feature through ecobee mobile app in the “**Main Menu**” under “**eco+.**” See Figure 2. below demonstrating how eco+ and ‘Adjust for Humidity’ is toggled ‘ON’ by default after new customers completes new device registration.

Figure 2. eco+ and ‘Adjust for Humidity’ after new device registration

New customers registering ecobee devices are introduced to eco+ during their first-run of setting up a new ecobee account. Customers complete new account and device registration by clicking ‘Continue to eco+ set up’ or by clicking ‘Not right now’



Following new account registration, all customers will arrive at “**Main Menu**” and can see “eco+” is **enabled** (toggled ON) by default and ‘Adjust for Humidity’ toggled **ON** by default.



Background of “Adjust for Humidity” (Project Activity)

The project activity is the patented ‘Adjust for Humidity’ feature that is offered to customers for free through eco+ and is only available on ecobee smart thermostat devices. In order to quantify the project emissions, the ‘Adjust for Humidity’ feature (i.e., the VCS project) is measured against ecobee smart thermostat devices that did not enable eco+ and ‘Adjust for Humidity’. The project activity could not occur without an ecobee device being installed as this is needed to construct the baseline scenario. As noted in PD Section 3.4, the baseline scenario are the emissions from heating and cooling energy load of homes with an ecobee device that did not enable eco+ and ‘Adjust for Humidity’ while the project emissions are emissions from heating and cooling energy loads of homes with an ecobee devices equipped with eco+ and ‘Adjust for Humidity’.

The project activity and primary driver of energy savings through eco+ is the patented feature “Adjust for Humidity”. The development of this feature was informed by the principles of thermal comfort and the humidity index (i.e., humidex). Thermal comfort refers to the subjective feeling of temperature in the surrounding environment. The humidity index is a measurement that expresses how the combined effects of warm temperatures and humidity are perceived by a person. By applying these two principles, the ecobee smart thermostat and the “Adjust for Humidity” feature measures and takes into consideration the home’s temperature and humidity when determining the temperature at which a customer feels comfortable. In essence, the feature takes advantage of a home’s indoor humidex (a blend of temperature and moisture in the air) and automatically controls the HVAC equipment to manage the desired setpoint temperature to lower energy consumption while keeping residents feeling comfortable. It monitors these conditions around-the-clock and all year-long to deploy micro-HVAC adjustments to lower energy consumption while ensuring the home feels comfortable for its residents.

Figure 2 shows the scientific explanation of the “Adjust for Humidity” feature and Figure 3 shows the layman’s illustration. The psychrometric chart is a staple of building science and HVAC design. The graph illustrates dry bulb temperature on the x-axis and moisture content on the y-axis. Lines of constant relative humidity are represented by the curved lines running from the bottom left and sweeping up through to the top right of the chart. The annotated areas of the chart show where the feature is active. Essentially, the feature exploits the fact that humans feel wet bulb temperature rather than dry bulb temperature, and thus at certain moisture content levels, the executed setpoint of the thermostat can be raised (in cooling mode) or lowered (in heating mode) to reduce HVAC consumption.

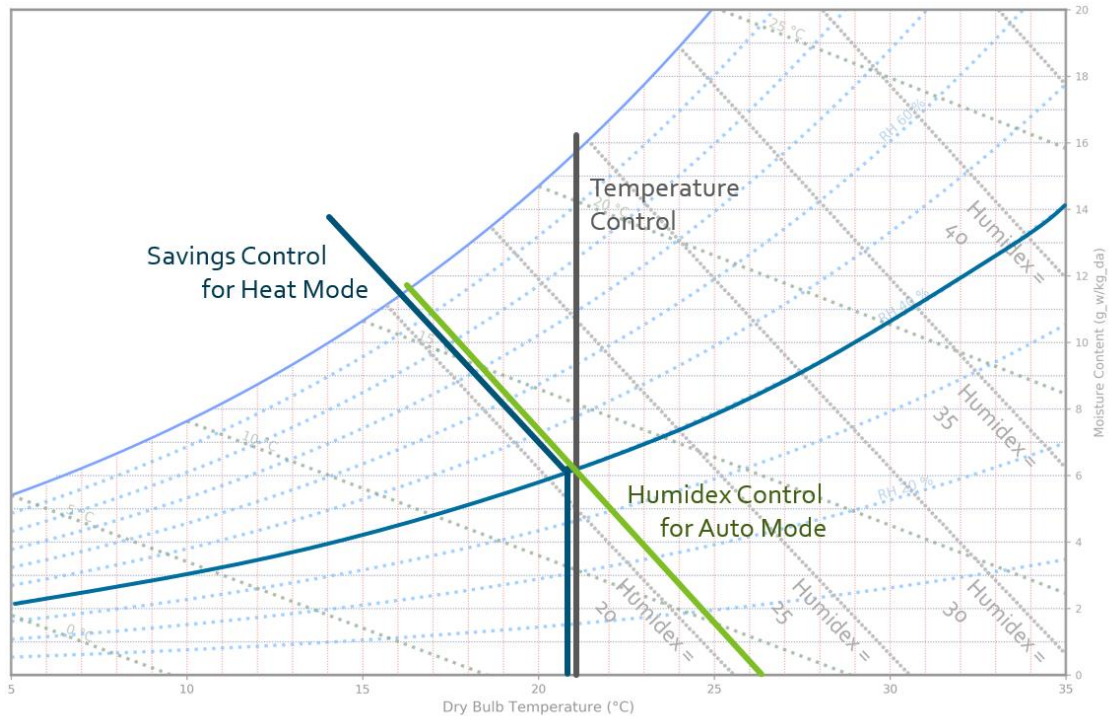


Figure 2: Psychrometric Chart with Adjust for Humidity Illustration

Figure 3 compares average sensed and executed temperatures for devices in the Hot-Humid climate zone during July 2021. The difference between the blue and grey line is the “offset” imposed by the humidity feature. By raising thermostat setpoints, the amount of cooling energy required is lowered. These small micro-adjustments across millions of thermostats add up to significant energy savings and emissions reductions. In heating mode, the offset works in the opposite direction with executed setpoints less than sensed temperatures.

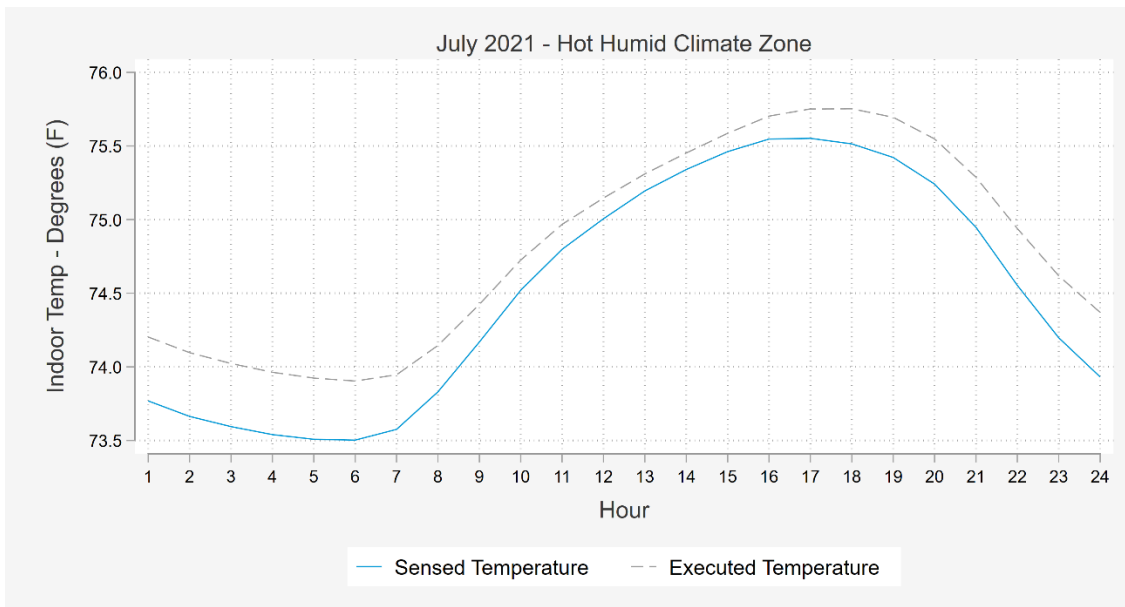


Figure 3: Adjust for Humidity Applied Example

Figure 4 illustrates how the feature works across different ambient conditions using the same data from July 2021 in the Hot-Humid climate zone. Each point is one day (31 points). While some level of offset is present every day, the algorithm is more aggressive when outdoor temperatures are high and relative humidity is low.

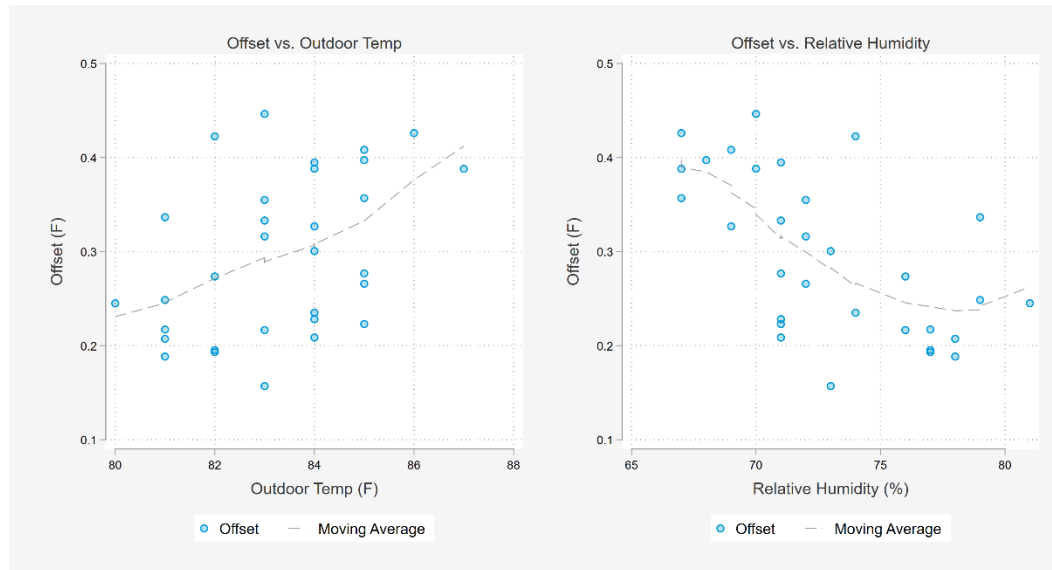


Figure 4: Offset Versus Outdoor Temperature and Relative Humidity (July 2021)

ecobee undertook a pilot study in 2019 and 2020 to assess the results of eco+ including the energy efficiency enhancement.¹⁰ During this time, the eco+ platform was deployed across North America to a large pilot group of ecobee thermostats to demonstrate the capabilities of the eco+ platform. The pilot included a population of approximately 240,000 ecobee thermostats.

Following the pilot, ecobee enlisted a third-party measurement and verification (M&V) consultant, Demand Side Analytics, LLC (DSA) to assess the energy impacts of the eco+ platform. The results of the pilot demonstrated measurable energy efficiency improvements when comparing the experimental group (devices that received eco+ and participated in the pilot) against the control group (devices without eco+). With positive results demonstrated from the pilot study, ecobee began implementing a phased roll out of eco+. The full roll out was completed by March 03, 2021 to existing ecobee smart thermostats and offered on new ecobee smart thermostats on a go forward basis.

The project activity expands this functionality to 2,524,333 ecobee thermostats in the U.S during the first monitoring period which includes 1,226,319 already installed devices that received the free eco+ thermostat optimization platform through an over-the-air software upgrade and another 1,298,014 devices offered eco+ for free upon installation. Carbon revenue would support the one time and on-going costs ecobee incurs for implementing the

¹⁰ Evaluation Performed by Demand Side Analytics, available at <https://www.ecobee.com/en-us/ecoplusemv/>

energy efficiency enhancement provided by eco+ which generates no additional revenue for the company.

1.13 Project Location

The project boundary is the geographical boundary of the contiguous United States, shown below in Figure 5 with the coordinates of 39.9023, -100.1146, where 2,524,333 ecobee smart thermostats with eco+ and Adjust for Humidity reside in 62% of US zip codes as illustrated in the map below. Each dot on the map represents US zip codes with ecobee smart thermostats with eco+ and “Adjust for Humidity”.

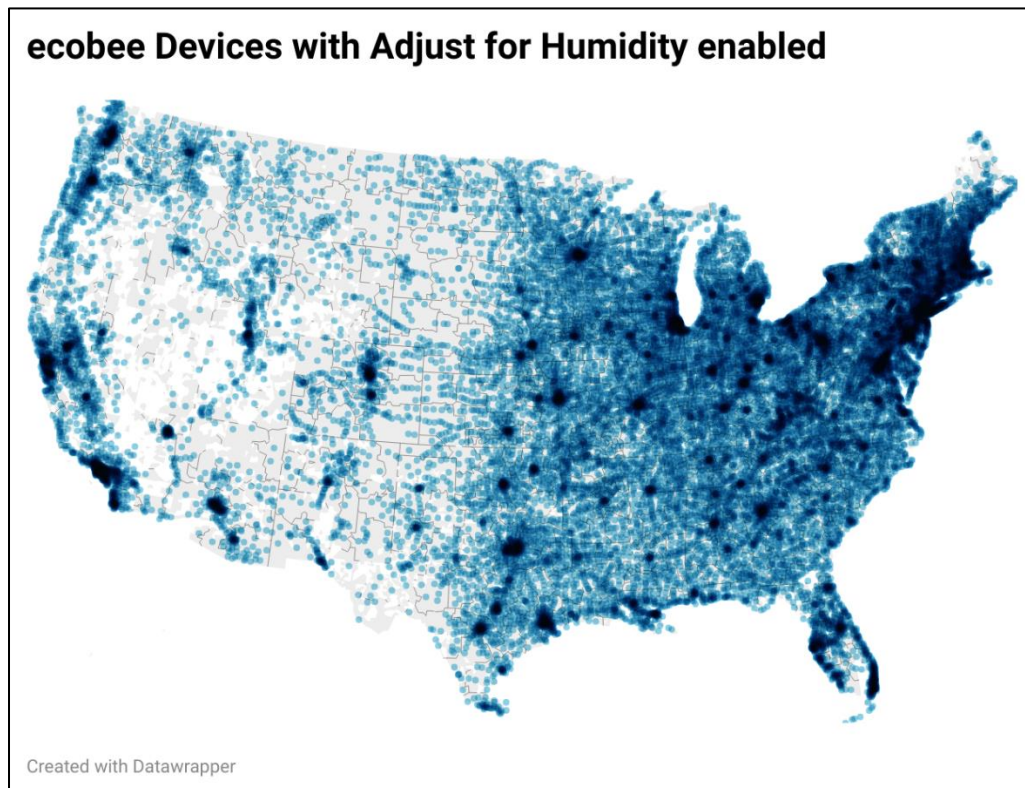


Figure 5: Map of Contiguous USA with Project Thermostat Locations

1.14 Conditions Prior to Project Initiation

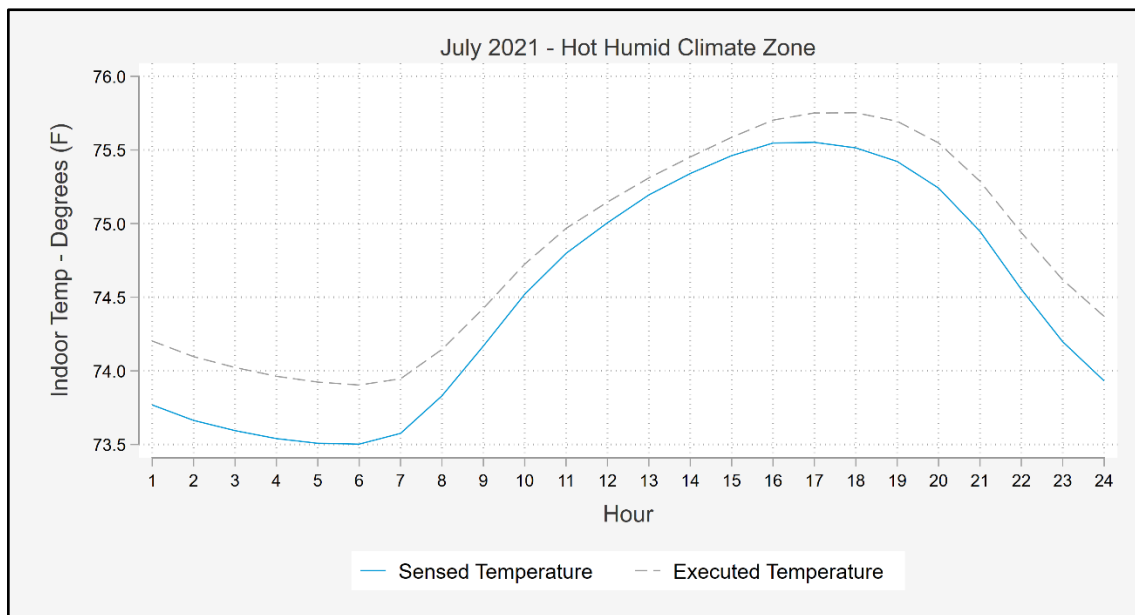
The baseline scenario for this project activity is the cooling and heating loads of a home with an ecobee thermostat without eco+ and “Adjust for Humidity”. The “Adjust for Humidity” feature saves energy and reduces emissions through “offsets” of the thermostat setpoints. In the winter or cooler months, the feature lowers heating setpoints and reduces energy used for heating. In the summer or warmer months, the feature increases cooling setpoints and reduces energy used for cooling.

To further elaborate on the baseline and project scenario, consider a home with a 75 °F (22 °C) thermostat setpoint in the summer and a 65 °F (18 °C) thermostat setpoint in the winter. The heating and cooling loads of this home, given the climate and home construction attributes, is the baseline scenario. If the “Adjust for Humidity” feature implements an average offset of 0.5°F, the executed setpoints are changed to 75.5°F in the summer and 64.5°F in the winter.

The project scenario is the heating and cooling loads of the home under these executed setpoints made by the “Adjust for Humidity” feature. As the executed setpoints lower the differential between outdoor temperature and setpoint, the cooling and heating loads are lowered.

“Adjust for Humidity” was developed and designed to be an energy saving only feature as it measures and takes into consideration the home’s indoor temperature and humidity when determining a temperature that will feel comfortable to residents based on their desired indoor temperature. The feature monitors these conditions year-round to deploy micro-HVAC adjustments to lower energy usage, thereby saving overall energy consumption. In other words, the project activity has been implemented to further drive incremental HVAC energy savings and it would not be possible for the project activity to increase energy usage or CO₂ emissions due to the core functionality which is to only adjust set points based on humidity in a way that reduces energy consumption.

The figure below is a demonstration of the feature which compares the average sensed and executed temperature for devices in Hot-Humid climate zone. The difference between the blue and grey line is the “off set” imposed by the feature. By raising thermostat setpoints, the amount of cooling energy required is lowered. These small adjustments across millions of thermostats add up to significant energy savings and emissions reductions annually. In heating mode, the offset works in the opposite direction with executed setpoints less than sensed temperatures.



1.15 Compliance with Laws, Statutes and Other Regulatory Frameworks

This project is in compliance with all relevant national, state and local regulations. In addition, the use of this technology is not required by any law or regulation anywhere within the jurisdiction eco+ is deployed.

As part of this project, ecobee conducted a review of several state and federal guidelines that are relevant to HVAC and thermostats in homes. The most relevant regulations include the following:

DOE Standards¹¹: The Department of Energy (DOE) establishes energy-efficiency standards for certain appliances and equipment, and currently covers more than 60 different products. Authority to undertake this effort was granted by Congress¹², and DOE follows a four-phase process¹³ when reviewing existing and developing new standards. Each product page provides information on recent updates, current standards and test procedures, waivers, exceptions, and exemptions, statutory authority, and historical information. None of these regulations address thermostats, indicating this project activity is neither required by law nor prohibited by law.

State Level Building Codes:

The State of California's Title 24 of Building Energy Efficiency Standards (Energy Code) requires that new construction of homes and buildings must install smart thermostat devices that meet technical specifications and functional capabilities outlined in Appendix JA5¹⁴ – *Technical Specifications for Occupant Controlled Smart Thermostats*. The required technical specifications and functional capabilities are:

- 1) Setback capabilities: the ability to adjust the set point temperature
- 2) Restart settings and Rejoin: in the event of device power loss, the device automatically restores itself to the most recently programmed settings, reconnects to network and automatically rejoin functions to restore physical and logical communication
- 3) Event responses: the ability to respond to price signals and demand response signals (including override function, modifying settings during an event, and timed or delayed events), and
- 4) User display and interface: have capability to display information to the user (i.e., network connection status, sensed temperature, setpoint, demand response / price response indicator)

Based on the list of required technical specifications, an ecobee smart thermostat device meets all the required minimum functionality and capabilities and is an eligible device that can be installed in new homes and buildings to comply with California Energy Code.

The project activity goes above and beyond the baseline capabilities of smart thermostats and exceeds the minimum requirements mandated by the California Energy Code. The project activity itself is the patented HVAC energy efficiency feature that takes indoor humidity measurements to automatically adjust HVAC usage and is available for free only on ecobee smart thermostats. A thermostat functionality that uses indoor humidity measurements to automatically make adjustments to HVAC in a way that incrementally conserves HVAC energy usage has not been listed as a minimum required technical capability of smart thermostats installed in new homes in California. For these reasons, California should be included within the project boundary.

¹¹ U.S Department of Energy. Office of Energy Efficiency & Renewable Energy. Standards and Test Procedures – Buildings.
<https://www.energy.gov/eere/buildings/standards-and-test-procedures>

¹² U.S Department of Energy. Office of Energy Efficiency & Renewable Energy. Statutory Rules and Authorities – Buildings.
<https://www.energy.gov/eere/buildings/statutory-rules-and-authorities>

¹³ U.S Department of Energy. Office of Energy Efficiency & Renewable Energy. Standards Development and Revision – Buildings.
<https://www.energy.gov/eere/buildings/standards-development-and-revision>

¹⁴ CEC 2022 Building Energy Efficiency Standard. Appendix JA5. Technical Specifications for Occupancy Controlled Smart Thermostats.
https://www.energy.ca.gov/sites/default/files/2022-12/2022%20Joint%20Appendix%20JA5%20_Requirements%20of%20OCST.pdf

It is important to note that the 'Adjust for Humidity' feature is not required capability of smart thermostats installed in new buildings as outlined in California Building Energy Code and JA5. The fact that ecobee and other smart thermostats are deployed across the USA indicates these devices comply with local laws and – as demonstrated by the DOE Appliance Standards and California Building Energy Code – the project activity (eco+ and "Adjust for Humidity" feature) is not required by law.

City of Austin, Texas - Ordinance No. 20160623-099

By way of clarification, Ordinance No. 20160623-099 is applicable only within the jurisdiction of Austin, Texas and not applicable to the broader state of Texas. The Ordinance requires under section R403.1.1.1. – Thermostat Connectivity to Internet: *"the thermostat controlling the primary heating or cooling system of the dwelling unit shall be capable of:*

1. *Connecting to the internet via either a cable or WiFi connection, and*
2. *Allow cooling and heating set points to be altered remotely¹⁵."*

Based on the two (2) requirements found in this section, ecobee smart thermostats meet the required basic functionalities and are eligible devices that can be installed in new homes in Austin, Texas. However, the Ordinance does not require thermostats installed in new homes in Austin, Texas to have a functionality that uses indoor humidity measurements to automatically make adjustments to HVAC equipment in a way that incrementally conserves HVAC energy usage. The ecobee project activity is an additional functionality that exceeds the requirements of thermostats that are to be installed in new homes in Austin, Texas. For these reasons, Austin, Texas should be included within the project boundary.

The use of a humidity measurement adjustment functionality embedded in smart thermostats has not been required by any law or regulation within the jurisdiction the patented feature is available for enablement by ecobee customers. It is also worth noting that for the purposes of quantifying and measuring the project activity's emission impact, the baseline scenario is defined as emissions from heating and cooling energy load by homes with ecobee devices that did not enable eco+ and the free and patented 'Adjust for Humidity' feature or, in other words, the **baseline scenario** are homes with an ecobee device that have the minimum required technical capabilities listed in the California Building Energy Code and Austin, Texas Ordinance and have not enabled the additional functionality that is the project activity.

The state of California and the City of Austin, Texas have not been excluded from the project boundary as the existing regulations and mandates related to smart thermostat installations in new home constructions are not considered applicable to the project activity. ecobee's project activity goes above and beyond the baseline capabilities of smart thermostats as the project activity is focused on the additional functionality that surpasses and exceeds the minimum requirements of smart thermostats mandated by both the California Energy Code and Austin's Ordinance No. 20160623-099. The project activity itself is the patented HVAC energy efficiency feature that takes indoor humidity measurements to automatically adjust HVAC usage and is available only on ecobee smart thermostats.

1.16 Double Counting and Participation under Other GHG Programs

1.16.1 No Double Issuance

Is the project receiving or seeking credit for reductions and removals from a project activity under another GHG program?

☐ Yes ☒ No

If yes, provide required evidence of no double issuance as outlined by the VCS Standard.

1.16.2 Registration in Other GHG Programs

Is the project registered or seeking registration under any other GHG programs?

☐ Yes ☒ No

If yes, provide the registration number and all relevant details.

1.16.3 Projects Rejected by Other GHG Programs

Has the project been rejected by any other GHG programs?

☐ Yes ☒ No

If yes, provide the program name(s), reason(s) and date for the rejection, justification of eligibility under the VCS Program, and any other relevant information.

1.17 Double Claiming, Other Forms of Credit, and Scope 3 Emissions

1.17.1 No Double Claiming with Emissions Trading Programs or Binding Emission Limits

Are project reductions and removals or project activities also included in an emissions trading program or binding emission limit? See the *VCS Program Definitions* for definitions of emissions trading program and binding emission limit.

☐ Yes ☒ No

If yes, provide all required evidence of no double claiming as outlined by the VCS Standard.

1.17.2 No Double Claiming with Other Forms of Environmental Credit

Has the project activity sought, received, or is planning to receive credit from another GHG-related environmental credit system? See the *VCS Program Definitions* for definition of GHG-related environmental credit system.

☐ Yes ☒ No

1.17.3 Supply Chain (Scope 3) Emissions

Do the project activities specified in Section 0 affect the emissions footprint of any product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ No

If yes:

Is the project proponent(s) or authorized representative a buyer or seller of the product(s) (goods or services) that are part of a supply chain?

☐ Yes ☒ No

If yes:

Has the project proponent(s) or authorized representative posted a public statement on their website saying, “Carbon credits may be issued through Verified Carbon Standard project [project ID] for the greenhouse gas emission reductions or removals associated with [project proponent or authorized representative organization name(s)] [name of product(s) whose emissions footprint is changed by the project activities].”

☐ Yes ☒ No

1.18 Sustainable Development Contributions

The project activity contributes to Sustainable Development Goals 7.3, 8.2, 11.6 and 12.2 through the development and deployment of an energy efficiency enhancement, the patented feature “Adjust for Humidity” delivered through a thermostat optimization platform, eco+, to ecobee smart thermostats.

The project directly contributes to SDG 7.3, 8.2, 11.6 and 12.2 in several ways. The development of this feature directly contributes to economic productivity, technological upgrade and innovation as the development, operation and maintenance of eco+ is supported by more than 30 full-time equivalents in the area of Data Science, Product Management and Engineering and is projected to increase by dozens of additional full-time equivalents in addition to the retention of the core team to continuously improve and maintain the project activity. The development of the project activity directly impacts the energy usage associated with a home’s heating and cooling system, thereby improving overall energy efficiency, reducing energy usage including fossil fuels, decreasing harmful pollutants (i.e., PM2.5), improving air quality and reducing adverse impact on the environment.

The Biden-Harris Administration in the United States has set federal level climate goals¹⁶, including reducing U.S. greenhouse gas emissions 50-52% below 2005 levels in 2030, reaching 100% carbon pollution free electricity by 2035, achieving a net-zero emissions economy by 2050 and delivering 40% of the benefits from federal investments in climate and clean energy to disadvantaged communities. The project activity contributes to the reduction of U.S. GHG emissions as the “Adjust for Humidity” feature reduces the HVAC energy usage in millions of homes across the USA. The reduction in total kWh of electricity consumption and mmcf reduction

¹⁶ The White House. President Biden’s Historical Climate Agenda.

<https://www.whitehouse.gov/climate/#:~:text=President%20Biden's%20Actions%20to%20Tackle%20the%20Climate%20Crisis&text=As%20part%20of%20that%20vision,zero%20emissions%20economy%20by%202050>

in natural gas consumption equates to reduction and avoidance of GHG emissions released into the atmosphere.

Please see Appendix E for full details on the current project contributions and contributions over the project lifetime for each SDG listed.

1.19 Additional Information Relevant to the Project

1.19.1 Leakage Management

The applied methodology VM0008 states that: “*Appliances, heating/cooling equipment and/or mobile homes that are replaced shall be properly disposed of and their disposal shall be documented.*” For this project activity the heating/cooling equipment that is being controlled by the thermostats and the thermostat optimization platform are not being disposed of and thus, leakage does not need to be considered.

1.19.2 Commercially Sensitive Information

No commercially sensitive information has been excluded from the public version of the project description document.

1.19.3 Further Information

There is no additional information. This section is not applicable.

2 SAFEGUARDS AND STAKEHOLDER ENGAGEMENT

2.1 Stakeholder Engagement and Consultation

2.1.1 Stakeholder Identification

VCS Program defines a stakeholder¹⁷ has “*any person or entity who can potentially affect or be affected by the project activities*”.

The project activity involves ecobee smart thermostats equipped with eco+ which enables additional functionality resulting in personalized energy efficiency optimization that will further reduce heating and cooling usage in the home beyond what would happen in the absence of the energy efficiency enhancement. The primary driver of energy savings though eco+ is the patented feature “Adjust for Humidity”. The feature takes advantage of a home’s indoor humidex (a blend of temperature and moisture in the air) and automatically controls the HVAC equipment to manage the desired setpoint temperature to lower energy consumption while keeping residents

¹⁷ VCS Program Definitions v4.4. <https://verra.org/wp-content/uploads/2023/08/VCS-Program-Definitions-v4.4.pdf>

feeling comfortable. It monitors these conditions around-the-clock and all year-long to deploy micro-HVAC adjustments to lower energy consumption while ensuring the home feels comfortable for its residents.

