How to Truly Succeed with Energy Optimization, Energy Storage & Solar Projects

MIDWEST Facility Masters CONFERENCE

Today’s Speakers:

Moderator: Katy Glynn | Account Executive | Siemens Smart Infrastructure

Ronald C. Anderson, CPMM, CPS CSBO | Executive Director | Oak Park & River Forest High School District 200

Jeff Oke, PE, LEED AP | Client Executive | IMEG Corp.

Graham Morin, CEM | Business Development | Seimens Distributed Energy Systems

Remember to drop off your business card up front to receive additional information on this topic.

Your Success will be Unique:

1. All facilities are different and will require a customized approach.
2. Knowing the right questions to ask is the key to your success.
3. Mapping out a long-term plan will save time, money and align expectations.

Remember to drop off your business card up front to receive additional information on this topic.

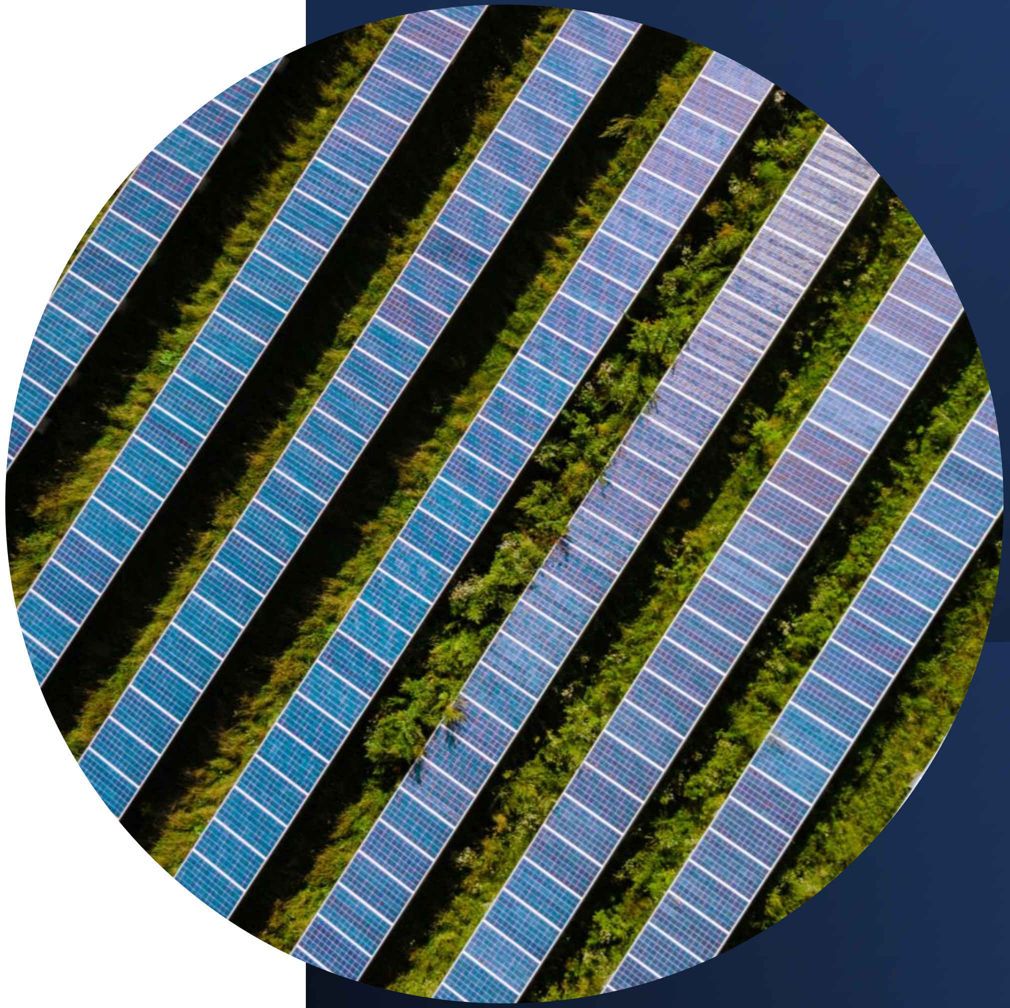
Ron Anderson, CPMM, CPS, CSBO

Executive Director of Operations

Oak Park and River Forest
High School District 200

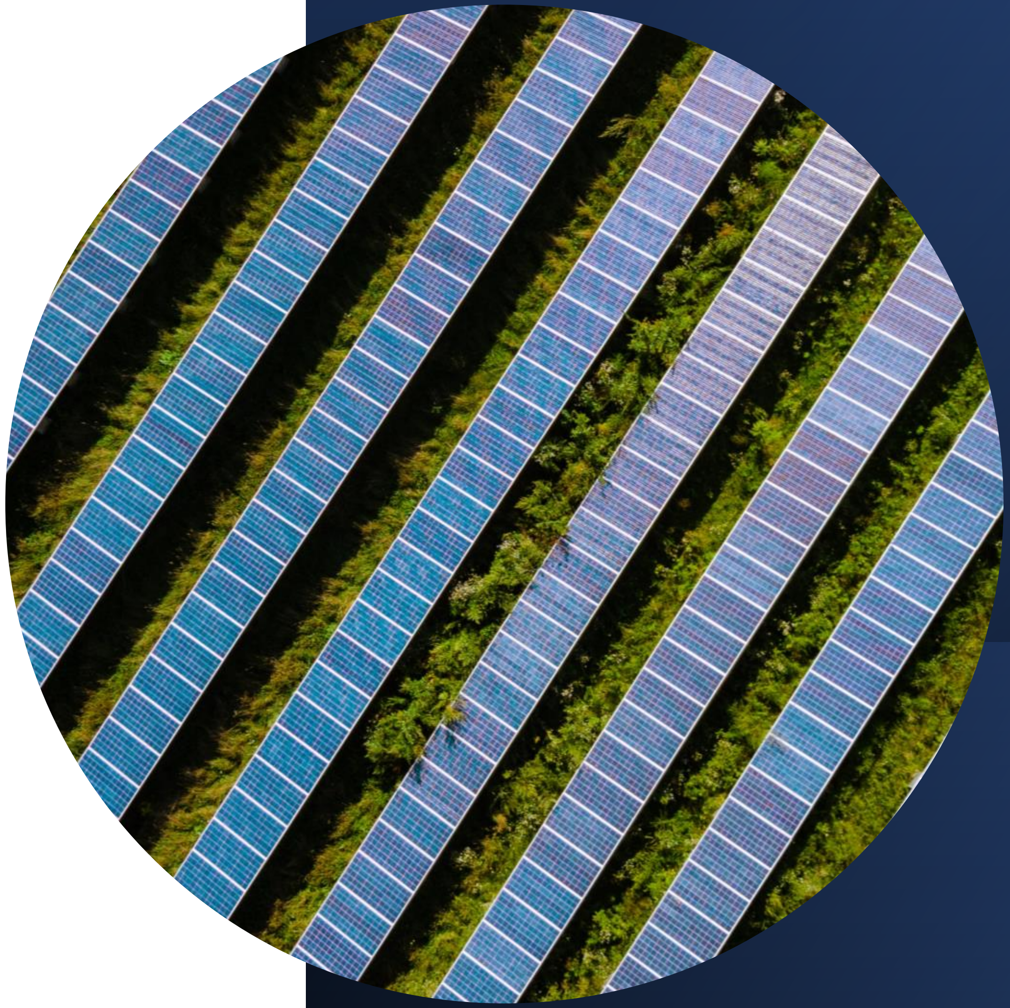
Sustainability Efforts

- **ComEd Facility Assessment**
  - Identify Energy Efficient Projects
- **Joined ComEd/Nicor Gas Strategic Energy Management (SEM) Cohort**
  - Identify Low and No Cost Projects and Include Students Participation
- **Joined Illinois Green School Project**
  - Project-based challenge for K-12 schools to devise and implement creative no- to low-cost energy, water and waste initiatives, and sustainable practices
- **Purchase 100% Green Electricity**
  - From MC Squared
- **Building Automation System (BAS)**
  - Control Temperatures and Mechanical Equipment Remotely



