Passive Production Homes

HERS Says "Stop!" Passive House Says "Go!"

North American Passive House Conference
Pittsburg, PA, October 18, 2013

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ESSENTIAL HABITAT
healthy spaces for humans

New Town Builders, Denver, CO

Infill Builder, Zero Energy/Green Focused

Image: New Town Builders

New Town's Business Imperative

"Zero Energy" Home (HERS 0)

- @ Cost Parity w/ Standard Home (PITI + Utilities)
- ~10 kW PV, Commercial Size, Declining Subsidies

Goal

- "Zero Energy" w/ Smaller PV System
- "HERS 40 Before PV"
- Passive House or HERS?

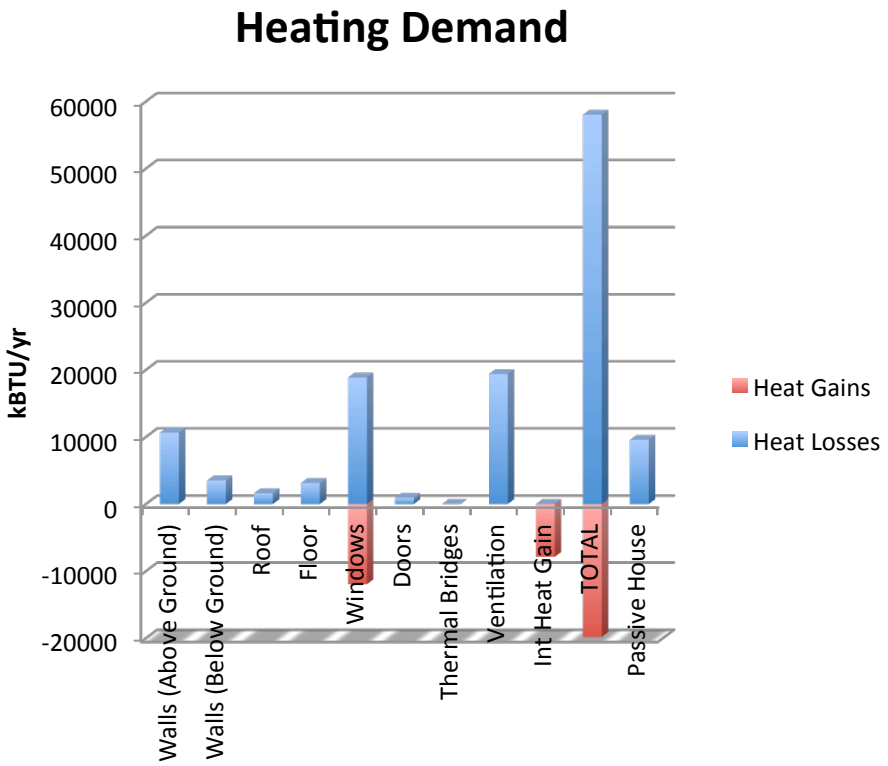
Denver, CO Climate

- 6020 HDD_{65}, 679 CDD_{65}
- High Insolation Levels

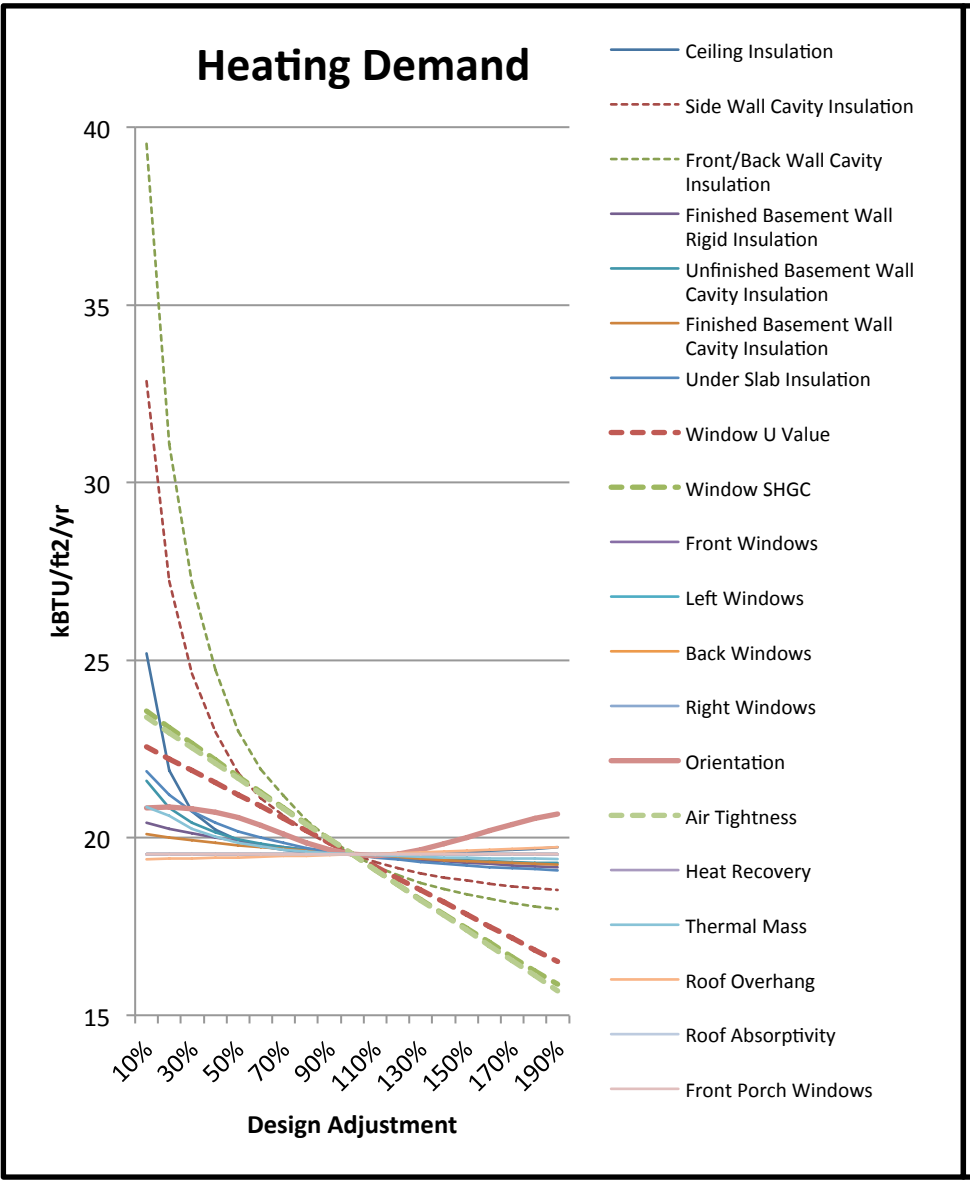
PH Analysis: Existing ZNE Home

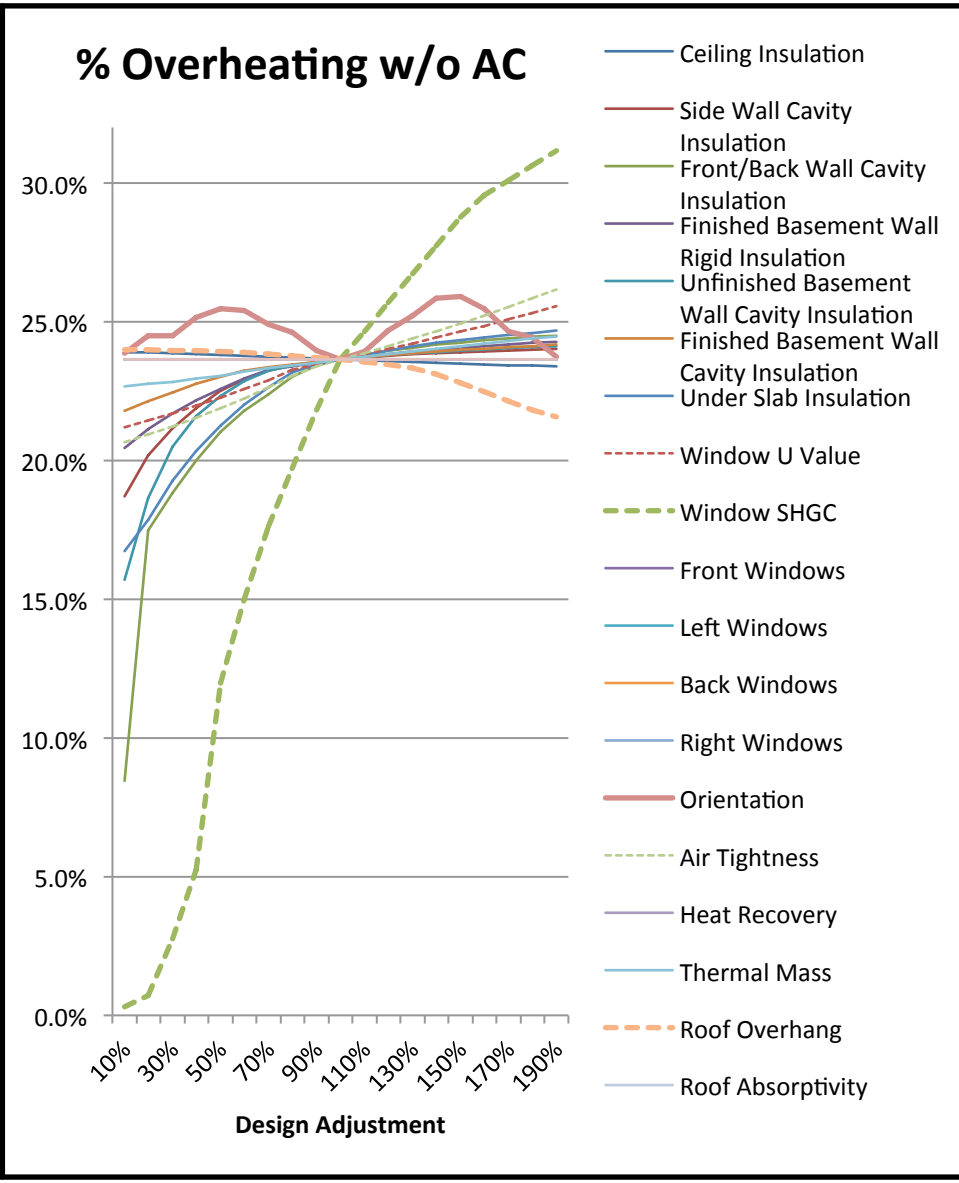
Analysis: ZNE Home (PHPP)

Shell Aspect	ZNE Home
Orientation	South
Basement Floor	6” EPS (R25)
Basement Walls	4” EPS + 3.5” Cellulose (R29)
Walls	9.5” Cellulose, Dbl. Stud (R33)
Attic	24” Cellulose (R96)
Windows	U-Value: 0.19 (US Triple Pane, Argon) SHGC: 0.35 Areas: 87 ft^2 N 123 ft^2 E 201 ft^2 S 41 ft^2 W
Air-Tightness	~2 ACH_{50}
Ventilation	0% HRV (Supply Only)
Heating Demand	**21.35 kBTU/ft^2/yr**
Cooling Demand	1.36 kBTU/ft^2/yr
Overheating w/o AC	**22.1%**



ZNE: "Low-Hanging Fruit"



