DRAFT

Eastsound, Washington

2020 – 2040
Long Range Plan

Washington 9 (WA0009) San Juan

I hereby certify that this 2020-2040 Long Range Plan was prepared by me or under my direct supervision and that I am a duly registered professional engineer under the laws of the State of Washington.

By: ____ ________________________

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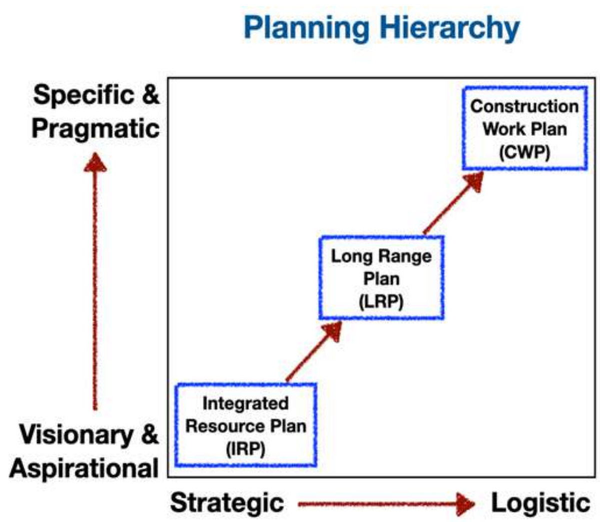
January 20, 2021

I. A Message to all Co-op Members

This is an official submittal required by the Rural Utility Service (RUS). The purpose of this Long Range Plan (LRP) is to submit a planning document to the RUS, to secure capital project funding from them. The specific capital projects in this LRP are for OPALCO projects only, funded through retail rates, and do not include outside funding sources such as governmental grants and member funded projects. We anticipate additional funding sources will arise as we develop the numerous projects in this LRP that may reduce the need for RUS funding. We will amend the LRP as additional funding sources become available. OPALCO's LRP springs from the vision and direction set by OPALCO's Integrated Resource Plan (IRP). As we said in the IRP, "*There has never been a more important time to learn about the tremendous changes that are taking place with energy and climate change.*" We encourage members to read the IRP as a foundation for understanding this LRP.

The LRP acts as a bridge between the visionary/strategic IRP and OPALCO's very detailed Construction Work Plans (CWP) that are grounded in specific and pragmatic details of implementing the increased local energy resources and resilience envisioned in OPALCO's IRP. While not as specific as the CWP, the LRP is an essential management and budgeting tool for navigating complex project roadmaps and securing funding from the Department of Agriculture Rural Utility Service (RUS), which provides capital to electric co-ops.



While the IRP and the LRP adopt a 20-year planning horizon, the CWPs cover 4-year periods – about the most you can plan for when getting into the specifics of costs, permits, purchase orders and system buildout. For an example, see the most recent 2017 – 2020 CWP.

The LRP highlights existing system analysis, design criteria, long-range system evolution, and capital project cost projections. At a minimum, the long-range plan should:

- Determine the most practical and economical means of serving existing and future system loads while maintaining reliable service;
- Identify changes, such as additions, upgrades or retirements of facilities and delivery points, as they are needed in order to meet system requirements; and
- Estimate capital requirements for implementing the Preferred Plan.

We are at a tipping point. The northwest region's energy resource mix is changing rapidly as accelerating climate impact drives the need for rapid decarbonization to quickly reduce the burning of fossil fuels – coal, gasoline, natural gas. These changes are unfolding as we speak and will accelerate over the next five years and beyond.

The more we understand about the trends, options, costs and benefits, the more informed our choices, and the better our solution will be.

Things you can do to be informed and engaged:

- **Read this LRP**. There is a lot of information here. While more technical than the IRP, it will give you a feel for the evolving building blocks of our local energy system. You will have questions. Contact us to deepen the conversation. We are here to help and welcome opportunities to meet with members.

- **Explore questions and ideas with your co-op staff and board members**. Contact the OPALCO staff to deepen the conversation. They have expert understanding of the issues and projects and value hearing your experience and thoughts.
- **Come check out a co-op board meeting** (currently via Zoom). They are packed with information and insight. Here's the calendar.
- **Attend** co-op town halls and candidate forums. See the calendar link above.
- **Explore** the OPALCO website. It's loaded with helpful information and tools.
- **Check out the Switch it Up! Program**: low-interest, on-bill-financing to switch to low-cost electric heating and transportation. It can literally save you thousands of dollars a year in energy.
- **Share** this information and encourage your friends to get engaged. It's going to take all us working together to build a healthy and sustainable future power supply.

OPALCO Nordine Jensen scholarship regional co-op ICUA Youth Rally in Idaho

II. Executive Summary

LRP Highlights

This section reviews the highlights of OPALCO's Long Range Plan. Subsections review current system capacity, grid evolution, strategic capital projects, and capital project funding strategy.

Synopsis

In response to accelerating climate disruption the world will spend over $20 trillion on new energy infrastructure between now and 2040 to decarbonize the planet. This may have significant effects on reliability, especially in the near-term, as old coal power plants are rapidly shut down, before adequate clean energy resources are deployed to replace their capacity. Rolling blackouts are projected to increase, especially during the next few years, exacerbated by climate impacted extreme weather events.

To maintain reliability, and reduce our dependance on mainland power, OPALCO will accelerate its grid modernization and local renewable energy development programs. But we will do this in a way that minimizes impact on rates, by focusing on developing solar and storage resources that serve critical systems and services during outages, rather than OPALCO's entire 20 island service area. **Capital projects are kept modest, focused on "no regrets" projects that provide maximum benefit to co-op members, with minimum rate impact.**

The size of these new systems are designed to generally track the increase in load that comes from the electrification of transportation and heating. That new load will generate new revenue to help pay off RUS loans. Additional funding will come from grants, and direct member investment in community solar subscriptions.

It's important to note that though the focus on this LRP is on new system and generation resource development, the value of hydro is even more apparent as we increase our need for firm reliable power. Hydro power is:

- Much lower cost and longer lasting than battery storage for firming solar. It is the ultimate backup battery, helping us avoid billions of dollars of storage cost for winter firming of solar.
- For at least the next decade, it is lower cost than solar + battery local solutions for energy supply.
- Hydro is 97% greenhouse-gas free, making it the cleanest source of energy for decarbonizing the planet through the electrification of transportation and heating.

The following sections highlight key elements of this Long Range Plan.

OPALCO Grid Capability

OPACO's current system has sufficient capacity to serve member load well beyond the next 20 years of this LRP.

- Average system summer load is 18 MW, winter load is 30 MW, and winter cold-snap peak load is typically 60 to 65 MW – all well within the current system capacity of 105 MW.
- Annual energy consumption is typically about 215 MWh, growing at about 1% per year to a projected 260 MWh by 2040, driven largely by the **electrification of transportation**, and population growth. Though kWh load is increasing, the increase in peak demand remains manageable through deployment of dispatchable load, EV charging, and storage systems as discussed below.
- A sensitivity analysis exploring the impact of high EV load growth could result in 2% annual load growth, to a projected 320 MWh by 2040, well within the current 1,000 MWh annual system capability. Peak load can be managed through dispatchable storage and load, to shift demand to off-peak hours. This has multiple benefits, including improving load factor, reduced aging of the system, and reduced BPA demand charges, as well as new load revenue to fund LRP projects.

Climate Disruption Is Accelerating Grid Evolution

Accelerating climate disruption, extreme weather, and land and ocean ecosystem collapse is compelling nations and states to decarbonize their economies very quickly. The historic 2015 Paris Climate Accord seeks, at minimum, to limit average global temperature rise to "well below 2°C" in the present century, compared to pre-industrial levels.

More recently, the Washington State Clean Energy Transformation Act (CETA) commits the state to a path of no coal generation by end of 2025 and 100% clean energy by 2045. This is a bold move, recognizing the need to reduce carbon emissions as fast as possible. But equally important is what Washington replaces that coal energy with. Washington recognizes hydropower as a critical source of generation in order to meet this goal. Similarly, the state of Oregon and many cities and electric utilities in the Northwest are all working towards carbon-free energy goals. To meet these goals, hydropower – with its energy storage firming capabilities and carbon-free attributes – will be especially important as it helps the region add even more renewable power to its resource mix. It is the go-to firm, clean, affordable energy resource. As western states decommission coal generation, the economics of supply and demand will put upward pressure on hydro pricing.

- **Renewable energy** (solar, wind, hydro, tidal) **needs to be scaled up at least six times faster** for the world to start to meet the goals set out in the Paris Agreement.
- Between now and 2040, **the world will spend over $20 Trillion on Energy Infrastructure**.
- A decarbonized power sector, dominated by renewable sources, is at the core of the global transition to a clean sustainable energy future. **The share of renewable energy in the power sector is projected to increase from 25% in 2017 to 85% by 2050**, mostly through growth in solar and wind power generation. In the Pacific Northwest, **this puts tremendous pressure on hydro, which will be an essential part of firming intermittent solar and wind resources both in the Northwest, and along the entire west coast**. Resource adequacy will be compromised, resulting in increased rolling blackouts and mainland power outages.

Even though OPALCO is fortunate to have very low carbon firm hydro, the global race to decarbonize will challenge our little utility like never before.

As seen above, load-serving capacity is excellent, thanks to decades of investment in up-sized underground distribution cable and substation elements. This allows us to focus capital plans on **increasing local energy resilience**, **bi-directional transactional system capability**, and **local renewable energy generation** to adapt to emerging regional energy resource shortages.

Uncertainty

This 20-year long range plan endeavors to strike a balance between **uncertainty** and **probability**. Though it is difficult to know what will happen next week, much less 20 years from now, there are some notable markers along the way that we anchor our plan to:

- **Washington Clean Energy Transformation Act** (CETA) – The first milestone is in 2022, when each utility must prepare and publish a clean energy implementation plan with its own targets for energy efficiency and renewable energy. By 2025, utilities must eliminate coal-fired electricity from their state portfolios. By 2030 utilities must be greenhouse gas neutral, which means utilities have flexibility to use limited amounts of electricity from natural gas if it is offset by other actions. By 2045, utilities must supply Washington customers with electricity that is 100% renewable or non-emitting, with no provision for offsets.
- **New BPA contract in 2028** – With CETA reducing regional capacity and increasing new intermittent solar and wind resources, and California's hunger for firm hydro energy to firm their solar resource portfolio, we expect BPA hydro to be in demand, driving the cost of energy up faster than previous years.
- **Grid Parity** – With the price of wholesale BPA power rising, and price of solar + storage and tidal falling, there will come a point where local renewable energy will be lower cost than BPA. At that point, we can temper BPA's rising cost with buildout of local solar + storage. We estimate wholes power grid parity to be around 2030 but can imagine many scenarios that advance or delay that date. It's important to note that grid parity for solar and tidal must incorporate the cost of storage into the calculation of the Levelized Cost of Energy (LCoE), since solar, wind and tidal energy a not firm like hydro, and will require some measure of storage to firm them in normal conditions. We say normal because there are occasional extreme periods where the sun doesn't shine and the wind doesn't blow that would require uneconomic amounts of storage to bridge the gap (days, weeks, …). We expect BPA to be the ultimate backup battery, for many years to come. Battery storage would be sized for the more nominal daily firming of solar, to keep budgets more reasonable and reduce impact on cost and rates.
- **Carbon legislation** – Putting a price on carbon is likely, to accelerate decarbonizing the atmosphere. Carbon taxes will accelerate beneficial electrification, EV adoption, load growth and kWh sales. Carbon taxes may drive increased grants and subsidies for renewable energy and grid modernization.
- **Changing government administration energy and climate policy** – will act to speed or slow the transition.

Taken together, these uncertain events require us to remain nimble as we adapt to change. We are the most certain with the first construction work plan (CWP), and expect some degree of adjustment as we move toward the outer CWPs.

Increasing Local Energy Resilience

As climate disruption and decarbonization efforts accelerate, the coming decade will see increased resource scarcity, mainland outages and destructive extreme weather events. To protect our local economy and community, OPALCO is increasing local energy resilience, especially for population centers and critical systems. Since the local renewable energy resources we develop (described below) serve only a fraction of the load, we want to be able focus those local resources toward population centers and services that the community depends on during extended outages. To do that we are developing a tactical mix of systems and services that increase our ability to quickly adapt and reconfigure the grid in response to regional and local outages and imbalances, including:

- **Dispatchable load and EV chargers, smart thermostats, and storage** will find increasing application in homes and businesses as members adopt Smart Gird best practices to increase energy efficiency and home/business energy management.
- OPALCO will provide **incentives to co-op members to reduce their load during times of peak system demand**. This will help OPALCO reduce mainland load during regional cold snaps and resource shortages, reducing the occurrence of rolling blackouts. It also helps reduce peak demand charges from BPA, and wear and tear on OPALCO's grid.
- **Configure population centers and critical systems as micro-grids** that continue to operate during mainland outages, using sectionalizing to isolate from the larger grid, and allocate local co-located solar and storage resources to ride through the outage.
- **Sectionalize the entire OPALCO grid** to support dynamic reconfiguration by rerouting power around local outage areas, to keep the lights on for most members until repairs are made**.**

Increasing Local Renewable Energy Generation

Local renewable generation, in combination with continued energy efficiency programs, form the cornerstone of increased local energy resilience. **The preferred plan will increase local renewable utility energy generation to 13% of projected 2040 load**.

- **Community Solar is the first phase in OPALCO's drive to increase local energy generation.** Funded by subscribers to the service, OPALCO will build as much as members want, subject to availability of permittable land.
- **During local and regional outages, Community Solar array output can be allocated to population center and critical system micro-grids** using sectionalizing grid control elements (discussed above).
- **Battery storage systems are used to firm intermittent local renewables (solar, wind and eventually tidal power) and mitigate regional and local power outages.** In addition, OPALCO will incentivize members to adopt dispatchable storage and load systems to expand and diversify the Co-op's portfolio of storage and load shedding systems.
- **Utility-Scale Solar will be built if there are too few subscribers to the Community Solar program, to augment capacity for the population center and critical system micro-grids.** The objective is to have a combined capacity of about 20 MW. Funding as much of the new utility solar capacity through community solar subscriptions helps keep rates lower.
- **Tidal power generation may be ramped up in the later 2030s,** as that emerging power resource cost approaches grid parity with BPA wholesale energy cost. The Salish Sea has strong tidal flow, making tidal energy to the northwest what solar energy is to the southwest. This depends on local community interest in having tidal generation systems in our local waters. While solar energy is not optimal in the pacific northwest, especially in gray winter months, **tidal power is strong year-round**. We anticipate using grants to explore tidal power potential in the 2020s, identifying optimal locations that have adequate tidal velocity, working with our community to understand benefits and challenges of tidal generation systems. In the 2030s, as tidal power approaches grid parity, with community support, OPALCO would begin deployment as fast as logistics and equity allow. Alternatives include massive solar plus storage to compensate for the problematic and intermittent nature of solar in the northwest. This would require an estimated 1,200+ acres of land, and vast amounts of hydrogen storage to bridge the winter gap when solar output is five times less than summer, while load doubles.

Protecting Our Investments

As Benjamin Franklin reminded us *"An ounce of prevention is worth a pound of cure."* It's easier and cheaper to prevent something from happening in the first place than to repair the damage after it has happened. To that end, OPALCO has several projects that are aimed at extending the life of critical expensive systems, including submarine cables, transformers, and distribution systems. Mitigation programs we will put in place and described in this LRP include:

- Continued **upsizing infrastructure** including submarine, transmission and distribution cables. This helps the cables run cooler, extending their life, and it reduces system energy losses. The up-sized cables give us additional headroom to handle new load growth with existing infrastructure for many decades to come.
- **Cathodic protection of submarine cables** will reduce saltwater corrosion, extending cable life an estimated five-to-ten years. A typical interisland submarine cable could cost $20 million or more to replace. Shifting that expense out allows us to build equity and invest in further preventive and generation resources.
- **Submarine cable load sharing**, like cathodic protection, will extend the life of the cable by sharing the load across both redundant paired submarine cables. Load is halved, significantly reducing heat, wear and tear. This load sharing requires special switching system improvements to ensure seamless switchover in the event one cable fails. Full load must be transferred over to the remaining cable in a safe and coordinated manner.
- Numerous **battery storage** use cases help extend the life of the OPALCO system, especially submarine, transmission and distribution systems. From an analysis by Pacific Northwest National Labs (PNNL), benefits include reduction of various BPA charges, including load shaping charge, demand charge, transmission charge. Additional benefits include solar intermittence mitigation, volt-VAR/CVR, transmission deferral, genset cost avoidance, and reduction of outage economic impact.

Beyond these special projects, the bread and butter of preventive system maintenance, carried on by OPALCO since 1937, focuses on replacing aging system elements including relays, transformers, old distribution cable, meters, voltage regulators, poles, etc.

Capital Project Costs

This LRP evaluates several potential plans and details a **preferred plan**. In addition to the preferred plan, we review two **alternate plans** (go slow, minimize debt, and go fast, maximizing local solar + storage), and a sensitivity analysis looks at impact of increased load beyond forecast, increased inflation rate, and increased funding from sources beyond RUS (e.g., grants, direct member investment, etc.).

The table below summarizes the various plans and sensitivity analysis for Average Annual CWP Cost and Total 20-year CWP Cost projections. The Preferred Plan will increase local renewable utility energy generation to 13% of projected 2040 load. The Go Slow plan would only add member financed community solar, representing about 1% of projected 2040 load. The Go Fast plan will increase local renewable utility energy generation to 23% of projected 2040 load.

Plan	Average Annual Cost	Total 20-year Cost
Preferred Plan (2020 $)	$9,452,732	$189,054,636
Alternative Plan 1: go slow, minimize borrowing	$6,390,600	$127,812,000
Alternative Plan 2: go fast, maximize local energy	$12,129,587	$242,591,741
Inflation Analysis		
• Preferred Plan + 2% Inflation	$11,988,433	$239,768,669
• Preferred Plan + 4% Inflation	$15,317,290	$306,345,792
• Preferred Plan + 6% Inflation	$19,694,569	$393,891,389
Local Renewable Generation Funding		
Generation cost portion of Preferred Plan	$2,843,652	$56,873,031
25% non-RUS funding for generation	$710,913	$14,218,258
35% non-RUS funding for generation	$995,278	$19,905,561
50% non-RUS funding for generation	$1,421,826	$28,436,516

Capital Improvements Funding Strategy

All of the capital projects described above are right-sized to keep the system safe and reliable, preserve capital, and build equity for major strategic projects, including tidal energy and submarine cable replacement, that will occur in the 2030s and 2040s. Until then, **capital projects are kept modest, focused on "no regrets" projects that provide maximum benefit to co-op members, with minimum rate impact**. As discussed above, this includes increasing local solar and storage resources and wrapping sectionalizing elements around it to increase reliability and channel local energy to population centers during mainland/local outages.

Rather than trying to become energy independent from the mainland with massive solar and battery systems, costing billions of dollars and requiring 1,200 or more acres of land, we build equity until much more effective year-round tidal energy resources come online.

Funding for these projects is organized to minimize impact on rates, by drawing on a progressive hierarchy of sources, where RUS funding is the funding of last resort. Funding sources include:

- **Grants** from Federal, state and private sources, including the US Department of Energy, Washington State Department of Commerce Clean Energy Fund, Pacific Northwest National Laboratory, Bonneville Environmental Foundation, University of Washington Pacific Marine Energy Center, and the Rural Utility Service Rural Energy Savings Program (RESP).
- **Direct Member Investment** by co-op members who subscribe to OPALCO's Community Solar program, or are incentivized to purchase storage systems, heat pumps, dispatchable water heaters and EV chargers using RESP funds through OPALCO's Switch It Up! on-bill financing program. This helps members save money on their TOTAL energy bill (gasoline, propane, electricity), support increasing local energy resilience, while helping OPALCO make the load more efficient and dispatchable.
- **Revenue from significant new load as EV market share accelerates.** EVs are rapidly approaching capital cost parity with fossil-fueled cars. At that point, incentivized by increased rebates and tax credits, we expect 2025 and beyond to see significant lift in EV load and associated kWh sales, allowing the co-op to build equity faster, to bootstrap investment in many of these LRP projects.
- **Private Investors** with tax appetite invest in multi-megawatt projects to take advantage of Federal renewable energy tax credits. Though tax credits have been scaling back in the past few years, in the next few years, with renewed focus on combatting climate disruption, new tax credits may be forthcoming.
- **Sell Volt-Amp Reactance (VARS) to BPA** - BPA and generation utilities like delivering power with voltage and current precisely in phase and with minimal noise or spikes. But reactive loads on the grid, such as motors, tend to make this challenging. OPALCO's submarine cables are highly capacitive and can help the mainland condition their power using VARS from OPALCO.
- **Rural Utility Service Funding** is the most common source of LRP funding, since the inception of the RUS program in 1934. For OPALCO, it will be the funding of last resort, after exhausting the funding resources above. We do this to minimize impact on member rates and "keep our powder dry" as we build equity for major investments in tidal energy resources and replacement of some of our biggest interisland submarine cables in the 2040 timeframe.

About OPALCO and the LRP

For 84 years and growing, OPALCO has been dedicated to providing safe, reliable, clean, affordable and sustainable energy to our members.

The Co-op is financially strong, navigating a path of innovation for resilience, as we adapt to a changing world.

We have a diverse membership that inspires us to be our best. We have staff and crews that endeavor to serve our members to the highest standards. We have community-minded partners that help us do more with less, honor us with grants, all in a spirit of cooperation.

OPALCO has one of the most complex rural grids in the nation. We serve 20 islands through thousands of miles of submarine cables, transmission lines, storm-hardened underground distribution, and fiber – connecting 11,300 member homes and businesses through eleven substations. Our grid is constantly evolving to meet the needs of our members and the changing world we live in.

This LRP adds detail to our 20-year energy roadmap and vision described in the IRP. It details the investments needed to ensure safe, reliable, affordable and sustainable service well into the future.

The LRP is a "living document" updated periodically to keep pace with emerging challenges and solutions.

As outlined in the IRP, there are a number of enormous **challenges** and potential **opportunities** that are rapidly playing out regionally, nationally and globally:

- **Climate disruption** – driving rapid regional shift to low carbon energy resources, away from coal, increasing reliance and value of clean, firm, affordable hydro and local energy resources.
- **Shifting energy resource landscape** that, if ignored, will likely lead to rate shock. Local energy resilience is increasingly essential and moving to the foreground, with mainland power ultimately becoming a backstop rather than the main event.
- **Beneficial electrification** of fossil-fueled transportation and heating to reduce climate impact and keep member rates (and TOTAL energy bills) lower
- **Increasing global risk and opportunity** that requires a smart, agile, fast follower approach to innovation. The next four-to-eight years will be particularly dynamic.

For more on all this, see the **Challenges and Opportunities** chapter in the IRP.

Planning Timeline

Here is expected timeline – dates may vary as plan details are refined.

	Date	Activity
✓	February 2018	Strategic Long-Range Vision
✓	March 2018	Long-Range Capital Projects Work Session
✓	May 2018	Long-Range Financial Work Session equity, cash, debt
✓	August 2018	Cost of Service Analysis (COSA)
✓	September 2018	Rate Structure Review supporting COSA
✓	October 2018	Rate Structure Approval
✓	Q2 – Q3 2019	Update Integrated Resource Plan (IRP) to 2020 - 2040
✓	August 2019	Review draft IRP
✓	September 2019	Review final IRP
	Q1 2021	Review and approve final Long Range Capital Plan (LRCP) capital projects
	Q1 2021	Review and Approve 2022 to 2025 CWP and Financial Plan
	Q1 2021	Update Member Communications Plan

OPALCO Mission

Orcas Power & Light Cooperative serves our membership with safe, reliable, sustainable and cost-effective essential utility services with a commitment to the utilization of renewable resources and carbon reduction.

Audience

- **OPALCO Members** The LRP is an essential resource for members to understand how we are evolving our energy services, and give feedback.
- **OPALCO Board and PNGC** To affirm and facilitate strategic planning and oversight.
- **OPALCO Management and Staff** Together with Mission and Strategic Directives, drives investment and project selection to meet objectives.
- **Rural Utility Service** Proforma tool for planning, budgeting, funding and managing projects.

Purpose

This LRP takes the IRP's long-range goals for generation resources for the next 20 years, adds projections on population and load growth, to define a system evolution that meets the co-ops mission and service needs of our members, through 2040. The LRP provides detail, organized around the key structural elements of a modern grid, including transmission, distribution, substations, generation, storage, and grid control elements. The LRP prepares the Co-op to thrive in a rapidly changing environment.

The LRP helps OPALCO in providing the flexible and efficient infrastructure required to meet the evolving energy needs of our membership.

The LRP provides a picture of the future electric system. It specifies line conductor sizes, primary voltages, and new delivery point locations; addresses transmission needs; and provides a basis for the distribution system and power supplier to make sound decisions to satisfy long-range system needs.

The plan allows the borrower to evaluate proposed sites for future substations and transmission lines and to purchase right-of-way in advance if state statutes and corporate by-laws allow. This can result in significant cost savings, especially in high-growth areas.

At the heart of this LRP are three chapters central to our commitment to providing safe, reliable sustainable and affordable energy to our members over the 20-year LRP planning horizon.

- **Load Forecast** – The load forecast projects load through 2040. That load drives the System Design and capital projects required to meet the projected load.
- **System Design - Present** – A snapshot of the current system, including power supply, transmission, substations, distribution, grid control, system energy losses, and historical data.
- **System Design – Long Range Plan** – Details how the present system will evolve over the next 20 years.
- **Capital Requirements** – Details capital expenditures required to implement the 20-year plan. The plan and expenditures are broken into five Capital Work Plans (CWP) that each span four years.

This LRP provides OPALCO with a plan for system evolution based on engineering analyses. Electrical utilities can best serve their consumers by using long range plans which establish guidelines for determining the type, location, and timing of facility additions or changes required to provide adequate and economical service. This plan for long range requirements helps the Cooperative meet the twin goals of a) minimizing untimely additions and b) avoiding the construction of facilities which will become prematurely obsolete.

We employ a “fast follower” strategy; adopting emerging technologies deployed by “early adopters” when they have proven out and achieved parity pricing with the technologies they are replacing. For example, Germany was an early adopter of wind and solar. Since 2002, Germany has spent ~$220 billion and has halted additional subsidies because residential electricity rates have reached US36¢/kWh. While Germany gets 35% of its electricity from renewables today, they have not reduced emissions since 2009.

This LRP helps insure we meet our mission statement for the next twenty (20) years. The LRP was developed with an emphasis on improving service reliability, mitigating the impact of increasing mainland wholesale power pricing, and preparing for increased potential of mainland regional Loss of Load (LOL). We do this by incrementally increasing local energy resources including solar, storage and, eventually, tidal systems to meet the energy demand of the Co-op members. This report will be used for the sequential development of the four-year Construction Work Plans, spanning the 20-year planning horizon, and determine long term capital expenses.

III. LRP Overview

Background

OPALCO serves San Juan County, which lies in the Puget Sound, along the coast of northern Washington. San Juan County is an archipelago consisting of 428 islands totaling an area of over 170 square miles. OPALCO serves twenty of those islands. Six of those islands (Orcas, San Juan, Lopez, Shaw, Blakely, and Decatur) account for over 90% of the land area and support much of the population. A map of the OPALCO service area is shown below.

Geologically, the San Juan archipelago originates from a submerged mountain range crossing Puget Sound in a northwesterly direction. The topography shows significant variation in elevation ranging from over 2,400 feet above sea level to nearly 1,350 feet below sea level. Some regions are quite mountainous and forested, while others provide areas well suited for agriculture and grazing. There are 12 lakes of over ten acres, totaling nearly 760 surface acres. There are no major rivers.

We have little industry in our service area, with about 80% residential and 20% light commercial members. OPALCO currently serves about 11,400 members through 15,200 meters. We expect that will grow about 20% through 2040.

The basic economy of the area has historically been driven by tourism, agriculture, small commercial business, and fishing. Since there are no railroads or major highways, all commerce is by boat, plane or truck. A ferry system is the primary link with the mainland and the commuting by ferry, as well as by airplane and private boat, is common between islands. There are no natural gas or oil pipelines on the islands, which tends to restrict energy use to electricity. The ferries are expected to shift from diesel to electric in the coming decade.

Load Forecast

Overview

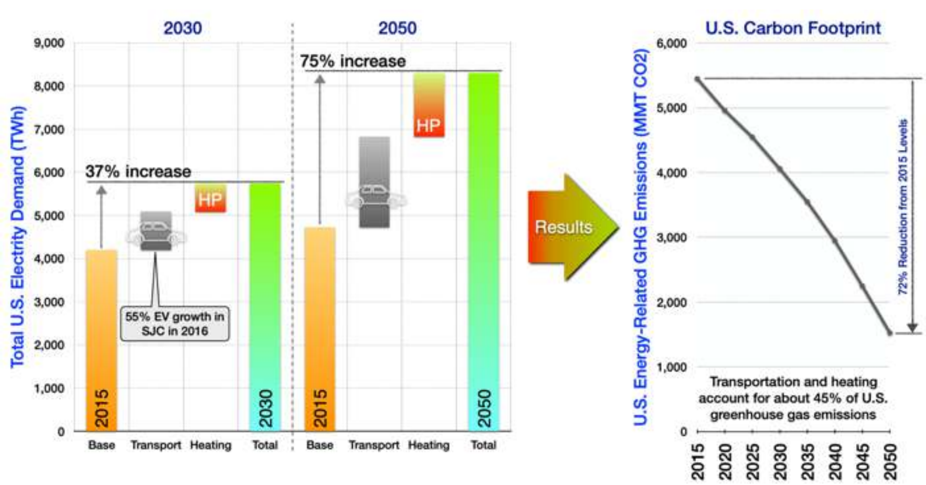
OPALCO load is winter peaking. The climate of the area is generally moderate year-round due to the influence of maritime air masses from the Pacific Ocean and the moderating influence of the surrounding Salish Sea. The late spring and summer tend to be relatively dry, while the late fall and winter tend to be wet. The islands receive 18 to 30 inches of precipitation annually, the majority of which is drizzle or light rain. Temperatures are rarely extreme with the summer average high daily mean in the low seventies and the winter average low daily mean in the low thirties. The average annual low temperature is approximately forty degrees. With climate change, we are seeing warmer winters, which have moderated load grown.

The moderate winter temperatures are ideal for heat pump heating. OPALCO very successful Switch It Up! efficiency program helps members switch from fossil-fueled and electric resistance heating to super-efficient ductless heat pumps. Most OPALCO members heat with electricity and their switching to heat pumps drives significant reduction of load. Though those who switch from fossil-fueled heat contribute to increased load, that increase is modest due to the super-efficient nature of ductless heat pumps. The net effect is reduced load (see charts below).

The planning process calls for the careful projection of load growth. Load has been projected in this study in terms of annual peak demand and level of electrical energy consumption for the entire system. It should be noted that beyond ten years, the forecasting process is highly susceptible to unpredictable variations in the general conditions shaping load. It is recommended that load projections contained in this plan be reviewed every year and that the plan be revised whenever a significant divergence from the projections in this study are noted.

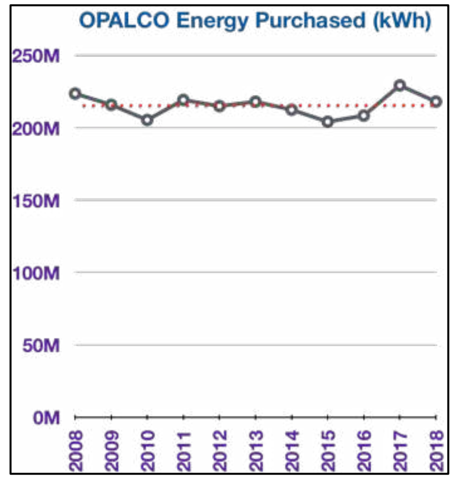
For the past decade, monthly energy consumption was about 950 kWh per member. San Juan county load growth has been fairly flat as population growth slowed, and OPALCO's energy efficiency programs helped members reduce energy use. But over the next 20 years, we project steady growth in load as beneficial electrification of heating and transportation become the norm. The 2019 system non-coincident peak was 63,422 kW. The projected non-coincident 2040 system peak is 71,250 kW.

Nationally, Brattle Group is projecting an aggressive 1.6% CAGR in electric utility load growth between now and 2030, driven largely by the rapidly increasing popularity of Electric Vehicles (EVs). By 2050, Brattle Group projects that beneficial electrification could reduce greenhouse gas emissions by 72% (see chart below). Forty four percent of WA state carbon emissions come from fossil-fueled transportation. San Juan County residents have put a priority on climate action and reducing carbon emissions, and have embraced EVs, with consistent 60+% annual growth of EVs over the past five years.



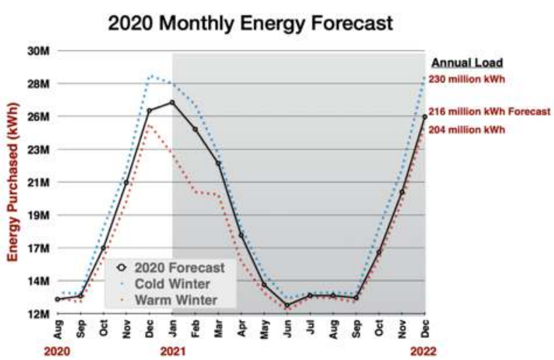
Referring to the beneficial electrification discussion in the IRP, we expect load growth to lift-off around 2022, as EV capital cost becomes lower than fossil-fueled vehicles. We expect load growth to be similar for residential and commercial members, as they both embrace beneficial electrification.

WA Department of Transportation has started converting diesel ferries to hybrid electric eFerries. We expect our service area, which has four ferry terminals, to begin supporting eFerry charging in the 2030s. This will require an estimated 10 MW charging load spike during the 15-minute typical terminal time, off-loading and loading vehicles. Using grants from WA Clean Energy Fund and PNNL, OPALCO has been innovating pairing of storage with the grid to moderate demand spikes. This work will influence our ferry terminal charging system designs.



Referring to the chart at right, while annual total member energy use has a floor of about 200 million kWh, it can increase 15% depending on winter weather. Colder winters can pulse the load to 65 MW peaks when wind blows from the North and temperatures plummet below 20ºF. In a cold year, annual energy has approached 230 million kWh.

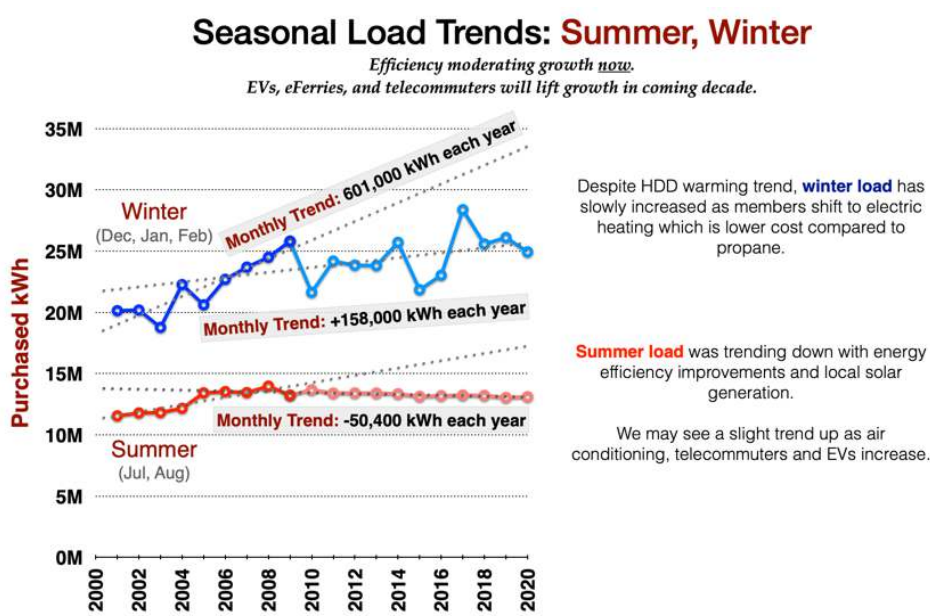
The chart at left shows the load range between warm and cold winters.



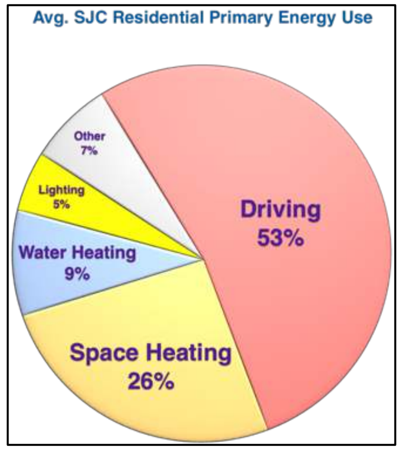
Weather driven variations aside - with slowing population growth and the success of energy efficiency programs, annual load has been essentially flat for the past 10 years.

That said if we explore a seasonal view, we see some important trends emerging. Referring to the chart below, note that before 2010, and the global financial crisis, rapid population growth was driving strong load growth in summer and especially winter.

But since then, growth has moderated, with summer load declining slightly and winter load barely growing. Much of this is due to a combination of three things - slowing population growth, OPALCO energy efficiency programs, and climate change warming winters.



Trends Impacting Load



As the chart at right shows, **transportation**, **heating**, and **water heating** - account for over 80% of residential energy use. The electrification of transportation and heating are a major opportunity for combating climate change and saving members money on their TOTAL energy bill (gasoline, propane, electricity).

The following table summarizes trends that we expect will influence load in the 20-year LRP planning horizon.

Trend	Context	Implication
County Population	Late 20th century growth was exponential. The past decade it has slowed to less than 1% per year.	Steady small contribution to increase in new load. COVID may make it more desirable to leave metro areas for island life, using broadband and Zoom to work from home.
Energy Efficiency	Energy efficiency continues to be the lowest cost "resource:" about 3¢ per kWh. Though many of the easy things – e.g. LED lighting – have been done, the remaining potential is substantial (see 7th Power Plan), particularly heating, water heating and transportation.	OPALCO should continue to fund effective energy efficiency programs, especially for heating, transportation, and smart appliances. The County should promote building standards that increase efficiency (e.g. insulation, passive solar, net-zero best practices).
Grid Efficiency	Just as efficiency makes sense for members, it makes sense for the Co-op's grid. It helps reduce system size, energy losses, and general wear and tear.	Continue upsizing distribution cable to reduce losses. Use grid control backbone and smart technology to monitor and control grid for optimal efficiency.

Trend	Context	Implication
Peak Load	Recent WA decarbonization legislation has essentially created an unfunded mandate to reduce carbon emitting energy sources. Coal plants are being decommissioned, but there is no plan or funding yet to replace coal with new cleaner resources. This leaves an ever-increasing gap between load and the generation resources needed to meet it. Extreme cold winter events will create unpredictable spikes in regional load demand. With fewer resources online, the NW Power and Conservation Council predicts a 30-50 % chance of a major outage in the next 10 years.	Demand spikes will create major regional outages and larger more frequent peak demand charges. Local storage, resilient grid, and local energy resources can help keep the power on for critical county functions and reduce demand charges. Rates and policy may need to be tuned to incentivize best practices that reduce demand spikes: Demand Response Units (DRUs), home storage, dispatchable EV chargers, smart water heaters, etc.
Battery Storage	Battery Storage System (BSS) costs are dropping. Batteries help reduce peak spikes in load and support critical systems during outages. Utilities are increasingly deploying utility-scale batteries and providing incentives for members to install their own dispatchable home/office batteries. This offers members the dual benefit of outage protection, while helping the Co-op avoid expensive BPA demand charges, by dispatching storage during times of peak demand.	Increase deployment of dispatchable utility-scale and member storage systems. Incentivize member storage systems with credits for dispatch of storage to reduce load. Take advantage of grants and low interest finance programs from WA CEF, DOE, and NRECA, to reduce cost. Storage helps with multiple use cases, including peak shaving demand spikes, outage mitigation, reducing transmission system wear and tear, meeting electric ferry charging demand spikes.
Electric Vehicles	SJC EV ownership grew 63% in 2018. The County has one of the highest per capita EV ownerships in the U.S. With battery costs dropping, it is estimated that EVs will be lower cost than comparable fossil fueled cars around 2022. This will lead to rapidly accelerating EV market share. Likely encouraged with a price on carbon (see discussion in IRP Resource section).	EVs will significantly reduce member total energy cost and CO_2 emissions. Over time, EVs will bring significant new revenue to the co-op. We expect more driving in summer than winter, contributing to a flattening of annual load in coming decades. Though EVs are very efficient, typically contributing less than 2,500 kWh per EV per year, as EV sales begin to go exponential in mid-2020’s, rates should be designed to encourage charging at night when other demand is typically low. Dispatchable chargers should be offered and incentivized as soon as available.

Trend	Context	Implication
Electric Ferries	WSF is slowly converting their fleet to electric (hybrid) ferries, accelerating starting in the later 2020s. Charging will be mostly during daytime hours, putting significant new load on the grid and bring substantial new revenue to the Co-op. Electric ferries are lower cost to operate, and whale friendly - quieter, less polluting and lower emissions.	As with EVs, new revenue will help keep member rates lower. To mitigate spikes in demand during ferry charging, battery storage will be deployed starting in 2019, adding more every other year, for dispatch on demand during ferry charging cycles.
Heat Pumps	Heat pumps are super-efficient and can cut member heating costs in half or better. More than 80% of heating in the County is electric, mostly resistance heating. Heat pumps will substantially reduce heating costs for members and heat load on the grid. Heat pumps pay back quickly. That, coupled with OPALCO's On Bill Financing (OBF) program, ensures most heating in the county will shift to heat pumps in the coming decades. Fossil fuel pricing is very volatile. When members switch to electric, they will find that they are not only saving money, their heating and driving bills are more stable and predictable.	Continue OBF program and deepen incentives to accelerate the shift from fossil fuel to electric. This helps members save on their TOTAL energy costs, while reducing climate impact. Converting resistance heat to heat pumps results in significant reduction of load and savings for members. Converting fossil fuel heating to heat pumps also saves members significant costs, with slight increase in winter load. Net load change is likely toward reduction of load.
Heating	Climate change is warming our winters. We have observed a steady reduction in Heating Degree Days (HDD). With our OBF program accelerating uptake of heat pump heaters and water heaters, we should expect heat load to decrease. It is slightly balanced by new load from members who are switching from fossil fuel to heat pump heaters. But heat pumps are so efficient, that the net load change is projected to be minimal and may actually result in a reduction of load.	Net heat load, even with beneficial electrification, is expected to decline, driven largely by climate impact on warming winters. Combined with increasingly warm summers and air conditioning (see next AC trend discussion), we expect a flattening of annual load in coming decades.