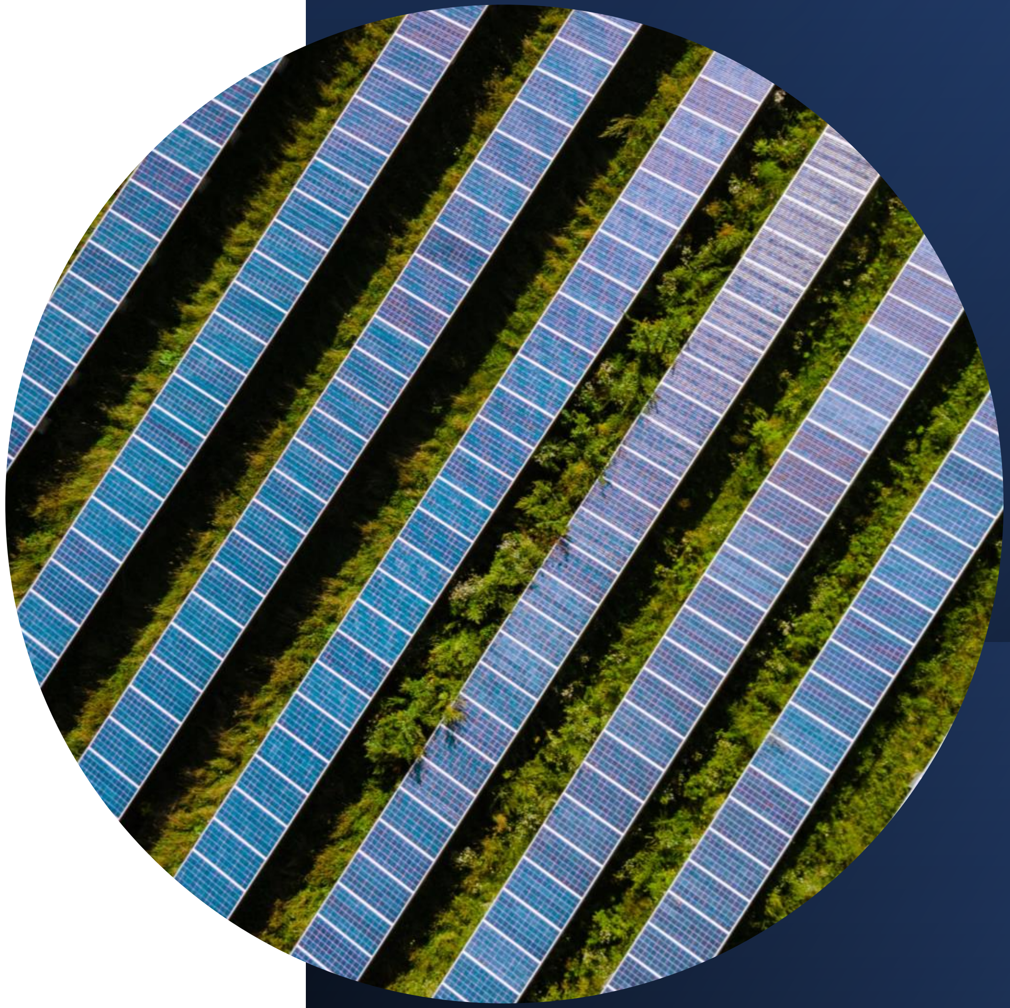
Energy Efficiency

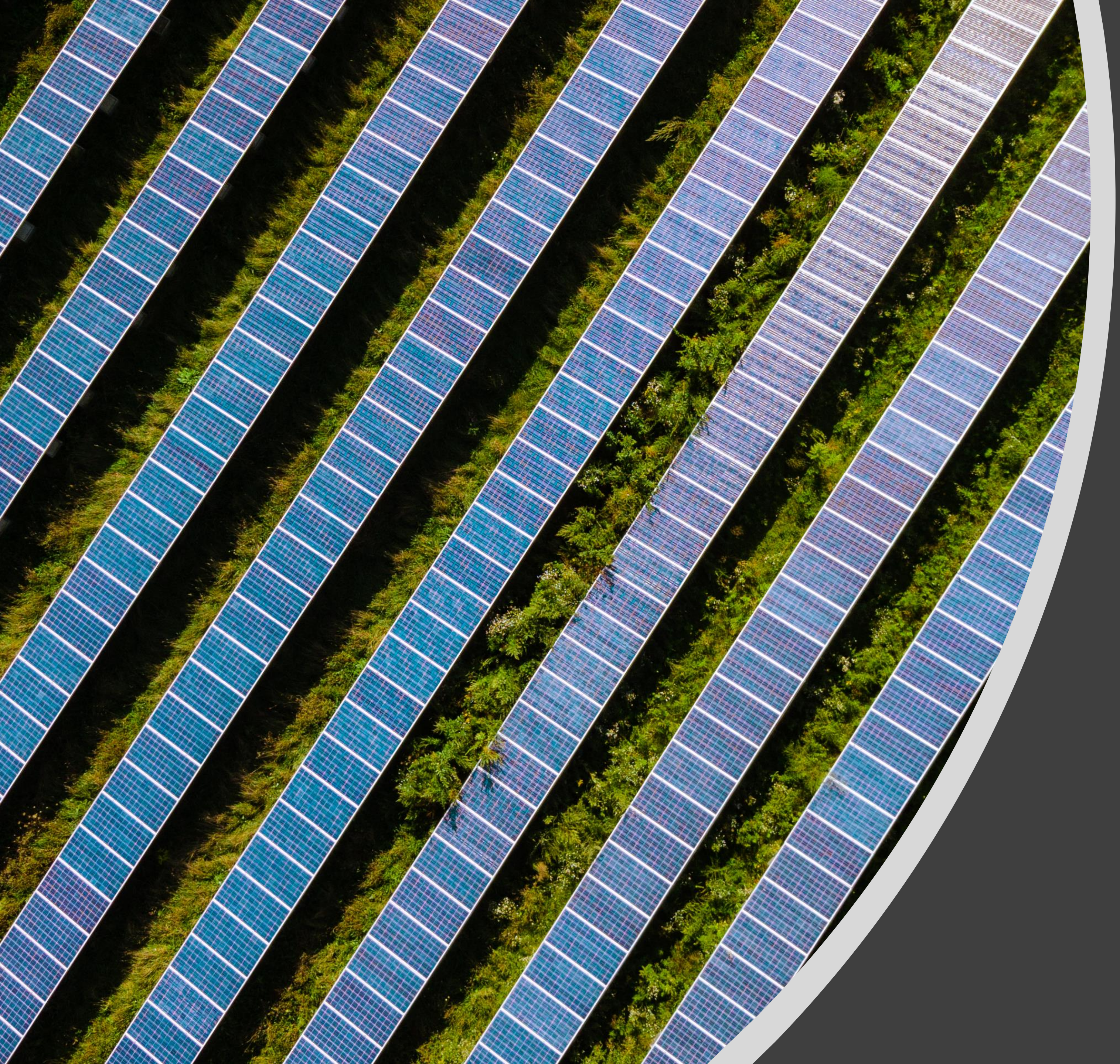
- Reflective White Roofing
  - Check for Incentives
- Photovoltaic Solar Panel Array On The Student Resource Center (SRC)
- Lighting System That Uses Less Power
- Daylight Harvesting Near Exterior Walls
- Mechanical System That Uses Things Like Energy Recovery
- High Efficiency Boilers Upgrade
- Temperature & Mechanical Equipment Setbacks In Unoccupied Areas Using The BAS



Forward Students Focus

- Benchmark and Understand Our School's Energy Use
- Conduct A School Building Energy Efficiency Treasure Hunt
- Encourage Our School Community to Adopt Energy-Efficient Habits
- Measure Cost Reductions and Finance Energy-Efficiency Upgrades
- Spread the Word
- Help Become an **ENERGY STAR** School





Questions?