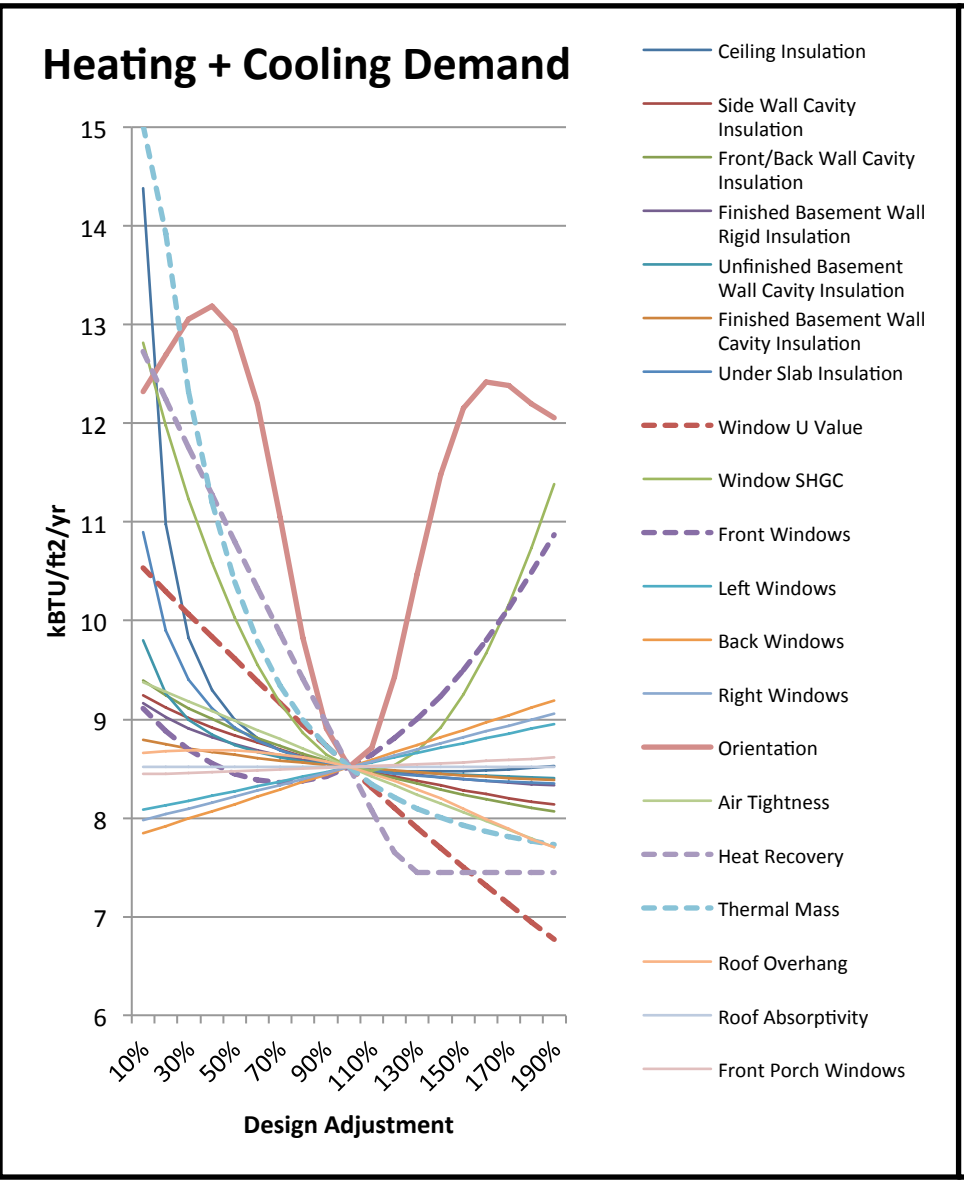


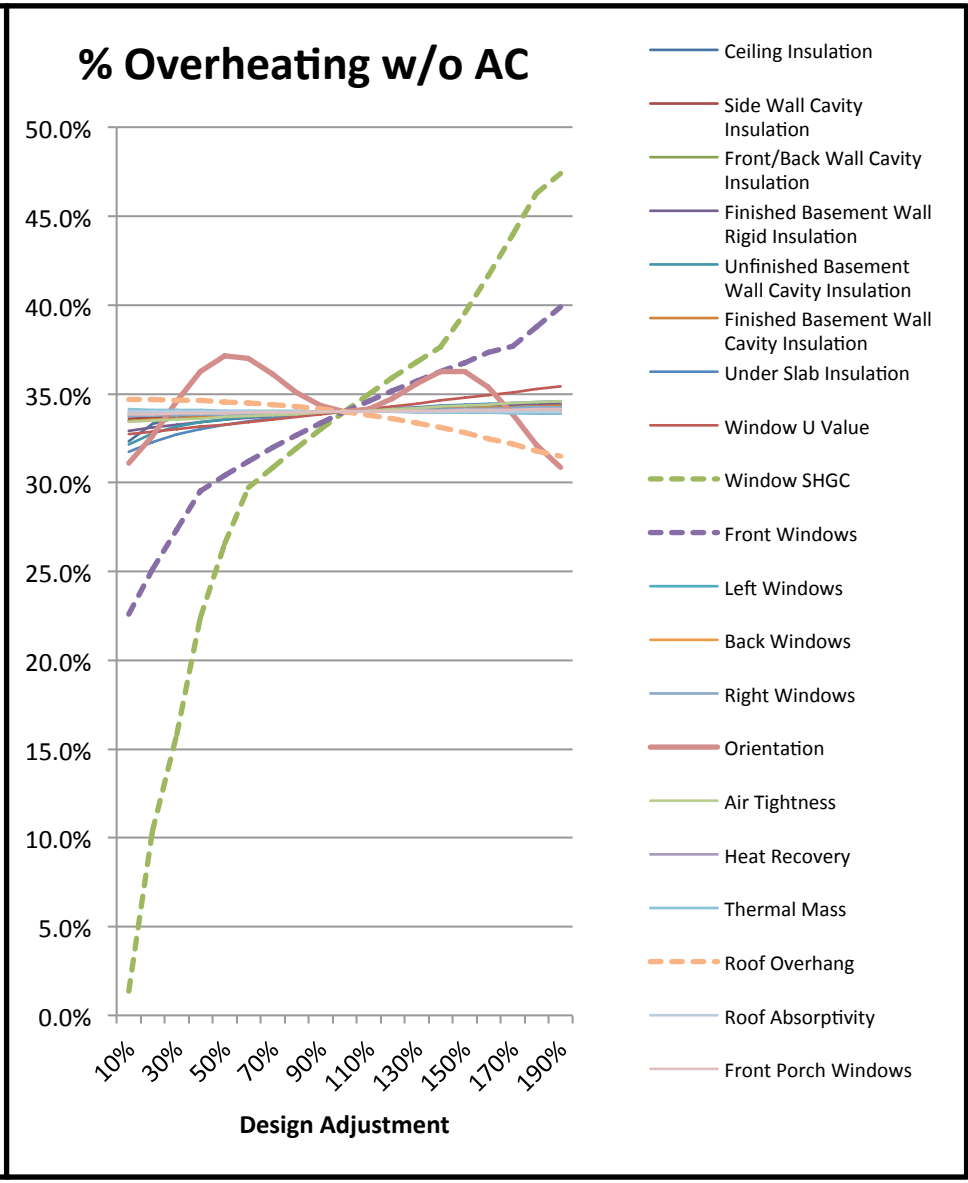
PH Upgrade (Incomplete)

Analysis: ZNE Home vs. Passive House (PHPP)

	ZNE Home	**Passive House**
Orientation	South	South
Basement Floor	6" EPS (R25)	6" EPS (R25)
Basement Walls	4" EPS + 3.5" Cellulose (R29)	4" EPS + 3.5" Cellulose (R29)
Walls	9.5" Cellulose, Dbl. Stud (R33)	**5.5" Cellulose + 4" Polyiso or 12" Cellulose Dbl. Stud (R42)**
Attic	24" Cellulose (R96)	24" Cellulose (R96)
Windows	U-Value: 0.19 (US Triple Pane, Argon) SHGC: 0.35 Areas: 87 ft^2 N 123 ft^2 E 201 ft^2 S 41 ft^2 W	**U-Value: 0.11 (EU Triple Pane, Argon) SHGC: 0.29 (N,E,W) 0.62 (South) Quantity: 2.6x South (unshaded), 0.5x West**
Air-Tightness	~2 ACH_{50}	**0.6 ACH_{50}**
Ventilation	0% HRV (Supply Only)	**80% HRV**
Heating Demand	**21.35 kBTU/ft^2/yr**	4.67 kBTU/ft^2/yr (22%)
Cooling Demand	1.36 kBTU/ft^2/yr	**3.84 kBTU/ft^2/yr (282%)**
Overheating w/o AC	**22.1%**	**34.0%**

PH: “Low-Hanging Fruit”





Passive House: HERS in the Way!

Shell Aspect	HERS Reference	HERS 40 (% of Reference)	Passive House (% of Reference)
Orientation	East	East	South
Basement Floor	R1 (uninsulated)	R1	R25
Basement Walls	R17	R19	R29
Walls	R17	R38	R42
Attic	R33	R48	R96
Windows	U-Value: 0.350 SHGC: 0.55 111.35 ft^2 ea. N,E,S,W	U-Value: 0.240 (US Double Pane) SHGC: 0.240 87 ft^2 N 123 ft^2 E 201 ft^2 S 41 ft^2 W	U-Value: 0.11 (EU Triple Pane) SHGC: 0.29 N,E,W | 0.62 S Quantity: 2.6x S (unshaded), 0.5x W
Air-Tightness	9.4 ACH_{50} (SLA 0.00048)	3.0 ACH_{50}	0.6 ACH_{50}
Ventilation	0% HRV (Infiltration)	0% HRV (Exhaust Only)	80% HRV
Heating Demand	44.17 kBTU/ft^2/yr	26.11 kBTU/ft^2/yr (59%)	4.67 kBTU/ft^2/yr (11%)
Cooling Demand	4.44 kBTU/ft^2/yr	2.39 kBTU/ft^2/yr (54%)	3.84 kBTU/ft^2/yr (86%)
HERS Score	**100**	**40**	**34**

Why? PHPP vs. REM/Rate

Result	HERS Reference	HERS 40 (% reference)	PH (% reference)
PHPP			
Heating Demand (kBTU/yr)	88,782	52,481 (59%)	9,387 (11%)
Cooling Demand (kBTU/yr)	8,924	4,804 (54%)	7,718 (86%)
H+C Demand (kBTU/yr)	**97,706**	**57,285 (59%)**	**17,105 (18%)**
REM/Rate			
Heating Demand (kBTU/yr)	52,900	30,700 (58%)	11,300 (21%)
Cooling Demand (kBTU/yr)	20,800	5,000 (24%)	10,400 (50%)
H+C Demand (kBTU/yr)	**73,700**	**35,700 (48%)**	**21,700 (29%)**
HERS Score	100	40	34

PHPP predicts more heating improvement for Passive House than REM/Rate.
REM/Rate predicts more cooling demand & % improvement than PHPP.
Passive House cooling demand blunts heating improvements when combined.

