Greening Buildings for Carbon Neutrality

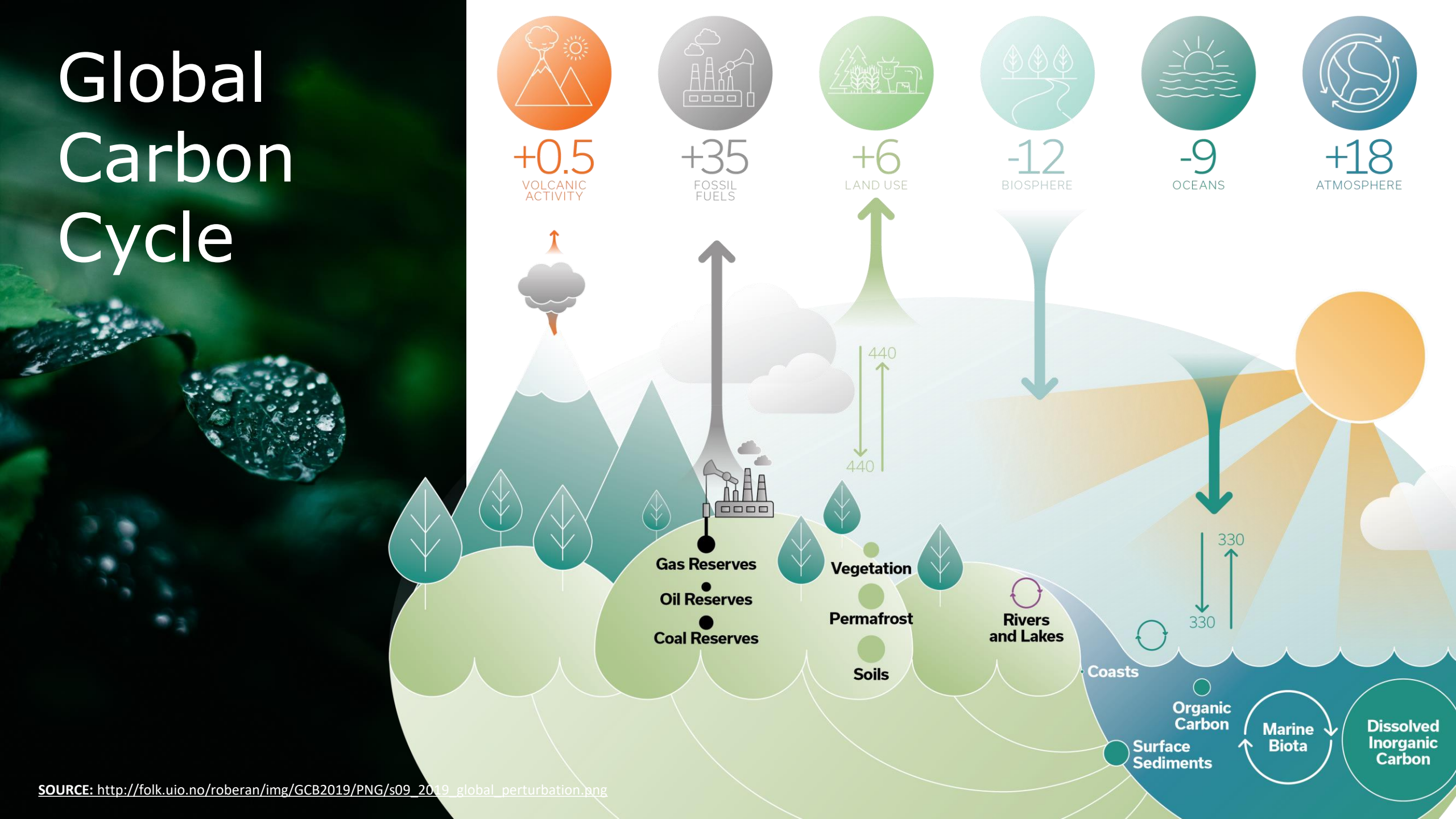
April 27, 2022| Presented by Marc P Brune, PE

LEWIS AND CLARK | 1805

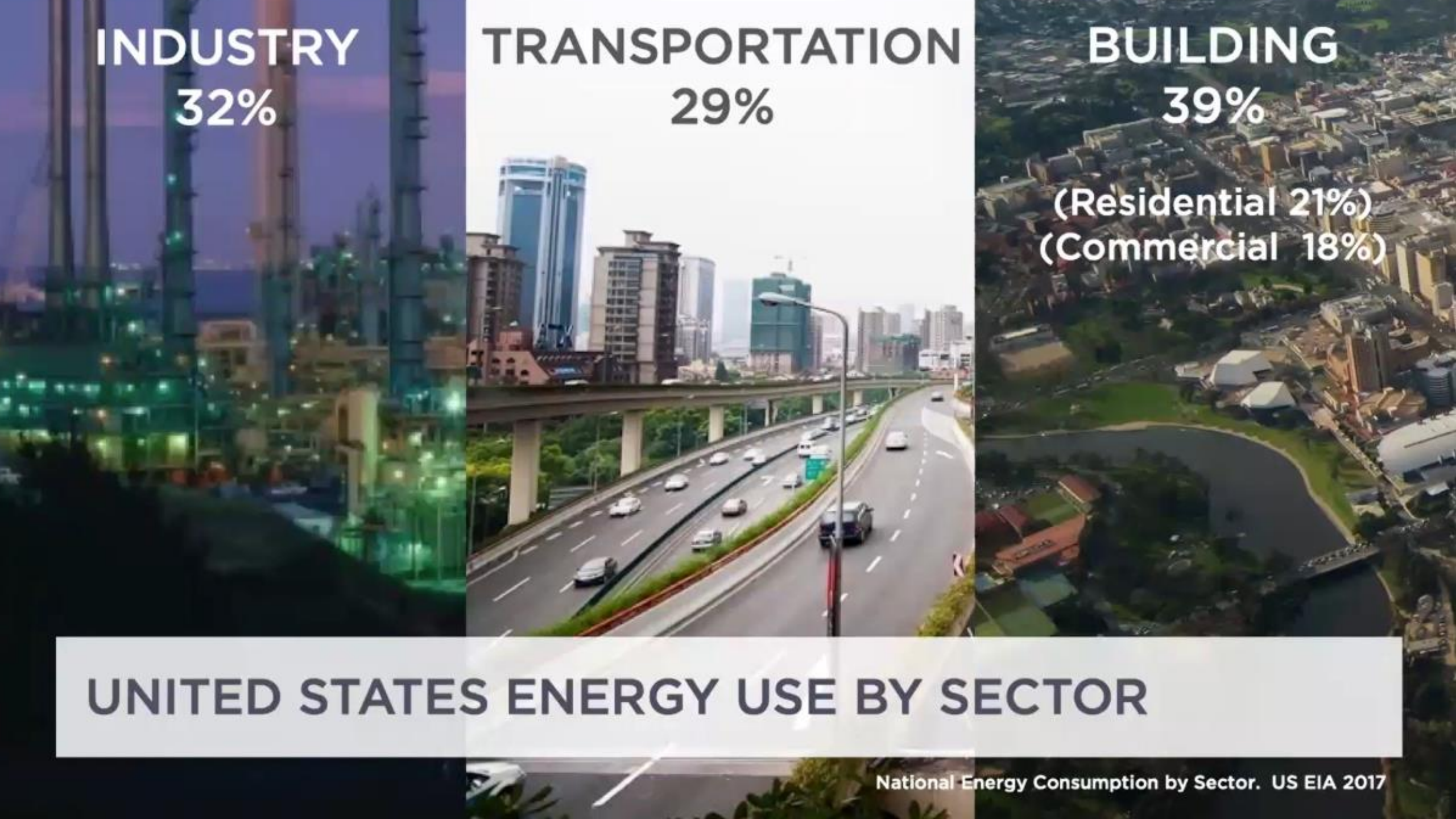
FIRST AND STARK STREET | 1852
PORTLAND, OR

CELILO FALLS | OREGON

Global Carbon Cycle



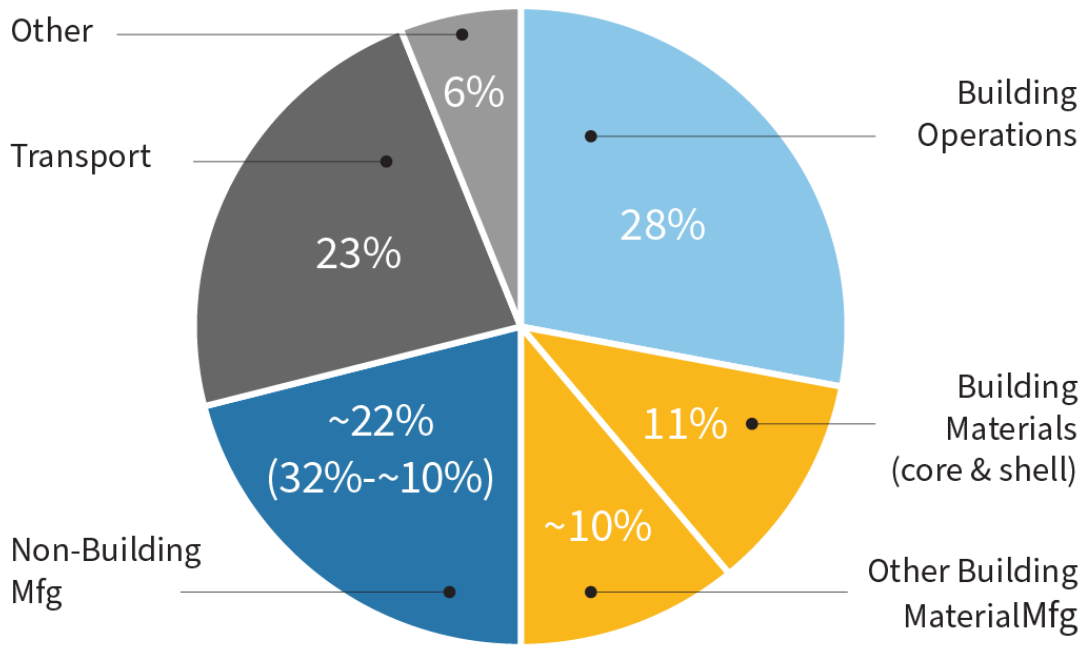
SOURCE: http://folk.uio.no/roberan/img/GCB2019/PNG/s09_2019_global_perturbation.png