Stakeholder Identification	Based on the project activity's scope and potential impacts, ecobee identified two groups of stakeholders: Group 1: Industry Professionals. 7 participants were selected based on their professional backgrounds and experiences in the energy industry, energy efficiency, environmental law, energy measurement and verification, building and sustainability, carbon accounting, ESG reporting and some being owners of ecobee devices. 3 of 7 (or 43%) of the participants were also owners and users of ecobee smart thermostats. The remainder of the participants were familiar with and had a good understanding of ecobee and smart thermostats in general. Group 2: ecobee Customers. 12 ecobee users were selected and were recruited based on these requirements: - Is an ecobee smart thermostat user - Based in the United States - Had awareness of eco+ - Enabled eco+ - Range across age, gender and region
Legal or customary tenure/access rights	This section is not applicable. The stakeholder groups and participants who attended the consultation sessions do not come from groups that hold access rights to territories and resources.
Stakeholder diversity and changes over time	This section is not applicable. The project activity does not impact the social, economic or cultural diversity of the stakeholder group. Stakeholder groups who were identified and attended the consultation sessions were experienced professionals and users of ecobee smart thermostats with eco+ enabled.
Expected changes in well-being	This section is not applicable. There are no expected changes in the well-being and other stakeholder characteristics relative to the baseline scenario, including changes to ecosystem services identified important to stakeholders.
Location of stakeholders	Stakeholder groups that attended the consultation sessions are located throughout the USA and Canada and attended the sessions virtually.
Location of resources	This section is not applicable as the stakeholder groups who attended the consultations do not come from groups that hold customary access rights to resources and territories.

2.1.2 Stakeholder Consultation and Ongoing Communication

Date of stakeholder consultation	Group 1: Industry Professionals – Virtual session held on 16-January-2023 Group 2: ecobee Customers – Virtual sessions held on 20-June-2024
Stakeholder engagement process	Group 1: Industry Professionals Outreach and notice about the stakeholder consultation session took place between December 2022 and January 2023 via e-mail correspondences. The session was virtually hosted on January 16, 2023. The participants that attended the stakeholder consultation session were experienced professionals selected for their backgrounds in energy efficiency, environmental law and advocacy, energy measurement and verification, building and sustainability, and carbon accounting and ESG reporting. In addition to their expert knowledge, some of the participants are also owners and users of ecobee smart thermostats with eco+ and the “Adjust for Humidity” feature. Stakeholders participated in an online session where ecobee presented the details of the project activity. Group 2: ecobee Customers Between June 13, 2024 – June 18, 2024, 667 randomly selected ecobee users that had eco+ enabled on ecobee thermostat devices received a recruitment e-mail inviting interested participants to complete a screener survey. The survey inquired on country, state of residence, age, gender, ecobee products currently in use, level of familiarity of eco+ and “Adjust for Humidity” and level of familiarity of voluntary carbon markets. A total of 12 eligible ecobee users were selected and confirmed to participant in two (2) virtual focus group sessions that were both held on June 20, 2024 at 10:00am (EST) and 2:00pm (EST). Participants were a diverse group and included an even distribution of men and women, from various U.S. states, and varied in age between 25 – 75 years old.
Consultation outcome	Group 1: Industry Professionals During the session, ecobee presented the overall objectives of the project activity, provided explanations on why carbon finance was needed and what the benefits would be for consumers and the environment. Throughout the session, participants had access to the chat function to raise questions, add comments and provide inputs. Questions that were raised by stakeholders during the Q&A segment primarily focused on project design, offset ownership and emissions calculation clarification points. No major objections to the project were raised. At the end of session, stakeholders were provided with contact details of ecobee members Tamara Dzubay and Jeanny Do who remain available for follow up inquiries. Since the session on 16-January-2023, no additional comments, inquires and inputs have been received by ecobee from this stakeholder group. The video recording and transcript of Q&A portion has been provided to the VVB and can be provided to Verra upon request.

	Group 2: ecobee Customers ecobee facilitators presented on the overall objectives of the focus group session, the project activity itself including eco+ and the “Adjust for Humidity” feature, provided explanation on why carbon finance is needed to sustain the project activity and introduced participants to the voluntary carbon markets, carbon standards and the project validation and verification process. Throughout the session, participants were encouraged to use the chat function to raise questions, add comments and provide inputs. The sessions were recorded and all feedback and discussion points were documented for future reference. Recordings and presentation slide deck were provided to the VVB and can be made available to Verra upon request. Following the presentation, the guided discussion during the Q&A segment primarily focused on familiarity of eco+, “Adjust for Humidity” feature and the carbon markets. Participants reacted very positively when they learned about how ecobee is seeking to register a carbon project for carbon finance to sustain the project activity. It was their preference for ecobee to keep eco+ and its feature free and for ecobee to use carbon finance to continuously maintain and improve eco+ operations. By keeping eco+ free, it helps participants feel they are making a small, collective contribution towards climate change by enabling the feature, with one participant commenting <i>“nice to hear that [ecobee] is using offsets to better things.”</i> Other participants who were familiar with eco+ but less familiar with the “Adjust for Humidity” feature were excited to enable or keep the feature on to contribute to the positive environmental impact. No major objections were raised. At the end of the sessions, participants were provided with contact details of the facilitators who remain available for follow up inquires. Since the session on 20-June-2024, no additional comments, inquires and inputs have been received from this stakeholder group.
Ongoing communication	Following both stakeholder group consultation sessions, participants were provided with contact details of ecobee members and facilitators that presented during the sessions as a mechanism for ongoing communication with stakeholder groups should they wish to raise concerns about the project activity. All ecobee members have been available for any on-going communication throughout the implementation of the project activity. Since the stakeholder sessions, no additional comments or concerns have been raised by stakeholder groups. ecobee will provide e-mail updates to stakeholder groups if there are any changes in identifiable risks, cost and benefits from the project activity. Communicating benefit sharing, ongoing FPIC process and relevant laws and regulations covering worker’s right in host country are not applicable to this project activity.
Stakeholder input	Group 1: Industry Professionals

	Participants posed questions during a Question & Answer session at the end of the presentation primarily related to project design, offset ownership and other issues addressed in this PDD. Group 2: ecobee Customers A guided discussion was conducted following main presentation of the carbon project. The primary facilitator posed questions about eco+, Adjust for Humidity and the voluntary carbon markets to each participant and documented their responses for reference. The key takeaways and comments from the session were: - Users were familiar with eco+, its features and somewhat familiar with carbon programs and carbon markets. - Users reacted positively to learning about ecobee registering a carbon offset project for carbon finance. - Users prefer eco+ to remain free and use of carbon finance to sustain eco+ was welcomed - Other comments include general feedback on other features and UX experience of ecobee's mobile app.
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2.1.3 Free Prior and Informed Consent

Obtaining consent	This section is not applicable as obtaining consent from those concerned including indigenous people, local communities and customary rights holder is not applicable. The project activity involves ecobee smart thermostats equipped with eco+ which enables additional functionality resulting in personalized energy efficiency optimization that will further reduce heating and cooling usage in the home beyond what would happen in the absence of the energy efficiency enhancement.
Outcome of FPIC	Not applicable.

2.1.4 Grievance Redress Procedure

Development process	Not applicable.
Grievance redress procedure	Not applicable.

2.1.5 Public Comments

Comments received	Actions taken
On 12-August-2022 one (1) comment was received during the public review period (26-JUL-2022 to 25-AUG-2022): <i>“Can’t this be a part of the Ecobee marketing budget? Seems like it decreases cost for their consumer electricity/heating bill which could increase sale”</i>	In answering this comment, it is helpful to think of the project in two categories: 1) ecobee smart thermostats already installed in homes prior to the deployment of eco+ and “Adjust for Humidity”, and 2) ecobee smart thermostats offered eco+ and “Adjust for Humidity” upon installation. Category 1): Prior to the deployment of eco+ and Adjust for Humidity, approximately 1.1 million ecobee smart thermostats were already sold and installed in homes. As the eco+ had not been developed, it’s clear that these customers purchased an ecobee smart thermostat for reasons unrelated to the energy efficiency enhancement provided by eco+ and “Adjust for Humidity”. Therefore, the project activity could not have been part of the marketing budget in selling smart thermostats as this feature had not existed. Category 2): ecobee conducts quarterly customer surveys to understand the key drivers towards the purchase of smart thermostats which helps inform marketing strategies and ecobee’s product marketing guidelines. Some of the key drivers towards purchasing a smart thermostat include: mobile access and control, ease of use, compatibility with home ecosystems and strong data security. Based on the customer survey results, the incremental energy performance of residential HVAC systems gained from eco+ and “Adjust for Humidity” are not part of the primary drivers or incentives for customers to purchase a smart thermostat, nor are they specifically called out in ecobee’s marketing campaigns. ecobee develops marketing campaigns that are designed to a) drive awareness and positive perception of ecobee’s brand and b) drive sales on all ecobee products, not just the smart thermostats with eco+ and “Adjust for Humidity”. An example is ecobee’s 2021 brand marketing campaign (“BE” campaign) that occurred throughout the crediting period, which came from a need to develop a creative platform that spoke to the entire ecobee home solution and suites of products. An RFP process was initiated to partner with the best agency that understood ecobee’s needs and challenges. Once the agency was selected and had designed a slogan that could be applied generically to the suite of products and services, ecobee

	then undertook focus group studies to test the reception of the campaign messaging. The “BE” campaign focused on highlighting the whole home ecobee experience (i.e. all ecobee products and services working together) with the goal of raising awareness of the ecobee brand, ultimately to generate demand that is then converted to sales. In developing this campaign, ecobee focused on marketing the entire ecobee ecosystem and suite of products and services. For example, the slogan “<i>be home</i>” and “<i>be sure</i>” was attached to the ecobee SmartCamera, “<i>be smart</i>” and “<i>be comfortable</i>” was attached to the smart thermostats, and “<i>be amazed</i>” was attached to the overall ecobee brand. As a result, this drives incremental sales of new smart thermostats alongside other ecobee products and services. Other examples of ecobee developing a marketing campaign that drivers overall brand awareness and sales of ecobee’s suite of products and services is the 2023 ecobee Smart Security (“eSS”) campaign. The eSS campaign is focused on promoting a next-generation security system that uses ecobee’s advanced smart devices including the newly launched ecobee Smart Doorbell Camera, sensors, and smart thermostats as a security base station. The eSS campaign demonstrates how the various features and benefits of the Smart Security services work optimally when integrated with a full suite of products. Building on the eSS campaign, ecobee recently launched the 2024 Smart Home campaign, focusing on positioning ecobee as a holistic, all-in-one smart home products and security solutions company. The tagline “<i>Get yourself a smarter home</i>” is used to highlight ecobee’s suite of products and services that together provides security, peace of mind, and comfort. As a result, this drives incremental sales of all ecobee products and services.
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2.2 Risks to Stakeholders and the Environment

Risks identified	Mitigation or preventative measure taken
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Risks to stakeholder participation	No risks identified to any stakeholders and the environment.	There are no negative consequences or risks associated with this project. This project activity involves existing and new ecobee smart thermostats receiving the free thermostat optimization platform eco+ that reduces a home's incremental energy usage by controlling the HVAC equipment and does not involve the construction of any facility or involve actions that would have measurable environmental impact or risks to stakeholders.
Working conditions	No risks related to working conditions as result of project activity	There are no risks to the working conditions associated with this project. The development, operation of eco+ is supported by more than 30 full-time ecobee employees. ecobee is an Equal Opportunity Employer, adheres to Employment Standards Act, Accessibility for Ontarians with Disability Act, Occupational Health and Safety Act and maintains policies in Employee Privacy Workplace Violence, Harassment and Psychological Safety to ensure it provides safe and healthy working conditions for all employees.
Safety of women and girls	No risks identified to the safety of women and girls in local community as a result of project activity.	There are no risks to the safety of women and girls associated with this project. This project activity involves existing and new ecobee smart thermostats receiving the free thermostat optimization platform eco+ that reduces a home's incremental energy usage by controlling the HVAC equipment and thus poses no danger or harm to women and girls.
Safety of minority and marginalized groups, including children	No risks identified to the safety of children, minority and marginalized groups in local community as a result of project activity.	There are no risks to the safety of children, minority and marginalized groups associated with this project. This project activity involves existing and new ecobee smart thermostats receiving the free thermostat optimization platform eco+ that reduces a home's incremental energy usage by controlling the HVAC equipment and thus poses no danger or harm to children, minority and marginalized groups.
Pollutants (air, noise, discharges to water, generation of waste, release of hazardous materials)	No risks or impacts caused by pollutants identified as result of project activity.	There are no negative pollutant impacts associated with this project. This project activity involves existing and new ecobee smart thermostats receiving the free thermostat optimization platform eco+ that reduces a home's incremental energy usage by controlling the HVAC equipment. Project activity reduces pollutants such as PM2.5 in addition to reducing CO ₂ emissions.

2.3 Respect for Human Rights and Equity

2.3.1 Labor and Work

Use the table below to demonstrate the project's respect for rights related to work and labor.

Discrimination and sexual harassment	This project activity involves existing and new ecobee smart thermostats receiving the free thermostat optimization platform (eco+ and "Adjust for Humidity") that reduces a home's incremental energy usage by controlling the HVAC equipment. The thermostat optimization platform was developed and continues to be implemented and maintained by a team of 30+ product managers, data scientists and software engineers. ecobee is an Equal Opportunity Employer, adheres to Employment Standards Act, Accessibility for Ontarians with Disability Act, Occupational Health and Safety Act and maintains policies in Employee Privacy Workplace Violence, Harassment and Psychological Safety.
Management experience	Same as above.
Gender equity in labor and work	Same as above.
Human trafficking, forced labor, and child labor	Same as above.

2.3.2 Human Rights

ecobee's parent company Generac Power Systems, is a member of the Responsible Business Alliance¹⁸ (RBA), the world's largest industry collation dedicated to response business conduct in global supply chains and endorses a policy regarding the Fighting Against Forced Labour and Child Labour in Supply Chains Act. As a subsidiary of Generac, ecobee adheres to the RBA's Code of Conduct commitment that includes establishing systems and structures necessary to ensure the business does not infringe on workers rights nor the wellbeing of their communities.

The project activity does not involve any persons, work or labor that would contravene international human rights law, and UN declarations and conventions. This project activity involves an energy efficiency enhancement deployed through a free thermostat optimization platform (eco+ and 'Adjust for Humidity') that reduces a home's incremental energy usage by controlling the HVAC equipment.

2.3.3 Indigenous Peoples and Cultural Heritage

This section is not applicable as the project activity itself does not infringe on the rights of indigenous peoples and their cultural heritage. This project activity involves an energy efficiency enhancement deployed through a free thermostat optimization platform (eco+ and 'Adjust for Humidity') that reduces a home's incremental energy usage by controlling the HVAC equipment.

2.3.4 Property Rights

¹⁸ Responsible Business Alliance. Members. <https://www.responsiblebusiness.org/about/members/>

Using the table below, describe the property rights of IPs, LCs, and customary rights holders and demonstrate respect of such rights.

Rights to territories and resources	Not applicable.
Respect for property rights	Not applicable.

2.3.5 Benefit Sharing

Process used to design the benefit sharing plan	Not applicable.
Summary of the benefit sharing plan	Not applicable.
Approval and dissemination of benefit sharing plan	Not applicable.

2.4 Ecosystem Health

	Risks identified	Mitigation or preventative measure taken
Impacts on biodiversity and ecosystems	No risk or impacts on biodiversity and ecosystems identified	This project activity involves an energy efficiency enhancement deployed through a free thermostat optimization platform (eco+) that reduces a home's incremental energy usage by controlling the HVAC equipment. The project activity itself does not involve any risks or impacts to the environment, including biodiversity, ecosystems, soil degradation, soil erosion, water consumption and stress.
Soil degradation and soil erosion	No risk of soil degradation and soil erosion identified.	Same as above.
Water consumption and stress	No risk of water consumption and stress identified.	Same as above.
Usage of fertilizers	No risk to fertilizers identified.	Same as above.

2.4.1 Rare, Threatened, and Endangered species

Is the project located in or adjacent to habitats for rare, threatened, or endangered species?

☐ Yes ☒ No

Species and habitat	Not applicable as project is not located in or adjacent to habitats for rare, threatened or endangered species.
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2.4.2 Introduction of species

This section is not applicable to this project activity.

2.4.3 Ecosystem conversion

This section is not applicable to this project activity.

3 APPLICATION OF METHODOLOGY

3.1 Title and Reference of Methodology

Type (methodology, tool or module).	Reference ID	Title	Version
Approved VCS Methodology	VM0008	Weatherization of Single Family and Multi-Family Buildings – Sectoral Scope 3	1.1

3.2 Applicability of Methodology

VM0008 methodology has the following applicability criteria, and the right column describes how this project activity complies with each criterion:

Applicability Conditions	Justification of project compliance
<i>The condition of the Dwelling shall be and remain adequate for Project activities according to nationally recognized Weatherization best practice standards. Project activities may not result in a violation of health and</i>	The project meets this applicability condition. Dwellings apart of project activity maintains a heating, ventilation, and air-conditioning (“HVAC”) system – a system and condition of the dwelling commonly required by local state building codes and regulations. In the USA, federal regulations provide the framework for the U.S. Department of Energy’s Weatherization Assistance Program¹⁹ (WAP). These rules and regulations give state and local weatherization program guidelines to provide energy efficiency improvements in low-income household dwellings and is considered the nation’s single largest residential whole-house energy efficiency program. The WAP maintains a list of approved weatherization measures²⁰ and initiatives that covers mechanical measures, building shell measures, health & safety, electric baseboard measures and client education activities. Of the mechanical measures, “installing a programmable thermostat” is listed as a weatherization best practice to improve the energy efficiency of a residential HVAC system. Dwellings that have installed a smart thermostat meet U.S. weatherization best practices as smart thermostats are considered an advanced type of programmable thermostat. A

¹⁹ Office of State and Community Energy Programs. About the Weatherization Assistance Program. <https://www.energy.gov/scep/wap/about-weatherization-assistance-program>

²⁰ Office of State and Community Energy Programs. Whole-House Weatherization. <https://www.energy.gov/scep/wap/whole-house-weatherization>.

safety, environmental, or other relevant regulations.	programmable thermostat is a device that regulates a home's temperature by controlling HVAC equipment. A programmable thermostat allows a user to designate specific temperature set points for specific times and days of the week. In order for programmable thermostats to be effective in delivering energy savings, customers are required to take action by programming and properly maintaining a schedule. What distinguishes smart thermostats from programmable thermostats is that smart thermostats are Wi-Fi-enabled and connect with an application on a smartphone or tablet, which allows users to monitor and control their heating and cooling remotely. This connectivity allows for enhanced functionality that can automate energy management through features and user settings. The connectivity of smart thermostats also enables the runtime of HVAC equipment to be recorded through device level embedded metering.
The replacement Appliances and mobile homes must replace functioning Appliances, and/or occupied homes.	This criterion is not applicable as the project does not involve the replacement of appliances or mobile homes.
The Dwelling must be occupied. Vacancy is permitted on an intermittent basis for up to three months, or if the Dwelling is occupied seasonally on an annual basis.	The project meets this applicability condition. ecobee maintains a database of information that is collected and recorded by ecobee devices, including 1) telemetry HVAC runtime data (i.e., record of when HVAC equipment is on or off), 2) motion events (i.e., detection of motion within the vicinity of the device and/or detection of motion from external room sensors) and 3) temperature set point holds (i.e., temperature holds manually set on the device or in-app). These data points in combination with an active internet connection meets the applicability condition. To demonstrate how these data points and an active internet connection are used together to meet the applicability condition, ecobee performed an occupancy analysis on a sample group of 111,282 devices that includes both the control and treatment group. The analysis reviewed the percentage of devices that registered 288 motion events in 3-month periods or had registered 12 set point holds on the device. ecobee used a threshold of 288 motion events as this represents 288 5-minute intervals within 24 hours / 1444 minutes in a day and threshold of 12 set point holds in any 3-month period. 288 instances of motion and 12 set point change in any 3-month period were determined to be a very strong indicator to infer a dwelling is occupied. For instance, if a device registered at least 3 motion events a day, that device would exhibit 270 motion events (3 events x 90 days) and if a set point hold was made once a week, that device would exhibit 12 set point holds in 3-month period. To satisfy the applicability condition which notes "dwelling must be occupied. Vacancy is permitted on an intermittent basis for up to 3 months, or if dwelling is occupied seasonally on an annual basis," the events were applied in 3-month blocks to account for any intermittent vacancy that took place up to 3 months. The applicability condition considers a dwelling occupied even when the dwelling is vacant for up to 3 months. For the purposes of this occupancy analysis, any 3-month block that did not have 288 instances of motion or 12 set point holds made on the device was inferred as unoccupied or inconclusive. The analysis takes into consideration the following: • There are 111,282 devices in the analysis • There are 2 monitoring periods = 24 months • In 24 months, there are 8 blocks of 3-month periods • Each of the 111,282 devices has 8 blocks of 3-month periods

- In each 3-month block, does the device exhibit 288 motion events or register 12 set point holds made on the device? If yes, how many of those 3-month periods meet the motion event threshold?

The results are as such:

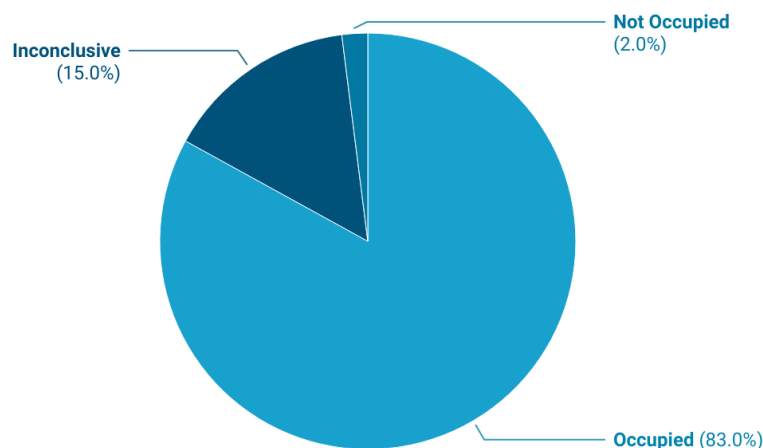
- 83% of 3-month periods contained in the sample featured 288 motion events or 12 set point hold were made on the device. Based on these results, ecobee infers these devices are in occupied homes.
- 2.0% of 3-month periods contained in the sample featured less than 288 motion events and experienced no set point hold made on the device. Based on these results, ecobee infers these devices could be in unoccupied homes.
- 15% of 3-month periods contained in the sample corresponded to devices without motion detection capabilities (i.e., ecobee3 lite without SmartSensor) and featured no set point holds made on the device. Based on these results, ecobee cannot make an inference on the occupancy of the home (ie., inconclusive).

This project activity meets the applicability condition as demonstrated by the results of the analysis. By reviewing a combination of data sets (motion events and setpoint holds made on the device), ecobee infers 83% of homes in the project activity are occupied and not vacant for up to 3 months. These data points could only be measured and communicated from the dwellings to ecobee with an active internet connection. In other words, the analysis demonstrates that there is a strong correlation between these data sets collected from within dwellings with active internet connection and ecobee's ability to infer occupancy.

To be conservative, the results of this analysis (i.e., 83% of dwellings in sample group are occupied and meet applicability condition) is factored into claimed emission reductions for the evaluation period of Mar 03/2021 - Mar 02/2023 ([Claimed Emission Reductions] x [0.83]).

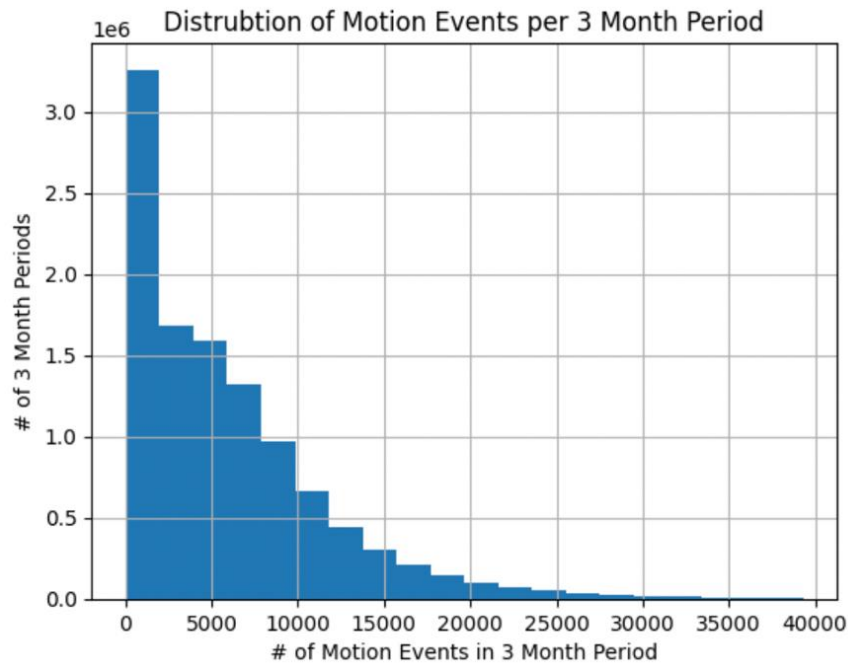
Please see below for illustrations of results from the occupancy analysis:

ecobee Carbon Project - Occupancy Analysis



The analysis reviewed percentage of devices in sample that featured 288 motion events or 12 set point holds in 3 month periods.

Created with Datawrapper



The capacity of any replacement Appliance or replacement component of a central heating/cooling system shall satisfy the post-retrofit heat load, cooling load and electricity demand (“Energy Load”) within the Dwelling.

This criterion is not applicable to the project as the project activity does not involve the replacement of any appliance or direct component of the heating/cooling equipment.

The project activity is only measuring and accounting for the incremental energy savings and emission reductions associated with eco+ and the “Adjust for Humidity” feature of ecobee smart thermostat devices. The project activity baseline is the heating and cooling loads of a home with an ecobee smart thermostat without eco+ and the “Adjust for Humidity” feature.

The project activity is not measuring the overall savings generated from the replacement of a previous thermostat with an ecobee smart thermostat as ecobee does not collect data on the previous thermostats in place prior to the installation of the ecobee device to use as the baseline condition. For those reasons, ecobee would not claim overall savings associated with thermostat replacement and this would not constitute a replacement of appliance or replacement component of a central heating/cooling system.

In case of heating/cooling systems that serve multiple Dwellings, all residential Dwellings connected to the system shall be included in the Project.

This criterion is not applicable. The ecobee thermostats included in this project activity control unitary HVAC units that serve a single and independent residential unit (i.e., detached house, semi-detached house, or apartment).

The Project must not be mandated or regulated by local or federal law or regulation.

The project meets the applicability condition. The project is in compliance with all relevant national, state and local regulations in the USA. The use of the project activity (the eco+ technology and the “Adjust for Humidity” feature) is not required by any law or regulation anywhere within the jurisdiction eco+ is deployed.

Please see Section 1.15 of PD for details on the U.S Department of Energy’s energy efficiency standards of more than 60 appliances and equipment products, of which smart thermostats and eco+ are not covered.

Please see Section 1.15 of PD for more details on California’s Building Energy Efficiency Standards and City of Austin’s Ordinance outlining the required functionalities of smart thermostats to be installed in new buildings, which do not require the project activity, eco+ and “Adjust for Humidity”.

The Dwelling must meet or exceed the performance benchmark as calculated for the Same Building Stock. As evidenced by data, dwellings exceeding this performance benchmark would, with 90% certainty, not have happened without the intervention created by the Project

This project activity meets the applicability condition. Demand Side Analytics (DSA) is able to calculate the performance benchmark and meet the protocol's definition of 'Same Building Stock' using ecobee's data which includes dwelling address, dwelling square footage and self-reported type of residence.

Performance benchmark meeting or exceeding 90%.

DSA employs a panel regression using lagged dependent variables and clustered standard errors to jointly measure additionality and quantify the impacts of customers enabling the eco+ software. Panel regressions allows DSA to test if the project activity (i.e., the effect of eco+) in any given month is statistically different than zero, which ensures that the measured changes to electricity usage are additional. VM0008 sets the performance benchmark as a value above average performance that represents a percent savings in energy consumption that dwellings are not likely to reach with 90% certainty in the absence of the project. DSA has used regressions to test the impact of the project activity in any given month that is statistically significant at 95% confidence level (i.e., more rigorous than 90%), which ensures the measured changes to electricity usage are additional.

