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Northeast Sustainable Energy Association Conference

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Hamilton Way - Case Study of a High Performance Community in a Cold Climate

Building Science Corporation

Building America U.S. Department of Energy Research Toward Zero Energy Homes

NELSON CONSTRUCTION

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Learning Objectives

- Understand methodology involved for a systems engineering approach to whole house energy performance
- Understand decision making process from a designer as well as builder perspective
- Understand differences in energy simulation results compared to actual use and occupancy energy use

Project Background

- Builder Desire to move towards low energy buildings
- Need for guidance to help make informed decisions
  - Best practices
  - Product and technology choices
  - Internal company education
  - Avoiding future liability

Project Background

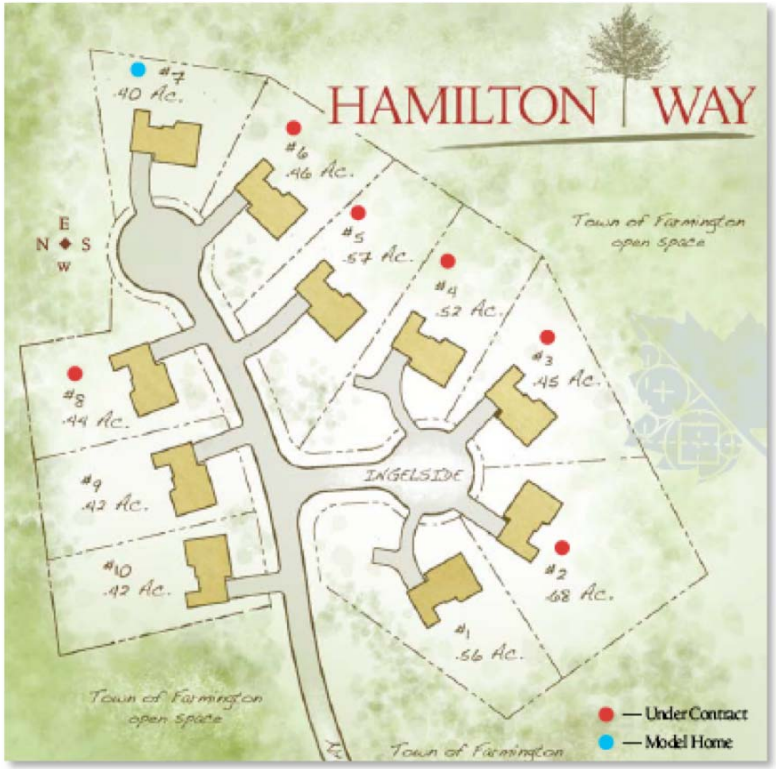
- Partnership between Nelson Construction and Building Science Corporation
- Community supported by the US Department of Energy's Building America Program