UNITED STATES ENERGY USE BY SECTOR

National Energy Consumption by Sector. US EIA 2017

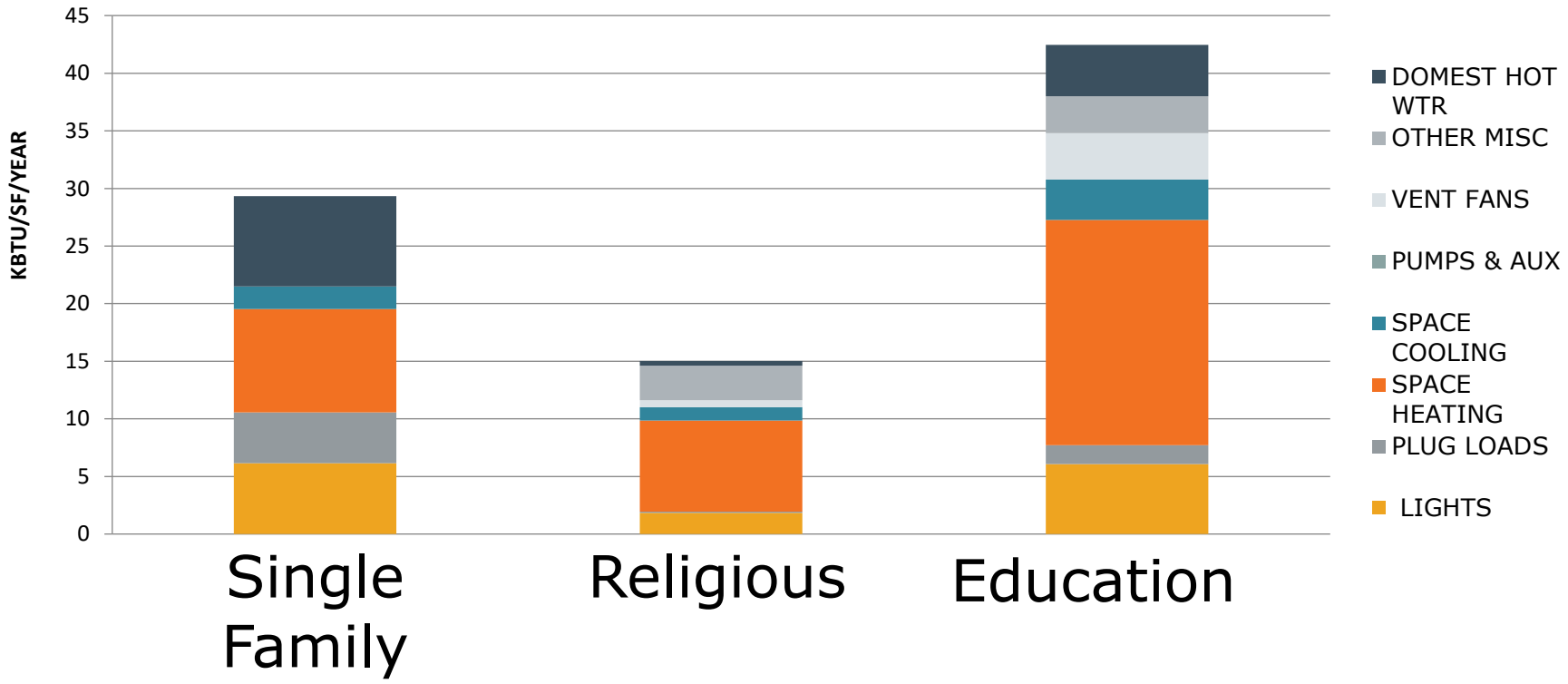
Emissions by Sector



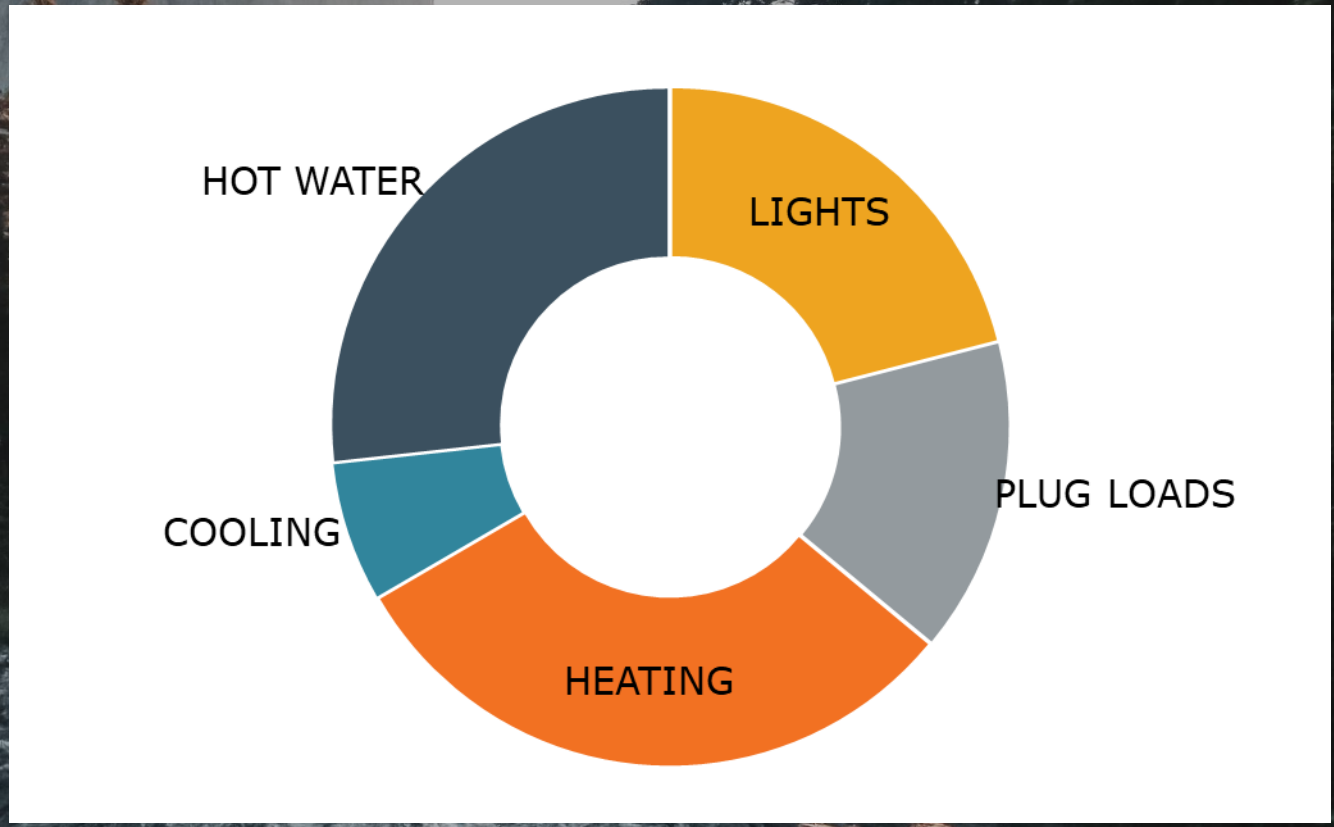
Adapted from 2019 Global Status Report, Global Alliance for Building and Construction (GABC) and Architecture 2030.

- The building and construction sector has a vital role to play in eliminating carbon, as it is responsible for approximately 40% of global carbon emissions.

Typical Energy Use



Typical Home Energy Use – Pacific Northwest



Lights

Incandescent

Compact Fluorescent

LED

Domestic Hot Water

Insulation

Electrification

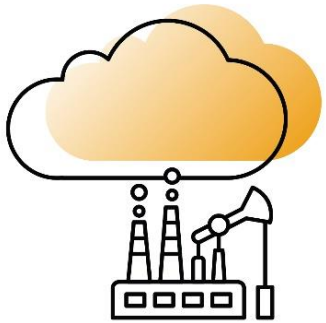
Heating, Cooling, Kitchens

Why?

Why should we electrify buildings?

GREENING OF THE GRID

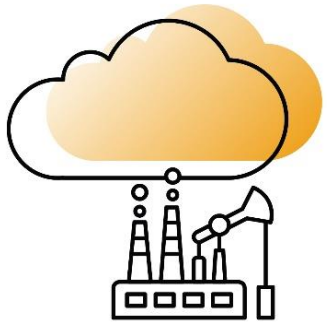
2019



NATURAL GAS

ALL ELECTRIC

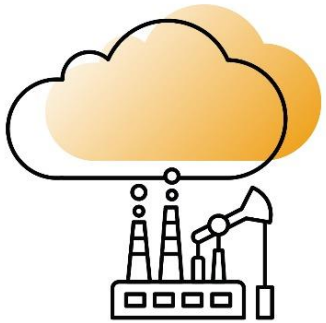
2030



NATURAL GAS

ALL ELECTRIC

2045

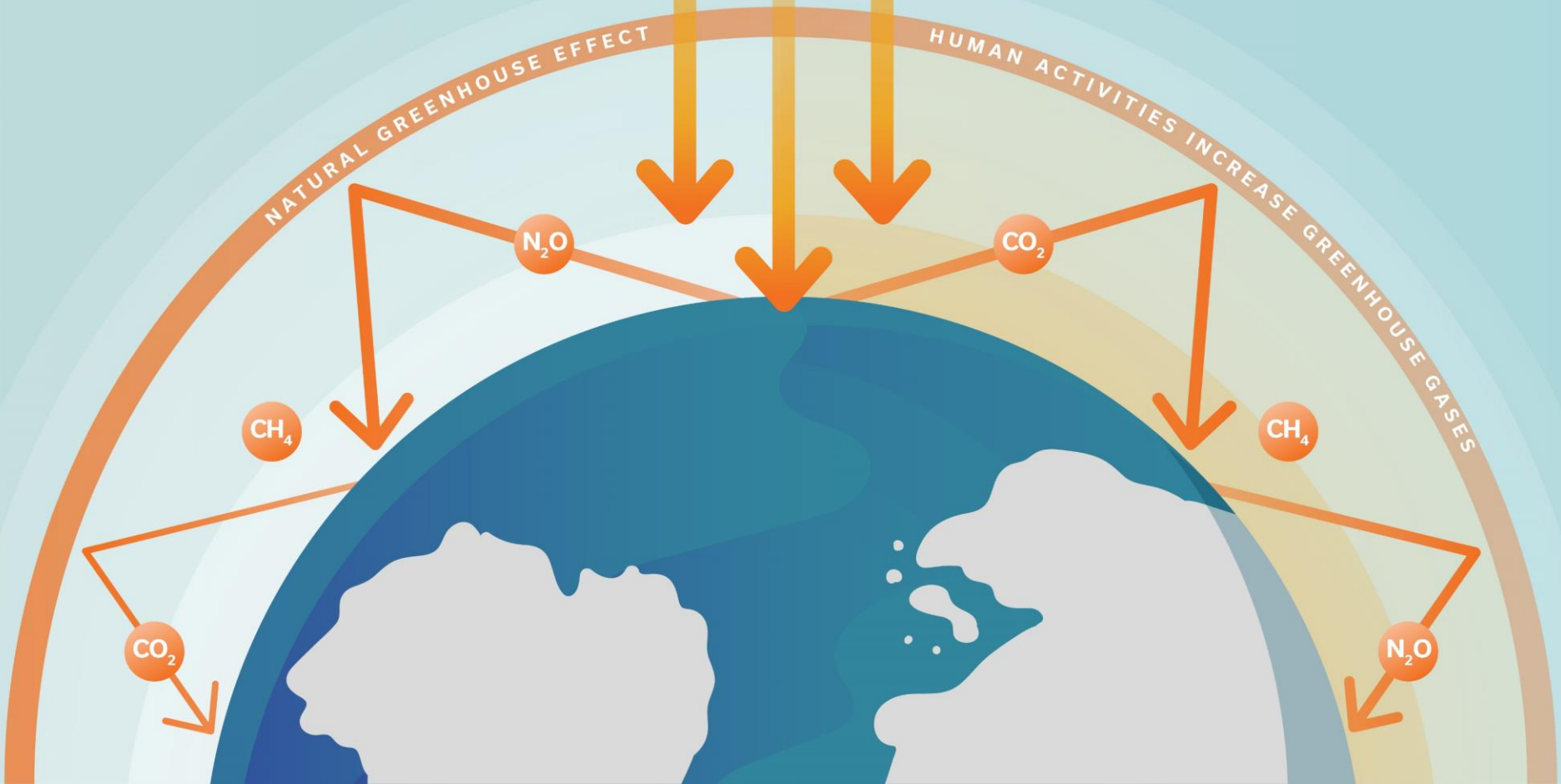


NATURAL GAS

ALL ELECTRIC

Natural Gas

Greenhouse Gases



Global Warming Potential

Carbon Dioxide

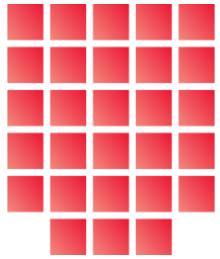
1

UNIT OF CO2

Methane – 100 Yr GWP

1

UNIT OF CH4



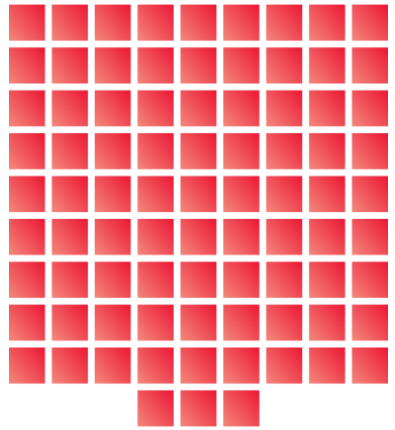
28

UNITS OF CO2

Methane – 20 Yr GWP

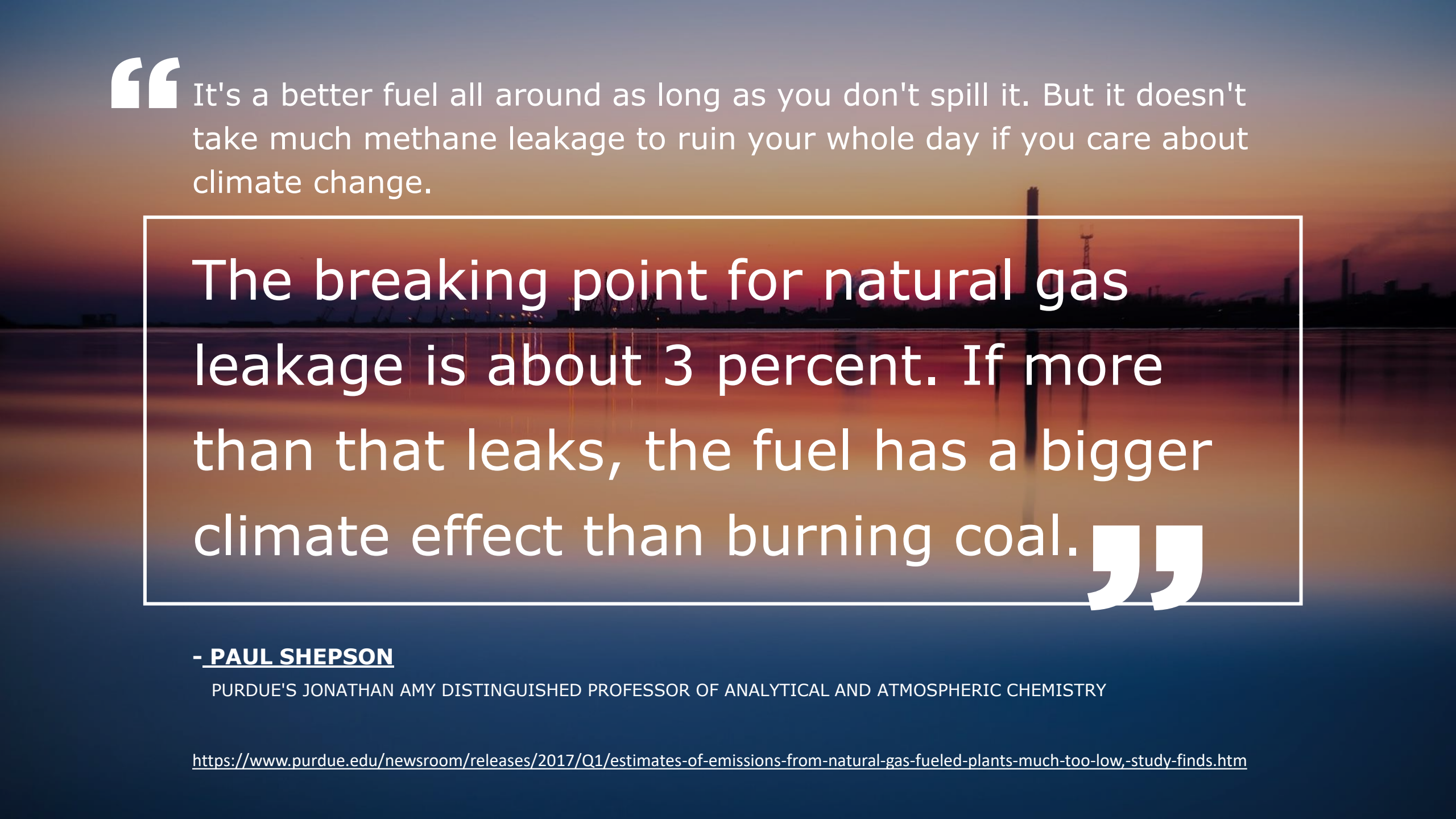
1

UNIT OF CH4



84

UNITS OF CO2



“It's a better fuel all around as long as you don't spill it. But it doesn't take much methane leakage to ruin your whole day if you care about climate change.

