



Architecture + Activism
Decarbonizing Strategies for
New Construction Residential

ONION
FLATS

ARCHITECTURE

Tim McDonald

tim@onionflats.com

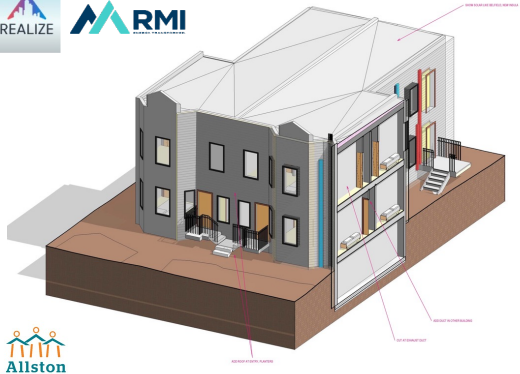
215.783.5591



1997

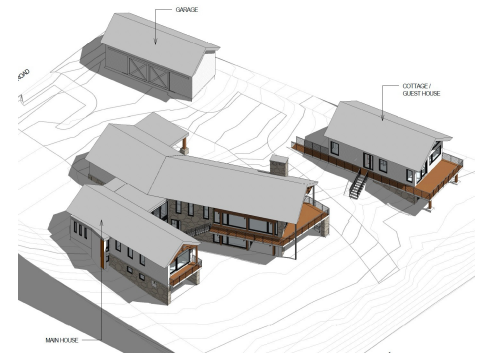
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2024



1-39 Hano St
Boston, MA

20 units, *Passive House, NZE*
RMI: REALIZE Retrofit Program



Lake House
Thompson, PA

Single Family home, *Passive House, NZE*



Rust House
Phila, PA

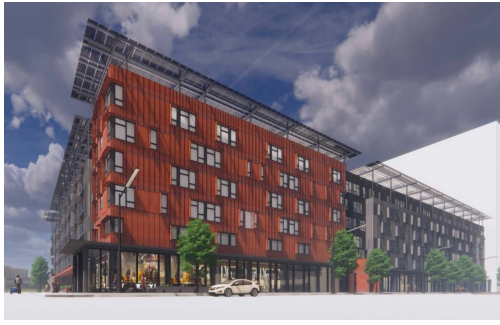
Single Family home, *Passive House*

CURRENT + RECENT PROJECTS



Copper Flats
Phila, Pa

88 units, *Passive House, NZE*



Morris Steel
Phila, PA

692 units, *Passive House, NZE*



Mercill Flats
Jackson Hole, WY

30 units, *Passive House, NZE*



Mermaid Lane
Phila, PA

280 units, *Passive House, NZE*



1600 North St
Baltimore, MD
17 units, **Passive House, NZE**



Snow King
Jackson Hole, WY
24 units, **Passive House, NZE**



Fairmount Commons
Newark, NJ
240 units, **Passive House, NZE**



Rhodia
Louisville, KY
600 units, **Passive House, NZE**



Parade St. Commons
Erie, PA
40 units, **Passive House, NZE**



Vine St NZE
Philadelphia, PA
220 units, **Passive House, NZE**



Radwyn Housing
Radwyn, PA
48 units, **Passive House, NZE**



STABLE FLATS 2015: 26 townhomes



\$150/sf

STABLE FLATS 2015: 26 townhomes

PREFABRICATE





MAKE IT TIGHT VENT IT RIGHT

FINAL AIRFLOW

.49 ACH 50



ENERGY/BUILDING CONSULTANTS & ENGINEERS

One Crescent Drive • Philadelphia, PA 19112 • 1-888-MAGRANN • www.magrann.com

New Jersey • Pennsylvania • Kentucky • Ohio

BUILDING LEAKAGE TEST COMPARISON

Test #1

Test File: Depressurization File
Date of Test: 7/5/2012
Customer: Onion Flats, LLC
111 West Norris Street
Philadelphia, Pennsylvania 19122
Phone: 215-783-5591

Test #2

Test File: Pressurization File
Date of Test: 7/5/2012
Customer: Onion Flats

Test Results

	Test #1	Test #2	Change	Percent
1. Airflow at 50 Pascals:	293 CFM	201 CFM	-92 CFM	-31.4 %
	0.48 ACH	0.33 ACH	-0.15 ACH	-31.4 %



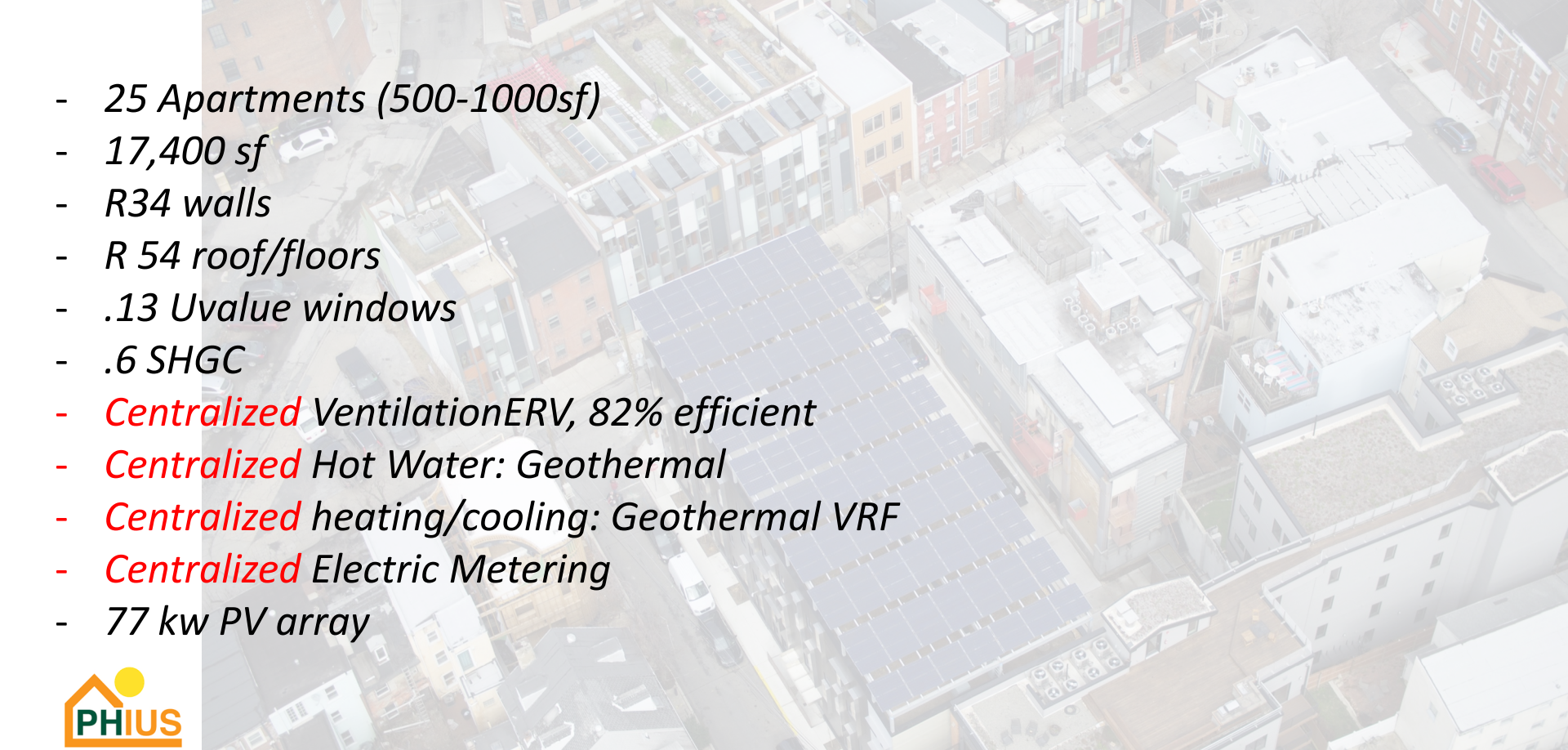




INTEGRATE SOLAR





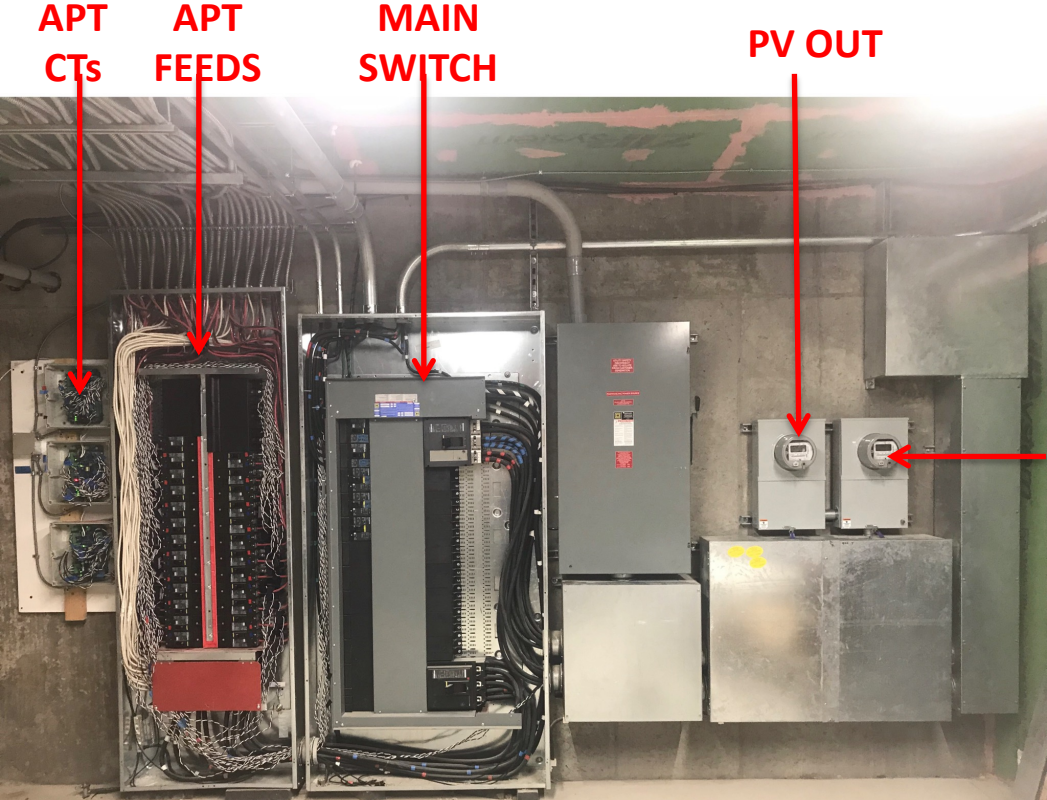
- 
- 25 Apartments (500-1000sf)
 - 17,400 sf
 - R34 walls
 - R 54 roof/floors
 - .13 Uvalue windows
 - .6 SHGC
 - **Centralized** VentilationERV, 82% efficient
 - **Centralized** Hot Water: Geothermal
 - **Centralized** heating/cooling: Geothermal VRF
 - **Centralized** Electric Metering
 - 77 kw PV array

PANELIZE



ELECTRIFY + SIMPLIFY

(master meter)



TENANTS CHARGED
FLAT FEE OF
\$100/month
for ALL utilities

ELECTRICITY
IN





INTEGRATE SOLAR

INCENTIVIZE
+ EDUCATE



WHO'S WHO???



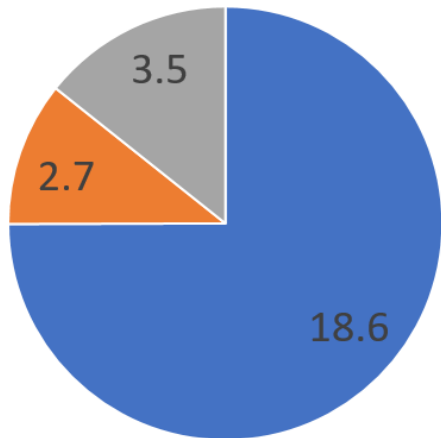
\$169/sf

Home
Building Electricity
Apartment Energy
DHW
Data

Summary ^

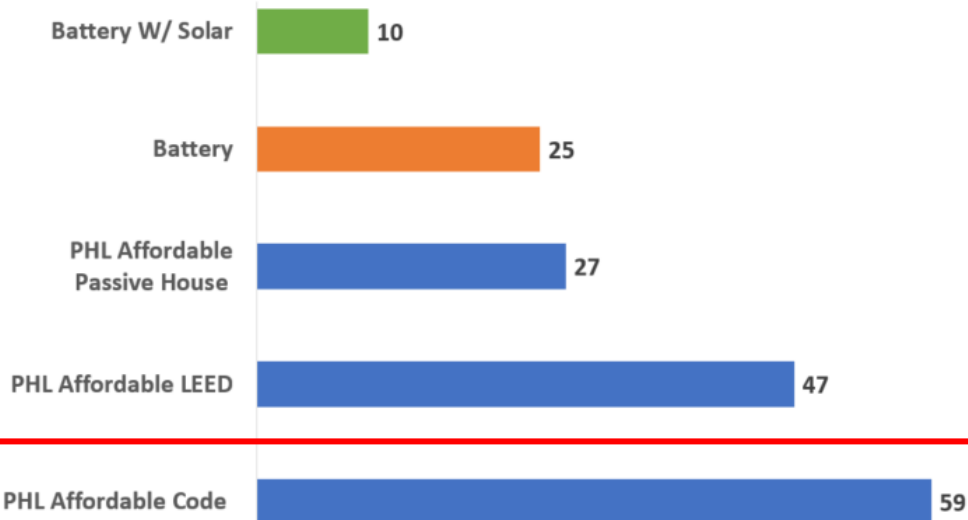
Battery End Use

2020-2021



- Total Baseload Site Energy
- Total Heating Site Energy
- Total Cooling Site Energy

EUI: Site Energy Use Intensity Comparison (kBtu/SF)



83% BETTER THAN CODE BLDG

- 28 Apartments (300-500sf)
- 24,141 sf
- R34 walls, panelized system
- R 54 roof/floors
- **DE-Centralized** VentilationERV
- **DE-Centralized** heating/cooling
- **SEMI-Centralized** Hot Water
- **Centralized** Electric Metering
- 174 kw PV array

FRONT FLATS 2020: 28 units and Office



- 28 Apartments (300-500sf)
- 24,141 sf
- R34 walls, panelized system
- R 54 roof/floors
- *DE-Centralized* VentilationERV
- *DE-Centralized* heating/cooling
- *SEMI-Centralized* Hot Water
- *Centralized* Electric Metering
- 174 kw PV array

FRONT FLATS 2020: 28 units and Office



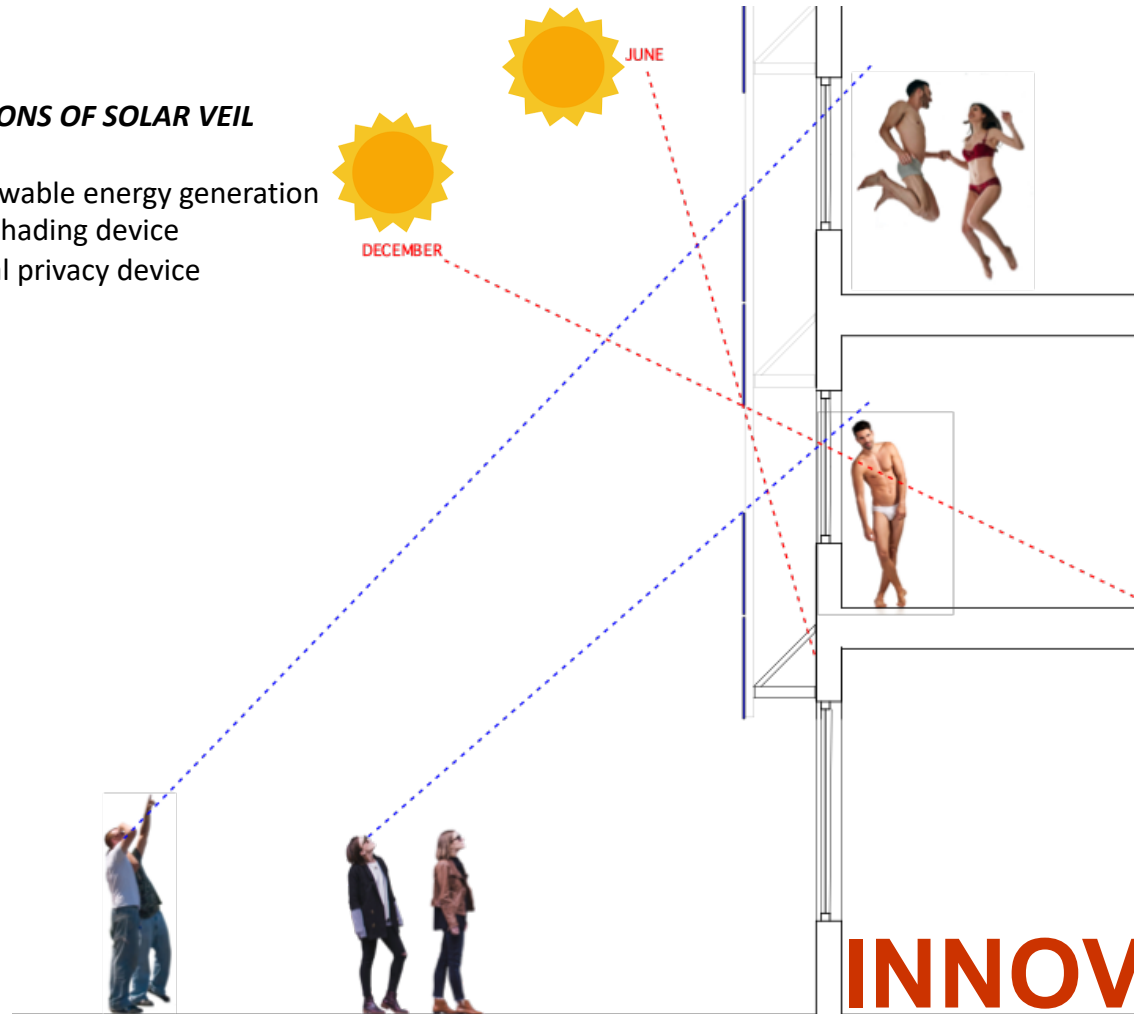
INTEGRATE SOLAR





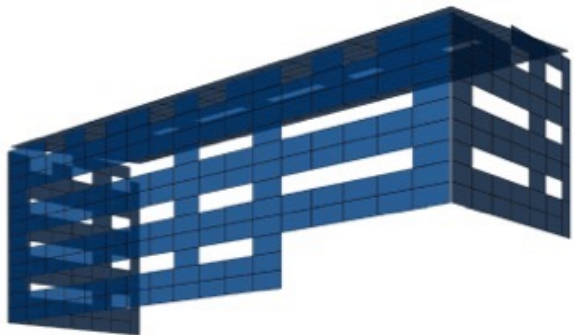
FUNCTIONS OF SOLAR VEIL

- Renewable energy generation
- Sun shading device
- Visual privacy device



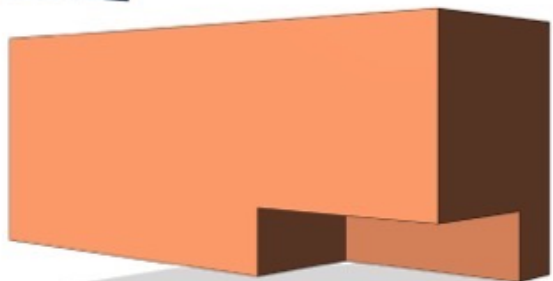
INNOVATE





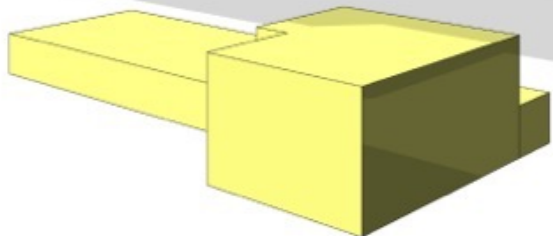
SOLAR
PRODUCTION
165,260 kWh/yr

PROJECTED
156,698 kWh/yr



RESIDENTIAL
CONSUMPTION
138,501 kWh/yr

PROJECTED
131,648 kWh/yr



OFFICE/STORAGE
CONSUMPTION
30,402 kWh/yr

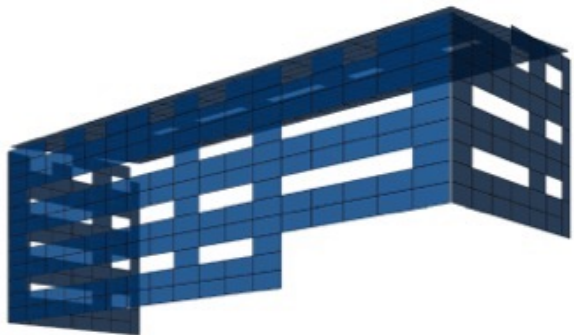
TOTAL BUILDING
CONSUMPTION
168,904 kWh/yr