Project Overview

- Hamilton Way
- Located in Farmington, CT
- DOE Climate Zone 5A

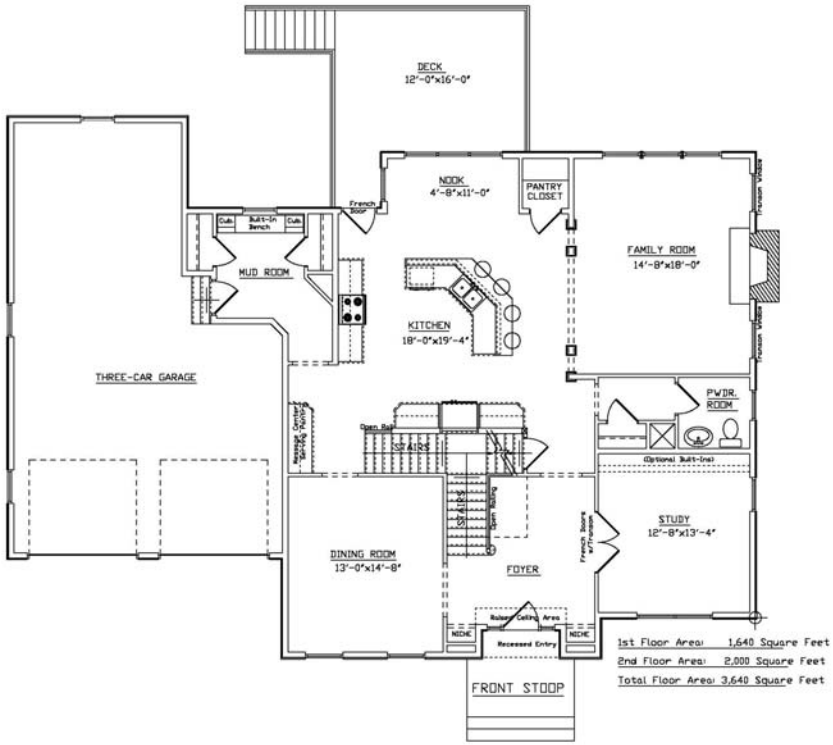
Project Overview

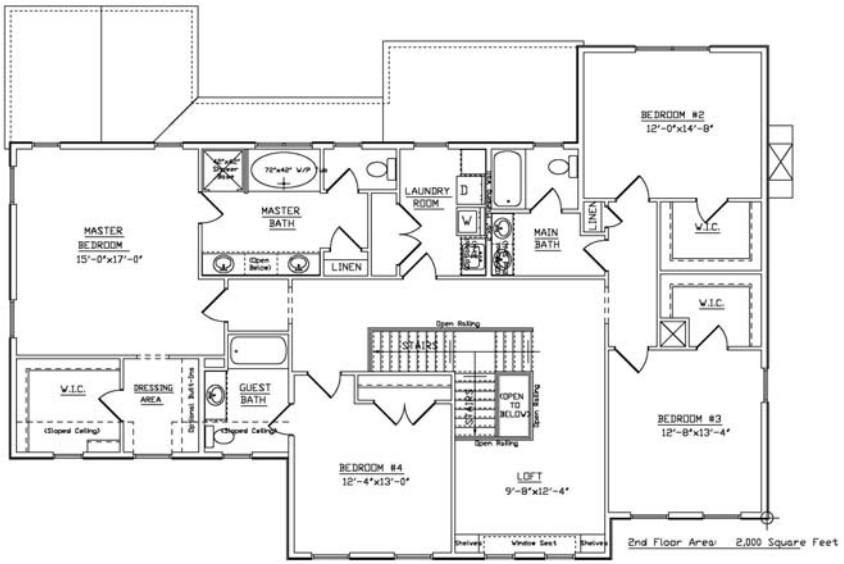
- 3 Plan Types with 2 Options
  - Sedgwick
    - Standard (3600ft^2 + *1600ft2 bsmt*)
    - Walkout (3700ft^2 + *1600ft2 bsmt*)
  - Griswold
    - Standard (3000ft^2 + *1200ft2 bsmt*)
    - Walkout (3300ft^2 + *1300ft2 bsmt*)
  - Ridgewood
    - Standard (3300ft^2 + *1400ft2 bsmt*)
    - Walkout (3300ft^2 + *1400ft2 bsmt*)



Project Overview

- Typical House
  - Single family residence
  - 4 bedrooms
  - 3 to 4 bathrooms
  - Conditioned basement





Preliminary Design Analysis

- Focus on “low load” buildings
- Cold climate – conductance and infiltration dominate space conditioning loads – focus on high R-value assemblies and air tightness.
- High efficiency heating system key in Climate zone 5A to manage the remaining load – however high efficiency appliances used throughout.
- Energy reduction goals met without the addition of renewable energy technologies – offered as a option for home buyers