The breaking point for natural gas leakage is about 3 percent. If more than that leaks, the fuel has a bigger climate effect than burning coal.”

- PAUL SHEPSON

PURDUE'S JONATHAN AMY DISTINGUISHED PROFESSOR OF ANALYTICAL AND ATMOSPHERIC CHEMISTRY

https://www.purdue.edu/newsroom/releases/2017/Q1/estimates-of-emissions-from-natural-gas-fueled-plants-much-too-low,-study-finds.htm

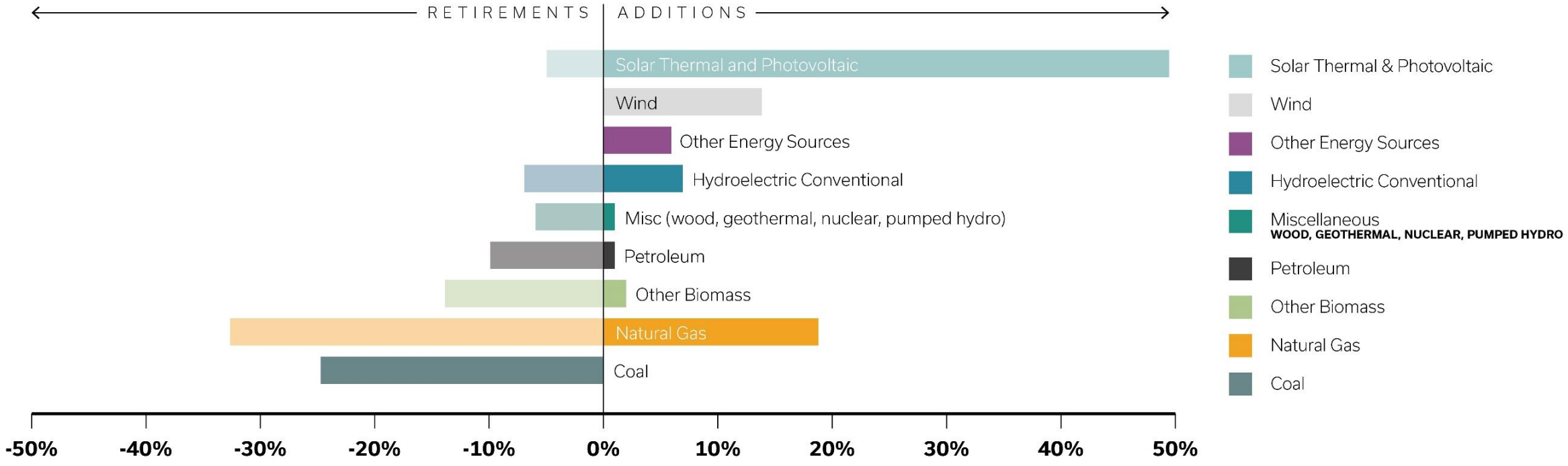
EagleClaw Midstream Pecos Plant

Electricity

NEW ELECTRICITY | NATIONALLY

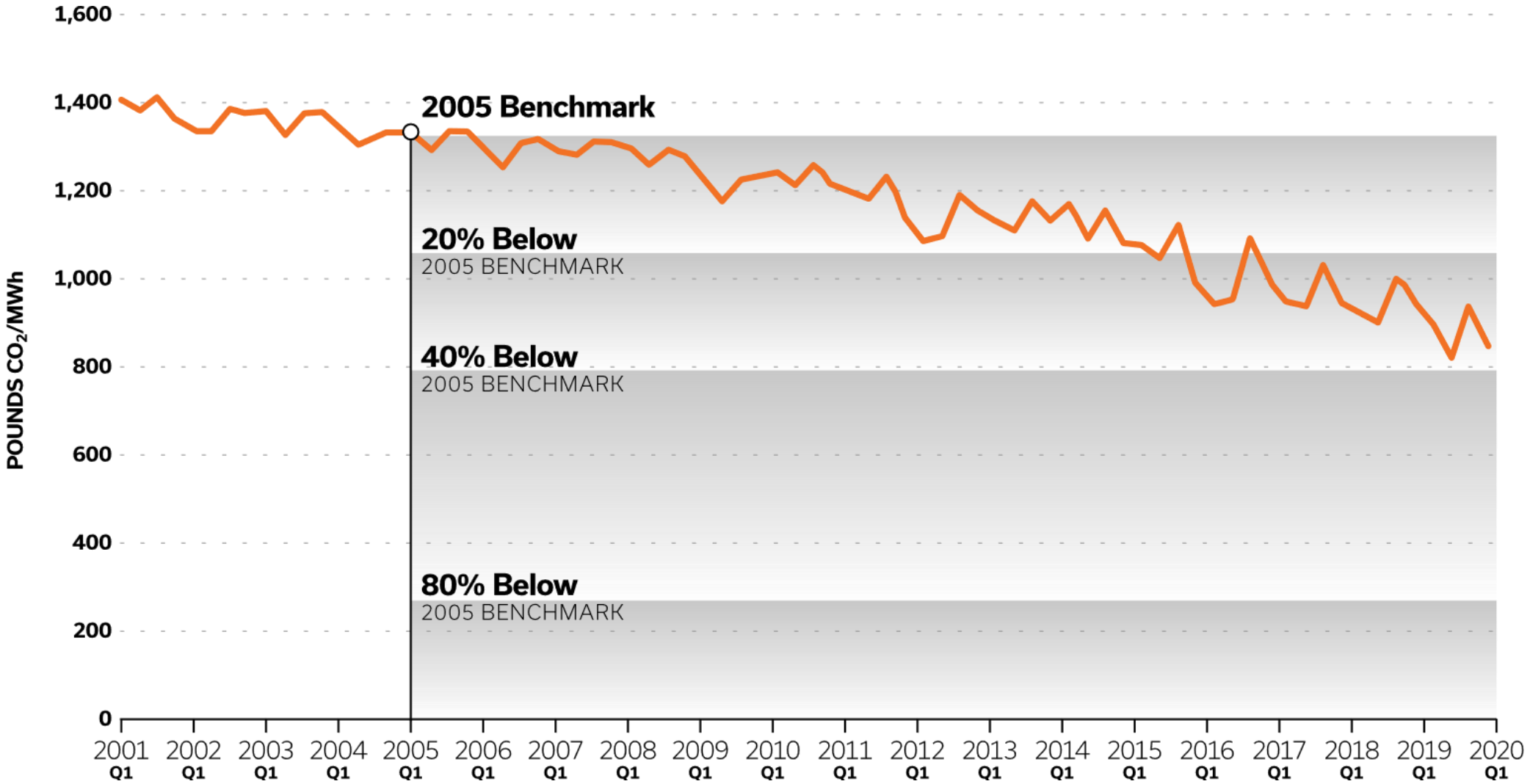
Anticipated Generation

2019-2023



Source: U.S. Energy Information Administration, Form EIA-860, 'Annual Electric Generator Report.' | These data reflect plans as of December 31, 2018
Other Energy Sources include batteries, hydrogen, purchased steam, sulfur, tire-derived fuels and other miscellaneous energy sources.| https://www.eia.gov/electricity/annual/html/epa_04_05.html

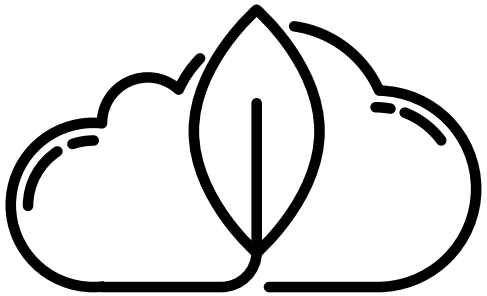
US POWER SECTOR CO_2 EMISSIONS INTENSITY



Source: https://emissionsindex.org/#chart-1-view-1

Decarbonization Plans

California

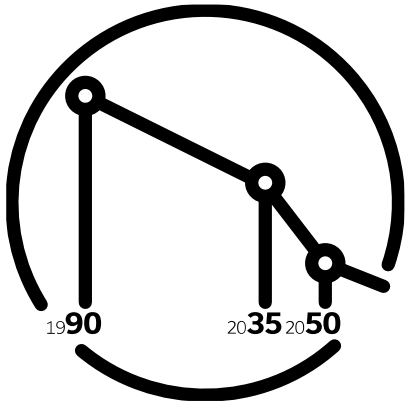


100%

Carbon-Free

ELECTRICITY BY 2045

Oregon

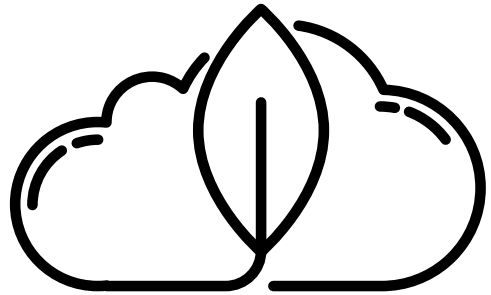


BELOW 1990 EMISSIONS LEVELS

45% → 80%

Carbon Reduction — Carbon Reduction

Washington



100%

Carbon-Free

ELECTRICITY BY 2045

80% Carbon-Free

ELECTRICITY BY 2030

Oregon Passed House Bill 2021:

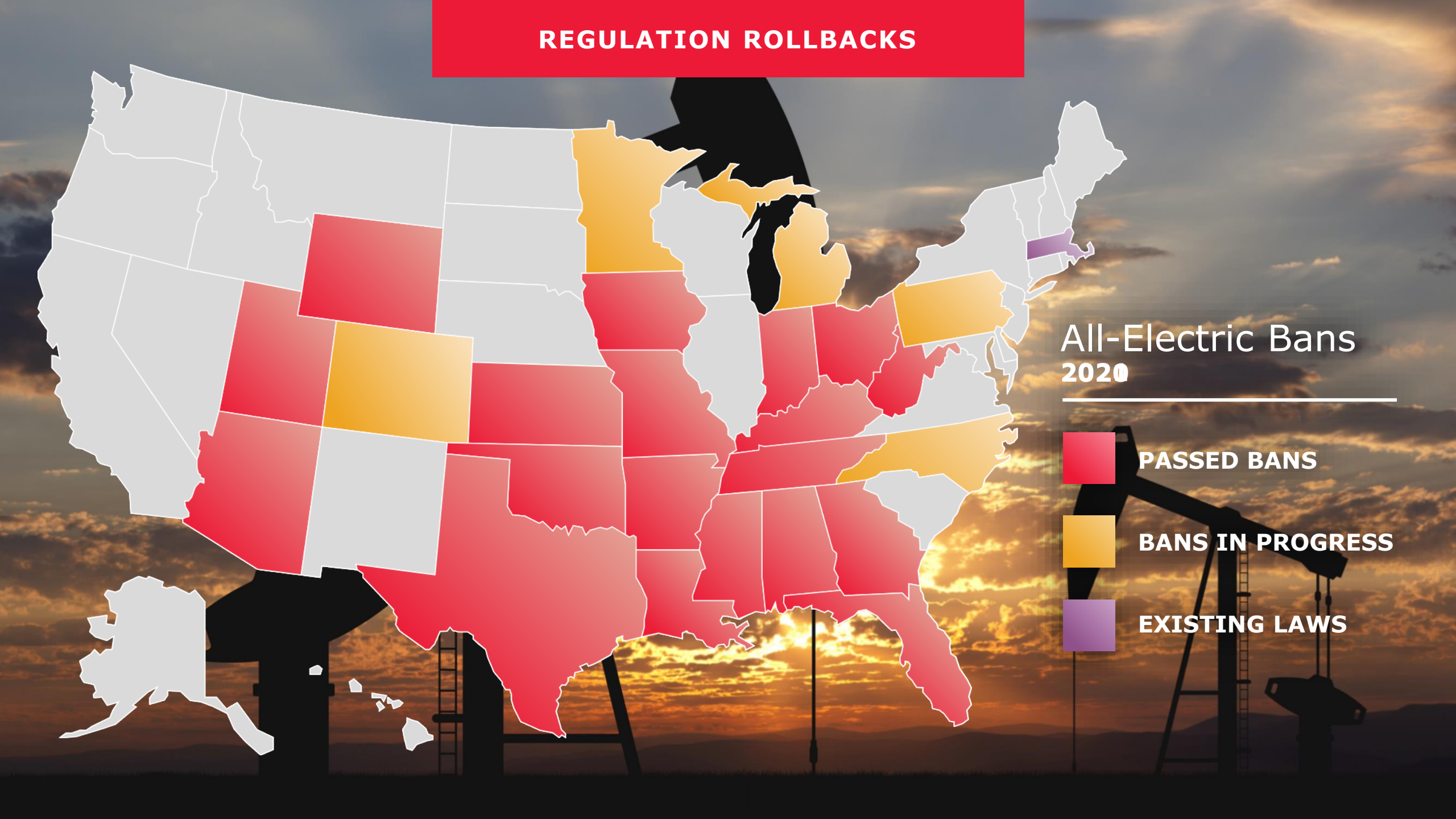
- **Commits to 100% Clean & Renewable Electricity by 2040**
- **Bans the construction or expansion of new natural gas plants in Oregon.**

