Understanding Adoption of Sustainable Forest-Based Heating Alternatives for Northern Forest Homes and Communities

Principal Investigator: Joe Short, Northern Forest Center, jshort@northernforest.org
18 North Main St., Suite 204, Concord, NH 03301-4926
Co-Principal Investigators: Maura Adams, Northern Forest Center, madams@northernforest.org
Cecilia Danks, University of Vermont, cdanks@uvm.edu
Kimberly Wallin, University of Vermont, kimberly.wallin@uvm.edu
William Keeton, University of Vermont, wkeeton@uvm.edu
Jessica Leahy, University of Maine, Jessica_leahy@umit.maine.edu
Jennie Stephens, Northeastern University, j.Stephens@northeastern.edu

Completion date: June 30, 2019

Summary of Findings

- Potential purchasers of automated wood pellet heating systems (AWPH) are motivated largely by values: interest in environmental and local economic benefits.
- Primary deterrents are upfront cost, lack of comparative options, lack of technical support, and compatibility with existing buildings.
- Financial incentives are critical, but additional types of support enable diverse customers to buy AWPH and build the market for these systems.

Funding for this project was provided by the Northeastern States Research Cooperative (NSRC), a partnership of Northern Forest states (NH, VT, ME, NY), in coordination with the USDA Forest Service. http://www.nsrcforest.org

Project Summary

Public and private incentive programs have encouraged conversions to high-efficiency, low-emission, automated wood pellet heating systems as a strategy to promote renewable energy and support local economies in the Northern Forest of Maine, New Hampshire, Vermont, and New York. Despite these efforts, the adoption of these systems remains slow.

This study examined social, economic, policy and environmental factors that affect building owners' decisions to transition from fossil fuels to automated wood pellet boilers and furnaces (AWPH) that utilize regionally-sourced wood pellets.

Interviews with 60 consumers, technology and fuel suppliers, NGOs, and state agency personnel provided in-depth qualitative data, which was complemented by a 4-state survey of adopters and informed non-adopters of AWPH systems (n=690; 38% response rate). Literature reviews added insight into the environmental impacts of wood pellet production and use.

Data show that AWPH consumers, who should be considered "early adopters" due to the limited number of AWPH systems in the region, are largely value-driven. Both environmental values (e.g. desire to find alternative to fossil fuels, concern for air quality and belief in climate change) and social values (e.g. support for the local economy and wood products industry) influenced consumer decisions. AWPH consumers are also concerned about upfront costs and availability of technical support and bulk delivered pellets.

Financial incentives, which are offered by all four states, were highly influential, but additional decision support offered by a non-profit (e.g. site visits, informational workshops, local print media) were rated highly where they were available. These additional supports enabled a broader range of people (lower income, more risk averse) to choose AWPH – an important means of moving past early adopters of this technology to the majority.

Literature reviews showed that wood pellet heating can be carbon positive depending on feedstock mix, harvesting methods, and location. The pellet manufacturing process eliminates the risk of spreading forest pests (compared to moving firewood), but precautions must still be taken when transporting wood to pellet plants.

Findings can help state actors to conduct effective programs that promote sustainable approaches to wood heating.

Background and Justification

- Each Northern Forest state (ME, NH, VT, NY) has developed programs and policies aimed at promoting adoption of lower-carbon heating technologies, as heating is a major contributor to greenhouse gas emissions and energy expenses.
- These programs and policies include incentives and other supports for automated wood pellet heating (AWPH) technology.
- AWPH technology refers to high-efficiency, low-emission wood pellet boilers and furnaces fed automatically from bulk storage units. These are central heating systems that require no backup heat source and very limited human intervention.

Wood pellet boiler example.
Pellet storage unit not shown.
Photo source: https://bournesenergy.com

Background and Justification (continued)

- Each Northern Forest state offers financial incentives for residents, businesses and/or public institutions to convert to AWPH. The first program began in 2011.
- Despite these incentive programs, the level of adoption of AWPH remains low across the region.

