Powerful Facility
Energy Conference

Connecting the Dots

Chris Lowen, P.E., LEED AP,
Glumac – Director of Building Sciences

Kyle Adams & Lyudmila Arseniy
Puget Sound Solar

March 16, 2023

Energy vs Emissions

ENERGY (EUI)

EMISSIONS (TONS OF CARBON)

Utility Power Source Mix & Policy

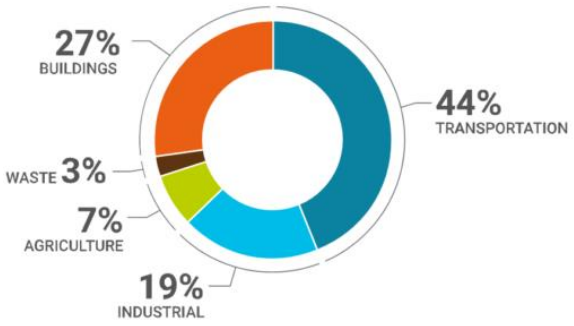
HOUSE BILL 1257 (2019)

Compliance Dates	gsf threshold
June 2026	220,000
June 2027	90,000
June 2028	50,000

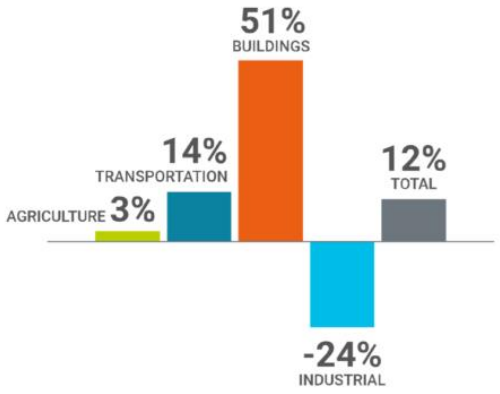
ALL-ELECTRIC REQUIREMENTS

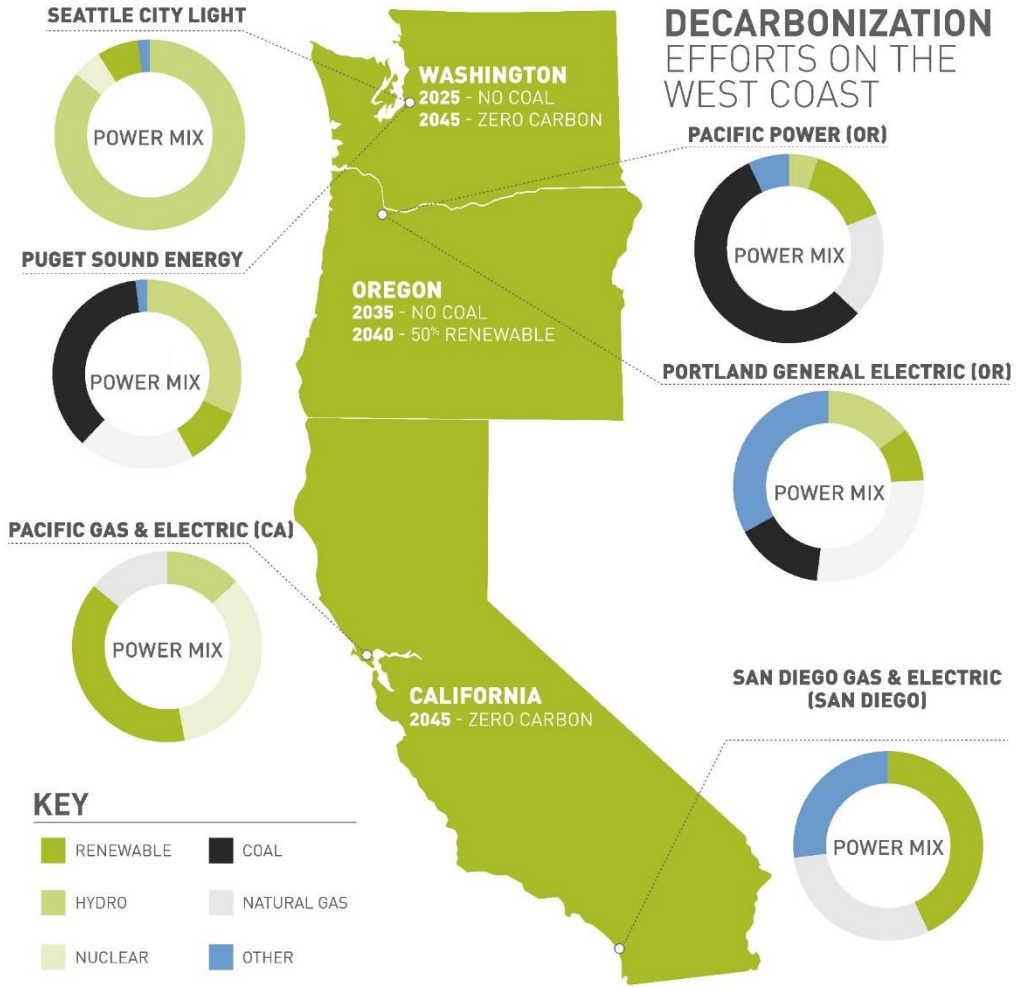
Washington State Energy Code

Buildings are the second largest source of greenhouse gas emissions in Washington (2015)



As Washington's population has grown, greenhouse gas emissions from buildings jumped significantly from 1990-2015





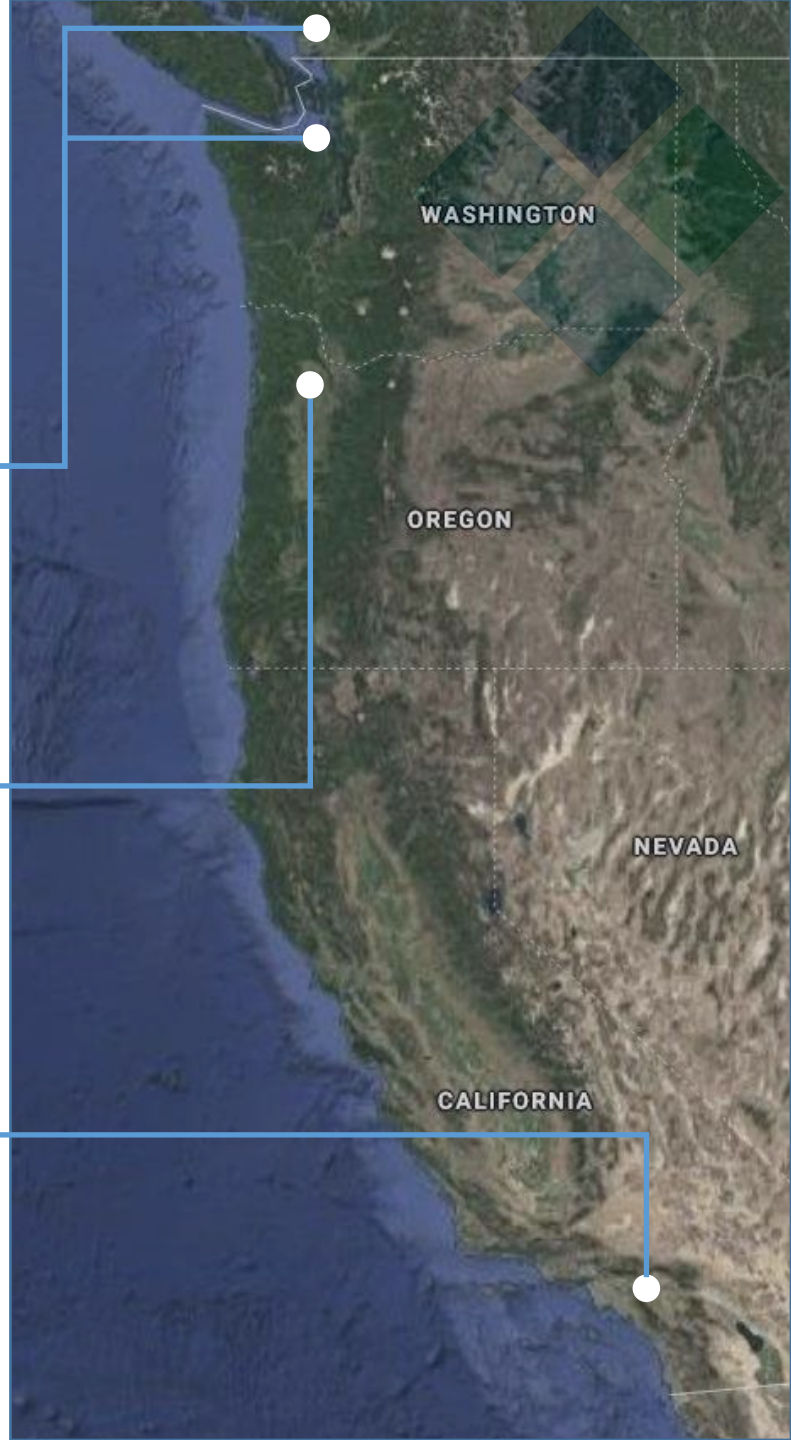
Building Location Matter

OFFICE BUILDING
EUI = 30
200,000 sf

SEATTLE/VANCOUVER
= 50 TONS CO2e

PORTLAND
= 1,100 TONS CO2e

LOS ANGELES
= 700 TONS CO2e



Approaching Carbon Neutrality

Carbon Neutrality
Partnering with the Utilities






220 lbs CO2/ MMBtu → **117** lbs CO2/ MMBtu → **0** lbs CO2/ MMBtu

Source: U.S. Energy Information Admistration

Carbon Neutrality Planning is NOT

+

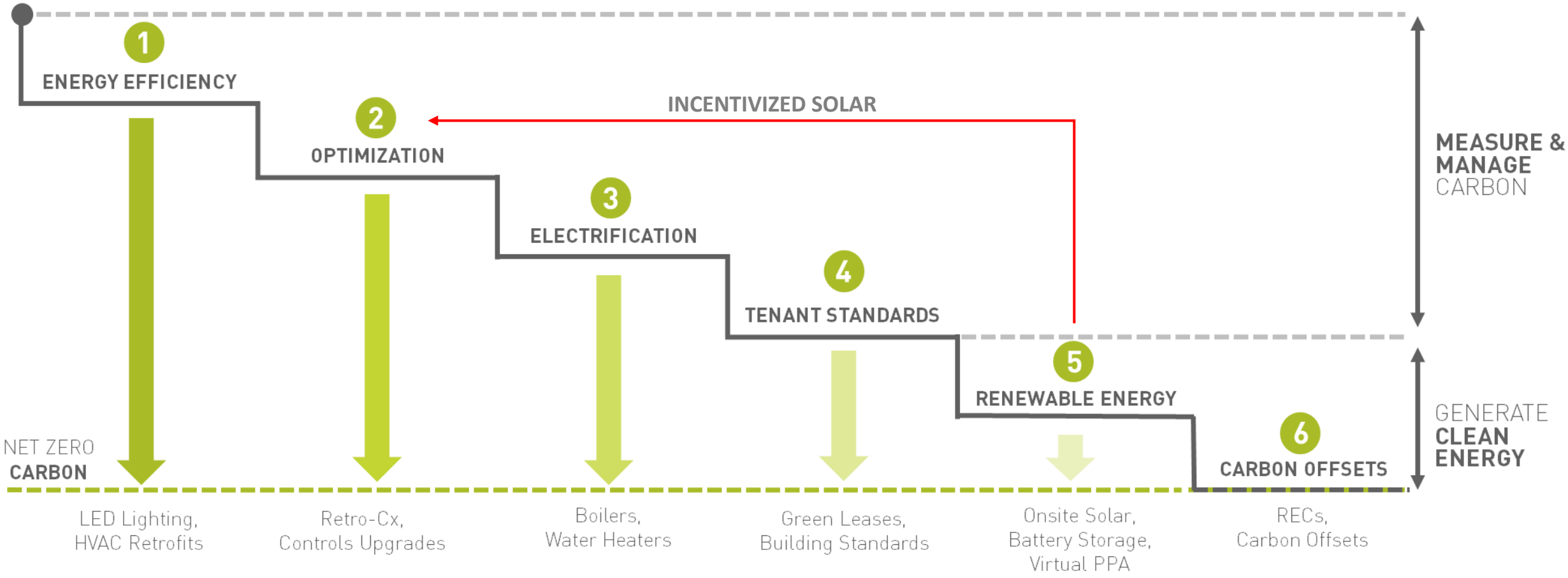
=

Unless you want it to be

+

=

Carbon Neutrality Planning



Planning Approach

MEASURE & PLAN
0-3 MONTHS

- Determine Goals
- Develop KPIs
- Identify Data Sources
- Collect Data

ASSESS STRATEGIES
3-12 MONTHS

- Energy Efficiency
- RCx / Optimization
- Electrification
- Tenant Standards
- Renewable Energy
- Carbon Offsets