Additionally:

- Provides $50 million for community-based clean energy projects.
- Invests in the creation of good, family-wage jobs that benefit frontline communities.
- Requires good wages and benefits for workers employed on larger renewable energy projects.
- Requires tribal consultation on clean energy projects that could impact sites of archeological, traditional, cultural, and religious importance.
- Allows cities in Oregon to create so-called "green tariffs," where they agree to pay utilities more money for power from a cleaner mix of sources in order to meet their own climate goals

www.climatesolutions.org
https://www.opb.org/article/2021/06/26/oregon-lawmakers-carbon-emissions-reduction-goals-state-energy-grid/

REGULATION ROLLBACKS




All
Electric
at
Home

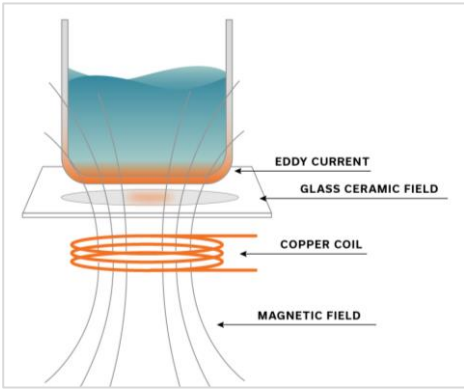
Cooking

Impact on Air Quality

Efficiency comparison

Speed, Precision and Ease of Use

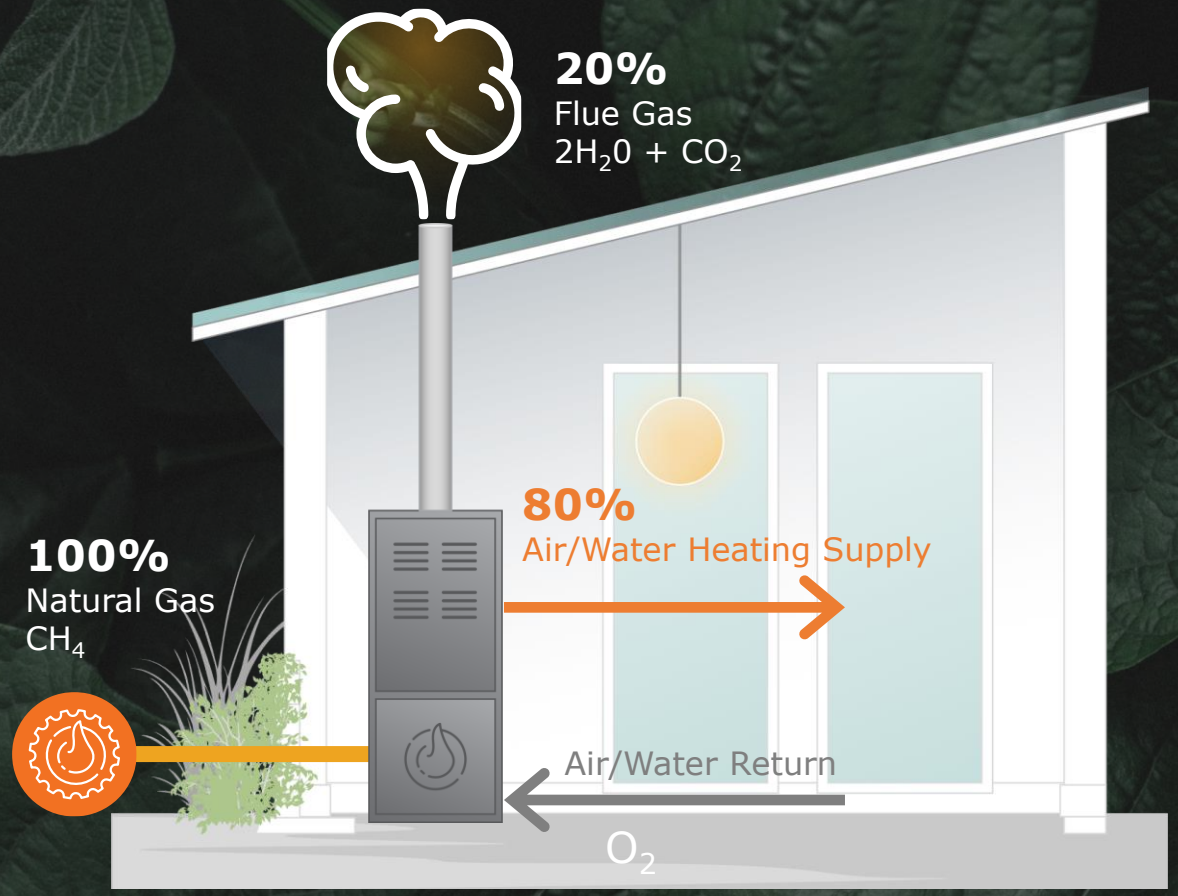
Michelin Star Chefs switching to all electric kitchens

	Gas Cooktop	Electric Conduction Cooktop	Electric Induction Cooktop
			
	Gas emissions from combustion	No gas emissions from combustion	No gas emissions from combustion
	~40% Efficiency	~75% Efficiency	~85% Efficiency
	8 minutes to boil 0.75L water	7 minutes to boil 0.75L	4 minutes to boil 0.75L water

