SUMMARY OF FINDINGS

This report relies on a web survey distributed among residential customers in Connecticut from April 4 to June 16, 2018. 1,606 individuals completed the survey and were included in the final analysis.

Research question: What triggers households’ decision to select a new heating and cooling system? And what factors influence the decision about what kind of system to install?

More than half of respondents heat their homes with fuel oil, while around 10% use a heat pump as the primary heating system.

Concern about equipment age is the most important trigger for households to consider a new primary heating system. Around 30% of respondents expect to be replacing their primary heating system in the next 5-10 years.

Around a third of the respondents incorporated additional home improvements at the same time they installed their current primary heating system, such as replacing windows and adding insulation.

17% of the respondents have never heard of heat pumps, and several believe that heat pumps will not work well in the New England climate.

Concern about cooling costs is the most important trigger for installing a heat pump.

Solar PV ownership is a significant trigger of heat pump installations.

Satisfaction with existing systems is the dominant reason why respondents do not expect to install a heat pump in the next 5-10 years.

Economic factors are most important in influencing choice of heating and cooling systems, followed by equipment reliability and comfort.
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1. BACKGROUND

This survey is part of the project Feasibility of renewable thermal technologies in Connecticut.

This project has been supported financially by the Connecticut Green Bank, Yale University, United Illuminating, and Eversource through the CT Energize initiative. The Connecticut Department of Energy and Environmental Protection (DEEP) served as an advisor.

The key research question of the survey: What triggers households’ decision to select a new heating and cooling system? And what factors influence the decision about what kind of system to install?

2. METHODOLOGY

2.1 SURVEY DESIGN

The data analyzed in this report relies on survey responses from residential customers in Connecticut who:
- Have received support to install solar PV from the Connecticut Green Bank;
- Have received support for energy audits from United Illuminating or Eversource; or
- Subscribe to information on energy efficiency and updates from the Governor’s Council for Climate Change.

The web survey was mainly distributed by email from April 4 to June 16, 2018. 164 of 1,744 responses came from phone interviews.

The survey announced that respondents would be entered into a sweepstake for a chance to win one of ten $25 gift cards.

The data has been cleaned to avoid duplicate responses, as people received the same survey from different stakeholders.

The survey was specifically designed to map the importance of key factors and sources of information for choosing primary and secondary heating sources.

1,606 individuals completed the survey and were included in the final analysis.
### 2.2 SUMMARY STATISTICS

**HOW DOES THE SURVEY SAMPLE COMPARE TO THE CONNECTICUT POPULATION?**

<table>
<thead>
<tr>
<th>DESCRIPTION</th>
<th>SURVEY SAMPLE</th>
<th>CONNECTICUT</th>
<th>SOURCES CT STATISTICS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population</td>
<td>1,606</td>
<td>1,355,000</td>
<td>US Census</td>
</tr>
<tr>
<td>Households that installed solar PV (%)</td>
<td>66.8</td>
<td>4.6</td>
<td>SEIA</td>
</tr>
<tr>
<td>Median household income (thousands of 2016 dollars)</td>
<td>NA</td>
<td>71.8</td>
<td>US Census</td>
</tr>
<tr>
<td>Fraction of households with annual income &lt;$50,000 (%)</td>
<td>6.7</td>
<td>37.0</td>
<td>US Census</td>
</tr>
<tr>
<td>Fraction of college grads (%)</td>
<td>71.2</td>
<td>38.0</td>
<td>US Census</td>
</tr>
<tr>
<td>Median age (years)</td>
<td>NA</td>
<td>40.9</td>
<td>US Census</td>
</tr>
<tr>
<td>Fraction of population age 55 years and above (%)</td>
<td>46.9</td>
<td>29.1</td>
<td>US Census</td>
</tr>
<tr>
<td>Owner-occupied houses (%)</td>
<td>96.8</td>
<td>66.5</td>
<td>US Census</td>
</tr>
<tr>
<td>Electricity cost (Cent/kWh)</td>
<td>NA</td>
<td>17.34</td>
<td>EIA</td>
</tr>
</tbody>
</table>

### 2.3 HYPOTHESES

Customers who are considering investments like solar PV or other home improvements are more open to investment in renewable thermal technologies.

Important contextual factors that influence whether renewable thermal technologies are considered include:

- Changing thermal needs, such as adding space or thermal services
- A broken boiler or distribution system
- External influences, such as prices and campaigns
- Change of home ownership
- Equipment age
- Existing user habits, such as contacting the familiar contractor for advice on heating equipment

For some types of systems, peers and neighbors have a strong influence on the intention to install renewable heating and cooling.

