

Connecticut Residential Ground Source Heat Pump Impact Evaluation & Market Assessment

September 17, 2014

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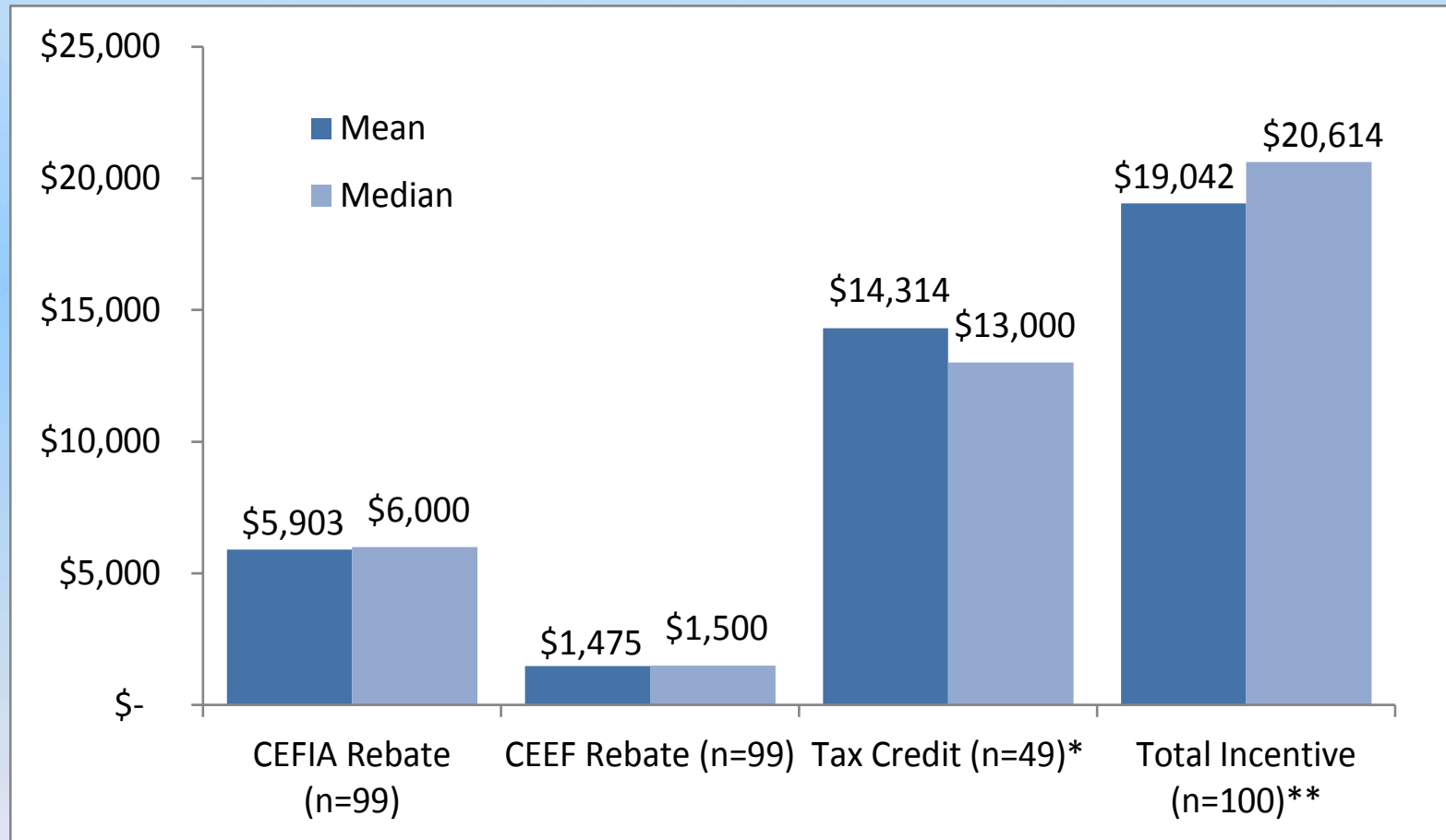
Presentation Overview

- Program Summary
- Evaluation Plan
- Results
 - Gross Savings
 - Net Savings
 - Program & Market Assessment
- Recommendations

Program Summary

- CEFIA
 - Required ENERGY Star Tier 1 GSHP system
 - 2009-2010: \$1,200/ton - \$2,000/ton
 - 2010-2012: \$1,050/ton - \$1,200/ton
- CEEF
 - New homes meet ENERGY STAR criteria
 - Existing homes pass HES min. requirements
 - Verification of Installed Performance report
 - \$500/ton; \$1,500 max
- 326 projects completed as of Jan. 2012

