

Net Zero Energy Case Study:

Prairie Trails School Remodeling Project

November 2, 2021

for the

2021 Midwest Facility Masters Conference




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V1

Agenda:

- Introductions
- About District 26
- Project background
- System Panel Selection Process
- Solar selection process
- Grant requirements
- Ongoing maintenance considerations
- Cost data
- Questions



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Introductions

Lyndl Schuster, Speaker
- *Asst. Supt for Business Services, River Trails School District 26*



Dan Whisler, Speaker
- *Director Buildings & Grounds, River Trails School District 26*



Ron Richardson, Speaker
- *Vice President, FGM Architects*

FGMAARCHITECTS



Introductions

Name: Troy Kerr, Speaker
- *Project Manager, FGM Architects*

FGMARCHITECTS

Name: Aaron Raftery, Speaker
- *Account Manager, Trane*

TRANE
TECHNOLOGIES

Name: Jeff Oke, PE, LEED AP, Speaker
- *Principal, IMEG Corp.*

IMEG

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About District 26



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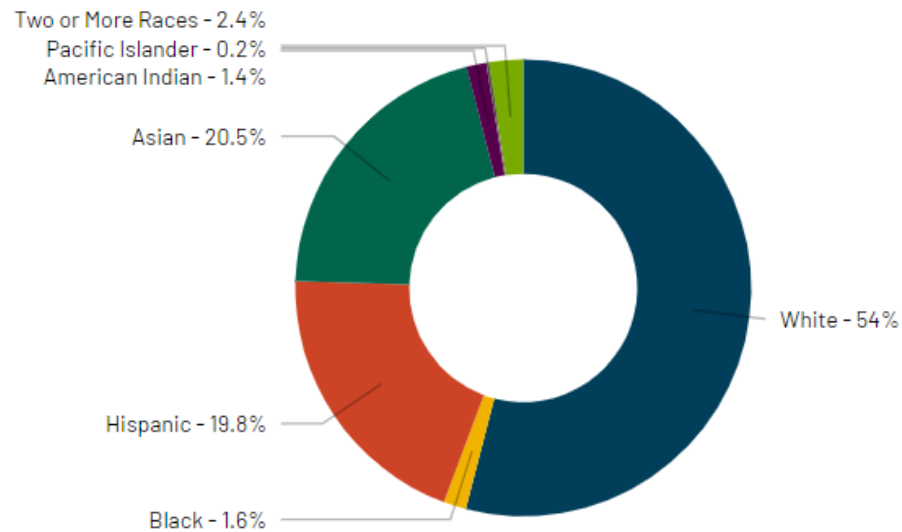
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About River Trails School District 26

- ❖ Suburban Chicago School District
- ❖ 1605 Students in 4 schools
- ❖ 1 Pre-K and K School (Prairie Trails)
- ❖ 2 Elementary Schools (1 to 5)
- ❖ 1 Middle School (6-8)
- ❖ 49 languages spoken
- ❖ 29% Low Income
- ❖ 23% English Learners
- ❖ Average per-pupil expenditure: \$14,659

Racial/Ethnic Diversity - 2020



About River Trails School District 26



- ❖ U.S. Dept. of Education 2015 **Green** Ribbon School
 - ❖ River Trails Middle School

- ❖ **Energy Star** Certification
 - ❖ All 3 Schools Received Award
 - ❖ Prairie Trails School Net Zero Energy (not applied yet)

- ❖ U.S. Dept. of Energy Better Buildings Challenge Award
 - ❖ Achieve 20% Improvement in Energy Efficiency by 2026
 - ❖ Accomplished in 2015
 - ❖ New Goal of 30% by 2026



Getting Buy-In

Board



Administration



Passionate Teachers



Students




Community



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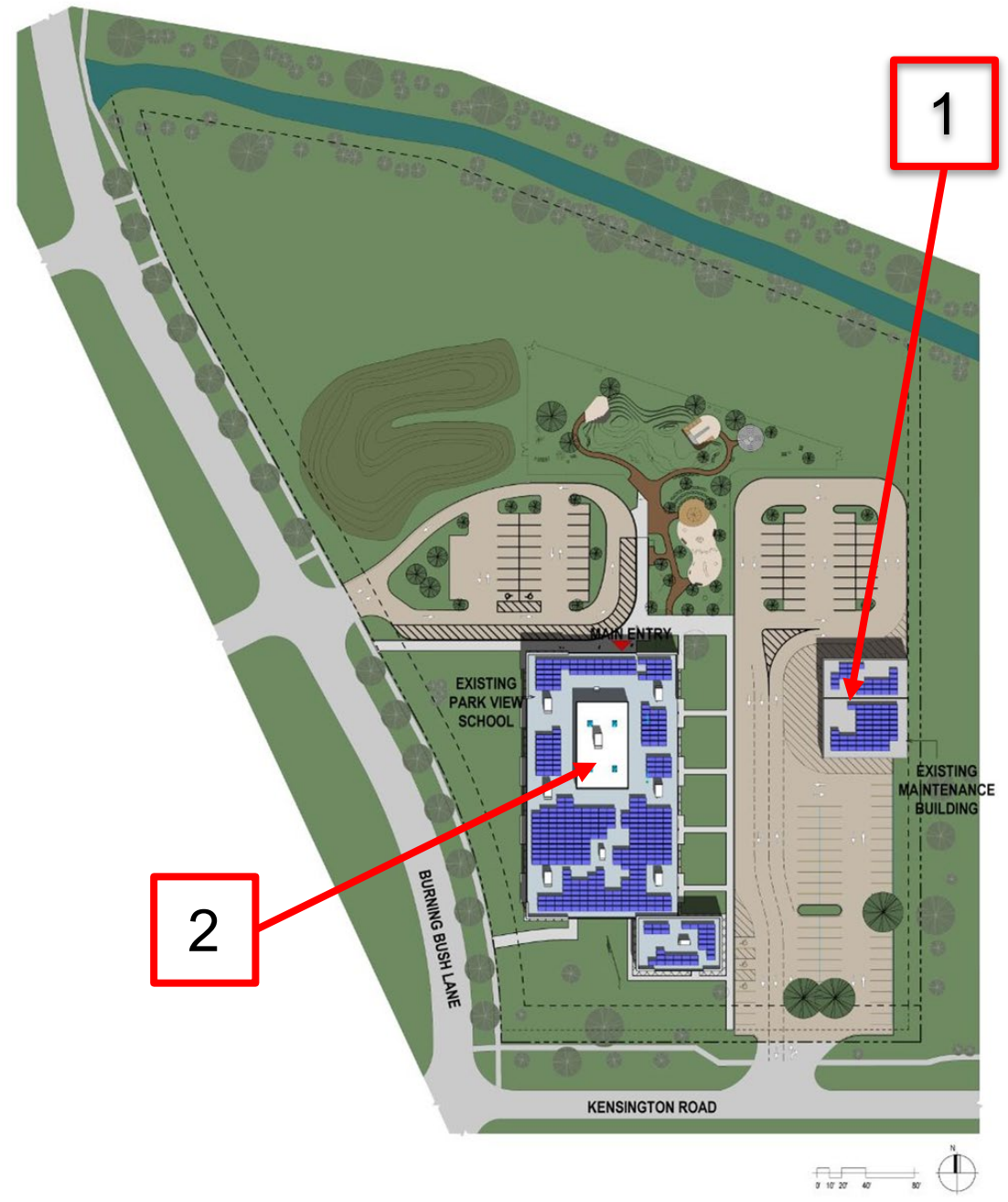
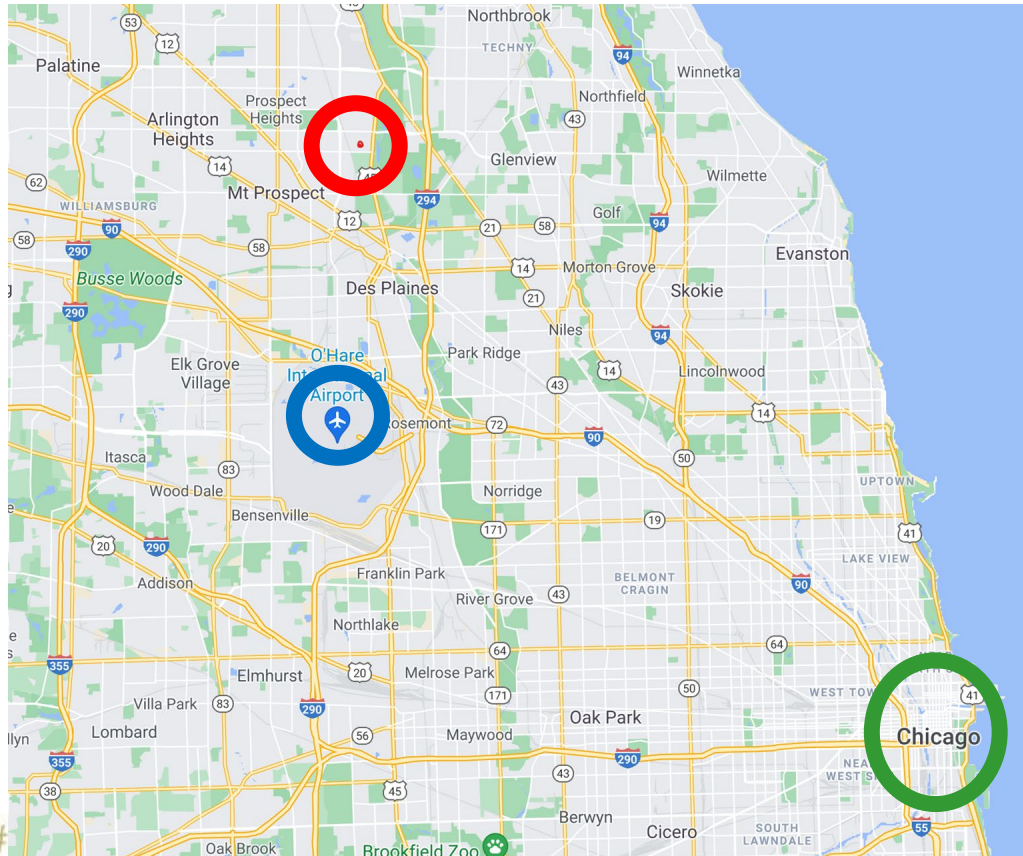
Project Background