NET *POSITIVE*
RESIDENTIAL
ENERGY PRODUCTION
26,758 kWh/yr

PROJECTED
25,050 kWh/yr

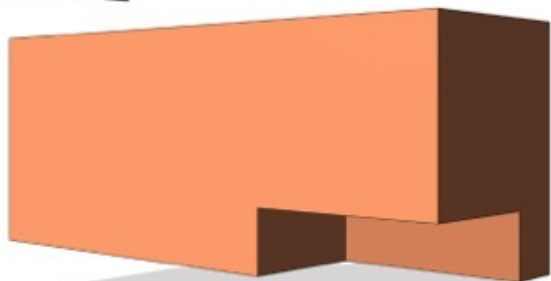
MONITORED ACTUAL 2020 CONSUMPTION/PRODUCTION

2020 Month	Solar Generation kWh	Total Building Usage kWh
Jan	12,207	9,819
Feb	11,346	9,106
Mar	15,290	9,412
Apr	14,797	9,124
May	15,290	10,065
Jun	18,708	17,237
Jul	16,156	21,471
Aug	13,866	21,706
Sep	15,411	17,411
Oct	12,262	15,399
Nov	11,749	14,593
Dec	8,177	13,562
Total	165,260	168,904



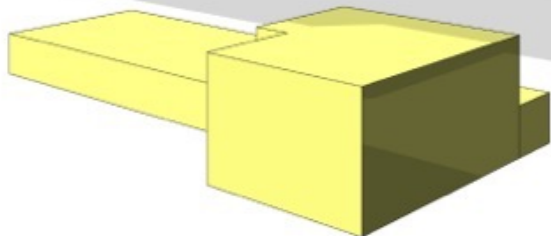
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OFFICE/STORAGE
CONSUMPTION
30,402 kWh/yr

TOTAL BUILDING
CONSUMPTION
168,904 kWh/yr

NET *POSITIVE*
RESIDENTIAL
ENERGY PRODUCTION
26, 758 kWh/yr

PROJECTED
25,050 kWh/yr

UTILITIES AS REVENUE

**\$40/month x 28 x 12 =
\$13,440.00**

**26,758 kWh x \$.12=
\$3211.00**

**\$16,651.00
ADDITIONAL
REVENUE**

HEATING, COOLING, VENTILATION, DEHUMIDIFICATION

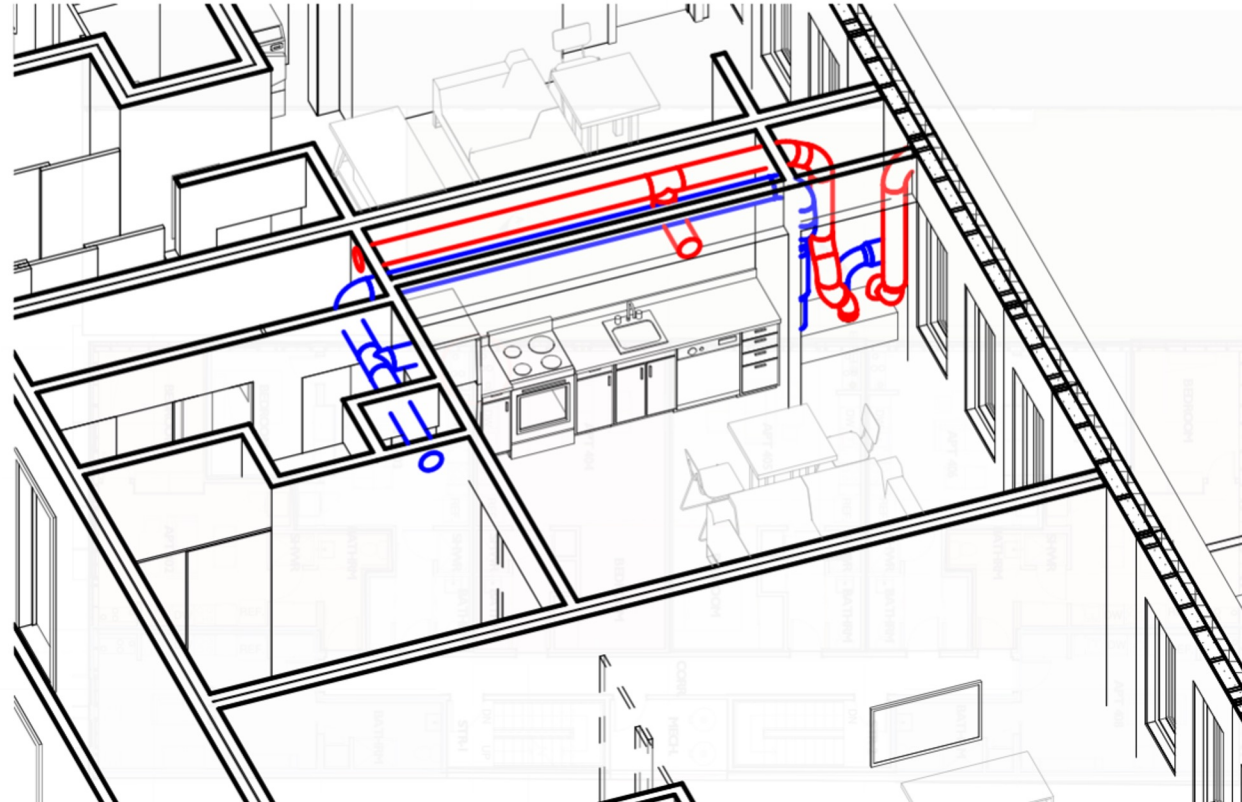


- Decentralized
- Combination ERV, heating, cooling
- Condenser self-contained
- No separate HVAC needed for hallways

B

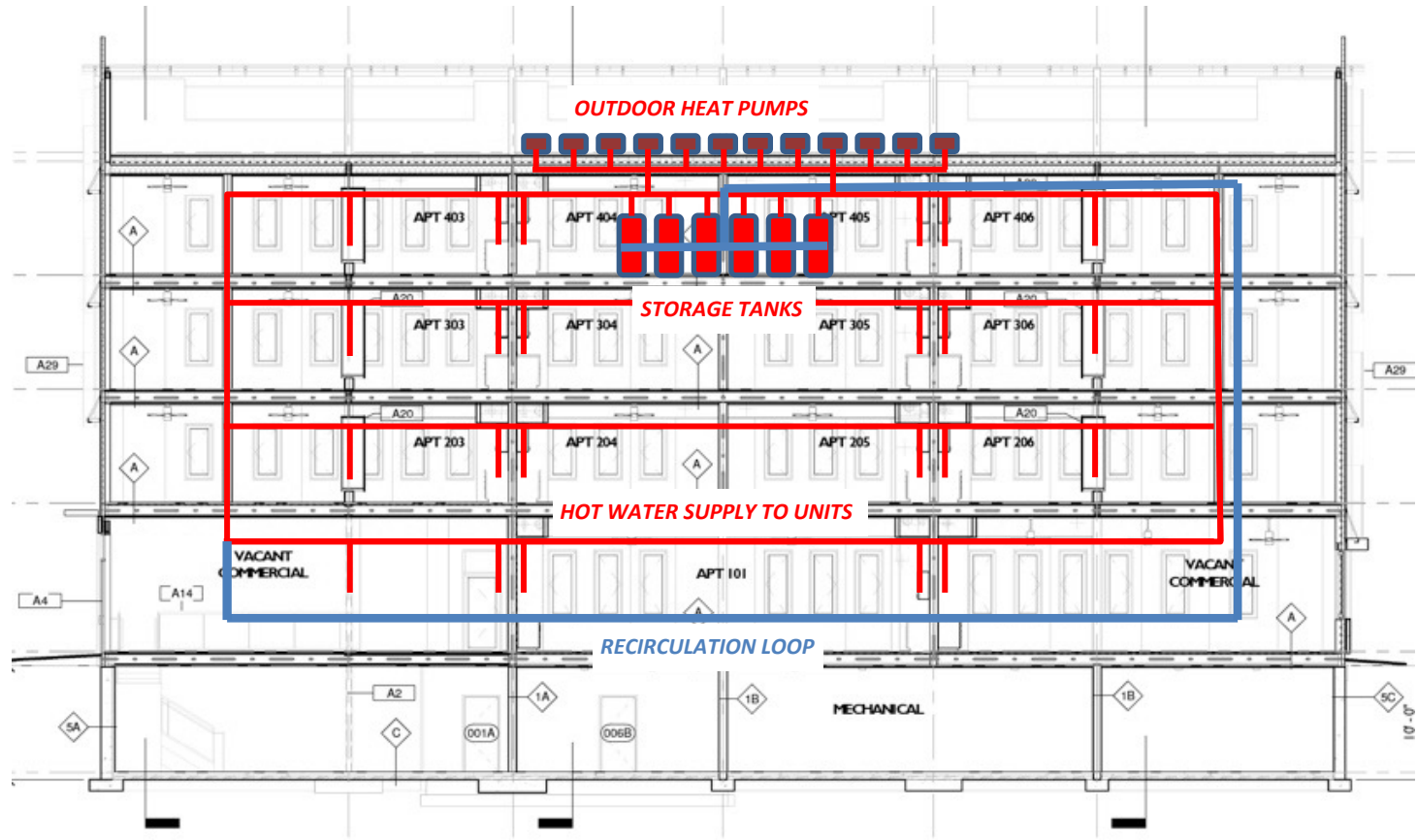
A

DECENTRALIZE





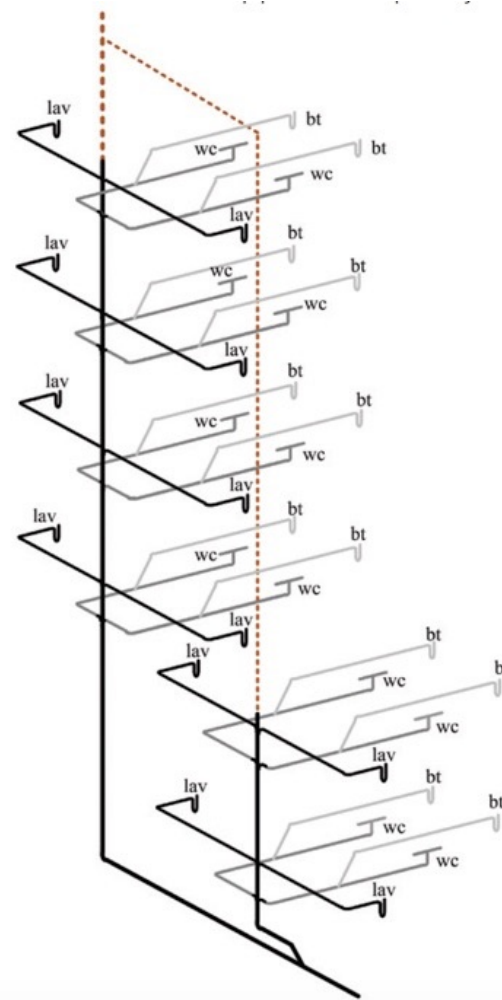
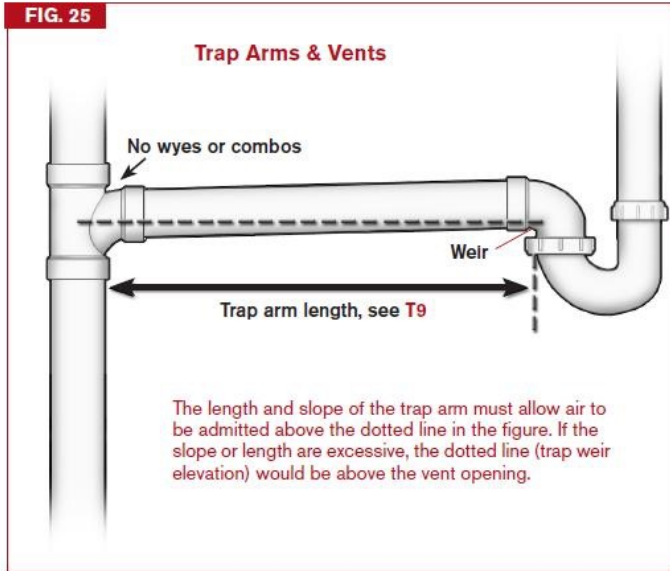
HVAC Closet merged with Kitchen cabinetry



Domestic Hot Water Strategy: *CENTRALIZED*

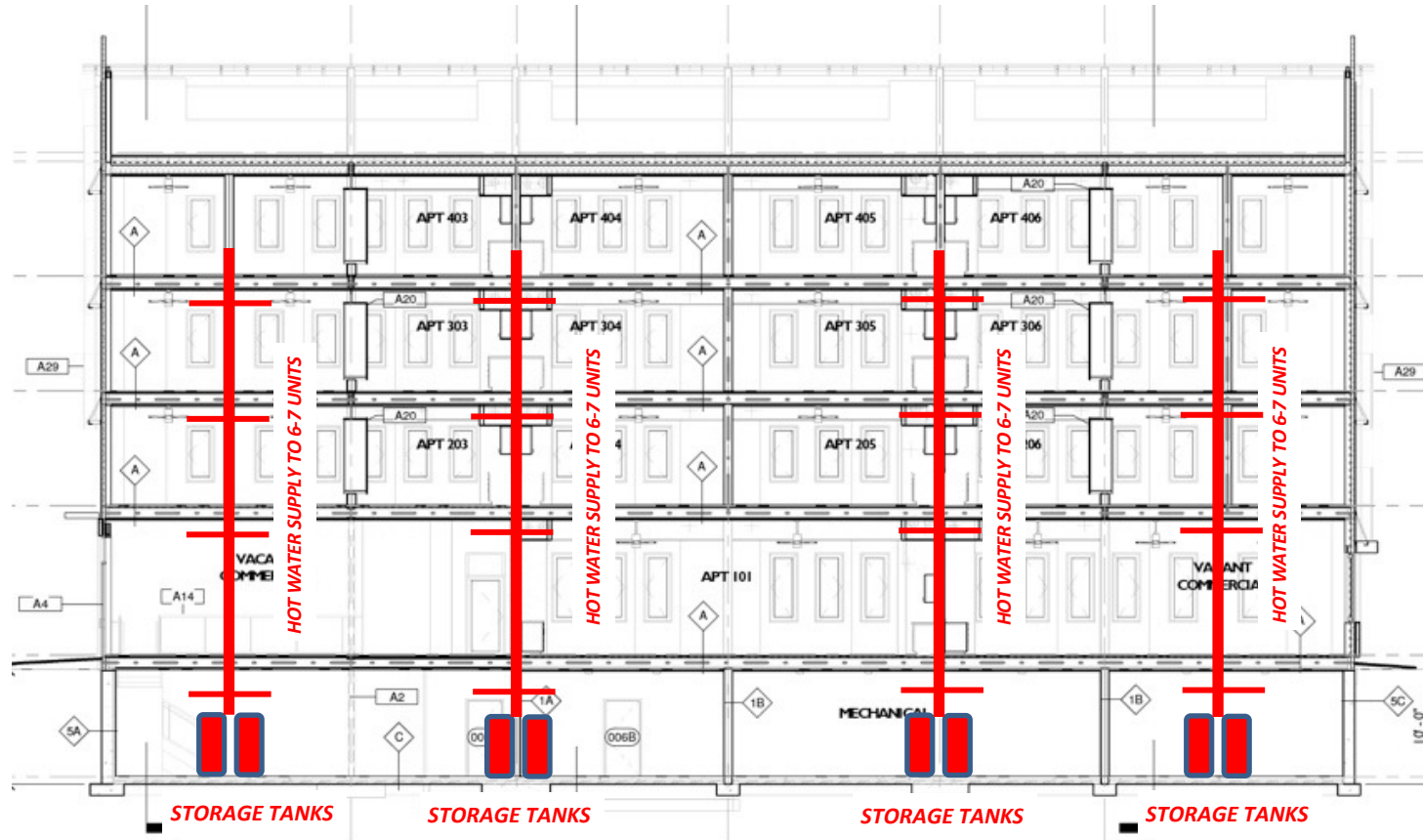
Table 9	MAX. TRAP ARM DISTANCE [T3105.1] & (T10-1)	
Trap Arm (in.)	[IRC] Distance Trap to Vent	(UPC) Distance Trap to Vent
1 1/4	5ft.	2ft. 6in.
1 1/2	6ft.	3ft. 6in.
2	8ft.	5ft.
3	12ft.	6ft.
4 or larger	16ft.	10ft.

Trap arm length from WC [unlimited] (6ft.)

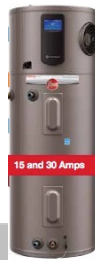


Single Stack System for a Six Story Building

Domestic Hot Water Strategy: FOLLOW THE VENT STACK!!

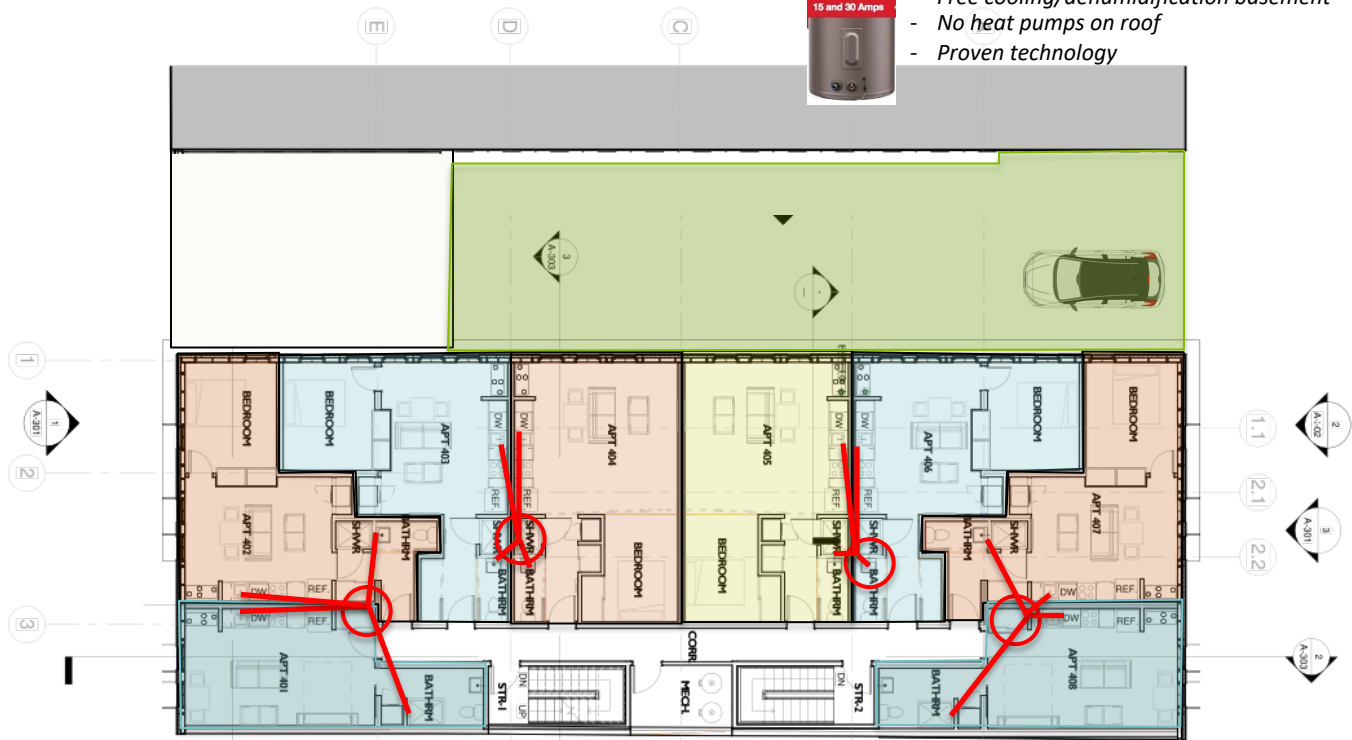


Domestic Hot Water Strategy: FOLLOW THE VENT STACK!!