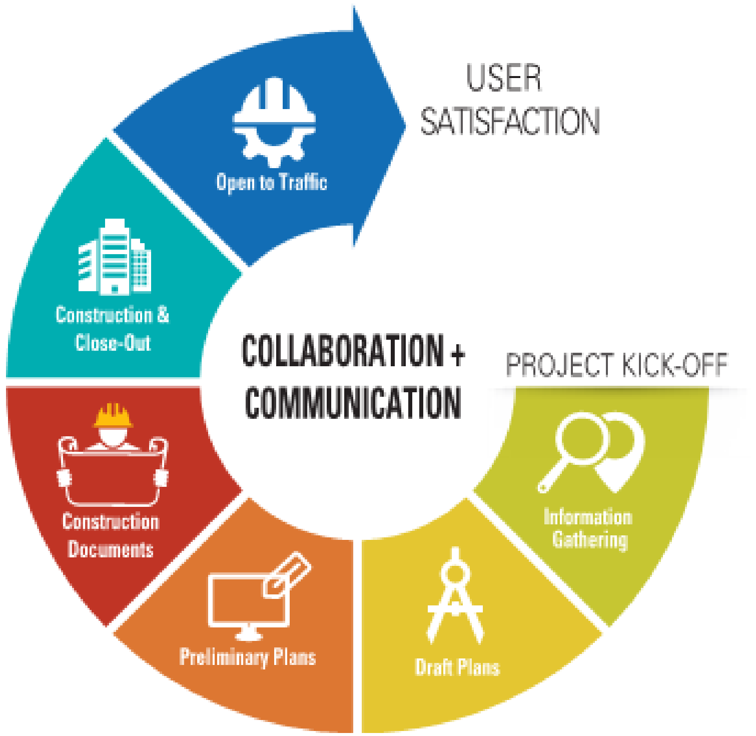
Jeff Oke, PE, LEED AP

Principal | Client Executive

High Performance Energy Design Approach

Key Strategies ….

- Ask a Lot of Questions
- Understand Project Goals
- Future Considerations
- Brainstorm Strategies
- System Options
- Benchmarking
- Renewable Options
- District / Design Team / Contractor Buy-in
- Building Commissioning



High Performance Energy Design Approach - Key Strategies

Envelope

- Orientation
- Optimize glazing size and properties
- Shading
- Infiltration reduction
- Reduce load to unlock high performance HVAC

Lighting

- LED
- Daylighting controls
- Occupancy controls

Plug loads

Target key IT and occupancy controls

HVAC

- System Selection
- Geothermal
- Natural Ventilation
- Energy Recovery

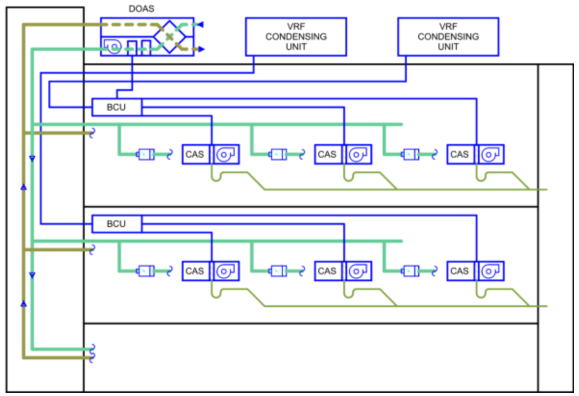
Energy Supply

- Wind Power
- Solar photovoltaic
- Consider solar thermal
- Solar Domestic Water Heating Systems

Building Commissioning

- Engineered Systems
- Building Envelope

DOAS Decoupled with Variable Refrigerant Flow



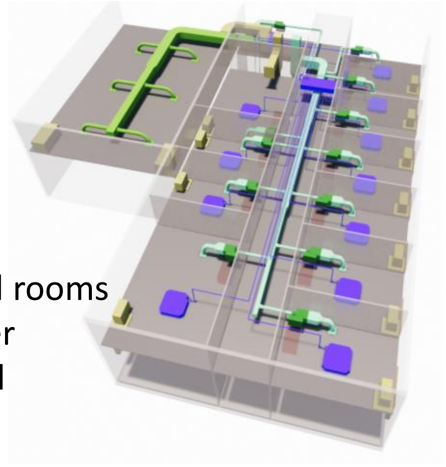
A dedicated outdoor air (DOA) system decouples the ventilation from space conditioning. The decoupled DOA provides adequate ventilation (or outdoor air) to the space. Variable Refrigerant Flow (VRF) Fan Coil Units or Cassettes provide space conditioning.

Each cassette contains a filter, refrigerant coil and a local fan. A VRF system also contains a Condensing Unit and a zone controller. The Condensing Unit will add or reject heat from the building. The zone controller will deliver the appropriate temperature refrigerant to each space. If necessary, a VRF system can transfer heat from one space to the next without rejecting it to the outdoors. The VRF Cassette system controls space temperature by varying both the temperature and the quantity of air delivered to the space. The decoupled DOA system controls the ventilation based on the needs and usage of the space (e.g. CO2 sensors). Dehumidification is often achieved through the DOA system but can also be satisfied by the cassette when needed.

The popularity of dedicated outside air systems is driven by a need to reduce transport energy (energy required to move heating and cooling through a building) satisfy space IEQ with lower ventilation rates and reduced reheat typically associated with VAV systems. Since the VRF system can share the load between spaces, less energy is used to produce heating or cooling.

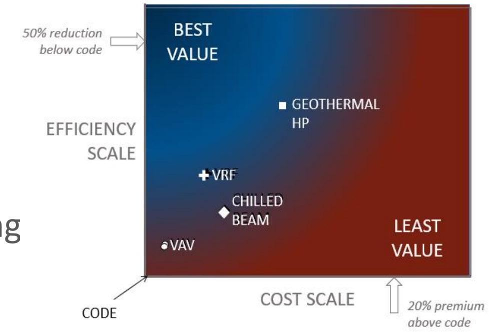
Benefits/Pros:

- Relatively simple to understand
- Smaller Ductwork
- Small piping
- Lower Transport Energy
- Reduced Ventilation Rates
- Inherent Redundancy
- Shares load between spaces.
- Smaller central AHU units and mechanical rooms
- Smaller energy recovery wheel (and better payback) than VAV energy recovery wheel
- Local dehumidification possible
- Potential for lower floor to floor heights
- Fans can cycle off to save energy since OA is provided separately

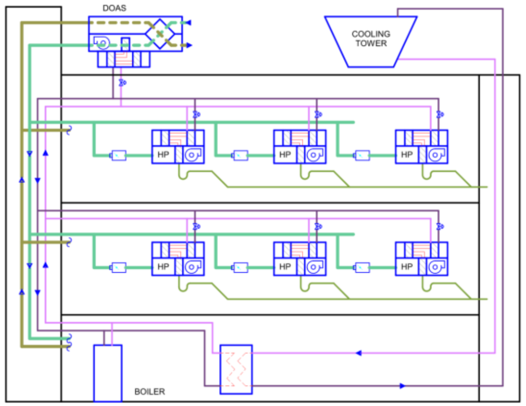


Considerations/Cons:

- Proprietary System
- Decentralized Maintenance.
- Less industry experience
- More Piping
- No airside economizer
- Refrigerant inside the occupied building
- Need room or plenum space for larger terminal unit
- Potential acoustic issues from local fans



DOAS Decoupled with Water to Air Heat Pumps



A dedicated outdoor air (DOA) system decouples the ventilation from space conditioning. The decoupled DOA provides adequate ventilation (or outdoor air) to the space. The water-to-air heat pumps provide space conditioning.

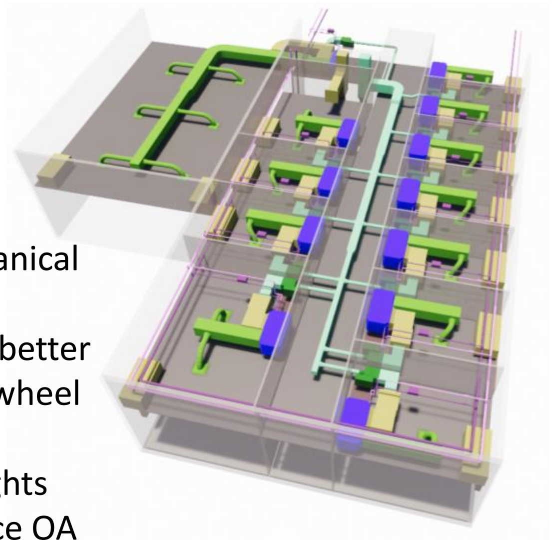
Each Heat Pump contains a filter, refrigerant coil and circuit and local fan. The heat pump system controls space temperature by varying both the temperature and the quantity of air delivered to the space. The heat pump unit decides whether the space is in heating or cooling and switches the refrigerant circuit accordingly.

The decoupled DOA system controls the ventilation based on the needs and usage of the space (e.g. CO2 sensors). Dehumidification is primarily achieved through the DOA system but can also be satisfied by the heat pump when needed.

