Seattle City Light

2021 Grid Modernization Plan and Roadmap

Authors—Grid Modernization Team

Uzma Siddiqi, PE; Mike Dozier, PE; Ryan Pham, PE; Eli Smith, EIT

Electrification and Strategic Technology Division
Energy Innovation and Resources Business Unit
Seattle City Light

April 2021

Table of Contents

Sponsorship Statement

Emeka Anyanwu, Seattle City Light's Energy Innovation and Resources Officer

Our world, and our City are changing. Of that there can no longer be any doubt. Not only has the COVID pandemic been a wake-up call to help us clearly see the vulnerabilities in our societal structure, but it has also helped highlight areas of opportunity to build the future. Grid modernization has emerged clearly as an indispensable component of the future that is unfolding before our very eyes, and this document lays out the first steps in a long-term undertaking to transform our distribution system.

Meeting that quest will require Seattle City Light to evolve in ways large and small, and truly reimagine our operational and business models. In so doing we will best be able to honor our mission to *"Create a shared energy future by partnering with our customers to meet their energy needs in whatever way they choose"*. Enabling choice through partnership will require anticipating the different possible choices our customers may make (and in many cases, already are making) and building a system prepared to deliver on those choices. The expert consensus conclusion of our industry is that the grid of the future is flexible, dynamic, and smart—and therefore is the price of entry to enable such choice.

Built into this future is the urgent and compelling need to boldly face the climate crisis and take bold action to reduce the harmful effects of carbon in our atmosphere. That bold action will call for a new approach to delivering the energy that powers our customers' homes, businesses, and communities. To build that next generation energy delivery system, we must envision the future; to start from where we are to build the foundation to get us to that destination. Defining the first steps of that journey is at the heart of the approach detailed in this Grid Modernization Roadmap. As the saying goes, it is important to know where you come from to know where you are going; and so, we always will honor and live up to our legacy of operating a system that provides the highest levels of reliability for our customers. But we must also now focus on new layers to the energy chain – decarbonization/electrification, resiliency, power quality, and customer participation through behind-the-meter resources and energy management. **Above all, we absolutely must insist that our efforts be grounded in the highest principles of racial and social justice, and be willing to hold ourselves to a high standard—one of not only avoiding the creation of inequity, but truly committing to a deep and uncompromising purpose of reversing the effects of historic failures to do so.**

We are at the point of change—indeed some would say we are past that point. Our future is now in Seattle, and the transformation of our grid will ensure we are prepared to lead the way. We cannot thrive in that future without a commitment to the grid modernization journey, one that will call on the mobilization of all the creativity, ingenuity, and resourcefulness of City Lighters across the entire organization. Likewise, meeting our customers' changing energy needs requires closely partnering and jointly planning for the long-term. We look forward to engaging you all as collaborators and partners in this work!

Executive Summary

Seattle City Light (SCL) has produced this **Grid Modernization Plan and Roadmap** to support the key operational objectives of affordability and reliability, while developing the skills and technologies necessary to enable increased customer electrification and improve grid resiliency and security. This plan begins to chart a path forward for SCL employees, the Seattle City Council, and the customer-owners. It describes specific projects and tasks for the next two years, as well as laying the foundation of five-year and ten-year goals, with projects spanning across planning, operations, supporting technologies, and physical infrastructure upgrades. This work will be implemented by the Grid Modernization team and others throughout SCL. The plan is built upon industry best practice recommendations and will be regularly updated, starting this year with support from industry experts at the Electric Power Research Institute (EPRI) with an increased focus on electrification enablement and equity. An overview of the Plan can be found on the next two pages in Table 1.

Plan - Roadmap	2022	2025	2030
Tier 1: High Priority or Work Initiated (alphabetical)			
Continuing Grid Mod Planning	**Update Grid Mod Plan with EPRI**, increasing focus on electrification	**Implementation begins** —Continue to gather resources and implement projects	**Project Close-out and New Project Planning** — Implement Grid Mod projects and review previous work
Cybersecurity for Grid Mod Monitoring & Control	Projects integrate cybersecurity	Enhanced cyber monitoring for Grid Mod projects	Standardized cybersecurity processes, including grid edge
DA-FLISR Expansion	**FLISR Expansion** — Continue with implementation Integrated with OMS and centralized OT Cybersecurity system	**Pilot New Technologies** — Pilot with additional cutting-edge to further improve system reliability, power quality	**Large scale implementation**. Deploy proven, newest technologies to further improve customer satisfaction, system reliability, power quality, and operation efficiency
Demand Response Pilot	**Program Pilot** — Residential/small commercial pilot project with grid-interactive water heaters. Define value & needs.	**Demand Response Expansion** — Develop programs for load shifting, other grid services. Pilot other types of DR. Develop benefit-cost analysis tools.	**DR Market Sales** — Implement DERMS for DR management. Engage in regional programs at MW scale.
Duwamish Delta Test Bed Project	**Outreach and Selected Pilots**	**Expand electrification and NWS**	**Review and expand program**
Energy Storage Technology	**Feasibility Studies** — Batteries becomes a standard option for solving a variety of problems.	**Technical Development and Pilot Implementation** — Develop standardized benefit/cost analysis, develop in house technical & planning skills, pilot new procedures.	**In-House Expertise** — Storage is managed for grid benefits. Fully valued by analytical methods. Implement DERMS.
Landis and Gyr Mesh Communication Network Assessment	**Operational Project Deployments** — Deploy operational projects which use the L+G mesh network	**Network Evaluation** — Evaluate the operational capabilities of the L+G mesh network and determine possible alternatives	**Long-term Network Plan** — Conduct a final evaluation of the L+G mesh network to determine if it will meet the future needs of SCL and create a course of action for SCL upon contract end with L+G
Line Sensor Deployment	**Pilot Deployment** — Deploy ~100 sensors. Display fault data to dispatchers.	**System-wide Deployment** — Full scale deployment throughout SCL system.	**ADMS Integration** — Integration of sensor data into DMS or ADMS. Monitor trends in sensor development.

Plan - Roadmap	2022	2025	2030
PNNL Seattle Waterfront Resiliency Study	**Technical Study** — Conduct a technical study on the feasibility of networked microgrids at port facilities	**Resiliency Planning** —Based on the results of the technical study, plan projects to increase the resiliency and reliability of the Seattle waterfront	**Microgrid Funding and Build-out**—Begin the construction of microgrid or other resiliency projects at Seattle port terminals where most feasible
Tier 2: Needing Resources (alphabetical)			
AGA: Enhanced Electrical Connectivity Model	Plan and pilot with six OH feeder	Validate the entire electrical model in the LRDS GIS	Build the distribution system model in ADMS using verified GIS model
DA-Advanced Integration	Cybersecurity monitor system is designed & built for DA-FLISR.	Implement new OMS, integrate with DA-FLISR. Design & implement Feeder Management System (FMS), integrate with security monitoring	Integrate DA-Remote Switching with OMS, FMS.
DA-Remote Switching	Plan, develop communication architecture, lab testing	Pilot with two systems	Large scale implementation and integration
DER Interconnection Studies and Procedures	Update interconnection procedure.	Implement monitoring & control to support grid services. Pilot new procedures.	DER interconnection procedures fully integrated into planning process. Implement DERMS.
Non-Wires Solutions Analysis	Screening Criteria Evaluation — Develop NWS screening criteria for new projects	Project Deployments— Deploy NWS projects where most feasible and record lessons learned	NWS Maturation — Continue developing in-house knowledge of NWS through deployments of new projects and revise screening criteria where necessary
Managed EV Charging	Study and Analysis — Analyze EV load profiles and the effect of passive charge management on charging behavior	Managed Charging Pilot Phase — Pilot managed charging where most effective and feasible	Widespread Managed Charging and V2G Pilot — Expand managed charging across multiple classes of vehicles (heavy duty fleets, private residential) to reduce the negative effects of mass EV charging on grid infrastructure. Begin piloting V2G if technically feasible
Miller Community Center Microgrid Plan	Data collection and assessment	O&M Training for SCL staff	ADMS system integration
OT Field Area Network – Pilot Project	Design network architecture Lab testing	Pilot with two systems	Large scale implementation and usages
Targeted Lightning Arresters on OH Transformers	Study, Plan, and Limited Rollout	Execute LA Implementation Plan	Assess LA Plan for installation

Table 1: Plan and Roadmap Overview

Introduction

This report provides an overview of Grid Modernization and describes its relation to SCL's mission, vision, values, and the drivers of the future electrical grid at SCL. The report details eighteen projects which will help SCL lay the foundation for further project development and modernization efforts.

In 2020, the Grid Modernization team was formed at SCL to develop and support implementation of a comprehensive plan to start SCL on the path to the implementing the next-generation distribution system. The team has put together an actionable program of work for the Grid Modernization Plan and Roadmap, covering key areas for advancements identified by SCL's engineering and operational groups. The plan identifies two-year, five-year, and ten-year goals for each project. Existing resources will be used to implement the initial two-year work for these projects. The longer-term projects will require additional resources. Projects span across operations, planning, supporting technologies, and physical infrastructure upgrades.

The team will partner with EPRI in 2021 to update and refine the plan, guided by the City of Seattle priorities of decarbonization and equity using electrification as a key tool to advance these goals. The updates will be reflected in the 2022 Grid Modernization Plan and Roadmap. This work will be incorporated into SCL's utility-wide ten-year strategic thinking and six-year capital budget planning. These efforts will ensure that SCL is ready for the new technologies, challenges, and changing customer expectations facing the utility sector.

What is Grid Modernization?

Grid Modernization is an effort by utilities to implement new technologies and processes to create the grid of the future. The Department of Energy states that "the grid of the future will deliver resilient, reliable, flexible, secure, sustainable, and affordable electricity." [1]

Grid Modernization in the United States

States across the country have been moving forward on upgrading their electrical grids. In 2019, 46 states and the District of Columbia enacted some type of legislative or regulatory action related to Grid Modernization. [2] The ten most active states were Arizona, California, Colorado, Hawaii, Minnesota, New Hampshire, New York, North Carolina, South Carolina, and Virginia.

Key components of actions in 2019 included:

- Energy storage, including interconnection (AZ, CA, CO, MN, NH, NY, NC, SC)
- Microgrids, multiple issues addressed (CA, HI, NH)
- System planning and value of DERs (CA, NY, SC)
- Grid intelligence and data initiatives (AZ, CO, HI, MN, NH, NY, NC, VA)

---

[1] https://www.energy.gov/grid-modernization-initiative

[2] https://nccleantech.ncsu.edu/2020/02/05/4683/

- Rate pilots (AZ, CA, NC, VA)
- Investor-owned utility business model considerations, including performance-based regulation (CO, HI, MN)

Washington state has yet to enact or adopt any grid modernization regulatory or statutory requirements or rules.

Grid Modernization at Seattle City Light

The DOE guidance as stated above offers great foundational objectives for the SCL Grid Modernization projects. The grid must be resilient; able to withstand stresses without failing. The grid must be reliable and quickly recover from potentially disruptive impacts, both physical and cyber. The modern grid should also be flexible so it can both deliver and receive power, and quickly and automatically respond to changing conditions and fault events. The secure grid should not allow for intrusions and should be positioned to respond and recover quickly should they occur. To be sustainable, the energy delivered by (including that generated in) the grid should be carbon free. And finally, the grid should continue to be affordable so that everyone can enjoy the benefits of energy.