Trend	Context	Implication
Air Conditioning	We are starting to see a slight increase in Cooling Degree Days (CDD). As climate impact warms our summers, and with increased market share of heat pumps – which include air conditioning – we expect this trend to accelerate. This will add new load, during summer, when load is traditionally at half of winter load. With the OBF program accelerating uptake of heat pumps for more efficient electric resistance and fossil-fueled heaters, we expect members will enjoy the convenience of cooling on hotter days.	The combination of AC, with EV and electric ferry load (higher in summer) will lead to new higher summer load. Climate change is reducing snowpack and shifting hydro toward winter, so one might expect summer wholesale BPA rates to increase. But new load can be met by the increase in local solar production – both community and rooftop solar.
Lighting	Most members have converted to efficient LED lighting. Those that haven't will soon. Though winters are warming, they are still dark, and a part of winter load is the extended nighttime, with members turning their lights on earlier in the afternoon and keeping them on later in the morning.	Lighting contribution to load will remain flat, more in winter than summer. Expect that home supply shops will continue to trumpet the benefits of efficient LED lighting, further reducing lighting's share of the load.
Summer	In the coming decades, climate impact will generally increase summer temperatures, higher occurrence of extreme heat days. Being surrounded by the Salish Sea, with waters a tempering 55ºF in summer, will keep us cooler than the mainland. That said, on still days, in full summer heat, we project increased use of air conditioning. Shade trees are becoming an increasingly important form of passive cooling to reduce the need for AC. And, with increased summer hustle and bustle, EVs will be more of a presence around the islands, increasing summer load. With climate impact, summer droughts will likely increase, stressing water systems and aquifers. We expect to see an increase in desalination water systems, which are energy intensive. This will be a new contribution to load.	Climate change is reducing snowpack and shifting hydro toward winter, so we may expect higher summer BPA wholesale rates. But this may be balanced by more local community and rooftop solar production (and eventually tidal generation) – offsetting demand from BPA. The combination of AC, EV and ferry load (higher in summer), potential desalination system load, and reduced winter heating load, will lead to a net flatter annual load shape. Flat load is desirable. We should encourage members to plant deciduous trees around their homes and businesses to increase shade (passive cooling) and absorb CO_2.

Trend	Context	Implication
Winter	In the coming decades, climate impact will reduce cold winters. That said, climate impact brings increasing extreme weather – extreme rain, cold, wind – all things that will bring periods of extreme cold. Generally warmer winters may lead to less "snow-bird" empty homes, leading to higher winter occupancy and higher energy consumption in what had been empty homes, with thermostats set to 50ºF.	Climate change is reducing snowpack and shifting hydro toward winter, with snow replaced by rain and runoff. So, we may expect lower winter BPA wholesale rates compared to summer. This will complement the dearth of solar production in winter – 80% less than summer. About 35% of member homes are unoccupied in the winter. Warmer winters may lead to increased occupancy and more load.

EVs – A Significant Driver of New Load

Transportation is the state's largest source of greenhouse gas emissions at 45%. Advancements in electric vehicle (EV) technology in conjunction with the state's abundant and inexpensive, low-emission hydroelectricity, enables the state to greatly reduce greenhouse gas emissions by dramatically increasing the number of electric vehicles on our roads. The continued electrification of the state's transportation system will be vital to meeting the state's long-term greenhouse gas emission goals.

With very clean, low-cost electricity in the northwest, Washington state has become a leader in US EV market share, second only to California. The table below Shows 2018 EV market share and growth from 2017, for San Juan County, California, Washington, and Oregon. WA EV market share grew 71%, to just under 5% market share. This mirrors what we are seeing in San Juan County, where EVs grew at 63% in 2018.

State/County	2018 EV Market Share	2018 Growth
San Juan County	**6.11%**	**63%**
California	**7.84%**	**56%**
Washington	**4.28%**	**71%**
Oregon	**3.41%**	**44%**

As of January 2020, there were 52,000 plug-in electric vehicles registered in Washington State.

EV Highlights for San Juan County

As of December 31, 2018, there were 246 plug-in electric vehicles registered in San Juan County – a 63% increase from 2017.

- Battery electric vehicles (BEV): 182
- Plug-in hybrid electric vehicles (PHEV): 64

EVs are now an important component of our load forecast. As EV market share increases, it will help the Co-op increase beneficial electrification load, helping keep rates lower through increased kWh sales.

Electric Ferries

Electric ferries (eFerries) are proliferating around the world, especially in Nordic countries in their island archipelagos, which are similar to the Salish Sea. Contribution to load will pale in comparison to EV load but will represent a notable new source of revenue none the less.

eFerries reduce air, noise and water pollution, are whale-friendly and a smart economic choice over our current fleet of diesel-powered ferries. OPALCO is well positioned to support eFerries in the islands.

OPALCO's hybrid fiber-wireless communication network supports high-speed real-time data flow between the new class of electric ferries and the ferry operations center. An example from the EV world: According to McKinsey, a typical connected EV generates about 25GB of data per hour.

Electric ferries will help increase use of OPALCO's grid, strengthening revenue, which helps keep rates lower for members. When an eFerry docks, it begins a rapid charging cycle – drawing an estimated 8 MW for about 15 minutes. OPALCO was awarded $1 million WA Clean Energy Fund grant for innovative grid-scale battery storage system. OPALCO's innovative approach to grid-storage may help WSF electric ferries avoid about $691,000 in annual demand charges that would typically be incurred during rapid ferry charging. That's over $40 million in savings over the life of the ferry.

In the **LRP** discussion below, a distributed mix of utility-scale and member storage will be used to avoid demand charges from BPA.

Demand load will be large, which OPALCO will manage using a mix of utility-scale and member storage, which offer a multi-use resource to firm local renewable energy intermittence, peak demand events on cold winter days, transmission congestion relief and asset deferral, and outage mitigation.

eFerries are Whale Friendly

eFerries are emit significantly less air and noise pollution. According to WA Governor Inslee's Office "A recent study found southern resident orcas lose up to 97 percent of their ability to communicate with each other due to noise pollution."

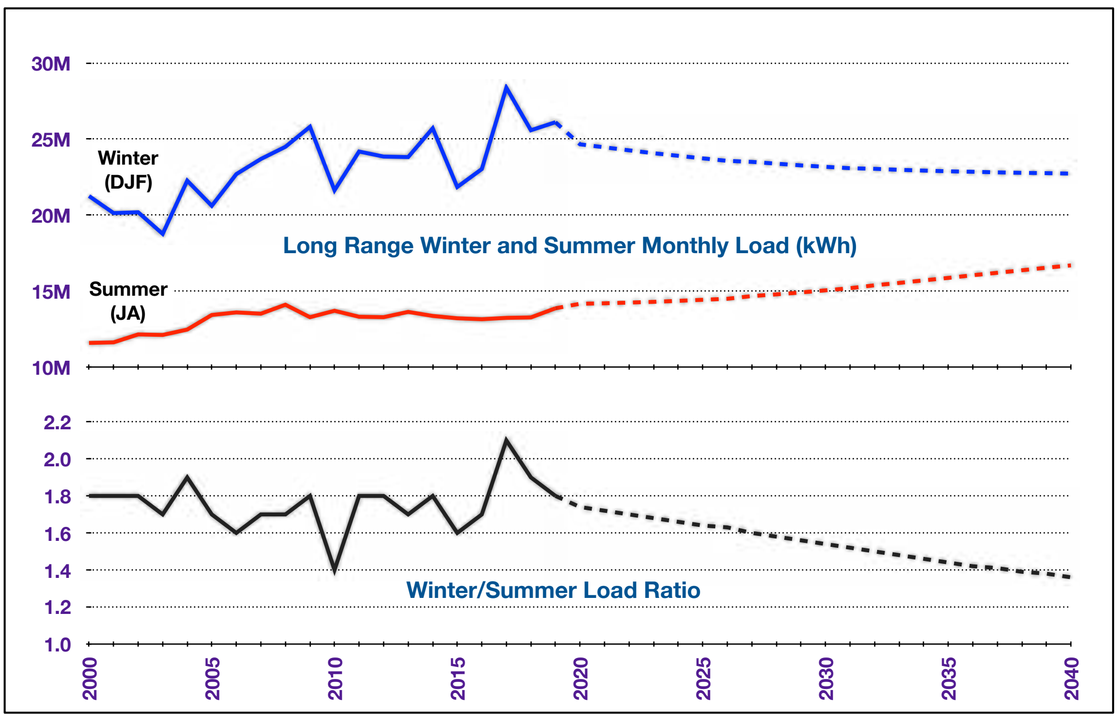
In a recent review of the Nordic electric ferry Elektra, Ship Technology magazine said: "What's particularly noticeable about traveling on the Elektra is the complete lack of vibrations and engine noise."

The electrification of transportation is shifting fossil-fueled vehicles to clean northwest hydro power – reducing the biggest contribution to climate change. In combination with electrification of heating, load increases, which helps moderate rates for co-op members and reduce their TOTAL energy bills by an estimated $2,000 per year.

Shifting Seasonal Load

Referring to the chart below, the upper section shows **monthly load** for winter of each year (blue line – December, January, February average), and summer (red line – July, August average). The lower section shows the **ratio of winter to summer load**. The **load ratio** has been fairly flat from 2000 through 2019, with winter load being about 1.8 times summer load. But our long-range forecast is for the ratio to trend downward. Primary drivers include:

- Winter Load Decreasers
  - Warming winters due to climate impact – reducing heat load
  - Increasing efficiency of winter heating – reducing winter load
  - Members continue to convert incandescent lighting to LED, reducing lighting load during long dark winters. About 5% of home energy use goes to lighting.
- Summer Load Increasers
  - Warming summers due to climate impact – increasing AC load
  - Increasing EV load, with more driving in summer than winter
  - Increasing eFerry load in the 2030s, with more stops in the summer
  - Desalination plants mostly run in the summer and, with climate change, are increasing their output as water becomes scarcer for a growing population. For example, six desalination plants in the county currently desalinate about a million gallons per year, using about 25,000 kWh.



In general, having a Winter Summer Load Ratio closer to 1.0 improves Load Factor – less peak demand in winter – which helps keep winter bills lower for members, and more load in summer, when the economy is strongest, with more jobs and better wages and income.

Conservation and Energy Efficiency

Conservation and energy efficiency measures serve as a means to continue the same level of electric services and uses while reducing consumption. These measures ensure that new and existing facilities are cost effective, minimize or reduce load requirements, defer capital investment and maintenance, and reduce purchase requirements.

The major sources of conservation potential are heating, water heating, and lighting. Secondary potential comes from appliances and consumer electronics, which happen organically as manufacturers constantly improve the efficiency of their products, with incentives from public policy standards (e.g. FTC Energy Guide).

Based on OPALCO's service area, load profiles, and service mix, the majority of potential is in the residential sector. The measures used to achieve these figures include the following:

- Heat pump supplements and upgrades
- Lighting conversions
- Consumer electronic replacements and upgrades
- Water conservation and heating replacements and upgrades
- Home envelope upgrades

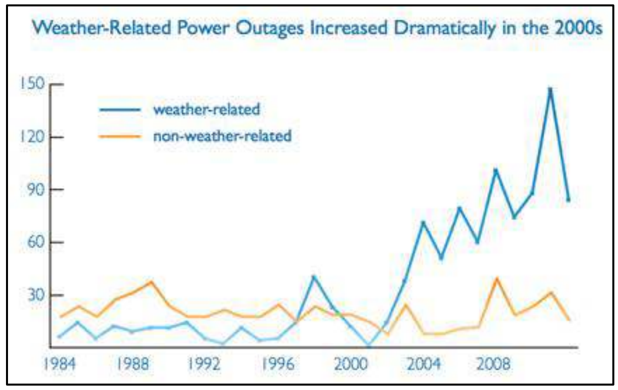
OPALCO's Switch it Up! program is helping members save money and energy. See the discussion above in the **Key Concepts** section.

Load and the Impact of Weather

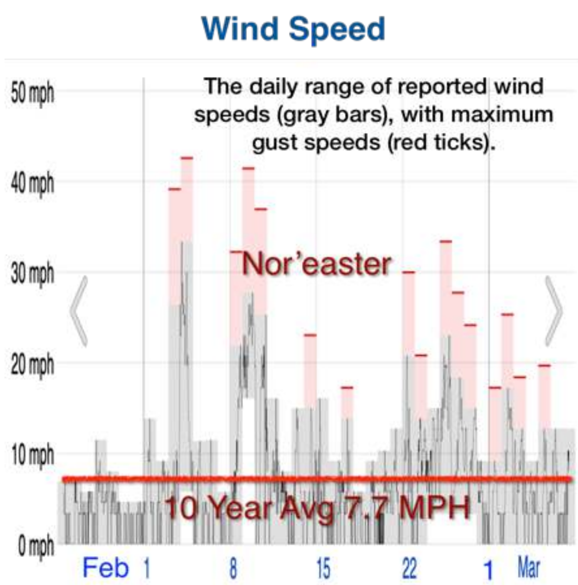
A massive 78% of the total U.S. power outages are related to **extreme weather events**, at a cost of $20 billion per year (source: Congressional Research Service).

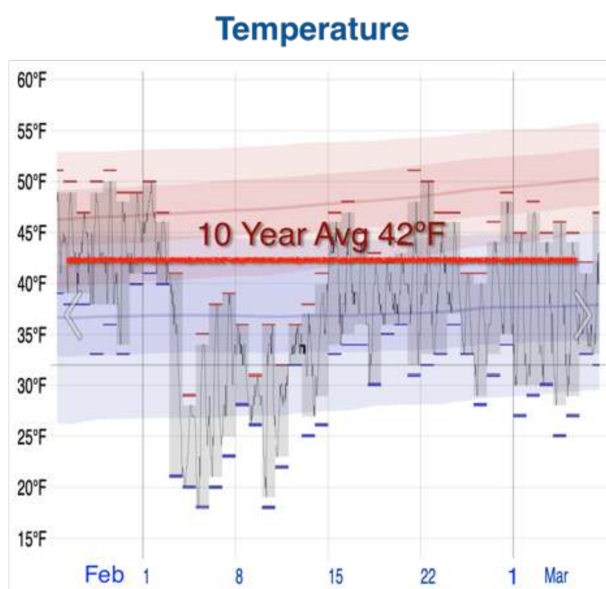
SJC electricity outages cost the local economy about $3.5 million per year (source: Lawrence Berkeley Labs Interruption Cost Estimator (ICE)).

In OPALCO's service area most damage occurs during periods of high wind and extreme cold. A recent example occurred in February 2019 when a Nor'easter blew in for about a week, bringing extreme cold temperatures and very strong winds. See charts below.



While most of OPALCO's distribution system is storm-hardened by undergrounding, the high-voltage transmission lines necessitate aerial deployment, on poles, which make them more vulnerable to tree fall, especially common on Shaw Island, where some of the oldest trees are located. Those old trees often have rotten cores that cause the tree to fail during periods of high wind. The chart below shows wind and temperature extremes for February 2019.





2018 Load Forecast

BPA, PNGC, and OPALCO completed the load forecast in October of 2018. This forecast includes a 0.53% increase to loads for the duration of the 20-year period excluding load growth due to fuel switching, energy efficiency and conservation programs. Factors which effect this growth are as follows:

- Economy
  - Commercial Activities
  - Residential Growth
  - Rate Based Load Shift
- Climate Change Impact: reduced heating load, increased cooling load
- Fuel Switching
  - Fossil fueled cars switched to EVs now, accelerating in mid-2020s
  - Fossil fueled ferries switching to eFerries in the 2030s
  - Fossil fueled heating switched to heat pumps
  - Fossil fueled water heaters switched to heat pumps
- Conservation/Energy Efficiency
  - Long-term trends of residential use
  - Retail market electronics availability
  - Resistance heating switched to heat pumps
  - Resistance water heaters switched to heat pumps
- Distributed Generation
- Smart Grid Efficiencies

Large Power Loads (Winter 2020)

OPALCO is a rural cooperative, with about 10,000 residential households, and 1,000 small business. There are currently no large loads. As discussed in the load forecast section above, we anticipate potential large loads in the 2030s from electric ferries rapidly recharging their batteries during 15-minute docking as they unload and load vehicles traveling from and to the mainland. These loads can draw 10 MW while charging. OPALCO is planning increased distributed storage to mitigate those spikes in demand.

Growth Projections

The 2019 system non-coincident peak was 63,422 kW. The projected non-coincident 2040 system peak is 71,250 kW. See discussion in Load Forecast above.

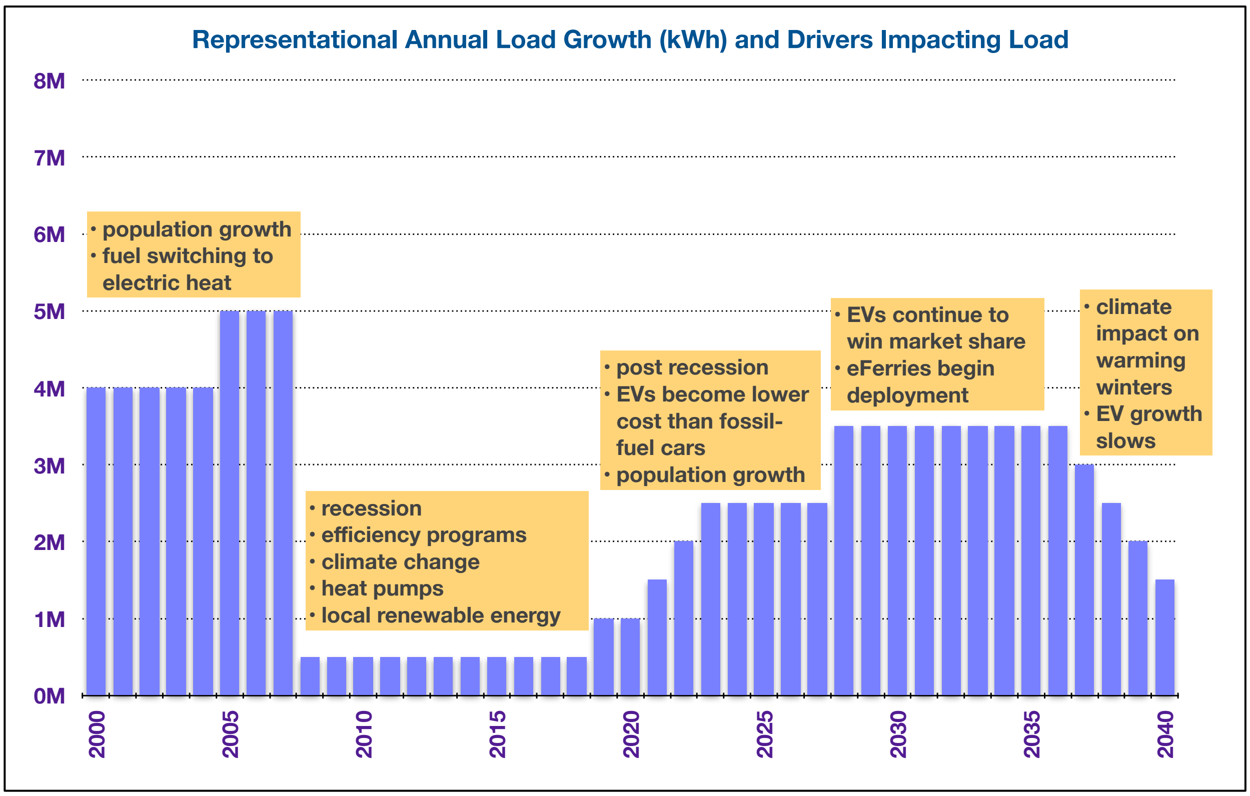
BPA Ten-Year Load Forecast for OPALCO

Each year BPA prepares a load forecast for OPALCO for the next 10 years. It uses a simple approach that only takes into account the past 10 years of load. There is no forward-looking consideration of trends, new load, and so forth. The most recent load forecast – November 2018 – projected annual load growth at a minimal .3%, with peak demand growing at .2%. OPALCO takes this and many other factors into consideration to forecast load.

Representational Long-Range Load Forecast

In the near-term, load will continue be flat to slightly up, driven primarily by population, and members converting from fossil-fueled heating and transportation to electric – saving money and reducing carbon emissions. In 2023, load will gently start to increase as the market share for EVs, electric ferries, and air conditioning become mainstream in our territory. Summer load growth will outpace winter. The chart below shows how we project this will play out through 2040. Major drivers of load include:

- **2000** - Load grows strongly, driven by strong population growth and members fuel switching to low-cost electric heat from expensive fuel oil and propane.
- **2010** - Load flattens as recession hits, population growth flattens, OPALCO initiates energy efficiency programs and heat pump incentives, climate impacts warming winter, and rooftop solar accelerates.
- **2023** - Load grows as EVs hit price parity with gasoline cars, accelerating market share.
- **2028 -** Load growth accelerates as WSF begins deploying electric ferries.
- **2035 -** Load growth contracts as climate impact accelerates, reducing winter heating load. WSF eFerries deployment completes. EVs have displaced fossil-fueled cars and growth slows. There may be some added loads due to desalination ramping up due to climate impact on potable water availability.



OPACLO's Long Range LOAD Forecast

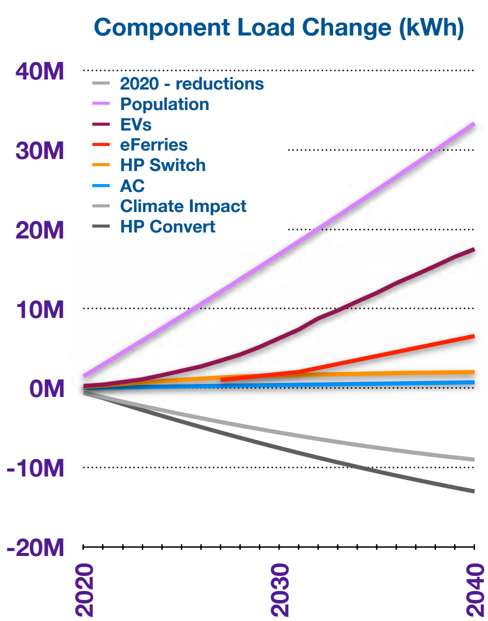
From the load growth rates and drivers discussed above, the chart below provides a component and composite view of our 20-year load forecast.

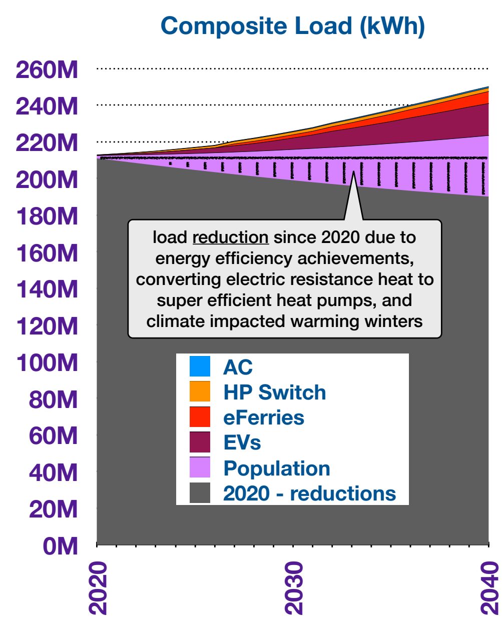
- **Population growth**, even though it is less than 1%, it remains the most significant component of load growth. Each new member consumes an average of about 12,000 kWh per year.
- **EV charging** load starts softly but ramps up in the mid-2020s as the price of EVs become less than fossil-fueled cars.
- **eFerries** start to come online in the 2030s.
- **Climate Impact** with warming winters significantly reduces load.
- **Heat Pump Conversions** from electric resistance heat also reduces load significantly. Members switching from fossil-fueled heat to heat pumps has only a minor increase on load (orange line) and air conditioning, which is rare in our moderate climate, will find increasing use as climate change warms summers, but with only minor increase to load.

As can be seen in the chart at right, the load is projected to grow from a current nominal 210 million kWh to 250 million kWh by 2040, an average annual growth rate of .95%.

See the Sensitivity Analysis discussion in the Long Range Plan **Capital Requirements** section below for variations on load growth assumptions.

population + EVs + eFerries + fuel switching + AC - efficiency - climate reduced heating





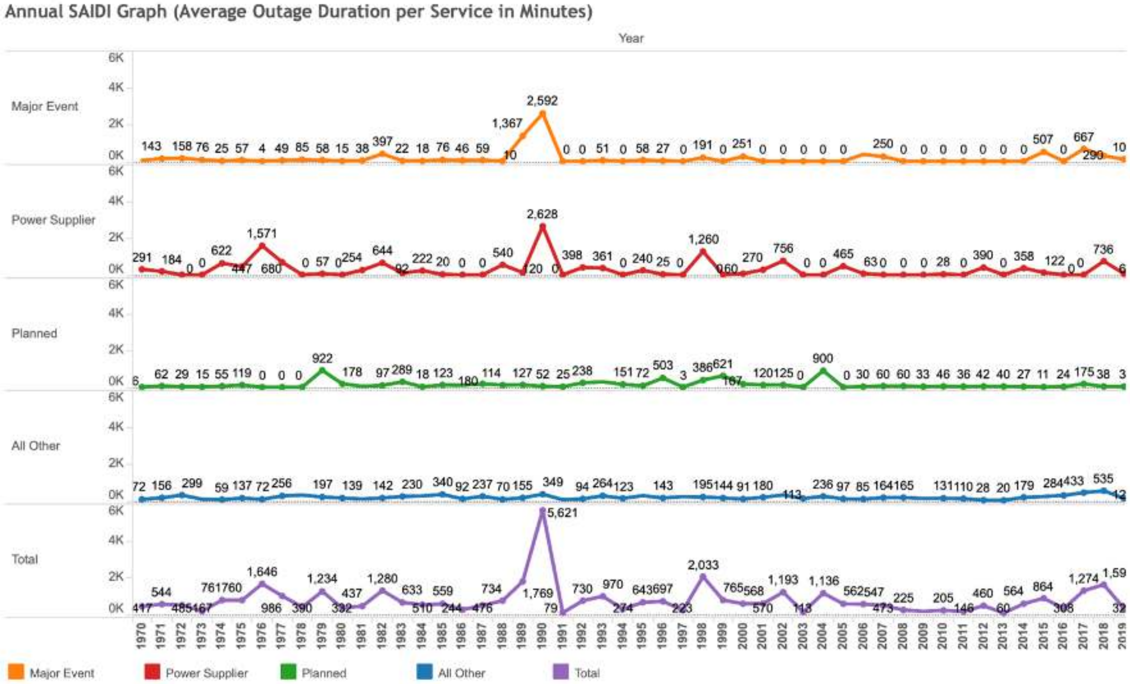
Reliability

Present

OPALCO service territory is a 20-island chain in the middle of the Salish Sea. The system experiences winter storm systems that are challenging. As can be seen in the SAIDI chart below, back-to-back winter storms in 1989 and 1990 resulted in major outages, spanning weeks. Since that time, OPALCO has invested heavily in undergrounding our distribution system; currently 90% of distribution is underground. This has improved reliability markedly, but at the cost of increased outage duration, due to the need to excavate to repair a cable. And buried cable is much more expensive to install and maintain than aerial cable.

We do not have any large industrial loads, and most of our large commercial or critical loads currently have backup generation. In addition, forthcoming storage projects will provide backup power to our population centers and critical systems, discussed below.

Annual SAIDI Graph (Average Outage Duration per Service in Minutes)



Though our distribution has been storm-hardened, we are finding that climate change is increasing extreme rain and wind events that can stress our transmission system, which can’t be buried without great expense and risk to safety and outage restoration times.

Emerging Risk

In 2019, Washington State passed historic legislation, Senate Bill 5116 (SB5116), Washington Clean Energy Transformation Act (CETA). This bill puts into motion a complex set of interdependent actions intended to speed a transition to clean energy but offers no plan or funding to get there.

CETA commits the state to a path for no coal generation by end of 2025 and 100% clean energy by 2045. This is a bold move, recognizing the need to reduce carbon emissions as fast as possible. But, equally important is what Washington replaces that coal energy with. Washington recognizes hydropower as a critical source of generation in order to meet this goal. Similarly, the state of Oregon and many cities and electric utilities in the Northwest are all working towards carbon-free energy goals. To meet these goals, hydropower – with its energy storage firming capabilities and carbon-free attributes – will be especially important and it helps the region add even more renewable power to its resource mix. It is the go-to firm, clean, affordable energy resource. As western states decommission coal generation, the economics of supply and demand will put upward pressure on hydro pricing.

The NW Power and Conservation Council recently wrote:

“The loss-of-load probability increases from 6 percent in 2021 to 7 percent in 2022, and to 8 percent in 2024. The analysis shows that the region will need about 800 megawatts of new capacity to maintain adequacy through 2024. If some of the coal-fired generators at the Jim Bridger plant in Wyoming and the two other generators at the Centralia plant retire by 2024, as currently planned, the probability would increase to about 30 percent, a situation similar to what happened in the 1990s that led to the West Coast energy crisis, when the problem was not retiring existing plants but just not building enough new ones.”

To mitigate the impact of mainland Loss of Load, OPALCO’s System Design will increase local renewable energy resources, including solar and tidal generation, and storage focused on increasing local energy resilience in population centers and for critical systems.

Though there have been calls by co-op members for energy independence from the mainland, it is not remotely practical for our little distribution co-op, in a rural predominantly residential low load customer base. The poor winter performance of solar, and the high cost of storage to bridge the seasonal gap would require over 1,200 acres of land for required solar and storage resources, at a cost in excess of $13 billion.

The advent of tidal energy in the next decade may help, since it has strong energy intensity and year-round performance, removing the need for large amounts of storage. But tidal generation levelized cost of energy is currently out of reach.

IV. System Design – Present

This section describes OPALCO's existing system as of the end of 2019.

Power Supply (PNGC, BPA, local – solar, tidal, storage)

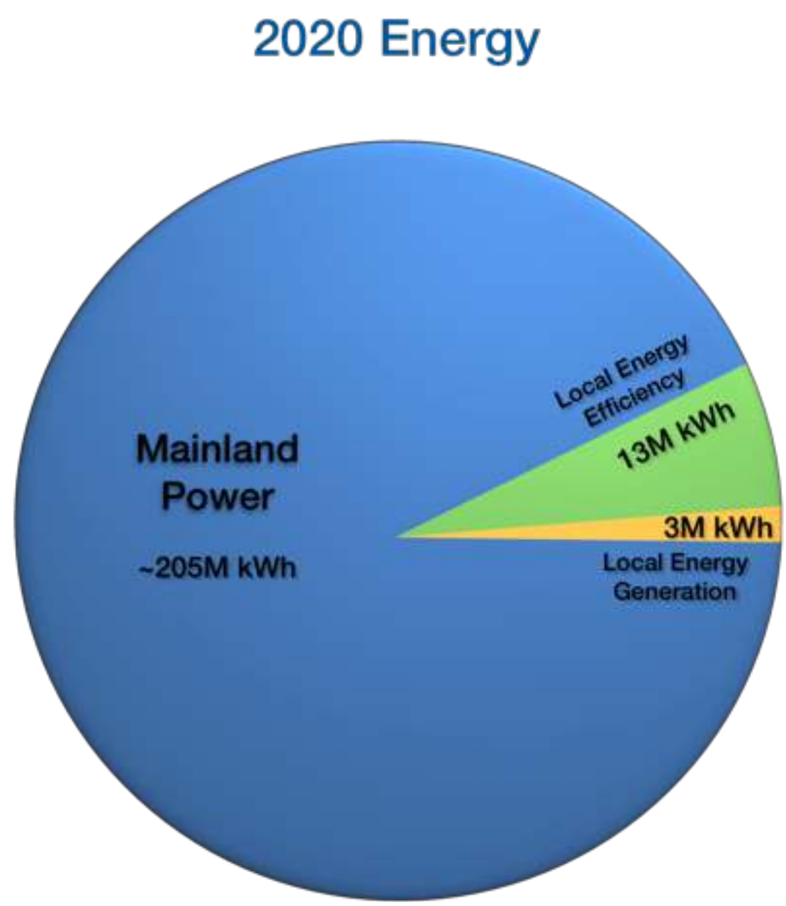
OPALCO purchases power from Bonneville Power Administration through a management contract with Pacific Northwest Generation Cooperative (PNGC). This contract is up for renewal in 2028. Power is supplied from BPA's Fidalgo Substation through two submarine cables (115 kV and 69 kV). The points of interconnection to OPALCO are on Lopez and Decatur Island and fed at 69 kV. OPALCO currently owns and maintains 43 miles of 69 kV transmission in our service area.

Current Resource Mix

Most our energy comes from BPA. Over the past decade though, local energy resources have made significant advance. Local renewables – mostly solar, with some wind and micro-hydro – now contribute about three million kWh a year, and cumulative energy efficiency has contributed about 14 million kWh.

In 2018, OPALCO built its first community solar array, about 500 kW DC, at the time, one of the largest in the state. That increased local solar production by over 30%. Member interest in subscribing was strong, and we estimate there is subscriber potential for an additional 1 MW of capacity.

OPALCO will continue to ramp up local renewable energy resources, increasing local energy resilience, moderating rates as local renewables become more cost effective than BPA, and reducing dependence on mainland power. The chart below shows the current resource mix.



Transmission

OPALCO owns and operates approximately 43 miles of 69 kV transmission lines, supplying eleven distribution substations. This includes 10 transmission submarine cables, covering 15 miles. These lines and associated submarine cables can adequately supply loads projected in this LRP. Reliability and maintenance are of the utmost importance to extend the life of the submarine cables. Based on the age of the submarine cables the life expectancy should be adequate for the next 20 years, but provisions to replace one of the older cables should be in place.

The key to maintaining if not extending the life of the cables is reducing the duration of faults through faster protection schemes, monitoring temperature and oil pressure of the cable, and upgrading the protection to be able to split the load between redundant cables (reduce heat). In addition, OPALCO is innovating the application of storage and cathodic protection to extend the life of submarine cables be reducing heating and corrosion.

Substations

OPALCO presently provides service to its members at 12.7/7.2 kV distribution voltage. The table below shows the primary and secondary voltage rating and the existing transformer capacity at each substation.

Substation	MVA (base)	MVA (top)	Voltage
Shaw	5	5	69/12.47 kV
Orcas	12	12	69/12.47 kV
Eastsound	12	20	69/12.47 kV
Olga	7.5	7.5	69/12.47 kV
Lopez	12	16	69/12.47 kV
Blakely	2.5	2.5	69/12.47 kV
Decatur	2.5	2.5	69/12.47 kV
Roche Harbor	12	22.4	69/12.47 kV
Friday Harbor	12	22.4	69/12.47 kV
Gravel Pit	12	20	69/12.47 kV

Aging transformers will need to be replaced and maintained over the next twenty years.

Service Reliability

Service reliability is an important factor in measuring quality of service provided to the member. Although weather is uncontrollable, some measures can be taken to promote reliable service. A vigorous program of right-of-way clearing to alleviate problematic foliage conditions will continue to be maintained. Foliage in rights-of-way cause outages and obstruct the movement of line crews during storms, thereby increasing outage length. Periodic reviews of easements and right-of-way areas will continue and be expanded when needed and feasible.

Replacement of aging poles and conductors in accordance with an ordinary replacement program will lower material failures. These programs will also aid in reducing weather-related outages, particularly those caused by wind and/or ice storms.

Replacement of aging underground conductor when greater than one failure is seen in an installation area, soil type and conductor type.

Additionally, multi-phasing and load balancing will significantly reduce the number of members interrupted during a single-phase outage and will reduce outage lengths. In many areas where multi-phasing is required, the existing sectionalizing devices cannot be sized to pick up the entire cold load. This significantly increases the outage lengths since the line crews must re-energize the line in sections. Continued multi-phasing and the addition of new sectionalizing points will substantially reduce outage time per member. New sectionalizing points will be added as a part of the *Sectionalizing Study* in addition to the projects included within this plan.

The upgrade of inter-substation tie lines will improve reliability by providing available capacity for load shifts as well as eliminating old, deteriorated conductors from the system. The Cooperative will use 336.4 kcmil ACSR conductor on major overhead inter-substation tie lines and 500 kcmil Al conductor on major underground inter-substation tie lines.

Automation for our substations and distribution system will be a primary focus in the next 20 years. Automatic transferring of loads between substation will be of utmost importance. This will require software, switch improvements, and potentially communication infrastructure upgrades.

Investments in communication infrastructure for distribution automation and system monitor and control will aid in reduction of outage and response times. This infrastructure will provide accessibility to system loads, switching status, outage extent, and awareness of other personnel in the area. Distribution automation will help reduce outage times by decreasing the time to configure the system to isolate the faulted condition which in turn will reduce the total members affected by the outage.

Distribution Circuits

As discussed above, OPALCO has invested heavily in undergrounding our distribution system: currently 90% of distribution is underground.

OPALCO has 1,248 miles of power lines (89% underground). This includes 15 distribution submarine cables, covering seven miles. Overall, the distribution system is in satisfactory condition, as noted in the RUS Form 300 Review Rating Survey (See Appendix).

Our transmission and distribution systems have been engineered with up-sized conductors to minimize loss and allow for expansion. Our focus is on protection of the existing system. Growth of our load through 2040 is well within the nominal load carrying capacity of our current transmission and distribution system.

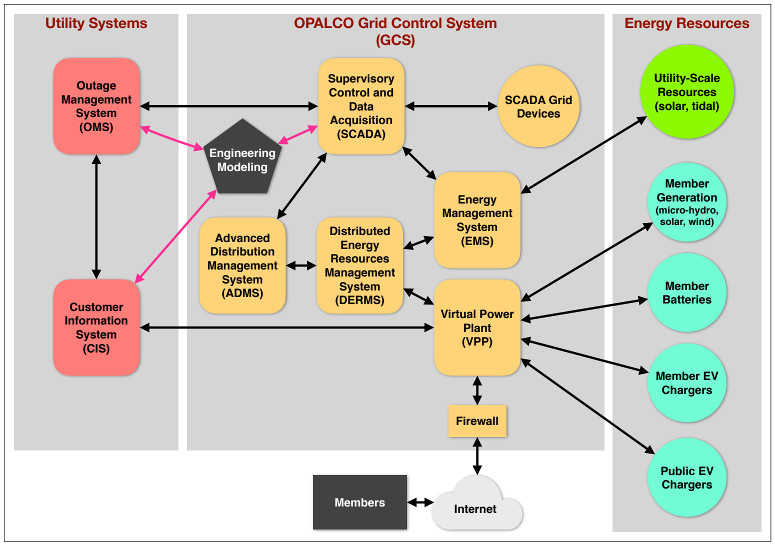
Voltage regulators are presently being used on several feeders to maintain acceptable voltage levels at system extremities and defer capital investment if feasible. In most instances, voltage regulators are used to correct the voltage drop caused by long distances from the source rather than voltage drop caused by large loads. The use of a large number of voltage regulators will result in excessive line losses due to the losses in the regulators as well as those of the smaller conductor and/or single-phase lines serving loads. Re-conductoring and multi-phasing could be used to improve voltage conditions where economically justifiable.

Examination of the circuit loading suggests that there should be an effort directed toward maximizing phase balance on circuits and substation transformers. Multi-phasing improvements are designed to not only correct phase balance, but to improve voltage characteristics, reliability, coordination and line losses.

Grid Control Systems

OPALCO's SCADA system is used to monitor and control the system. Referring to the diagram below, the system is evolving from a conventional SCADA system to incorporate elements that support increased local renewable energy resources, including dispatchable storage, utility-scale renewables, member renewables, dispatchable EV chargers

OPALCO Grid Control Network



System Energy Losses

The system annual energy losses from 2014 through 2020 are as follows:

Year	Losses	Percentage
2014	14,118,192	6.6
2015	12,908,377	6.3
2016	12,285,569	6.1
2017	13,026,268	6.4
2018	13,156,011	6.4
2019	13,287,841	6.4
2020	13,420,569	6.4

Historical System Data

The exhibits referenced in the Long Range Plan Support Material section below illustrate historical system data used in the detailed analysis of system operations. System historical data was reviewed for system peak loads, energy purchased, energy sales, members billed, service interruptions, service extensions, commercial loads and circuit loads.

V. System Design – Long Range Plan

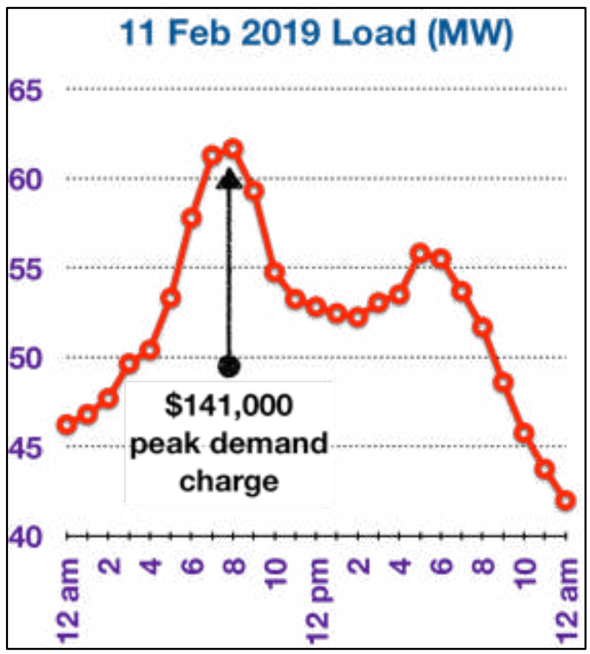
The section discusses the preferred long-range plan from 2020 to 2040, and the strategic trends that shape the plan to deliver safe reliable affordable and environmentally sustainable energy to our co-op members. Alternate plans are discussed in the Sensitivity Analysis Exhibit.

The Preferred Plan preserves capital by emphasizing focused strategic investment in infrastructure that ensures increased local energy resilience for population centers and critical systems but avoids large scale very expensive generation projects until solutions become more affordable and viable. For example, solar and wind projects are very inefficient, with low-capacity factor and significant seasonal underperformance. Tidal power has strong performance across all seasons but is very expensive. That said, member rooftop solar will be encouraged, as long as the economics and impact on rates can be fairly balanced for all members, including those members that can't afford or are unable to host rooftop solar.

The Preferred Plan can best be described as a middle path, that we think of as the "no regrets" approach: invest in systems that we can all agree are necessary, and "keep our powder dry" until economics and technical viability support more comprehensive local energy systems deployment.

Overview

On February 11, 2019, cold temperatures, driven by freezing Nor'easter winds, had members turning up the heat as they arose that morning. The morning load peaked at 63 MW, the mid-day trough was at 53 MW – a 10 MW peak demand spike. That peak cost us $141,000. That peak becomes very expensive if the region as a whole can't meet load.



To shave the peak above would require about 10 MW of storage. At $2 million per MW of storage, that is a $20 million-dollar problem that dwarfs the $16 million Lopez San Juan submarine cable.