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Prairie Trails Background:

- Building Area- Approx. 29,000 sf
- District Needed Classroom Space



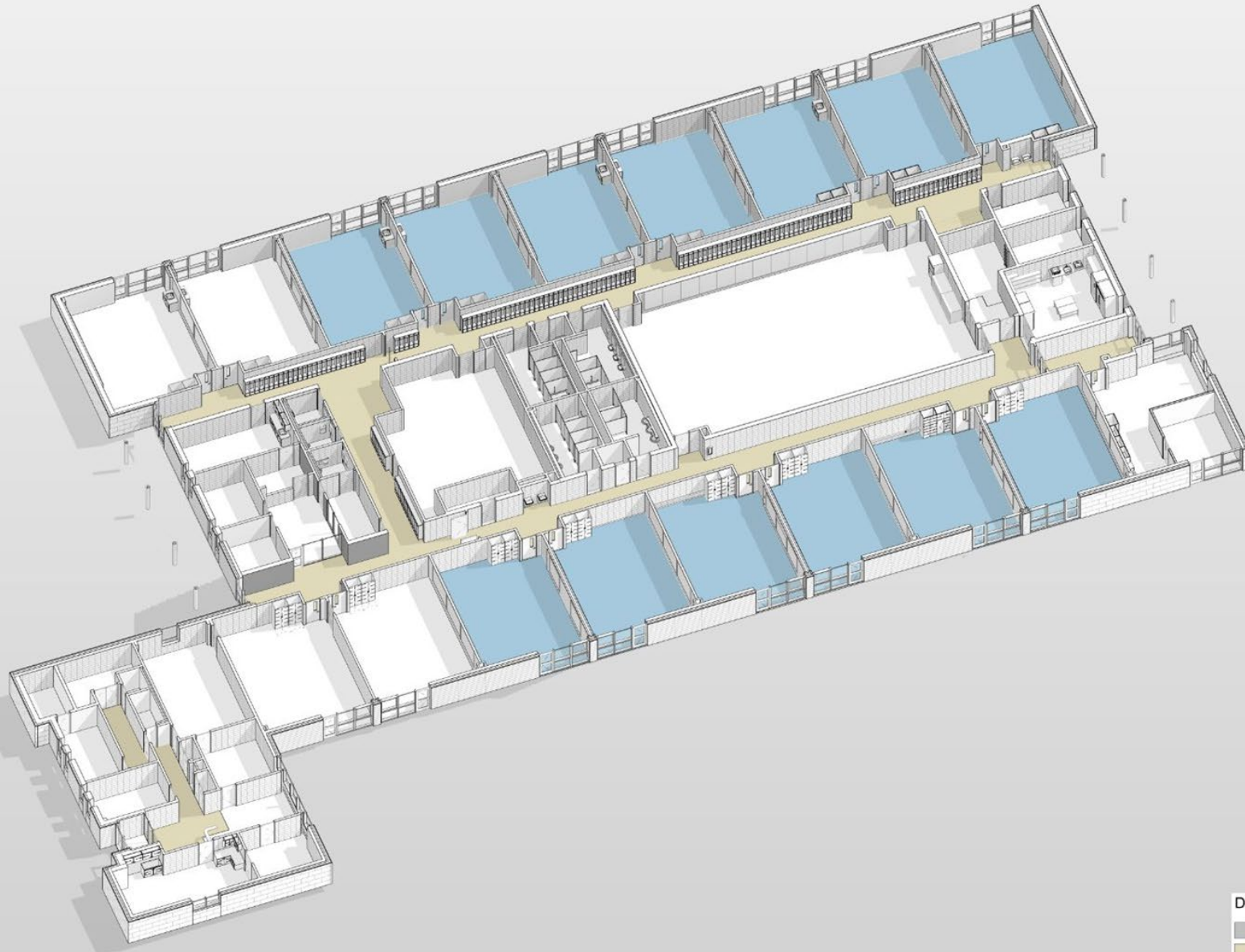
Prairie Trails Background:

- Original School Completed in 1966



Prairie Trails Background:





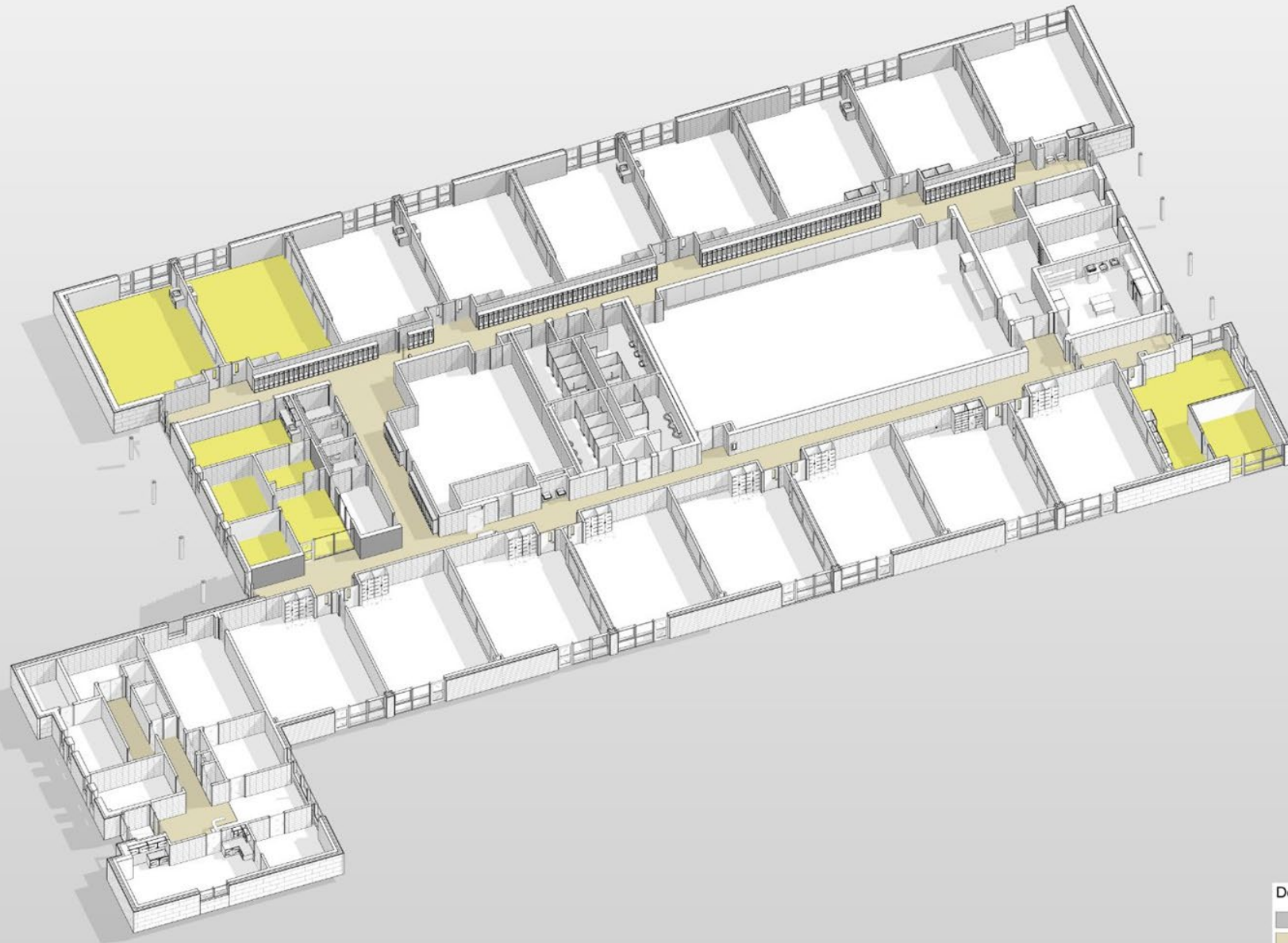
Department Legend

- Building Support
- Circulation
- Classroom
- District Office
- Gymnasium
- Kitchen
- Teacher Support