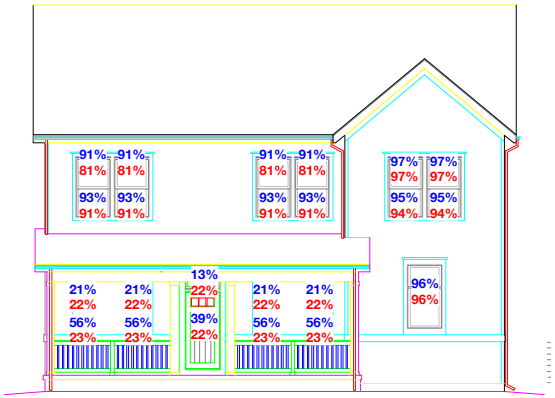
Why? Shell vs. Total Energy

Site Energy: HERS Reference, HERS 40 and Passive House

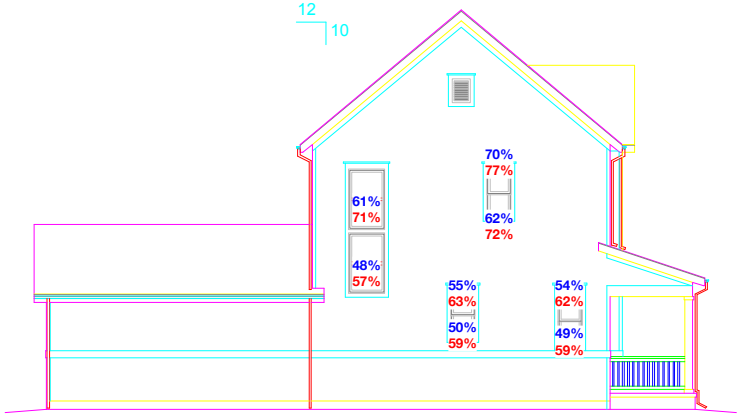
Result	REM/Rate: Reference Home kWh/yr | kBTU/yr	REM/Rate: HERS 40 (% reference) kWh/yr | kBTU/yr	REM/Rate: PH (% reference) kWh/yr | kBTU/yr	PHPP: PH (% reference) kWh/yr | kBTU/yr
Heating	34,900	10,100 (29%)	3,800 (11%)	3,155 (9%)
Cooling	7,300	1,000 (14%)	2,100 (29%)	1,559 (21%)
Hot Water	24,300	15,200 (63%)	**15,200 (63%)**	**8,041 (33%)**
Lights	3,164 | 10,796	1,259 | 4,296 (40%)	**1,259 | 4,296 (40%)**	**128 | 437 (4%)**
Appliances	2,358 | 8,047	1,966 | 6,707 (83%)	1,966 | 6,707 (83%)	1,844 | 6,292 (78%)
Fans	235 | 800	131 | 448 (56%)	434 | 1,494 (187%)	355 | 1,211 (151%)
MELs	3,306 | 11,281	3,306 | 11,280 (100%)	**3,306 | 11,280 (100%)**	**376 | 1,283 (11%)**
Total Energy	**28,553 | 97,424**	**14,371 | 49,033 (50%)**	**13,153 | 44,879 (46%)**	**6,441 | 21,977 (23%)**
HERS Score	100	40	34	

DHW, Lights & Miscellaneous Electrical Loads (MELs) much larger in REM/Rate.
A singular performance metric blunts shell improvements.

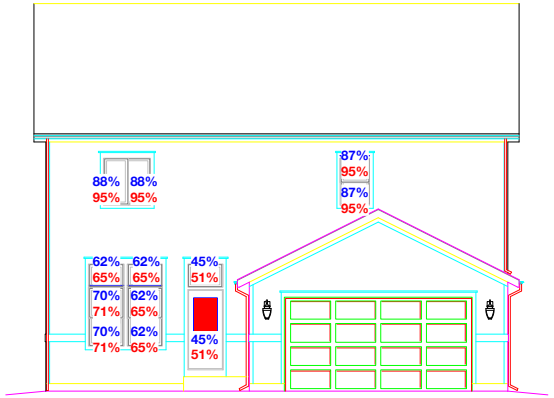
Why? Shading Calcs vs. Guesses



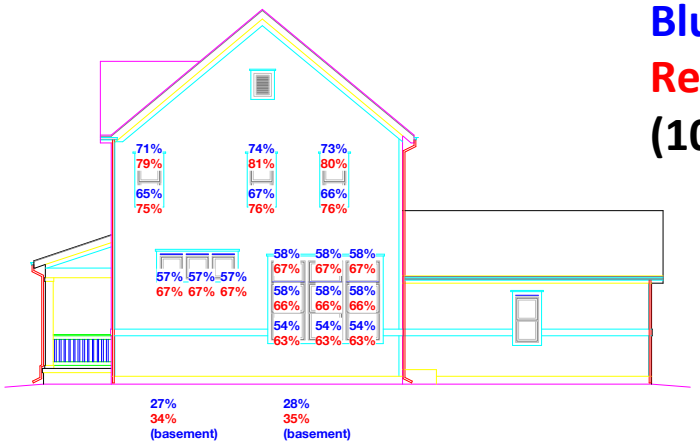
South Façade (PHPP)



East Façade (PHPP)



North Façade (PHPP)

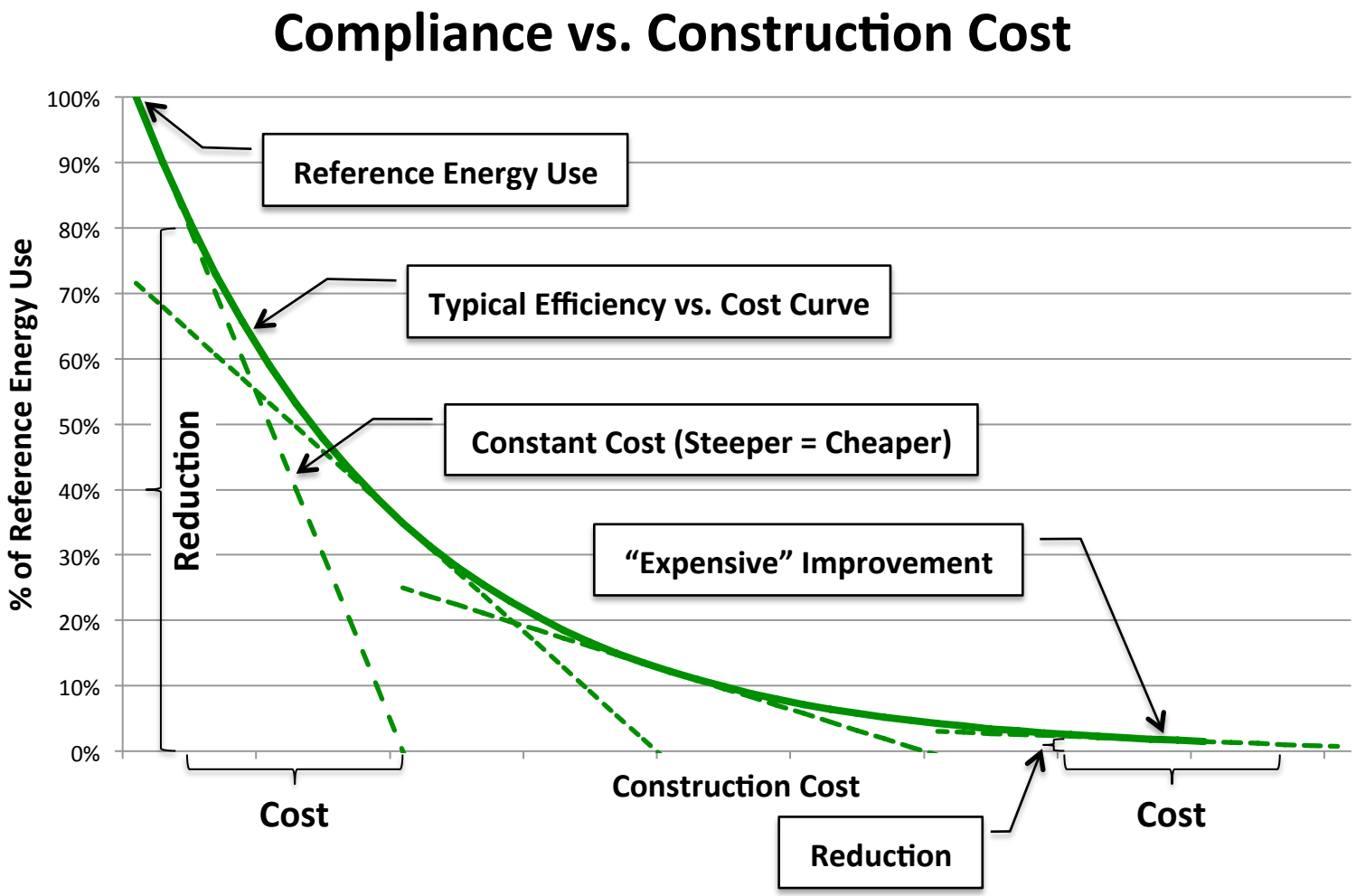


West Façade (PHPP)

Blue=Winter Access
Red=Summer Access
(100%=No Shading)

PHPP calculates Summer/Winter shading from building & surrounding geometry.
REM/Rate has 4 possible values for each season (HERS 40 set to 40% N, 70% E,S,W).

Why? Compliance is "Sticky"
Regardless of Reference Point



Why? Energy Metrics

Source Energy vs. nMEULs

Passive House: Source (Primary) Energy

Site Energy = Demand / Equipment Efficiency

Source Energy = Site Energy x PE Factor

Imperative: Environmental Impact

HERS DHW, Heating & Cooling: Normalized Modified End Use Load (nMEUL)

$nMEUL = Load_{ref} \times (nEC_{rated}/EC_{ref})$

$nEC_{rated} = EC_{rated} \times (a \times EEC_{rated} - b) \times (EEC_{ref}/EEC_{rated})$

HERS "Load" = PHPP "Demand", EC = Energy Consumption, nEC = Normalized Energy Consumption, EEC = Equipment Efficiency Coefficient (BTU-input/BTU-output)

$a = (EEC\_e,r - EEC\_e,b) / [(EEC\_o,r - EEC\_o,b) * EEC\_e,r]$

$b = [EEC\_o,r * (EEC\_e,r - EEC\_e,b)] / [EEC\_e,r * (EEC\_o,r - EEC\_o,b)] + 1$

e = electricity, o = "other" fuel, r = reference home equipment (NAECA), b = best available equipment (ARI/GAMA)

Imperative: "Fuel Neutrality"

Reference Publication: Fairey, P., J. Tait, D. Goldstein, D. Tracey, M. Holtz, and R. Judkoff, "The HERS Rating Method and the Derivation of the Normalized Modified Loads Method." Research Report No. FSEC-RR-54-00, Florida Solar Energy Center, Cocoa, FL, October 11, 2000.

Words of Wisdom: HERS Score

- "One of the most frustrating things to me is that the HERS software gives us lots of credit for mechanical solutions (Heat Pumps, Tankless Hot Water, etc.) but almost nothing for a better window. …I'm hoping that there are inputs to the HERS software that can make it more responsive to things we KNOW matter."

  – Gene Meyers, CEO, New Town Builders

- "…imagine trying to get an A on a multiple-choice exam, but only being allowed to answer 80% of the questions!" – John Semmelhack, Think Little

Wisdom: Performance vs. Compliance

2012 GMC Yukon Denali 1500 (15 MPG)

2012 Honda Civic HF (33 MPG)

2012 Yukon Denali 1500 Hybrid (21 MPG)

2012 Honda Civic Hybrid (44 MPG)

40% (6 MPG) Improvement = "HERS 60"

33% (11 MPG) Improvement = "HERS 67"

Reference: www.fueleconomy.gov, US DOE

Performance is an absolute standard, compliance is always relative to the project.