Water to air heat pump systems use a condensing water system to provide or remove heat in a space. The condensing water system must be connected to a heat sink (remove the heat) or a heating source (add heat). The condensing water system can be connected to a geothermal well field or a cooling tower and boiler. A Variable Air Volume System (VAV) is and all air system. A single air handling unit delivers air to both condition the space and provide adequate ventilation (or outdoor) air.

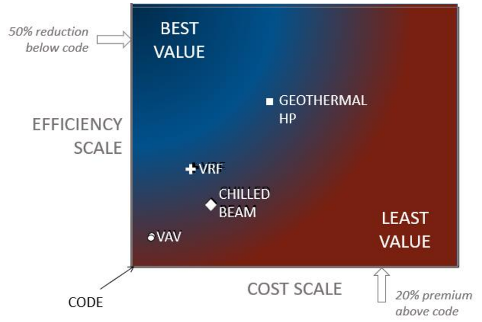
Benefits/Pros:

- Relatively simple to understand
- Smaller Ductwork
- Lower Transport Energy
- Reduced Ventilation Rates
- Inherent Redundancy
- Smaller central AHU units and mechanical rooms
- Smaller energy recovery wheel (and better payback) than VAV energy recovery wheel
- Local dehumidification possible
- Potential for lower floor to floor heights
- Fans can cycle off to save energy since OA is provided separately

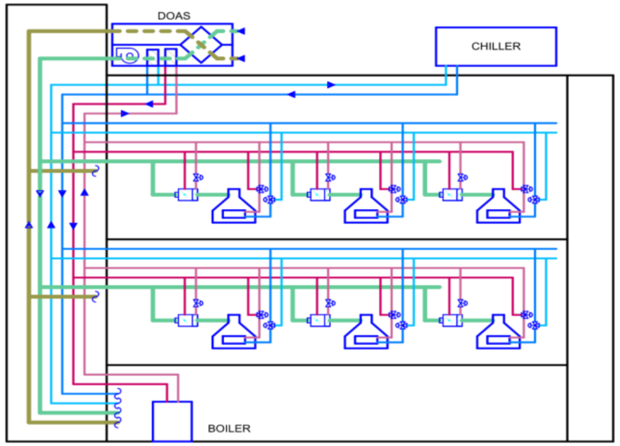


Considerations/Cons:

- Decentralized Maintenance.
- Less industry experience
- No airside economizer
- More Piping
- Need room or plenum space for larger terminal unit
- Potential acoustic issues from local fans



DOAS Decoupled with Chilled Beams



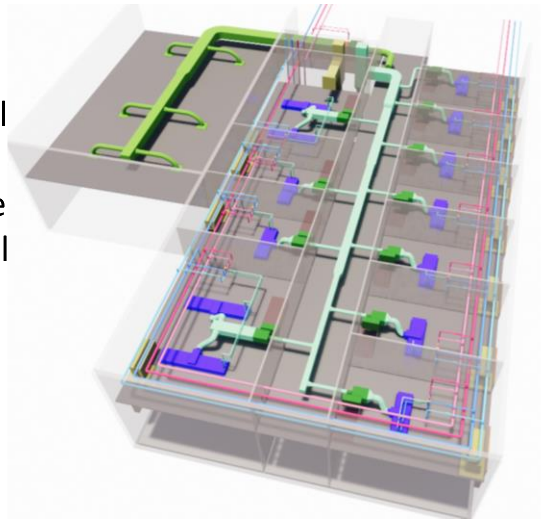
A dedicated outdoor air (DOA) system decouples the ventilation from space conditioning. The decoupled DOA provides adequate ventilation (or outdoor air) and dehumidification to the space. Chilled Beams provide space conditioning.

Each chilled beam contains a coil and nothing more. An active chilled beam relies on the DOA system to induce flow through the coil. The chilled beam system controls space temperature by varying the temperature of the air delivered to the space. The decoupled DOA system controls the ventilation based on the needs and usage of the space (e.g. CO_2 sensors). Dehumidification is achieved through the DOA System to prevent condensation on the chilled beams.

The popularity of dedicated outside air systems is driven by a need to reduce transport energy (energy required to move heating and cooling through a building), satisfy space IEQ with lower ventilation rates and reduced reheat typically associated with VAV systems.

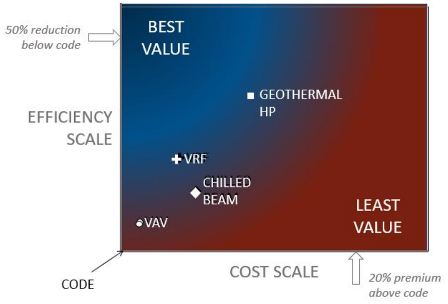
Benefits/Pros:

- Smaller Ductwork
- Lower Transport Energy
- Reduced Ventilation Rates
- Inherent Redundancy
- Smaller central AHU units and mechanical rooms
- Smaller energy recovery wheel (and bette payback) than VAV energy recovery wheel
- Local dehumidification possible
- Potential for lower floor to floor heights
- No fans in the space



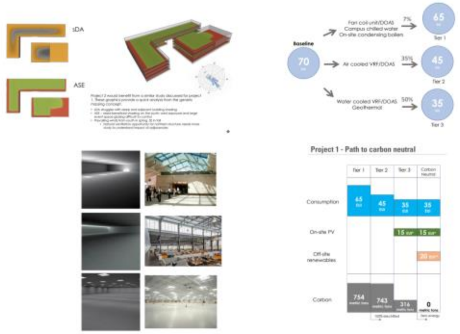
Considerations/Cons:

- Less industry experience
- More Piping
- No airside economizer
- Concern with condensation on the beam coils.
- More complicated DOA control
- Difficult to understand dehumidification control
- Best applied to spaces with high sensible and low latent loads
- Undersized nozzles can create acoustic and fan energy concerns
- Additional space dewpoint sensors

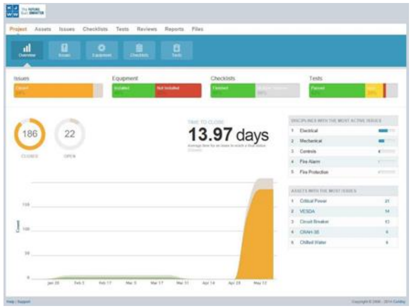


Energy Modeling Approach

Performance Goal Setting



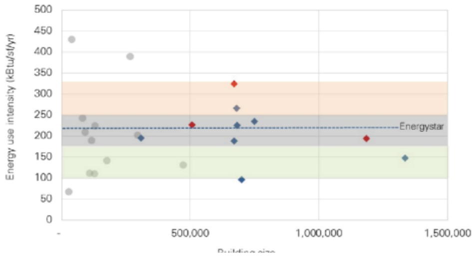
Rapid Performance Modeling



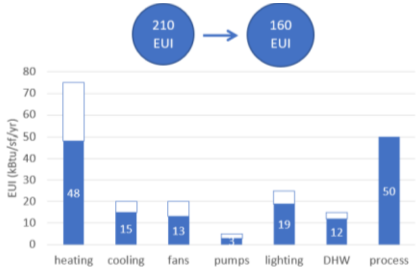
Commission for function, performance + monitoring

PRE-RFP	INTERVIEW	SD	DD	CD	CA & SUBSTANTIAL COMPLETION

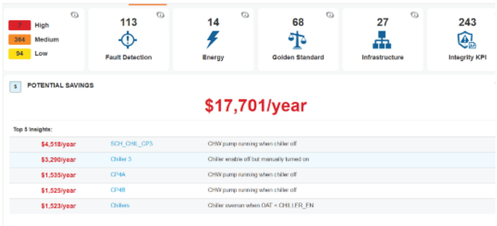
Benchmarking



Detailed energy analysis + Performance verification plan



Consumption analysis + corrective action



Utility Rates

Estimated Direct-Purchased utilities costs (Including Surcharges):	FY19	FY20
Water, Sewer & Storm (per ccu) [1]	9.987	10.825
Natural Gas (per ccf)	0.377	0.400
Electric (per kwh)	0.085	0.086

