



The Path to Net Zero in Low-Income, Multifamily Buildings

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New Jersey's Clean Energy Program

- Statewide clean energy initiative, administered by the NJBPU
- Promotes energy efficiency, geothermal & renewable energy (including solar, wind, marine hydrokinetics: small hydropower, wave, & tidal, and sustainable biomass)
- Results in a stronger economy, less pollution, lower costs and reduced demand for electricity
- 2012 results:
 - Annual energy savings of 637,478 MWh of electricity
 - 1,463,843 Dekatherms of natural gas
 - 1,407,665 of renewable generation and 35,012 of distributed generation from combined heat and power systems
 - Reductions in CO₂ emissions are equivalent to taking 793,000 cars off the road for a year
- Financial incentives, programs and services for residential, commercial and municipal customers



**Vermont
Energy Investment
Corporation**

- Nonprofit with 25 years experience reducing economic, environmental costs of energy
- Comprehensive focus and results
 - Energy efficiency – Renewable energy – Transportation
- National & international consulting & implementation
 - Program design, planning, & evaluation – policy & advocacy – research
- Clients are government agencies, regulators, utilities, foundations, advocates
- Operate 3 Energy Efficiency Utilities





Climate Choice Homes



Climate Choice Homes Overview

- Highest tier in NJCEP Residential New Construction program
- Established in 2009, revised in 2012
- Technical spec highlights:
 - 50% more efficient than IECC 2009
 - 50% of projected electricity use from PV
 - 50% of hot water load through solar thermal
- 5 builders and developers have participated
 - Significant interest from multifamily sector
- 104 units have enrolled, ~75 completed to date

Technical Spec available at:

<http://www.njcleanenergy.com/files/file/Residential%20Programs/NJ%20ENERGY%20STAR%20Homes/NJ%20CCH%20Min%20Tech%20Spec%20V2%20FINAL.PDF>



CCH Incentive Structure

- Single Family - \$10,000 to achieve 50 HERS, plus \$800 per index point below 50 points (maximum incentive is \$26,000/unit)
- Multiple Single Family (“Townhouse”) - \$7,000 to achieve 50 HERS, plus \$500 per index point below 50 points (maximum incentive is \$17,000/unit)
- Multiple-Family Building (“Multifamily”) - \$4,000 to achieve 50 HERS, plus \$400 per index point below 50 points (maximum incentive is \$12,000/unit)



R&D Project

- Examined 11 Climate Choice Homes units
 - Energy and environmental monitoring
 - Comparison of modeled to actual energy use
 - Life cycle cost analysis
 - Occupant surveys
- Used the results to develop recommendations for the NJ program with respect to policy, technical specifications, and program design



Multifamily Building Overview



70-unit affordable multifamily building in Northern NJ
HERS 36, 14.47 kBtu/sf
Received \$392,000 in total, or \$5,600 per unit, in incentives



Envelope & Renewables

- Envelope
 - Wood frame with closed cell foam and fiberglass insulation between the studs and rigid foam sheathing
 - The wall's full brick veneer is outboard of a 1" airspace from the sheathing
 - Window U value is .25 and the solar heat gain coefficient is .23
- Renewables
 - Centralized PV
 - Generates an average of 40,000 kWh/month
 - Used to offset common area electricity use
 - Solar thermal
 - South facing liquid indirect system with a collector area of 1,025 square feet
 - Projected contribution to the domestic hot water load was modeled at 78%



Building Characteristics

HERS Index	HERS Index (without renewables)	49
	Actual HERS Index (with renewables)	36
Envelope	Air Leakage (ACH50 at building level)	2.85
HVAC Proper Installation	Ductwork located in conditioned space	100%
	HRV or ERV	HRV
HVAC Equipment	Heating AFUE minimum	95.5%
	Central AC SEER	15
	Motor	ECM
Water Heating System	Water heater EF	.89
	Low-flow faucets and showerheads	low-flow
Lighting	Energy Star fixtures or bulbs	100%
Renewables	PV or Solar Hot Water Heating	PV & Solar
Appliances	Refrigerator	CEE Tier 3



Results of Building-Level LCC

NOTES

- 75 year building lifetime
- 5% discount rate
- Actual construction costs
- Modeled energy use
- Incentives are included
- DOE estimates for utility rate and SREC price escalation
- Unlike NPV, simple payback does not take into account time value of money

	Multi-Family Building
Baseline NPV	(\$57.24/SF)
As-Built NPV	(\$54.51/SF)
Δ NPV	\$2.73/SF
Simple Payback	9 years



Variation Among Units

	Unit 5	Unit 10	Unit 7	Unit 8	Unit 6	Unit 9	Unit 11
Size	669	669	675	675	857	1075	1075
Inhabitants	4	3	2	2	3	2	4
Thermostat Settings (Winter / Summer)	73F / 77F	72F	80F / 75F	74F / 72F	75F	70F	74F / 72F
Energy Use Intensity (kBtu/sf)	22.49	29.83	23.54	32.79	33.09	26.67	19.89
% Reduction from NJ Average EUI	66%	55%	64%	50%	50%	59%	70%



Lessons Learned



Best Specs are Prescriptive and Flexible

- Developers who are new to this performance level appreciated the prescriptive path but needed site-specific flexibility
- Modifications to technical spec in 2012:
 - Hot water was expanded from just HPWH and tankless to include other technologies
 - Renewable requirement was made fuel and technology “blind” by allowing either PV or solar hot water to provide 50% of the hot water energy load
 - Drain water heat recovery systems were added



Technical Assistance is Needed

- Air sealing and tight construction requirements were difficult to meet
- Program offered additional assistance:
 - Provided the builders and design team with a description of air sealing techniques at initial design planning meeting
 - Instituted an additional air sealing inspection after framing, but prior to insulation being installed
 - Added a pre-drywall blower door test in addition to the final blower door test
 - Developed a video on air sealing/construction practices for builders



Video on air sealing/construction practices available at:

<http://www.njcleanenergy.com/residential/programs/nj-energy-star-homes/nj-energy-star-homes>



Modeling has Limitations

- Purpose of energy modeling is to compare a structure to itself with different design options, not to reliably predict the future
- REM/Rate's limits on thermostat settings meant that the software could not accurately reflect actual thermostat settings in some units
- In the multifamily building, natural gas usage was much closer to predicted consumption than electricity use was



Resident Education is Critical

- Residents typically were not aware that they were living in very energy efficient housing
- Many residents kept their thermostat at the same setting at all times
- One resident was not able to say what temperature their thermostat was set to, as they did not know how to use their programmable thermostat





Misc. Electric Loads are Key

- NJ experience consistent with recent NREL study:
 - In a typical home, 14% of energy use goes to MELs
 - In a high performance home, that increases to 32%





Field Research has Benefits, Challenges

- Benefits
 - Monitoring provided insight into how residents operated their homes and helped flag malfunctioning equipment
 - Resident interviews helped explain the data, gauge satisfaction with the building, and uncover the need for new program elements
- Challenges
 - Equipment required a steady, reliable internet connection to transmit data, which was not present at some sites
 - Significant on-site commissioning was needed to ensure reliable operation of equipment
 - Resident interviews were difficult to complete



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