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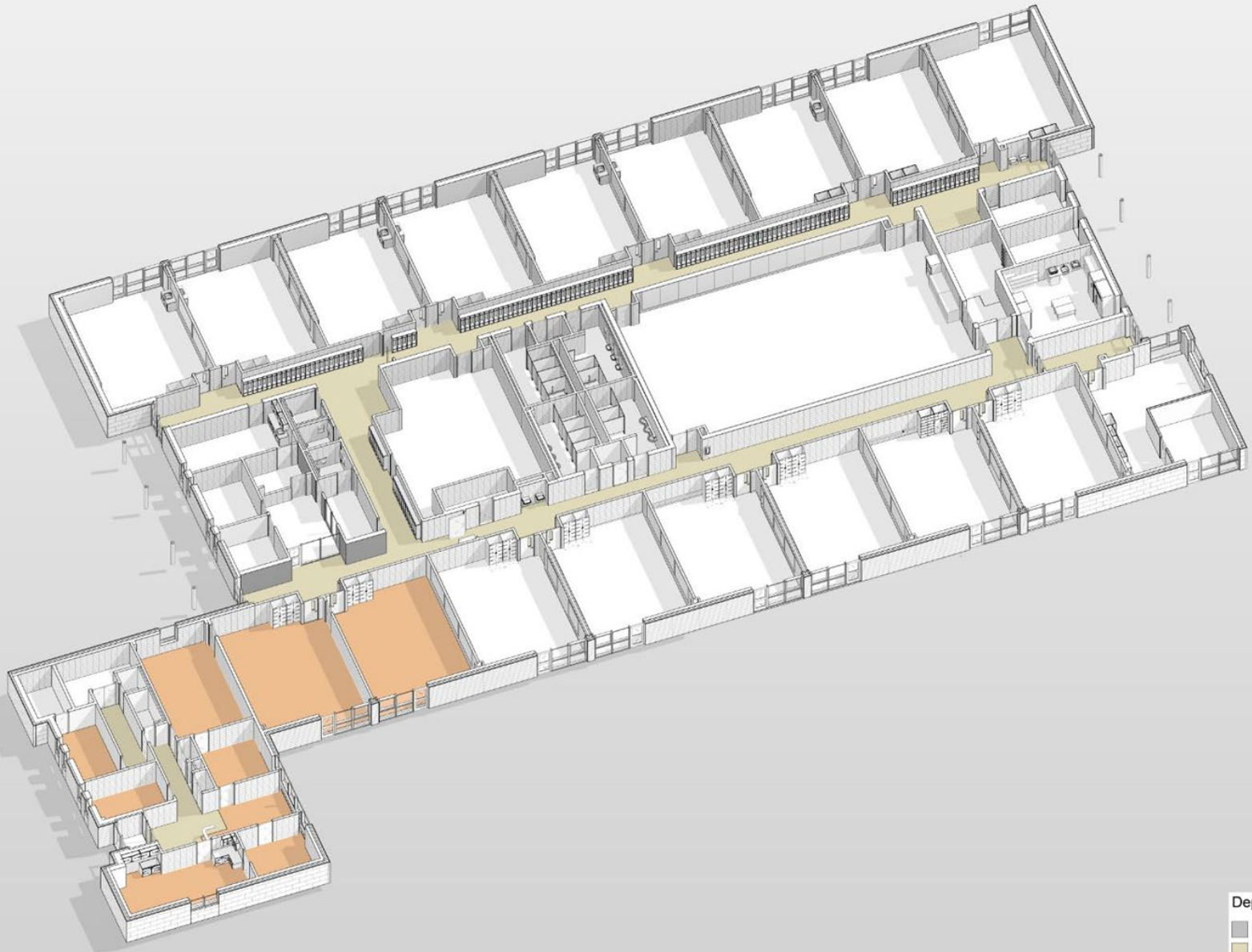
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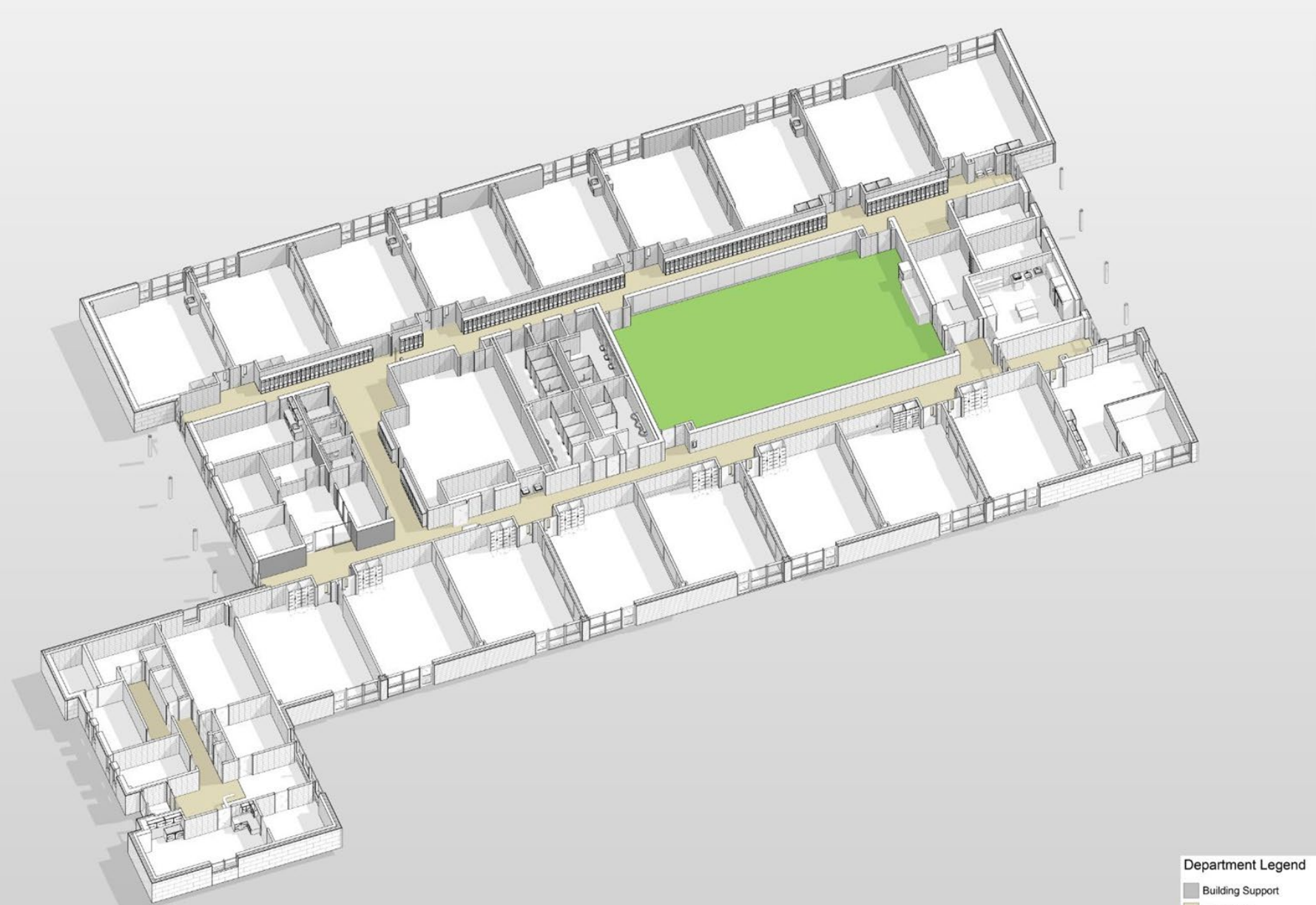
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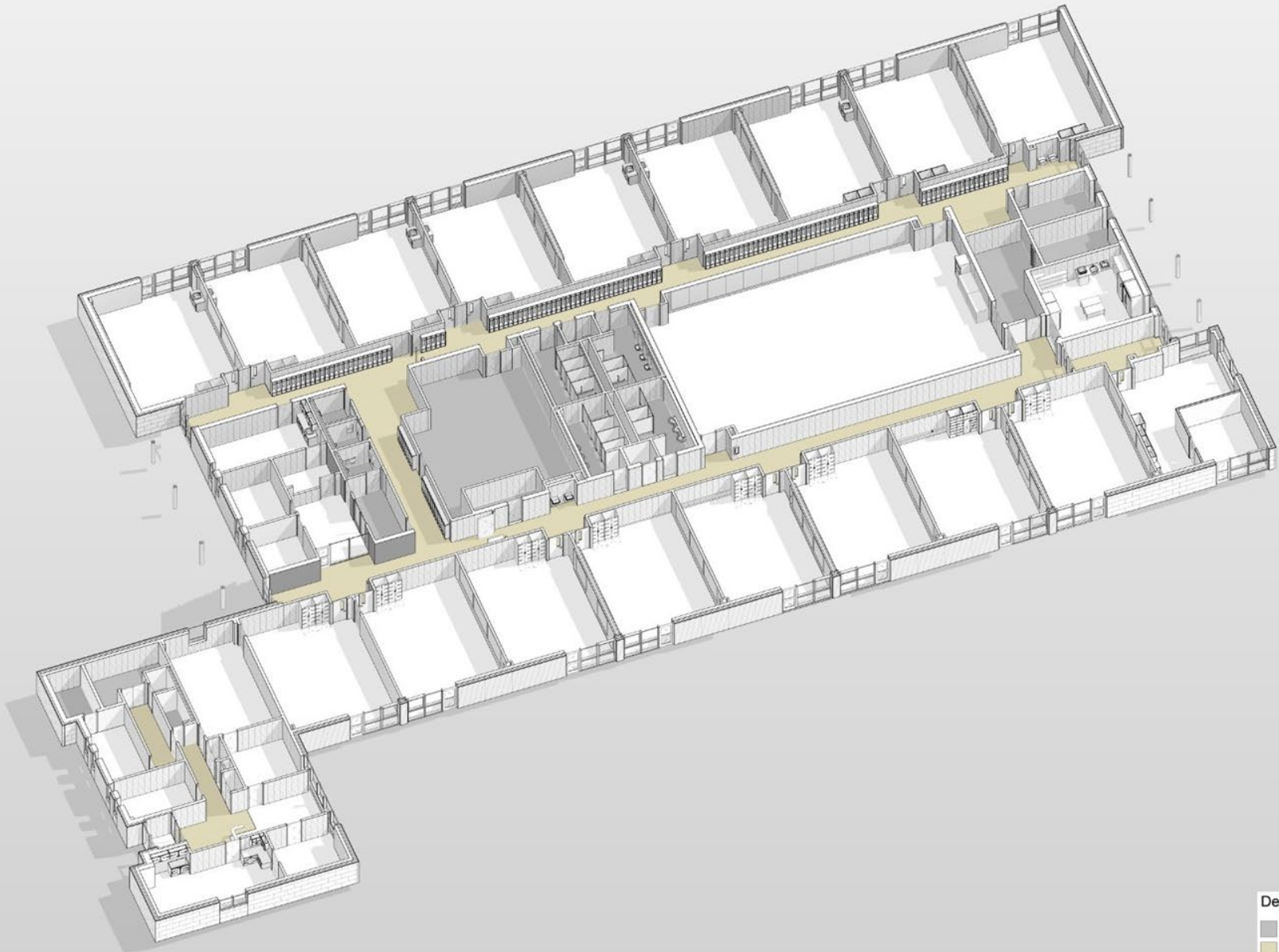
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- Department Legend
- Building Support
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 - Teacher Support