Typical Incentive Levels



- Federal tax credit available for 30% of total project cost

Evaluation Objectives

- Quantify energy and peak demand savings of the Connecticut residential GSHP program
- Quantify improvements in air quality
- Assess the GSHP program for potential improvements
- Assess the market for GSHPs in Connecticut

Evaluation Tasks

- On-site metering at 40 participating homes
 - Short-term metering
 - 21 existing & 19 new construction homes (Feb. – Apr. 2012)
 - Long-term metering
 - Subset of 10 homes (retrieved Aug/Sept 2012)
- Assessment of system design
 - Manual J sizing
 - Field and loop sizing
- Analysis of energy and demand savings using DOE-2 energy models
- Estimation of emission reductions
- Telephone surveys with 100 participating customers (Nov. 2012)
- In-depth telephone interviews with 10 participating contractors (Oct. 2012)

DOE-2 Modeling

- Two DOE-2 prototype models
 - New Construction
 - Existing Homes
- Each prototype had two baselines
 - CEFIA baseline
 - Oil hot water boiler plus CAC
 - CEEF baseline
 - ENERGY STAR Tier 1 GSHP

CEFIA Gross Savings Per Existing Home

Metric	Electric Savings (kWh)	Oil Savings (gallons)	Total Energy Savings (MBTU)
Annual Savings	-6,554	804	90,616
Heating Mode Savings	-6,412	804	91,099
Cooling Mode Savings	-142		-484
Heating Savings/S.F.	-2.4	0.3	34.2
Cooling Savings/S.F.	-0.05		-0.18
Summer Coinc. Dmd. kW	0.66		
Winter Coinc. Dmd. kW	-2.9		

CEFIA Gross Savings Per New Construction Home

Metric	Electric Savings (kWh)	Oil Savings (gallons)	Total Energy Savings (MBTU)
Annual Savings	-6,539	723	79,270
Heating Mode Savings	-5,798	723	81,853
Cooling Mode Savings	-741		-2,527
Heating Savings/S.F.	-1.3	0.16	17.8
Cooling Savings/S.F.	-0.16		-0.55
Summer Coinc. Dmd. kW	1.13		
Winter Coinc. Dmd. kW	-2.9		

CEFIA Gross Emission Reductions Per Home

Metric	Existing Home (lbs/yr)	New Construction (lbs/yr)
Electricity		
CO2	-7,584	-7,566
CH4	-404	-403
NO2	-95	-94
Residential Fuel Oil		
CO2	18,223	16,385
Net CO2 Emissions	10,639	8,819

CEEF Gross Savings Per Home

Electric Savings	Existing Home	New Construction
Annual kWh	2,206	3,681
Heating Mode kWh	1,641	2,791
Cooling Mode kWh	566	890
Heating kWh/SF	0.62	0.61
Cooling kWh/SF	0.21	0.193
Summer Coinc. Dmd. kW	0.34	0.48
Winter Coinc. Dmd. kW	0.5	0.9

CEEF Gross Realization Rates

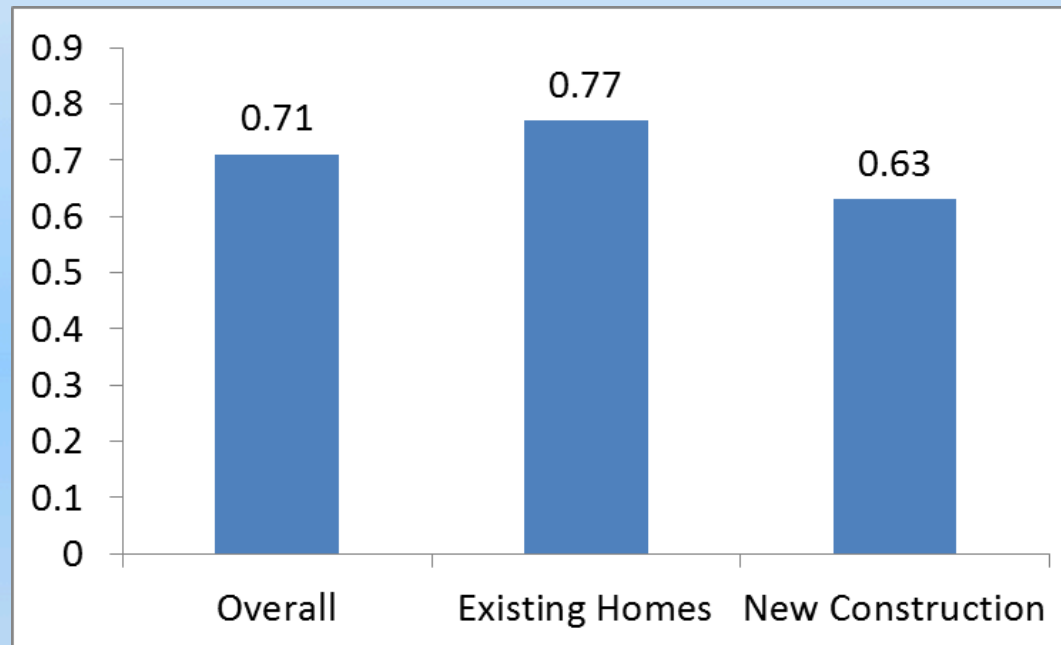
Type of Home	Evaluated CEEF Baseline Savings Per Participant (Annual kWh)	CL&P Tracking System Savings Per Participant (Annual kWh)	Gross CEEF Realization Rate
Existing Home	2,206	1,454	1.52
New Construction	3,681	1,044	3.53