Solutions could combine a distributed mix of storage and dispatchable load, for example:

- 3 MW of utility-scale storage. Distributed around the service area, at optimal locations to serve population centers and minimize degradation of power quality due to increasing intermittent resources like solar and wind. Deployed incrementally before 2028.
- 3 MW, about 300 members with 10 kW, of dispatchable storage each (see storage discussion below). Incentivized starting in 2020 with full deployment by 2028.
- 2 MW of demand response units on water heaters and other substantial member load, incentivized with billing credits any time their load is dispatched. Incentivized starting in 2020 with full deployment by 2028.
- 2 MW of dispatchable commercial member standby generation during peak demand periods (not outages), including OPALCO, grocery stores, hospitals and government, incentivized with billing credits any time their generation resource is dispatched. Incentivized starting in 2021 with deployment by 2025.

This strategic investment is similar to what OPALCO did following the storms of 1989 and 90 that knocked down major co-op infrastructure and required significant capital investment in undergrounding distribution cables. Unlike back then, the Co-op has now developed a strong set of financing options to minimize impact on rates. It will take a skillful steady investment that leverages a mix of grants, RESP funds and incentives for member generation/storage to tackle this.

OPALCO continues to monitor the Levelized Cost of Energy (LCoE) of local renewable energy resources and as those costs approach the slowly rising cost of BPA, and as those energy resources become viable for utility-scale application, they will be added to the grid reducing our dependency on mainland power, increasing local resilience and moderating the rising cost of mainland power.

Renewable energy resource costs have been falling, while BPA pricing has been slowly rising. The point at which they cross is called **Grid Parity**. In other words, Grid Parity is the point at which an emerging technology becomes economically viable. At that point, the emerging technology has increasing cost savings compared to the legacy technology (see discussion below).

In the near term, **before Grid Parity and CETA** (see discussion above), OPALCO will:

- Focus on keeping retail rates low by leveraging the low cost (4.4¢ per kWh) of BPA energy.
- Balance usage rates to encourage fuel switching to build revenue to help reduce rate increases.
- Secure as many grants as possible for solar, storage and dispatchable load, keeping it modest until grid parity.
- Invest in energy efficiency and beneficial electrification.
- Build as much community solar as members want – at least another 1 MW.
- Improve high-value local energy resilience with microgrids around population centers. The community solar arrays will generally be deployed near population centers and critical services with sectionalizing systems to form isolated micro-grids during outages.
- Evaluate and implement new programs to offer dispatchable storage and DRUs to help mitigate peak load conditions.

We expect that wholesale local renewable energy resources will become competitive with BPA wholesale electric rates around 2025 (Grid Parity). See analysis and definition below. **After Grid Parity**:

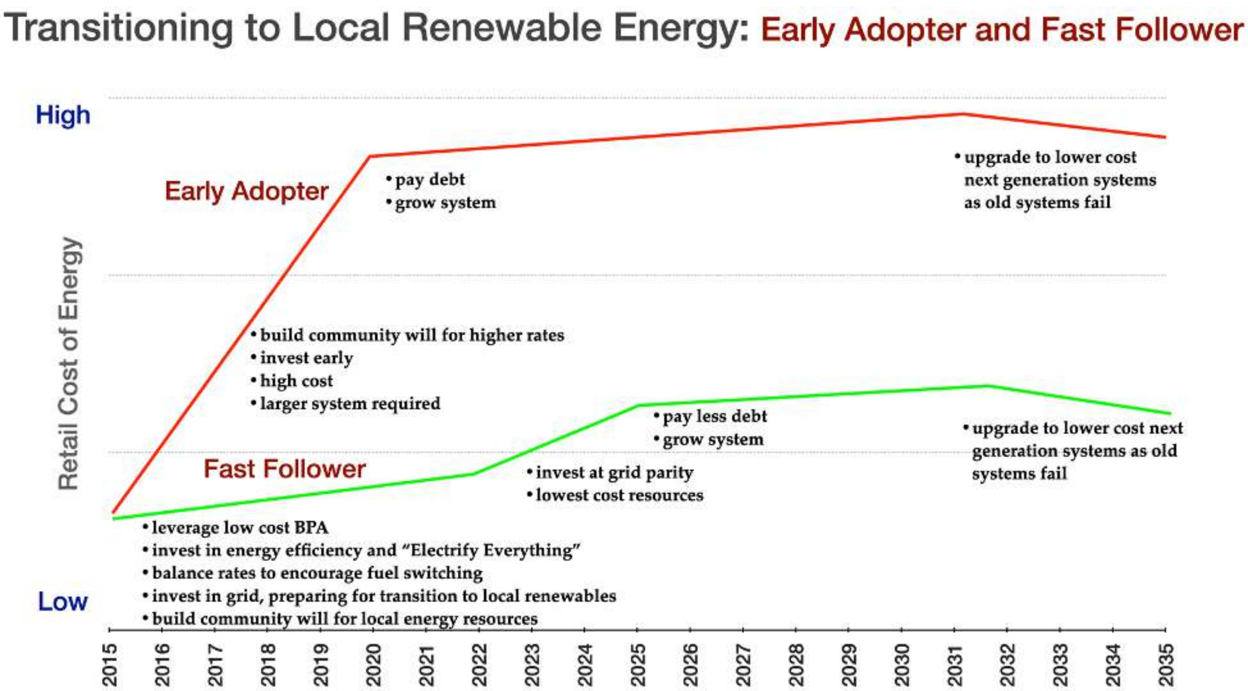
- Ramp up a transition to viable lower cost local energy resources using BPA as backup and firming. This will bend the arc of rising BPA energy costs through application of falling local energy resource costs.
- When tidal energy resources hit grid parity, and with community support, add that into the local mix to fill the winter low solar production gap (see **Winter Problem** discussion below).

The table below summarizes the recommended resources to be developed, the purpose of those new resources, and the investment source, before and after grid parity.

	Before Grid Parity	After Grid Parity
Resources	Deploy modest amounts of local renewable energy resources: a combination of solar + storage + demand response, community solar, and utility-scale solar. Incentivize rooftop solar, dispatchable home storage, and demand response units.	Continue modest deployment of seasonal local renewable energy resources (solar, wind), as they become affordable. Preserve capital until year-round resources such as tidal become economic, to significantly reduce our dependence on mainland power, probably in the later 2030s.

	Before Grid Parity	After Grid Parity
Purpose	Increase local energy resilience, especially for critical services in the county: first responders, population centers, government. Community solar helps members lower the cost of their electricity. Reduce vulnerability to demand charges. A portion of community solar will go to low-income members, with the support of grants and RUS funds.	Increase local energy resilience. Cushion against the increasing cost of mainland power.
Investment Source	Community solar is paid for by subscribers. Utility-scale solar is funded through grants and rates. Demand response paid for through grants and rates.	Grants, rates.

Referring to the chart below, OPALCO has been employing a Fast Follower strategy, generally waiting for Early Adopters to prove out emerging technologies and letting the price point of viable systems improve.



Being a Fast Follower has important advantages and benefits for the Co-op. We benefit from the Early Adopter experience: revealing the actual costs for emerging technologies and the best practices needed to get the most out of them. We can make better economic and technical decisions. This results in better ROI and reduced risk for the Co-op.

Before grid parity, we use grants to be a faster fast follower by reducing the cost of the new resource and trialing the technology in preparation for grid parity.

As the LCoE of local renewables approaches grid-parity, OPALCO will begin ramping up local renewable resources, meeting demand with the lowest cost, cleanest sources. As with **Early Adopters**, this investment is paid for with a combination of grants and debt, but the debt financed is smaller for **Fast Followers**, since the capital cost of the systems is smaller, and the system size needed is less, thanks to the energy efficiency achievements that preceded the build-out of local renewables. In addition to lower cost of capital, there is also the added benefit from delaying build-out until grid-parity: systems being acquired are state of the art, being 10 to 20 years newer than systems put in place by **Early Adopters**.

We want to be Smart Fast Followers, monitoring LCoE trends and viability of solutions, and erring on the side timely investment that gets the most bang for the buck for the co-op and members.

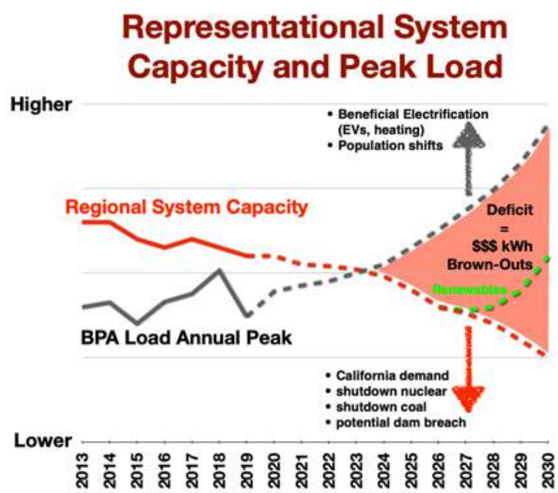
Resource Adequacy and Potential Mainland Loss of Load

As mentioned above, OPALCO expects increased probability of Loss of Load in the coming decade. The problem is two-fold: the mainland is reducing capacity and there is no plan or funding to replace that capacity. The table below summarizes the actions that are underway that will impact regional power capacity and the impact/reaction that reduction will have. Reduced mainland capacity will necessitate development of local energy resources to mitigate mainland challenges. This is discussed in the Energy Resources section below.

Action	Reaction
• Increased hunger for climate friendly hydro, especially in California • CETA • Decommissioning coal/nuke plants • Potential dam removal	• Reducing capacity • Demand charge increases • Energy cost increases • Brownouts • Rolling blackouts

Reduced capacity and the attendant impact will lead to increased costs for OPALCO and our members. There are two kinds of cost:

- **Direct** Cost of Power: energy cost and demand charges
- **Indirect** Cost of Outages



The potential impact of capacity shortages on cost of power are shown at right, representationally. The regional capacity is falling while load is increasing and accelerating as beneficial electrification hits its stride in the mid-2020s.

The development of new local and regional renewables can mitigate outages, but it will take time to implement an adequate capacity to balances losses.

Which brings us to the **indirect costs**. As the potential for outages and brownouts increase, there is an is an associated interruption cost. We use the Department of Energy Interruption Cost Estimator (ICE) to calculate the cost. The table below summarizes the results for residential and commercial members in the OPALCO service area. The column at right shows the value of improving reliability by 30%, for a total benefit of about $38 million over a 25-year improvement asset life.

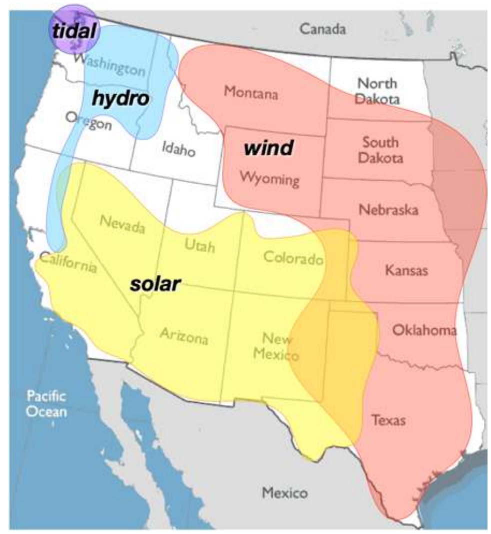
Members	Meters	Typical Outage Event Cost	Value of 30% Reliability Improvements
Residential	13,200	$217,957	$1,030,287
Commercial	1,900	$6,381,580	$37,326,937
Total	15,100	$6,599,538	$38,357,224

Members	Meters	Typical Outage Event Cost	Value of 30% Reliability Improvements
Notes		Typical February outage event: **SAIFI = 1.74** **SAIDI = 358**	Project start: 2020 Inflation: 2% Asset Life: 25 yrs Discount Rate: 6% **SAIFI = 1.4** **SAIDI = 240**

As we respond to the emerging risk of capacity shortfalls, we are attempting to thread the needle by scaling investments to mitigate increasing risk associated with inaction. Rolling blackouts will have a galvanizing effect on members, helping them realize the seriousness of the problem. But we risk losing the trust of the public. The more we can anticipate the outage risk, communicate the urgency of the problem, and make the investments to mitigate risk, the less the impact on the Co-op and its members. Development of multi-megawatts of local resources such as solar and tidal will present significant siting challenges.

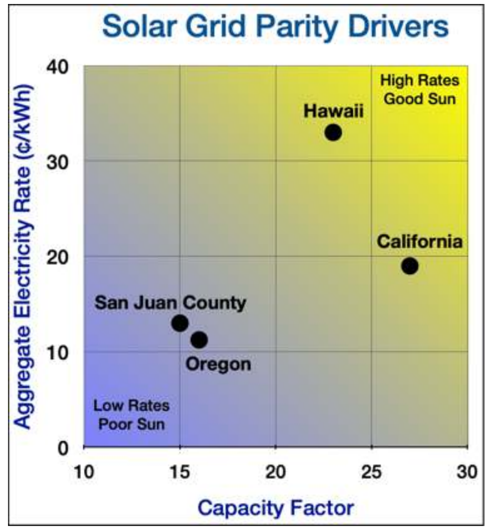
The next few sections discuss energy resources we anticipate deploying over the 20-year planning horizon of this LRP.

Local Renewable Energy



- With renewable energy, it's all about "*location, location, location.*" Where is a given resource most abundant? As the chart at right shows, solar is best in the southwest, wind in the midwest plains, hydro in the northwest and tidal in the Salish Sea.
- In the interest of diversity though, solar, wind, tidal and storage, in combination with hydro for firming, ensure maximum reliability when the "wind don't blow and the sun don't shine."
- Tidal energy is the optimal renewable for our area, but it is in the early stages of development and it may be one or two decades before it is economic and competitive with hydro. Unlike solar, tidal is abundant day and night and year-round. And it is less obtrusive.
- Solar is not optimal in northwest winters. Electric load doubles in winter, while solar output is one fifth compared to summer. Solar is more expensive than hydro, but more affordable than tidal, for at least the next decade.
- OPALCO estimates that to be energy independent from the mainland would require more than 1,200 acres of solar. And, keep in mind, that solar will do nothing to reduce the county's carbon emissions, since it is offsetting hydro which is lower carbon than solar. See discussion below.
- The County has said they want to preserve the rural character and natural beauty of the island and solar requires special permitting that may limit how many acres of land are available, along with "Not in my back yard!" (NIMBY) mindset.
- While there is some wind generation in the county, wind is meager and not economic. the best wind available is on the top of Mount Constitution. Again, preserving rural character and natural beauty may lead to permitting issues.

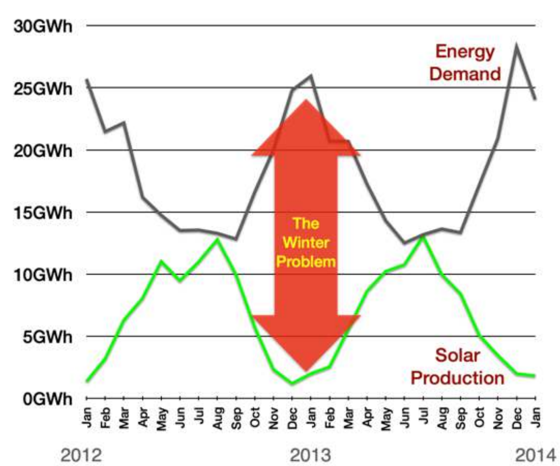
- When a renewable resource is deployed in less optimal locations, it has a reduced *Capacity Factor*. The chart at right shows how the same solar panel has reduced output in the northwest compared to the southwest. This increases the effective cost of solar. And, since northwest electric rates are lower than the southwest, adoption of solar is less economic. We don't anticipate grid parity (cheaper than hydro) until about 2026.
- Local renewable energy will not reduce local fossil fuel emissions, since OPALCO energy is cleaner than solar and wind. But it will increase our local energy resilience and reduce dependance on mainland power.



Renewables Example

Some co-op members have asked what it would take to be energy independent from the mainland. The following analysis describes what would be required to generate all energy locally for current load, using a combination of solar and storage batteries to serve OPALCO's members: about 8,000 homes and 1,000 small businesses.

- The County uses about 207 million kWh per year. On the coldest winter mornings, the County will need about 62,000 kW peak. On the mild summer days, the County draws about 11,000 kW minimum. Throughout the year, the County averages about 24,000 kW average.
- To power that load, would require 204,000 kW of utility-scale solar, costing an estimated $204 million, on 1,225 acres of land, if it can even be permitted and acquired.
- To store energy for use at night and in dark winter days, would require 83,331,000 kWh of battery storage, costing $12.5 billion, and 83 acres of land.
- Total cost of solar + storage + land is estimated to cost about $12.7 billion.
- This yields a total cost of $3.08 per kWh (solar + Battery + land), compared to $.045 per kWh from BPA: about a 70X increase in member energy cost. An average 1,000kWh member electric bill would increase to more than $3,000 per month.
- The chart at right shows a rooftop solar approach. With member rooftop solar, 8,000 roofs x 10kW/roof would generate 81,040MWh, or 39% of the annual load, but the price for this would be 3X higher than the same amount of utility scale solar. This assumes that many roofs have adequate sunshine and all 8,000 homeowners could afford to deploy those rooftop arrays. This does not solve the massive need for storage. Only a small fraction of rooftop solar homes add storage to the mix, and when they do, it is a small fraction of what is required to be off grid.

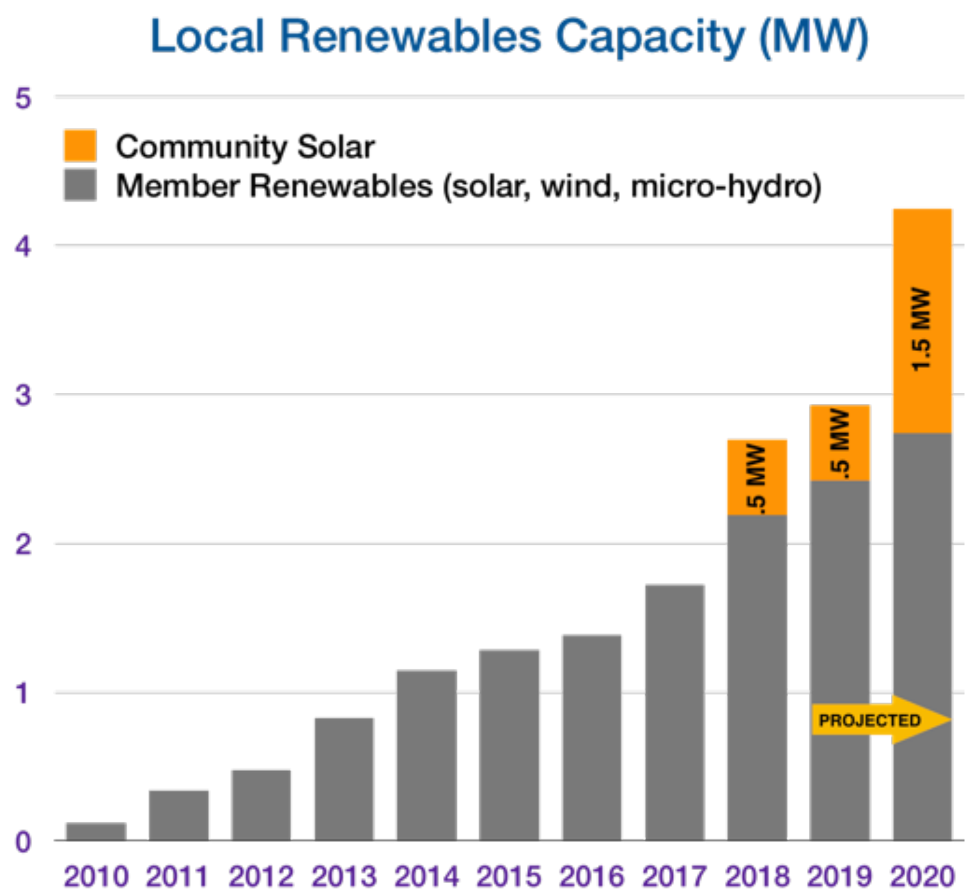


- Cost analysis does not consider new transmission, distribution and substation upgrades required. It's also worth noting that such an investment would need to be repeated every 30 years for solar asset and every 20 years for the battery asset to replace aged equipment.

- A 50% reduction in total county power usage (unlikely) cuts the price in about half.
- Neither scenario is realistic unless another renewable source with a higher capacity factor and ELCC (Effective Load Carrying Capacity) is available (most likely candidate is tidal), then the goal of local generation is: 1) emergency supply, routed to critical resources, and 2) a buffer against price volatility due to peak pricing, or Time of Use pricing from the mainland market.
- Though still not economically practical, it is important to appreciate the pros and cons of each approach. There is no perfect solution. Over time, innovation will provide improved systems that can meet our needs. One of the reasons we are pretty excited about tidal energy is that it is abundant here in the Salish Sea, year-round, day and night, unlike solar, hence requiring minimal expensive storage. Over the next decade or two, OPALCO expects a number of options to become economically and technically feasible.

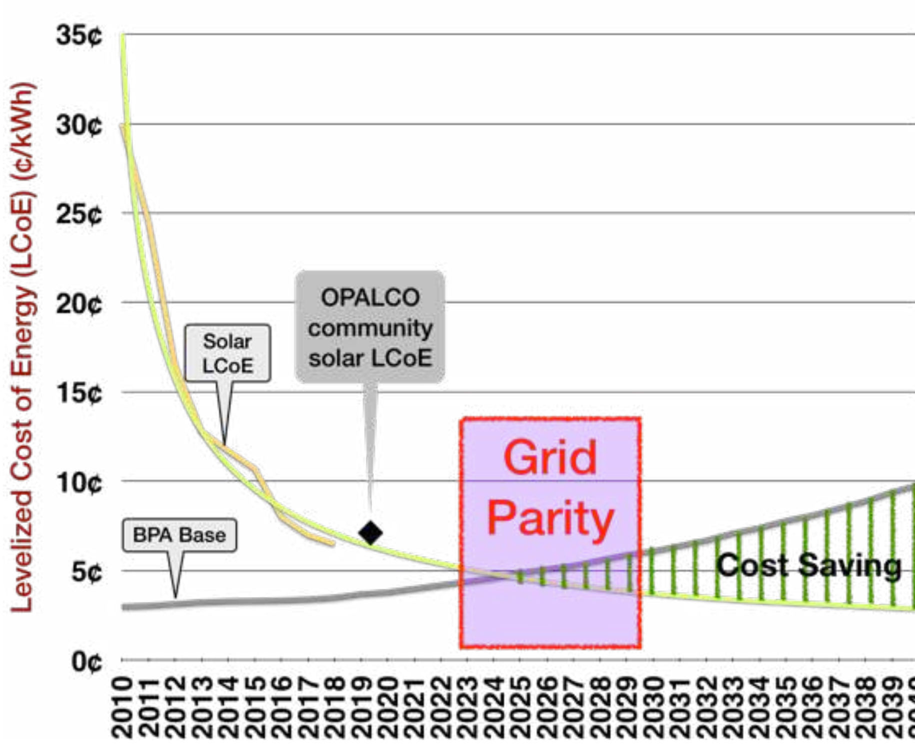
Solar Resource Overview

Solar LCoE has been falling steadily for the past decade and is beginning to flatten out. A 2018 increase in WA renewable energy production incentives accelerated solar rooftop deployments by members, and OPALCO built a .5 MW community solar array on Decatur Island. The chart below shows local renewable energy capacity by year with projected capacity for 2019 and 2020 (due to COVID, the 2020 community solar addition has been pushed to 2021).



Northwest Solar LCoE and Grid Parity

As discussed above, renewable energy resource costs have been falling, while BPA pricing has been slowly rising. The point at which they cross is called **Grid Parity**. In other words, Grid Parity is the point at which an emerging technology becomes economically viable. At that point, the emerging technology has increasing cost savings compared to the legacy technology (see slide below).



Once a resource is at grid parity or better, it can be added into the energy portfolio to replace or moderate the cost of legacy energy sources.

Grid parity of solar with retail electricity cost is projected to occur in about 2025, and with wholesale BPA power cost, in about 2030.

The notion of grid parity tends to be focused on simple Levelized Cost of Energy (LCoE). But when comparing firm BPA wholesale price to intermittent solar, it's complicated. To create an equivalent firm solar output requires combining solar with battery storage to ride through cloud hits and nighttime or rainy day gray periods of low solar output. It gets more complicated because OPALCO doesn't use storage solely to firm solar. Our typical grant-winning innovations apply storage for 7 different use cases, including:

- Load Shaping Charge Reduction;
- Demand Charge Reduction;
- Transmission Charge Reduction;
- Submarine Transmission Cable Replacement Deferral;
- Volt-VAR/Conservation Voltage Reduction;
- PV Production; and
- Outage Mitigation

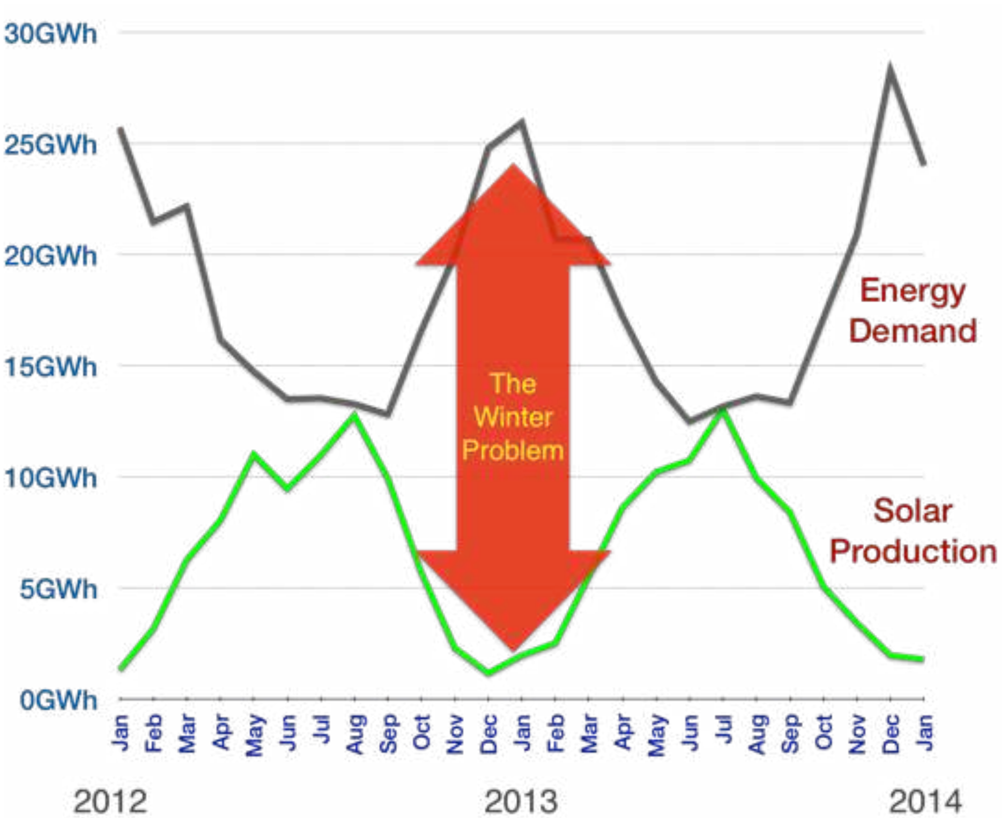
Taken together, the multi-use of storage reduces the cost for each applicable use cast compared to standalone applications.

And when solar and storage are combined for mitigation of the occasional outage, the indirect benefits can be substantial, especially when applied to micro-grids for population centers and critical systems, where SJC electricity outages cost the local economy an estimated $3.5 million per year.

The Winter Problem

San Juan County solar in summer is quite good but, in winter, output drops to one-fifth of summer output while load doubles. We call this "the winter problem." The best year-round resource for our region is tidal energy, but it is an emerging technology, and we don't expect it to be affordable until the 2030s.

OPALCO rooftop solar members use the grid as their battery, generating energy in the summer, selling excess to the grid, using net metering and buying it back in the winter when solar output is minimal. The chart below offers an example of the winter problem. Assuming each home had good sun, and had a 7.5 kW array, solar would only meet about 38% of the county's electric load, due to limitations of sun in the northwest. In winter, load doubles, but solar decreases by 80%. But, with climate change… winters are warming and summers are, too. There will be reduced need for winter heat and increased need for summer air conditioning. Snowpack is decreasing, which means less hydro flow in summer, which could mean lower hydro production and higher hydro costs in summer when big cities have increased air conditioning load. Solar can help fill the gap from reduced summer hydro. And, increasing local renewable energy such as solar, wind and tidal helps increase local energy and economic resilience.



Storage – Utility-Scale and Member-Owned

While there are a number of approaches to energy storage, in this section we focus on two:

- Utility-scale Storage
- Member-owned Storage

Storage: Utility-Scale

Energy storage is the Swiss Army knife of a 21st century grid. It provides OPALCO with the ability to store energy for a variety of use cases including:

- Bulk energy – arbitrage and capacity
- Outage mitigation, support microgrids
- Peak shaving and load shifting – reduces demand charges
- Transmission congestion relief and asset deferral
- Firming intermittent renewable resources
- Ancillary services – regulation, spin and non-spin reserve, load following, frequency response, flexible ramping, voltage support, black start
- Distribution deferral, voltage support, conservation voltage regulation

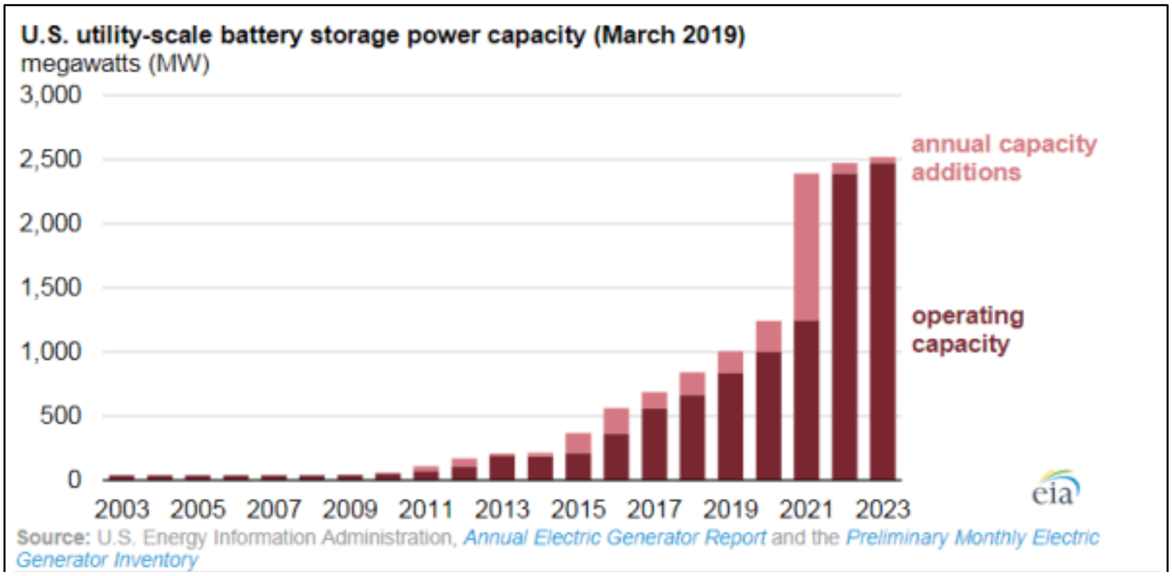
Energy storage will be a critical part of our efforts to reduce peak load on OPALCO's system.

PNNL advises that for every 1 MW of solar, we should balance with about 200 kW of storage.

Storage will be an essential tool to help us increase local energy resilience and keep rates lower as peak demand charges for mainland power increase. Energy industry analyst Gregor Macdonald recently observed:

> *According to the EIA, solid annual growth in 2019 and 2020* ***will be followed by a disruptive high growth year in 2021****, followed by a resumption of much lower growth in years 2022 and 2023 (see chart below). As wind and solar costs continue to fall, that makes the cost of whole-system projects fall entirely, even if cost decline rates for storage are lagging. Moreover,* ***utilities from Arizona to Florida are deciding that not only does it not make sense to build new natural gas generation****, but in some cases, it now makes sense to build storage, instead of new wind and solar. Why? Because everyone else is already busy deploying new wind and solar: so why not be a market-maker in electricity supply via storage-capacity versatility, in addition to being an electricity generator? In order to have exposure to everything coming in the grid ecosystem, utilities have discovered there's not only a new profit center to exploit around storage, but* ***storage itself is the gateway to surviving a very disruptive transition****.*

The jump in 2021 is largely being driven by the expiring Investment Tax Credit (ITC), with investors wanting to maximize their renewable energy credit ROI.



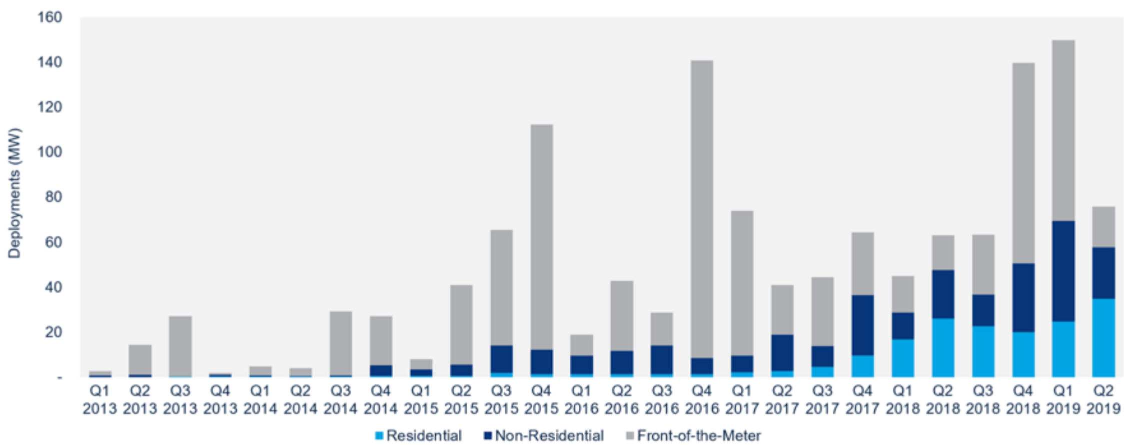
Storage: Member-owned

Members are starting to install energy storage systems in their homes and businesses. The most common applications are for:

- Outage protection
- Outage protection with solar to ride through more extended outages and smooth solar intermittency
- Dispatchable storage – Charging the home storage system at night, during low use time, and selling it back during peak demand times on signal from OPALCO. The storage can still be used for outage protection.

Member storage can be configured to be dispatchable by the utility, during periods of high demand. This helps the utility save on BPA demand-charges, passing the savings on to the member through billing credits. An electric co-op in the east has a pilot program up and running. OPALCO is monitoring their program for possible replication.

The chart below shows the significant increase in U.S. Residential battery storage (light blue), and business storage (dark blue). New data finds that at a record-breaking 35 megawatts deployed in 2019 Q2, the United States residential storage market climbed 41 percent quarter-over-quarter in megawatt terms. Q2's strong performance was the result of rising customer interest and support incentives in more state markets. We are seeing this mirrored in OPALCO's service area, with increasing member interest in battery storage for both home and office.



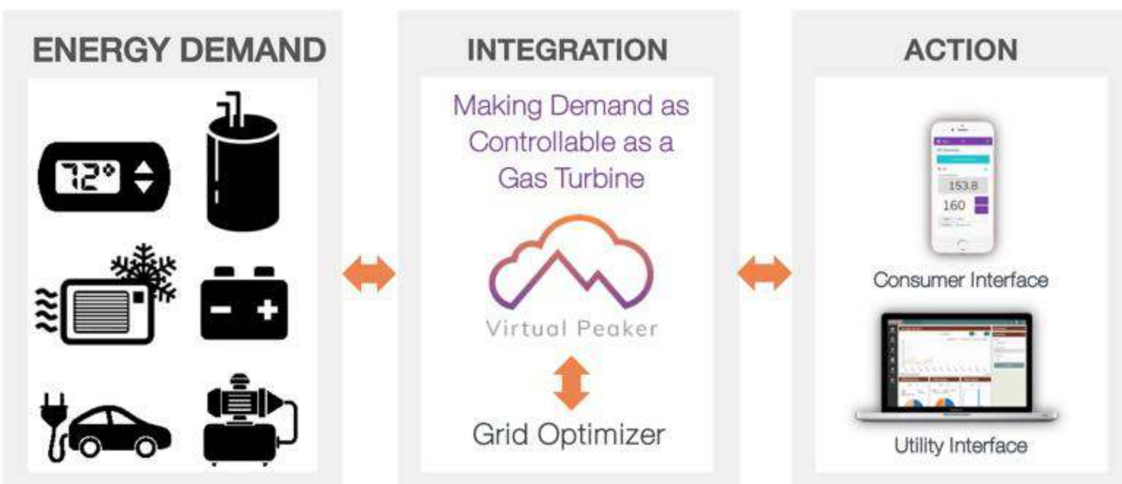
Like solar, member-owned batteries are typically connected to the home and the grid through an inverter. Efficiency is important. In the example below, the graphic shows a Tesla Powerwall charging and discharging through a Xantrex inverter. Round-trip efficiency is about 87%.

The synergistic combination of utility-scale and member-owned storage provides a much higher return on investment for the member and the Co-op. Since outages are infrequent, the battery has few opportunities to deliver value. Members can realize more value by making it dispatchable:

- Provides outage backup power for the member
- Helps the member earn bill-credits to pay off the battery
- Saves the Co-op money by reducing peak demand charges
- Improves grid load factor
- Reduces the amount of utility-scale storage the Co-op needs to invest in

OPALCO is in conversation with another electric co-op that has launched some innovative on-bill financing programs to deploy dispatchable storage (and water heaters) into member homes and businesses. In this model:

- 2,000 battery systems are being deployed to residential customers
- Customers pay $15 per month or a one-time payment of $1,500 per 5 kW home storage module
- Approximately 70% of participating customers signed up for the monthly charge option, while 30% opted to make the one-time up-front payment
- Used for utility peak demand reduction – 10MW of dispatchable storage capacity.
- There about 5 to 10 peak events per month, requiring about 3 hours of constant rate discharge from the distributed storage network
- Customer have access for outage resiliency
- This project is estimated to generate approximately $2 million of NPV value over the 15- year life of the project
- The storage network is managed using Virtual Peaker which interfaces the utilities grid control system with the 2,000 batteries, as well as EV chargers, smart water heaters and DRUs to manage dispatchable load reduction on demand (see below). It also gives the member control of their connected devices – e.g. storage, water heaters, EVs, thermostats, etc.
- Advance Distribution Energy Platforms can serve as an Internet of Things (IoT) alternative, removing the need for a separate EV electric meter, to control time of use of EV chargers to mitigate increased demand charge. These platforms empower the member and the co-op shift load to off-peak hours.



While large utilities concentrate on utility-scale solutions, Virtual Peaker is an ideal solution for co-ops, to help members adopt right-sized solutions for their needs, while helping the co-op increase local energy resilience and ability to manage a distributed network of co-op, home and business member systems.

OPALCO will be exploring innovative ways to cooperatively work with members to incentivize storage for the home and business. For example, OPALCO might sell a home battery system, through local service organizations, to member at cost. The customer can use it for arbitrage, battery backup, firming rooftop solar, and optimizing TOU, TOG patterns. In return, OPALCO will require occasional dispatch of a portion of the storage capacity to mitigate system demand spikes. This same approach can be applied to OPALCO sourced dispatchable EV chargers when members are charging EV car batteries.

Tidal Resource Overview

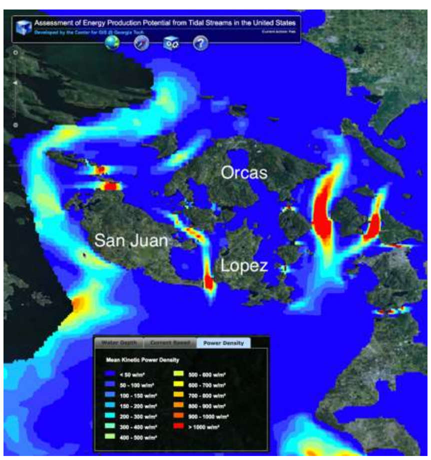
Tidal energy potential in San Juan County may be enormous. OPALCO is working with University of Washington Pacific Marine Energy Center and tidal energy manufacturers to understand tidal flow requirements, tidal potential around the county, and community interest and support for these potential projects.

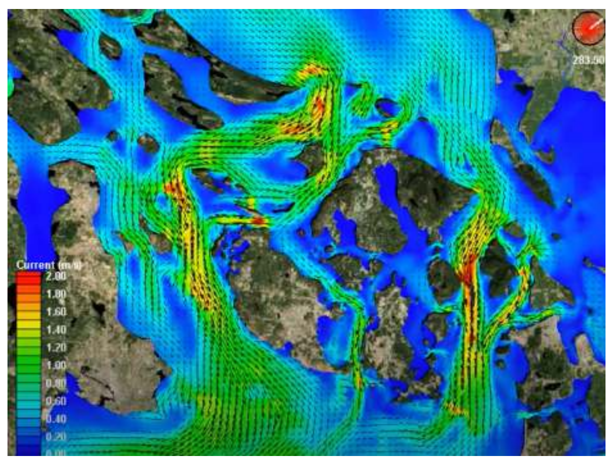
Tidal energy may have several features suited to our island service area:

- Just as sun is better in southern states, tidal energy is best in the northern latitudes, where tidal flows along coastal waters move massive amounts of water back and forth about four times each day. The chart below shows areas of strong tidal flow in red. Note that this chart is largely representational. OPALCO will work to refine flow data to better assess tidal velocity to ensure it meets minimum tidal generation system requirements.
- Tidal energy is predictable energy. This predictability makes the management of tidal energy much simpler than the highly intermittent nature of solar and wind energy.
- Tidal energy is year-round energy, with minimal seasonality. It can help fill the solar winter gap.

That said, we recognize that just because a resource is being used elsewhere doesn't mean that the community will support it in our territory. OPALCO has a long track record of care for our environment. Any development of tidal resources needs to be done with community support, and engagement with stakeholders, including those most involved with our sensitive marine environments such as the Friends of the San Juans and The SeaDoc Society.

The graphics below are representational, showing the potential for tidal power development, showing tidal kinetic energy (w/m^3, left) and velocity (m/s, right).