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- Department Legend
- Building Support
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System Evaluation Process



Mechanical System Selection

System/ Plant	EUI		Energy Cost	
	(kBtu/ sqft/ yr)	% Savings	(\$/ yr)	% Savings
Baseline: 90.1-2013	75	-	\$ 30,128	-
Single Pipe Hybrid Geothermal	20	74%	\$ 21,854	27%
Single Pipe 100% Geothermal	20	74%	\$ 21,682	28%
VRF Hybrid Geothermal	17	78%	\$ 18,264	39%
VRF 100% Geothermal	16	78%	\$ 18,026	40%
VRF Air Cooled	23	69%	\$ 25,327	16%

Energy Source	Utility Costs	
Electric	\$0.086 per kWh	\$0.025 per kBtu
Natural Gas	\$0.386 per therm	\$0.004 per kBtu

Envelope Assumptions	
Exterior Wall:	R-18 (U-0.055)
Roof:	U-0.032
Windows:	U-0.42 and SHGC: 0.40
Window to Wall Ratio:	35%



DOAS Coupled with VRF System



Dedicated Outside Air System (DOAS)

DOAS Components:

ECM Motor Fan

Electronically Commutated Motor

Energy Recovery Wheel

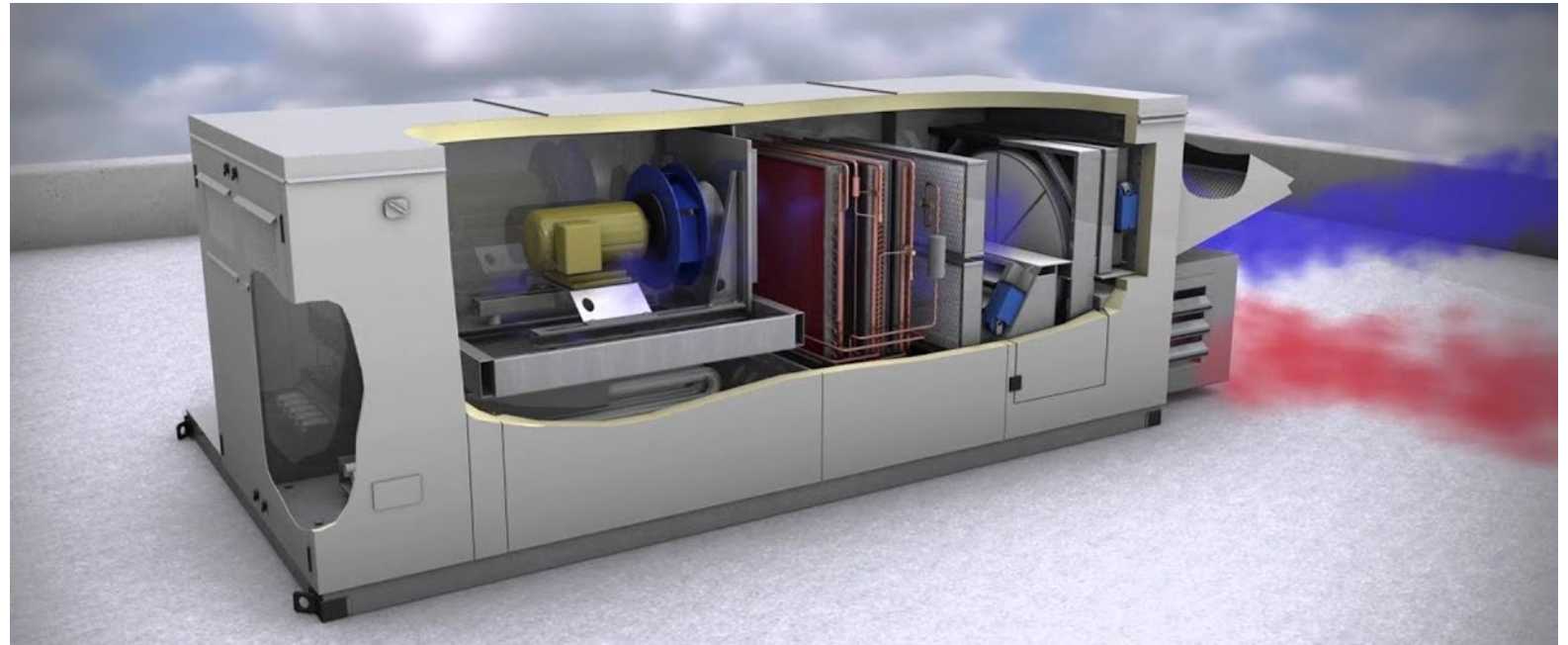
All building exhaust is recovered

Digital Scroll Compressors

Heat Pump Heating

Coefficient of Performance of 2.3

Operates in heating down to 0°F



Ventilation w/ Heat/Energy Recovery

AHRI CERTIFIED
www.ahrifactory.org

Certificate of Product Ratings

AHRI Certified Reference Number : 518128 Date : 11-20-2019 Model Status : Active

Old AHRI Reference Number :
Brand Name : Airxchange
Product Type : Wheel
Model Number : ERC-3014C
Selection Software Name :
Selection Software Version :

Rated as follows in accordance with the latest edition of ANSI/AHRI 1000 (I-P) Performance Rating of Air-to-Air Exchangers for Energy Recovery Ventilation Equipment and subject to rating accuracy by AHRI-sponsored, independent, third party testing:

Nominal Air Flow (scfm) : 1400
Pressure Drop (at nominal airflow, in. H2O) : 1.00

Leakage Ratings	PressureDiff	EATR(%)	OACF	PurgeAngle
Test 1 :	0	2.4	1.04	N/A
Test 2 :	0.5	0.8	1.08	2
Test 3 :	1	0.9	1.10	1

	Sensible(%)	Latent(%)	Total(%)
100% Air Flow Heating :	76	70	74
75 % Air Flow Heating :	80	75	78
100% Air Flow Cooling :	76	70	72
75% Air Flow Cooling :	80	75	77

	Net Sensible(%)	Net Latent(%)	Net Total(%)
100% Air Flow Heating :	76	70	74
75 % Air Flow Heating :	80	75	78
100% Air Flow Cooling :	74	69	72
75% Air Flow Cooling :	80	74	77

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Active Model Status are those that an AHRI Certification Program Participant is currently producing AND selling or offering for sale; OR new models that are being marketed but are not yet being produced. *Production Stopped* Model Status are those that an AHRI Certification Program Participant is no longer producing BUT is still selling or offering for sale.

**Ratings that are accompanied by WAS indicate an involuntary re-rate. The new published rating is shown along with the previous (i.e. WAS) rating.

