Feasibility of Renewable Thermal Technologies (RTT) in Connecticut

Helle H. Gronli
Associate Research Scientist, Yale

Department of Energy and Environmental Protection
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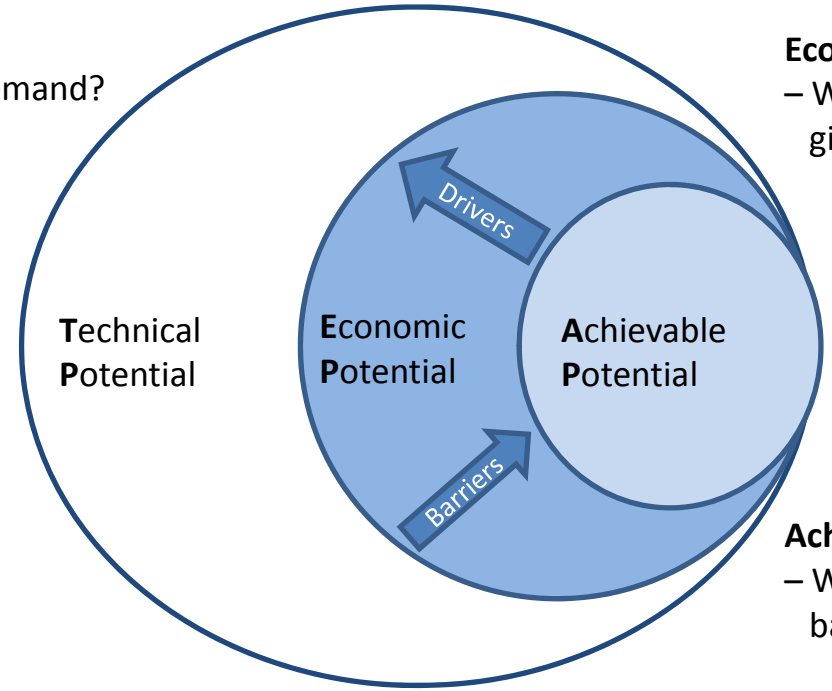
Roadmap

- Why a feasibility study?
- What is the potential?
- How do renewable thermal technologies compete?
- What are the barriers?
- What are possible solutions?

Technical Potential
– How big is the thermal demand?



Economic Potential
– What is economically feasible given the competition analysis?

Achievable Potential
– What is realistic given barriers and drivers?