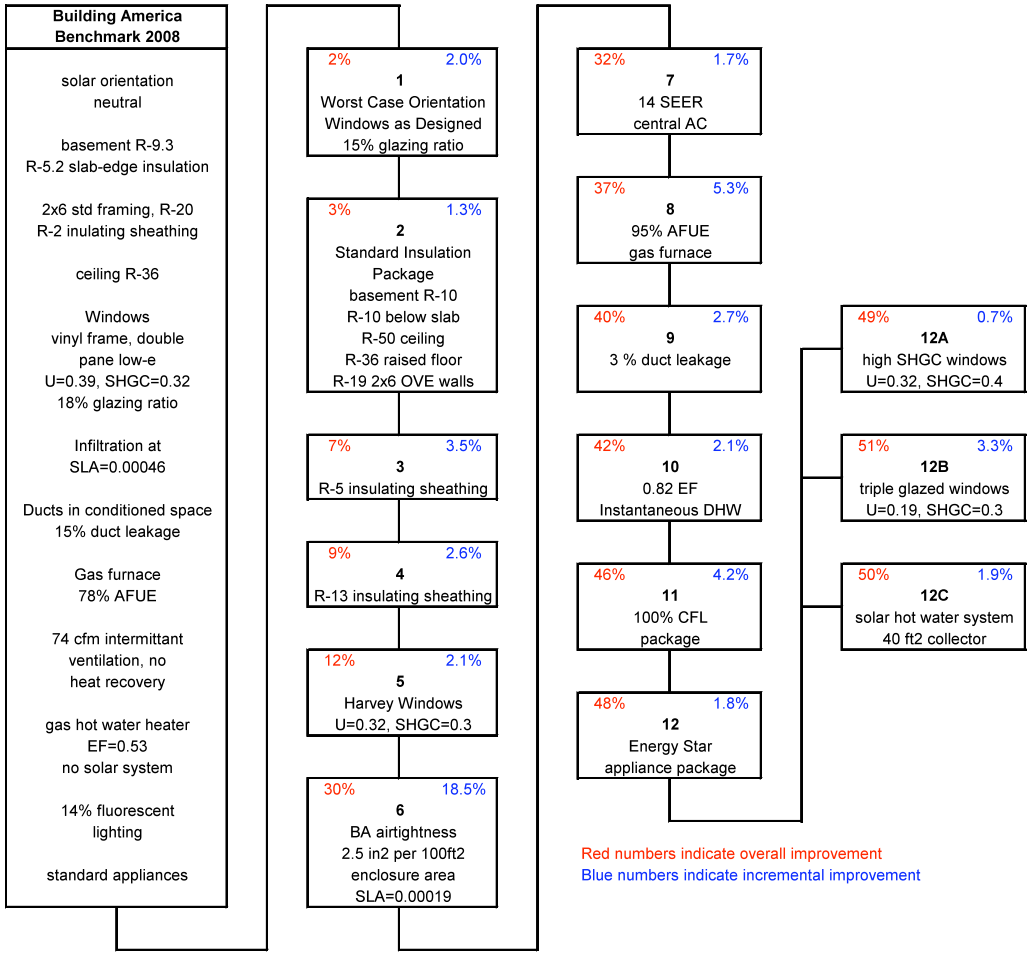
Preliminary Design Analysis

- Initial plan chosen as model for the community (Sedgwick walkout – Lot 7)
- Hourly energy simulations run to examine benefits of each energy consumption reduction method

Sedgwick plan front elevation

Preliminary Design Analysis

- For each parametric step the following was examined
  - Site and Source energy savings
  - Utility costs savings
  - Capital cost for energy reduction strategy
  - Market acceptance

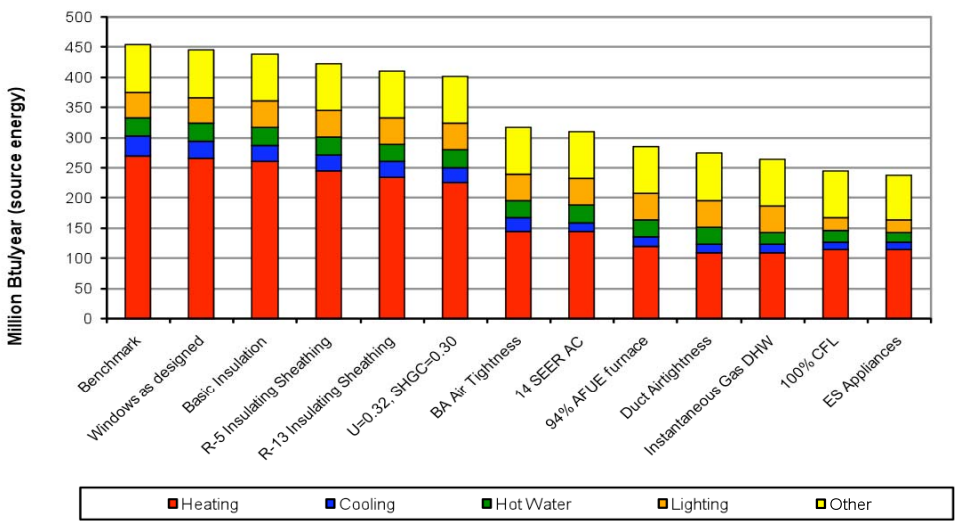


Preliminary Design Analysis

	Annual Site Energy			
	BA Benchmark		Prototype 1	
End-Use	kWh	therms	kWh	therms
Space Heating	1752	2277	722	961
Space Cooling	2842		1119	
DHW	0	270	0	144
Lighting*	3781		1761	
Appliances + Plug	6810	0	6459	0
OA Ventilation**	15		18	
Total Usage	15199	2547	10079	1105
Site Generation	0	0	0	0
Net Energy Use	15199	2547	10079	1105

*Lighting end-use includes both interior and exterior lighting

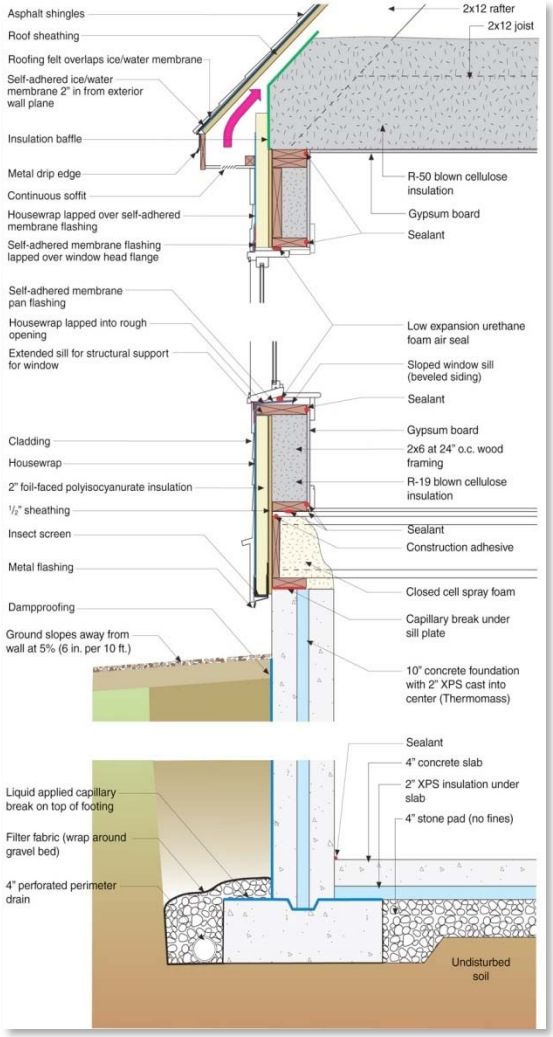
**In EGUSA there are currently no hooks to disaggregate OA Ventilation, it is included in Space Heating and Cooling