State incentive programs for advanced wood pellet heating technology, 2018

	Efficiency Vermont (EVT)	VT Clean Energy Development Fund (CEDF)	New Hampshire Public Utilities Commission	Efficiency Maine	New York State Energy Research & Development Authority
Incentive percentage / amount	Flat $2,000	Flat $5,500 plus $500 for thermal storage	40% (up to $10,000)	33% (up to $5,000)	45% (up to $20,000)
Number of participants	363 (includes CEDF participants)	363 (includes EVT participants)	385	618	45

Background and Justification (continued)

The Northern Forest Center, a regional non-profit, supplemented state incentive programs with a Model Neighborhood Project (MNP) in each state. Designed to build awareness and market demand for AWPH, each MNP offered:

- Additional financial incentives
- Informational workshops
- Media coverage
- One-on-one coaching by local staff during consumers' evaluation and decision-making process
- Opportunities to view local AWPH installations
- Direct, regular contact with equipment and pellet vendors to build a more robust local supply chain

The MNP approach is more costly and time-consuming than simply making an incentive available. We sought to find out whether this approach yielded significantly different results than the state programs (which actively promote their incentives on a statewide basis, if at all), and if so, which interventions were most effective.

Methods

1. Qualitative: Semi-structured Interviews (n=60)

- Stratified sample of interviewees by state in the following categories:
  - Adopters of AWPH technology within MNP areas
  - Informed non-adopters (those who gathered information about AWPH but then chose not to adopt)
  - AWPH equipment distributors and installers
  - MNP community representatives
  - Energy policy decision-makers
- Interviews were recorded, transcribed, and coded for emergent and expected themes using Nvivo software
- Interviewing adopters and non-adopters within MNP sites enabled researchers to get an in-depth understanding of the special case of the MNP
- Interviews provided rich understanding of decision-making processes and rationales, and provided the foundation for the regional consumer survey

Methods (continued)

2. Quantitative: State-wide survey Consumer Surveys (n=690)

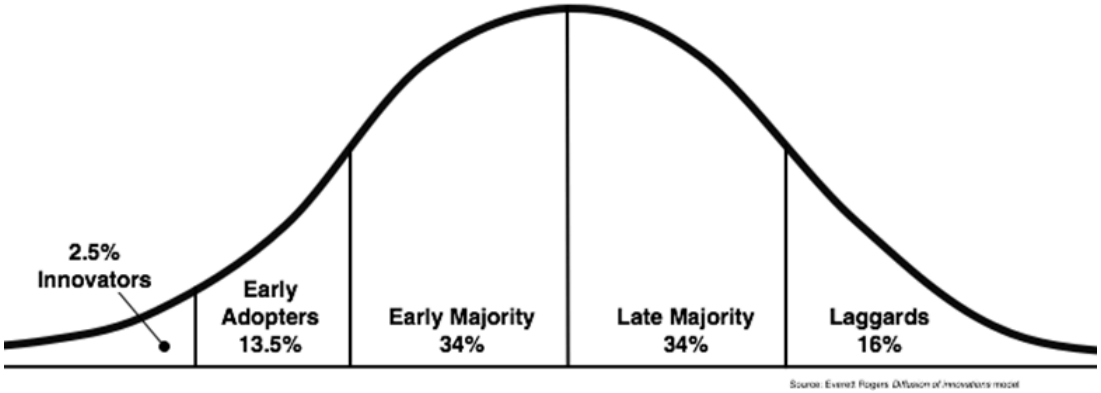
- Survey protocol (following Dillman 2014)
  - All adopters who utilized state incentives for AWPH (source: state agencies), plus an equal number of informed non-adopters (source: AWPH vendors)
  - Sent to 1,832 homeowners and representatives for business, community, and non-profit facilities
  - Sent in both paper and email format (using SurveyMonkey), depending on the contact information available, with repeated reminders sent over several months
  - Non-response bias testing with 100 non-respondents.

- Survey Response
  - 690 returned surveys (38% response rate)
  - 67% of respondents were adopters, 33% were non-adopters

- Data Analysis: SPSS chi-squared and Kriskul-Wallace tests

Methods (continued)