Photo by Oregon Department of Forestry


Photo by Koert Michiels

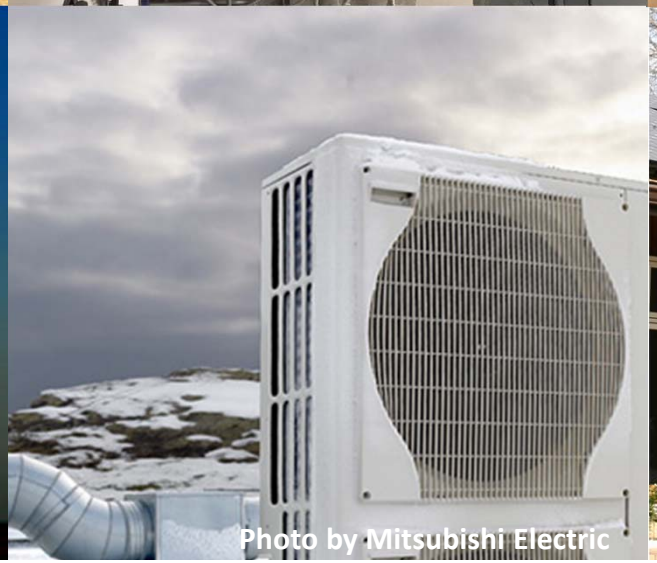
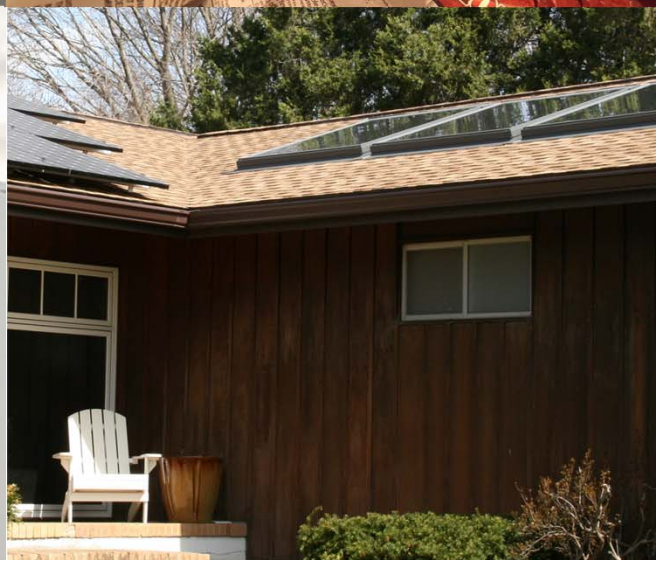
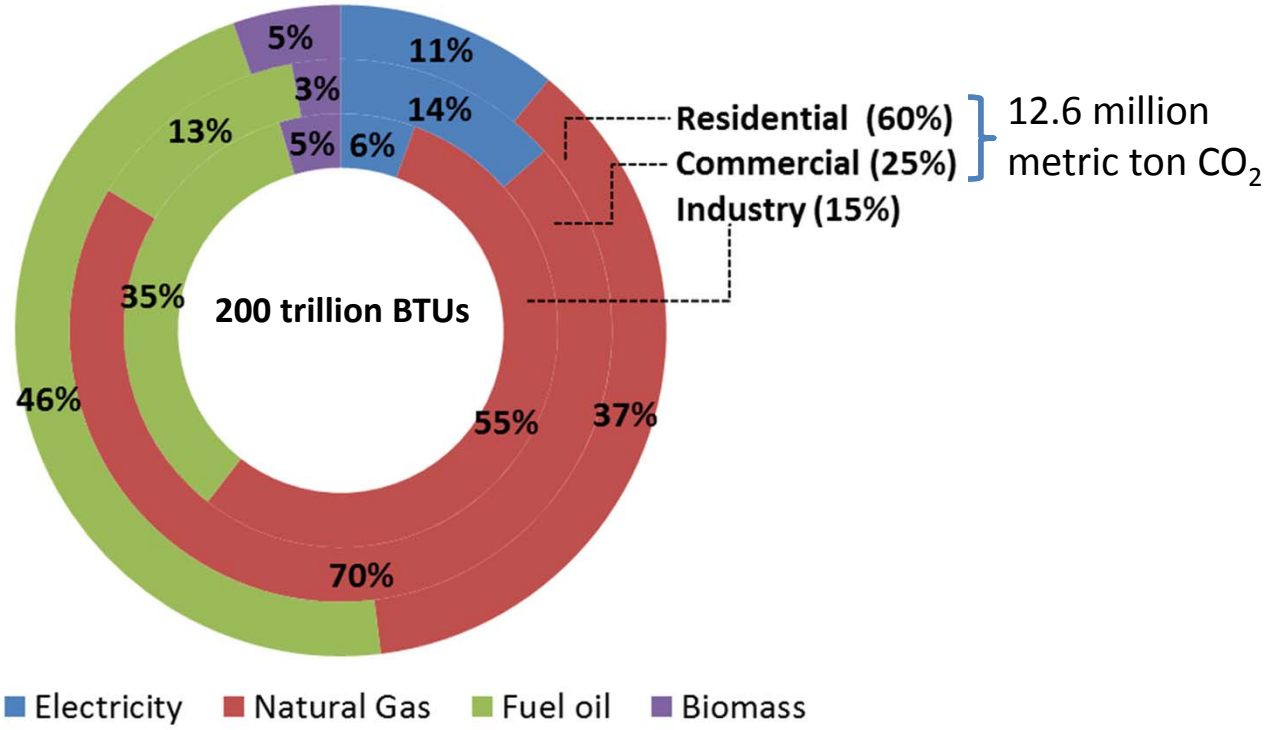


