

Flywheel Development: Project Profiles



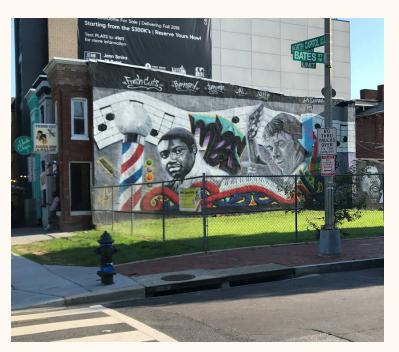
Perry Street Townhomes

Located in Mount Rainier, MD

4 market rate townhouses

Prince George's County's First Passive House net zero residences

Highest sales price for a home in Mount Rainier



Cycle House

Located at the intersection of North Capitol and Bates Street in the NOMA neighborhood

16 rental units serving people at 60% AMI and below over ground floor retail

19,000 square feet of gross building area



Stack Eight

Located in Ward 8 near the Congress Heights metro

18 new construction stacked flats and townhomes. 100% affordable homeownership

27,000 square feet of gross building area

DC's first Living Building Challenge Petal Certified project. DC's first net zero energy affordable housing project

Stack Eight Project: Deep Dive



Stack Eight Project

Location: Congress Heights neighborhood in Southeast DC. The site is two blocks from St. Elizabeth's and the Metro station

Competitive RFP issued by the DC Department of Housing and Community Development in 2016. Project awarded to Flywheel Development in 2017

Program: 18 for-sale stacked flats and townhouses maximizes permittable density on site, 100% affordable to 50 and 80% AMI

Construction Start: Summer /Fall 2020

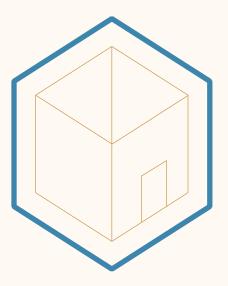
Innovations: passive house + net zero on-site, battery backup power for critical loads, district energy system for heating/cooling/hot water



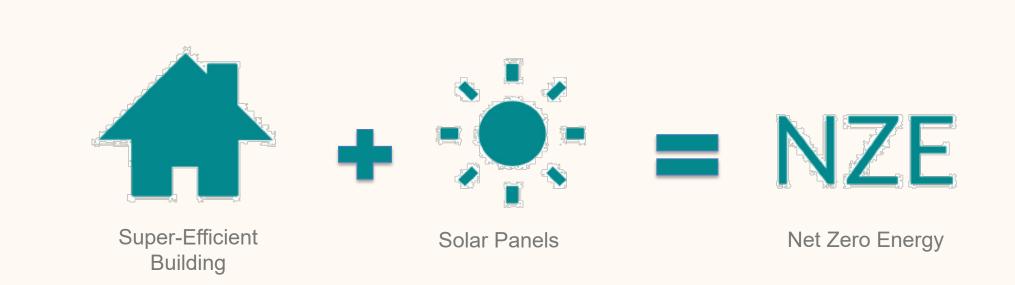




Designing for Net Zero Energy



The Basic Equation



Set Your Goals: Different standards sometimes provide synergies, sometimes are duplicative

NZE-First Design: Design the building with net zero energy in mind from the beginning

Solar Potential Analysis: Conduct a solar potential analysis of rooftops -- how much solar can we generate on site?

Innovation is Key: Passive House standard sets a limit on energy use/square foot/per year: 4.29 kWh/ft2/year. Our internal target is 3.75

Build It: Find efficiencies with modern construction techniques of modular and panelized

Unit 1-12 Stack Eight, Congress St SE Washington DC

Report

Project Name

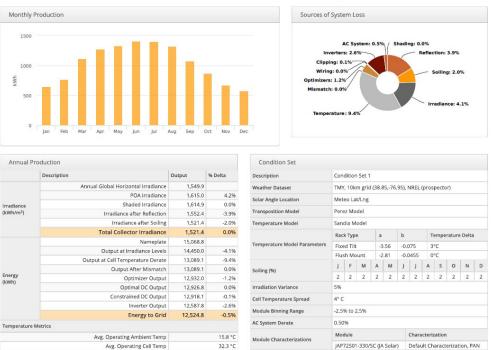
Project Address

Prepared By

Simulation Metrics







Device

SF10K (SolarEdge

P400 NA (SolarEdge)

Component Characterization

4674

4674

Operating Hours

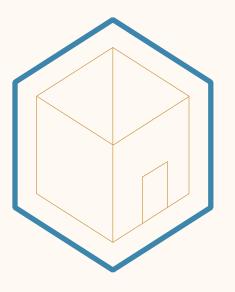
Solved Hours

Characterizatio

Mfg Spec Sheet

Default Characterization

Designing for Net Zero Energy:



Setting Goals and Standards

9

Passive House: How we get to net zero; PHPP/quantitative analysis undergirding Living Building Challenge performance requirements

Living Building Challenge, NZE: Energy: goes 5% beyond net zero with 105% on-site performance and backup power requirements

Enterprise Green Communities: required for many affordable housing projects, net zero earns significant points towards certification

Baseline Code: (easy)



Stack Eight's LBC Petals



RESTORING A HEALTHY INTERRELATIONSHIP WITH NATURE

(IMPERATIVE 02)

(IMPERATIVE 03)