Wisdom: Passive House Standard

Shell Performance
Comfortable,
Good IAQ,
Durable,
Open Building

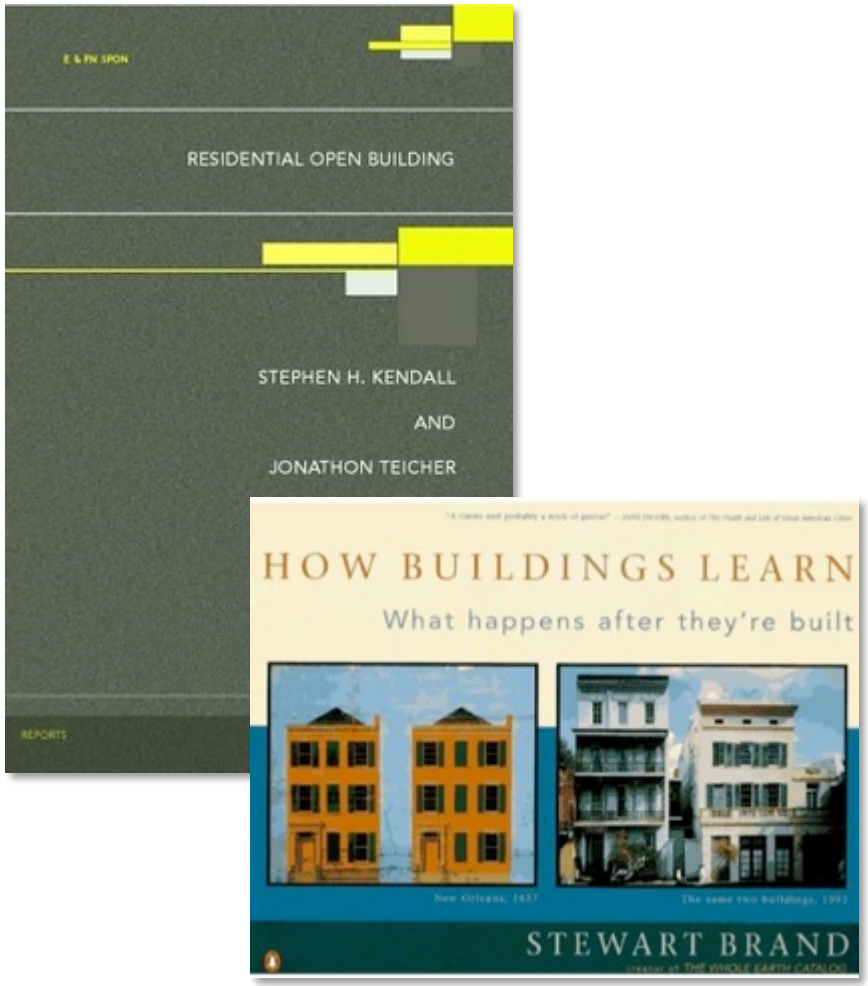
1. **Air Leakage**
2. **Heating and Cooling**

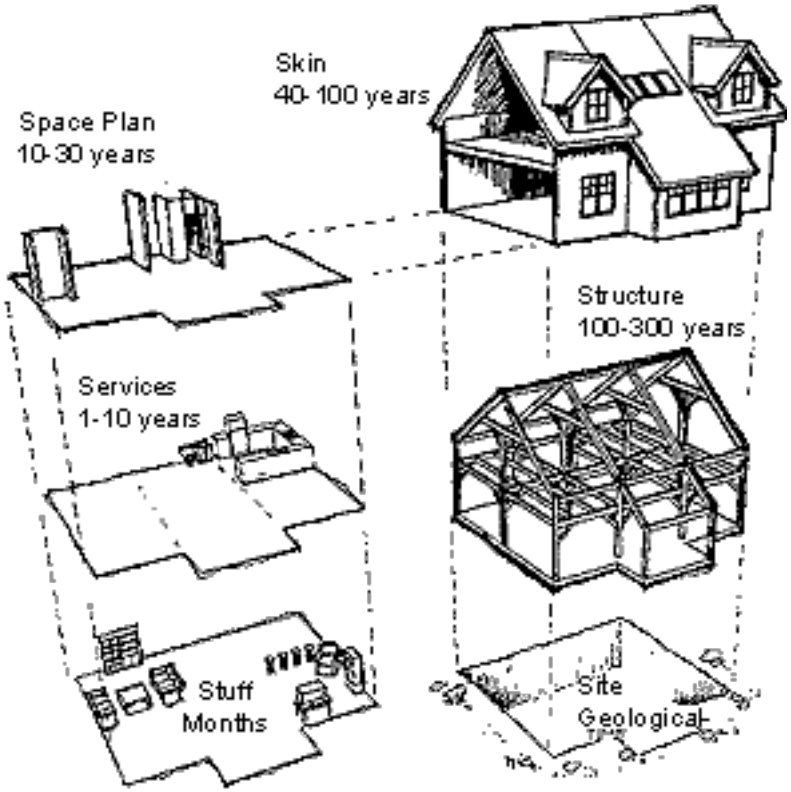
Energy Demand
Low Utilities
& Carbon

3. **Source Energy**
   (Before Renewables)

Wisdom: The Shell Matters

Open Building



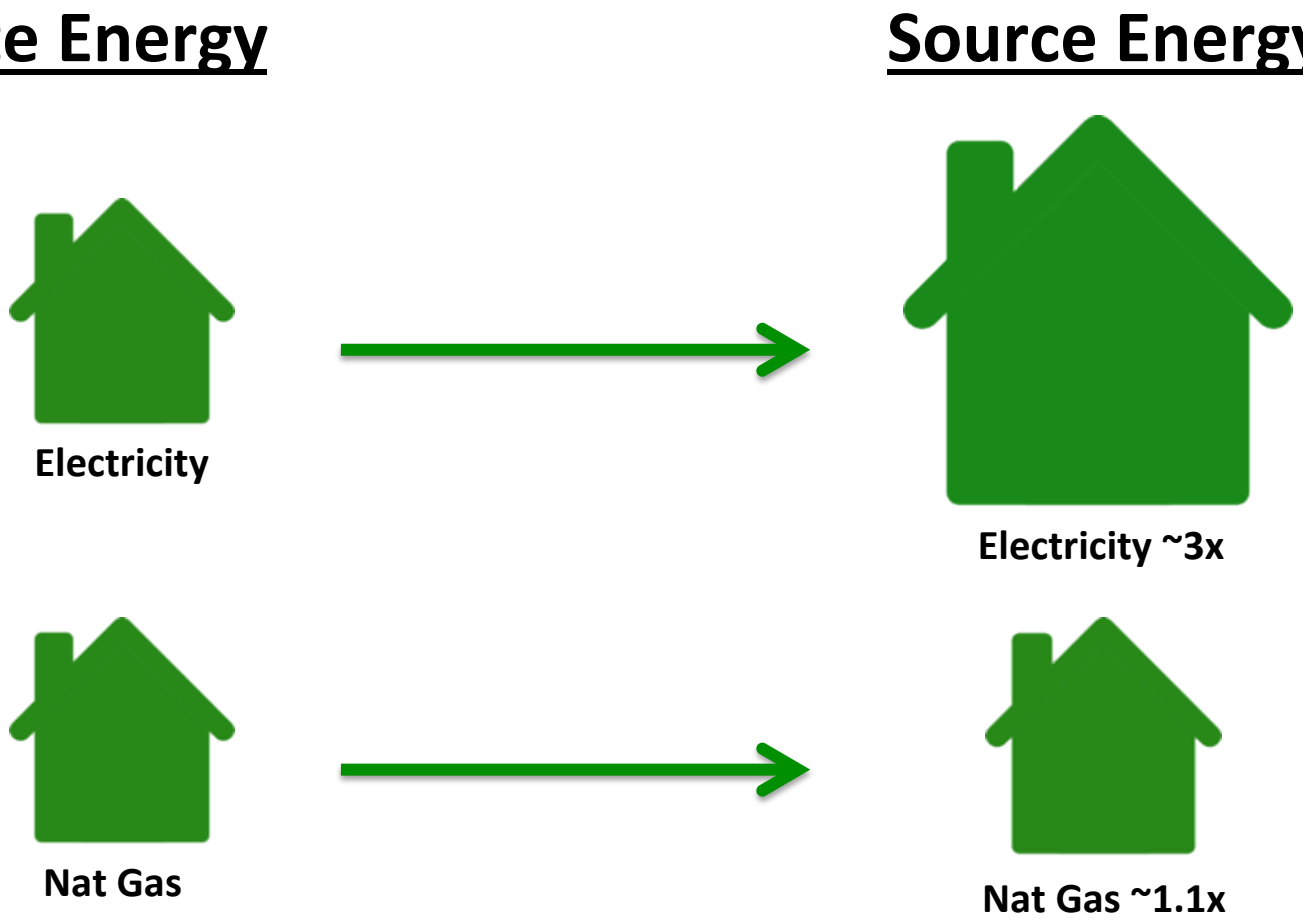


The Six S's

Image Source: ***OPEN Prototype Home - Building the Future***
www.MadeForOne.com

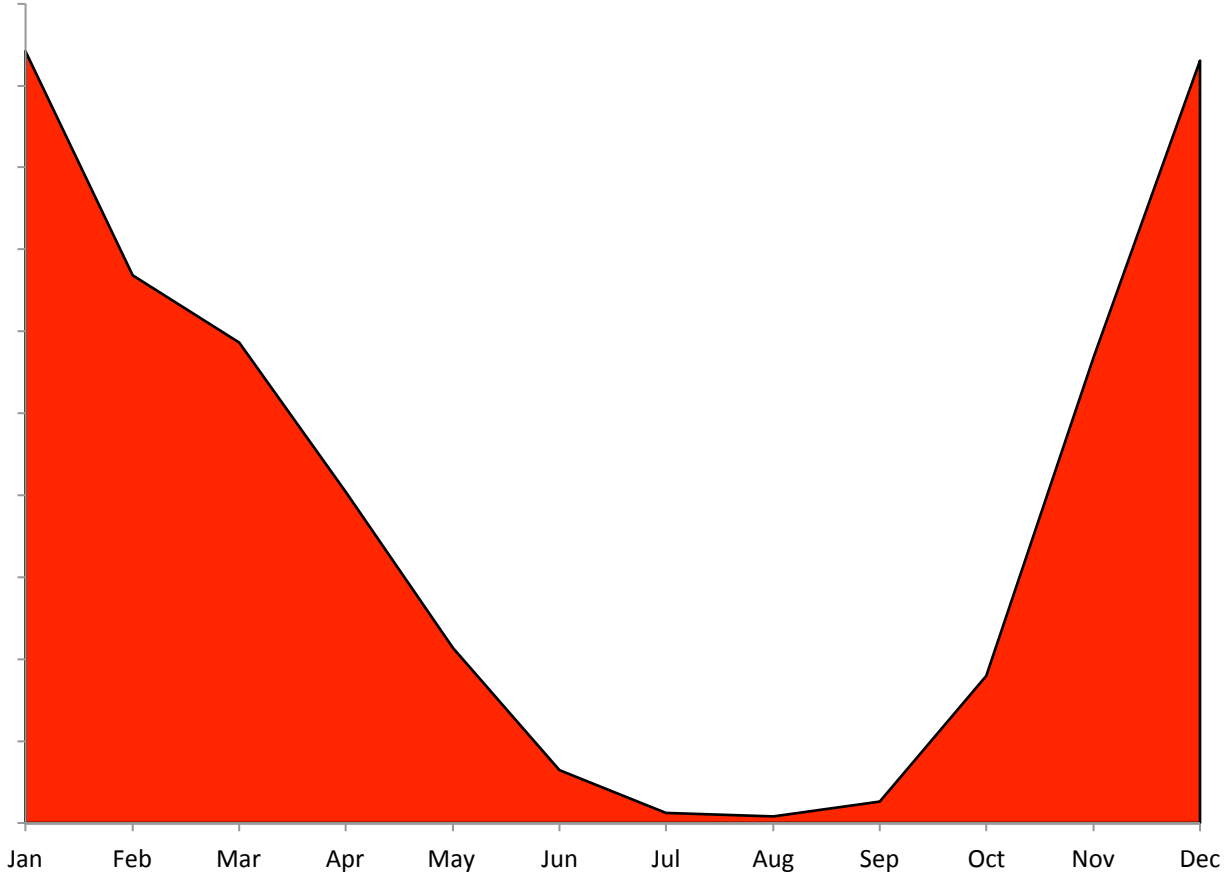
Wisdom: Source Energy Matters

Site vs. Source Environmental Impact

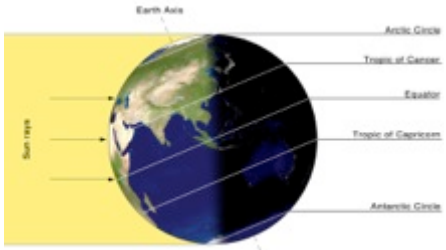


Wisdom: Passive House vs. ZNE

Just Add Solar & Call It Done?

