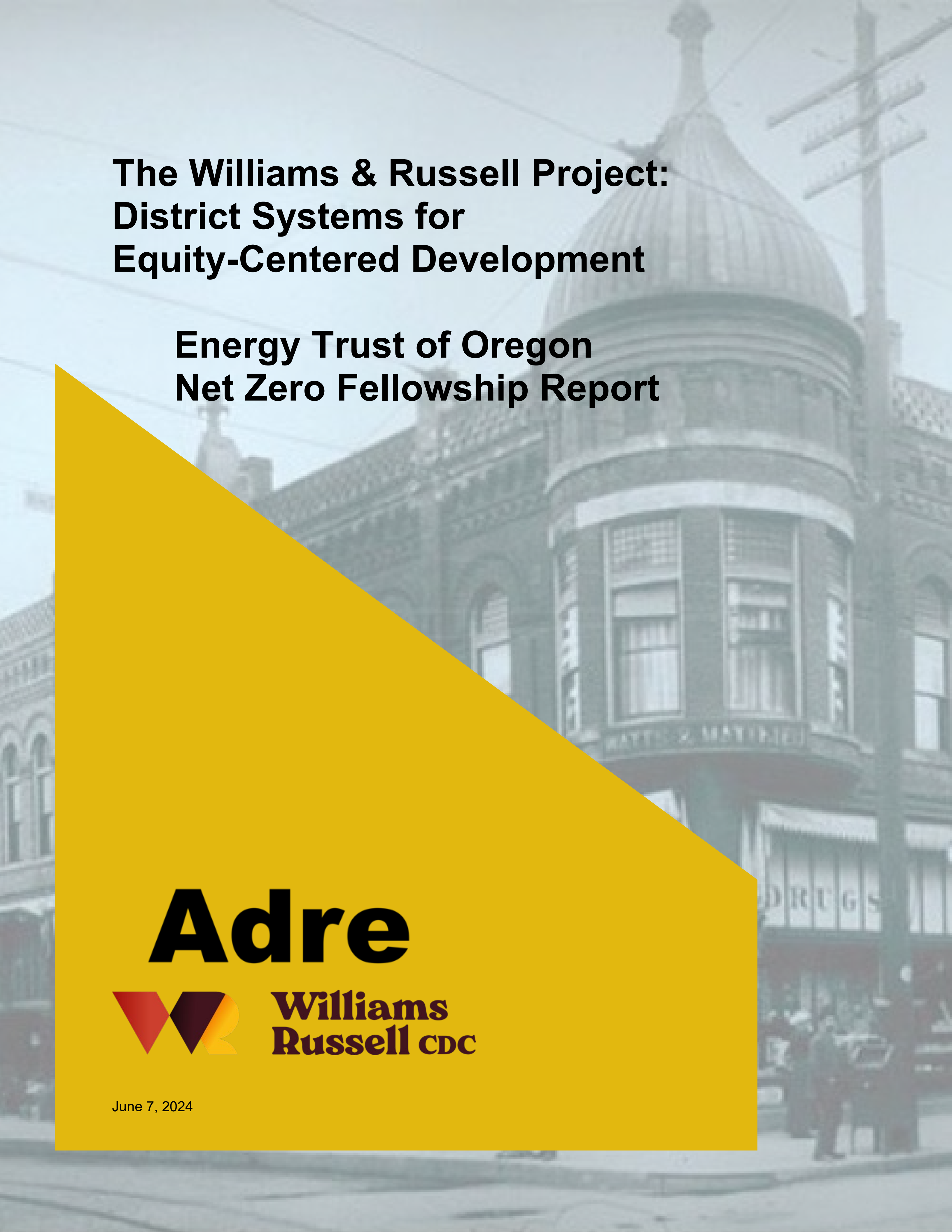

# The Williams & Russell Project: District Systems for Equity-Centered Development

## Energy Trust of Oregon Net Zero Fellowship Report

Adre

Williams Russell CDC

June 7, 2024

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This is an executive summary that compliments the presentation entitled
**The Williams & Russell Project:**
**District Systems for Equity-Centered Development**
dated June 7, 2024.

The intention of this research process is to explore opportunities of district systems that align with the community's development goals of economic development, environmental sustainability and cultural resiliency.

Presentation pages will be referred to per section in this report.

# TEAM ACKNOWLEDGMENTS

*See pages 3-4 in the presentation.*

The Williams & Russell research project, **District Systems for Equity-Centered Development**, is a collaboration lead by:

- Adre, Research and Development Lead
- Williams and Russell CDC (W+R CDC), project client
- COR, City of Roses, Waste Systems Lead
- Biohabitats, Water Systems Lead, hydrology and water engineering
- PAE, Energy Systems Lead, mechanical, electrical and plumbing engineering
- LEVER, Architecture
- Colas Construction, General contractor, cost estimation

The fellowship team are industry leaders in sustainable building design and using leading technologies at district scales. In addition to the main collaborators, Adre had conversations with Pacific Power, Pacific Northwest National Laboratory (PNNL), and third party microgrid providers, ENEL X, Mid Valley Power, Infracenters. The research would not have been possible without the support of Energy Trust of Oregon.

# RESEARCH PROCESS

*See pages 5-7 in the presentation.*

The intention of this research project is to understand and explore district systems for the Williams & Russell Development, and to align with the development's equity-centered goals.

## RESEARCH GOALS

The three main pillars of the Williams & Russell Project development research project are environmental sustainability, financial viability and resiliency. The team defined resiliency as having power during outages, being grid-connected and to be able to confidentially operate and maintain the systems. Environmental sustainability includes, but is not limited to, renewable energy, water collection, heating and cooling and waste diversion. Economic viability focuses on analyzing the upfront investment of district systems and operational cost savings as well as potential revenue opportunities.

With these intentions in mind, the research team followed this approach and posed the following questions:

1. **Research Systems and Explore Design options**
   - How can district systems build community resiliency and economic benefits?
   - What are possible district waste, water and energy systems?

2. **Learn from Existing Projects**
   - What are the challenges and lessons in district systems from other projects?

3. **Estimated Cost for Interested Parties to Make Decisions**
   - Are the upfront costs of a district system, operations and maintenance costs worth it to benefit the community?

4. **Discussions with Utility about Partnership**
   - What microgrid design is most beneficial to communities that can be supported by utilities?

With the community benefit goals in mind, Adre led the exploration of the district systems, focusing on waste, water and energy. This included but was not limited to waste management practices and water systems including rainwater collection, greywater collection and reuse. This also included on-site energy generation and distribution with solar photovoltaic arrays, geothermal energy and an evaluation of energy storage technologies; heating and cooling methods, hydronic heat pump and backup battery storage.

