



# UM 2005 Distribution Work Group

## April 21, 2022, Notes

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May 13, 2022

Below are notes from the April 21, 2022, DSP Work Group meeting.

**Attendees included (but were not limited to):**

- PUC
  - Nick Sayen, Staff
  - Heide Caswell, Staff
- PacifiCorp
  - Jennifer Angell
  - Erik Anderson
  - Tyler Jones
  - Daniel Talbot
  - Daniel Morgan
  - Alex Osteen
  - John Rush
  - Jonathan Connelly
- Energy Trust
  - Jeni Hall
  - Spencer Moersfelder
- OSSIA/OCEAN: Shannon Souza
- Renewable NW: Micha Ramsey
- Oregon DOJ: Natascha Smith
- TeMix: Stephen MacDonald
- PGE
  - Aharown Luke
  - Andy Eiden
  - Bachir Salpagarov
  - Jennifer Galaway
  - Sam Newman
  - Misty Gao
  - Joe Boyles
  - Shadia Duery
  - Walle Brown
  - Emilie Dierickx
- Idaho Power
  - Marc Patterson
  - Jim Burdick
  - Chris Cockrell
  - Kelley Noe
  - Alison Williams
  - Tyson Kent

**Questions/clarifications/etc. on follow up materials from March 31, 2022, meeting**

There were no questions or clarifications on the follow up materials from the March 31, 2022, meeting.

**PGE-led discussion: Requirement 5.4.a, Near-term Action Plan other investments, Risk Management**

Requirement 5.4.a reads:

*5.4.a - Action Plan: Provide a 2-4 year plan consisting of the utility's proposed solutions to address grid needs and other investments in the distribution system.*

Joe Boyles presented on PGE's plans to file information on "other investments" in the 2-4 year Action Plan, as well as supporting information to be included in the Part 2 filing. The discussion then shifted to risk management. Emilie Dierickx presented PGE's approach to integrating risk management into asset management. Both topics used the slides attached.

## Adjourn

The meeting adjourned around 2:30 pm Pacific.

**Please note for your reference future DSP Work Group meetings dates include:**

Date and Time
May 19, 2022, 1:00 – 4:00 pm Pacific
June 16, 2022, 1:00 – 4:00 pm Pacific

## Parking-lot for outstanding issues and questions

1. Where and how data will be stored is an important question to discuss early so there is a way to manage, keep safe, and access data as it comes in (from 5/7/21 Data Transparency Workshop).
2. Volunteers to work on establishing common definitions for distribution system planning discussions (from 5/7/21 Data Transparency Workshop).
3. Volunteers to work on further completing Figure 2 for priority data types (from 5/7/21 Data Transparency Workshop).
4. What are preferred sources of public data that include demographics and other details that adequately characterize our communities? (from 6/30/21 Technical Work Group meeting)
5. Working subgroup to focus on demographic and socioeconomic data, useful energy planning metrics, and quantifying measures and data sources for equity (from 6/30/21 Technical Work Group meeting).
6. Working subgroup to focus on practices for handling public accessibility of data (from 6/30/21 Technical Work Group meeting).
7. Venue for solutions providers (companies and vendors) that could provide technology and services to implement DSP.
8. Identify areas of overlap and potential collaboration in utilities' current practices, with the goal of minimizing discrepancies, regarding:
  - cost effectiveness methodologies,
  - forecasting approaches, including consideration of how EE and DER forecasting feeds into the IRP process,
  - current practices/developments in hosting capacity analysis.
9. Additional steps to disseminate distribution system data, including assessing maps already developed to identify best practices, inclusion of equity data in maps already developed, and organizing/validating/publishing distribution system data not already made public.
10. Locational value.
11. Use of hosting capacity analysis to guide proactive utility investments.

## Questions or Feedback

Questions and comments can be directed to Nick Sayen via email at [nick.sayen@puc.oregon.gov](mailto:nick.sayen@puc.oregon.gov) or by telephone at 503-510-4355.

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# Distribution System Plan Part 2 – Near-term Action Plan

Joe Boyles, DSP Project Manager

April 21, 2022



PGE envisions a 21st century community centered distribution system that Accelerates decarbonization through DER programs, non-wires solutions, virtual power plants and other mechanisms to strategically provide community benefits, especially to environmental justice communities, while improving metrics around safety, reliability, resiliency, and security.



# Distribution System Vision Overview

## Goals

Our vision aims to achieve the three goals:

- Advance environmental justice
- Accelerate DER adoption
- Maximize grid benefits

## Execution Strategy

To execute on our vision and realize our goals for the distribution system, PGE has developed and is working on five strategic initiatives:

- Empowered Communities
- Modernized Grid
- Resilience
- Plug and Play
- Evolved Regulatory Framework

# Strategic Initiatives for Execution

## Empowered Communities

Enabling equitable participation in the clean energy transition



## Grid Modernization

Enabling an optimized grid platform for a safe, secure, reliable system



## Resilience

Anticipating, adapting to, withstanding, and quickly recovering from disruptive events



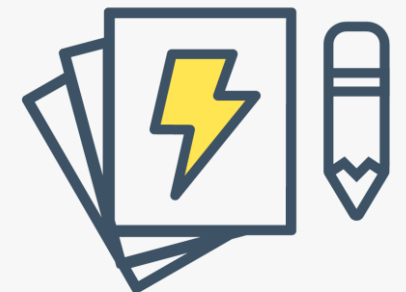
## Plug and Play

Improving access to grid edge investments to accelerate customers' clean energy transition



## Evolved Regulatory Framework

Evolving the regulatory framework to support utility investment in customer and community centered solutions



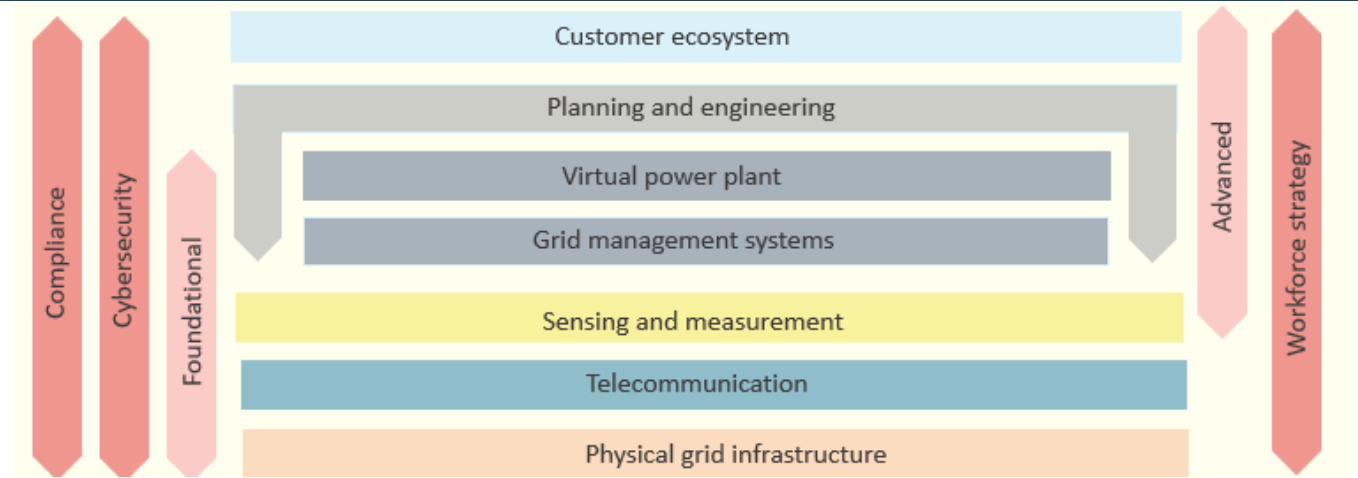
# Chapter Take-Aways

Corporate Strategy	Decarbonize		Electrify		Perform
DSP Vision	21st century community-centered distribution system				
DSP Goals	Advance environmental justice goals		Accelerate DER adoption		Maximize grid benefits
DSP Strategic Initiatives	<b>Empowered communities</b> Enabling equitable participation in the clean energy transition through human-centered planning and community engagement	<b>Modernized grid</b> Optimizing a grid platform that is safe, secure and reliable through current and future grid capabilities	<b>Resilience</b> Strengthening the grid’s ability to anticipate, adapt to, withstand and quickly recover from disruptive events	<b>Plug and play</b> Improving access to DER investments needed to accelerate customers’ clean energy transitions through such activities as hosting capacity analysis	<b>Evolved regulatory framework</b> Evolving the regulatory framework needed to support utility investment in customer- and community-centered solutions

# Empowered Communities

Focus Area	Goals	Objectives	Outcomes
Develop Competency	Build skills and resources that help PGE address our gap in competency in community engagement and operationalizing equity	In NWA, Part 2, ensure frequent communication, feedback loops, follow-thru, early and often engagement and transparent report outs.	Build durable, long-lasting, and mutually beneficial relationships with community partners and after relationship is cultivated, work towards partnership with community-based organizations (CBOs) representing environmental justice communities.
Activate CBO Participation	Center meaningful participation of environmental justice communities	In NWA, Part 2, advocate for representation on House Bill 2021 Community Benefit and Impact Advisory Group (CBIAG), build CBO capacity/resources via financial assistance, and pursue direct community engagement as a complement to CBO partnership	Members of environmental justice communities are able to contribute and be involved in a meaningful way
Unlock Demographic Data	Rely upon a diversity of data (GARE Racial Equity Tool, Step #2) and diversity of research (including both quantitative and qualitative)	Ensure engagement is informed by data and tailored to the needs and interests of affected communities.	Understand community energy needs, desires, barriers and interest in clean energy planning and projects and where opportunities exist.