Lot 7 - parametric analysis graph

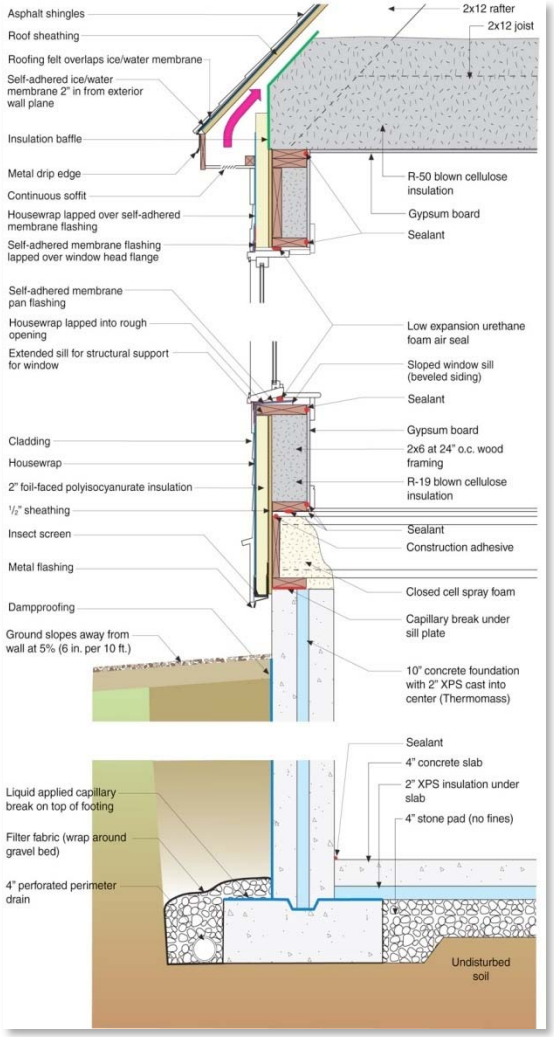
Community Design

- Building Enclosure
  - Ceiling
    - Rafter framing with cellulose at ceiling level (R-50)
  - Walls
    - 2x6 wood studs at 24” o.c. with cellulose cavity insulation (R-19) and 2” foil faced polyisocyanurate insulating sheathing (R-13)
  - Framed Floors Over Unconditioned Spaces
    - 2x12 I-joists at 16” o.c. with 2” closed cell spray foam (R-12) to the underside of the floor sheathing. Remaining joist space fill with fiberglass batts (R-32)



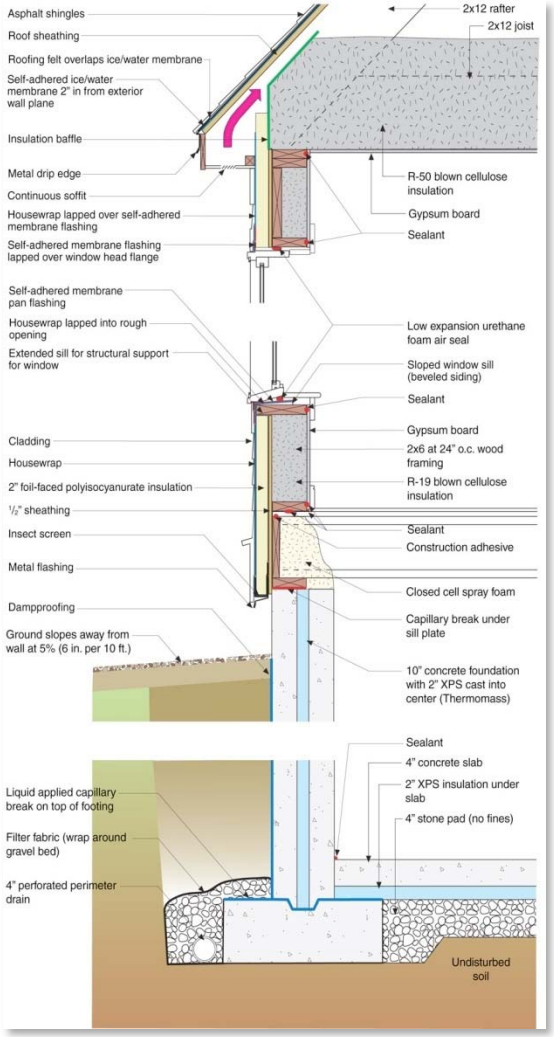
Community Design

- Building Enclosure
  - Foundation
    - Concrete basement walls with 2” XPS (R-10) cast into the concrete
    - Concrete floor slab with 2” XPS (R-10) under the slab
  - Windows
    - Double glazed Low-E vinyl windows
      - U = 0.32
      - SHGC = 0.27



