Port of Seattle
P.O. Box 1209
Seattle, WA 98111-1209
Tel: 787-3000

www.portseattle.org

SUSTAINABLE DESIGN APPROACH & SUSTAINABLE DESIGN STRATEGY
WORLD TRADE CENTER WEST HVAC REPLACEMENT

PURPOSE

This serves as a summary document for the sustainable design coordination for the World Trade Center West's (WTCW) Heating, Ventilation, and Air Conditioning (HVAC) Replacement project. Additional information can be found in meeting minutes, commission documents, and the University Mechanical Contractors December 2018 *Investment Grade Audit & Energy Services Proposal* and mechanical system design documents developed by the firm Ecotope.

SUSTAINABLE DESIGN APPROACH

The WTCW HVAC Replacement project was identified as a pilot project for the Sustainable Evaluation Framework. Staff hired consultants to provide alternatives to replace end-of-life HVAC equipment. An internal interdisciplinary team was formed to evaluate alternatives to balance costs occupant comfort, overall system and building energy efficiency, and advance the Century Agenda greenhouse gas (GHG) goals. Meetings were held in late 2018 and 2019 to complete energy audits, conduct building assessments, and identify potential components to form the basis of the HVAC system replacement alternatives. Port of Seattle (Port) project staff met in January and February of 2020 to evaluate consultant audit findings and recommendations, prioritize goals, and identify and compare alternatives based on the project's sustainability criteria.

FRAMEWORK CRITERIA

Coordination on this project and development of alternatives occurred prior to adoption of the Sustainable Evaluation Framework and identification of the Framework Criteria. Goals identified during project development align with the adopted Framework Criteria in the following manner:

- **Reduce GHG Emissions/ Protect Health and the Environment.** Staff created alternatives to replace the end-of-life equipment while also maximizing overall system, building, and energy efficiency, to reduce maintenance and operating costs, and to reduce GHG emissions. Tenant health, comfort and disruptions during construction also were considered.

PROJECT GOALS

The Port's interdisciplinary team met in January 2020 to solidify project goals.

- **Cost Effectiveness**
  - Balance project costs against environmental benefits
  - Incorporate cost-benefit analyses for all alternatives, including life cycle cost, incremental net present value, and carbon cost alongside capital cost

    - Consider project delivery efficiencies, including identification of additional work that could be completed as part of planned primary HVAC replacement efforts
    - Leverage energy efficiency measures to reduce utility costs for the Port and building tenants and maximize utility rebates and incentives to drive down project costs.
- **Greenhouse Gas Emission Reduction**
    - Eliminate use of fossil natural gas for heating to reduce greenhouse gas emissions
    - Advance efforts to achieve Century Agenda goals
- **Energy Efficiency**
    - Reduce building energy use intensity from pre-project 2017 baseline
    - Maximize overall energy savings
- **Impacts to Tenants**
    - Incorporate HVAC technologies that offer occupant comfort improvements
    - Minimize disruption to tenants during the construction process

SUSTAINABLE DESIGN STRATEGY

The aforementioned goals were used to evaluate three design alternatives. A cost-benefit analysis was assembled for each alternative and recommendations were presented to the project sponsors in February of 2020. This project included replacement of the building's two HVAC systems and related components that would be affected or could be replaced while working on these systems.

DESIGN STRATEGIES

- **Alternative 1: In-kind System.** This was the original design plan for the project. It included a like-for-like electric rooftop unit (RTU) replacement with no other proposed changes to the WTCW's mechanical systems. This approach would incorporate a similar, but significantly more modern RTU, powered by electricity, and use the existing ductwork and controls.

- **Alternative 2: State-of-the-art System.** This design alternative includes replacing the existing RTU with a state-of-the-art high efficiency dedicated outdoor air system (DOAS) unit for ventilation, upgrading controls, and a decoupled variable refrigerant flow (VRF) air-source heat pump system in place of existing variable air volume boxes (VAV) for improved zonal space conditioning. The project also includes replacing the kitchen HVAC system, which currently runs on natural gas, with an electric system that includes hood and exhaust fans with variable frequency drives (VFD), VRF electric heat pumps, and a small DOAS unit. This approach would eliminate natural gas use for heating.