# PGE's Modernized Grid Framework



## Foundational capabilities

- The set of core platform investments needed to improve resolution and basic control of the distribution system.
- These investments follow a least-cost, best-fit approach, usually through a request for proposal (RFP) or similar process.

## Advanced capabilities

- Investments that build on or, in some cases, supplement foundational investments to develop advanced controls of the grid.
- Depending on their function, either go through a benefit-cost analysis or use a least-cost, best-fit approach.

## Overarching capabilities

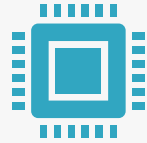
- Impact both foundational and advanced capabilities investment.
- Are key considerations when making the investments after the primary need is addressed.
- Include cybersecurity, workforce implications and other compliance needs.

# Desired Outcomes



## **Decarbonization**

By managing DERs connected to the grid, grid operators can co-optimize across available resources to ensure least cost and carbon intensity in resource dispatch.



## **Reliability**

Investments in sensors and communication devices to improve resolution of the distribution grid can help operators better predict distribution system needs and take necessary steps to prevent system reliability issues.



## **Resiliency**

Through investments in smart algorithms and sensing devices feeder sections can be isolated to create microgrids that provide resilience during severe weather.



## **Security**

While grid modernization investments increase the number of access points for cyber security risks, PGE is taking proactive steps through investments in cyber security solutions and integration of cyber-physical security in planned investments.

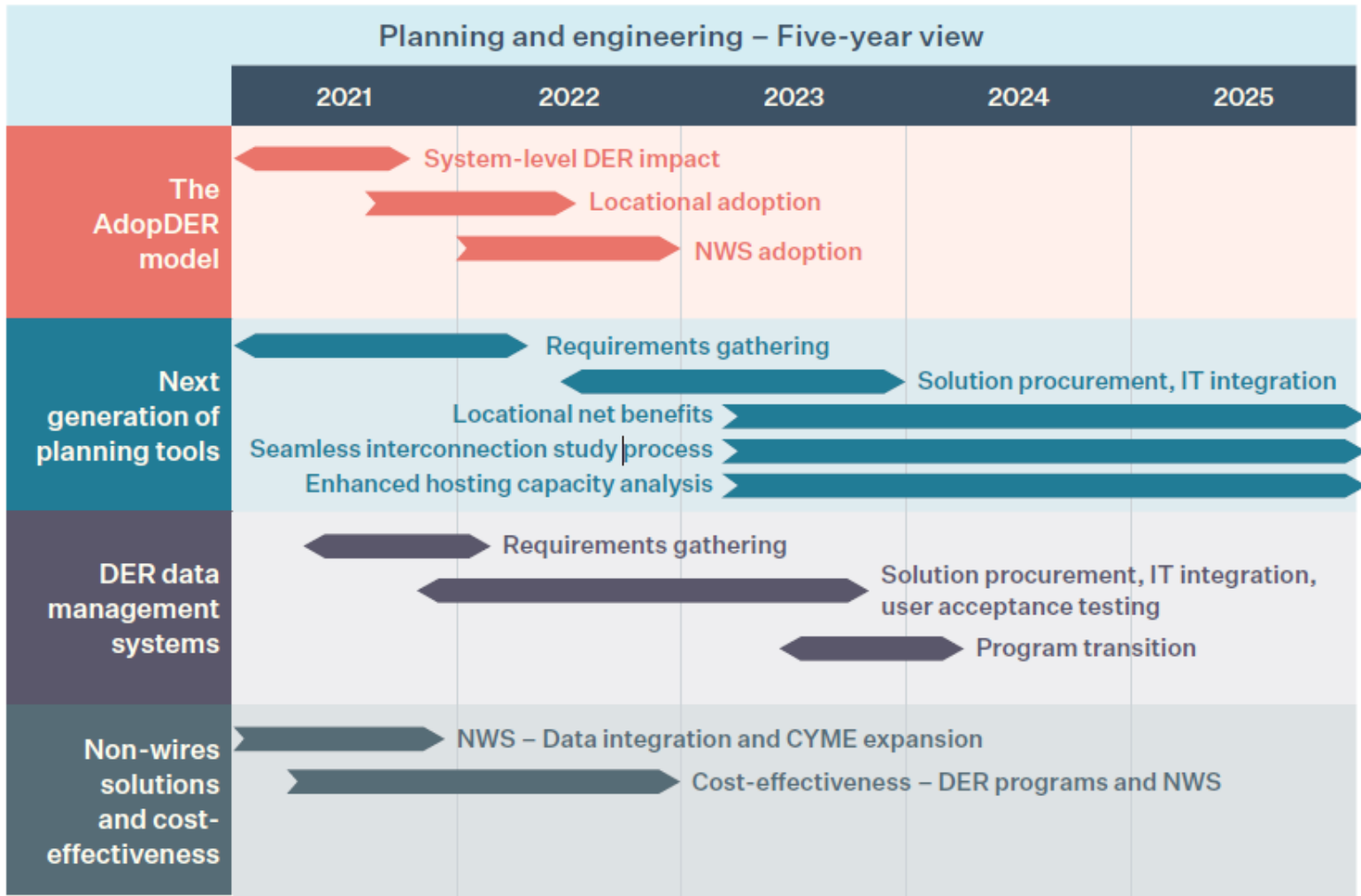


## **Assist Environmental Justice Communities**

Through investments in analytics platforms that use smart meters, PGE can develop improved rate designs and DER programs to assist with energy burden relief in environmental justice communities. PGE has already started developing this load shaping solutions through its Time of Use programs.

# Planning and Engineering - Planned Investments

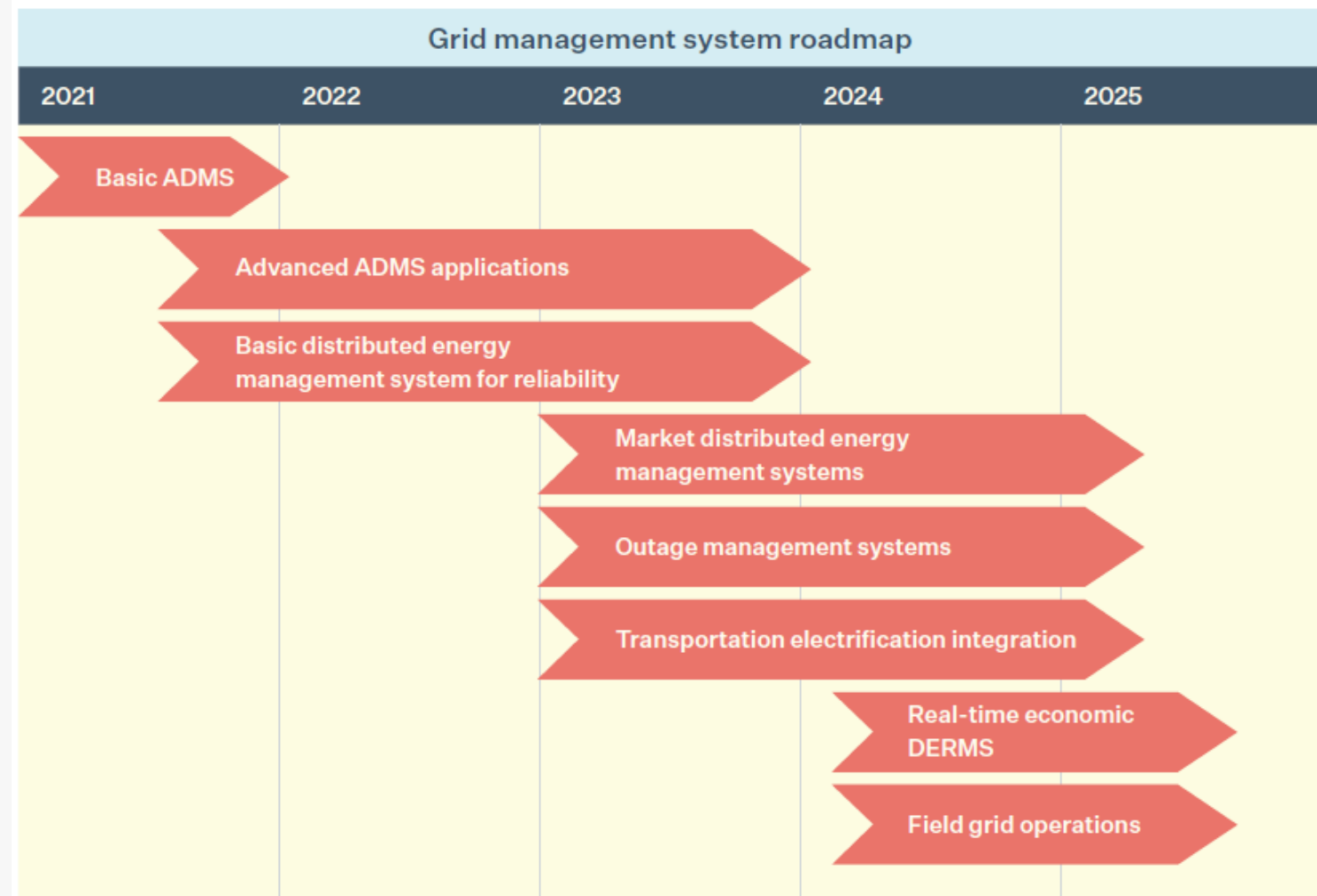
A suite of integrated tools that support distribution system planning and engineering functions to enable optimal grid investments including DER integration through information exchange and non-wires solutions