AND HABITAT EXCHANGE

BEAUTY

CELEBRATING DESIGN THAT UPLIFTS THE HUMAN SPIRIT

NET POSITIVE ENERGY



PLACE









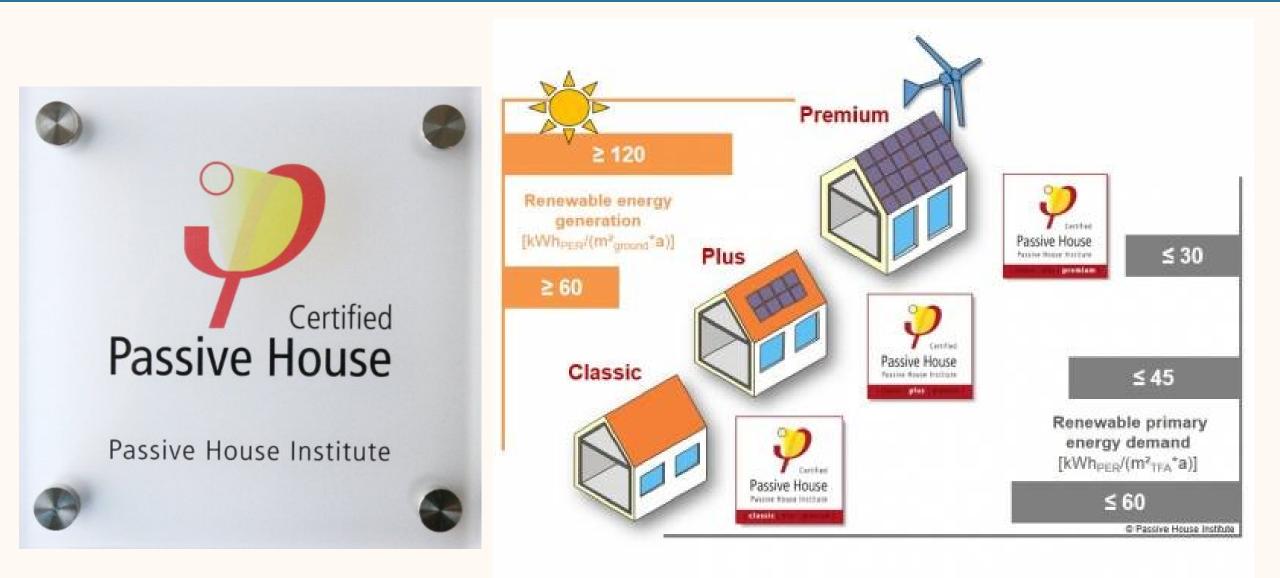


One hundred and five percent of the project's energy needs must be supplied by on-site renewable energy on a net annual basis, without the use of on-site combustion.¹⁵ Projects must provide onsite energy storage for resiliency.¹⁶

- 15 Refer to the v3.1 Energy Petal Handbook for a list of renewable energy systems, clarifications, and exceptions, including sub-metering requirements.
- 16 Single-family residences must demonstrate that sufficient back-up battery power is installed for emergency lighting (at least 10% of lighting load) and refrigeration use for up to one week for greater resiliency. All other project types must create a resiliency plan appropriate to the occupancy type that includes, at minimum, the capacity to store the energy equivalent to 10% of the lighting load for one week.

SCALE JUMPING PERMITTED FOR URBAN AGRICULTURE

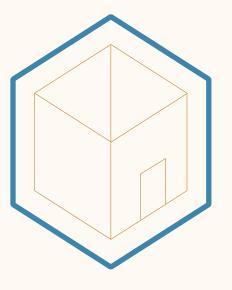
Stack Eight's Passive House Goal

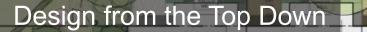




Designing for Net Zero Energy:

NZE-First Design





9.10

41.04



167

SEREES

RELATED

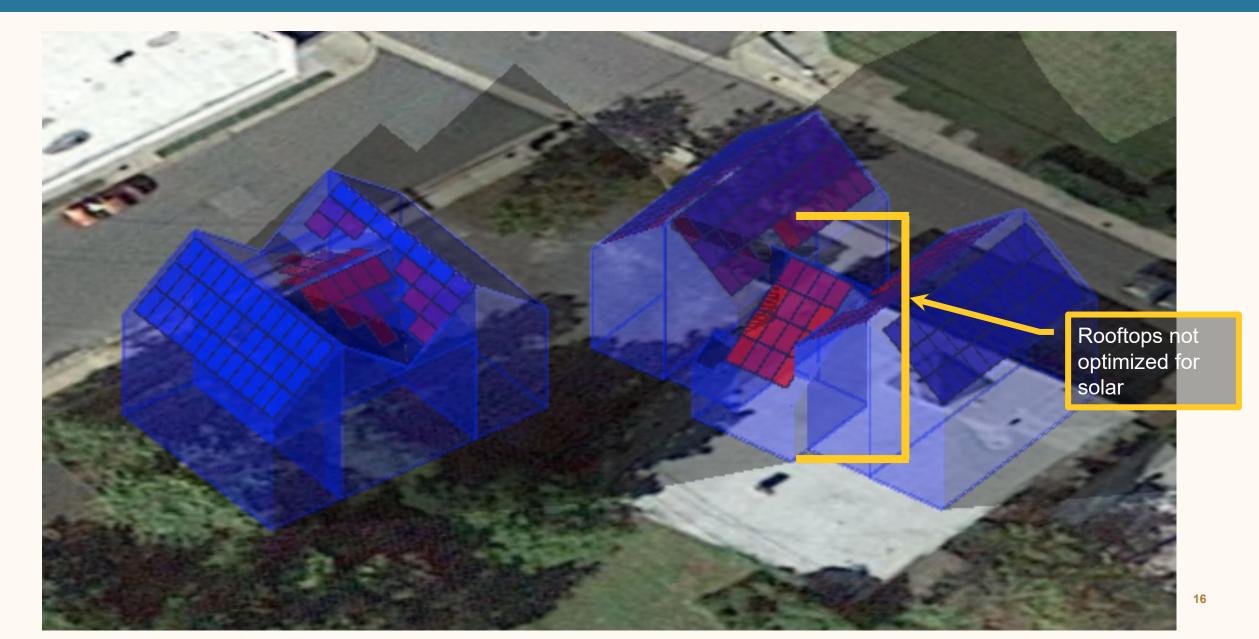
DETAILS

WELL

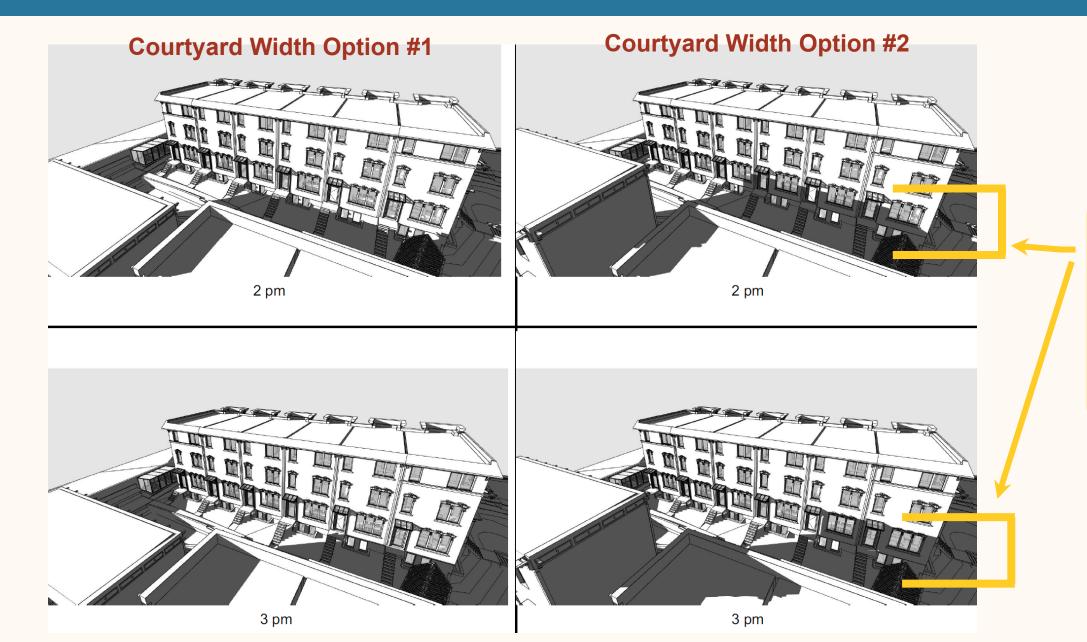
CORE

£04£16

N 72'39'

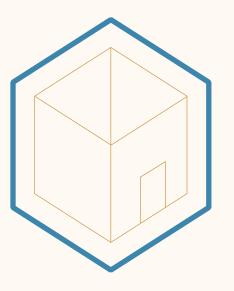


NZE-First Campus Design



These windows receive less light in Option #2, which would have increased overall project EUI

Designing for Net Zero Energy:



Solar Analysis



Quantify Solar Output: Turn site characteristics into annualized energy use expectations

If the solar provides enough power for our demand, we can achieve net zero, otherwise we need to beat the Passivhaus maximum allowable energy use



Simulator Version Ce606dc177-3213c093a0-cbb9fffcef Monthly Production Sc 1500 1000 1000 1000

Unit 1-12 Stack Eight, Congress St SE Washington DC

System Metrics

Unit 1-12

9 90 kW

9.85 kW

12.52 MW

78.3%

1,265.1

(prospector)

Load Ratio: 1.01

TMY, 10km grid (38,85-76,95), NREI

Design

Module DC

Nameplate

Inverter AC Nameplate

kWh/kWp

Annual Production

Performance Ratio

Weather Dataset

Report

Project Name

Project Address

Prepared By

Annual Production

rradiance

(kWh/m²)

Energy

(kWh)