HEATING FUNDAMENTALS

Conventional Gas Heating

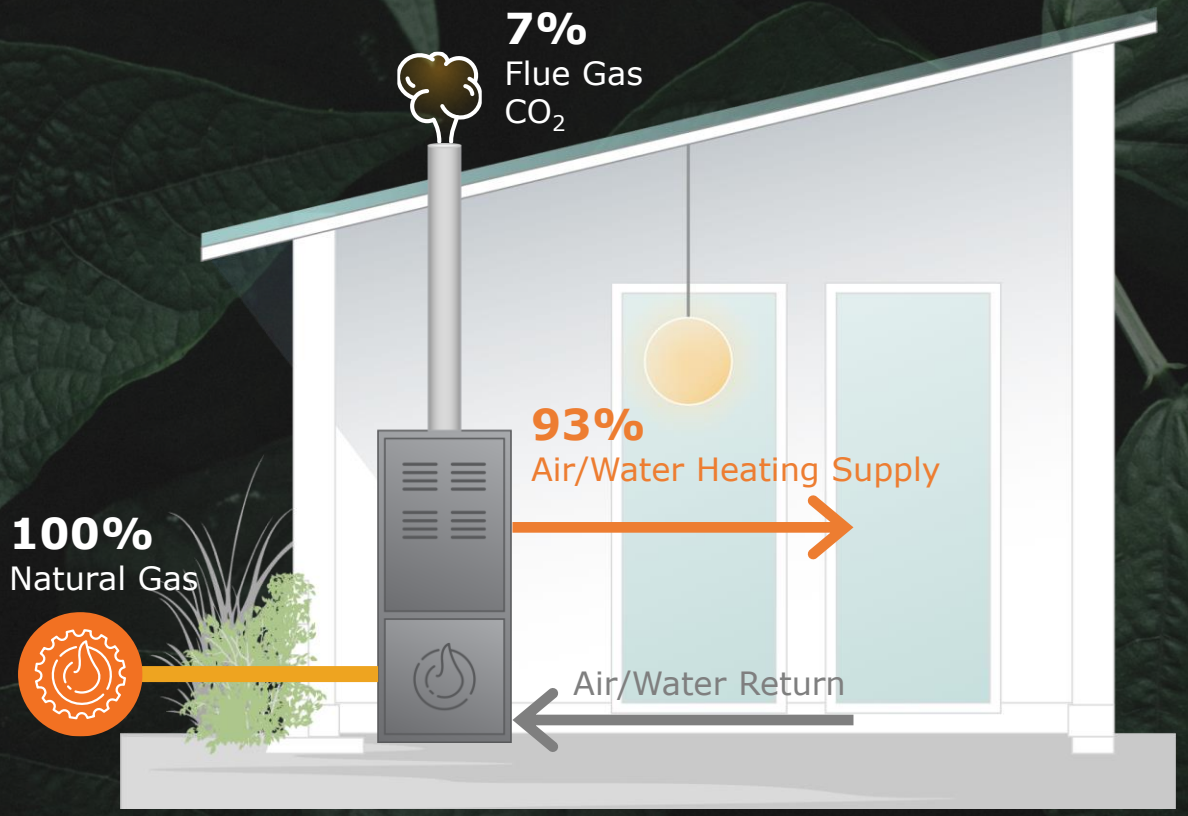
BOILER | FURNACE | WATER HEATER



$CH_4 + O_2 \rightarrow 2H_2O + CO_2$

Condensing Gas Heating

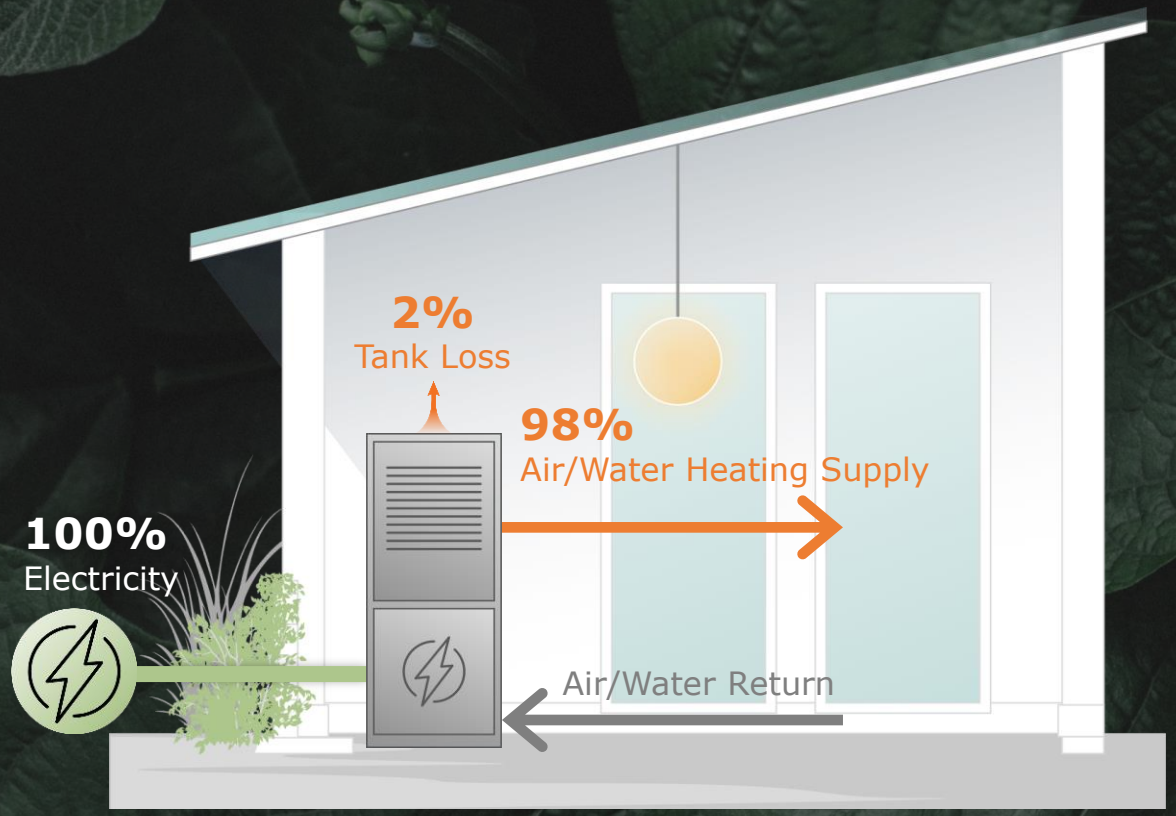
BOILER | FURNACE | WATER HEATER



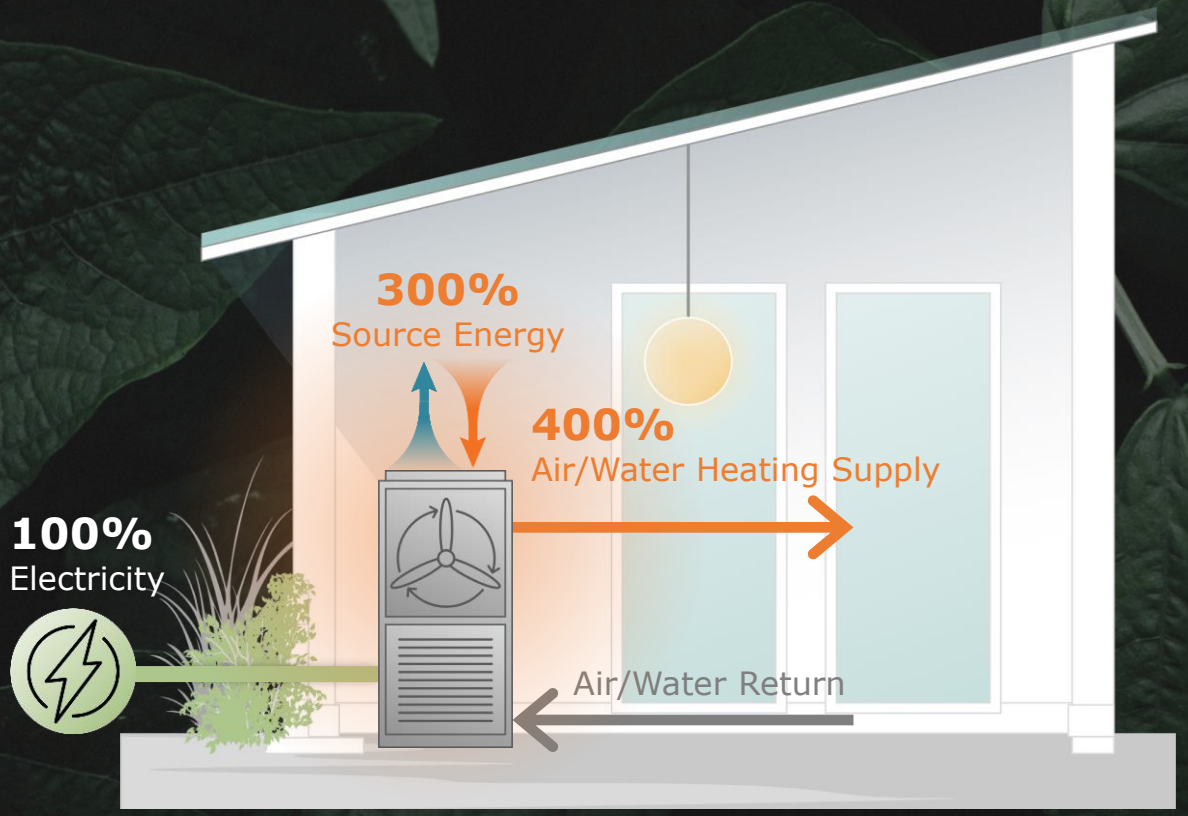
HEATING FUNDAMENTALS

Electric Resistance

BOILER | FURNACE | WATER HEATER

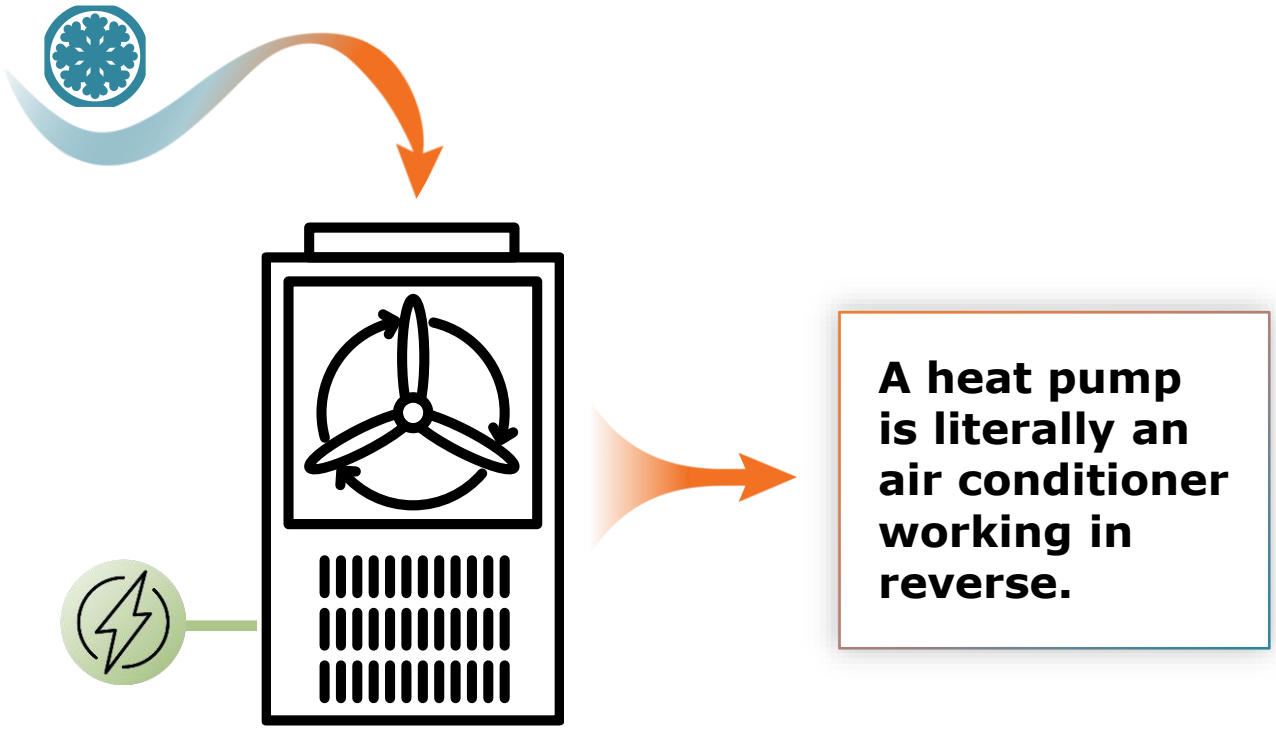


Electric Heat Pump



Heat Pump Fundamentals

Heat pumps transfer heat from a low temperature source to a higher temperature destination



A heat pump is literally an air conditioner working in reverse.

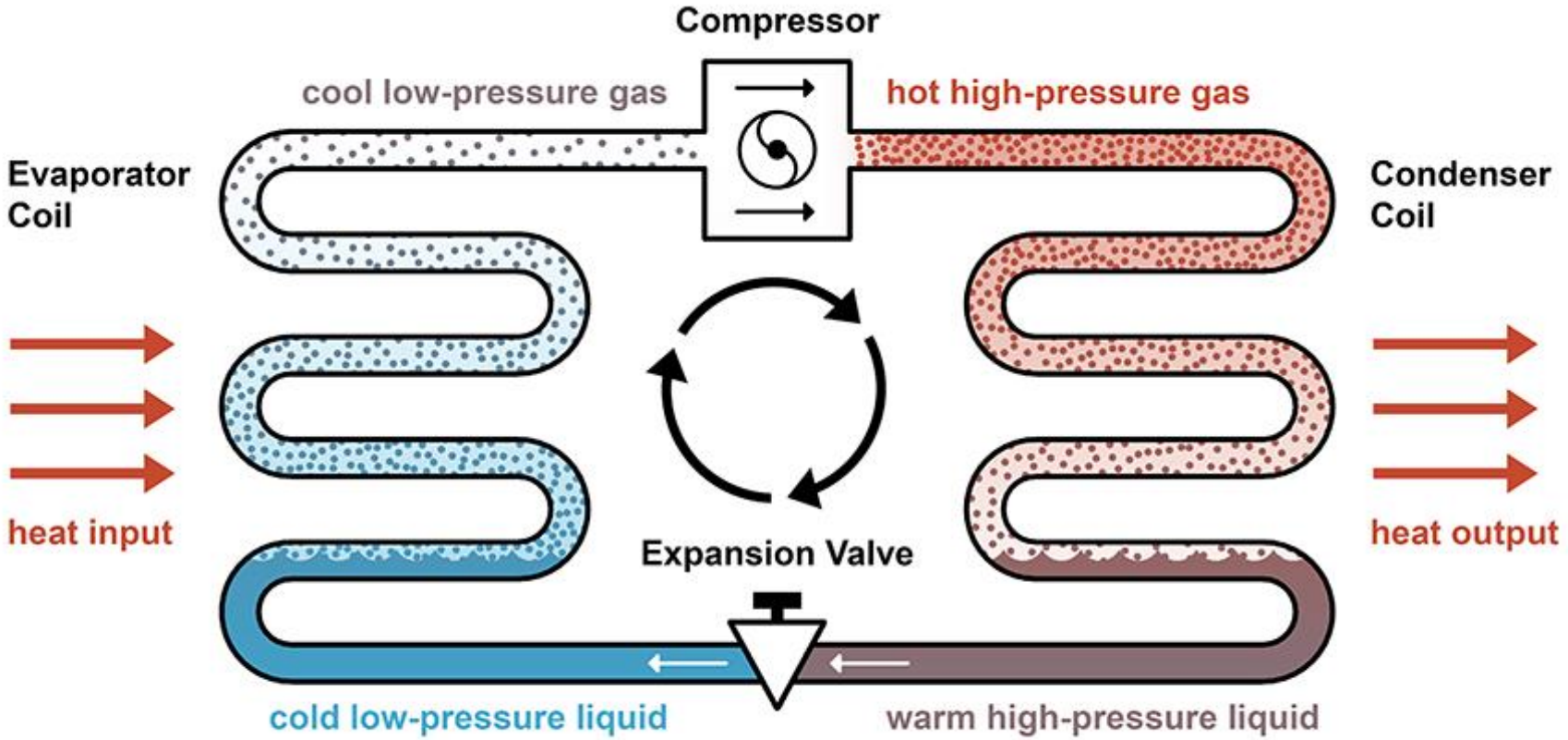
Air Conditioning and Refrigeration

When you are trying to move heat **out of a cooler environment** to a warmer environment, we call it a refrigerator or air conditioner.

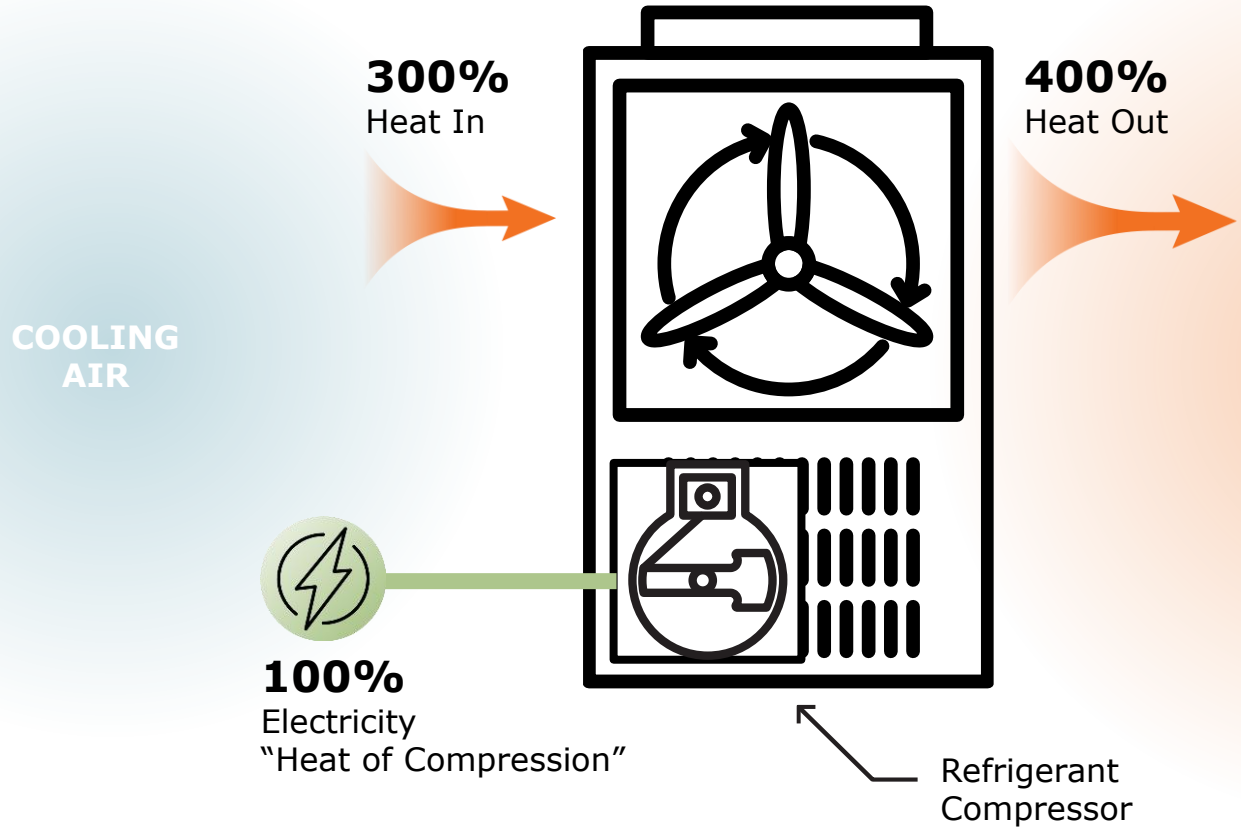
Heat Pump Heating

When you are trying to move heat **into a warmer environment** from a colder environment, we call it a heat pump.