Adre led the research team exploring the development of the Williams & Russell Project as one of the first microgrid energy systems in the Pacific Northwest. Historically, district energy systems are used on university, hospital and research campuses, as well as military bases and airports to generate a site's heating, cooling and energy needs. A centralized community heating and cooling center, most often gas powered, distributes heating, cooling and energy to a campus's facilities which reduces or eliminates its dependence on the grid.

District energy also provides sites with emergency preparedness so buildings can be powered by on-site energy generation and storage during power outages of the broader energy grid. However, district energy systems are infrequently used in urban planning and real estate development, especially on a smaller scale. The Williams & Russell Project introduces new challenges and opportunities of conventional district energy systems.

## RESEARCH METHODOLOGY

The research methodology included the following:

1. Brainstorm all district systems with industry leaders.
2. Research district systems that are feasible for the project.
3. Develop design options based on the project assumptions.
4. Calculate the estimated cost of district systems.
5. Discuss findings with project stakeholders and receive their feedback.
6. Discuss with Third-Party infrastructure owner/operators.
7. Discuss with utility about partnership and grid-interconnectivity.
8. Present findings to stakeholders.

**Systems Brainstorming Workshop**
The first research step was to host a brainstorming workshop with the research team, identifying the endless possibilities of district system approaches that can address paths to net zero water, waste and energy. Once all ideas were on paper, the team analyzed and identified systems that responded to the guiding questions and were categorized by the following:

> **'Next-Level,'** Next-Level design ideas are precedents of built systems that are still beyond standard sustainable building design practices that work towards a path to net zero.
>
> **'Stretch'**, Stretch design ideas are beyond high-level sustainability metrics, have higher outcomes to attain net zero, are not common practice, may have higher upcharges to construct and maintain and may have added operational requirements.
>
> **'Dream Ideas**' Dream Ideas are incredibly ambitious, with high impact in achieving net zero or net positive, highly unlikely and or even unprecedented in the region.

Once the team categorized the design ideas, the research team identified feasible systems and approaches for waste, water and energy.

**District systems that were identified:**

- **Waste:** Recycling, compost and reduction of waste in general.
- **Water:** Rainwater collection and gray water recycling for non-potable uses.
- **Energy:** Energy efficiency, renewable power generation, battery storage and microgrid.

The brainstorming session was incredibly beneficial to have all the expertise gathered in the same space to understand the intersections of system types and strategies that can be implemented on the building scale as well as the district scale. Conclusions of the brainstorm were pursuing stretch ideas.

At the end of the workshop, the fellowship team also defined Power Resiliency for the project as two days (48 hours) of backup power in a grid outage.

#### Develop Design Options and Cost Estimate

The research team analyzed and designed feasible project options for water, waste and energy district systems. Once design options were selected, Colas provided a rough order of magnitude cost estimates. Cost estimates were essential in understanding added capital expenses not only for construction, but for operations and maintenance.

#### Partnership Discussions

The fellowship team met with three third-party owners and operators that are experienced in district systems, especially microgrids. The companies included Enel X, Mid Valley Power and Infracenters.

Following the conversations with third-party district system owners and operators, the fellowship team met with the utility Pacific Power, facilitated by Energy Trust, to discuss the feasibility of a district microgrid and grid-interconnectivity partnership.

#### Conversations with Stakeholders

Design options and cost estimates were shared with project stakeholders for feedback throughout the process. A primary question from stakeholders was the infrastructure ownership and operations requirements and options. Knowing these systems require experienced technical operators, and that the overall development will have multiple owners, understanding the options of ownership and operations is critical for stakeholders to make informed decisions.

## DEVELOPMENT OVERVIEW

*See pages 10-18 in the presentation.*

## DEVELOPMENT CONCEPT

The Williams & Russell Project site is a 1.7-acre city block in the heart of Portland's Albina neighborhood. It once stood as the thriving African American Hill Block commercial district but was condemned and acquired by the City of Portland and Prosper Portland through urban renewal, becoming the location for an expansion of the Legacy Emanuel Hospital in the 1970s. All structures on site were demolished for a planned expansion that was never realized. The Williams & Russell Project comprises of three main developments, Affordable Apartments, Affordable Homeownership and the Black Business Hub. Affordable Homeownership and Black Business Hub are being developed by Adre and the Affordable Apartments are being developed by PCRI. The overall project is intended to create pathways for residents to return to the area, with a sense of healing, hope and pride. The affordable spaces offer business growth opportunities. Access to workforce education promotes economic development in NE

Portland, responding to the community's desire for wealth generation through knowledge, resources, health and community.

In addition to being a restorative justice project, the site will be redeveloped with sustainability at the forefront of every decision, serving as an example of resilient urban infill development.

**Williams and Russell CDC**

Williams and Russell CDC (W+R CDC) is the primary owner of the development. W+R CDC's mission is committed to fostering a community-led development that honors the legacy of the past while creating a thriving future. Through affordable housing, homeownership opportunities and establishing a Black Business Hub, W+R CDC aims to empower and uplift the Black community, promoting equity, wealth creation and economic resilience.

Resiliency, cultural specificity, environmental responsiveness and financial growth have all been key tenants in the project's development. With these guides in mind, as well as experiencing firsthand power outages and droughts from wildfires, ice storms, heat domes and other severe climate events, Adre and W+R CDC came together to discuss what the project can do on a district level, beyond the individual building designs, to support the community recovery during climate events. District systems quickly became a tangible path to address community resiliency.

Adre has presented the district systems research and approach to W+R CDC (as well as PCRI) multiple times over the course of the research, presenting the approach, soliciting questions and concerns and identifying key pinch points to consider in the operations and maintenance of the projects.
Feedback from W+R CDC and PCRI on the various designs informed the team to prioritize district designs that focused on campus residents, focused on ease of operations and maintenance and had grid connectivity.

W+R CDC has been working with the Black community for years to identify key dreams for the project. This project has been community led from the beginning, and it is important that the entire design contains community benefits.

W+R CDC's key values are equity, justice, economic empowerment, sustainability and innovation. District systems are opportunities for W+R CDC to implement these values in the project at a district scale. It is known that communities of color continue to be disproportionately and negatively impacted by climate events and endure longer recovery times as a result of systemic exclusionary practices. This research is an opportunity to build resiliency, environmental sustainability, social equity, and financial viability for the Williams and Russell community.

## DISTRICT SYSTEMS OVERVIEW

*See pages 19-21 in the presentation.*

### DISTRICT SYSTEMS COMPONENTS

This research focused on district systems of waste, water and energy. Waste systems included diversion from landfill, recycling and composting food waste.  Water systems included rainwater and greywater systems. Energy systems included energy efficiency of passive and active approaches including geoexchange, renewable energy generation with solar, back up energy storage systems and microgrids.