Not only must the City Light grid meet the needs of existing customer-owners, but it also needs to be ready for enablement of electrification, in the near-term, through support of the SCL Transportation Electrification Strategic Investment Plan[3] (TESIP). The approach for strategic investments is described in the TESIP, including partnerships and pilots with public transit agencies such as King County Metro and Washington State Ferries and with fleet truck operators such as UPS.

This SCL Grid Modernization Plan will concentrate on grid and other physical assets as well as selected enterprise technologies. The Plan also identifies areas where legislative, regulatory or rate design changes may be needed that affect implementing the Grid Modernization projects.

Appendix A has a list of related terms defined for common usage at Seattle City Light. These definitions are sometimes different at other utilities.

Grid Modernization: Guided by City Light Values

Seattle City Light holds the following values as guiding principles towards its mission of delivering safe, reliable, and affordable power to its customer-owners: Customers First, Environmental Stewardship, Equitable Community Connections, Operational and Financial Stewardship, and Safe and Engaged Employees. This Grid Modernization Plan will enhance and accelerate SCL’s ability to uphold all these values.

---

[3] https://cospowerlines-wpengine.netdna-ssl.com/wp-content/uploads/2020/09/SCL-Transportation-Electrification-Strategic-Investment-Plan-2021-2024-w-attachments.pdf

- **Equitable Community Connections**
  - Especially as SCL rethinks the very architecture of the grid – including the meter as a point of demarcation – strong and broad community relationships will be very important to the success of projects. These kinds of integrated projects can fundamentally change the relationship the Utility has to its community partners for the better. SCL will leverage existing outreach efforts to engage with customers on the impacts and benefits of Grid Modernization projects.
- **Customers First**
  - Grid Modernization efforts allow the Utility to meet today's expectations and to adapt to changing customer needs. One example of such change is the customer desire for connection of distributed energy resources (DER). The Grid Modernization effort intends to achieve improved DER interconnection standards within the next two years. DERs will serve as a valuable resource for customer choice, resilience, and economics. These resources must also become a well-integrated and increasingly valuable part of how the grid itself is planned and operated.

Equitable Access

The prioritization of new projects in this plan will help ensure that new grid technologies are equitably distributed throughout the Seattle area. New planning methods such as non-wires solutions will help reduce capital expenditures and ensure continued access to clean, affordable electricity for all customer-owners.

Community Partnerships

New projects, especially those that utilize DERs or flexible load through demand response programs, will be strengthened through community partnerships throughout Seattle.

Healthy Air and Water

Electrification enablement is a key focus of this plan. With the electrification of key sectors such as public transit and the ferries, there will be significant reductions in emissions and pollution.

Resilience for Vulnerable Communities

Environmental justice communities throughout Seattle are at particularly vulnerable to environmental and natural disasters. City Light will target new technology deployments in these areas to increase their resilience to such events.

Building a Visible Energy Future

Customer-owners should be involved and be able to see the results of Seattle's commitment to creating a new energy future. This will be apparent through highly recognizable projects such as the Miller Community Center Microgrid and future DER-based projects.

- **Environmental Stewardship**
  - Decarbonization efforts will be greatly supported by Grid Modernization, as a key part of the plan is to increase the capacity for electrification and customer adoption of renewable DERs. Increases in system efficiency will best match supply and demand, getting the most out of existing renewable generation resources and reducing the need for incremental generation over the long-term.
  - SCL will ensure equitable outcomes for Grid Modernization by prioritizing Environmental Justice Communities for planning and deployments of operational projects and investments in system assets.
- **Operational and Financial Excellence**
  - Grid Modernization projects focus on increasing system reliability, flexibility, and security, all of which are critical to continued operational excellence.
  - By considering alternative methods to traditional investment, SCL should aim to decrease capital expenditures related to the buildout of new infrastructure.
- **Safe and Engaged Employees**
  - Grid Modernization is only possible through cooperation between multiple teams. Coordinating these efforts across departments will help SCL break down siloes.
  - A key aspect of Grid Modernization, increasing operational visibility, will allow the SCL grid to be operated more safely.

Drivers of Grid Modernization

Grid Modernization will allow SCL to meet the needs of its customer-owners and external partners. For example, the TESIP outlines the long-term plans of SCL to incentivize and meet the growing demand for electric vehicle (EV) charging on the distribution network. An updated strategy that prioritizes non-wires solutions will enable SCL to execute the TESIP at the highest value to customer-owners while controlling costs and meeting the timelines of both present and future partners of SCL. Similarly, economics, technology evolution, and changing codes in the region are driving customers to electrify building heating. This is another growing source of load for SCL. Consideration of non-wires solutions and new demand flexibility will provide new tools to allow the Utility to efficiently and cost effectively serve customers.

SCL customer-owners also have changing preferences about how their energy is delivered and what sources of energy they receive. DERs, such as solar power, are becoming increasingly popular among residents in the greater Seattle area. The Grid Modernization Plan will address this change in customer-owner preferences with new interconnection standards for DERs to both formalize and streamline the process for connecting distributed generation sources.

Development of Project Tables

The team is using the EPRI Grid Mod Framework to build a program that can be adapted and scaled as needed as shown in Figure 1. The current projects fall into four categories: planning, operations, supporting technology, and physical infrastructure. The project selection process drew upon conversations throughout the utility and the Utility Next project portfolio, benchmarking with other utilities, and discussions with industry experts. These projects will allow the Grid Modernization team to support a wide range of groups across the utility.

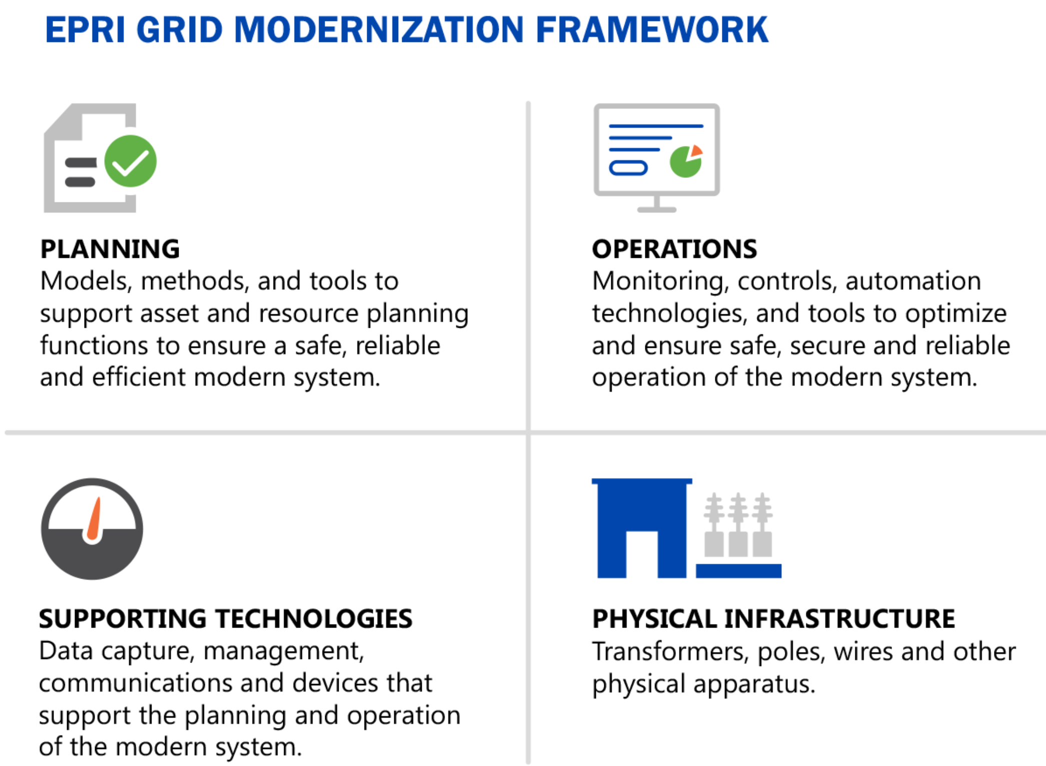

Figure 1: Grid Modernization Project Organization

Existing SCL Grid Modernization Efforts

In the last few years, City Light has been implementing many projects that fall under the "Grid Modernization" umbrella. The utility has updated the billing system and installed advanced metering infrastructure (AMI) meters throughout the service territory. The technical staff has embraced new technology that operates distribution switches either remotely or automatically. The crews have completed the fiber communication Operational Technology (OT) backbone connecting substations, generation plants, and the centralized control facilities. The recently constructed Grid Mod Lab, in the SCL's TMO building, is a dedicated space for testing new technologies and training personnel in their use. The Outage Management System (OMS) is being upgraded and the Energy Management System (EMS) was reimplemented and now has an upgrade schedule.

City Light has nearly completed the deployment of an AMI network for billing about half a million customers. The Utility is also able to use this network and the Advanced Grid Analytics (AGA) platform to assess the loading of distribution transformers through AGA's Asset Loading module. In addition, City Light has been working since 2015 to deploy fault location, isolation, and service restoration (FLISR) distribution automation equipment on the most outage prone feeders at multiple substations. This system significantly reduces the number of customers affected by, and the duration of, power outages. It is critical to a resilient and reliable grid.

In 2019, the Utility began to participate in a regional utility DER planning group with PSE, Snohomish PUD, Tacoma Power, Avista, and Pacific Power to share technical approaches in implementing new technologies. SCL also began to deploy distribution line sensors which will provide a near-real time alert to dispatchers about faults. As a “value added” feature, the communication system being used is the same as the AMI meters. The reimplementation of the OMS, especially relating to system status data, will be crucial to best utilizing this project and others like it.

The Grid Mod Team has developed detailed project tables. Some of the work proposed is an extension of on-going Grid Modernization projects, while others are newer ideas that benefit our customer-owners or have operational value. These are described in a later section of this document. The tables identify the current state, two, five, and ten-year goals for each project, as well as action items required to meet those goals. Risks and required integrations associated with each project are also described. There is a brief description of each project’s value and importance to SCL’s mission. They are sorted by category but are not listed by importance. Prioritization will be reflected in the next update to this plan and will require further discussion and decision-making. Leadership will be providing strategic guidance, and implementation will ultimately depend on what projects are funded and staffed for 2021-2022 and beyond.

Budget: Existing and Future

Other than the existing work done by the Grid Modernization team around distribution automation, the projects listed in this document are currently unbudgeted. Funds for project work over the next two years will come from various SCL CIP and O&M budgets. Later phases of implementation under this Grid Modernization plan will require incremental capital requests and re-prioritizing existing capital funding as City Light modernizes approaches and solves problems in new ways.

Staffing: Existing and Future

The Grid Modernization team at City Light will be involved in every project outlined in this document. However, these projects and the broader Grid Modernization effort requires participation and support from a wide variety of teams within City Light. In many cases, Grid Modernization projects will affect work procedures as City Light approaches traditional problems in new and innovative ways. As such, the Grid Modernization team has made recommendations as to which groups should be involved in each project. See Table 2 for an overview of the projects and lead teams. This report also identifies projects where external consultants may be necessary. For the complete list, see the Grid Mod Project Staffing section.