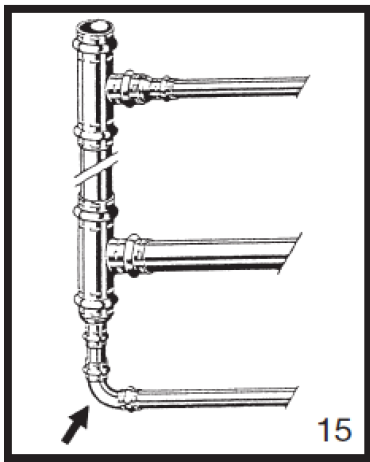
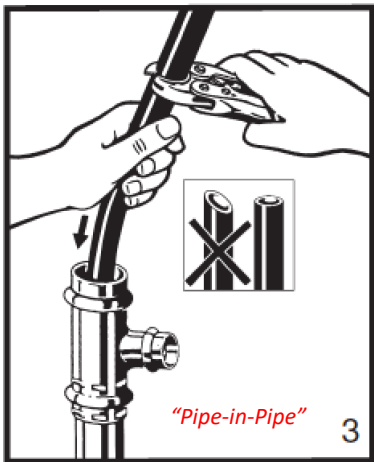
RHEEM HPWH

- ½ PRICE!!
- ½" the piping/heat loss
- Located in basement
- Free cooling/dehumidification basement
- No heat pumps on roof
- Proven technology



2ND -4TH FLOORS

Domestic Hot Water Strategy: SEMI-CENTRALIZED



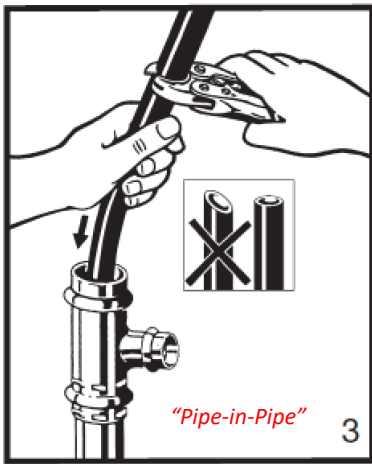
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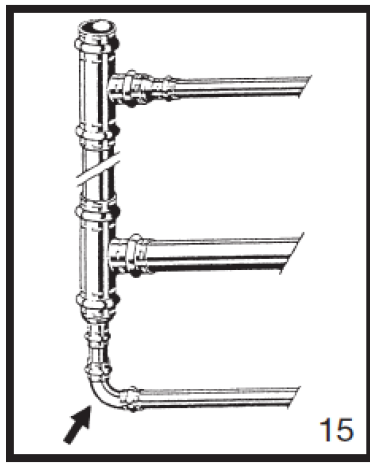
2ND -4TH FLOORS

PIPE-IN-PIPE Recirculation Loop Strategy



"Pipe-in-Pipe"

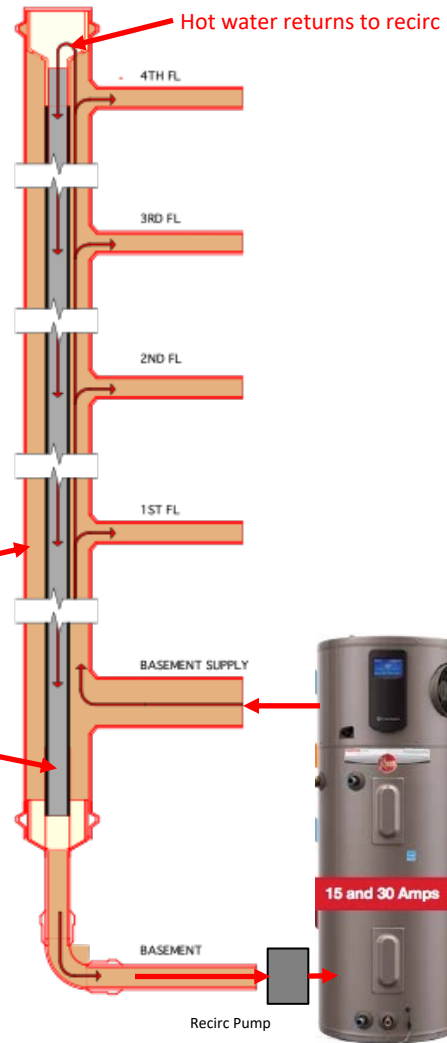
3



15

Copper Hot water supply line to apartments

PVC Recirc line



PIPE-IN-PIPE Recirculation Loop Strategy

2 – 80 gallon HPWH for 6-7 Apartments



FIRST

CERTIFIED
PASSIVE HOUSE
IN
PENNSYLVANIA

START: APRIL 20, 2012

CERTIFICATE OF OCCUPANCY: JULY 20, 2012



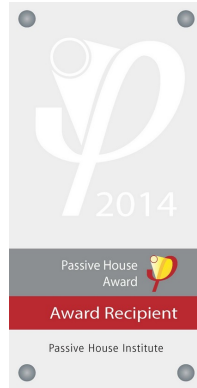
RECIPIENT OF THE

2014 INTERNATIONAL
PASSIVE HOUSE AWARD



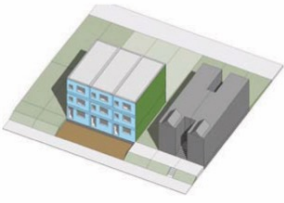
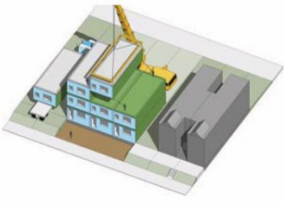
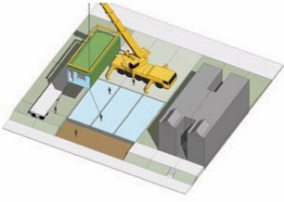
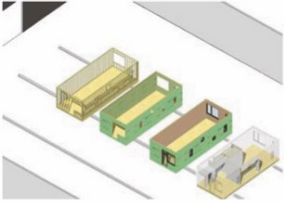
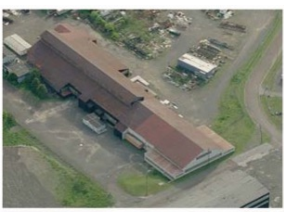
SECOND PLACE WINNER

2015 PHIUS AWARD
"AFFORDABLE HOUSING"

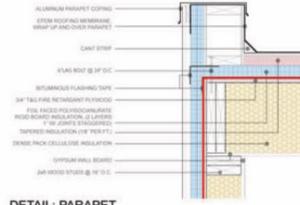


BELFIELD HOMES
PHILADELPHIA, PENNSYLVANIA 19141

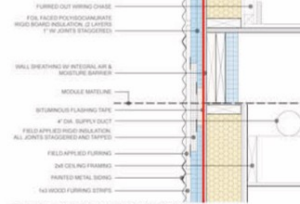




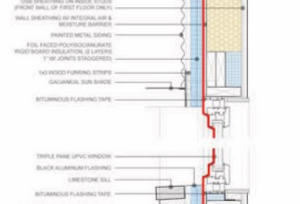
FACTORY BUILD



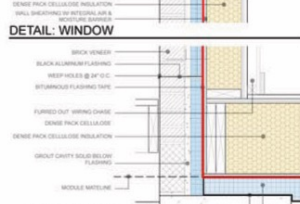
DETAIL: PARAPET



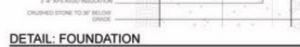
DETAIL: MODULE CONNECTION



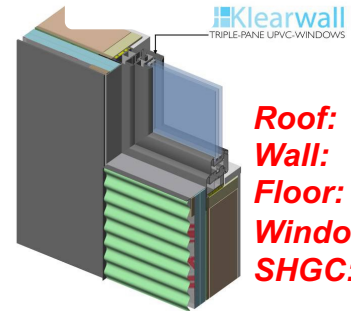
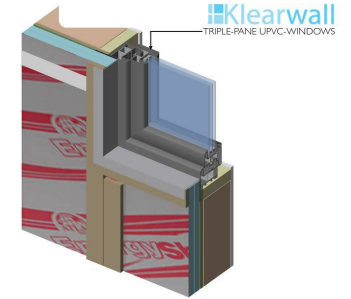
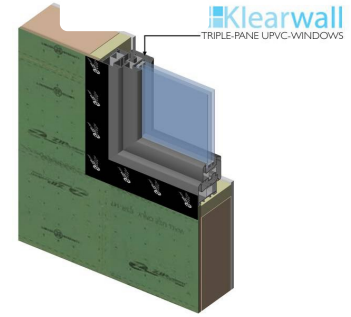
DETAIL: WINDOW



DETAIL: FOUNDATION



0 1 2 3 4 5



Roof: R52.3
Wall: R33.6
Floor: 58.4
Window: .11
SHGC: .63









\$129/sf



PHFA

PENNSYLVANIA HOUSING FINANCE AGENCY



An aerial photograph of a residential neighborhood. In the foreground, a modern, multi-story building with a flat roof is covered in solar panels. The building has several windows with teal-colored frames. The surrounding area consists of various residential buildings, some with gabled roofs, and a mix of greenery. The sky is blue with scattered white clouds.

**MAKE ALL AFFORDABLE HOUSING
NET-ZERO-ENERGY-CAPABLE BY 2030**



9% Low Income House Tax Credit (LIHTC)

QAP

Qualified Allocation Plan

POINTS-BASED SYSTEM



Total points	120
Community and Economic Impact	30
- Underserved Areas	
- Senior Occupancy Developments	
- Preservation	
Development Characteristics	25
- Smart Site Selection	
- Enterprise Green Communities	
Resident Population and Services	50
- Income and Rent Targeting	
- Designated Populations and Supportive Services	
- Accessible Units	
- Large Families	
Development Process	15
- Noncompliance	
- Ability to Proceed	
Development Cost Savings	10

POINTS-BASED SYSTEM



Total points	120
Community and Economic Impact	30
- Underserved Areas	
- Senior Occupancy Developments	
- Preservation	
Development Characteristics	25
- Smart Site Selection	
- Enterprise Green Communities	
- PASSIVE HOUSE	10
Resident Population and Services	50
- Income and Rent Targeting	
- Designated Populations and Supportive Services	
- Accessible Units	
- Large Families	
Development Process	15
- Noncompliance	
- Ability to Proceed	
Development Cost Savings	10

38% applied as Passive House projects

7 PH projects Funded

YEAR 1 A NATIONAL Net-Zero-Energy Initiative by **2030**
2015

Construction Cost Summary from PHFA Applications

2015 Costs

Single Family / Townhouse

Proj. No.	County	Climate Zone	Units (by BR Qty)					Total Units	Bldg. Area	Constr. \$	\$/Unit	\$/SF
			0	1	2	3	4+					
SF-1	Franklin	5A			33	21		54	70,218	7,051,522	130,584	100
SF-2	Schuylkill	5A		3	9	5		17	21,151	2,238,725	131,690	106
SF-3	Philadelphia	4A		5	19	31	5	60	79,795	9,363,626	156,600	117
SF-4	Allegheny	5A			26	19		45	63,548	8,863,631	196,970	117
SF-5	Lycoming	5A		16	34			50	66,147	8,141,437	162,829	123
SF-6	Bradford	5A		10	24	16		50	62,956	7,964,823	159,296	127
SF-7	Centre	5A			20	20		40	53,652	7,523,233	188,081	140
SF-8	Lebanon	5A			46	16		62	84,168	11,742,459	189,395	140
SF-9	Bradford	5A		2	26	12		40	59,954	8,369,296	209,232	140
SF-10	Butler	5A		3	39	18		60	67,904	9,827,275	163,788	145
SF-11	Erie	5A			9	34		43	53,454	7,870,669	183,039	147
SF-12	Dauphin	5A		3	3	25	4	35	61,504	9,192,750	262,650	149
SF-13	Berks	5A		22	20	16		58	62,097	9,305,340	160,437	150
SF-14	Franklin	5A		7	25	24		56	77,469	11,791,991	210,571	152
SF-15	Luzerne	5A		26	15	15		56	56,250	8,968,491	160,152	159
SF-16	Union	5A		5	12	8	6	31	43,868	7,071,066	228,099	161
SF-17	Chester	4A		48	12			60	58,349	9,809,238	163,487	168
SF-18	Allegheny	5A		4	30	18		52	77,351	12,979,386	249,604	168
SF-19	Berks	5A		10	21	11		42	57,722	9,785,000	232,976	170
SF-20	Montgomery	4A		16	24	15		55	61,480	11,113,700	202,067	181
SF-21	Delaware	4A		8	34	14		56	65,790	12,184,074	217,573	185
SF-22	Philadelphia	4A			17	16	2	35	45,476	8,905,240	254,435	196
SF-23	Allegheny	5A		14	9			23	28,205	5,552,583	241,417	197
SF-24	Westmoreland	5A		28	8			36	43,872	8,331,567	231,432	245
SF-25	Philadelphia	4A		10	19	11		40	46,757	11,453,809	286,345	245

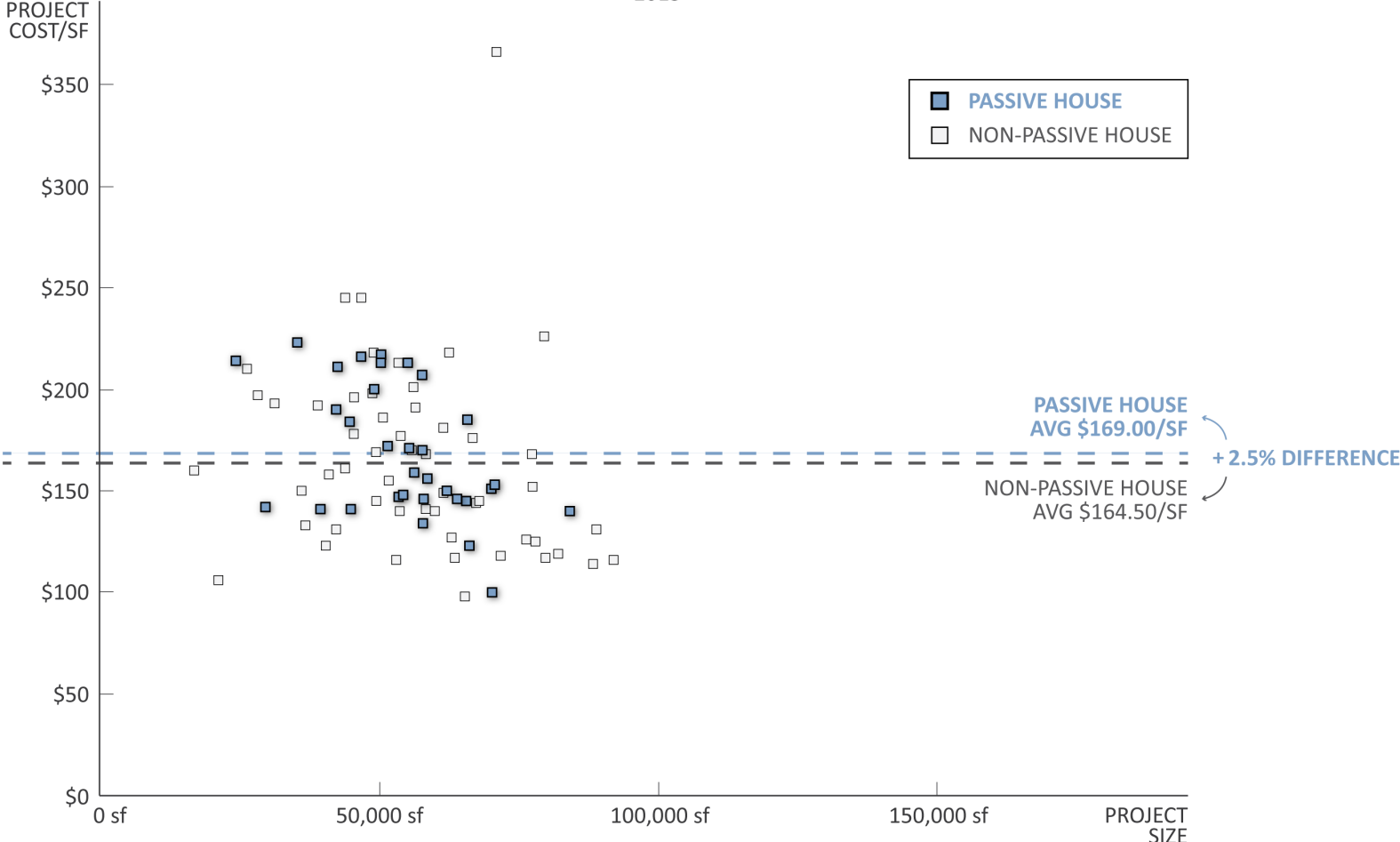
Adaptive Reuse

AR-1	Lehigh	5A		34	4	11		49	65,339	6,392,809	130,465	98
AR-2	Erie	5A		29	16			45	53,021	6,152,972	136,733	116
AR-3	Philadelphia	4A	12	54				66	77,975	9,751,707	147,753	125
AR-4	Allegheny	5A	2	49	4			55	65,577	9,514,764	172,996	145
AR-5	Delaware	4A		53				53	51,690	8,030,480	151,518	155
AR-6	Philadelphia	4A		44				44	49,406	8,361,579	190,036	169
AR-7	Montgomery	4A		33	3	7		43	55,832	9,468,816	220,205	170
AR-8	Philadelphia	4A			28	10		38	53,840	9,515,893	250,418	177
AR-9	Dauphin	5A	5	17	6			28	45,434	8,075,064	288,395	178
AR-10	Allegheny	5A		33	3			36	50,664	9,436,523	262,126	186
AR-11	Philadelphia	4A		46				46	56,478	10,795,027	234,675	191
AR-12	Philadelphia	4A		27	10			37	48,768	9,658,098	261,030	198
AR-13	Philadelphia	4A		30	21			51	62,509	13,609,683	266,857	218
AR-14	Washington	4A		17	7			24	35,299	7,856,113	327,338	223
AR-15	Philadelphia	4A		62				62	70,991	25,995,741	419,286	366