### DISTRICT SYSTEMS AND COMMUNITY BENEFITS

District systems are an opportunity for the community to benefit from resilient approaches that minimize water use onsite, reduce operational costs of the buildings, lower utility costs to residents and workers, provide power during outages and potentially provide a path of revenue by solar generation and energy storage onsite. The main community benefits that were identified were environmental sustainability, resiliency and economic viability.

# WASTE SYSTEMS

*See page 22-23 in the presentation.*

## WASTE GOALS

The research team identified waste systems as an opportunity to reduce the carbon footprint onsite. With residents, workers and visitors collocated on the site, there will be a higher waste load. The research team posed the question, **what are the paths to make the development net zero waste?**

The team talked with Alando Simpson at City of Roses (COR), leader in sustainable waste management, about district waste systems for the project.

Key findings from conversation with COR are that the City of Portland requires waste management companies to collect waste, yard debris and co-mingled recycling. Metro has specific voluntary waste recycling programs for items, such as paint, hazardous materials and electronics, available to individuals. They can participate in the Metro programs by bringing their materials to Metro sites. Other individual voluntary programs such as Ridwell, ZeroCycle and Trashie are serviced in Portland, though there is a cost impact to the individual.

A district waste system would provide onsite post-consumer collections that the waste management company would sort and distribute to the respective material streams. Post-consumer collections (i.e. clothing, furniture 'non-recyclable plastics, food, etc.) are above and beyond the city requirements.

The site is currently serviced by Republic Waste Management and is franchised across the city of Portland. Because waste management is franchised, there is not an opportunity for an alternative waste management provider on site. Republic Waste Management will only support waste diversion streams required by the City of Portland. These include yard debris, composting and co-mingled recycling. Given the building programming and end users of homeowners, residents, business owners and their employees, there is an intention and onus put on individuals to sort and distribute their waste in the specific categories of recycling, compost, yard debris and waste to landfill.

As a result, the project will not be pursuing a district waste system after building completion. However, there is an opportunity for the project to have a path to net zero waste during the construction of the development, as the project has control over who it can hire to complete this work. The project will focus on path to net zero waste management during construction, reducing waste, recirculating materials to be repurposed and diverting waste from landfills above and beyond the city of Portland requirements. Examples of this are salvaging materials, efficiencies in material use in construction and reducing waste materials brought on site.

# WATER SYSTEMS

*See pages 24-29 in the presentation.*

The fellowship team worked with Biohabitats, leaders in sustainable hydrology design and building water systems. The Williams & Russell Project has several innovative water infrastructure alternatives. Biohabitats analyzed the project program and concept design to develop a list of appropriate alternatives to explore further with the community, design team and other project stakeholders.

## WATER SYSTEMS GOALS

The water goal for the project research is to identify all site opportunities to collect rainwater, determine the most impactful water reuse strategy and identify simple operational systems with minimal costs. The designs focus on rainwater collection for non-potable demands and collected greywater from sinks, tubs and laundry for non-potable demands.

**The 5 water design options include:**

**Rainwater (2 options)**

**Option 1**
Rainwater collected on roofs used for toilets in Black Business Hub and Affordable Homeownership.

**Option 2**
Rainwater collected on roofs used for toilets in Affordable Apartments.

**Greywater Systems (3 options)**

**Option 3**
Greywater collected from Affordable Apartments is used for site irrigation.

**Option 4**
Greywater collected from Black Business Hub and Affordable Homeownership is used for toilets in Black Business Hub.

**Option 5**
Greywater collected from Affordable Apartments used for toilets in Affordable Apartments.

## RAINWATER DESIGN OPTIONS

Rainwater collection and reuse is an efficient design system, especially in the Pacific Northwest. In Portland, due to the stormwater collection requirements, using rainwater for non-potable functions is a great way to reduce non-potable water requirements onsite. Below are two design options using onsite rainwater collection.

**Option 1: Rainwater Collected on Roofs Used for Black Business Hub and Affordable Homeownership Toilets**
This water design proposes to use all the rainwater collected from building roofs for toilet flushing in the Black Business Hub and Affordable Homeownership projects. The rainwater collected will meet 70-80% of the non-potable flushing demands for the entire year. This design requires a 20,000-gallon rainwater collection cistern and requires a 100sf semi- conditioned mechanical room for water treatment equipment.

**Option 2: Rainwater Collected on Roofs Used for Affordable Apartments Toilets**
This water design proposes to use all the rainwater collected from building roofs for toilet flushing in the Affordable Apartments project. The rainwater collected will meet 70-80% of the non-potable flushing demands for the entire year. Like Option 1, this design requires a 20,000-gallon rainwater collection cistern and requires a 100 sf semi-conditioned mechanical room for water treatment equipment.

**Rainwater Use, Design Regulations, Operations and Savings**
Rainwater systems are simple maintenance to achieve water savings for 7-9 months out of the year. These designs follow Charter 16 of the Oregon Plumbing Code (2021 UPC). The deficit of rainwater collection would be in the summer to early fall months where Oregon experiences drought.

## GREYWATER DESIGN OPTIONS

Greywater collection and reuse are more efficient design systems, utilizing water from bathroom sinks, kitchen sinks, bathtubs and laundry for non-potable functions like irrigation and toilet flushing. Greywater systems do require additional waste and connective piping and do not replace the typical piping. Greywater systems also do require quarterly maintenance by an experienced professional. Below are three design options using greywater design reuse.

**Option 3: Greywater from Affordable Apartments Used for Site Irrigation**
Greywater collected from the Affordable Apartments would be used for site irrigation. Up to 1,200 gallons of greywater would be treated and stored for reuse (tier 2 permit limit). The system would send anything over 1,200 gallons per day to the city sewer. The system would also have passive overflows to the city sewer for emergencies. The main treatment component would be an Advantex® Textile Treatment System (made in Oregon by Orenco Systems). The system would require approximately 400 sq. ft. of space to house treatment components.

**Option 4: Greywater from Black Business Hub and Affordable Homeownership Used for Black Business Hub Toilets**
Greywater from the Black Business Hub and the Affordable Homes would be collected and treated to use for the Black Business Hub toilet flushing demands. Up to 1,200 gallons of greywater would be treated and stored for reuse (tier 2 permit limit). The system would send anything over 1,200 gallons per day to the city sewer. The system would also have passive overflows to the city sewer for emergencies. The main treatment component would be an Advantex® Textile Treatment System (made in Oregon by Orenco Systems). The system would require approximately 400 sq. ft. of space to house treatment components.