3. Diffusion of Innovation Theory: Applicable to AWPH

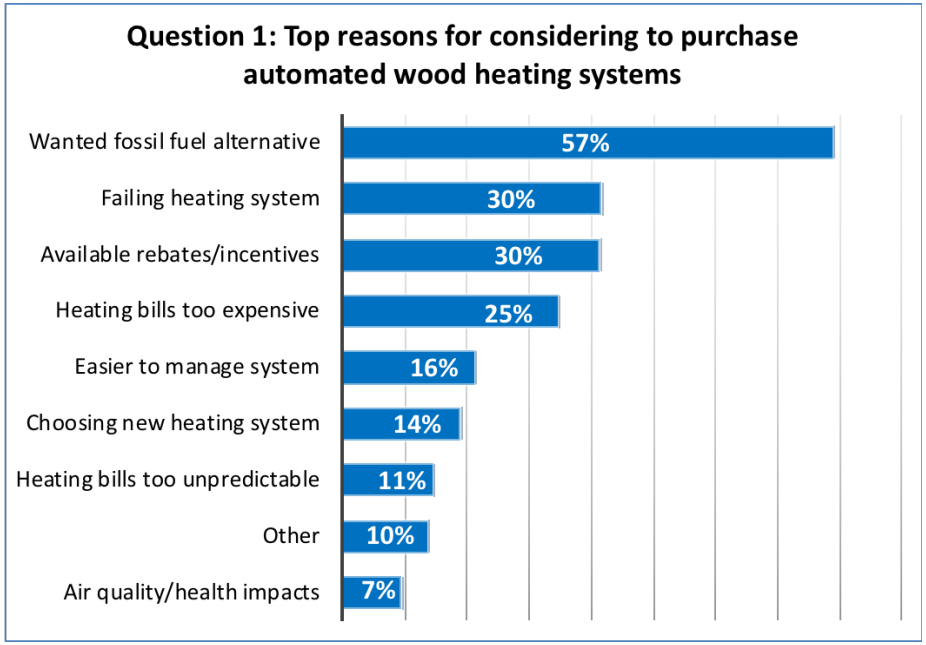


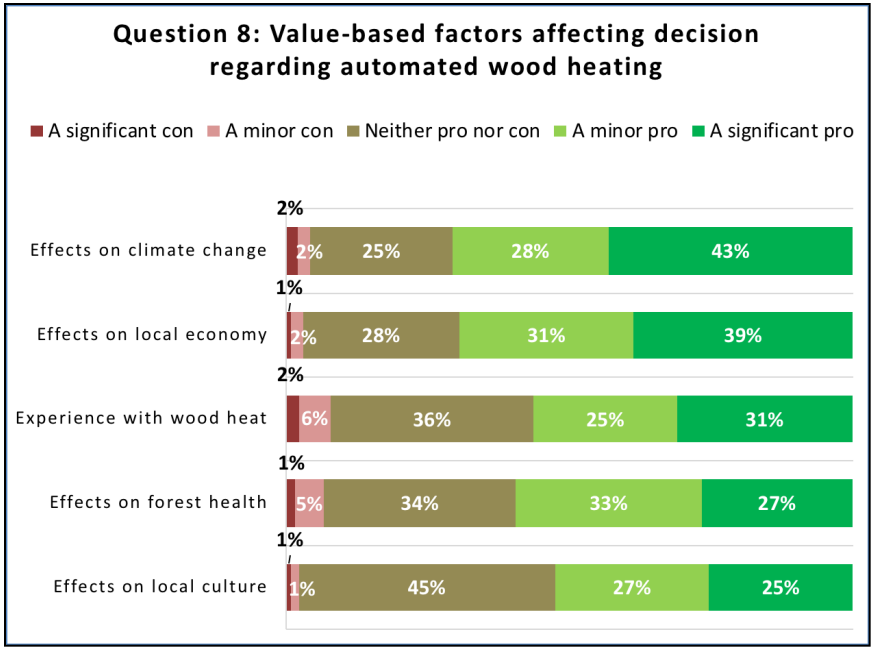
Source: Rogers, E. M. (2003). Diffusion of innovations. New York: Free Press.

- Theories regarding diffusion of innovation and sociotechnical systems are useful to help understand adoption of AWPH. These theories were used to develop the survey questions and codes for qualitative analysis.
- Because so few systems have been purchased, most of the people interviewed fell in the “early adopter” category, and factors that are important to this group may be somewhat different than the majority of potential purchasers.