Multi-Story / Elevator

MS-1	Northumberland	5A		35				35	40,397	4,276,084	122,174	106
MS-2	Dauphin	5A		22	14		50	88,314	10,055,562	201,111	114	
MS-3	Dauphin	5A		18	59		77	92,000	10,668,511	138,552	116	
MS-4	Lancaster	5A		46	6		52	71,758	8,456,719	162,629	118	
MS-5	Blair	5A		33	20		53	82,070	9,727,007	183,528	119	
MS-6	Chester	4A		46	15		61	76,340	9,638,964	158,016	126	
MS-7	Lancaster	5A		13	39	26	78	88,910	11,681,226	149,759	131	
MS-8	Clearfield	6A		24	6		30	42,254	5,551,584	185,053	131	
MS-9	Indiana	5A		40			40	36,743	4,898,995	122,475	133	
MS-10	Bradford	5A		50	6		56	57,817	7,738,172	138,182	134	
MS-11	Cambria	5A		32	11		43	44,887	6,341,616	147,479	141	
MS-12	Dauphin	5A		38	16		54	58,335	8,201,250	151,875	141	
MS-13	Mifflin	5A		30	4		34	39,447	5,559,187	163,506	141	
MS-14	Fayette	5A		12	12		24	29,566	4,192,325	174,680	142	
MS-15	Allegheny	5A		24	12	13	49	67,340	9,698,634	197,931	144	
MS-16	Lackawanna	5A		44	4		48	49,460	7,159,738	149,161	145	
MS-17	Lehigh	5A		54	7		61	63,949	9,318,159	152,757	146	
MS-18	Centre	5A		37	11		48	57,959	8,490,644	176,888	146	
MS-19	Chester	4A		41	3	5	49	54,287	8,007,477	163,418	148	
MS-20	Fayette	5A		21	3		24	36,064	5,407,359	225,307	150	
MS-21	Chester	4A		61	3		64	70,083	10,557,500	164,961	151	
MS-22	Allegheny	5A		54	12		66	70,689	10,787,052	163,440	153	
MS-23	Allegheny	5A		40	6		46	58,617	9,134,790	198,582	156	
MS-24	Wayne	6A		36	4		40	40,959	6,460,530	161,513	158	
MS-25	Centre	5A			12		12	16,796	2,683,900	223,658	160	
MS-26	Beaver	5A		40	12		52	55,361	9,468,440	182,085	171	
MS-27	Lancaster	5A		51			51	51,500	8,871,635	173,954	172	
MS-28	Allegheny	5A		52	8		60	66,733	11,716,729	195,279	176	
MS-29	Montgomery	4A		40	4		44	44,687	8,202,314	186,416	184	
MS-30	Montgomery	4A		50			50	42,265	8,029,015	160,580	190	
MS-31	Crawford	5A		36	4		40	38,953	7,490,675	187,267	192	
MS-32	Philadelphia	4A		9	8	7	24	31,220	6,031,050	251,294	193	
MS-33	Westmoreland	5A		47			47	49,080	9,825,224	209,047	200	
MS-34	Philadelphia	4A		58	4		62	56,120	11,262,762	181,657	201	
MS-35	Philadelphia	4A	60				60	57,672	11,915,227	198,587	207	
MS-36	Philadelphia	4A		20	4		24	26,284	5,523,620	230,151	210	
MS-37	Philadelphia	4A		34	11		45	42,523	8,964,723	199,216	211	
MS-38	Philadelphia	4A		52			52	50,275	10,703,403	205,835	213	
MS-39	Philadelphia	4A		39	11		50	53,416	11,371,112	227,422	213	
MS-40	Philadelphia	4A		45	5		50	55,099	11,747,269	234,945	213	
MS-41	Philadelphia	4A		24			24	24,284	5,194,462	216,436	214	
MS-42	Philadelphia	4A		45			45	46,754	10,118,014	224,845	216	
MS-43	Philadelphia	4A		53			53	50,312	10,900,733	205,674	217	
MS-44	Philadelphia	4A		54			54	48,965	10,664,381	197,489	218	
MS-45	Philadelphia	4A	88				88	79,650	18,005,791	204,611	226	

CONSTRUCTION COST OF PROPOSED PROJECTS TO PHFA 2015



DATA SOURCE: PENNSYLVANIA HOUSING FINANCE AGENCY
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St. John Nueman
Phila, PA
52 Units



Wynne
Phila, PA
51 Units



Sacred Heart
Allentown, PA
61 Units



WhiteHall
Spring City, PA
49 Units



Hillcrest
Pittsburgh, PA
65 Units



Washington Square
Townhomes
Chambersburg, Pa
54 Units



Mann Edge
Lewistown, Pa
34 Units



7 Passive House Projects **COMPLETED**

10 PH projects Funded

Construction Cost Summary for PHFA 2016 Applications													
Proj. No.	County	Climate Zone	Units by BR Qty					Total Units	Resid. Bldg. Area	Resid. Constr. \$	\$ / Unit	\$ / SF	
			0	1	2	3	4+						
SF-01	Dauphin	5A		14	16	15	15	60	99,625	10,419,031	173,65	105	
SF-02	Lebanon	5A		9	32	14		55	78,627	8,446,000	153,56	107	
SF-03	Lycoming	5A		20	40			60	82,730	9,436,382	157,23	114	
SF-04	Columbia	5A			7	17		24	48,499	5,669,777	236,24	117	
SF-05	Philadelphia	4A		5	19	31	5	60	79,795	9,739,093	162,33	122	
SF-06	Wyoming	5A			30	12		42	72,100	9,168,380	218,29	127	
SF-07	Erie	5A		8	20	18		46	85,819	10,964,900	238,36	128	
SF-08	Lancaster	5A		6	33	21		60	78,825	10,259,118	170,98	130	
SF-09	Cumberland	5A			18	34		52	75,275	9,921,606	190,80	132	
SF-10	Centre	5A		6	24	18		48	75,737	10,193,457	212,36	135	
SF-11	Lehigh	5A		19	27	16		62	71,254	9,631,860	155,39	135	
SF-12	Lancaster	5A		41	79	18		138	154,370	21,137,388	153,10	137	
SF-13	Erie	5A			9	31		40	53,454	7,870,669	196,76	147	
SF-14	Montgomery	4A			19	29		48	59,976	8,858,000	184,54	148	
SF-15	Lebanon	5A			49	13		62	82,974	12,349,192	199,18	149	
SF-16	Cumberland	5A			10	30	10	50	72,707	10,865,524	217,31	149	
SF-17	Schuylkill	5A		1	11	5		17	21,544	3,225,548	189,73	150	
SF-18	Berks	5A			10	21	11	42	57,722	8,755,000	208,43	152	
SF-19	Berks	5A			22	20	16	58	62,097	9,440,383	162,76	152	
SF-20	Franklin	5A			6	21	21	48	66,583	10,404,256	216,75	156	
SF-21	Lehigh	5A		9	15	20	4	48	53,333	8,377,963	174,54	157	
SF-22	Chester	4A			19	18	11	48	58,541	9,248,927	192,68	158	
SF-23	Cumberland	5A		5	22	8		35	44,186	7,656,200	218,74	173	
SF-24	Montgomery	4A			8	21	15	6	50	65,907	11,589,411	231,78	176
SF-25	Allegheny	5A		35	16	14		65	87,255	15,376,648	236,56	176	
SF-26	Delaware	4A		8	34	14		56	65,212	11,914,849	212,76	183	
SF-27	Philadelphia	4A			17	16	2	35	45,476	9,441,620	269,78	208	
SF-28	Armstrong	5A			24			24	28,812	6,017,450	250,72	209	
SF-29	Philadelphia	4A			28	14		42	47,964	10,022,268	238,62	209	
SF-30	Philadelphia	4A		11	10	11		32	31,619	6,732,433	210,38	213	
SF-31	Philadelphia	4A			8	19	24	4	55	66,383	19,011,723	345,66	286
SF-32	Philadelphia	4A		45				45	23,302	7,408,602	164,63	318	

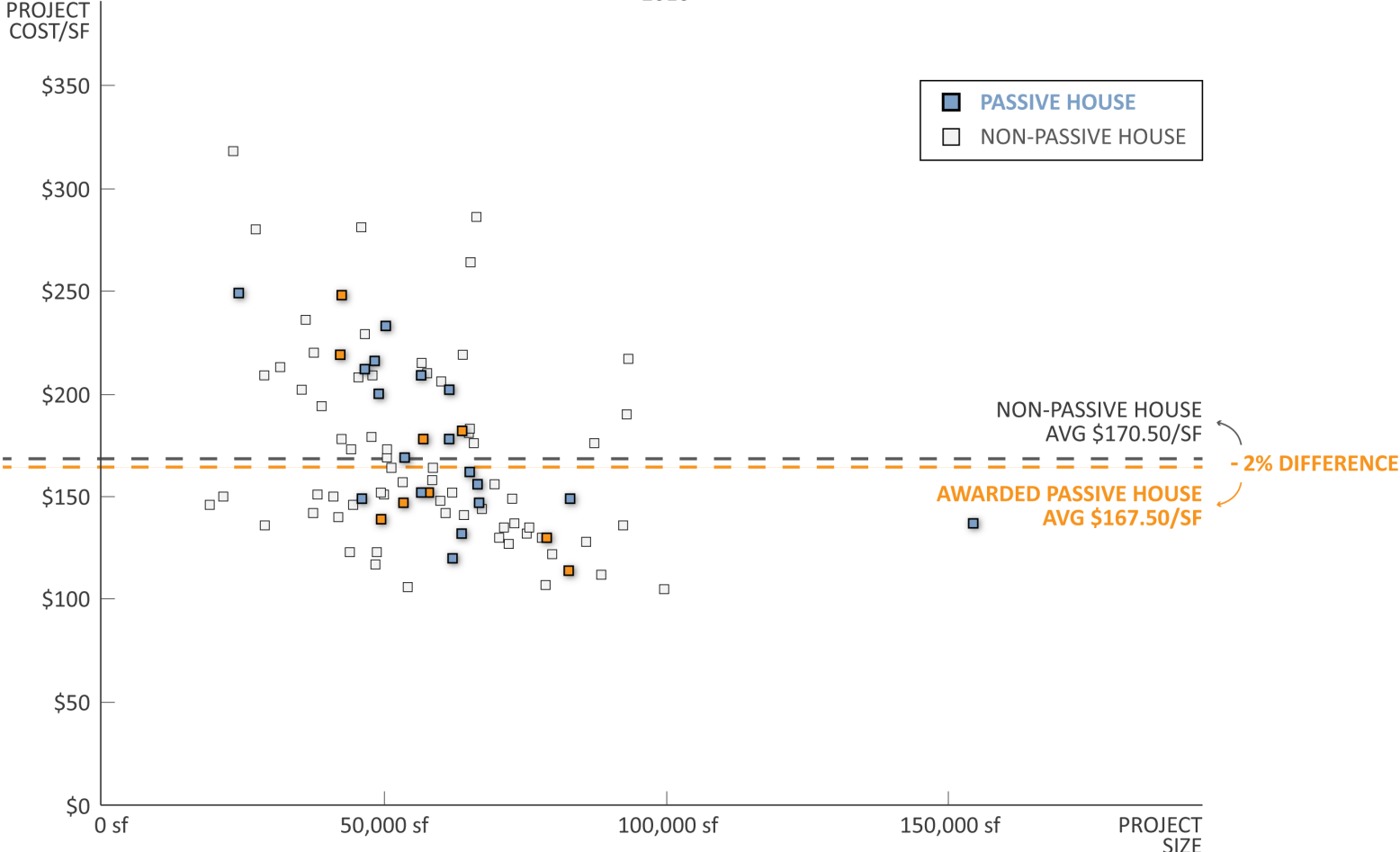
AR-01	Monroe	5A		36	4			40	54,215	5,753,672	143,82	106
AR-02	Luzerne	5A		6	54	2		62	88,489	9,900,711	159,69	112
AR-03	Philadelphia	4A		12	54			66	77,978	10,123,117	153,31	130
AR-04	Allegheny	5A		33	8			41	70,409	9,181,888	223,93	130
AR-05	Butler	5A		44	18			62	73,114	10,046,992	162,08	137
AR-06	Washington	5A		24				24	41,046	6,169,663	257,09	150
AR-07	Allegheny	5A		2	49	4		55	65,190	10,592,039	192,53	162
AR-08	Delaware	4A			50			50	50,548	8,727,828	174,57	173
AR-09	Philadelphia	4A			60			60	65,041	11,803,992	196,79	181
AR-10	Philadelphia	4A			74			74	93,285	20,223,060	273,25	217
AR-11	Philadelphia	4A		20	37			57	63,960	14,005,881	245,77	219
AR-12	Perry	5A		28	3			31	36,152	8,548,665	275,73	236

Multi-Story / Elevator Buildings

MS-01	Berks	5A		40	20			60	62,149	7,432,636	123,87	120
MS-02	Tioga	6A		34	6			40	48,735	5,999,734	149,93	123
MS-03	Dauphin	5A		35	2			37	43,964	5,421,065	146,55	123
MS-04	Bradford	5A		38	12	6		56	63,768	8,446,000	150,83	132
MS-05	Lancaster	5A		46	6			52	92,370	12,565,629	241,67	136
MS-06	Fayette	5A		12	12			24	28,904	3,942,323	164,26	136
MS-07	Cambria	5A		32	11			43	49,491	6,879,001	159,97	139
MS-08	Clearfield	6A		24	6			30	41,915	5,855,263	195,15	140
MS-09	Chester	4A		56	3			59	64,180	9,033,100	153,13	141
MS-10	Centre	5A		16	34			50	60,912	8,666,068	173,33	142
MS-11	Clinton	5A		28	4			32	37,454	5,333,806	166,66	142
MS-12	Allegheny	5A		24	12	13		49	67,340	9,698,634	197,99	144
MS-13	Luzerne	5A		32	3			35	44,543	6,503,636	185,89	146
MS-14	Dauphin	5A		20				20	19,157	2,803,860	140,13	146
MS-15	Butler	5A		68				68	66,845	9,821,302	144,43	147
MS-16	Westmoreland	5A		15	13	8		36	46,095	6,855,424	190,43	149
MS-17	Lackawanna	5A		12	12	8	4	36	50,019	7,560,000	210,00	151
MS-18	Northumberland	5A						32	38,240	5,789,694	180,93	151
MS-19	Centre	5A		37	11			48	57,959	8,781,136	182,90	152
MS-20	Lackawanna	5A		44	4			48	49,460	7,493,999	156,13	152
MS-21	Allegheny	5A		30	34			64	69,605	10,837,117	169,33	156
MS-22	Dauphin	5A		43	11			54	51,319	8,411,465	155,78	164
MS-23	Montgomery	4A		60				60	58,681	9,643,959	160,73	164
MS-24	Adams	5A		39	4			43	50,532	8,515,443	198,03	169
MS-25	Clarion	5A		48				48	53,668	9,090,720	189,30	169
MS-26	Allegheny	5A		40	6			46	56,969	10,124,143	220,00	178
MS-27	Allegheny	5A		28	8			36	42,500	7,582,274	210,67	178
MS-28	Chester	4A		47	13			60	61,551	10,982,435	183,00	178
MS-29	Delaware	4A		38	3			41	47,797	8,539,207	208,29	179
MS-30	Allegheny	5A		52	8			60	63,861	11,647,354	194,13	182
MS-31	Philadelphia	4A		37	44			81	93,000	17,635,125	217,73	190
MS-32	Crawford	5A		36	4			40	38,953	7,552,475	188,88	194
MS-33	Westmoreland	5A		47				47	49,080	9,801,657	208,56	200
MS-34	Bucks	4A		56	10			66	61,576	12,448,922	188,60	202
MS-35	Lycoming	5A		23	11			34	35,437	7,169,151	210,89	202
MS-36	Philadelphia	4A		61				61	60,137	12,416,322	203,55	206
MS-37	Bradford	5A		40	10			50	56,580	11,852,026	237,00	209
MS-38	Philadelphia	4A		58	4			62	57,653	12,079,768	194,86	210
MS-39	Philadelphia	4A		52				52	46,619	9,903,739	190,47	212
MS-40	Philadelphia	4A		60				60	56,672	12,174,301	202,96	215
MS-41	Philadelphia	4A		45				45	48,351	10,464,750	232,50	216
MS-42	Montgomery	4A		50				50	42,265	9,236,729	184,75	219
MS-43	Allegheny	5A		29	4			33	37,592	8,284,054	251,03	220
MS-44	Philadelphia	4A		46	4			50	46,640	10,701,164	214,03	229
MS-45	Philadelphia	4A		53				53	50,312	11,711,200	220,96	233
MS-46	Philadelphia	4A		34	11			45	42,520	10,560,747	234,63	248
MS-47	Philadelphia	4A		24	24			24	24,284	6,040,593	251,66	249
MS-48	Philadelphia	4A		60				60	65,340	17,249,402	287,40	264
MS-49	Luzerne	5A		36				36	27,296	7,653,000	212,58	280
MS-50	Philadelphia	4A		48				48	46,000	12,915,822	269,00	281

YEAR 2 A NATIONAL Net-Zero-Energy Initiative by 2030
2016

CONSTRUCTION COST OF PROPOSED PROJECTS TO PHFA 2016



DATA SOURCE: PENNSYLVANIA HOUSING FINANCE AGENCY
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Morningside Crossing
Pittsburgh, PA
46 Units



Glassport
Glassport, PA
55 Units



Mt. Lebanon Sr. Housing
Pittsburgh, PA
60 Units



Roxbury Place
Johnstown, PA
43 Units



Westminster @ Windy
Phillipsburg, PA
48 Units



Parade St. Commons
Erie, PA
40 Units



The Willows
Landisville, PA
60 Units



Muncy Green
Muncy, PA
60 Units



Montgomery Park
Norristown, PA
50 Units



Anthony Wayne Senior
Phila, PA
45 Units



10 Passive House Projects **COMPLETE**

8 PH projects Funded

Construction Cost Summary of 2018 PHFA Applications												
Ref. No.	County	Climate Zone	Units by BR Qty					Total Units	Resid. Bldg Area	Resid Constr \$	\$ / Unit	\$ / SF
			0	1	2	3	4+					
SF-01	York	5A			10	13	23	44,064	4,475,121	194,570	102	
SF-02	Dauphin	5A				22	22	44	66,603	8,409,248	191,119	126
SF-03	York	5A	6	23	24	3	56	72,013	9,258,025	165,322	129	
SF-04	Berks	5A			24	22	46	66,030	8,557,500	186,033	130	
SF-05	Lebanon	5A	18	26	16		60	76,101	10,333,056	172,218	136	
SF-06	Franklin	5A		7	25		32	54,375	8,150,464	254,702	150	
SF-07	Philadelphia	4A	2	5	11	2	20	29,503	4,490,975	224,549	152	
SF-08	Lackawanna	5A	12	12	8	4	36	50,019	7,805,595	216,822	156	
SF-09	Franklin	5A	6	21	21		48	66,583	10,727,005	223,479	161	
SF-10	Multiple Co's	5A	52				52	52,330	8,909,580	171,338	170	
SF-11	York	5A	18	9	7		34	35,636	6,396,969	188,146	180	
SF-12	Allegheny	5A	47	10			57	48,150	9,106,659	159,766	189	
SF-13	Westmoreland	5A	3	6	9		18	20,489	4,108,548	228,253	201	
SF-14	Allegheny	5A	4	7	9		20	26,198	5,407,155	270,358	206	
SF-15	Armstrong	5A			24		24	29,147	6,230,195	259,591	214	
SF-16	Susquehanna	6A	34	2			36	31,103	7,031,404	195,317	226	
SF-17	Philadelphia	4A		17	16	2	35	45,476	10,281,980	293,771	226	
SF-18	Philadelphia	4A	11	10	12		33	34,388	8,875,449	268,953	258	
SF-19	Philadelphia	4A	28	12			40	46,232	12,214,948	305,374	264	
SF-20	Philadelphia	4A	12	18	11	9	50	71,903	21,367,901	427,358	297	