**Option 5: Greywater from Affordable Apartments Used for Affordable Apartment Toilets**
Greywater from the Affordable Apartments would be collected, treated, and stored for reuse for the Affordable Apartments toilet flushing demands. (tier 3 – no flow limit). The system would also have passive overflows to the city sewer for emergencies. The main treatment component would be an Advantex® Textile Treatment System (made in Oregon by Orenco Systems). The system would require approximately 800 sq. ft. of space to house treatment components.

**Greywater Use, Design Regulations, Operations and Saving**
Options 3, 4 and 5 for greywater reuse follow Oregon Administrative Rules (OAR) Chapter 340, Division 053 - Greywater reuse and disposal system rules for tier 2 General Permit (2402). Specific maintenance is required; but can be performed by facility staff or a third party. Flow must be diverted seasonally (i.e., open valve in spring and close valve in autumn). There is a possibility that a permit could require a licensed operator. Water savings is year around, as long as there is demand from the users. Most of the irrigation demand or all the flushing demand can be met with treated greywater.

**Greywater Treatment and Reuse Mechanical Room**
Option 5 design is based on the Rose Villa Housing project in Portland Oregon. Components of the mechanical treatment room from Biohabitats in Rose Villa Housing project include an influent flow meter, a50 micron screen filter, non-potable supply pumps and an ozone recirculation loop. Textile filters, potable backup valve and a pressure tank. This project has been in construction and operations for over a year and has been performing successfully in Oregon.

## WATER SYSTEMS ESTIMATED COSTS

Below is the rough order of magnitude cost estimate for the five water systems. Pricing was provided by Colas Construction, RMS and CHC Hydro. It includes the supplemental water system storage, piping and mechanical room and general contractor costs for the rainwater and greywater systems above the conventional waste system. Note all costs below are above the cost of the existing conventional systems.

- Options 1 and 2, the rainwater design cost the same, approximately $302,400.
- Option 3 using greywater from affordable apartments for site irrigation cost is approximately $540,000.

- Option 4 using greywater from the Black Business Hub and Affordable Homes for Black business Hub toilet flushing is approximately $643,745.
- Option 5 using greywater from the Affordable Apartments for Affordable Apartment toilet flushing is approximately $949,180.

### WATER SYSTEMS SUMMARY

The table on page 28 of the presentation illustrates the water design options and compares the following:

- Simplicity of the system
- Space required on site
- Energy needed to operate the systems
- Operations and maintenance
- Water saved
- Rough order of magnitude cost

## ENERGY SYSTEMS

*See pages 30-65 in the presentation.*

The fellowship team worked closely with PAE and LEVER, the project leads on engineering and architecture to develop design approaches for district energy systems. The district energy systems address the overall project goal of resiliency.

### ENERGY SYSTEMS GOALS

**How Are We Defining Resiliency?**

Resiliency is a multifaceted approach to responding to a primary loss of power. For this project, the team established that resiliency is to have backup power for two days (48 hours).

**Energy System Components**

Resiliency is built through layers of components, starting with the foundation of energy efficiency approaches. This includes passive design solutions like insulation and daylight and active design solutions like geoexchange for heating and cooling. The next components of resiliency are onsite renewable energy generation including solar panels, followed by an onsite backup energy storage system (BESS), or a battery, and ultimately, a microgrid.

## ENERGY EFFICIENCY

*See pages 32-38 in the presentation.*

### ENERGY EFFICIENCY GOALS

**Approach**

The design team identified energy targets to meet Architecture 2030 for buildings which is 15 energy use intensity (EUI). In order to achieve these energy targets, the design will use energy efficient building design (envelope, high performance windows, insulation and fixtures). The buildings will utilize heat pumps and outdoor air systems. The development will have a district geoexchange loop that is connected to all buildings.

The guiding question for the research:
***Is net-zero operations feasible?***

### ENERGY EFFICIENCY DESIGN

The energy analysis for the Williams and Russell campus project has been developed using “case study buildings” to model each building type to be as close to net zero as possible. All energy analysis was conducted in IESVE energy modeling software and all energy results were normalized to align to current program estimates.

The following is a summary of the case study buildings for each program type along with a summary of the Central Plant Concept analysis.

**Reference Multifamily Building:**
**Affordable Apartments**
The building energy analysis for the affordable Apartments is based off a comparable five-story L-shaped building reference model. This project has a low energy use intensity with heat pump operations for both space heating and domestic hot water.

**Reference Single Family Building:**
**Affordable Homeownership**
The building energy analysis for the affordable homeownership project uses a simple “shoebox” model of one block of townhomes, with key energy efficiency metrics adopted from the multifamily reference model.

**Reference Office Building:**
**Black Business Hub**
The building energy analysis for the proposed Black Business Hub is based on a four-story version of the PAE Living Building reference model. This project has achieved a net positive energy design and is currently operating within that energy budget.

**Central Plant Analysis**
The loads from all the above reference buildings were aggregated into an hourly spreadsheet analysis to explore potential Central Plant options. The results presented in this report are based on the Geo-Exchange plant concept with water source heat pumps serving all building heating, cooling and domestic hot water energy demands.

**Affordable Apartments**
The team analyzed the geoexchange system for the affordable apartments. The national average EUI for multifamily is 59 EUI. By Oregon code, multifamily is 35 EUI. Highlights of the design system consist of a high-performance envelope, window to wall ratio of 19%, energy efficient fixtures, a district geoexchange loop with distributed heat pumps and a Dedicated Outdoor Air System (DOAS). The proposed designed system provides a 65% heat recovery and reduces the EUI to 23 EUI.

**Affordable Homeownership**
The team analyzed the geoexchange system for affordable homeownership. The national average EUI for a single-family home is 100 EUI. By Oregon code, single-family is 40 EUI. Highlights of the design system consist of a geoexchange loop with distributed heat pumps and a fresh air ventilation and exhaust in the ceiling. The proposed designed system provides a 65% heat recovery and reduces the EUI to 22 EUI.

**Black Business Hub**
The team analyzed the geoexchange system for the black business hub. The national average EUI for office is 53 EUI. By Oregon code, office is 45 EUI. Highlights of the design system consist of a geoexchange loop with distributed heat pumps and a DOAS. The proposed designed system provides a 72% heat recovery and reduces the EUI to 20 EUI.

**District Geoexchange Loop**
The district energy efficiency design is a geoexchange with condenser loop for heating and cooling for all three buildings with centralized geothermal bores. A geoexchange system is an integrated energy

efficient mechanical system using heat recovery from the earth. The earth's temperature is consistent and reliable.