Lead Team	Projects
AMLP – Asset Management	• Targeted Lightning Arrestors on OH Transformers
AMLP – GIS	• Advanced Grid Analytics: Enhanced Connectivity Models
AMI – OPS	• Landis and Gyr Mesh Communication Network Assessment
CCES	• Demand Response Pilot
EST – Electrification	• Managed EV Charging
EST – Grid Mod	• Continued Grid Modernization Plan Development • Distribution Automation (all projects) • Line Sensor Deployment • OT Field Area Network – Pilot Project • PNNL Seattle Waterfront Resiliency Study
EST – Strategic Technology	• Miller Community Center Microgrid Plan
ETO – Distribution Planning	• DER Interconnection Studies and Procedures • Energy Storage Technology • Non-Wires Solutions Analysis
SCL Enterprise Cybersecurity	• Cybersecurity for Grid Monitoring and Control

Table 2: Grid Mod Staffing Overview

Organizational Change Management Approach

Multiple models have been developed to prepare and support individuals and teams in making organizational changes. Prosci's ADKAR model[4] is one of the commonly used approaches for this purpose. There are five building blocks of successful change for an individual:

- Awareness of the need for change
- Desire to participate and support in the change
- Knowledge of what to do during and after the change
- Ability to realize or implement the change as required
- Reinforcement to ensure the results of a change continue

[4] https://www.prosci.com/resources/articles/why-the-adkar-model-works

Based on surveys of practitioners, Prosci has assembled seven factors, as shown in Figure 2, that are best practices[5] for managing change:

1. Mobilize an active and visible primary sponsor
2. Dedicate change management resources
3. Apply a structured change management approach
4. Engage with employees and encourage their participation
5. Communicate frequently and openly
6. Integrate and engage with project management
7. Engage with middle managers

Figure 2: Prosci's Seven Best Practices Factors for Change Management

[5] https://www.prosci.com/hubfs/367443/2.downloads/thought-leadership/7-Best-Practices-in-Change-Management-TL.pdf?hsLang=en-ca

Organizationally, SCL's leadership is actively engaged in sponsoring change management efforts; however, the application is often limited to a few practitioners and is not generally viewed as a key competency of the organization. In the next two years, the Grid Mod Team will identify two or three key factors and incorporate those into the project work. Change management is a key aspect of transformative work such as Grid Modernization. Effectiveness in change management will be key to success. Recommendations will be made to leadership on whether additional resources, efforts, or training are needed.

Conclusion and Next Steps

By completing the 18 projects described in this document, SCL will be able to enable electrification efforts and to advance organizational and technical preparedness for future grid technologies. The SCL Grid Modernization Team is the facilitating organization for the work presented in this and future versions of the plan. The entire utility shares ownership of the work and the goals to implement the vision presented here as depicted in Figure 3. The Electrification and Strategic Technology division will serve as monitors of progress. The team will coordinate and collaborate with the utility's strategic vision and support overall organizational engagement. Ultimately, grid modernization will help ensure that SCL is able to deliver equitable, resilient, reliable, flexible, secure, sustainable, and affordable electricity to our customer-owners for years to come.

Figure 3: Distributed Project Implementation with Grid Mod Team supporting as strategic lead

Grid Modernization Dependencies

After projects are selected, a timeline incorporating resourcing constraints can be built. Given the optionality of the current plan, a dependency diagram shows interdependence of projects that appear disparate. This section shows the most significant dependencies for projects in this roadmap.

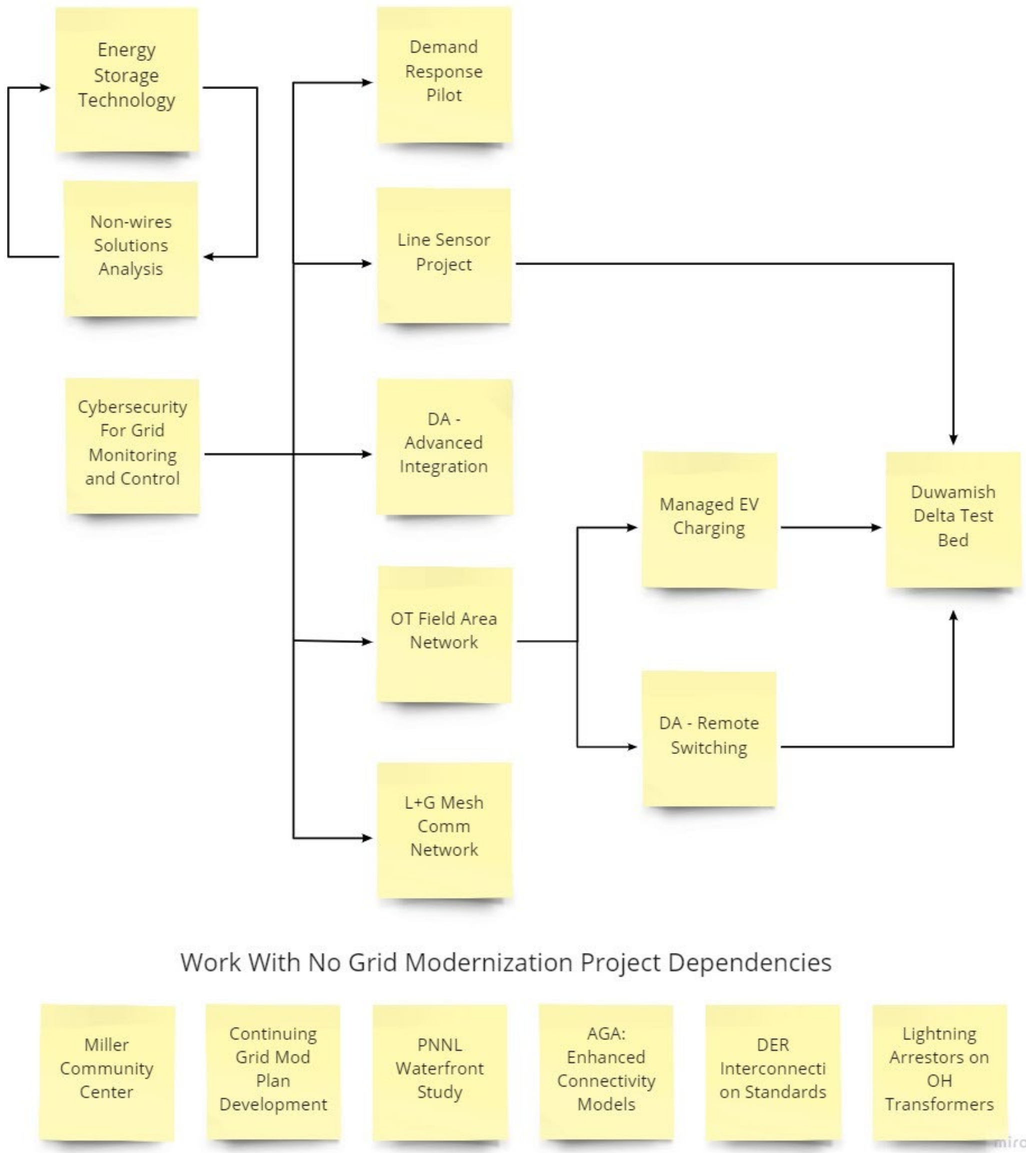

Figure 4: Grid Modernization Plan Dependencies

Detailed Project Tables

(Two-year goals are highlighted in grey)

<table>
<tr><th colspan="4">SCL's Detailed Capability Development — Planning</th></tr>
<tr><th colspan="4">Objective: Focusing the Grid Mod Plan Development</th></tr>
<tr><td colspan="4">Prioritization Reason: Modernizing the grid will take a concerted and well thought out effort with a focus on electrification enablement and equity.</td></tr>
<tr><td>Continuing Grid Mod Planning</td><td colspan="3">Goals</td></tr>
<tr><th>Current State (2021)</th><th colspan="2">Future State (5 years)</th><th>Future State (10 years)</th></tr>
<tr><td>Technical
• Distribution Automation project (DA-FLISR)
• Line Sensor Pilot
• 2021-2022 Grid Mod Plan – Based on EPRI Framework (Planning, Operations, Supporting Technologies, Physical Infrastructure)
Policy:
• Loosely organized federation of projects</td><td colspan="2">Technical
• Determine the long-term scope (10 year or longer) of the Grid Mod Roadmap
• Define and/or confirm Organizational Grid Mod Objectives
• Identify Technical and Organizational Capabilities to achieve each objective
• Develop Roadmaps and System Engineering Analysis
• Develop and obtain funding for key projects
Process
• Update Grid Mod Plan on regular intervals
• Funding for identified projects
• Project approach identified and key SCL positions obtained, identified, and filled</td><td>Technical
• Implemented Grid Mod projects
Process
• Update Grid Mod Plan on regular intervals</td></tr>
<tr><th colspan="2">Action Items: Current State → 5-Yr Future State</th><th colspan="2">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="2">• Hire and engage with EPRI to build a long-term Grid Mod Roadmap
• Perform business case analysis to justify budget and staffing
• Implement projects</td><td colspan="2">• Continue to Implement projects</td></tr>
<tr><th colspan="2">Considerations and Risks to Achieving the Future State</th><th colspan="2">Dependencies and Integrations</th></tr>
<tr><td colspan="2">• Paradigm shift for many parts of the organization—previously problem and budget driven moving towards objectives and capability driven</td><td colspan="2">• Integration with SCL business processes so the Roadmap can be implemented.</td></tr>
</table>

<table>
<tr><th colspan="3">SCL’s Detailed Capability Development — Planning</th></tr>
<tr><th colspan="3">Objective: Update SCL Procedures for New Customer Technologies</th></tr>
<tr><td colspan="3">Prioritization Reason: In the recent past, SCL customer-owners are adding more solar and other DERs (Residential and Commercial scale). SCL’s interconnection procedures were developed in 2009 and are ready for realignment with the business processes.</td></tr>
<tr><th>DER Interconnection Studies and Procedures</th><th colspan="2">Goals</th></tr>
<tr><th>Current State (2021)</th><th>Future State (5 years)</th><th>Future State (10 years)</th></tr>
<tr>
<td>Process:
• Currently processes accommodate customer requests but don’t necessarily integrate with the distribution system
• Interconnection Procedures from 2009/2012; “solar” only, new technologies not considered.
• Multi-step process based on size:
1) submit application (size, location, details);
2) pay study fee;
3) study impact (duration varies significantly);
4) study results issued;
5) design, construction, testing
6) contracts & documentation</td>
<td>Technical:
• Interconnection Procedures incorporating IEEE 1547-2018 aka “smart” inverters
• Standardized use cases, including grid services
• Studied feeder-level hosting capacity
• Monitoring and control requirements in place to support grid services
Policy:
• Monetize functionality of “smart” inverter-based systems, including grid services
Process:
• Updated screening criteria for DERs
• Pilot new processes to validate improvements
Tools:
• Online customer application DER portal</td>
<td>Process:
• DER interconnection process to feed into other “planning” processes to capture load forecasting impacts from DER
Tools:
• Automated interconnection process for DER
• Implemented DERMS</td>
</tr>
</table>