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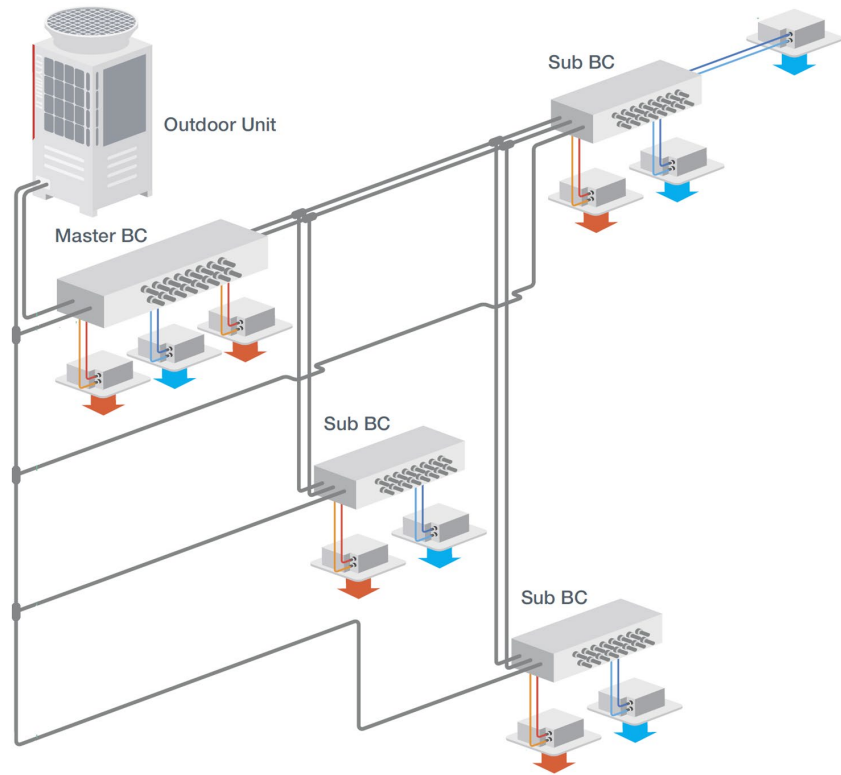
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AHRI ERV performance extrapolation - straight line method												
WUFI Inputs												
Sensible Recovery Efficiency				Total Design Airflow								
0.81				10,435								
Humidity Recovery Efficiency												
0.75												
Model	Units	CFM	Net Sensible (%)		Net Latent (%)		Weighted Sensible Recovery	Weighted Humidity Recovery	Net Sensible Slope		Net Latent Slope	
			Heating	Cooling	Heating	Cooling			Heating	Cooling	Heating	Cooling
DOAS-1	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0759	0.0714	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	980	80.8	81.2	76.0	75.0						
DOAS-2	100% AHRI Rated Airflow	1,400	76	74	70	69	0.1114	0.1017	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	1,570	74.1	71.1	67.6	66.6						
DOAS-3	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0725	0.0684	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	930	81.4	82.1	76.7	75.7						
DOAS-4	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0765	0.0720	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	990	80.7	81.0	75.9	74.9						
DOAS-5	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0712	0.0671	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	910	81.6	82.4	77.0	76.0						
DOAS-6	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0563	0.0537	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	700	84.0	86.0	80.0	79.0						
DOAS-7	100% AHRI Rated Airflow	1,400	76	74	70	69	0.1112	0.1014	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	1,565	74.1	71.2	67.6	66.6						
DOAS-8	100% AHRI Rated Airflow	1,400	76	74	70	69	0.0739	0.0696	0.0114	0.0171	0.0143	0.0143
	75% AHRI Rated Airflow	1,050	80	80	75	74						
	Design airflow	950	81.1	81.7	76.4	75.4						
RTU-1	100% AHRI Rated Airflow	3,200	65	64	61	60	0.1626	0.1418	0.0200	0.0143	0.0143	0.0143
	75% AHRI Rated Airflow	2,400	72	69	66	65						
	Design airflow	1,840	92.2	83.4	80.4	79.4						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						
	100% AHRI Rated Airflow						0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
	75% AHRI Rated Airflow	0										
	Design airflow		0.0	0.0	0.0	0.0						

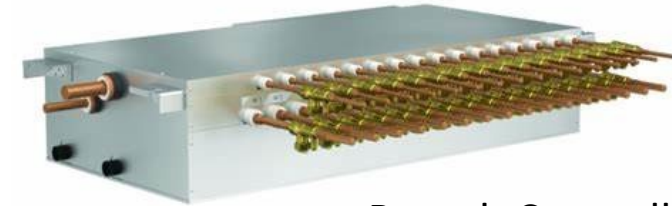


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Variable Refrigerant Flow System



Air Source
Condensing Unit



Branch Controller

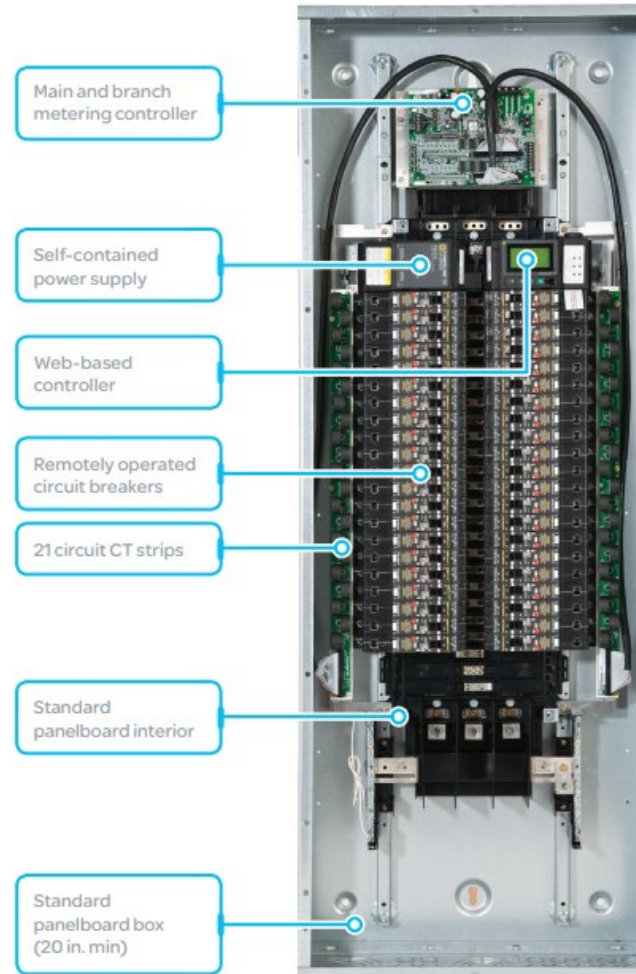


Terminal Unit - Cassette

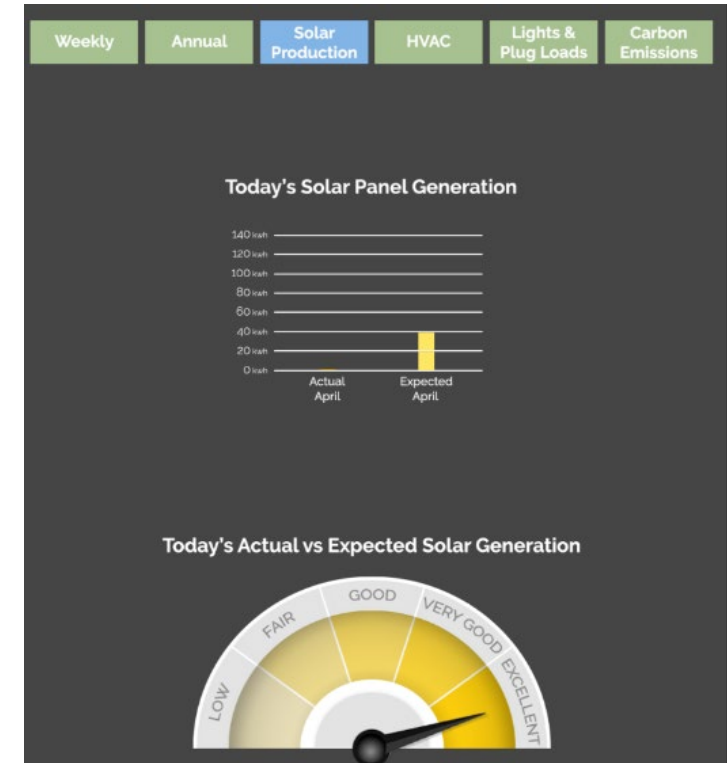
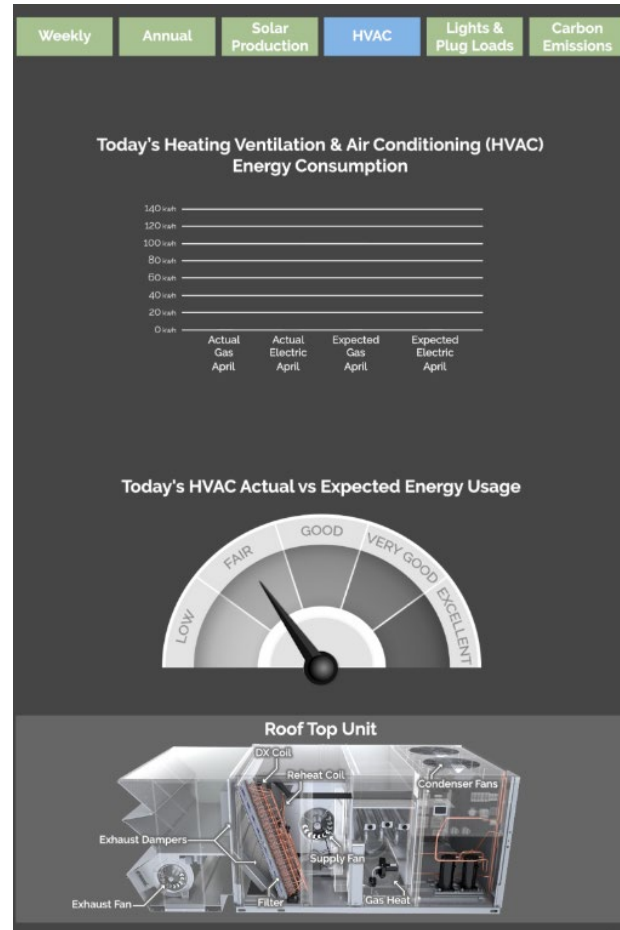
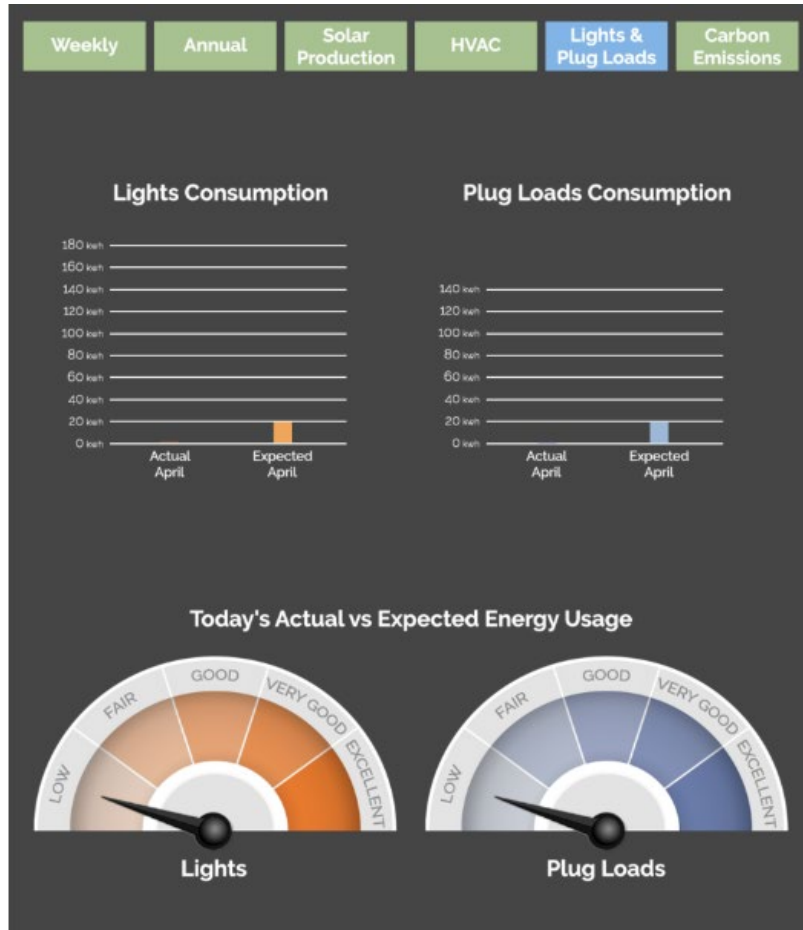