Biomass Resource Overview

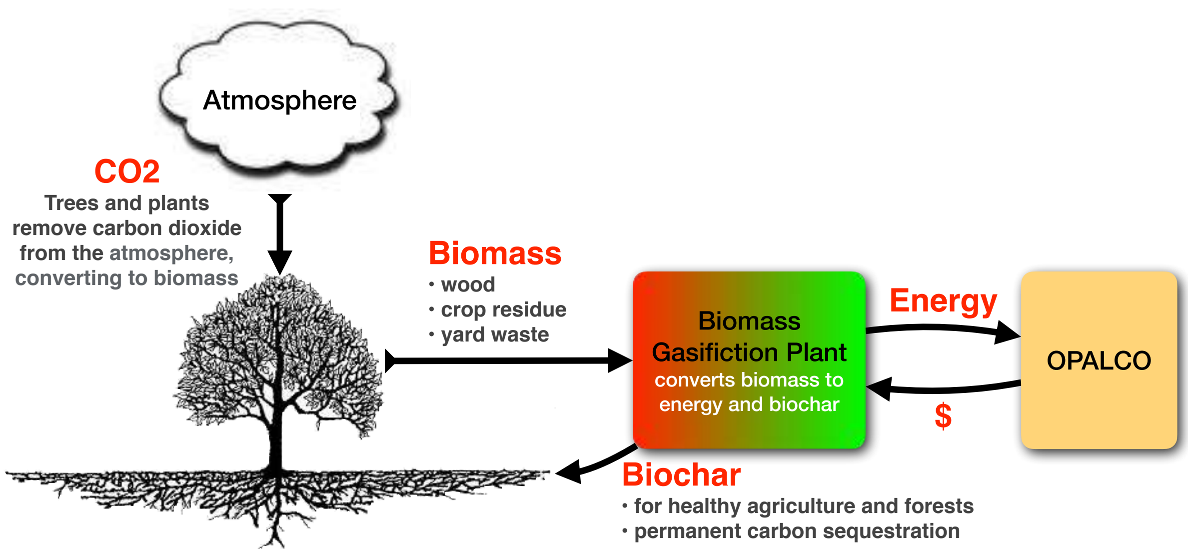
We are seeing positive developments and interest in the County toward biomass and biochar carbon sequestration and Combined Heat and Power (CHP) production. The primary benefit is reduction of fire risk in the county and increase in soil health.

The Orcas Exchange and San Juan Islands Conservation District are exploring grants and emerging biogasification technology to process woody biomass. This can have the beneficial side effects of:

- **Reduced fire risk** in a climate impacted world. Increased proactive stewardship of county forests, removing wood fall and woody biomass "fuel" from forest floors, and using it to generate energy.
- **Energy production**, sold to OPALCO, to help cover operation costs of the plant and collection of biomass from forest, farms and homes.
- **Biochar production** from the plant can be used to improve the health of the soil and produce revenue for the plant to operate.
- **Job creation** is driven by the labor-intensive nature of this technology. It requires gathering and transport of biomass from forests and yards, processing that biomass for gasification, operation of the plant, processing the biochar for delivery to farms and forests. Much more complex than a simple solar array. But with the special benefits of reducing fire risk and increasing soil health.

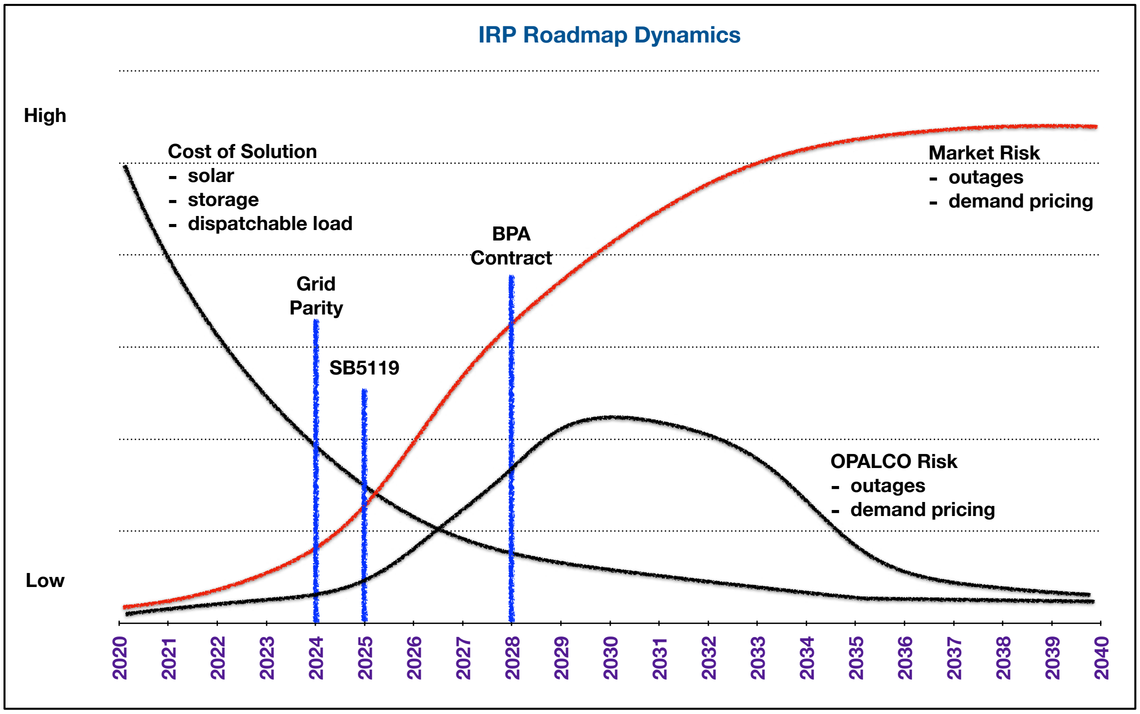
There appears to be good potential grant funding from WA Department of Commerce and Forestry Service to help make the operational costs sustainable.

The chart below offers a simple example of how biomass plant works.



Resource Roadmap

OPALCO's resource roadmap unfolds over a very dynamic decade ahead, with retail grid parity expected around 2024, CETA legislation decommissioning coal plants by 2025, and negotiation of a new BPA contract by 2028. The chart below shows how trends in **local renewable energy resource cost**, and **mainland power reliability, market, and cost risk** playout against these important markers.



Initially, OPALCO's risk is lower than market risk, thanks to the contract guarantees for BPA power. But we and BPA co-exist in a complex shared transmission system, making it difficult to know how buffered we will be from CETA effects. As we increase our local generation resource portfolio, especially with winter-strong tidal capacity, we expect to see that risk reduce.

Given the above dynamics, the table below summarizes a recommended roadmap for OPALCO resource development, in four-year Capital Work Plan (CWP) increments.

CWP Strategic Roadmap for Preferred Plan

The table below summarizes themes and key actions for each four-year Construction Work Plan (CWP).

Beyond key projects, continual maintaining and upgrading is ever present, and detailed below. Each of the following Themes, Benefits and Actions tie back to our Mission and Strategic Directives: safe, clean, cost-effective, reliable and sustainable energy, with a commitment to the use of renewable resources and carbon reduction.

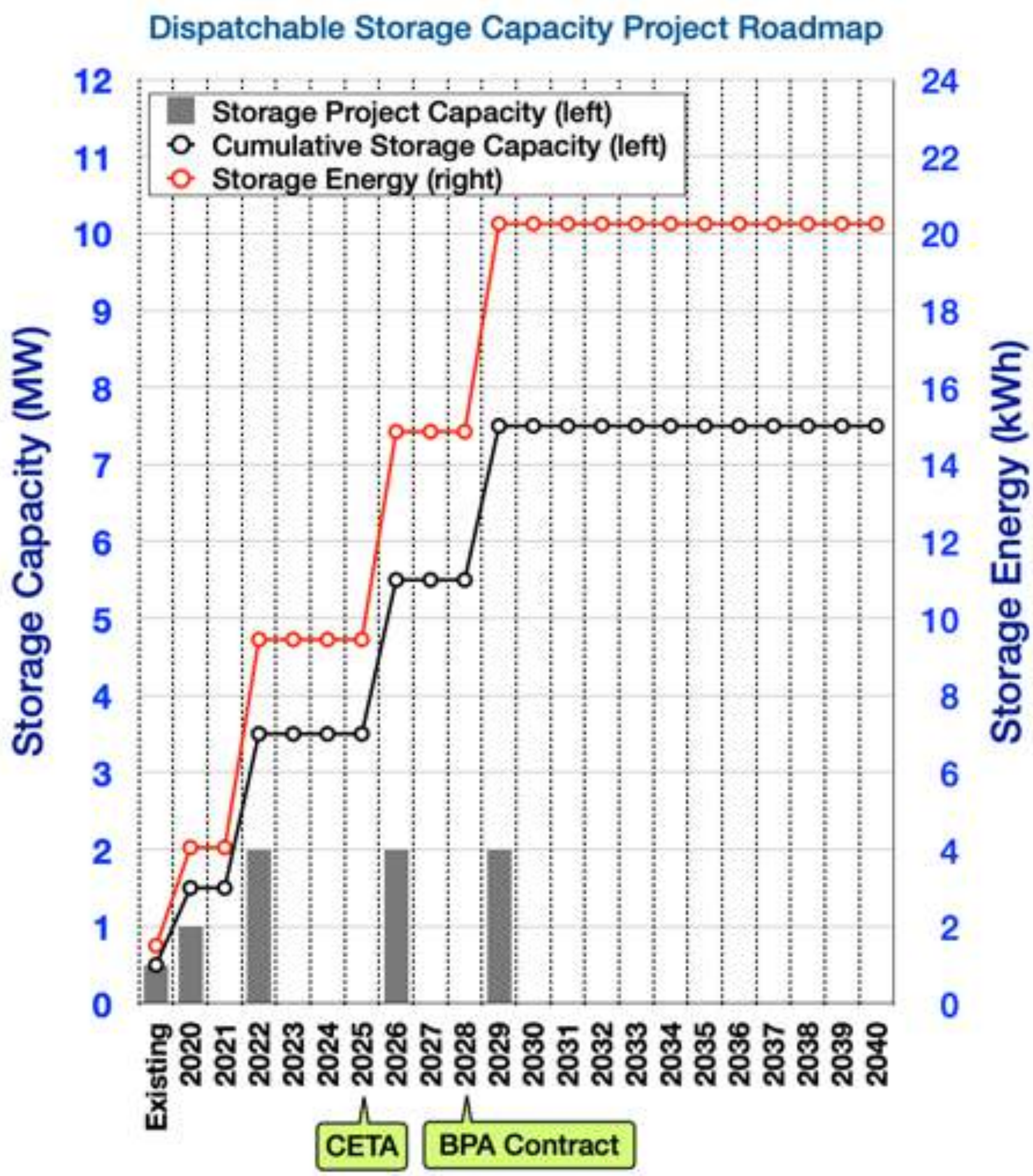
Schedule	Theme and Benefits	Actions
2020 – 2024 **CWP 1** **Before Wholesale Solar Grid Parity** **CETA Rolling Blackout Mitigation**	**Themes:** • Manage BPA and local resources for maximum reliability. • We have robust communications system (Rock Island). Do the same for the power system, with grid modernization best practices, meter upgrades that enable minute-by-minute TOU and TOG transactional grid. • Rock Island becomes our Tier 1 deployment support for batteries, EV chargers, smart home devices, and training. • Increase local energy resilience at minimum cost to members through community solar subscriptions, grants and RESP funds. • This helps increase local energy resilience, especially for critical services in the County: first responders, population centers, government. Community solar helps members lower the cost of their electricity. • Continue beneficial electrification programs. **Resources**: Mitigate mainland Loss of Load **System**: Increase resiliency and foundation for beneficial electrification in 2030s. Cathodic protection can shift submarine cable replacement 5 to 10 years further out, building equity.	**Grid Modernization** • Continue grid modernization projects. • Increase loops, sectionalizing, regulation. • Cathodic protection of submarine cables. **Local Renewable Energy** • Deploy as much community solar as members want (at least 1 MW) – funded by subscribers. • Cooperate with partners on grant-funded tidal projects that help assess potential solutions. **Dispatchable Load** • Create incentives and OBF program for 3 MW dispatchable home storage - funded by subscribers, grants and RESP funds. • Create incentives and OBF program for 2 MW dispatchable load (water heaters, EV chargers) for home and business - funded by grants and RESP funds. • Create incentives for dispatchable commercial member generation for peak demand mitigation.
2025 – 2028 **CWP 2** **Before Wholesale Solar Grid Parity**	**Themes:** • Modestly increase ramp up utility-scale solar to increase local energy resilience, but preserve capital for tidal when it hits grid parity. • Cushion against the increasing cost of mainland power. <u>Rate inflation should start to flatten due to increased EV charging kWh usage</u>. • Continue beneficial electrification programs. More revenue helps moderate rate increases. **Resources**: Mitigate mainland Loss of Load **System**: Increase resiliency and foundation for beneficial electrification in 2030s	• Increase local solar and storage resources for critical systems. • Increase loops, sectionalizing, regulation, cathodic protection of submarine cables • Deploy all cost-effective local energy resources, including solar, storage and dispatchable load solutions, funded by grants, RESP and rates. • Continue grid modernization projects. • Continue tidal power collaborations, through grant funded projects.
2029 – 2032 **CWP 3** **Wholesale Solar Grid Parity**	**New BPA Contract, Build Equity** • Accelerate deploying local solar energy solutions until tidal is economic. • Optimize mix of local generation with BPA as firming and gap filling. • Prepare for potential submarine cable replacement in 2033 (this may be delayed due to beneficial cathodic protection). • Continue beneficial electrification programs.	• Possibly replace Lopez to Orcas submarine cable. • Continue deploying all cost-effective local energy resources, including solar, storage and dispatchable load solutions, funded by grants, RESP and rates. • Continue grid modernization projects. • As tidal approaches grid parity, prepare for deployment when cost effective.

Schedule	Theme and Benefits	Actions
2033 – 2036 **CWP 4** **eFerry Terminals, Build Equity**	• Build equity for forthcoming submarine cable replacement projects and tidal deployment. • Rate increases are tempered by increased EV and eFerry usage and kWh from charging. • Continue beneficial electrification programs.	• Deploy high power ferry charging infrastructure, funded through grants, RESP program, rates. • Deploy tidal when economic and acceptable to community.
2037 – 2040 **CWP 5** **Build Equity, Deploy Tidal at Grid Parity**	• Switch from solar to tidal investment at grid parity, to strengthen winter generation resource portfolio. Further reducing dependence on mainland power and pricing. • Build equity for tidal deployment and forthcoming submarine cable replacement projects. • Continue beneficial electrification programs. • Significant portion of energy use is now generated locally, year-round.	• Deploy tidal energy resources at grid parity, Funded with grants, RESP programs, investors, rates.

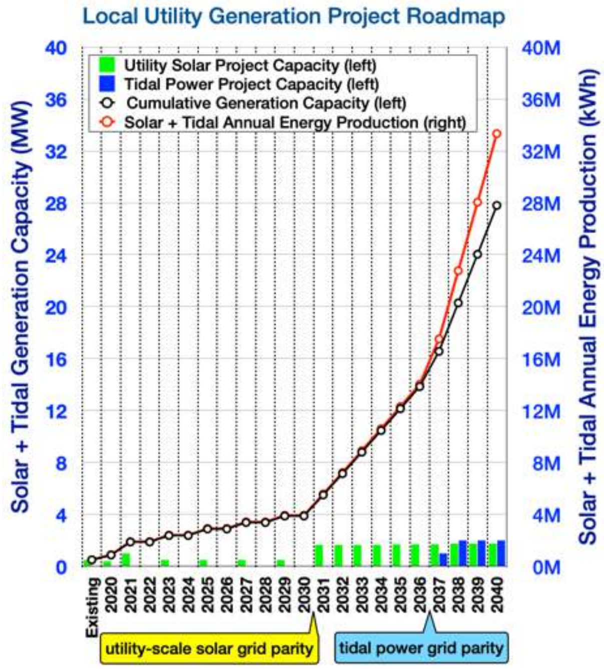
The next two sections detail the storage and renewable energy components of the roadmap.

Storage Project Roadmap for Preferred Plan

The roadmap below lays out a mix of dispatchable storage resources, with a goal of having 5.5 MW of utility-scale storage capacity by 2028. As discussed above, additional member storage is planned, with grants and direct member investment funding that cost.



Local Renewable Generation Project Roadmap for Preferred Plan



The roadmap at right lays out a mix of local renewable energy resources between now and 2040, with a goal of building solar capacity at a rate that meets member demand for community solar subscriptions, until wholesale grid parity, estimated at 2030. Then buildout utility-scale solar at a higher rate to further reduce dependence on mainland power and increase local energy resilience.

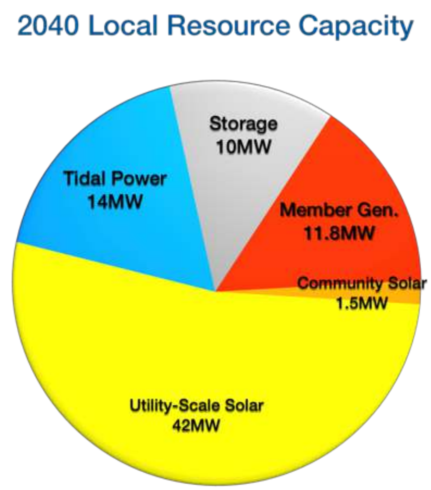
We expect tidal generator LCoE to hit BPA wholesale grid parity in the mid-2030s at best. At that point we ramp up deployment as fast as possible, subject to permitting and approval by co-op members.

As mentioned in discussion above, local renewable energy resources help moderate the rising cost of mainland energy and improve local energy resilience. With climate impact accelerating, it is possible that deployment of local renewables might accelerate, if grant funding rises, allowing us to build more for less.

It's worth remembering that as we ramp up local generation, the load on the mainland cables is reduced, extending the life of the transmission and submarine cables through congestion relief and asset deferral. That improves the cost-benefit equation.

Winter, Summer, Night, Day Example

The Preferred Plan calls for a more modest deployment of local renewable energy, the example below offers a more substantial deployment, to explore some of the implications of a larger mix of intermittent and seasonal resources compared to BPAs firm 24/7 power. In this example mix of local renewable energy, each resource with its own seasonal and daily productions patterns, has some remarkable implications for when we draw on mainland power. We are in the early stages of modeling this, but here are a few preliminary implications to consider:



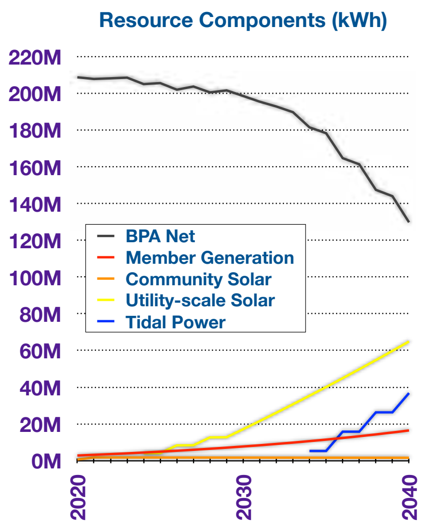
- 14 MW of tidal power yields 4 MW of power (30% Capacity Factor). That is day and night, winter and summer.
- 55 MW of local solar (member + community + utility), yields 8 MW of power (11% Capacity Factor). That is daytime only in summer. In winter solar is daytime only, and 20% of summer – 1.6 MW.
- Summer load in 2040 is forecast to typically be 17 MW. So, summer daytime load will be mostly met by local generation. Summer nights tidal is still generating, but we will need more mainland power. In summer, mainland power daytime rates may be expensive due to climate heating, increased demand for air conditioning, and reduced hydro flow due to reduced snowpack.
- Winter load in 2040 is forecast to typically be 23 MW. So, winter daytime load will be mostly met by mainland generation. Daytime will have about 1.6 MW of solar on the occasional sunny day. Day and night will have about 4 MW of tidal. That gives us about 5.6 MW of local energy, leaving about 17 MW

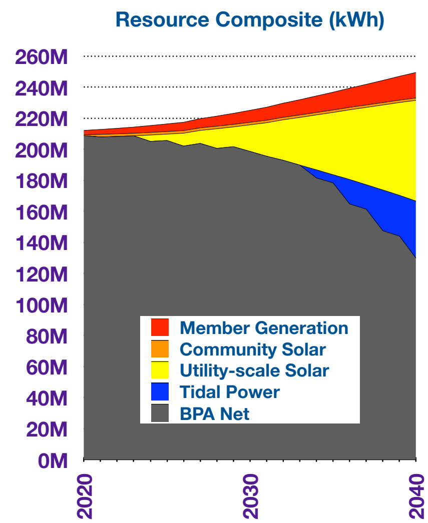
need from the mainland. In winter, mainland power daytime, and especially nighttime rates may be less expensive than summer, with warming winters, reduced heat load, and a shift in hydro from summer to winter as snow decreases, and winter rains increase, increasing winter hydro flow.

Given the example above, the chart below shows the energy production over time as we ramp up the local energy resource mix. The left chart breaks out the component energy resources in the mix. The right chart shows the combination of the components.

BPA + Local Generation Energy Forecast

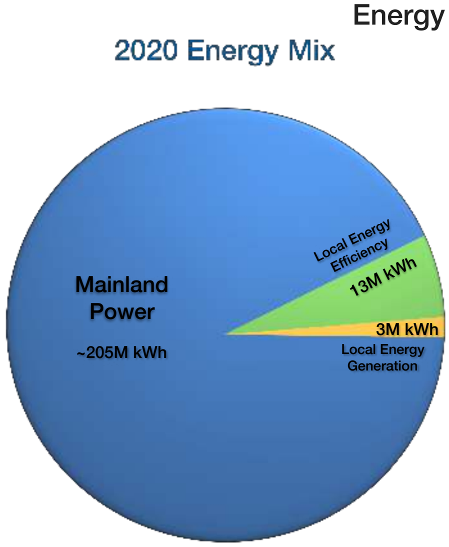
BPA + Member Generation (solar, wind, micro-hydro) + Community Solar + Utility-scale Solar + Tidal

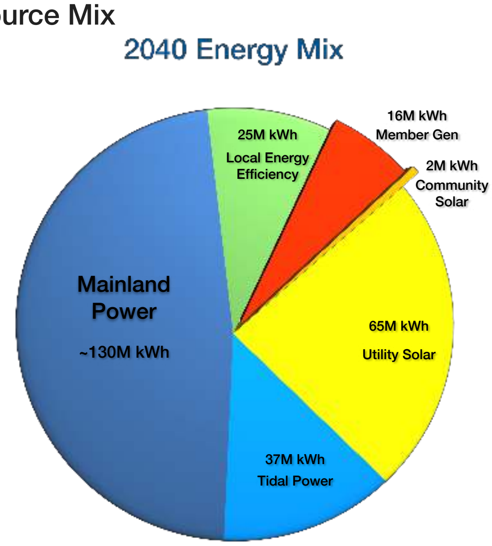




For the example above, the chart below shows the energy production mix for 2040 compared to 2020. It is worth noting that 52% of the energy is still coming from the mainland in this example. The 2040 resource mix requires a steady aggressive resource development commitment. There are a number of challenges behind this, including securing and permitting adequate siting for local solar, tidal, wind and other resources. The Preferred Plan uses a scaled back approach to local solar and storage resources, until grid parity is reach, especially with regard to tidal deployment, which has the best performance year-round compared to solar.

Energy Resource Mix





The Transactional Grid

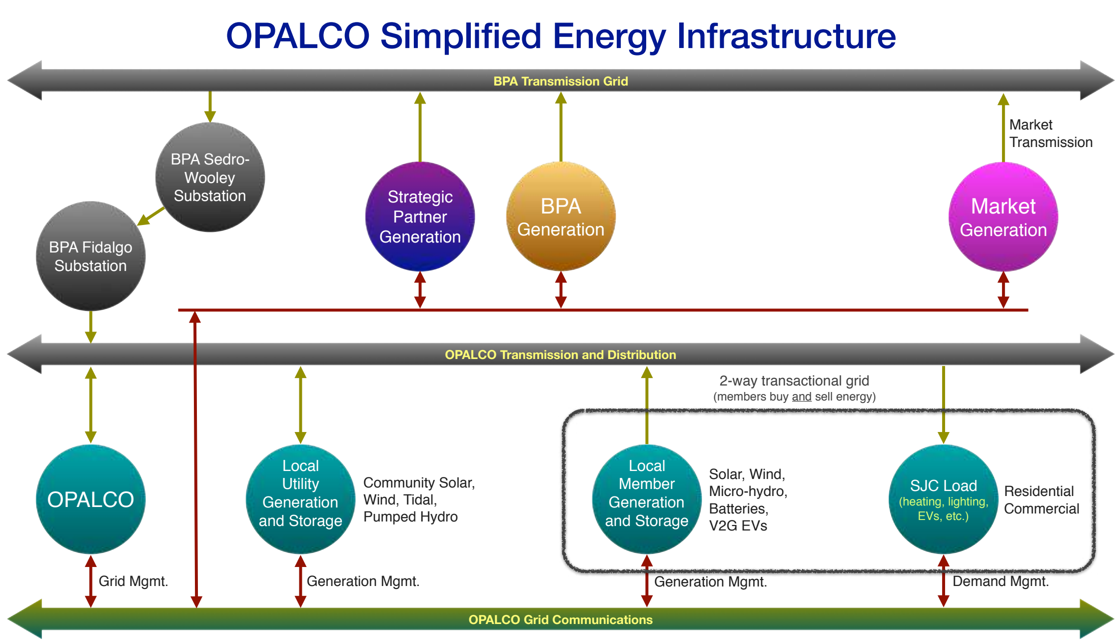
The combination of energy + internet enables a local collaborative commons, powered by local renewable energy resources, whose lower marginal cost enables a more robust resilient local economy.

paraphrasing Jeremy Rifkin, discussing the Internet of Things (IoT), energy + internet, collaborative commons

We are in the early stages of a highly transactional grid. As communication protocols standardize, we will see increased two-way energy and information flow, members buying and selling energy, solar + batteries increasing local energy resilience, a reliable fiber and wireless internet. OPALCO will increasingly serve as a balancing exchange for members as they buy and sell energy from each other, with BPA serving as a vital source of firm energy when local energy demand exceeds local generation capacity.

OPALCO serves co-op members on 20 islands by routing energy from BPA and local renewable resources through the **Grid** to member's homes and businesses. The grid is composed of submarine, aerial and buried cables interconnecting substations, switches, voltage regulators managed through a network of fiber, interconnecting all the elements, and connecting them to a control system designed to keep energy flowing reliably and safely.

The diagram below shows the major components of the grid, including BPA, strategic partners and market energy providers routing power through the Sedro-Wooley and Fidalgo stations to OPALCO's local transmission and distribution system that connects the islands. Energy can be routed to members. And it can be routed from members who generate electricity from solar, wind, and micro-hydro resources, and sell what they don't use back to OPALCO, for sharing with other co-op members.

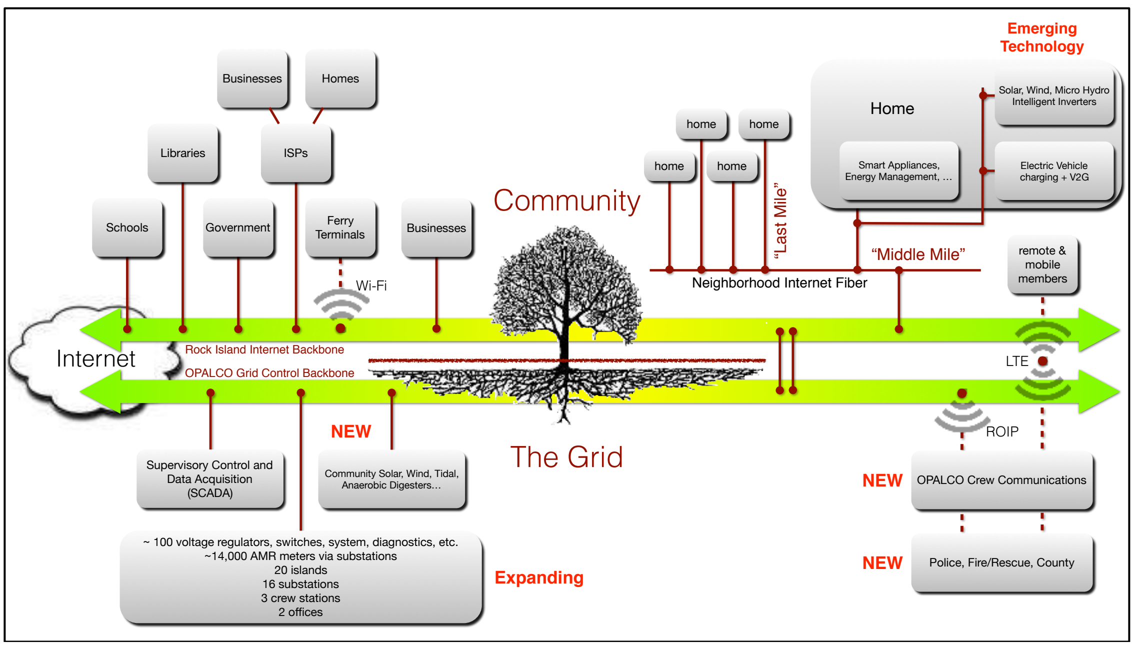


The grid will increasingly carry more of this two-way energy flow, as more and more local renewable generation is added to the grid. This flow of energy is managed using the grid control backbone for grid communications via optical fiber network.

This network supports:

- very fast efficient and reliable grid operations
- smooth interconnection with local renewable energy resources – e.g. solar, wind, storage
- increased energy efficiency
- better customer service

The grid control backbone also provides a layer of communications system for communicating between OPALCO offices and with field crews. This communications capability is expanding to fill communication holes throughout the county that have limited first responder communications. This will improve public safety and the reliable reach of county communication systems. The wireless component of the grid communication system employs LTE wireless radio spectrum purchased by the Co-op and configured to provide wireless radio and phone capability.



This intersection of energy and internet is often referred to as the Smart Grid. This integrative whole-systems approach is synergistic, taking the grid the Co-op developed, starting in 1937, and transforming it into the grid of the 21st century:

- more local
- more distributed
- two-way (consuming and generating, buying and selling energy)
- sourced from increasingly intermittent generators such as solar and wind

At an energy Roundtable meeting with OPALCO, Dan Kammen said:

> *"In order to make renewable energy into a stable energy resource, it is necessary to monitor power supply and demand in real time and to obtain a balance between supply and demand by integrating conventional electric grid with up-to-date information and communication technologies. The internet-*

enabled Smart Grid will foster a well-managed local energy generation portfolio of solar, wind, tidal, hydro and energy storage resources."

To date, most grid communication is between OPALCO's grid control elements such as substations, switches, voltage regulators and meters. As open Smart Grid interface standards for home solar and wind inverters and electric vehicles, and smart appliances solidify, grid communications will extend to those devices, too. This enables reliable connection of many member generators to the grid, maintaining voltage and frequency quality, and facilitating a vibrant energy sharing economy where member generators and storage systems sell energy back to the grid when they have a surplus and demand is high. On the demand side, appliances and consumer devices can be managed to reduce load during peak demand periods, holding energy costs down. Co-op members reduce energy, save money and increase energy generation: making money by sharing energy.

As Lena Hansen, a principal in the Rocky Mountain Institute's (RMI) electricity practice noted:

The "distributed system platform" places the customer at the center of the grid equation as never before. This is not by any means incremental…[utilities are] taking a very whole-systems transformative approach.

Dan Cross-Call, a senior associate in RMI's electricity practice noted:

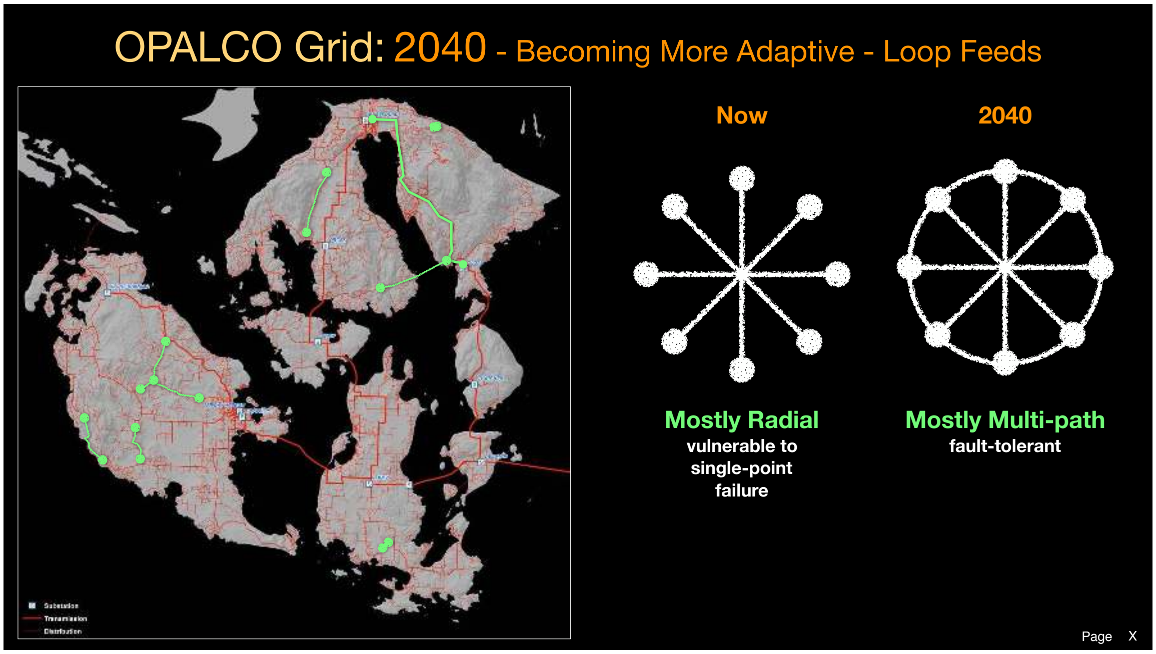
This two-way flow of electrons, services, and values won't happen without the communications infrastructure to relay all that data and decision making. Adding a layer of IT to the grid is essential.

Smart Grid is a term you could interpret many different ways and means many different things, but at the most basic level, it's a question of how you make the grid intelligent using IT.

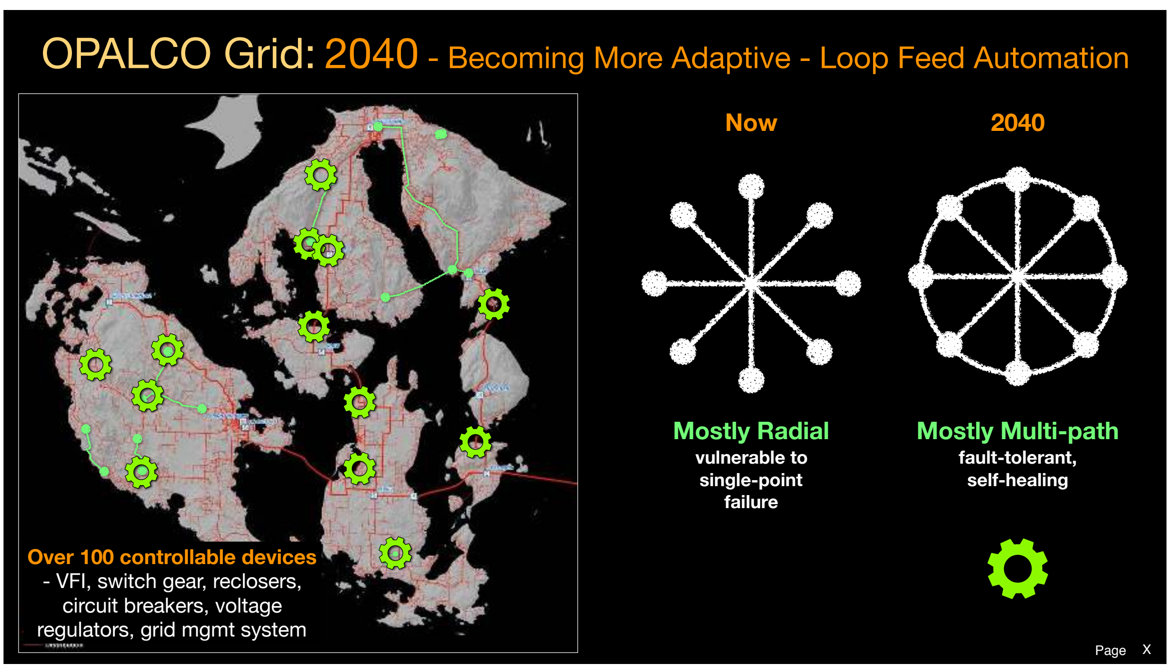
Which way are electrons flowing? Who is providing or consuming what energy services, at what times, in what places?"

Key Grid Modernization Initiatives for Preferred Plan

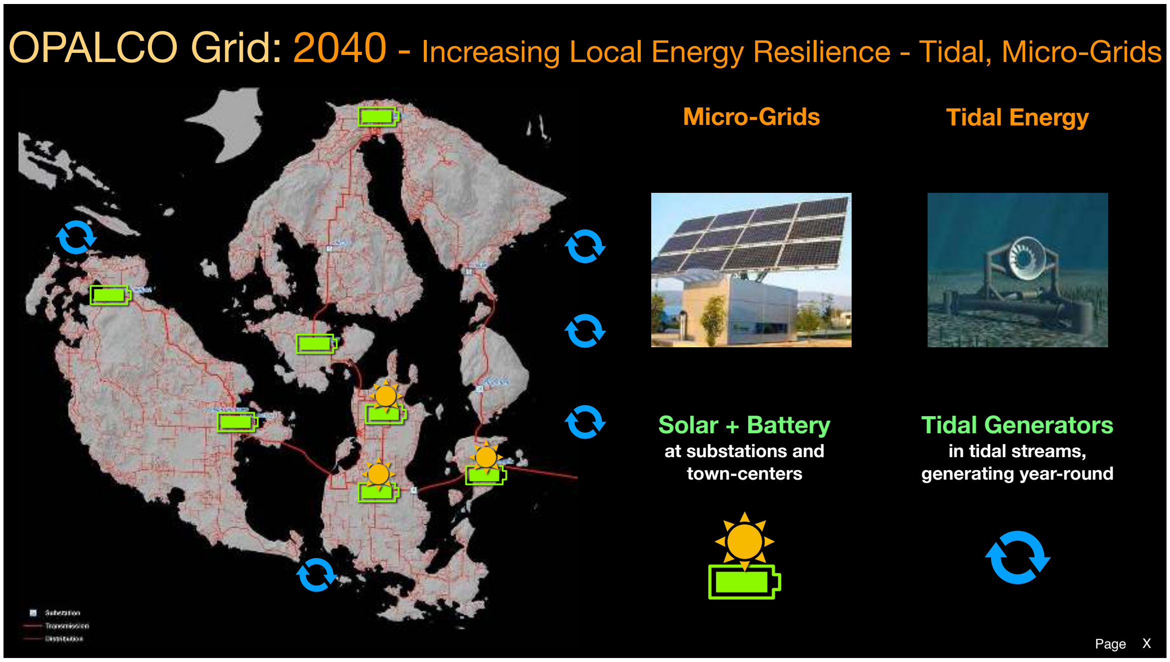
OPALCO is making the grid more multi-path: creating multiple ways for transmission and distribution to get energy to members. If a tree takes out one path, we want an alternative to reroute energy to members. The chart below shows planned new paths in green.



To reroute energy on those redundant paths, OPALCO plans on adding a variety of loop-feed automation, controlled by our fiber grid-control backbone, to quickly route around failures using a mix of switches, reclosers and smart devices. See chart below. OPALCO's grid modernization investment now allows crews, using iPads, to access grid status information and control features, which improves insight on problems, solutions and safety.

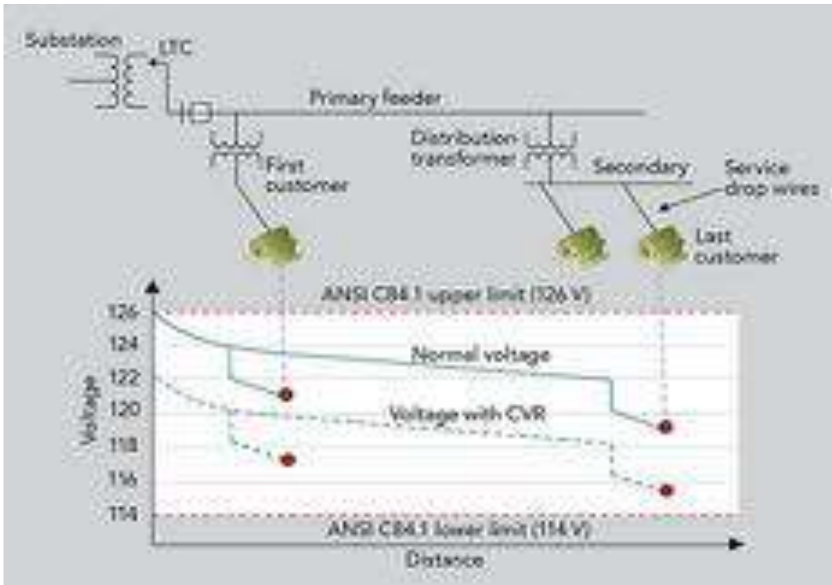


The expanded reach of the grid allows for better integration of local energy resources, including member generation (solar, wind, micro-hydro), member storage, utility-scale storage, and population-center micro-grids. See chart below. This will increase local energy resilience and help moderate rate inflation, keeping rates lower than if we depended solely on mainland power. We expect BPA to always be part of the mix, using it to firm local intermittent resources, and supply extra capacity during days of peak demand, beyond the capacity of our local energy resource portfolio.

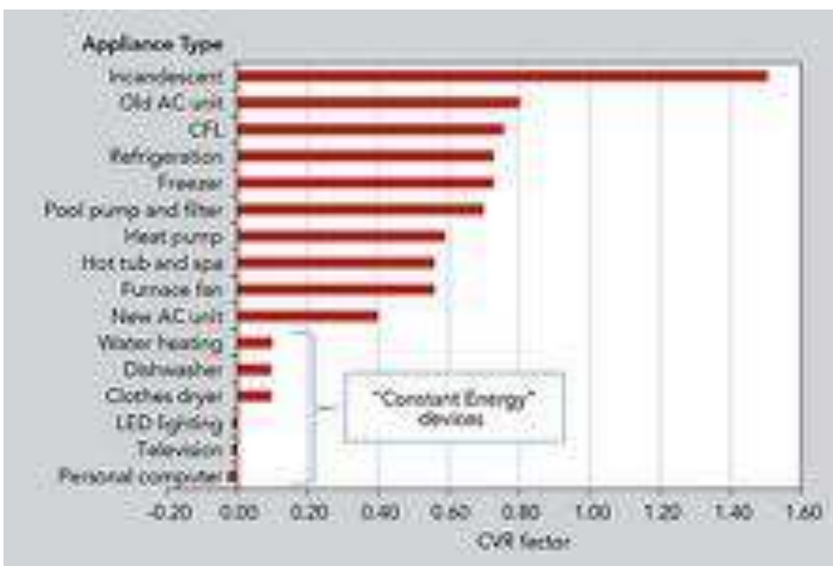


Conservation Voltage Reduction

Conservation voltage reduction (CVR) is a means to reduce energy usage by reducing the voltage across the grid. By optimizing the voltage during peak times this method can be used as a means of peak shaving. CVR would be intentionally lowering the voltage served to our members to the minimal acceptable band as defined by industry practices (American National Standards Institute).