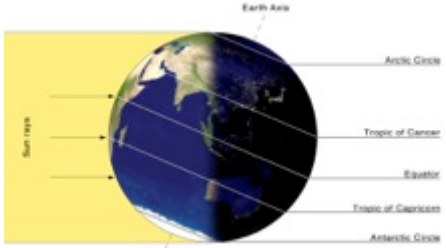


Summer



Winter

Winter



Summer

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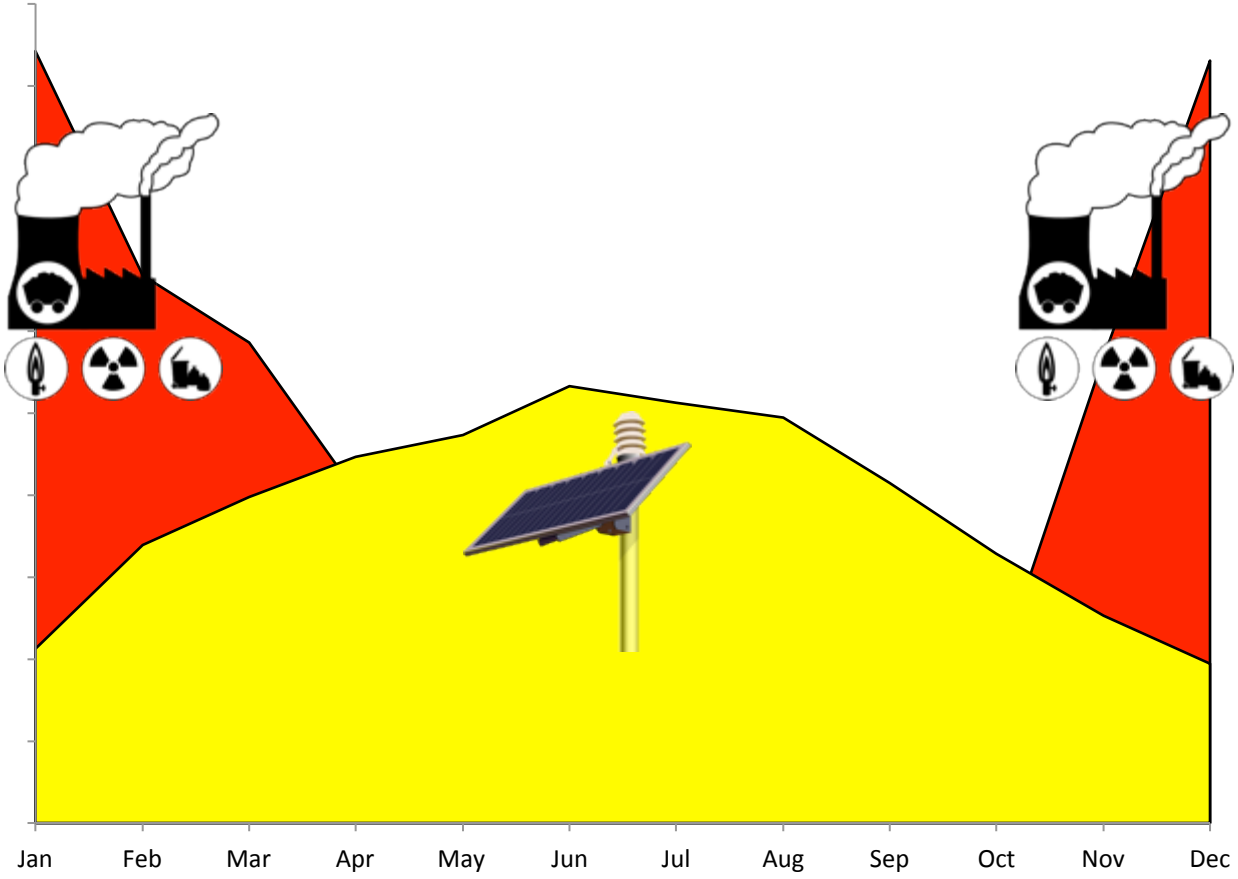
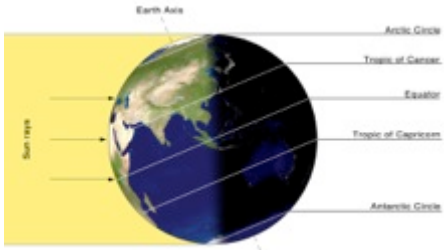


Heating Demand

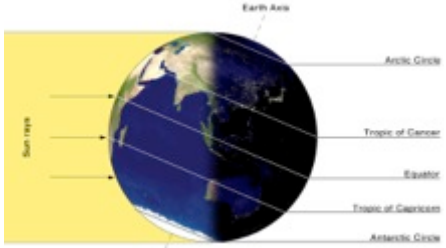
Solar

Summer



Winter

Winter



Summer

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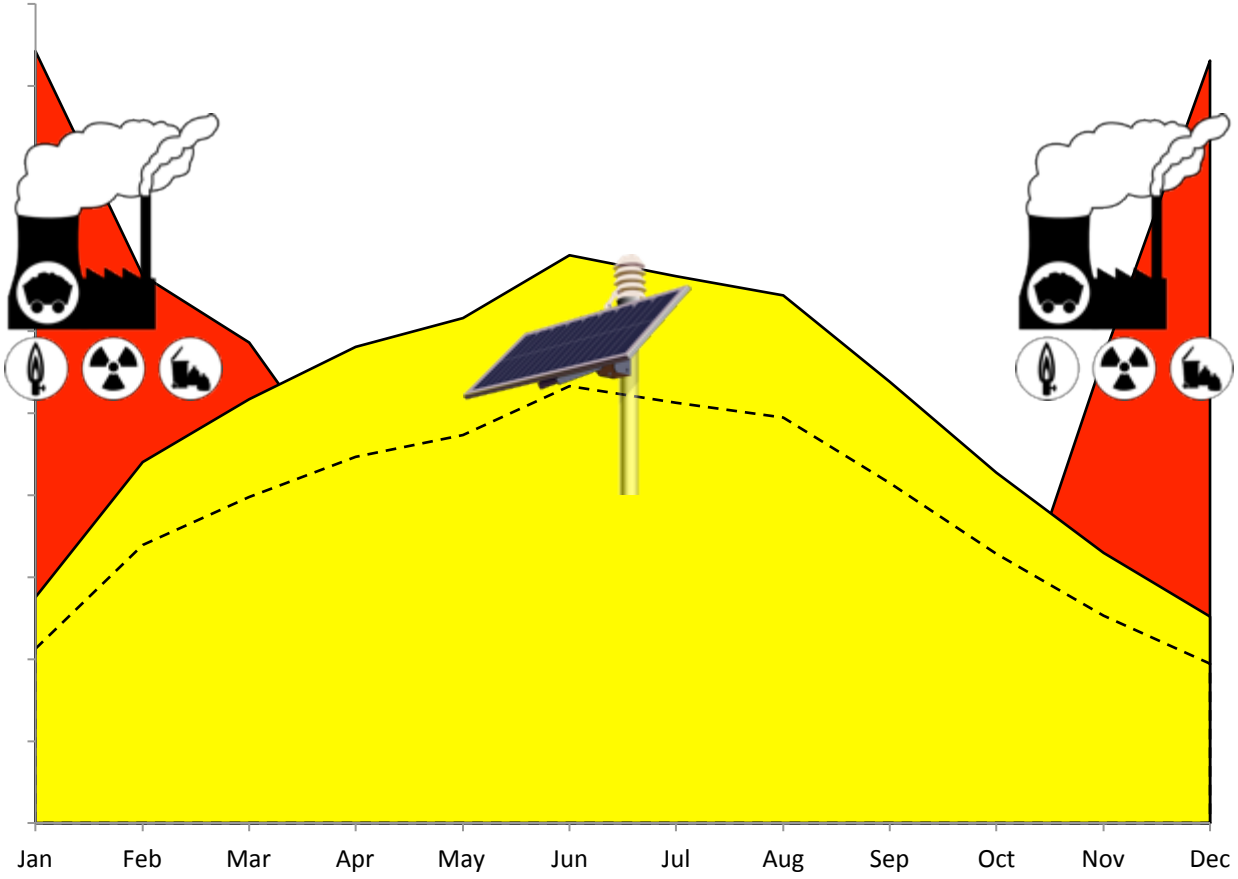
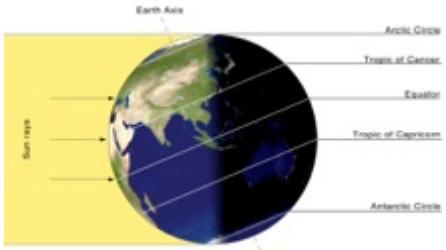