<table>
<tr><th>Action Items: Current State → 5-Yr Future State</th><th>Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr>
<td>• Establish desired use cases for DERs, including grid services
• Establish a value for DER grid services, using a repeatable process
• Update the interconnection process and address the inverter settings reqts
• Assess and implement any new policies for customer provided grid services. Change to a two-way financial relationship
• Improve the technical analysis process for fast-track and screening criteria
• Develop an online application portal for DERs with customer self-screening
• Develop a policy and plan, addressing monitoring information and control (MIC) for customer owned DERs, and implement plan</td>
<td>• Develop new tool sets to further automate and decrease time for management and technical review of interconnection
• Integrate DER interconnection process into greater planning process to feed DER data into load and DER forecasts</td>
</tr>
<tr><th>Considerations and Risks to Achieving the Future State</th><th>Dependencies and Integrations</th></tr>
<tr>
<td>• Operationally, the primary utility function is to “protect” the grid, balancing the benefits of any given DER against exposing the grid to new risks
• Evolving industry standards for DER operation and interconnection
• Limited value of DERs for grid services without direct control and communications
• Lack of policy relevant to monitoring information and control (MIC) for DER.
• SCL staff lacks availability and expertise to implement to implement program
• Many internal and external stakeholders with different priorities</td>
<td>• Integrate new SCL DER Interconnection Standards with current work flows
• New tool sets work with existing applications
• Regulated by WA state, for DER interconnections (WAC 480-108)</td>
</tr>
</table>

<table>
<tr><th colspan="4">SCL's Detailed Capability Development — Planning</th></tr>
<tr><th colspan="4">Objective: Extract Additional Value from AGA Tool</th></tr>
<tr><td colspan="4">Prioritization Reason: Enhance accuracy of distribution system electrical connectivity model for better planning, engineering and operation.</td></tr>
<tr><td>AGA: Enhanced Electrical Connectivity Model</td><td colspan="3">Goals</td></tr>
<tr><th>Current State (2021)</th><th colspan="2">Future State (5 years)</th><th>Future State (10 years)</th></tr>
<tr>
<td>• SCL has implemented three AGA (Advanced Grid Analytics) modules:
  ○ Asset Loading Module
  ○ Revenue Protection Module
  ○ Reliability Planner Module
• GIS model accuracy is essential for planning and engineering
• GIS electrical model connectivity is a requirement for OMS (reimplementing currently) and ADMS (future)
• The most common challenge of ADMS implementation is the GIS model accuracy.
• Some planning tools can verify GIS models, but with limitations.</td>
<td colspan="2">• GIS LDRS upgrade is complete
• AGA Model Validation modules improve the electrical connectivity model in GIS (Service Transformer to Substation) and CCB (Meter to Service Transformer)
• The detailed GIS model of distribution system will be verified using AGA data verification module.
• The electrical connectivity model is ready to integrate with OMS
• The GIS loop radial distribution model is valid and ready for ADMS implementation</td>
<td>• GIS network is upgraded
• The detailed new GIS model of distribution system will continue to be verified using AGA data verification module.
• ADMS successfully build distribution system model using the verified GIS model.</td>
</tr>
<tr><th colspan="2">Action Items: Current State → 5-Yr Future State</th><th colspan="2">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr>
<td colspan="2">• The GIS team uses AGA to validate the electrical model in the LRDS GIS upgrade implementation
• Test and verify that AGA modules can be used to improve the electrical connectivity model accuracy
• Complete connectivity model validation using AGA
• Verify GIS model and AGA data verification module of four to six OH feeders using other engineering tools and field verification.
• Evaluate the AGA module performance with those OH feeders
• Use the AGA validated data for OMS outage identification
• Use those four to six feeders for ADMS concept demo</td>
<td colspan="2">• The GIS team uses AGA to validate the electrical model in the LRDS GIS data maintenance
• Continue to use the AGA validated data for OMS
• Use the AGA validated data for ADMS implementation</td>
</tr>
<tr><th colspan="2">Considerations and Risks to Achieving the Future State</th><th colspan="2">Dependencies and Integrations</th></tr>
<tr>
<td colspan="2">• The GIS upgrade is postponed due to resource adjustment
• The AGA performance is unknown. If this project moves forward, suggest to use phase approach and have different contract for each phase depending on previous phase performance.</td>
<td colspan="2">• Resources and budget to implement the plan
• The new upgraded OMS with DA-FLISR and Remote Switching support
• The OT centralized cybersecurity system, and OT network landing zone are in place
• GIS LRDS Project has been completed</td>
</tr>
</table>

<table>
<tr><th colspan="6">SCL's Detailed Capability Development — Planning</th></tr>
<tr><th colspan="6">Objective: Provide Innovative Solutions to Customers</th></tr>
<tr><td colspan="6">Prioritization Reason: The Port of Seattle is a key infrastructure partner for the City of Seattle. Keeping the Port operational will help Seattle recover after major natural disasters.</td></tr>
<tr><th colspan="2">PNNL Seattle Waterfront Resiliency Study</th><th colspan="4">Goals</th></tr>
<tr><th colspan="2">Current State (2021)</th><th colspan="2">Future State (5 years)</th><th colspan="2">Future State (10 years)</th></tr>
<tr><td colspan="2">Technical
• The waterfront is served from the north and south 26kV distribution system and the downtown network system
• SCL has many switching points in the 26kV system
• SCL's network grid has very few outages but is geographically constrained and does not serve large industrial loads
• Washington State Ferries is in the process of electrifying two routes out of Colman Dock
Policy
• City Light is working with Port of Seattle to develop their Clean Energy Strategic Plan to decarbonize their operations</td><td colspan="2">Technical
• Technical study of networked microgrids with multiple sources of electricity generation
• 10-Year Action Plan for Resilient Ports
Policy:
• Supporting resilient ports for social good
• Decarbonize transportation, including vehicles and marine vessels
• Increase clean energy jobs on waterfront
Process:
• Identify problems and possible solutions→Study Feasibility→Concept/Pilot projects→Assess→Full Implementation→Training
Tools:
• Study using GridLAB-D</td><td colspan="2">Technical
• Build-out system of microgrids with waterfront partners
Policy
• Incentivize renewable generation
• Explore new ownership and maintenance models for DERs as system assets
• Encourage/Monetize resilient ports for social good</td></tr>
<tr><th colspan="3">Action Items: Current State → 5-Yr Future State</th><th colspan="3">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="3">• Partner with PNNL to complete the networked microgrid study
• Assess regional social value of resilient ports
• Train people for clean energy jobs related to renewable energy microgrids</td><td colspan="3">• Apply for grants to build microgrids
• Design the system of microgrids
• Build microgrids</td></tr>
<tr><th colspan="3">Considerations and Risks to Achieving the Future State</th><th colspan="3">Dependencies and Integrations</th></tr>
<tr><td colspan="3">• Resiliency problem is too hard to solve with limited infrastructure spending
• Land is difficult to set aside for microgrid equipment or renewable energy resources
• Operational complexity outweighs benefits</td><td colspan="3">• Federal and State grants available
• Coordinated clean energy plans for the City of Seattle, the Port of Seattle, the NW Seaport Alliance, etc.</td></tr>
</table>

<table>
<tr><th colspan="4">SCL's Detailed Capability Development — Planning</th></tr>
<tr><th colspan="4">Objective: Offer New Technologies to Environmental Justice Communities</th></tr>
<tr><td colspan="4">Prioritization Reason: The City of Seattle is committed to decarbonization and equity and this program advances both goals.</td></tr>
<tr><td>Duwamish Delta Test Bed Project</td><th colspan="3">Goals</th></tr>
<tr><th>Current State (2021)</th><th colspan="2">Future State (5 years)</th><th>Future State (10 years)</th></tr>
<tr>
<td>Technical
• Served by multiple substations–Customer-owners in neighborhoods around the Duwamish River served by portions of SCL South Substation, Delridge Substation, and Duwamish Substation
• Vulnerable to natural disasters such as earthquakes, liquefaction, etc.
• Aging infrastructure in some areas
Policy:
• SCL has no special policies related to the electrical system in this area
• SCL assesses projects using a Race and Social Equity Toolkit
Process:
• SCL has no special technical or business processes related to the electrical system in this area
Tools:
• SCL using standards analysis and engineering tools in this area</td>
<td colspan="2">Technical
• Upgrade Duwamish feeder breakers with SCADA
• Identify targeted electrification projects, concentrating on transportation electrification. Work with the TE Program Manager and considering personal vehicles, fleets, buses, trucks, dredging, etc.
• Explore feasibility of NWS to facilitate increased electrification for some projects
• Pilot projects implemented (line sensors, remote switching, etc.)
• Demand Response Pilot in the Duwamish Valley
• SCL-PNNL Study for waterfront networked microgrids
• SCL-PNNL H2@Scale DOE Study Project
Policy:
• Prioritize grid improvements in Envir. Justice communities by Establishing Grid Mod Test Bed
• Thru electrification, support City of Seattle decarbonization goals and improve air quality
• Local jobs to implement the pilot projects
Tools:
• Advanced Planning to incorporate NWS in SCL infrastructure decisions
• Partnerships for workforce development</td>
<td>Technical, Policy, Process, and Tools
• Develop longer-term goals in the near-term after further exploration</td>
</tr>
<tr><th colspan="2">Action Items: Current State → 5-Yr Future State</th><th colspan="2">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr>
<td colspan="2">• Focus portion of TE SIP towards the Duwamish Delta/Duwamish Valley
• Community and Stakeholder outreach to establish a SCL Grid Mod test bed for equitable outcomes for customer-owners
• Scope and implement Duwamish Delta pilot projects (including line sensors, remote switching, Demand Response, etc.)
• Support PNNL studies with technical staff and data
• Obtain wider COS support for this approach</td>
<td colspan="2">• Develop longer-term TE and Grid Mod goals in the near-term after further exploration
• Continue new technology test bed to offer solutions in an Environmental Justice community</td>
</tr>
<tr><th colspan="2">Considerations and Risks to Achieving the Future State</th><th colspan="2">Dependencies and Integrations</th></tr>
<tr>
<td colspan="2">• Staff resources—focused pilot-area program manager and technical staff
• Limited focus of TE Program Manager
• Budget for new pilot projects</td>
<td colspan="2">• Continued access to On-Call Consultant Roster
• Collaboration with City of Seattle departments and neighborhood organizations and advocates
• PNNL and DOE resources</td>
</tr>
</table>