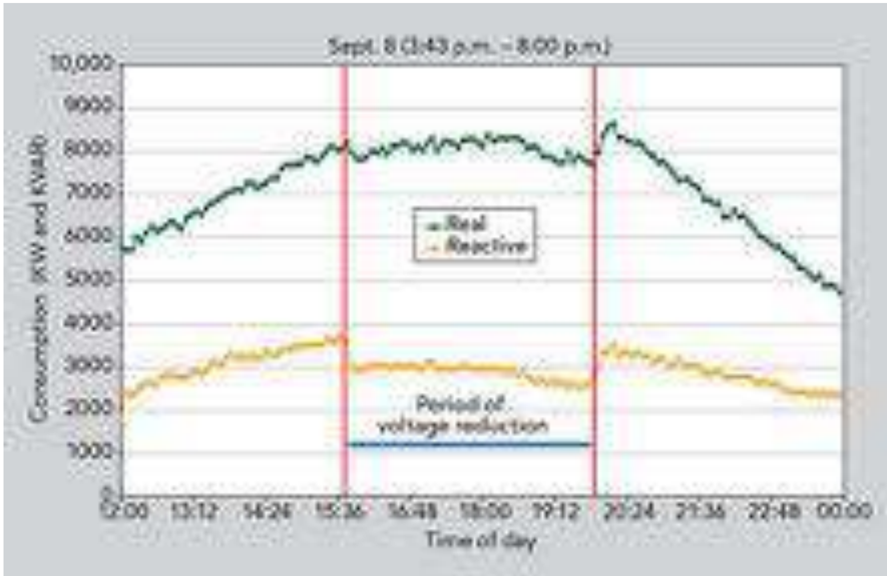
The risk with operating at such a low voltage is that during heavily loaded times or during a temporary fault on an adjacent feeder (or even a distant transmission line) could cause service disruptions to our members. CVR has little effect on power electronic based devices, while resistive and inductive type devices consume less power at lower voltages. OPALCO can currently implement expanded voltage optimization with minimal cost.



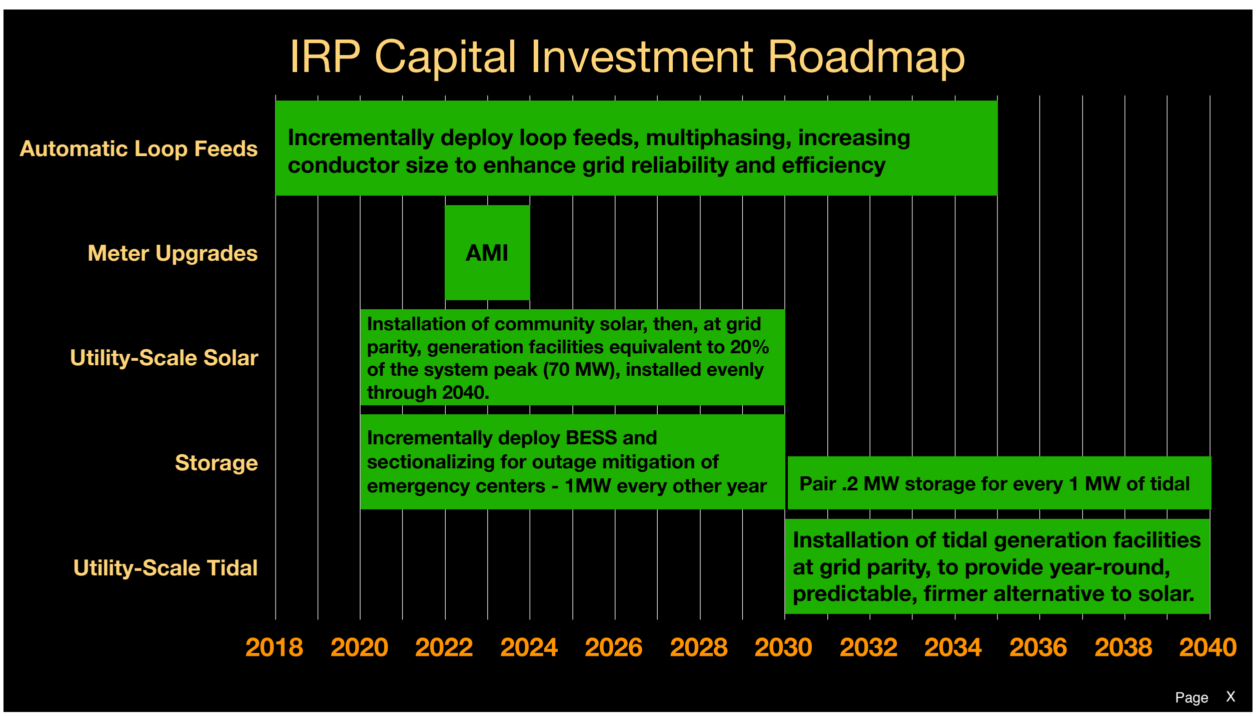
Based on all studies performed by OPALCO, the co-op's CVR factor is close to 1.0. Typical target voltages during peak periods range from 118 V to 123 V, depending on how much the feeder or bus can tolerate. The Co-op estimates it saved between $500,000 and $600,000 on demand charges in 2014 alone. The SCADA system has paid for itself many times over in the past 30 years.

The chart below shows how real and reactive power consumption clearly drop off when voltage is reduced and return to normal values when full voltage is restored.

OPALCO will be evaluating voltage optimization for peak shaving, battery storage and circuit optimization so that our members will be as minimally impacted by future industry changes.



Grid Modernization Roadmap for Preferred Plan



Additional Capital Project Highlights

In addition to the deployment of local renewable energy generation and storage systems and grid control elements described above, this section describes the more conventional power system improvements to be deployed through 2040.

Multi-phasing and Re-conductoring

The entire distribution system is modeled in MilSoft's WindMil. For each section of line that had capacity or voltage problems based on the year 2040 projections, several options were developed and reviewed by the engineering and operations teams. The alternatives were reviewed from a least cost and operational standpoint to determine the best solution. Feeders with voltage drop problems were addressed by means of voltage regulators. In areas where feeder regulation already exists or where design criteria dictated, the lines were re-conductored or multi-phased as required. Where conductor capacity was insufficient, the conductor was replaced.

Multi-phasing and re-conductoring projects in this LRP will be re-constructed in the existing right-of-way unless otherwise stated in the project descriptions.

Increased Substation Capacity

All substation loads were evaluated to ensure the substation transformers and voltage regulators limits will not be exceeded by the projected loads. If the projected loads exceed the limits set by the design criteria, this work plan will address one of two options: an increase in substation capacity or the switching of a portion of that substations load to another substation.

Distribution Line Voltage Regulators

Voltage regulators are used throughout the system to correct inadequate voltages. Additional voltage regulators have been recommended as a short-term least-cost alternative to extensive multi-phasing or line re-conductoring improvements.

Conductor Replacements

Approximately 60 miles of conductor has been specifically identified by OPALCO as posing significant reliability risks and targeted for replacement. This has been planned for through a single work plan item to allow the cooperative staff to locate and replace lines as needed based on faults, neutral condition and other factors.

Transmission

An additional transmission tap has been planned for increased reliability and power quality. This tap will also allow for loop feed capabilities for decreasing outage time during major events. In addition, replacement of a transmission submarine cable will continue in this work plan to maintain redundancy.

LRP Design Criteria

Improvements recommended in this LRP represent actions required to maintain standards for safety, adequate voltage, thermal loading and service reliability levels. The following outline describes basic design criteria used in this plan.

Transmission Circuits

- Maximum of 50% of line rating
- Submarine terminal stations insulation ratings – one voltage class higher
- Ordinary conductor replacement based on imminent need rather than age
    - Replace when facilities experience in excess of 5 outages per year per member for 2 consecutive years (non-ROW related outages)

Distribution Circuits

- Maximum voltage drop – 5 volts (120 V base)
- Maximum of one stage of line voltage regulation
- Conductor loading
  - 50% of the thermal capacity for inter-substation ties
  - 80% of the thermal capacity for radial circuits
- Maximum of 35 amps on single-phase taps
- Ordinary conductor replacement based on imminent need rather than age
  - Replace when facilities experience in excess of 5 outages per year per member for 2 consecutive years (non-ROW related outages)
  - Replace URD cable after second failure per section or concentric neutral corrosion

Substations

- Initial loading of substation transformers to 60% of base capacity rating
- Existing transformer loaded to fan cooled rating for short-term peaks
- Utilize ANSI/IEEE Guide for loading liquid immersed equipment, including power transformers and voltage regulators
- Power loss evaluations of new transformer purchases

Voltage Regulation

- Load not exceeding standard manufacturer capacity or thermal rating
- Used where voltage drop is greater than 5 volts (120 V base) and conductor replacement is not feasible

Distribution Transformers

- Load at or near standard manufacturer capacity rating
- New transformer purchases evaluated for power loss optimization and total ownership costs

Conductor Sizing

- Overhead Transmission
  - 396.5 kcmil ACSR Ibis (26 X .1236, 7 X .1236) (594 amps)
  - 336.4 kcmil ACSR Linnet (26 X .1137, 7 X .0884) (529 amps)
  - 4/0 ACSR Penguin (6 X .1878, 1 X .1878) (357 amps)
- Submarine Transmission
  - Load based
- Overhead Distribution
  - Single-phase
    - 1/0 ACSR for low-load levels (242 amps)
  - Three-phase

        - 336.4 kcmil ACSR for main feeders (529 amps)

- Underground Distribution
- Single-phase
    - 1/0 AL with Full Concentric Neutral within 2" Conduit
    - 4/0 AL with Full Concentric Neutral within 4" Conduit
- Three-phase
    - 1/0 AL with 1/3 Concentric Neutral within 6" Conduit (175 amps)
    - 4/0 AL with 1/3 Concentric Neutral within 6" Conduit (255 amps)
    - 500 MCM AL with 1/3 Concentric Neutral within 6" Conduit (415 amps)
- Submarine Distribution
    - Single-phase
        - #2 Cu

Sectionalizing

- Maximum of 40 momentary outages per feeder per year
- Maximum of 2 hours of outages per member per year – urban
- Maximum of 5 hours of outages per member per year – rural
- Limit loads on reclosers to 80% of trip coil rating
- Minimum phase-to-ground fault pick up capability
- Device use will be as follows:
    - Underground
        - Vacuum Fault Interrupter (VFI) – Loads greater than 40 Amps
        - Fused Junction Cabinet – Loads up to 40 Amps (when feasible)
        - Fused Elbow – Loads up to 40 Amps (when above not feasible)
    - Overhead
        - Recloser – Overhead with greater than 40 Amps or based on fusing
        - Fuse K Curve – Loads up to 40 Amps or no greater than 100K sizing

Capacitors/Reactors & Power Factor

- Goal of 95% lagging to 95% leading power factor

Line Improvements

- Improve voltage levels
- Maintain adequate thermal capacity
- Balance phase loads
- Line-loss reduction
- Improve reliability
- Address O&M Survey, RUS Form 300 concerns

- Underground cable installation and replacement based on outage and corrosion of cables

Construction Program

The system improvements recommended in this LRP are listed herein along with their estimated cost, a discussion of their need, and the scheduling of their installation. All costs associated with adding new services and to the system and increasing service sizes are paid for by the prospective members. This program is referred to as Contribution in Aid of Construction (CIAC). This policy is in place due to the large initial costs for building to the new service in addition to the high probability of the service remaining idle for most of the year.

Periodic replacement of existing poles, crossarms, etc. is required for numerous reasons. When such replacements are made, it is often necessary to install units with greater height or strength requirements. When lines are relocated due to road changes or to eliminate cross-country sections, the Cooperative should install poles of strengths suitable for long-range conductor size and, in some instances, to install part or all the long-range conductor. Normal operations require the routine addition of poles in existing lines, either for joint use attachments or to improve clearance.

Inflation of the cost of materials and labor is a continuing factor that must be considered. For this reason, the cost estimate for construction during 2020-2040 was adjusted to reflect the latest indices of the Bureau of Labor Statistics Consumer Price Index for the Seattle-Tacoma-Bremerton area. The recommended system improvements are summarized to conform to RUS Form 740C.

Alternate Approaches

Due to the relatively low load growth projected over the next twenty years, the main focus of the next twenty years is to **replace aging equipment**, **upgrade protection schemes** and **automate the system to reduce outage time** to our members. Additionally, a key mission for us at OPALCO is to continually look to local renewable energy sources as a means to **increase local energy resilience**.

There are four approaches we consider in planning. Our **preferred plan** incorporates the hybrid Maintenance/Replacement approach.

- **Do Nothing** - No transformer or submarine cable replacements with zero infrastructure upgrades (e.g. Cathodic Protection).
  - Pros – Low-cost solution that is a “wait till it fails” strategy.
  - Cons – Reduced reliability, potential environmental impacts, and potential catastrophic failures.
- **Minimal upgrades** - Add in monitoring devices and cathodic protection to prepare for future failures which provides us with a shorter failure window. This could extend the life of existing assets and could potentially provide OPALCO with the greatest economic life.
  - Pros – Increased asset life with minimal cost, short term replacement plans versus a “run till it fails” strategy and provide OPALCO with possibly the greatest asset life scenario.
  - Cons – Shorter window to replace expensive assets. Aging asset life expectancy may not be extended leading to a decreased economic benefit.
- **Full Replacement** - Replace assets on a life cycle such as a 30-40 year cable life and a 40-50 year transformer life.
  - Pros – Planned costs are accounted for over the next 20 years and providing the most reliable service.
  - Cons – Potentially replacing equipment that has more life resulting in unneeded expense.

- **Hybrid Maintenance/Replacement** - Monitor and evaluate replacements, but plan on replacements for a given life cycle. This would account for potential replacements at the given interval but extend the interval out on a case-by-case basis.
  - Pros – Planned costs are accounted for over the next 20 years and monitoring/maintenance could extend equipment out to maximize the life of the asset.
  - Cons – Equipment may not be able to be extended past its life and could result in extra unneeded expense.

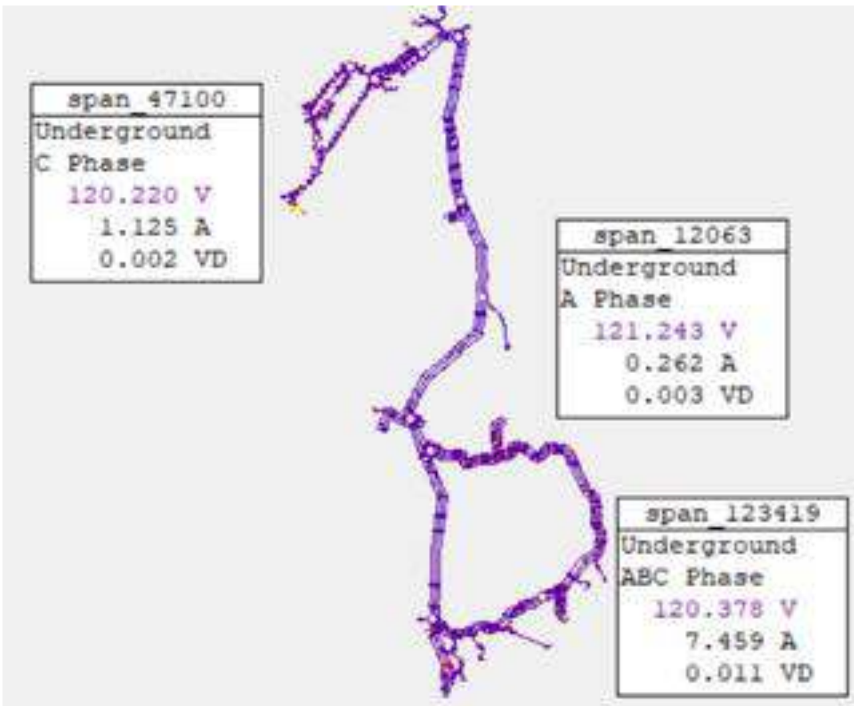
Voltage Analysis

The following maps provide a voltage analysis for each island in OPALCO's service territory. Line color indicates voltage in or out of limits – blue represents nominal to 2.5% voltage drop, purple is from 2.5% to 5%, and anything beyond a 5% voltage drop is shown in red.

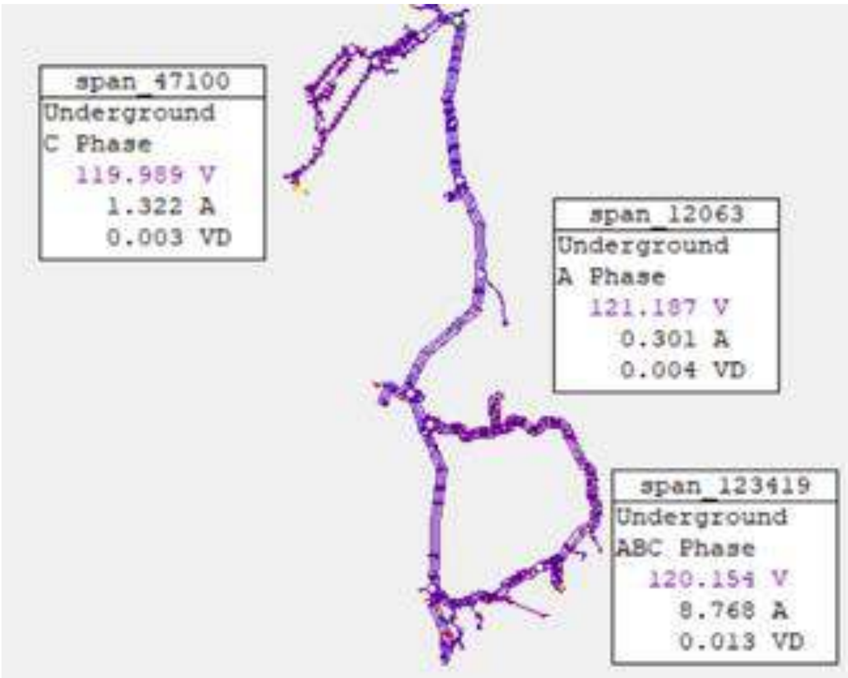
In general, areas with significant voltage drop will be mitigated with converting applicable single phase tap to 3-phase, replacement of aged equipment, upgraded transformers, improved voltage regulator deployment, and dispatchable EV chargers and load.

Blakely

2020 Winter Load without regulator(s)

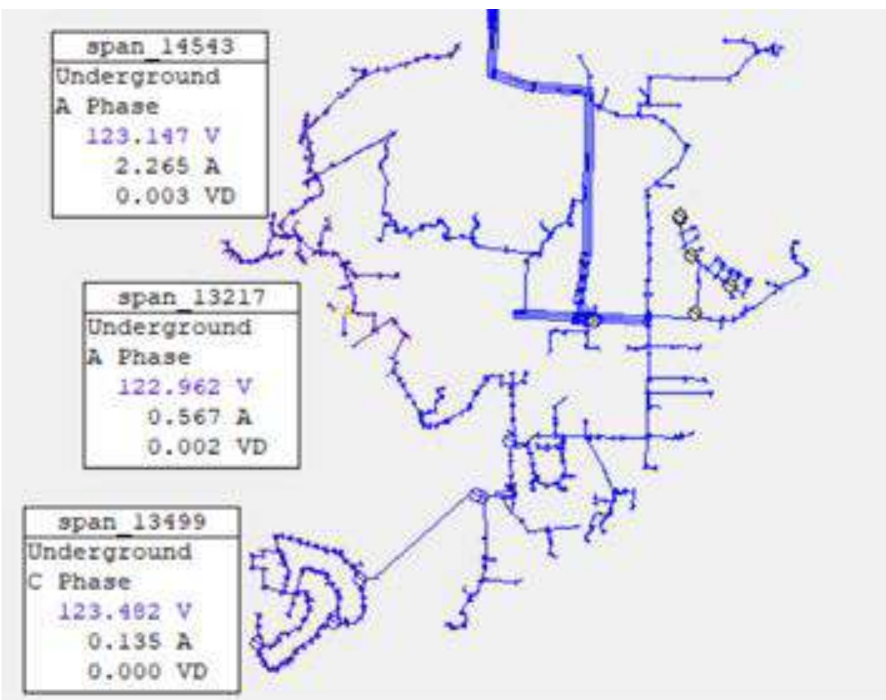


2040 projected winter load without regulator(s)

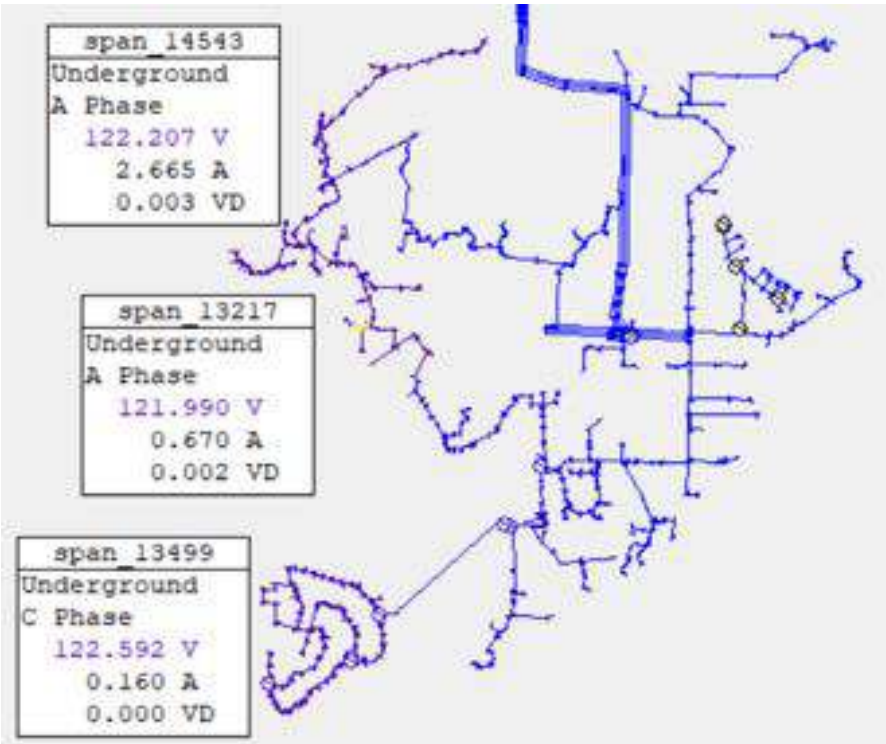


Decatur

2020 Winter Load without regulator(s)



2040 projected winter load without regulator(s)

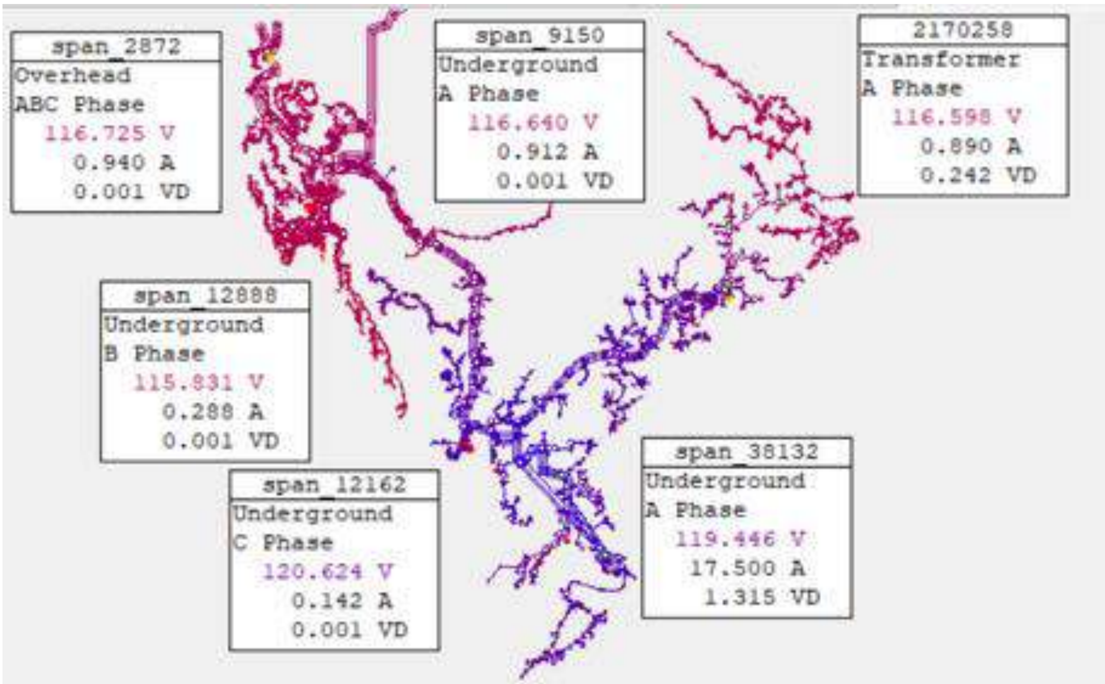


Olga

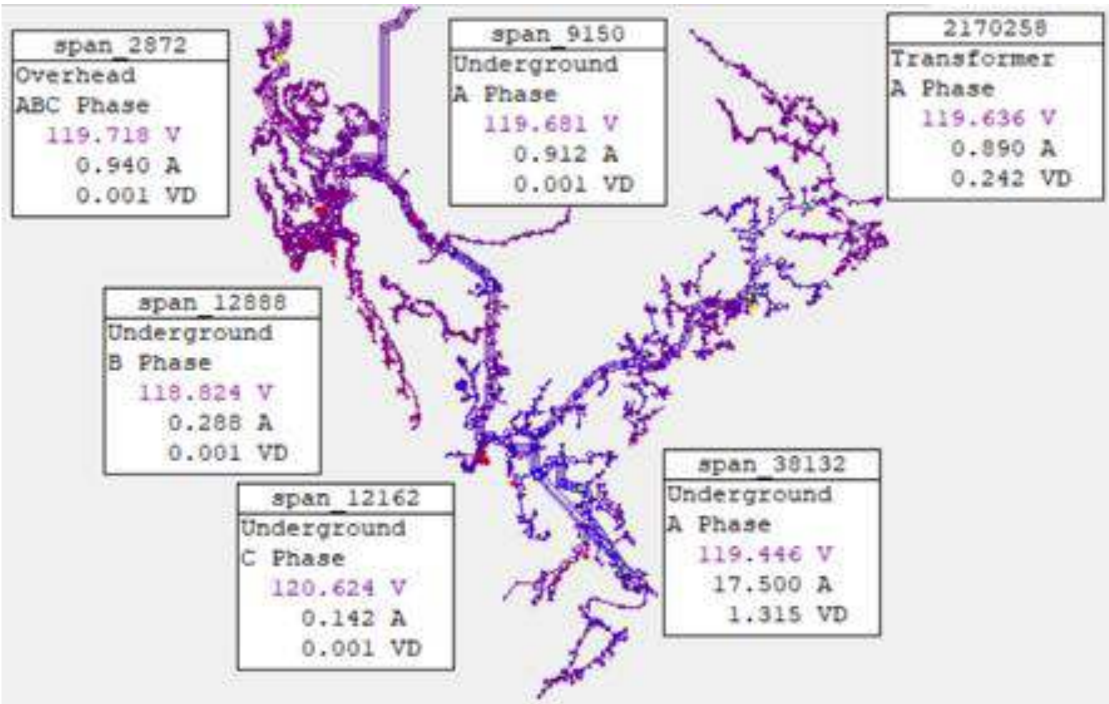
Projects include:

- Replace single phase tap out to Eagle Lake that needs to be replaced with 3-phase.
- Add a spare regulator backup from Eastsound
- Replace aging equipment in Olga
- Support dispatchable EV charging

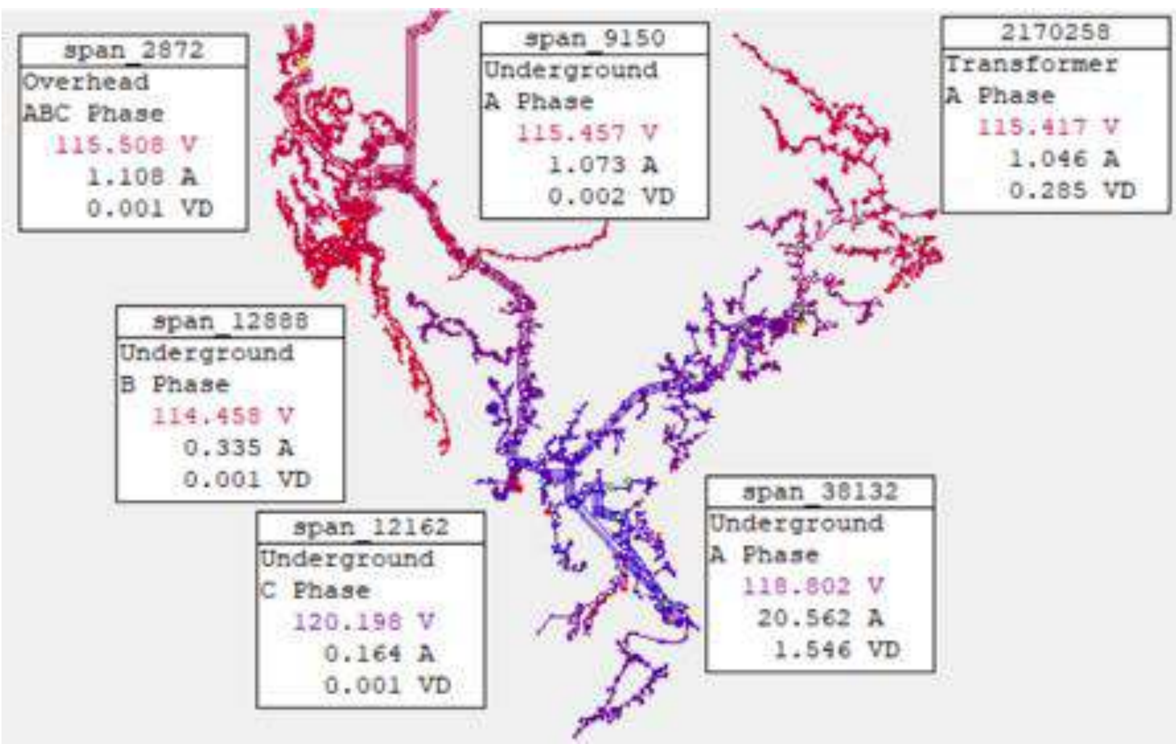
2020 Winter Load without regulator(s)



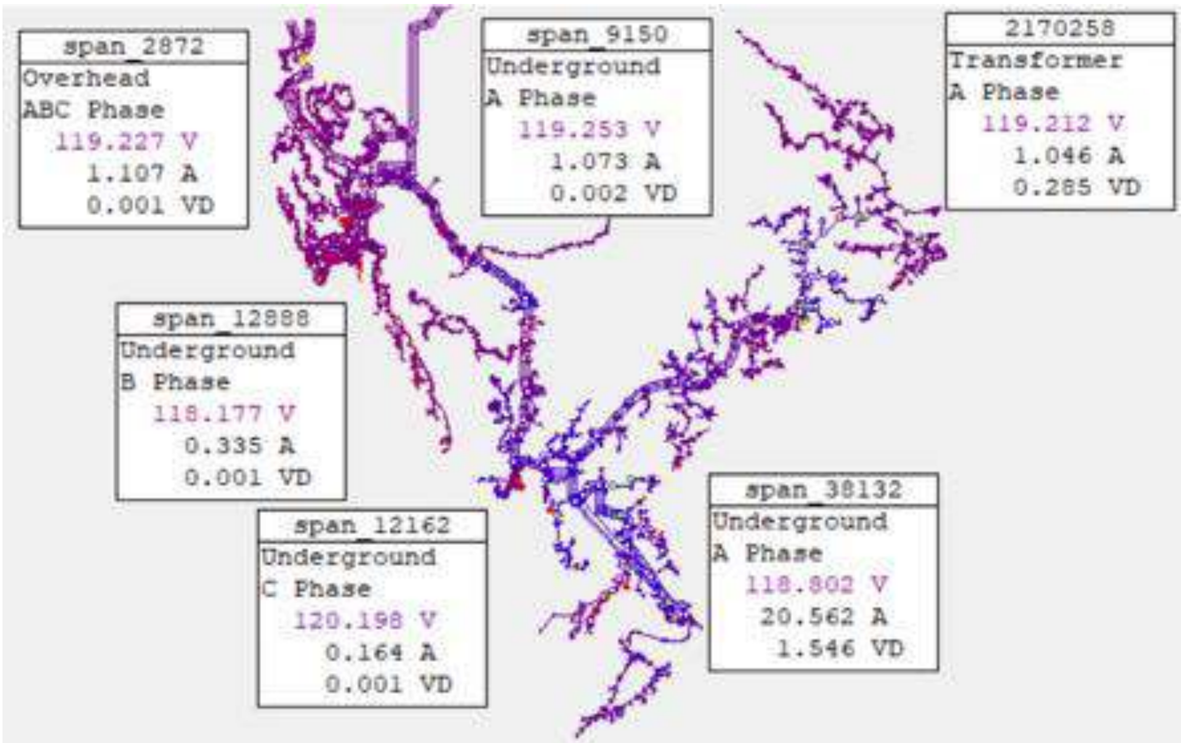
2020 Winter Load with regulator(s)



2040 projected winter load without regulator(s)

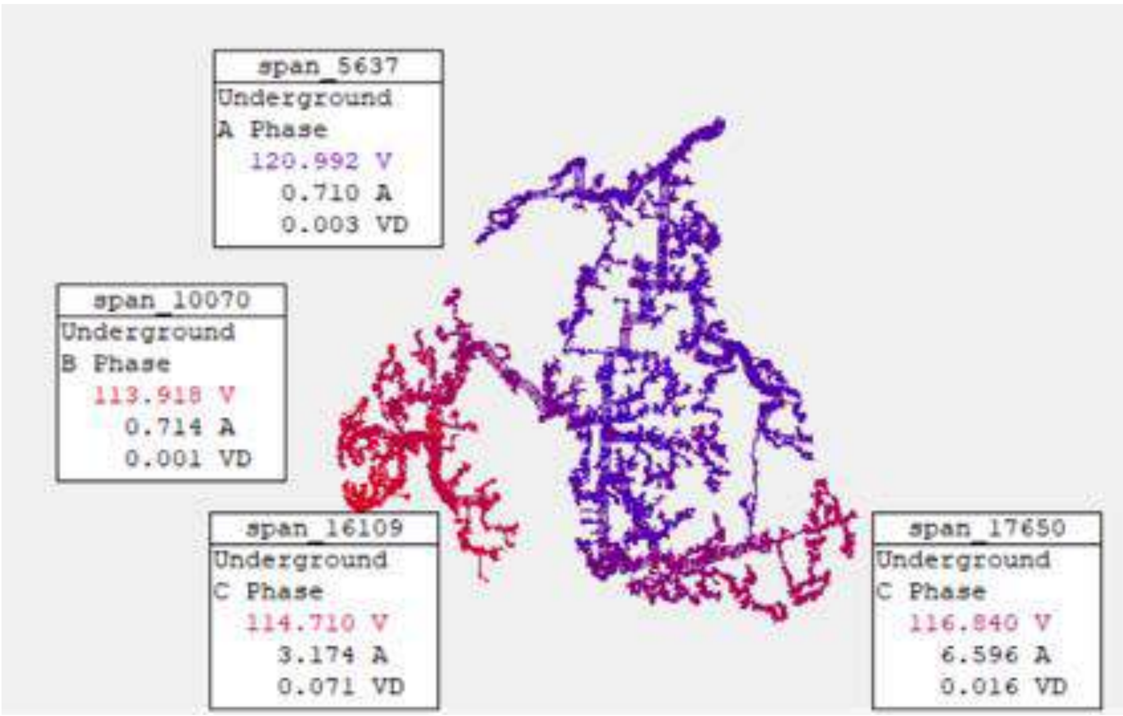


2040 projected winter load with regulator(s)

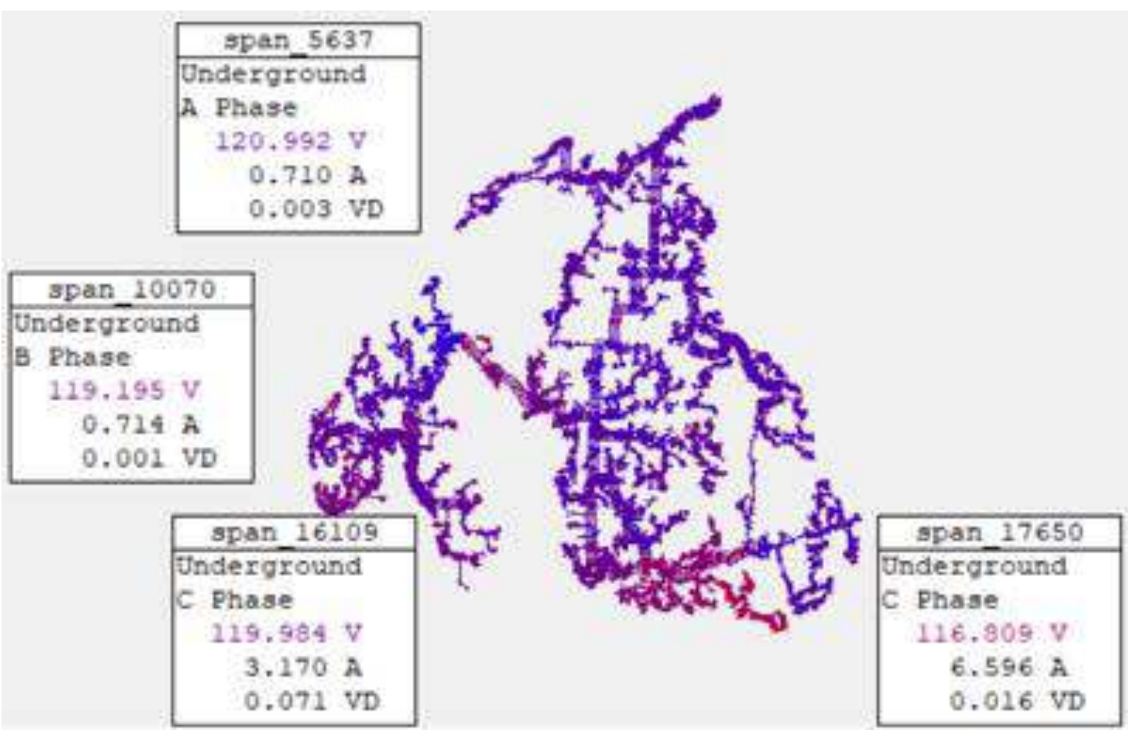

span_2872
Overhead
ABC Phase
119.227 V
1.107 A
0.001 VD
span_9150
Underground
A Phase
119.253 V
1.073 A
0.002 VD
2170258
Transformer
A Phase
119.212 V
1.046 A
0.285 VD
span_12888
Underground
B Phase
118.177 V
0.335 A
0.001 VD
span_12162
Underground
C Phase
120.198 V
0.164 A
0.001 VD
span_38132
Underground
A Phase
118.802 V
20.562 A
1.546 VD

Orcas Substation

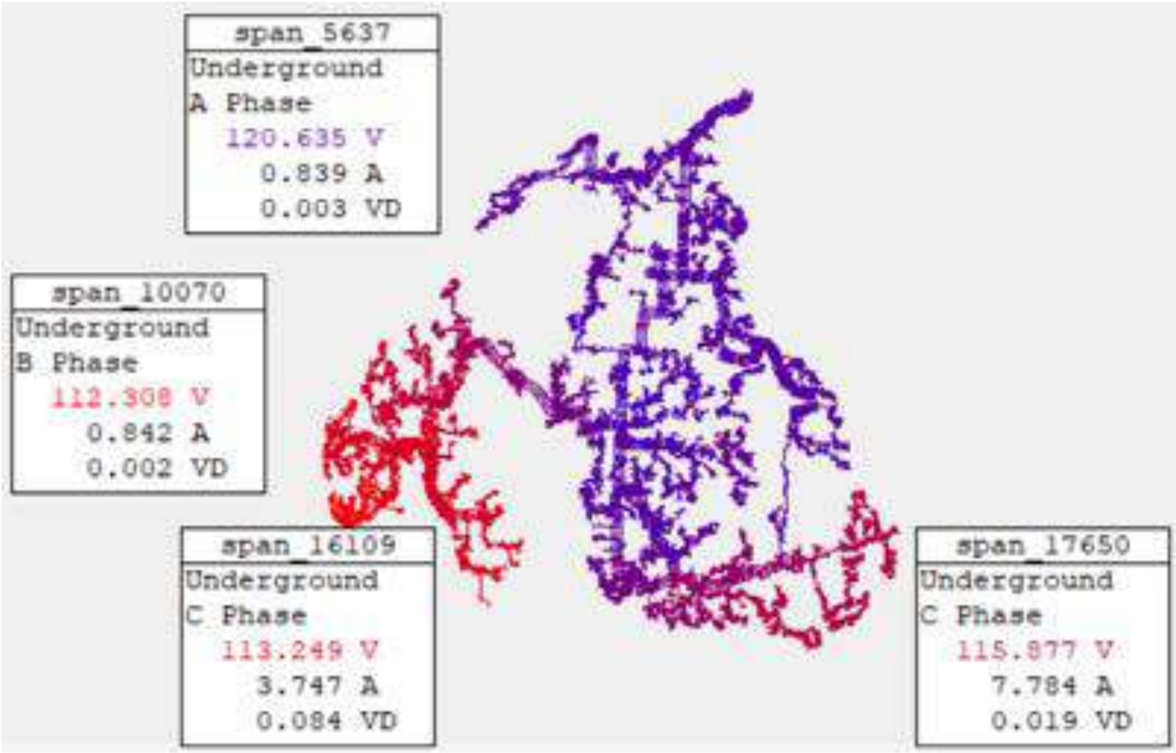
2020 Winter Load without regulator(s)