Energy Efficient Lighting and DHW

- All LED Lighting
- All lighting on vacancy sensor or occupancy sensor where possible
- DHW loop on thermostat-controlled “on demand” system
- Measurement and verification electrical panels for energy monitoring

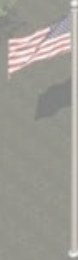
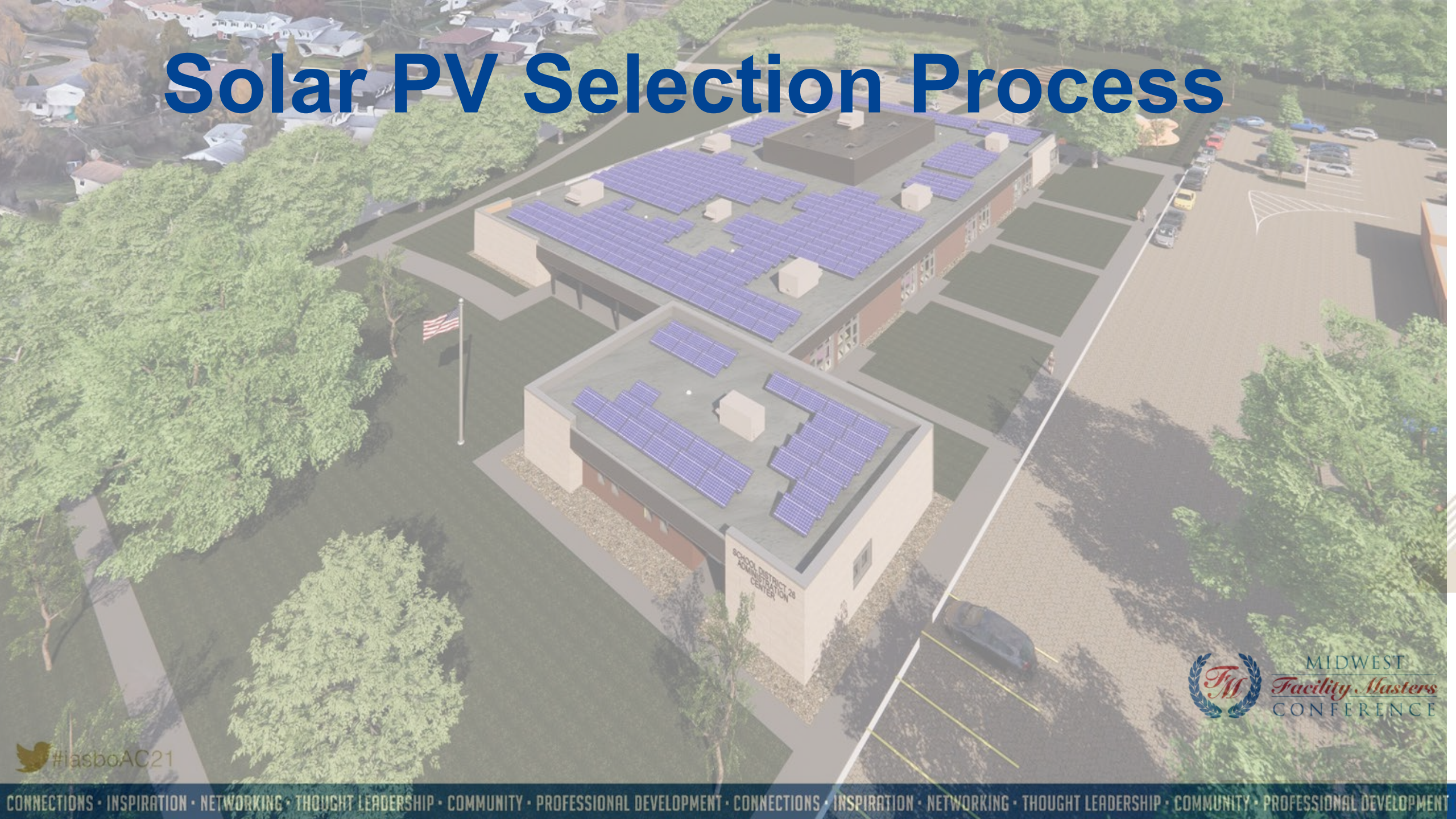


Energy Monitoring



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Solar PV Selection Process



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PV Procurement Considerations

Ownership Options:

- Power Purchase Agreement
- Direct Purchase



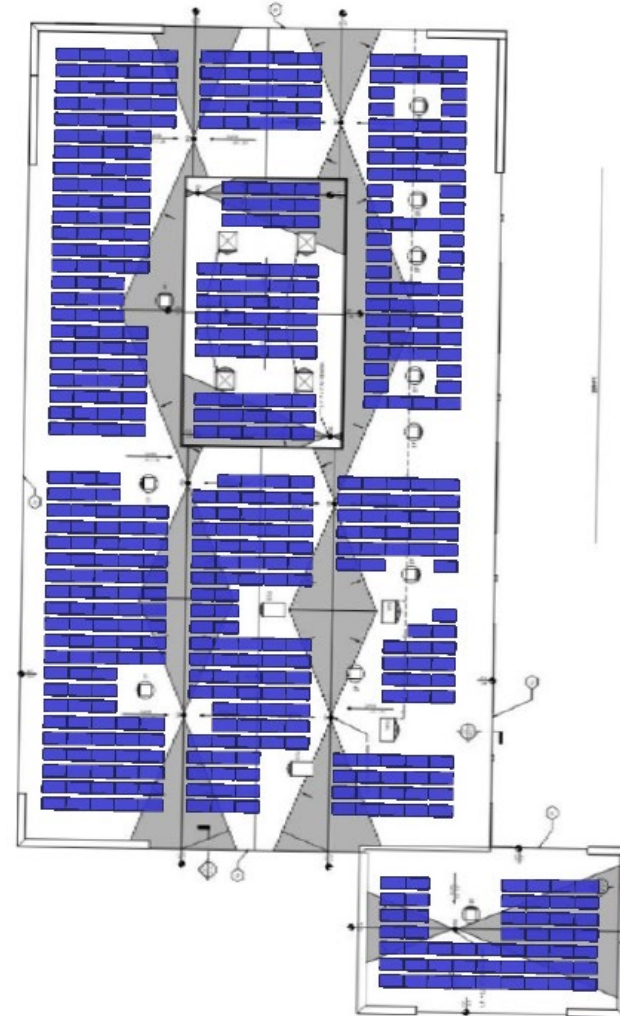
Available Incentives:

- Solar for All
- Adjustable Block Program
- IL Clean Energy Community Foundation