Community Design

- Building Enclosure
  - Air Barrier
    - “Critical Seal” approach
      - Caulked and sealed interior gypsum
      - Closed cell spray foam
        - Rim joists
        - Band joists
        - Top plates (ceiling plane)
        - Mechanical and electrical penetrations
    - Performance target
      - 2081 to 2470 CFM50
      - 3.0 to 3.3 ACH50



Community Design

- Mechanical
  - Heating
    - 94% sealed combustion natural gas furnace
  - Cooling
    - 14 SEER central air conditioning system
  - Distribution
    - Single air handler with 2 zones
    - All ducts inside conditioned space
    - Combination sheet metal and flex ducts
    - Compact central distribution for ducts with high wall registers
  - Return Pathways
    - 2 returns (low first floor and high second floor)
    - Transfer grilles or jump ducts at bedrooms

Community Design

- Mechanical
  - Ventilation
    - Supply only system integrated with the central air handling unit
    - Pollutant exhaust ventilation at bathrooms and kitchen
  - Domestic Hot Water
    - 0.82 EF Instantaneous gas hot water system

Community Design

- Lighting and Appliances
  - Lighting
    - 100% Compact fluorescent lighting provided for all fixed lighting in the home
  - Appliances
    - Energy Star Appliances

- Renewable Energy
  - Photovoltaic Systems
    - Not standard, but offered as an option for the homes

Community Design

- Energy Modeling Results

ESTIMATED WHOLE HOUSE ENERGY USE BY PLAN NUMBER					
Plan No.	Source (MMBtu/ year)	Site (MMBtu/year)	Area + Bsmt (sq ft)	No. of Bedrooms	% Electric
Sedgwick (Standard)	228	137	3611 + 1616	4	25
Sedgwick (Walkout)	236	145	3695 + 1653	4	23
Ridgewood (Standard)	215	127	3337 + 1404	4	26
Ridgewood (Walkout)	221	132	3356 + 1410	4	26
Griswold (Standard)	211	124	3062 + 1255	4	27
Griswold (Walkout)	215	127	3299 + 1323	4	27

Construction

- Foundations
  - 2” XPS Cast into concrete foundation wall

Construction

- Walls
  - 2x6 wood studs at 24” o.c. with cellulose cavity insulation (R-19) and 2” foil faced polyisocyanurate insulating sheathing (R-13)

Construction

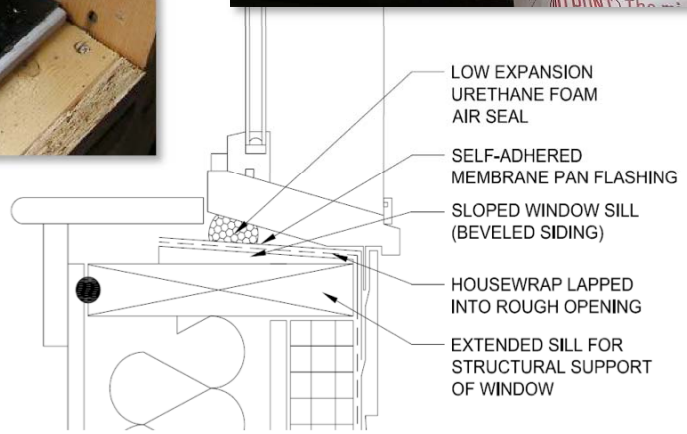
- Roof
  - Rafter framing with cellulose at ceiling level (R-50)

Construction

- Framed Floors Over Unconditioned Spaces
  - 2x12 I-joists at 16” o.c. with 2” closed cell spray polyurethane (R-12) with the remaining cavity filled with fiberglass batts (R-32)

Construction

- Windows
  - Double glazed Low-E vinyl windows
    - U = 0.32
    - SHGC = 0.27



Construction

- Air Barrier
  - “Critical Seal” approach
    - Caulked and sealed interior gypsum
    - Closed cell spray foam at common larger gaps

Construction

- Heating
  - 94% sealed combustion natural gas furnace
- Cooling
  - 14 SEER central air conditioning system