<table>
<tr><th colspan="4">SCL's Detailed Capability Development — Planning</th></tr>
<tr><th colspan="4">Objective: Explore New Approaches to Solve Traditional Problems</th></tr>
<tr><td colspan="4">Prioritization Reason: SCL requires, based on regulations and technical necessity, screening and evaluation criteria for non-wires solutions (NWS) during the planning process.</td></tr>
<tr><th>Develop Non-Wires Solutions Design and Application Guidelines</th><th colspan="3">Goals</th></tr>
<tr><th>Current State (2021)</th><th colspan="2">Future State (5 years)</th><th>Future State (10 years)</th></tr>
<tr><td>Technical:
• Customers are increasingly deploying DERs and District Energy Systems that could be considered NWS
• SCL staff are learning about the benefits of NWS to facilitate new large loads
• Feeder utilization is based on annual peak loading (winter and summer) – not hourly (8760) or 576 cases
Process:
• NWS are not considered as alternatives to traditional investments
• SCL has no formal processes to value, screen, or evaluate NWS
• Many of City Light's largest customers are developing long-term electrification plans that could create significantly and costly demands for the deployment of traditional T&D solutions.</td><td colspan="2">Technical:
• SCL has developed NWS screening criteria and incorporates NWS into the planning process
• Feeder utilization limits and forecasts based on 576 or 8760 analysis
• New NWS analysis tools on-boarded
Policy:
• NWS are considered as alternatives to traditional investments
• Probabilistic forecasts for DERs included in the Integrated Resource Plan
• Programs are in place to fairly compensate customers for NWS projects where applicable (on-site DERs, demand response, etc.)
Process:
• SCL has a defined process and proper evaluation criteria for NWS option projects</td><td>Technical:
• NWS screening and evaluation criteria have been updated to reflect recent trends and lessons learned during previous NWS projects
• SCL has evaluated available tools to automate processes where possible</td></tr>
<tr><th colspan="2">Action Items: Current State → 5-Yr Future State</th><th colspan="2">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="2">• Do a "Best Practice" analysis of other utilities and existing frameworks for NWS screening and evaluation
• Develop NWS screening criteria, application guidelines, engineering standards and specifications for projects
• Pilot the developed tools and skills into upcoming projects (e.g. ferry and bus electrification)
• Formalize processes in SCL distribution planning around NWS
• Select proper tools for NWS analysis to be done</td><td colspan="2">• Continue to evaluate available tools in the market that would automate or make easier NWS analysis
• Compile lessons learned on the deployment of NWS for future projects
• Update NWS screening and evaluation criteria to capture new market trends and widen criteria to include more projects</td></tr>
<tr><th colspan="2">Considerations and Risks to Achieving the Future State</th><th colspan="2">Dependencies and Integrations</th></tr>
<tr><td colspan="2">• SCL lack the internal resources and/or technical skillset to develop NWS screening criteria internally/independently
• Tools currently available may not allow planners to properly evaluate NWS
• Additional distribution planners may need to be hired
• Common understanding of NWS technologies required (PV, batteries, demand response, TOD rates, managed EV charging, etc.)</td><td colspan="2">• NWS processes should integrate effectively with distribution planning processes
• SCL must abide by RCW 19.280.100 Distributed Energy Resource Planning, including NWS
• Collaboration required across SCL groups for NWS analysis (e.g. EST, ESE, Distribution Planning)
• Customer interest and engagement may be required</td></tr>
</table>

SCL's Detailed Capability Development — Planning

Objective: Assess Batteries as Solutions to many Grid and Customer Issues

Prioritization Reason: Energy storage is an integral part of NWS. An understanding of its usefulness & effectiveness is required for advanced planning purposes.

Energy Storage Technology — **Goals**

Current State (2021)	Future State (5 years)	Future State (10 years)
Technical: • SCL has relatively high voltage (26.4 kV) and short feeders, which tend to minimize grid support issues. • Current voltage control equipment includes load tap changers and capacitor banks in substations; few devices are located on feeders. • There are a few small customer-owned battery energy storage systems (BESS) • City Light is deploying storage at the Miller Community Center Microgrid • Storage is being considered to help manage Washington State Ferry electrification Policy: • Market value of storage is still evolving. • Power quality issues are addressed in response to customer complaints. Process: • ESEs, planners, & distribution engineers work mainly with traditional methods of serving customer-owners. They do not have the time or tools to analyze alternative solutions.	Technical: • Energy storage technology is employed on the distribution system, where appropriate, to solve a variety of problems. • Typical uses include power quality issues, feeder capacity upgrades, load smoothing, resiliency, etc. Policy: • Planning for electrification has a long term, strategic focus • Non-wires Solutions (NWS) such as energy storage are considered a standard method of addressing problems on the grid Process: • Engineers & planners develop the skills needed to analyze situations where NWS should be considered as an alternative to traditional energy delivery methods. • SCL adopts a standardized methodology for benefit-cost analysis for all distributed energy resources. • SCL develops expertise and ownership of maintenance for City owned storage systems	Policy: • SCL develops a strategic plan for electrification that considers all viable methods of delivering power to customers. • Storage is fully valued by analytical methods. Process: • NWS becomes a standard tool used by engineers & planners to address technical or financial limitations encountered with traditional methods. • SCL manages storage for the benefit of the distribution and transmission grids.

Action Items: Current State → 5-Yr Future State	Action Items: 5-Yr Future State → 10-Yr Future State
• Incorporate knowledge about NWS into planning. Additional training for technical personnel about considerations for the uses and limitations of various storage technologies and about analysis of storage options for grid benefits. • Develop and implement a standardized benefit-cost analysis for use with DERs	• Develop a strategic approach that considers long-term customer load projections. • Develop communications and software that enable storage management by dispatchers.

Considerations and Risks to Achieving the Future State	Dependencies and Integrations
• Energy storage is a broad and evolving field. Full understanding requires covering a lot of technical material. • SCL technical personnel have limited time available to learn new technology. • Strategic development requires support from top level management. It may also entail reorganization. • Analytical tools & methods must be unique to SCL. This development requires time & effort. • Management of storage on the distribution grid for the benefit of the transmission grid requires very careful and detailed planning studies to protect the distribution system.	• Pilot projects should involve SCL engineers & technicians in order to develop in-house understanding of the technologies and how to maintain these systems. • Storage management depends on development of a suitable communications system. • New technologies may require additional and/or revised safety procedures.

<table>
<tr><th colspan="6">SCL's Detailed Capability Development — Operations</th></tr>
<tr><th colspan="6">Objective: Minimize Customer Outages</th></tr>
<tr><td colspan="6">Prioritization Reason: One of the most effective technologies to improve system reliability and customer satisfaction. Also, improve operational efficiency, situation awareness, reduce carbon footprint, and enhance safety.</td></tr>
<tr><td colspan="2">DA-FLISR Expansion</td><th colspan="4">Goals</th></tr>
<tr><th colspan="2">Current State (2021)</th><th colspan="2">Future State (5 years)</th><th colspan="2">Future State (10 years)</th></tr>
<tr><td colspan="2">• Seven DA feeders are in service.
• Working on five feeders out of University substation and four feeders out of Creston substation
• Using automated switches to improve efficiency and reduce sustained outages which are caused by faults on main lines.</td><td colspan="2">• Implement the planned additional FLISR schemes on multiple feeders at multiple substations
• Fully integrated with the OMS
• Integrated with the centralized OT Cybersecurity system
• Implement additional cutting-edge technologies to further improve system reliability, improve power quality, reduce momentary outages, and reduce operational cost.</td><td colspan="2">• Expand the implementation to 20% total overhead feeders
• Further implement cutting-edge technologies to further improve system reliability, improve power quality, reduce momentary outages, and reduce operational cost.
• Leading in implementing new technologies to improve customer satisfaction, system reliability, power quality, and work efficiency.
• Integrated with potential ADMS</td></tr>
<tr><th colspan="3">Action Items: Current State → 5-Yr Future State</th><th colspan="3">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="3">• Develop the needed staff resources for the program.
• Continue to implement the expansion of DA-FLISR
• Integrate DA with OMS
• Build DA cybersecurity monitoring system and integrate it to the centralized OT cybersecurity system</td><td colspan="3">• Evaluate the performance of the new pilot projects using new FMS (Feeder Management System)
• Implement the proved successful technologies from pilot projects to the main program
• Continue to expand the implementation, averaging two feeders per year.
• Develop and implement the integration plan with future ADMS</td></tr>
<tr><th colspan="3">Considerations and Risks to Achieving the Future State</th><th colspan="3">Dependencies and Integrations</th></tr>
<tr><td colspan="3">• The primary risks are lacking of funding and dedicated resources
• Higher priority projects in later years of the project may take away some resources and funding.
• Many internal and external stakeholders with different priorities
• Routine maintenance required.</td><td colspan="3">• Resources and budget to implement the plan
• Integrate with current EMS, PI historian, updated OMS and future ADMS</td></tr>
</table>

<table>
<tr><th colspan="6">SCL's Detailed Capability Development — Operations</th></tr>
<tr><th colspan="6">Objective: Improve Operational Efficiency</th></tr>
<tr><td colspan="6">Prioritization Reason: Improve system reliability, operational efficiency, situation awareness, reduce carbon footprint, and enhance safety.</td></tr>
<tr><td colspan="2">DA-Remote Switching</td><th colspan="4">Goals</th></tr>
<tr><th colspan="2">Current State (2021)</th><th colspan="2">Future State (5 years)</th><th colspan="2">Future State (10 years)</th></tr>
<tr><td colspan="2">• SCL distribution switches are manual operation, except for DA-FLISR feeders
• Manual switching is taking significantly longer time to restore outages, is more expensive, and is less safe
• No situation awareness in real-time
• Manual switching increase carbon footprint due to more windshield time</td><td colspan="2">• Two pilot systems in two different areas are in service. Each system will include two feeders with two normal-closed switches and one normal-open switches
• The new systems are integrated with SCADA/EMS
• Integrated with potential NWS projects
• Integrated with potential TE projects
• Integrated PI historian
• Integrated with DA-FLISR
• Developed plan for system-wide implementation</td><td colspan="2">• A dedicated team is formed to implement the project in large scale
• Expand the implementation up to 50% of total overhead feeders depending on the budget and staffing resources
• Improve system reliability, enhance customer satisfaction, improve safety, and reduce carbon footprint. The larger size of the project, the more impact it will have
• Integrated with potential ADMS
• Support future TE, NWS projects
• Expand the system capabilities in some areas to become DA-FLISR to further improve system reliability</td></tr>
<tr><th colspan="3">Action Items: Current State → 5-Yr Future State</th><th colspan="3">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="3">• Develop the needed staff resources for the program.
• Study potential TE and NWS potential areas, distribution system performance, outage and switching history, other distribution projects to select pilot feeders that can provide optimal benefits
• Test required communications in a lab and in the field for different environments
• Integrate with EMS/SCADA and PI historian
• Integrate with OMS, DA-FLISR, etc.
• Integrate with potential TE and NWS projects
• Evaluate the pilot projects
• Study distribution system performance, outage and switching history, planned TE, NWS and other distribution projects to develop short-term and long-term plan for expanded system.</td><td colspan="3">• Form a dedicated team including various engineers, dispatcher, EMS specialists, technicians, line crews with support from the E-team
• Develop construction, material, practice standards relating to project's material and construction
• Develop construction priority schedule
• Design, install and commission the large-scale implement project</td></tr>
<tr><th colspan="3">Considerations and Risks to Achieving the Future State</th><th colspan="3">Dependencies and Integrations</th></tr>
<tr><td colspan="3">• The primary risks are lack of funding and dedicated staffing resources
• Higher priority projects in later years of the project may take away some resources and funding.
• Many internal and external stakeholders with different priorities</td><td colspan="3">• Must have an expanded cyber-secure communication network ready for this project as described in the "OT-Field Area Network project"
• Need new cybersecurity monitoring system
• Resources and budget to implement the plan
• Integrate with current EMS, PI historian, OMS, DA-FLISR and future ADMS</td></tr>
</table>