Photo by Mitsubishi Electric



Thermal Demand in Connecticut 2014

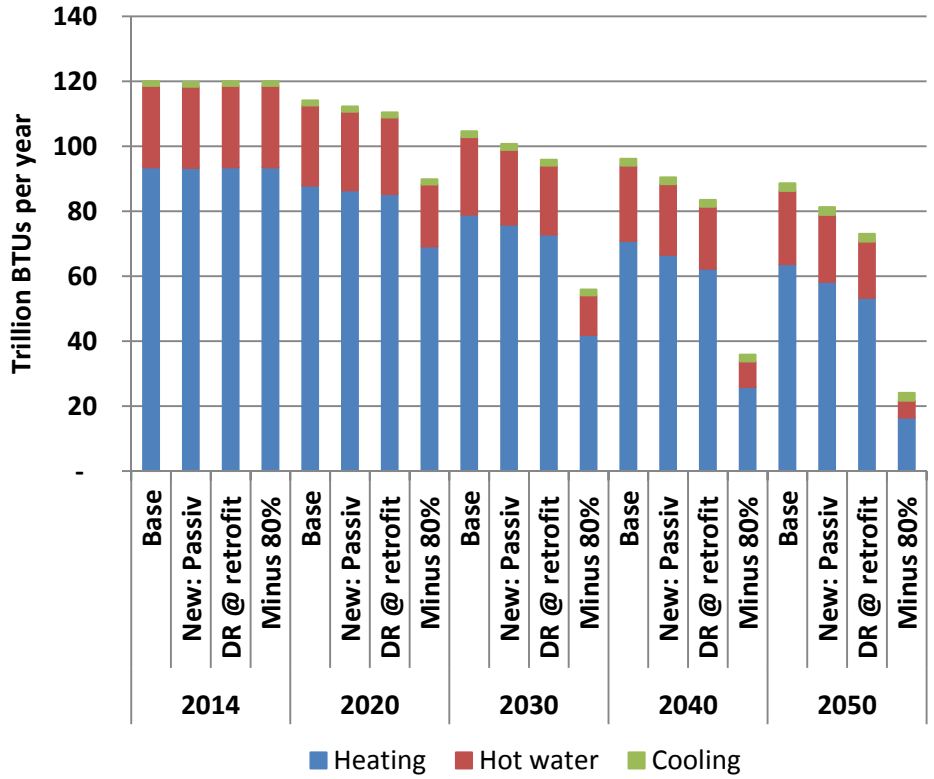


Sources: EIA SEDS and own analysis

Demand Analysis – Main Findings

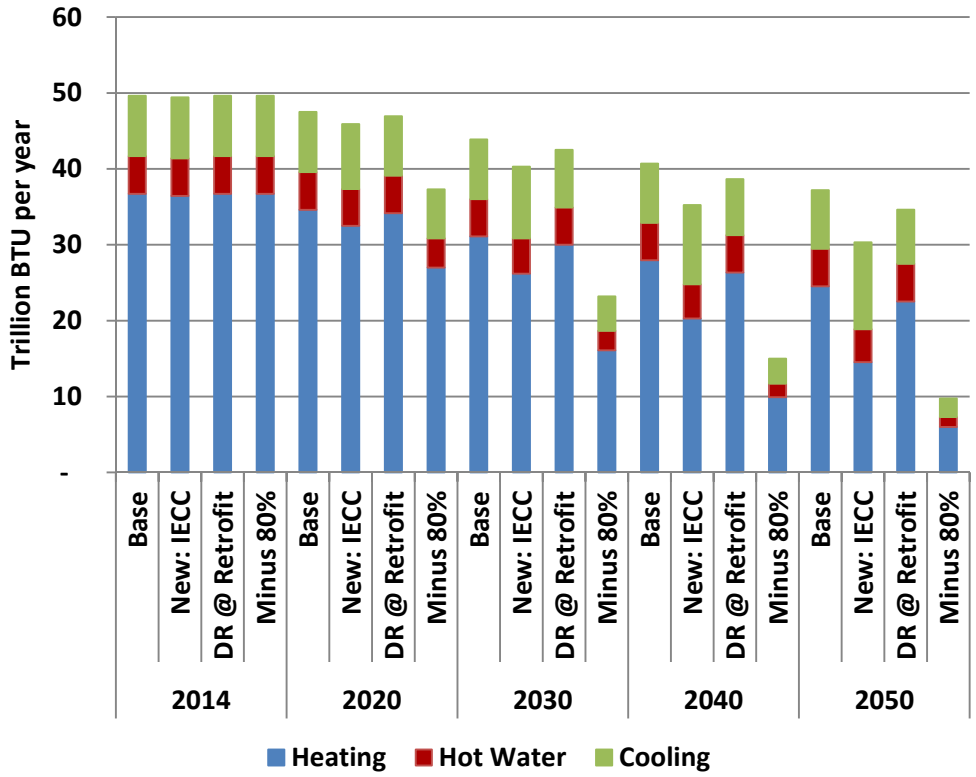
- Thermal demand in buildings is estimated to 103 – 142 trillion BTUs in 2050
- Ambitious building codes may considerably impact thermal demand, particularly in the commercial sector where the rate of new construction is expected to be high
- Higher outdoor temperatures reduce the thermal demand by 15 trillion BTUs per year by 2050
- An 80 percent reduction of the thermal demand by 2050 require a considerable number of buildings undergoing deep retrofit per year