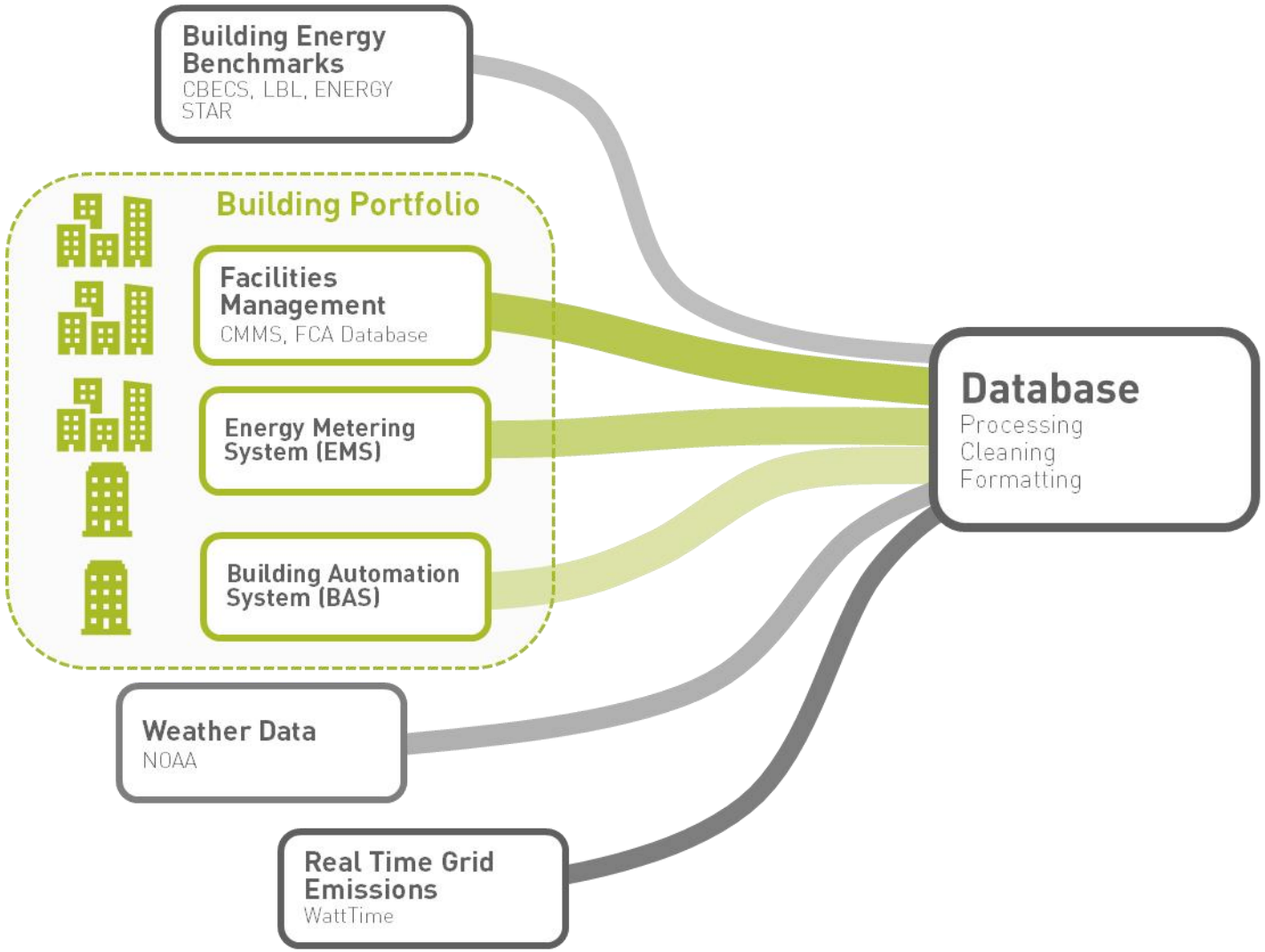
DEVELOP ACTION PLAN
5 YEARS

- Cost Estimates
- Procurement
- CapEx Planning
- Financial Modeling

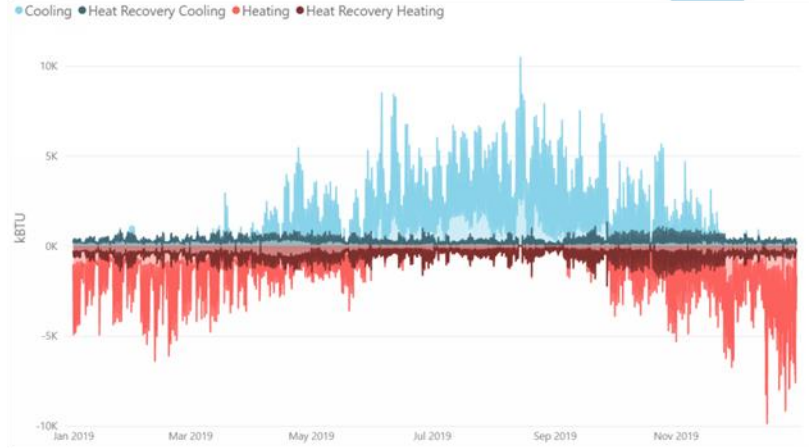
MONITOR IMPLEMENTATION
5-30 YEARS

- End of Life Equipment Replacement Plans
- Monitor KPIs
- Revaluate Action Plans

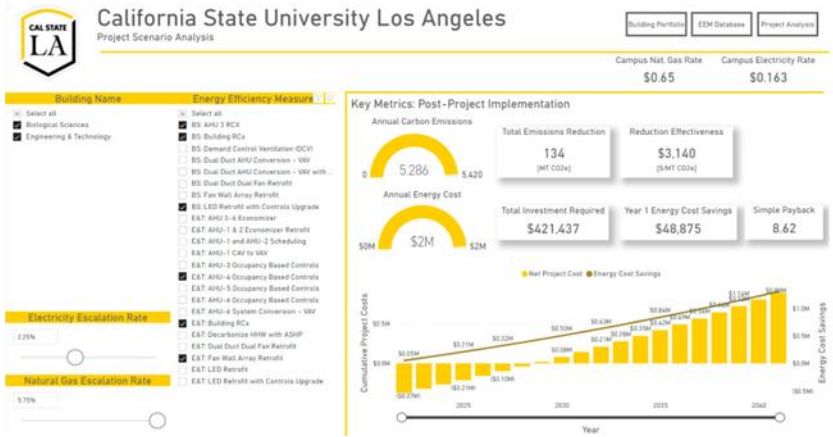
Data-Informed Approach



NET ZERO CARBON ASSESSMENTS



FINANCIAL MODELING



Capex Planning

- Re-assess existing CapEx plans
- Identify projects with energy implications
- Infrastructure assessment & identify EUL for high carbon intensive equipment

- Ready buildings for net zero carbon operations
- Review & update building standards
- Implement green leases with new / existing tenants

- Electrified equipment
- Renewable energy
- Carbon offsets

Capex Planning

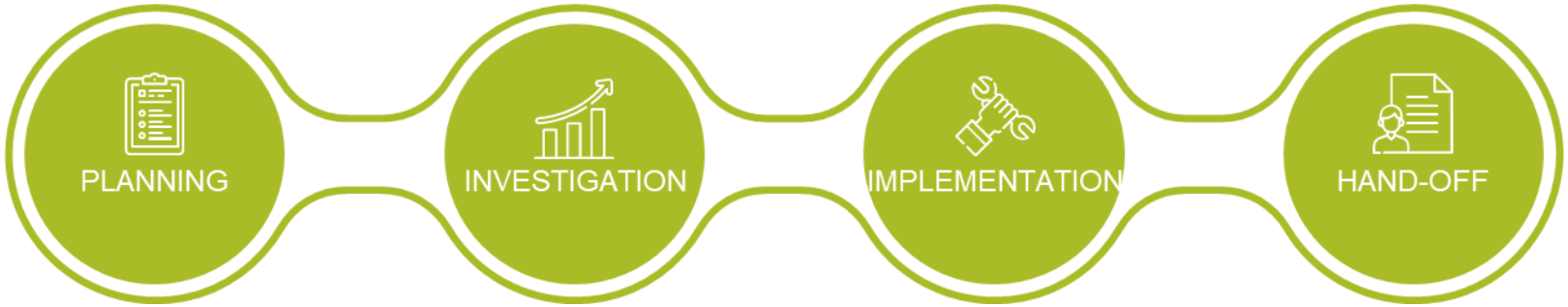
CAPEX PROJECT	CONSIDERATIONS	BAU APPROACH	NET ZERO APPROACH
Boiler Replacement	What is existing peak load?	Like for like boiler replacement	Heat recovery chiller
HHW Riser Replacement	What is existing HHW loop dT? What would the dT of an electrified system be?	Replace riser with same pipe sizes	Replace riser sized for future HHW dT after conversion to electrified system
Restroom Renovation	Does the restroom need recirculating hot water?	Maintain connection to central DHW loop	Install point of use electric water heater
Electrical Panel Upgrade	Is the panel at maximum capacity? Will the panel potential serve additional electrical equipment?	Replace panel with came capacity	Replace with upsized panel to support future electrification measures
Elevator Modernization	How often is elevator used? Are there long lines at elevators often?	Motor replacement, cab renovations	Smart elevator control systems, regenerative elevators
Office Floor TI	Does the building plan to electrify the heating system in the future?	Size HW coils to existing HW temperature (180F)	Size HW coils to lower HW temperature (130F)

Strategies Impact on Financials

	First Cost	Payback	Operating Cost Reductions	Climate Impact
Efficiency	Moderate	Less than 10 years	High	High
Electrification	High	Varies	Moderate	High
On-Site Solar + Storage	High	Less than 20 years	High	High
Virtual PPA	None	Immediate	Small	Moderate
Offsets/RECs/ Green Power	None	No payback	None	Low

Building Decarbonization Strategies

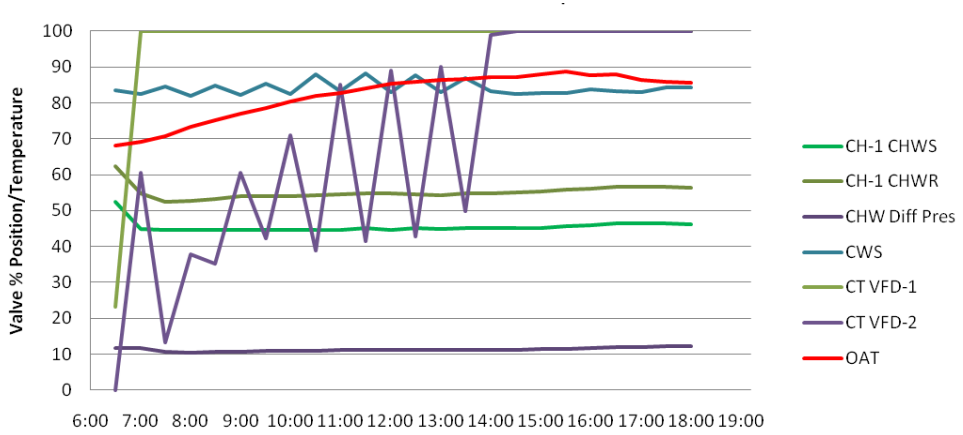
Building Audits

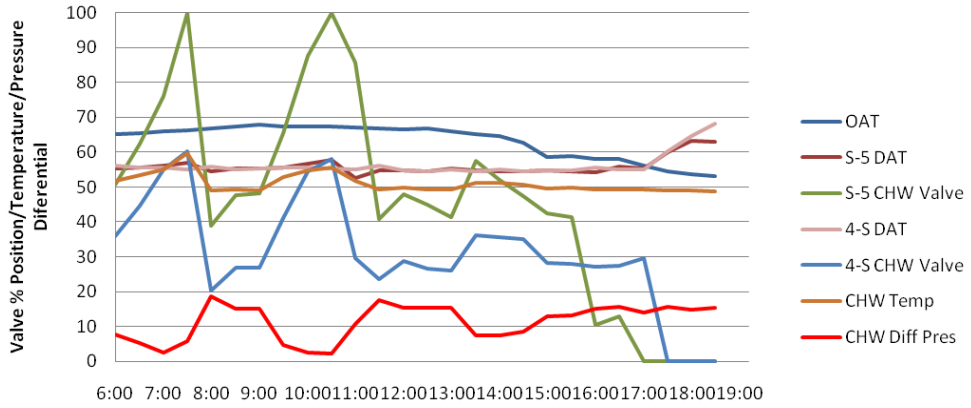


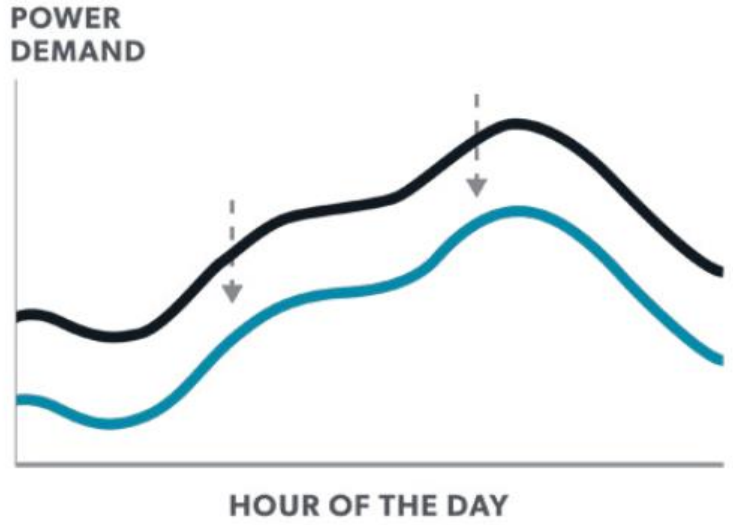
- A platform to verify and get feedback on your ideas
- Access to a list of opportunities, their impact, and potential funding sources from experts

Strategy: Optimization

CONTROLS SYSTEMS





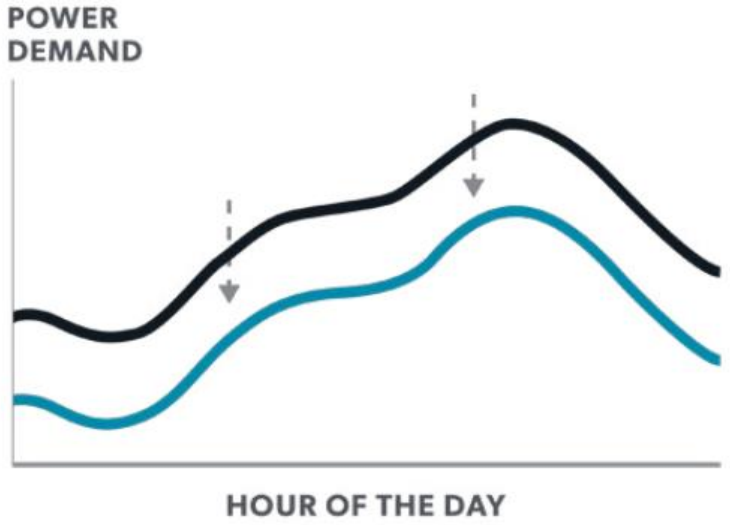


STRATEGIES

- FDD Software
- BMS Data Analytics
- Existing Building Commissioning
- Energy Audits

Strategy: Optimization

WORKING WITH FACILITIES TEAMS

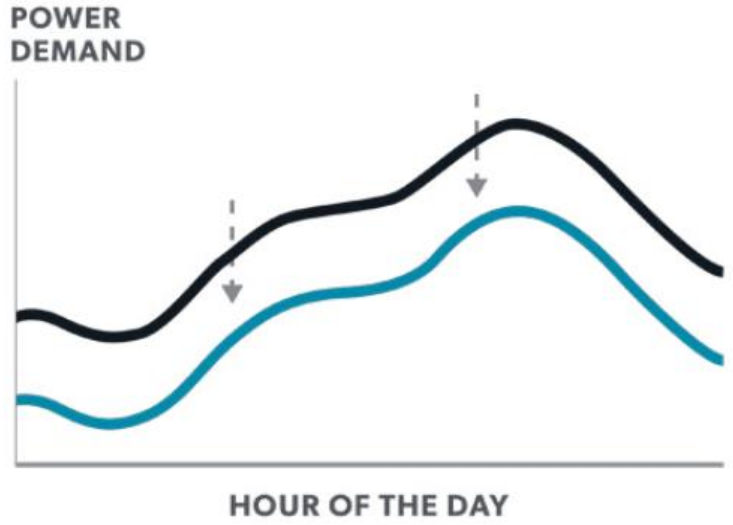


STRATEGIES

- Training
- Providing energy tracking tools & resources
- Participating in Facility Optimization Programs

