Seattle Office of Sustainability & Environment

INTEGRATED DESIGN LAB
UNIVERSITY of WASHINGTON // W

Seattle Midsize Office Building

An energy efficiency and electrification path to carbon neutral

About

Size & Vintage: Approx. 55,000 sf office building, built between 1946 and1979.

Projected Total Energy Savings: Nearly 60%, reducing the building's EUI[1] to 31 kBtu/sf/yr.

Projected Total Emissions Reduction: 80 MT/CO2e annually.

Projected Utility Cost Savings[2]: $43,500 annually.

Estimated Total Plan Costs: $975,000 ($17.70/sf).

Consultants: University of Washington Integrated Design Lab and Solarc Energy Group.

Midsize post-war office buildings, ranging from 20,000 to 100,000 square feet (sf) and built between 1946 and 1979, are fairly common in Seattle, making them an ideal pilot for exploring energy efficiency and electrification measures to achieve net-zero emissions. The actual building modeled for this pilot is one of about 75 buildings in Seattle of this vintage and size range. Median site energy use intensity for offices like these is about 55 kBtu/sf/yr.

> ***At the IDL, we're excited to help building owners plan energy efficient electrification retrofits for their existing buildings. These often iconic Seattle buildings have great potential for renewal, both to meet Seattle's climate goals and to make them healthier indoor environments, creating better-quality buildings for owners and occupants alike.***
>
> **Chris Meek, Director of UW Integrated Design Lab**

Why "electrify" an existing building?

Buildings are one of the largest and fastest growing sources of Seattle's climate pollution — contributing more than one-third of the city's core greenhouse gas emissions. More than 90 percent of Seattle's building-related emissions comes from burning fossil fuels like gas and oil for hot water, space heating, and appliances.[3] Since most existing buildings will still be here in 2050, electrifying them, along with all-electric new construction, is needed to address climate change.

With most water and heating equipment having a lifespan of 20 to 25 years, going electric now when replacing equipment that's near or at the "end of life" is a smart way to futureproof existing buildings. Doing so aligns building assets with where the market is headed, gets in front of rising construction costs, and reduces risk in the face of potential future regulations on carbon emissions. Already, the 2018 Seattle Energy Code limits gas use for space and hot water in most new commercial construction, substantial alterations, and equipment replacements.[4]

1 EUI = Energy Use Intensity, which is a measure of a building's total annual energy, in kBtus, per square foot of space.

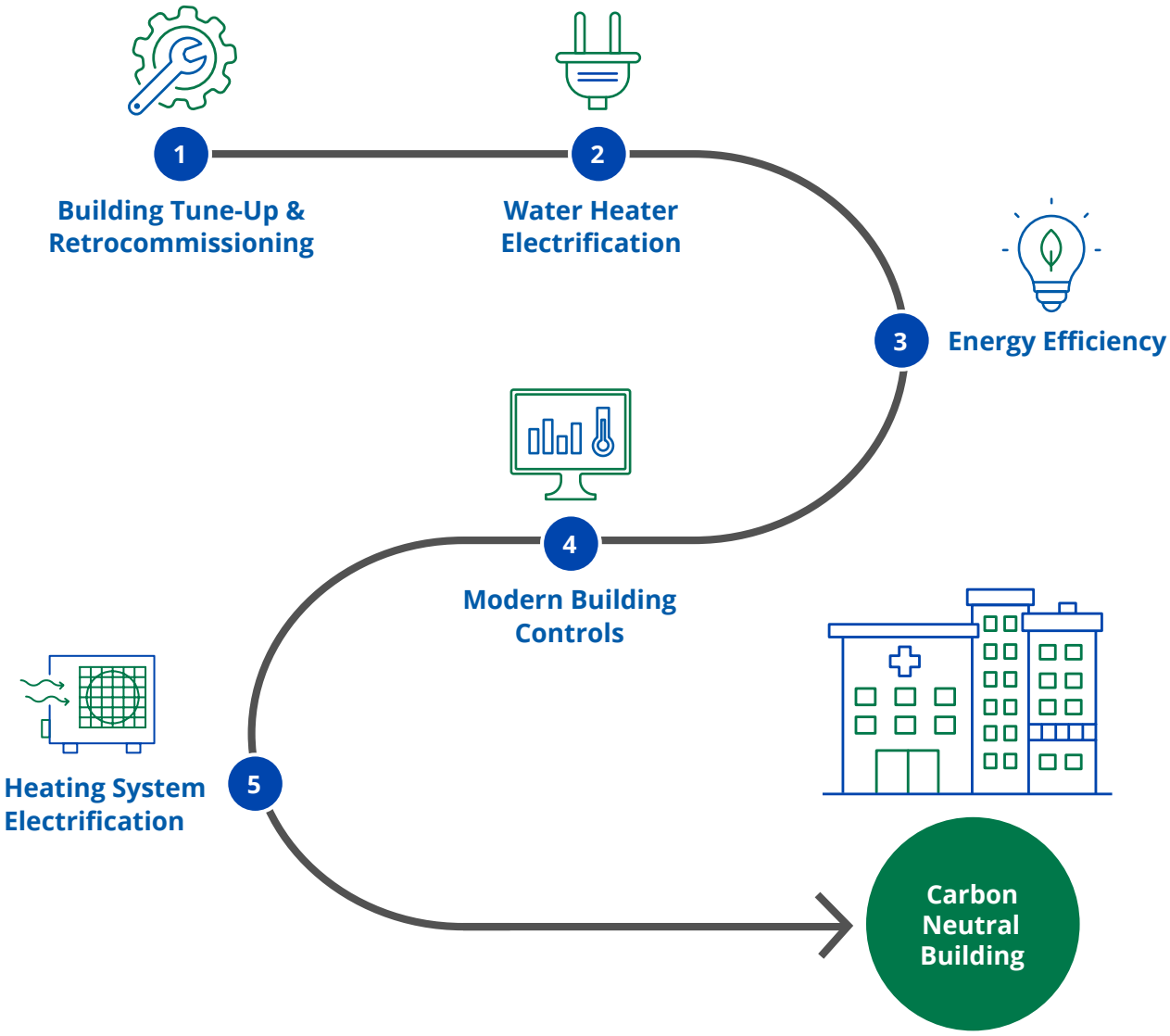
2 Utility prices based on 2021 rates of $0.91/therm and $0.11/kWh. Due to the regulatory uncertainty around carbon emissions (Washington State and/or Federal Carbon Taxation), gas costs may be subject to future increases at significantly higher rates than equivalent electricity from low-carbon sources.