Heating Demand

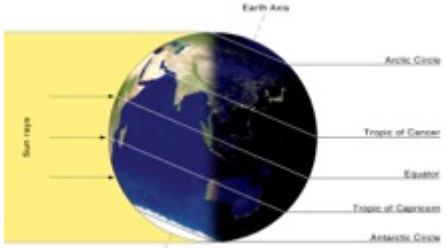
Solar

Summer



Winter

Winter



Summer

Wisdom: Passive House vs. ZNE

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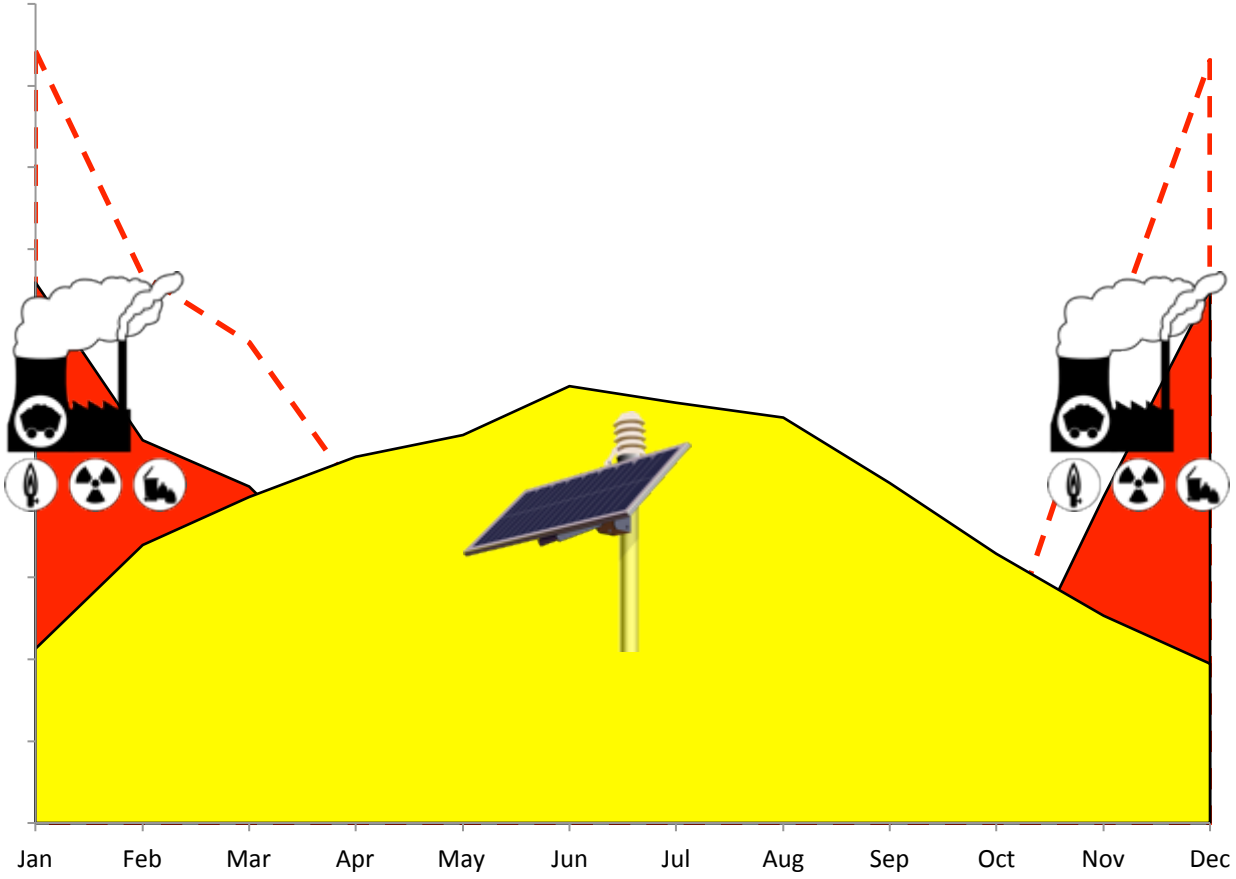
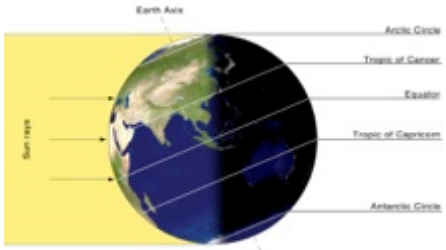


Heating Demand

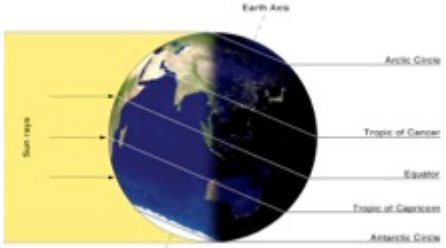
Solar

Summer



Winter

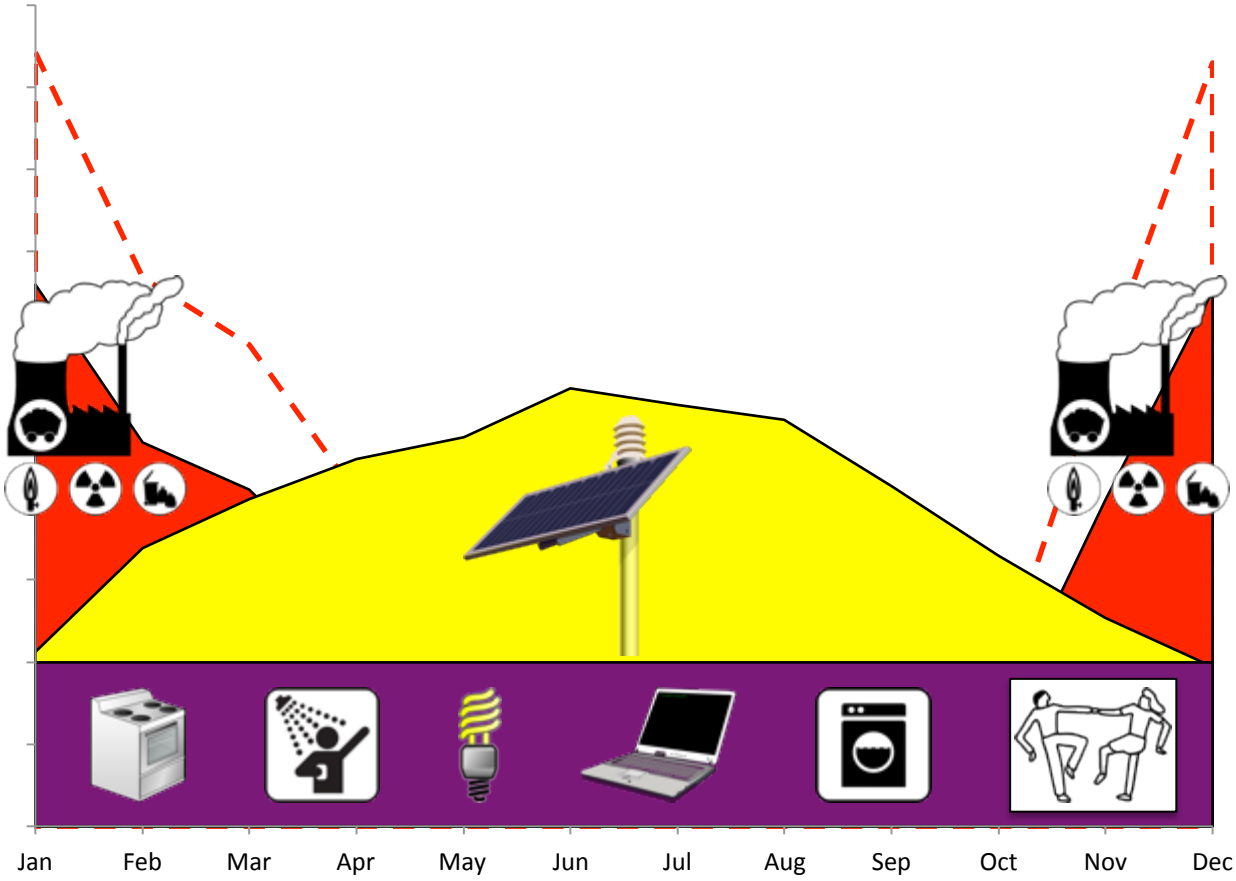
Winter



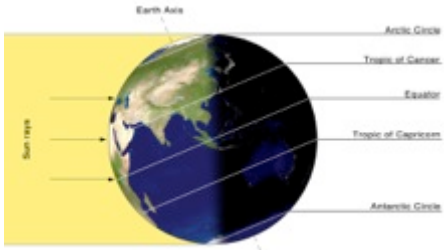
Summer

Wisdom: Passive House vs. ZNE

Just Add Solar & Call It Done?



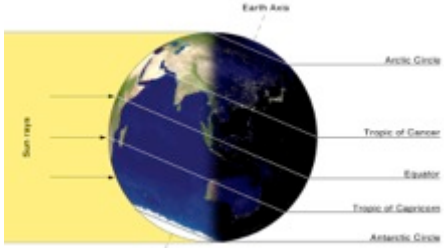
Summer



Winter

- Heating Demand
- Solar
- Internal Heat Gain

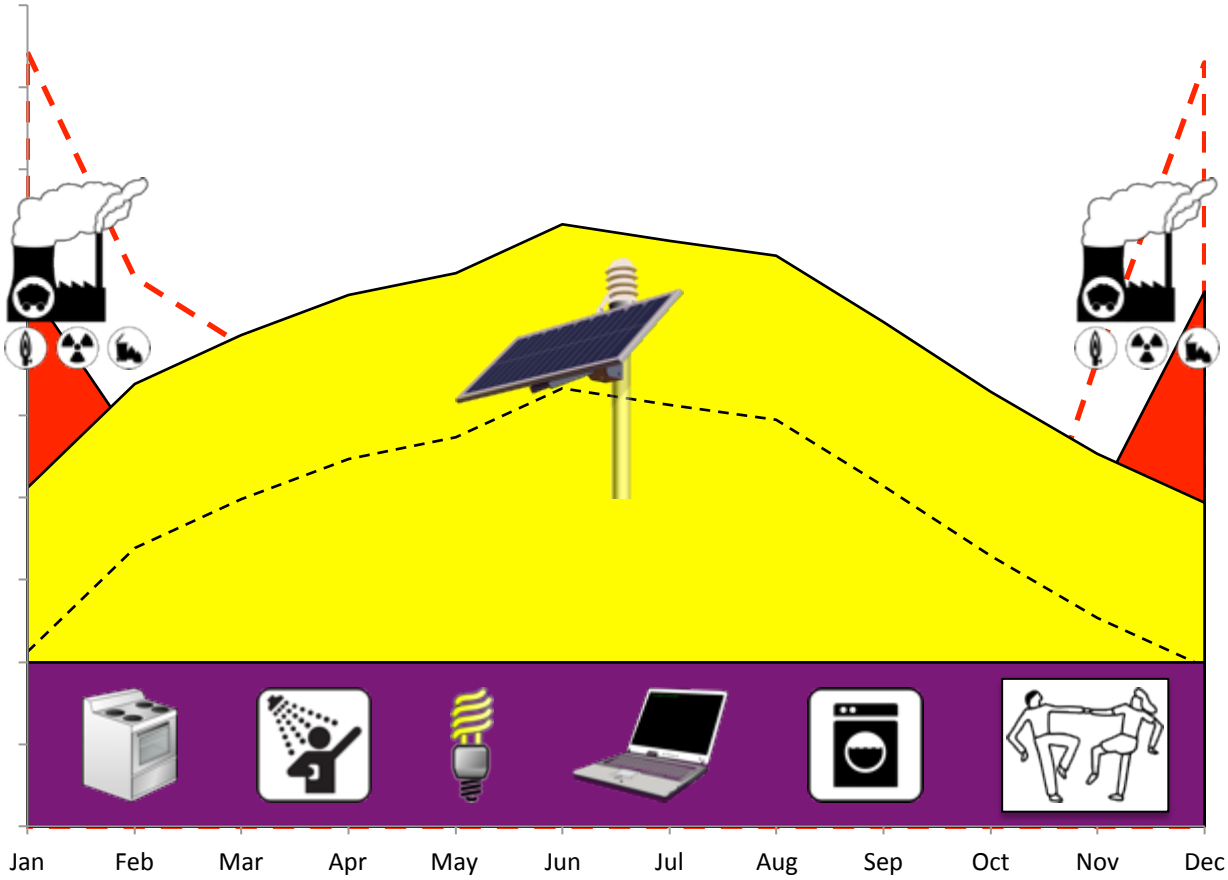
Winter



Summer

Wisdom: Passive House vs. ZNE

Just Add Solar & Call It Done?