Residential Thermal Demand Projections 2050 - Sensitivities



Market potential

Commercial Thermal Demand Projections 2050 - Sensitivities



Market potential

Competition Analysis and Economic Potential

- Find the financially most competitive technology for 7 archetypal customers

Incumbent technologies

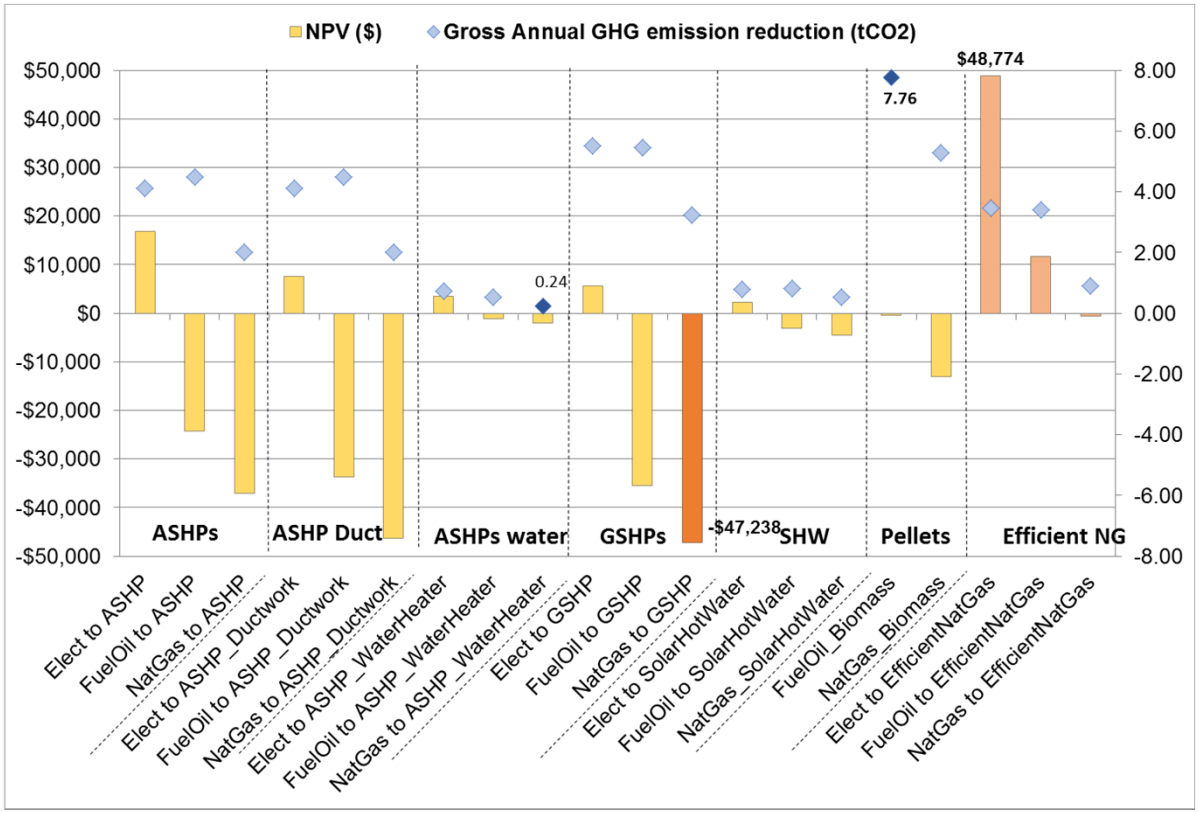
- Fuel oil boilers
- Standard natural gas boilers
- Conventional electric technologies

Proposed renewable technologies

- Air source heat pumps (ASHP)
- Ground source heat pumps (GSHP)
- Solar water heating (SHW)
- Biomass pellets
- Highly efficient natural gas boilers