The sample group of 111,282 total devices were divided into control and treatment groups, split between equipment types:

Equipment Type	Control	Treatment
Not Heat Pump	40,000	40,000
Heat Pump	11,282	20,000
Total	51,282	60,000

'Same building stock' means dwelling:

1) in the same state, province or region:

The control and treatment groups reside in similar climate regions across the contiguous USA:

Climate Region	Control	Treatment
Cold	31.40%	34.90%
Dry	12.69%	12.78%
Hot Humid	15.84%	21.23%

Marine	10.95%	4.70%
Mixed Humid	29.12%	26.38%
Total	100.00%	100.00%

2) In the same category (single family or multi-family):

The control and treatment groups reside in similar housing categories:

Housing Type	Control	Treatment
Apt/Condo	9.41%	9.56%
Detached	57.07%	59.89%
Semidetached	15.14%	10.97%
Other/NA	18.38%	19.58%
Total	100%	100%
Mean Sq Ft	2,568	2,665

3) Inhabited by same income group (low income, middle income or high income) as defined by a recognized authority:

DSA utilized zip code of control and treatment groups to evaluate dwellings inhabited by similar income groups. DSA assigned each zip code against the 2021 census household income²¹ quantiles. As demonstrated below, the distribution of zip codes of median income quantiles is similar between control and treatment group:

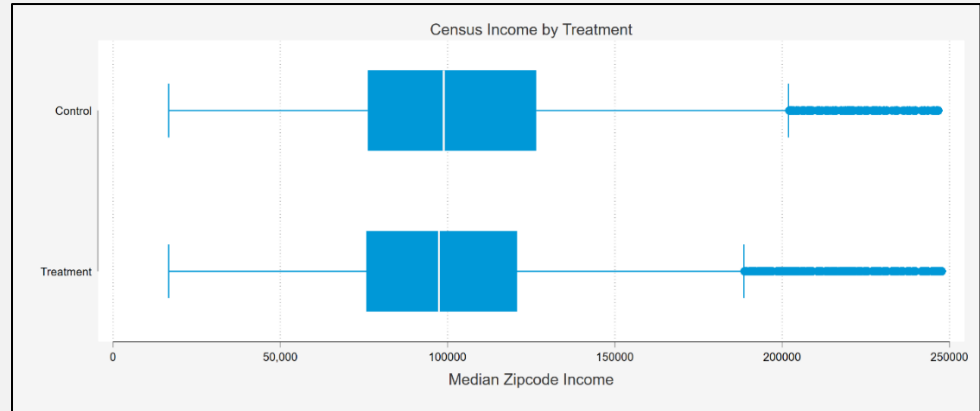
Share of zip code median income of households by Census Quintiles:

	Control	Treatment
Lowest Quintile \$0-\$28,007	0.06%	0.06%
Second Quintile \$28,008-\$55,000	6.39%	5.36%
Third Quintile \$55,001-\$89,744	33.23%	35.87%
Fourth Quintile \$89,745-\$149,131	47.24%	48.86%
Top Quintile >=\$149,132	13.08%	9.84%
Median Value	\$98,973	\$97,394

According to the 2021 poverty guidelines published by the US Department of Health and Human Services (US-HHS), a family of 4 earning \$26,500/year or less is considered to be at the poverty level. US-HHS classifies households making 200% or less than the poverty line as low income, or for a family of four - \$53,000. Of the treatment households in the sample, 4.44% resided in a zip code whose median income was below that threshold, compared to 5.51% of control households.

²¹ Tax Policy Center. Statistics. Household Income Quintiles 2021. Found on <https://www.taxpolicycenter.org/statistics/household-income-quintiles>.

Below is a visualization of income distribution between control and treatment group based on zip code. For each customer, DSA collected median zip code income from the American Community Survey 5-year 2022 data.



The methodology is applicable to weatherizing whole buildings, replacing mobile homes or implementing individual energy efficiency measures within existing Dwellings of Category A, B, C, or D.

Project activity is applicable to methodology VM0008 and falls under “Category B – Efficiency enhancement of the Building Envelope and central heating and/or cooling system only.”

The project activity does not involve fuel switching.

This criterion is not applicable as the project does not involve fuel switching.

In the case of “replacement” of a mobile home, the word “retrofit” shall be read to mean replacement throughout the methodology.

This criterion is not applicable as the project does not involve the replacement mobile homes.

The methodology may be applied in any geographic region, provided appropriate

This project activity is applied to the contiguous United States.

data exist to establish the level of performance benchmark for the Same Building Stock of a Project's geographic region.	
When sampling, the minimum number of Dwellings or appliances to be sampled shall be the square root of the total number of Dwelling i or Appliances included in the Project.	This project activity meets the applicability condition. Total number of devices i is 2.5 million, making the square root of sample size 1,581, exceeding 100 dwellings. The project activity maintains telemetry data and thus uses a larger sample. As sample size increases, the potential error introduced by sampling decreases. 1) Sample data was computer generated and randomly selected based on prescribed criteria. Data was selected in no particular order and not grouped. Stratified sampling and simple random sampling were used. Devices are stratified based on equipment type (heat pump or no heat pump)²². Then they are stratified based on whether they have the 'Adjust for Humidity' feature enabled. A simple random sample was drawn from within these four strata.
When the control group approach (Approach 3 in Part C. Emission Reductions and Monitoring Parameters) is utilized, the size of the control group shall be the square root of the total number of Dwellings in the Project, but need not exceed 100 Dwellings. In any sampling approach, the following conditions must be met: 1) The sample shall be statistically valid, and may be one of the following: a. Simple random sample b. Systematic sampling	2) Sample is representative of the population as same filters were applied to the treatment and control group sample and both groups include devices from all over the United States. The distribution of devices in the treatment and control group sample mirror ecobee's overall device footprint and the population of the US. The prescribed criteria for selection of sample data were: Thermostat model is one of: - ecobee3 - ecobee3 lite - ecobee4 - ecobee smart thermostat with voice control - thermostat has valid US zip code - thermostat in contiguous USA - thermostat first connected prior to March 1st, 2018 Based on the above, 4 sample groups were created based on the following criteria: a) Heat Pump Acceptors: - Has heat pump - "Adjust for Humidity" enabled > 95% of the time - Enrolled in eco+ prior to March 1st, 2021 b) No Heat Pump Acceptors: - No heat pump - "Adjust for Humidity" enabled > 95% of the time - Enrolled in eco+ prior to March 1st, 2021

²² ecobee confirms if heat pump was or was not installed during evaluation period by analyzing the "hasHeatPump" group's yearly runtime data that was recorded between March 2021 and February 2023. The recorded runtime data included 1) comp heat (compressor heat), 2) aux heat (auxiliary heat) and 3) comp heat + aux heat as heat pumps produces 3 sets of runtime data. Of the "hasHeatpump" devices that recorded aux heat runtime data at the beginning of evaluation period, 1.6% of devices recorded a combination of comp heat + aux heat runtime data by the end of the evaluation period. From this analysis, we infer that less than 2% of dwellings that only exhibited aux heat data at start of evaluation period may have installed a heat pump system to exhibit comp heat + aux heat runtime data at the end of evaluation period.

c. Stratified sampling within the Same Building Stock
d. Cluster sampling.

2) The sample must be representative of the population.

3) The data must come from an approved source, i.e. a certified energy auditor, or a nationally recognized data source.

4) Actions that may bias the sample shall be avoided. Sampling shall include Dwellings that are dispersed geographically. For each defined Building Stock included in the Project activity, sampling shall occur. Criteria include region, Dwelling type, and income

c) Heat Pump Deniers:

- Has heat pump
- Not enrolled in eco+

d) No Heat Pump Deniers:

- No heat pump
- Not enrolled in eco+

3) Data sources that were referenced for emission quantification of this project activity are nationally recognized, approved and accepted data sources.

Data	Source	Found in Project Activity
ecobee's thermostat run-time data / telemetry data	Nationally recognized and accepted data source by the U.S Department of Energy in its Uniform Method Protocol for smart thermostats which specifically allows for the use of thermostat runtime data and recommends a uniform method on how to use thermostat runtime data to quantify energy impacts ²³ Accepted data source used by the U.S Environmental Protection Agency as part of the ENERGY STAR® certification process to demonstrate field savings to meet certification requirements ²⁴	The dependent variable of the regression analysis and used as the basis for calculating project activity's emissions impact ²⁵ .
ecobee's Weather Data	Weather stations operated by or certified by the National Weather Service / National Oceanic and Atmospheric Administration	Temperature and humidity are used as explanatory variables in the regression analysis to explain variations in heating and cooling use and isolate the impact of the eco+ feature set ²⁶
Emissions and Generation Resource	Published by the U.S Environmental Protection Agency, a nationally recognized federal agency. eGRID provides emission factors that estimate emissions associated	Used to calculate the emission avoidance from reduction in electric HVAC system runtime ²⁷ . eGRID

²³ In section 3.2.2 of the protocol, the DOE supports the use of thermostat runtime/telemetry data as appropriate for measurement and verification by stating: "Because thermostat telemetry data are usually available for the periods before, during, and after the optimization for both participants and nonparticipants, evaluators can construct accurate baseline HVAC runtimes and estimate the optimization savings." (<https://www.nrel.gov/docs/fy23osti/86175.pdf>)

²⁴ ENERGY STAR Connected Products Method, developed by the EPA provides framework for evaluating energy savings associated with connected thermostats. Telemetry data, which includes real-time or near real time data transmission can be utilized within this method to demonstrate field savings. Equipment type and interval dates are metadata fields required to measure percentage in run time reduction. ENERGY STAR Connected Thermostat Products. Method to Demonstrate Field Savings Version 1.0 (rev. Dec-2016). <https://www.energystar.gov/sites/default/files/Version%201.0%20Method%20to%20Demonstrate%20Field%20Savings%20of%20ENERGY%20STAR%20Connected%20Thermostats.pdf>

²⁵ Telemetry data / run-time data were used in regression models found in PD Appendix D – Regression Model Outputs.

²⁶ Controlling for weather and use of lagged dependent variables were applied in regression model found in Appendix D of PD.

²⁷ Marginal emissions rates from the EPA's AVOID Emissions and geneRation Tool (AVERT) rather than average emissions rates from the EPA's eGRID, are the appropriate rates for assessing the impact of energy efficiency programs because such programs reduce emissions at the margins. Often, especially during the highest demand days when eco+ generates greatest impact, the marginal electricity plant (ie., the most expensive plant) is far more polluting than the average electricity plant. Base load plants with low or no marginal cost (ie., renewables and nuclear) are never turned off if they can generate electricity. When eco+ lowers demand for the system, the grid reduces supply from the plants with the highest marginal cost, which are often natural gas, diesel, or coal plants. AVERT is the preferred source of marginal emissions rates because it is specifically designed to capture marginal rates, rather than EPA's eGRID which focus on average weights. However, out of an abundance of conservatism, DSA calculated emissions reductions using average emissions rates. This demonstrates how

Integrated Database (eGRID) emission factors	with electricity generation in different regions of the US.	used to demonstrate avoidance of average emissions rather than marginal emissions ²⁸ .
Conversion of natural gas savings to CO ₂ e (117 pounds per MMBtu)	Published by the US Energy Information Administration (EIA) ²⁹	Used to calculate the emissions avoidance from reductions in fossil fuel heating system runtime
HVAC Connected Load Assumptions	Published by state-level agencies, Technical Reference Manuals (TRM) are nationally accepted sources by the U.S Department of Energy in its Uniform Method Protocol ³⁰ for obtaining runtime-to-energy conversion factors ³¹ .	Used in equations converting seconds of runtime to reduced MWh or MMBtu for appropriate HVAC system (heat pump or non-heat pump)

4) Actions that could bias the sample were avoided at each stage of the analysis. Sampling includes dwellings that are dispersed across USA's 5 climate region (cold, dry, hot humid, marine, mixed humid), dwelling types (apartment/condo, detached, semi-detached and other), and HVAC equipment (heat pump or non-heat pump).

3.3 Project Boundary

Define the project boundary and identify the relevant GHG sources, sinks and reservoirs for the project and baseline scenarios (including leakage if applicable). Add rows as needed.

Source		Gas	Included?	Justification/Explanation
Baseline	Grid electricity consumption by heating/cooling systems or other electric appliances	CO ₂	Yes	Only CO ₂ emissions from grid connected electricity generation shall be accounted for.
		CH ₄	No	
		N ₂ O	No	
		Other	No	

the project activity has taken the most conservative approach in calculating emission reductions even though marginal emission rates from AVERT could be considered applicable to this project activity. DSA used EPA's 2022 Emissions & Generation Resource Integrated Database to quantify emissions impacts presented in PD and Monitoring Report to be conservative. eGRID average emission factors referenced in Appendix C – EPA Emission Factors of PD and in CO₂ Dashboard excel file.

²⁹ Converting reduction in natural gas savings (MMBtu) to CO₂ savings. U.S. Energy Information Administration. Natural gas explained. <https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php#:~:text=About%20117%20pounds%20of%20CO,MMBtu%20of%20distillate%20fuel%20oil.>

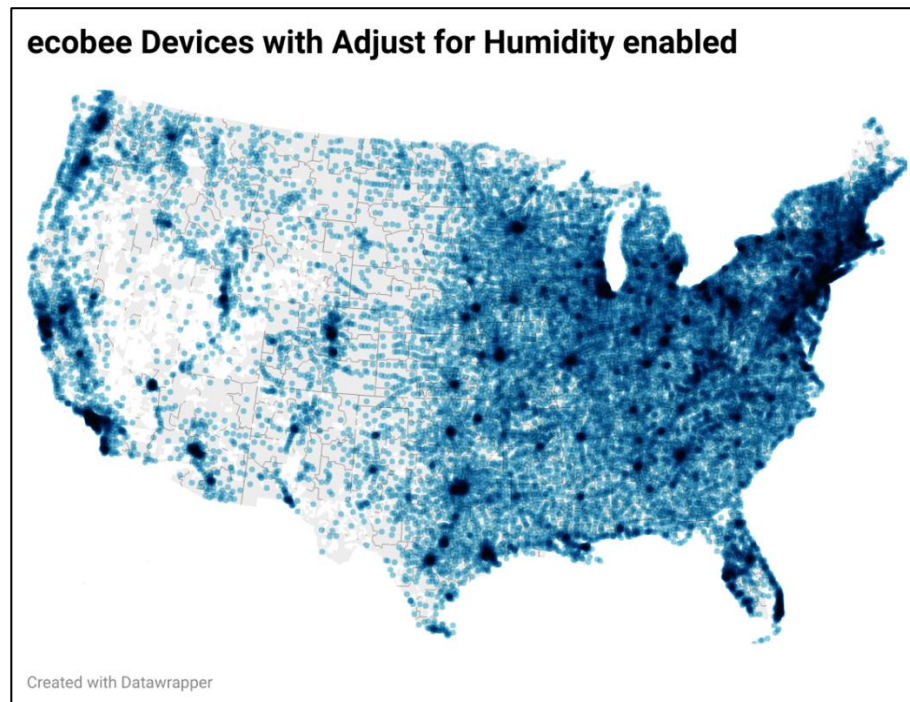
³⁰ In section 3.2.3.2.1 protocol, the DOE supports the use of using connected load assumptions from regional technical reference manuals by stating, "The most widely used approach for obtaining runtime-to-energy conversion factors is to draw from region-specific technical reference manuals (TRMs)." (<https://www.nrel.gov/docs/fy23osti/86175.pdf>)

³¹ Connected load assumptions found in Appendix A of PD and connected load research found in Appendix B of PD.

Source		Gas	Included?	Justification/Explanation
	Fossil fuel consumption by heating systems	CO ₂	Yes	Only CO ₂ emissions from fossil fuel combustion shall be accounted for.
		CH ₄	No	
		N ₂ O	No	
		Other	No	
	Emissions from wood combustion for heat	CO ₂	No	Not applicable.
		CH ₄	No	
		N ₂ O	No	
		Other	No	
Project	Grid electricity consumption by heating/cooling systems or other electric appliances	CO ₂	Yes	Only CO ₂ emissions from grid connected electricity generation shall be accounted for.
		CH ₄	No	
		N ₂ O	No	
		Other	No	
	Fossil fuel consumption by heating systems	CO ₂	Yes	Only CO ₂ emissions from fossil fuel combustion shall be accounted for.
		CH ₄	No	
		N ₂ O	No	
		Other	No	
	Emissions from wood combustion for heat	CO ₂	No	Not applicable.
		CH ₄	No	
		N ₂ O	No	
		Other	No	
Leakage	Emissions from improper disposal of	CO ₂	No	Not applicable.
		HFC	No	

Source	Gas	Included?	Justification/Explanation
appliances (e.g. refrigerators)	CH ₄	No	
	N ₂ O	No	
	Other	No	

The project boundary is the geographical boundary of contiguous United States with the coordinates of 39.9023, -100.1146, where 2,524,333 ecobee smart thermostats with eco+ and 'Adjust for Humidity' reside in 62% of US zipcodes. This is illustrated in the map below. Each dot on the map represents U.S. zip codes with ecobee smart thermostats with eco+ and "Adjust for Humidity".



3.4 Baseline Scenario

The baseline scenario represents the conditions most likely to occur in the absence of the project. This project activity falls under Category B: Efficiency enhancement of the Building envelope and/or central heating/cooling system whereby *"the baseline scenario consist of fossil fuel consumed to satisfy the heat and cooling load prior to project implementation. Electricity shall only be included when it is a heating or cooling source within the Dwelling. Appliances and their corresponding electricity consumption shall not be included"*

Baseline Scenario for Category B – Control Approach

Please refer to Section 1.14 – Conditions Prior to Project Initiation.

The baseline scenario for this project activity is the heating and cooling loads of a home with an ecobee thermostat without eco+ and “Adjust for Humidity”. The “Adjust for Humidity” feature saves energy and reduces emissions through “offsets” of the thermostat setpoints. In the winter or cooler months, the feature lowers heating setpoints and reduces energy used for heating. In the summer or warmer months, the feature increases cooling setpoints and reduces energy used for cooling. An illustration is provided in Section 1.12 (Figures 3, 4, and 5) to demonstrate the feature’s function.

To further elaborate the baseline and project scenario, consider a home with a 75 °F (22 °C) setpoint in the summer and a 65 °F (18 °C) thermostat setpoint in the winter. The heating and cooling loads of this home, given the climate and home construction attributes, is the baseline scenario. If the “Adjust for Humidity” feature implements an average offset of 0.5 °F, the executed setpoints are changed to 75.5 °F (24 °C) in the summer and 64.5 °F (17.5 °C) in the winter. The project scenario is the heating and cooling loads of the home under these executed setpoints made by the “Adjust for Humidity” feature. As the executed setpoints lower the differential between outdoor temperature and setpoint, the heating and cooling loads are lowered.

The baseline scenario is estimated using both the treated thermostats in the pre-period and the control group devices in the pre and post-period. DSA uses telemetry data from 50,000 ecobee devices in the same housing stock on the same day without the “Adjust for Humidity” feature to model the baseline scenario. These devices experience an offset of 0.00°F and thus the heating and cooling loads are what the treated homes heating and cooling load would be in absence of the project activity.

3.5 Additionality

VM0008’s procedure for demonstrating additionality is outlined below:

A Project shall demonstrate additionality for project activities in category A, B or C using the Performance Method that incorporates the performance benchmark.

*The **Performance Method** provides as follows:*

Category B: *Efficiency enhancement of the Building Envelope and/or central heating/cooling system: The percent savings in the pre- and post-retrofit Energy Load of each Dwelling in the Project shall be equal to or greater than the performance benchmark. The performance benchmark is the same as defined in Category A (which is the performance benchmark is a value above average performance that represents a percent savings in energy consumption that Dwellings are not likely to reach with 90% certainty in the absence of the Project). Although Category B comprises measures to the Building Envelope only, the same performance benchmark can be used if the percent savings is calculated for the entire energy consumption of the Dwelling and not just for the consumption of heating and cooling energy. This way, savings achieved under the Project are comparable to overall trends. By broadening the base, savings from the Project are diluted. They would be higher if calculated for the savings in heat and cooling energy alone.*

The performance benchmark for Category B, x, shall be calculated as follows³²:

For data following a normal distribution:

The performance benchmark is based on the standard deviation of the sample.

Equation 1

$$x = a + 1.85\sigma$$

Where:

x = Performance benchmark

a = Average performance³³

σ = Standard deviation (sigma) of the percent savings in the Same Building Stock Energy Load

For data not following a normal distribution:

The performance benchmark is equal to the 90th percentile value within the numerically ordered sample. To calculate the 90th percentile the sample data point values ($v_1, v_2, \dots, v_N$) must be ordered from least to greatest. The 90th percentile value is equal to the value of the data point with the rank at which 90% of the data falls below.

Equation 2

$$a. \quad n = (NP_{90} / 100) + 0.05$$

b. x = the value of the data point at rank n calculated in equation 2a.

Where:

x = Performance benchmark

n = Rank of the ordered data point falling at the 90th percentile

N = Total number of data points included in the sample

P_{90} = 90th percentile

To be additional, Dwellings must satisfy the following condition:

Equation 3

$$\frac{EL_{Pre, i} - EL_{post, i}}{EL_{Pr}} * 100 \geq x_{e, i}$$

³² Under a normal bell curve distribution, the mean plus or minus 2σ encompasses 95% of the statistical sample. Therefore 97.5% of the data falls below the value x, if x is calculated as the mean plus 2σ . A 90% likelihood of the data falling below the value x is calculated as the mean plus 1.85σ .

³³ To correct for any potential increase in electricity consumption due to an increase in electric appliances, the statewide percent increase in electricity consumption, as reported by the U.S. Department of Energy or other recognized authority, will be added to the value of the average performance to make the performance benchmark even more rigorous and conservative if such electricity data are reasonably available and it is feasible to do so. For example, in the US the value of the increase in regional electricity consumption may be obtained from the following website: http://apps1.eere.energy.gov/states/state_information.cfm

Where:

$EL_{pre, i}$ = Pre-retrofit energy load of Dwelling i

$EL_{post, i}$ = Post-retrofit energy load of Dwelling i

Demand Side Analytics, LLC and Using Panel Regressions to Quantify Project Activity Emission Reductions

ecobee has enlisted Demand Side Analytics, LLC (DSA), a third-party evaluation, measurement and verification firm, to analyze and quantify this project activity's emission reductions. DSA was enlisted for their expertise on data driven research and insights and on predictive and casual analytics. DSA offers extensive expertise in evaluation, measurement and verification (EM&V), distributed energy resource integration, transmission and distribution system planning, targeting analytics, and benefit cost analysis. The strength of their team is that they provide access to true experts. The team includes data scientists, applied statisticians, economists, and engineers. The experts involved in the development of the regression model and quantification of ecobee's project activity emission reductions are:

- **Partner and Applied Statistician** whose work is centered around estimating the impacts of demand side interventions to alter the way homes and businesses use energy. Their experiences include 10+ years in the energy industry performing evaluation, measurement and verification (EM&V) on a wide variety of demand response, dynamic pricing, and energy efficiency programs implemented across North America. They specialize in statistical analysis of energy usage data, sampling, experimental design, and benefit cost modeling and is comfortable working in Stata, SAS, SQL, and Excel. They hold a Bachelor's of Science in Psychology and a Master's of Science in Applied Statistics from Kennesaw State University.
- **Consultant**, who has extensive training in causal inference and experimental design and has experience working in economics at both think tanks and in the private sector. They hold a Ph.D. in Agriculture and Resource Economics from UC Berkeley, where their research focused on using large datasets to study energy efficient and climate-friendly consumer products, and where they taught a course on energy markets.
- **Quantitative Analyst, Data Scientist** with a background in economics, specializing in causal inference research designs applied to real-world problems and has contributed to demand response evaluations in multiple states. Their expertise lies in leveraging predictive modeling techniques, including machine learning algorithms, to drive actionable insights from complex datasets and they hold a Master's Degree in Economics from the University of Texas at Austin.

DSA's quantification model employs a panel regression using lagged dependent variables³⁴ and clustered standard errors to jointly measure 1) additionality and 2) quantify the impacts of ecobee devices with eco+ and "Adjust for Humidity".

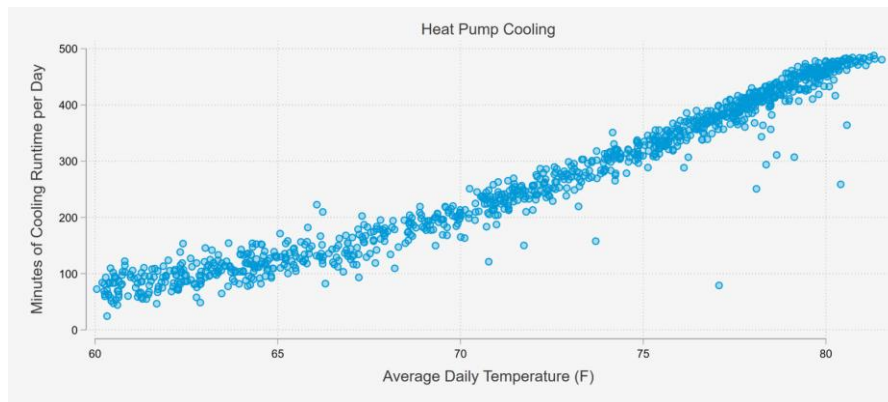
For this project activity, panel regressions are the most suitable approach for evaluating energy usage of energy efficiency activities of HVAC systems in buildings. As noted by the National Renewable Energy Laboratory³⁵ and given the wealth of data recorded by ecobee devices, regressions are the best approach to control for unobserved trends in electricity use and allows for more flexibility in controlling for temperature rather than relying on a correction factor. It is the only approach suitable to assess energy consumption data. Regression, more specifically ordinary least squares (OLS) regression, is the preferred method of casual inference according to the Nobel Prize winners Josh Angrist and his co-author Jorn-Steffen Pischke. In their book *Mostly Harmless Econometrics*, "regression can be used to approximate experiments in the absence of random assignment." OLS regression provides the best linear unbiased estimators (the Gauss-Markov theorem³⁶) and when there are omitted variable bias due to non-random selection.

³⁴ In a panel regression analysis, a lagged dependent variable refers to the value of the dependent variable from a previous time period or period of observation. Panel data typically involves observing multiple entities (such as individuals) over multiple time periods. When including a lagged dependent variable in a panel regression model, it is essentially using past values of the dependent variable as an explanatory variable for its current or future values.

³⁵ Agnew, K. and Goldberg, M. (2016). Chapter 8: Whole-Building Retrofit with Consumption Data Analysis Evaluation Protocol – The Uniform Methods Project: Methods for Determining Energy Efficiency Savings for Specific Measures. National Renewable Energy Laboratory. <https://www.nrel.gov/docs/fy17osti/68564.pdf>

³⁶ The Gauss-Markov theorem states that the OLS estimator is the best linear unbiased estimator and give five conditions: linearity, random sampling, non-collinearity, exogeneity, and homoscedasticity.

1. Linearity: this condition is never possible to prove, but the assumption is a common one used in all regression analysis. This means that all parameters have a mathematical transformation that allows them to have the same marginal effect regardless of value. The relationship between outdoor temperature and heating/cooling consumption across the heating/cooling range is widely accepted to follow a linear relationship. We create the CDD and HDD terms to separate cooling and heating operation, allowing and satisfying the linearity assumption. The figure below shows average daily cooling runtime as a function of outdoor temperature and reveals a classic linear relationship.



2. Random Sampling: DSA took random samples conditional on treatment from the population, so this condition is satisfied. Note, this assumption *does not* assume random assignment of treatment.
3. Non-Collinearity: the regressors are not perfectly correlated with each other. This condition is satisfied by dropping one of the values of the months from the vector of month variables when calculating the month fixed effects. Without dropping one month from that control vector, the regression would be impossible to solve for. This has no effect on the values of the estimates of βt and only slightly changes the interpretation of the betas calculated for the

Regression allows the analysis to include controls that correct for bias and discovery of causal relationship. It is for these reasons that the project activity is employing a panel regression to quantify the baseline and project emissions.

Panel regressions enable DSA to assess whether the effect of eco+ in each month differs significantly from zero, thereby confirming that any observed changes in electricity usage are additional. VM0008 defines a performance benchmark above average, representing energy savings that dwellings are unlikely to achieve with 90% certainty without the project. DSA employs regressions to rigorously test the project's impact each month at a 95% confidence level (more rigorous than 90%), ensuring that changes in electricity usage measured are indeed in addition to the baseline usage.

This approach is analogous to **Equation 1** and **Equation 3** of VM0008 Performance Method, because the energy usage of homes and impact of the treatment (ie., eco+) is distributed normally. As the usage data is normally distributed, Equation 1 was considered instead of Equation 2. As a reminder, Equation 1 computes x , the benchmark:

$$x = a + 1.85\sigma$$

Where a is the average performance of all housing stock, σ is the standard deviation of the performance of all housing stock. a is defined as: “the annual average percent savings in weather normalized energy consumption in Dwellings from the Same Building Stock over the three most recent years for which data are available”, and should be corrected for any statewide changes in electricity usage for the current year by “the statewide percent increase in electricity consumption, as reported by the U.S. Department of Energy or other recognized authority, will be added to the value of the average performance”.

To translate that into DSA's frequentist approach, a is the average performance of all treated homes in the treatment period if they had been untreated. While a is ultimately unknowable, DSA makes an estimate of a by taking a sample of all ecobee customers, sampling equally from 1) customers who accepted the treatment and 2) customers who did not the treatment (ie, control group), and using that to estimate the lagged dependent variable OLS regression:

time fixed effects, which are of no interest to us anyway. This is a very common way of dealing with the non-collinearity condition.

4. Exogeneity: This is the most important condition and is often referred to as the zero conditional mean assumption. This states that there are no confounding variables that are omitted from the regression that are included in the error term. For instance, if weather was omitted then the effect of weather on HVAC runtime would then be loaded into the error term. If we had a truly random experiment, that might be okay, since treatment and control samples would experience the same weather on aggregate, but since we have non-random treatment, we need to include weather in the regression. Other non-observable factors likely played into the decision to self-select into treatment, so we use a lagged dependent variable as well, which allows us to not only use the controls of non-treated customers, but the control of the treated customers before treatment, which removes the selection into treatment bias and maintains exogeneity.

5. Homoskedasticity: This condition states that the error term is consistent across all values of the explanatory variables. If it was not, then we might calculate error terms that are too low. In practice, this condition is almost never met, so researchers use different standard errors that are larger and robust to heteroskedasticity, essentially increasing the standard errors to account for this variation in the size of the error term. We do this when we cluster our standard errors by household. By making this correction, we may fail to reject the null hypothesis when we should have (type 2 error), but we ensure that our 95% confidence intervals never reject the null hypothesis when it should not have (type 1 error).

$$y_{it} = \beta_t m_t c_i + y_{it-1} m_t + m_t + cdd_{it} + hdd_{it} + h_{it} + d_t + \varepsilon_{it}$$

Ultimately a is analogous to the estimated value of y_{it} (the number of seconds the heating or cooling that is running for person i on day t) when $c_i = 0$ (where c_i is an indicator value of treatment) and where t is a post treatment time period. To ensure this estimate is weather normalized, DSA includes weather controls (heating degree days hdd_{it} , cooling degree days cdd_{it} , and humidity h_{it}). To ensure this is the same building stock, DSA uses the exact same homes, but before treatment as controls (in the form of the lagged dependent variable (y_{it-1})). To ensure this is controlled for the current year statewide trend in energy savings, DSA uses the untreated controls to help estimate year/month (m_t) and day of week (d_t) controls.