Construction

- Distribution
  - Single air handler with 2 zones
  - All ducts inside conditioned space
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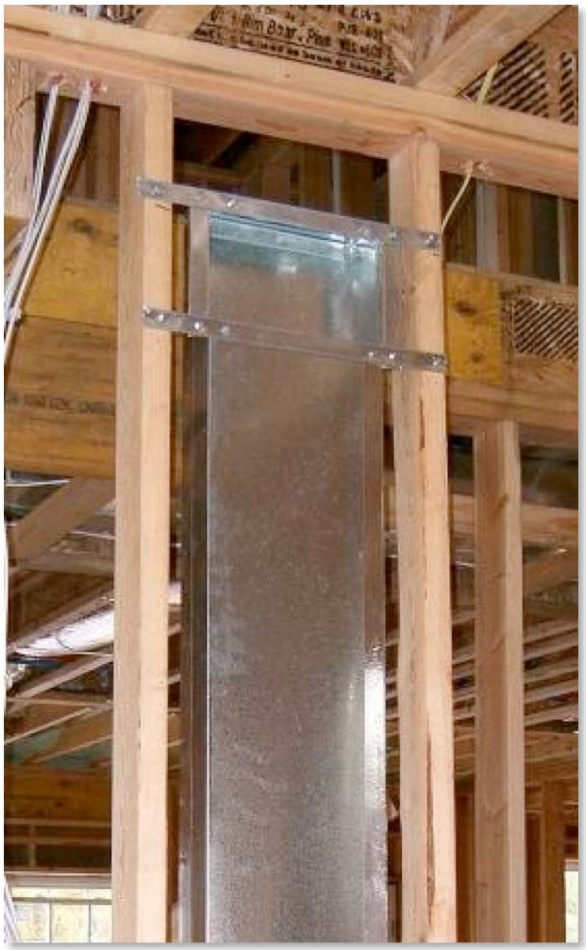


Construction

- Return Pathways
  - 2 returns (low first floor and high second floor)
  - Transfer grilles or jump ducts at bedrooms
- Ventilation
  - Supply only system integrated with the central air handling unit
  - Pollutant exhaust ventilation at bathrooms and kitchen
- Domestic Hot Water
  - 0.82 EF Instantaneous gas hot water system

Construction

- Lighting
  - 100% CFL in all fixed lighting
- Appliances
  - Energy Star Appliances

- Renewable Technologies
  - Photovoltaics

Construction

Performance Testing

- Each house tested for overall air tightness and duct system leakage

- The results of the testing were input into the simulation models and the plans were re-analyzed

Performance Testing

Lot #	Address	Plan Name	Target CFM50	Measured CFM50	Measured CFM50/ft2 E.A.		Target ACH50	Measured ACH50
1	2 Ingelside	Sedgwick (Standard)	2431	1813	0.19		3.0	2.2
2	4 Ingelside	Sedgwick (Standard)	2431	1779	0.18		3.0	2.2
3	3 Ingelside	Ridgewood (Walkout)	2221	1387	0.16		3.0	1.9
4	1 Ingelside	Griswold (Walkout)	2368	1544	0.16		3.3	2.2
5	4 Hamilton Way	Sedgwick (Walkout)	2470	1713	0.17		3.0	2.1
6	6 Hamilton Way	Griswold (Walkout)	2368	1645	0.17		3.3	2.3
7	8 Hamilton Way	Sedgwick (Walkout)	2470	1891	0.19		3.0	2.3
8	7 Hamilton Way	Griswold (Standard)	2081	1252	0.15		3.1	1.9
9	5 Hamilton Way	Sedgwick (Standard)	2431	1946	0.20		3.0	2.4
10	3 Hamilton Way	Ridgewood (Standard)	2195	1473	0.17		3.0	2.0

Construction Costs

- Standard Construction Package = $115.00/ft2
- Additional costs for energy improvements = 5% of construction cost
- Approximately $20,000 per house
- Sale Prices $650,000 to $800,000

Marketing Benefits

- Public relations opportunities
- Marketing advantage compared to competitor construction
- Community acceptance/approval
- Builder reputation benefits