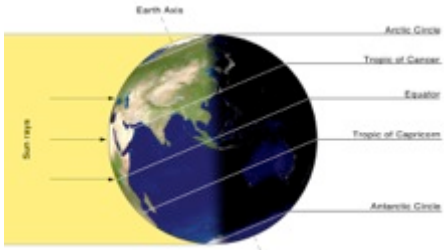


Heating Demand

Solar + IHG

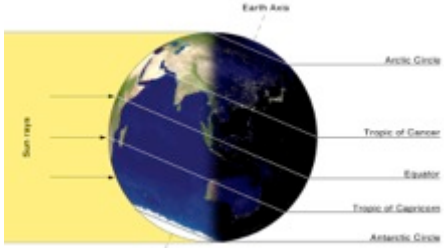
Internal Heat Gain

Summer



Winter

Winter



Summer

Wisdom: Renewables

What's Working?

Denmark 5,574,000 pop.
Wind: >200 MW (19%)
Solar: >4 GW (30%, 8 years early!)
Renewable Target: 100% by 2050
2013: No gas or oil heaters in new homes
2016: No gas or oil heaters replaced

Germany 82,000,000 pop.
Solar: >30 GW (3%), Wind: >30 GW (8%)
8 of 17 Nuclear Plants Closed, all by 2022
2012: 25% Renewable Electricity
Renewable Targets: 2020 35%, 2050 80%

California 38,000,000 pop.
Solar ~2GW (1%), Wind: 5.5 GW (5%)
Renewable Targets: ~~2010 20%~~, 2020 33%

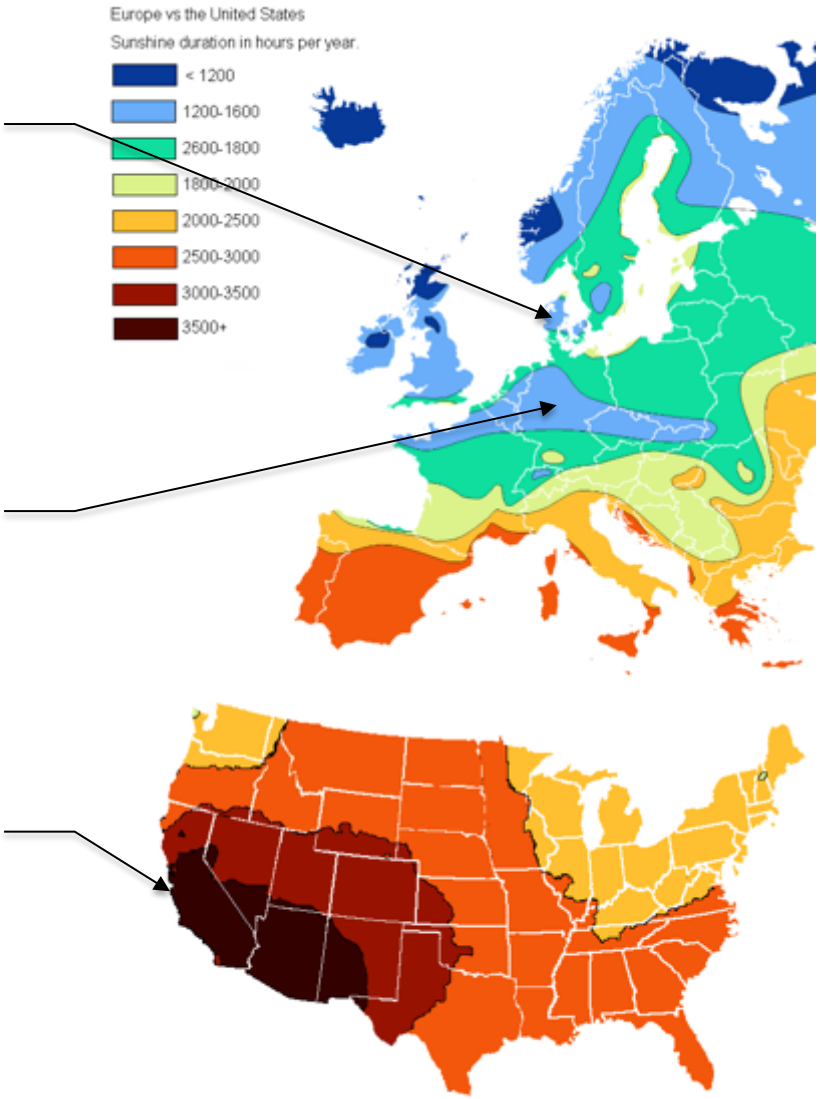
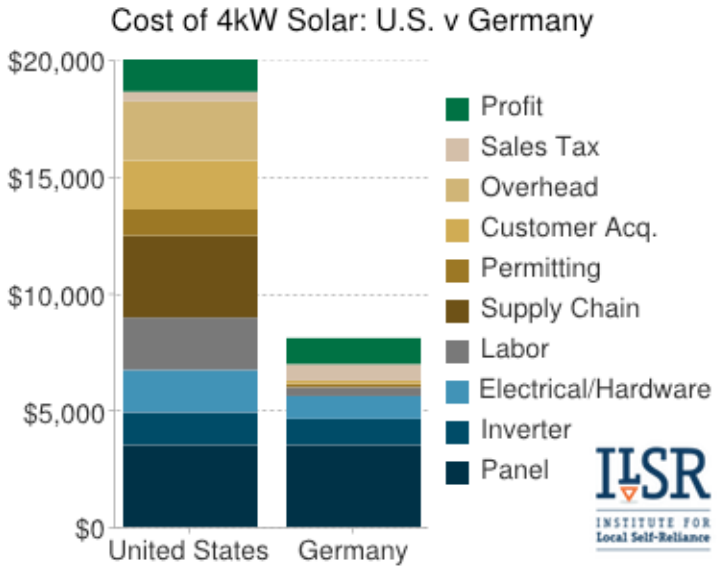


Image: www.reddit.com

Wisdom: Renewables

What About Cost?



	US Incentives	German FiT $/kWh	German FiT w/ US Sun	% Revised German FiT/ US Incentives
Residential	$0.246	$0.231	$0.139	56%
Commercial	$0.203	$0.195	$0.117	58%
Utility	$0.107	$0.160	$0.096	89%

Source: A better (more cost effective) mousetrap? How much do U.S. tax benefits cost per kWh of solar production? - NREL

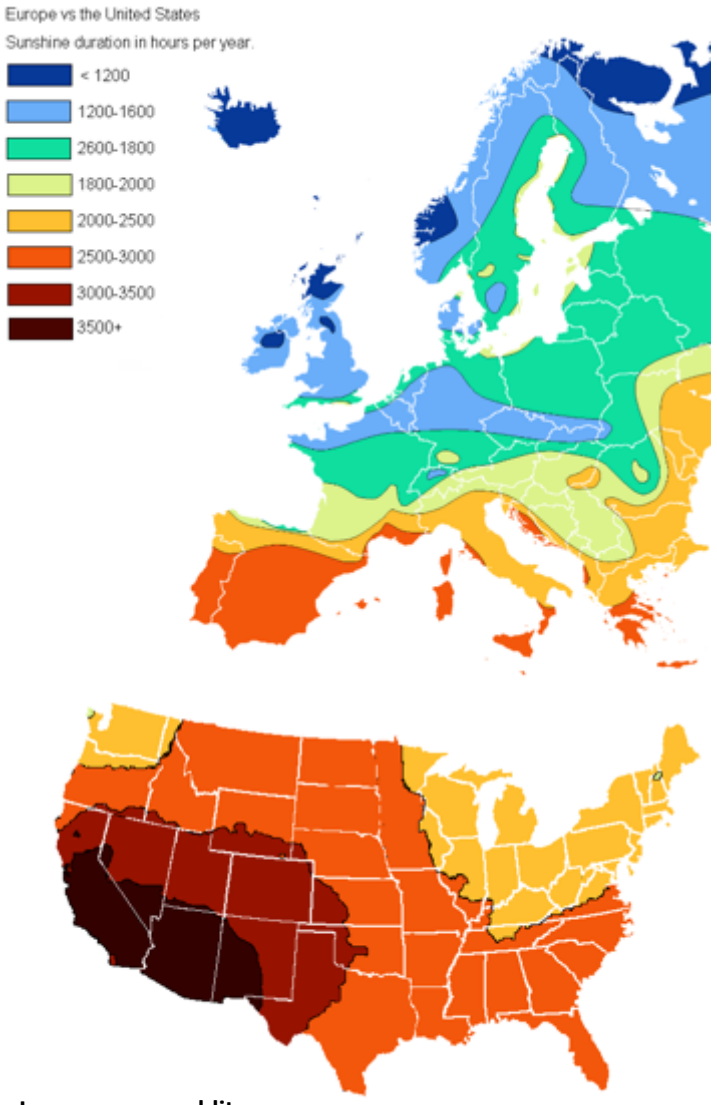
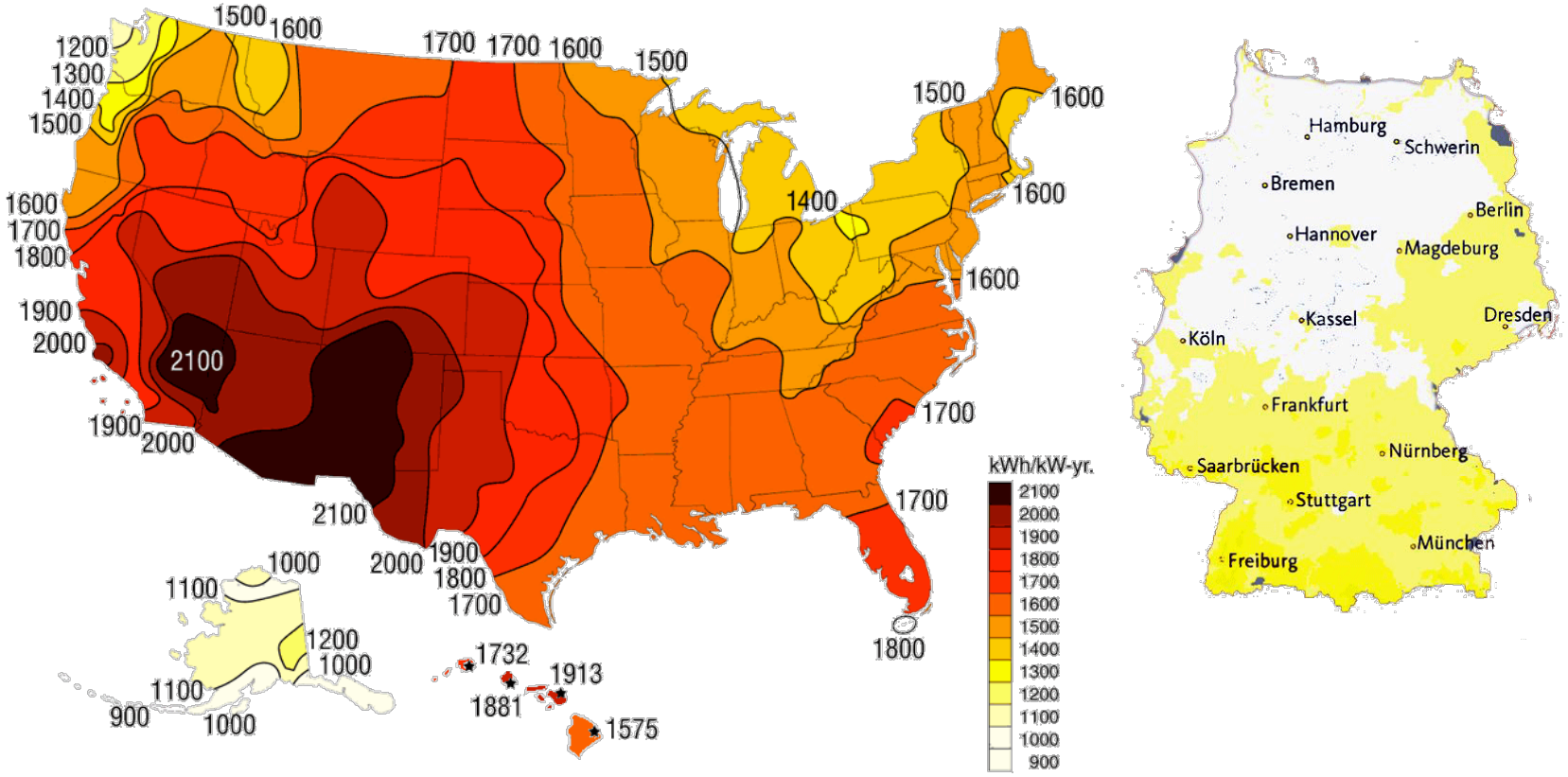