Strategy: Optimization

TENANTS

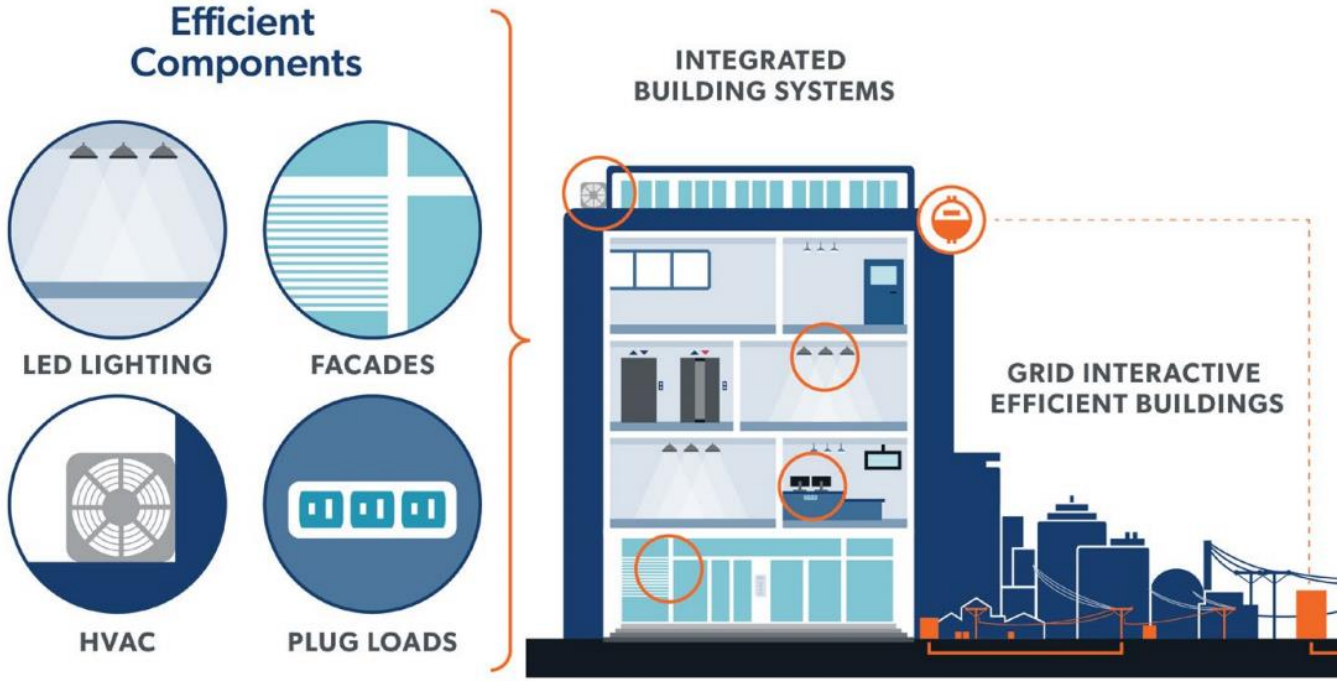


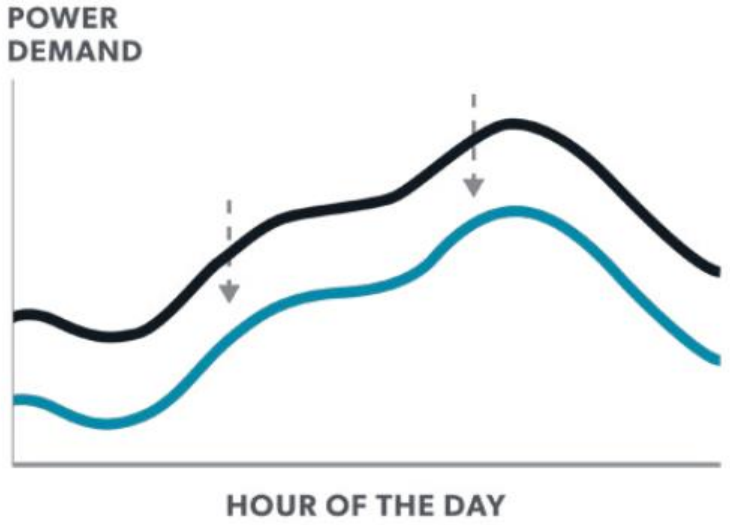
STRATEGIES

- Green Leases
- Consolidate Electrical Equipment
- Common Amenities (Print centers, break rooms, meeting rooms)
- Hours of Operation vs Occupancy
- Vertical Transport

Strategy: Efficiency

SMART BUILDINGS



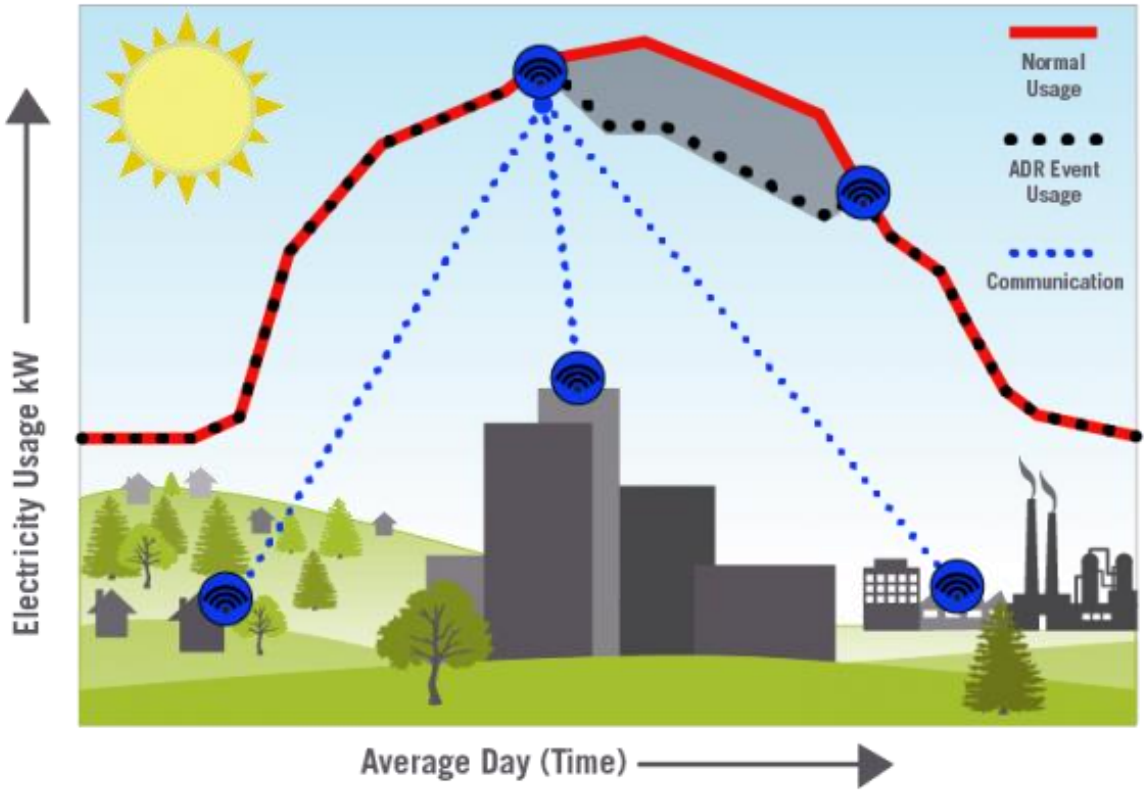


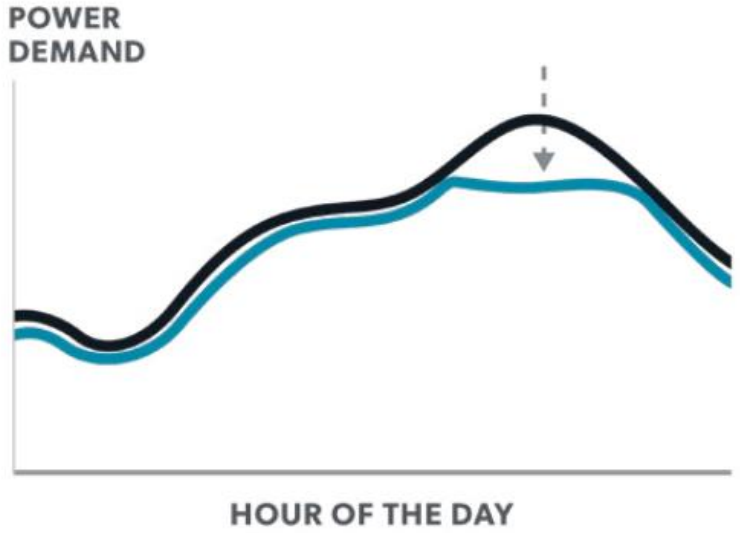
DESIGN STRATEGIES

- Glazing Upgrades
- Facades maintenance/leakage
- LED Lighting
- Efficient Electrified HVAC
- Plug Load Management

Strategy: Shed Load

DEMAND RESPONSE





DESIGN STRATEGIES

- Demand Response
  - Dim Lighting
  - Reduce Room Setpoints
  - Limit Elevator Operation

Building Electrification

Application Tiers - HVAC

Tier 0

- Electric Resistance

Tier 1

- Split Systems/Variable Refrigerant Flow (VRF)