Note: Includes future initiatives

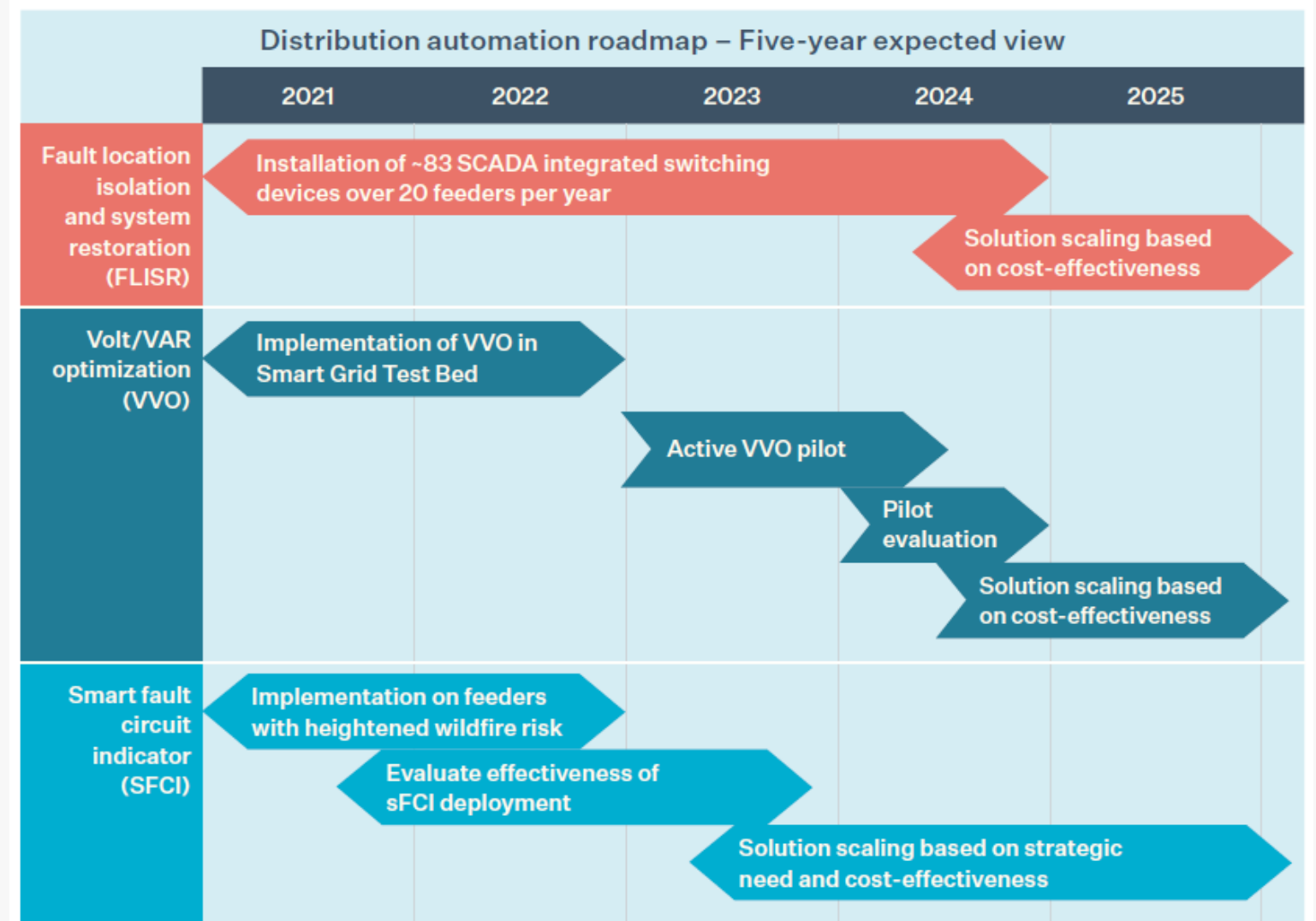
# Grid Management Systems – Planned Investments

A set of computer-aided tools used by operators of electric utility grids to monitor, control, and optimize the performance of the distribution system. Shifting from central management of one-way power flows supplied by relatively few bulk generators to coordinating large numbers of DERs creating two-way power flows may cause grid stability issues. As DER adoption grows, the number of possible control actions will increase and the time to execute those control actions will decrease beyond the capability of human grid operators to react to events on the electric grid. Safety and reliability issues will increase in both frequency and magnitude unless advanced technologies are used to stabilize our electric grid.



# Distribution Automation – Planned Investments

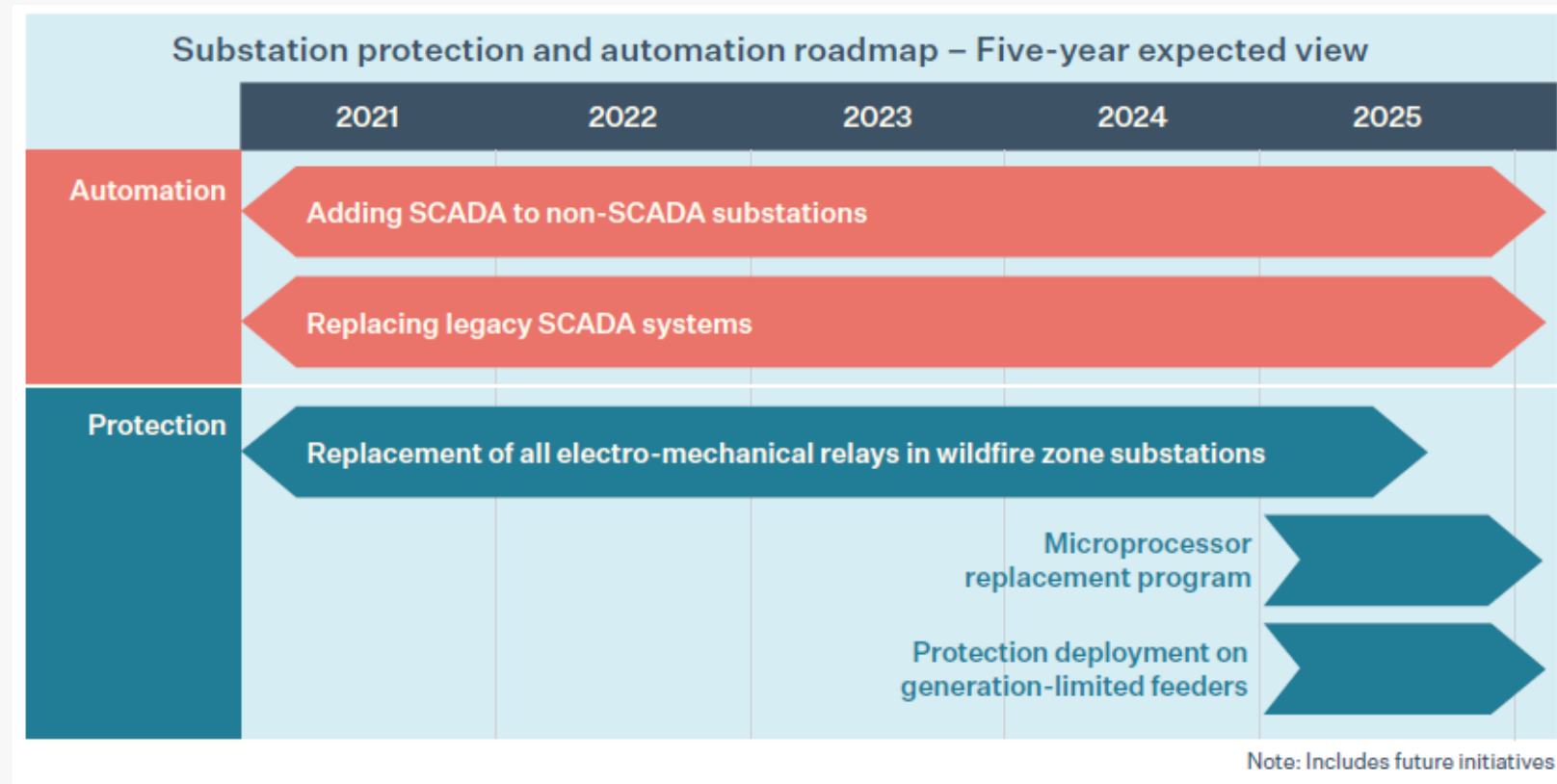
DA is the umbrella of smart grid solutions aimed at solving power system issues by integrating various equipment, devices and data into a centralized system (the ADMS). These solutions include fault location isolation and service restoration (FLISR), volt-VAR optimization (VVO) and smart faulted circuit indicator (sFCI) integration. Each DA solution requires a unique set of integrated devices and systems to fully realize the benefits. Feeders targeted for DA implementation are those with a high exposure to non-asset failure risk. DA will reduce the total number of customer outage minutes for a sustained mainline fault and minimize the consequence of sustained mainline faults.