Utility Rates Used

Estimated Direct-Purchased utilities costs(Including Surcharges):	FY09	FY10	FY11	FY12	FY13	FY14	FY15	FY16	FY17	FY18
Water, Sewer & Storm ($ per ccu)	5.990	6.310	6.694	8.709	8.548	8.467	8.594	8.953	9.502	10.136
Natural Gas ($ per ccf)	0.999	0.842	0.724	0.717	0.695	0.514	0.507	0.491	0.358	0.413
Electric ($ per kwh)	0.078	0.079	0.080	0.084	0.082	0.091	0.093	0.086	0.078	0.081

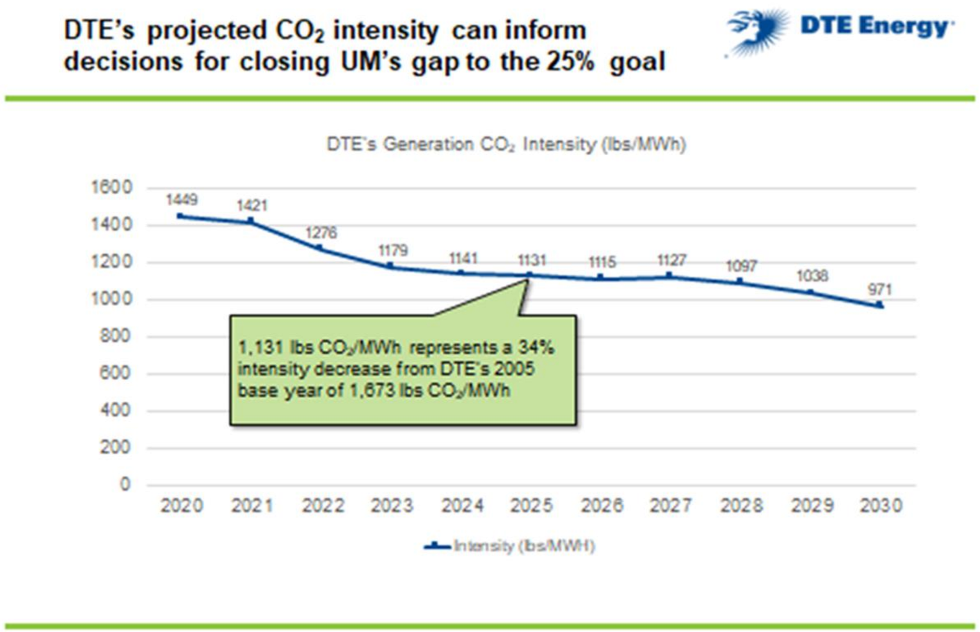
Natural gas cost on a consistent decline

Electric cost consistent over the years

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

The current electric rate is **6 times** that of natural gas

CO_2 Emission Rates



DTE has a projected goal of net carbon zero for its electric company by 2050.

The system options were evaluated using CO_2 rates from DTE's projected Year 2023

Energy Source	Metric Tons of CO_2	
Electric	0.000535 per kWh	0.000157 per kBtu
Natural Gas	0.0053 per therm	0.000053 per kBtu

Currently using electric over natural gas produces **3 times** the amount of CO_2

System Options

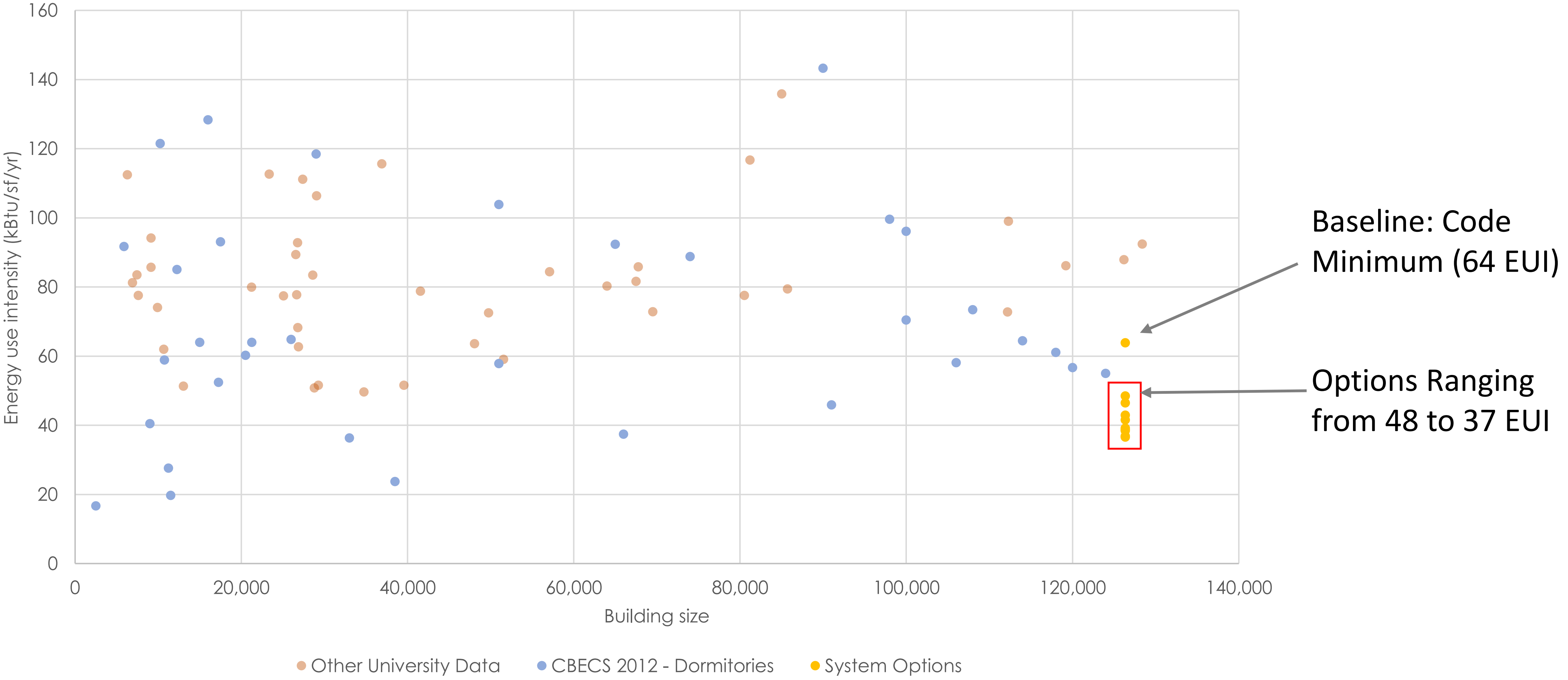
System/Plant	First Cost	EUI		Energy Cost		CO2		SPB (yr)	CO2 (DTE 2050 Net Carbon Zero Goal)	
		(kBtu/sqft/yr)	% Savings	($/yr)	% Savings	(metric tons)	% Savings		(metric tons)	% Savings
Baseline: PTAC*	$ 4,096,000	64	-	$ 122,706	-	873	-	-	200	-
Fan Coils - Water Cooled Chiller/Condensing Boiler*	$ 4,322,000	48	24%	$ 99,227	19%	692	21%	10	137	32%
Fan Coils - Full Geothermal**	$ 5,307,000	38	40%	$ 109,598	11%	699	20%	92	32	84%
Fan Coils - Hybrid Geothermal**	$ 4,727,000	42	35%	$ 112,179	9%	725	17%	60	50	75%
VRF - Air Cooled*	$ 4,480,000	43	33%	$ 99,986	19%	672	23%	17	91	55%
VRF - Full Geothermal**	$ 5,388,888	37	42%	$ 104,432	15%	667	24%	71	32	84%
VRF - Hybrid Geothermal**	$ 5,128,000	39	39%	$ 104,542	15%	676	23%	57	47	77%
WSHP - Water Source Heat Pump**	$ 4,618,000	46	27%	$ 101,651	17%	695	20%	25	115	43%
WSHP - Full Geothermal**	$ 5,288,000	37	43%	$ 103,586	16%	662	24%	62	32	84%
WSHP - Hybrid Geothermal**	$ 5,008,000	39	39%	$ 108,347	12%	696	20%	64	40	80%

- Blue highlight: Lowest First Cost (other than the baseline), Lowest Energy Cost, and Shortest Payback
- Green highlight: Lowest EUI and Lowest CO2
- First Cost column is for one building
- * Assumes Condensing Boilers for domestic hot water heaters
- ** Assumes Heat Pump for domestic hot water heaters with gas booster heater