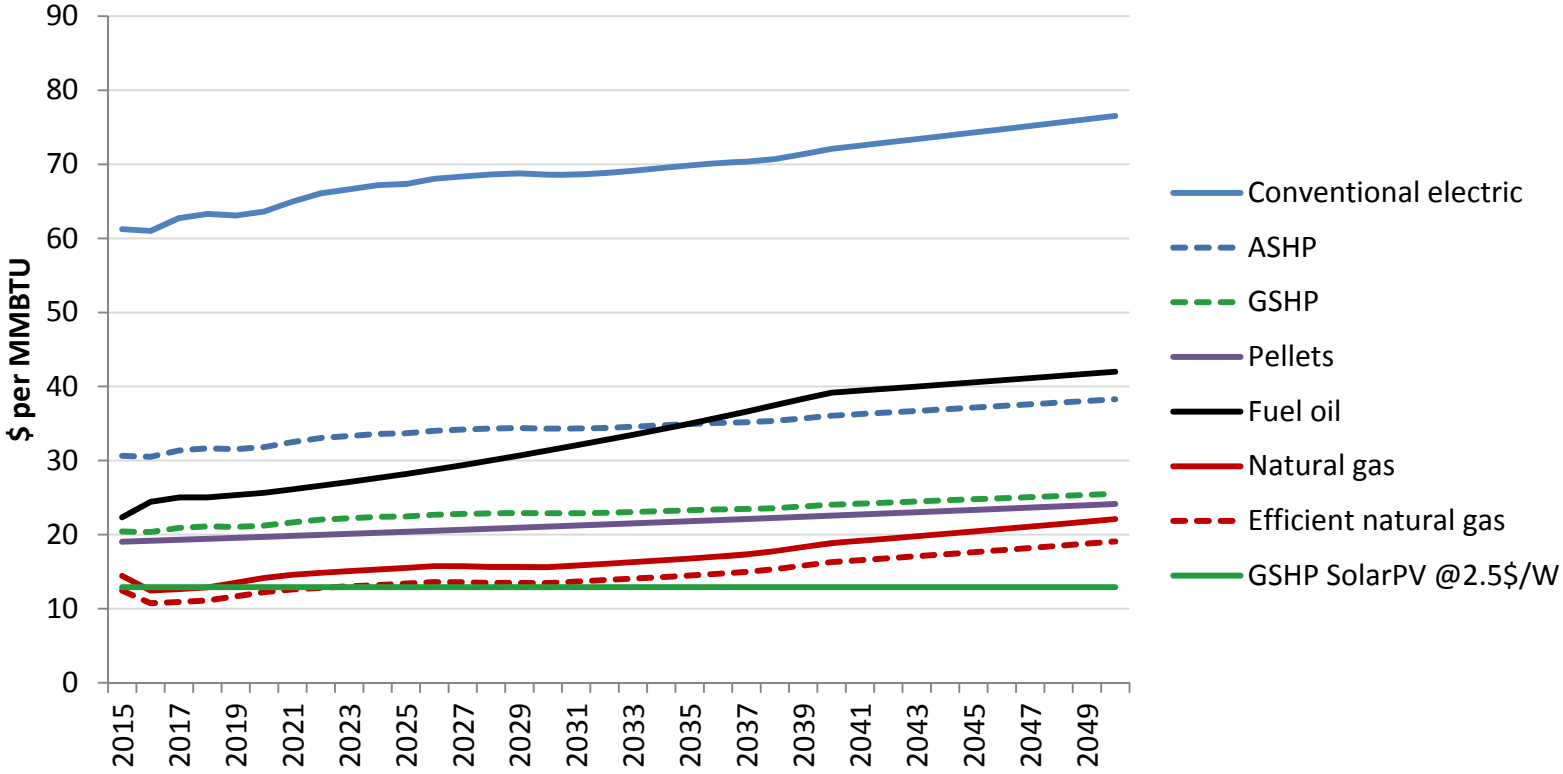
- Estimate the economic potential for each technology based on which is the most competitive to supply the technical potential

Single-family – Net Present Values and GHG emissions



* GHG emission factors are based on the IPCC framework.
Connecticut takes a more conservative approach when accounting for emissions from biomass

Operational Fuel Costs of Different Heating Alternatives



Proposed thermal technology	Instead of	Single-family	Multi-family	Education	Food Service	Health	Hotel	Office
ASHP with no ductwork needed	Electricity	■	■	■	■	■	■	■
	Fuel Oil							
	Natural Gas							
ASHP with ductwork needed	Electricity	■	■					
	Fuel Oil							
	Natural Gas							
ASHP water heating	Electricity	■	■					
	Fuel Oil							
	Natural Gas							
GSHP	Electricity	■	■	■	■		■	
	Fuel Oil							
	Natural Gas							
Solar Water Heating	Electricity	■	■		■	■		
	Fuel Oil							
	Natural Gas							
Biomass pellets	Fuel Oil			■	■	■	■	
	Natural Gas							
Highly efficient natural gas	Electricity	■	■	■	■	■	■	■
	Fuel Oil	■	■	■	■	■	■	■
	Natural Gas							