Note: Includes future initiatives

# Substation Protection and Automation – Planned Investments

Substations serve as the hub of energy transmission and delivery. State-of-the-art substations enable reliable and resilient operation of the grid. Substations need to be equipped with modern protection and automation (e.g., SCADA with device and data integration) to realize many of the capabilities needed to operate the modern grid.



# Resilience Overview



## **Customer Infrastructure Resilience** –

investigation into customer-sited solutions, such as microgrids, batteries, and other DERs, that enable customers to ride through events and, during normal conditions, provide services to the grid.

**PGE Infrastructure Resilience** – investment in infrastructure, such as grid hardening, integrated grid, energy supply hardening, that mitigates the occurrence of outages during an event such as wildfire, wind and ice.

**Operational Resilience** – improvements in PGE's ability to meet customers' needs during events and accelerate the restoration of service through emergency preparedness, outage response and customer support.

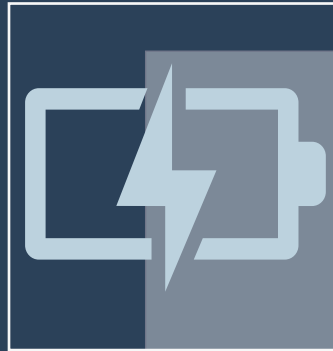
# Customer Infrastructure Resilience



## Community Resource Centers

Partner with municipalities to:

- Ensure the availability of clean water
- Enable emergency services to continue functioning
- Provide a place of respite for citizens to cool off, warm up, get connected and power equipment



## Residential Battery Pilot

- Help customers afford whole-home backup power
- Lay the groundwork for expanding microgrid capabilities



## Microgrids

- Provide customers with solutions to prevent loss of inventory, keep patients safe, and allow them to remain open when customers need them most

# Infrastructure Workstreams & Initiatives

## Wildfire Mitigation



- Wildfire Risk Assessment & Modeling
- Situational Awareness
- Design & Construction Standards
- Inspection & Maintenance Plans

## Event Learnings



- Feb Ice Storm Event Learnings
- Texas Energy Crisis Event Learnings
- June Heatwave Event Learnings
- Environmental Withstand Criteria Updates

## Customer Resiliency Planning



- Mt Hood Improvements
- Willamette Valley Improvements
- Planning & Design Criteria Updates
- Critical Customer (public safety related) Reliability Assessments

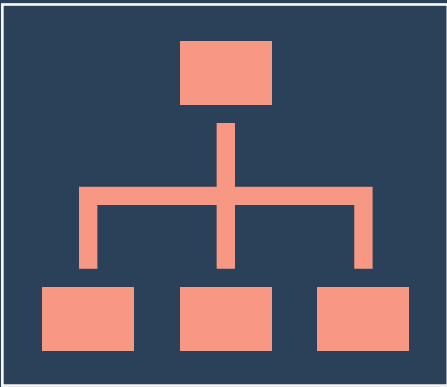
## Data Resiliency Planning



- Telecom Single Points of Failure Analysis
- Telecom Risk Modeling
- AMI Resilience Improvements

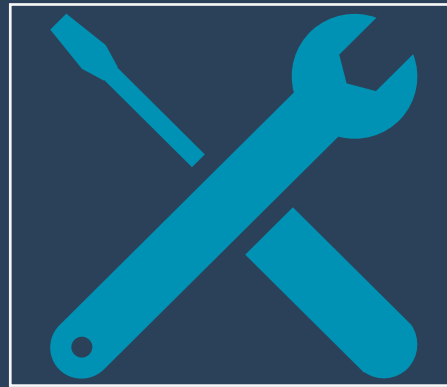
# Operational Workstreams & Initiatives

## Incident Command Structure



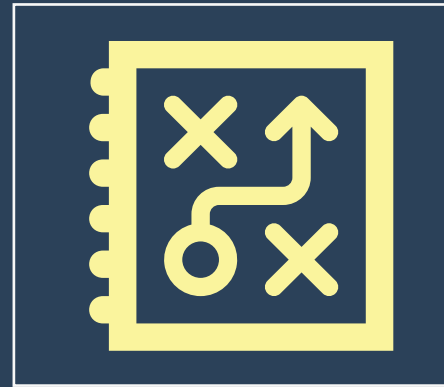
- Outage Management Planning and Preparation
- Community Engagement and Public Information Tools

## Tools & Equipment



- Portable Generators
- Device Batteries
- Tablets
- Contract Crew Work Tracking Tool

## Playbooks



- Staging Site Operational Plan
- End-to-End Assessment Process
- Wire-down, Wire-watcher and Damage Assessment program

## Supply Chain



- Storeroom readiness
- Partnerships
- Critical Materials & Service Provider Requirements
- Inventory Management

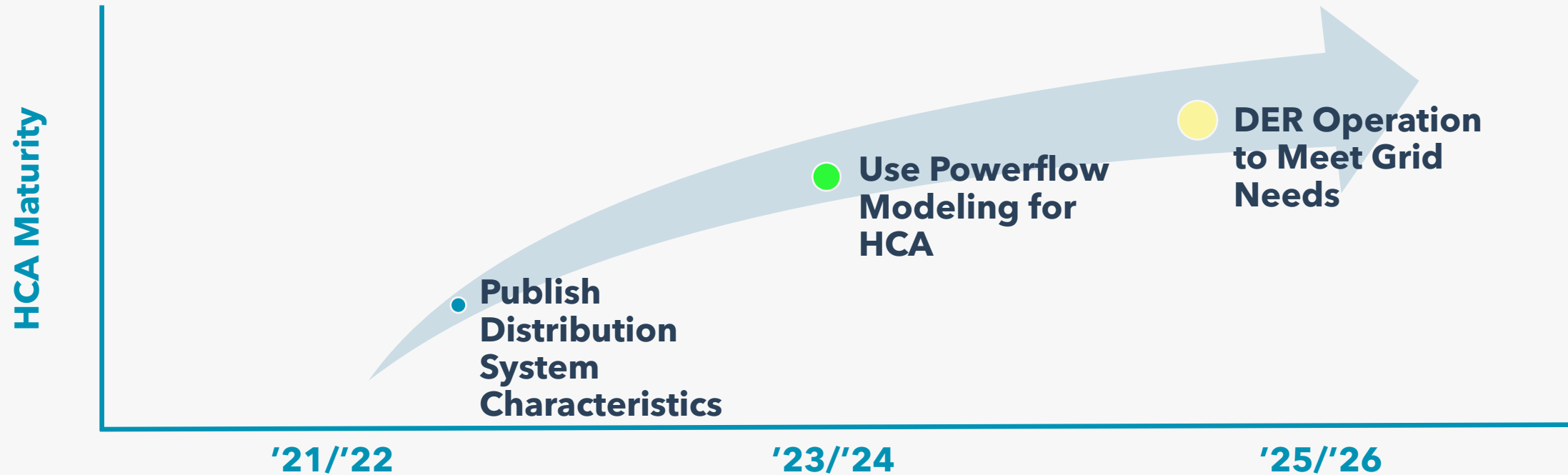
# Plug and Play Overview



Our plug and play initiative discusses how we can improve access to grid edge investments needed to accelerate customers' clean energy transitions through such activities as:

- Removing barriers to interconnection, e.g., hosting capacity analysis,
- Streamlining the interconnection process, and
- Developing the capability to connect dynamic devices (e.g., batteries).