Customers are more likely to consider renewable alternatives for their secondary energy system than their primary.
3. ANALYSIS

3.1 EXISTING HEATING AND COOLING SYSTEMS

A majority of respondents heat their homes with fuel oil. More than half of respondents have fuel oil or propane installed as a primary heating system. 10% of respondents use a heat pump as their primary heating system. This is probably higher than statewide average due to the survey selection.

More than half of respondents have central air conditioning.

13% of respondents use a heat pump for cooling.

Most respondents have cooling. Only 7% of respondents have no cooling system installed.

ASHP: Air Source Heat Pump
GSHP: Ground Source Heat Pump
3.2 PRIMARY HEATING SYSTEM

What Triggered the Installation?

Equipment at the end of its useful life is the main factor prompting households to install a new primary heating system.

- The most common trigger to install a new primary heating system is when the old one is at the end of its useful life, a factor mentioned by 45% of respondents.

- Energy prices are the second-most common trigger to install the existing primary heating system, mentioned by 26% of respondents.

- 24% of respondents mentioned home improvement as a trigger to install the existing primary heating system.

- Respondents with a heat pump as the primary heating system were to a significantly\* higher degree triggered by the following factors:
  - Installed solar or wanted cooling
  - Energy prices
  - Expert advice and energy audits
  - Moved into a new home

\* two-sided tests of differences in means. P-value < 0.01
Age of Equipment
28 percent of respondent households are considering replacing their primary heating in the next 5-10 years

- 28% of respondents indicate that in 5-10 years they will definitely replace their primary heating, or that there is a very good chance they will.

- Heat pumps have been installed as primary heating in recent years, not only for cooling.

- Of the small share of respondents with electric resistance heating (4%), a fifth indicate that in 5-10 years they will definitely replace their primary heating, or there is a very good chance they will.

- While more than 20% of respondents with fuel oil as primary heating indicate that their equipment is 20 years old or older, only 12% of these respondents indicate that in 5-10 years they will definitely replace their primary heating, or there is a very good chance they will.
To Keep, or Not?
How well an existing system works, and how old it is, are determining factors

- Respondents expecting to replace their primary heating system in the next 5-10 years do so for two main reasons: the existing heating equipment is at the end of its useful life (52%) or to lower heating costs (52%).

- Many respondents expecting to keep their existing primary heating system for the next 5-10 years do so because the existing equipment works well (67%).

- The second most important reason to keep an existing primary heating system is that it is new (52%).

- For respondents with a heating system 15 years old or more, the dominant reason to keep it is that it is working well. Plans to move to a new home (28%) and monthly heating costs already being low (20%) are the second and third most important reasons to keep an existing solution.
3.3 HEAT PUMP SYSTEMS

What Triggered the Installation?

Cooling is the dominant trigger for installing heat pumps

- Respondents include 294 heat pump owners, of which 136 with a heat pump as primary heating.
- Cooling is the most common trigger for installing heat pumps, mentioned by 47% of respondents.
- The second-most common trigger to install heat pumps is tied to the installation of solar panels (26%).
- Solar PV owners are to a larger extent heat pump owners. 21% of solar PV owners have heat pumps installed compared to 13% for respondents without solar PV installed.
- Energy prices, mentioned by 26%, are a trigger of roughly equal power compared to solar panels. Energy prices are significantly* more important to respondents with a heat pump installed as primary heating.
- Moving to a new home is a significantly stronger trigger for installing a heat pump for primary heating than for secondary heating.
- 52% improved their home at the same time as installing a heat pump.
- A majority (61%) of the heat pump owners received a rebate from Energize CT. A smaller fraction (21%) financed their heat pump through a CT Green Bank loan.

* two-sided tests of differences in means. P-value < 0.01
Install, or Not?