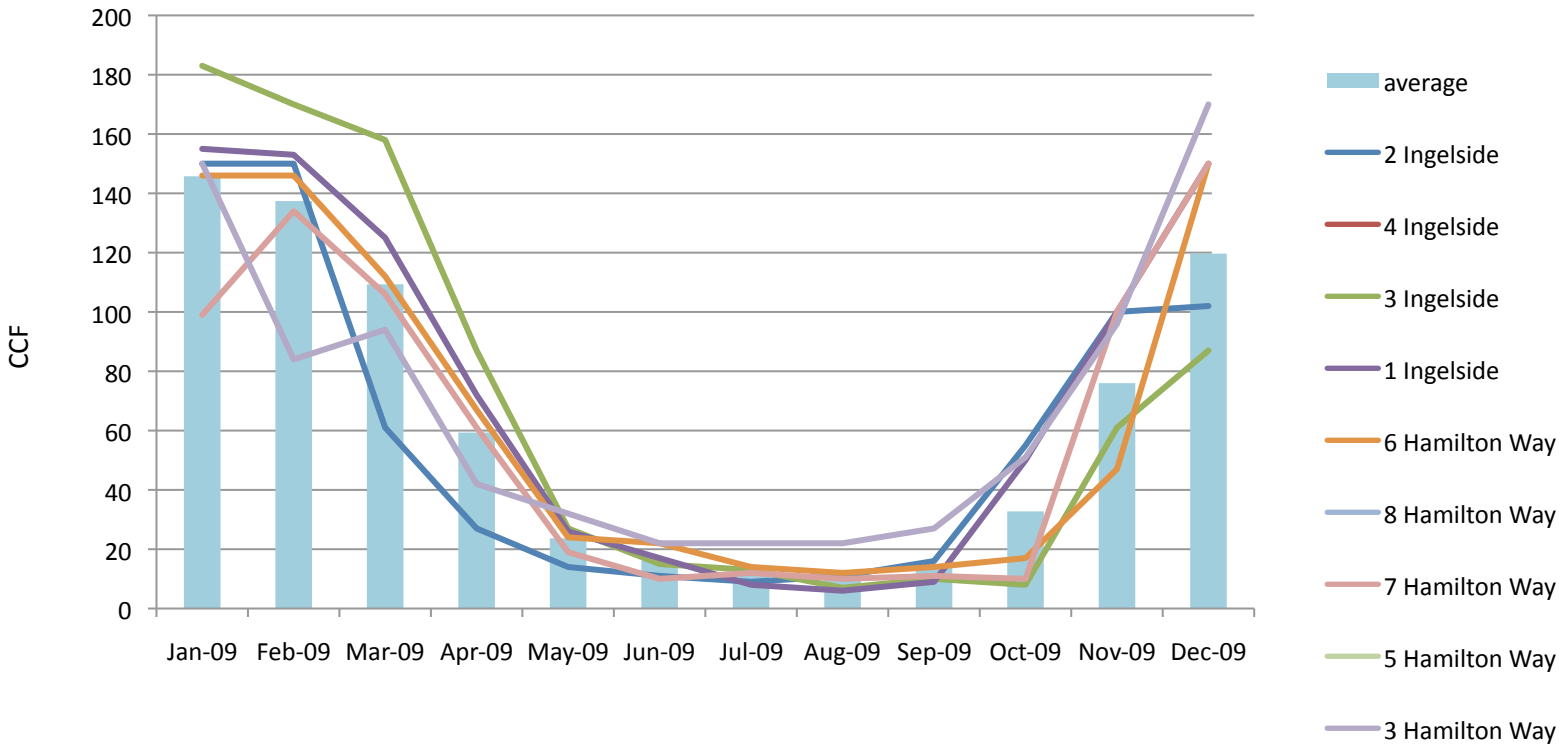
Collected Data

- Natural Gas Usage (CCF)

		Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	12 month total
1	2 Ingelside	150	150	61	27	14	11	9	11	16	55	100	102			***706***
2	4 Ingelside															0
3	3 Ingelside	183	170	158	87	27	15	13	7	10	8	61	87	194	172	826
4	1 Ingelside	155	153	125	72	26	17	8	6	9	50	100	150			***871***
5	4 Hamilton Way	78	128	91	61	246	382	297	258	324	127	39	74			2105
6	6 Hamilton Way	146	146	112	67	24	22	14	12	14	17	47	150			***771***
7	8 Hamilton Way															
8	7 Hamilton Way	99	134	106	61	19	10	12	10	11	10	100	150			***722***
9	5 Hamilton Way															
10	3 Hamilton Way	150	84	94	42	32	22	22	22	27	51	96	170			***812***

Collected Data

- Natural Gas Usage (CCF)