# Hosting Capacity Roadmap



## Hosting Capacity Analysis (HCA)

- Publish info about equipment, performance and queue to inform siting, reduce failed applications
- Expand data displayed on Net Metering map
- Identify how ADMS can support HCA

- Use ADMS to support powerflow modeling and
- Use HCA in distribution studies and investment planning, e.g., add capacity for DER penetration

- Increase granularity, data sharing, frequency
- Leverage ADMS/DERMS to match DERs with load

## Interconnection

- HCA as screening tool for developers/customers
- Technical outreach & education regarding data

- More granular visualization of hosting capacity in GIS

- Recruit DERs to meet grid needs
- Evolve distribution market functions

Target Use Cases

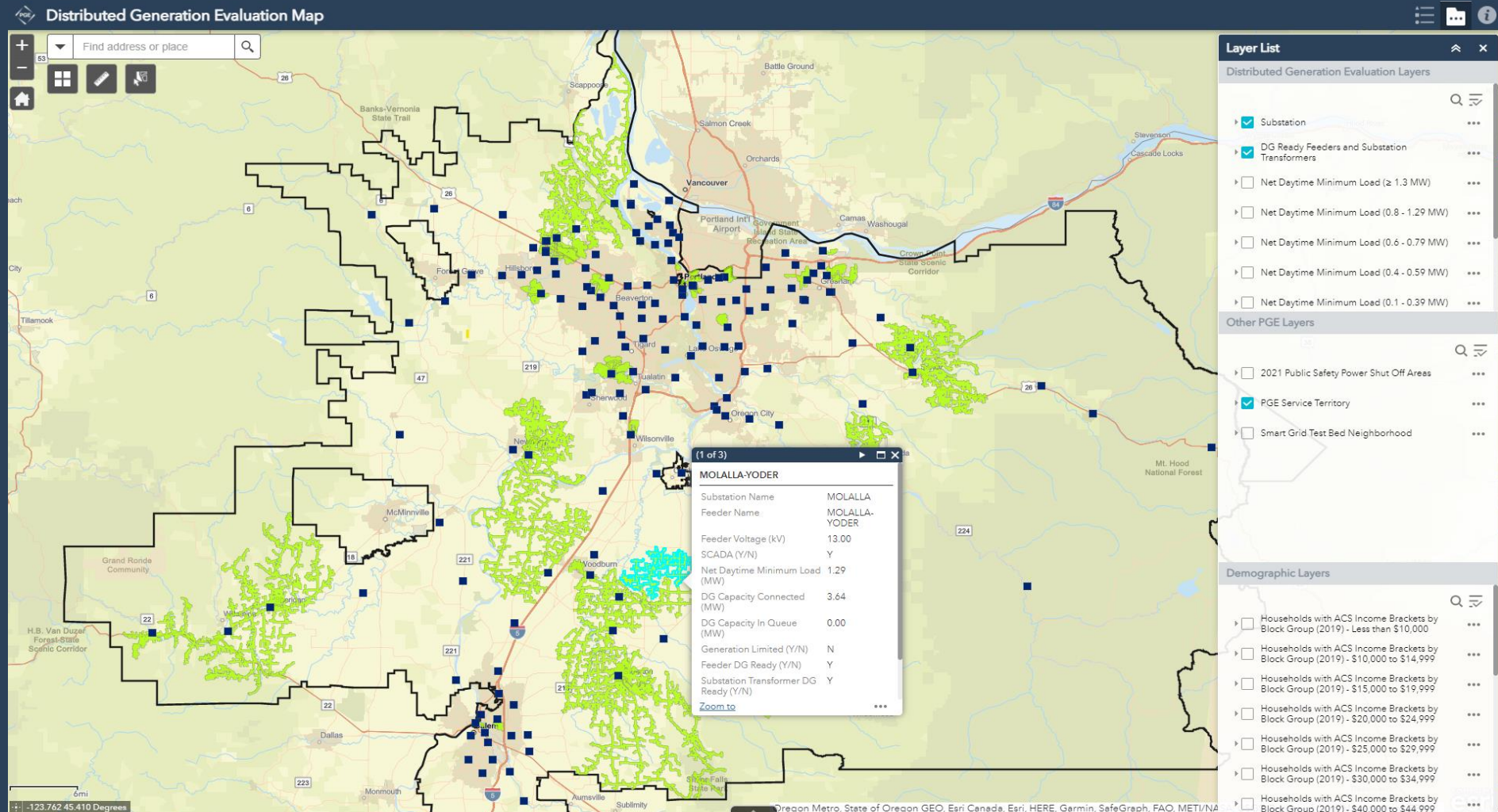
Identify favorable DER locations  
Communicate DER Readiness  
Accelerate screening process

Support investment decision-making to increase DER Readiness

Promote DER investment to address Grid Needs, facilitate distribution market operations

# Distributed Generation Evaluation Map

[ArcGIS Web Application](#)



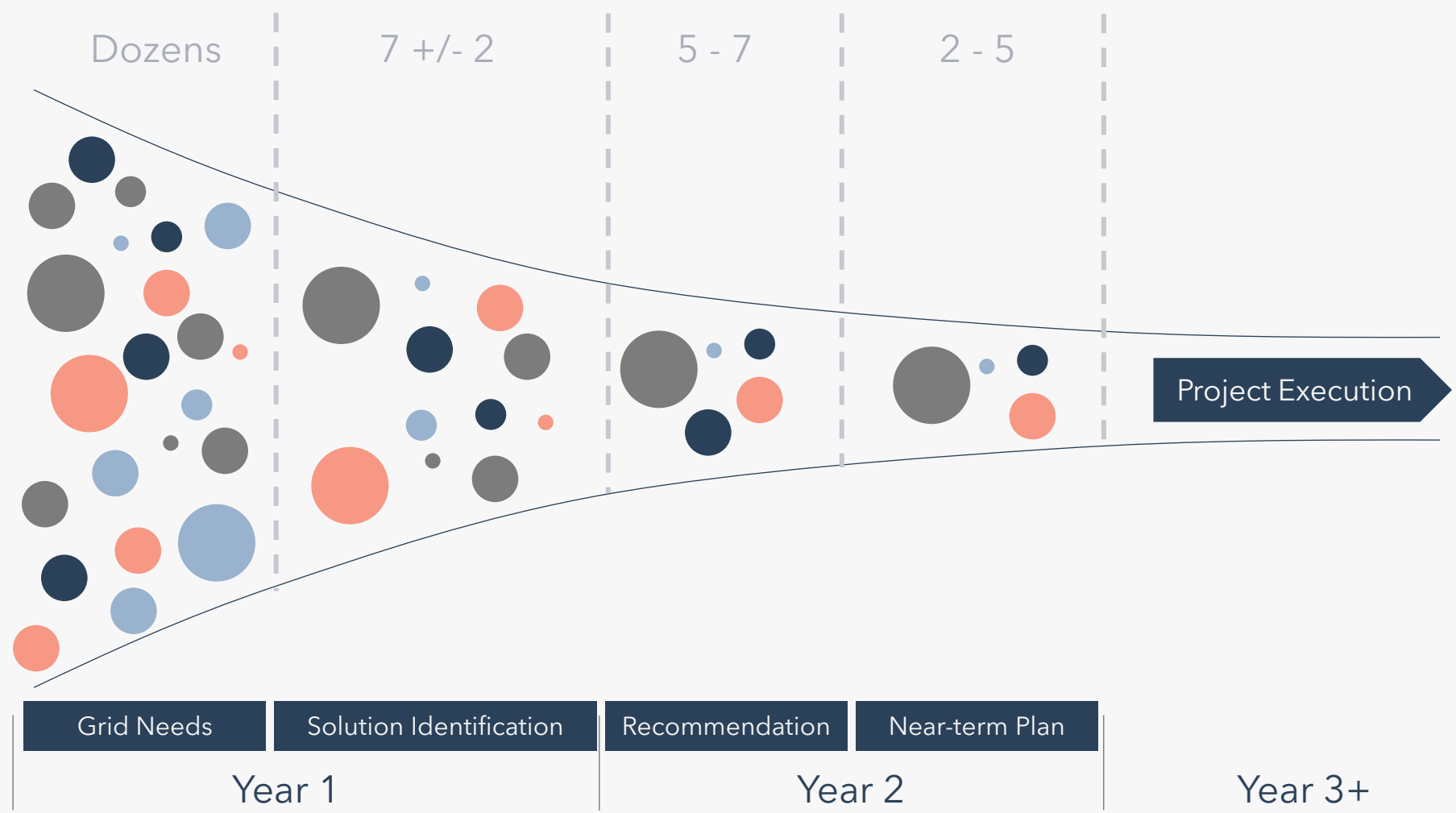
# Supporting Information

# Current T&D Project Categorization

Portfolio	Sub-Portfolio	Category	DSP Investment Categories
Transmission and Distribution	Grow (load growth/ econ. dev.)	<b>Capacity/Flexibility</b> – increase capacity and/or flexibility to address load growth or increased demand; may include capacity-driven compliance and reliability projects	<ul style="list-style-type: none"> <li>System expansion or upgrades for capacity</li> <li>New Customer Projects</li> </ul>
		<b>Customer/Partner</b> – investments involving a commitment to a customer, internal partner, municipality, or co-owner; includes critical service restoration and our obligation to serve; applicable to both sustaining and growth sub-portfolios	
	Sustain (keep the lights on)	<b>Compliance</b> – address a non-capacity related compliance requirement from FERC, NERC, OPUC, EPA, DEQ or other regulatory body	<ul style="list-style-type: none"> <li>System expansion or upgrades for reliability and power quality</li> <li>Preventive maintenance</li> <li>Age-related replacements</li> <li>Metering</li> <li>Grid modernization*</li> </ul>
		<b>Reliability</b> – enhance reliability, resiliency and security; includes proactive repair/replace in kind projects as well as broader improvement initiatives	
		<b>Operations</b> – address tools, safety, restoration of non-critical services, and efficiency improvements	