- High realization rates primarily due to longer hours of operation

NTG Estimation

- NTG estimated via telephone surveys with participants
 - Asked to rate the level of importance on their decision
- Multiple incentives and differing baselines posed a challenge
- Participants most likely to collectively consider the aggregate impact of all three incentives/credits, rather than the separate impact of each individual incentive
- The NTG ratios were estimated regarding the overall decision to install a GSHP system
 - Not feasible to ask participants to rate the importance of incentives on specific “portions” of their decision

NTG Ratios

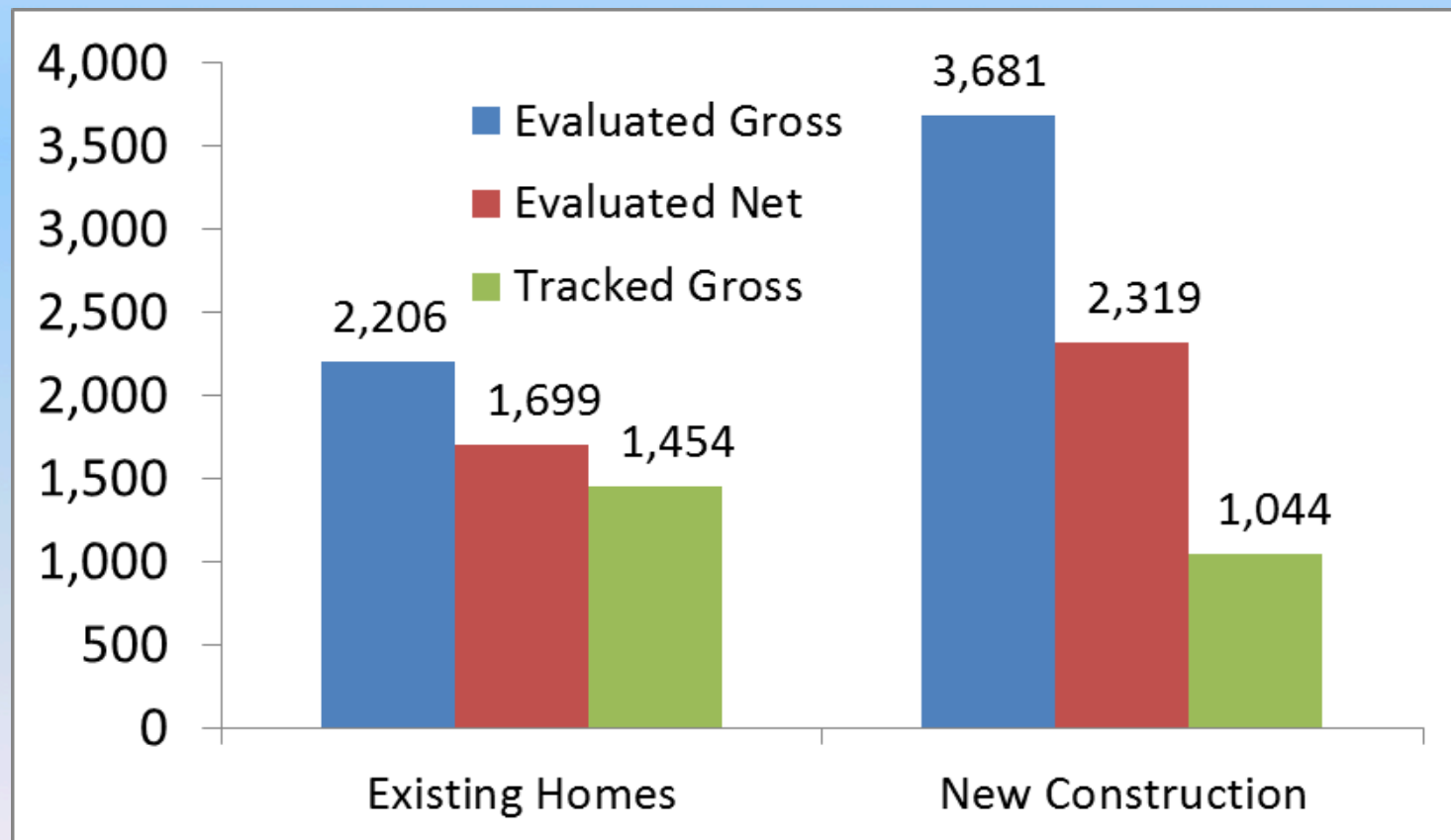


Several factors may lead to modest NTG Ratios

- Program participants have considerably higher incomes than typical CT residents
 - 72% vs. 33% > \$100,000 annual income
- Most new homes are financed

CEEF Net Savings

Annual kWh Savings Per Participating Home



System Sizing & Performance

- **Ground source heat pumps are sized to meet homes' largest space conditioning requirements**
- **The systems, on average, are slightly oversized for heating loads**
 - Manual J calculations - average heating sizing ratio of 1.21 for newly constructed homes and 1.24 for existing homes

System Sizing & Performance

- **The systems appear to be performing somewhat below the manufacturer-rated efficiencies**
 - 85% for existing homes and 91% for newly constructed homes
 - Primarily due to differences in the operating conditions in the field compared to the manufacturers' testing facilities
- **The recovery fields for the GSHP loops appear to be sized correctly**

Program Participation

- **Contractors play an important part in disseminating program information to homeowners**
- **Homeowners are highly satisfied**
 - Average satisfaction ratings of 9.4 out of 10 for the new GSHP systems and 9.1 for the program
- **Contractors are somewhat satisfied**
 - Contractors rated their overall satisfaction with the program as a 6 out of 10
 - Most contractors consider it “a good program” and commended its effective distribution of incentives and the demeanor and diligence of program staff
- **Contractor eligibility requirements are reasonable**
 - Licensing, accreditation, insurance, and references

Program Processes

- **The VIP report yields a mixed response**
 - Some contractors believe the technical details required are valuable to both perform and verify and it has changed the way they are checking their installations
 - Other contractors find it to be time consuming and frustrating
 - They believe their VIP reports have been rejected because program staff thought the systems were *too* efficient, the formulas in the worksheet were incorrect, or they did not know how to interpret the data if it did not meet expectations