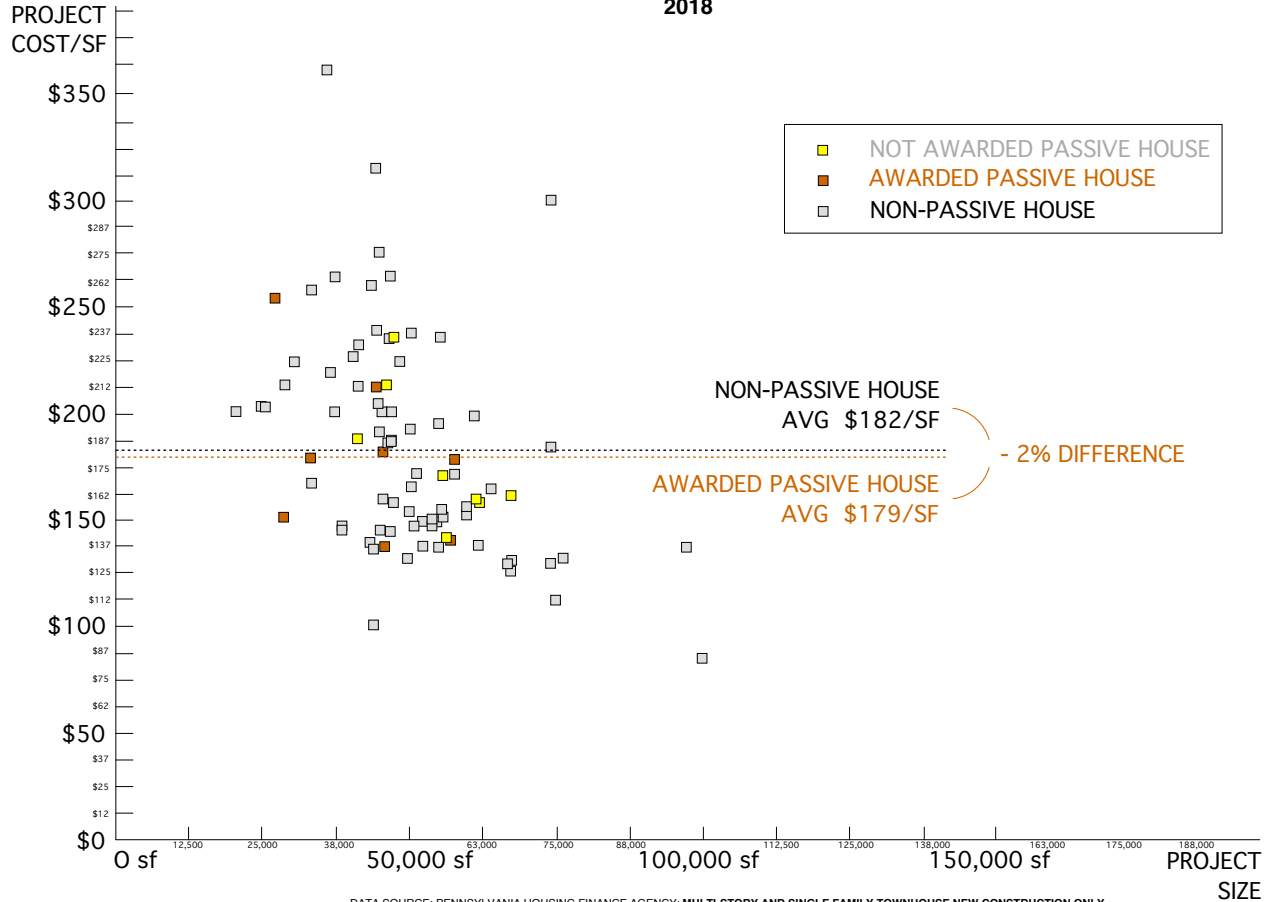
Construction Cost Summary of 2018 PHFA Applications												
Ref. No.	County	Climate Zone	Units by BR Qty					Total Units	Resid. Bldg Area	Resid Constr \$	\$ / Unit	\$ / SF
			0	1	2	3	4+					
MS-01	Erie	5A			45		45	100,201	8,587,936	190,843	86	
MS-02	Lancaster	5A	44	18			62	76,045	8,306,538	133,976	109	
MS-03	Lancaster	5A	45	15			60	68,993	8,544,047	142,401	124	
MS-04	Cumberland	5A	14	12	16		42	49,581	6,440,993	153,357	130	
MS-05	Berks	5A	45	12			57	59,916	7,892,757	138,469	132	
MS-06	Westmoreland	5A	15	13	8		36	46,095	6,087,669	169,102	132	
MS-07	Fayette	5A	18	18			36	42,820	5,679,247	157,757	133	
MS-08	Dauphin	5A	35	2			37	43,928	5,896,750	159,372	134	
MS-09	Bradford	5A	63	12			56	63,759	8,603,563	153,635	135	
MS-10	Allegheny	5A	30	10			40	54,495	7,335,570	183,394	135	
MS-11	Lancaster	5A	46	6			52	94,440	12,791,060	245,982	135	
MS-12	Centre	5A	16	34			50	60,599	8,371,068	167,421	138	
MS-13	Montgomery	4A	42	14			56	60,166	8,477,023	151,375	141	
MS-14	Luzerne	5A	32	3			35	44,543	6,416,086	183,317	144	

Ref. No.	County	Climate Zone	Units by BR Qty					Total Units	Resid. Bldg Area	Resid Constr \$	\$ / Unit	\$ / SF			
			0	1	2	3	4+								
MS-14	Luzerne	5A					32	3			35	44,543	6,416,086	183,317	144
MS-15	Clinton	5A					28	4			32	37,454	5,470,901	170,966	146
MS-16	Dauphin	5A					20	29			49	53,976	8,066,609	164,625	149
MS-17	Washington	5A					21	25			46	53,310	8,000,885	173,932	150
MS-18	Franklin	5A					36	4			40	54,596	8,326,929	208,173	153
MS-19	Chester	4A					57	3			60	60,931	9,310,170	155,170	153
MS-20	Northumberland	5A					32	4			36	43,826	6,998,140	194,393	160
MS-21	York	5A			16	26	8				50	63,425	10,125,538	202,511	160
MS-22	Allegheny	5A					27	18	9		54	64,875	10,797,000	199,944	166
MS-23	Westmoreland	5A					43	4			47	50,680	8,439,569	179,565	167
MS-24	Clearfield	5A					24	6			30	35,984	6,065,728	202,191	169
MS-25	Beaver	5A					44	8			52	57,297	9,797,660	188,417	171
MS-26	Northampton	5A					12	33	15		60	60,212	10,329,351	172,156	172
MS-27	Montgomery	4A					60				60	61,110	10,869,266	181,154	178
MS-28	Dauphin	5A					38	11			49	48,638	8,730,738	178,178	180
MS-29	Montgomery	4A					66	8			74	74,468	13,541,230	182,990	182
MS-30	Clarion	5A					39	3			42	48,847	8,988,545	214,013	184
MS-31	Philadelphia	4A					28	13			41	49,625	9,204,879	224,509	185
MS-32	Lehigh	5A					27	13			40	40,937	7,663,199	191,580	187
MS-33	Allegheny	5A					31	3	1		35	46,015	8,714,276	248,979	189
MS-34	Butler	5A					30	13	1		44	50,825	9,697,495	220,398	191
MS-35	Delaware	4A					58				58	57,365	11,293,126	194,709	197
MS-36	Bucks	4A					68	1			69	62,844	12,503,344	181,208	199
MS-37	Delaware	4A					38	3			41	43,515	8,746,409	213,327	201
MS-38	Blair	5A					43	2			45	47,642	9,595,216	213,227	201
MS-39	Tioga	5A					34	6			40	32,800	6,591,082	164,777	201
MS-40	Lycoming	5A					18	6			24	26,749	5,419,721	225,822	203
MS-41	Philadelphia	4A					44				44	46,306	9,443,528	214,626	204
MS-42	Philadelphia	4A					52				52	46,619	9,893,465	190,259	212
MS-43	Crawford	5A					37	2			39	40,256	8,580,594	220,015	213
MS-44	Allegheny	5A					46				46	48,600	10,405,629	226,209	214
MS-45	Luzerne	5A					36				36	36,784	8,100,000	225,000	220
MS-46	Philadelphia	4A					11	11	8		30	39,650	8,957,527	298,584	226
MS-47	Allegheny	5A					19	13	11		43	41,797	9,558,272	222,285	229
MS-48	Philadelphia	4A					46	4			50	48,315	11,197,257	223,945	232
MS-49	Philadelphia	4A					60				60	57,672	13,556,215	225,937	235
MS-50	Philadelphia	4A					45				45	48,351	11,428,626	253,969	236
MS-51	Philadelphia	4A					37	10			47	50,527	12,095,152	257,344	239
MS-52	Philadelphia	4A					32	6	6		44	44,889	10,869,638	247,037	242
MS-53	Philadelphia	4A					24				24	24,284	6,253,770	260,574	248
MS-54	Allegheny	5A					30	20			50	37,290	9,905,483	198,110	256
MS-55	Philadelphia	4A					20	30			50	46,110	12,718,548	254,371	276
MS-56	Philadelphia	4A					48				48	45,000	14,294,705	297,806	318
MS-57	Philadelphia	4A					46				46	31,878	11,701,929	254,390	367

YEAR 3-4 A NATIONAL Net-Zero-Energy Initiative by 2030
2017-18

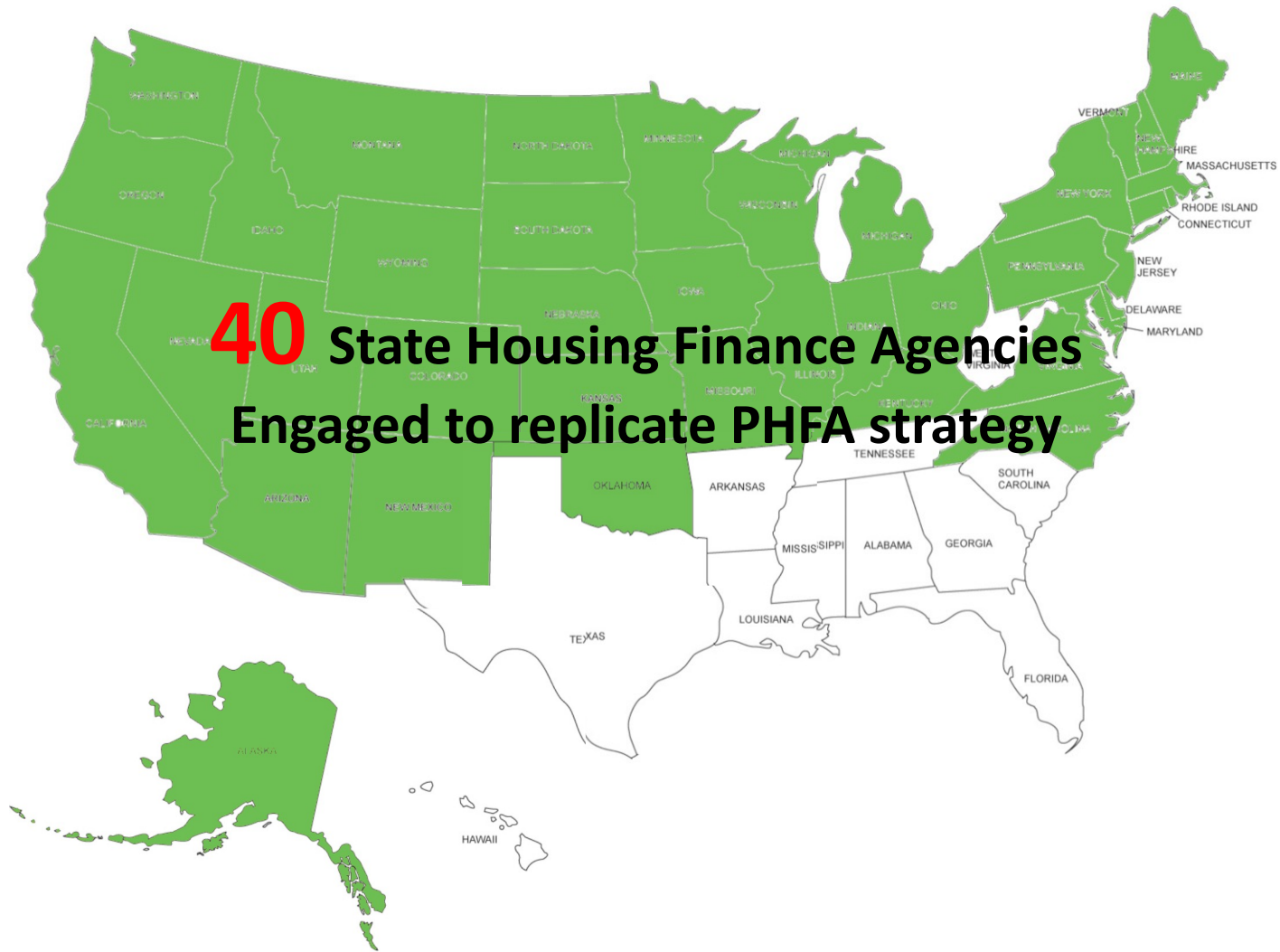
CONSTRUCTION COST OF PROPOSED PROJECTS TO PHFA

2018



DATA SOURCE: PENNSYLVANIA HOUSING FINANCE AGENCY: MULTI-STORY AND SINGLE FAMILY TOWNHOUSE NEW CONSTRUCTION ONLY

YEAR 3-4 A NATIONAL Net-Zero-Energy Initiative by **2030**
2017-18



18 COMMITTED!!

- 1 California
- 2 Connecticut
- 3 District of Columbia
- 4 Delaware
- 5 Idaho
- 6 Illinois
- 7 Maryland
- 8 Massachusetts
- 9 Montana
- 10 New Hampshire
- 11 New Jersey
- 12 New York
- 13 Ohio
- 14 Pennsylvania
- 15 Rhode Island
- 16 South Dakota
- 17 Vermont
- 18 Virginia



PENNSYLVANIA

NEW YORK

18 COMMITTED



NYC: *The House at Cornell Tech, Knickerbocker Commons, Sendero Verde*



NEW HAMPSHIRE: *Gilford Village Knolls*



SOUTH DAKOTA: *Student Passive House Project and Copper Pass Apartments*

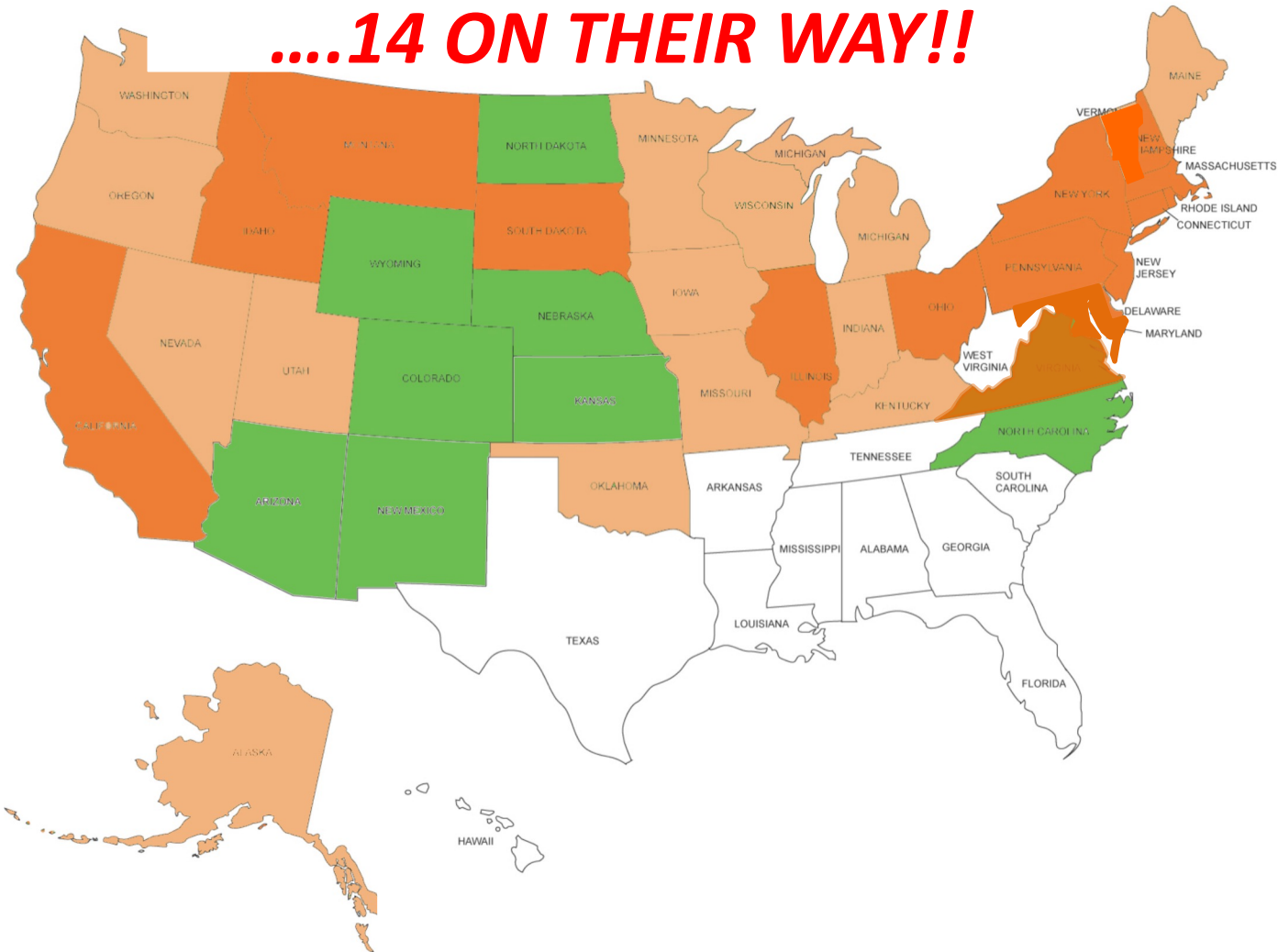


OHIO: *Fairwood Commons*



....14 ON THEIR WAY!!

- WASHINGTON
- OREGON
- NEVADA
- UTAH
- MINNESOTA
- IOWA
- MISSOURI
- OKLAHOMA
- WISCONSIN
- MICHIGAN
- INDIANA
- KENTUCKY
- MAINE
- ALASKA



WASHINGTON

OREGON

NEVADA

....14 ON THEIR WAY!!



Vermont: Elm Place

WISCONSIN



Minnesota: West Side Flats



Oregon: The Orchards at Orenco



**Maine: Bayside Anchor Passive House
Village Centre Passive House**



Missouri: Second and Delaware, Kansas City





**THANK
YOU**

Tim McDonald
tim@onionflats.com
215.783.5591



Decarbonization Priorities for Affordable Housing (in California)



Katie Ackerly, David Baker Architects | LBNL | March 27, 2024



DL

GOUGH

Gough

Fulton

SFCM

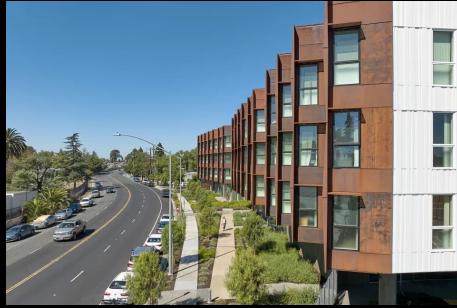
An aerial view of a modern city street. The street is lined with contemporary, multi-story buildings featuring large windows and modern architectural details. In the distance, a prominent white dome, likely a state capitol building, is visible against a clear sky. The street is active with traffic, including cars and a yellow taxi. Street signs for 'Gough' and 'Fulton' are visible. The overall scene depicts a vibrant, urban environment.