Cooling costs is a trigger and satisfaction with existing system a show-stopper

**WHY INSTALL HEAT PUMP IN THE NEXT 5-10 YEARS**
(Choose as many as apply)

- Lower my cooling costs
- Concern for the environment
- Stabilize heating costs
- Energy system needs upgrade
- Increase comfort
- Utilize my solar panels
- Cooling equipment is at end of life
- Want to install cooling
- Fuel flexibility
- Plan to improve the home
- Other
- Advice HES assessment (energy audit)
- A short payback period
- New space that needs heating and cooling
- Family situation likely to change
- Plan to buy a house

**WHY NOT INSTALL HEAT PUMP IN THE NEXT 5-10 YEARS**
(Choose as many as apply)

- Existing solution works well
- Existing solution is new
- Other
- Existing solution is convenient
- Too expensive to install
- Heating and cooling costs are already low
- Plan to move to another house
- Other renovations more needed
- Changes to the house would be needed
- Do not know where to start
- Do not trust the technology
- Financing not available
- Finding an installer is a hassle
- I will be renting

- 467 respondents (40%) say there is some, a very good, or a definitive chance of installing a heat pump in the next 5-10 years.

- Respondents expecting to install a heat pump in the next 5-10 years: want to lower their cooling costs (36%), have concerns for the environment (34%), and wish to stabilize heating costs (30%).

- 17% of respondents have never heard of heat pumps.

- Respondents who have heard of heat pumps but have no interest in one are pre-dominantly happy with their existing solution. 43% mention “existing solution works well” as a reason why they are not interested in installing a heat pump in the next 5-10 years.

- Respondents have a variety of “other” reasons not to install a heat pump in the next 5-10 years, the most common being heat pumps already being installed and a perception that heat pumps do not work well in the New England climate.
3.4 WHICH FACTORS IMPACT THE CHOICE OF A SYSTEM?

Energy savings are the key factor in evaluating heating and cooling solutions, followed by reliability and comfort features.

<table>
<thead>
<tr>
<th>Factor</th>
<th>Number of Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy savings</td>
<td>100</td>
</tr>
<tr>
<td>Reliability of equipment</td>
<td>85</td>
</tr>
<tr>
<td>Comfort</td>
<td>82</td>
</tr>
<tr>
<td>Indoor air quality</td>
<td>80</td>
</tr>
<tr>
<td>Suitability of your house</td>
<td>79</td>
</tr>
<tr>
<td>Current price of heating</td>
<td>78</td>
</tr>
<tr>
<td>Expected future price of heating</td>
<td>76</td>
</tr>
<tr>
<td>Concern for the environment</td>
<td>75</td>
</tr>
<tr>
<td>Ease of use</td>
<td>74</td>
</tr>
<tr>
<td>Current cost of installation</td>
<td>73</td>
</tr>
<tr>
<td>Availability of a reputable installer</td>
<td>72</td>
</tr>
<tr>
<td>Whether you own or rent</td>
<td>71</td>
</tr>
<tr>
<td>Future cost of installation</td>
<td>70</td>
</tr>
<tr>
<td>Prior familiarity with equipment</td>
<td>69</td>
</tr>
<tr>
<td>Recommendation by a friend</td>
<td>68</td>
</tr>
<tr>
<td>Time it takes to install</td>
<td>67</td>
</tr>
</tbody>
</table>

- Respondents rate energy savings as the most important factor when they are choosing a heating and cooling system, with a mean rating of 89%. Reliability of equipment is rated the second-most important factor (mean 85%) and comfort third (mean 82%).

- Respondents with heat pumps as primary heating system value the following factors higher than respondents with other primary heating systems (pairwise two-tailed T-test, p-value < 0.05).
  - Concern for the environment
  - Suitability of house
  - Energy savings
  - Comfort
  - Whether renting or owning
  - Availability of a reputable installer
3.5 WHO CHOSE THE SYSTEM?

The respondents have, to a large extent, been involved in choosing heating and cooling systems.

**WHO CHOSE THE PRIMARY HEATING SYSTEM?**

- Building owner
- Other of household
- Joint household decision
- Respondent
- Already installed

**WHO CHOSE THE HEAT PUMP?**

- Building owner
- Other of household
- Already installed
- Joint household decision
- Respondent

- Respondents involved in choosing a primary heating system, either alone or as a joint household decision, are:
  - Both male and female (equal share).
  - Educated (63% with college degree).
  - Older (58% are 55 years and older).
  - From all income categories but LMI is underrepresented compared to CT summary statistics.
  - Dominated by members of 1-2 person households (51%).

- Heat pump installations are newer than other systems. A larger share of respondents have been involved in choosing a heat pump than the primary heating system.

- Owners of heat pumps installed as primary heating system are generally older, better educated and have smaller households than other respondents.
3.6 WHOSE OPINION MATTERS FOR CHOOSING THE SYSTEM?

Energize CT, vendors and installers are important influencers

- Respondents indicate Energize CT as the most important source of information when choosing a primary heating system (28%).