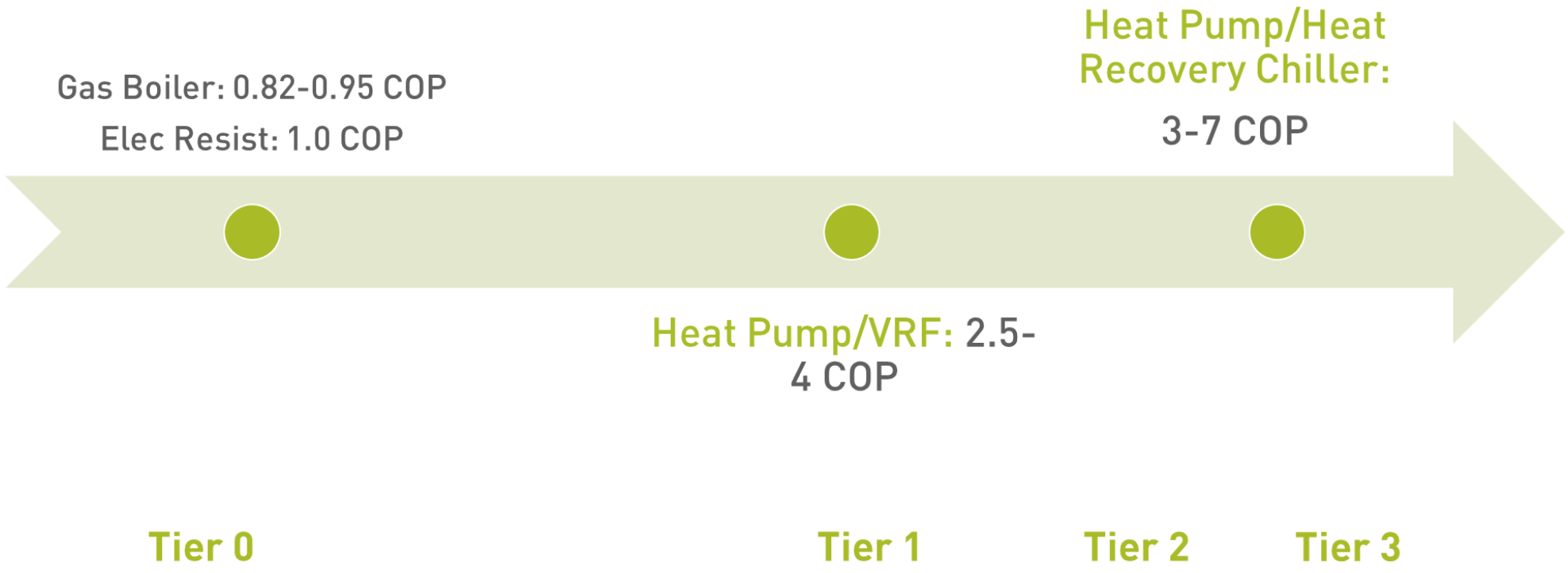
Tier 2

- Air-Source Hydronic Heat Pumps

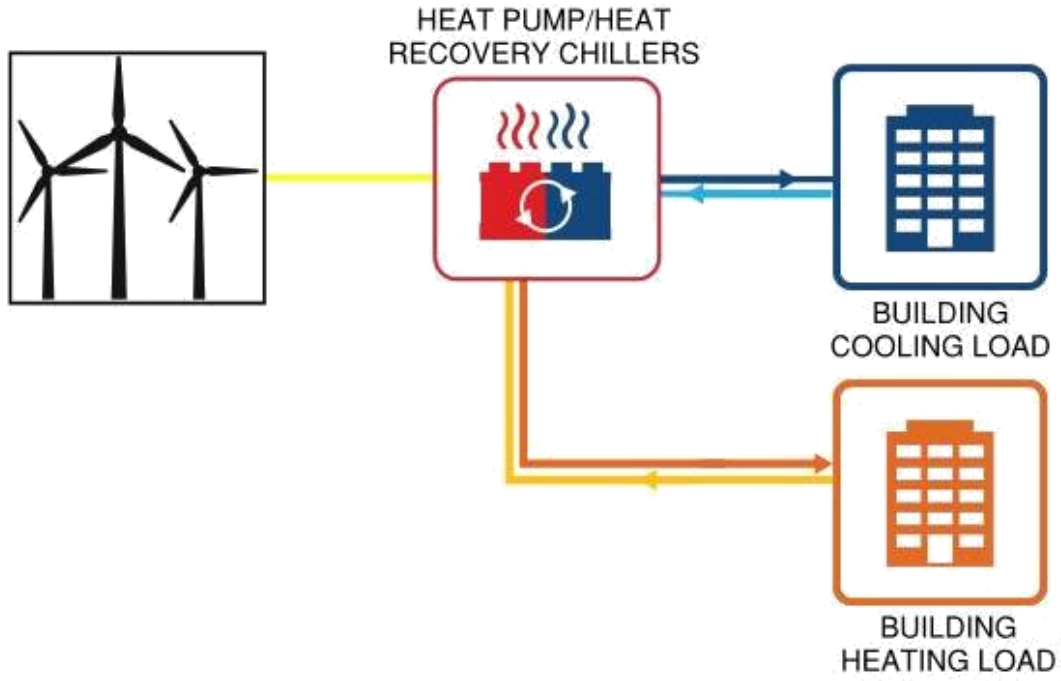
Tier 3

- Water-Source Hydronic Heat Pumps

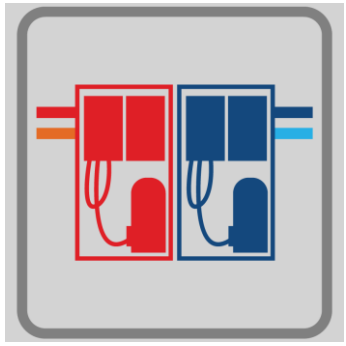
Efficiency Comparison



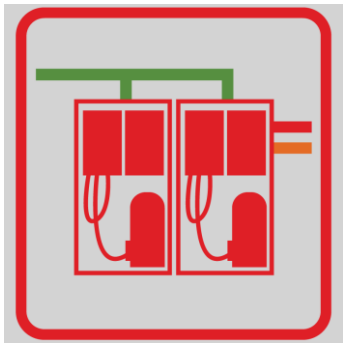
Heat Pumps



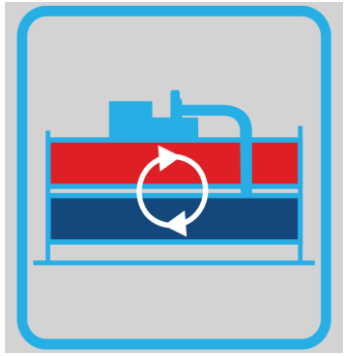
Modes of Operation



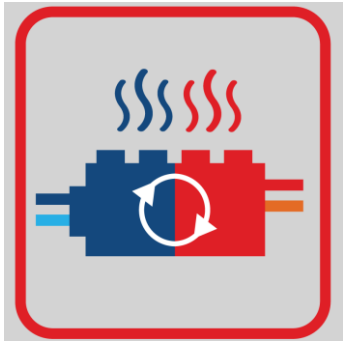
heating and cooling



heating only



full heat recovery



heat recovery + air source

Building Electrification

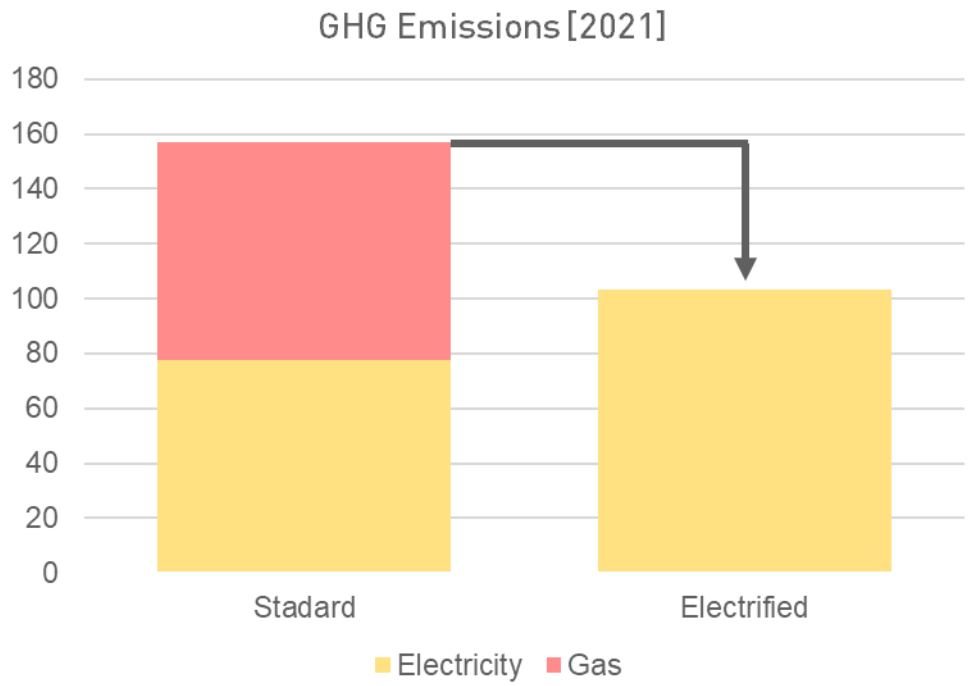
TYPICAL 200,000 SF OFFICE BUILDING

Standard building system

- Chillers + Boilers
- Gas or Point of Use Electric Water Heaters
- Gas Appliances (cafe)

Fully electric building design

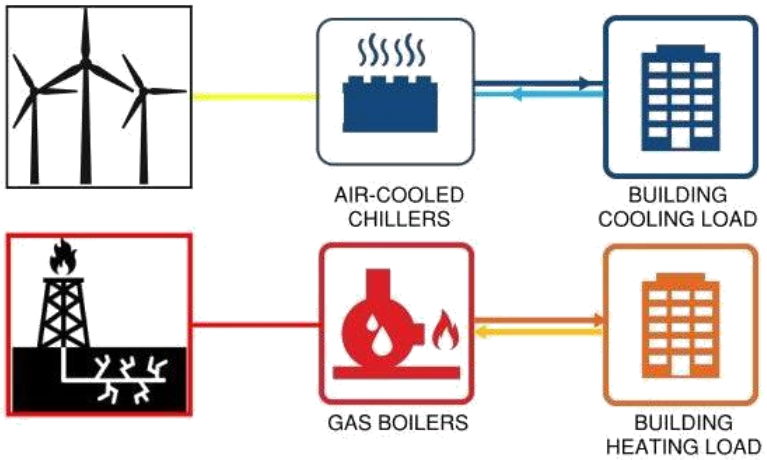
- Heat Pumps / Heat Recovery Chillers
- Heat Pump Water Heaters / Point of Use Electric Water Heaters
- Electric Appliances (cafe)

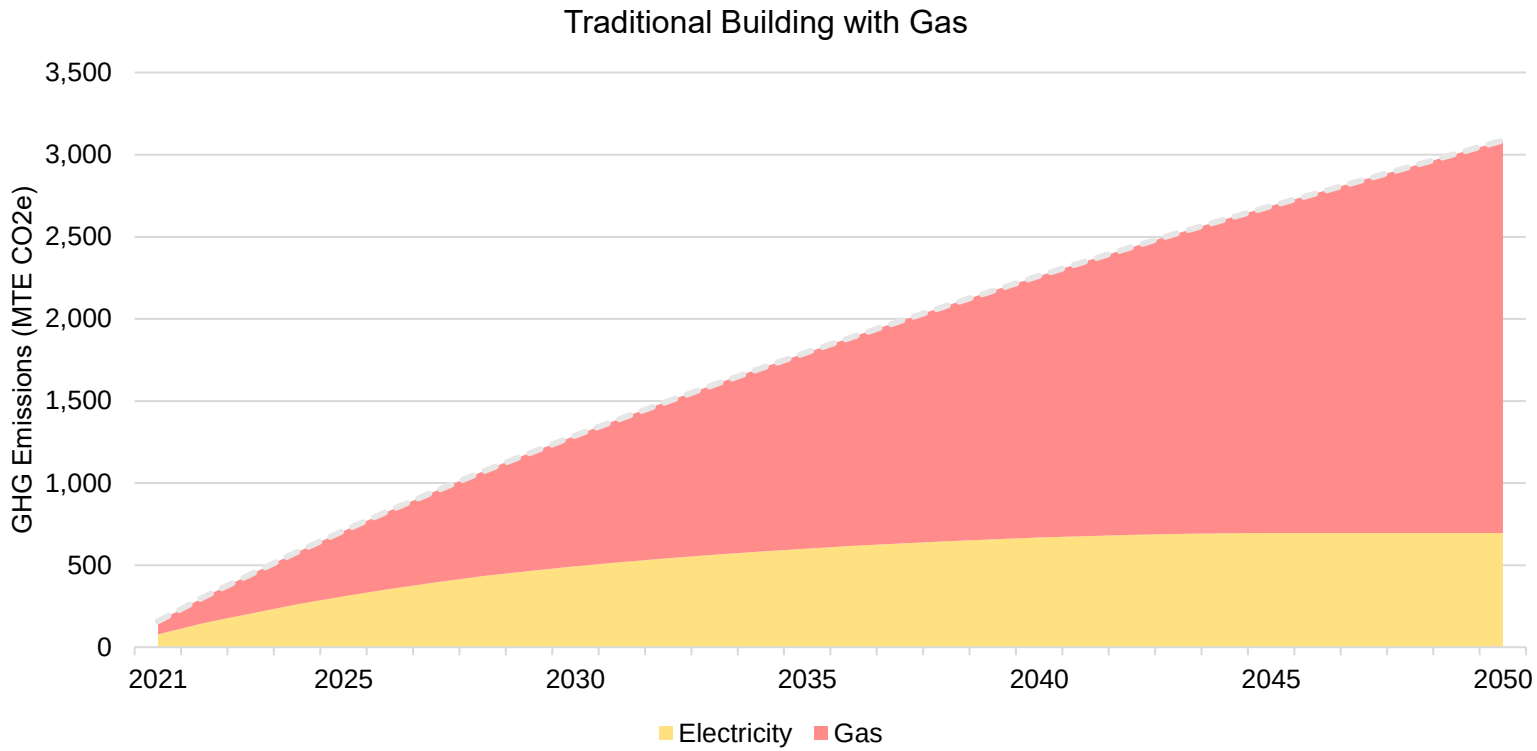


34% REDUCTION
in GHG Emissions (2021)

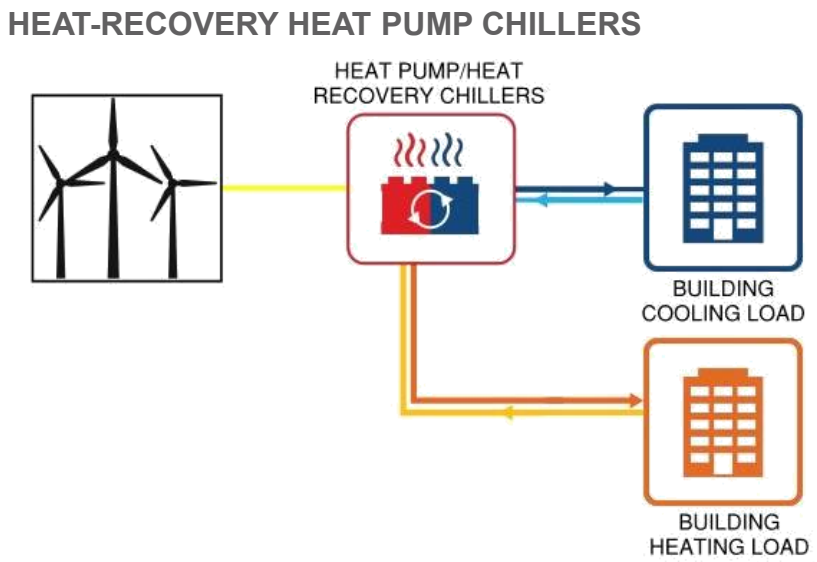
Standard Building Systems

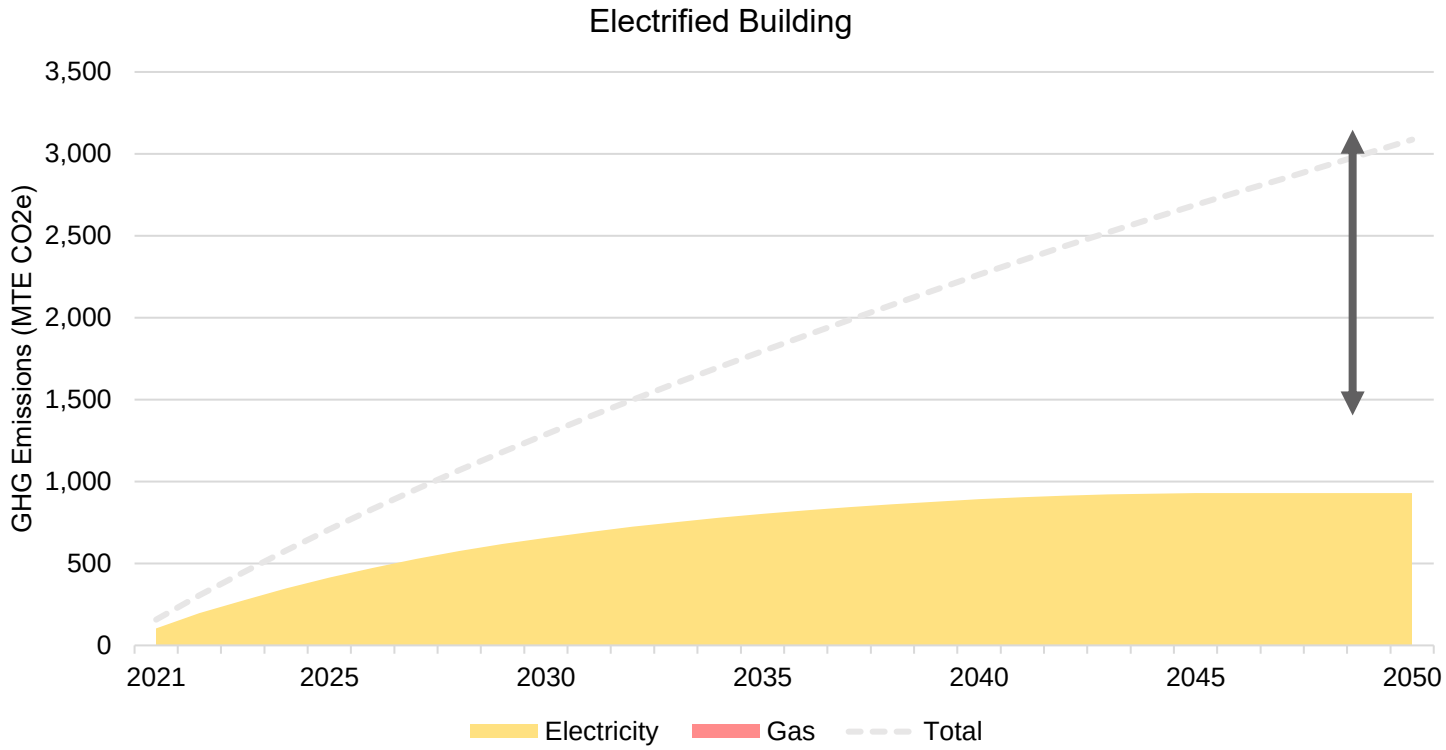
AIR-COOLED CHILLERS & GAS BOILERS





All-Electric Building Systems



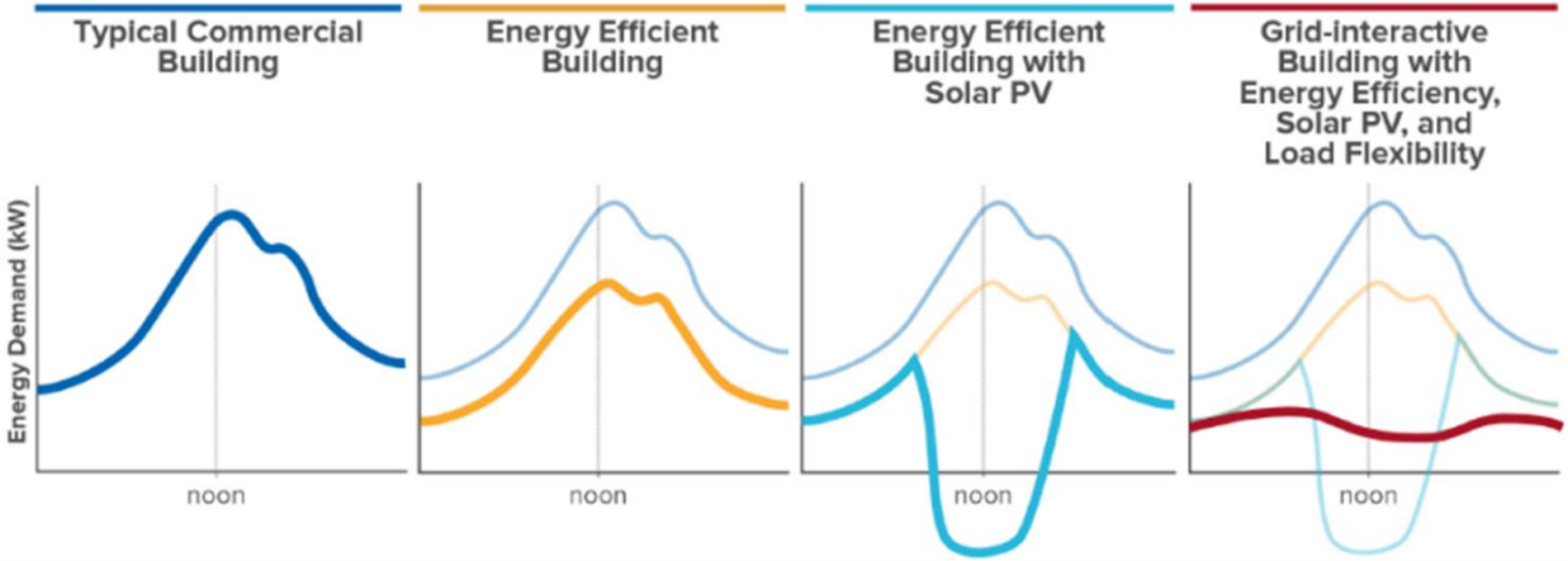


70% REDUCTION

in GHG Emissions (2021-2050)