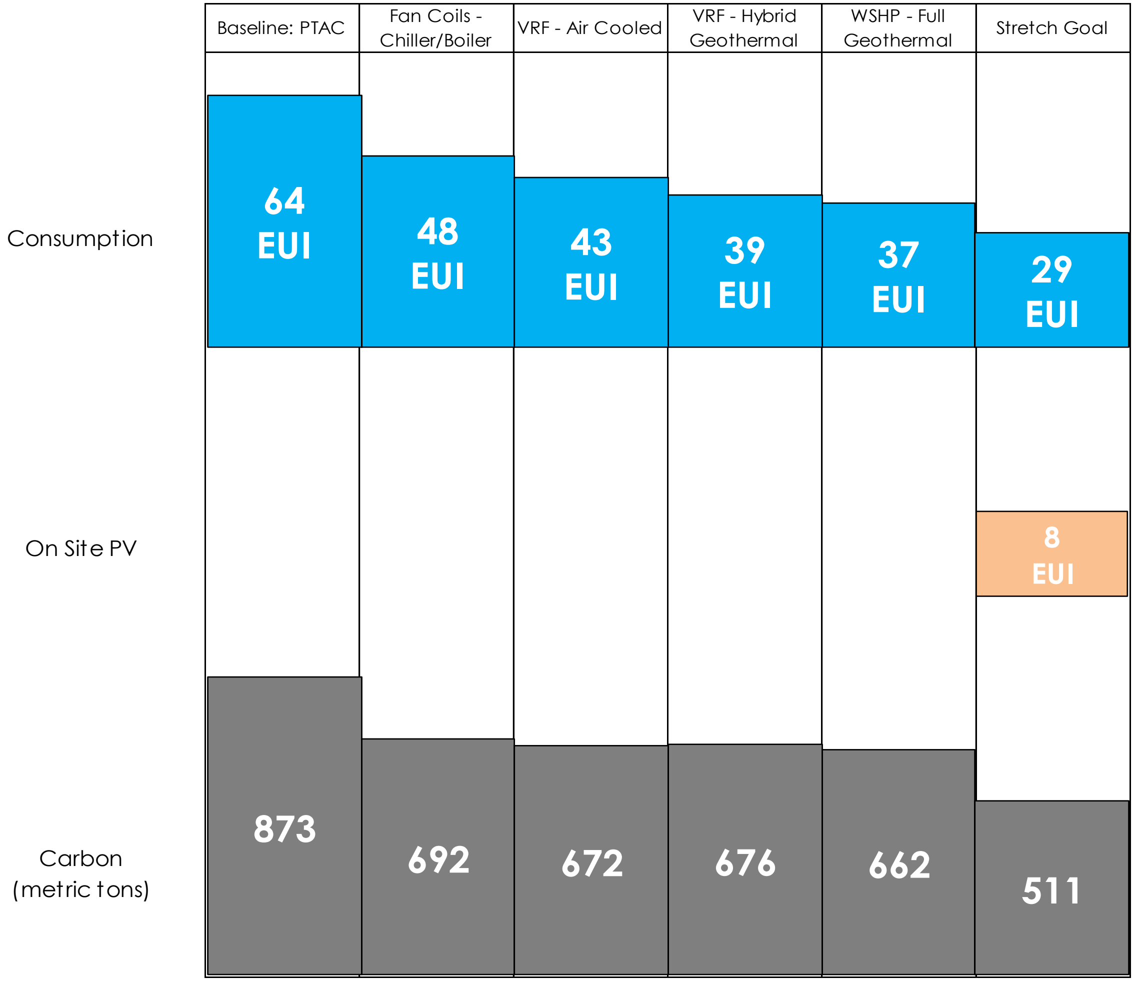
Envelope Assumptions

Exterior Wall:	R-42 (U-0.024)
Roof:	U-0.032
Windows:	U-0.50 and SHGC: 0.40
Window to Wall Ratio:	40%

Benchmarking



Lane Diagram

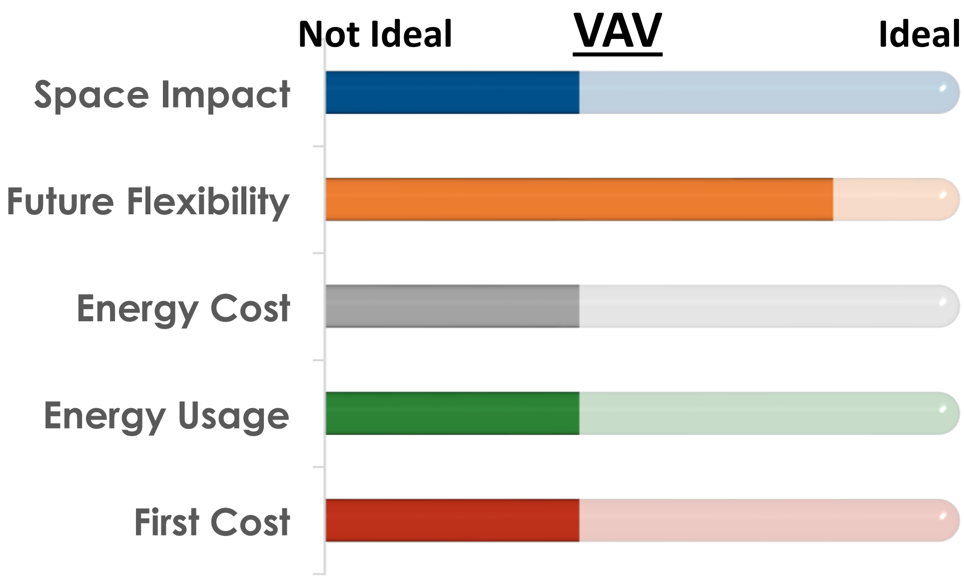


This lane diagram provides a visual representation of various system selections with their energy consumption and carbon output. Each subsequent lane reduces carbon usage. The stretch goal lane adds on site solar PV to the rooftop for the WSHP Full Geothermal option. The addition of the PV reduces the consumption by 8 EUI and reduces annual carbon to 511 metric tons.

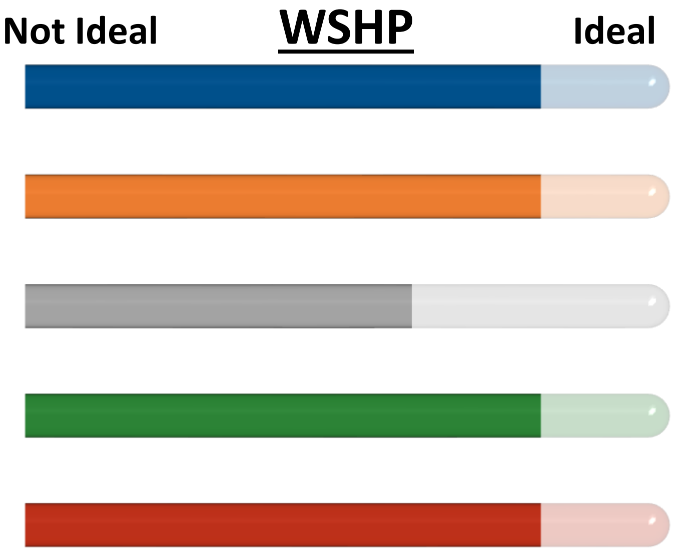
<u>Notes</u>

- Carbon based on actual lbs CO2/MWh from electric utility (DTE Energy
- * On-site PV - 215 kW system, ~ 280,000 kWh/year

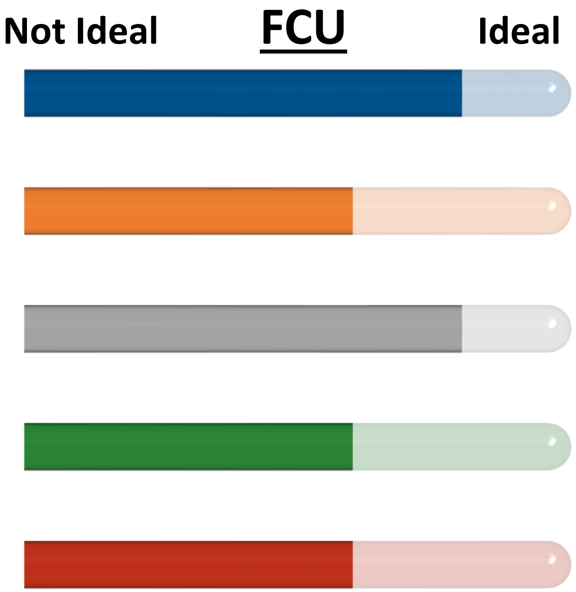
System Evaluation Based on School District Criteria