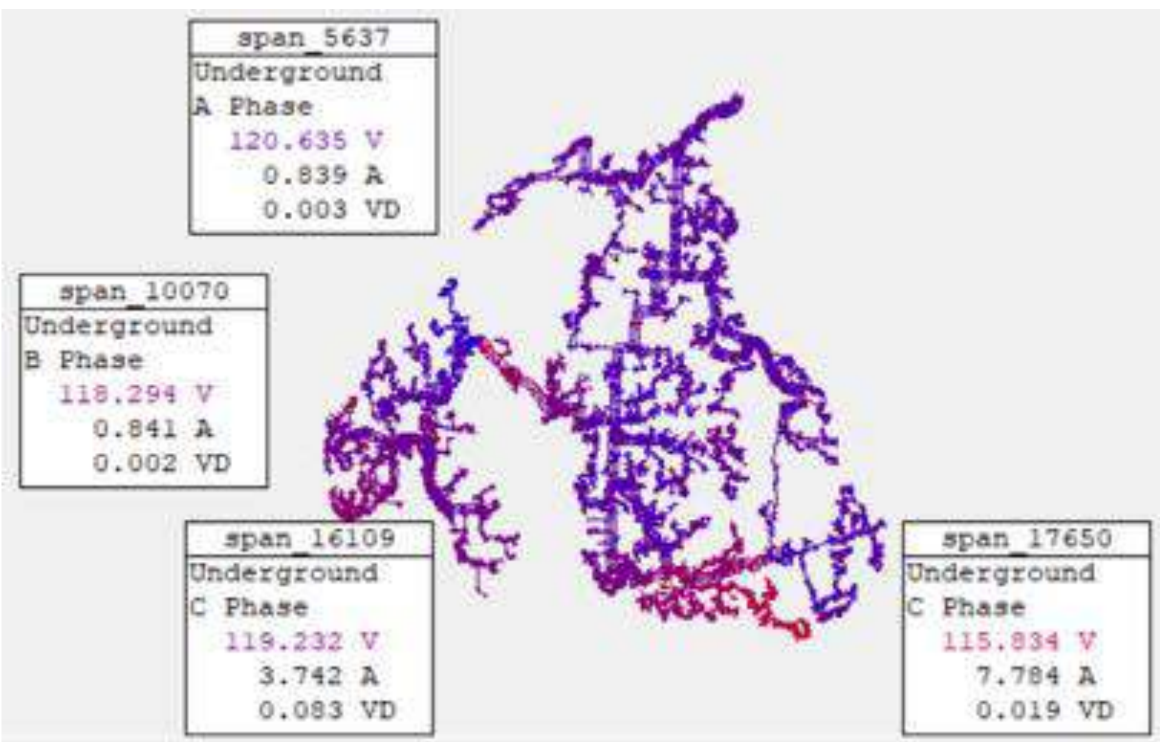
2020 Winter Load with regulator(s)



2040 projected winter load without regulator(s)



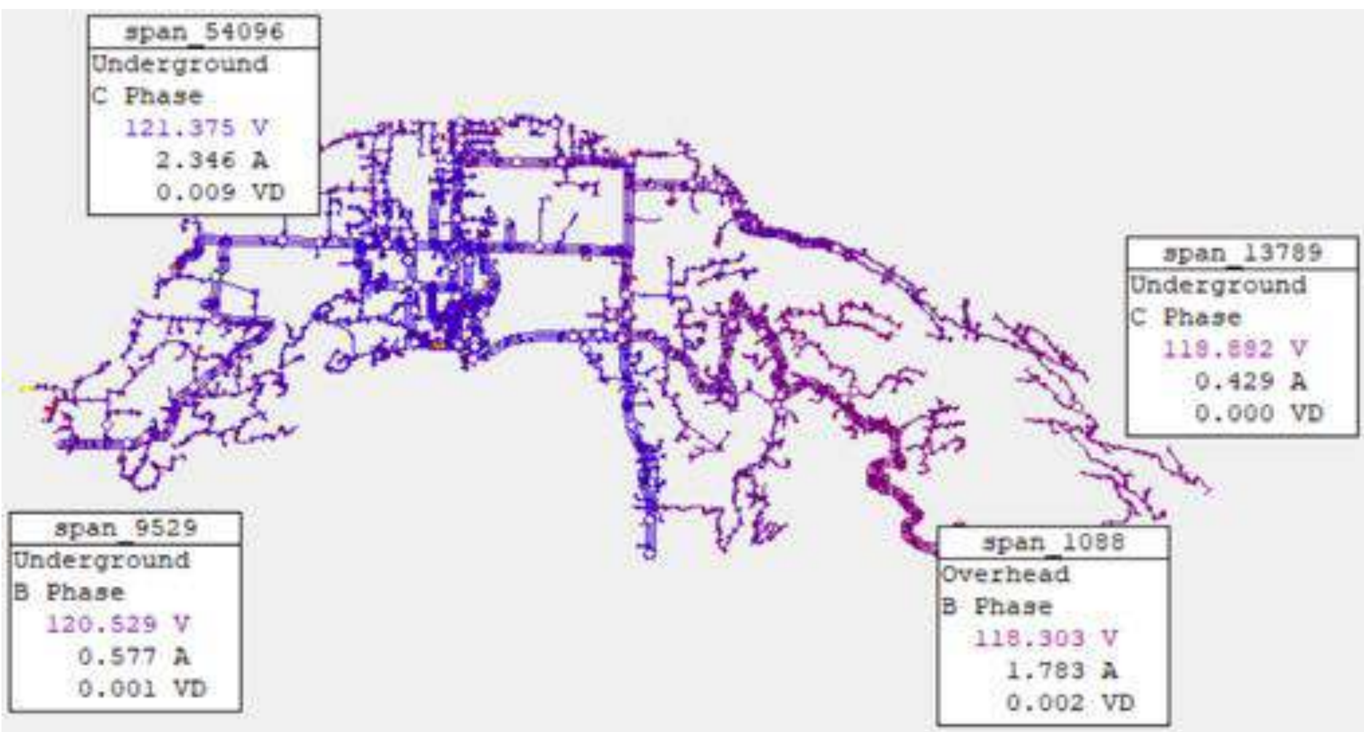
2040 projected winter load with regulator(s)



Eastsound Substation

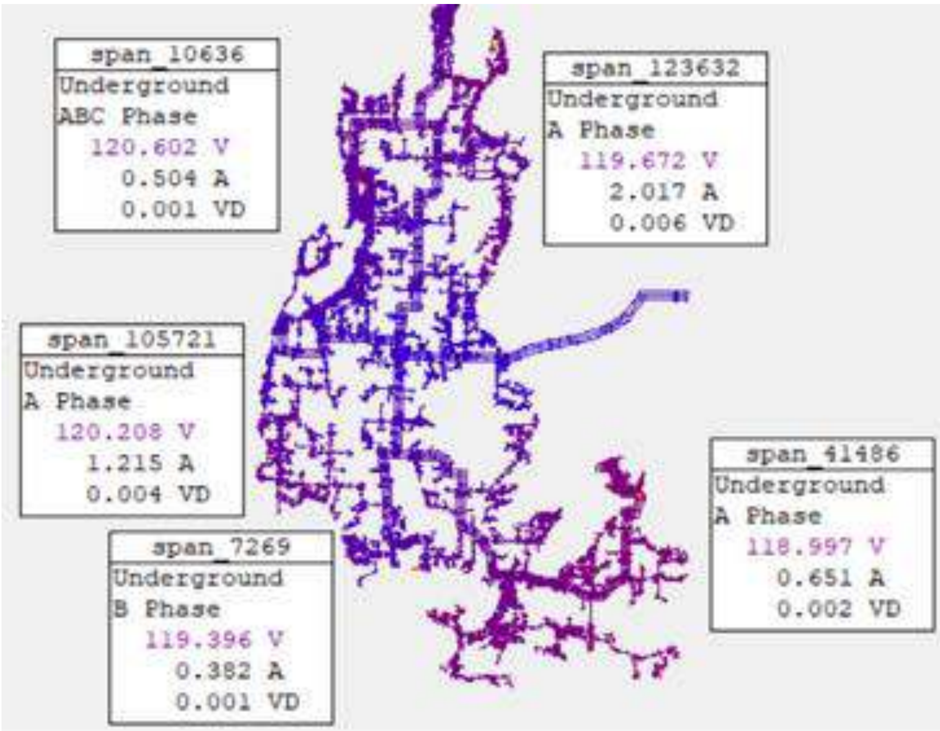
2020 Winter Load without regulator(s)

2040 projected winter load without regulator(s)

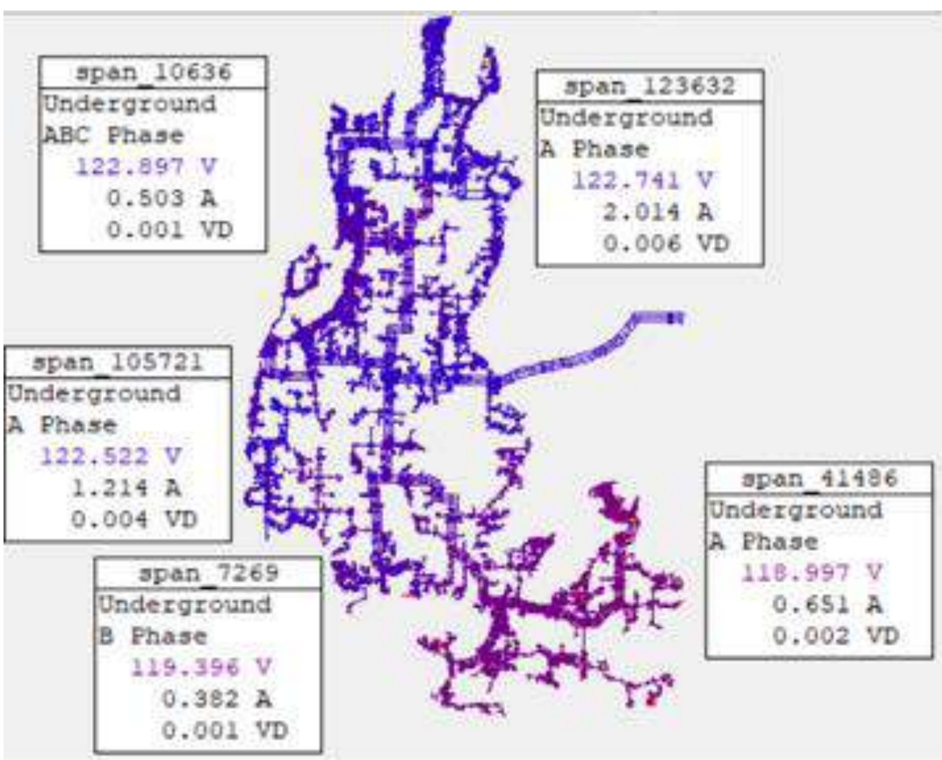


Lopez

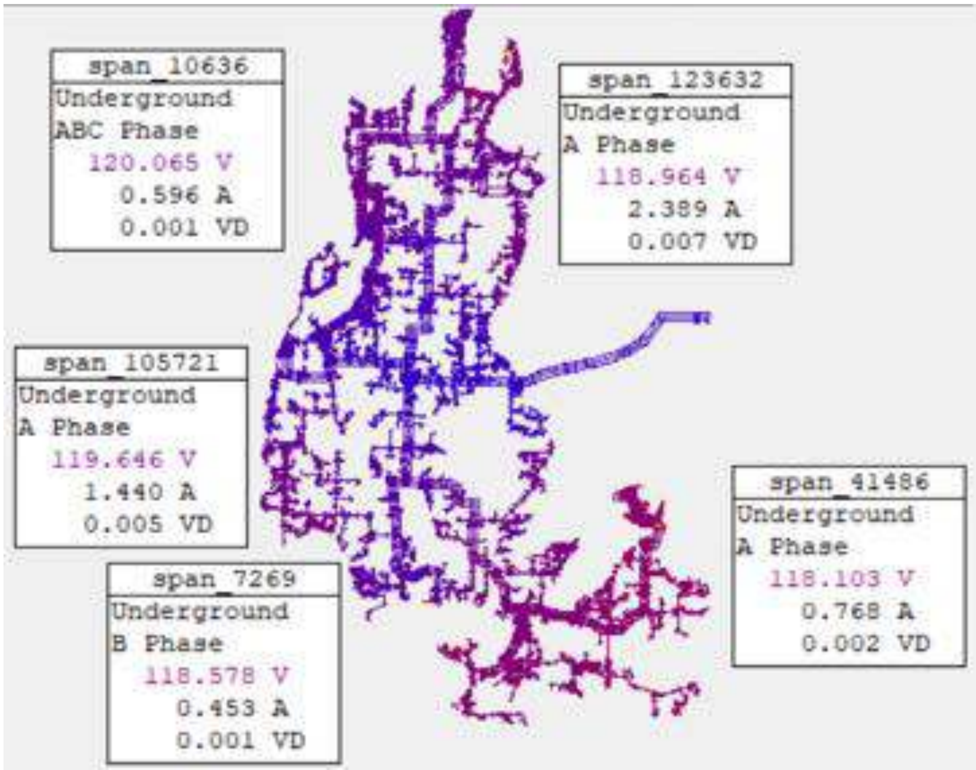
2020 Winter Load without regulator(s)



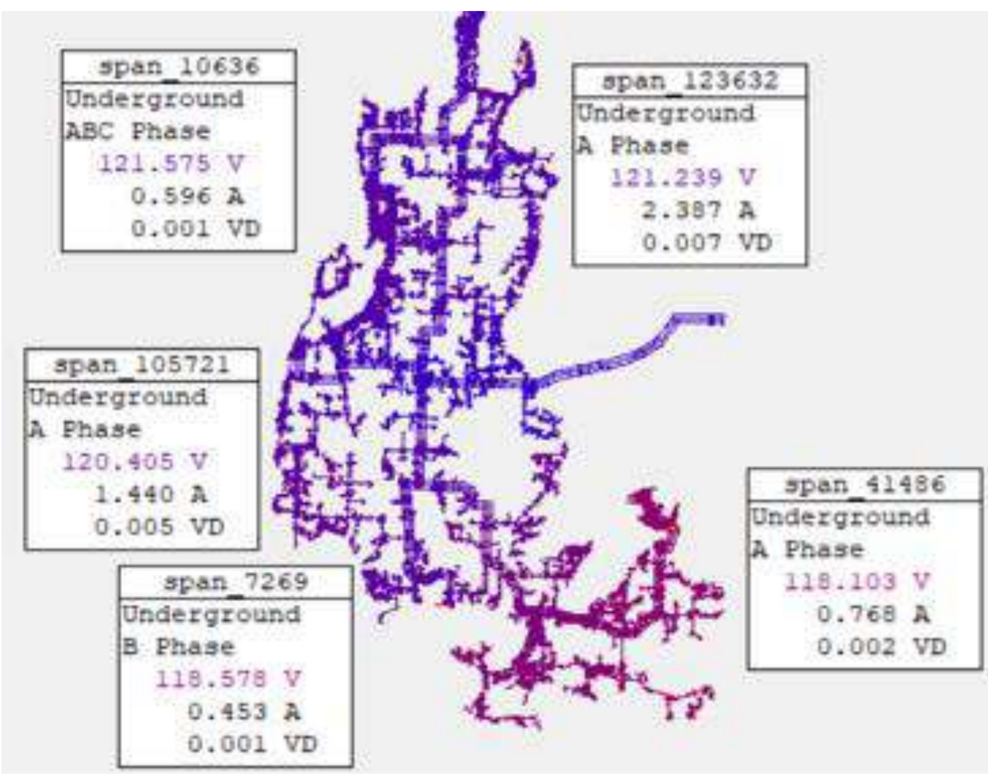
2020 Winter Load with regulator(s)



2040 projected winter load without regulator(s)

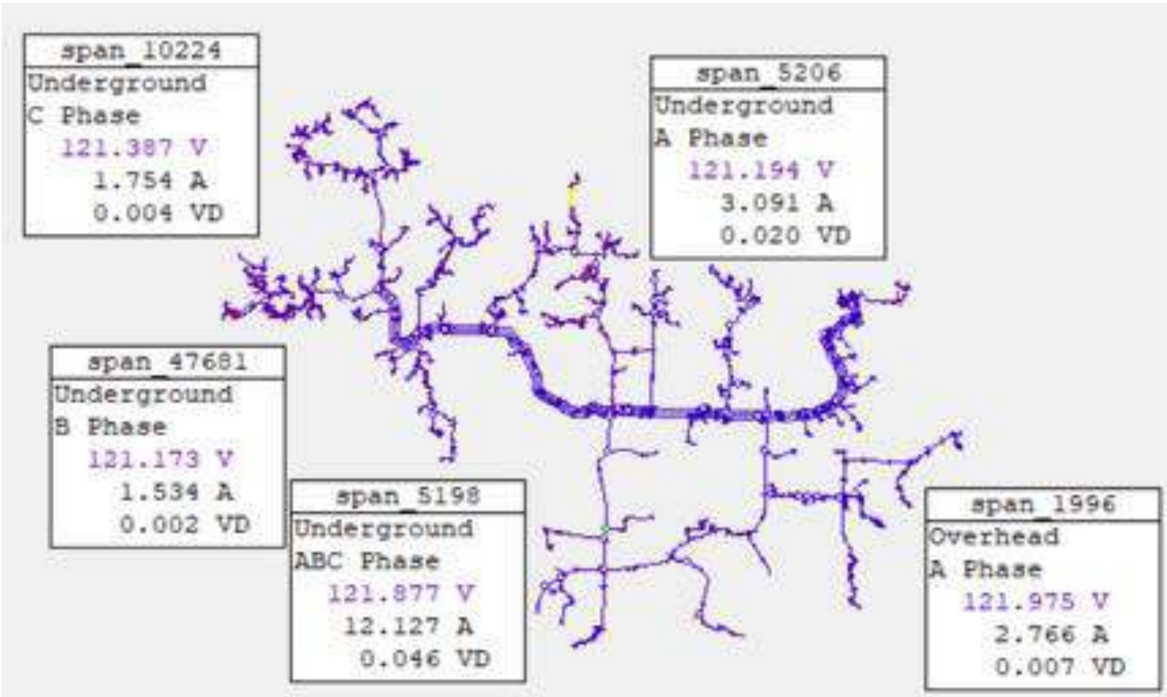


2040 projected winter load with regulator(s)

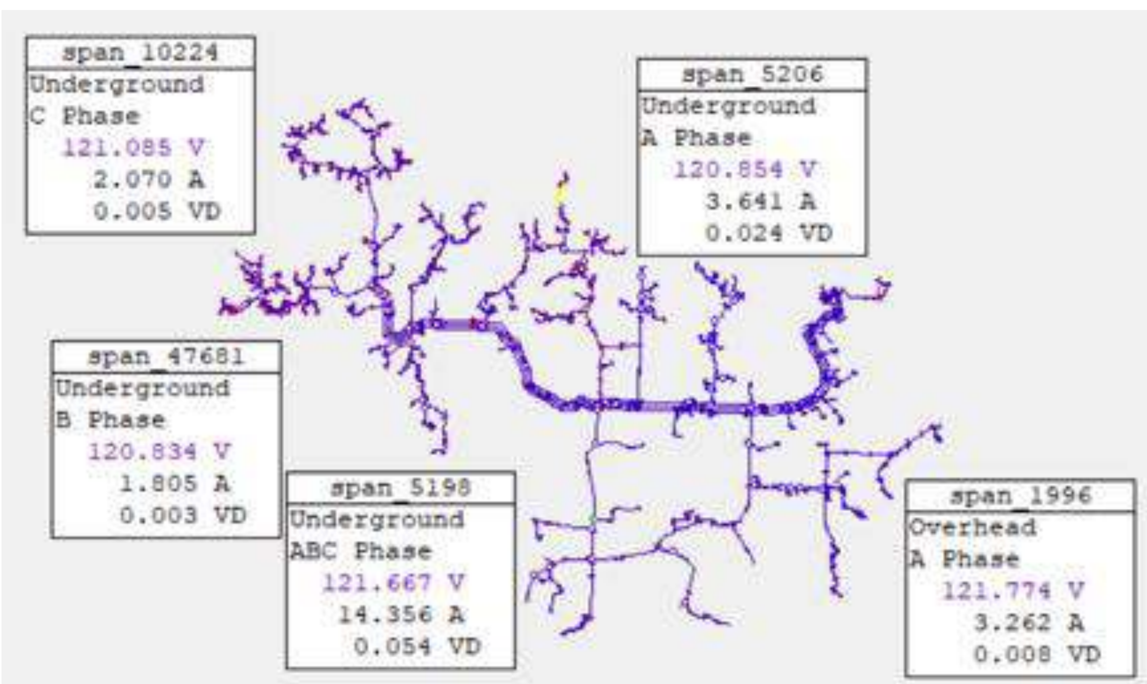


Shaw

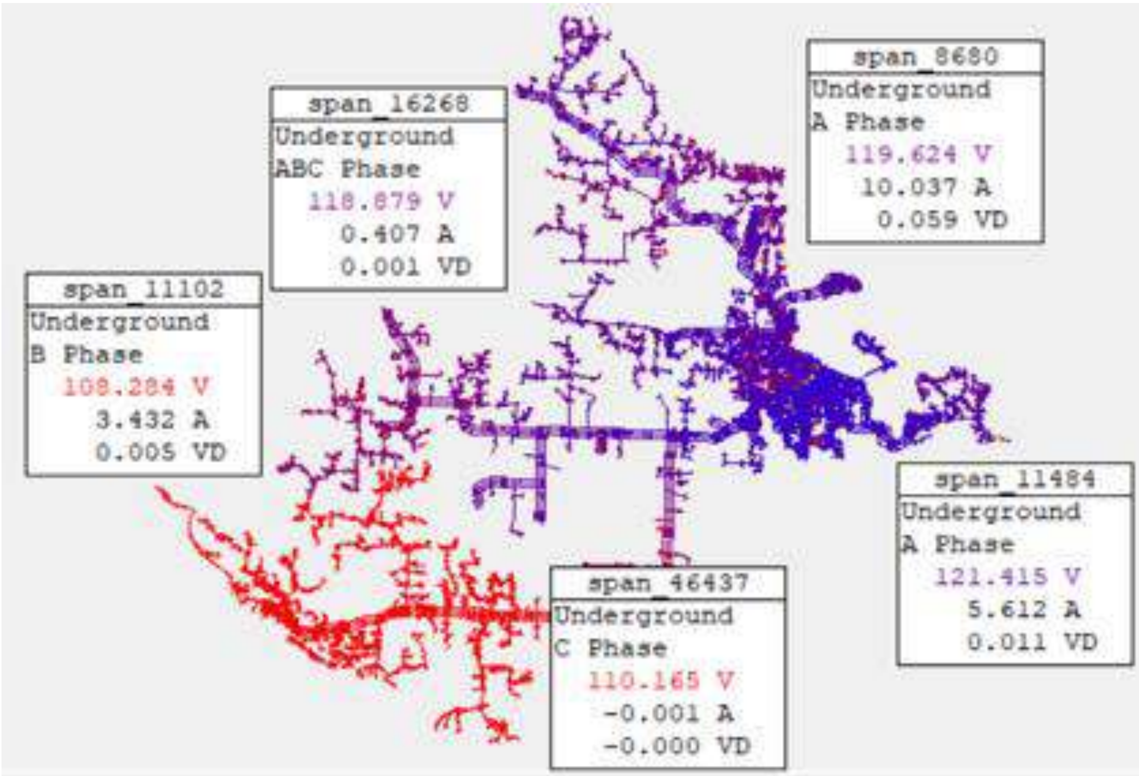
2020 Winter Load without regulator(s)



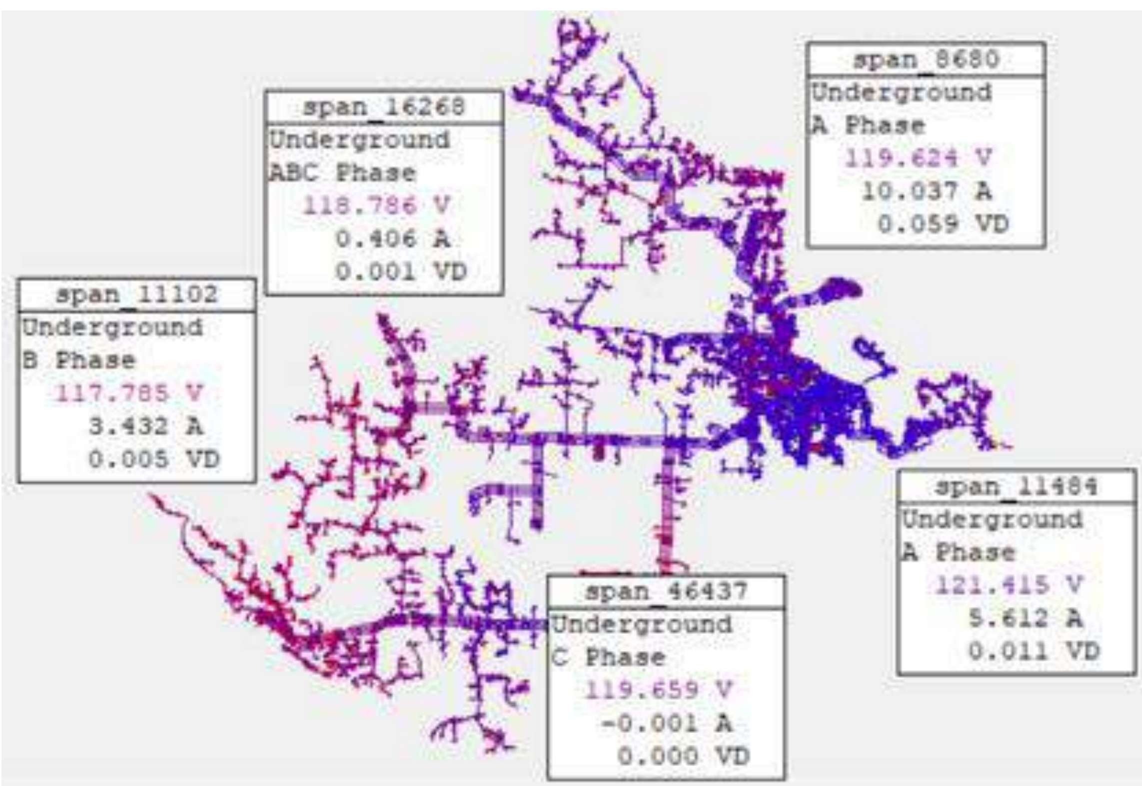
2040 projected winter load without regulator(s)



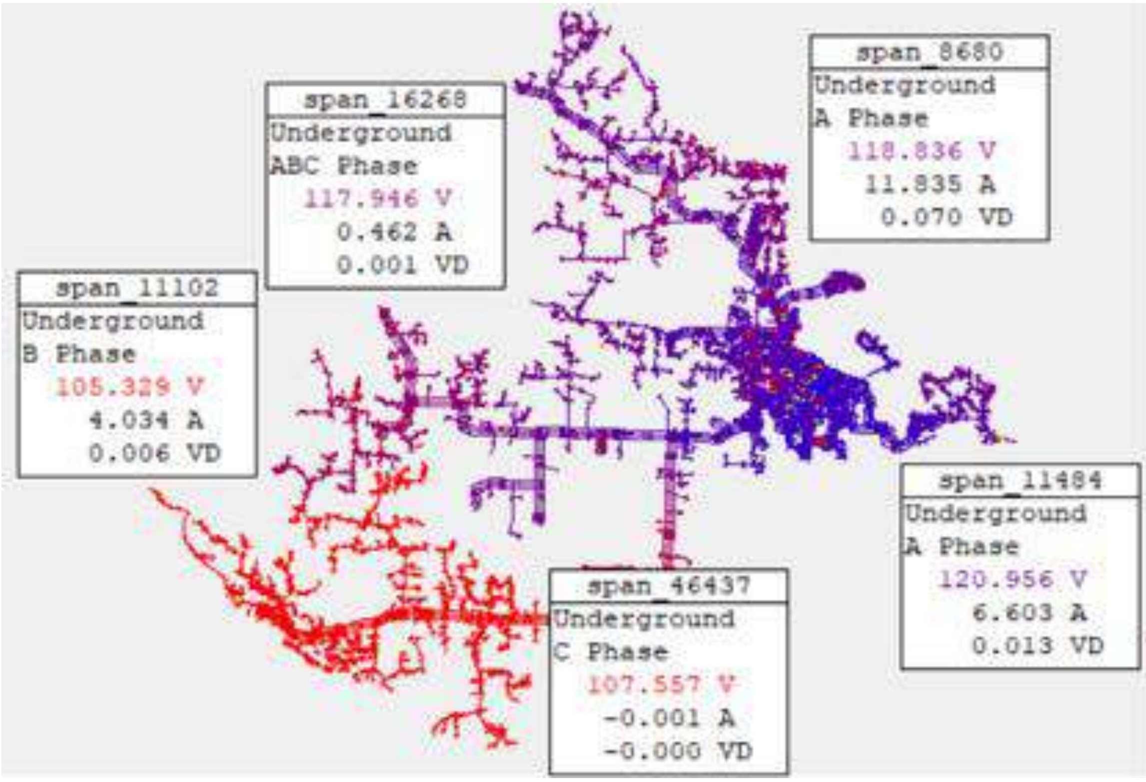
2020 Winter Load without regulator(s)



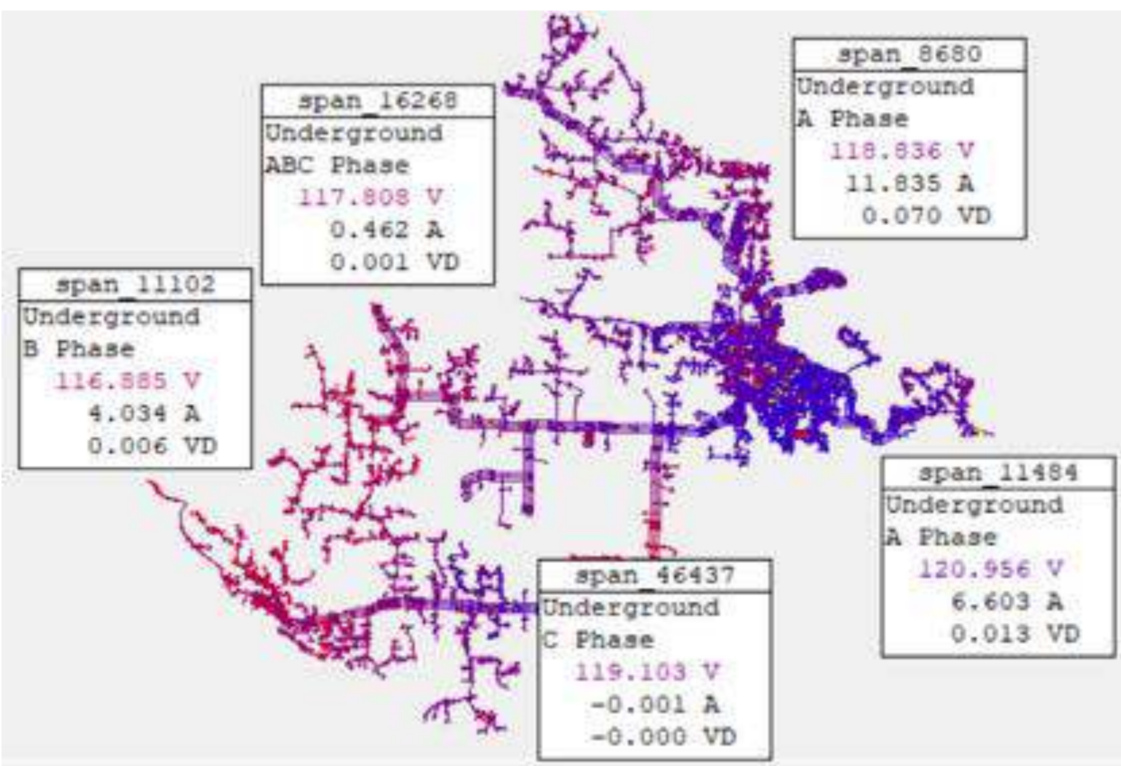
2020 Winter Load with regulator(s)



2040 projected winter load without regulator(s)

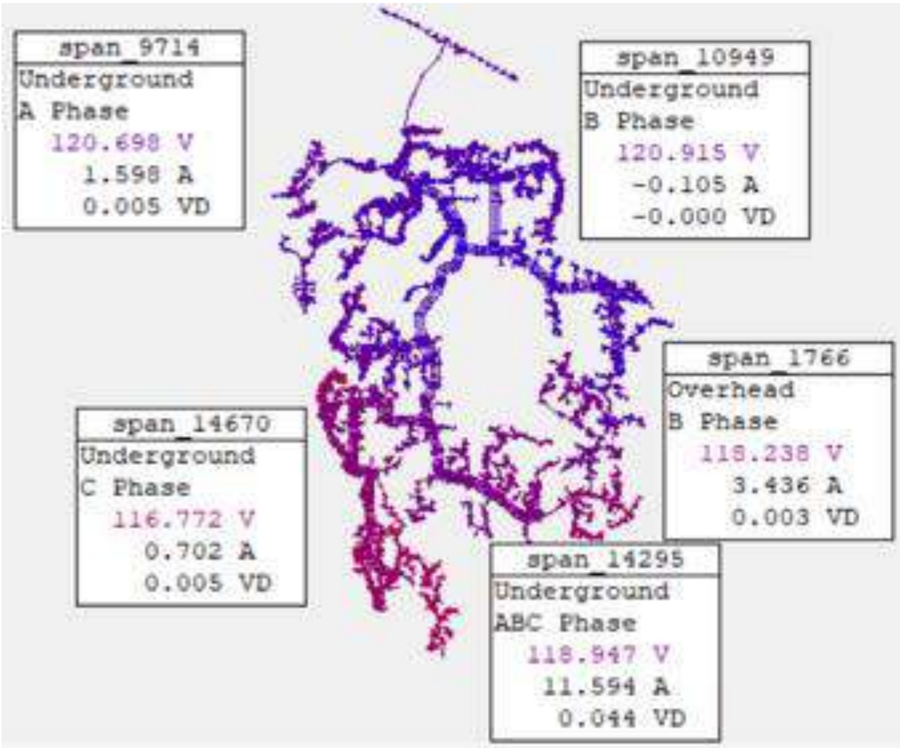


2040 projected winter load with regulator(s)

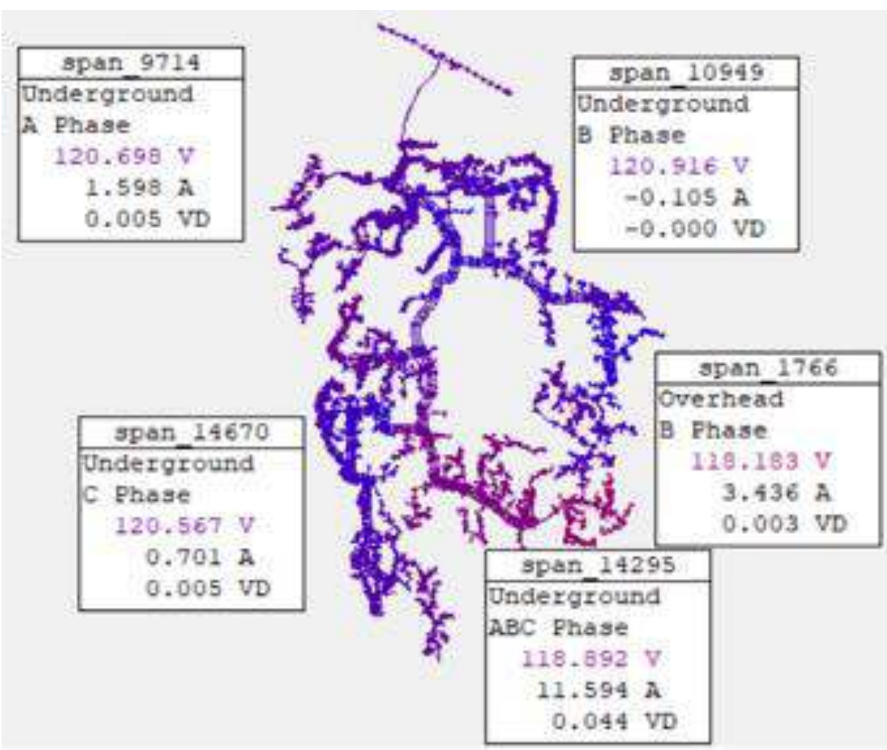


Roche Harbor

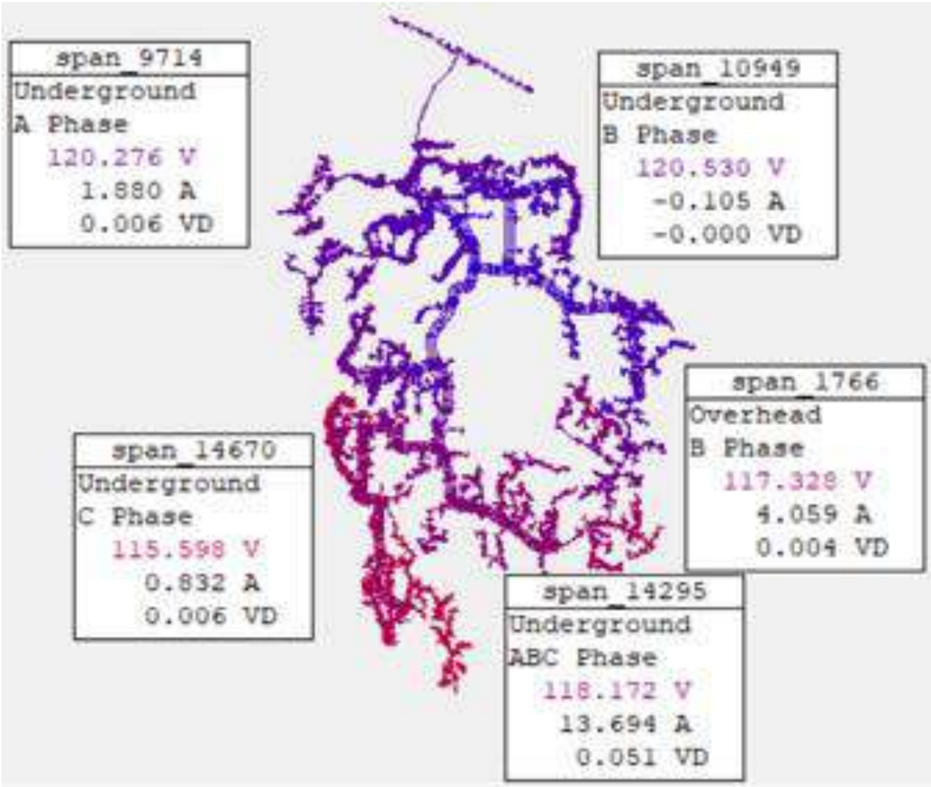
2020 Winter Load without regulator(s)



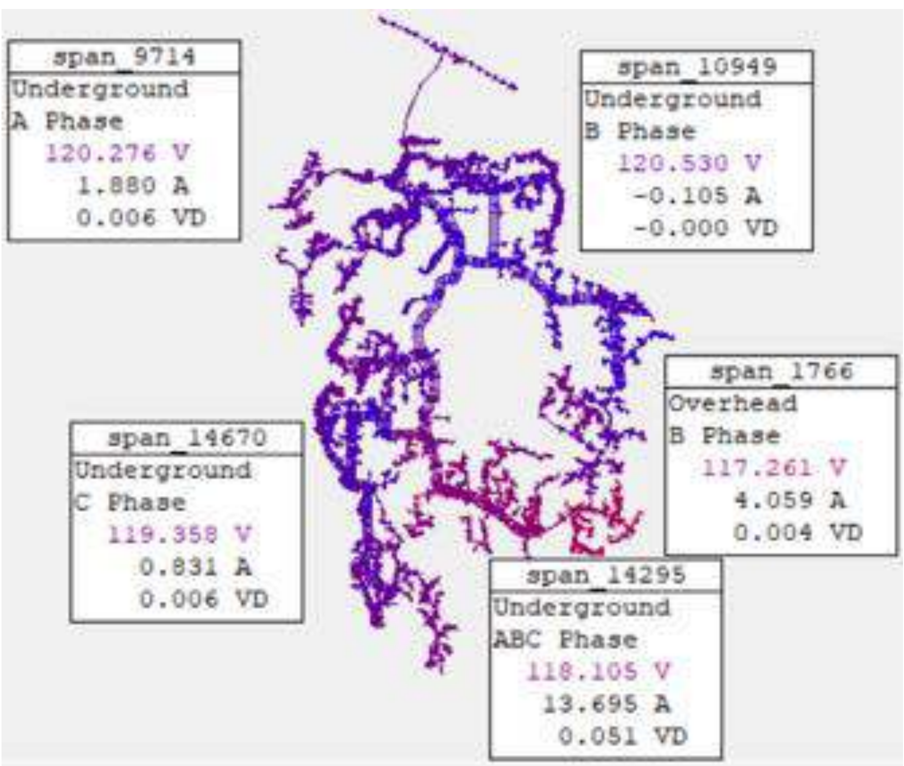
2020 Winter Load with regulator(s)



2040 projected winter load without regulator(s)

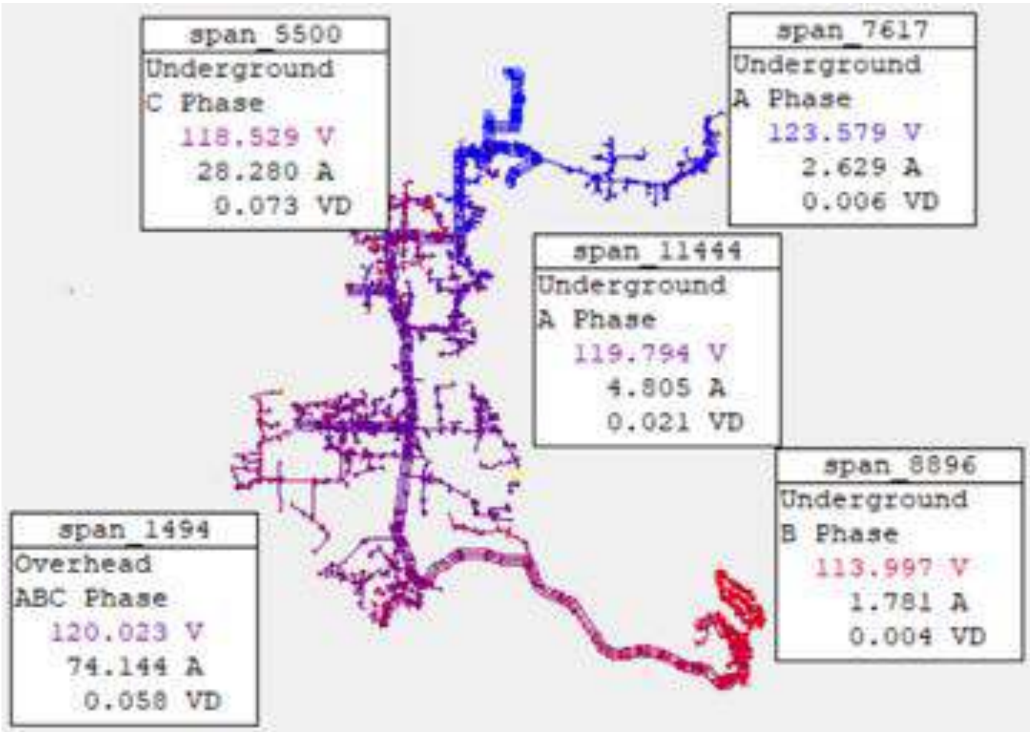


2040 projected winter load with regulator(s)