What’s Next

Building Load Flexibility



ENERGY EFFICIENCY
Reduces and flattens electrical demand

RENEWABLE ENERGY
Reduces energy use and peak demand

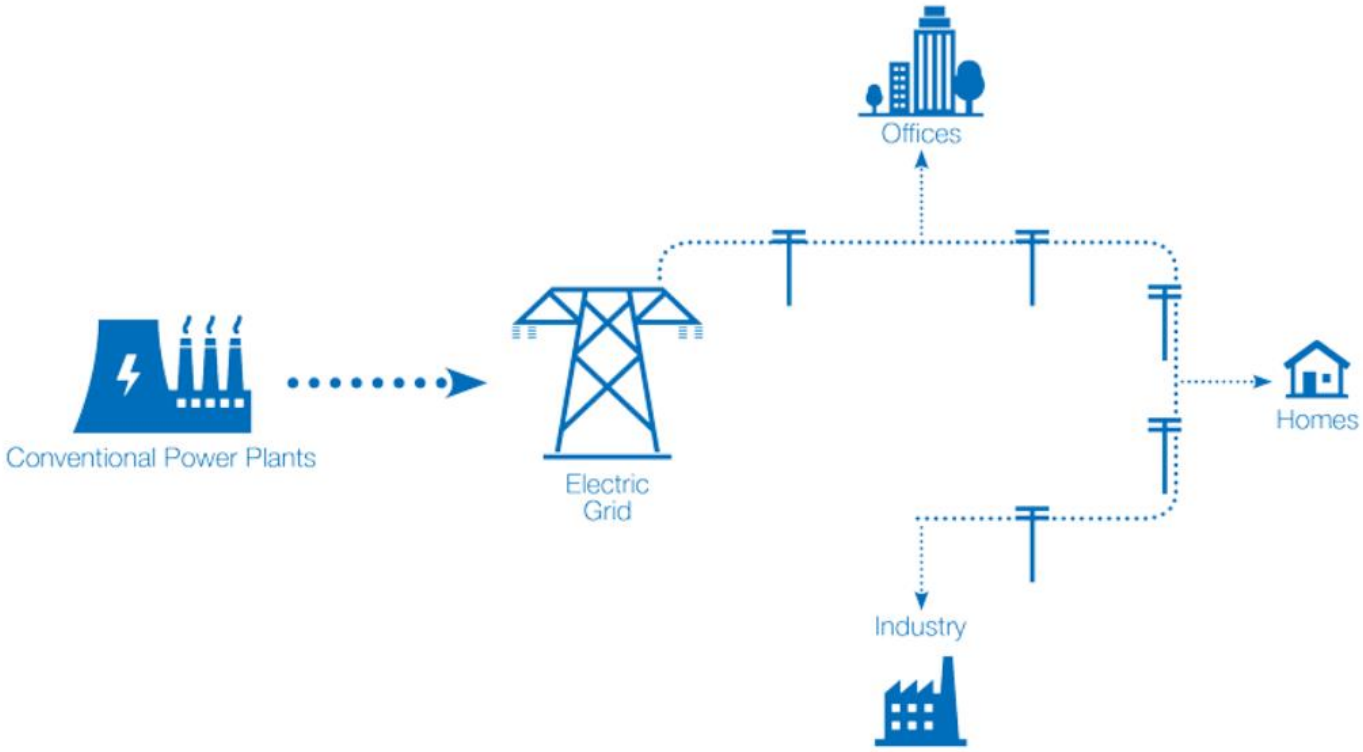
Cause steep ramp up of electrical loads

DEMAND FLEXIBILITY
Optimizes electrical loads to reduce demand charges

Supports grid stability and reliability

Grid-interactive Buildings

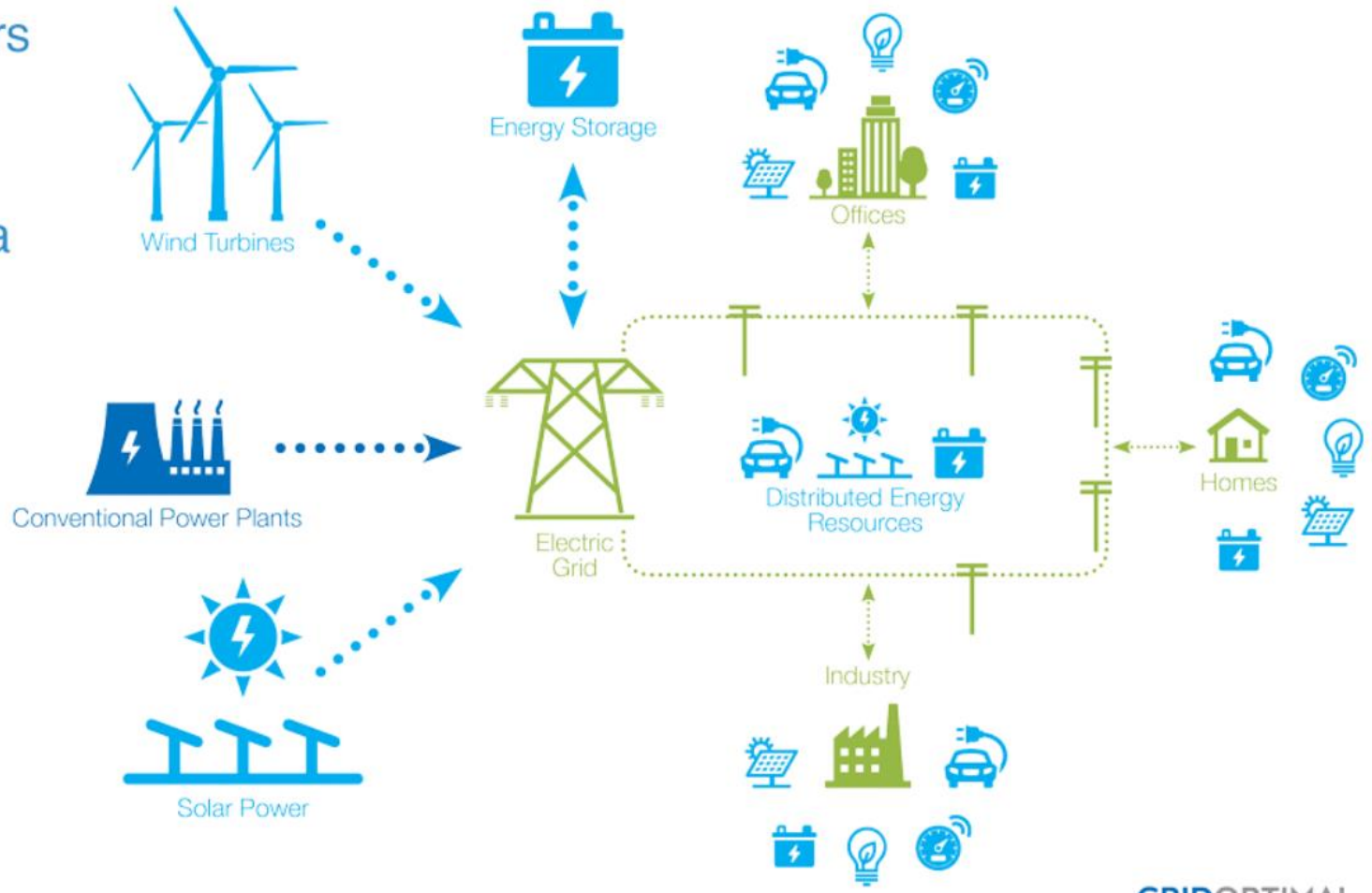
The one-way electricity grid of the past



GRIDOPTIMAL BUILDINGS INITIATIVE

Grid-interactive Buildings

GridOptimal empowers players on both sides of the meter to actively support the transition to a carbon free grid



GridOptimal Technologies and Strategies:

- renewable energy
- energy efficiency
- electric vehicle
- energy storage
- smart connected controls

GRIDOPTIMAL BUILDINGS INITIATIVE

Powerful Facility
Energy Conference

Can Solar Work For You?

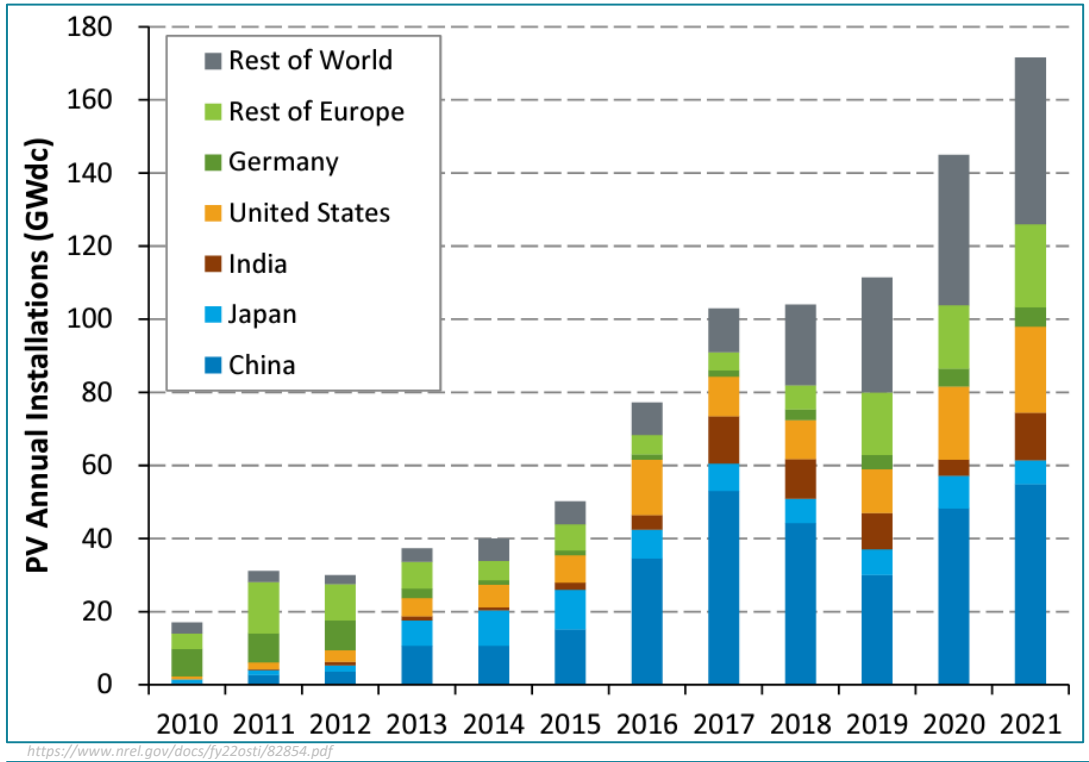
Kyle Adams & Lyudmila Arseniy

Puget Sound Solar

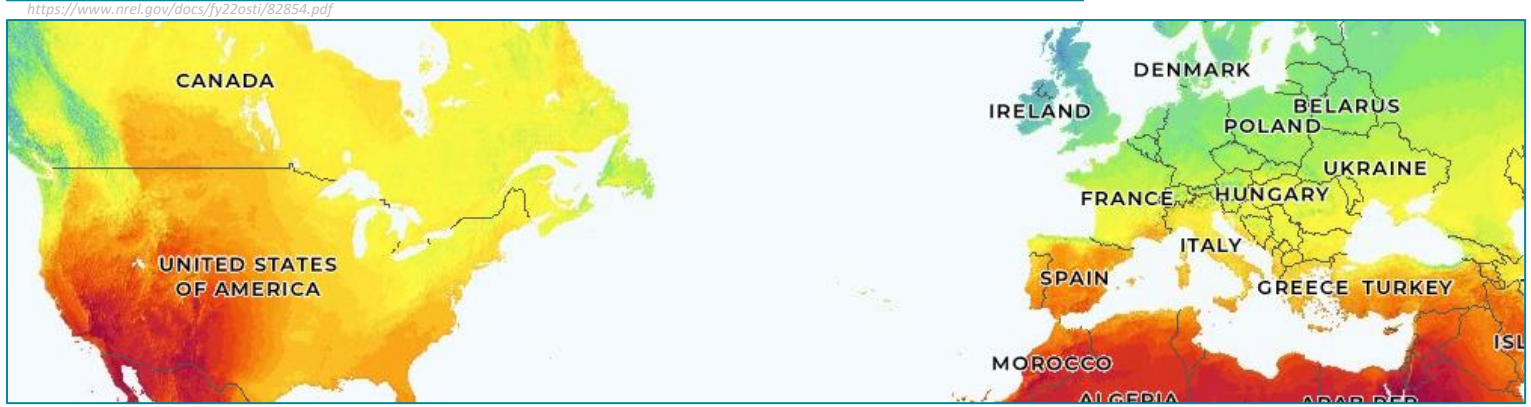
March 16, 2023

Solar in WA?