3 https://www.seattle.gov/Documents/Departments/OSE/ClimateDocs/2018_GHG_Inventory_Dec2020.pdf

4 2018 Seattle Energy Code: https://www.seattle.gov/sdci/codes/changes-to-code/2018-seattle-code-adoption/project-documents. For guidance on substantial alterations, review the SCDI tip sheet: https://www.seattle.gov/DPD/Publications/CAM/cam314.pdf

Steps to carbon neutral for a midsize office building:

Existing buildings can and must be part of a solution to climate change. In this case, the UW Integrated Design Lab and Solarc Energy Group conducted modeling on a typical midsize office building, and identified a five-step path to **reduce energy use by nearly 60 percent and emissions by 92 percent** to achieve an all-electric, carbon neutral building.[5] An optional solar parking canopy for net zero-energy is also included.



Solar Energy (Bonus Step)

Adding a 23,000 sf parking canopy of solar photovoltaic panels (430kW system) enables the building to achieve net-zero energy use, which means that **all the energy to power the building could be generated on site.** The parking canopy also provides shade and rain protection for tenants.

Estimated cost: $3,000/kW (installed capacity)

5 In 2019, Seattle City Light emissions factors were 41.57 lbs. Co2/MWh and City Light offsets these emissions to achieve carbon-neutral status as an electric utility. Building owners should, however, participate in the utility's Green Up Program to call their building net-zero at the site. Visit https://www.seattle.gov/city-light/business-solutions/renewable-energy-services

1 Building Tune-Up & Retrocommissioning

Optimizing existing equipment to work as well as it can reduces energy use 12 percent and emissions 6 percent. This involves adjusting set-points and schedules and reducing heating, ventilation, and cooling (HVAC) system leaks, which supports meeting Seattle's Building Tune-Ups requirement.

Estimated cost: $0.45/sf

2 Water Heater Electrification

Replacing the original, 50+-year-old gas domestic hot water (DHW) heater with two SANDEN CO2 electric heat-pump water heaters is estimated to reduce gas use 8 percent and emissions 6.5 percent. Since DHW equipment has few dependencies on other efficiency measures, it can be upgraded before the energy efficiency step, avoiding an emergency replacement and realizing emissions reductions early on.

Estimated cost: $0.50/sf

This stepped approach can help building owners meet nearer term energy efficiency requirements like Seattle Building Tune-Ups and the Washington Clean Buildings Act, while also planning for future electrification actions that reduce climate emissions.

Nicole Ballinger, Buildings and Energy Strategic Advisor at Seattle Office of Sustainability & Environment

3 Energy Efficiency

Lighting and plug load measures are projected to lower total energy use by 23 percent, while improving comfort and aesthetics, helping right-size future electric equipment, and meeting the Washington State Clean Buildings Act EUI targets.

Washington State Clean Buildings
The State EUI target for existing commercial offices over 50,000 sf is 60 to 66 kBtu/sf/yr depending on use. **Learn more »**

3a **Updating the lighting to LED** with Luminaire Level Lighting Controls on the interior modernizes the office and enables tenants to control the lighting. Upgrading exterior lighting to LED brightens the parking lots. These combined updates reduce electric use 18 percent.