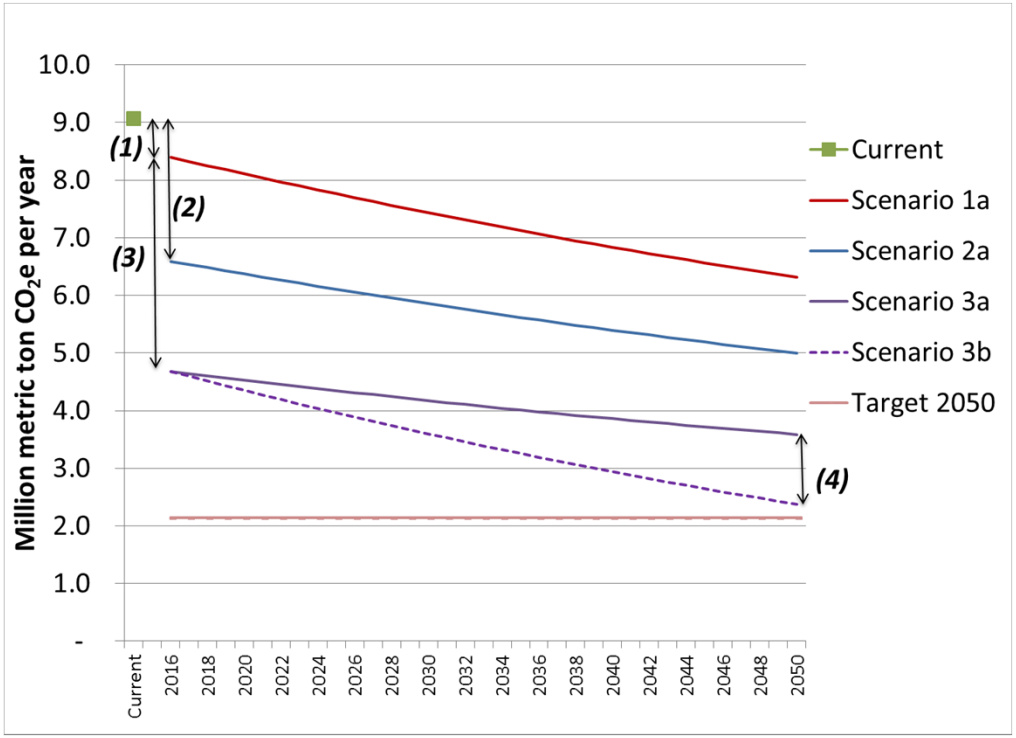
Competitive Thermal Alternatives (Base case)

- Heat pumps and solar water heating are competitive to conventional electric technologies
- Pellet boilers replacing fuel oil boilers are financially competitive in several commercial buildings

→ Economic potential 19 %

- Highly efficient gas boilers are competitive to conventional electric and fuel oil for space and water heating