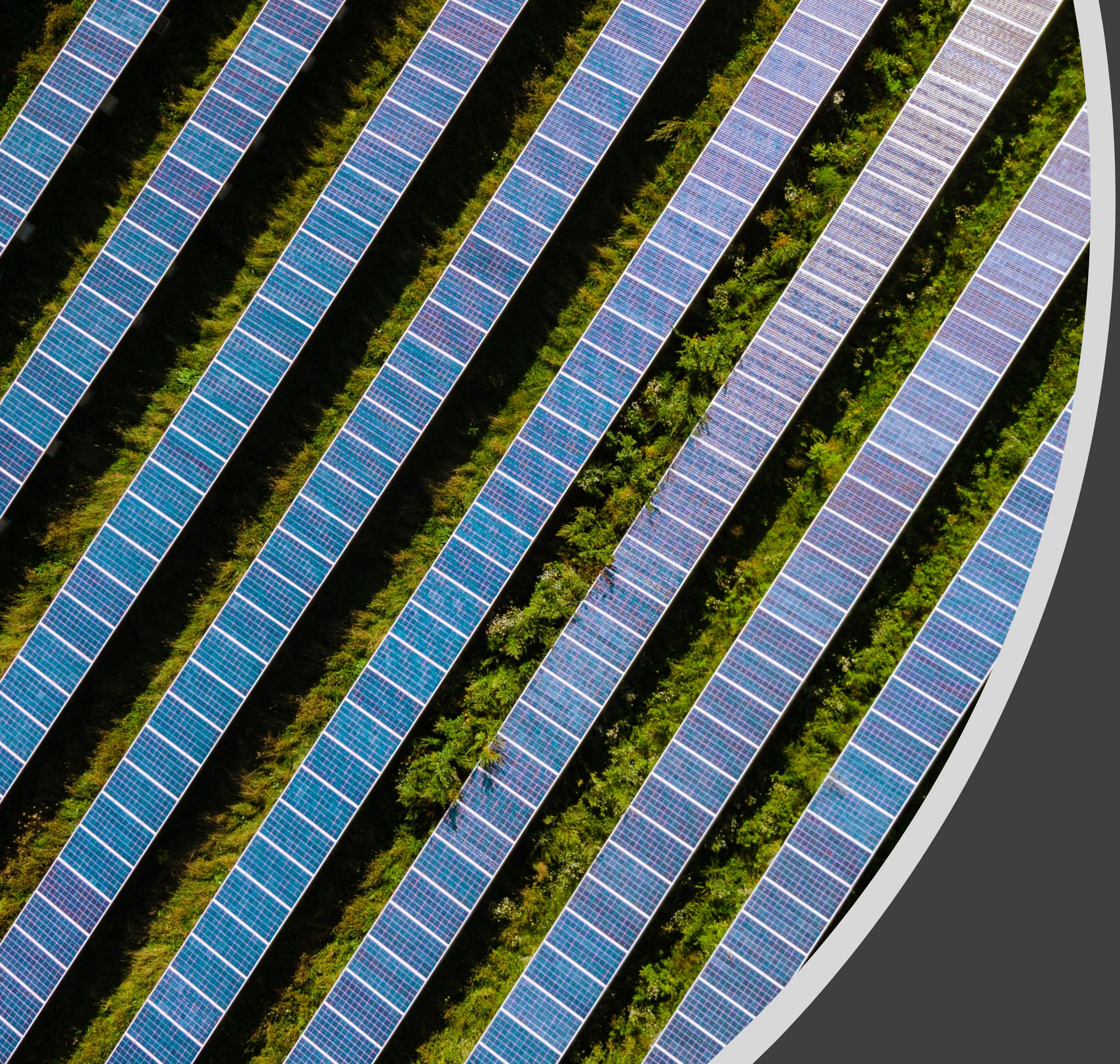
- Flexible for Future Reconfigurations
- Easy to Maintain
- Majority of Maintenance is outside of the tenant Space
- Larger Ductwork
- Larger AHUs and Mechanical Spaces



- Flexible for Future Reconfigurations
- Low First Cost
- Energy Efficient
- Smaller Ductwork
- Smaller AHUs and Mechanical Spaces
- Heat pumps are simple to maintain but there are many of them throughout the building
- High System Redundancy
- Easy to provide heating and cooling during non-business hours



- Energy Efficient
- Simple to Maintain
- Slightly less flexible due to four-pipe configuration
- High First Cost
- Small Ductwork
- Small AHUs and Mechanical Spaces



Questions?

Graham Morin, CEM

Business Development, Distributed Energy Systems

SIEMENS

2021 Midwest Facility Masters Conference

Total Energy Management is where best practices intersect

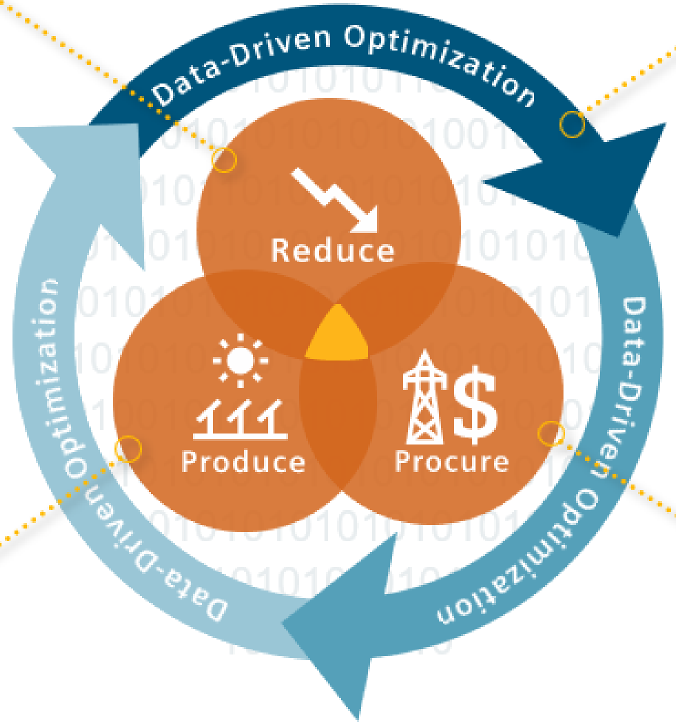
SIEMENS
Ingenuity for life

Reduce:

Drive down energy consumption in order to reduce costs and the environmental impact of your organization.

Data-Driven Optimization:

Continuously analyze and optimize your building(s) and the improvement actions you've taken to be more precise and effective with your investment decisions.



Produce:

Generate and store energy on-site so that you are less reliant on the grid and have a more sustainable energy-mix.

Procure:

Manage the energy purchasing process as a way to lower total energy spend, mitigate risks and meet sustainability targets.

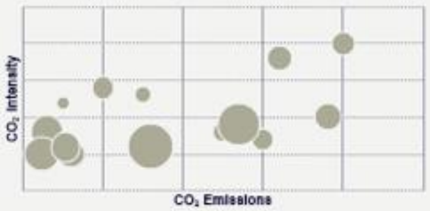
…to achieve long-term business goals through continuous improvement and innovative financial solutions.