Study Results (continued)

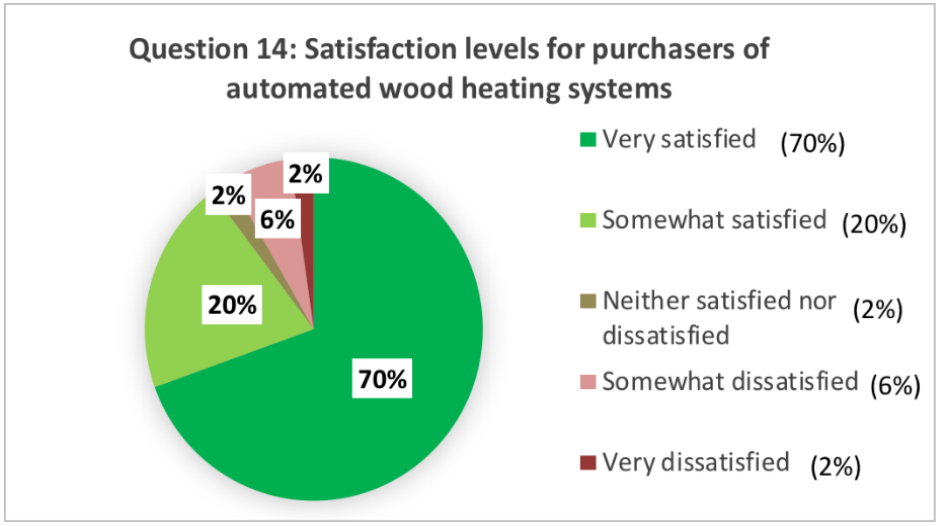
The top reason for considering AWPH was the desire to find an alternative to fossil fuels. Value-based factors such as impacts on the environment and local economy were important as well, especially when oil prices were low. When oil prices were higher, economic considerations were more influential.

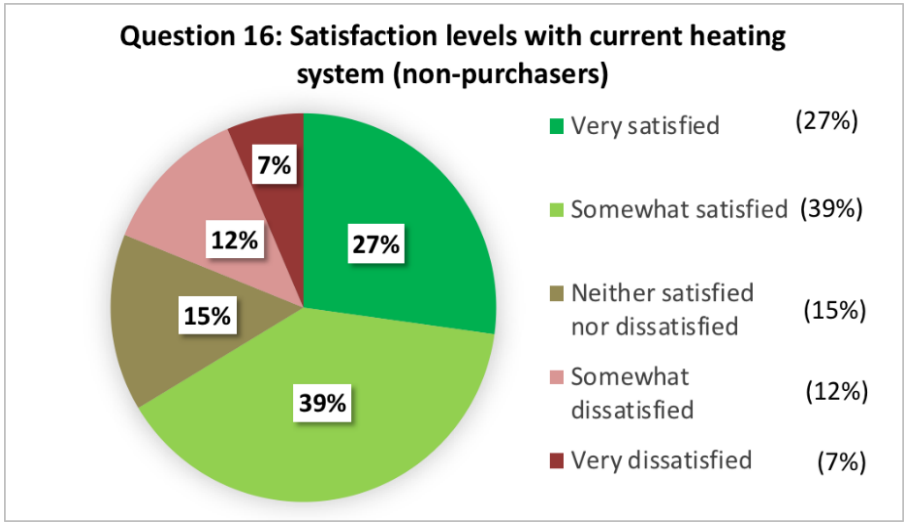




Study Results (continued)

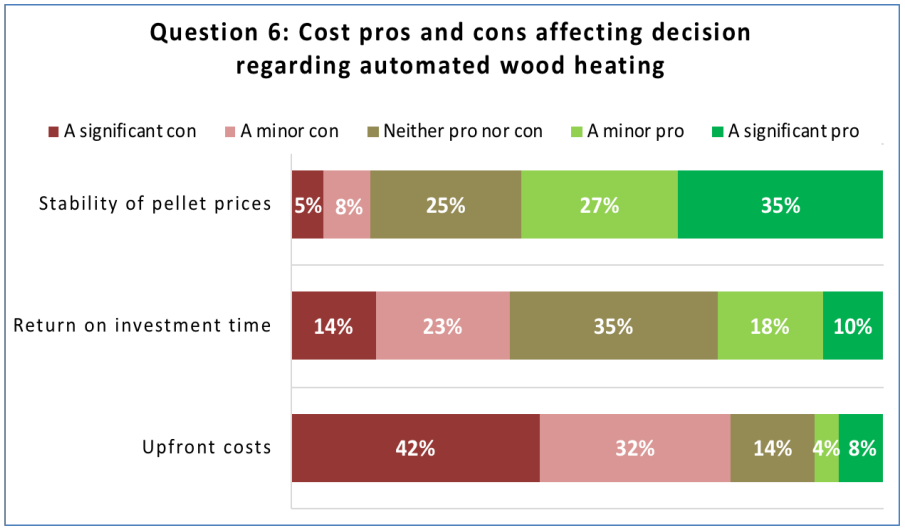
Purchasers of AWPH were much happier with their heating systems than those who chose to purchase another type of heating system or stay with their old system. Qualitative data showed that word of mouth is a very important factor in motivating people to adopt AWPH, so high satisfaction rates should be good for market development. *So why is adoption still so low?*