\* Not included in the T&D portfolio

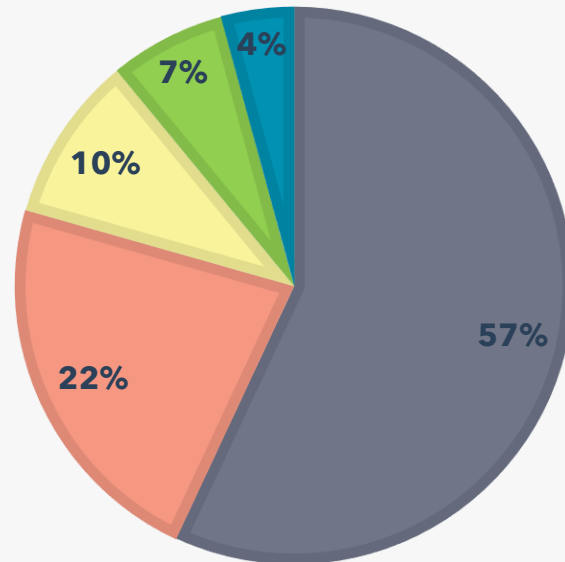
# T&D Project Development Funnel



Needs/Solutions of Different Size and Type

# 2020 T & D Spending

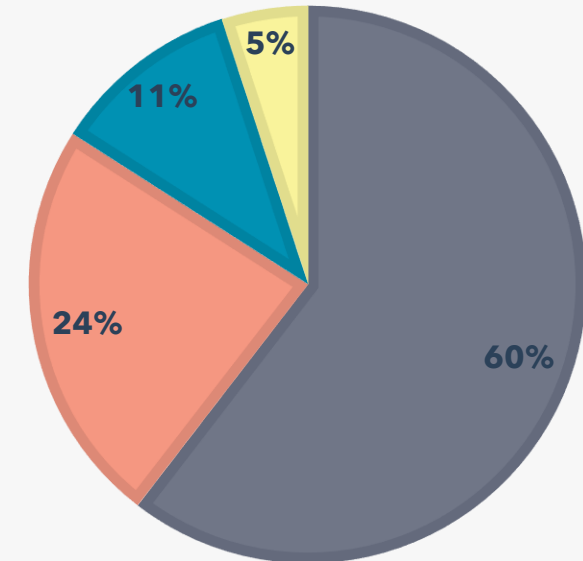
## 2020 ACTUALS BY CATEGORY



■ Customer/Partner ■ Compliance ■ Reliability ■ Operations ■ Capacity/Flexibility

Categories	2020 Actuals
Customer/Partner	\$ 132,213,613
Compliance	\$ 52,121,709
Reliability	\$ 22,411,838
Operations	\$ 15,690,824
Capacity/Flexibility	\$ 9,729,692
<b>Grand Total</b>	<b>\$ 232,167,676</b>

## 2020 ACTUALS LED BY DIST. PLANNING



■ Customer/Partner ■ Compliance ■ Capacity/Flexibility ■ Reliability

Categories	2020 Actuals
Customer/Partner	\$ 53,780,202
Compliance	\$ 21,014,522
Capacity/Flexibility	\$ 9,729,692
Reliability	\$ 4,444,346
<b>Grand Total</b>	<b>\$ 88,968,762</b>

# Example of Near-term Action Plan

## Examples

### **Project: Tree Wire Install (\$1.4 M/yr)**

*Sustain-Reliability*

Alignment to Corporate Strategies and Goals: **Yes**

Firm Commitment: **No**

Execution Readiness: **Yes**

Quantified Benefits: **Yes**

- This project uses asset risk analytics to identify areas to install covered tree wire to reduce customer minutes interrupted (CMI). Initial capital investment is made to scope and design the work according to the asset risk analytics and then considerations are made for construction based on timing, materials and resources. A renewed focus has been made on CMI and due to the benefit of having work scoped and ready for design and execution, PGE is able to accelerate the work in order to align with corporate strategy.

### **Project: Remote Connect Meters (\$2.2 M/yr)**

*Sustain-Operations*

Alignment to Corporate Strategies and Goals: **Yes**

Firm Commitment: **No**

Execution Readiness: **Yes**

Quantified Benefits: **Yes**

- This project installs remote connect customer meters. The benefits included cost avoidance, faster reconnection for customers, avoided truck rolls and truck maintenance costs as well as office support and field support required due to remote connect meters.

### **Project: Build Evergreen Substation (~\$35-45 M)**

*Grow-Compliance*

Alignment to Corporate Strategies and Goals: **Yes**

Firm Commitment: **Yes**

Execution Readiness: **Yes**

Quantified Benefits: **Yes**

- On a 2018 study for NERC compliance (TPL-0010-4), PGE identified existing transmission system constraints such that a loss of existing bulk transformers in Hillsboro coupled with increasing load requests would result in PGE having to shed load due to system overload. A multi-year project was created with planning/engineering and materials requests up front. This project was temporarily deferred during COVID pandemic due to re-evaluation of load and area growth, pushing completion out a few years.

### **Project: Roseway Substation Expansion (\$13 M)**

*Grow-Capacity/Flexibility*

Alignment to Corporate Strategies and Goals: **Yes**

Firm Commitment: **No**

Execution Readiness: **Yes**

Quantified Benefits: **Yes**

- A new residential housing development in south Hillsboro necessitated a substation expansion to meet future load demands. This project also provided an opportunity to add a new transmission line that increases reliability in the region and allowed PGE to offload load from adjacent substations to improve performance and operations.

# Strategic Asset Management – Economic Risk Models

Emilie Dierickx, Manager – Asset Management Planning  
April 21, 2022



# Goals of Today



**Asset Management  
Journey**



**Models & Benefits**



**Methodology &  
Applications**



**Risk  
Concentrations**

# PGE's Asset Management Journey

## 2013 - 2015

- **T&D PAS 55 Assessment**
- Strategic Asset Management (SAM) department formed
- Initial AM Policy developed
- Risk model workshops, POC's, and initial development

## 2016 - 2017

- Created T&D Risk Register
- Developed geographic risk models
- Developed model integrated project evaluation tool (IPT)

## 2018 - 2019

- Applied risk methodology to seismic and wildfire analysis
- T&D maintenance optimization
- **Generation ISO 55000 Self-Assessment**
- Generation asset risk model POC

## 2020 - 2021

- Developed Asset Management Commitment
- Developed Asset Management Strategy
- Develop Generation asset models
- Enhance geographic risk modeling
- Establish "Sustain the Business" Investment Portfolio

# What Do the Risk Models Do?

- Allow us to assess the amount of quantitative risk (in dollars) present in our fleet
- Quantitative risk is used to prioritize long-term capital investments and optimize maintenance decisions.
- Risk modeling allows us to obtain a better understand of lifecycle costs and build better business cases for investments, upgrades, and replacements

## What are the hard benefits?

- ↓ asset failures and ↑ system reliability
- ↑ asset life leads to ↓ future capital expenditures
- ↓ maintenance costs leads to ↓ customer price pressure

## What are the soft benefits?

- A unified way to identify, evaluate & prioritize projects
- Cross-functional collaboration across business lines
- A common language from sponsor to portfolio management
- Works for other business cases: wildfire, seismic & remote sensing
- OPUC acceptance of risk methodology

# RISK MODELS – CURRENT AND FUTURE DEVELOPMENT

## Existing & Available

### Economic Life Cycle Models

Substation Assets

- ✓ Transformer
- ✓ Circuit Breaker
- ✓ Relay System
- ✓ SCADA System
- ✓ Switch

Distribution Assets

- ✓ UG Cable
- ✓ Line Transformer
- ✓ Recloser
- ✓ Regulator
- ✓ Switch

Generation Assets <sup>(1)</sup>

- ✓ Steam Turbines
- ✓ Gas Turbines
- ✓ Transformers
- ✓ 4160V Breakers
- ✓ Condenser
- ✓ Circ Water Pumps/Motors