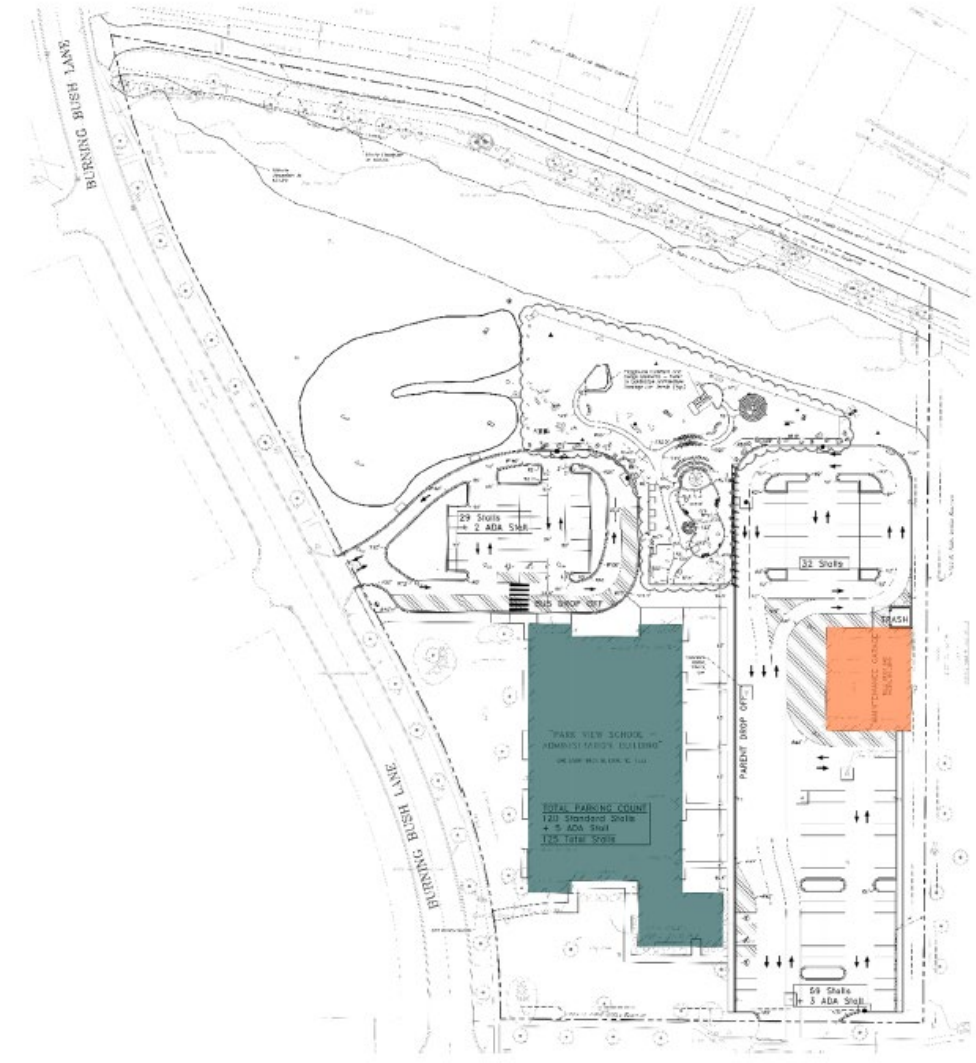
Design & Development Challenges

- Target performance changes
- 20% NZE safety factor
- DG Interconnection requirements
- ICECF metering requirements



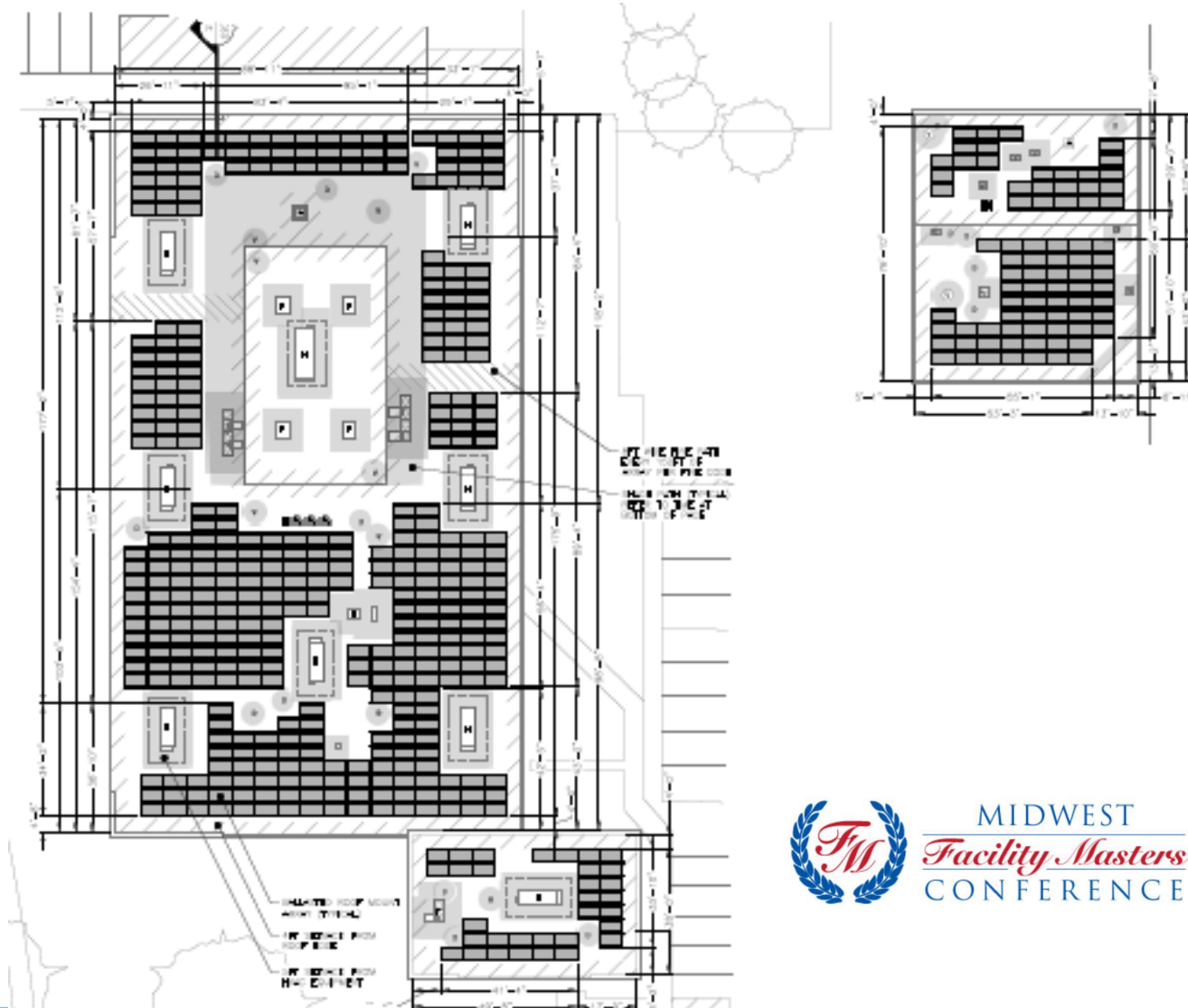
Space Constraints

- Roof shading – trees & HVAC screens
- Limited/no ground options
- High cost of canopy structures

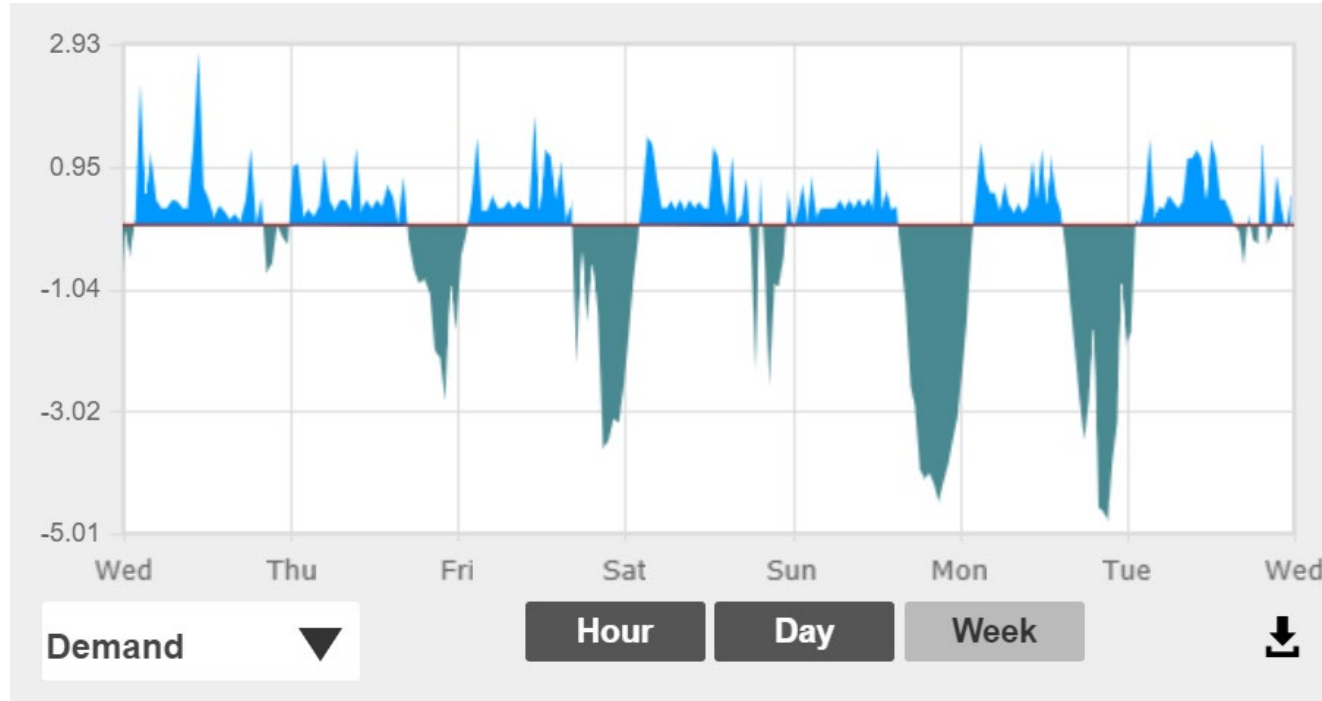


Final System Design

- 206.4 kW DC nameplate
- 430-watt modules
- Module-level optimizers to offset shading impact
- 239.5 MWh annual production