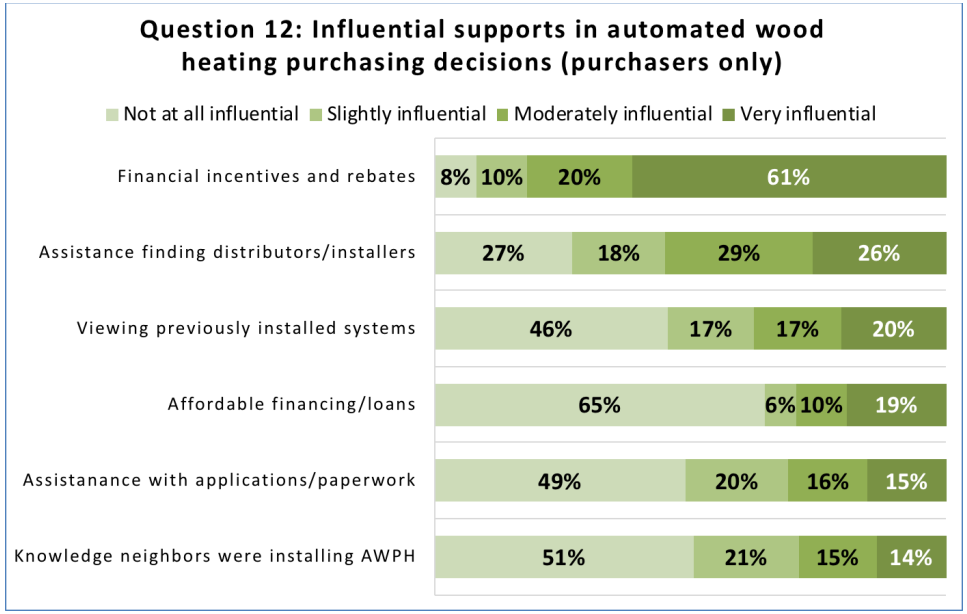




Study Results (continued)

- Upfront cost is a major barrier for many, despite financial incentives.
- Factors *other than* incentive amount affect adoption in each state: NY incentives are high but adoption low, for example, while ME incentives are low and adoption much higher.
- Limited supply-side actors (relatively low number of installers, bulk pellet fuel vendors, etc.) is a barrier to adoption – but lack of adoption is a barrier to supply-side development, creating a problematic feedback loop.





Study Results (continued)

The Model Neighborhood Project's additional supports appear to have reached beyond the value-driven early adopters into the more cost-conscious, risk-averse "early majority."

Survey Findings

- 26.3% of survey respondents were in MNP areas (25% of adopters)
- On average, MNP participants have fewer innovator/ early adopter characteristics than non-MNP respondents
  - Residential adopters and non-adopters in MNP areas tend to have lower incomes and less education than non-MNP respondents.
  - People in MNP areas tended to consider themselves less likely to adopt new technologies (but was a not statistically significant difference).
- One question asked how various supports influenced decision-making. MNP-area respondents rated almost all of the supports as more highly influential than non-MNP respondents. These included:
  - Financial incentives / rebates
  - Knowledge of others in my neighborhood were installing AWPH
  - Ability to view installed systems
  - Assistance in contacting installers and distributers
  - Affordable loans/financing

Survey Findings (con't)

- No difference between MNP area and others regarding values or belief in climate change.
- The lower the income, the more respondents valued technical support – which MNP helped to provide.
- MNP area respondents were significantly <u>less</u> likely to say they considered AWPH because:
  - They wanted an alternative to fossil fuels.
  - Their heating system had failed.
- MNP area respondents were statistically <u>more</u> likely to say they considered AWPH because they:
  - Wanted something easier to manage.
  - Found out about incentives.
  - Were looking to replace a cordwood stove or boiler.
  - Saw air quality as a significant pro of AWPH.