The geoexchange system consist of the following:

- Geothermal bores (250' cables in the ground)
- Central mechanical room
- Supply and return piping to buildings
- Heat pumps (in the buildings)

The advantage of this system is that it is an integrated district system and can provide heat recovery load share between buildings and provide heat during an outage. The disadvantages of the geoexchange system are higher first costs, requires digging (75) 250' bores and requires dedicated technical property management to operate and maintain the system.

### GEOEXCHANGE ESTIMATED COSTS

Below is the rough order of magnitude cost estimates for the geoexchange system. Costs were provided by Colas Construction. All costs assume 70 geothermal bores, all heating equipment, heat pumps and contractor contingency and markup (8%).

- 70 Geothermal bores $477,000
- Heating equipment $300,000
- Contingency and mark up $62,160

The total of all three development geoexchange systems is approximately $840,000.

### ENERGY EFFICIENCY SUMMARY

To summarize the campus, using a geoexchange loop with distributed heat pumps for all buildings, the whole district has a load of 22 EU. The breakdown is 57% of the load for the Affordable Apartments, 18% of the load is for the Affordable Homeownership project and 25% of the load is for the Black Business Hub.

To answer the research question, ***Is Net Zero Operations Feasible?***

> With energy efficiency measures and district geoexchange loop, the project achieved 34% of Net Zero operations
>
> The energy use has been reduced by 66% (65 EUI to 22 EUI)

## SOLAR GENERATION

*See pages 39-47 in the presentation.*

### SOLAR GENERATION GOALS

The solar goal for the project is to be on a path to net zero energy by identifying all site opportunities where solar can be placed, determine the most productive array, consider solar array orientation, single vs dual tilt and adding a solar canopy over site to analyze the feasibility of Net Zero energy onsite.

The guiding question for the research:

> **Is Net Zero Operations feasible?**

### SOLAR GENERATION DESIGN

**Single Tilt Roof**

The first solar design option is using a single tilt solar array. Traditionally, solar arrays are integrated on building rooftops to face south with single tilt racking systems, which is the optimal, highest efficiency orientation. In recent years, as panel efficiency has increased and panel cost has decreased, east/west oriented arrays with dual tilt racking have become of interest.

PAE explored the feasibility of single and dual tilt racking on the single-family dwellings and found the limited roof space and the property line designations to be incompatible with these design approaches. As a result, we explored a third option.

Unlike the apartments and office complex, the single-family dwellings have a sloped roof. As such, flush mount racking is the good choice. With a south facing roof slope of 15.3 degrees the roofs fall within range for flush mount racking. Since each unit will be independently owned and the array size is fairly small, this initial design is based on residential panels with an inverter in each home. Additionally, residential inverters can meet the standard residential voltages of 120/240V. The total roof top capacity of the Black Business Hub, Affordable Apartments and Affordable Homes is 351 KW.

**Dual Tilt Roof**
Due to the efficiency and larger capacity for power generation, the dual tilt design, which orients the panels east/west, is the project's base design. For all three buildings, the total roof top capacity is 377 KW, 610 panels.

**Dual Tilt and Canopy**
To increase production capacity, this design option introduces a solar canopy over the central plaza of the development. The canopy increases capacity to 567 KS and 567 panels.

**Dual Tilt, Canopy and Geoexchange**
To increase capacity, PAE proposed to add a solar plaza canopy and Geoexchange system. The canopy and geoexchange increases production to 607 KW, with 956 panels and reduces overall energy load.

## SOLAR GENERATION ESTIMATED COSTS

Below is the rough order of magnitude cost estimates for the solar systems. Cost estimates were provided by Colas Construction. All costs include the full infrastructure system including solar panel modules, inverters, optimizers, panel claws, conduit and contractor contingency and markup (8%).

- Affordable Homeownership solar is approximately $284,325
- Affordable Apartments solar is approximately $407,656
- Black Business Hub Solar is approximately $260,463

The total of all three developments for solar is approximately $1.07M. The additional solar canopy is approximately $495,981. The full solar with the expanded solar panel canopy is approximately $1.56M.

## SOLAR GENERATION SUMMARY

*See page 46 in the presentation.*
The site and project can meet 41% net zero energy, given the annual estimated usage for the site is 1,005,0000 kw/ annually. For all solar designs, whether single tilt or dual tilt, there is solar access above 80%. The additional solar canopy will provide site shading and more solar generation, thus meeting 65% to net zero energy. However, the additional solar canopy introduces additional infrastructure costs to the project. The project also benefits from a geoexchange system, adding more capacity.

There are many opportunities for solar generation onsite. Using the more producing orientation, the dual tilt orientation, the total rooftop solar generation across the development is 377KwH using 610 panels. By adding the geoexchange and solar canopy, the total possible onsite power generation is 605kwh using 956 panels.

To answer the research question, ***Is Net Zero Operations Feasible?***

With energy efficiency measures, district geoexchange loop and solar with dual tilt and canopy, the project achieved 65% of net zero operations.

## ENERGY SYSTEMS SUMMARY

The table on page 47 of the presentation illustrates the district energy design system options and compares the following:

- Simplicity of the system
- Space required on site
- Energy needed to operate the systems
- Operations and maintenance
- Energy generated and/or saved
- Rough order of magnitude cost

# BATTERY STORAGE

*See pages 48-54 in the presentation.*

## BATTERY STORAGE GOALS

The goals of the Backup Energy Storage System (BESS) are to provide backup power onsite for two days. The goal is to prioritize residential use over office use. The BESS modules are large, 10' wide x 14' long x 7' high. Due to the sizes of the battery modules, a project goal is to balance the size of the BESS system with the open green space.

### BATTERY SIZING OPTIONS

**Option A: 100% Backup Power** includes full power, lighting, internet, refrigeration, heating and cooling, cold water, appliances and power outlets.

**Option B: 50% Backup Power** means that the building owners decide during design which 50% of the building stays operational. Priority powered spaces would be communal areas (hallways and community rooms).

**Option C: 100% Backup Power, Half of the Loads for All Housing.** This option includes a smaller battery module to provide 50% power for all housing.

**Option D: 100% Backup Power for Affordable Apartments Only.** This option includes a smaller battery module to provide 100% power to just the apartments.

### Methodology

The goal in this research is to provide options to meet two different levels of outage events that the Williams and Russell district could face in the coming years. The analysis involves two levels of event, one from a perspective that prepares for as close to normal operation during an outage as possible, as well as a 50% load shed to save power during an outage.

A variety of modeling software tools were used to analyze each element in the system. The modeling focused on maintaining the overall reduced carbon footprint goals of the project wherever possible. While the team is aware the project cannot meet net zero, the design attempts to get as close to net zero as possible.