Temperature Metrics

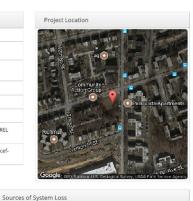
Simulation Metrics

Stack Eight

Thomas Bone

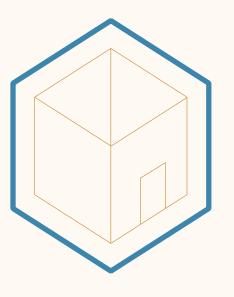
tbone@civicsolar.com

Congress St SE Washington DC



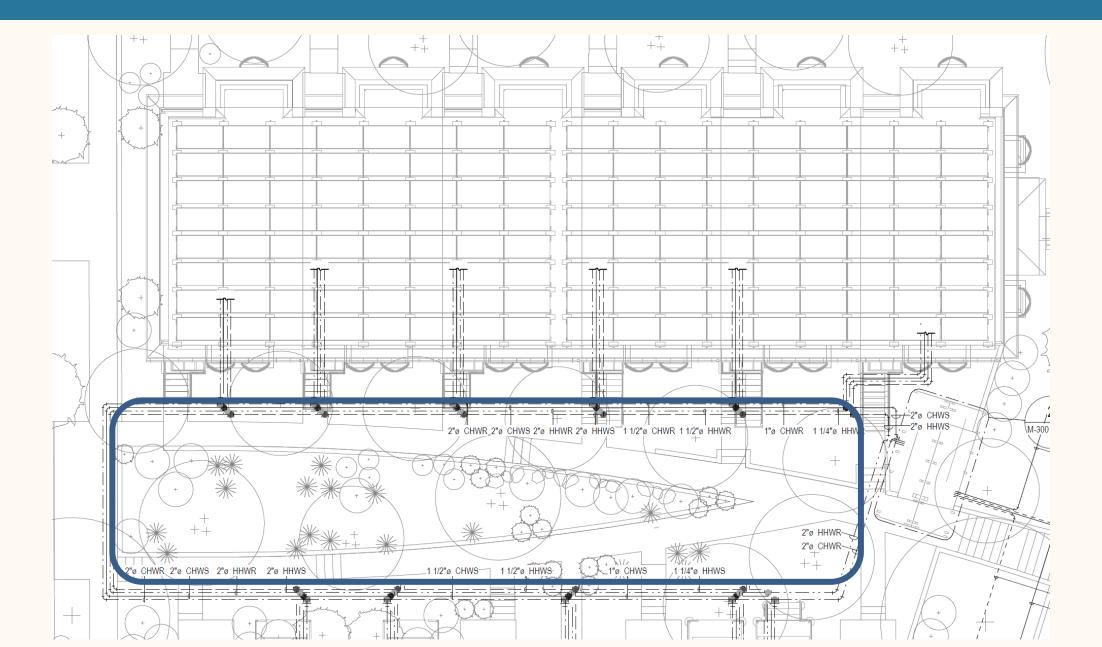
AC System: 0.5% / Shading: 0.0% Inverters: 2.6% Clipping: 0.1% Wiring: 0.0% Soiling: 2.0% Optimizers: 1.2% Mismatch: 0.0% nce: 4.1% Aug Condition Set Output % Delta Description Condition Set 1 Annual Global Horizontal Irradiance 1.549.9 Weather Datase TMY, 10km grid (38.85,-76.95), NREL (prospector) POA Irradiance 1.615.0 4.2% Solar Angle Locati Meteo Lat/Lng Shaded Irradiance 1.614.9 0.0% Perez Mode insposition Mo Irradiance after Reflection 1.552.4 -3.9% 1.521.4 Irradiance after Soiling -2 0% Temperature Mod Sandia Model 1,521.4 0.0% Total Collector Irradiance Rack Type Temperature Delta Nameplate 15,068.8 emperature Model Para Fixed Til -3.5(-0.075 3°C Output at Irradiance Levels 14,450.0 -4.1% Flush Moun -2.8 -0.0455 0°C Output at Cell Temperature Derate 13,089.1 -9.4% M J J A S O N D Output After Mismatch 13.089.1 0.0% Soiling (%) 2 2 2 2 2 2 2 2 2 2 2 2 2 Optimizer Output 12,932.0 -1.2% Optimal DC Output 12.926.8 0.0% Irradiation Variance 5% Constrained DC Output 12,918.1 -0.1% 4° C **Cell Temperature Spread** Inverter Output 12,587.8 -2.6% Module Binning Range -2.5% to 2.5% 12,524.8 -0.5% Energy to Grid 0.50% AC System Derate Module Characterization Avg. Operating Ambient Temp 15.8 °C Module Characterization Avg. Operating Cell Temp 32.3 °C IAP72S01-330/SC (IA Solar) Default Characterization, PAN Device Characterizatio Component Characterization 4674 SE10K (SolarEdge) Default Characterization **Operating Hours** 4674 P400 NA (SolarEdge) Mfg Spec Sheet Solved Hours

Designing for Net Zero Energy:



Innovation is Key

District Energy System



22

District Heating and Cooling

Passive House reduces loads by 80%

Location: Peak cooling loads for Stack Eight's units are ³/₄ ton for cooling – and regular loads much lower. Far too small for conventional equipment

District Energy system: creates a cost and energy savings opportunity: avoids oversized equipment, captures waste heat by creating hot and cold water simultaneously, allows units to "share" free energy

Load Aggregation: all 18 units are served by 10 tons of centralized heating and cooling equipment, using only six 500' deep geothermal wells – the same number you might see on one conventional house





Islandable Backup Power: Designed to keep critical systems online in the event of a power outage – and allow solar to continually recharge storage during an outage event

Critical Loads: Energy recovery ventilation, refrigerators, 10% of lighting, emergency plugs are backed up per Living Building Challenge (ILFI) requirements. Because of the building's high insulation levels, heating/cooling is not a critical load

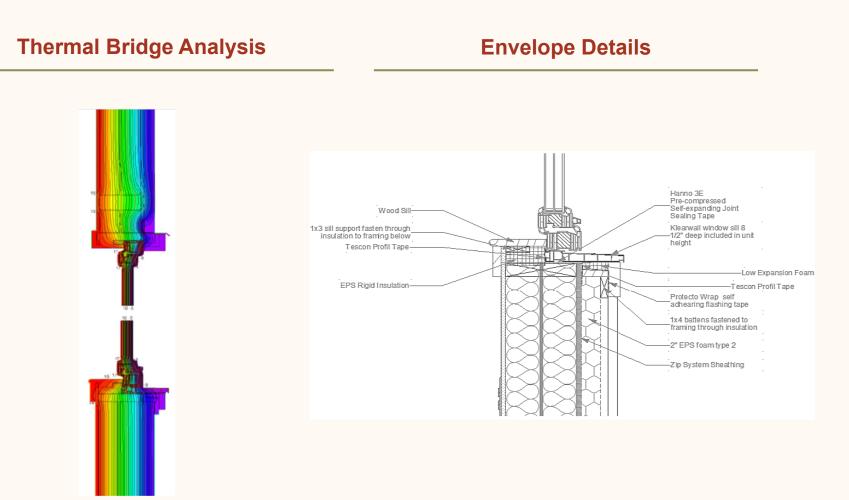
Passive House Reduces Battery Size: We only need

16 batteries for all 18 units



Energy Performance First

- Materials are selected for energy performance (e.g. windows and doors)
- Construction assemblies are modeled for their energy performance