As this is a frequentist methodology, DSA does not use the standard deviation of a , but does apply something analogous and more direct. DSA calculates the estimated effect of being in the treatment group during treatment (that effect is represented by β_t), as the impact of using the eco+ technology. Since this is a regression, that estimated treatment effect has its own standard deviation. DSA only count estimates of β_t if they are statistically different than zero at the 95% confidence level. This test which measures the noisiness of the treatment effect is analogous to adding 1.85σ in Equation 1, but in VM0008's 1.85σ , it measures the total home energy usage as a whole. VM0008's Equation 1 is less conservative than DSA's frequentist methodology because it includes false positive results from the energy usage of an entire home, while DSA limits energy usage to only the treatment effect of eco+ on the HVAC equipment.

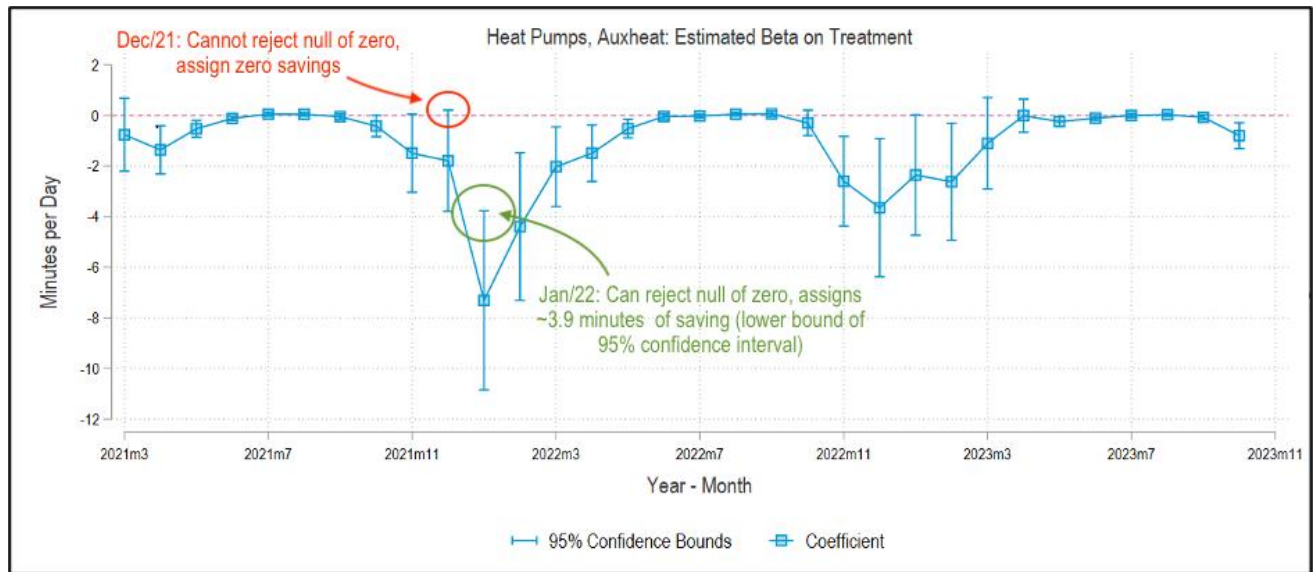
The statistical test that DSA runs on each month/cooling/heating method's estimate of β_t is also analogous to VM0008's **Equation 3** which describes that, in order for each home to be considered additional, the home's change in energy usage must be above the benchmark. Rather than conducting an energy usage evaluation on every home in the project activity for additionality, DSA uses an approach whereby they either 1) reject the null hypothesis that eco+ treatment has a positive savings effect on the population of treated homes for a certain type of HVAC use in a certain month, or 2) cannot reject the null hypothesis that there is no effect from eco+ on the population as a whole, in which DSA continues to assume that the effect of eco+ is zero for cooling or heating method in a certain month.

This avoids including some number of homes that, by random chance, exhibit low energy usage during months where no treatment effect is observed on the whole for a certain month (for instance, the effect of eco+ on heating during summer months). Since DSA is estimating the effect of treatment on treated homes, it makes sense to include all of the treated homes in that estimate. If DSA excluded homes that have a lower sensitivity to treatment, then DSA would likely accept an effect that in reality, did not exist and their estimate of the size of the effect would go up. While all treated homes are included in the additionality estimate, those with smaller reductions in energy usage drag down the total estimate of the impact of the treatment.

DSA applies greater conservatism in their methodology than VM0008's Equation 3. For instance, if a month's β_t passes the statistical 95% confidence test, DSA's best guess for the true value of being in the treatment group is β_t . Instead of using β_t , DSA uses the lower bound of the confidence interval around β_t . This would be analogous to reducing the additionality estimates for each dwelling by 1.96σ (1.96 because DSA use 95% CI, not the 90% suggested by VM0008).

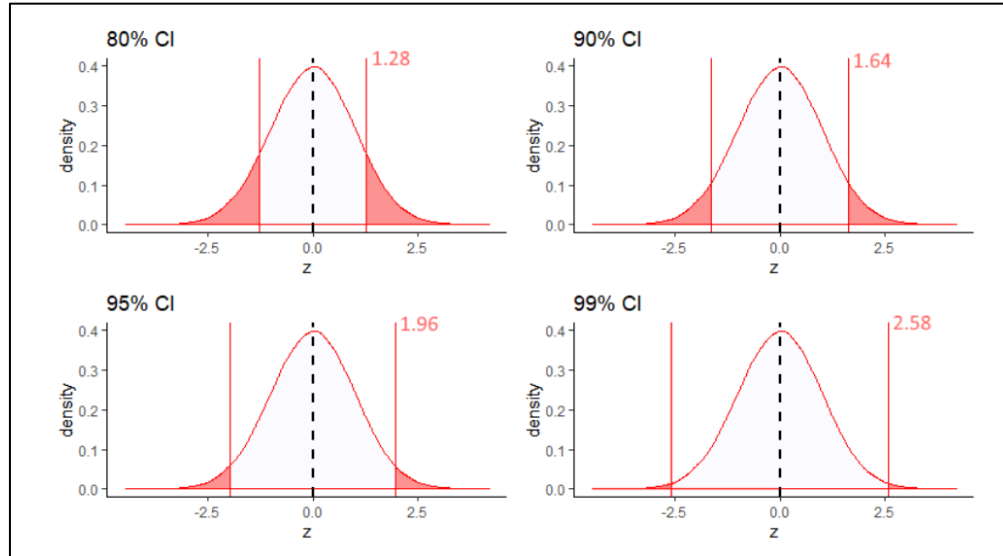
As an illustration, the point estimates of β_t for treatment's effect on the usage of heat pump-auxiliary heat customers is displayed in the figure below. The whiskers around each point estimate represent the 95% confidence interval. For most months, no effect of treatment is estimated, but the coldest months have larger treatment effects. For January 2022, DSA estimates a treatment effect of nearly 3.9 minutes a day, and since the confidence interval does not include zero, they reject the null and accepts the lower bound of the point estimate as the true value of treatment for that month (circled in green). However, in the month of December

2021, DSA estimates an impact of treatment of 2 minutes per day, but the null hypothesis of zero is included in the confidence interval (circled in red), so they cannot reject the null, and therefore assign no savings to the auxiliary heat components of heat pumps systems for December 2021.



While it's true that there were some customers in the treatment group in December 2021 that probably had large reductions in the use of their heat pump -auxiliary heating after controlling for weather, time fixed effects, and customers past usage (the lagged dependent variable), in aggregate, DSA cannot say with 95% confidence that the change over the entire population of treated customers was significant consistent enough to be the result of treatment, and not due to chance alone for the particular month.

Use of the lower bound of the 95% confidence is more conservative than using the lower bound of the 90% confidence interval because the 95% confidence interval is wider. The image below shows four identical normal distributions. With a 90% confidence interval, 10% of the area under the curve sits outside the interval. With a 95% confidence interval, only 5% of the area is outside the interval. This means that the lower bound of 95% confidence interval is further left. Selecting the lower bound of the 90% confidence interval would (a) mean a less stringent performance benchmark than 95% confidence interval meaning fewer months are zeroed out and (b) returns a lower estimated quantity of CO₂ avoided for those month that satisfy the performance benchmark.



Sampling for Panel Regression Model

When eco+ was rolled out to all ecobee customers, customers had the option to enable the software or not enable it, effectively self-selecting and creating a control group (deniers of eco+) and treatment group (acceptors of eco+) to sample from. To minimize bias introduced by the non-randomized selection into the treatment group, DSA constructed the sample for the panel regression by randomly selecting customers from the treatment groups (i.e., acceptors of eco+) and from the control groups (i.e., deniers of eco+)³⁷. Between equipment type, control group and treatment group, a total of 111,282 devices were used for sampling.

Equipment Type	Control	Treatment
Not Heat Pump	40,000	40,000
Heat Pump	11,282	20,000
Total	51,282	60,000

Figure 6 illustrates how the treatment and control groups were sampled to construct the panel regression analysis.

³⁷ DSA constructed the control and treatment group for sampling analysis between “compliers – have eco+” and “deniers – do not have eco+”. Upon randomly selecting devices into control and treatment groups, DSA recognized a significant imbalance with respect to compliers and deniers amongst the Maryland population with 21% deniers and 2% compliers. From a statistical perspective, this would have created source of bias due to the oversampled control group from Maryland with only 2% in treatment and 19% in controls. Effectively, if any unobserved variable affects all Maryland devices differently than non-Maryland devices throughout the experiment, the control group will result with different outcomes than the treatment group in ways that are not related to the treatment, but related to the control group dominated by Maryland. As a solution and to ensure identical looking control and treatment groups and to minimize bias, DSA determined that Maryland would not be included for the sampling analysis and would omit these devices from the regression. A total of 12,282 Maryland devices were excluded from the analysis (10, 871 deniers and 1,411 compliers). The analysis in the PD takes into account the exclusion of Maryland for a final total of 111,282 devices split between heat pumps, not-heat pumps, compliers (treatment) and deniers (control).

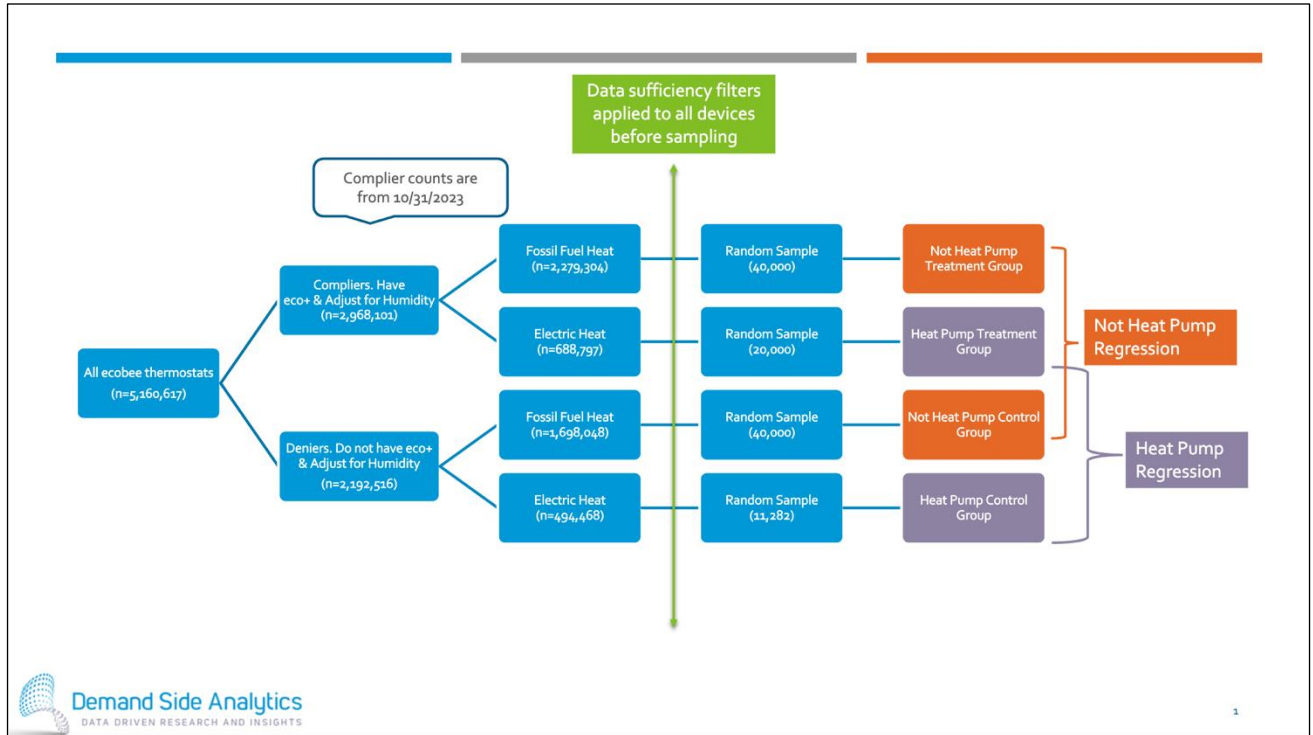


Figure 6. Sampling for control and treatment groups

Identification of HVAC Equipment and Heating Sources for Emission Quantification Analysis

The emission quantification analysis measures the project activity's impact based on the HVAC equipment and fuel sources connected to ecobee devices. For the purpose of this project activity, the emissions analysis considers impact only from fossil fuel furnaces (i.e., natural gas furnaces) and electric heat pumps only (i.e., electricity).

ecobee identifies the type of HVAC system based on wiring configuration during installation of the device. An electric heat pump system is detected by the smart thermostat when a wire has been installed in the O/B terminal and a furnace / boiler is detected in lieu of the O/B terminal wire. Upon registration of the device, customers are asked to confirm their HVAC systems as either having a furnace /boiler or an electric heat pump. Once the customer confirms their HVAC system, the response is recorded in ecobee's back-end systems under the variable "hasHeatPump" – 'TRUE' indicating a heat pump or 'FALSE' indicating a furnace/boiler.

As of March 02, 2023³⁸ (the end of monitoring period), 1,987,514 (77.98%) of total ecobee devices were recorded to be connected to furnaces / boilers ('hasHeatPump - FALSE') indicating 'fossil fuel heat' and 561,378 (22.02%) were connected to heat pumps ('hasHeatPump - TRUE') indicating 'electric heat'.

³⁸ The daily footprint list with the variables "USBuildingClimateZone", "hasHeatPump", "x_date" and "n_tstats" was shared with DSA to perform emission quantification analysis and to construct the CO2_Dashboard file. The daily footprint list records exact number of active and registered devices and is not a national or regional average count of ecobee devices.

The latest U.S EIA's RECS³⁹ which provides information on the adoption of heating equipment and fuel types across the US, reports that of the 117.74M surveyed homes that uses space heating equipment, 53.26M (or 45%) uses natural gas air furnaces, 16.13M (or 13.6%) uses electric heat pumps and 13.82M (or 11.7%) uses electric air furnaces. For the purposes of quantifying the emissions impacts result and based on what ecobee is able to determine from wiring configuration, devices connected to furnaces are assumed to have natural gas (i.e., fossil fuel heat) and devices connected to heat pumps are assumed to have electricity (i.e., electric heat). This was the conservative approach as electric furnaces are 2.5x more carbon intensive due to how inefficient electric furnaces are at heating⁴⁰.

Considerations and Variables for Panel Regression

DSA received from ecobee a comprehensive set of data points, including average daily outdoor temperature, humidity, device's zipcode, self-reported square footage of home and type of residence. While ecobee does not gather income data from users, DSA has access to dwelling locations and some self-reported information regarding home size and type. Given that customers choose to participate in the program voluntarily, it is natural to observe slight variations in home types and locations between the treatment and control groups. To mitigate potential biases stemming from self-selection, DSA incorporate controls for time, weather, and lagged dependent variables in the panel regression. As demonstrated in Table 1, the customers in the treatment group are slightly more likely to live in detached and larger residences. Nonetheless, both control and treatment groups predominantly reside in similar types of housing. They share more similarities with each other as ecobee thermostat users than with the broader U.S. population.

Table 1: Self-Reported Housing Stock

Housing Type	Control	Treatment
Apt/Condo	9.41%	9.56%
Detached	57.07%	59.89%
Semidetached	15.14%	10.97%
Other/NA	18.38%	19.58%
Total	100%	100%
Mean Sq Ft	2,568	2,665

When dividing the control and treatment group into five (5) climate regions (seen in Table 2) there is significant coverage in all U.S. climate regions, with slight distribution differences between the two groups. This varied distribution of geographies could be the result of weather influencing the results of the panel regression, so extra care has been taken into consideration to control for variances. DSA used weather controls, time fixed effects and lagged dependent variables to control for any bias introduced by the self-selection of the control and treatment groups.

Table 2: Climate Regions

Climate Region	Control	Treatment
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³⁹ U.S. Energy Information Administration (EIA). Consumption and Energy. Residential Energy Consumption Survey (RECS). Space Heating in U.S homes, by climate region, 2020. <https://www.eia.gov/consumption/residential/data/2020/hc/pdf/HC%206.6.pdf>

⁴⁰ Demand Side Analytics' calculates carbon intensity difference between electric furnaces and gas furnaces. Assumptions are 60000 BTU/hour and 1000 lbs per MWh. Electric uses 17.58 kWh/hr and gas uses 0.06 MMBtu/hr. CO₂ emission rates are 117 lbs/MMBtu of gas and 1000 lbs/MWh of electricity. CO₂ emissions from 1 hour of usage is: 17.585 lbs of CO₂ for 1 hour of electric furnace runtime and 7.02 lbs of CO₂ for 1 hour of gas furnace runtime. The ratio is 2.50.

Cold	31.40%	34.90%
Dry	12.69%	12.78%
Hot Humid	15.84%	21.23%
Marine	10.95%	4.70%
Mixed Humid	29.12%	26.38%
Total	100.00%	100.00%

Time-fixed effects⁴¹ account for variation that is consistent across households but varies across time, for example, the state of the national economy or the changing of the seasons. Because the population of customers has a wide geographic footprint, customers are likely to experience very different weather within the same month, so month fixed effects are not sufficient by themselves. Therefore, DSA chose to include weather as an independent variable in their regression models as well. This adjustment allows the analysis to incorporate weather controls while accounting for variations in equipment type and heating/cooling functions.

DSA created five (5) separate regression models to analyze impact of the program on the five types of HVAC equipment runtime:

- a) Electric heat pumps:
 - 1) seconds of cooling, 2) seconds of heating, 3) seconds of auxiliary heating
- b) Fossil fuel furnaces:
 - 4) seconds of cooling and 5) seconds of heating.

$$y_{it} = \beta_t m_t c_i + y_{it-1} m_t + m_t + cdd_{it} + hdd_{it} + h_{it} + d_t + \varepsilon_{it}$$

Where:

- y_{it} is the outcome of interest in seconds for person i on day t ,
- m_t is an indicator variable for year-month,
- c_i is an indicator variable for treatment, so the coefficients of interest are β_t . A separate coefficient is calculated for each year month m_t of the treatment period. The rest of the terms are control variables, which have their own coefficients (which are not notated in order to increase legibility).
- y_{it-1} is the lagged dependent variable, which is the mean of all dependent variable values in the pre-period in the month that day t is in for household i .
- cdd_{it} is a continuous variable for the number of degrees above 60 (anything below is zero) while hdd_{it} is the number of degrees below 60 (anything above is zeroed out),
- h_{it} is humidity,
- d_t is an indicator of day of week, and

⁴¹ "Pre-existing time dynamic variation" refers to variations of weather across geography. Time-fixed effects can control for the monthly variation that is consistent across geographies, but if treatment and control have slightly different geographies, and those geographies have different weather in the same month, a month fixed effect will not correct for those differences. DSA included weather as independent variable in the model and why the analysis allowed those weather controls to vary by equipment type and by heating and cooling function.

- ϵ_{it} is the error term.

To address the serial correlation within individual observations y_{it} , DSA clusters the standard errors by individual i . This method introduces conservatism into the model by significantly widening the confidence intervals for each coefficient. As a result, it increases the likelihood that DSA will fail to reject the null hypothesis $\beta_t = 0$.

VM0008's performance benchmark aims to ensure that the project activity delivers genuine energy savings rather than results influenced by random variation, advocating for rejecting the null hypothesis at the household level based on changes in annual energy consumption. DSA extends this principle by applying a 95% confidence interval at the aggregate level, enhancing the rigor and conservatism compared to a 90% confidence interval.

In DSA's approach, β_t is calculated for each year and month and must achieve 95% statistical significance to be considered statistically significant; otherwise, the coefficient is set to zero. This approach ensures that measured changes in electricity usage are indeed additional due to the project activity.

To ensure conservative estimates in emission reduction calculations, DSA uses the lower bound of the 95% confidence interval, which is calculated by subtracting 1.96 times the standard error from the point estimate. The point estimate represents the best estimate of eco+'s impact, while the confidence interval indicates the range where DSA is 95% confident the true impact lies. By selecting the lower end of this interval, DSA adopts an extremely conservative stance on the impact of eco+.

3.5.1 Regulatory Surplus

Is the project located in an UNFCCC Annex 1 or Non-Annex 1 country?

- ☒ Annex 1 country ☐ Non-Annex 1 country

This project is located in the United States, a country listed under Annex 1 of the Parties to the UNFCCC and is not mandated by any law, statute or other regulatory framework.

Are the project activities mandated by any law, statute, or other regulatory framework?

- ☐ Yes ☒ No

If the project is located inside a Non-Annex 1 country and the project activities are mandated by a law, statute, or other regulatory framework, are such laws, statutes, or regulatory frameworks systematically enforced?

- ☐ Yes ☐ No

Not applicable.

3.5.2 Additionality Methods

As described in 3.5 Additionality, DSA's quantification model employs a panel regression using lagged dependent variables and clustered standard errors to jointly measure additionality and

quantify the impacts of customers enabling the eco+ software. Coefficients in regressions must pass a significance test of 95%, or the coefficient will be zeroed out. DSA uses proper clusters and controls to ensure that the confidence intervals are set correctly. Given the richness of the project activity's data, a panel regression is more precise way to control for unobserved trends in electricity use than relying on an electricity correction factor and allows for more flexible controls to temperature. Panel regressions also allows DSA to test if the effect of eco+ in any given month is statistically different than zero, which ensures that the measured changes to electricity usage are additional.

3.6 Methodology Deviations

Methodology Deviation 1

VM0008's Category B – efficiency enhancements of the building envelope and central heating/cooling and applying the control group approach states *“electricity and fuel bills be collected for both groups annually throughout the project crediting period.”* Groups refers to 1) the control group comprising of dwellings that have not been weatherized as part of the project and 2) the sample group comprising of dwellings to be weatherized.

ecobee proposes an alternative path to metering⁴². Internet of Things (“IoT”) technology has advanced since the latest revision of VM0008 v1.1 in 2012. Advanced technologies now have embedded metering which directly measures outputs. ecobee smart thermostats have accompanying telemetry data⁴³ which directly measures granular intervals of time that an HVAC system is running. Using this data is the most accurate approach to measure the project activity because telemetry data does not include the noise of other end uses and those impacts on energy use that are unrelated to the project activity. Additionally, given the number of individual homes within the project boundary, it is not feasible to get utility data from all of them because not all utilities have installed advanced metering infrastructure (AMI) for residential customers (in these instances, the utility meter only measures monthly consumption). Where utilities have installed AMI meters for residential customers, not all utilities have established a protocol to share this data with third parties. Even in instances where utilities have an established protocol for sharing interval consumption data with third parties, the customer authorization process is so cumbersome that very few customers complete the steps required to do so.

As outlined in Appendix A, ecobee's approach directly measures reductions in run-time of the HVAC equipment. This data is complemented by conducting a sample of actual changes in electricity consumption at homes with ecobee thermostats installed. As Figure 7 shows, there is a very high correlation ($R^2 = 0.988$) between ecobee's telemetry/runtime data and the associated utility meter data. This demonstrates that if ecobee can measure changes in run-time pre and

⁴² ecobee does not collect data for energy use at the whole home level (i.e., utility bills) for both statistical and practical reasons. ecobee devices and more specifically, eco+ incrementally lowers heating and cooling consumption of HVAC equipment without altering energy usage of other appliances in the home – making it nearly impossible for the device to record energy usage of other sources. As a result, the only impact is likely to be on the energy usage of when the HVAC equipment is on or off. The signal ecobee is measuring is a small change in usage on the order of minutes per day. If the electricity and gas utility bills of customers were measured, the analysis would be introducing numerous random variables (or noise) to the regressions from other energy consuming appliances in the dwelling. The additional variables from other end uses would make an already small signal difficult to correctly estimate. ecobee only has access to telemetry runtime data of heating and cooling systems and does not have access to whole home utility level data.

⁴³ The telemetry data directly measures the HVAC run-time scheduled by an ecobee thermostat and no other measurements from other end uses (i.e., other appliances in the dwelling) that are unrelated to the project activity. ecobee's telemetry data directly takes measurements of 5 minute granular intervals of a HVAC system runtime.

post project, estimating the actual reductions in electricity and gas consumption will be very accurate.

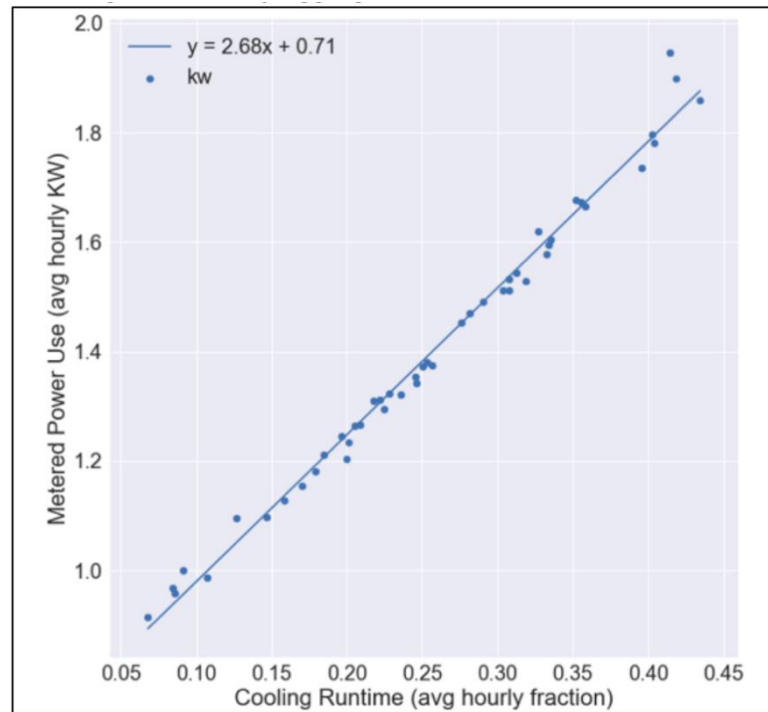


Figure 7 - Correlation of HVAC Runtime Data to Utility Metered Data⁴⁴

Thus, for this project activity, ecobee is seeking to deviate from VM0008 – Category B Control Group approach by not collecting electricity and fuel bills from the sample and control group annually to measure the difference in energy consumption between the two groups as the basis for calculating emission reductions. Instead, ecobee will collect data in run-time of HVAC appliances controlled by the ecobee thermostat.

Smart thermostats measure granular intervals of time that an HVAC system is running. To convert this to kWh, there needs to be an assumption on HVAC power draw. There has been extensive field research done in state technical reference manuals regarding average HVAC connected load at the state/regional level as detailed in Appendix B. Technical Reference Manuals (TRMs) are valuable resources for state regulators, utilities, and program administrators and implementers for estimating the energy and demand savings of end-use energy efficiency measures. Using these resources to determine average HVAC connected load, smart thermostat runtime data can be used as a proxy for retail meter data for measurement and verification (M&V) purposes as detailed in Appendix A.

In fact, thermostat runtime data is commonly used in this way for utility thermostat optimization evaluation, and the Department of Energy Uniform Method Protocol for evaluating smart

⁴⁴ Figure 6 - Correlation of HVAC Runtime Data to Utility Metered Data is showing percent of an hour the air conditioner is operating on the X-axis (0.25 equals to 15 minutes of cooling) and demand for electricity on the Y-axis. This graph demonstrates how the consumption of electricity is linear with cooling runtime as air conditioners consume a certain amount of electricity current when operating and consumes nothing when not operating.

thermostats specifically allows for the use of thermostat runtime data and recommends a uniform method on how to use thermostat runtime data to quantify energy impacts.⁴⁵ A 2019-2020 evaluation prepared for the Massachusetts Program Administrators stated that an impact analysis on smart thermostat programs “relied exclusively on thermostat telemetry data to estimate impacts after converting thermostat runtime data to estimated energy.” Table 3 below includes a sample of other examples of utility programs evaluated using thermostat runtime/telemetry data.

Table 3. Examples of North American Utility Programs Using Thermostat Telemetry for Measurement & Verification

Utility	Program Name	Link
Xcel Energy New Mexico	Saver's Stat	https://www.xcelenergy.com/staticfiles/xcelresponsive/Company/Rates%20&%20Regulations/Regulatory%20Filings/NM-DSM-2017-Annual-Report-with-Attachments.pdf
Xcel Energy Colorado	Smart Thermostat Pilot	https://www.xcelenergy.com/staticfiles/xcelresponsive/Company/Rates%20&%20Regulations/Regulatory%20Filings/CO-Smart-Thermostat-Pilot-Evaluation.PDF
National Grid	ConnectedSolutions	http://ma-eeac.org/wordpress/wp-content/uploads/2017-NGrid-DR-Eval-Final-Report-2018-03-30.pdf
CPS Energy	Rush Hour Rewards Pilot Program	https://www.sanantonio.gov/Portals/0/Files/Sustainability/STEP/CPS-FY2015.pdf
Vectren	Residential Smart Thermostat Pilot	http://vectrened.com/assets/downloads/planning/irp/IRP-2018-smart-cycle-evaluation.pdf
United Illuminating	Smart Savers Rewards	https://energizect.com/sites/default/files/2022-07/CT%20X1932%20Demand%20Response%20EMV%20Support%20Study%20-%20Final%20Clean_060322.pdf

An illustrative example would be that ecobee runtime data shows a reduction of HVAC runtime of 0.1624 hours compared the baseline. The state/regional Technical Reference Manual lists the average HVAC system size (connected load) to be 3.6 kW. In order to obtain the impacts, the coefficient impacts can be multiplied by the connected load assumption.

$$-0.1624 \text{ hours} * 3.60 \text{ kW per hour} = -0.58 \text{ kW}$$

$$(\text{Runtime}_{\text{project,hrs}} - \text{Runtime}_{\text{baseline,hrs}}) * \text{ConnectedLoad}_{\text{kW}} = \text{Impacts}_{\text{kWh}}$$

Note that a negative impact implies savings.