**We design thoughtful places
that uplift communities**



40 years
13,000+ homes
400+ awards
multifamily experts

DBA's first zero energy
supportive housing project



ILFI Affordable
Housing pilot



Zero-emissions affordable
Central Heat Pump WH Pilot



Modular
Passive House



Next EPIC Challenge
Grid-Responsive Housing (unbuilt)



REALIZE-CA
Deep-Energy Retrofits



An aerial photograph of a modern, multi-story apartment building with a mix of white and dark brown facades. The building is situated on a street corner. In the background, there is a large body of water, a bridge, and a city skyline under a clear sky. The text "What does it mean to decarbonize housing?" is overlaid in large white font across the center of the image.

**What does it mean to
decarbonize housing?**

First, a poll!

Which measures do you think contribute the most to decarbonization in the housing sector?

Please rank your top 3:

1. Reducing **housing burden** and the number of people who are un-housed
2. Increasing **access to low-carbon transport** and amenities from residential developments
3. Increasing **density** of housing development (more dwelling units per acre)
4. Reducing **operational emissions** of multifamily buildings
5. Reducing **embodied emissions** of multifamily buildings
6. Designing multi family homes in a way that brings **joy, safety, health** and **resilience** to residents

**Housing
(how and where
people live)
impacts climate
in multiple ways,
although some
are hard to
measure.**

Mobility



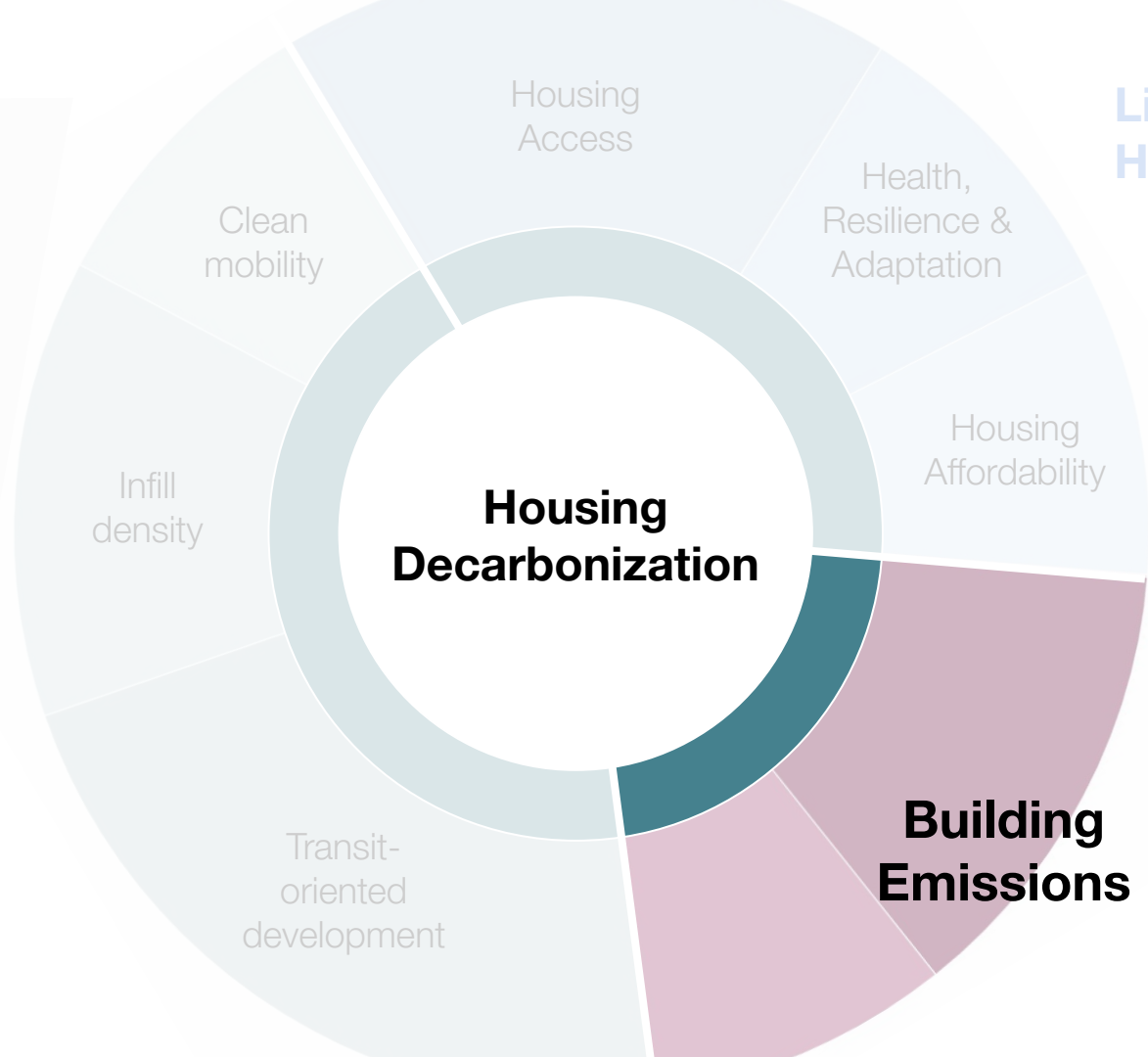
**Livable
Homes**

**Physical
Building**



Housing
(how and where
people live)
impacts climate
in multiple ways,
although some
are hard to
measure.

Mobility



Housing Decarbonization Design Priorities

1. Build to the **maximum density** that economics allows to support desirable, permanent homes
 2. Identify what **the everyday needs of residents** and operators are, and design for them.
 3. Eliminate **permanent fossil fuel infrastructure** on-site
-
4. Target **<25 kbtu/sf-year gross site energy use intensity**
 5. Maximize **benefit of solar PV (and storage) to residents and housing providers**
 6. Plan thoughtfully for **electric vehicles** and other other low-carbon modes of transportation
 7. Exercise **simple, efficient material use** and industrialized construction methods
-
8. Target **embodied emissions**, especially concrete, refrigerants, and finishes

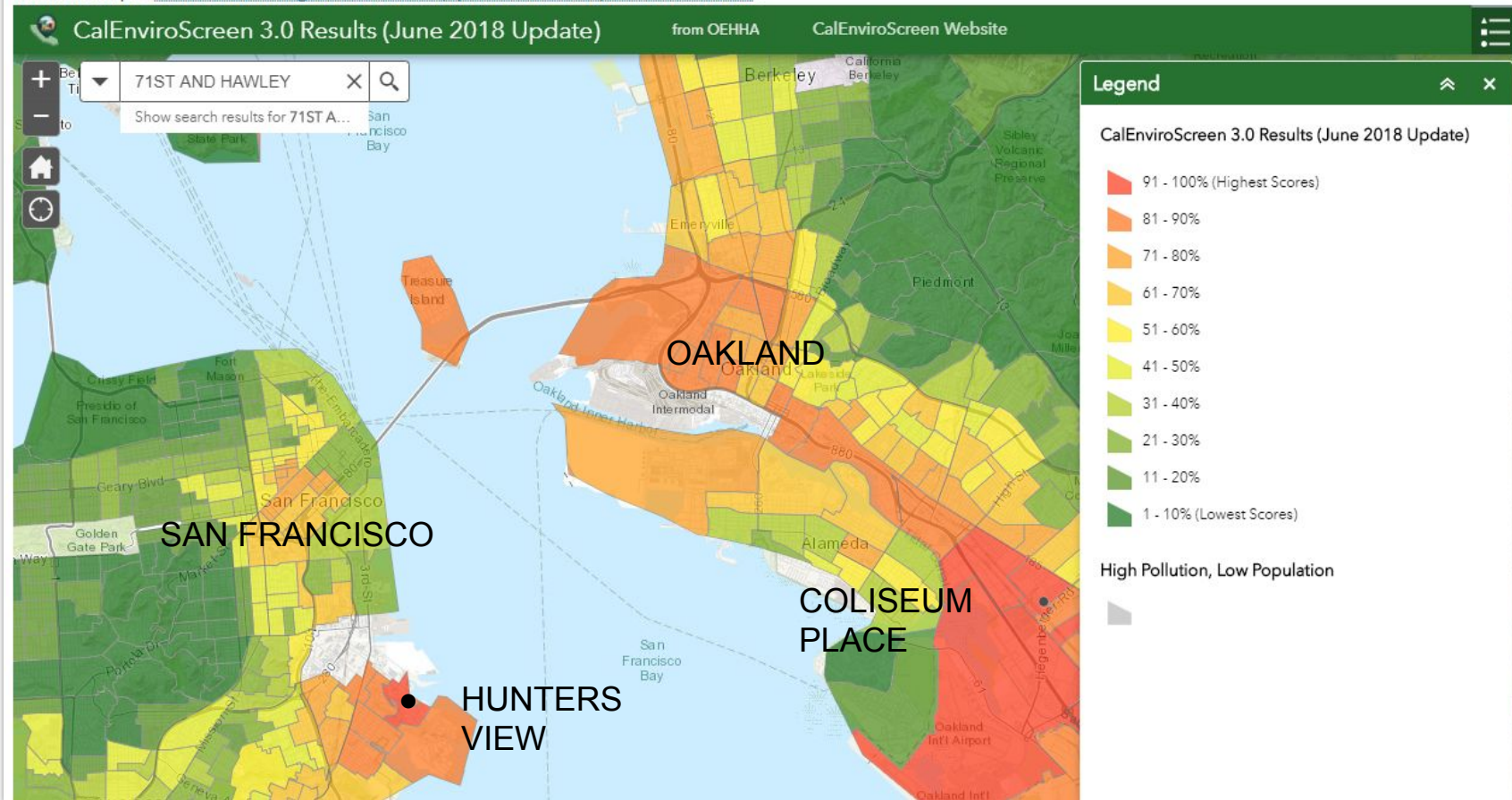
A modern bedroom with a bed, dresser, and desk. The room features a white ceiling fan, a bed with a blue blanket, a dresser with a plant, and a desk with a lamp and books. The text is overlaid on the image.

2

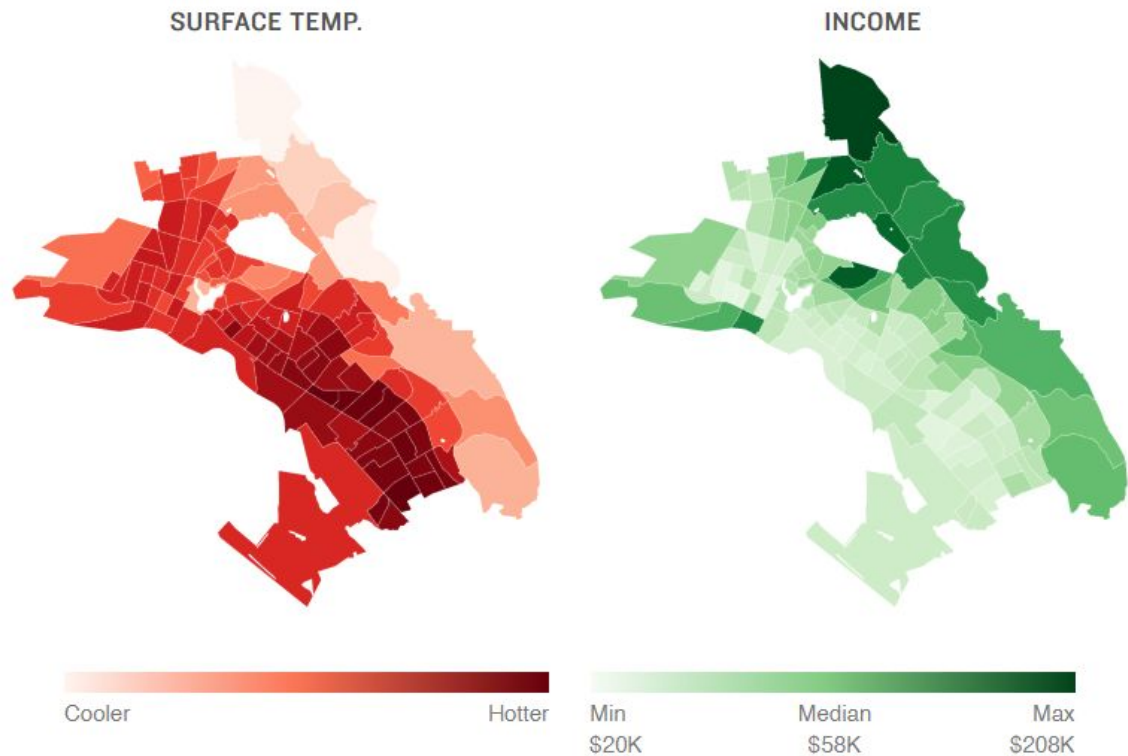
Design for everyday needs of people

Make decisions that **expand opportunity**, prioritize health, comfort and control, and **provide meaningful refuge** in the face of rapid change.

Note: The map of [SB535 disadvantaged communities \(updated June 2018\)](#) can be found here.



Environment & Equity | Heat and air quality are site-specific



Environment & Equity | Heat and air quality are site-specific

Air Quality Index (PM2.5) in Oakland



12 days

Camp Fire, November 2018

Environment & Equity | Systems for efficiency, health & comfort



PurpleAir Zen
Air Quality Monitor

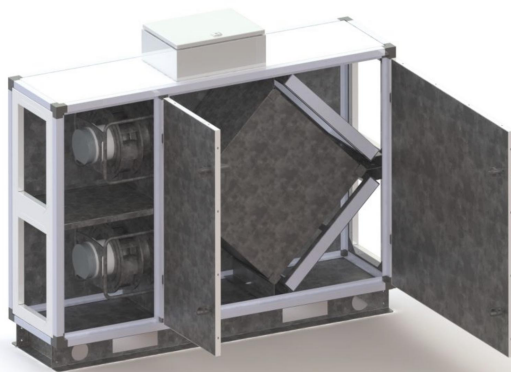


Haiku Ceiling fan
(match donation)



Summit 4-burner
induction cooktop

Central HRV
Swap-out MERV15
filter for smoke days









Ephoca vertical
All-In-One PTHP

Environment & Equity | Harmful chemicals must be taken seriously in buildings

GREEN SCIENCE POLICY INSTITUTE HOME TOPICS RESOURCES BLOG FAQ ABOUT EVENTS CONTACT US DONATE

The Six Classes Approach to Reducing Chemical Harm

Healthier Products, Healthier People

1 Highly Fluorinated	2 Antimicrobials	3 Flame Retardants	4 Bisphenols + Phthalates	5 Some Solvents	6 Certain Metals
					



Environment & Equity | Community-informed amenities

 Free Building Wi-fi



San Francisco
Public Library

**Self-Serve
Library**



**Park w/ BBQ's &
Community Garden**

**Kitchen/Cafe &
Produce**



Environment & Equity | Design matters!



TUESDAY
Demolition



WEDNESDAY
Site Preparation



THURSDAY
Kit Switch Delivery



Modular kitchen installation at Kings View Manor, Fresno



Retrofit Scope

205 & 217 Isabella Ave, Corona del Rey

- Prefabricated Wall Panels
- New Lateral Bracing
- All-In-One Mechanical Pod (217)
- High-Efficiency Heat Pump and HRV (205)
- Full Electrification

Property needs

- No wall or roof insulation. **Energy use** and **comfort** are major issues
- Addressing **deferred maintenance** on general plumbing is a high priority
- Major **stucco damage** and some interior pest and dry-rot damage
- Interior gyp and exterior stucco are both hot (**asbestos**)
- **No exterior sheathing**, inadequate and damaged lateral bracing
- Inadequate **drainage**



What's not solved | Human-centered “decarbonization”

I'll come back to this



3

Eliminate **permanent fossil fuel** infrastructure on site

Focus on Hot Water



Electrification | What is already electric?

	New Market Rate	New Affordable	Existing Affordable
Fire place	X	NA	NA
Range/Cooktop	X	✓	X
Space heating	✓	✓	?
Space cooling	✓	✓	✓
BBQ	X	✓	X
In-unit dryers	✓	✓	?
Common dryers	NA	✓	X
Water heating	X	X	X

Electrification | What is already electric?

	New Market Rate	New Affordable	Existing Affordable
Fire place	X	NA	NA
Range/Cooktop	X	✓	X
Space heating	✓	✓	?
Space cooling	✓	✓	✓
BBQ	X	✓	X
In-unit dryers	✓	✓	?
Common dryers	NA	✓	X
Water heating	X	X	X

“Cultural” → (points to X in New Market Rate for Fire place, Range/Cooktop, and BBQ)

Water heating (row highlighted with a red rounded rectangle)

Central Heat Pump WH Considerations

- Efficiency
 - T24 modeling
 - Refrigerants
 - Cost
 - Capacity (no. apts. served)
 - Size and weight
-
- Quality control (skids)
 - Union labor?
 - Design flexibility



**Sanden
(SanCO2)**



Mitsubishi



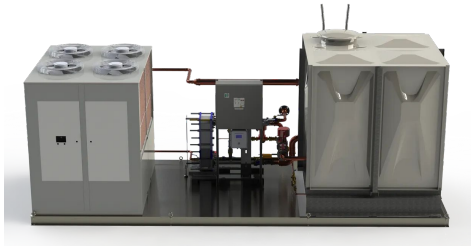
Nyle



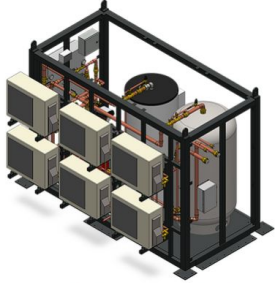
Colmac



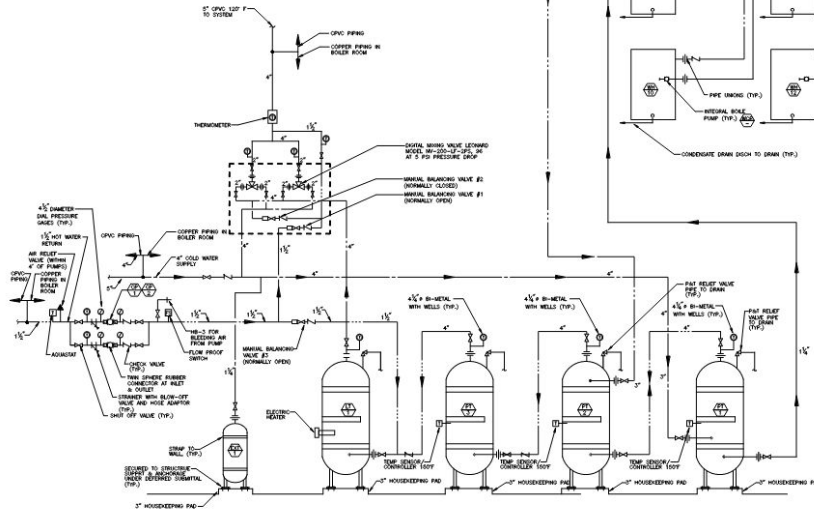
Lync



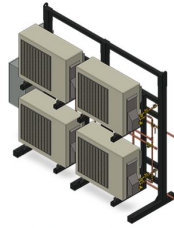
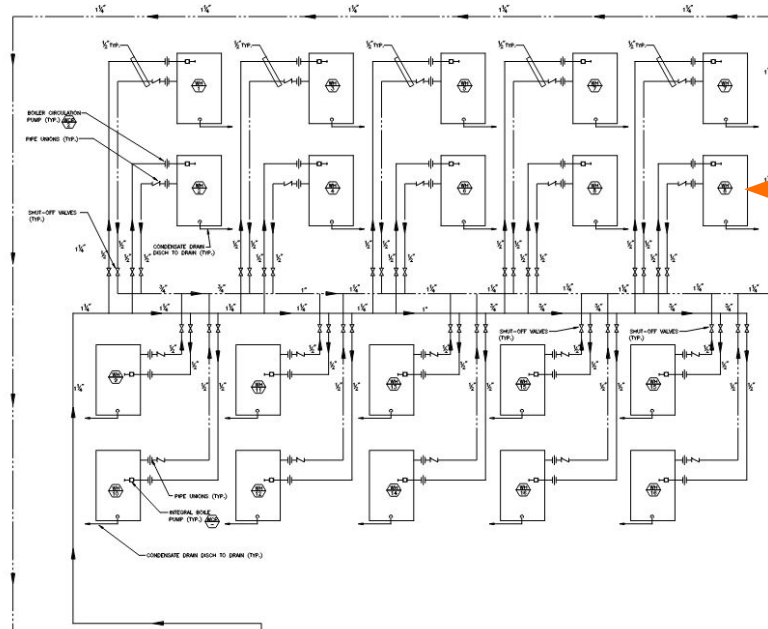
SanCO2 Built-up vs Skid



Waterdrop



1 DOMESTIC HOT WATER HEATER PIPING DIAGRAM
NO SCALE



Built-up

Droplet



What's not solved | Heat Pump Water Heaters

1. Greater accuracy and flexibility in T24 compliance software
2. Quality control issues (built-up systems)
...and union labor issues (skid systems)
3. Commissioning as standard practice...