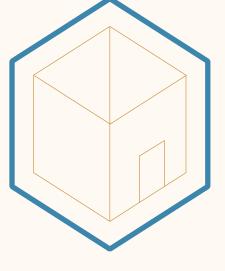


Energy Modeling

	as determination																				Pass	ive House with P	were Ver
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	East windows	3	11.63	m ²				Results con	me from th	he 'Windows'	worksheet.				0	ast windows		0.998	961	1803			
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9 10 11 12 13 14 15 16	[model]_Wal_51037_5 [model]_Wal_50033_5 [model]_Wal_37880_5 [model]_Wal_37880_5 [model]_Wal_517302_W [model]_Wal_517372_W [model]_Wal_372265_W	1 1 1 1 1 1	External wall - Andrient External wall - Andrient		1 1 1 1 1 1 1 1	x(7. x(7. x(7. x(8. x(8. x(8. x(8. x(8. x(8. x(8.	10 x 10 x 10 x 10 x 16 x 13 x 13 x	229 5.40 5.40 6 2.26 6 3.70 6 2.11 6 3.05 7 3.47			 Solution Solution Solution Solution Solution Solution Solution Solution)+)-)-)-)-)-)-)-	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 2.6 = 1.0 = 0.4 =	12. 82/ 24/ 13/ 10/ 4.3 27/ 10. 12/	2 01 6 01 8 01 9 01 9 01 9 01 9 01 1 01 4 00	Lad-MAYERS - Double Shad Walls Trad-MAYERS - Double Shad Walls	0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139	100 168 190 168 138 190 258 258 258 258	90 90 90 90 90 90 90 90 90	East South South South South South West West	0.99 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 15 16 17	[model]_Wal_51027_5 [model]_Wal_50033_5 [model]_Wal_37886_5 [model]_Wal_37886_5 [model]_Wal_51782_W [model]_Wal_517879_W [model]_Wal_517879_W [model]_Wal_517879_W	1 1 1 1 1 1 1 1 1	External wall - Ansbient External wall - Ansbient		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	x(7. x(7. x(7. x(8. x(8.))))))))))))))))))))))))))))))))))))	10 x 10 x 10 x 10 x 16 x 13 x 13 x	2.29 5.40 2.26 3.70 2.11 4 3.05 4 3.05 4 3.47		36.52	 A A)+)-)-)-)-)-)-)-	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 2.6 = 1.0 = 0.4 = 4.7 =	12. 82/ 24. 13. 10. 4.3 27. 10. 13. 9.6	2 01 6 01 8 01 8 01 9 01 9 01 9 01 1 01 1 01 4 00 9 01	Lot MATTERS - Double Shud Walls from MATTERS - Double Shud Walls from MATTERS - Double Shud Walls for MATTERS - Double Shud Walls	0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.247 0.139	100 168 190 168 138 190 258 258 258 258 259 259	90 90 90 90 90 90 90 90 90 90 90 90 90	East South South South South South West West West	0.99 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 16 16 17 18	[model]_Wal_516327_5 [model]_Wal_56633_5 [model]_Wal_37886_5 [model]_Wal_37886_5 [model]_Wal_37886_8 [model]_Wal_517362_W [model]_Wal_517362_W [model]_Wal_517864_W [model]_Wal_517864_W	1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	External wall - Antibient External wall - Antibient		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	x(7. x(7. x(7. x(8. x(8.))))))))))))))))))))))))))))))))))))	10 x 10 x 10 x 10 x 16 x 13 x 13 x	229 5.40 5.40 6 2.26 6 3.70 6 2.11 6 3.05 7 3.47		30.52	 A A)-)-)-)-)-)-)-)-)-)-)-)-	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 2.6 = 1.0 = 0.4 = 4.7 = 1.7 =	12. 62. 24. 13. 10. 4.3 27. 10. 4.3 27. 10. 13. 9.6 7.5	2 01 6 01 8 01 8 01 9 01 9 01 1 01 1 01 1 01 0 00 0 00	tad MAYEES - Double Stud Walls trad MAYEES - Concester Walls trad MAYEES - Concester Walls	0.139 0.139 0.130 0.130 0.139 0.139 0.139 0.139 0.139 0.139 0.247 0.139	100 168 190 168 138 190 258 258 280 280 280 280 280	03 00 00 00 00 00 00 00 00 00 00 00 00	East South South South South South South West West West West West	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 16 16 17 18 19	[model]_Wal_51037_5 [model]_Wal_50033_5 [model]_Wal_37880_5 [model]_Wal_378945_5 [model]_Wal_517302_W [model]_Wal_517372_W [model]_Wal_517874_W [model]_Wal_517874_W [model]_Wal_517874_W	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	External wall - Antibient External wall - Oncound		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	x (7, x (7, x (7, x (7, x (8, x (8, x (8, x (8, x (9, x (9,	10 x 10 x 10 x 10 x 10 x 10 x 10 x 14 x 13 x 16 x 14 x 15 x 16 x 15 x 16 x 10 x 10 x 10 x 10 x 10 x 10 x 10 x 10	5.49 5.49 2.28 3.70 2.11 3.05 5.3.47 3.05 5.3.47 3.63		30.52 8.66 25.51	 A A)+)-)-)-)-)-)-)-)-)-	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 2.6 = 1.0 = 0.4 = 4.7 = 1.7 = 0.0 =	12. 12. 12. 12. 12. 12. 12. 12.	2 01 6 01 8 01 8 01 9 01 9 01 9 01 1 01 4 00 9 00 5 00	Lad MATERS - Double Shad Walls had MATERS - Double Shad Walls bad MATERS - Double Shad Walls bad MATERS - Double Shad Walls bad MATERS - Converts Walls	0.139 0.139 0.130 0.130 0.139 0.139 0.139 0.139 0.247 0.139 0.247 0.247	100 168 190 168 138 190 258 258 258 260 258 260 258 258	00 90 90 90 90 90 90 90 90 90 90 90 90 9	East South South South South South West West West West West North	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 16 16 17 18 19 20	[model]_Wall_510327_5 [model]_Wall_50033_5 [model]_Wall_370860_5 [model]_Wall_370860_5 [model]_Wall_517870_W [model]_Wall_517870_W [model]_Wall_517874_W [model]_Wall_517854_W [model]_Wall_517854_W [model]_Wall_517854_N	8 8 8 8 8 8 8 8 8 8 8 8 8 9 9 9	External well - Ambient External well - Orbund		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	x(7, x(7, x(7, x(8, x(3, x(3,))))))))))))))))))))))))))))))))))))	10 x 10 x 10 x 10 x 16 x 13 x 13 x	5.49 5.49 2.28 3.70 2.11 3.05 5.3.47 3.05 5.3.47 3.63		30.52 8.66 25.51 19.92	 A A)-)-)-)-)-)-)-)-)-)-)-	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 2.6 = 1.0 = 0.4 = 4.7 = 1.7 = 0.0 =	12. 12. 12. 12. 12. 12. 12. 13. 10. 13. 27. 10. 13. 27. 10. 13. 27. 10. 13. 27. 10. 13. 27. 10. 13. 10. 13. 10. 13. 10. 13. 10. 13. 10. 10. 10. 10. 10. 10. 10. 