- Same irradiation as early leaders
- Cool climate benefits
- Rain Benefits



https://www.nrel.gov/docs/fy22osti/82854.pdf

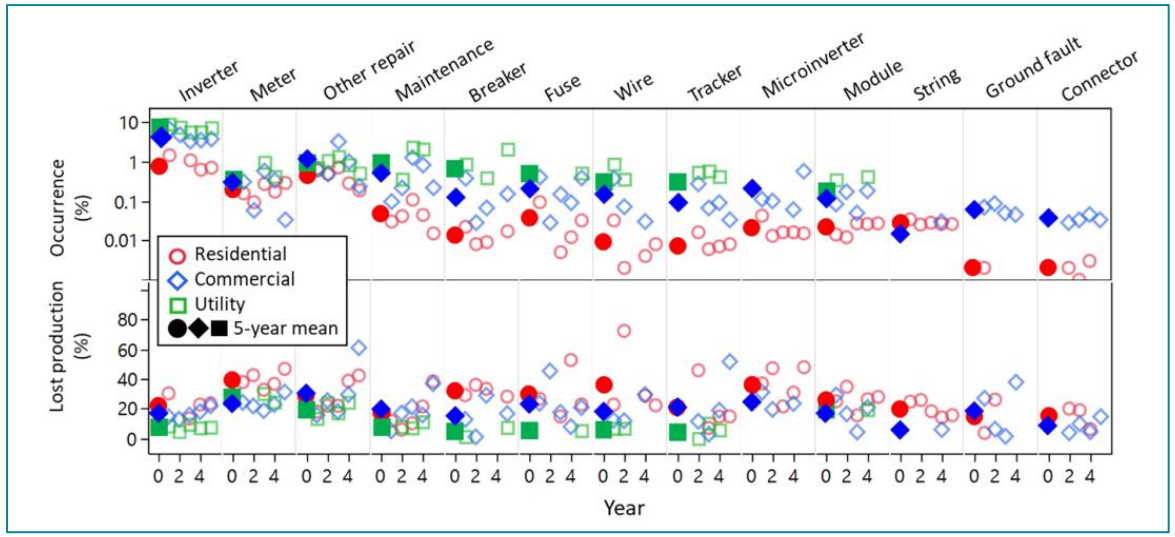


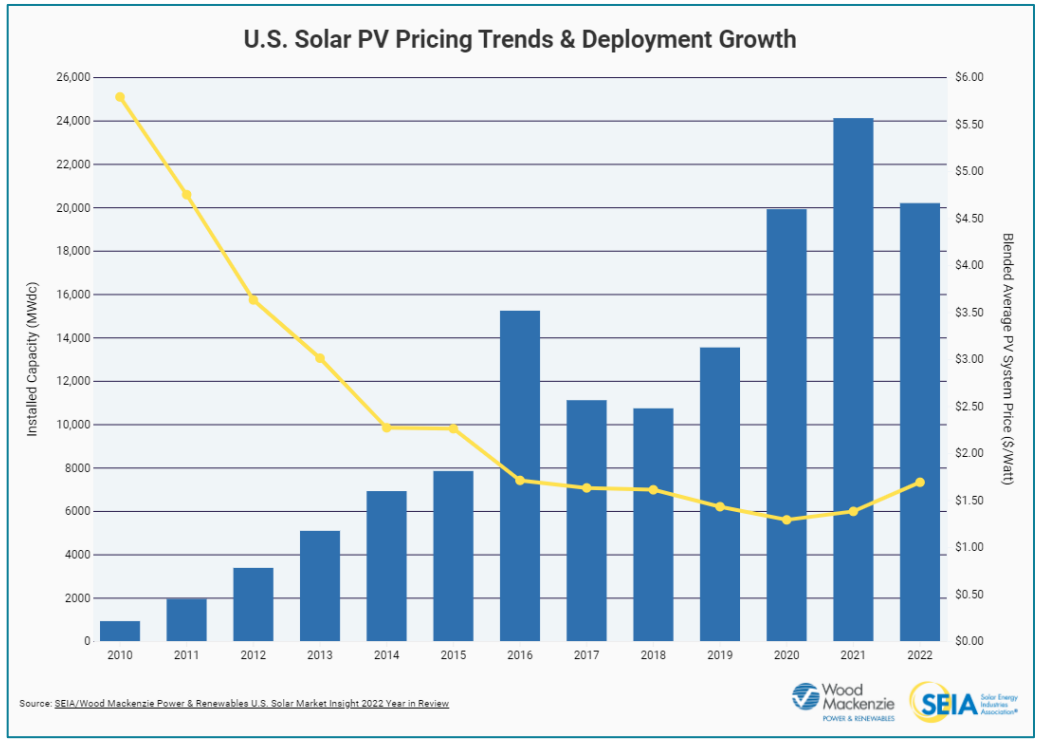
https://globalsolaratlas.info/map

Sources: NREL Spring 2022 Solar Industry Update, Global Solar Atlas

Improvements

- Cost decreases
- Failure rates low
- Incentives

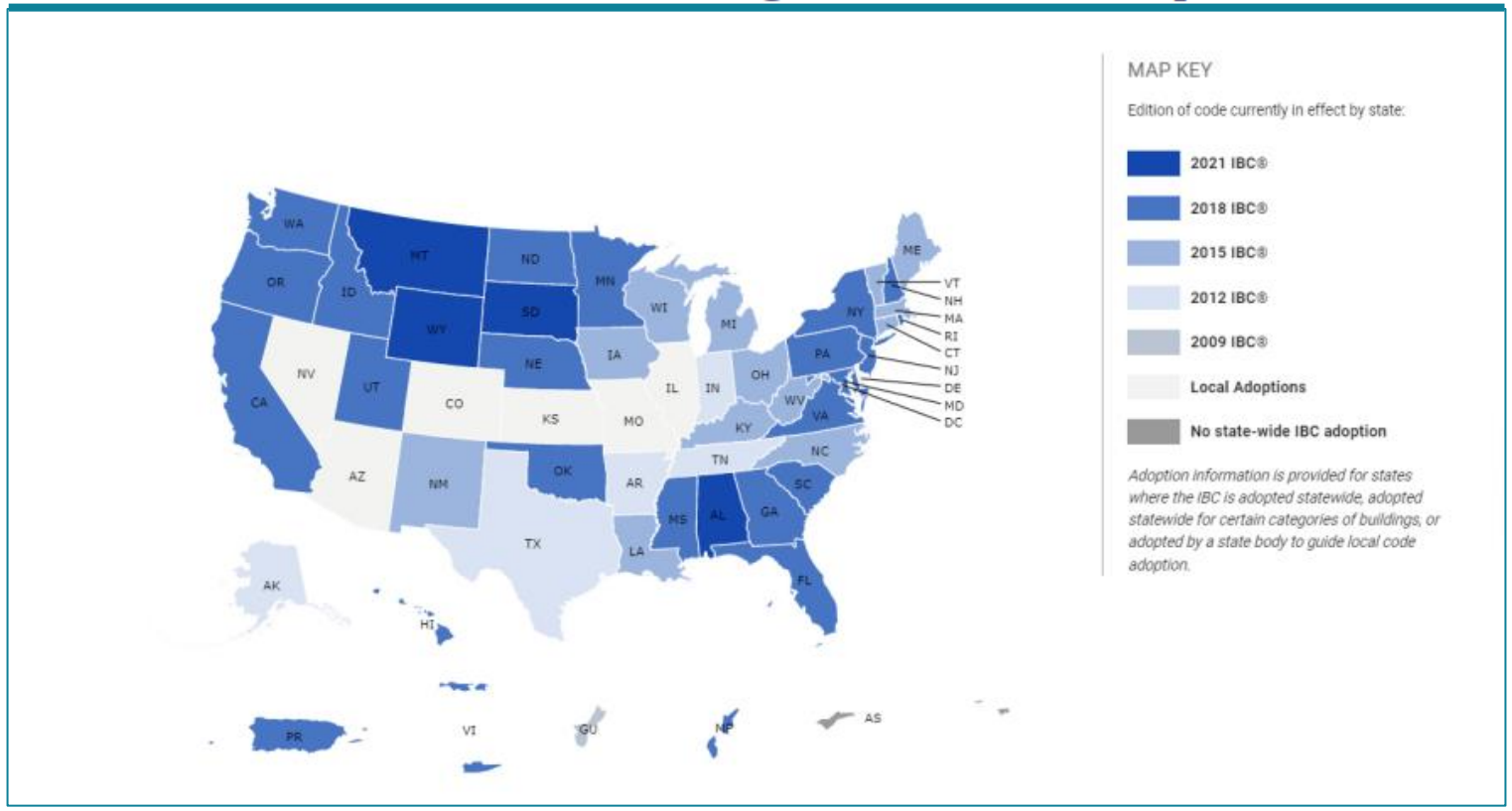


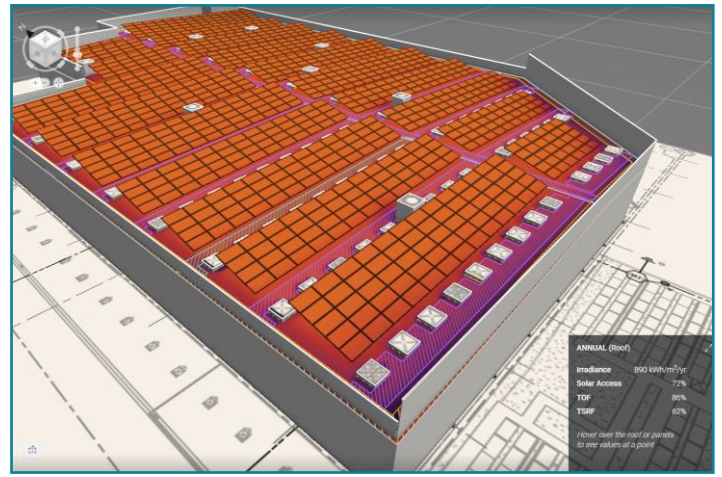


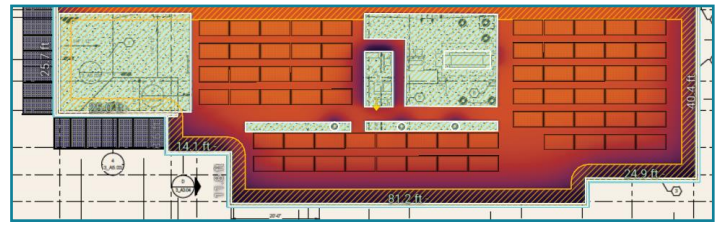
Sources: PV Field Reliability Status - OSTI.GOV, SEIA U.S. Solar Market Insight 2022 Year in Review

Codes & Considerations

International Building Code Adoption







Source: 2021 International Building Code

Rebates

- Net metering
- Sales Tax Exception
- Federal Income Tax Credit
- MARCS Depreciation

Summary of Investment Tax Credit (ITC) and Production Tax Credit (PTC) Values Over Time

			Start of Construction						
			2006 to 2019	2020 to 2021	2022	2023 to 2033	The later of 2034 (or two years after applicable year[a])	The later of 2035 (or three years after applicable year[a])	The later of 2036 (or four years after applicable year[a])
ITC	Full rate (if project meets labor requirements[b])	Base Credit	30%	26%	30%	30%	22.5%	15%	0%
		Domestic Content Bonus				10%	7.5%	5%	0%
		Energy Community Bonus				10%	7.5%	5%	0%
	Base rate (if project does not meet labor requirements[b])	Base Credit	30%	26%	6%	6%	4.5%	3%	0%
		Domestic Content Bonus				2%	1.5%	1%	0%
		Energy Community Bonus				2%	1.5%	1%	0%
	Low-income bonus (1.8 GW/yr cap)	<5 MW projects in LMI communities or Indian land				10%	10%	10%	10%
		Qualified low-income residential building project / Qualified low-income economic benefit project				20%	20%	20%	20%

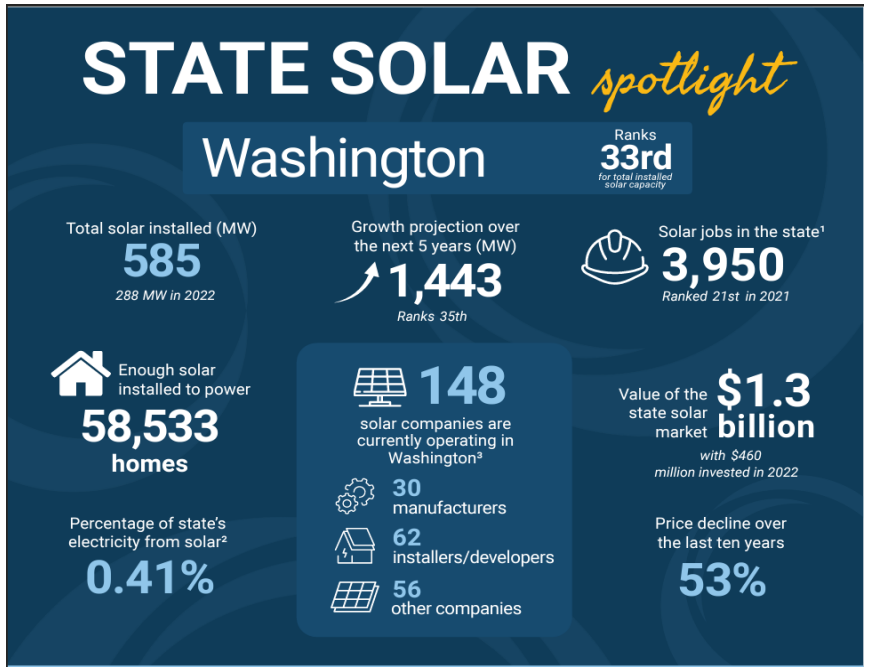
Source: [Federal Solar Tax Credits for Businesses | Department of Energy]

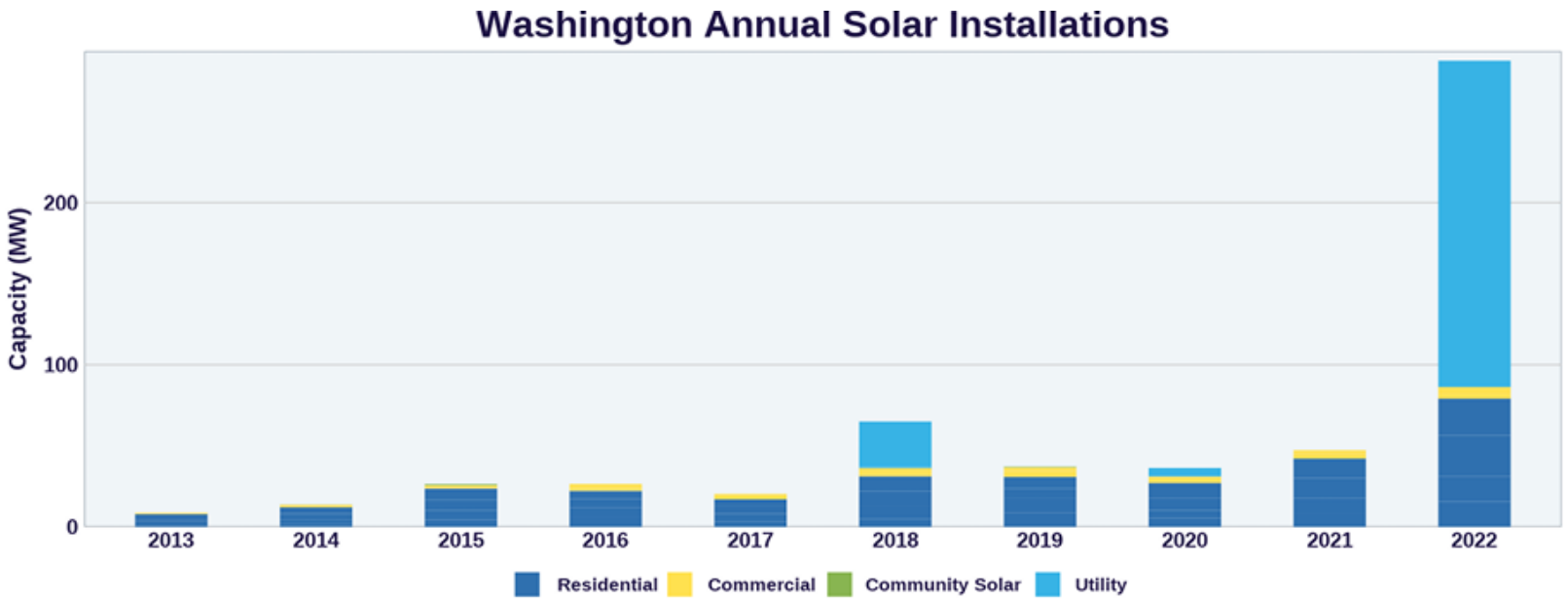
Grants and Funding

- Rural Energy for America Program (REAP)
- WA State Commerce - Green Power Solar Grant program
- WA State Commerce - Solar Plus Storage for Resilient Communities
- Department of Energy: Photovoltaics Research and Development
- WSU: Community Solar Expansion Program
- Clean Energies to Communities' Program
- **Community Solar opportunities**