SCL's Detailed Capability Development — Operations		
Objective: Improving the Integration and Cybersecurity of the DA System		
Prioritization Reason: Enhance cybersecurity, improve system reliability and operational efficiency of the DA systems.		
DA-Advanced Integration	**Goals**	
Current State (2021)	**Future State (5 years)**	**Future State (10 years)**
• Current DA systems integrated with SCADA/EMS and PI historian. • The integration with OMS is essential but has not been implemented due to limitation of the existing OMS (2009) version. • Lack of OMS-DA integration reduces dispatchers' efficiency, leads to confusion, and inaccurate outage reports and reliability indices • New OMS upgrade is being planned (2021+) • Enterprise OT cybersecurity monitoring system is being developed (DA needs its cybersecurity monitoring system.) • Lack of effective tool to collect and analyze outage events data, to proactively diagnose and troubleshoot DA device conditions to optimize the system performance	• New DA cybersecurity monitoring system is designed, and built for DA-FLISR • The cybersecurity system will be integrated with the OT centralized cybersecurity system • New upgraded OMS is implemented • DA-FLISR is integrated with new upgraded OMS • The new Feeder Management System (FMS) is designed and implemented. • FMS is integrated with cybersecurity monitoring system, with OT network landing zone and remote access.	• The new DA-remote switching system is integrated to the DA cybersecurity monitoring system. • The new DA-remote switching system is integrated to OMS • FMS will integrate with the DA-remote switching system • The new integration will also cover for the expanded/large scale DA-FLISR and remote switching systems

Action Items: Current State → 5-Yr Future State	**Action Items: 5-Yr Future State → 10-Yr Future State**
• Develop the needed staff resources for design, implementation and manage the new systems • Confirm OMS upgrade (2021+) requirements support DA-FLISR • Set up and test OMS and DA-FLISR integration in a lab environment • Test and implement OMS and DA-FLISR integration • Design and test cybersecurity system for DA-FLISR in the Grid Mod Lab • Implement the new cybersecurity system and test with DA-FLISR system • Integrate the new cybersecurity system with the OT centralized cybersecurity system • Design and test FMS in the Grid Mod Lab • Design, implement, and test FMS with Shoreline DA feeders (original pilot) • Integrate all DA feeders to FMS, OMS, and cybersecurity	• Set up and test OMS and DA-remote switching integration in a lab environment • Test and implement OMS and DA-remote switching integration • Design and test the DA cybersecurity system for DA-remote switching in the Grid Mod lab • Test the DA cybersecurity system with the new DA-remote switching system • Design, implement, and test FMS with the pilot remote switching system • Integrate all future DA-FLISR, remote switching with OMS, DA cybersecurity monitoring system, and FMS

Considerations and Risks to Achieving the Future State	**Dependencies and Integrations**
• The primary risks are lack of funding and dedicated staffing resources • System integration is typically challenging and may take more time and effort than initially forecast • The OMS and cybersecurity system will be upgraded periodically and this may cause delay in the subsequent integration	• Resources and budget to implement the plan • The new upgraded OMS support DA • The OT centralized cybersecurity system, and OT network landing zone are in place.

<table>
<tr><th colspan="6">SCL’s Detailed Capability Development — Operations</th></tr>
<tr><th colspan="6">Objective: Enable Connections to Distributed Equipment</th></tr>
<tr><td colspan="6">Prioritization Reason: The project will expand SCL capabilities and functionalities to improve system resiliency, reliability, responsiveness, and adaptation, to speed up decarbonization, to enhance safety, to improve operational efficiency, to increase life expectancy of assets, and to optimize energy delivery and customer service options</td></tr>
<tr><th colspan="2">OT Field Area Network</th><th colspan="4">Goals</th></tr>
<tr><th colspan="2">Current State (2021)</th><th colspan="2">Future State (5 years)</th><th colspan="2">Future State (10 years)</th></tr>
<tr><td colspan="2">• SCL AMI project is utilizing radio mesh network which is less expensive than an SCL owned Field Area Network, but it is also less reliable, secure, high latency, narrow bandwidth. It is not currently used for critical control applications.
• The communication for DA-FLISR is fiber optics, which is reliable, secure, fast speed, broad bandwidth, yet, is more capital intensive, and takes longer to implement.
• Identified the need for reliable, secure communication to meet the needs of new field technologies. Those new projects include but are not limited to Managed TE, DER, NWS, DA-FLISR, remote switching, line sensor, etc.</td><td colspan="2">• Two pilot systems in two different areas are implemented and evaluated—criteria: Environmental Justice Communities, hilly-treed areas, etc.
• The pilot communication will serve one or two new grid mod projects: remote switching, line sensor managed TE, DER, Connected Grid Building, or NWS
• The new systems are integrated with SCADA/EMS/ADMS
• Developed plan for large scale implementation</td><td colspan="2">• A dedicated team is formed to implement the project in large scale
• Expand the implementation up to 50% of SCL service area depending on the budget and staffing resources
• The new communication will serve as standard communication for new distribution field projects such as managed TE, DER, NWS, DA-FLISR, remote switching, line sensor, etc. and reduce their cost, reduce design and implementation durations and increase their chance of success</td></tr>
<tr><th colspan="3">Action Items: Current State → 5-Yr Future State</th><th colspan="3">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="3">• Develop the needed staff resources for the program.
• Develop the high-level communication system network design
• Develop new communication devices specs and purchase new devices
• Test the new communication in the lab
• Study and selected two different testing areas to test the communication performance with different environments.
• Design, install and commission the pilot projects
• Evaluate the pilot projects
• Develop the plan for possible large-scale implementation
• Obtain budget for large-scale implementation project</td><td colspan="3">• Form a dedicated team including various engineers, technicians, line crews with support from the E-team
• Develop construction, material, practice standards relating to project’s material and construction
• Develop construction priority schedule
• Design, install and commission the large-scale implement project
• Develop communication network guidelines including common communication protocols for new distribution field projects such as but not limited to managed TE, DER, NWS, DA-FLISR, remote switching, line sensor, energy delivery optimization, advanced distribution system protection.</td></tr>
<tr><th colspan="3">Considerations and Risks to Achieving the Future State</th><th colspan="3">Dependencies and Integrations</th></tr>
<tr><td colspan="3">• The intention is to supplement and possibly replace the AMI mesh network with a more robust and capable OT FAN
• The primary risks are lack of funding and dedicated staffing resources
• Higher priority projects in later years of the project may take away some resources and funding
• Many internal and external stakeholders with different priorities.
• Communication technologies have short lifecycles and current best technologies can be outdated quickly</td><td colspan="3">• Resources and budget to implement the plan
• Integrate with backbone communication, and DA-FLISR communication networks.
• Evaluate possible shared City infrastructure.</td></tr>
</table>

<table>
<tr><th colspan="6">SCL's Detailed Capability Development — Operations</th></tr>
<tr><th colspan="6">Objective: Implement and Analyze Demand Side Management</th></tr>
<tr><td colspan="6">Priority consideration: Demand response is an emerging technology which City Light can use for a variety of grid services, e.g. load shifting</td></tr>
<tr><td colspan="2">Demand Response Pilot</td><th colspan="4">Goals</th></tr>
<tr><th colspan="2">Current State (2021)</th><th colspan="2">Future State (5 years)</th><th colspan="2">Future State (10 years)</th></tr>
<tr><td colspan="2">Technical:
• SCL currently has not implemented demand response or customer-controlled loads
• Initial pilot scoping and valuation work was conducted with a focus on industrial customers
• Demand Response Potential has been assessed as part of City Light's Conservation Potential Assessment
• Integrated Resource Plan updates forthcoming in early 2021 will inform long-term value of demand response resources
• Interest has been expressed in a residential and small-commercial focused pilot with impacts in the Duwamish Valley.</td><td colspan="2">Technical:
• Conduct pilot project (2021-2022).
• Define grid value and peak-shaving needs now and in the future
• Grid interactive water heaters and possibly smart thermostats for residential customers and/or small commercial
• Assess pilot results and potential long-term value
• Review relevant case studies at other utilities, including behavioral DR
Policy:
• Consider demand response programs for load shifting and other grid services.
Process:
• Develop & pilot various DR programs.
• Engineers & planners develop the skills needed to analyze situations where DR should be considered for grid benefits.
• SCL adopts a standardized methodology for benefit-cost analysis for demand response resources.</td><td colspan="2">Technical:
• SCL has installed a Distributed Energy Resources Management System (DERMS) for wide-scale implementation of DR control.
• Participating customer resources and customer sectors expand.
Policy:
• SCL is engaged in regional DR programs at MW scale.
• SCL actively seeks grid benefits from DR.
Process:
• DR becomes a standard tool used by marketers, planners, & engineers to produce financial and grid benefits for SCL's customer-owners.</td></tr>
<tr><th colspan="3">Action Items: Current State → 5-Yr Future State</th><th colspan="3">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="3">• Determine specific objectives of DR pilot. Involve participating groups in this process.
• Plan & execute pilot; assess results.
• Share results with interested parties at SCL.
• Review case studies covering technology for incorporating small-commercial winter peaking DR and assess the value of this targeted sector.</td><td colspan="3">• SCL builds on pilot programs for various types of DR.
• Successful pilot programs are then rolled out at scale.
• SCL pursues opportunities for DR in the energy markets.</td></tr>
<tr><th colspan="3">Considerations and Risks to Achieving the Future State</th><th colspan="3">Dependencies and Integrations</th></tr>
<tr><td colspan="3">• Some DR techniques, e.g. EV charging, have not been shown to be cost effective (not enough participants). Therefore, it is important to consider the experience of other utilities when designing a DR program.
• Cybersecurity & data security are significant challenges to DR control design.
• DR is a broad and evolving field. Full understanding requires covering a lot of technical material.
• SCL technical personnel have limited time available to learn new technology.
• Equity needs to be carefully considered in program roll-out.</td><td colspan="3">• Pilot projects should involve SCL engineers & technicians in order to develop in-house understanding of the technologies and how to maintain these systems.
• The most effective DR requires a suitable communications system. Current candidates include cellular modems, AMI networks, FM radio broadcast, and customer Wi-Fi connections.
• DR at scale requires DERMS.
• New technologies may require additional and/or revised safety & operating procedures.</td></tr>
</table>

SCL's Detailed Capability Development — Operations

Objective: Assist Customers with Optimized Charging for the Grid

Prioritization Reason: SCL is committed to helping customer-owners lower their carbon footprints. Creating a managed EV charging program could ultimately allow more EVs to exist on the SCL distribution system while minimizing additional required capacity buildout.