⁴⁵ In section 3.2.2 of the protocol, the DOE supports the use of thermostat runtime/telemetry data as appropriate for measurement and verification by stating: “Because thermostat telemetry data are usually available for the periods before, during, and after the optimization for both participants and nonparticipants, evaluators can construct accurate baseline HVAC runtimes and estimate the optimization savings.” (<https://www.nrel.gov/docs/fy23osti/86175.pdf>)

Methodology Deviation 2

VM0008's Category B – efficiency enhancements of the building envelope and central heating/cooling and applying the Control Group approach states, “...the project shall not prevent or deny weatherization to any homeowner or individual for the purposes of maintaining the control group” and in a subsequent section, “the sample group shall come from Dwellings included in the Project Activity. The control group shall be selected from dwellings not included in the project activity and shall have the following requirements established in section 1.9 Part A: 1) Participants shall not have the ability to “opt-in” to the control group”.

The control group approach describes two (2) requirements that could be interpreted as being mutually exclusive and at odds to one another. Any project with a control group would deviate from VM0008 because it is impossible to satisfy two mutually exclusive requirements.

If “opting into the control group” is defined as declining the eco+ offer then ecobee can either:

- 1) Withhold the eco+ offer from some devices to create the control group (which is at odds with methodology because weatherization is denied), or
- 2) Rely on the fact that some ecobee owners decline the eco+ offer to construct the control group (which is at odds with methodology because ecobee is allowing them to decline the treatment)

Ultimately, the project can't have a control group unless you either deny someone the treatment or allow them to deny it. If denying the eco+ offer is "opting into the control group" then it is impossible to have a control group

As stated above, the methodology does not allow prevention or denial of treatment (i.e., weatherization) to any individual which means in the case of this project, ecobee cannot have a random control group as that would deny the treatment for the purpose of maintaining the control group. For this project activity, the treatment (i.e., software upgrade) was made available to all devices which users could decide to enable or opt-in.

For this analysis, the control and treatment group could only be constructed with devices that either 1) never enabled the feature or 2) enabled the feature. The control group was deliberately constructed of devices that never ever had the feature enabled and if or when the feature is enabled, they are removed from the control group. An interpretation of this could be that users not enabling the feature and not opting into the treatment group are effectively opting into the control group unknowingly. However, by this logic there could be no other ability to construct a control group for this project that does not also deny them the treatment.

Methodology Deviation 3

VM0008 describes that project activities in Category B are to demonstrate additionality using the performance method and shall calculate performance benchmark using Equation 1 and Equation 2.

The performance benchmark procedure described in Equations 1 and 2 implies a household-by-household analysis where the determination is made for a given housing unit. As the project activity is assessing hundreds of thousands of devices using a panel regression, it does not produce results for each individual device. Instead, the panel regression provides the average effect for the entire population. If we were to run each unit individually and average the results of the individual regressions, the result would converge to the same result as the panel regression.

However, the notion of an individual household analysis is complicated by the control group approach. In VM0008 Section 8 on page 26 states that “the difference in the energy

consumption between the control group and the sample group each year will constitute the fuel and electricity savings for all Dwellings in the Project for that year and shall serve as the basis for calculating emission reductions.” Since DSA is modeling a difference across groups, individual unit analysis is not feasible. We don’t create pairs of treated and untreated homes that would allow for an individual comparison of one treated and one control device. The interpretation of the method is that the difference in the groups is the output of interest.

There are a number of elements of the methodology which are deliberately conservative, but the decision to run a panel regression is not one of them. A panel regression pools the homes of interest together and returns an estimate of their average performance (what we care about). With an individual house level approach, we would have to run each device in the treatment and control group separately and then perform a second step to average them. It’s effectively an order of operation questions.

Imagine the following example with average ages of people in a restaurant.

Group A: 36, 29, 51, 55

Group B: 22, 30, 47, 64

The mean of Group A is 42.75 years old. The mean of Group B is 40.75. The difference in average age is 2 years. We could also take difference of each member in Group A with the average of B. Or do paired difference and average the results. No method is more conservative than another because the underlying math is the same. The use of a panel regression is more practical, uses less computing power, returns easier to interpret results, and consistent with most econometric research of the past two decades.

This approach is also using the lower bound of the confidence interval, meaning all claimed energy savings are statistically significant and claims the lower bound of the margin of error. The approach applied instead of the Equation 1 and 2 aligns with the methodology in spirit with respect to additionality and performance benchmarking. The approach was adapted for the scope and scale of the analysis and applied an extremely conservative assumption to the results by calculating CO₂ avoidance with the lower bound of the savings estimate. Please refer to Section 3.5 of the PD for full details on how panel regressions are used to demonstrate additionality and why they are the most appropriate approach for this project activity.

4 QUANTIFICATION OF ESTIMATED GHG EMISSION REDUCTIONS AND REMOVALS

Defining Pre-Period and Post-Period for Emission Quantification Analysis

ecobee undertook a pilot study in 2019 and 2020 to assess the results of eco+. During this period, eco+ platform was deployed across the USA to a large pilot group of ecobee thermostats to demonstrate the capabilities of the platform. The pilot included a population of approximately 240,000 ecobee smart thermostats.

The pre-period was defined as January 1, 2018 to July 14, 2019 (period before eco+ pilot study), and the treatment period defined as March 1, 2021 to October 31, 2023 (period after eco+ full roll out). When reviewing the pre-period, the treatment and control devices have similar HVAC usage patterns. For instance, the control group of non-heat pumps has slightly higher cooling demands (Figure 8) and the control group with heat pumps have higher demand for auxiliary heat

when experiencing colder temperatures (Figure 11). The most notable variance between treatment and control group is amongst customers using their heat pump for compressor heating⁴⁶, where the control group of heat pumps uses more compressor heat than the treatment group of heat pumps using compressor heating.

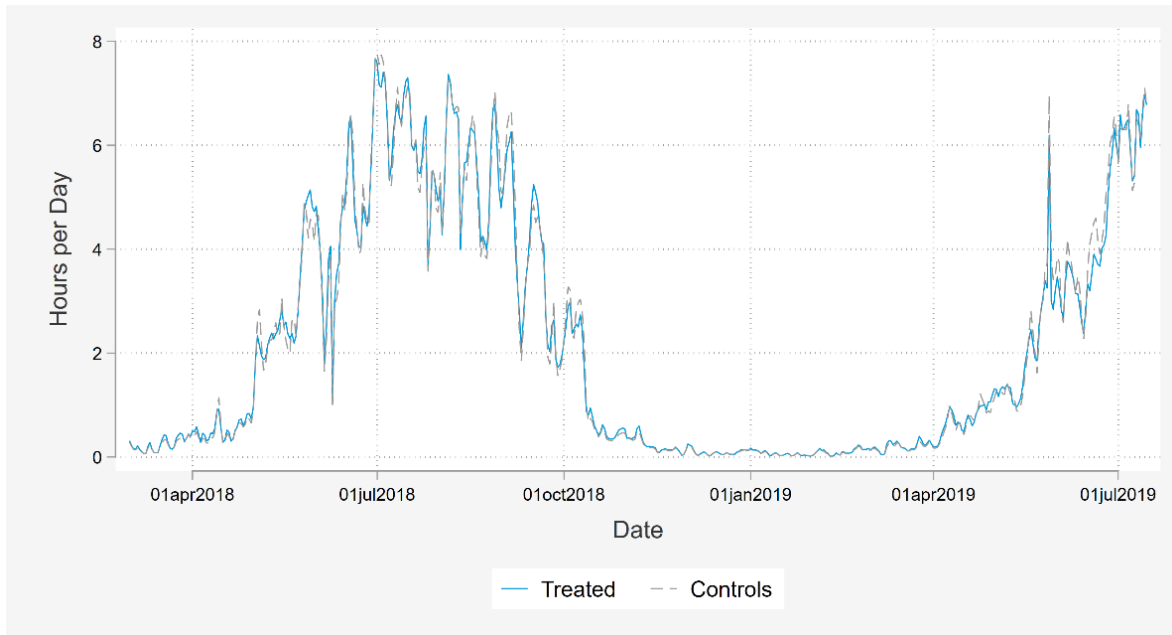


Figure 8: Pre-Period Comparison – Cooling, No Heat Pump

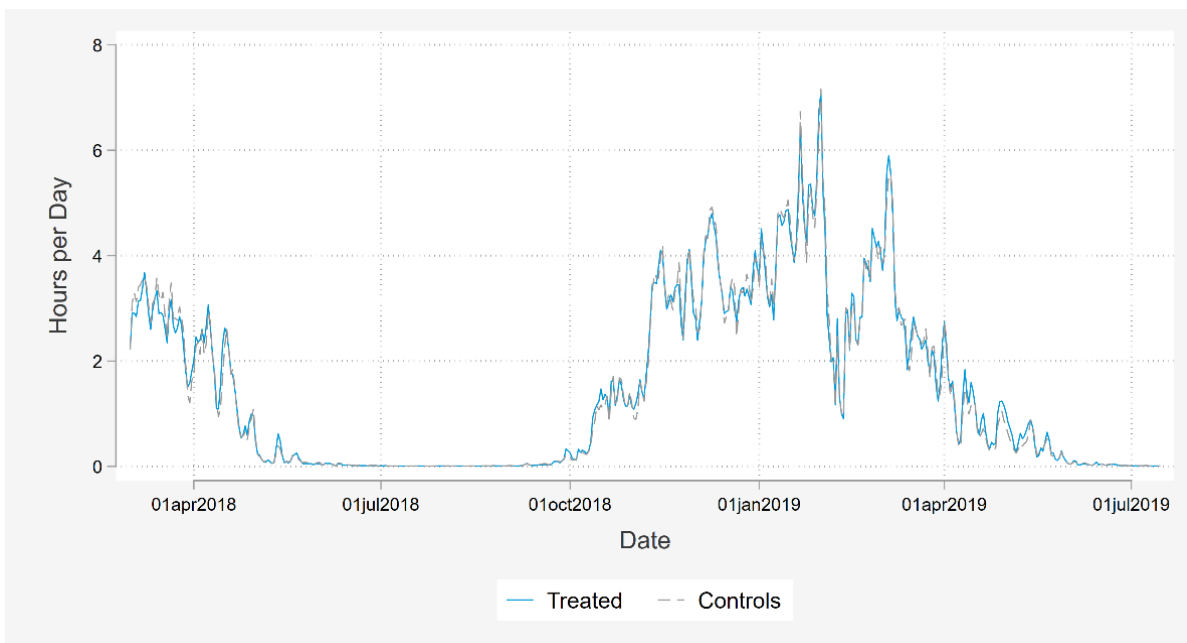


Figure 9: Pre-Period Comparison – Heating, No Heat Pump

⁴⁶ "Compressor heating" for heat pump owners refers to the runtime of the heat pump itself, as opposed to runtime of the auxiliary heater component of the heat pump.

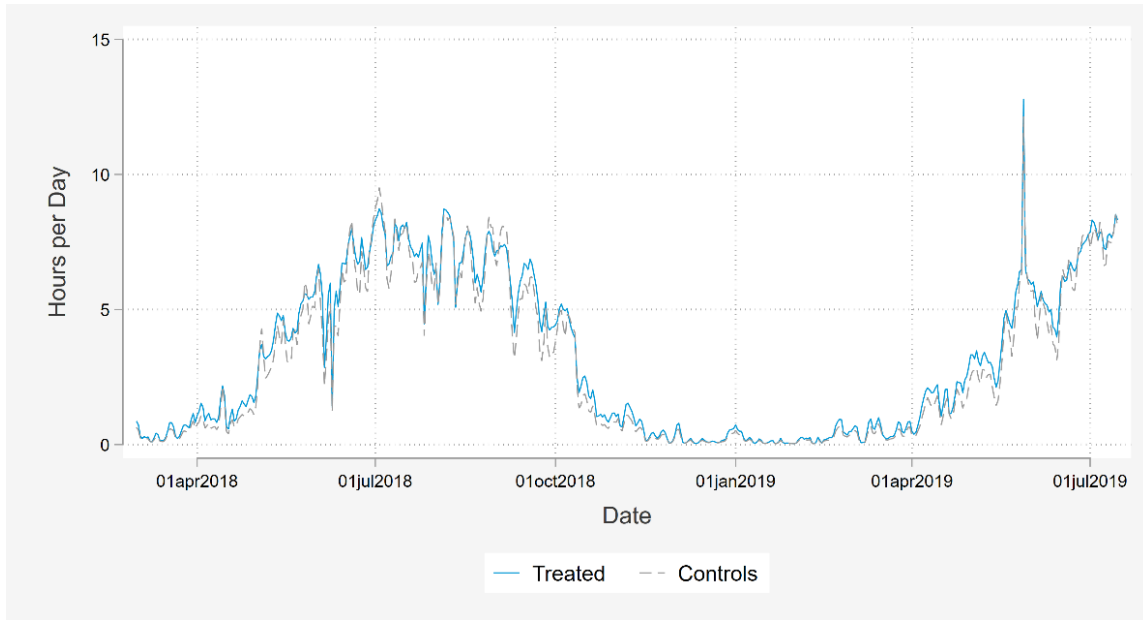


Figure 10: Pre-Period Comparison – Cooling, Heat Pump

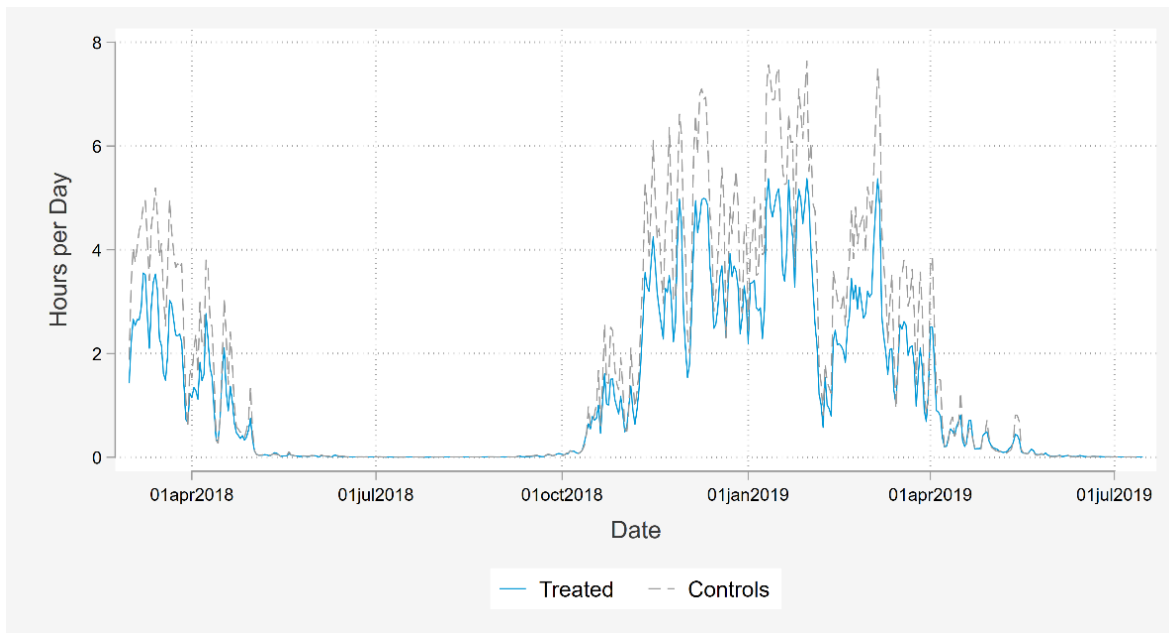


Figure 11: Pre-Period Comparison – Compressor Heating, Heat Pump

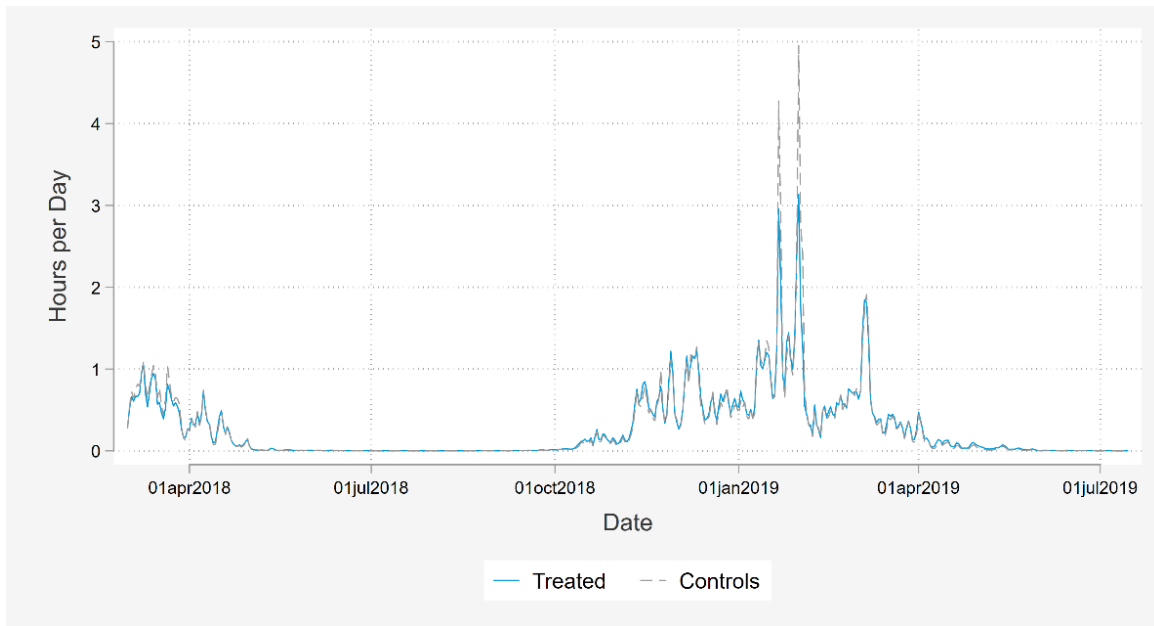


Figure 12: Pre-Period Comparison – Auxiliary Heating, Heat Pump

DSA addresses the differences and variances in these HVAC usage levels by using the lagged dependent variable⁴⁷. The key observation is that the change between the two groups from pre-period to after the treatment period is solely due to the project activity itself (i.e., the enablement of eco+ and the “Adjust for Humidity” feature).

Figure 13 displays how the average household’s demand for cooling, heating, and auxiliary heating differs between the control and treatment groups of heat pump users over time. These differences fluctuate predictably due to seasonal changes and weather conditions. To ensure accurate comparisons, DSA adjusted for weather effects and used monthly lagged dependent variables instead of annual ones. By analyzing eco+’s impact month by month, DSA could account for seasonal variations—for example, expecting a greater influence on cooling demand in summer compared to winter. This approach provides a nuanced understanding of eco+’s effects across different months.

⁴⁷ In a panel regression analysis, a lagged dependent variable refers to the value of the dependent variable from a previous time period or period of observation. Panel data typically involves observing multiple entities (such as individuals) over multiple time periods. When including a lagged dependent variable in a panel regression model, it is essentially using past values of the dependent variable as an explanatory variable for its current or future values.

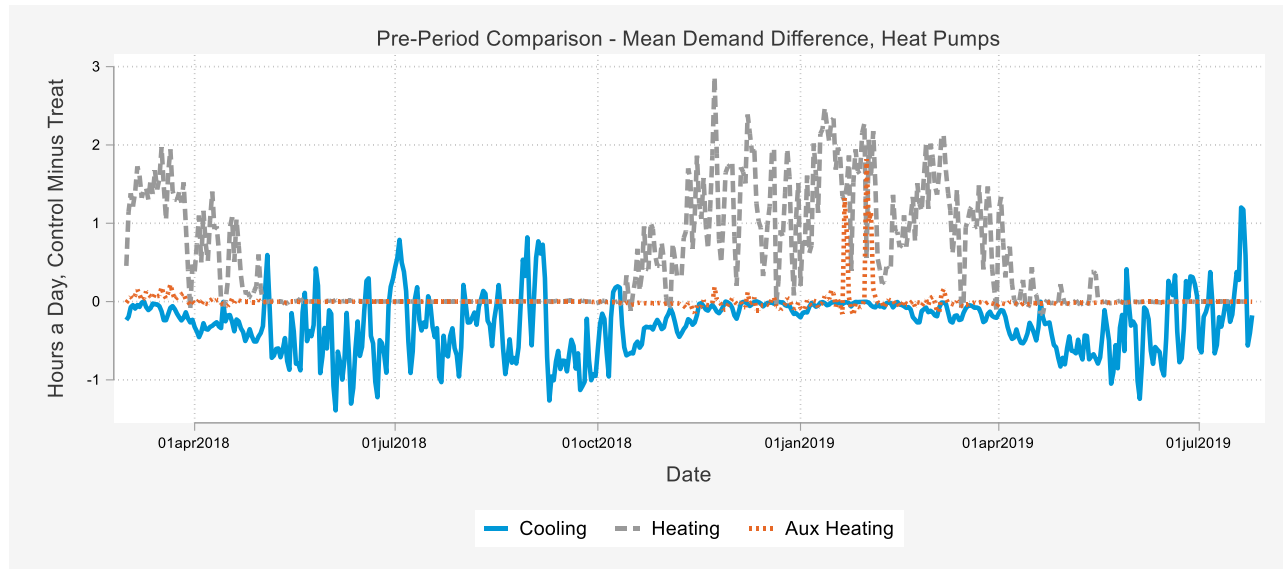


Figure 13: Heat Pump Pre-Treatment Differences

Rationale for including weather controls in regression models

The HVAC equipment runtime is influenced by daily weather conditions. To accurately measure the impact of the treatment (eco+) rather than variations in weather between treated and control groups, DSA incorporated weather controls (CDD, HDD, and humidity) into the regression analysis. Temperature affects cooling runtime differently than heating, and its impact on runtime varies depending on the efficiency of the equipment used (ie., more efficient heat pumps may require less operation time). Failing to properly model these differences could lead to estimation errors, as weather effects would not be fully accounted for.

Two solutions were considered: 1) integrating heating/cooling and equipment type with temperature controls in a single comprehensive regression; 2) splitting the data into five (5) separate regressions and estimating distinct weather coefficients for each subset of HVAC equipment and its heating and cooling elements. DSA opted for the latter approach due to the large dataset size made available by ecobee.

This was the preferred approach as large dataset minimizes sampling bias and due to varying emission impacts based on fuel type and equipment, it simplifies the calculation of emission estimates of the project activity.

4.1 Baseline Emissions

The baseline emission shall be comprised of dwellings from the same building stock that have not been weatherized. In other words, baseline emission shall be defined as emissions from heating and cooling energy load by dwellings with ecobee devices that did not enable the thermostat optimization platform eco+ and the “Adjust for Humidity” feature. Refer to Section 3.4 (Baseline Scenario) of this PD document for explanation on how baseline emissions are determined.

4.2 Project Emissions

The project emissions are defined as emissions from heating and cooling energy load by dwellings with ecobee devices equipped with the thermostat optimization platform eco+ and the “Adjust for Humidity” feature. Project emissions can be estimated by first estimating the values for y_t (daily runtime estimates)

for all the regression equations. Once emissions are estimated, DSA converts runtime estimates in the same way as described in Section 4.4 to obtain the project emissions estimates.

Project activity's baseline emission, project emissions and overall emission reductions for first monitoring period 03-March-2021 to 02-March-2023 are available and can be reviewed in the accompanying emission reductions workbook excel sheet called "CO2_Dashboard_Lowerbound."

4.3 Leakage Emissions

The applied methodology, VM0008 leakage refers to emissions from improper disposal of appliances. It states *"when the appliance is not disposed of according to applicable laws and regulations there will be leakage from continued operations. The leakage emission shall be calculated and excluded from emission reductions as described in the methodology"* For this project, appliances such as heating/cooling equipments are not being disposed of. The project activity utilizes smart thermostats installed in homes to reduce heating and cooling usage specifically, thus leakage does not need to be considered.

4.4 Estimated GHG Emission Reductions and Carbon Dioxide Removals

Regression Model Outputs, and Equations Converting MWh to CO₂ Reduction

The regression model outputs predict the impacts of enrollment of eco+ on HVAC runtime in seconds per day for each of the five heating and cooling scenarios. Please see Appendix D for table of regression output results.

The coefficients of interest, β_i , are the coefficients under the heading "ym#c.complier" in each regression model. The values in the "coefficient" column are the point estimates for the effect of having eco+ on the runtime for each of the five respective variables of interest (1) heat pump/cooling, 2) heat pump/heating, 3) heat pump/aux heating, 4) non-heat pump/cooling, 5) non/heat pump/heating. The table in Appendix D displays the robust clustered standard errors (shown as *std.err* in the table) of the estimate of each co-efficient. From the point estimates and standard errors, DSA can report the *p* value of *t* tests on the null hypothesis. These *p* values report the probability given the data and regression that the true value of the coefficient is zero (i.e., the probability that eco+ has no impact). DSA estimated that 95% of all true co-efficient values (the numbers that the point estimates are estimating) lie within the 95% confidence intervals reported.

Rather than using the point estimate, DSA applies a conservative approach and uses the lower bound of the 95% confidence interval. The lower bounds are calculated by multiplying the standard errors by 1.96 and subtracting that from the point estimates. In the equations below, all instances of β_i represent this lower bound of the point estimates. To further illustrate the coefficients of interest, the first set of regression output results (1/5) in Appendix D are for cooling of non-heat pump treatment group ("ALL, non_heat_pump, compcool"). The "ym#c.complier" coefficients (displayed in negative coefficients) are the impacts of eco+ on cooling measured in seconds of runtime per day. Using September 2021 ("2021m9") as an example (highlighted in Appendix D), eco+ and "Adjust for Humidity" feature reduced 18 minutes ("-1088.52" seconds or 0.3 hours) of cooling runtime per day on average. The hourly runtime saved is converted to kWh per day which is then converted to CO₂ saved. The coefficient having a *p* value

of “0.000” indicates that the impact of eco+ on cooling runtime is statistically significant, or in other words, the probability that eco+ had an impact is significant.

Converting Seconds of HVAC Run-time into CO₂ Reductions

DSA calculated emissions reductions using average emissions rates from the EPA’s Emissions & Generation Resource Integrated Database (eGRID)⁴⁸ which reports the total and average CO₂ equivalent emissions from electricity consumption per U.S. state⁴⁹. In order to create a national average representative of ecobee, DSA weighted each average emissions rate by the percentage of heat pump and non-heat pump customers in the sample (Please refer to Appendix C for more details).

This resulted in two average rates: 1) 755 lbs/MWh for heat pump customers and 2) 776 lbs/MWh for non-heat pump customers. These values were used to calculate the estimates for emissions reductions with the below conversion equations, where 755 is used for “CO₂rate” in heat pump equations and 776 is used for “CO₂rate” in the non-heat pump equation.

The equations converting seconds of runtime to emissions reductions are the following:

Cooling: Heat Pumps and Non-Heat Pumps:

$$\frac{\beta_{it}}{3600} * days * \frac{kWperdevice}{1000} * \frac{CO_2rate}{2204.6}$$

Where “β_{it}” is the predicted change in seconds. Dividing by 3600 puts it in hours per day, and then multiplying it by the number of days in the month translates it to hours per month. “kWperdevice” is 3.21kW per device (weighted average for cooling) and transforms the value to kWh. Dividing it by 1000 converts it to MWh. Dividing by 2204.6⁵⁰ transforms the value to metric tons per month.

Heating: Non-Heat Pumps:

$$\frac{\beta_{it}}{3600} * days * \frac{furnacesize(kBTU)}{1000} * \frac{117}{2204.6} + \frac{\beta_{it}}{3600} * days * \frac{furnacefan(kW)}{1000} * \frac{CO_2rate}{2204.6}$$

This equation has two components: 1) the furnace (ie., natural gas), 2) furnace fan (ie., electric) There are 117 lbs of CO₂ in every MMBtu of natural gas⁵¹.

Heating: Heat-Pumps, Compressors:

$$\frac{\beta_{it}}{3600} * days * \frac{HeatPumpCompressor}{1000} * \frac{CO_2rate}{2204.6}$$

⁴⁸U.S. EPA. Emissions & Generation Resource Integration Database (eGRID). <https://www.epa.gov/egrid>

⁴⁹ U.S. EPA. Emissions & Generation Resource Integration Database (eGRID). State Output Emission Rates 2022. https://www.epa.gov/system/files/documents/2024-01/egrid2022_summary_tables.pdf

⁵⁰ 2204.6 is the number of pounds in a metric ton and value was sourced directly from [U.S Energy Information Administration \(EIA\)](#).

⁵¹ Converting reduction in natural gas savings (MMBtu) to CO₂ savings. U.S. Energy Information Administration. Natural gas explained. <https://www.eia.gov/energyexplained/natural-gas/natural-gas-and-the-environment.php#:~:text=About%20117%20pounds%20of%20CO,MMBtu%20of%20distillate%20fuel%20oil.>

Heating: Heat-Pumps, Auxiliary:

$$\frac{\beta_{it}}{3600} * days * \frac{HeatPumpAuxiliary}{1000} * \frac{CO_2rate}{2204.6}$$

These estimates for carbon abatement for each month are then all summed together to obtain the annual abatement estimate. Each month's estimates are stored in ERR excel workbook "CO2_Dashboard_V2_LowerBound_10_07_2024" and is provided to the VVB and Verra as an accompanying document.

Please see ERR ("CO2_Dashboard_V2_LowerBound_10_07_2024") that includes "Heating Conversions Example" tab and "Cooling Conversions Example" tabs providing conversion for both heat pumps and non-heat pumps based on and heating cooling runtime. Baseline and impact calculation have also been included in these tabs. When reviewing the ERR, please note the value in cell C28 ("Average Devices") of "ecobee_CO2_Dashboard_V2_LowerBound.xlsx" is only for display and does not affect the underlying emissions impact calculations. These calculations are based on the number of ecobee units with the 'Adjust for Humidity' feature enabled. The model uses the daily runtime readings from these units to estimate the average runtime savings in seconds per day for each month (t). To ensure that the model's temporal structure is consistent, DSA calculated the monthly average of the daily unit counts, which helps maintain alignment in the estimation process.