Source: https://www.solarwa.org/grants_and_funding_opportunities

WA Spotlight





Source: https://seia.org/state-solar-policy/washington-solar

Current 2018 Codes

- C406.1 -Additional energy efficiency credit requirements
- C406.5 -Energy credits (Table) - On-site renewable energy
- C411 -Solar Readiness
- E101.1 -On-site renewable energy systems.
  - Each new commercial building or addition larger than 5,000 square feet of gross conditioned floor area shall include a renewable energy generation system consisting of at least 70 watts rated peak photovoltaic energy production per 1,000 sqft of conditioned sqft
- C412 -Seattle Energy Code - Same as E101.1

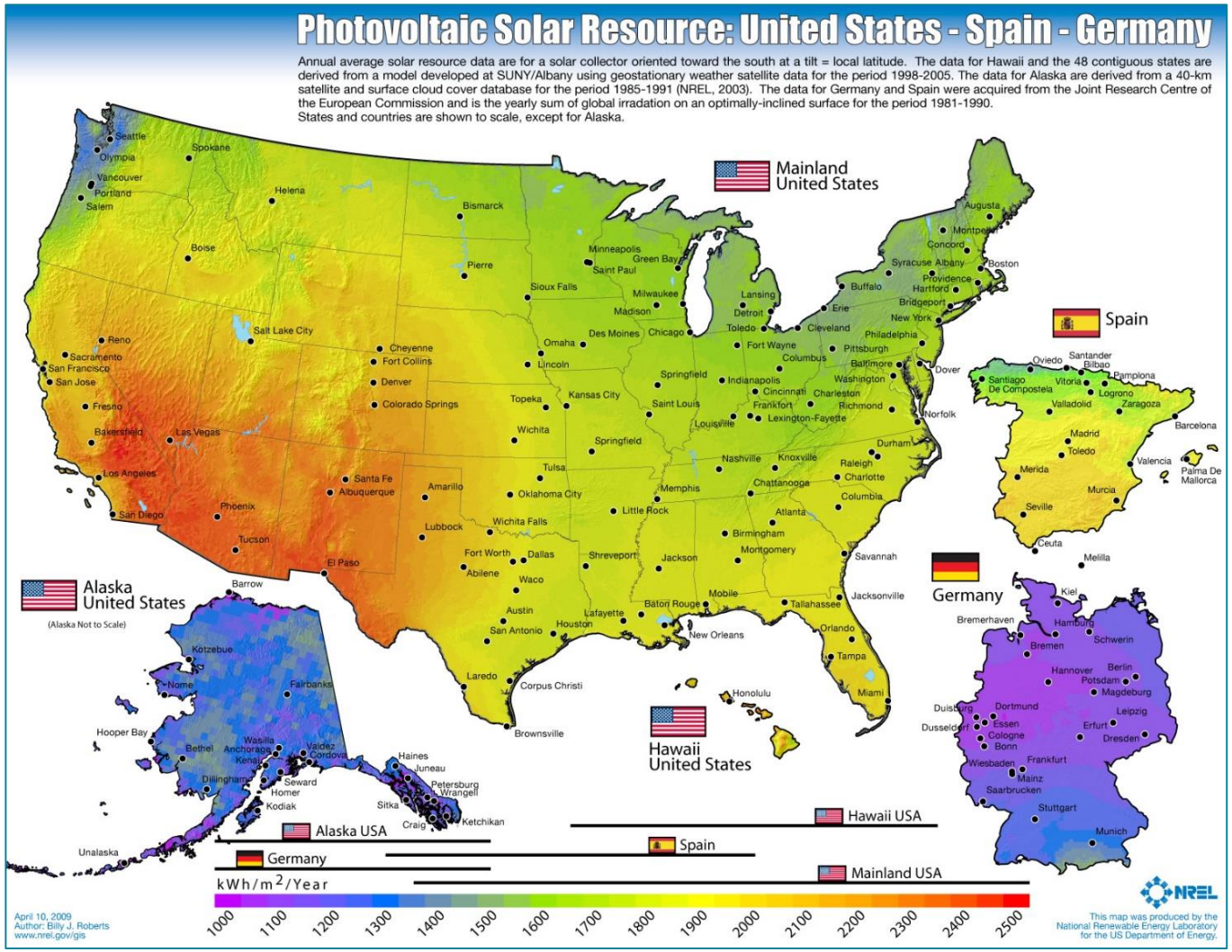
Source: 2018 International Building Code

2021 Codes Cont'd

- C411: Renewable energy requiring each new building or addition larger than 10000 sqft of condition floor area shall include a renewable energy generation system consisting of not less than .5 W/sqft (10000 sqft x .5 W = 5000 Watts)
  - There are 3 exceptions to void C411.1 ***BUT*** if you qualify for the exceptions. An additional 18 credits will be required in C406.2 to comply
- C411.2.2 Documentation requirements for off-site renewable energy systems
- C411.2.3 Renewable energy certificate (REC) tracking

Source: 2021 International Building Code

Annual Average of Solar exposure



Source: https://www.nrel.gov/gis/solar-resource-maps.html

Thank You

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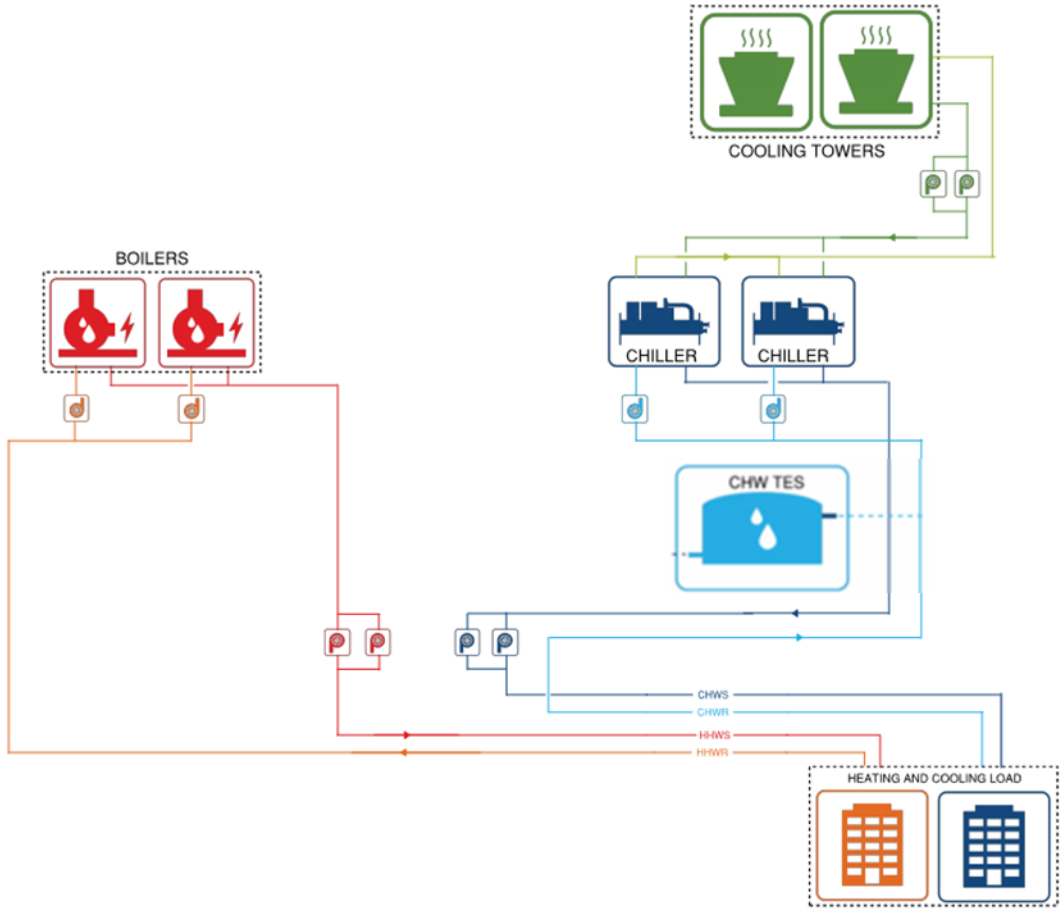
Case Study
Glumac

SMUD HQ OFFICE CENTRAL PLANT

EXISTING CENTRAL PLANT



SMUD HEADQUARTERS CAMPUS

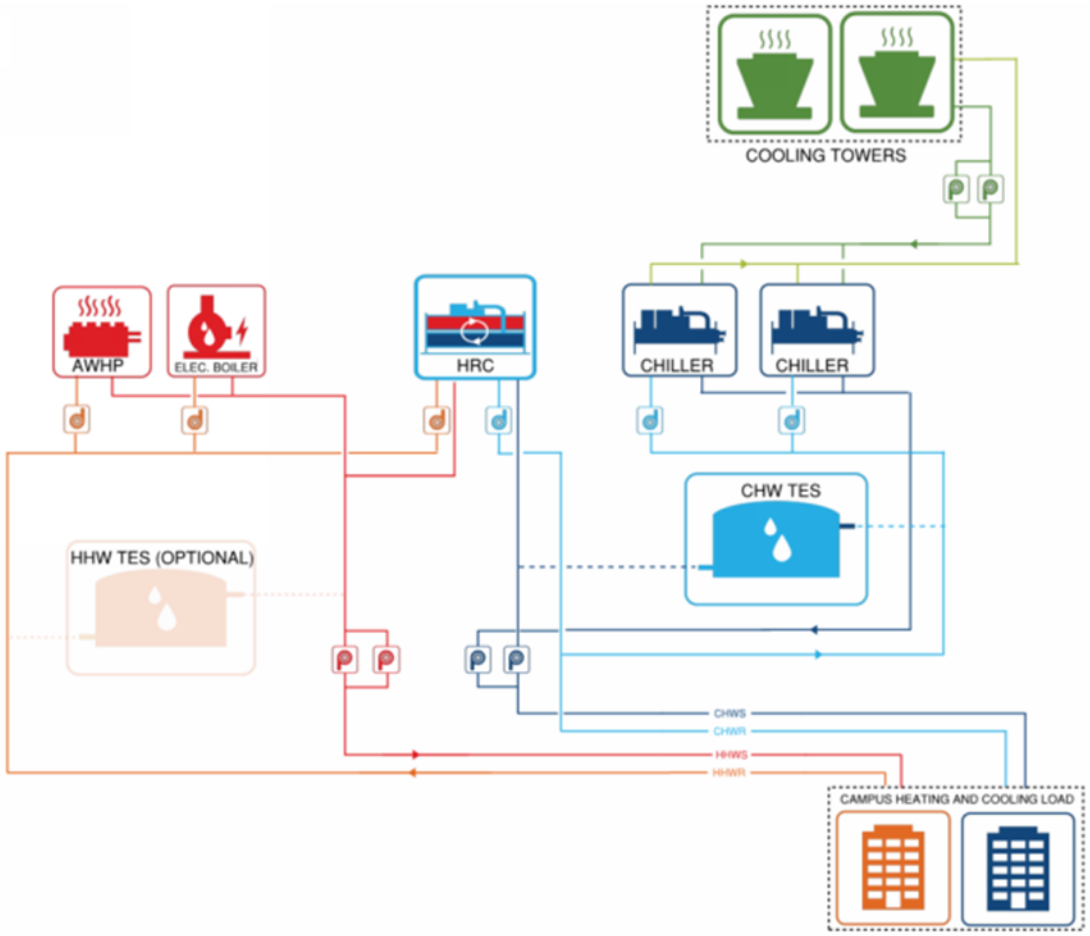
- 2x Buildings – 335,000 SF
- 2030 Net Zero Carbon Goal

EXISTING EQUIPMENT

- 1,300 tons Chilled Water Plant
  - 500-ton (2012)
  - 600-ton (1993)
  - 200-ton (1993)
  - 700,000-gallon TES
- 7,500 MBH Hot Water Plant
  - 3x 2,500 MBH condensing boilers (2012)
  - 160F max supply temp (180F original design)

SMUD HQ OFFICE CENTRAL PLANT

HEAT RECOVERY RETROFIT



NEW EQUIPMENT

- 150-ton Heat Recovery Chiller
  - Leverages Heat Recovery
  - Replace 200-ton pony chiller