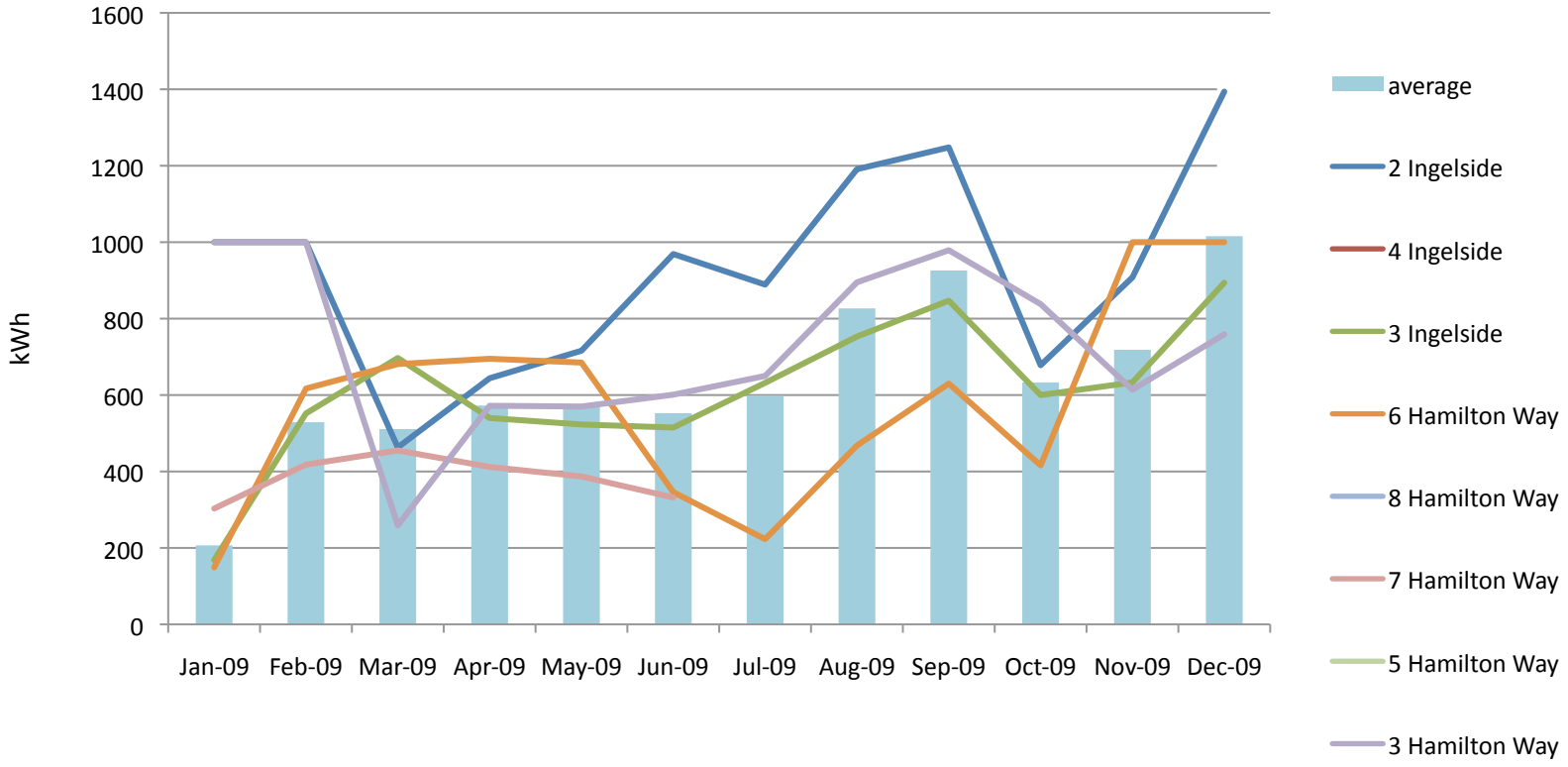
Collected Data

- Electric Usage (kWh)

		Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Feb-10	12 month total
1	2 Ingelside	1000	1000	463	644	716	969	889	1191	1248	678	908	1394			***11100***
2	4 Ingelside	784	1485	1405	1159	1747	2156	2195	1526	2045	1714	1036	1221	1577	1291	18473
3	3 Ingelside	168	552	697	540	523	515	632	753	847	600	633	894			7354
4	1 Ingelside	433	396	260	247	173	198	164	373							
5	4 Hamilton Way	1000	1000	1351	1469	1965	1054	1200	1087	1748	1088	737	827	1306		***14526***
6	6 Hamilton Way	149	617	681	695	685	346	223	468	630	416	1000	1000			***6910***
7	8 Hamilton Way															
8	7 Hamilton Way	303	418	455	412	387	332									
9	5 Hamilton Way															
10	3 Hamilton Way	1000	1000	259	572	570	601	650	895	979	838	614	759	897	740	8634

Collected Data

- Electric Usage (kWh)



Collected Data

- Modeled vs. Measured Performance

			Modeled		Collected	
Lot #	Address	Plan Name	kWh	Therms	kWh	Therms
1	2 Ingelside	Sedgwick (Standard)	10217	989	***11100***	***706***
2	4 Ingelside	Sedgwick (Standard)	10042	909	18473	
3	3 Ingelside	Ridgewood (Walkout)	9778	881	7354	826
4	1 Ingelside	Griswold (Walkout)	9916	930		***871***
5	4 Hamilton Way	Sedgwick (Walkout)	10379	921	***14526***	2105
6	6 Hamilton Way	Griswold (Walkout)	9944	950	***6910***	***771***
7	8 Hamilton Way	Sedgwick (Walkout)	10080	978		
8	7 Hamilton Way	Griswold (Standard)	9705	817		***722***
9	5 Hamilton Way	Sedgwick (Standard)	10332	1059		
10	3 Hamilton Way	Ridgewood (Standard)	9942	821	8634	***812***

Questions