 - In some instances, contractors report altering their practices to make systems *less* efficient in order to meet program requirements
 - Likely refers to the VIP requirement that systems perform within 15% of AHRI-rated efficiency and capacity levels.

Program Processes...

- **Some contractors believe program staff require more technical knowledge**
 - Despite some contractors' praise for program staff, others are troubled by their perception that program staff appear to have little technical knowledge and training regarding GSHP systems
- **Other contractor complaints include paperwork, CEFIA fund management, and cross-program coordination**
- **The program does not appear to be overlooking any substantial savings opportunities**
 - According to 5 contractors, the program is not missing any savings opportunities in program homes
 - Other contractors believe the rigorous HES efficiency standards and project pre-approval requirements may discourage participants, and the ineligibility of open loop GSHP systems and the lack of a requirement for desuperheaters may result in missed savings

Market Assessment

- **Word of mouth is the most common method of learning about GSHPs**
- **Participants are primarily motivated to install GSHPs due to energy concerns**
 - Save energy (36%), reduce energy costs (23%), and help the environment/reduce carbon footprint (21%)
- **More than one-half of participants had concerns about installing a GSHP, primarily regarding reliability**
- **Contractors perceive a large opportunity for residential GSHPs in Connecticut**
 - About one-half of existing homes and nearly all newly constructed homes are good candidates for GSHP
- **However, contractors' expectations vary for Connecticut's GSHP market in the coming years**
 - Some anticipate sales will decrease or flatten given the disappearance of federal tax credits in 2017, while others believe sales will increase due to growing awareness
 - Some predict that prices will increase due to improved efficiency, while others believe prices will remain stable

Recommendations

- Continue advanced training in GSHP design, installation, and performance for CEEF and/or CEFIA program staff
- Consider investigating redesign of the VIP spreadsheet to allow for more flexibility
- If the CEFIA incentives return:
 - Improve integration to seamlessly offer joint program to both contractors and customers
 - Reintroduce CEFIA incentives after the federal tax credit expires in 2017
 - Consider revising the CEFIA baseline assumptions for natural gas or propane heating system
 - New construction