Qualitative data largely concurred, plus:

- Consumers liked the energy audits, in cases where the MNP included them.
- MNP participants were highly motivated by the prospect of lowering overall heating costs.

Study Results (continued)

Literature review: Forest pest implications of pellet feedstock

- The spread of key forest pests in the Northeast in the context of climate change could increase supply of low-grade salvage wood for wood biomass energy.
- The pelletization process removes risk of spreading forest pests and pathogens. Pellets are a better way to move wood biomass than firewood or woodchips, from a phytosanitation perspective.
- Literature from abroad suggests concern about phytosanitation and treatment before the wood reaches the pellet plant. This has not been well documented in US literature. On-site communition and local pellet plants with small feedstock radii may help reduce the threat of spreading forest pests.

Literature review: Ecological implications of wood energy use

- The impact of wood energy on biodiversity, soil health, carbon emissions, and other factors can be positive or negative depending on context: feedstock mix, forest management practices, whether it's being used for heat or electricity, combustion technology, what would be used otherwise, etc.
- Using wood for heat in the Northern Forest can be part of the energy mix that mitigates climate change. Ecological impacts can be minimized by ensuring sustainable wood harvesting techniques, monitoring impacts, and adapting forest management accordingly.
- Place-based lifecycle analyses of wood energy costs and benefits (including the entire production cycle) should inform the policies and regulations that guide forest management and harvesting, as well as further our general understanding of how wood energy use affects ecological systems.

Outreach

- Feel Good Heat: Insights from the NSRC project are informing a regional Automated Wood Heat marketing campaign developed by the Northern Forest Center with 50 partners to build awareness of AWPH technology. www.feelgoodheat.org
- Northeast Wood Heat Leadership Summit: January 2019 at UVM
  - 75 wood heat professionals from the Northern Forest and Massachusetts attended.
  - Representatives from state agencies in all four Northern Forest states participated.
  - A listserv created after the event has facilitated continued information-sharing
- Over 10,000 views of the Northern Forest Center's wood heat web pages and 22,000 views of www.feelgoodheat.org since June 2017.
- At least 15 conference presentations by Northern Forest Center staff, including the 2018 European Pellet Conference in Wels, Austria.

Relevant communications from the Northern Forest Center, including coverage by outside publications, include:

- "Feeling Good About Wood Heat." Maura Adams, Biomass Magazine, 5/25/19.
- "Model Neighborhood Project Reflections." Maura Adams, Northern Forest Center blog, 5/15/19.
- "Coming Together in the Name of Wood Heat." Maura Adams, Biomass Magazine, 2/18/19.
- "Heat local: group says wood pellets make sense in the North Country." David Sommerstein, NCPR, 10/6/17.
- "UNH Research Finds Wood Pellets Outperform Fossil Fuels, Natural Gas in Reducing Greenhouse Gas Emissions." UNH Newsroom, 11/20/17.

Implications and Applications

This project shows that while financial incentives are critical, they're not the only policy tool that should be used to increase AWPH adoption. Our research demonstrates that several other strategies increase AWPH adoption and may merit public investment:

- **Dedicated support staff to provide one-on-one support to potential adopters and be a liaison to supply-side actors.** Roles this project demonstrated to be beneficial include:
  - Providing technical assistance to answer questions, provide information, and/or connect potential adopters with local technicians is a critical support for AWPH adoption, especially among older and lower income residents.
  - Cultivating stronger local networks of suppliers and technical experts.
  - Helping with program paperwork reduces barriers for both the consumer and the installer.
- **Investment in the supply chain** such as installer and servicer training or grants for bulk pellet delivery trucks
- **Program outreach on a local level**
  - Publicizing incentives through local media campaigns, not just online.
  - Providing opportunities to view previously installed systems.
  - Creating a density of promotion and adoption, then visibility and normalization.