**Geographic Risk**

- ✓ Vegetation/Weather Risk
- ✓ Wildfire Risk
- ✓ Animal Risk
- ✓ Public Risk

**Business Case Tools**

- ✓ Risk Register
- ✓ Integrated Planning Tool

**Maint. Optimization**

- ✓ Sub: SCADA & Relays
- ✓ Sub: Breakers & Transformers
- ✓ Distribution: Switches, reclosers & regulator

## Planned for 2022+

### Economic Life Cycle Models

T&D Assets

- ✓ Poles & Structures
- ✓ **Tx Consequences\***

Generation Assets

- ✓ Thermal (Tier II) <sup>(2)</sup>
- ✓ Hydros <sup>(3)</sup>
- ✓ **Wind\***

**Geographic Risk**

- ✓ Enhancements to Vegetation/Weather Risk
- ✓ Enhancements to Wildfire
- ✓ **Seismic Risk\***

**\* 2023+**

1) Completing model data validation in 2022  
2) Focus is primarily Tier II assets, but also adding incremental Tier I assets didn't model in 2020/2021  
3) Work will likely continue into 2023

# Detailed Example



# Risk Management

Risk Management is foundational to Asset Management and our decision-making process

## How is risk defined?

***RISK** = Probability of Failure X Consequence of Failure*

# Building Blocks of Annual Failure Probability - What It Is & How It Works



## Problem Statement:

What is the annual failure probability of a 46-year-old Sub Transformer?

Let's orient ourselves first.



"Health Index (HI) Score" = 100 - Deterioration

"Effective Age" = Calendar Age + Deterioration\*

\* An asset's effective age will never be considered younger than it actually is.

"Failure Multiplier" = A number > 1 that represents known bad vintages or manufacturers that make a particular asset failure more likely.



## Q: What is the annual failure probability based on age?

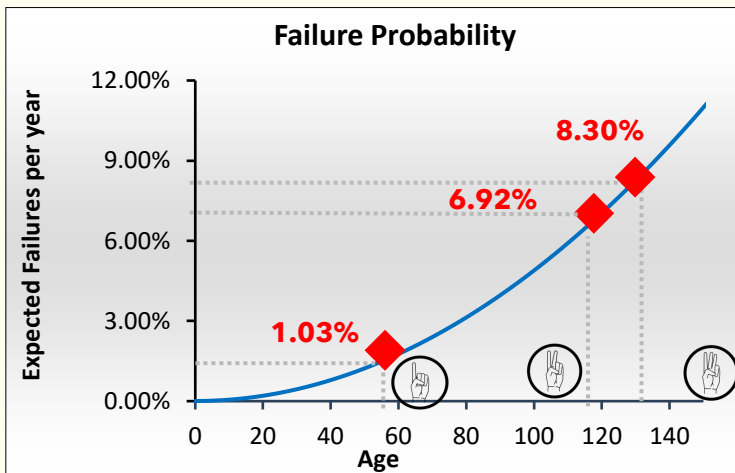
Develop Weibull failure curves using

- PGE failure data
- Industry information
- SME expertise

Determine what is the annual failure probability of an asset based on its age

### Example: 46 year-old transformer

We can determine the base annual probability failure for a 46-year-old transformer is: **1.03%**



## Q: Has any degradation occurred?

Develop HI via SME workshops to:

- Identify major mechanisms could lead an asset to degrade or end of life
- Identify tests/inspections that tell us how far a degradation process has progressed?
- Identify degradation score for each test/inspection



A B C D E



Is it acting better, as anticipated or worse than what we would anticipate for its calendar age?

If worse, adjust its effective age.

### Example: Solid Insulation

Poor Furan Oil Analysis (Grade, D confidence 90%) can drive it to end of life.

HI drops to **55** which raises "Effective Age" to 119. Annual failure probability jumps to **6.92%**.



## Q: Are there any known bad vintages, manufacturers or environmental conditions that would make this asset more prone to failure than others in this asset class?



Or in other words, are there failure multipliers?

Identify any failure multipliers via SME workshops via:

- PGE failure data
- SME expertise

### Example: Arcing Tapchanger

This would add an additional 20% chance of failing.

We would multiply the current annual failure probability by **1.20** to account for the impact of tapchanger

Annual failure probability would jump to **8.30%**  
Effective Age would reach ~**130 years**.

## Annual Failure Probability Summary

- 1: Based on age - **1.03%**
- 2: Including degradation - **6.92%**
- 3: Including failure multiplier - **8.30%**

Example provided for illustrative purposes only

Probability of Failure (%)

x

Consequence Of Failure (\$)

=

Risk (\$)

## Grid

### Economic impact of reliability issues for customers:

- + Customer Type (R, C, I)
- + Load impacted
- + Duration of impact (U, R, R)
- + Environmental & Safety Impacts
- + Cost of Repair

Consequence of Failure (\$)  
\$0.9M

## Transformer Consequence Scenarios

75%

Transformer Trips Under Load (Repairable) \$0.6M

15%

Maintenance Finds Failure \$0.0M

9%

Transformer Trips Under Load (Failed) \$3.1M

1%

Catastrophic Failure \$19.0M

Weighted Average  
Consequence of Failure  
\$0.9M



# Risk Methodology

Probability of Failure (%)

**X**

Consequence Of Failure (\$)

**=**

Risk (\$)

## Asset Failure:

- Type of asset
- Age of asset
- Condition of asset

## Geographic Risk:

- Vegetation
- Weather
- Animals
- Public

## GRID & GENERATION

Direct impact of event on PGE.  
Environmental and safety impacts.

### GRID

Economic impact of  
reliability issues for  
customers:

- + Customer Type (R, C, I)
- + Load impacted
- + Duration of impact

### GENERATION

Economic impact of  
outage, derate or  
efficiency:

- + MWs impacted
- + Duration of impact
- + Replacement Power  
Cost

Expressed as a financial value

Probability of Failure (%)

8.30%

**X**

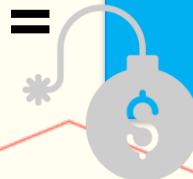
Consequence of Failure (\$)

\$0.9M

**=**

Risk (\$)

\$0.1M



Example provided for illustrative purposes only

# Practical Application



# Substation Transformer Example



Substation Transformer is 47 years old. It has a 1.29% probability of failure but has a \$2.7M consequence of failure.

**Should it be replaced now or later?**



**Probability of Failure:**

**1.29%**



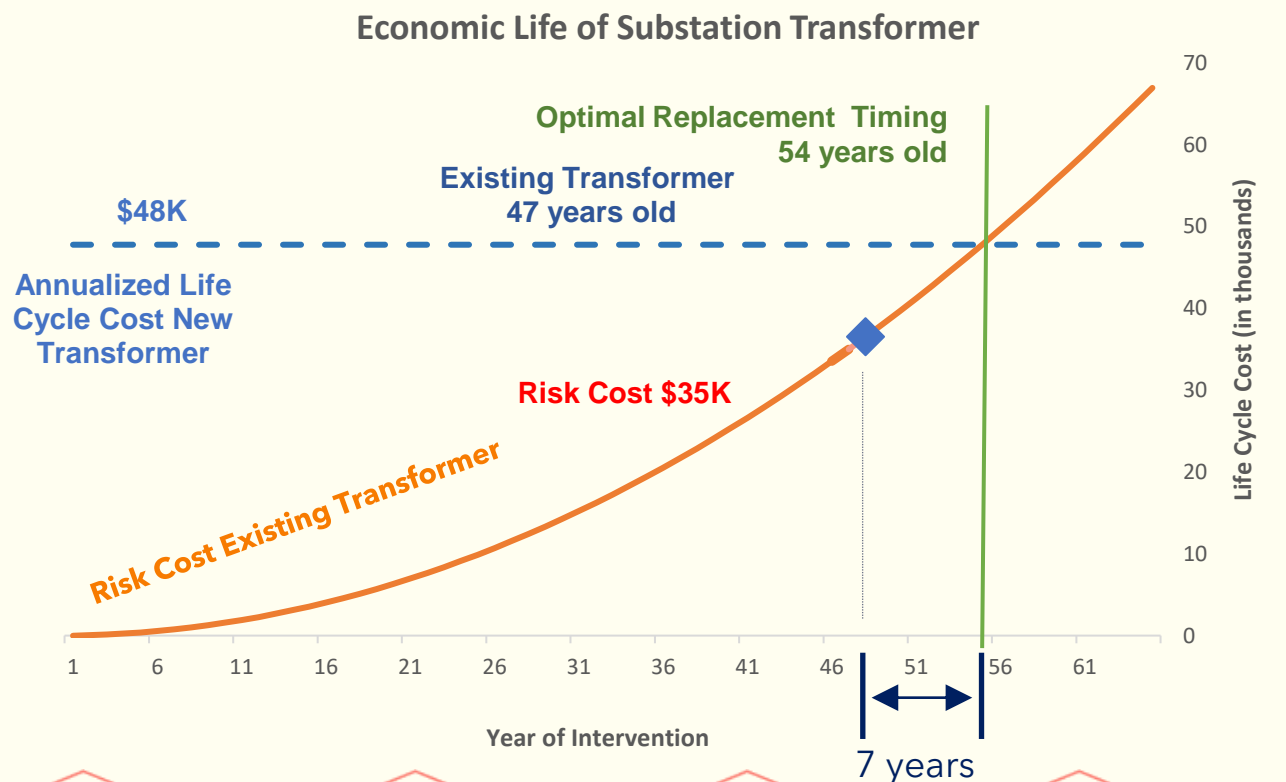
**Consequence of Failure:**

**\$2.7M**



**Risk:**

**= \$35K**



## Outputs of Economic Life Cycle Model

Annualized life cycle cost new transformer	\$48K
Risk Cost of existing transformer	\$35K
Years to Replacement	7 years