Developing the Right Action Plan

Align to organizational commitments

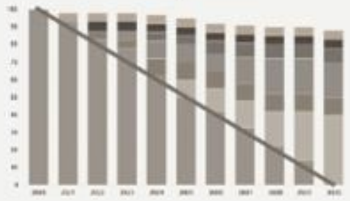
- Materiality assessment
- Goals and targets
- Commitments to established frameworks

Understand hot spots and prioritize activity



- Portfolio energy and carbon analysis
- Identify opportunities and risks
- Maximize impact

Plot to long-term plan



- Identify levers to success
- Forecast emissions
- Align opportunities with targets

Execute strategies

- Implementation planning
- Assess financial impact and define funding mechanisms

Assess and re-evaluate

Digitalization

Measure performance

Decarbonization Roadmap: From Strategy to Implementation

Siemens Approach: Advisory and implementation

Keys to Success

- Organization alignment
- Clarity on commitments
- Resource allocation
- Financial strategies

Lever 1
Reduce consumption

Lever 2
Produce energy on-site

Lever 3
Transition to electrification

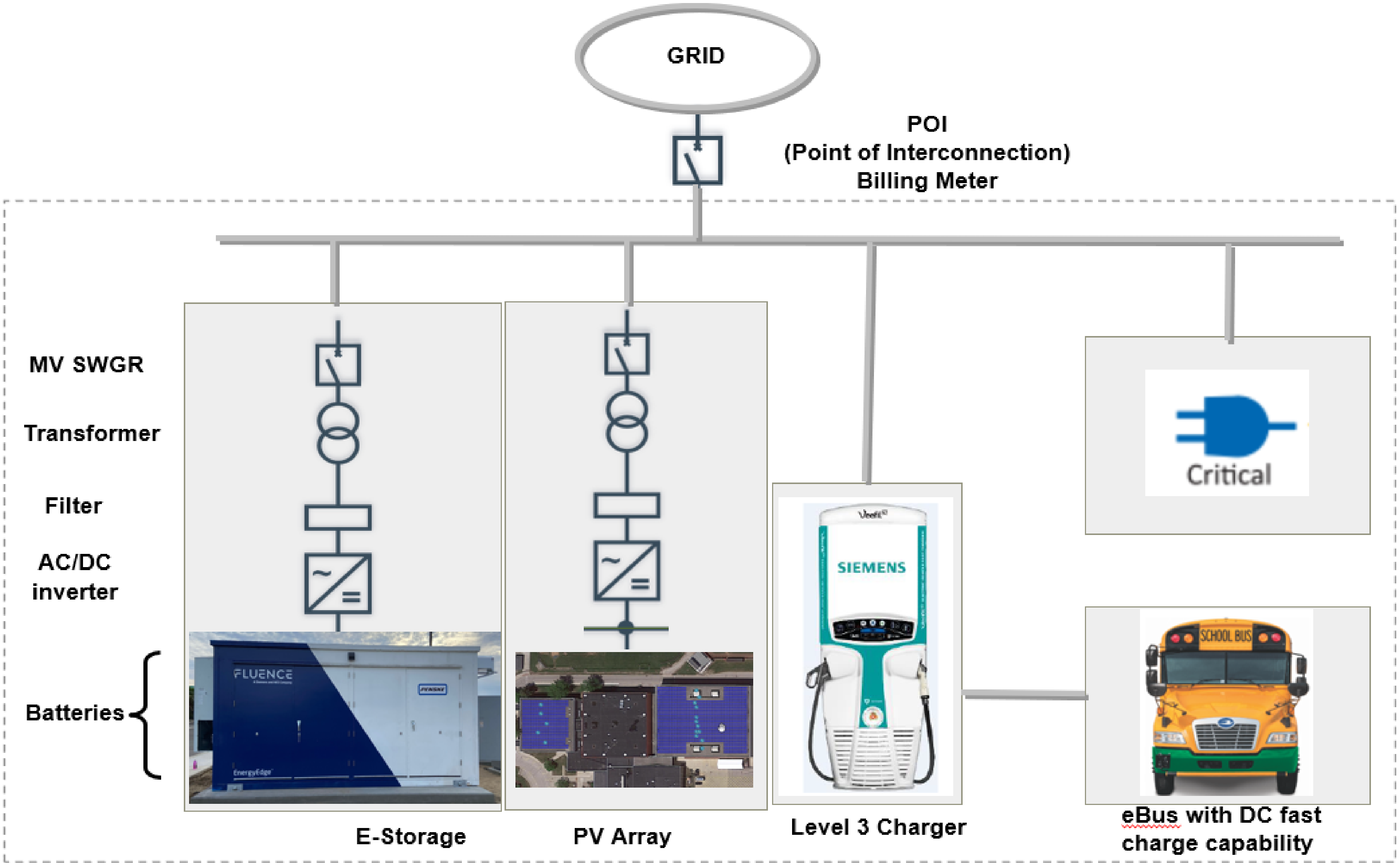
Lever 4
Procure clean energy

Lever 5
Fill the gaps

Infrastructure Improvement; Innovative Financial Structures and Options

Alignment with Organizational Risk & Commitments

Microgrid Enabled Smart Charging and Utility Optimization (Conceptual Overview)



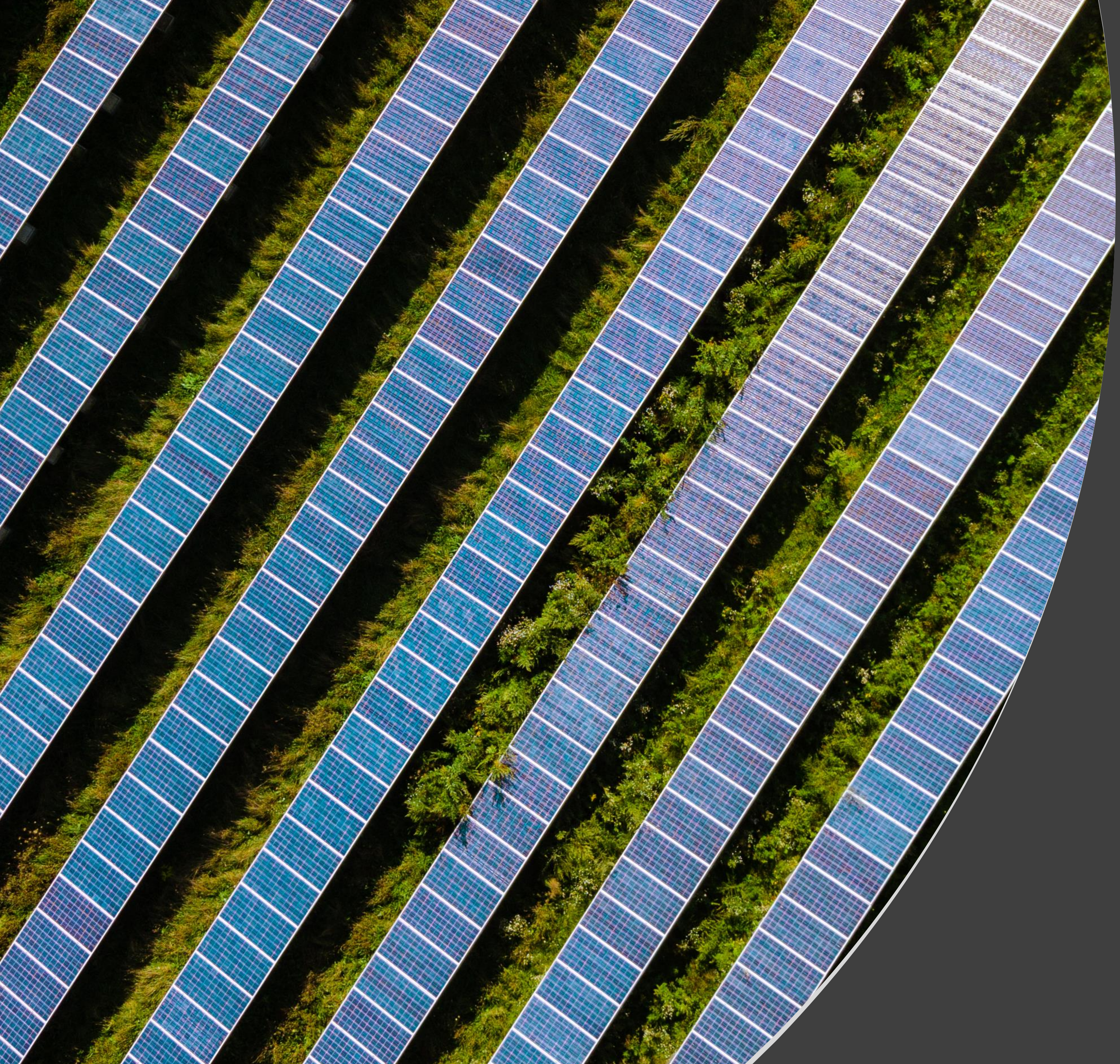
Advanced controls allow integration of PV and storage assets

Advanced safety features for Li-Ion batteries

Critical loads can be fed from BESS during grid disturbances

Building will not see impact of charging load and PV+battery will also:

- Lower Demand Charges
- Reduce energy consumed from grid
- Demand Response



Questions?

Thank You!

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