4

Energy Efficiency: Target <25 kbtu/sf-year EUI

There's more opportunity for decarbonization in **quality assurance** than in new technology.

Energy Efficiency Design | DBA Energy Use Intensity (EUI) Targets

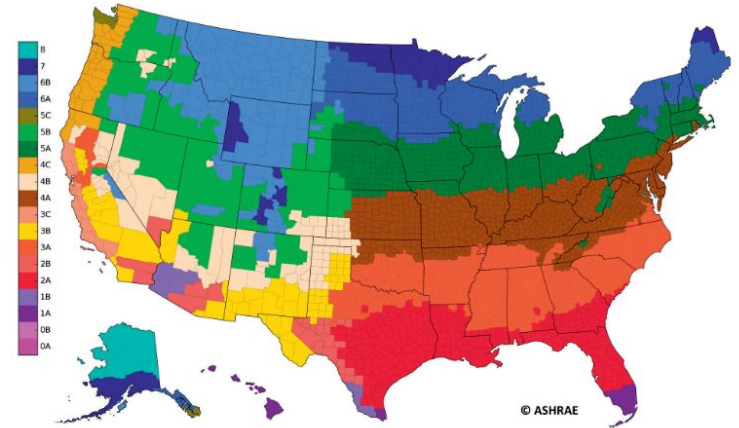
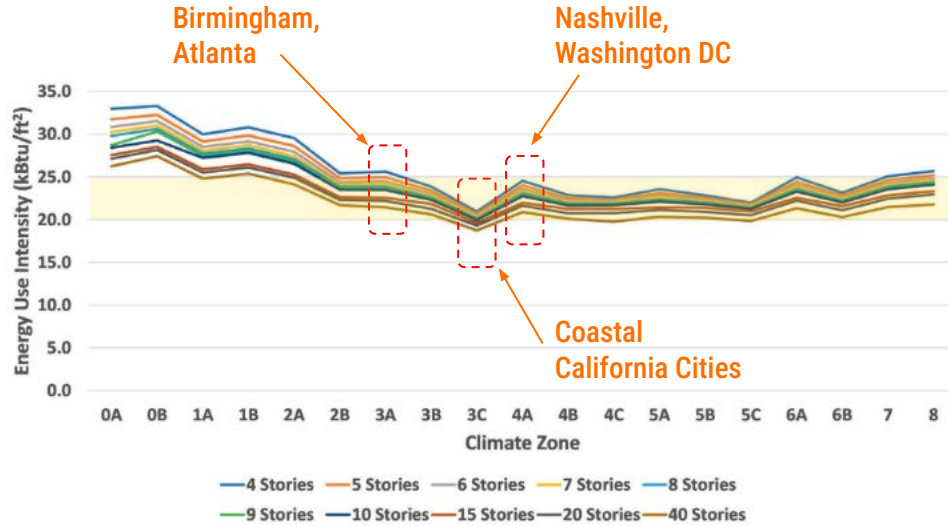
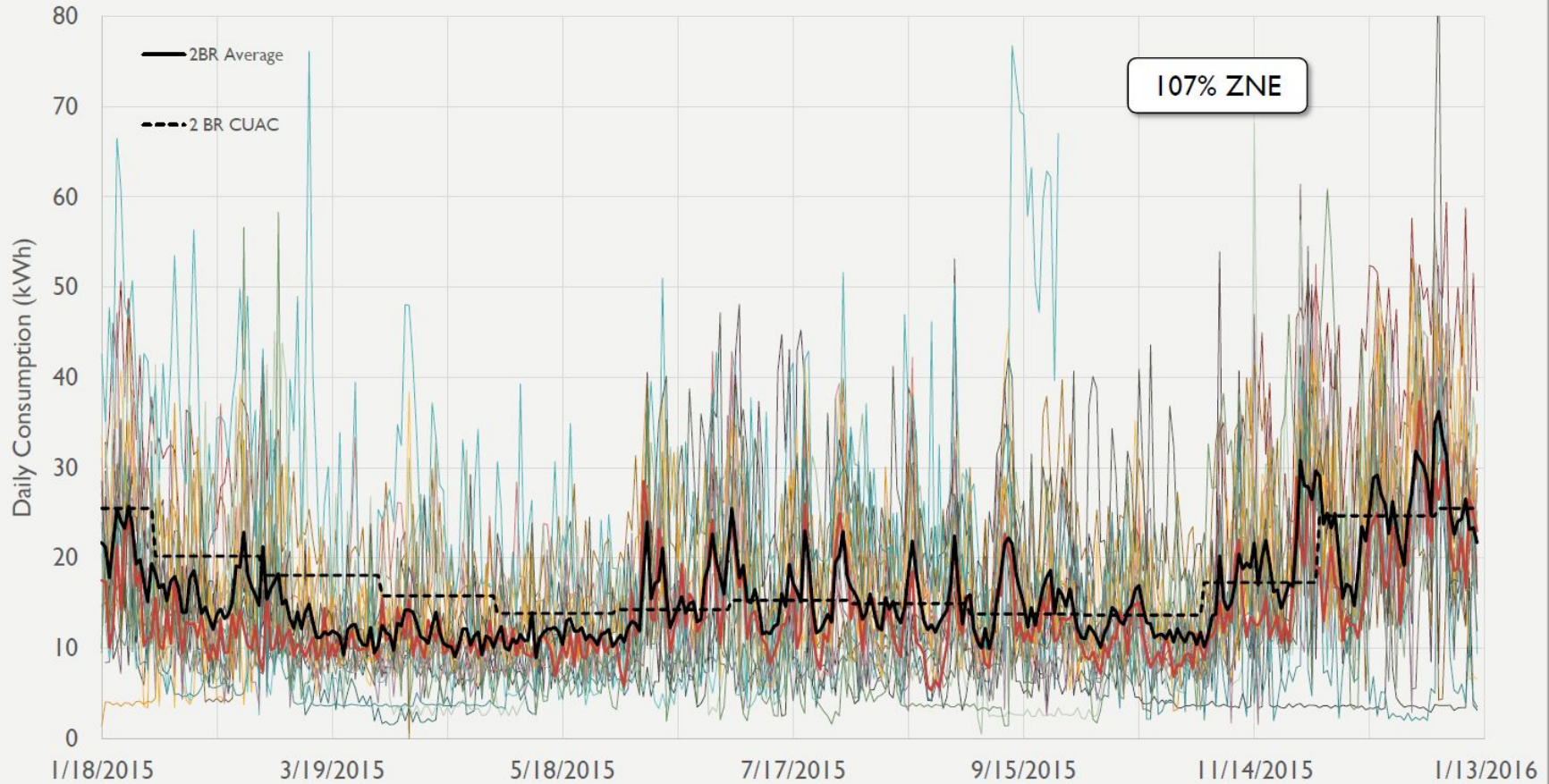


Figure 3-2 Climate Zone Map for U.S. States and Counties
Figure A-2, ASHRAE 2021

Source: ASHRAE AEDG ZNE Multifamily Design Guide

Daily Electricity Consumption in 2-Bedroom Apartments at Dixon, CA



What's not solved | Energy Efficiency & Quality Assurance

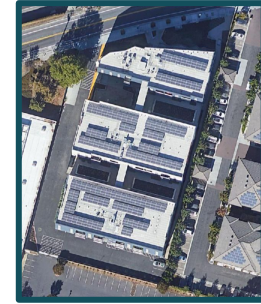
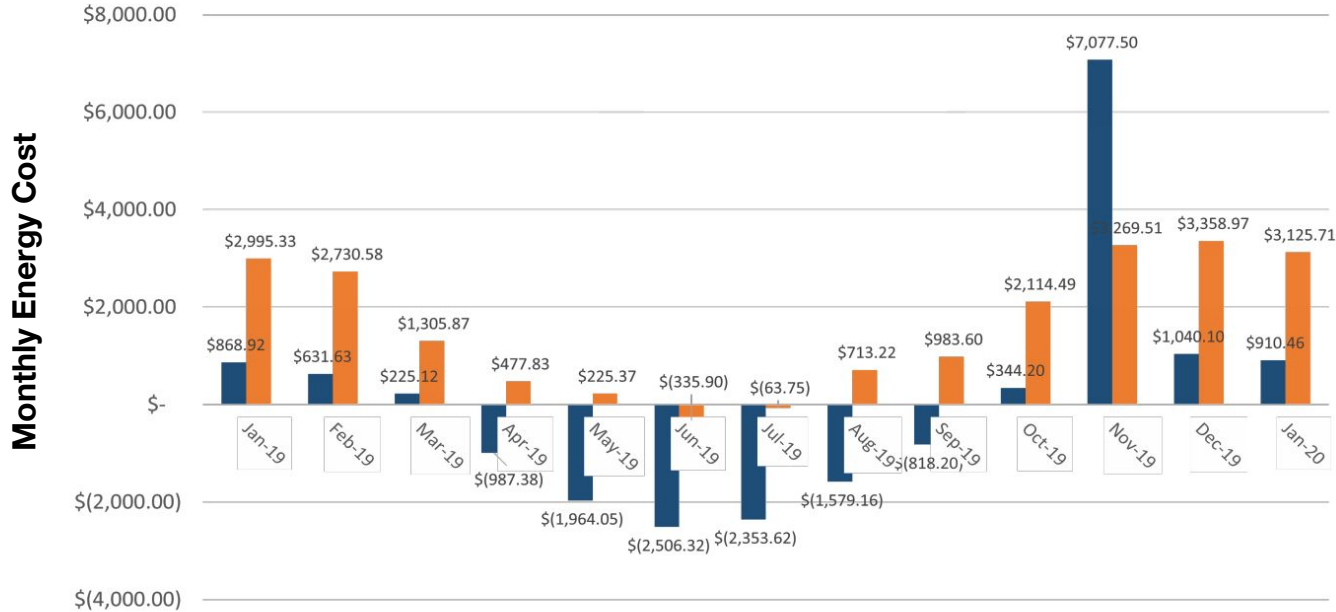
1. Commissioning is not standard practice.
2. Non-profit housing providers generally are not investing effectively in portfolio performance
3. There is a misplaced emphasis on new technologies



5

Maximize the benefit of Solar PV - and energy storage - to building residents and operators

Operating Cost | Gas vs All-electric



Edwina Benner

Completed 2018
All-electric
110,000 SF
66 family homes

Common area energy costs 2019:
-\$21



Onizuka Crossing

Completed 2015
Mixed Fuel
102,000 sf
58 family homes

Common area energy costs 2019:
\$17,775

Courtesy: Amelie Besson, MidPen Housing

Same lot size, program, city, developer, architect, MEP engineer, and general contractor

2022 Energy Code includes PV and Battery Storage

TDV Site energy multiplied by factors representing how expensive the energy is

Source Site energy multiplied by energy source factor (transmission losses)

C2. TDV ENERGY COMPLIANCE RESULTS FOR PERFORMANCE COMPONENTS (Annual TDV Energy Use , kBtu/ft ² · yr)			
COMPLIES ²			
Energy Component	Standard Design (TDV)	Proposed Design (TDV)	Compliance Margin (TDV) ¹
Space Heating	2.61	2.34	0.27
Space Cooling	8.77	11.01	-2.24
Indoor Fans	17.79	13.72	4.07
Heat Rejection	0	0	0
Pumps & Misc.	0.49	0.66	-0.17
Domestic Hot Water	52.37	49.44	2.93
Indoor Lighting	25.45	25.45	0
Flexibility	---	---	---
EFFICIENCY COMPLIANCE TOTAL	107.48	102.62	4.86 (4.5%)
Photovoltaics	-54.5	-53.24	-1.26
Batteries	-3.33	-2.46	-0.87
TOTAL COMPLIANCE	49.65	46.92	2.73 (5.5%)

CA. SOURCE ENERGY COMPLIANCE RESULTS FOR PERFORMANCE COMPONENTS (Annual SOURCE Energy Use , kBtu/ft ² /yr)			
COMPLIES ²			
Energy Component	Standard Design (SOURCE)	Proposed Design (SOURCE)	Compliance Margin (SOURCE) ¹
Space Heating	0.36	0.31	0.05
Space Cooling	0.15	0.23	-0.08
Indoor Fans	1.52	1.2	0.32
Heat Rejection	0	0	0
Pumps & Misc.	0.07	0.09	-0.02
Domestic Hot Water	4.53	4.15	0.38
Indoor Lighting	2.27	2.27	0
Flexibility	---	---	---
EFFICIENCY COMPLIANCE TOTAL	8.9	8.25	0.65 (7.3%)
Photovoltaics	-1.58	-1.54	-0.04
Batteries	-0.78	-0.61	-0.17
TOTAL COMPLIANCE	6.54	6.1	0.44 (6.7%)

Three compliance calculations

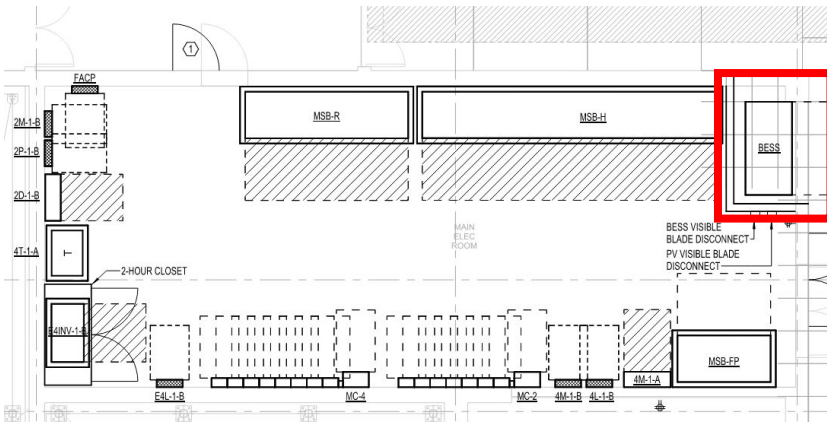
Batteries | Why to install a battery (other than grid stewardship)



1 Emergency back-up power

Are outages likely over the life of this building?

How vulnerable is the resident population to consequences of power failure?

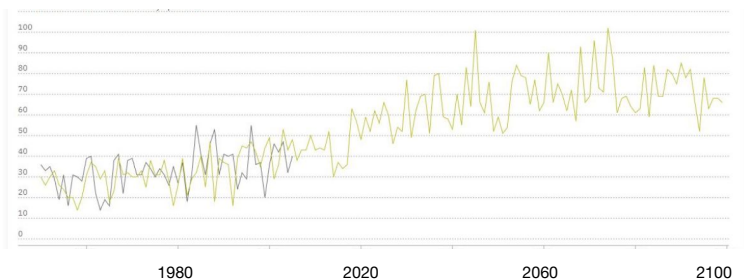


Resilience

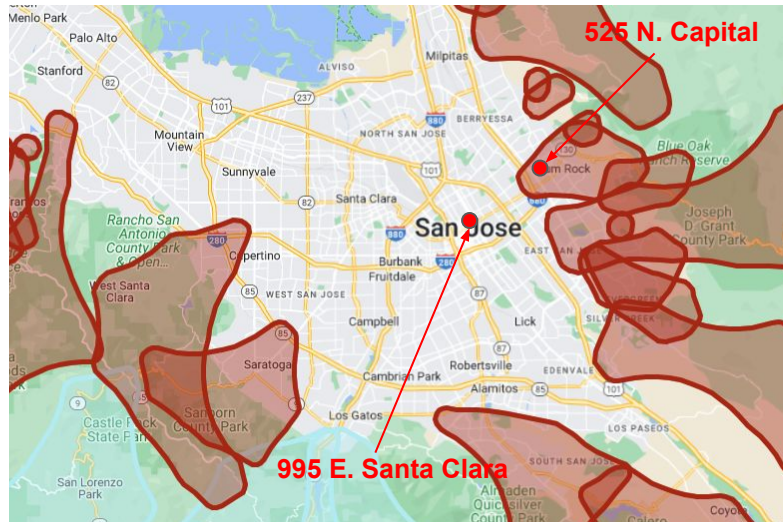
Power Outage Scenarios for two San Jose sites

	Duration	Likelihood
Average outage (DOE data)	8 hrs	
Heat wave-related black-out*	1-3 hrs	1-5 a year
Winter storm	1-2 days	Once every 1-3 years
Major Earthquake	3-7 days	Once in next 30 years
Public Safety Power Shutoff	1-7 days	?