Managed EV Charging	Goals	
Current State (2021)	**Future State (5 years)**	**Future State (10 years)**
Technical • EV Fast Chargers are currently being piloted with time-of-use rates • A residential lease-to-own model program has provided 35 residents with 240V chargers. • SCL is collaborating with King County Metro to electrify transit buses • A UW Capstone Project, supervised by EST's Strategic Tech team, is studying managed charging of UW fleet vehicles Policy • Seattle City Council has approved the SCL Transportation Electrification Strategic Investment Plan (TESIP)	Technical • SCL has studied benefits of managed EV charging • Pilot project for managed charging of fleet medium and heavy-duty EVs (V1G) to avoid overloading on feeder laterals • SCL has identified load profiles for EVs • SCL has analyzed the effect of passive charge management (TOD pilot) Process • A residential rate pilot has been reviewed and is in place if financially tenable • Engagement with SCL customer-owners related to TESIP goals on managed charging	Technical • A V2G pilot for medium and heavy-duty EVs has been put in place assuming SCL has willing fleet-operating stakeholders, exploring customer and/or SCL benefits • Developed standards for managed EV charging Process • Based on pilot success and the adoption of EVs in SCL territory, SCL has or is in the process of adopting a V2G program • Developed rates for multiple managed EV charging options

Action Items: Current State → 5-Yr Future State	Action Items: 5-Yr Future State → 10-Yr Future State
• Study benefits and challenges of managed EV charging • Complete an analysis on the effects of passive charge management (e.g. TOD rates) • Complete a detailed map of expected EV growth • Areas of concern due to EV fleets on the SCL network must be identified • A proper incentive structure for customer-owners in the V1G pilot should be drafted for a pilot project • Assess customer interest in managed charging options. • Analyze the EV load profiles using the specially installed EV meters, AMI meters/load disaggregation software or EPRI data	• Study V2G managed charging benefits and technical and operational challenges • Market V2G technology should be monitored until the industry becomes mature enough for SCL to pursue a pilot project • Note areas/times of day that are of particular worry which V2G technology might alleviate problems • Fleet-owning customers should be engaged with to determine interest in a V2G pilot

Considerations and Risks to Achieving the Future State	Dependencies and Integrations
• Cybersecurity analysis will be needed for SCL actively managed charging • Customer privacy concerns if data is collected on charging behavior • Equity goals should be considered with any new EV charging projects • V2G technology voids the current warranties of electric vehicles • SCL will need to assess distribution protection impacts of EV managed charging	• Customer interest in V1G or V2G pilot projects is vital to project success • Communications infrastructure would be required to communicate to EV chargers • Additional buildout of EV charging infrastructure • Installing EV chargers with capabilities to meet the needs of the grid • An ADMS or DERMS would be required to give control of V2G fleets to dispatchers and give insight to dispatchers

<table>
<tr><th colspan="6">SCL's Detailed Capability Development — Operations</th></tr>
<tr><th colspan="6">Objective: Increase Situational Awareness for Dispatchers</th></tr>
<tr><td colspan="6">Prioritization Reason: The existing overhead fault current indicators are nearing end-of-life on the SCL distribution system. Replacing these sensors with smart line sensors would increase dispatcher capabilities and reduce customer outage times.</td></tr>
<tr><th colspan="2">Line Sensor Deployment</th><th colspan="4">Goals</th></tr>
<tr><th colspan="2">Current State (2021)</th><th colspan="2">Future State (5 years)</th><th colspan="2">Future State (10 years)</th></tr>
<tr><td colspan="2">Technical
• Distribution fault current indicators (FCIs) exist on the system but do not communicate to SOC and are reaching end-of-life
• Underground FCIs are being deployed (without communication)
• A pilot project using AMI-enabled line sensors from L+G has been completed</td><td colspan="2">Technical
• Smart line sensor deployment on the distribution system which communicate to dispatchers at SOC when a fault is sensed
• A study has been done to measure the effects of the line sensors on standard outage measurements (CAIDI)
• Full-scale deployment of line sensors</td><td colspan="2">Technical
• Monitoring of trends in FCI/line sensor technology
Process
• Completed integration into a DMS or ADMS</td></tr>
<tr><th colspan="3">Action Items: Current State → 5-Yr Future State</th><th colspan="3">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="3">• Determine the preferred communications network for this project
• Final selection of vendor products – line sensors and other related deployed equipment
• Deploy line sensors on small scale (~100) and report on performance
• Assign personnel to manage and monitor the sensors
• Create a plan to integrate line sensor data into future DMS or ADMS systems that SCL will deploy
• Deploy line sensors on a system-wide scale
• Report on the effects of the line sensors on standard outage measurements (CAIDI)</td><td colspan="3">• Continue to monitor line sensor functionality, and make changes to the project if necessary
• Replace line sensors as necessary if they fail, or begin a new project to find a replacement product
• Integrate line sensor monitoring into the SCL DMS/ADMS</td></tr>
<tr><th colspan="3">Considerations and Risks to Achieving the Future State</th><th colspan="3">Dependencies and Integrations</th></tr>
<tr><td colspan="3">• Smart sensor information that is communicated back to SOC may raise cybersecurity concerns
• Staff to monitor the health of the line sensor system and flag devices or areas of concern would be required for a large-scale deployment</td><td colspan="3">• Integration of FCI/line sensor data into a DMS or ADMS is critical to their long-term usability by dispatchers
• Communications infrastructure is required to support devices and a new SCL-owned communication network might be required</td></tr>
</table>

<table>
<tr><th colspan="6">SCL's Detailed Capability Development — Supporting Technologies</th></tr>
<tr><th colspan="6">Objective: Extract Additional Value from Installed Equipment</th></tr>
<tr><td colspan="6">Prioritization Reason: The L+G communications for AMI is an existing asset that SCL has committed to long-term for billing. Planning and operations projects that utilize the L+G mesh network will extract additional value.</td></tr>
<tr><th colspan="2">L+G Mesh Communication Network Assessment</th><th colspan="4">Goals</th></tr>
<tr><th colspan="2">Current State (2021)</th><th colspan="2">Future State (5 years)</th><th colspan="2">Future State (10 years)</th></tr>
<tr><td colspan="2">Technical:
• SCL has nearly completed the AMI meter project for billing.
• AGA modules are used by planning, engineering, and new services groups at SCL.
Policy:
• SCL has a contract with L+G through 2031 (Signed in 2016 for 15 years)
Process:
• The mesh network is owned and managed by L+G (until 2031)</td><td colspan="2">Technical:
• Utilization of the L+G network for operations, for example, distribution system – monitoring only
• Understanding the cybersecurity and performance capabilities (bandwidth, latency, etc.) of this network
Process:
• Secure lower cost, grid edge communications system
• Assess the future of the L+G network (SCL operation/ownership or L+G management or upgrade)</td><td colspan="2">Policy
• Final evaluation of the L+G network (SCL operation/ownership or L+G management or upgrade) as approaching 2031
Technical
• Defined and implemented project for any changes to the AMI Comm network</td></tr>
<tr><th colspan="3">Action Items: Current State → 5-Yr Future State</th><th colspan="3">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr><td colspan="3">• Assess possible additional uses for the comm network (non-L+G equipment) to maximize the value of the asset
• Evaluation of new L+G offerings and services available using the L+G mesh network
• Evaluate the Cybersecurity assessment for operations projects
• Plan operational projects for the next five years based on the results to date
• Determine if SCL ownership of the L+G network is feasible after the contract end</td><td colspan="3">• Finalize a plan with internal stakeholders on the future of the L+G mesh communication network
• Define and implement comm network changes/upgrades</td></tr>
<tr><th colspan="3">Considerations and Risks to Achieving the Future State</th><th colspan="3">Dependencies and Integrations</th></tr>
<tr><td colspan="3">• Investing in the L+G network through various projects locks SCL into L+G offerings for the future
• L+G Infrastructure will likely be near or at end-of-life by 2031
• There is little in-house technical knowledge of the L+G network at City Light
• Operational projects may present cybersecurity risks</td><td colspan="3">• If the L+G network is used for operations purposes, L+G solutions should be linked to SCL technologies (OMS, ADMS)</td></tr>
</table>

SCL's Detailed Capability Development — Supporting Technologies		
Objective: Keep the Grid Secure		
Prioritization Reason: Cybersecurity of grid connected components is critical for the operation of a secure modern grid.		
Cybersecurity for Grid Mod Monitoring & Control	**Goals**	
Current State (2021)	**Future State (5 years)**	**Future State (10 years)**
Process: • Lack of cybersecurity analysis or understanding is sometimes cited as a reason for not undertaking new technology projects • Customer owned grid connected equipment is not monitored or controlled and SCL cybersecurity is not addressed because there is no communication	Technical: • Standardized security (both cyber & physical) analysis is applied Grid Mod Projects • Security reports are automatically generated for review and/or action. Policy: • Cybersecurity standards always apply • All communication between SCL and its customer's equipment is secured and monitored. • Every Grid Mod Project integrates cyber protections along with traditional design and analysis Process: • Cybersecurity is built into the customer connection process. Tools: • Various available security techniques and applications.	Policy: • Updated standardized cybersecurity policy Process: • Asset management of all cyber devices owned by SCL, including on grid edge devices • Connected DER are continuously monitored for cybersecurity issues. Tools: • One or more standardized communication systems designed for DER communication are available for most projects.

Action Items: Current State → 5-Yr Future State	**Action Items: 5-Yr Future State → 10-Yr Future State**
• Establish and use standardized cybersecurity review process and standard practices for Grid Mod Projects • Implement security management tools to automatically monitor connections and generate event files and reports. • Establish body of work for SCL employees to support cybersecurity.	• Assess standardized cybersecurity policy • Implement asset management for all cyber devices. • All engineers and technicians are trained to configure cyber protection in OT assets. • Establish standardized communication methods for DER.
Considerations and Risks to Achieving the Future State	**Dependencies and Integrations**
• Most employees do not consider cybersecurity an integral part of their job duties—this new function needs to be integrated into all disciplines. • Cybersecurity technologies are continuously evolving; there are no industry standards. • Communication networks and associated cyber requirements for DER have not been standardized; there are many competing technologies. • Difficulty verifying DER settings after interconnection without communication and hence realizing the actual grid value. • Lack of cyber policy relevant to monitoring, information, and control (MIC)	• Many internal and external stakeholders with different priorities. • Cybersecurity is a specialty field and should be supported at the project level by dedicated technical staff.

SCL's Detailed Capability Development — Physical Infrastructure

Objective: Obtain Additional Learnings from Innovative Installation

Prioritization Reason: SCL will be responsible for the operation and maintenance of the Miller Community Center Microgrid for the life of the system. This project offers opportunities for both internal and external workforce development.