Implications (continued)

Other conclusions to inform effective AWPH incentive programs include:

- Focusing on locations where AWPH is locally relevant (near forests, communities with historical reliance on the forest economy) can capitalize on existing consumer values and create compact supply chains.
- Pairing renewable energy adoption programs with energy efficiency programs is a successful outreach technique and especially necessary when fossil fuel prices are low. Combining incentives for sustainable heating technology with incentives for building efficiency measures reduces both upfront costs and ongoing fuel costs.

Future Directions

The Northern Forest Center is using the findings of this research to:

- Inform consumer awareness-building of AWPH technology through a regional marketing effort developed with over 50 public and private partners: www.feelgoodheat.org
- Partner with state and federal agencies to help shape more effective incentive programs and policies that support AWPH adoption
- Provide AWPH vendors with information on how to best appeal to consumers

The UVM research team is looking at options to conduct a GIS-based study that explores the effect of proximity to forests, pellet plants and distributers on AWPH adoption in the Northern Forest region.

List of Products

Peer-reviewed publications

- Edling, L. and C. Danks. (2018). To adopt or not to adopt? That was our question: Insights on energy transitions from a study of advanced wood heating. *Energy Research & Social Science*. https://doi.org/10.1016/j.erss.2018.06.019.
- Guo, T., J. Leahy, E. Huff, C. Danks and M. Adams. (2018) A social network analysis of a regional automated wood pellet heating industry in pursuing homeowner satisfaction. *Forest Products Journal*. https://forestprodjournals.org/doi/abs/10.13073/FPJ-D-17-00055
- Neidermeier, A., C. Danks, K. Coleman and K. Wallin. (In review). Forest pests and wood pellets: A literature review of the opportunities and risks in the United States' northeastern forests. *Biomass and Bioenergy.*
- Edling, L. and C. Danks. (In prep). Interacting Leverage Points: Diffusion of Advanced Wood Pellet Heating in the Northeastern United States from a Systems Perspective. Expected submission to *Energy Research & Social Science in* July 2019.
- Edling, L. and C. Danks, M. Adams, and J. Short. (In prep). Supporting Actors: The Role of State Policy and Private Programs in Advancing Local and Renewable Heating Technology. Expected submission to *Energy Policy* in August 2019.

List of Products (continued)

Ph.D. Dissertations

- Edling, L**.** A systems perspective on an energy transition: the interacting factors affecting the adoption of advance wood heating systems. Defense date August 26, 2019.

Undergraduate Theses

- Bowanko, R. 2018. Exploring Public Perceptions of Wood Heat: The Influence of Ecological Impacts on the Adoption of Advanced Wood Heating. University of Vermont.

Technical reports

- Wechsler, A., L. Edling, C. Danks, R. Bowanko, C. Brodie, and M. Adams. (2019). Deciding How to Heat: Factors affecting automated wood pellet heating systems.
- Adams, M. L. Edling, C. Danks, J. Short and A. Wechsler. (In prep). Supporting sustainable wood heating in the Northern Forest: Lessons Learned for Practitioners and Policy-Makers.

List of Products (continued)

Conference Presentations

- Danks, C., L. Edling, R. Bowanko, and A. Weschsler. (2019). “Deciding How to Heat: A Study of Factors Affecting Automated Wood Heat Purchasing Decisions in the Northern Forest.” At the Northeast Wood Heat Leadership Summit, Burlington, VT, January 8.
- Bowanko, R. (2018). "Exploring Public Perceptions of Wood Heat: The Influence of Ecological Impacts on the Adoption of Advanced Wood Heating.“ At the Renewable Energy Vermont Conference, Burlington, VT, October 18.
- Edling, L. (2018). “The Transition to Automated Wood Pellet Heating in the Northeastern United States: A Case of Whole System Reconfiguration.” At the International Sustainability Transitions Conference, Manchester, England, June 12.
- Edling, L. (2018). “Factors Affecting the Conversion to Modern Wood Heating Technology in the Northern Forest Region: A Systems Analysis.” at the UVM Student Research Conference, Burlington, VT, April 19.

List of Products (continued)

Conference Posters

- Edling, L. and C. Danks. (2016). “Factors Affecting the Conversion to Modern Wood Heating Technology in the Northern Forest Region: A Systems Analysis.” Poster presentation for the ECANUSA Conference, Burlington, VT, December 7.