*Number of Extreme Heat Days



2019 PG&E Public Safety Power Shut-off

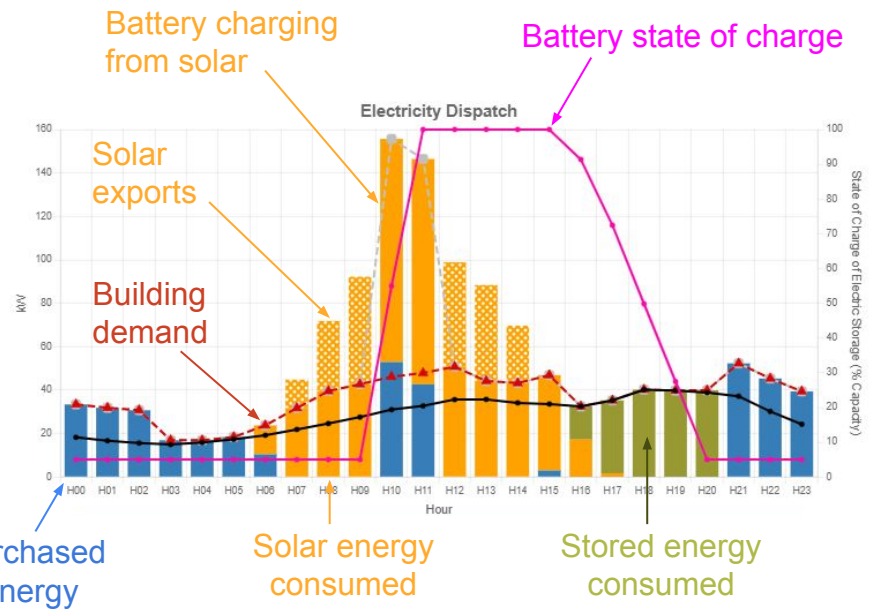
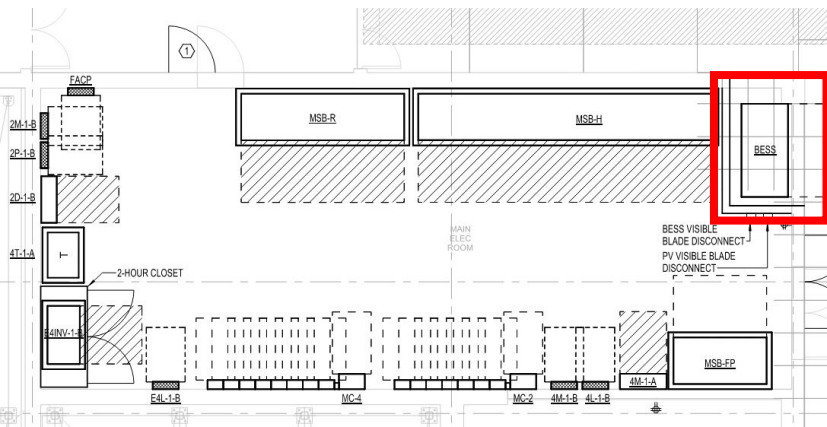


Batteries | Why to install a battery (other than grid stewardship)



2 Load shedding

If you have to have a battery, get the most of the investment

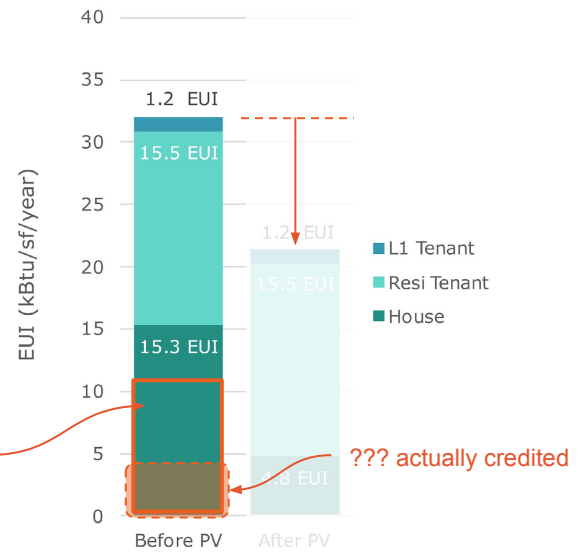


525 N. Capital | Accounting under NEM 3.0

1

Conventional

- Owner takes all PV credits
- The annual bill offset depends on what portion of total common energy load takes place in the middle of the day



~ 30% of annual energy use generated

63% of total common

???' actually credited

Upsizing Water Heating for Maximum Load Flexibility



A central water heater **is a thermal battery!**

Increasing storage can reduce reliance on battery storage and increase return on solar.

There is increased upfront cost for equipment & additional engineering design effort but the payback is ~5 years*

*EPIC challenge analysis

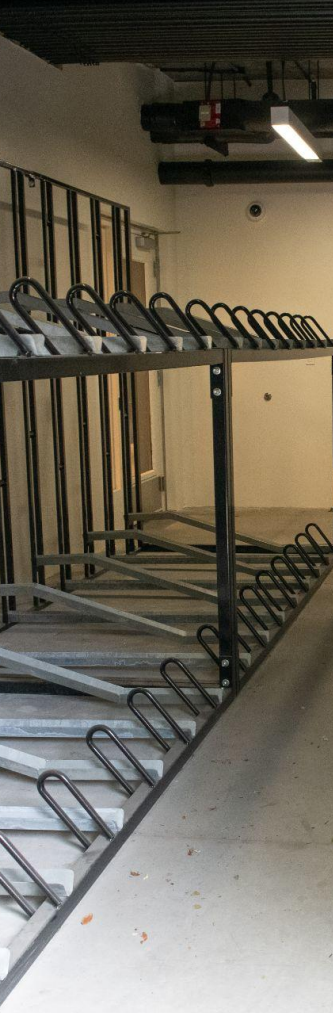
What's not solved | Energy Efficiency & Quality Assurance

1. All-electric IS more expensive to build and operate for buildings with limited roof area. Misinformation about this made sure that this unsolved burden is not anyone's focus.
2. Incentive programs are often misaligned with funding criteria such that projects can't take advantage of them
3. The code is pushing battery storage without the tools to determine economics of PV, BESS, efficiency, and thermal storage investments in light of new code and tariff rules.



6

Plan thoughtfully for **low-carbon transportation** options





7

Exercise **simple, efficient material use**
The cheapest and lowest-emissions materials are the ones not used

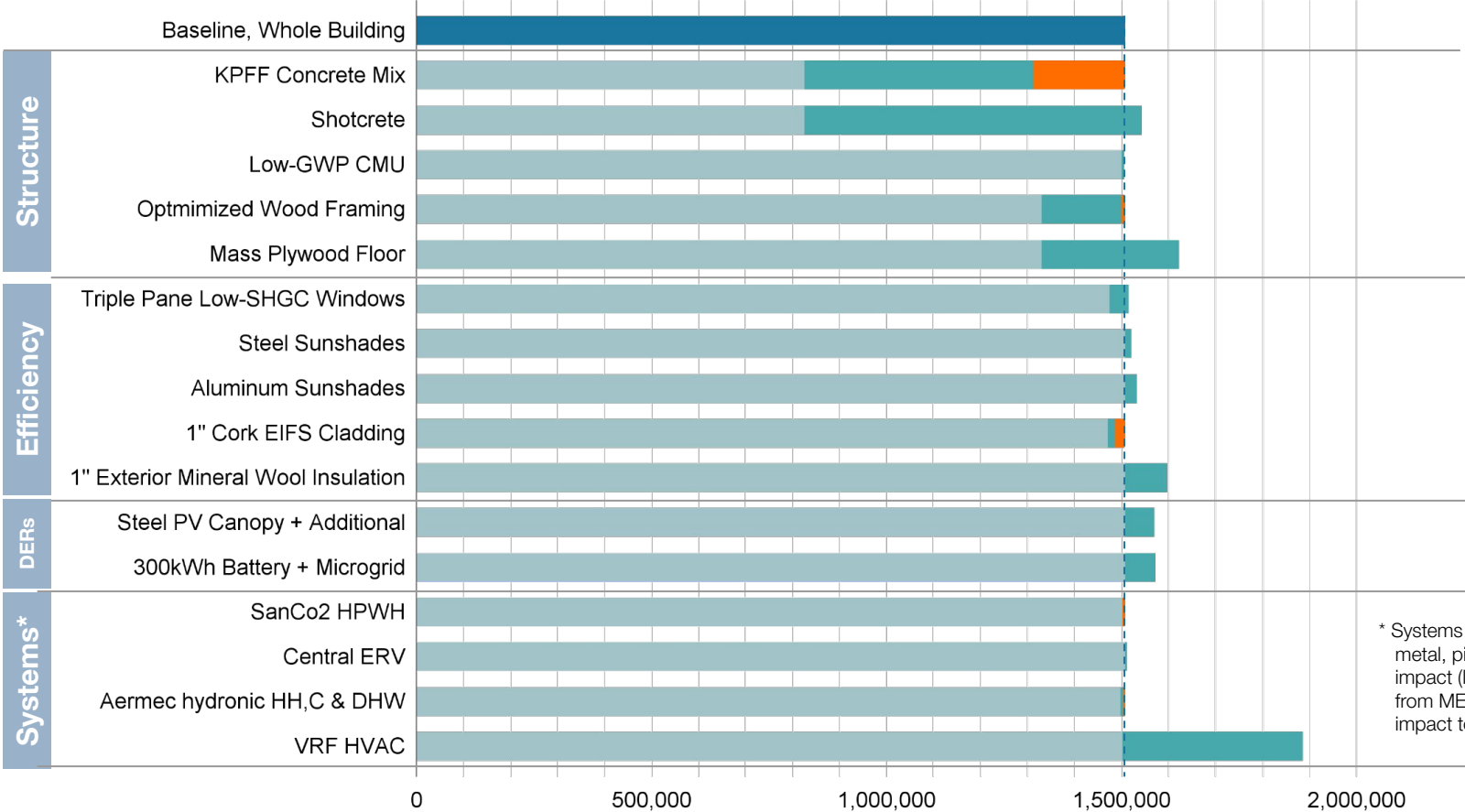


8

Target **embodied emissions**
in priority materials

Embodied Emissions | Impact by Design Measure

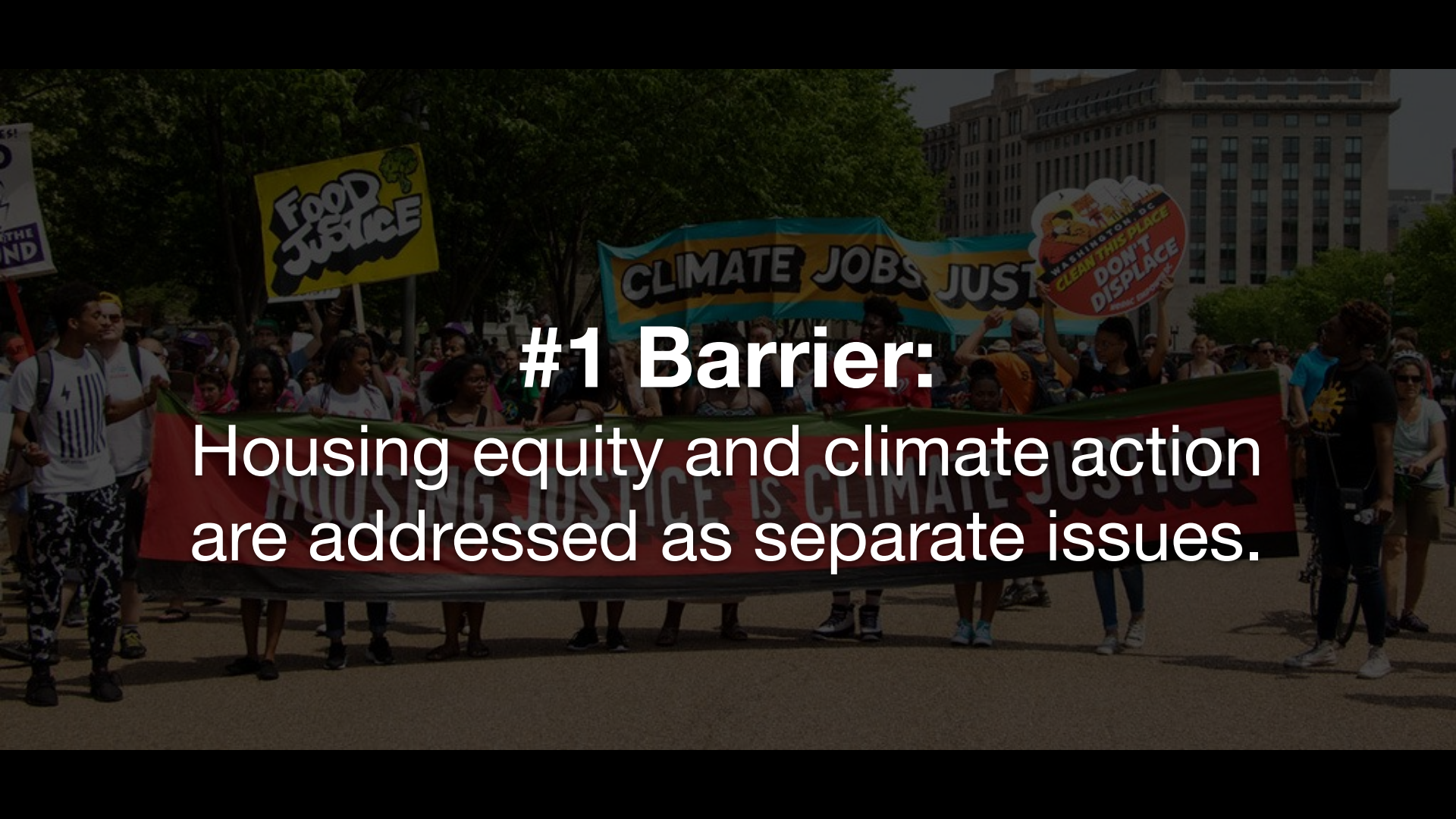
■ CO2(e) contribution of measure
■ Savings from baseline



* Systems includes only sheet metal, piping and refrigerant impact (leakage) over 30 years from MEP2040 refrigerant impact tool

In Conclusion...





#1 Barrier:

Housing equity and climate action are addressed as separate issues.

The Environmentalists



“Non-energy benefits”

Energy and Carbon

- Technology-centric policies and programs
- Innovation = new technologies, “disruption”
- Solutions adapted from other markets (single family)

The Housers



“Helping the environment”

Building homes

- CalGreen and T24 are “good enough”
- Compliance and cost drive decisions
- Mission-informed criteria are difficult to clarify

What Integration Looks Like

- **Programs** (Retrofit, New Construction) are driven by **human metrics**
- **Technology development** focuses on **people**
 - ‘Normal’ end users (families, children, seniors)
 - Creating delivery systems
 - Right to repair, right to maintain

*“You don’t want a panel,
you want a retrofit
delivery system”*

–Michele Knapp, Funform

What Integration Looks Like

- **Housing developers** and **funders** recognize what code does not deliver:
 - quality assurance,
 - tools for optimizing economics,
 - climate adaptation,
 - toxic-free environment,
 - resident belonging and well-being



1. Challenges and Barriers: Examination of the major challenges and barriers. This will include an explanation of why these challenges exist and their potential impact on the environment and society.

Key barrier:

- Housing and climate action are addressed as separate issues
- Policies do not prioritize the human interests (residents, non-profit managers), and so they are less successful than they could be (example: energy or carbon reduction over resilience/health/safety/deferred maintenance)
- Technology is still leading the conversation. The bigger opportunity is to get the industry to deliver the current state of the art

2. Solutions and Strategies: Examination of potential solutions and strategies for overcoming these challenges and barriers, with a focus on practical steps that homeowners, policymakers, and organizations can take.

- Focus on hot water
- Commissioning
- Transportation demand management planning
- Plan appropriately for outages and extreme weather. One size does not fit all
- Don't think good design doesn't matter - inspiration, art&craft, materials that age well, daylight design and connection to nature

3. Identifying Gaps: Identification of the gaps in knowledge and practice. This will include an analysis of where progress has been made, where challenges remain, and where additional research and investment may be necessary.

- Additional research and investment should focus on developing and delivering products for this specific marketplace.



Thank You



Decarbonizing Multifamily Affordable Housing Case Study: Light Tree Apts -- East Palo Alto

Hosts: Berkeley Lab & Building Decarbonization Coalition Seminar Series

Tom White, Director of Building Performance and Sustainability,
Eden Housing, Hayward, California

March 27, 2024





OUR MISSION

Eden Housing creates and sustains high-quality affordable housing communities that advance equity and opportunity for all.

Changing our world, one corner at a time!





Light Tree Apartments and Townhomes





Electrification Strategies for Existing Buildings

- Retrofit, rehab, or capital improvements
- Determine if existing electrical infrastructure sufficient for power demand
- Evaluate and document existing conditions
- Transformers, feeder cables and branch circuit wiring
- Free-up existing electrical capacity for new systems
- Monitor and analyze gas and electricity peak demand loads
- 15amp appliances, 100amp subpanels, single and three phase
- Meter banks and service disconnects
- Transformer upgrades
- Gas disconnections





ELECTRIFICATION LOAD REDUCTION STRATEGIES

DHW loads

- Showerheads, faucets, minimize crossover
- Efficient dishwashers, clothes washers, insulate pipes.

HVAC Loads

- Insulate envelope
- Minimize duct runs
- Select high efficiency 120V low amperage appliances
- Lower ACH

Upgrades

- Lighting
- Cooking
- Miscellaneous Equipment

Offset Increased Electricity Loads with Photovoltaics

- System sizing
- Allocations to common area and/or tenants
- Battery energy storage
- Synching w thermal storage

NON-ENERGY BENEFITS:

- Improved IAQ
- Energy Cost Savings
- Lower GHG





LIGHT TREE APARTMENTS



Project Owners	Eden Housing & East Palo Alto Community Alliance and Neighborhood Development Organization (EPACANDO)
Project Residents	185 homes for low-income and extremely low-income families and individuals, including 30%-60% AMI units set-aside for formerly homeless, former foster youth (FFY) and intellectually and developmentally disabled (I/DD)
Location	1805 East Bayshore Road, East Palo Alto
Site Details	3.38 acres
Units	94 existing units constructed in 1968, 2-3 story slab on grade townhomes, no active cooling 128 units newly constructed 57 substantially rehabilitated units, 37 units demolished
Completion Date	April 2023
Development Cost	\$36.2 million rehab portion; ~\$44 million new construction hard costs
Developer	Eden Housing, Inc. and EPACANDO
Architect	Okamoto Saijo Architecture
General Contractor	Johnstone Moyer, Inc.





LIGHT TREE ELECTRIFICATION

- New electric HVAC, central HPWH mechanical and electrical systems
- New electric utility service
- Existing gas service discontinued
- New solar photovoltaics system to offset owner+tenant loads
- New elevators for existing three-story buildings
- EV charging stations





Good incentives offset a lot of the cost of the install

Assoc. for Energy Affordability provided technical support throughout electrification process

Construction bid phase incentive would increase savings

System sizing difficult with mixed rehab/new construction

Extra coordination with subcontractor for new equipment

Space limitations for indoor and outdoor HPWH equipment

Path of transporting/handling larger tank inside a building, existing structural conditions, outdoor placement

Min. piping connections causing conflicts inside building

Title 24 modeling CHPWH

Noise levels of HPWH





Priorities to smooth path to electrify

- Solve disconnect between state all-electric program incentives and scoring metrics for LMI tax credits and tax-exempt bonds
- Electrification requires more onsite PV to offset added loads
- Tax credit allocation policies are not electrification-friendly due to lack of data on utility cost impact to tenants

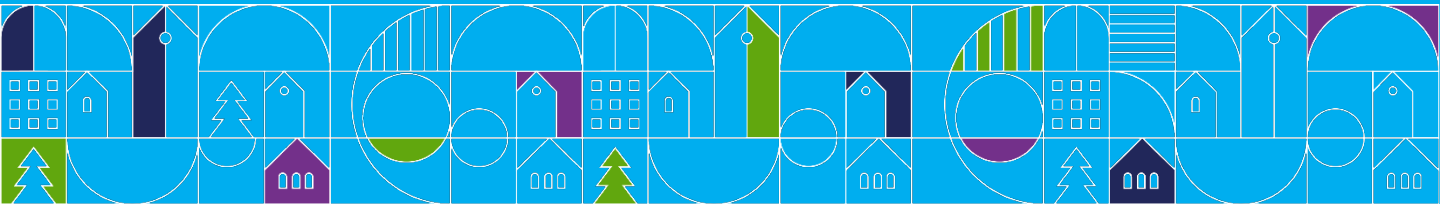
Challenges to be addressed

- Unitary HPWH for every resident more expensive per unit than central system?
- Maintenance costs due to sophistication/type of CHPWH equipment
- Install and redesign costs associated with bulk retrofits of DHW & HVAC mechanical equipment
- Owner-Tenant split incentives for early bulk replacements
- IOU high electric rates, both Time of Use (TOU) and non-TOU
- Local reach code and design review ordinances





RESOURCES





Zero Emissions All-Electric Multifamily Construction Guide, by Redwood Energy, 2019

[Accelerating Electrification of California's Multifamily Buildings: Policy Considerations And Technical Guidelines](#), by StopWaste and Association For Energy Affordability (AEA), 2021

[Electrification Technical Assistance Program](#) by TRC, Peninsula Clean Energy and Silicon Valley Clean Energy

[US Dept of Energy Better Climate Challenge](#)

[Ecosizer](#) tool for sizing centralized heat pump water heater systems for multifamily buildings

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