Miller Community Center Microgrid Plan	**Goals**	
Current State (2021)	**Future State (5 years)**	**Future State (10 years)**
Technical: • The Miller Microgrid has broken ground and will likely be operating in Q1 2021 • The University of Washington (UW) will be writing a report after analyzing data from use case data tests Washington State Clean Energy Fund 2 (CEF2) grant • Data and operations are not currently integrated into the SCL EMS (Physical security is monitored by SCL) • Microgrid O&M is SCL responsibility	• SCL has trained internal and external personnel to operate and maintain microgrid, PV, and battery systems • SCL collects data from the PV+Storage Miller Microgrid and assesses value streams • Investigate settings for smart inverter systems • The Miller Community Center will continue to function as a place of haven in case of a larger power outage • City Light will define and implement through this project the cybersecurity needs of utility owned equipment on a customer site	• The community center will continue to function as a place of haven • Integration of data and operations into an ADMS system

Action Items: Current State → 5-Yr Future State	**Action Items: 5-Yr Future State → 10-Yr Future State**
• Testing of use cases for data collection in support of the UW team working on the analytics report • Assess the Miller Microgrid on-going value streams • Determine the in-house skills required to operate and maintain this microgrid system with a focus on battery systems • Conduct personnel training on new technology with the Lighting Design Lab • Develop findings/insights from implementing and operating the Miller Microgrid that can inform potential future microgrid design, development, and installation.	• Integrate monitoring, control, and data collection with an ADMS and redesign of microgrid controls to allow remote operation and ADMS integration

Considerations and Risks to Achieving the Future State	**Dependencies and Integrations**
• SCL Operations and Maintenance (O&M) work for the Miller Community Center Microgrid will be done for the near future by an outside consultant • SCL crews have not been trained to operate or maintain a microgrid or associated equipment • Dispatchers, crews, and SFD should conduct emergency operations training around the microgrid • ADMS implementations are often costly and complicated	• SCL needs to have available staff for new technology training • Long-term integration of data and operations will require an ADMS

<table>
<tr><th colspan="4">SCL's Detailed Capability Development — Physical Infrastructure</th></tr>
<tr><th colspan="4">Objective: Reduce Repeat Customer Outages</th></tr>
<tr><td colspan="4">Prioritization Reason: Improve the reliability for customer-owners in areas where lightning strikes often occur and reduce operational costs.</td></tr>
<tr><th>Targeted Lightning Arresters on OH Transformers</th><th colspan="3">Goals</th></tr>
<tr><th>Current State (2021)</th><th colspan="2">Future State (5 years)</th><th>Future State (10 years)</th></tr>
<tr>
<td>Technical:
• SCL's distribution system averages 113 overhead transformer failures caused by lightning strikes every year.
• Lightning strikes often occur repeatedly in the same areas.
Policy:
• Lightning arresters are not installed on overhead transformers, except for "back-lot" locations that are difficult to access.
• Failed transformers are replaced in-kind regardless of the cause of failure.
• Lightning arresters are always installed on terminal poles to protect underground cables.
Process:
• SCL stocks approximately 500 replacement transformers in various voltage configurations.</td>
<td colspan="2">Technical:
• Studied the effectiveness of OH distr. transformer lightning arrestors and related economic benefits.
• Common types of overhead transformers in the most lightning-prone areas of SCL's system are equipped with arresters.
• Cost of conversion is minimized by purchase of factory-installed arresters.
Policy:
• Established process after review of engineering study, which could include proactively adding lightning protection to installed transformers or adding arrestors to all new and lightning damaged transformers.
• Updated OH distribution transformer lightning arrestor policy based upon economic justification
Process:
• Purchase common types of spare transformers that are factory-equipped with lightning arresters and used to replace lightning-damaged transformers.</td>
<td>Technical:
• Value based approach to lightning arrestors on overhead transformers
Policy:
• All new and replaced overhead transformers are equipped with lightning arresters.
Process:
• All transformers are ordered with factory-installed lightning arresters.
• SCL will no longer need to stock two separate transformer configurations, one with and one without a lightning arrester.</td>
</tr>
<tr><th colspan="2">Action Items: Current State → 5-Yr Future State</th><th colspan="2">Action Items: 5-Yr Future State → 10-Yr Future State</th></tr>
<tr>
<td colspan="2">• Conduct an engineering study on the effectiveness of OH distribution transformer lightning arrestors and related economic benefits.
• Study to evaluate proposal to install arresters on replacement transformers when the original unit failed because of lightning
• Select an appropriate arrester class that will minimize arrester failure
• Choose the common size(s) and configurations of transformers to be protected
• Modify storm response and maintenance policy to ensure that this practice is incorporated into response by line crews
• Review previous lightning arrestor installation policy and study cost benefit of standard installation of lightning arrestors
• Stock a recommended quantity of transformers with factory-installed arresters for low cost and rapid response time</td>
<td colspan="2">• Study the effectiveness of applying lightning arresters to overhead transformers.
• Continue to replace non-arrester-equipped transformers when they fail in service.</td>
</tr>
<tr><th colspan="2">Considerations and Risks to Achieving the Future State</th><th colspan="2">Dependencies and Integrations</th></tr>
<tr>
<td colspan="2">• SCL lacks the in-house capability to perform the value analysis for the limited use of lightning arresters on overhead transformers.
• SCL must staff the study with a project manager and a subject matter expert.
• The lightning arresters may not offer enough protection to justify the cost.
• The arresters themselves may have too high a failure rate to justify their use.
• On-going management of two variations of the same type of transformer.</td>
<td colspan="2">• The ability of lightning arresters to protect the transformer as well as the downstream customer wiring.
• The failure rate of various types of lightning arresters.
• The economic value of this type of transformer protection.
• The cost and logistics of keeping both arrester-equipped and non-arrester-equipped transformers in stock.</td>
</tr>
</table>

Grid Mod Project Staffing

This section provides an initial staffing plan for the Grid Mod Plan projects, including leads, participants, consultants, and stakeholders.

Project	Project Manager/Coordinator	Participating SCL Teams	Other Interested SCL Teams	External Partners/Consultants
DER Interconnection Studies and Procedures	ETO- Distribution Planning	CCES-Solar Team EST-GridMod	ETO-Distribution Engr ETO-Network Engr	
AGA: Enhanced Electrical Connectivity Model	AMLP-GIS	ETO-Planning Ops-AMI UTD-PMO ETO-Distribution Engr	EST-GridMod SOC-Dispatchers	Vendor (L+G)
PNNL Seattle Waterfront Resiliency Study	EST-GridMod	EST-StrategicTech ETO-Distribution Planning		PNNL Port of Seattle Northwest Seaport Alliance
Duwamish Delta Test Bed Project	EST-GridMod	EST-StrategicTech ETO-Planning	ETO-Distribution Engr SOC-Dispatchers	COS Partners Duwamish Valley Stakeholders PNNL
Non-Wires Solutions Analysis	ETO- Distribution Planning	EST-GridMod EST-StrategicTech ETO-Distribution Engr ESE CCES	SOC-Dispatchers SOC-Operators SCL Enterprise Cybersecurity Ops	Vendors and Consultants
Energy Storage Technology	ETO-Distribution Planning	EST-GridMod EST-StrategicTech ETO-Distribution Engr ESE	SOC-Dispatchers SOC-Operators SCL Enterprise Cybersecurity Ops	Vendors and Consultants
Continuing Grid Mod Plan Development	EST-GridMod	ETO-Planning EST-StrategicTech	SOC-Operators Many others	Partner (EPRI)
DA-FLISR Expansion	EST-GridMod	SOC-Dispatchers ETO-PSA, Engr, Planning, Comm Ops-Comm Techs Ops-Line Crews	SCL Enterprise Cybersecurity SOC-Operators Ops-Relay Techs	Vendor (S&C)

Project	Project Manager/Coordinator	Participating SCL Teams	Other Interested SCL Teams	External Partners/Consultants
DA-Remote Switching	EST-GridMod	SOC-Dispatchers ETO-PSA, Engr, Planning, Comm Ops-Comm Techs Ops-Line Crews Ops-Relay Techs	SCL Enterprise Cybersecurity SOC-Operators	Vendor (S&C)
DA-Advanced Integration	EST-GridMod	SCL Enterprise Cybersecurity UTD-PMO Ops-Comm Techs ETO-PSA SOC-Dispatchers	Ops-Relay Techs	Vendors
OT Field Area Network – Pilot Project	EST-GridMod	Ops-Comm Techs Ops-Line Crews ETO-Distribution Engr SCL Enterprise Cybersecurity	ETO-PSA SOC-Dispatchers ETO-Comm	Vendor Comm Consultants
Demand Response Pilot	CCES	EST-GridMod CCES-Account Execs ETO-Planning ETO-PSA	Ops-Comm Techs SOC-Dispatchers	Vendor BPA
Managed EV Charging	EST-Electrification	CCES ETO-Distribution Engr ETO-Planning AMLP-ESE	SOC SCL Enterprise Cybersecurity EST-GridMod Ops-Comm Techs	Vendors Sys Protection Consultant
Line Sensor Deployment	EST-GridMod	SOC-Dispatchers SCL Enterprise Cybersecurity PSAutomation	Ops-Distribution Engr Ops-Overhead Line Crews	L+G SMEs
Landis and Gyr Mesh Communication Network Assessment	AMI Ops	EST-GridMod SCL Enterprise Cybersecurity PSAutomation	Ops-Comm Techs ETO-Comm Engr	L+G SMEs

Project	Project Manager/Coordinator	Participating SCL Teams	Other Interested SCL Teams	External Partners/Consultants
Cybersecurity for Grid Mod Monitoring & Control	SCL Enterprise Cybersecurity	EST-GridMod ETO Ops-Comm Techs	SOC	Customer-owners with DERs Vendors and Consultants
Miller Community Center Microgrid Plan	EST-StrategicTech	LDL Ops-Stations PSAutomation	ETO-Distribution Engr SOC Ops-Overhead Line Crews EST-GridMod	Training Consultants SFD O&M Contractor
Targeted Lightning Arresters on OH Transformers	AMLP-Asset Management	ETO-Distribution Engr Ops-Overhead Line Crews Ops-Warehouse	Standards Engr SOC EST-GridMod	Lightning Engr Consultant

Appendix: Glossary

Advanced Distribution Management System (ADMS): The software platform that supports the full suite of distribution management and optimization. An ADMS includes functions that automate outage restoration and optimize the performance of the distribution grid. ADMS functions being developed for electric utilities include fault location, isolation and restoration; volt/volt-ampere reactive optimization; conservation through voltage reduction; peak demand management; and support for microgrids and electric vehicles.[6]

Distributed Energy Resources (DER): "A source or sink of power that is located on the distribution system, any subsystem thereof, or behind a customer meter. These resources may include, but are not limited to, electric storage resources, distributed generation, thermal storage, and electric vehicles and their supply equipment." [7]

Distributed Energy Resources Management System (DERMS): A software platform that is used to organize the operation of the aggregated DER within a power grid.[8]

Enterprise Technology Roadmap: An [enterprise] "technology roadmap is a visual document that communicates the plan for technology initiatives" at an enterprise-wide level of an organization. This roadmap typically outlines when, why, and what technology solutions will be implemented to help the organization move forward while avoiding costly mistakes. [9]

Fault Location Isolation and Service Restoration (FLISR): Distribution automation system which detects and responds to faults in order to minimize the number of customers affected by a distribution system outage.

Grid Architecture: "… is a discipline with roots in system architecture, network theory, control engineering, and software architecture, all of which we apply to the electric power grid. An architectural description is a structural representation of a system that helps people think about the overall shape of the system, its attributes, and how the parts interact." [10]

Operational Technology: "… is hardware and software that detects or causes a change, through the direct monitoring and/or control of industrial equipment, assets, processes and events." [11] The term has become established to demonstrate the technological and functional differences between traditional IT systems and Industrial Control Systems environment, the so-called "IT in the non-carpeted areas"

---

6 https://www.gartner.com/en/information-technology/glossary/advanced-distribution-management-systems-adms

7 https://www.ferc.gov/CalendarFiles/20180215112833-der-report.pdf

8 https://www.next-kraftwerke.com/knowledge/derms#:~:text=A%20distributed%20energy%20resources%20management,distributed%20energy%20resources%20(DER)

9 https://www.aha.io/roadmapping/guide/product-roadmap/what-is-a-technology-or-it-roadmap

10 https://www.pnnl.gov/grid-architecture

11 https://www.gartner.com/en/information-technology/glossary/operational-technology-ot