Estimated GHG Emissions of Residential Thermal Demand

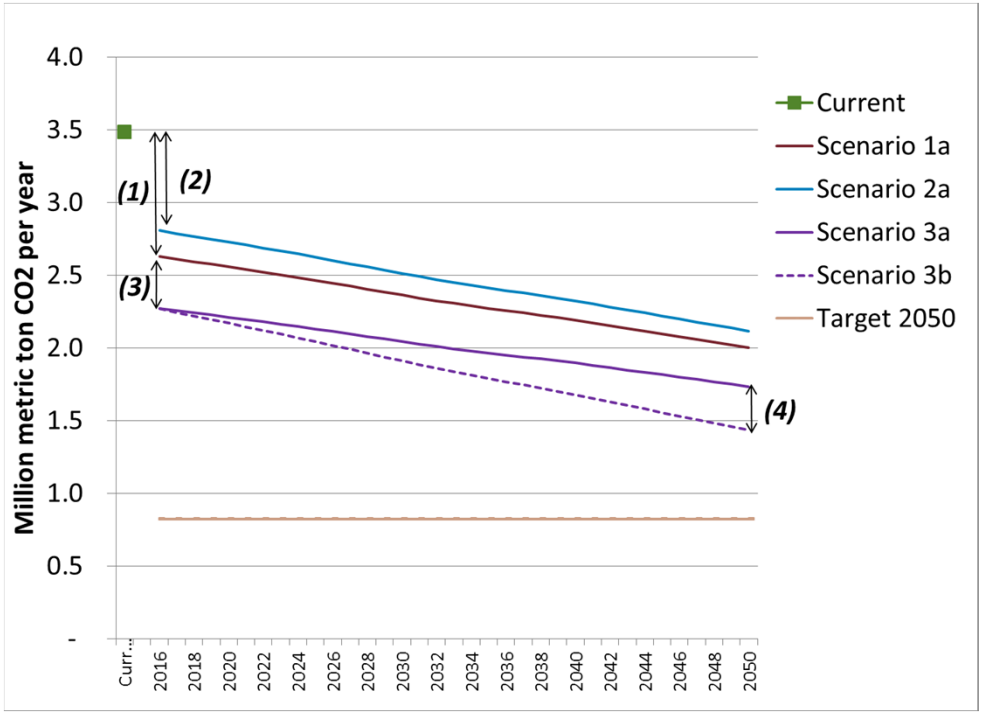


Current estimate 9.1 mill ton $C0_2e$

1. Competitive RTT - an immediate reduction of 0.6 mill ton $C0_2e$
2. Competitive RTT and efficient gas boilers an immediate reduction of 2.4 mill ton $C0_2e$
3. Competitive RTT and enforced deployment of GSHPs and efficient bas boilers halves the GHG emissions
4. 75% renewable electricity add a reduction of 1.2 mill ton $C0_2e$ by 2050

* GHG emission factors are based on the IPCC framework.
Connecticut takes a more conservative approach when accounting for emissions from biomass

Estimated GHG Emissions of Commercial Thermal Demand



Current estimate 3.5 mill ton $C0_2e$

1. Competitive RTT - an immediate reduction of 0.8 mill ton $C0_2e$
2. Competitive RTT and efficient gas boilers - an immediate reduction of 0.7 mill. ton $C0_2e$
3. Competitive RTT and enforced deployment of GSHPs and efficient bas boilers brings the GHG emissions to 65 percent
4. 75% renewable electricity add a reduction of 0.4 mill ton $C0_2e$ by 2050

* GHG emission factors are based on the IPCC framework.
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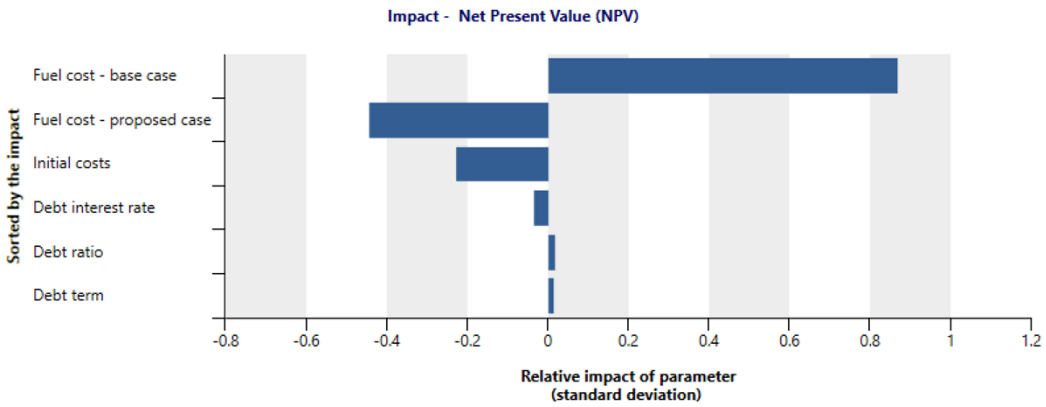
Sensitivity Analysis



1. Fuel costs
   of the incumbent technology
   a) 50 % increase
   b) 100 % increase
   of the new technology
   c) 25 % reduction
   d) Heat pumps + solar PV
2. Initial costs
   a) 25 % reduction
   b) Part load
3. Thermal Renewable Energy Credits
4. Carbon price of 41 $ per ton CO_2
5. Debt interest rate
6. Debt term
7. Combinations

Proposed thermal technology	Instead of	Single-family	Multi-family	Education	Food Service	Health	Hotel	Office
ASHP with no ductwork needed	Electricity							
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	Natural Gas							
ASHP water heating	Electricity							
	Fuel Oil							
	Natural Gas							
GSHP space heating and cooling	Electricity							
	Fuel Oil							
	Natural Gas							
Solar Water Heating	Electricity							
	Fuel Oil							
	Natural Gas							
Biomass pellets space heating and hot water	Fuel Oil							
	Natural Gas							
Highly efficient natural gas	Electricity							
	Fuel Oil							
	Natural Gas							

Sensitivity Analysis

Description

- Initial costs are 25 % down
- Solar PV reduces electricity costs of heat pumps by 25 %
- Fossil fuel costs are 50 % up

An increasing number of RTTs become competitive against fuel oil

High upfront costs

"We cannot afford to pay extra for environmental value, and the project has to be 'Zero out of pocket'"