Total Emission Reductions using Average Emissions Rate from EPA's Emissions & Generation Resource Integrated Database (eGRID)

The excel workbook "CO2 Dashboard_V2_LowerBound_10_07_2024" contains the project activity's total emission impact sorted by equipment type (heat pump or non-heat pump), crediting year, and emission calculation based on EPA average emission grid factor.

Table 5: Estimated Total Emission Reductions using average emission rates from eGRID

Vintage period	Estimated baseline emissions (tCO ₂ e)	Estimated project emissions (tCO ₂ e)	Estimated leakage emissions (tCO ₂ e)	Estimated reduction VCUs (tCO ₂ e)	Estimated removal VCUs (tCO ₂ e)	Estimated total VCUs (tCO ₂ e)
03-Mar-2021 to 31-Dec-2021 (achieved)	2,999,118	2,839,476	0	0	0	159,642
01-Jan-2022 to 31-Dec-2022 (achieved)	6,447,557	6,222,659	0	0	0	224,898
01-Jan-2023 to 31-Dec-2023 (estimates)	8,056,871	7,722,866	0	0	0	334,005

01-Jan-2024 to 31-Dec-2024 (estimates)	10,006,261	9,607,192	0	0	0	399,069
01-Jan-2025 to 31-Dec-2025 (estimates)	11,823,478	11,369,838	0	0	0	453,639
01-Jan-2026 to 31-Dec-2026 (estimates)	14,188,173	13,664,475	0	0	0	523,699
01-Jan-2027 to 31-Dec-2027 (estimates)	17,025,808	16,421,230	0	0	0	604,578
01-Jan-2028 to 02-Mar-2028 (estimates)	3,405,162	3,288,837	0	0	0	116,325
Total	73,952,428	71,136,573	0	0	0	2,815,855

For projects required to assess permanence risk:

Per VM0008 protocol, as this project activity is a non-AFOLU project there is no requirement to calculate or assess permanence risk associated to the project activity. The AFOLU Non-Permanence Risk Tool is not applicable. Tables relevant to non-permeance risk have been removed from this template.

5 MONITORING

5.1 Data and Parameters Available at Validation

The tables below are monitoring parameters for the Performance Benchmark of Category B – Efficiency enhancement of the Building Envelope and/or central heating/cooling system as outlined in methodology VM0008. DSA applied a daily regression model rather than the annual comparison of treatment and control group consumption suggested in VM0008.

Data / Parameter	Compressor $Cooling_{it}$ (Y_{it} in cooling regression)
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Data unit	Seconds of air conditioning runtime for device i on date t
Description	This value is aggregate from the 5-minute telemetry ecobee maintains from all devices for each thermostat in the treatment and control group of the measurement sample.
Source of data	ecobee thermostats
Value applied	N/A - This is a measured value.
Justification of choice of data or description of measurement methods and procedures applied	HVAC runtime varies seasonally based on weather trends. DSA chose to model using daily level run-time data rather than annual totals as suggested in VM0008 to significantly improve accuracy. Modeling based on 365 days provides more data points for the regression to be more precise in estimating the impacts of the project activity across a range of weather conditions.
Purpose of data	This parameter is the dependent variable of the cooling regression. The panel regression is described in Section 3.4, 3.5 and 3.6.
Comments	N/A

Data / Parameter	Auxiliary $Heat_{it}$ (Y_{it} in heating regression)
Data unit	For furnaces and boilers: Seconds of heating runtime for device i on date t For heat pumps: Seconds of auxiliary (backup) heating runtime for device i on date t
Description	This value is aggregate from the 5-minute telemetry ecobee maintains from all devices for each thermostat in the treatment and control group of the measurement sample.
Source of data	ecobee thermostats
Value applied	N/A This is a measured value.
Justification of choice of data or description of measurement methods and procedures applied	HVAC runtime varies seasonally based on weather trends. DSA chose to model using daily level run-time data rather than annual totals as suggested in VM0008 to significantly improve accuracy. Modeling based on 365 days provides more data points for the regression to be more precise in estimating the impacts of the project activity across a range of weather conditions.
Purpose of data	This parameter is the dependent variable of the heating regression. The panel regression is described in Section 3.4, 3.5 and 3.6.
Comments	N/A

Data / Parameter	Compressor $Heat_{it}$ (Y_{it} in heating regression)
Data unit	For furnaces and boilers: not applicable For heat pumps: Seconds of compressor (outdoor condensing unit) heating runtime for device i on date t
Description	This value is aggregate from the 5-minute telemetry ecobee maintains from all devices for each thermostat in the treatment and control group of the measurement sample.
Source of data	ecobee thermostats
Value applied	N/A - This is a measured value.
Justification of choice of data or description of measurement methods and procedures applied	HVAC runtime varies seasonally based on weather trends. DSA chose to model daily level run-time data rather than annual totals as suggested in VM0008 to significantly improve accuracy. Modeling based on 365 days provides more data points for the regression to be more precise in estimating the impacts of the project activity across a range of weather conditions.
Purpose of data	This parameter is the dependent variable of the heating regression. The panel regression is described Section 3.4, 3.5 and 3.6.
Comments	N/A

Data / Parameter	Standard Deviation
Data unit	Seconds
Description	Confidence interval on the coefficients that estimate the effect of eco+ by year and month
Source of data	Calculated from panel regression
Value applied	95% confidence interval, clustered on household
Justification of choice of data or description of measurement methods and procedures applied	Panel regressions are the preferred approach for assessing energy consumption data and preferred method of casual inference used by the National Renewable Energy Laboratory. Regressions are the best approach to understand if a significant effect exists by using all observations that are treated (regardless if their individual difference is significant) and then look at the joint significance of the coefficient on treatment. The measurement took place on November 29, 2023 and was conducted by Hal Gordon and Nixon Candiales from DSA. Data and code available upon request.
Purpose of data	- Calculation of baseline emissions - Calculation of project emissions
Comments	Provide any additional comments

Data / Parameter	m_t
Data unit	Dummy variable
Description	year by month dummy variables
Source of data	ecobee thermostats
Value applied	1/0
Justification of choice of data or description of measurement methods and procedures applied	When used alone, this vector of dummies controls for time variant unobserved variables. When it is interacted with treatment, it allows DSA to get a dynamic treatment effect by year month
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	N/A

Data / Parameter	c_i
Data unit	Dummy variable
Description	The treatment variable, complier
Source of data	ecobee thermostats
Value applied	1/0
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	N/A

Data / Parameter	y_{it-1}
Data unit	Seconds
Description	Lagged Dependent Variables
Source of data	ecobee thermostats

Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Lagged Dependent variables control of the level of demand for heating or cooling by individual and month. This is a critical control as the treatment and control groups showed slight differences in pre-treatment period. Including pre-treatment data and performance period data results in a more precise estimate of the project activity impact. Using household lagged dependent variables means DSA is able to control for each individual households idiosyncratic taste for heating and cooling. After controlling for these, what remains is the true effect of eco+ and Adjust for Humidity.
Purpose of data	Control of trends in heating and cooling consumption at the device level during the pre-treatment period - Calculation of baseline emissions - Calculation of project emissions
Comments	N/A

Data / Parameter	cdd_{it} hdd_{it} & h_{it}
Data unit	Degrees above 60 F for cdd_{it} , degrees below 60 F for hdd_{it} and relative humidity for h_{it}
Description	Weather variables
Source of data	ecobee thermostats
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	By separately estimating the coefficients on cold days and warm days, we allow for maximum flexibility in estimating the impact of disparate weather, which is critical because this helps to control for slight differences in geography
Purpose of data	- Calculation of baseline emissions - Calculation of project emissions
Comments	N/A

Data / Parameter	d_t
Data unit	Dummy variable
Description	Day of week dummy
Source of data	ecobee thermostats

Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Day of week is recognized as an important factor in estimating daily demand for heating and cooling as weekday and weekend residential demand profiles often look different since residents spend more time at home during weekends.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	N/A

Data / Parameter	Number of fuel type • Electric heat (heat pump) • Fossil fuel heat (no heat pump)
Data unit	Calculated at the device level
Description	Indicator variable for having a heat pump
Source of data	ecobee thermostats
Value applied	1 or 0
Justification of choice of data or description of measurement methods and procedures applied	We calculate impacts separately for homes with heat pumps and homes with no heat pumps
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	N/A

Data / Parameter	Number of Dwellings in Building Stock b
Data unit	Number of houses
Description	Number of houses with the treatment (ie., treatment group) in random sampling analysis
Source of data	ecobee thermostats
Value applied	Number of homes with eco+ (treatment) in random sampling analysis: • Non-heat pump cooling: 38,206

	- Heat pump cooling: 18,346 - Non-heat pump aux heat: 38,206 - Heat pump compressor heat: 18,346 - Heat pump aux heat: 18,346
Justification of choice of data or description of measurement methods and procedures applied	The total building stock is used, along with the lower bound of the estimated impact of eco+ and the emissions rate, to calculate the total tons of emissions abated.
Purpose of data	- Calculation of baseline emissions - Calculation of project emissions
Comments	N/A

5.2 Data and Parameters Monitored

The list of data and monitored parameters are the same as the list of available parameters listed above in Section 5.1.

Data / Parameter	Compressor $Cooling_{it}$ (Y_{it} in cooling regression)
Data unit	Seconds of air conditioning runtime for device i on date t
Description	This value is aggregate from the 5-minute telemetry ecobee maintains from all devices for each thermostat in the treatment and control group of the measurement sample.
Source of data	ecobee thermostats
Value applied	N/A - This is a measured value.
Justification of choice of data or description of measurement methods and procedures applied	HVAC runtime varies seasonally based on weather trends. DSA chose to model using daily level run-time data rather than annual totals as suggested in VM0008 to significantly improve accuracy. Modeling based on 365 days provides more data points for the regression to be more precise in estimating the impacts of the project activity across a range of weather conditions.
Purpose of data	This parameter is the dependent variable of the cooling regression. The panel regression is described in Section 3.4, 3.5 and 3.6.
Comments	N/A

Data / Parameter	Auxiliary $Heat_{it}$ (Y_{it} in heating regression)
Data unit	For furnaces and boilers: Seconds of heating runtime for device i on date t For heat pumps: Seconds of auxiliary (backup) heating runtime for device i on date t
Description	This value is aggregate from the 5-minute telemetry ecobee maintains from all devices for each thermostat in the treatment and control group of the measurement sample.
Source of data	ecobee thermostats
Value applied	N/A This is a measured value.
Justification of choice of data or description of measurement methods and procedures applied	HVAC runtime varies seasonally based on weather trends. DSA chose to model using daily level run-time data rather than annual totals as suggested in VM0008 to significantly improve accuracy. Modeling based on 365 days provides more data points for the regression to be more precise in estimating the impacts of the project activity across a range of weather conditions.
Purpose of data	This parameter is the dependent variable of the heating regression. The panel regression is described in Section 3.4, 3.5 and 3.6.
Comments	N/A

Data / Parameter	Compressor $Heat_{it}$ (Y_{it} in heating regression)
Data unit	For furnaces and boilers: not applicable For heat pumps: Seconds of compressor (outdoor condensing unit) heating runtime for device i on date t
Description	This value is aggregate from the 5-minute telemetry ecobee maintains from all devices for each thermostat in the treatment and control group of the measurement sample.
Source of data	ecobee thermostats
Value applied	N/A - This is a measured value.
Justification of choice of data or description of measurement methods and procedures applied	HVAC runtime varies seasonally based on weather trends. DSA chose to model daily level run-time data rather than annual totals as suggested in VM0008 to significantly improve accuracy. Modeling based on 365 days provides more data points for the regression to be more precise in estimating the impacts of the project activity across a range of weather conditions.
Purpose of data	This parameter is the dependent variable of the heating regression. The panel regression is described Section 3.4, 3.5 and 3.6.
Comments	N/A

Data / Parameter	Standard Deviation
Data unit	Seconds
Description	Confidence interval on the coefficients that estimate the effect of eco+ by year and month
Source of data	Calculated from panel regression
Value applied	95% confidence interval, clustered on household
Justification of choice of data or description of measurement methods and procedures applied	Panel regressions are the preferred approach for assessing energy consumption data and preferred method of casual inference used by the National Renewable Energy Laboratory. Regressions are the best approach to understand if a significant effect exists by using all observations that are treated (regardless if their individual difference is significant) and then look at the joint significance of the coefficient on treatment. The measurement took place on November 29, 2023 and was conducted by Hal Gordon and Nixon Candiales from DSA. Data and code available upon request.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	Provide any additional comments

Data / Parameter	m_t
Data unit	Dummy variable
Description	year by month dummy variables
Source of data	ecobee thermostats
Value applied	1/0
Justification of choice of data or description of measurement methods and procedures applied	When used alone, this vector of dummies controls for time variant unobserved variables. When it is interacted with treatment, it allows DSA to get a dynamic treatment effect by year month
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	N/A

Data / Parameter	C_i
Data unit	Dummy variable
Description	The treatment variable, complier
Source of data	ecobee thermostats
Value applied	1/0
Justification of choice of data or description of measurement methods and procedures applied	N/A
Purpose of data	- Calculation of baseline emissions - Calculation of project emissions
Comments	N/A

Data / Parameter	y_{it-1}
Data unit	Seconds
Description	Lagged Dependent Variables
Source of data	ecobee thermostats
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Lagged Dependent variables control of the level of demand for heating or cooling by individual and month. This is a critical control as the treatment and control groups showed slight differences in pre-treatment period. Including pre-treatment data and performance period data results in a more precise estimate of the project activity impact. Using household lagged dependent variables means DSA is able to control for each individual households idiosyncratic taste for heating and cooling. After controlling for these, what remains is the true effect of eco+ and Adjust for Humidity.
Purpose of data	Control of trends in heating and cooling consumption at the device level during the pre-treatment period - Calculation of baseline emissions - Calculation of project emissions
Comments	N/A

Data / Parameter	cdd_{it} hdd_{it} & h_{it}
Data unit	Degrees above 60 F for cdd_{it} , degrees below 60 F for hdd_{it} and relative humidity for h_{it}
Description	Weather variables
Source of data	ecobee thermostats
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	By separately estimating the coefficients on cold days and warm days, we allow for maximum flexibility in estimating the impact of disparate weather, which is critical because this helps to control for slight differences in geography
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	N/A

Data / Parameter	d_t
Data unit	Dummy variable
Description	Day of week dummy
Source of data	ecobee thermostats
Value applied	N/A
Justification of choice of data or description of measurement methods and procedures applied	Day of week is recognized as an important factor in estimating daily demand for heating and cooling as weekday and weekend residential demand profiles often look different since residents spend more time at home during weekends.
Purpose of data	• Calculation of baseline emissions • Calculation of project emissions
Comments	N/A

Data / Parameter	Number of fuel type • Electric heat (heat pump) • Fossil fuel heat (no heat pump)
Data unit	Calculated at the device level

Description	Indicator variable for having a heat pump
Source of data	ecobee thermostats
Value applied	1 or 0
Justification of choice of data or description of measurement methods and procedures applied	We calculate impacts separately for homes with heat pumps and homes with no heat pumps
Purpose of data	- Calculation of baseline emissions - Calculation of project emissions
Comments	N/A

Data / Parameter	Number of Dwellings in Building Stock b
Data unit	Number of houses
Description	Number of houses with the treatment (ie., treatment group) in sampling analysis
Source of data	ecobee thermostats
Value applied	Number of homes with eco+ (treatment) in random sampling analysis: - Non-heat pump cooling: 38,206 - Heat pump cooling: 18,346 - Non-heat pump aux heat: 38,206 - Heat pump compressor heat: 18,346 - Heat pump aux heat: 18,346
Justification of choice of data or description of measurement methods and procedures applied	The total building stock is used, along with the lower bound of the estimated impact of eco+ and the emissions rate, to calculate the total tons of emissions abated.
Purpose of data	- Calculation of baseline emissions - Calculation of project emissions
Comments	N/A

5.3 Monitoring Plan

Method of Measurement

To cause an HVAC system to run, ecobee thermostats power specific relays on the back of the device corresponding to specific HVAC systems. When a relay is powered, its corresponding system runs. In regular operation, ecobee thermostats record whether a relay is powered or unpowered. This information is discretized on device to 5-minute intervals. Every 15 minutes, a packet of data corresponding to the previous 3 intervals is sent from the device to ecobee's servers. This data is then consumed on the server side, preprocessed, and stored in a Google Cloud BigQuery table known as ISM (Interval Status Messages). It is from the ISM table that runtime data was pulled for the purposes of this analysis. Broadly, the server-side processing can be abstracted as 3 steps:

1. Read and store data sent from devices
2. Validate data
3. Group data by thermostat and writes data to table

The architecture diagram in Figure 14 illustrates the flow of data from its reception on the server side to its storage in the ISM table.

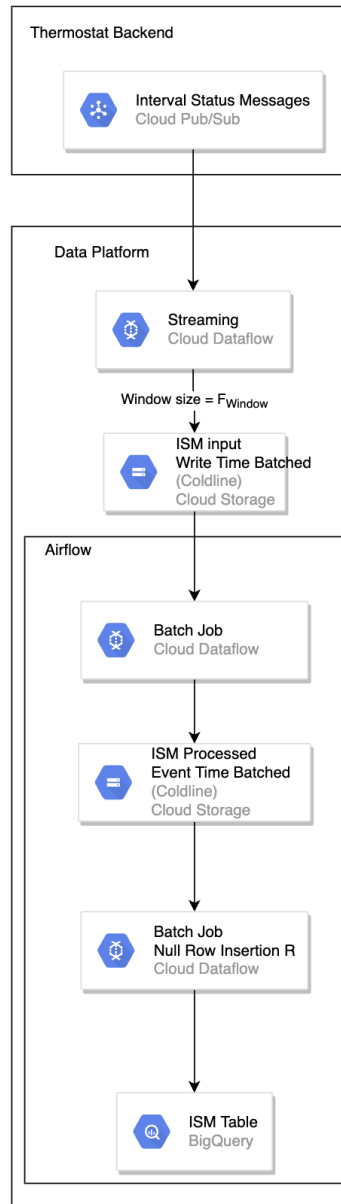


Figure 14 - Architecture diagram to illustrate the flow of data from its reception on the server side to its storage in the ISM table.

Organizational Responsibilities and Competencies

The above pipeline is managed by the Data Platform team at ecobee. This team is comprised of skilled professionals in the field of Data Engineering. The transmission of the data from the device to the server is managed by the Firmware team. This team is comprised of skilled professionals in the field of firmware development, some of whom have been overseeing this process for over 5 years without issue.

The core technical team involved in this project activity includes the following individuals:

1. Senior Machine Learning Engineer as the project activity's Technical Lead. They are required to have an extensive knowledge and expertise in the fields of applied math's,

- statistics, machine learning, data science, data analysis data engineering, software engineering, orchestration, automating and hold at least a Bachelor's Degree in Engineering and Applied Science or a related degree. They are considered the leading company authority and internal expert on the operation of ecobee's "Adjust for Humidity" feature which has helped customers save energy without sacrificing thermal comfort.
2. Manager, Embedded Systems (Firmware) who is responsible for overseeing the team of embedded firmware engineers that develop the software that goes on the thermostats that collects the data and delivers to ecobee servers. They are required to have extensive knowledge and expertise in the fields of software engineering, platform development, software design and architecture, agile development and holds a least a Bachelor's Degree in Computer Science or a related degree.
 3. Engineering Manager, Data Platform, who is responsible for maintaining the data pipelines for any new library/data upgrades, creating monitoring policies to ensure the team is aware of if the pipeline is not working as intended and maintaining the data storage where the thermostat runtime data gets stored as an end result. They are required to have extensive knowledge and expertise in the fields of data engineering, software engineering, data modelling and hold at least a Bachelor's Degree in Computer Science or a related degree.

Oversight Policies and Internal Auditing

Firmware: The Firmware Team executes a series of integration tests that are run using ecobee's thermostat simulation platform to ensure that, for a given version of firmware, the runtime values sent from the device in simulation are as expected.

Server: Along with managing the automated execution of the pipeline itself, the Data Platform team also manages an alerting policy to ensure pipeline health. If the number of unprocessed messages exceeds 1,000,000 (this corresponds to ~2 minutes of inactivity/delay), an alert is sent to a person on call. There is a person on call 24 hours a day, every day of the year.

The Data Platform team also monitors that the ISM table upload pipelines run successfully. Any issues with this pipeline are committed to be resolved within 24 hours.

The pipelines that populate the ISM table also include writes to cold storage (as illustrated in the architecture diagram above). This ensures that if ISM data is ever lost, it can be recreated using the exact data from which it was originally generated. While this provides a safety net in the case of larger issues, this has never been required.

In addition to this, there exist integration tests for all 3 pipelines used for ISM table population. Any time a change is made to any of these pipelines, these tests are run to ensure that the pipelines still operate as desired.

Data Recording: Runtime data fields that are recorded are listed in the data dictionary presented in Table 6 below.

To prevent data anomalies, ecobee employs the use of Protocol Buffers (protobuf in short). Messages are composed using a pre-defined and agreed-upon format which is then put into code and handed to all parties involved in the message transfer. This means message is:

- composed inside the thermostat firmware into a "protobuf message",

- converted to a transferable format that cannot be modified (i.e. serialized),
- sent over / forwarded to the Data Platform team for storage,
- deserialized and decomposed using the same rules that were used to compose it,
- stored in the database forever (indefinitely)

This eliminates the process of dealing with erroneous data and data is assured to be abided to expected format 100% of the time. It avoids the human intervention of correcting the data by 100%.

Internal Auditing Procedures and Policies for Handling Non-Conformances

There are two ways the team handles non-conformances:

- 1) Threshold for the data: If the data is empty and does not reach the threshold of 655.375 MB it is discarded for that time period.
- 2) Map values as is for all the data. To make data more readable the following procedures are followed:
 - Convert temperature and humidity readings to Fahrenheit (°F)
 - Combine readings from many sensors associated with a thermostat into a single row corresponding to that particular thermostat
 - Remove non-ascii characters from string values
 - Map null to null strings

ecobee tracks the failures that occur due to threshold and they are very rare (occurring less than <1% of the time).

Sampling and Data Transfer Process

ecobee maintains a database containing thermostat metadata. This includes data points such as thermostat location, HVAC equipment types, heating/cooling mode, and other relevant thermostat information. This table is populated upon installation and registration of a new thermostat and updated whenever a user makes a change. For a given monitoring period, ecobee uses this table to filter for eligible devices (i.e., units) within the period that meet the project activity's prescribed criteria and applicability conditions in order to perform emission quantification analysis.

HVAC malfunctions were not explicitly considered during runtime determination. HVAC malfunctions are independent of the eco+ intervention so it would occur at equivalent rates in the treatment and control group. The strength of utilizing a control group approach lies in the fact that HVAC malfunctions occur in both the control and treatment group. This ensures that the estimated impact of the eco+ remains unbiased, as any influence of malfunctioning units is distributed equally across both groups. Consequently, the presence of malfunctions does not disproportionately affect the treated population and thereby safeguarding the validity of the impact estimate.

The data sets that were securely transferred from ecobee's databases to DSA include a sample of 111,262 randomized devices that meets criteria (listed in Table 6 below) for defined control group and treatment group. The sampling data and protocol are outlined below.

Data Transfer Process between ecobee and DSA

1. ecobee's Technical Lead developed SQL queries to obtain data requested by DSA (found in Table 6: Data Request) while maintaining user anonymity.
2. Queries were executed in ecobee's private BigQuery. Query results were written to private BigQuery Tables.
3. Tables were exported to Google Cloud Storage bucket hosted by ecobee.
4. DSA was granted viewer access to the specific bucket containing relevant data. No other permissions were granted to DSA.
5. Link to Google Cloud bucket was passed securely to DSA using Keybase.

The sampling protocol had the following steps:

1) Pre-Screening of eligible thermostat devices:

Eligible thermostats devices that were used for panel regression had to meet the following criteria:

- Runtime data is available continuously from March 1, 2018 to March 02, 2023
- Device location is within the contiguous United States (one of the lower 48 states) with a valid postal zip code
- There was no change in location (home/dwelling) over the five-year period
- Device is connected to either a heating or a cooling system
- Device is in a home / location where device either enabled eco+ or did not

For the accepters (i.e., the treatment group)

- Device received the eco+ offer and enabled eco+ by March 1, 2021
- The "Adjust for Humidity" feature was enabled for at least 95% of the days since eco+ was enabled and activated. Based on date range, this means the feature was enabled for ~700 days depending on the exact invitation and acceptance date

For the deniers (i.e., the control group)

Either:

- Devices that do not have eco+ at all
- Devices that received eco+ but did not enable any of the features

2) Sampling Protocol:

The data for the panel regression came from a random sample of ecobee customers:

- The sample were randomly selected from the millions of ecobee customers who were active from early March 2018 to late October 2023.
 - 80,000 customers without heat pumps, evenly divided between those who opted into eco+ (treatment group) and those who did not (control group)

- 31,828 customers with heat pumps, where 20,000 were in treatment group and 11,282 were control in control
- DSA was provided with daily thermostat data for each customer starting on March 1, 2018 until March 2, 2023. For heat pump owners, three dependent variables were made available: 1) seconds of cooling, 2) seconds of heating, and 3) seconds of auxiliary heating, while non-heat pump customers have 4)seconds of cooling and 5) seconds of auxiliary heating.

3) Post-Screening of Data.

Any daily observations that had mean temp below -20 and above 115 °F were dropped⁵²

Table 6: Data Request

Data Item	Description
1. Device Characteristics and Configuration	a) Thermostat ID (hashed) b) Home/Location ID c) Time Zone d) State e) Postal Code f) Group (Acceptor or Denier) g) Has Heat Pump (Boolean) h) Allow Heat Pump with Aux Heat (Boolean) i) Eco+ Enabled Date (null for Deniers) j) Home Details (type, size, floors, bedrooms, age, occupants) if available k) Climate Zone (if available) l) Cool stages (n) m) Heat stages (n)
2. Eco+ Features Data	At the daily level: a) Thermostat ID (hashed) b) Date c) Comfort Level (Slider Level) d) Adjust for Humidity Enabled (Boolean) e) Occupancy Enabled (Boolean) f) TOU Feature Enabled (Boolean)

⁵² Such high and low temperature reading composed a vanishingly small number of readings in the sample. Of the 57,812,467 customer days in the sample, only 329 had temperature readings that were lower than -20 or higher than 115, which means DSA dropped 0.0005% of the sample. These drops were made because many of them were obviously anomalous, ranging from -2449°F (nearly 2000 degrees colder than absolute zero) to 142°F (ten degrees warmer than the all time high measured on Earth). ecobee relies on Apple Weatherkit and Darksky Weather API for these daily outdoor temperature measurements, and occasional erroneous values are impossible to avoid. By dropping 0.0005% of observations with obviously wrong readings, DSA avoid errors in this weather data from making the weather controls less effective.

g) DR Feature Enabled (Boolean)	
3. Thermostat Runtime Data	At the <u>hourly</u> level: a) Thermostat ID b) Datetime UTC c) Observations (count of 5-minute records collapsed across the day. 12 indicates a complete series for the hour) d) Compcool1 (sum of seconds in hour) e) Compcool2 (sum of seconds in hour) f) Auxheat1 (sum of seconds in hour) g) Auxheat2 (sum of seconds in hour) h) Compheat1 (sum of seconds in hour) i) Compheat2 (sum of seconds in hour) j) Cooling Setpoint (Average) k) Heating Setpoint (Average) l) Outdoor Temperature (Average) m) Outdoor Relative Humidity (Average) n) Indoor Humidity (Average) o) Indoor Temperature at the Thermostat without Adjust for Humidity (Average)

APPENDIX A: CONNECTED LOAD ASSUMPTIONS

Translating HVAC runtime, or changes in runtime, to energy usage and demand requires the project proponent to make an assumption about the size of the HVAC units connected to ecobee thermostats. ecobee collected HVAC unit size and efficiency measurements/assumptions from various technical reference manuals (TRMs), appliance saturation studies, and evaluation reports which are presented in Appendix B.

In these industry sources, air conditioning size information is generally presented in one of three metrics:

- kW** – The main metric of interest as this is a direct parameter in the methodology. This is usually determined by spot measurements of instantaneous power draw or trending measurements of power or current. It may or may not include the power draw of the indoor circulating fan.
- Tons** – A measure of cooling output, or capacity. One ton is the amount of heat required to melt one ton of ice in a 24-hour period (288,000 BTU or 12,000 BTU per hour).
- Capacity in BTU per Hour** – Interchangeable with tons.

Since the metrics of cooling capacity are output measurements, an assumption about the efficiency of the system is required to convert output capacity to the input power requirement. To facilitate this conversion and leverage size ratings in tons or BTU/hour ecobee collects average Seasonal Energy Efficiency Ratio (SEER) values for existing air conditioner stock and uses the values to convert to kW. SEER ratings include the fan power requirements.

ecobee categorized each source from the literature review presented in Appendix B into one of five climate zones and used the results to inform assumed HVAC unit size for each climate zone. Tables 1, 2 and 3 below show the results of the company's research and final assumptions by climate zone.