The study looked at each element from an electrical needs standpoint as well as the financing necessary for each piece of the system proposed.

The result is two different possible designs that can meet basic resiliency goals as well as preserving the carbon reduction goals of the project.

**Guide to Read Resiliency Tool Outputs**
The design is modeled and analyzed in a resiliency tool model. This measures energy loads and sources, duration of the modeled outage, battery size, percentage of solar and then a pass/graph determining whether the BESS meets the resilience goals.

**Option A: 100% Backup Power**
Option A is designed for full 100% site load and full battery storage. The full battery storage is 6,120 Kwh of stored energy, has 9 battery modules and uses only rooftop solar generation. The advantage of Option A is that it provides full resilience for the entire site all year long. The disadvantage of Option A is the size of the required battery will use all the site's green space.

**Option B: 50% Backup Power**
Option B is designed for 50% site load and smaller battery storage. Option B provides 1,320 Kwh of stored energy, has two battery modules and is using only rooftop solar. The goal of this design is to meet partial resiliency for the site. The advantages of Option B are that it provides 50% load of the entire site for 2/3 of the year, with smaller battery size, preserving green space, has a smaller footprint and less initial cost. The disadvantage for Option B is that the site is only partially resilient.

**Option C: 100% Backup Power, Half of Loads for All Housing**
Option C is designed for full 100% backup power of half the housing loads for both the Affordable Apartments and the Affordable Homeownership. Option C provides 1,320 Kwh of stored energy, has two battery modules and is using only rooftop solar. The advantages of Option C are that it provides 50% resiliency for all housing 3/4 of the year, with smaller battery size, smaller footprint and provides critical load backup to all residents during an outage. The disadvantages of Option C are that it only provides backup to residents and not office users, and only critical power loads are supported.

**Option D: 100% Backup Power, Affordable Apartments Only**
Option D is designed for full 100% Affordable Apartments load and a smaller battery storage of 1320 Kwh stored energy. Option D provides the backup power to only the Affordable Apartments, which is the majority of households on campus, and the primary users during a power outage. Advantages of Option D are that it meets the full load of the Affordable Apartments with smaller battery size, smaller footprint and prioritizing residents during outage. The disadvantages are that it only provides backup to apartment residents, not homeowners or office users.

## BATTERY STORAGE SUMMARY

*See page 54 in the presentation.*

The table on page 54 of the presentation illustrates the district resiliency systems options and compares the following:

- Solar panel location
- Solar panels dedicated to BESS
- BESS size
- BESS number of modules
- Battery cost

Note: Option C and D assumes the Black Business Hub backup battery storage is given to the residents during a power outage. The BESS system specified is ELM Microgrid 250 kW/660 kWh.

Key takeaways of the battery design options are:

- The battery module size required to meet 100% backup power would be so large, it will eliminate all site greenspace.
- Prioritizing residents to have access to backup power is feasible with a significantly smaller battery module.

## MICROGRID

*See pages 55-65 in the presentation.*

The fellowship team sees microgrids as the future of the energy industry. This study allowed the team to move beyond theoretical analysis to explore real world challenges.

### MICROGRID GOALS

The goals of the microgrid are to identify opportunities for a microgrid, understand the requirements of a microgrid to be grid-connected and see if the microgrid can be supported by the utility.

The guiding question in the microgrid research is:
***Can we create a district microgrid that is owned and operated by the utility?***

### MICROGRID DESIGN

The microgrid design options lay out microgrid components across the buildings of the development. It looks at single building versus district requirements. The design identifies what equipment is utility owned and customer owned, the designs all include an island disconnect point from the utility grid.

### WHAT IS A MICROGRID?

*See page 57 in presentation for reference diagram.*

According to the US Department of Energy Microgrid Exchange Group, a microgrid is a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid. A microgrid can connect and disconnect from the grid to enable it to operate in both grid-connected or island-mode. Microgrids consist of the following components:

- **Loads:** Any system that uses energy.
- **Onsite Generation and Storage:** Solar Panels and Battery
- **Microgrid Controller:** Control system for the microgrid can also include controllable electrical equipment like circuit breakers.
- **Microgrid Disconnect:** A disconnection point from utility to a microgrid where systems can operate independently

### HOW DOES A MICROGRID OPERATE?

*See page 58 in presentation for reference diagram.*

The microgrid can be connected to the utility grid as well as independently of the utility grid.
When the microgrid is **Grid Connected,** it works in collaboration with the utility grid. Benefits include reduced operating costs, improved grid resilience and reduced operating emissions.

When the microgrid is **Grid Disconnected**, the microgrid operates independently of the utility grid. The benefit of disconnect is locally sourced energy, providing resiliency during a grid outage.

**Grid Connection Requirements**
In order for a microgrid to be grid- connected, the design must provide the following:

- **One Meter Connection**: The utility will only connect to one meter of district microgrid.
- **Island Disconnect:** A disconnection point from utility to a microgrid where systems can operate independently.
- **Microgrid Controller** (medium voltage switch): Equipment that coordinates the components of the system (solar and battery and building loads).

**Option A: Individual Buildings Microgrids**
*See page 59-60 in presentation for reference diagrams.*

Option A is a traditional behind-the-meter microgrid for each building. Each building has its own BESS, island disconnect point and has one primary meter on the customer side. The main building disconnects along with all loads and Distributed Energy Resources (DERs) are located on the customer side of the meter. The microgrid disconnect point and system controls are also behind-the-meter within the customer's distribution infrastructure.

Each building will be served from the Pacific Power infrastructure at the nearest connection point. Since the buildings are independent of each other, the service connections could be to multiple points within the Pacific Power distribution network.

With this approach, a whole building microgrid is unlikely for the multifamily housing project. Rule 8 allows for a master meter configuration with DERs located behind that meter, but Rule 8 includes restrictions that make this approach challenging for many projects. As a result, microgrid backup is only feasible for the house loads.

With this approach, the project might consider options to include more systems on the house meter to improve the resiliency within this framework.

Each building has its own solar, battery and meter on the customer side. The advantages of Option A are that there are precedents for completing this now. The disadvantage of Option A is that the microgrid for Affordable Apartments can only be connected and back up the house loads (communal load i.e. community room, hallways, lobby). Individual apartment units will not have backup power.

**Option B: District Microgrid Ready**
*See page 61-62 in presentation for reference diagrams.*

The intent of Option B is to create an opportunity for a future campus microgrid. The Day 1 state might still be traditional behind-the-meter microgrids as described in Option A, yet the intent with Option B is to open up the possibility for a campus microgrid in the future as funding allows.