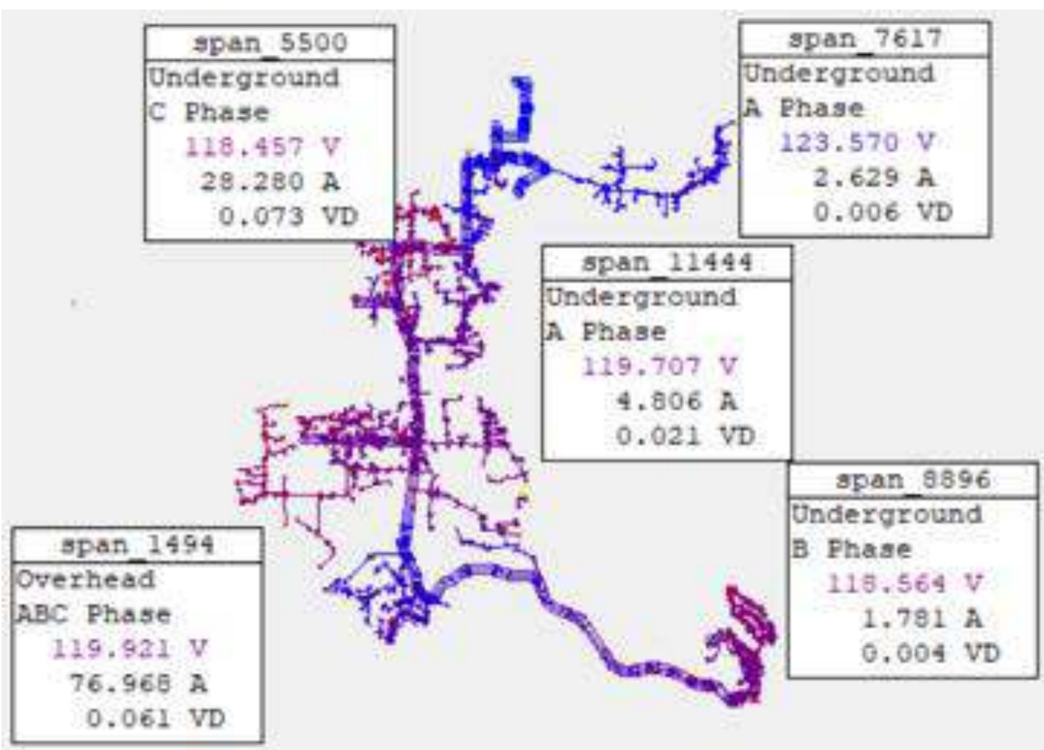


Gravel Pit

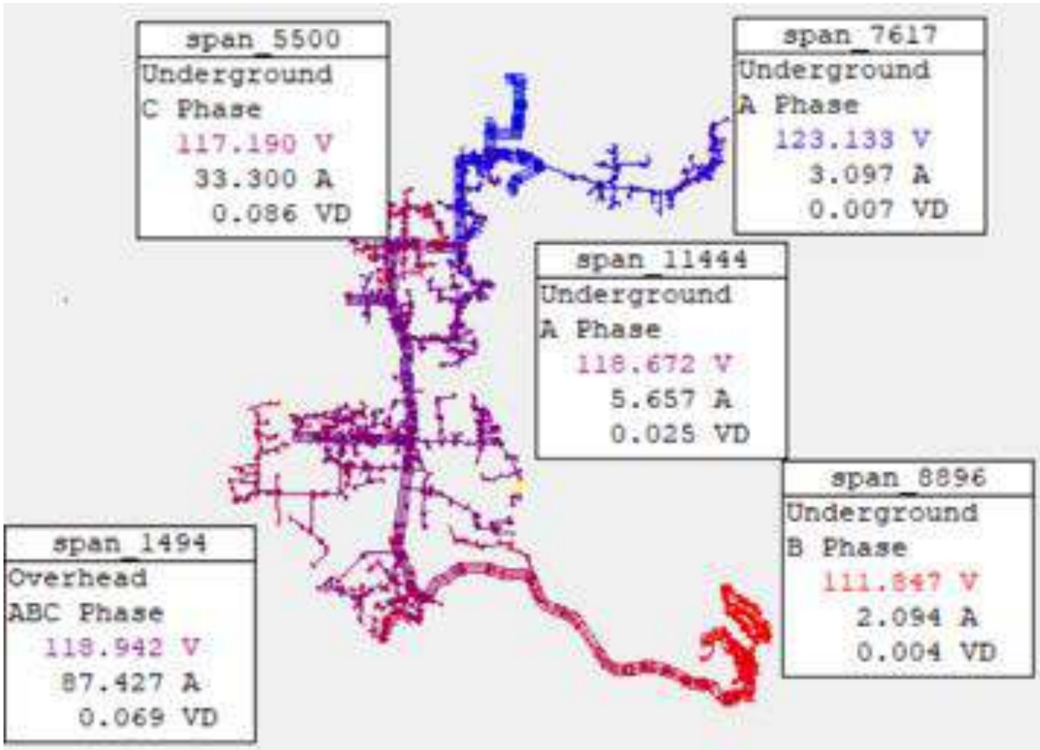
2020 Winter Load without regulator(s)



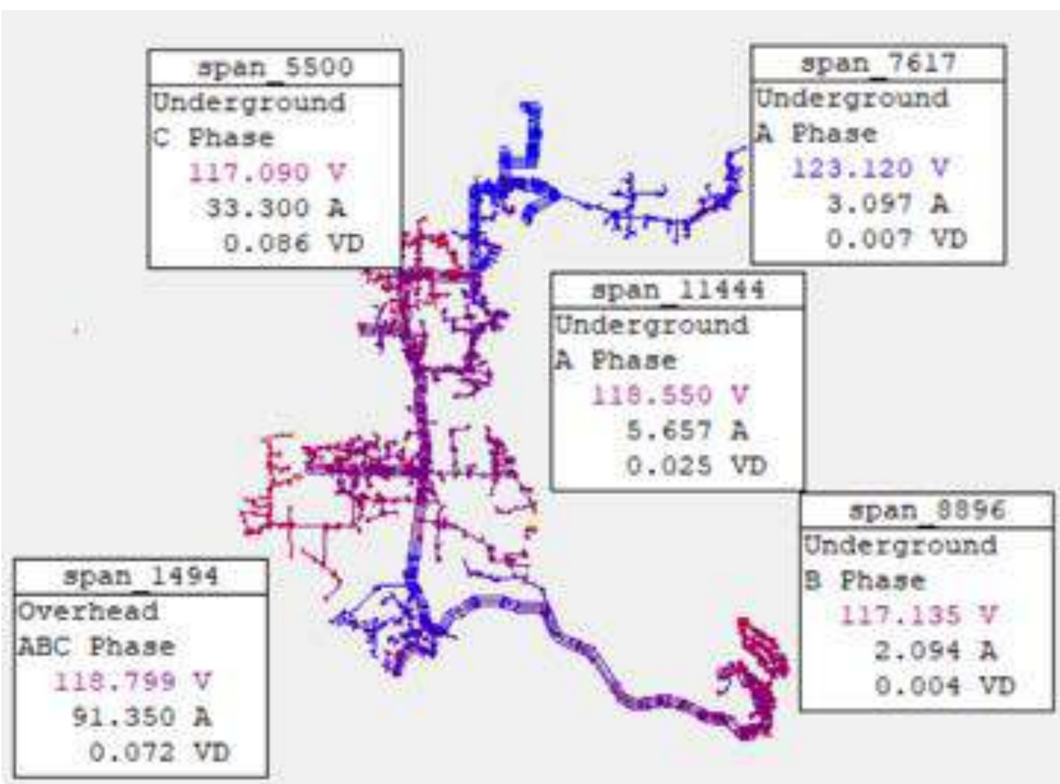
2020 Winter Load with regulator(s)



2040 projected winter load without regulator(s)



2040 projected winter load with regulator(s)



Power Supply

Power supply comes primarily from BPA.

- Average system summer load is 18 MW, winter load is 30 MW, and winter cold-snap peak load is typically 60 to 65 MW – all well within the current system capacity of 105 MW.
- Annual energy consumption is typically about 215 MWh, growing at about 1% per year to a projected 260 MWh by 2040, driven largely by the **electrification of transportation** and population growth.

The Preferred Plan calls for generating about 10% to 15% of load locally through community and utility scale solar, tidal, and member rooftop solar generation, by 2040.

Transmission

Overview

Transmission line construction, repair and modification shall follow current RUS 7 CFR Part 1728F-810 standards. Yearly average transmission line loading shall not exceed 50% of the yearly average rated capacity of the transmission line conductor. All transmission line poles are inspected on a seven-year schedule. Replacement of existing poles is based on inspection finding (inspect every 5 to 7 years) and 30 to 45 year maximum pole life. Poles and/or crossarms to be replaced if found to be physically deteriorated by visual inspection and/or tests. Primary new transmission line construction shall be overhead (except for underwater crossings).

Submarine Cables

Transmission line segments using underwater/underground submarine cable(s) shall be designed using non-oil-filled 69 kV rate armored cables. OPALCO has standardized on 350 MCM Cu lead shielded cables. All submarine cables are designed for 460 amps continuous uses with short period (4 hours) 125% overload rating. All submarine cables are seismically rated for OPALCO's seismic zone. Submarine cable terminal, where OPALCO transitions from underground to overhead are sized one voltage class higher due to the capacitive voltage induced at the terminals by the submarine cable(s) during periods of low usage.

Cathodic Protection (Submarine Cables):

As an intermediate step over the next ten years, the goal is to add cathodic protection to all of our submarine cables. This will increase the life of the cable by reducing the effects of corrosion on the cable armor thus preventing premature loss of integrity. The following cables will be protected:

- Decatur to Blakely 69 kV submarine cable ($250,000)
- Blakely to Orcas 69 kV submarine cable ($250,000)
- Lopez to Shaw 69 kV submarine cable #1 ($250,000)
- Lopez to Shaw 69 kV submarine cable #2 ($250,000)
- Shaw to Orcas 69 kV submarine cable #1 ($250,000)
- Shaw to Orcas 69 kV submarine cable #2 ($250,000)
- Lopez to San Juan 69 kV submarine cable #1 ($250,000)

Differential Protection (Redundant Submarine Cables):

OPALCO has a fantastic communication infrastructure which can in turn be used to help protect the submarine cable assets. One of the biggest shortfalls to the current protection schemes is that running the redundant cable could cause a potential mis-operation due to the lack of selectivity in the current protection schemes. By adding differential protection schemes OPALCO can run the three redundant submarine cable paths in parallel reducing losses while also increasing reliability. The following addition are planned over the next twenty years.

- Additional circuit switcher at SJ-2 feeding SJ-4 with new relaying to provide differential protection. ($350,000)
- Differential protection on the existing SJ-1-1 and SJ-3 circuit. ($50,000)
- Additional circuit switcher at SH-1 feeding SH-3 with new relaying to provide differential protection. ($250,000)
- Additional circuit switcher at SH-2 feeding SH-4 with new relaying to provide differential protection. ($250,000)
- Additional circuit switcher at OR-2 feeding OR-4 with new relaying to provide differential protection. ($250,000)
- Additional circuit switcher at OR-1 feeding OR-3 with new relaying to provide differential protection. ($250,000)

Transmission Sectionalizing

One way to increase reliability or "keep the lights on" for more of OPALCO's member is to properly sectionalize parts of our transmission system to isolate the fault while also minimizing the impact of the outage. Future substation designs will incorporate a standard line control scheme whereas one side of the substation can stay energized while the other side is in a faulted condition. One area that is currently only protected by one breaker is the Decatur to Blakely to Olga line. The twenty-year plan will add a breaker at the South end of Blakely to provide reclosing on the overhead section, as well as a breaker on the South end of Orcas to provide reclosing on the overhead section headed toward Olgas substation.

All future overhead transmission line terminals will be equipped with breakers to allow for faster reclosing intervals. Additionally, all future relays will be purchased with impedance-based distance elements to further increase coordination within our system as well as better coordinate with our upstream service provider.

Substations

Substation transformer average yearly loading shall not exceed 60% of the nameplate rating on the transformer. Substation loading shall not exceed 110% of the transformer nameplate ratings.

The overall system transformation was studied not only on an individual substation basis, but also on a total system basis to determine the optimum capital to power loss ratio while keeping the transformers from exceeding their top forced air rating. A similar evaluation criterion was used on substation voltage regulators and line reclosers.

Sectionalizing and Protection Criteria

All circuits leaving substations shall have both instantaneous and overcurrent protection. Sectionalizing enhancements will be recommended to reduce momentary outages to 40 per feeder per year and extended outages on urban feeders to an average of 2.0 hours per year per member. The extended outages on rural feeders will be 5.0 hours per year per member.

In general, an acceptable range of set points is defined by a minimum and maximum. When evaluating an existing setting that falls outside of the acceptable range, a preferred value will be determined. For creation of new settings, the preferred value is used when possible.

69 kV Transmission Line Protection

Overcurrent element performance is more susceptible to changes in system fault contribution than distance elements which is why current protection practices at OPALCO require all new line relays to be installed with impedance-based distance elements as well as be capable of line differential protection.

- All new line relay terminals will have the following protective elements:
  - Impedance based distance elements (21P/G)
  - Directional instantaneous overcurrent (67P/G)
  - Differential capable (87L)
- Breakers will be required for all overhead protected lines.
- C400 or greater three phase current transformers and three-phase line potential transformers will be required for all future installs.

Transformer Protection Guidelines

All new transformer protection packages installed at OPALCO will require a high-side circuit switcher or circuit breaker with dual slope differential protective elements. Additionally, temperature monitoring and alarming that can be viewed remotely will be a requirement for all future installs. Further evaluation of future technologies that provide more information of the transformer health or provide an indication of potential failure will be considered.

Distribution Protection Guidelines

Breakers/reclosers, as well as switchgear, will be capable of time overcurrent and directional overcurrent protection as well as the ability detect line and bus voltage.

Capacitors/Reactors

Power factor will be continually monitored. Projects will be submitted for amendment when instances of correction are needed.

Line Improvements

Multi-phasing will be used to aid in voltage improvement, elimination of overloaded conductors, reduction of power losses, and improvements of system sectionalizing performance.

Voltage regulation will be used when voltage drop is greater than five volts and where conductor replacement can be delayed.

Transformer Replacements

Over the next twenty years OPALCO has identified four transformers that will likely need to be replaced. The age of the transformers is the primary reason for replacement; however, increased load and redundancy are also factors. Continual monitoring and maintenance should extend the life of these transformers, but a plan for replacement going forward is imperative due to the long lead times, cost and construction requirements. Future transformers will be equipped with high-side protection (circuit switcher or circuit breaker), differential protection, temperature monitoring, transformer health monitoring and station regulators.

- Olga Transformer: ($1,000,000)
  - The Olga transformer is not only one of OPALCO's oldest transformers, but it also provides an important alternate path to Orcas via Decatur. This transformer needs to be replaced as an aging asset as well as to increase load requirements to supply the island of Orcas in the event of an outage from the Lopez transmission line.

- Orcas Substation: ($1,000,000)
  - Orcas substation has the oldest transformer in OPALCO's assets, which will need to be replaced over the coming years. Continued monitoring is key to determine near end of life or end of life for this transformer.
- Friday Harbor Substation: ($1,000,000)
  - Friday Harbor's transformer will need to be replaced over the coming years. Continued monitoring is key to determine near end of life or end of life for this transformer. Additionally, an increase in transformer size will be required to accommodate future load and redundancy requirements.
- Roche Harbor Substation: ($1,000,000)
  - Roche Harbor's transformer will need to be replaced over the coming years. Continued monitoring is key to determine near end of life or end of life for this transformer. Additionally, an increase in transformer size will be required to accommodate future load and redundancy requirements.

Substation Redundancy - Lopez Backup Transformer

Lopez currently does not have a means to provide a redundant distribution source like the other two major islands (Orcas and San Juan). This complicates maintenance at the Lopez station, as an outage is generally required to do much needed preventative maintenance. The plan would be to take one of the older substation transformers (likely Olga) and construct additional bus work at the current Lopez station such that both transformers can be running simultaneously and provide redundancy to one another.

Distribution Circuits

Voltage regulation will be used to achieve short-term deferral of capital investment.

Loads on single-phase taps should be limited depending on the size of the protective device and the overall sectionalizing coordination. Single-phase line fuses or reclosers should be limited to 50-amp devices, where practical. There will certainly be occurrences where larger single-phase tap line devices are applied, most particularly when these taps are closer to the substation and fault levels, including minimum fault levels, are higher. Application of sectionalizing equipment along single-phase taps may be required to provide adequate protection while deferring expensive multi-phasing projects.

Conductor replacement of overhead and underground lines will be based on outage occurrences of the cables. Due to the variance of soil types in our service area, the corrosion may vary and requires inspections on a greater frequency after 20 years of installed life. All new installations of URD will be in conduit to provide a maximum cost benefit for the life of the trenched facilities.

The equipment additions within this plan allows for integration to OPALCO's communication infrastructure. This provides monitoring, control, and automation capabilities to increase safety, efficiency and reliability.

Based on the twenty-year load growth, no significant changes to the distribution system are required. The voltage drop study indicated that the system stayed within our operating parameters during projected peak loads. OPALCO will continue to look at converting single phase to three-phase distribution lines to improve reliability, decrease losses and create redundancy. Reliability and redundancy are the key components to OPALCO's long range plan. The focus will be on automating our system with existing and new intelligent controllers as well as creating redundant paths for distribution feeders to limit customer outages and or outage time.

Over the next twenty years, OPALCO will be looking at ways to automate the distribution system using the existing and future communication infrastructure. This will lead to an increased system reliability, decreased system outages and provide a more robust system with alternate sources. Reliability will come in the form of reduced system outages by pinpointing outages with a combination of smart relays and fault indicators communicating back into OPALCO's SCADA system. Outages will be decreased by sectionalizing the faulted area while restoring power to folks automatically. In addition, feeds have been identified between substations to provide an alternate source that will automatically switch over in the event of a fault. The following distribution automation schemes have been identified:

- Roche Harbor substation circuit 71 and Friday Harbor substation circuit 52 automation scheme. This will allow load to be picked up in either direction sectionalizing the system when there is a fault and automatically picking up load. Additionally, under heavily loaded times from either station the alternate feeder would be able to switch load around to optimize the system. ($250,000)
- Roche Harbor substation circuit 73 and Friday Harbor substation circuit 53 automation scheme. This will allow load to be picked up in either direction sectionalizing the system when there is a fault and automatically picking up load. Additionally, under heavily loaded times from either station the alternate feeder would be able to switch load around to optimize the system. ($250,000)
- Gravel Pit substation circuit 53 and Friday Harbor substation circuit 53 automation scheme. This will allow load to be picked up in either direction sectionalizing the system when there is a fault and automatically picking up load. Additionally, under heavily loaded times from either station the alternate feeder would be able to switch load around to optimize the system. ($250,000)
- Orcas substation circuit 42/circuit 43 and Eastsound substation circuit 103 automation schemes. This will allow load to be picked up in either direction sectionalizing the system when there is a fault and automatically picking up load. Additionally, under heavily loaded times from either station the alternate feeder would be able to switch load around to optimize the system. ($250,000)
- Olga substation circuit 81 and Eastsound substation circuit 104 automation schemes. This will allow load to be picked up in either direction sectionalizing the system when there is a fault and automatically picking up load. Additionally, under heavily loaded ($250,000)

Backup distribution tie between Olga, Blakely and Decatur substation. Due to the limited load, it is difficult to justify a backup substation to either Blakely or Decatur. The planned alternative is to tie the three islands from Olga with a distribution cable by utilizing the existing 25 kV cable and adding a neutral. ($600,000)

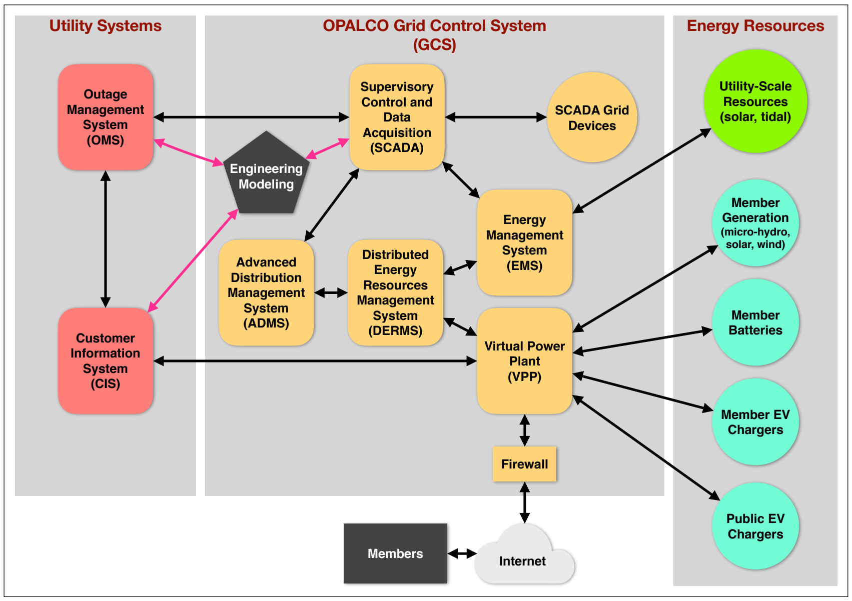
For redundancy proposes an alternate feed to Orcas substation from Olga through means of a distribution cable is planned. This would allow Orcas island to be entirely off of the Decatur feed in the event of an outage from Lopez. ($6,500,000)

Grid Control Systems

Referring to the diagram below, the system is evolving from a conventional SCADA system to incorporate elements that support increased local renewable energy resources including dispatchable storage, utility-scale renewables, member renewables and dispatchable EV chargers.

OPALCO's SCADA system is used to monitor and control the system. In addition, we recently deployed an Energy Management System (EMS) for battery storage systems (stand alone with monitoring from SCADA). In the near future, we will expand control to with an Advanced Distribution Management System (ADMS) and then a Distributed Resource Management System (DERMS).

OPALCO Grid Control Network



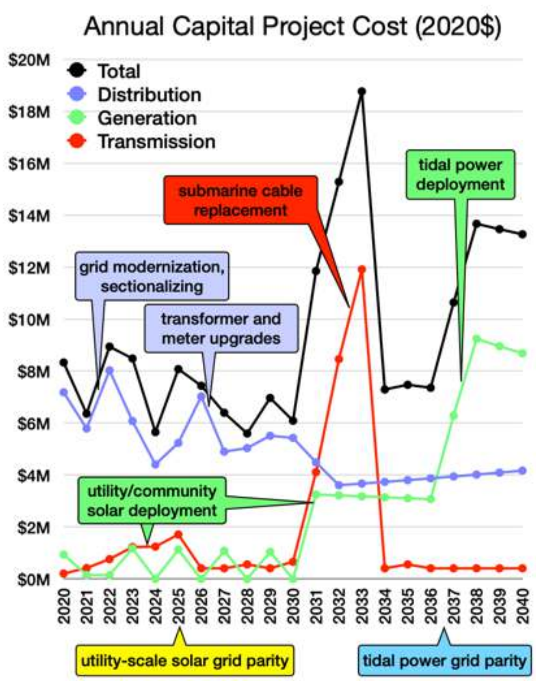
System Energy Losses

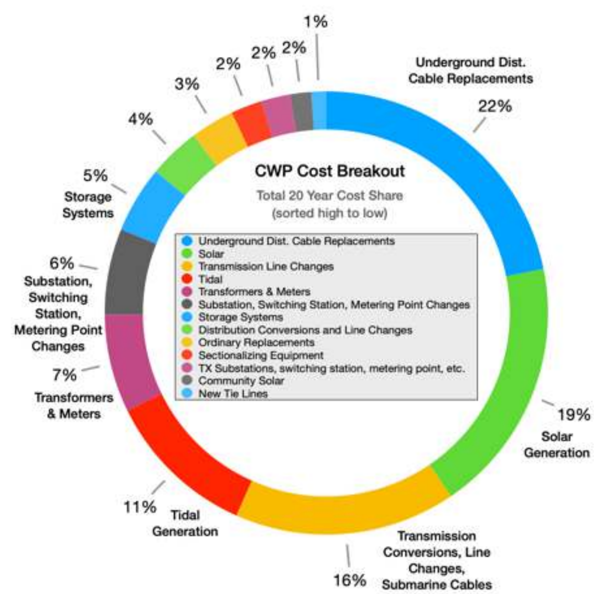
As discussed above, OPALCO minimizes system losses by over-sizing conductors, to reduce loss and support new growth in the coming decades. Since the cost to install underground is so expensive it is better to over-size than have to replace for unforeseen load increases. OPALCO is continually looking at ways to reduce energy losses such as lower impedance transformers and proper voltage regulation across the system. Areas that can be upgraded to three-phase are continually evaluated, and as such helps decrease energy losses. Other projects outlined in the LRP include running submarine cables pairs in parallel to halve load, new regulator controls, upgraded substation transformers and multi-phasing projects help reduce overall losses on the system.

VI. Capital Requirements

The following sections detail the **Preferred Plan** for each of the five Construction Work Plans (CWPs) from 2021 through 2040. This information is presented in tabular form, with each table dividing costs into several major categories – **Distribution**, **Transmission**, **Generation** and **Other**. Each category has applicable subcategories. The most significant items typically are related to undergrounding cables, submarine cables, substation work, and local renewable resources such as utility-scale/community solar and storage systems. The columns on the right show how given categories apply to core missions of safety, reliability and environmental health.

It's worth noting that as we move beyond the first CWP, toward the outer years of the 20-year plan, specific project cost estimates become more schematic and subject to change, based on difficult-to-assess cost trends and emerging technology learning curve improvements. For example, the levelized cost of tidal generators currently reflect the expensive early R&D phase of development. As tidal generation shifts into commercial development and scales up, we expect the price to reach grid parity in later 2030s, but this assumption is subject a variety of variables that are difficult to pin down this early in the innovation cycle.





CWP 1 - 2021 through 2024

Schedule	Theme and Benefits	Actions
2021 – 2024 **CWP 1** **Before Wholesale Solar Grid Parity** **CETA Rolling Blackout Mitigation**	**Themes:** • Manage BPA and local resources for maximum reliability. • We have robust communications system (Rock Island). Do the same for the power system, with grid modernization best practices, meter upgrades that enable minute-by-minute TOU and TOG transactional grid. • Rock Island becomes our Tier 1 deployment support for batteries, EV chargers, smart home devices, and training. • Increase local energy resilience at minimum cost to members through community solar subscriptions, grants and RESP funds. • This helps increase local energy resilience, especially for critical services in the County: first responders, population centers, government. Community solar helps members lower the cost of their electricity. • Continue beneficial electrification programs. **Resources**: Mitigate mainland Loss of Load **System**: Increase resiliency and foundation for beneficial electrification in 2030s. Cathodic protection can shift submarine cable replacement 5 to 10 years further out, building equity.	**Grid Modernization** • Continue grid modernization projects. • Increase loops, sectionalizing, regulation. • Cathodic protection of submarine cables. **Local Renewable Energy** • Deploy as much community solar as members want (at least 1 MW) – funded by subscribers. • Cooperate with partners on grant-funded tidal projects that help assess potential solutions. **Dispatchable Load** • Create incentives and OBF program for 3 MW dispatchable home storage - funded by subscribers, grants and RESP funds. • Create incentives and OBF program for 2 MW dispatchable load (water heaters, EV chargers) for home and business - funded by grants and RESP funds. • Create incentives for dispatchable commercial member generation for peak demand mitigation.

CWP 1 Capital Projects by Category

RUS CWP DESCRIPTION			2021	2022	2023	2024
DISTRIBUTION						
100	New Services		$0	$0	$0	$0
200	New Tie Lines		$200,000	$300,000	$0	$500,000
300	Conversions and Line Changes		$1,560,000	$1,300,000	$600,000	$75,000
400	New Substations, switching station, metering point, etc.		$0	$0	$0	$0
500	Substation, Switching Station, Metering Point Changes		$300,000	$1,080,000	$2,475,000	$60,000
550	Storage Systems		$680,000	$2,120,000	$0	$0
600	Miscellaneous Distribution Equipment					
	601	Transformers & Meters	$375,000	$393,000	$412,000	$894,000
	602	Sets of Service Wires to increase Capacity	$0	$0	$0	$0
	603	Sectionalizing Equipment	$315,000	$300,000	$300,000	$500,000
	604	Regulators	$150,000	$140,000	$100,000	$100,000
	606	Ordinary Replacements	$250,000	$335,000	$271,000	$282,000
	607	Overhead to Underground Conversions	$95,000	$50,000	$60,000	$63,000
	608	Underground Dist. Cable Replacements	$1,503,000	$1,605,000	$1,670,000	$1,737,000
700	Other Distribution Items					
	701	Engineering Fees	$0	$0	$0	$0
	704	SCADA	$213,000	$223,000	$65,000	$67,000
	705	AMR	$0	$0	$0	$0
	706	Communications/Fiber	$150,000	$180,000	$125,000	$130,000
TRANSMISSION						
800	New Tie Line		$0	$0	$0	$0
900	Substations, switching station, metering point, etc.		$71,000	$400,000	$850,000	$600,000
1000	Line Changes		$350,000	$364,000	$379,000	$645,000
1100	Other Transmission		$0	$0	$0	$0
GENERATION						
1200	Generation					
1201	Solar		$0	$0	$1,176,490	$0
1202	Tidal		$150,000	$150,000	$0	$0
1203	Community Solar		$3,000,000	$0	$0	$0
	Community Solar Member Contributions		-$3,000,000	$0	$0	$0
1203	Other		$0	$0	$0	$0
		RUS CWP TOTAL	$6,362,000	$8,940,000	$8,483,490	$5,653,000

CWP 2 - 2025 through 2028

Schedule	Theme and Benefits	Actions
2025 – 2028 **CWP 2** **Before Wholesale Solar Grid Parity**	**Themes:** • Modestly increase ramp up utility-scale solar to increase local energy resilience, but preserve capital for tidal when it hits grid parity. • Cushion against the increasing cost of mainland power. Rate inflation should start to flatten due to increased EV charging kWh usage. • Continue beneficial electrification programs. More revenue helps moderate rate increases. **Resources**: Mitigate mainland Loss of Load **System**: Increase resiliency and foundation for beneficial electrification in 2030s	• Increase local solar and storage resources for critical systems. • Increase loops, sectionalizing, regulation, cathodic protection of submarine cables • Deploy all cost-effective local energy resources, including solar, storage and dispatchable load solutions, funded by grants, RESP and rates. • Continue grid modernization projects. • Continue tidal power collaborations, through grant funded projects.

CWP 2 Capital Projects by Category

RUS CWP DESCRIPTION			2025	2026	2027	2028
DISTRIBUTION						
100	New Services		$0	$0	$0	$0
200	New Tie Lines		$0	$0	$0	$1,000,000
300	Conversions and Line Changes		$120,000	$175,000	$175,000	$175,000
400	New Substations, switching station, metering point, etc.		$0	$0	$0	$0
500	Substation, Switching Station, Metering Point Changes		$1,600,000	$1,000,000	$1,000,000	$60,000
550	Storage Systems		$0	$2,587,961	$0	$0
600	Miscellaneous Distribution Equipment					
	601	Transformers & Meters	$775,000	$786,000	$1,198,000	$1,260,000
	602	Sets of Service Wires to increase Capacity	$0	$0	$0	$0
	603	Sectionalizing Equipment	$450,000	$160,000	$160,000	$160,000
	604	Regulators	$20,000	$40,000	$40,000	$40,000
	606	Ordinary Replacements	$294,000	$294,000	$294,000	$294,000
	607	Overhead to Underground Conversions	$66,000	$66,000	$66,000	$66,000
	608	Underground Dist. Cable Replacements	$1,705,000	$1,756,000	$1,809,000	$1,863,000
700	Other Distribution Items					
	701	Engineering Fees	$0	$0	$0	$0
	704	SCADA	$69,000	$69,000	$69,000	$69,000
	705	AMR	$0	$0	$0	$0
	706	Communications/Fiber	$136,000	$90,000	$90,000	$50,000
TRANSMISSION						
800	New Tie Line		$0	$0	$0	$0
900	Substations, switching station, metering point, etc.		$1,300,000			$150,000
1000	Line Changes		$411,000	$411,000	$411,000	$411,000
1100	Other Transmission		$0	$0	$0	$0
GENERATION						
1200	Generation					
1201	Solar		$1,129,901	$0	$1,085,157	$0
1202	Tidal		$0	$0	$0	$0
1203	Community Solar		$0	$0	$0	$0
	Community Solar Member Contributions		$0	$0	$0	$0
1203	Other		$0	$0	$0	$0
		RUS CWP TOTAL	$8,075,901	$7,434,961	$6,397,157	$5,598,000

CWP 3 - 2029 through 2032

Schedule	Theme and Benefits	Actions
2029 – 2032 **CWP 3** **Wholesale Solar Grid Parity**	**New BPA Contract, Build Equity** • Accelerate deploying local solar energy solutions until tidal is economic. • Optimize mix of local generation with BPA as firming and gap filling. • Prepare for potential submarine cable replacement in 2033 (this may be delayed due to beneficial cathodic protection). • Continue beneficial electrification programs.	• Possibly replace Lopez to Orcas submarine cable. • Continue deploying all cost-effective local energy resources, including solar, storage and dispatchable load solutions, funded by grants, RESP and rates. • Continue grid modernization projects. • As tidal approaches grid parity, prepare for deployment when cost effective.

CWP 3 Capital Projects by Category

RUS CWP DESCRIPTION			2029	2030	2031	2032
DISTRIBUTION						
100	New Services		$0	$0	$0	$0
200	New Tie Lines		$0	$0	$0	$0
300	Conversions and Line Changes		$175,000	$175,000	$175,000	$175,000
400	New Substations, switching station, metering point, etc.		$0	$0	$0	$0
500	Substation, Switching Station, Metering Point Changes		$60,000	$2,000,000	$1,000,000	$60,000
550	Storage Systems		$2,081,644	$0	$0	$0
600	Miscellaneous Distribution Equipment					
	601	Transformers & Meters	$598,000	$598,000	$598,000	$598,000
	602	Sets of Service Wires to increase Capacity	$0	$0	$0	$0
	603	Sectionalizing Equipment	$160,000	$160,000	$160,000	$160,000
	604	Regulators	$40,000	$40,000	$40,000	$40,000
	606	Ordinary Replacements	$294,000	$294,000	$294,000	$294,000
	607	Overhead to Underground Conversions	$66,000	$66,000	$66,000	$66,000
	608	Underground Dist. Cable Replacements	$1,919,000	$1,977,000	$2,036,000	$2,097,000
700	Other Distribution Items					
	701	Engineering Fees	$0	$0	$0	$0
	704	SCADA	$69,000	$69,000	$69,000	$69,000
	705	AMR	$0	$0	$0	$0
	706	Communications/Fiber	$50,000	$50,000	$50,000	$50,000
TRANSMISSION						
800	New Tie Line		$0	$0	$0	$0
900	Substations, switching station, metering point, etc.			$250,000	$250,000	
1000	Line Changes		$411,000	$411,000	$3,861,000	$8,461,000
1100	Other Transmission		$0	$0	$0	$0
GENERATION						
1200	Generation					
1201	Solar		$1,042,185	$0	$3,251,359	$3,215,009
1202	Tidal		$0	$0	$0	$0
1203	Community Solar		$0	$0	$0	$0
	Community Solar Member Contributions		$0	$0	$0	$0
1203	Other		$0	$0	$0	$0
		RUS CWP TOTAL	$6,965,829	$6,090,000	$11,850,359	$15,285,009

CWP 4 - 2033 through 2036

Schedule	Theme and Benefits	Actions
2033 – 2036 **CWP 4** **eFerry Terminals, Build Equity**	• Build equity for forthcoming submarine cable replacement projects and tidal deployment. • Rate increases are tempered by increased EV and eFerry usage and kWh from charging. • Continue beneficial electrification programs.	• Deploy high power ferry charging infrastructure, funded through grants, RESP program, rates. • Deploy tidal when economic and acceptable to community.

CWP 4 Capital Projects by Category

RUS CWP DESCRIPTION			2033	2034	2035	2036
DISTRIBUTION						
100	New Services		$0	$0	$0	$0
200	New Tie Lines		$0	$0	$0	$0
300	Conversions and Line Changes		$175,000	$175,000	$175,000	$175,000
400	New Substations, switching station, metering point, etc.		$0	$0	$0	$0
500	Substation, Switching Station, Metering Point Changes		$60,000	$60,000	$60,000	$60,000
550	Storage Systems		$0	$0	$0	$0
600	Miscellaneous Distribution Equipment					
	601	Transformers & Meters	$598,000	$598,000	$598,000	$598,000
	602	Sets of Service Wires to increase Capacity	$0	$0	$0	$0
	603	Sectionalizing Equipment	$160,000	$160,000	$160,000	$160,000
	604	Regulators	$40,000	$40,000	$40,000	$40,000
	606	Ordinary Replacements	$294,000	$294,000	$294,000	$294,000
	607	Overhead to Underground Conversions	$66,000	$66,000	$66,000	$66,000
	608	Underground Dist. Cable Replacements	$2,160,000	$2,225,000	$2,292,000	$2,361,000
700	Other Distribution Items					
	701	Engineering Fees	$0	$0	$0	$0
	704	SCADA	$69,000	$69,000	$69,000	$69,000
	705	AMR	$0	$0	$0	$0
	706	Communications/Fiber	$50,000	$50,000	$50,000	$50,000
TRANSMISSION						
800	New Tie Line		$0	$0	$0	$0
900	Substations, switching station, metering point, etc.				$150,000	
1000	Line Changes		$11,911,000	$411,000	$411,000	$411,000
1100	Other Transmission		$0	$0	$0	$0
GENERATION						
1200	Generation					
1201	Solar		$3,179,065	$3,143,523	$3,108,379	$3,073,627
1202	Tidal		$0	$0	$0	$0
1203	Community Solar		$0	$0	$0	$0
	Community Solar Member Contributions		$0	$0	$0	$0
1203	Other		$0	$0	$0	$0
		RUS CWP TOTAL	$18,762,065	$7,291,523	$7,473,379	$7,357,627

CWP 5 - 2037 through 2040

Schedule	Theme and Benefits	Actions
2037 – 2040 **CWP 5** **Build Equity, Deploy Tidal at Grid Parity**	• Switch from solar to tidal investment at grid parity, to strengthen winter generation resource portfolio. Further reducing dependence on mainland power and pricing. • Build equity for tidal deployment and forthcoming submarine cable replacement projects. • Continue beneficial electrification programs. • Significant portion of energy use is now generated locally, year-round.	• Deploy tidal energy resources at grid parity, Funded with grants, RESP programs, investors, rates.

Capital Projects by Category

RUS CWP DESCRIPTION				2037	2038	2039	2040
DISTRIBUTION							
100	New Services			$0	$0	$0	$0
200	New Tie Lines			$0	$0	$0	$0
300	Conversions and Line Changes			$175,000	$175,000	$175,000	$175,000
400	New Substations, switching station, metering point, etc.			$0	$0	$0	$0
500	Substation, Switching Station, Metering Point Changes			$60,000	$60,000	$60,000	$60,000
550	Storage Systems			$0	$0	$0	$0
600	Miscellaneous Distribution Equipment						
		601	Transformers & Meters	$598,000	$598,000	$598,000	$598,000
		602	Sets of Service Wires to increase Capacity	$0	$0	$0	$0
		603	Sectionalizing Equipment	$160,000	$160,000	$160,000	$160,000
		604	Regulators	$40,000	$40,000	$40,000	$40,000
		606	Ordinary Replacements	$294,000	$294,000	$294,000	$294,000
		607	Overhead to Underground Conversions	$66,000	$66,000	$66,000	$66,000
		608	Underground Dist. Cable Replacements	$2,432,000	$2,505,000	$2,580,000	$2,657,000
700	Other Distribution Items						
		701	Engineering Fees	$0	$0	$0	$0
		704	SCADA	$69,000	$69,000	$69,000	$69,000
		705	AMR	$0	$0	$0	$0
		706	Communications/Fiber	$50,000	$50,000	$50,000	$50,000
TRANSMISSION							
800	New Tie Line			$0	$0	$0	$0
900	Substations, switching station, metering point, etc.						
1000	Line Changes			$411,000	$411,000	$411,000	$411,000
1100	Other Transmission			$0	$0	$0	$0
GENERATION							
1200	Generation						
1201	Solar			$3,039,264	$3,005,285	$2,971,686	$2,938,462
1202	Tidal			$3,247,314	$6,234,843	$5,985,450	$5,746,032
1203	Community Solar			$0	$0	$0	$0
	Community Solar Member Contributions			$0	$0	$0	$0
1203	Other			$0	$0	$0	$0
			RUS CWP TOTAL	$10,641,578	$13,668,128	$13,460,135	$13,264,494

Alternate Plan Analysis

Overview

The Preferred Plan should be viewed as a "middle path" that strikes a balance between increasing local energy resilience and debt. Local energy resilience is focused on population centers, rather than the entire service area, which helps keeping funding requirements more restrained than a full-on deployment of local energy resources, costing billions of dollars and requiring over 1,200 acres of scarce permittable land.

This section highlights two alternate plans.

Alternate Plan 1 - Go Slow, Minimize Debt

This plan departs from the preferred plan in the following ways:

- No solar or storage beyond what can be funded through direct member investment (e.g. community solar subscriptions, and grants).
- No tidal energy deployment

Alternate Plan 2 - Go Fast, Maximize Local Solar + Storage and Tidal

This plan departs from the preferred plan in the following ways:

- Deploy 2 MW of solar per year, firmed by .5 MW of storage per year through 2035, then deploy 2 MW of tidal per year through 2040.

Analysis

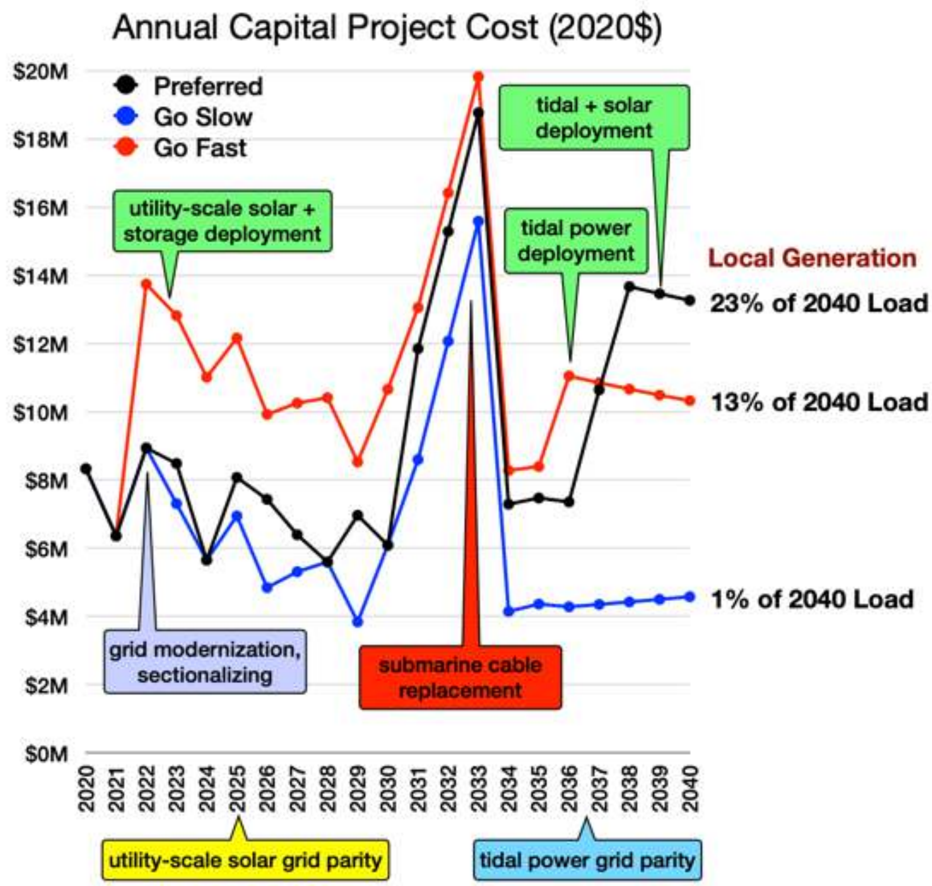
The table below compares the preferred and alternate plans, showing the MW capacity 20 year buildout for solar, storage and tidal energy resources.