Table 1: Connected Load Assumption by Climate Zone, Cooling

Climate Zone	Tons	SEER	kW per Device
01 Cold	2.75	10.5	3.10
02 Dry	3.25	10.5	3.48
03 Hot Humid	3.25	10.5	3.60
04 Mixed Humid	2.75	10.5	3.04
05 Marine	2.60	10.5	2.93
Weighted Total	2.78	10.5	3.21

Table 2: Connected Load Assumption by Climate Zone, Heating (Furnace)

Region	Furnace Size (kBTU/hour)	Furnace Fan (kW)
01 Cold	77.7	0.56
02 Dry	60.0	0.56
03 Hot Humid	65.0	0.56

04 Mixed Humid	75.5	0.56
05 Marine	62.5	0.56
Weighted Total	68.4	0.56

Table 3: Connected Load Assumption by Climate Zone, Heating (Heat Pump)

Region Name	Heat Pump Compressor Size (kW)	Heat Pump Auxiliary Size (kW)
01 Cold	3.47	9.53
02 Dry	2.88	7.91
03 Hot Humid	2.42	7.68
04 Mixed Humid	3.02	8.32
05 Marine	3.00	8.25
Weighted Total	3.02	8.52

APPENDIX B: CONNECTED LOAD RESEARCH

Document Name	Document Type	State	Year Effective	Climate Zone	URL	Page/ Table/ Other Source	Size (tons)	SEER for Existing Units
Wisconsin Focus on Energy 2019 Technical Reference Manual	TRM	WI	2019	Cold/Very Cold	https://www.focusonenergy.com/sites/default/files/Focus_on_Energy_2019_TRM-Update.pdf	Pg. 937	2.425	12.1
State of Minnesota Technical Reference Manual for Energy Conservation Improvement Programs version 3.0	TRM	MN	2020	Cold/Very Cold	http://mn.gov/commerce-stat/pdfs/mn-trm-v3.0.pdf	Pg. 42	2.5	11.5
Iowa Energy Efficiency Statewide Technical Reference Manual Version 2.0	TRM	IA	2017	Cold/Very Cold	https://efs.iowa.gov/cs/groups/external/documents/docket/mdax/njq1/~edisp/1645801.pdf	Pg. 121	3	8.6
2019 Illinois Statewide Technical Reference Manual for Energy Efficiency Version 7.0	TRM	IL	2019	Cold/Very Cold	http://ilsagfiles.org/SAG_files/Technical_Reference_Manual/Version_7/Final_9-28-18/IL-TRM_Effective_010119_v7.0_Vol_3_Res_092818_Final.pdf	Pg. 79	2.8	9.3
Technical Reference User Manual (TRM) No. 2014-87	TRM	VT	2015	Cold/Very Cold	https://puc.vermont.gov/sites/psbnew/files/doc_library/ev-technical-reference-manual.pdf	Pg. 531 of document	3	
Rhode Island Technical Reference Manual For Estimating Savings from Energy Efficiency Measures - 2018 Program Year	TRM	RI	2018	Cold/Very Cold	http://www.ripuc.org/eventsactions/docket/4755-NGrid-2018-TRM-RI.pdf	Pg. M-51	2.7	10
Missouri Technical Reference Manual Volume 3 Residential Measures - Final March 31, 2017	TRM	MO	2017	Mixed-Humid	https://exportmissouri.mo.gov/docs/default-source/default-document-library/mo_trm-2017_vol-3_res_measures_033117_final.pdf?sfvrsn=0	Pg. 120	2.8	10
DC SEU TRM Characterizations	TRM	DC	2017	Mixed-Humid	-	Pg. 87	2.67	
Xcel Deemed Savings Technical Assumptions	Survey	CO	N/A	Cold/Very Cold	https://www.xcelenergy.com/staticfiles/xcel-responsive/Company/Rates%20&%20Regulations/Regulatory%20Filings/CO-DSM-HEAC-Deemed-Savings.pdf	Pg. 4	3	10
The Effect of Residential Equipment	Survey	FL	1997	Hot-Humid	http://www.fsec.ucf.edu/en/publications/html/FSEC-PF-328-97/index.htm	Table 3	3.29	

Capacity on Energy Use, Demand, and Run-Time								
Analysis of Historical Residential Air-Conditioning Equipment Sizing Using Monitored Data	Survey	WA	1993	Marine	https://digital.library.unt.edu/ark:/67531/metadc1310394/m2/1/high_res_d/10134448.pdf	Pg. 10	2.635	
Technical Reference Manual for APS Energy Efficiency Programs Program Year 2013	TRM	AZ	2014	Hot-Dry/Mixed-Dry	https://images.edocket.azcc.gov/docketpdf/0000150538.pdf	Pg. 23, Table 3.3	3.75	11
Texas Technical Reference Manual Version 6.0 Volume 2: Residential Measures Program Year 2019	TRM	TX	2019	Hot-Humid	http://www.texasefficiency.com/images/documents/RegulatoryFilings/DeemedSavings/TRMv6.0%20Vol%202%20Residential%20Measures_Final.pdf	Pg. 2-345	3.7	
Energy Trust of Oregon Seasonal Savings Pilot Evaluation	Survey	OR	2017	Cold/Very Cold	https://www.energytrust.org/wp-content/uploads/2017/12/Energy-Trust-of-Oregon-Nest-Seasonal-Savers-Pilot-Evaluation-FINAL-wSR.pdf	Pg. 6-47	3	12
DSA Research	Field Survey	GA	N/A	Hot-Humid	-	DSA Research	2.9	
DSA Research	Field Survey	NM	N/A	Hot-Dry/Mixed-Dry	-	DSA Research	2.614	
Single-Family Weatherization Baseline Assessment (R5) Final Report Submitted to The Connecticut Energy Efficiency Fund, Connecticut Light and Power, & The United Illuminating Company	Survey	CT	2014	Cold/Very Cold	https://www.energizect.com/sites/default/files/R5-Connecticut%20Weatherization%20Baseline%20Assessment-FINAL%2006-04-14.pdf	Table 6-15 and 6-16	3	10.4
National Grid Rhode Island Residential Appliance Saturation Survey (Study RI2311) Report	Survey	RI	2018	Cold/Very Cold	http://www.ripuc.org/eventsactions/docket/6.%20National%20Grid%20RI2311%20RASS%20Final%20Report%2011OCT2018.pdf	Table 6		10.9
NEEA Residential Stock Assessment II Single-Family Homes Report 2016-2017 Revised 04/2019	Survey	WA	2019	Marine	https://neea.org/img/uploads/Residential-Building-Stock-Assessment-II-Single-Family-Homes-Report-2016-2017.pdf	Table 53		12.2
2018 Pennsylvania Statewide Act 129 Residential Baseline Study	Survey	PA	2019	Cold/Very Cold	http://www.puc.state.pa.us/Electric/pdf/Act129/SWE-Phase3_Res_Baseline_Study_Rpt021219.pdf	Table 90		12.2

2017 Residential Programs Evaluation Report	Survey	Ontario	2018	Canada	http://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2017/2017-Residential-Programs-Evaluation-Report.pdf?la=en	Pg. D-206	2.14	
2014 Consumer Program Evaluation Volume 1: Report	TRM	Ontario	2014	Canada	http://www.ieso.ca/-/media/Files/IESO/Document-Library/conservation/EMV/2014/PY2014-IESO-CP-Evaluation-Final-Report.pdf?la=en	Table 3-9	2.167	
Quick Start Energy Efficiency Annual Report Program Year 1 November 2014 – October 2015	TRM	LA	2014	Hot/Humid	https://www.all4energy.org/uploads/1/0/5/6/105637723/energy-quick-start-energy-efficiency-2014-2015-annual-report.pdf	Pg. 4-2		11.2

APPENDIX C: EPA EGRID EMISSION FACTORS

2022 eGRID Average Emissions Rates

Out of an abundance of conservatism, DSA calculated emissions reductions using average emissions rates. DSA used EPA's 2022 Emissions & Generation Resource Integrated Database⁵³ (eGRID2022) which reports the total and average CO₂ equivalent emissions from electricity by each U.S. state. In order to create a national average representative of eco+, DSA weighted each average emissions rate by the percentage of heat pump and non-heat pump customers in the sample. This resulted in two different average rates 1) 755 lbs/MWh for heat pump customers and 2) 776 lbs/MWh for non-heat pump customers).

State	CO ₂ e Emission Rate (lbs/MWh)	eco+ Heat Pump Customer Share	eco+ Non-HP Customer Share
AL	791.4	4.1%	0.9%
AR	1061.5	0.8%	0.6%
AZ	711.9	6.3%	2.7%
CA	457.5	5.8%	10.6%
CO	1173.1	0.2%	3.1%
CT	523.3	0.4%	1.1%
DC	554.9	0.3%	0.2%
DE	900.8	0.3%	0.2%
FL	818.6	18.2%	4.3%
GA	741.2	7.8%	3.7%
IA	621.6	0.1%	0.6%
ID	248.4	0.3%	0.9%
IL	592.4	1.0%	7.5%
IN	1576.6	1.7%	2.2%
KS	826.2	0.3%	0.7%
KY	1732.3	1.4%	0.5%
LA	820.7	0.4%	1.1%
MA	859.2	2.2%	2.9%
MD	640.5	3.5%	1.8%
ME	342.7	0.0%	0.2%
MI	1015.7	0.3%	5.2%
MN	773.8	0.2%	2.3%
MO	1517.8	1.6%	2.0%

⁵³ EPA. Summary Tables 2022. State Output Emission Rates. https://www.epa.gov/system/files/documents/2024-01/egrid2022_summary_tables.pdf

MS	888.7	0.5%	0.4%
MT	1031.4	0.1%	0.2%
NC	657.1	8.5%	2.3%
ND	1321.4	0.0%	0.1%
NE	1105.7	0.2%	0.3%
NH	306.5	0.3%	0.5%
NJ	488.6	0.3%	3.2%
NM	991.6	0.2%	0.6%
NV	678.7	1.1%	3.6%
NY	491.3	1.1%	3.3%
OH	1162.1	1.4%	2.9%
OK	689.1	0.4%	0.8%
OR	299.1	1.4%	1.4%
PA	714.2	2.0%	2.5%
RI	812.2	0.0%	0.3%
SC	559.9	4.7%	0.9%
SD	326.9	0.0%	0.1%
TN	697.7	3.4%	1.1%
TX	821.9	8.2%	11.7%
UT	1524.3	0.3%	2.1%
VA	590.0	5.6%	1.9%
VT	42.6	0.1%	0.2%
WA	186.0	1.8%	1.6%
WI	1178.4	0.2%	2.1%
WV	1974.3	0.5%	0.2%
WY	1817.6	0.0%	0.1%
Weighted National Avg (lbs/MWh)		755.44	776.42

APPENDIX D: REGRESSION MODEL OUTPUTS

name: LDV_Regressions

log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log

log type: text

resumed on: 11 Dec 2023, 13:02:28

All, non_heat_pumps, compcool1

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Linear regression

Number of obs = 52430202
 F(104, 60743) = 5137.64
 Prob > F = 0.0000
 R-squared = 0.6803
 Root MSE = 8011.2

(Std. err. adjusted for 60,744 clusters in dsa_id)

		Robust				
compcool1	Coefficient	std. err.	t	P> t	[95% conf. interval]	
ym						
2021m4	-108.5866	18.43473	-5.89	0.000	-144.7187	-72.45447
2021m5	-737.7641	37.44457	-19.70	0.000	-811.1556	-664.3727
2021m6	-1832.847	72.23286	-25.37	0.000	-1974.423	-1691.27
2021m7	-4796.283	81.60401	-58.78	0.000	-4956.227	-4636.339
2021m8	-3746.306	85.13822	-44.00	0.000	-3913.177	-3579.435
2021m9	-1987.991	60.79917	-32.70	0.000	-2107.157	-1868.824
2021m10	-802.249	32.39136	-24.77	0.000	-865.7361	-738.7618
2021m11	-23.22566	17.37714	-1.34	0.181	-57.2849	10.83359
2021m12	-171.5844	18.32237	-9.36	0.000	-207.4963	-135.6725

2022m1		-277.6241	15.48548	-17.93	0.000	-307.9756	-247.2725
2022m2		-192.5508	14.12915	-13.63	0.000	-220.244	-164.8577
2022m3		-76.52028	14.72156	-5.20	0.000	-105.3746	-47.66596
2022m4		-255.4146	22.3107	-11.45	0.000	-299.1436	-211.6855
2022m5		-926.7678	43.39546	-21.36	0.000	-1011.823	-841.7125
2022m6		-2654.961	70.60831	-37.60	0.000	-2793.354	-2516.569
2022m7		-5294.84	89.86559	-58.92	0.000	-5470.977	-5118.703
2022m8		-3867.711	89.90866	-43.02	0.000	-4043.932	-3691.489
2022m9		-1814.029	63.29481	-28.66	0.000	-1938.088	-1689.971
2022m10		-621.8555	30.72563	-20.24	0.000	-682.0779	-561.6332
2022m11		-99.77735	17.37982	-5.74	0.000	-133.8418	-65.71286
2022m12		-321.1469	18.40299	-17.45	0.000	-357.2168	-285.077
2023m1		-257.1175	19.06507	-13.49	0.000	-294.4851	-219.7499
2023m2		-183.6157	15.91326	-11.54	0.000	-214.8058	-152.4257
2023m3		-162.399	15.78837	-10.29	0.000	-193.3443	-131.4538
2023m4		-67.21061	23.1808	-2.90	0.004	-112.6451	-21.77616
2023m5		-447.6848	42.37489	-10.56	0.000	-530.7397	-364.6299
2023m6		-2603.298	65.24528	-39.90	0.000	-2731.179	-2475.417
2023m7		-4727.81	92.68769	-51.01	0.000	-4909.478	-4546.142
2023m8		-3589.802	92.05468	-39.00	0.000	-3770.23	-3409.375
2023m9		-2019.123	64.51392	-31.30	0.000	-2145.571	-1892.676
2023m10		-658.3347	36.83613	-17.87	0.000	-730.5336	-586.1358
ym#c.pre_compcool1							
2021m3		.5229644	.0180263	29.01	0.000	.4876327	.558296
2021m4		.472797	.0092973	50.85	0.000	.4545744	.4910197
2021m5		.39476	.0040371	97.78	0.000	.3868474	.4026727
2021m6		.6470573	.0037812	171.12	0.000	.6396461	.6544685
2021m7		.6636766	.0031462	210.95	0.000	.6575101	.669843
2021m8		.6937665	.0037323	185.88	0.000	.6864512	.7010818
2021m9		.5575464	.0039493	141.17	0.000	.5498056	.5652871
2021m10		.4733264	.0061454	77.02	0.000	.4612815	.4853714
2021m11		.2814542	.0134746	20.89	0.000	.255044	.3078644
2021m12		.6060541	.0315837	19.19	0.000	.5441501	.6679582

2022m1		.4856692	.0383471	12.67	0.000	.4105087	.5608296
2022m2		.4503006	.0237334	18.97	0.000	.4037832	.4968181
2022m3		.5602334	.0181514	30.86	0.000	.5246566	.5958101
2022m4		.5201765	.0101602	51.20	0.000	.5002624	.5400905
2022m5		.5276092	.0044584	118.34	0.000	.5188708	.5363477
2022m6		.6825503	.0039586	172.42	0.000	.6747914	.6903091
2022m7		.7282319	.0035173	207.04	0.000	.7213379	.7351258
2022m8		.6691425	.0038563	173.52	0.000	.6615842	.6767009
2022m9		.5251051	.0039323	133.53	0.000	.5173977	.5328125
2022m10		.3800647	.0059315	64.08	0.000	.3684391	.3916904
2022m11		.4775517	.0150218	31.79	0.000	.4481089	.5069945
2022m12		.4808879	.0279175	17.23	0.000	.4261695	.5356062
2023m1		.5693775	.0572916	9.94	0.000	.4570859	.6816691
2023m2		.6311017	.0315781	19.99	0.000	.5692086	.6929949
2023m3		.5716292	.0209404	27.30	0.000	.5305859	.6126726
2023m4		.4481431	.009669	46.35	0.000	.4291919	.4670943
2023m5		.400194	.0041924	95.46	0.000	.3919768	.4084111
2023m6		.5667581	.0038472	147.32	0.000	.5592175	.5742986
2023m7		.6802645	.0035857	189.71	0.000	.6732365	.6872926
2023m8		.6533486	.0039982	163.41	0.000	.645512	.6611851
2023m9		.5386795	.0042772	125.94	0.000	.5302963	.5470628
2023m10		.4286468	.0064749	66.20	0.000	.4159561	.4413376

|

ym#c.complier |

2021m3		-200.6917	19.2853	-10.41	0.000	-238.4909	-162.8924
2021m4		-288.8215	28.61814	-10.09	0.000	-344.9131	-232.7298
2021m5		-467.3884	45.88839	-10.19	0.000	-557.3298	-377.447
2021m6		-703.2517	76.63248	-9.18	0.000	-853.4516	-553.0518
2021m7		-1685.563	78.30781	-21.52	0.000	-1839.046	-1532.079
2021m8		-1357.917	83.54327	-16.25	0.000	-1521.662	-1194.172
2021m9		-1088.52	64.41471	-16.90	0.000	-1214.773	-962.2671
2021m10		-411.3306	36.19972	-11.36	0.000	-482.2821	-340.379
2021m11		-238.8944	19.20076	-12.44	0.000	-276.5279	-201.2608

2021m12		-105.4108	18.55927	-5.68	0.000	-141.7871	-69.03461
2022m1		-86.96906	11.65634	-7.46	0.000	-109.8155	-64.1226
2022m2		-184.4478	12.42764	-14.84	0.000	-208.8061	-160.0896
2022m3		-202.0184	19.6687	-10.27	0.000	-240.5691	-163.4677
2022m4		-235.3219	30.05579	-7.83	0.000	-294.2314	-176.4125
2022m5		-379.2715	51.57672	-7.35	0.000	-480.362	-278.181
2022m6		-341.8526	74.75922	-4.57	0.000	-488.3809	-195.3243
2022m7		-1278.541	86.61631	-14.76	0.000	-1448.309	-1108.773
2022m8		-1276.75	86.54804	-14.75	0.000	-1446.385	-1107.116
2022m9		-682.5995	65.73935	-10.38	0.000	-811.4488	-553.7502
2022m10		-185.4386	33.19794	-5.59	0.000	-250.5067	-120.3705
2022m11		-136.307	18.17216	-7.50	0.000	-171.9245	-100.6895
2022m12		-45.93816	14.10981	-3.26	0.001	-73.59344	-18.28289
2023m1		-90.63397	15.30335	-5.92	0.000	-120.6286	-60.63936
2023m2		-87.93191	15.75037	-5.58	0.000	-118.8027	-57.06113
2023m3		-148.8125	19.63732	-7.58	0.000	-187.3017	-110.3233
2023m4		-255.1908	29.58325	-8.63	0.000	-313.174	-197.2075
2023m5		-492.3895	50.28448	-9.79	0.000	-590.9472	-393.8318
2023m6		-278.9791	69.9363	-3.99	0.000	-416.0544	-141.9037
2023m7		-1227.527	88.68266	-13.84	0.000	-1401.345	-1053.709
2023m8		-1236.251	88.75509	-13.93	0.000	-1410.211	-1062.29
2023m9		-568.0651	66.84965	-8.50	0.000	-699.0906	-437.0396
2023m10		-189.6642	38.01044	-4.99	0.000	-264.1648	-115.1636
dow							
Monday		-97.18389	4.684716	-20.74	0.000	-106.3659	-88.00183
Tuesday		-197.0611	5.319913	-37.04	0.000	-207.4881	-186.634
Wednesday		-188.1203	5.405844	-34.80	0.000	-198.7158	-177.5248
Thursday		-130.383	5.208709	-25.03	0.000	-140.5921	-120.1739
Friday		-183.8673	4.684953	-39.25	0.000	-193.0498	-174.6847
Saturday		-116.953	3.072945	-38.06	0.000	-122.976	-110.9301
outdoor_humidity		16.16036	.8312239	19.44	0.000	14.53116	17.78956
cdd60		796.7194	3.672407	216.95	0.000	789.5215	803.9173

```

hdd60 |    22.69959    .6578891    34.50    0.000    21.41013    23.98905
_cons |   -1251.498    49.49703   -25.28    0.000   -1348.512   -1154.483

```

```
name: LDV_Regressions
```

```
log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log
```

```
log type: text
```

```
paused on: 11 Dec 2023, 13:08:43
```

```
name: LDV_Regressions
```

```
log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log
```

```
log type: text
```

```
resumed on: 11 Dec 2023, 13:08:43
```

All, non_heat_pumps, auxheat1

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```

Linear regression          Number of obs    =   52430202
                           F(104, 60743)         =    3758.97
                           Prob > F              =     0.0000
                           R-squared             =     0.6742
                           Root MSE           =     5107

```

(Std. err. adjusted for 60,744 clusters in dsa_id)

```

|               Robust
auxheat1 | Coefficient  std. err.      t    P>|t|     [95% conf. interval]

```

```
ym |
```

```

2021m4 |    642.2694    31.00684    20.71    0.000    581.4959    703.0429
2021m5 |   1136.691    47.18446    24.09    0.000   1044.21    1229.173
2021m6 |   1411.617    48.01285    29.40    0.000   1317.512   1505.722
2021m7 |   1483.168    44.81559    33.09    0.000   1395.329   1571.006

```

2021m8		1493.779	46.09195	32.41	0.000	1403.438	1584.119
2021m9		1427.639	51.68582	27.62	0.000	1326.334	1528.943
2021m10		1221.095	44.78139	27.27	0.000	1133.324	1308.867
2021m11		-126.309	50.93271	-2.48	0.013	-226.1373	-26.48078
2021m12		-416.8177	62.53977	-6.66	0.000	-539.3958	-294.2396
2022m1		-1197.132	68.32157	-17.52	0.000	-1331.042	-1063.221
2022m2		-782.8323	66.1954	-11.83	0.000	-912.5755	-653.0892
2022m3		-324.7885	42.42251	-7.66	0.000	-407.9367	-241.6402
2022m4		544.7067	42.46243	12.83	0.000	461.4802	627.9332
2022m5		1291.107	54.33586	23.76	0.000	1184.608	1397.605
2022m6		1377.913	47.97422	28.72	0.000	1283.884	1471.943
2022m7		1440.32	45.60628	31.58	0.000	1350.932	1529.709
2022m8		1477.024	46.15304	32.00	0.000	1386.564	1567.484
2022m9		1379.16	51.23754	26.92	0.000	1278.734	1479.586
2022m10		1039.281	44.62768	23.29	0.000	951.8103	1126.751
2022m11		855.3816	54.46579	15.70	0.000	748.6285	962.1348
2022m12		-170.341	72.20811	-2.36	0.018	-311.8691	-28.81288
2023m1		367.2638	64.9997	5.65	0.000	239.8642	494.6634
2023m2		-1.011865	63.61889	-0.02	0.987	-125.7051	123.6813
2023m3		182.3062	50.02172	3.64	0.000	84.26347	280.3489
2023m4		762.7861	42.22849	18.06	0.000	680.0181	845.554
2023m5		1322.212	45.92702	28.79	0.000	1232.195	1412.23
2023m6		1442.764	45.86345	31.46	0.000	1352.872	1532.657
2023m7		1446.771	44.79009	32.30	0.000	1358.983	1534.56
2023m8		1476.812	45.83066	32.22	0.000	1386.984	1566.64
2023m9		1496.111	52.69288	28.39	0.000	1392.833	1599.389
2023m10		1116.264	45.96684	24.28	0.000	1026.169	1206.359
ym#c.pre_auxheat1							
2021m3		.4495943	.0042737	105.20	0.000	.4412178	.4579708
2021m4		.4058663	.006105	66.48	0.000	.3939004	.4178321
2021m5		.5127173	.0251018	20.43	0.000	.4635177	.5619168
2021m6		.4754741	.095317	4.99	0.000	.2886524	.6622958
2021m7		.6871836	.1123698	6.12	0.000	.4669384	.9074288

2021m8		.5659051	.1645226	3.44	0.001	.2434403	.8883699
2021m9		.3372333	.097697	3.45	0.001	.1457469	.5287196
2021m10		.2786861	.0074546	37.38	0.000	.2640751	.2932972
2021m11		.4769298	.004787	99.63	0.000	.4675472	.4863124
2021m12		.5291473	.0052456	100.87	0.000	.5188658	.5394288
2022m1		.6196896	.0045648	135.75	0.000	.6107426	.6286366
2022m2		.7839002	.0064837	120.90	0.000	.7711921	.7966083
2022m3		.5114788	.0047799	107.01	0.000	.5021103	.5208473
2022m4		.5571632	.0073111	76.21	0.000	.5428334	.5714929
2022m5		.5008024	.0330958	15.13	0.000	.4359346	.5656703
2022m6		.6329122	.0922254	6.86	0.000	.4521502	.8136743
2022m7		.65493	.1312091	4.99	0.000	.3977596	.9121003
2022m8		.5405728	.1781063	3.04	0.002	.191484	.8896617
2022m9		.3399521	.0942722	3.61	0.000	.1551783	.5247259
2022m10		.377556	.0085489	44.16	0.000	.3608002	.3943118
2022m11		.4182914	.0046904	89.18	0.000	.4090981	.4274846
2022m12		.6324153	.0057032	110.89	0.000	.6212371	.6435936
2023m1		.4421706	.0039339	112.40	0.000	.4344602	.4498811
2023m2		.6623033	.0059483	111.34	0.000	.6506446	.673962
2023m3		.5089048	.0050424	100.93	0.000	.4990217	.5187879
2023m4		.367681	.0054275	67.74	0.000	.357043	.378319
2023m5		.3965516	.0211842	18.72	0.000	.3550306	.4380727
2023m6		.5747082	.0864146	6.65	0.000	.4053353	.7440811
2023m7		.6973138	.1194169	5.84	0.000	.4632564	.9313712
2023m8		.5567244	.168159	3.31	0.001	.2271323	.8863164
2023m9		.3936296	.1074615	3.66	0.000	.1830047	.6042544
2023m10		.3324017	.008072	41.18	0.000	.3165806	.3482227
ym#c.complier							
2021m3		-511.0138	40.15373	-12.73	0.000	-589.7153	-432.3124
2021m4		-295.1543	27.67048	-10.67	0.000	-349.3885	-240.9201
2021m5		-45.58306	16.52223	-2.76	0.006	-77.96669	-13.19944
2021m6		27.35981	7.611387	3.59	0.000	12.44146	42.27815

2021m7		35.36566	7.587094	4.66	0.000	20.49494	50.23639
2021m8		20.90602	7.681637	2.72	0.006	5.849989	35.96205
2021m9		-2.177428	9.522505	-0.23	0.819	-20.84157	16.48671
2021m10		-221.3037	21.42998	-10.33	0.000	-263.3065	-179.3009
2021m11		-478.1746	45.32205	-10.55	0.000	-567.006	-389.3433
2021m12		-625.032	54.61239	-11.44	0.000	-732.0725	-517.9916
2022m1		-708.4042	68.12192	-10.40	0.000	-841.9233	-574.885
2022m2		-224.7648	62.96339	-3.57	0.000	-348.1732	-101.3564
2022m3		-294.4861	42.63592	-6.91	0.000	-378.0526	-210.9195
2022m4		-339.4596	33.17779	-10.23	0.000	-404.4882	-274.431
2022m5		-121.3391	17.05609	-7.11	0.000	-154.7691	-87.90913
2022m6		-13.62349	12.03808	-1.13	0.258	-37.21817	9.971186
2022m7		1.151183	9.019417	0.13	0.898	-16.5269	18.82927
2022m8		24.74419	7.524745	3.29	0.001	9.99567	39.49271
2022m9		-4.211791	9.651239	-0.44	0.663	-23.12825	14.70467
2022m10		-204.4273	25.66551	-7.97	0.000	-254.7318	-154.1229
2022m11		-687.1479	49.18115	-13.97	0.000	-783.5431	-590.7527
2022m12		-601.1067	62.69137	-9.59	0.000	-723.982	-478.2314
2023m1		-905.7111	61.84873	-14.64	0.000	-1026.935	-784.4874
2023m2		-628.3952	59.38931	-10.58	0.000	-744.7984	-511.992
2023m3		-635.8556	50.57547	-12.57	0.000	-734.9837	-536.7276
2023m4		-310.2894	29.41641	-10.55	0.000	-367.9456	-252.6331
2023m5		-117.3567	15.54806	-7.55	0.000	-147.8309	-86.88246
2023m6		-22.55344	9.73135	-2.32	0.020	-41.62692	-3.479968
2023m7		22.81506	5.874799	3.88	0.000	11.30043	34.32968
2023m8		17.16776	6.792931	2.53	0.011	3.853595	30.48193
2023m9		-15.7549	11.24936	-1.40	0.161	-37.80367	6.293875
2023m10		-214.196	24.50544	-8.74	0.000	-262.2268	-166.1653
dow							
Monday		62.73367	2.413539	25.99	0.000	58.00312	67.46421
Tuesday		34.40028	2.448295	14.05	0.000	29.60162	39.19895
Wednesday		-19.80766	2.685449	-7.38	0.000	-25.07115	-14.54417
Thursday		-70.45965	2.854088	-24.69	0.000	-76.05368	-64.86563

Friday		-32.19225	2.619081	-12.29	0.000	-37.32565	-27.05884
Saturday		86.12216	1.76585	48.77	0.000	82.66108	89.58323
outdoor_humidity		-14.14432	.2830672	-49.97	0.000	-14.69914	-13.58951
cdd60		-2.090044	.9156585	-2.28	0.022	-3.884737	-.2953506
hdd60		401.5038	1.776372	226.02	0.000	398.0221	404.9855
_cons		-511.6714	46.75947	-10.94	0.000	-603.3201	-420.0227

name: LDV_Regressions

log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log

log type: text

paused on: 11 Dec 2023, 13:14:52

name: LDV_Regressions

log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log

log type: text

resumed on: 11 Dec 2023, 13:14:52

All, heat_pumps, compcool1

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Linear regression	Number of obs	=	20043334
	F(104, 23529)	=	2697.46
	Prob > F	=	0.0000
	R-squared	=	0.6729
	Root MSE	=	9283.5

(Std. err. adjusted for 23,530 clusters in dsa_id)

		Robust			
compcool1	Coefficient	std. err.	t	P> t	[95% conf. interval]

ym							
2021m4		-176.927	60.64021	-2.92	0.004	-295.7858	-58.06829
2021m5		-2407.422	114.2914	-21.06	0.000	-2631.441	-2183.404
2021m6		-2524.185	181.4745	-13.91	0.000	-2879.887	-2168.483
2021m7		-4836.721	211.3397	-22.89	0.000	-5250.96	-4422.481
2021m8		-3168.883	214.5866	-14.77	0.000	-3589.486	-2748.279
2021m9		-2228.743	157.1058	-14.19	0.000	-2536.681	-1920.805
2021m10		-1579.381	102.9787	-15.34	0.000	-1781.225	-1377.536
2021m11		-289.1722	68.11678	-4.25	0.000	-422.6855	-155.6589
2021m12		-511.9068	74.29651	-6.89	0.000	-657.5328	-366.2809
2022m1		-433.0906	63.77859	-6.79	0.000	-558.1007	-308.0804
2022m2		-432.7565	58.91742	-7.35	0.000	-548.2384	-317.2745
2022m3		-180.5891	59.94956	-3.01	0.003	-298.0941	-63.08403
2022m4		-257.96	80.0214	-3.22	0.001	-414.8071	-101.1129
2022m5		-2481.488	133.8398	-18.54	0.000	-2743.823	-2219.154
2022m6		-3177.442	187.2322	-16.97	0.000	-3544.43	-2810.455
2022m7		-4395.858	235.4565	-18.67	0.000	-4857.368	-3934.348
2022m8		-2423.851	229.7815	-10.55	0.000	-2874.238	-1973.464
2022m9		-1433.858	173.9335	-8.24	0.000	-1774.779	-1092.937
2022m10		-1171.609	96.44901	-12.15	0.000	-1360.655	-982.5623
2022m11		-205.1748	72.98484	-2.81	0.005	-348.2298	-62.11981
2022m12		-646.5647	62.45528	-10.35	0.000	-768.9811	-524.1483
2023m1		-524.3399	64.26486	-8.16	0.000	-650.3031	-398.3766
2023m2		-348.2312	61.97587	-5.62	0.000	-469.708	-226.7545
2023m3		-75.11494	65.78499	-1.14	0.254	-204.0578	53.8279
2023m4		2.520822	88.30635	0.03	0.977	-170.5653	175.607
2023m5		-1572.743	134.0544	-11.73	0.000	-1835.499	-1309.988
2023m6		-3094.168	185.3519	-16.69	0.000	-3457.47	-2730.867
2023m7		-3450.617	247.0342	-13.97	0.000	-3934.82	-2966.414
2023m8		-2229.769	242.2697	-9.20	0.000	-2704.633	-1754.904
2023m9		-1584.987	179.8436	-8.81	0.000	-1937.492	-1232.482
2023m10		-991.1067	109.7162	-9.03	0.000	-1206.158	-776.0558
ym#c.pre_compcool1							

2021m3		.635822	.0248369	25.60	0.000	.58714	.684504
2021m4		.5005138	.0088593	56.50	0.000	.483149	.5178785
2021m5		.5058068	.0051564	98.09	0.000	.4956998	.5159138
2021m6		.6157133	.0055199	111.54	0.000	.604894	.6265327
2021m7		.6672195	.0058235	114.57	0.000	.6558051	.6786339
2021m8		.653287	.0066388	98.40	0.000	.6402746	.6662994
2021m9		.5062298	.0055748	90.81	0.000	.4953028	.5171568
2021m10		.4952213	.0069302	71.46	0.000	.4816377	.5088048
2021m11		.2505982	.0128495	19.50	0.000	.2254125	.275784
2021m12		.6614087	.0433766	15.25	0.000	.5763877	.7464297
2022m1		.4424617	.0437631	10.11	0.000	.3566832	.5282401
2022m2		.4212844	.0212723	19.80	0.000	.3795893	.4629795
2022m3		.6271729	.024977	25.11	0.000	.5782163	.6761295
2022m4		.5509466	.0096552	57.06	0.000	.5320217	.5698714
2022m5		.5975176	.0060758	98.34	0.000	.5856087	.6094265
2022m6		.6875362	.0063263	108.68	0.000	.6751362	.6999361
2022m7		.7103704	.0067582	105.11	0.000	.6971239	.7236168
2022m8		.6104137	.0068155	89.56	0.000	.5970548	.6237726
2022m9		.4698826	.0057228	82.11	0.000	.4586655	.4810997
2022m10		.375663	.006405	58.65	0.000	.3631089	.3882172
2022m11		.4339173	.0131212	33.07	0.000	.4081989	.4596357
2022m12		.4756713	.0247606	19.21	0.000	.427139	.5242036
2023m1		.4868133	.0416795	11.68	0.000	.4051187	.5685079
2023m2		.5915393	.0238639	24.79	0.000	.5447644	.6383141
2023m3		.6930062	.0293724	23.59	0.000	.6354343	.750578
2023m4		.5330201	.0101376	52.58	0.000	.5131497	.5528905
2023m5		.4573153	.0058884	77.66	0.000	.4457737	.468857
2023m6		.5755672	.0061173	94.09	0.000	.5635769	.5875576
2023m7		.6685034	.006978	95.80	0.000	.6548261	.6821806
2023m8		.639869	.0075069	85.24	0.000	.625155	.654583
2023m9		.4949527	.0062941	78.64	0.000	.4826159	.5072896
2023m10		.404809	.00707	57.26	0.000	.3909513	.4186667

ym#c.complier |

2021m3		-293.8587	57.82767	-5.08	0.000	-407.2046	-180.5127
2021m4		-609.0568	81.40343	-7.48	0.000	-768.6127	-449.5008
2021m5		-725.3382	113.8988	-6.37	0.000	-948.5874	-502.0891
2021m6		-1581.974	158.284	-9.99	0.000	-1892.221	-1271.727
2021m7		-1868.142	167.9209	-11.13	0.000	-2197.278	-1539.006
2021m8		-1535.351	173.6778	-8.84	0.000	-1875.771	-1194.932
2021m9		-884.4416	144.3698	-6.13	0.000	-1167.416	-601.4675
2021m10		-335.6114	98.37477	-3.41	0.001	-528.4323	-142.7905
2021m11		-66.94345	48.15797	-1.39	0.165	-161.3362	27.44929
2021m12		24.40773	54.15114	0.45	0.652	-81.73202	130.5475
2022m1		97.32905	33.36128	2.92	0.004	31.93878	162.7193
2022m2		58.37175	38.67808	1.51	0.131	-17.4398	134.1833
2022m3		-162.8268	58.72026	-2.77	0.006	-277.9223	-47.73129
2022m4		-404.8164	85.63149	-4.73	0.000	-572.6597	-236.9732
2022m5		-381.0506	129.306	-2.95	0.003	-634.4988	-127.6025
2022m6		-755.7145	168.2277	-4.49	0.000	-1085.452	-425.9773
2022m7		-1198.383	187.0065	-6.41	0.000	-1564.928	-831.8385
2022m8		-1098.05	184.6712	-5.95	0.000	-1460.018	-736.0826
2022m9		-724.3141	155.8289	-4.65	0.000	-1029.749	-418.8793
2022m10		52.72307	88.06305	0.60	0.549	-119.8862	225.3323
2022m11		-11.3223	62.24107	-0.18	0.856	-133.3188	110.6742
2022m12		33.42525	38.07308	0.88	0.380	-41.20045	108.051
2023m1		40.86025	41.08572	0.99	0.320	-39.67043	121.3909
2023m2		-37.22628	53.29288	-0.70	0.485	-141.6838	67.23122
2023m3		-159.9345	63.63046	-2.51	0.012	-284.6543	-35.21468
2023m4		-634.6114	91.02647	-6.97	0.000	-813.0292	-456.1936
2023m5		-548.2737	127.1206	-4.31	0.000	-797.4382	-299.1091
2023m6		-871.0932	161.9414	-5.38	0.000	-1188.509	-553.6775
2023m7		-1230.881	197.4735	-6.23	0.000	-1617.942	-843.8203
2023m8		-875.268	200.5451	-4.36	0.000	-1268.349	-482.1866
2023m9		-590.0119	161.6563	-3.65	0.000	-906.8688	-273.155
2023m10		-43.64246	101.2283	-0.43	0.666	-242.0566	154.7717