The key element of Option B is that a controllable medium voltage switch/recloser vault and conduits would be installed within or on the boundary of the campus property. All the buildings would have service infrastructure connecting to or near the vault.

Even if minimal switching infrastructure is installed on Day 1, this would allow for the future installation of a controllable medium voltage switch/recloser with all the campus buildings being served from this single interconnection point. This would create a single point of distribution service connection for the campus allowing for a possible island-able campus microgrid in the future.

Per feedback from Pacific Power, all infrastructure downstream of the medium voltage switch would be customer installed, owned, operated and maintained. The exception is the meters at each residential unit would be Pacific Power owned.

The advantage of Option B is to use the efficiencies of construction with the building construction to build out the infrastructure of future microgrids. The disadvantage of this option is the feedback from the utility, which is that all infrastructure behind the meter is the customer's responsibility and it can only connect to a single meter connection for the full campus. Another disadvantage is that only a utility and two companies can service the medium voltage microgrid equipment as it is highly specialized.

**Option C: Multi-Metered Whole Building Microgrid**
*See page 63-64 in presentation for reference diagrams.*

Option C's approach in many ways is a traditional behind-the-meter single building microgrid. The key difference is the microgrid disconnect point for islanding operation is located on the utility side of the meter.

During blue-sky operations, this configuration looks identical to a typical behind-the-meter system. The main building disconnect, loads and all DERs are customer owned/operated and located behind-the-meter*.

*Note: A variation of this approach would allow the DERs to be connected ahead of the meter but before the microgrid disconnect point. This would open up the possibility for the interconnection of larger DER systems, like solar, to help support islanded microgrid operation while still benefiting from net energy metering during normal operation. The main challenge of this variation is the normal operation net metering structure, which would likely require policy variations not currently in place in Oregon.

The difference in installation and operation would only apply specifically to the islanded operating state. In this condition, the microgrid island utility disconnect point occurs ahead of the meters. This allows all building systems, regardless of meter branch, to be supported by the microgrid DERs.

This approach opens the resilience benefits of microgrid to multi-tenant buildings, such as multifamily housing. Without this approach, the centralized microgrid DERs can only support the loads on the shared meter, likely house loads. With Option C, the whole building would have off-grid operation capabilities assuming a BESS of sufficient size.

Advantages for Option C include a multimeter connection, resiliency for all apartment units, support for all building systems by district microgrid and sub metered office spaces. The disadvantage of this option is that there is no current path for a multi-meter microgrid with Pacific Power, and Rule 8 does not allow for multimeter connections to housing to a microgrid.

## MICROGRID SUMMARY

The table on page 65 of the presentation illustrates the microgrid design options and compares the following:

- Microgrid components
- Ownership
- Advantages
- Disadvantages
- ROM costs

Note: Actuals costs for the microgrid were not analyzed in this research. The microgrid is designed based on capacity of energy storage. The research does not address the operations across building owners

To answer the research question, ***can we create a district microgrid that is owned and operated by the utility?***

No. The only current path for a district microgrid is a campus-owned and operated microgrid.

## MICROGRID PARTNERSHIPS

*See pages 66-70 in the presentation.*

### UTILITY CONVERSATIONS

The research for a microgrid for the Williams & Russell Project led the project team to have initial conversations with the utility, Pacific Power. The partnership with the utility is crucial for the community to ensure critical safeguards of power-interdependence. The conversations were framed around the scenarios and design options described in previous sections.

The project team's main questions to Pacific Power are as follows:

- Is the utility willing and able to connect to a community microgrid with multiple meters?
- Are there utility incentives that can support the community with initial construction, operations and maintenance of the microgrid?

The project team and Energy Trust met with Pacific Power on October 11, 2023, and January 08, 2024, to discuss the project and gauge interest from the utility. Representatives from the Pacific Power Clean Energy Plan and Community Based Renewable Energy (CBRE) team were present and shared the following current microgrid ability:

- Pacific CBRE is in pilot stages.
- Pacific Power is in the beginning stages of Demand Response program for commercial and industrial buildings, not residential.
- There are no current incentive programs in place, or no current tariffs to support cost and operations of a microgrid.
- There is no current path for grid connection on district level.

There is an interest in theory to support the project, but only with the following conditions:

- Pacific Power only connects to one main meter for the full campus grid.
- The microgrid system is island able.
- Pacific Power is not responsible for any infrastructure aside from the point of connection at the meter. All of the infrastructure and required grid equipment will be owned and operated by someone else (i.e. controllable medium voltage switch/recloser, conduits, etc.).
- The microgrid cannot connect with residential due to Rule 8, which requires sub-metering per housing unit.

Within the conversation, Pacific Power questioned the need for a microgrid on this site, due to its adjacency to Legacy Hospital which is a trauma center, a power outage is unlikely. Pacific Power also stated that 30% of their service region is in Oregon and would be questioned by customers on preference to Oregon urban customers versus rural customers.

Based on the conversations with Pacific Power, if the project stakeholders want to consider a microgrid, the project team recommends Option A, individual building microgrids, as this is the only path that Pacific Power is currently considering that ensures grid connection for each building.

Advanced conversations and partnership with the utility is critical for considering microgrid developments.

The team has been working to have meaningful conversations with Pacific Power for over a year. Currently, Pacific Power is not set up for servicing a microgrid for multifamily housing and homeownership, which the development team sees as a priority for community resiliency. However, other utilities like PGE in Oregon and utilities across the country are more developed and have supportive paths to develop grid-connected community microgrids.

## OWNERSHIP AND OPERATIONS CONVERSATIONS

Understanding the system ownership and operations was critical for stakeholders to meet the project goals of financial viability. The team explored the following ownership structure of the district systems:

**Option 1: Single Owner, Williams and Russell CDC** are full owner and operator. In this option, W+R CDC is the sole owner that distributes and sells energy to all parties. It has simplified metering, and it requires a systems operator.

**Option 2: Co-Ownership of Williams and Russell CDC and PCRI** This option is a shared ownership model between W+R CDC and PCRI. This structure would have all projects metered separately, requires the Affordable Homeownership to be sub metered under one primary meter and requires a systems operator.

**Option 3: Third Party Owner/ Operator** This option outsources the ownership and operations to a third party who operates the infrastructure systems and sells energy to all parties. Having a third-party owner that is experienced in these advanced district systems was very intriguing to the project stakeholders, ensuring safeguards for operations and maintenance.

### Third Party Ownership Conversations

The team spoke with three third party owner/ operators, Enel X, MidValley Power and Infracenters, two are national operators and Infracenters is the local company working on the OMSI district microgrid. Both Mid Valley Power and Infracenters are interested, once Pacific Power has a path for microgrids.