Image: www.reddit.com

Wisdom: Renewables

Lessons from the “Energiewende”



Wisdom: Renewables

Lessons from the "Energiewende"

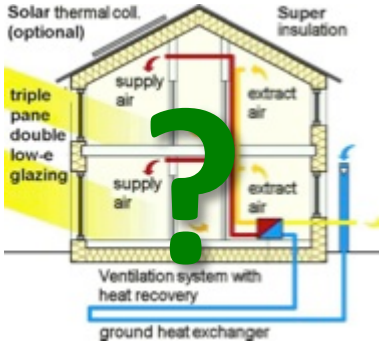
- Germany installed the same amount of solar that all of America possessed in totality and cumulatively since the 70s in just one month alone last year February (2012) – examiner.com
- >80x more peak solar power compared to demand than the US
- >21x more solar power per capita than the US
- >39x more solar power relative to electricity production
- 24x more solar per GDP than the US - cleantechnica.com
- New Solar World Record Germany 5.1 Terawatt-Hours (July 2013)
  - U.S. Record 0.764 TWh (May 2013)
  - #2 World Record German Wind Power 5 TWh (January 2013) - treehugger.com
- By 2010, [the four large utilities] accounted for only 6.5% of electricity generated in Germany – resilience.org

Sources: German American Solar team challenges the USA- Stop Fracking Start Paneling, examiner.com, 07/13/13
10 Huge Lessons We've Learned From Solar Power Success In Germany, cleantechnica.com, 02/09/13
Germany broke world solar power generation record in July with 5.1 TWh, leaving U.S. in dust, treehugger.com, 08/26/13
Germany's Energiewende — What Has Been Learned So Far?, resilience.org, 03/13/13

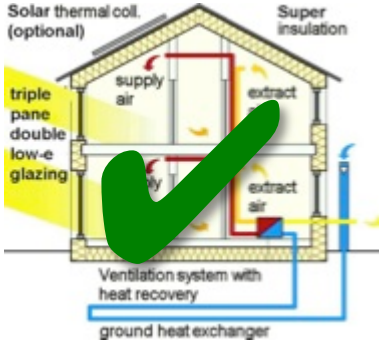
Wisdom: Market Signals

ZNE vs. Passive House + Feed-in Tariff (FiT)

ZNE



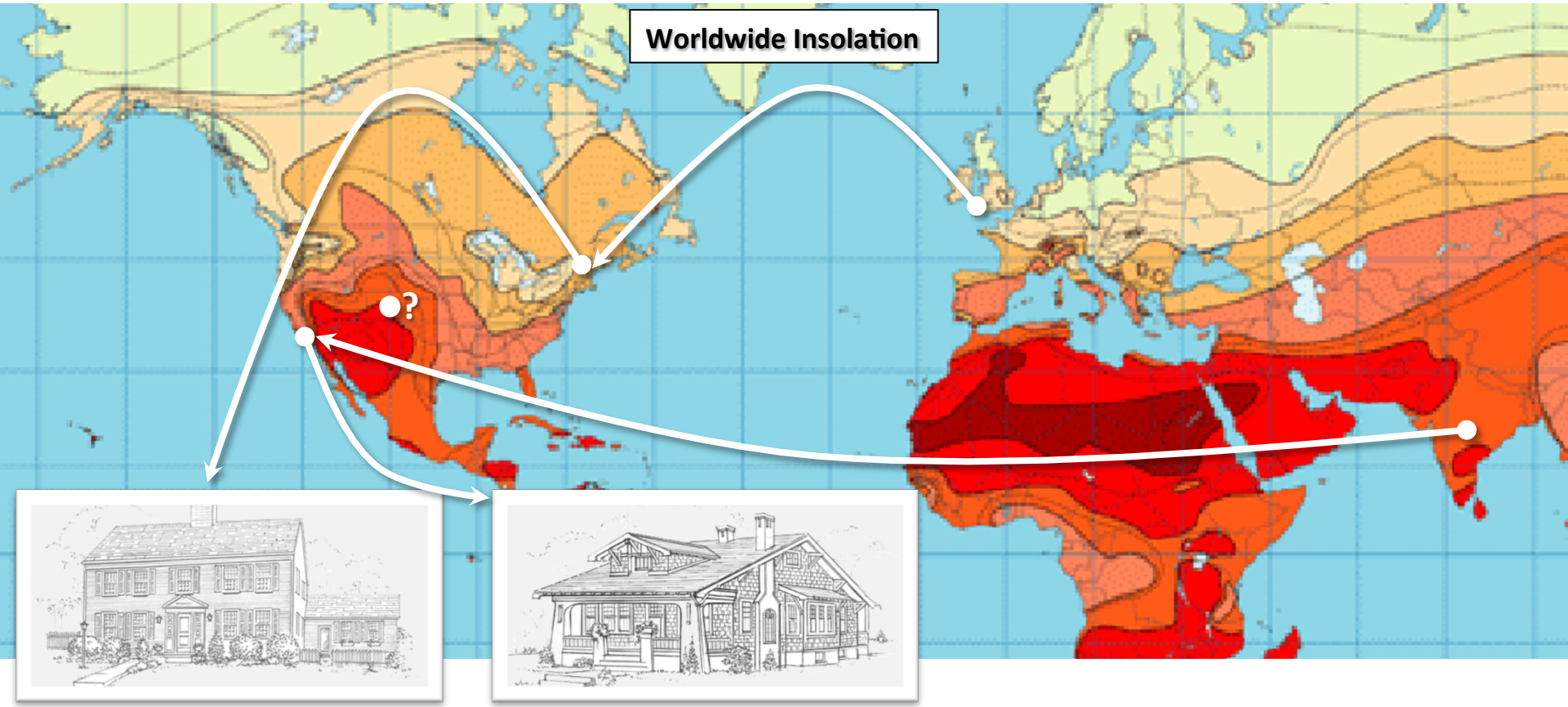
PH + FiT



Zero Net Energy	Passive House & FiT
Energy is “Free”	Bills are Low Because of Low Energy Consumption
Surplus Renewable Energy is Worthless	Surplus Renewable Energy is Valuable
High Consumers Benefit Most	Low Consumers & High Producers Benefit Most

Wisdom: Traditional Architecture

Choosing the Right Vernacular



Baṅglā

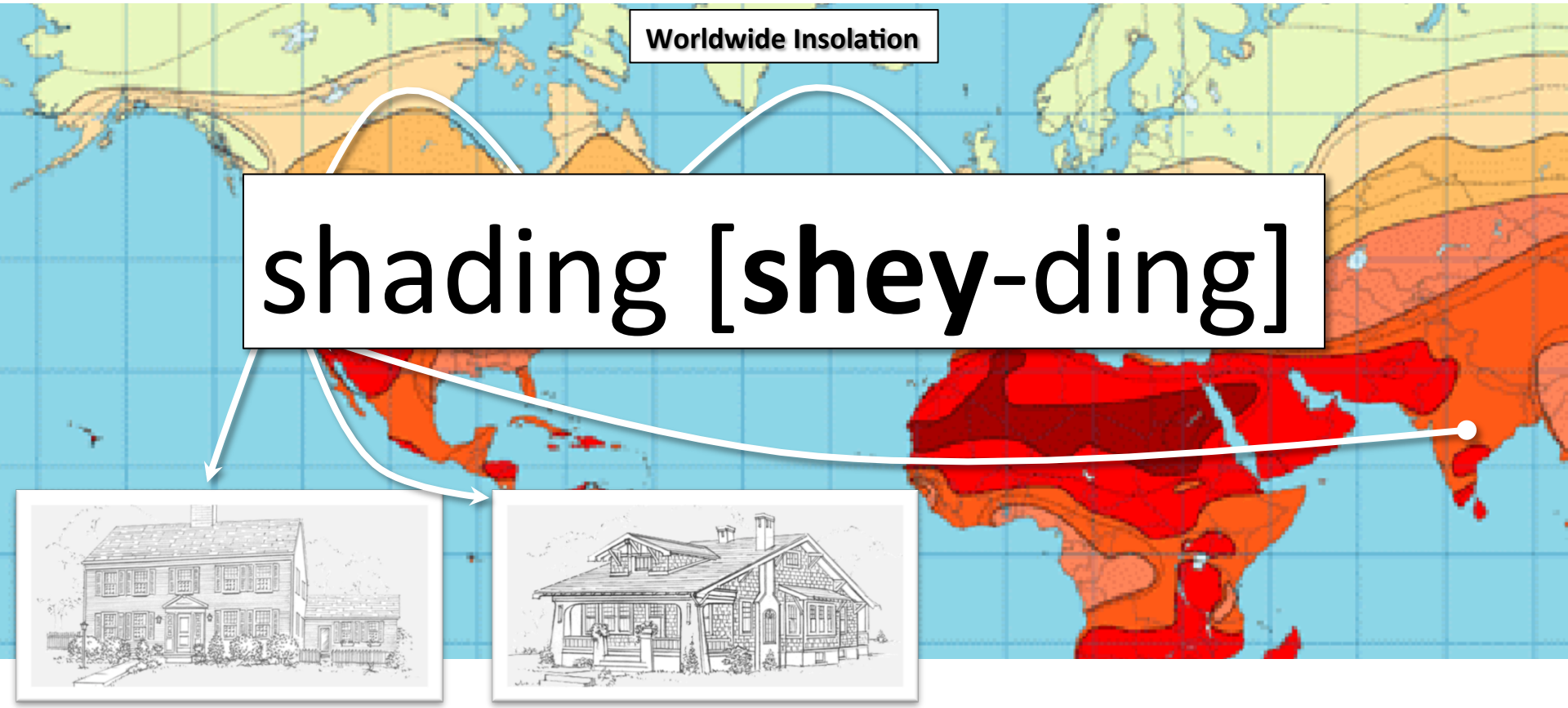
Baṅgalo

Bungale

Bungalow

Wisdom: Traditional Architecture

Choosing the Right Vernacular



Baṅglā
Baṅgalo
Bungale
Bungalow

Thank You! Questions?

HERS Says "Stop" and I Say "Go, Go, Go!"

Thanks To:

Gene Meyers, CEO, New Town Builders

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Graham Irwin

CPHC, CPBD, LEED AP+ BD&C, BPI BA

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