Net Zero Energy & Net Energy Metering



METER INFORMATION

Read Dates	Meter Number	Load Type	Reading Type	Previous	Present	Difference	Multiplier	Usage
2/19-3/20	272233897	I/O w/ Flow Thru	kWh From Grid	Actual	Actual			334
2/19-3/20	272233897	I/O w/ Flow Thru	kWh To Grid	Actual	Actual			383



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EXIT

EXIT

Design Overview + Grant Requirements



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Highlights:

- Made possible through an **Illinois Clean Energy Community Foundation** grant of up to **\$2,000,000**
- Summer 2021 completion; twelve-month performance evaluation required
- **Net Zero energy usage**
- Target **EUI of 24 to 29**
- Certification required through the **Passive House Institute US (PHIUS)**
The project must meet PHIUS+ and PHIUS+ Source Zero performance criteria.
 - PHIUS+ is a “high-performance building standard” – it challenges the building industry to construct buildings that can maintain a comfortable indoor environment **with very low operating energy.**
- **No natural gas** service to the school.



- Mechanical system
 - The existing hot water boiler system will be replaced with a **new electric variable refrigerant flow (VRF) system with heat recovery**. The VRF system is coupled with dedicated outside air units with energy recovery wheels for fresh air delivery. The multipurpose room will be conditioned by a single zone variable air volume packaged rooftop unit with energy recovery wheel and fresh air via demand control ventilation.
 - Code minimum: hot water boiler and air-cooled chiller serving unit ventilators
- New temperature controls: **load-specific electrical monitoring**, including plug loads, lighting loads, HVAC loads, and energy generation from the PV panels. Integration (monitoring and display) of the net-zero technologies will be through the BAS system. (The BAS system will monitor, not control, the solar panels)
- New solar panel system to produce electricity
 - **New rooftop photovoltaic system to generate on-site renewable energy.**

The annual production target is currently 239.5 MWh, which includes

a 22.7% buffer (grant- 10%)



- Roof system
 - The existing built-up roof system will be replaced. Increase **roof insulation performance value from R-30 to R-65 (average)** using additional thickness of polyisocyanurate foam board insulation. The system design includes additional parapet height to conceal additional insulation. New roof system to be a single ply synthetic rubber roof
- Exterior wall system
 - **The existing uninsulated exterior wall system will be modified to receive new wall cladding. The foundation will be modified to include new insulation below grade. The existing face brick will be removed and a new thermally broken rail system with new insulation will be applied. New exterior cladding will be applied.**
- The remodeling will include **new LED lighting**, with light harvesting, to reduce energy consumption
- New window system
 - The original single pane aluminum window system will be replaced with **a new double thermally broken curtain wall framing system with triple-pane dual low-e insulated glazing.**



PHIUS+ 2018

- PHIUS+ certification used as third-party verification of Net Zero performance
- Residential standard—**Not set up for commercial projects**
- Focuses on seven metrics
 - Heating Demand
 - Cooling Demand
 - Heating Load
 - Cooling Load
 - Source Energy
 - Site Energy
 - Air Tightness
- Can miss (not achieve the minimum design target) on **ONE** of the seven



Net Zero Energy Building Program

The **Illinois Clean Energy Community Foundation's** Net Zero Energy Building Program will award grants to new construction or retrofit projects that achieve site net zero energy performance or better, over the course of a year. Buildings must, at a minimum, offset all of their energy consumption with on-site generation from renewable resources. Grants will be paid incrementally, with full payment contingent on actual building performance.

Applicants:

- **501(c)(3) nonprofit organizations**
- **Local government agencies serving Illinois residents**
- **Colleges and Universities**

Projects

- Attain and maintain site net zero energy building performance, or better
- Obtain at least one of these certifications: PHIUS+, PHIUS+ Source Net Zero, Full Living Building Challenge, Petal (Energy) Living Building Certification, Zero Energy Living Building Certification (**Prairie Trails- PHIUS+ Source Net Zero**)
 - Achieving PHIUS+ means dramatically reducing demand. Achieving PHIUS+ Source Zero means meeting the small remainder with on-site or off-site renewable energy.
- Make education about net zero energy buildings an integral part of the project
- Monitor and make available on a public website “real time” load specific building performance
- Hold a "Grand Opening Celebration“


Challenges:

- Risk: approval process runs parallel to design. Owner must accept approval risk
- Liability
- Budgeting and coordination
- New technologies
- Schedule/qualified trades

Ongoing Maintenance Considerations



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Ongoing Maintenance Considerations

- **Deferred Maintenance is not an option**
 - Air makeup units and refrigeration units must be
 - inspected
 - tuned
 - kept in perfect condition.
- **Continuous building envelope inspections are a priority**
 - Areas to monitor:
 - door and window seals
 - door thresholds
 - caulk joints
 - mechanical dampers.



Ongoing Maintenance Considerations

- **Monitoring, trending and responding to BAS information is critical**
 - The energy load and solar generation reporting will help identify system issues early, and help meet annual energy goals.
- **Building content must be monitored to ensure NO**
 - personal refrigerators
 - microwaves,
 - heaters and fans
 - All of which will increase the building mechanical and electrical load.



Ongoing Maintenance Considerations


- **Limit use of operable windows**
 - moderate low enthalpy days only
 - to minimize the environmental impact on the facility.
- **Consistent adjustments of the building occupation schedule**
 - Best use of total energy consumption
 - Maximize generated renewable resources.



Cost Data



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Project Cost as of 11.11.20

		cost	area	cost/sf	
1	Hard Costs				
	a Construction Value/low bids	\$ 9,692,525.00	28,737	\$337.28	
	b CM FEES	\$ 391,343.00	28,737	\$ 13.62	
	c General Fixed Conditions (July - December)	\$ 156,640.00	28,737	\$ 5.45	
	d Insurance(.69%)	\$ 65,488.00	28,737	\$ 2.28	
	e Estimated Reimbursable Expenses	\$ 350,000.00	28,737	\$ 12.18	
	f Solar power (purchasing contract through Trane)	\$ 463,989.00	28,737	\$ 16.15	
	g Total Hard Cost	\$ 11,119,985.00	28,737	\$386.96	86%
2	Soft Costs				
	a Abatement	\$ 160,405.00	28,737	\$ 5.58	
	b Furniture	\$ 250,000.00	28,737	\$ 8.70	
	c Playground Equipment (not the full cost for the playground)	\$ 44,165.00	28,737	\$ 1.54	
	d Technology & A/V Allowance	\$ 165,900.00	28,737	\$ 5.77	
	e Monument Sign	\$ 42,318.00	28,737	\$ 1.47	
	f Professional Fees: (Acoustician, Civil, Attorneys, Mechanical, Architect etc.)	\$ 991,511.00	28,737	\$ 34.50	
	g Interactive Video learning (signage allowance)	\$ 50,000.00	28,737	\$ 1.74	
	h Net Zero Energy Commissioning & Certification	\$ 165,223.00	28,737	\$ 5.75	
	i Total Soft Cost	\$ 1,869,522.00	28,737	\$ 65.06	14%
3	Total Project Cost	\$ 12,989,507.00	28,737	\$452.01	100%
4	Grants:				
	a Net Zero Energy (maximum allowance)	\$ (2,000,000.00)	28,737	\$ (69.60)	
	b ISBE School Maintenance Grant	\$ (50,000.00)	28,737	\$ (1.74)	
	c ComEd Energy Grant	\$ (49,800.00)	28,737	\$ (1.73)	
	d Total value of grants	\$ (2,099,800.00)	28,737	\$ (73.07)	-16%
		\$ 10,889,707.00	28,737	\$378.94	



	Construction Values/Low Bids + Solar	Approximate Value of Prime Packages	Area	Cost/SF	% of Hard Cost
BP 1	Site and Concrete	\$ 2,400,000.00	28,737	\$ 83.52	24%
BP3	General Trades	\$ 3,060,925.00	28,737	\$ 106.52	30%
BP4	Roofing	\$ 719,000.00	28,737	\$ 25.02	7%
BP5	Flooring	\$ 415,000.00	28,737	\$ 14.44	4%
BP6	Fire Protection	\$ 126,000.00	28,737	\$ 4.38	1%
BP7	Plumbing	\$ 396,000.00	28,737	\$ 13.78	4%
BP8	HVAC	\$ 1,378,000.00	28,737	\$ 47.95	14%
BP9	Electrical (includes solar)	\$ 1,661,589.00	28,737	\$ 57.82	16%
		\$ 10,156,514.00			



 #iasboAC21

Questions and Answers

We thank you for your time!



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