- Almost half of respondents who have a heat pump mentions vendors or installers as the most common source of information.

- Own (online) research and consumer reviews were elaborated by many respondents choosing “other” sources as most important.
4. CONCLUSIONS

Respondent households with solar PV panels have proven more likely to own a heat pump. This is, in fact, one of the most important triggers for installing a heat pump among responding households. Heat pump adopters appear to be early movers with high environmental concern, which may explain why solar PV adopters are more likely to own a heat pump. Economic factors are generally important when choosing a heating and cooling system, and a heat pump is particularly attractive when it allows the solar PV owner to utilize the panels better.

Many respondents improved their home at the same time as they changed their primary heating system or installed a heat pump. These home improvements typically include new windows, insulation and upgrades to existing energy systems. Installing a new heating system in conjunction with doing home improvements reduces home owner transaction costs and are often mutually beneficial.

Several triggers for installing renewable heating and cooling are related to the contextual and domestic setting.
- Generally, respondents change their primary heating system when the existing one nears the end of its useful life.
- Adding cooling is the most important trigger for respondents to install heat pumps.
- Respondents installing a heat pump as the primary heating system were to a larger extent triggered by moving into a new home than respondents with a heat pump as a secondary system, and are also more concerned with economic factors.

Vendors and installers are sources that respondents would contact to inform themselves on heating and cooling systems. Energize CT is another important information source, particularly to potential heat pump owners who rely more on advice from others.
5. RECOMMENDATIONS

I  Develop market strategies differentiated by system age.
Households with old heating and cooling systems living in homes of high age are more likely to install a new system. So are customers in the process of moving into a new home. Whole-home heating and cooling systems such as ground source heat pumps, ducted air source heat pumps and biomass boilers should particularly address these segments.

Households are less inclined to replace new primary heating and cooling systems, but may be interested in adopting heat pumps for cooling, to utilize solar PV installations, or to lower energy costs. Reaching out to households with new primary systems may be particularly efficient for ductless air source heat pumps, which when installed well will increase general awareness of renewable cooling and heating options, priming further renewable-oriented customer choices down the road.

Access to data allowing for efficient market segmentation facilitates targeted messaging and new business models. Data that serves this purpose includes:
- Age of primary energy systems
- Age of homes
- Recently sold properties
- Solar PV adopters

II  Identify and engage ‘spearheads’ to grow the renewable heating and cooling market. These spearheads are stakeholders who already have a direct relation to the customers and serve as trusted sources.
Solar Ambassadors, primarily recruited from town select people, town managers and members of the town clean energy task force, have proven key to the success of Solarize campaigns. Since solar PV adopters seem to pair their solar panels with heat pumps, utilizing structures of former Solarize campaigns and engaging “Solar Ambassadors” can efficiently promote heat pumps.

The respondents value the opinion of vendors and installers when choosing heating and cooling systems. Equipping vendors and installers, including installers of HVAC and solar PV, with knowledge, messages and tools to advise the customers on renewable alternatives can increase adoption and spur new business models and partnerships.

III  Present the business case of renewable heating and cooling to customers.
Develop a simple tool allowing customers to compare alternative heating and cooling systems. In addition to economic factors, the tool should present key indicators for other factors that are important to the customer, such as reliability of equipment, comfort and environmental concerns.
IV  Provide neutral information and educate the market.

Many customers lack awareness of renewable heating and cooling alternatives; others are misinformed about their applicability. Energize CT appears to be a valuable platform and key source of information for households, particularly as a provider of neutral information for customers doing their own research. Households considering alternatives for primary energy systems seem particularly reliant on expert advice.

One purpose of community campaigns such as Solarize is to educate vendors, installers and customers. Through supporting a selection of initial campaigns, the policymaker can make sure that key and competent “spearheads” and partnerships are established in an otherwise immature market.

Community campaigns for renewable heating and cooling seem to be taking on a variety of names; HeatSmart, Heat Pump Challenge, and Thermalize. Establishing a brand across states would be beneficial from an outreach point of view.

ABOUT THE AUTHORS

Hele Gronli is a Resident Fellow at the Yale School of Forestry & Environmental Studies where she led the “Feasibility of Renewable Thermal Technologies in Connecticut” research project in partnership with the Connecticut Green Bank, Eversource, United Illuminating, Connecticut Department of Energy and Environmental Protection (DEEP) and the Yale Center for Business and the Environment.

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