```

dow |
Monday | -118.5633 9.941269 -11.93 0.000 -138.0488 -99.07775
Tuesday | -326.8943 10.99332 -29.74 0.000 -348.4419 -305.3467
Wednesday | -426.0654 11.36956 -37.47 0.000 -448.3504 -403.7803
Thursday | -344.543 10.86533 -31.71 0.000 -365.8398 -323.2463
Friday | -333.6712 9.59392 -34.78 0.000 -352.4759 -314.8665
Saturday | -159.3393 5.634947 -28.28 0.000 -170.3841 -148.2944
|
outdoor_humidity | 40.17105 1.495516 26.86 0.000 37.23974 43.10236
cdd60 | 772.6403 5.407617 142.88 0.000 762.041 783.2396
hdd60 | 30.32488 1.460497 20.76 0.000 27.46221 33.18755
_cons | -2643.425 107.4018 -24.61 0.000 -2853.94 -2432.911

```

```
name: LDV_Regressions
```

```
log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log
```

```
log type: text
```

```
paused on: 11 Dec 2023, 13:17:20
```

```
name: LDV_Regressions
```

```
log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log
```

```
log type: text
```

```
resumed on: 11 Dec 2023, 13:17:20
```

All, heat_pumps, auxheat1

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```

Linear regression      Number of obs      =    20043334
                       F(104, 23529)      =         176.25
                       Prob > F           =         0.0000
                       R-squared          =         0.2928
                       Root MSE        =        3179.4

```

(Std. err. adjusted for 23,530 clusters in dsa_id)

		Robust					
auxheat1	Coefficient	std. err.	t	P> t	[95% conf. interval]		
-----+-----							
ym							
2021m4		465.5333	28.85466	16.13	0.000	408.9763	522.0903
2021m5		631.7058	37.47096	16.86	0.000	558.2603	705.1513
2021m6		557.242	39.11894	14.24	0.000	480.5663	633.9176
2021m7		509.3604	38.94922	13.08	0.000	433.0174	585.7034
2021m8		509.8226	38.90319	13.10	0.000	433.5698	586.0754
2021m9		632.5898	39.04219	16.20	0.000	556.0646	709.115
2021m10		606.449	37.13103	16.33	0.000	533.6698	679.2283
2021m11		-128.121	44.00553	-2.91	0.004	-214.3747	-41.86734
2021m12		-81.55861	50.78651	-1.61	0.108	-181.1035	17.98625
2022m1		-397.1686	93.39866	-4.25	0.000	-580.236	-214.1012
2022m2		-42.57798	76.94693	-0.55	0.580	-193.3989	108.243
2022m3		84.38074	40.84212	2.07	0.039	4.327539	164.4339
2022m4		403.4286	37.68615	10.70	0.000	329.5613	477.2959
2022m5		615.2759	38.17341	16.12	0.000	540.4535	690.0982
2022m6		537.6395	39.14502	13.73	0.000	460.9127	614.3663
2022m7		458.1476	38.91897	11.77	0.000	381.8639	534.4313
2022m8		515.1046	38.95782	13.22	0.000	438.7448	591.4645
2022m9		613.3881	39.23621	15.63	0.000	536.4826	690.2936
2022m10		520.0743	37.71289	13.79	0.000	446.1546	593.994
2022m11		111.6175	51.29114	2.18	0.030	11.08355	212.1515
2022m12		571.773	74.72811	7.65	0.000	425.3011	718.2449
2023m1		-448.2717	63.00857	-7.11	0.000	-571.7726	-324.7708
2023m2		-47.76292	61.78886	-0.77	0.440	-168.8731	73.34725
2023m3		-122.3688	48.11989	-2.54	0.011	-216.6869	-28.05071
2023m4		452.9947	37.12228	12.20	0.000	380.2326	525.7568
2023m5		664.8658	39.03736	17.03	0.000	588.35	741.3815
2023m6		614.5378	39.36654	15.61	0.000	537.3768	691.6987
2023m7		467.1501	39.02722	11.97	0.000	390.6542	543.6459

2023m8		493.5698	39.13499	12.61	0.000	416.8627	570.277
2023m9		625.5959	39.36635	15.89	0.000	548.4353	702.7565
2023m10		598.0359	39.29528	15.22	0.000	521.0146	675.0572
ym#c.pre_auxheat1							
2021m3		.3594446	.0144289	24.91	0.000	.331163	.3877263
2021m4		.350127	.0248448	14.09	0.000	.3014297	.3988244
2021m5		.6119015	.084116	7.27	0.000	.4470288	.7767743
2021m6		.7177522	.1545138	4.65	0.000	.4148951	1.020609
2021m7		.7297802	.0521749	13.99	0.000	.6275141	.8320464
2021m8		.6714871	.0359858	18.66	0.000	.6009526	.7420217
2021m9		.349753	.1158799	3.02	0.003	.1226209	.5768851
2021m10		.1777031	.0183403	9.69	0.000	.141755	.2136512
2021m11		.2871653	.0155759	18.44	0.000	.2566355	.317695
2021m12		.3438998	.0172056	19.99	0.000	.3101757	.3776239
2022m1		.5717726	.0158667	36.04	0.000	.5406728	.6028724
2022m2		.6754876	.0238151	28.36	0.000	.6288083	.7221668
2022m3		.3402659	.0140365	24.24	0.000	.3127534	.3677784
2022m4		.3748496	.0264771	14.16	0.000	.3229528	.4267464
2022m5		.4627371	.0756289	6.12	0.000	.3144996	.6109746
2022m6		.7904873	.1381521	5.72	0.000	.5197003	1.061274
2022m7		.5492997	.0479977	11.44	0.000	.4552211	.6433783
2022m8		.566653	.0557276	10.17	0.000	.4574233	.6758827
2022m9		.2904078	.1016151	2.86	0.004	.0912355	.48958
2022m10		.1748784	.0202736	8.63	0.000	.1351407	.214616
2022m11		.2489093	.0141761	17.56	0.000	.2211233	.2766954
2022m12		.4247866	.019896	21.35	0.000	.3857891	.4637842
2023m1		.2440334	.0110862	22.01	0.000	.2223036	.2657631
2023m2		.4194145	.0185747	22.58	0.000	.383007	.4558221
2023m3		.2767344	.0152331	18.17	0.000	.2468765	.3065923
2023m4		.1644125	.0166181	9.89	0.000	.13184	.196985
2023m5		.2318503	.0406191	5.71	0.000	.1522341	.3114664
2023m6		.3848039	.0775471	4.96	0.000	.2328066	.5368012

2023m7		.6415954	.05999	10.70	0.000	.524011	.7591798
2023m8		.5679018	.0559004	10.16	0.000	.4583334	.6774703
2023m9		.1988565	.1066968	1.86	0.062	-.0102762	.4079891
2023m10		.0664968	.0123297	5.39	0.000	.0423299	.0906638
ym#c.complier							
2021m3		61.51439	44.58617	1.38	0.168	-25.8774	148.9062
2021m4		-35.62349	28.82478	-1.24	0.217	-92.12193	20.87495
2021m5		-34.30561	9.871908	-3.48	0.001	-53.65519	-14.95603
2021m6		-29.40917	3.481223	-8.45	0.000	-36.23259	-22.58575
2021m7		-20.8249	3.304556	-6.30	0.000	-27.30204	-14.34775
2021m8		-24.83479	2.99816	-8.28	0.000	-30.71138	-18.9582
2021m9		-26.25733	3.687195	-7.12	0.000	-33.48447	-19.03019
2021m10		-4.859162	12.65107	-0.38	0.701	-29.65607	19.93775
2021m11		12.17678	48.02252	0.25	0.800	-81.95047	106.304
2021m12		-52.45123	62.38256	-0.84	0.400	-174.7251	69.82264
2022m1		-358.1973	107.1991	-3.34	0.001	-568.3145	-148.0802
2022m2		-116.1548	89.02942	-1.30	0.192	-290.6582	58.34868
2022m3		-21.3233	48.44671	-0.44	0.660	-116.282	73.6354
2022m4		-39.84999	34.3245	-1.16	0.246	-107.1282	27.42826
2022m5		-32.11578	11.07282	-2.90	0.004	-53.81923	-10.41234
2022m6		-40.30539	3.972241	-10.15	0.000	-48.09124	-32.51954
2022m7		-31.78267	3.306267	-9.61	0.000	-38.26317	-25.30218
2022m8		-25.3935	3.067669	-8.28	0.000	-31.40633	-19.38067
2022m9		-30.13704	3.721083	-8.10	0.000	-37.4306	-22.84347
2022m10		4.751701	15.39211	0.31	0.758	-25.41782	34.92123
2022m11		-79.24791	54.18011	-1.46	0.144	-185.4444	26.94861
2022m12		-197.6397	83.88545	-2.36	0.018	-362.0606	-33.21874
2023m1		-39.1453	73.21296	-0.53	0.593	-182.6475	104.3569
2023m2		-43.65417	70.02757	-0.62	0.533	-180.9127	93.6044
2023m3		60.92896	55.30262	1.10	0.271	-47.46777	169.3257
2023m4		35.43998	20.18968	1.76	0.079	-4.133101	75.01306
2023m5		-16.14531	6.107476	-2.64	0.008	-28.11635	-4.174259
2023m6		-33.89491	3.46289	-9.79	0.000	-40.6824	-27.10742

2023m7		-38.28816	3.847149	-9.95	0.000	-45.82883	-30.7475
2023m8		-38.75499	3.579337	-10.83	0.000	-45.77072	-31.73926
2023m9		-34.89863	3.850904	-9.06	0.000	-42.44665	-27.35061
2023m10		-37.38725	15.65205	-2.39	0.017	-68.0663	-6.708212
dow							
Monday		-36.33659	1.709203	-21.26	0.000	-39.68674	-32.98644
Tuesday		-44.64207	1.923817	-23.20	0.000	-48.41288	-40.87127
Wednesday		-36.94932	2.436178	-15.17	0.000	-41.72439	-32.17426
Thursday		-31.66499	2.963224	-10.69	0.000	-37.4731	-25.85688
Friday		15.83322	2.716771	5.83	0.000	10.50817	21.15827
Saturday		56.39655	1.667272	33.83	0.000	53.12859	59.66451
outdoor_humidity		-.2073444	.2463542	-0.84	0.400	-.6902147	.2755259
cdd60		26.87099	.5611929	47.88	0.000	25.77102	27.97097
hdd60		166.0437	2.541524	65.33	0.000	161.0622	171.0253
_cons		-985.1522	46.66344	-21.11	0.000	-1076.616	-893.6888

name: LDV_Regressions

log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log

log type: text

paused on: 11 Dec 2023, 13:19:48

name: LDV_Regressions

log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log

log type: text

resumed on: 11 Dec 2023, 13:19:48

All, heat_pumps, compheat1

5 / 5

Linear regression

Number of obs = 20043334

```

F(104, 23529)      =      878.80

Prob > F           =      0.0000

R-squared          =      0.5642

Root MSE          =      7063.1

```

(Std. err. adjusted for 23,530 clusters in dsa_id)

		Robust				
compheat1		Coefficient	std. err.	t	P> t	[95% conf. interval]
-----+-----						
ym						
2021m4		595.8224	67.47516	8.83	0.000	463.5667 728.078
2021m5		993.0559	88.24142	11.25	0.000	820.097 1166.015
2021m6		1188.587	94.8768	12.53	0.000	1002.622 1374.551
2021m7		1257.213	95.96751	13.10	0.000	1069.11 1445.315
2021m8		1259.656	95.85519	13.14	0.000	1071.774 1447.538
2021m9		1180.443	95.74691	12.33	0.000	992.7732 1368.113
2021m10		900.9398	92.11017	9.78	0.000	720.3979 1081.482
2021m11		265.4702	120.9307	2.20	0.028	28.43826 502.5022
2021m12		-303.4537	123.815	-2.45	0.014	-546.1392 -60.76822
2022m1		-1294.786	185.5719	-6.98	0.000	-1658.519 -931.0528
2022m2		748.3732	157.72	4.74	0.000	439.2317 1057.515
2022m3		98.6408	100.1158	0.99	0.325	-97.59265 294.8742
2022m4		593.5685	94.29178	6.30	0.000	408.7505 778.3865
2022m5		1295.79	94.56522	13.70	0.000	1110.436 1481.144
2022m6		1140.523	95.88361	11.89	0.000	952.5852 1328.461
2022m7		1234.782	95.88513	12.88	0.000	1046.841 1422.723
2022m8		1238.209	95.83386	12.92	0.000	1050.368 1426.049
2022m9		1137.43	95.77877	11.88	0.000	949.6973 1325.162
2022m10		928.494	97.63928	9.51	0.000	737.1147 1119.873
2022m11		694.0926	122.6774	5.66	0.000	453.637 934.5482
2022m12		878.3696	165.4434	5.31	0.000	554.0899 1202.649
2023m1		289.7105	165.2276	1.75	0.080	-34.14634 613.5672
2023m2		940.5543	144.2177	6.52	0.000	657.8784 1223.23

2023m3		376.7479	120.881	3.12	0.002	139.8133	613.6825
2023m4		792.8505	95.26727	8.32	0.000	606.1204	979.5805
2023m5		1133.208	94.87461	11.94	0.000	947.2473	1319.168
2023m6		1158.089	96.27978	12.03	0.000	969.3744	1346.804
2023m7		1209.383	95.77699	12.63	0.000	1021.654	1397.112
2023m8		1212.595	95.75607	12.66	0.000	1024.907	1400.283
2023m9		1203.243	96.76768	12.43	0.000	1013.572	1392.914
2023m10		823.0297	96.5591	8.52	0.000	633.7676	1012.292
ym#c.pre_compheat1							
2021m3		.4392825	.0059537	73.78	0.000	.4276129	.4509522
2021m4		.446222	.0103436	43.14	0.000	.4259479	.4664961
2021m5		.5513308	.0332164	16.60	0.000	.4862245	.6164371
2021m6		.3248898	.0972184	3.34	0.001	.1343354	.5154443
2021m7		.7150955	.074439	9.61	0.000	.5691902	.8610009
2021m8		.2292488	.1382311	1.66	0.097	-.041693	.5001906
2021m9		.2937819	.0575655	5.10	0.000	.1809497	.4066141
2021m10		.2547251	.0105324	24.18	0.000	.2340809	.2753692
2021m11		.4878924	.0067791	71.97	0.000	.474605	.5011799
2021m12		.4471474	.0061731	72.44	0.000	.4350477	.459247
2022m1		.6691046	.0074617	89.67	0.000	.6544791	.68373
2022m2		.7569049	.010381	72.91	0.000	.7365575	.7772523
2022m3		.4528242	.006401	70.74	0.000	.4402778	.4653706
2022m4		.5758282	.0131338	43.84	0.000	.5500851	.6015714
2022m5		.5306646	.0542978	9.77	0.000	.4242375	.6370918
2022m6		.299917	.105039	2.86	0.004	.0940338	.5058001
2022m7		.4835697	.2512224	1.92	0.054	-.0088425	.9759818
2022m8		.251022	.1345549	1.87	0.062	-.0127143	.5147584
2022m9		.2110903	.0555338	3.80	0.000	.1022405	.3199401
2022m10		.3889428	.0115273	33.74	0.000	.3663485	.411537
2022m11		.3951645	.0062123	63.61	0.000	.3829879	.407341
2022m12		.5149947	.0077565	66.39	0.000	.4997913	.530198
2023m1		.4708885	.0062277	75.61	0.000	.4586819	.4830951

2023m2		.6193023	.009049	68.44	0.000	.6015657	.6370389
2023m3		.4773263	.0072748	65.61	0.000	.4630674	.4915853
2023m4		.3476913	.010779	32.26	0.000	.3265638	.3688188
2023m5		.3977579	.035325	11.26	0.000	.3285187	.4669971
2023m6		.2006155	.0468693	4.28	0.000	.1087486	.2924824
2023m7		.5227918	.1583937	3.30	0.001	.2123298	.8332538
2023m8		.2018175	.1187485	1.70	0.089	-.0309373	.4345724
2023m9		.2538149	.0531543	4.78	0.000	.149629	.3580008
2023m10		.2985773	.0114981	25.97	0.000	.2760403	.3211144

|

ym#c.complier |

2021m3		-667.8714	100.9823	-6.61	0.000	-865.8033	-469.9394
2021m4		-363.4972	64.06325	-5.67	0.000	-489.0653	-237.9291
2021m5		-184.8556	31.63559	-5.84	0.000	-246.8634	-122.8477
2021m6		-33.49433	13.76078	-2.43	0.015	-60.46635	-6.522306
2021m7		10.50805	8.486726	1.24	0.216	-6.126488	27.14258
2021m8		.9415688	7.683915	0.12	0.902	-14.1194	16.00254
2021m9		-33.09417	11.95752	-2.77	0.006	-56.53168	-9.656654
2021m10		-214.5985	41.83456	-5.13	0.000	-296.5969	-132.6
2021m11		-816.1474	126.9954	-6.43	0.000	-1065.067	-567.2282
2021m12		-832.0281	134.7868	-6.17	0.000	-1096.219	-567.8373
2022m1		-649.0649	206.0235	-3.15	0.002	-1052.884	-245.2455
2022m2		-594.8158	179.3137	-3.32	0.001	-946.2822	-243.3493
2022m3		-500.5692	108.8708	-4.60	0.000	-713.963	-287.1754
2022m4		-395.6828	80.45345	-4.92	0.000	-553.3767	-237.9888
2022m5		-310.0735	37.11735	-8.35	0.000	-382.8259	-237.321
2022m6		-40.79011	13.27963	-3.07	0.002	-66.81905	-14.76118
2022m7		-11.86249	8.936118	-1.33	0.184	-29.37786	5.652885
2022m8		.461447	7.176916	0.06	0.949	-13.60577	14.52867
2022m9		-43.28391	12.4363	-3.48	0.001	-67.65985	-18.90796
2022m10		-326.698	57.27204	-5.70	0.000	-438.9549	-214.4411
2022m11		-595.0199	122.8801	-4.84	0.000	-835.8728	-354.167
2022m12		-827.0609	176.5759	-4.68	0.000	-1173.161	-480.9607
2023m1		-685.233	168.8533	-4.06	0.000	-1016.196	-354.2695

2023m2		-681.5017	150.2934	-4.53	0.000	-976.0865	-386.9168
2023m3		-641.8778	126.4938	-5.07	0.000	-889.8139	-393.9417
2023m4		-330.1512	65.5116	-5.04	0.000	-458.5582	-201.7442
2023m5		-145.6336	27.93128	-5.21	0.000	-200.3807	-90.88649
2023m6		-57.05432	17.57381	-3.25	0.001	-91.50013	-22.60851
2023m7		-15.18023	8.009037	-1.90	0.058	-30.87847	.5179979
2023m8		-13.51498	7.606574	-1.78	0.076	-28.42435	1.394403
2023m9		-51.81862	17.60786	-2.94	0.003	-86.33117	-17.30607
2023m10		-129.6083	45.75282	-2.83	0.005	-219.2868	-39.92978
dow							
Monday		70.20386	4.773735	14.71	0.000	60.84703	79.56069
Tuesday		73.15041	5.32248	13.74	0.000	62.718	83.58282
Wednesday		-77.07952	5.934769	-12.99	0.000	-88.71206	-65.44699
Thursday		-243.6723	6.791048	-35.88	0.000	-256.9832	-230.3614
Friday		-283.8789	5.956664	-47.66	0.000	-295.5544	-272.2035
Saturday		-119.4921	3.686271	-32.42	0.000	-126.7175	-112.2668
outdoor_humidity		-17.82024	.5588514	-31.89	0.000	-18.91562	-16.72485
cdd60		-14.85335	1.267064	-11.72	0.000	-17.33688	-12.36983
hdd60		604.9322	6.240958	96.93	0.000	592.6995	617.1648
_cons		407.7363	110.745	3.68	0.000	190.669	624.8036

name: LDV_Regressions

log: F:\Projects\Ecobee\2023 CO2 Offsets\Modified Data\05 Output\LDV Regression Output.log

log type: text

paused on: 11 Dec 2023, 13:22:19

APPENDIX E: SUSTAINABLE DEVELOPMENT CONTRIBUTIONS

SDG Target	SDG Indicator	Net Impact on SDG Indicator	Current Project Contributions	Contributions Over Project Lifetime
7.3	By 2030, double the global rate of improvement in energy efficiency.	Energy efficiency is itself a form of energy and is the cleanest and most affordable form of energy. The project activities implemented have led to greater energy efficiency in homes and the subsequent reduction and avoidance in tonnes of GHG emissions.	By improving energy efficiency in homes, the project has prevented the release of 390,652 tonnes of CO ₂ during the first monitoring period.	Estimated to prevent the release of 2.8M tonnes of CO ₂ into the atmosphere
8.2	Achieve higher levels of economic productivity through diversification, technological upgrading and innovation, including a focus on high-value added and labour intensive sectors.	Highly technical positions created at ecobee through the implementation of the project activity. Technical jobs at ecobee created through the project will create new, highly-skilled employment opportunities.	The development, operation and maintenance of eco+ is supported by more than 30 full time equivalents in the area of Data Science, Product Management and Engineering.	Projected to increase by dozens of additional full time equivalents in addition to the retention of the core team to continuously improve and maintain the software.

11.6	By 2030, reduce the adverse per capita environmental impact of cities, including paying special attention to air quality and other waste management.	Project activity takes place within the U.S where over 2.5 million ecobee devices with eco+ and Adjust for Humidity resides in 62% of U.S zipcodes including major metropolitan areas. Project activity reduces energy usage and maximizes HVAC energy efficiency thereby decreasing PM2.5 emissions and improving air quality.	By improving energy efficiency in homes, the project has reduced PM2.5 emissions by more than 74,000 lbs during the monitoring period.	Estimated to prevent the release of more than 286,000 lbs of PM2.5, thereby improving air quality.
12.2	By 2030, achieve the sustainable management and efficient use of natural resources.	The implementation of the project activity results in kWh reduction of electricity consumption and mmcf reduction in natural gas consumption.	The project activity has decreased electricity consumption by more than 850,000 MWh and natural gas consumption by more than 6,400 mmcf during the monitoring period.	Estimated to decrease electricity consumption by more than 3.3 million MWh and natural gas consumption by over 36,000 mmcf

APPENDIX F: ATTESTATION LETTER FROM ECOBEE'S EVP

ecobee

Dear Verra Secretariat
secretariat@verra.org

Good Morning;

As a means of introduction, I am the Executive Vice President, ecobee Energy, and have been with the company 15 years and since the launch of our industry leading ecobee Smart Thermostat.

I, Chris Carradine, can attest that to the best of my knowledge the eco+ software will remain free to all our customers who own and are using ecobee thermostats throughout the crediting period and any subsequent crediting period renewals. If this were to change at any point during the crediting period or crediting period renewals, the project will cease to claim Verified Emissions Reductions as of the date that the software stopped being offered for free.

I trust that this addresses any concerns the Verra Secretariat might have in this regard.

Regards,



Chris Carradine
Executive Vice President
ecobee