## MICROGRID PARTNERSHIPS SUMMARY

The table on page 70 of the presentation illustrates the key take aways from conversations with the utility and the third-party microgrid owner and operators.

The Utility Conversation summary describes and compares the following:

- Key takeaways
- Barriers
- Opportunities

The Third-Party Ownership Conversation summary describes and compares the following:

- Options
- Advantages
- Disadvantages

# FUNDING

*See pages 71-72 in the presentation.*

## FUNDING SOURCES

Below is an overall list of key funding opportunities to support a district systems project.

#### FEDERAL GOVERNMENT

- **Inflation Reduction Act (IRA):** Tax credit potential up to 36% of system cost

- **Federal Investment Tax Credit (ITC):** 30% of commercial and residential
- **Environmental Protection Agency (EPA) Greenhouse Gas Reduction Fund**: Grants and Loans
- **US Department of Energy (DOE):** Grants

**STATE AND CITY GOVERNMENT**

- **Oregon Department of Energy (ODOE):** Grants
- **Portland Clean Energy Fund (PCEF):** Grants for equipment, operations and maintenance
- **Energy Trust of Oregon (ETO):** Incentives for energy efficiency, solar and battery storage

## DISTRICT SYSTEMS CONCLUSIONS

*See pages 73-76 in the presentation.*

### FINDINGS

District systems provide a lot of benefit and are the future in resilient development. Providing equity-centered development and working in communities of color, it is important to explore all options of environmental, social and financial resiliency.

District systems enable multiple smaller projects with multiple owners to share efficiencies and resources in water and energy systems. District systems distribute the initial costs across multiple buildings and reduce operational costs across multiple projects.

District energy systems provide access to power during an outage, providing additional resiliency and efficiencies to residents, workers and visitors that is not typical on the building scale.

Although there are additional initial and operational costs for district systems, they can be built into the overall budget and is fundable by city, state and federal programs.

There are current challenges of district system implementation. District systems have specialized equipment and require technically experienced property management to operate and maintain district systems. While the technology is available for district energy systems of microgrids, there is no current pathway for the utility to own and operate a multimeter system, which is a huge barrier for the creation of a multiple ownership districts and precludes multifamily residents from resilience benefits of microgrids.

### ARCHITECTURE 2030

The fellowship research is based on Architecture 2030's commitment to buildings being net zero by the year 2030 (EUI 0). In 2023, the target is 85% reduction of emissions of baseline designs (EUI 15). The district energy systems design used a multi-faceted approach to target a 15 EUI.

Below is a summary of the project's energy design outcomes:

- Designed district energy efficiency EUI = 22
- With solar on all buildings, canopy and geoexchange, the project can reach 65% net zero.
- Housing and office require a higher energy load than can be provided onsite with energy efficient design, solar generation, battery storage and a microgrid.

While the project design can meet 65% net zero onsite, the district can opt in for off-site solar to achieve net zero.

## REPLICABILITY

The findings from the district systems research for the Williams & Russell Project can be easily used for similar projects.

Here are some steps for replicability in similarly scaled projects:

1. **Build Consensus:** With stakeholders on resiliency goals and meet regularly to develop the systems, cost estimation and operational impact.
2. **Design for Building Efficiency:** Design for water efficiency, water recirculation, energy efficiency, passive design, solar and energy storage in each building (key community benefits and can be achieved with or without the district systems).
3. **Start Utility Conversations:** To understand what is feasible and identify constraints.
4. **Design Systems**
    a. **Waste System:** Work with waste management contractors to prioritize onsite recycling, composting and multiple streams that divert waste from landfill.

    b. **Water Systems:** Onsite water resources to be re-used for non-potable demand.

    c. **Energy Systems**: Onsite energy generation, storage and a microgrid provides a resilient system that operates in the event of an outage.

## CONCLUSION

There are a lot of opportunities for the development to be designed with a path to net zero for water and energy. The development design will incorporate water strategies, energy efficiency, passive design, solar generation and storage into each building, which provides key community benefits that can be achieved with or without the district systems.

## KEY TERMS IN RESEARCH

**Resiliency -** For this project, resiliency is for a major utility power outage of 48 hours. Generally, it is the planning and investment aimed at adapting to challenges in a manner that lessens impact of residents and communities.

**Community Resiliency -** Capacity for the community to withstand and recover from climate change disruptions, economic volatility and systemic and institutional injustices.

**District -** For this project, the district includes the full city block of Williams and Russell, including the three developments of Affordable Homeownership, Affordable Apartments and the Black Business Hub.

**Renewable Energy Source -** Power created by renewable source, like solar and wind.

**Energy Efficiency -** Resilience strategy to reduce energy required to provide services.

**Water Savings -** Reducing the amount of water required to provide services.

**Backup Energy Storage System (BESS) -** Energy stored onsite, i.e. battery.

**Energy Use Intensity (EUI) -** Measurement of energy load in a building.

**Operations and Maintenance (O&M) –** Day-to-day activities required to maintain systems and facilities.

**Microgrid (MG) -** Integrating low-capacity renewable energy sources with a distribution grid.

**Distributed Energy Resources (DERs) -** Small, modular energy generation and storage that provide electricity on site and is grid-connected.

**Islanding -** Where a DERs continues power and the electrical grid is disconnected from the system.

**Grey Water -** Relatively clean wastewater from baths, showers, sinks, washing machine and kitchen appliances.

**Demand Response (DR)** - Balancing the demand on power grids by encouraging customers to shift use to times when electricity is more plentiful through lower cost or monetary incentives.

**OZONE Generator -** Filters that intentionally emit ozone for disinfection for water treatment, compared to chlorination. Required equipment for tier 2 and tier 3 greywater systems.

**Geo-Exchange -** Energy efficient mechanical system using the recovery of heat from the earth using a heat pump.

**Ground Source HVAC -** Energy-efficient heating/cooling system for buildings using heat transferred to or from the ground. Geo-exchange is an example of ground source HVAC.

**Photovoltaic (PV) -** A solar panel system.

**Medium Voltage Switch Vault (MV Switch Vault) -** Space containing electrical equipment operating above 600 volts. Contains a centralized collection of circuit breakers, fuses and disconnect switches that protect, control and isolate electrical equipment.

**PAC Distributions -** Equipment and conduits owned by the utility.

**Customer Distributions -** Equipment and conduits owned by the customer.

**Behind the Meter -** Referring to any electrical equipment and distributions that is owned and operated by the customer.

**Front of the Meter -** Any electrical equipment that is owned and operated by the utility.