- **Alternative 3: Hybrid Approach.** This design includes like-for-like RTU replacement, a controls retrofit, and replacement of existing VAV boxes with newer models. The project also includes replacing the kitchen HVAC system, which currently runs on natural gas, with an electric system that includes hood and exhaust fans with VFD, VRF electric heat pumps, and a small DOAS unit. This approach would eliminate natural gas use for heating.

SUSTAINABLE DESIGN ALTERNATIVES ANALYSIS

A cost-benefit analysis was prepared for each alternative. Table 1 provides the summary matrix of how each alternative meets the project goals. It was determined that Alternative 3, *Like-for-like RTU Replacement with Controls Retrofit and VAV Box Replacement and Kitchen DOAS and VRF Heat Pump*, is preferred since it provides significant greenhouse gas reductions, eliminates natural gas as a heating source, uses new HVAC technologies, and provides only moderate disruption during construction and tenant comfort improvements at a marginal cost increase. Additional details are provided below.

- **Alternative 1: In-kind system.** A new like-for-like RTU is the lowest cost alternative, disrupts tenants minimally, but provides low tenant comfort and minimal overall energy efficiency improvements or greenhouse gas reductions.

- **Alternative 2: State-of-the-art System.** Use of a DOAS unit and air-source heat pumps to replace the existing RTU and natural-gas fired kitchen HVAC system provides an innovation example and an opportunity for the Port to pilot a state-of-the-art technology and achieve significant energy reductions while eliminating natural gas for heating within the building. This alternative presents the most innovative and ambitious approach to maximize energy efficiency, occupant comfort, and greenhouse gas reductions, but it has the highest cost of all design alternatives and largest disruption to tenants during construction.

- **Alternative 3: Hybrid Approach.** A more modern but similar RTU provides some energy efficiencies but use of a small electric DOAS and heat pump to replace the existing natural gas-fired kitchen HVAC system provides an innovation example and an opportunity for the Port to pilot a state-of-the-art technology while eliminating natural gas for heating within the building. This alternative helps meet the project's energy efficiency and greenhouse gas reduction goals through high efficiency components and by reducing GHG emissions from fossil fuels within the building, but it is more costly, and construction is more disruptive to tenants than the base like-for-like replacement.

DESIGN ELEMENTS

The detailed design elements will be part of the upcoming procurement for design and construction (Building Engineering Systems contract). This allows the Port to hire the contractor to design and construct a custom system. A Basis of Design, including performance specifications, is being developed as part of the Request for Proposals that is expected to be issued in August of 2020. Selection of a contractor will be based on meeting these design elements and performance specifications. System performance will be monitored as part of the contract.

Table 1. Alternatives Analysis WTCW HVAC Replacement Project

	Cost Effectiveness					Greenhouse Gas Emission Reduction		Energy Efficiency		Impacts to Tenants		
	Capital / Construction Cost	Life Cycle Cost	20 Year Incremental Net Present Value	Capital Carbon Cost ($/Mt CO_2 Avoided)	Lifecycle Carbon Cost ($/Mt CO_2 Avoided)	Maritime/EDD Building Energy Emissions Reduction (% from 2018 Emissions)	Lifetime CO_2 avoided (Metric Tons)	Expected Energy Use Intensity (reduction compared to 2017 baseline)	Annual Energy Savings (kBTUs)	Level of Work in Tenant Spaces	Construction Time	Tenant Comfort / Temperature Control
Alternative 1	$1.8M/1.3M	$3.3M	$0 (Baseline)	$172,000	$318,000	0.0%	10	68 (2%)	84,000	Low	Low	Low
Alternative 2	$6.7M/5.6M	$7.7M	-$4.4M	$13,000	$15,000	1.2%	519	43 (38%)	1,832,000	High	High	High
Alternative 3	$3.5M/2.8M	$4.9M	-$1.6M	$9,500	$13,000	0.9%	376	60 (14%)	668,000	Medium	Medium	Medium