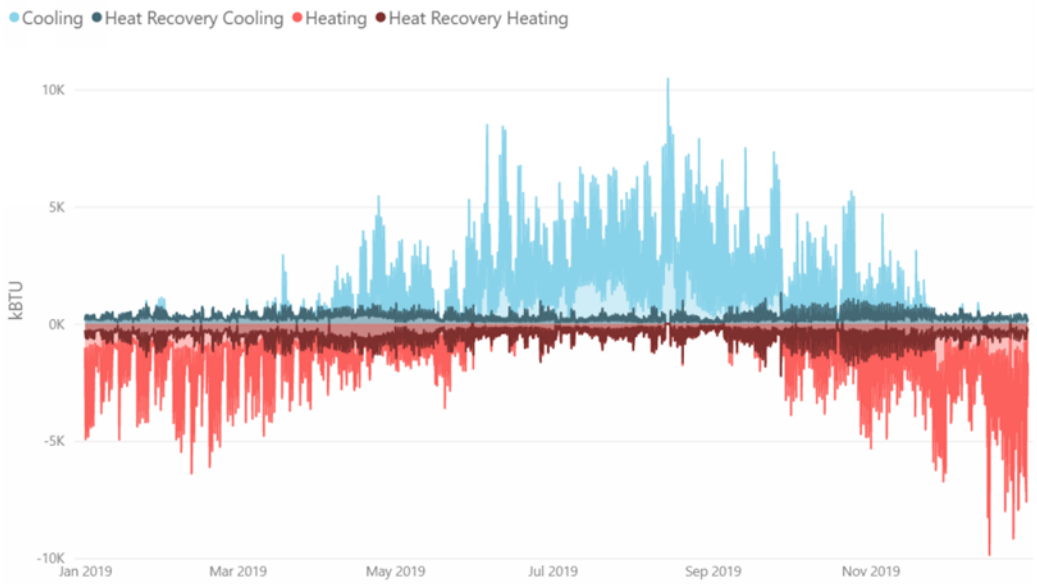


Figure 1: SMUD CHW/HHW Hourly Load Profile 2019

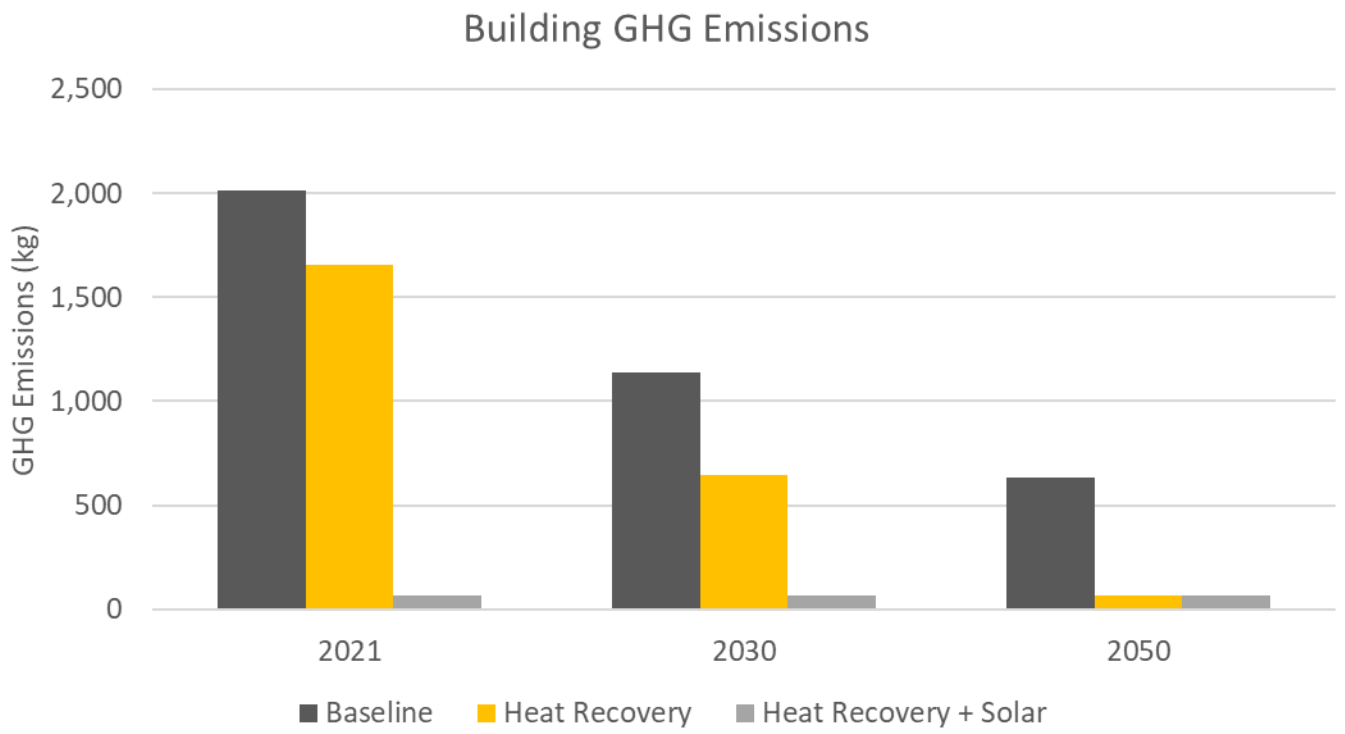
SMUD HQ OFFICE CENTRAL PLANT

Add Heat Recovery Chiller

- Replaces spare chiller
- HW temperature reset
- Positive return on investment

Signiant GHG Reduction

- 50% natural gas savings
- 88% with TES control optimization



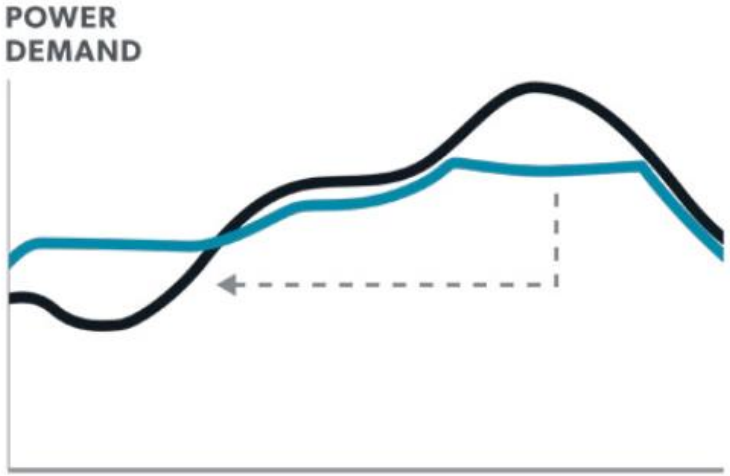
Strategy: Shift Load

THERMAL ENERGY STORAGE

TES WATER TANK

TES PHASE CHANGE

DOMESTIC WATER



POOL

THERMAL MASS

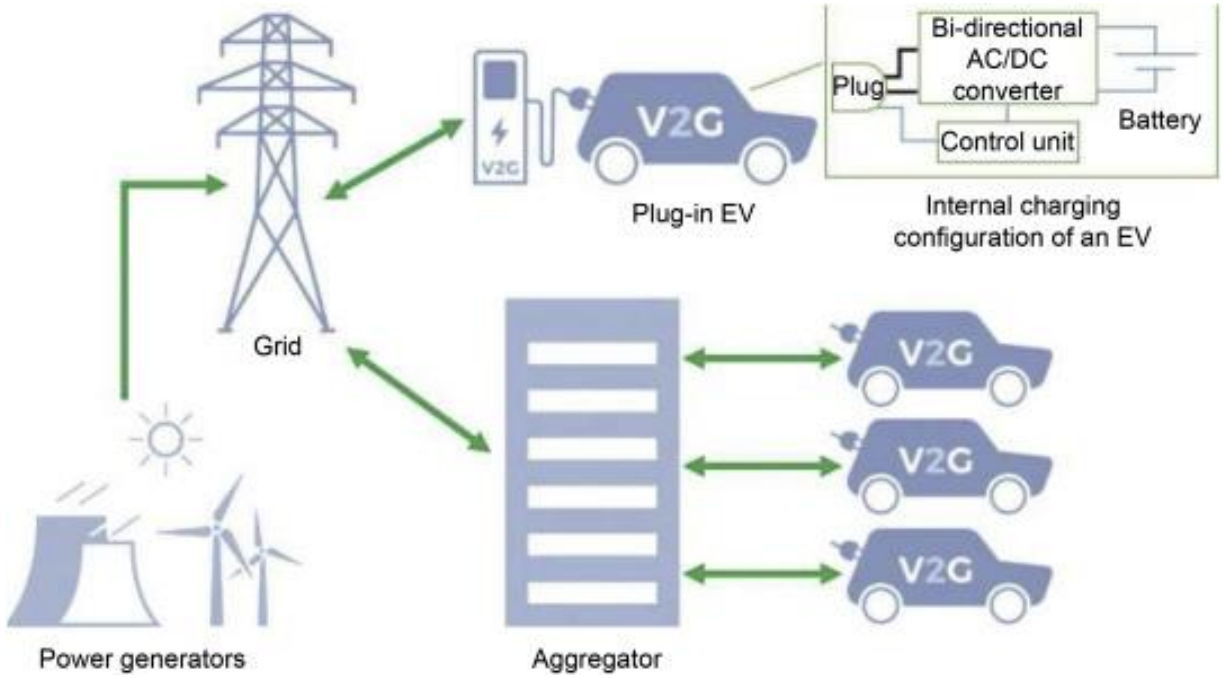
PHASE CHANGE MATERIAL

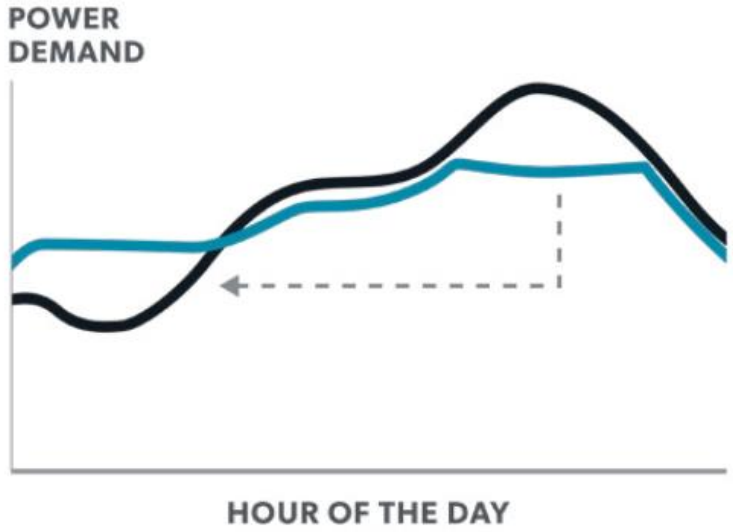
DESIGN STRATEGIES

- Battery Energy Storage
- Smart EV Charging
- Vehicle-to-Grid (V2G)
- Thermal Energy Storage
- Thermal Mass
- Pre Cooling / Heating Building

Strategy: Shift Load

VEHICLE-TO-GRID (V2G)



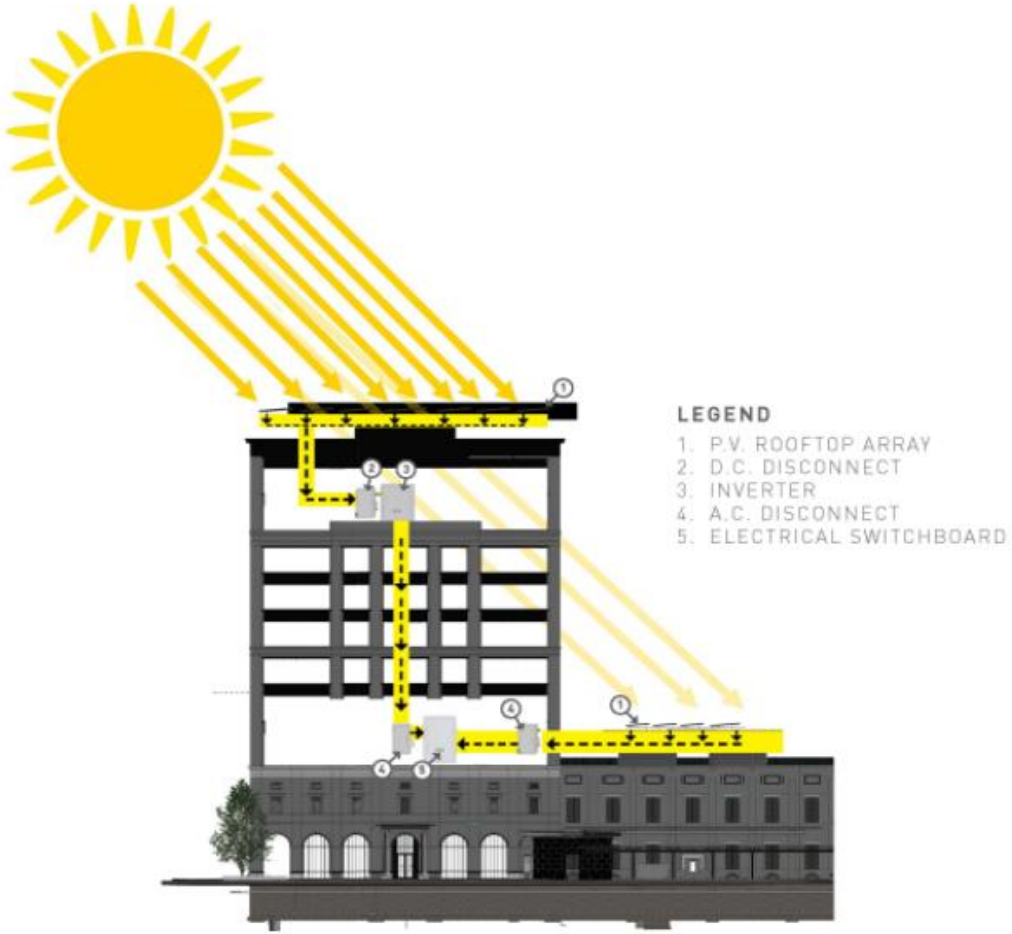


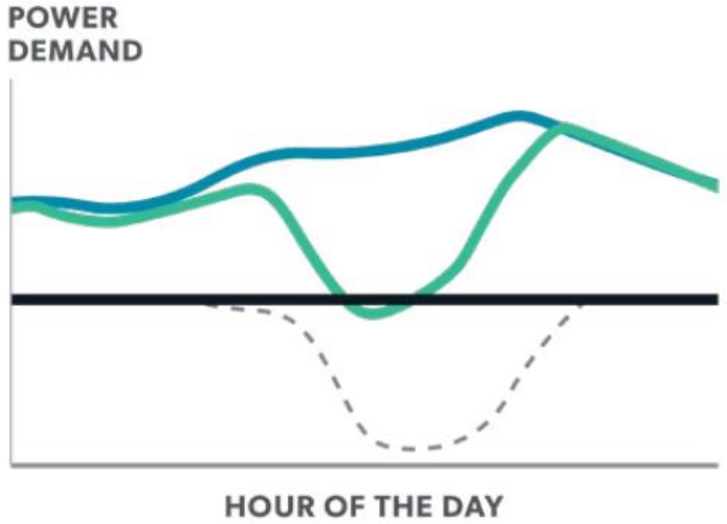
STRATEGIES

- Battery Energy Storage
- Thermal Energy Storage
- Smart EV Charging
- Vehicle-to-Grid (V2G)
- Thermal Mass
- Pre Cooling / Heating Building

Strategy: Generation

ROOFTOP & CARPORT SOLAR



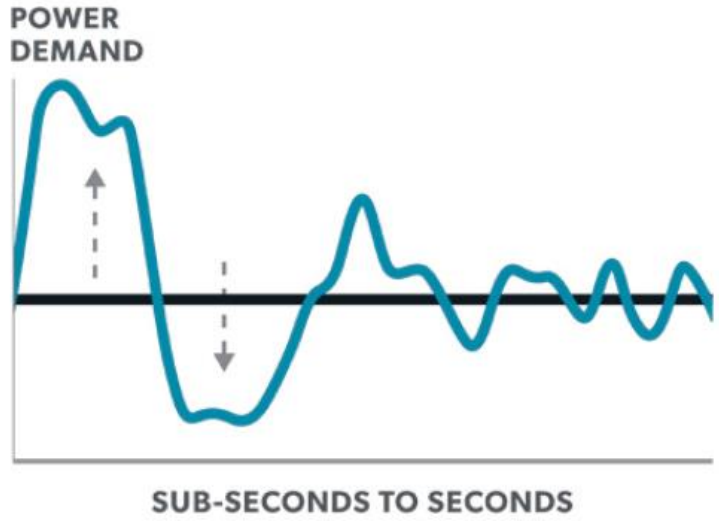


STRATEGIES

- Rooftop Solar
- Carport / Canopy Solar
- Building Integrated Solar (BIPV)
- *Wind (Rural Areas)*

Strategy: Dynamic Load Control

BATTERY STORAGE



STRATEGIES

- Battery Energy Storage

Thank You

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