10	2 01 6 01 8 01 8 01 9 01 9 01 1 01 1 01 1 01 0 00 0 00 5 00 9 00	Lad MATERS - Double Stud Walls free MATERS - Concerts Walls Dad MATERS - Concerts Walls	0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.247 0.247 0.247	100 168 190 168 138 190 258 258 258 269 258 260 258 258 348 348	00 90 90 90 90 90 90 90 90 90 90 90 90 9	East South South South South South West West West West West North North	0.99 0.99 0.99 0.99 0.99 0.99 0.99 0.99	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 15 16 17 18 19 20 21	[model]_Wal_516327_5 [model]_Wal_56633_5 [model]_Wal_378860_5 [model]_Wal_378860_5 [model]_Wal_378864_5 [model]_Wal_378864_5 [model]_Wal_517854_W [model]_Wal_517854_W [model]_Wal_517854_N [model]_Wal_517854_N [model]_Wal_517854_N	8 8 8 8 8 8 8 8 8 8 9 9 9 9	External wall - Ansbient External wall - Oncurd External wall - Oncurd External wall - Oncurd External wall - Oncurd		1 1 1 1 1 1 1 1 1 1 1 1 1 1	x(7, x(7, x(7, x(8, x(3, x(3,))))))))))))))))))))))))))))))))))))	x 10 x 11 x 12 x 13 x 14 x 15 x 16 x 17 x 18 x	229 5.49 226 3.70 2.11 4 3.05 4 3.63 4 3.63		30.52 8.66 25.51	 A B C C)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 1.0 = 0.4 = 1.7 = 1.7 = 1.7 = 0.0 = 0.0 =	12. 82/ 244 133 100 4.3 27/ 100 133 9.6 7.6 255 255 200 200	2 01 6 01 8 01 9 01 9 01 1 01 4 00 9 01 9 00 5 00 9 00 3 02	Los MATERS - Double Shud Walls had MATERS - Concents Walls bad MATERS - Concents Walls bad MATERS - Concents Walls bad MATERS - Concents Walls	0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.247 0.247 0.247 0.247 0.247	100 168 199 166 138 190 258 289 289 289 289 289 289 289 289 288 348 348 348	00 00 00 00 00 00 00 00 00 00 00 00 00	East South South South South South West West West West West North North East	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 15 16 17 18 19 20 21 22	[model]_Wal_51037_5 [model]_Wal_50033_5 [model]_Wal_50033_5 [model]_Wal_378940_5 [model]_Wal_378940_5 [model]_Wal_517320_W [model]_Wal_517320_W [model]_Wal_517320_W [model]_Wal_517324_W [model]_Wal_517324_N [model]_Wal_517324_N	8 8 8 8 8 8 8 8 8 8 8 9 9 9 9 9 9 9	Esternal well - Ambient Esternal well - Oncurd Esternal well - Oncurd Esternal well - Oncurd		1 1 1 1 1 1 1 1 1 1 1 1 1 1	x(7, x(7, x(8, x(8, x(3, x(3,))))))))))))))))))))))))))))))))))))	x 10 x 11 x 12 x 13 x 14 x 15 x 16 x x x x x x x x x x x x x x x x x x x	229 549 228 3.70 2.11 3.05 3.47 3.03 4 3.05 3.47 4 3.03 4 4 3.05 3.47 4 3.03 4 4 3.05 4 3.49 4 3.05 4 3.47 4 3.05 4 3.47 4 3.05 4 3.05 4 3.47 4 3.05 4 4 4 4 4 4 4 4 4 4 4 4 4		30.52 8.66 25.51 19.92	 A B C C)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 = 21.4 = 14.2 = 2.8 = 5.1 = 2.8 = 5.1 = 2.6 = 1.0 = 2.8 = 1.0	12. 82/ 244. 133. 100. 4.3 27/ 100. 133. 9.6 7.6 255. 255. 199. 200. 8.5	2 01 6 01 8 01 9 01 9 01 1 01 1 01 0 00 5 00 9 00 3 02 5 00	Tad-MAYEES - Double Shad Walls Tad-MAYEES - Double Shad Walls Dad-MAYEES - Concents Walls	0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.247 0.247 0.247 0.247 0.247	100 168 190 168 138 193 256 256 256 256 256 256 256 256 348 348 348 348	00 00 00 00 00 00 00 00 00 00 00 00 00	East South South South South South West West West West West North North East West	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23	[model]_Wall_516327_5 [model]_Wall_50633_5 [model]_Wall_378866_6 [model]_Wall_378866_5 [model]_Wall_378864_5 [model]_Wall_57786_W [model]_Wall_57786_W [model]_Wall_57786_W [model]_Wall_577864_W [model]_Wall_577864_N [model]_Wall_577946_N [model]_Wall_579946_W	8 8 8 8 8 8 8 8 8 8 9 9 9 9 9 9 9 9 9 9	External well - Ambient External well - Onound External well - Onound External well - Onound External well - Onound External well - Onound		1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1 1	x(7, x(7, x(8, x(8, x(3, x(3,))))))))))))))))))))))))))))))))))))	x 10 x 11 x 12 x 13 x 14 x 15 x 16 x x x x x x x x x x x x x x x x x x x	229 5.49 2.26 3.70 2.11 3.05 3.47 3.63 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		30.52 8.66 25.51 19.92 20.35	 A A)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 2.6 = 0.0 = 0.4 = 1.7 = 0.4 = 1.7 = 0.0 = 0.0 = 0.0 = 0.0 = 0.0 =	12. 82. 24. 13. 10. 13. 27. 10. 13. 27. 10. 13. 27. 26. 28. 28. 29. 20. 20. 8.5	2 64 6 74 8 74 9 64 9 7 9 7 9 7 7 9 7 7 7 7	Lot MAYTERS - Double Shud Walls hud MAYTERS - Concele Shud Hudle hud MAYTERS - Concele Shulls hud MAYTERS - Concele Shulls	6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.247 6.247 6.247 6.247 6.247	100 168 190 168 138 150 258 258 258 260 200 200 200 258 348 348 348 348 258 258	00 00 00 00 00 00 00 00 00 00 00 00 00	East South South South South South West West West North North North East West West	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 15 16 17 18 10 20 21 22 23 24	[model]_Wal_516327_5 [model]_Wal_56633_5 [model]_Wal_378860_5 [model]_Wal_378860_5 [model]_Wal_378864_8 [model]_Wal_378864_8 [model]_Wal_517854_W [model]_Wal_517854_W [model]_Wal_517854_W [model]_Wal_517854_N [model]_Wal_517854_N [model]_Wal_517854_N [model]_Wal_517854_W [model]_Wal_517854_W [model]_Wal_517785_W	8 8 8 8 8 8 8 8 8 8 8 8 9 9 9 9 9 9 9 9	External well - Ansbient External well - Oncurd External well - Oncurd		1 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5 5	x(7, x(7, x(7, x(8, x(8, x(4, x(3, x(3,x	x 10 x 11 x 12 x 13 x 14 x 15 x 16 x x x x x x x x x x x x x x x x x x x	229 549 228 3.70 2.11 3.05 3.47 3.03 4 3.05 3.47 4 3.03 4 4 3.05 3.47 4 3.03 4 4 3.05 4 3.49 4 3.05 4 3.47 4 3.05 4 3.47 4 3.05 4 3.05 4 3.47 4 3.05 4 4 4 4 4 4 4 4 4 4 4 4 4		30.52 8.66 25.51 19.92 20.35 127.60	· · · ·)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 - 21.4 - 21.4 - 21.4 - 2.8 - 2.8 - 2.8 - 2.8 - 2.8 - 2.8 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 -	12. 62. 24. 13. 10. 4.3 27. 10. 13. 9.6 7.6 25. 29. 20. 8.6.5 1.5 1.5 1.5 20. 20. 20. 20. 20. 21. 20. 20. 21. 21. 21. 21. 21. 21. 22. 23. 23. 24. 24. 24. 24. 24. 24. 24. 24. 24. 