REFRIGERATION CYCLE



HEAT PUMP EFFICIENCY

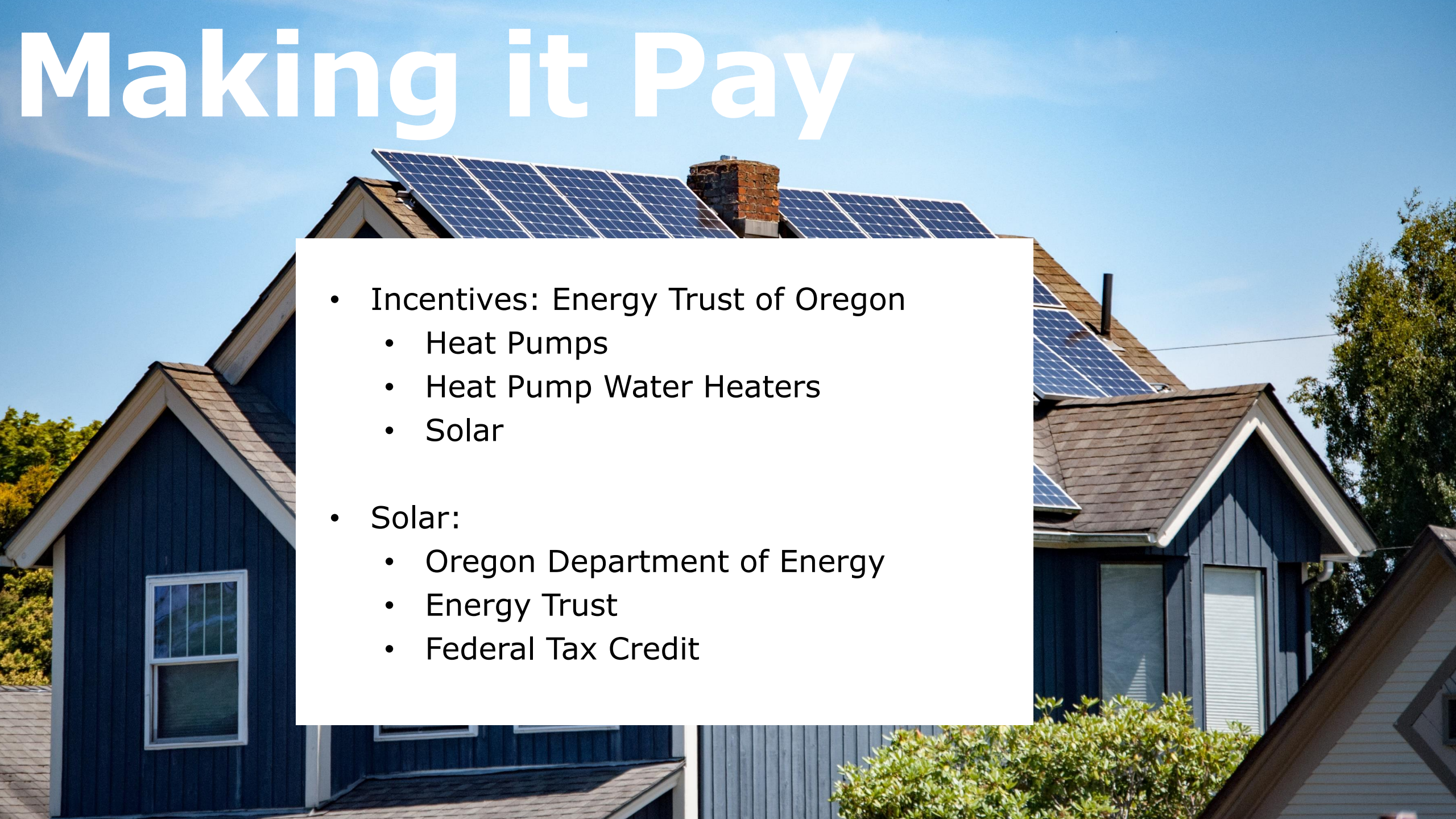


Coefficient of Performance (CoP)

HEATING EFFICIENCY
= 400%/100% = **4**

COOLING EFFICIENCY
= 300%/100% = **3**

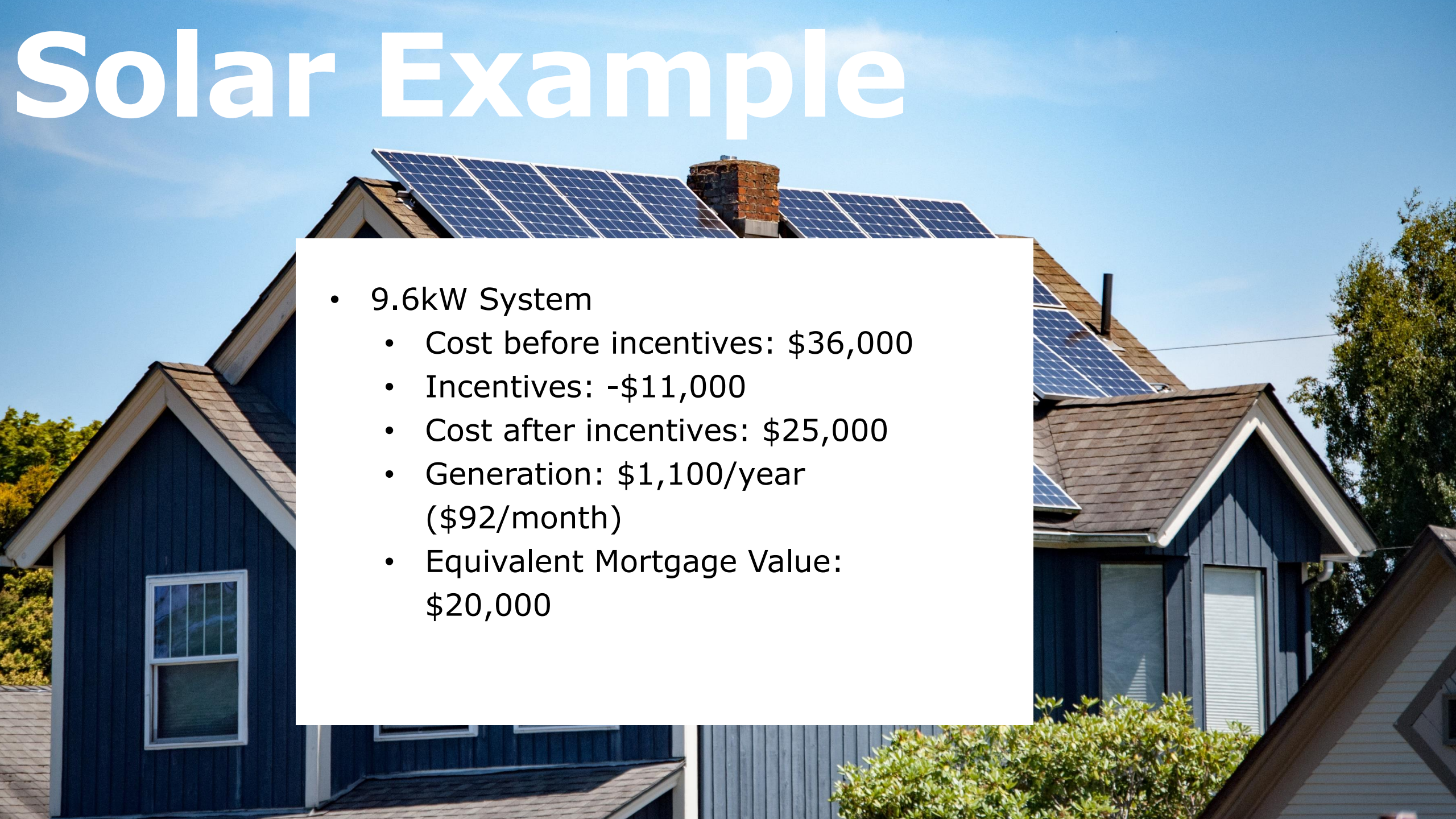
Making it Pay



- Incentives: Energy Trust of Oregon
  - Heat Pumps
  - Heat Pump Water Heaters
  - Solar

- Solar:
  - Oregon Department of Energy
  - Energy Trust
  - Federal Tax Credit

Solar Example



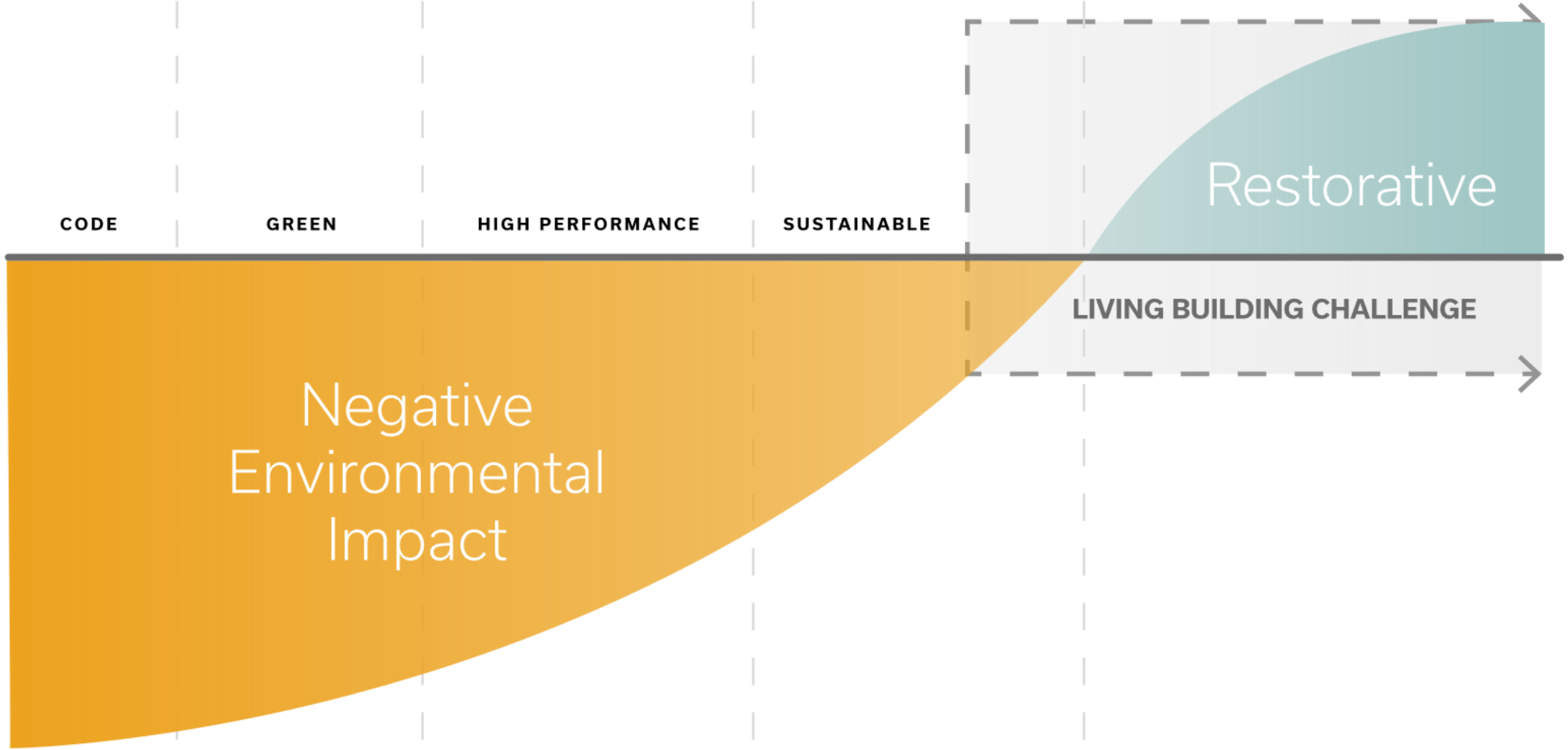
- 9.6kW System
  - Cost before incentives: $36,000
  - Incentives: -$11,000
  - Cost after incentives: $25,000
  - Generation: $1,100/year ($92/month)
  - Equivalent Mortgage Value: $20,000


“There are opportunities even in the most difficult moments.”
— WANGARI MAATHAI
Green Belt Movement Founder | 2004 Noble Laureate

LIVING BUILDING CHALLENGE

A Visionary Path to a Regenerative Future

INTERNATIONAL LIVING FUTURE INSTITUTE℠


CODE
GREEN
HIGH PERFORMANCE
SUSTAINABLE
Restorative
LIVING BUILDING CHALLENGE
Negative
Environmental
Impact