Plan	Solar (MW)	Storage (MW)	Tidal (MW)
Preferred Plan	20	6	7
Alternative Plan 1: go slow, minimize borrowing	0	0	0
Alternative Plan 2: go fast, maximize local energy	30	7.5	10

The table below compares the preferred and alternate plans, showing CWP 20-year average annual cost and total 20 year cost.

Plan	Average Annual Cost	Total 20-year Cost
Preferred Plan	$9,452,732	$189,054,636
Alternative Plan 1: go slow, minimize borrowing	$6,390,600	$127,812,000
Alternative Plan 2: go fast, maximize local energy	$12,129,587	$242,591,741

The chart below provides a year-by-year comparison of annual plan cost for preferred, go slow and go fast alternatives, along with what percent of 2040 load the local renewable energy generation portion of the plan will generate.


Annual Capital Project Cost (2020$)
$20M
$18M
$16M
$14M
$12M
$10M
$8M
$6M
$4M
$2M
$0M
Preferred
Go Slow
Go Fast
utility-scale solar + storage deployment
tidal + solar deployment
tidal power deployment
Local Generation
23% of 2040 Load
13% of 2040 Load
1% of 2040 Load
grid modernization, sectionalizing
submarine cable replacement
2020 2021 2022 2023 2024 2025 2026 2027 2028 2029 2030 2031 2032 2033 2034 2035 2036 2037 2038 2039 2040
utility-scale solar grid parity
tidal power grid parity

Sensitivity Analysis

Overview

This section highlights the Preferred Plan and discusses sensitivity to inflation rates, load growth, and funding variations.

Preferred Plan Summary

As discussed above, the Preferred Plan calls for:

- Leveraging the current substantial load carrying capability of the grid to accelerate uptake of beneficial electrification, especially EVs. This has the dual benefit of reducing member CO2 emissions and their TOTAL energy spending (electricity, gasoline, propane), while increasing co-op revenue to help fund the projects described in this LRP, thus reducing borrowing. Minimal new upgrades are required to serve anticipated load, thanks to OPALCO's decision to underground the bulk of its distribution system, doing so with up-sized cables in anticipation of increased future load.
- Deploy a modest .5 MW per year, through 2029, of seasonal local energy generation (solar, which is out of phase with seasonal winter-peaking load) until year-round solutions such as tidal become technically and economically viable, to reduce dependence on mainland power. This is deployed as subscriber-funded community solar as long as there is member appetite. Beyond that, it is member-funded utility solar once wholesale grid parity is reached. Either way, it is co-configured with storage (described below) and sectionalized to support micro-griding of population-centers and critical services during outages.
- Deploy .5 MW per year, through 2029, of utility-scale storage systems to mitigate demand spikes and increased mainland outages due to CETA, and increasing demand for hydro to firm intermittent renewables.
- Deploy .5 MW per year, through 2029, of dispatchable member storage and commercial generation to mitigate demand spikes and outages.
- Early steady investment in sectionalizing grid to increase resilience through real-time grid reconfiguration in presence of local outages, and micro-griding of population-centers and critical services in presence of local and mainland outages.
- Prepare for two significant submarine cable replacements in the 2030s and 40s, by building equity for five or more years before project launch. These projects may be shifted out by employing cathodic protection to extend their operational life.
- Early steady investment in cathodic protection of submarine transmission cables to extend their life by five to ten years before planned replacement. This preserves capital and builds equity for the projects above.

Sensitivity Analysis: High Load Growth

Ironically, OPALCO welcomes higher than expected load growth.

During the go-go 90s, OPALCO load grew at more than 1% per year. But since the global financial crisis in 2008, load growth has been steady at below .8%. This is due to slower population growth and OPALCO's award-winning energy efficiency programs.

As mentioned above, prudent planning for the future leads OPALCO to up-size all cables being deployed. OPACO's current system has capacity to serve member load well beyond the next 20 years of this LRP.

- Average system summer load is 18 MW, winter load is 30 MW, and winter cold-snap peak load is typically 60 to 65 MW – all well within the current system capacity of 105 MW.
- Annual energy consumption is typically about 215 MWh, growing at about 1% per year to a projected 260 MWh by 2040, driven largely by the **electrification of transportation** and population growth.

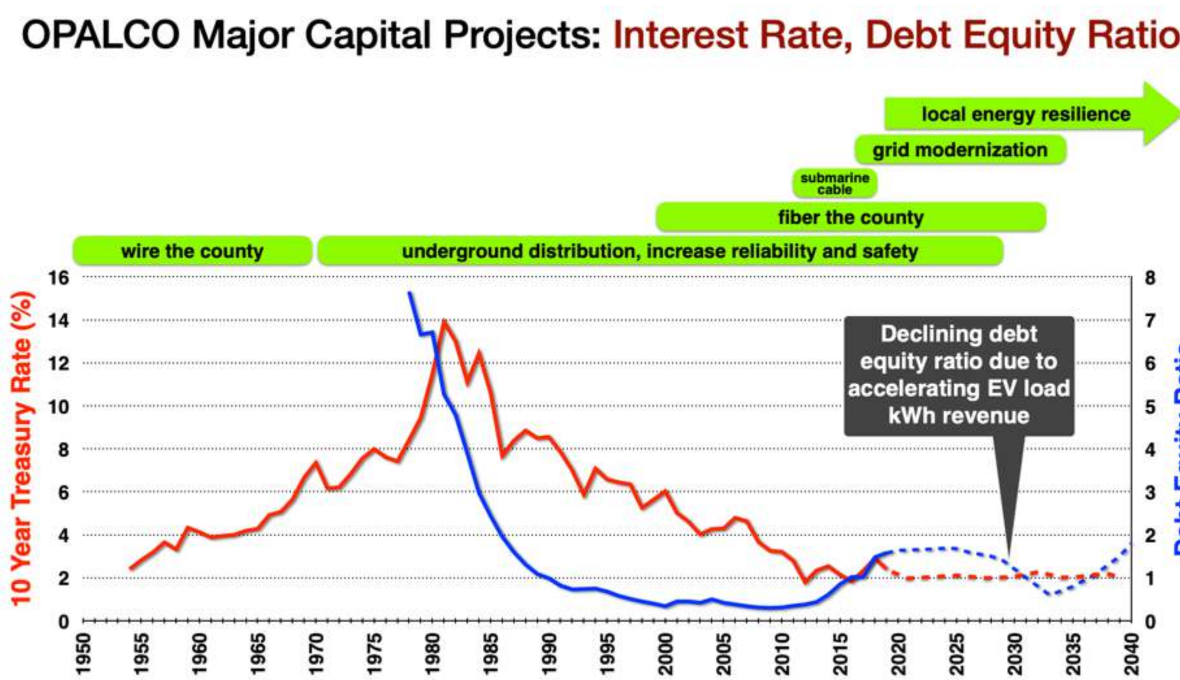
Given the robust load carrying capacity of the OPALCO system, higher load translates directly to increased kWh sales, which helps fund the various LRP projects in the Preferred Plan, and reduces the need for RUS financing.

A sensitivity analysis exploring the impact of higher population and EV load growth could result in 2% annual load growth, to a projected 320 MWh by 2040, well within the current 1,000 MWh annual system capability. Peak load can be managed (using the planned grid control systems described in this LRP) through dispatchable storage and load, to shift demand to off-peak hours. This has multiple benefits, including improving load factor, reduced aging of the system and reduced BPA demand charges.

And as discussed above, OPALCO is implementing system improvements to split load across redundant submarine cable pairs, reducing load 50% below current levels on those transmission cables, significantly extending their lifespan.

Sensitivity Analysis: High Inflation

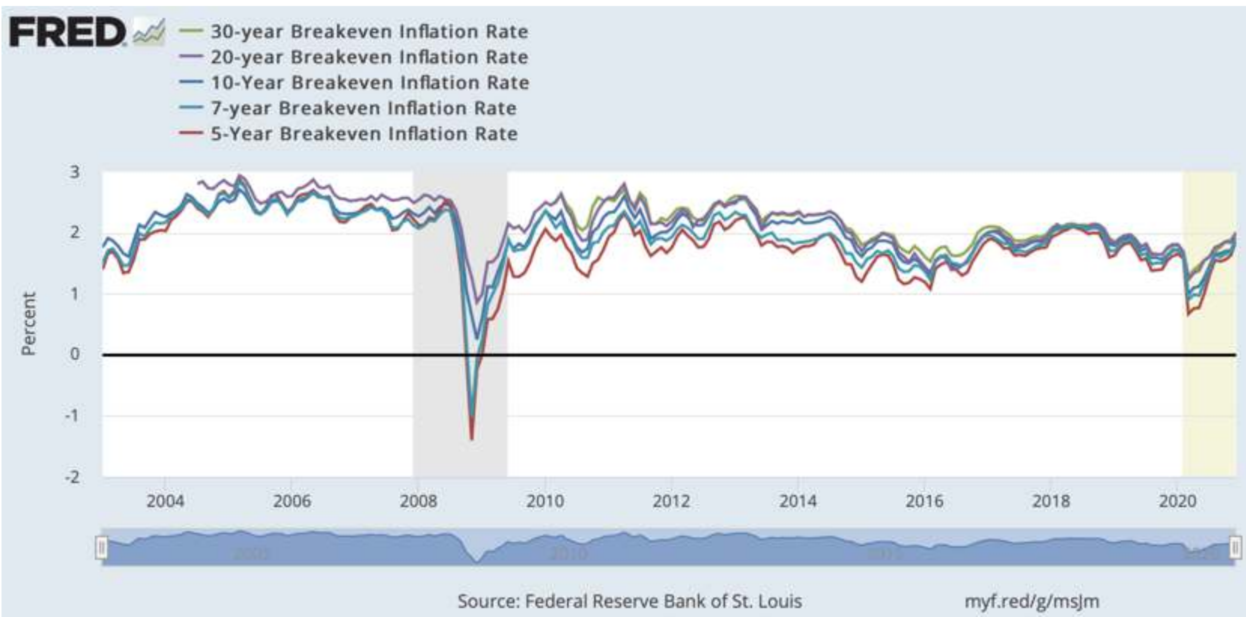
As can be seen in the chart below, the US inflation rate is at historic lows, at times becoming near deflationary. Since Fed Chairman Volker, the Fed seems to have cracked the code on how to prevent runaway inflation. OPALCO has taken advantage of low interest rates to the benefit of co-op members, with major projects undertaken including submarine cable replacement projects, distribution system cable undergrounding and fiber communications network expansion.



With the COVID pandemic and climate disruption driven investment in decarbonization requiring massive investments by the government, it would be natural to expect upward pressure on inflation. The emerging Modern Monetary Theory (MMT) suggests monetarily sovereign countries like the U.S., U.K., Japan and Canada, which spend, tax and borrow in a fiat currency they fully control, are not operationally constrained by revenues when it comes to Federal government spending. This may explain why inflation remains persistently low, despite generally rising national debt.

What level of inflation does the Fed expect over the next several years? The Federal Reserve Bank of St. Louis does excellent work analyzing the economy. Here's an excerpt of their inflation outlook, with chart below. The chart shows expectations for 5, 7, 10, 20, and 30 years out from the end of 2020:

> *"We could look at some surveys to try to answer this question, but nothing beats market measures where participants have some skin in the game. One such method of measuring inflation expectations is to compare how Treasury markets price two types of bonds: "normal" bonds—with a constant nominal interest rate—and "inflation-indexed" bonds—with a yield that includes realized inflation. One can tease out inflation expectations by subtracting the real bond yield from the nominal yield. This is the so-called break-even inflation that we show in the graph below for all available maturities.*
>
> *The graph shows that these expected inflation rates fan out at particular times, typically downward. And, every time, the shorter maturities seem to have the strongest reactions. This is simple arithmetic. For example, a 10-year expectation also contains the 5-year expectation; and, as long as expectations average out in the long run, the shorter-term expectation will be more variable. An exception would occur if the market expects "normal" inflation in the next five years, but "abnormal" inflation during the five years thereafter. That's very unlikely to happen, at least in terms of expectations."*



These are "expectations" and so much can happen to change those expectations, as can be seen by the impact of the global financial crisis in 2008. Uncertainty about inflation is not a plan, but it is worth considering the impact of inflation given the 20-year span of the LRP. Much can happen in that time. Twenty years ago, we were communicating with modems and cell phones only made phone calls.

The table below shows annual RUS CWP NET TOTAL, in 2020 dollars and for 2%, 4% and 6% inflation rates.

It's worth noting that nominal US inflation is currently running below 2%. That said, OPALCO is seeing BPA pricing inflating at about 3%, and some capital equipment and operational costs at up to 5%. Major capital renewable resource components are currently deflating – e.g., solar is deflating at -2%, storage at -7% and tidal at an estimated -4% to 7%. Tidal power is an emerging technology and years away from economic deployment. So we should take any projections with a grain of salt. We plan to simply shift tidal deployment until its levelized cost of energy is at parity with BPA wholesale pricing.

The table below summarizes impact on capital project costs for 0%, 2%, 4%, and 6% annual inflation. We show the Average Annual CWP Cost and Total 20-year CWP Cost projections.

Inflation Rate	Average Annual Cost	Total 20-year Cost
0%	$9,452,732	$189,054,636
2%	$11,988,433	$239,768,669
4%	$15,317,290	$306,345,792
6%	$19,694,569	$393,891,389

Inflation flows directly to rates. As mentioned above, BPA wholesale rates have been inflating at about 3% annually for the past 10 years. Despite that, careful management by the OPALCO team and board have consistently held rates that are comparable to the national average, despite having one of the most complex small utility systems in the nation, due to OPALCO serving 20 islands, in a harsh marine environment with very expensive submarine cables and 90% of the distribution system is storm-hardened buried cable.

Sensitivity Analysis: Funding Initiatives

The Preferred Plan assumes zero non-RUS funding. The reality is that OPALCO has been increasing good at securing financing through matching grants. We expect a number of solar, storage, tidal, and grid modernization projects will be funded partially through grants from Washington Clean Energy Fund, DOE, and PNNL. These grant programs are typically aimed at accelerating transition to local renewable energy, storage, grid modernization, and low-income renewable energy programs.

In addition, OPALCO will build as much community solar as co-op members are interested in subscribing to. Our first community solar array was entirely funded this way, with some grants and state generation credits, further reducing the cost, requiring no debt financing.

Once member thirst for community solar has been quenched, we will build utility scale solar, likely partially funded through grants and generation credits to reduce the need for RUS funds.

Storage systems have similar grant programs that we anticipate will help reduce the need for RUS Funds.

And by 2030, we expect that increased kWh sales from EV charging load will help bootstrap the cost of many capital projects in the following decade.

In combination, these alternative funding sources can help OPALCO reduce RUS funding and impact on rates.

The table below summarizes impact on generation capital project costs if alternative funding is secured for solar, storage, and tidal projects. We show the Average Annual CWP Cost and Total 20-year CWP Cost projections assuming 25%, 35% and 50% of funds come from non-RUS sources discussed above.

Non-RUS Funding	Average Annual Cost	Total 20-year Cost
0%	$2,752,882	$57,810,531
25%	$2,064,662	$43,357,898
35%	$1,789,374	$37,576,845
50%	$1,376,441	$28,905,266

VII. Long Range Plan Support Material

This section details the various Long Range Plan exhibits defined in the RUS *Electric System Long-Range Planning Guide*.

System Statistical Data

Owner: Russell, Jay

Notes: member growth, new service growth rate (Russell), , cost is member borne CIAC, neutral impact to finances

Substation Load Data

Key substation information is provided in the table below. Worth noting:

- **MVA Base** – the maximum load served at unity power factor, without cooling fans or pump running.
- **MVA Top** – the maximum continuous load served at unity power factor, with all cooling systems functional.
- **Maximum Historic Load** – The largest load served in the past 10 years. This usually occurs during a winter cold snap when electric heat load is peaking.

Substation	MVA – Base (MW)	MVA - Top (MW)	Max Historic Load (MW)	Impedance	Manufacturer	Year Manufacture	Protection	Load Factor	Remaining Life	Expected Life	Replace	Comments
Shaw	5	5	**1.1**	8.4	Standard Transformer	1980	65E	0.22	40	70	2050	
Orcas	12	12	**7.9**	7.55	Standard Transformer	1971	125E	0.66	49	60	2031	Transformer approaching end of life
Eastsound	12	20	**12.6**	6.55	Standard Transformer	1980	125E	0.63	40	60	2040	Transformer approaching end of life
Olga	7.5	7.5	**5.3**	7.5	Westinghouse	1974	65E	0.71	46	60	2034	Load approaching max transformer rating
Lopez	12	16	**9.8**	8.1	Cooper	1994	SEL-787E	0.61	26	70	2064	Transformer differential being upgraded
Blakely	2.5	2.5	**0.5**	7.12	Solomon	2017	SEL-387A	0.20	3	70	2087	Needs RTAC to communicate to relays
Decatur	2.5	2.5	**1**	7.08	Solomon	2017	SEL-351S	0.40	3	70	2087	No high side protection - Overcurrent from Tie breaker or line breaker
Roche Harbor	12	22.4	**9.2**	7.5	GE	1972	175E	0.41	48	60	2032	Pump broken - Top Rating 16 MVA
Friday Harbor	12	22.4	**17.9**	7.54	GE	1972	125E	0.80	48	60	2032	Load approaching max transformer rating
Gravel Pit	12	20	**6.5**	8.67	Kuhlman	2001	SEL-501	0.33	19	60	2061	Protection needs to be upgraded

Engineering and Economic Criteria

Overview

Improvements recommended in this LRP represent actions required to maintain standards for safety, adequate voltage, thermal loading and service reliability levels. The following outline describes basic design parameters used in this study.

Transmission Circuits

- Maximum of 50% of line rating
- Submarine terminal stations insulation ratings – one voltage class higher
- Ordinary conductor replacement based on imminent need rather than age
    - Replace when facilities experience in excess of 5 outages per year per member for 2 consecutive years (non-ROW related outages)

Distribution Circuits

- Maximum voltage drop – 5 volts (120 V base)
- Maximum of one stage of line voltage regulation
- Conductor loading
    - 50% of the thermal capacity for inter-substation ties
    - 80% of the thermal capacity for radial circuits
- Maximum of 35 amps on single-phase taps
- Ordinary conductor replacement based on imminent need rather than age
    - Replace when facilities experience in excess of 5 outages per year per member for 2 consecutive years (non-ROW related outages)
    - Replace URD cable after second failure per section or concentric neutral corrosion

Substations

- Initial loading of substation transformers to 60% of base capacity rating
- Existing transformer loaded to fan cooled rating for short-term peaks
- Utilize ANSI/IEEE Guide for loading liquid immersed equipment, including power transformers and voltage regulators
- Power loss evaluations of new transformer purchases

Voltage Regulation

- Load not exceeding standard manufacturer capacity or thermal rating
- Used where voltage drop is greater than 5 volts (120 V base) and conductor replacement is not feasible

Distribution Transformers

- Load at or near standard manufacturer capacity rating
- New transformer purchases evaluated for power loss optimization and total ownership costs

Conductor Sizing

- Overhead Transmission
  - 396.5 kcmil ACSR Ibis (26 X .1236, 7 X .1236) (594 amps)
  - 336.4 kcmil ACSR Linnet (26 X .1137, 7 X .0884) (529 amps)
  - 4/0 ACSR Penguin (6 X .1878, 1 X .1878) (357 amps)
- Submarine Transmission
  - Load based
- Overhead Distribution
  - Single-phase
    - 1/0 ACSR for low-load levels (242 amps)
  - Three-phase
    - 336.4 kcmil ACSR for main feeders (529 amps)
- Underground Distribution
  - Single-phase
    - 1/0 AL with Full Concentric Neutral within 2" Conduit
    - 4/0 AL with Full Concentric Neutral within 4" Conduit
  - Three-phase
    - 1/0 AL with 1/3 Concentric Neutral within 6" Conduit (175 amps)
    - 4/0 AL with 1/3 Concentric Neutral within 6" Conduit (255 amps)
    - 500 MCM AL with 1/3 Concentric Neutral within 6" Conduit (415 amps)
- Submarine Distribution
  - Single-phase
    - #2 Cu

Sectionalizing

- Maximum of 40 momentary outages per feeder per year
- Maximum of 2 hours of outages per member per year – urban
- Maximum of 5 hours of outages per member per year – rural
- Limit loads on reclosers to 80% of trip coil rating
- Minimum phase-to-ground fault pick up capability
- Device use will be as follows:
  - Underground
    - Vacuum Fault Interrupter (VFI) – Loads greater than 40 Amps
    - Fused Junction Cabinet – Loads up to 40 Amps (when feasible)
    - Fused Elbow – Loads up to 40 Amps (when above not feasible)
  - Overhead
    - Recloser – Overhead with greater than 40 Amps or based on fusing
    - Fuse K Curve – Loads up to 40 Amps or no greater than 100K sizing

Capacitors/Reactors & Power Factor

- Goal of 95% lagging to 95% leading power factor

Line Improvements

- Improve voltage levels
- Maintain adequate thermal capacity
- Balance phase loads
- Line-loss reduction
- Improve reliability
- Address O&M Survey, RUS Form 300 concerns
- Underground cable installation and replacement based on outage and corrosion of cables

Total Annual Fixed Charge Rate (TFCR)

TFCR = Cost of Capital + Oper. & Main. (O&M) + Taxes + Depreciation

Year	Cost of Debt (CD)	TIER	Cost of Capital (CC)	O&M as % of Avg Net Plant	Tax Rate	Depreciation Rate	Total Annual Fixed Charge Rate (TFCR)
2010	1.34%	3.21	4.29%	28.92%	1.70%	3.00%	37.92%
2011	1.31%	5.27	6.91%	28.30%	1.72%	3.07%	40.00%
2012	1.33%	2.07	2.75%	31.02%	1.61%	3.15%	38.52%
2013	1.32%	2.24	2.95%	30.96%	1.70%	3.07%	38.68%
2014	1.40%	1.13	1.59%	29.14%	1.86%	3.07%	35.66%
2015	1.39%	2.77	3.86%	28.00%	1.58%	3.18%	36.62%
2016	1.36%	3.80	5.16%	22.86%	1.47%	3.00%	32.49%
2017	1.16%	4.20	4.89%	21.15%	1.36%	2.74%	30.15%
2018	1.62%	2.94	4.75%	20.43%	1.40%	3.16%	29.75%
2019	1.85%	2.50	4.63%	21.32%	1.46%	3.30%	30.71%

Economic Conductor Life Cycle Analysis

Summary of 12.47 kV cable. Future Loading Based on a 1.50 % LGR for 30 years.

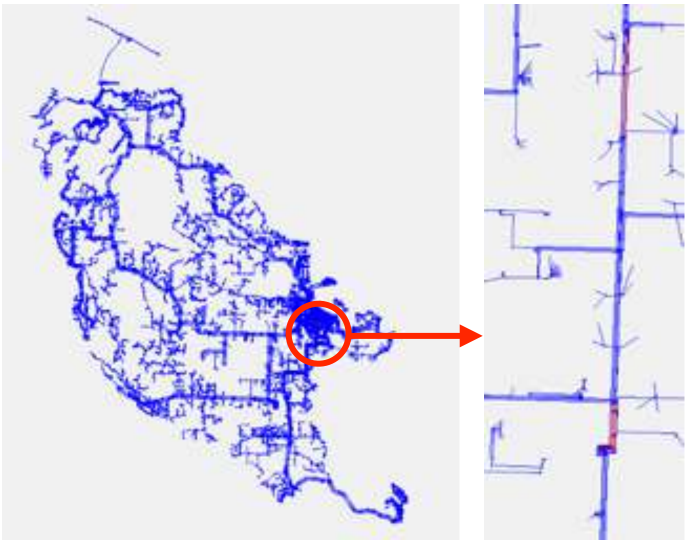
Overhead					
For loads below	125 Amps	use	1/0 ACSR	195	Amps
For loads between	125 Amps and 185 Amps	use	4/0 ACSR	290	Amps
For loads between	185 Amps and 275 Amps	use	336 kcmil	430	Amps
For loads above	275 Amps	use	397.5 kcmil	485	Amps
Underground					
For loads below	95 Amps	use	1/0 AL	150	Amps
For loads between	95 Amps and 140 Amps	use	4/0 AL	220	Amps
For loads above	140 Amps	use	500 MCM AL	350	Amps

Conductor Cost Analysis

Overhead	**Cost**	**Ohms per mile**
1/0 ACSR	$61,000	.79
4/0 ACSR	$75,000	.42
336 kcmil	$78,000	.27
396.5 kcmil	$84,000	.23
Underground		
1/0 ACSR	$225,000	.87
4/0 ACSR	$230,000	.43
500 MCM AL	$250,000	.18

Transmission System

Our transmission and distribution systems have been engineered with up-sized conductors to minimize loss and allow for expansion. Given that our focus is on protection of the existing system. Growth of our load through 2040 is well within the nominal load carrying capacity of our current transmission and distribution system, with one exception – A small portion of San Juan Island, in the town of Friday Harbor will require improvements. Replacing #2 AL with 4/0 AL (see figures below). The red area is the portion scheduled for upgrade. Blue represents that load does not approach 75% of the conductor ampacity. Red is anything over 75%.



Radial Transmission Line Reliability and Operational Assessment

Radial Transmission Line (RTL) Characteristics: RTL #: **Lopez to Orcas**

Name and Description: **Lopez to Orcas transmission line**

Operating Voltage (kV): **69 kV**

Conductor Size & Type: **336 ACSR**

Right-of-Way Width (feet): **50 feet**

Radial Distance (miles): **~19 miles**

Last Peak Load (MW): **~22 MW**

Peak Time (month, year): **Feb 2019**

Load Distance Service Factor (MW-Miles): **A ~1.2 MW-Mile**

Year Built: **Varies - Last updated in 2018**

With loss of the RTL, what % of load can existing distribution ties support? **10%**

Major Line Maintenance Cycle (years): 5

Year of Last Major Line Maintenance: **2018**

Right-of-Way Location (cross-country, roadside, etc.): **roadside**

Right-of-Way Maintenance Cycles (years): **3-5**

Frequency of Right-of-Way (years): Inspections 3-5; Mowing/Spraying 3-5; Danger Tree Removal 3-5; Side Trimming 3-5

Transmission Line provider: **BPA**

Impacted Distributors or Cooperatives: **NA**

RTL Reliability and Operational Questions

1. Does the RTL have a high Load Distance Service Factor (LDSF) greater than 150 megawatt-miles? **No**

2. Is the RTL poorly accessible as determined by the Owner during all or part of the year? **No**

3. Does the RTL serve a delivery point that provides power to high priority loads (e.g., hospitals, manufacturing parks, airports, commercial loads, etc.)? **Yes**

4. Is the conductor in deteriorated condition based on recent sample testing? **No**

5. Is the RTL condition contributed to more than three sustained outages over the last two years? **No**

6. Has there been an outage over four hours in the past five years attributed to the RTL (excluding those during a major storm)? **No**

7. Is the RTL in the power supplier's top 5% of most unreliable lines? **No**

8. Does the RTL owner have any major improvement plans in the near future or in the general area of the distributor/cooperative substation? **Yes**

9. Is the RTL operating at 69 kV or less and have a >50% of the conductor published full load amperes for the projected long-range peak loading conditions? **No**

Letter of Transmittal and Engineering Certification

Owner: Russell

Notes: https://www.opalco.com/wp-content/uploads/2017/06/OPALCO-2017-2020-CWP.pdf, Jay will help writing letter, find statement on existing work plan, on front page of current work plan - OPALCO.com

RUS Fixed Charge Summary

Owner: Russell, Travis

Notes: Russell will research then Travis, probably our historical loan rates

VIII. RUS Forms

RUS Form 260 - Checklist of Long-Range Planning Report

Owner: Russell

EXHIBIT K
CHECKLIST OF LONG-RANGE PLANNING REPORT (RUS FORM 260)

U. S. DEPARTMENT OF AGRICULTURE RURAL UTILITIES SERVICE **CHECK OF SYSTEM PLANNING REPORT** Reference Bulletin 1724D-101A	BORROWER DESIGNATION XX-XXX-XXXXXXX	
	DATE REPORT COMPLETED	NAME OF PLANNING ENGINEER

CHECK		**PART I - THE SYSTEM PLANNING REPORT** *(If "No" column is checked, explain under "Remarks")*
YES	NO	
		1. Does the report present an analysis of the existing system and basic data?
		2. Does the report present a transition from the existing system to the long-range system?
		3. Does the report contain a summary of the exploratory plans which the engineer considered?
		4. Did the borrower have a service reliability standard for the engineer to use as a means of evaluating continuity and reliability of service to consumers?
		5. Was each exploratory plan developed in sufficient detail to clearly establish the basis for selection of the recommended plan?
		6. Have all reasonable exploratory plans been considered?
		7. Have the transitional steps been formed by grouping together various system improvements requiring approximately the same load level?
		8. Are graphs presented relating estimated total plant investment to load levels?
		9. Is a table presented listing the fixed cost elements and the associated percentage of plant investment used for the economic comparisons?
		10. Are economic comparisons of exploratory plans presented on an annual cost basis?
		11. Are summaries of cost data tabulated and identified as called for in Bulletin 1724D-101A (6.5.4)?
		12. Does the report contain a circuit diagram of the complete system for each major step in the transition and for the long-range system as called for in Bulletin 1724D-101A(6.5.6)?
		13. Are the system's transmission lines, if any, and those of the power supplier or other utilities in or near the system's service area shown on the circuit diagrams or other diagrams?
		14. Is the report, including the analysis of the existing system, concise and well-organized so that management can easily work with the report without further engineering interpretation?
		15. Has a copy of a resolution signifying the board of directors' action concerning acceptance of the report been received?

DATE	SIGNATURE

RUS FORM 260 — CAB (7/96) 5-68

CHECK		PART II—DEVELOPMENT OF THE LONG-RANGE PLAN
YES	NO	
		1. Does the analysis of the existing system give a good understanding of the system's performance?
		2. Is the load level for the long-range system within the range of three to six times the average kwh/consumer/month for the highest peak month experienced to date?
		3. Does each exploratory plan presented, including the long-range plan, make use of existing facilities as long as it is economical to do so?
		4. Does each exploratory plan presented, including the long-range plan, provide a system which is designed to meet the required voltage standards?
		5. Does the transition from the existing system to the long-range system demonstrate a practical and economical development of the system?
		6. Are proposed voltage regulator installations in the long-range plan in accordance with the recommendations in RUS Bulletin 1724D-101A?
		7. Are the cost estimates used by the engineer reasonable?
		8. Are the design criteria established by management reasonable so that they do not rule out logical exploratory plans?
		9. In addition to the economic comparisons, are sufficient comparisons and considerations made to show the superiority of the selected long-range plan over the other exploratory plans?
		10. If indeterminate factors or uncertain conditions exist, is an alternate transition from the existing system to the long-range system proposed?
		11. Is the proposed long-range plan based on power sources that the engineer and the system's management are reasonably sure will be available?

REMARKS

DATE	COMPLETED BY — SIGNATURE

RUS FORM 260 — CAB (7/96) 5-68

RUS Form 261 – Summary of Long-Range Planning Report

Owner: Robert

EXHIBIT L
SUMMARY OF LONG-RANGE PLANNING REPORT (RUS FORM 261)

SUMMARY OF SYSTEM PLANNING REPORT	SYSTEM DESIGNATION	DATE PLANNING REPORT COMPLETED
	PLANNING ENGINEER	

PART I—GENERAL DATA

	2. LINE MILES		3. NO. OF CONSUMERS					7. PAST PEAK LOAD		
ITEMS 1.	TRANS. a.	DISTR. b.	ALL TYPES *(Including special loads)* c.	SPECIAL LOADS d.	TOTAL SYSTEM LOADS *(kW)* 4.	TOTAL SPECIAL LOADS *(kW)* 5.	TOTAL YEARLY SALES *(kWh)* 6.	kWh/CONS. /MO. a.	DATE b.	DESIGN LOAD kWh/CONS. /MO. PEAK MO. 8.
PRESENT SYSTEM AS OF________										
LONG-RANGE PLAN										

PART II—LINE MILES

	2. DISTRIBUTION				3. TRANSMISSION			
ITEMS 1.	12.5/7.2 kV a.	24.9/14.4 kV b.	______ kV c.	______ kV d.	________ kV a.	________ kV b.	______ kV c.	________ kV d.
PRESENT SYSTEM AS OF ___________								
LONG-RANGE PLAN								

PART III—SUBSTATIONS AND METERING POINTS

		3. PRESENT SYSTEM			4. LONG-RANGE PLAN		
NAME OR LOCATION* 1.	POWER SUPPLIER 2.	MVA a.	kV PRIMARY b.	kV SECONDARY c.	MVA a.	kV PRIMARY b.	kV SECONDARY c.

PART IV—INVESTMENT IN PLANT *(Thousands of Dollars)*

ITEMS 1.	TRANSMISSION LINES 2.	ALL SUBSTATIONS 3.	DISTR. TRANSFORMERS METERS & SERVICES 4.	ALL OTHER DISTR. FACILITIES 5.	TOTAL T&D PLANT 6.	GENERAL & PROD. PLANT 7.
PRESENT SYSTEM AS OF ___________					$0	
LONG-RANGE PLAN					$0	

RUS FORM 261 REV. 1-95 (CAB 5/96)

** Include those furnished by Power Supplier and designate with asterisk.*

RUS Form 300 Review Rating Survey – Operations & Maintenance

According to the Paperwork Reduction Act of 1995, an agency may not conduct or sponsor, and a person is not required to respond to a collection of information unless it display: valid OMB control number. The valid OMB control number for this information collection is 0572-0025. The time required to complete this information collection is estimated to aver 4 hours per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing collection of information

UNITED STATES DEPARTMENT OF AGRICULTURE
RURAL UTILITIES SERVICE

REVIEW RATING SUMMARY

BORROWER DESIGNATION

DATE PREPARED: 01/24/2020

Ratings on form are: NA: Not Applicable; 0: Unsatisfactory -- No Records; 1: Corrective Action Needed; 2: Acceptable, but Should be Improved -- See Attached Recommendations; 3: Satisfactory -- No Additional Action Required at this Time

PART I. TRANSMISSION and DISTRIBUTION FACILITIES

1. Substations (Transmission and Distribution)	(Rating)
a. Safety, Clearance, Code Compliance	3
b. Physical Conditions: Structure, Major Equipment, Appearance	3
c. Inspection Records - Each Substation	3
d. Oil Spill Preventior	3

2. Transmission Lines	(Rating)
a. Right-of-Way: Clearing, Erosion, Appearance, Intrusions	3
b. Physical Condition: Structure, Conductor, Guying	3
c. Inspection Program and Records	3

3. Distribution Lines - Overhead		(Rating)
a. Inspection Program and Records		3
b. Compliance with Safety Codes:	Clearances	3
	Foreign Structures	3
	Attachments	3
c. Observed Physical Condition from Field Checking:	Right-of-Way	3
	Other	

4. Distribution - Underground Cable	(Rating)
a. Grounding and Corrosion Control	3
b. Surface Grading, Appearance	3
c. Riser Pole: Hazards, Guying, Condition	3

5. Distribution Line Equipment: Conditions and Records	(Rating)
a. Voltage Regulators	3
b. Sectionalizing Equipment	3
c. Distribution Transformers	3
d. Pad Mounted Equipment	
Safety: Locking, Dead Front, Barriers	3
Appearance: Settlement, Condition	3
Other	3
e. Kilowatt-hour and Demand Meter Reading and Testing	3

PART II. OPERATIONS and MAINTENANCE

6. Line Maintenance and Work Order Procedures		(Rating)
a. Work Planning & Scheduling		3
b. Work Backlogs:	Right-of-Way Maintenance	3
	Poles	3
	Retirement of Idle Services	3
	Other	

7. Service Interruptions

a. Average Annual Minutes/Consumer by Caus (Complete for each of the previous 5 years)

PREVIOUS 5 YEARS (Year)	POWER SUPPLIER a.	MAJOR EVENT b.	PLANNED c.	ALL OTHER d.	TOTAL e.	(Rating)
2019	60	107	30	129	325	3
2018	736	290	38	535	1599	3
2017	0	667	175	433	1274	3
2016	0	0	24	284	308	3
2015	122	507	11	224	864	3

b. Emergency Restoration Plan

8. Power Quality	(Rating)
a. General Freedom from Complaints	3

9. Loading and Load Balance	(Rating)
a. Distribution Transformer Loadin	3
b. Load Control Apparatus	3
c. Substation and Feeder Loading	3

10. Maps and Plant Records	(Rating)
a. Operating Maps: Accurate and Up-to-Date	3
b. Circuit Diagrams	3
c. Staking Sheets	3

PART III. ENGINEERING

11. System Load Conditions and Losses		(Rating)
a. Annual System Losses	6.4 %	3
b. Annual Load Factor	40 %	3
c. Power Factor at Monthly Peak	98 %	3
d. Ratios of Individual Substation Annual Peak kW to kVA		0.98

12. Voltage Conditions	(Rating)
a. Voltage Surveys	3
b. Substation Transformer Output Voltage Spread	3

13. Load Studies and Planning	(Rating)
a. Long Range Engineering Plan	3
b. Construction Work Plan	3
c. Sectionalizing Study	3
d. Load Data for Engineering Studies	3
e. Load Forecasting Data	3

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PART IV. OPERATION AND MAINTENANCE BUDGETS

YEAR	For Previous 2 Years		For Present Year	For Future 3 Years		
	2014	2015	2016	2017	2018	2019
	Actual $ Thousands	Actual $ Thousands	Budget $ Thousands	Budget $ Thousands	Budget $ Thousands	Budget $ Thousands
Normal Operation	3,054,124	3,570,414	3,473,823	3,578,038	3,685,379	3,795,940
Normal Maintenance	1,778,516	1,713,924	1,702,147	1,753,211	1,805,808	1,859,982
Additional (Deferred) Maintenance						
Total	4,832,640	5,284,338	5,175,970	5,331,249	5,491,187	5,655,922

14. Budgeting: Adequacy of Budgets for Needed Work 3 *(Rating)*

15. Date Discussed with Board of Directors 8/18/2016 *(Date)*

EXPLANATORY NOTES

ITEM NO.	COMMENTS
1b	Substation Improvements to Shaw, Blakely and Decatur will occur 2017-2019.
2a	Transmission Line Right-of-Way clearing is identifying danger trees for removal.
7a	Service Interruptions are driven primarily by major storm or Power Supplier interruptions.
10a	Significant improvements in Operating maps have occurred over the last 2 years.
13a&b	In moving forward with the next 4 year CWP a new LRP will be needed which should include a Sectionalizing study.

General Comment:

Overall, there have been improvements in all areas and future projects to upgrade the distribution system and substations along with the installation of fiber throughout the system will enhance the utility's overall capabilities to provide safe, reliable, and reasonably affordable electricity.

		TITLE	DATE
RATED BY:	Joel Mietzner P.E.	System Engineer	08/01/16
REVIEWED BY:	Foster Hildreth	CEO &President	08/01/16
REVIEWED BY:	Rodney Peach	RUS GFR	08/01/16

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STATUS OF O&M ACTIVITIES
ATTACHMENT TO RUS FORM 300
(OPTIONAL FORM - NOT REQUIRED)

SYSTEM DESIGNATION	**Orcas Power and Light Cooperative - WA 0009**
Date Long Range System Engineering Plan Approved	**06/21/12**
Date Annual Work Plan Approved	06/21/12
Date of Last Load and Voltage Survey	01/01/16

YEAR	**2011**	**2012**	**2013**	**2014**	**2015**
STATISTICS					
Miles of Distribution Line	1,281	1,279	1,285	1,296	1,296
Miles of Transmission Line	43	43	43	43	43
Number of Substations	11	11	11	11	11
Sum of Substation Peak Demands (kW)	54	57	64	56	56
Average Number of Consumers	14,617	14,738	14,745	14,864	15,009
Plant Investment ($ x 1,000)	81,629	82,840	86,319	91,153	100,576
Operation Expense ($ x 1,000)	2,399	2,931	3,038	3,054	3,570
Maintenance Expense ($ x 1,000)	1,417	1,518	1,669	1,778	1,713
ROW CLEARING					
Units on System	156	156	156	156	156
Units Recleared	52	52	52	52	52
Regrowth Cycle (Years)	3	3	3	3	3
POLES					
Number on System	3,790	3,752	3,746	3,740	3,720
Number Inspected	450	460	440	460	450
Number Condemned	11	10	14	9	11
Number Replaced	30	35	30	35	42
OIL CIRCUIT RECLOSERS					
Number on System	2	2	2	2	2
Number Serviced	0	1	0	1	0
LINE REGULATORS					
Number on System	15	15	16	16	16
Number Serviced	15	15	16	16	16
METERS					
Number on System	14,617	14,738	14,745	14,864	15,009
Number Serviced	3,500	3,500	3,500	3,500	3,500
PATROL AND MAINTENANCE					
Miles of Distribution Patrolled	1,281	1,279	1,285	1,296	1,296
Miles Distribution Maintained	1,281	1,279	1,285	1,296	1,296
Miles of Transmission Patrolled	43	43	43	43	43
Miles of Transmission Maintained	43	43	43	43	43
Number of Substations Serviced	11	11	11	11	11
AVERAGE MINUTES OUTAGE PER CONSUMER					
Power Supply	0.00	390.00	145.00	358.00	122.00
Major Storm	0.00				507.00
All Other	110.00	28.00	20.00	179.00	224.00
Total	110.00	418.00	165.00	537.00	853.00

RUS Form **300** Attachment *(Rev. 3-09) (V2, 5/2009)*