24	2 01 6 01 8 01 9 01 9 01 1 01 1 01 1 01 1 01 1 01 1 01 1 01 0 00 0 00	Los MATERS - Double Shud Walls Los MATERS - Double Walls Los MATERS - Concester Walls Los MATERS - Concester Walls Los MATERS - Concester Walls	6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.247 6.2788 6.27888 6.2788 6.2788 6.27888 6.278888 6.2788888888888888788	100 168 190 168 138 258 258 280 280 280 280 280 280 280 280 288 348 348 348 348 348 348 348 348	00 90 90 90 90 90 90 90 90 90 90 90 90 9	East South South South South West West West West North North East West Hor	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25	[model]_Wal_51037_5 [model]_Wal_50037_5 [model]_Wal_50035_5 [model]_Wal_37894_5 [model]_Wal_51780_W [model]_Wal_51782_W [model]_Wal_51782_W [model]_Wal_51782_W [model]_Wal_51784_W [model]_Wal_51784_W [model]_Wal_51784_W [model]_Wal_51784_W [model]_Wal_51784_W [model]_Wal_51784_W [model]_Wal_51784_W	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	External well - Ambient External well - Onound External well - Onound			x(7, x(7, x(7, x(8, x(3, x(3,))))))))))))))))))))))))))))))))))))	x 10 x x x x	2.29 5.40 2.26 3.70 2.21 3.05 3.47 3.63 4 2.44 1.07		30.52 8.66 25.51 19.92 20.35 127.60 0.53)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 - 21.4 - 14.2 - 0.0 - 2.8 - 1.0 - 2.8 - 1.0 - 1.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 -	12. 12. 12. 13. 10. 13. 10. 13. 10. 15. 10. 15. 26. 19. 20. 20. 20. 20. 21. 12. 20. 21. 22. 23. 24. 24. 24. 24. 24. 24. 24. 24	2 64 64 64 64 64 64 64 64 64 64 64 64 64	Tad-MATERS - Double Shad Walls Tad-MATERS - Double Shad Walls Dad-MATERS - Concents Walls	6.138 6.138 6.139 6.139 6.139 6.139 6.139 6.138 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247	100 168 199 168 133 255 255 255 255 255 255 255 255 255 2	00 00 00 00 00 00 00 00 00 00 00 00 00	East Bouth Bouth Bouth Bouth West West West West West North North North East West West Hor	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26	[model]_Wall_516327_5 [model]_Wall_50633_5 [model]_Wall_37886_5 [model]_Wall_37886_5 [model]_Wall_37886_8 [model]_Wall_51736_W [model]_Wall_51736_W [model]_Wall_51786_W [model]_Wall_51786_W [model]_Wall_51786_N [model]_Wall_51786_N [model]_Wall_51786_N [model]_Wall_51786_W [model]_Wall_51786_W [model]_Wall_51786_W [model]_Wall_51786_W	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 9	External wall - Ambient External wall - Oround External wall - Oround RooffCeiling - Ambient RooffCeiling - Ambient			x(7, x(7, x(7, x(8, x(8, x(4, x(3, x(3,))))))))))))))))))))))))))))))))))))	x 10 x 11 x 12 x 14 x 15 x	2.29 5.40 2.24 3.70 2.24 3.05 3.47 3.83 4 3.83 4 4 4 4 4 4 4 5.44 4 5.44 4 5.44		30.52 8.66 25.51 19.92 20.35 127.60 0.53 51.64	A A)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 = 21.4 = 14.2 = 0.0 = 2.8 = 5.1 = 2.8 = 5.1 = 2.8 = 5.1 = 6.1 = 0.4 = 0.5 = 0.6 = 0.0 = 0.0 = 0.0 = 0.0 = 0.0 = 0.0 = 0.0 = 0.0 = 0.0 = 0.0 =	12. 62/ 24/ 13. 10. 13. 27/ 10. 13. 0.6 7.6 25. 10. 20. 6.6 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5 1.5	2 6 6 7 7 8 8 7 7 8 8 7 7 8 8 7 7 8 8 7 7 8 7	Lot MAYTERS - Double Shud Walls hud MAYTERS - Concerts Walls hud MAYTERS - Typ. Celling hud MAYTERS - Typ. Celling	0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.139 0.247 0.247 0.247 0.247 0.247 0.247 0.247 0.247	100 168 199 169 138 259 259 259 259 259 259 258 258 258 258 258 258 258 258 258 258	93 93 93 93 93 93 93 93 93 93 93 93 93 9	East South South South South South West West West West North North East West Hor Hor Hor Hor	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27	[model]_Wal_516327_5 [model]_Wal_56633_5 [model]_Wal_378860_5 [model]_Wal_378860_5 [model]_Wal_378860_5 [model]_Wal_378860_5 [model]_Wal_517878_W [model]_Wal_517878_W [model]_Wal_517878_W [model]_Wal_517864_N [model]_Wal_517864_N [model]_Wal_51788_W [model]_Wal_379160_N [model]_Wal_379160_N [model]_Wal_517788_W	8 8 8 8 8 8 8 8 9 9 9 9 9 9 9 9 9 9 9 9	Estemal well - Anbient External well - Onound External well	9		x(7, x(7, x(3, x(3,x	x 10 x x x x	2.29 5.40 2.24 3.70 2.24 3.05 3.47 3.83 4 3.83 4 4 4 4 4 4 4 5.44 4 5.44 4 5.44		30.52 8.66 25.51 19.92 20.35 127.60 0.53 51.64 142.47	A A B A C A)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 - 21.4 - 14.2 - 0.0 - 2.8 - 5.1 - 2.8 - 1.0 - 0.4 - 1.7 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 -	12. 62. 24. 13. 10. 13. 27. 10. 13. 27. 10. 13. 27. 28. 28. 28. 28. 14. 20. 8.5 1.5 15. 14. 20. 8.5 1.5 15. 14. 20. 20. 20. 20. 20. 20. 20. 20. 20. 20	2 6 6 7 7 8 8 6 7 7 8 8 6 7 7 8 8 6 7 7 8 8 6 7 7 8 8 6 7 7 8 7 8	Lad MATERS - Double Shad Walls had MATERS - Concerts Walls	6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.139 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.247 6.278 6.78	100 168 199 168 130 258 258 258 259 258 258 258 258 258 258 258 258 258 258	000 000 000 000 000 000 000 000 000 00	East Bouth Bouth Bouth Bouth West West West West West West West West	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.55 0.95 0.95 0.95 0.95 0.95 0.95	
9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28	[model]_Wall_516377_5 [model]_Wall_50633_5 [model]_Wall_30860_5 [model]_Wall_378860_5 [model]_Wall_378860_5 [model]_Wall_517362_W [model]_Wall_517362_W [model]_Wall_517362_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Wall_517364_W [model]_Roof_379500_H	8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8	External well - Ambient External well - Oncurd External well - Oncurd	9		x 7. x 7. x 8.	x 10 x 11 x 12 x 14 x 15 x	2.29 5.40 2.24 3.70 2.11 3.05 3.47 3.63 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4 4		30.52 8.66 25.51 19.92 20.35 1127,60 0.53 51.64 142,47 0.53	· · · ·)-)-)-)-)-)-)-)-)-)-)-)-)-)	4.0 - 21.4 - 14.2 - 0.0 - 2.8 - 5.1 - 2.6 - 2.7 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 - 0.0 -	122 62/ 244 133 143 277 100 143 277 100 143 275 275 275 275 285 295 295 295 295 295 295 295 295 295 29	2 0 00 8 00 8 00 9 00	1ad-MATERS - Double Shad Walls 1ad-MATERS - Concent Walls 1ad-MATERS - Conce	0.139 0.247 0.	100 168 199 168 130 258 269 269 269 269 269 269 269 269 258 269 258 258 258 258 258 258 258 258 258 258	99 90 90 90 90 90 90 90 90 90 90 90 90 9	East Bouth Bouth Bouth Bouth West West West West West West West West	0.90 0.90 0.90 0.90 0.90 0.90 0.90 0.90	0.95 0.65 0.95 0.95 0.95 0.95 0.95 0.95 0.95 0.9	
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Designing for Net Zero Energy:

Build It!



Modular Construction





Quality Control

Repeatable, reliable quality every time

Precision Manufacturing

Fully coordinated construction team and building trades



Superior Components

Quality modular homes are superior to "site-built" homes





Building a modular high performance building is like building a Swiss watch or Apple iPhone – the team spends many months in integrative design, ensuring that all the components are exactly right. Construction doesn't start until every detail is worked out.







- There is no shortcut to innovation. Encourage (actual) integrative design: Inspire, but force the team to collaborate if you have to. Challenge normal assumptions. Have very long conference calls. Be the worst (or best?) client ever
- **Developer-led design build:** there's a reason so many Passive House developers also wear another hat (or 3)
- Cost-effective, durable, reproducible solutions: Spend lots of time on R&D, then build on that. Sometimes the best products are not for sale in the USA and you have to go and find them. More – and more specialized consultants – is not the answer
- **Pre-fab:** Find ways to simplify construction, achieve efficiency. Don't build small multifamily or single family in the field if you can help it. We'd pay to bury the power lines if we had to
- Re-envision the team: Real estate is a form of serial entrepreneurship every deal is different – which discourages learning and collaboration. The team matters. Stack Eight's site plan was heavily influenced by the landscape architect – their discipline is usually an afterthought
- Nothing beats field experience: Its essential to suffer through the details on an actual construction project to understand how to design a buildable project

"Innovation in the construction industry continues to be constrained by deep-seated barriers, including a lack of emphasis on R&D, a high degree of fragmentation, and widespread risk aversion."

-Reinventing Construction: A Route to Higher Productivity, McKinsey, 2017

Jessica Pitts Flywheel Development jpitts@flywheeldevelopment.com 202.403.7338