PAE Living Building

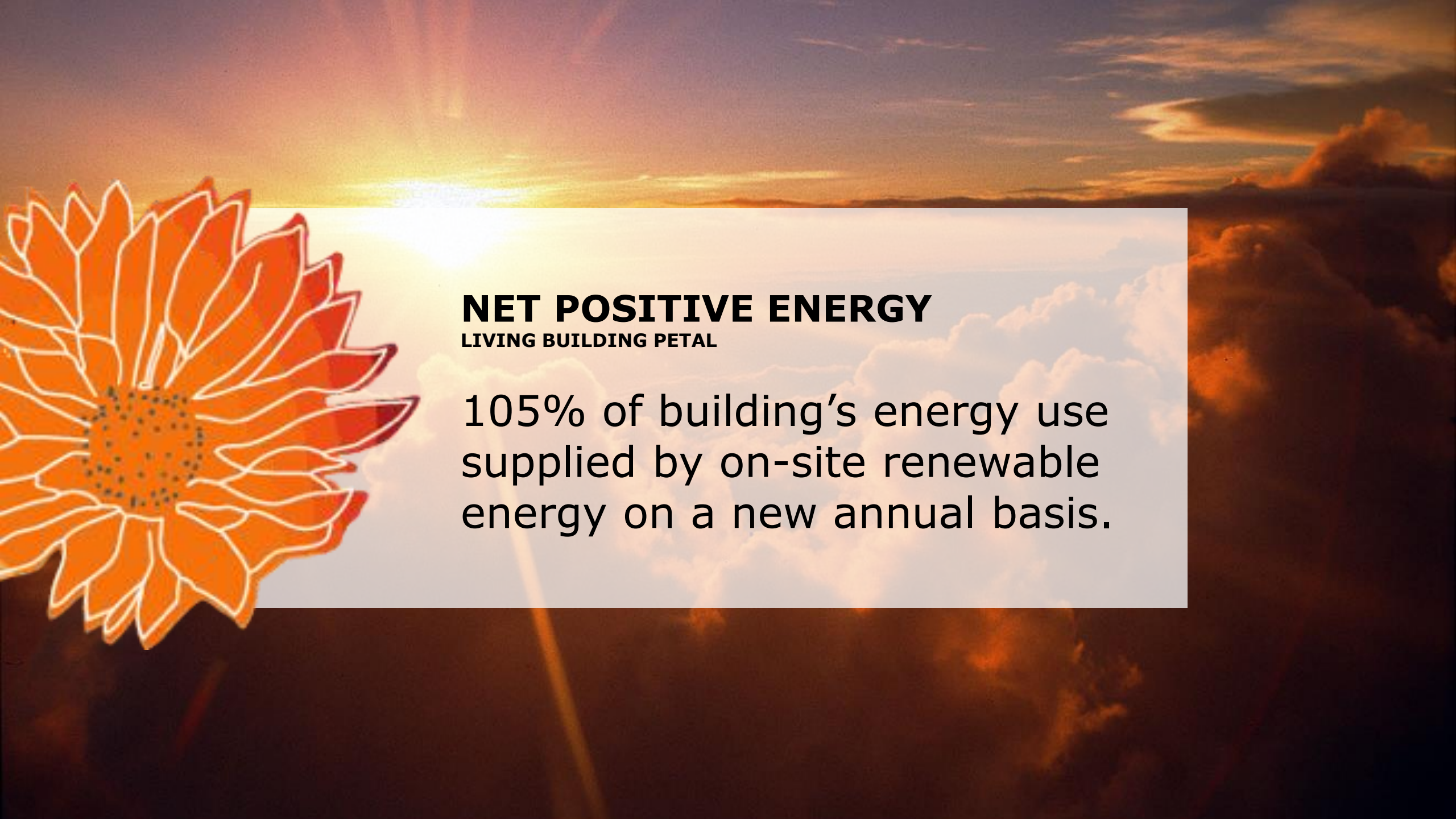
STATISTICS

58,000 sf

Full ILFI 3.1 Certification

500 Year Life

Developer Driven



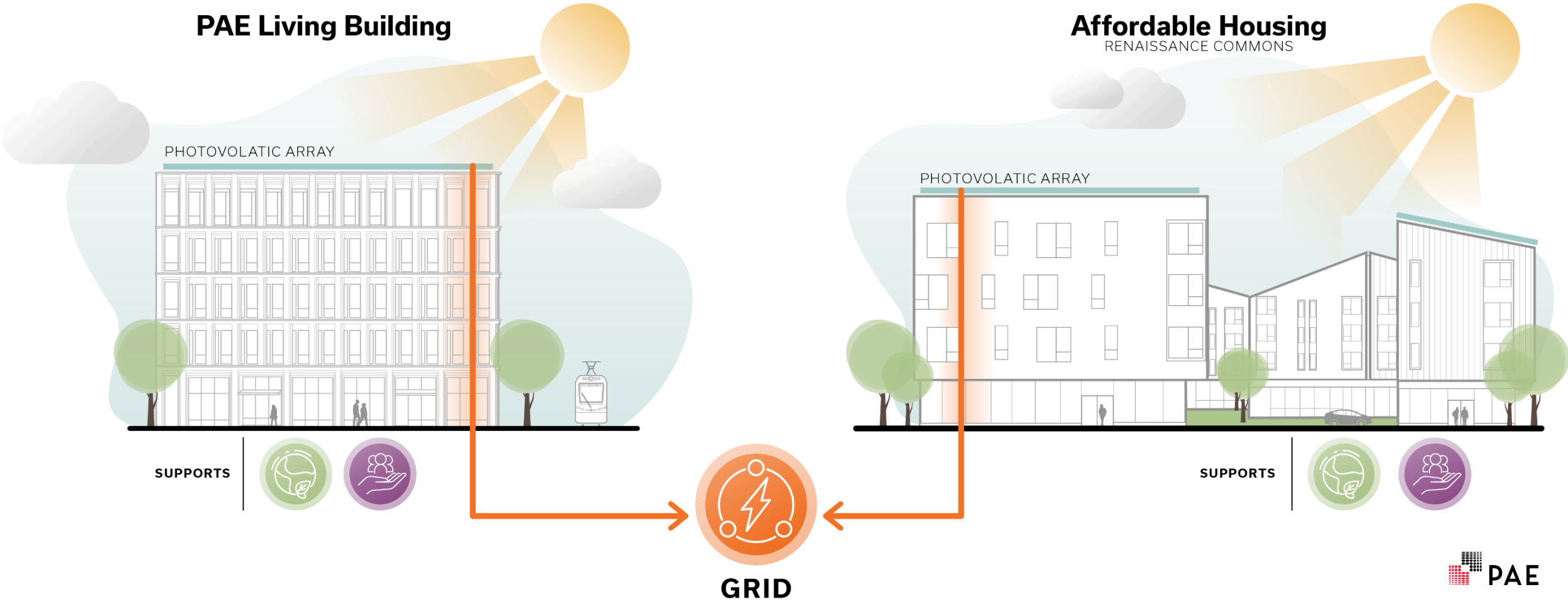
NET POSITIVE ENERGY

LIVING BUILDING PETAL

105% of building’s energy use supplied by on-site renewable energy on a new annual basis.