Estimated cost: $4.50/sf (interior) and $0.25/sf (exterior)

3b **Reducing plug load energy** by upgrading office equipment to ENERGY STAR™ products and installing smart plug strips that turn off non-essential equipment lowers electric use 5 percent.

Estimated cost: $0.30/sf (smart plug strips only)

4 Modern Building Controls

Upgrading the original pneumatic controls to direct digital controls (DDC) is critical to optimizing the heating system electrification and avoiding wasted energy. Energy use savings are projected at 4 percent, but larger savings may accrue through the ability to monitor use over time.

Estimated cost: $5.00/sf

5 Heating System Electrification

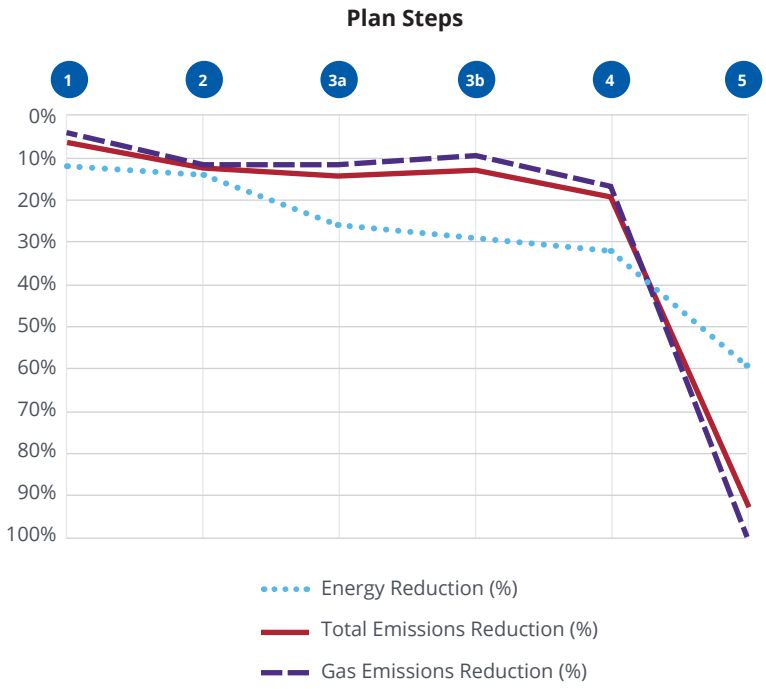
Replacing the 50+-year-old, gas-fired boiler with an air-to-water electric heat pump supports a carbon-neutral building with a total emissions reduction of 72.0 MT/CO2e tons annually and energy savings of 27 percent. Earlier energy efficiency steps reduce peak energy load, which helps avoid a costly electric service upgrade, although some internal electrical modifications still will be needed.

Estimated cost above a typical gas system replacement: $6.50/sf

Note: Cost estimates were derived from RSMeans (a construction cost database) or were provided by Solarc Energy Group, based on comparable projects.

Projected Energy and Emissions Savings by Step

This graph shows how the building's energy use (dotted line) decreases gradually at first, followed by big energy savings from the ultra-efficient electric heat pumps in step 5. For emissions (solid and dashed), the tune-up and water heater electrification offer small early reductions. While step 3 reduces energy use to prepare for right-sizing future electric equipment, emissions rise slightly in the short term. This is because the LEDs and ENERGY STAR equipment emit less waste heat that warms the space, so the gas heat may run more on cold days. The final heating system electrification, however, dramatically lowers energy use *and* achieves carbon neutral emissions. And, with earlier energy use reductions, this step can likely be done without a major electrical service upgrade.



Plan Steps		EUI (kBtu/sf/yr) Baseline=75	Projected Energy and Emissions Savings by Step (%)[6]			
			Electric	Gas	Total Energy	Total Emissions[7]
1 Building Tune-Up		65.5	17%	4%	12%	6%
2 Water Heater Electrification		64	-1%	8%	2%	6.5%
3 Energy Efficiency	a: Lighting	55	18%	-1%	12%	2%
	b: Plug Loads	53.5	5%	-2%	2%	-1.5%
4 Modern Building Controls		51	2%	8%	4%	7%
5 Heating System Electrification		31	-5%	83%	27%	72%
OVERALL PLAN SAVINGS			**36%**	**100%**	**59%**	**92%**

6 Negative numbers indicate an increase in either energy use or emissions, which is an expected result as the building's energy efficiency is improved along with changes in equipment fuel source.

7 Emissions factors: Gas - 5311 gCO2e per therm. https://portfoliomanager.energystar.gov/pdf/reference/Emissions.pdf
SCL Electric (2018) - 4.26 gCO2e per kWh. https://www.theclimateregistry.org/our-members/cris-public-reports.

Get started today.

Electrifying buildings is one of the most powerful levers for reducing climate emissions. Get started on your own path by talking with your facility staff and independent service providers to explore energy efficiency and electrification options well before you need to replace equipment. Contact **cleanbuildings@seattle.gov** for more information.