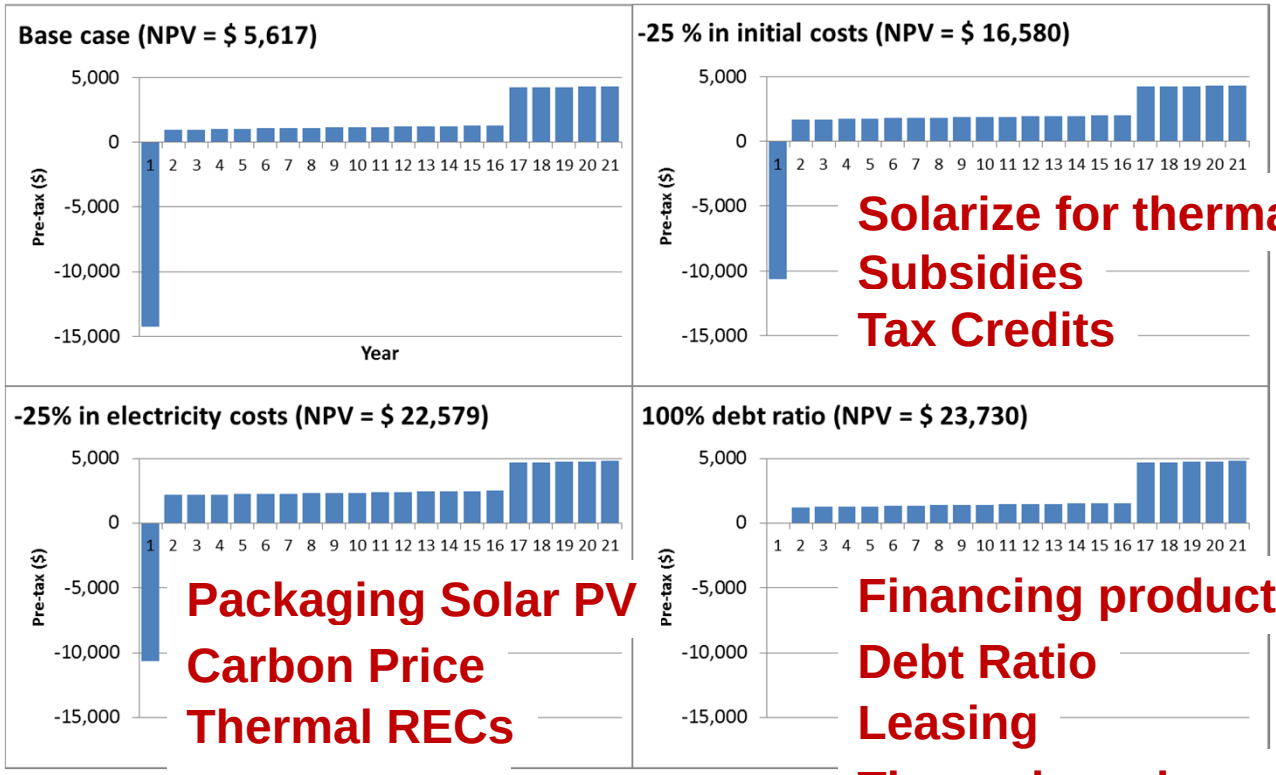
Institutional customer

"… The problem is: when you put everything up on your roof, there's an outlay of money - and you're cash poor until the tax rebate is returned"

Residential customer

Cash Flow Analysis

Single-family Home Replacing Conventional Electric by GSHP*



Solarize for thermal
Subsidies
Tax Credits

Packaging Solar PV
Carbon Price
Thermal RECs
Interest rates

Financing products
Debt Ratio
Leasing
Thermal service agreements

* Changes are cumulative

Awareness

"PV is killing solar thermal. The payback [for solar thermal technologies] with the tax credit is good, but it's not as sexy as PV"

Installer solar thermal

"When we talk to customers after the fact, they never talk about energy savings. They are always thrilled about how comfortable/quiet the home now feels. It's an interesting transformation— 'forget the savings, we love how comfortable our home is'"

Program administrator

Industry business models

"ESCOs are typically incentivized to choose projects that are most easily executed and can guarantee savings with relatively short payback periods"

"The work force needs to be developed"

Institutional customer

"Investments were synergistic. As geothermal becomes more efficient, so does use of Solar PV, which made spray foam insulation in the attic a good investment"

Residential customer

Conclusions

Achieving the targeted greenhouse gas emission depends on considerable

- reduction in thermal demand
- deployment of renewable thermal technologies
- de-carbonization of electricity generation
- and highly efficient natural gas boilers where natural gas is applied

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Annie Guo
Krizstina Pjeczka

Contact information
helle.gronli@yale.edu

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