Sustainable Communities

PAE LIVING BUILDING



PAE

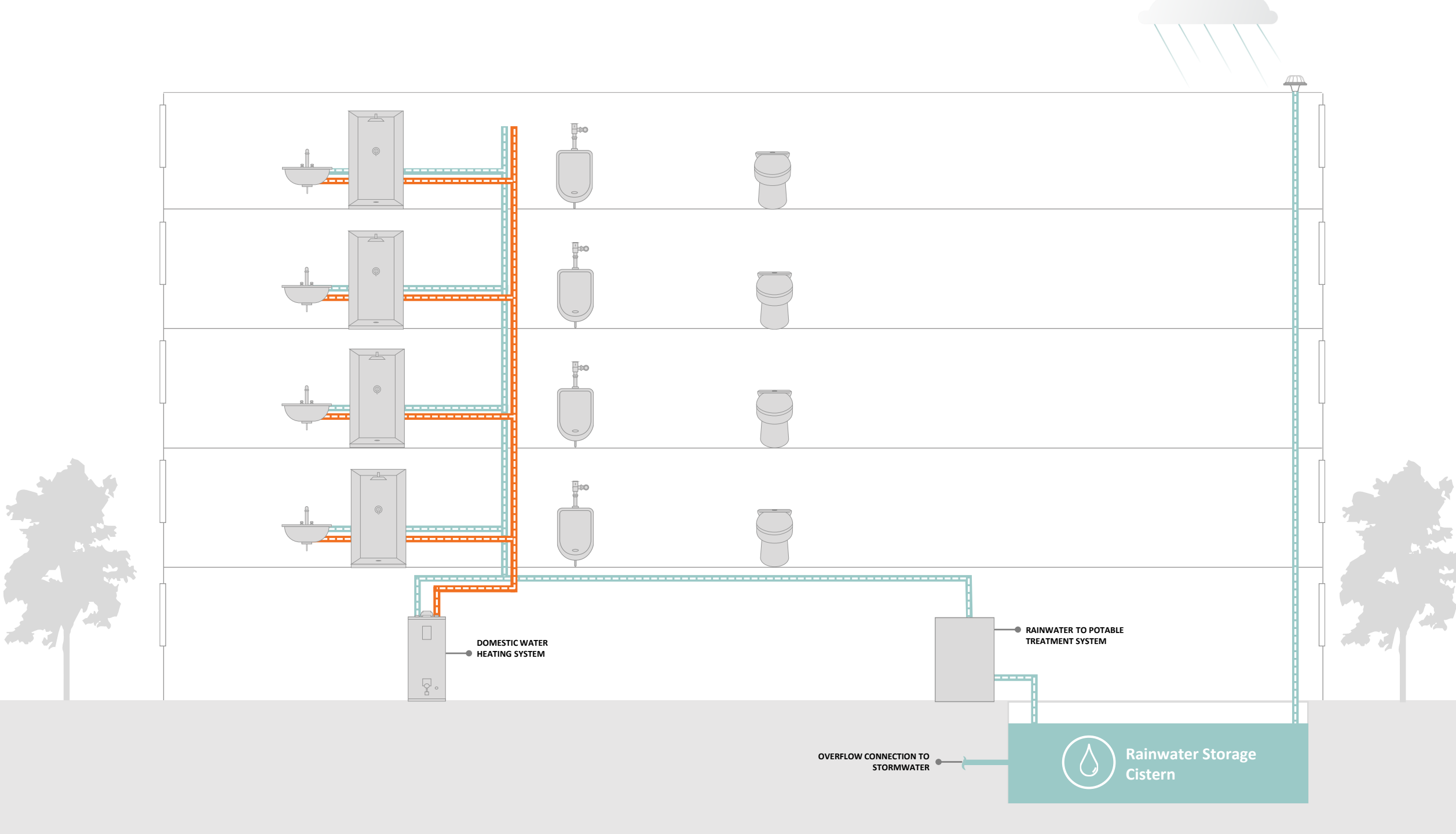
NET POSITIVE WATER

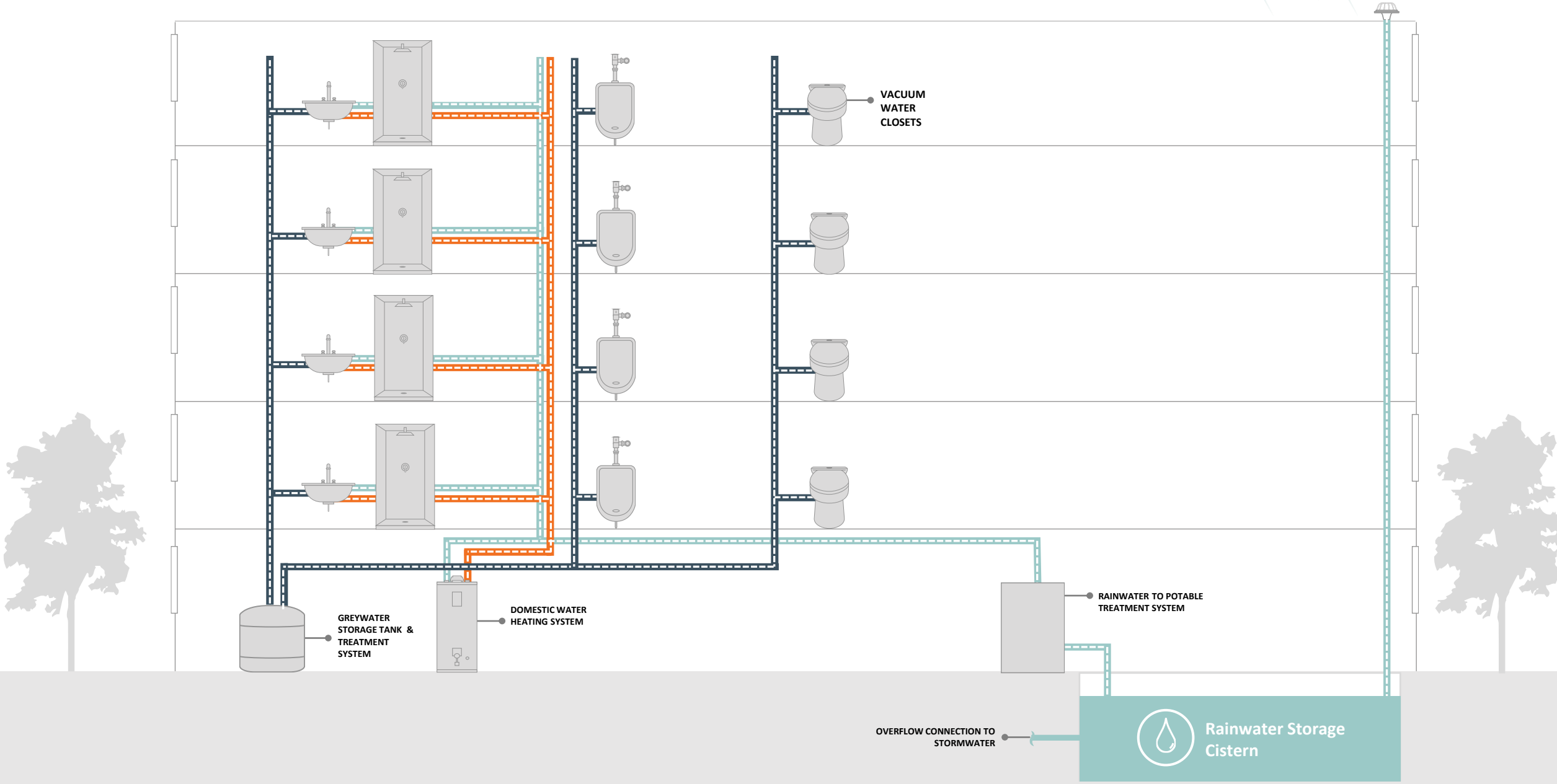
SUSTAINABLE WATER DISCHARGE

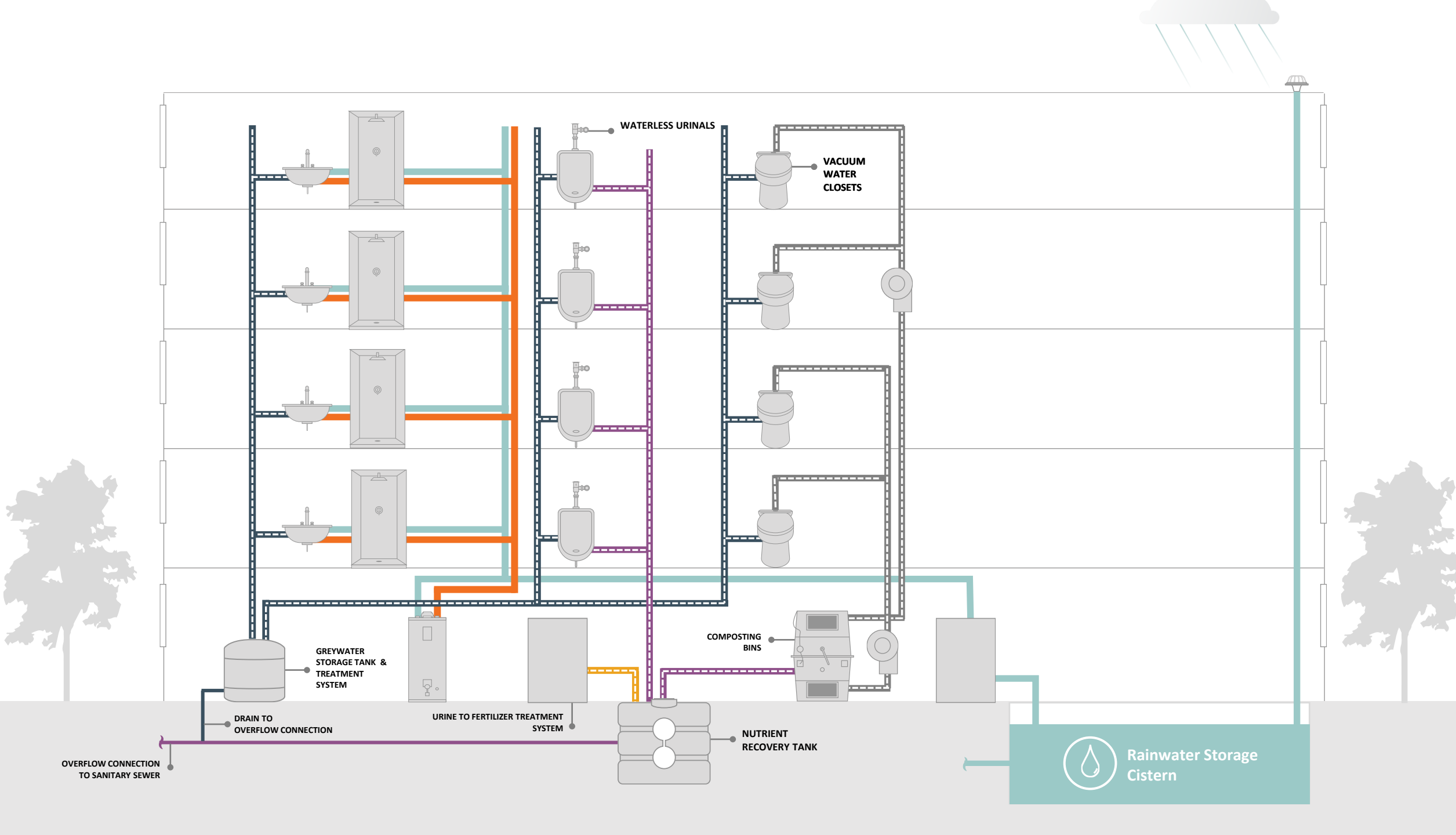
LIVING BUILDING PETAL

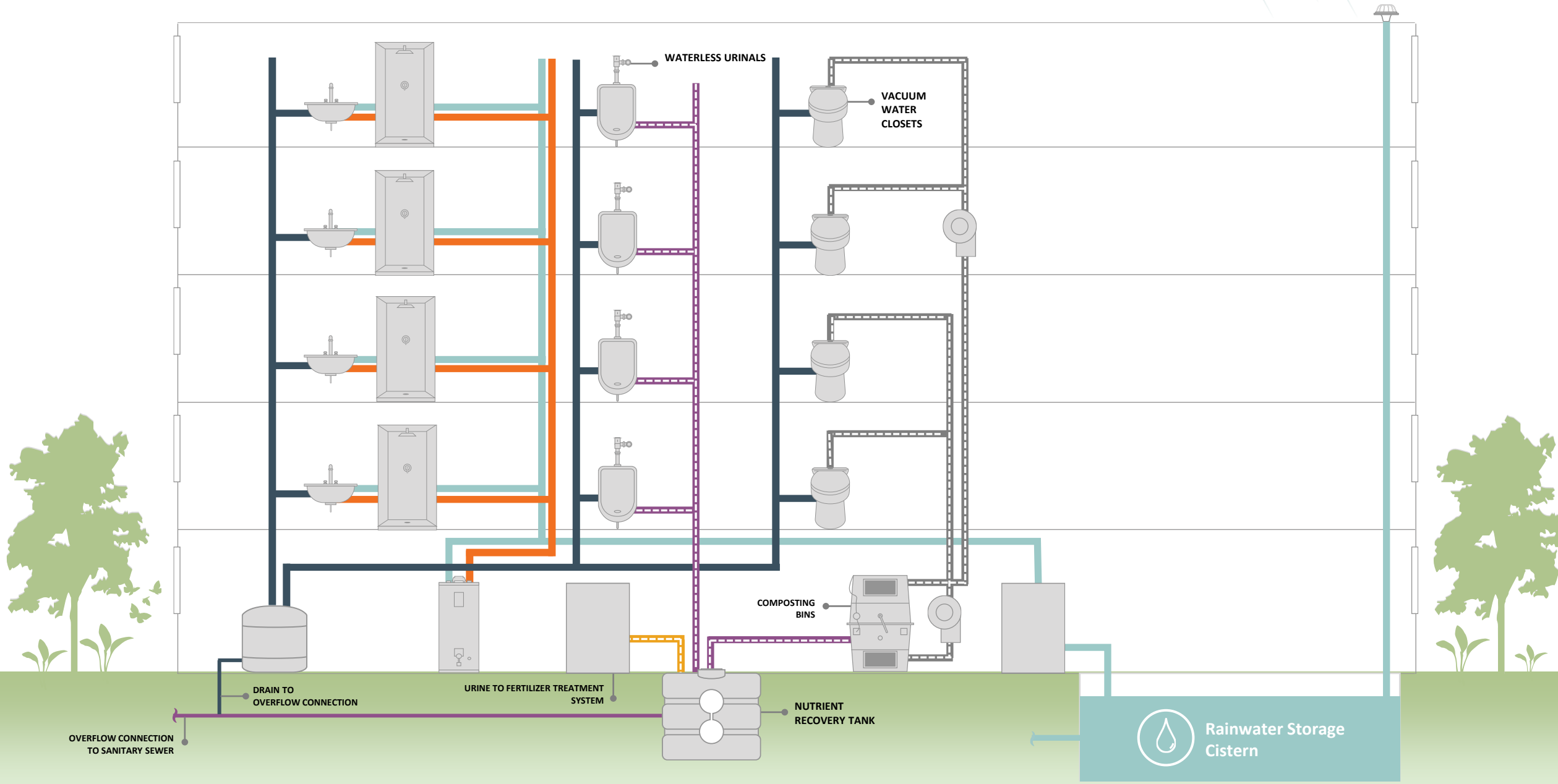
100% of water use from captured precipitation or closed loop water system.


PAE
Net Positive Water


DOMESTIC WATER
HEATING SYSTEM
RAINWATER TO POTABLE
TREATMENT SYSTEM
OVERFLOW CONNECTION TO
STORMWATER
Rainwater Storage
Cistern


VACUUM
WATER
CLOSETS
GREYWATER
STORAGE TANK &
TREATMENT
SYSTEM
DOMESTIC WATER
HEATING SYSTEM
RAINWATER TO POTABLE
TREATMENT SYSTEM
OVERFLOW CONNECTION TO
STORMWATER
Rainwater Storage
Cistern


WATERLESS URINALS
VACUUM WATER CLOSETS
GREYWATER STORAGE TANK & TREATMENT SYSTEM
COMPOSTING BINS
DRAIN TO OVERFLOW CONNECTION
URINE TO FERTILIZER TREATMENT SYSTEM
NUTRIENT RECOVERY TANK
OVERFLOW CONNECTION TO SANITARY SEWER
Rainwater Storage Cistern


WATERLESS URINALS
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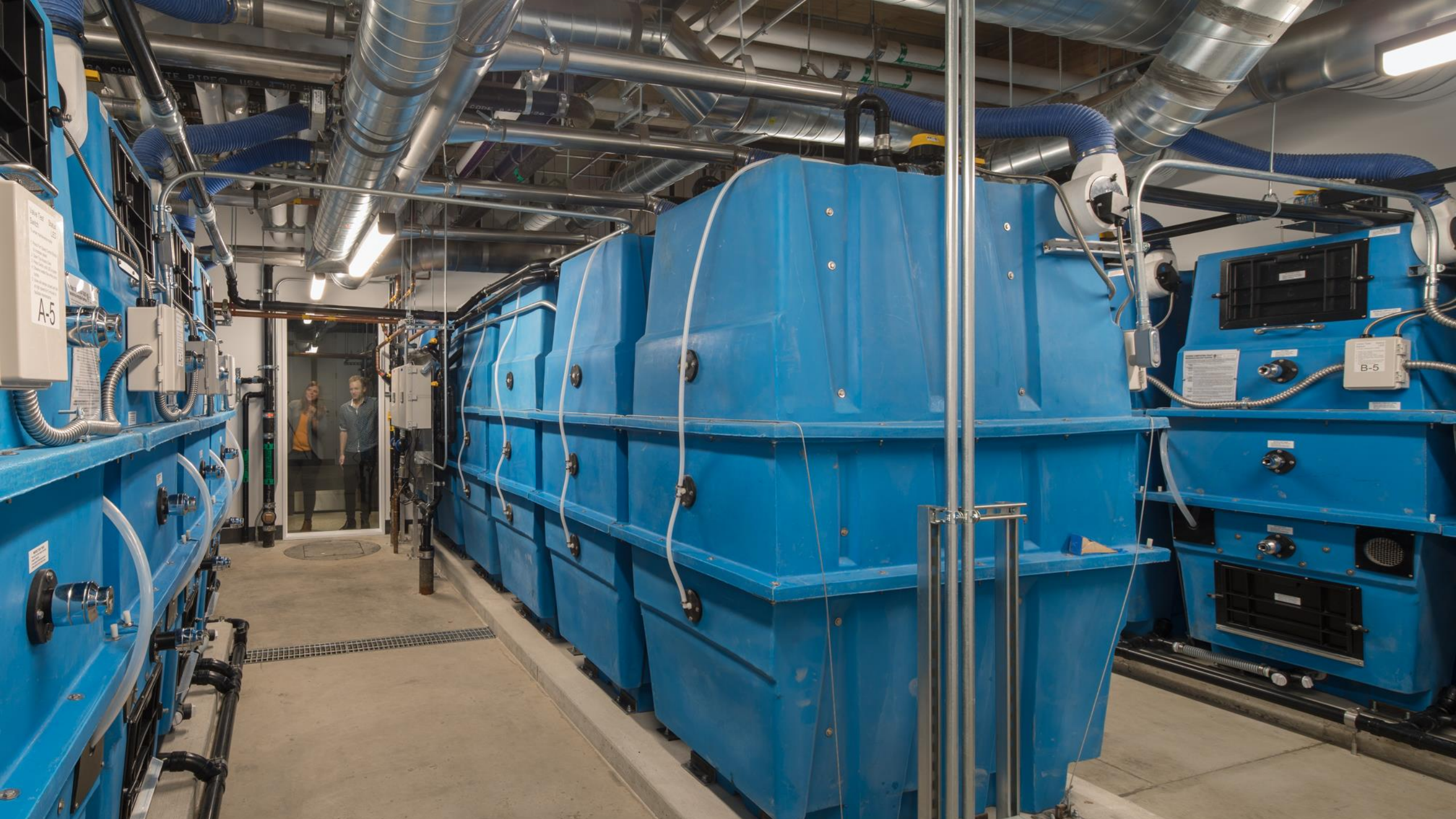
NUTRIENT RECOVERY TANK
OVERFLOW CONNECTION TO SANITARY SEWER
Rainwater Storage Cistern


DOMESTIC HOT WATER
DOMESTIC COLD WATER
DOMESTIC COLD WATER
DOMESTIC HOT WATER


A-5
B-5


LG
HYDRO KIT
LG
HYDRO KIT
LG
HYDRO KIT

Marc P Brune **PE, LEED AP**
PRINCIPAL, MECHANICAL ENGINEER
marc.brune@pae-engineers.com

503–226–2921

522 SW 5th Ave, Suite 1500
Portland, OR 97204