**Proactive Replacement Recommended in 7 years**

# Substation Transformer Example



Substation Transformer is 47 years old. It has a 1.29% probability of failure but has a \$2.7M consequence of failure.

## How much to spend on repairs?



Probability of Failure:

1.29%



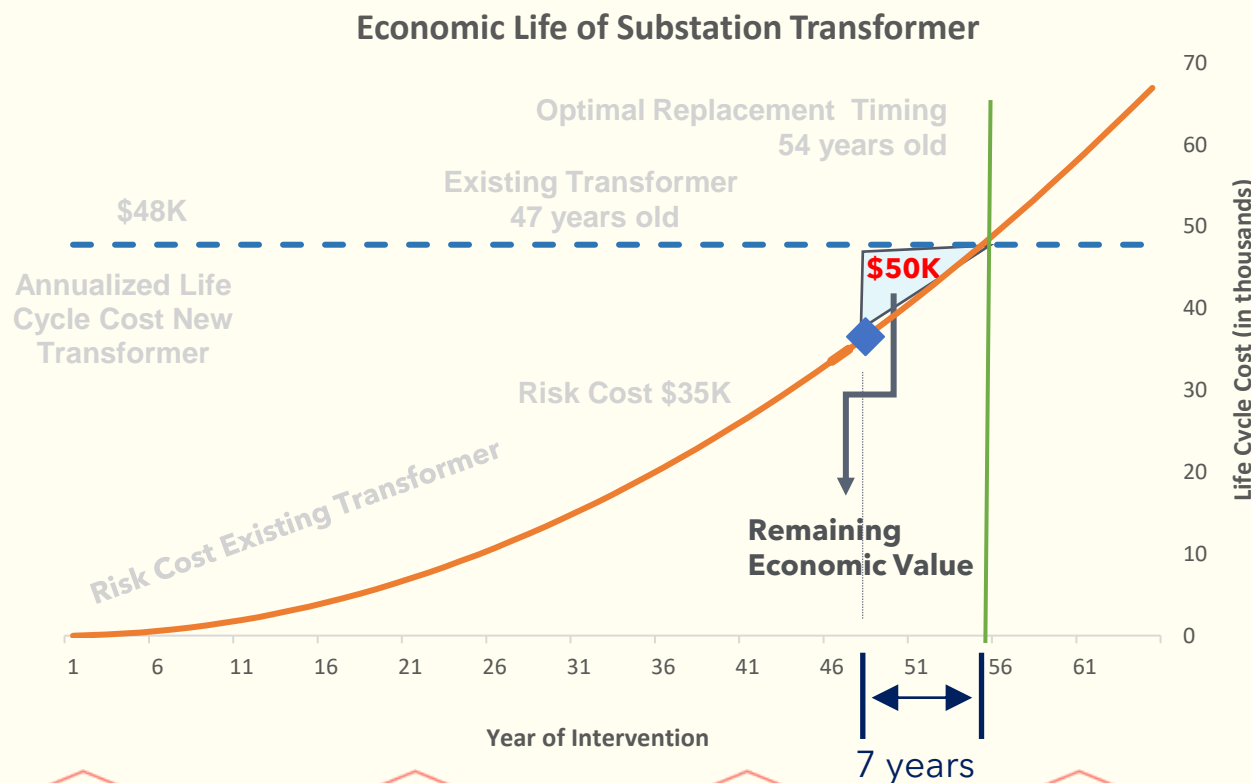
Consequence of Failure:

\$2.7M



Risk:

1.29% X \$2.7M = \$35K

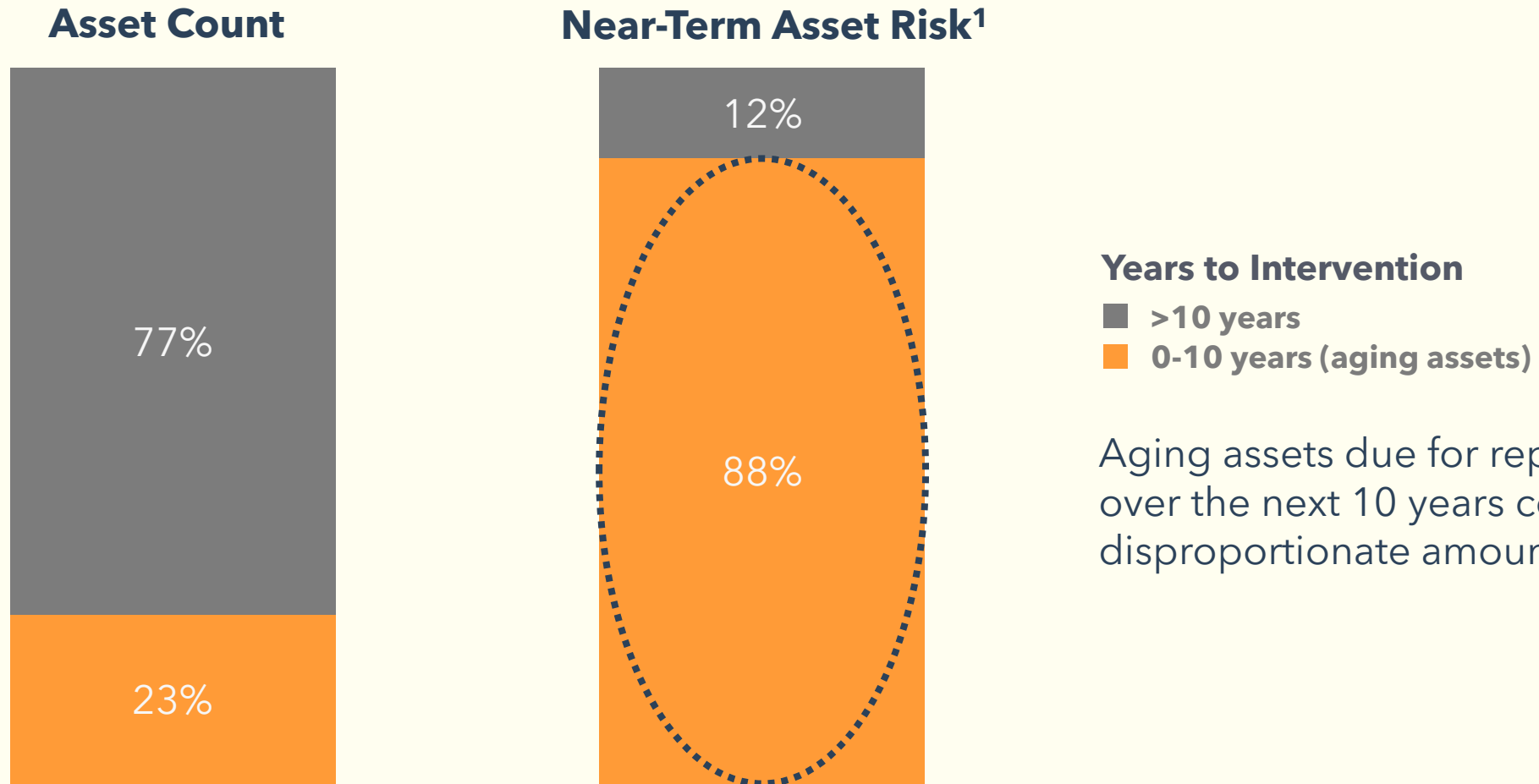


## Outputs of Economic Life Cycle Model

Annualized life cycle cost new transformer	\$48K
Risk Cost of existing transformer	\$35K
Years to Replacement	7 years
Cost Of Ownership, replaced now	\$1.0
Cost Of Ownership, replaced optimally	\$0.9
Remaining Economic Value	\$50K

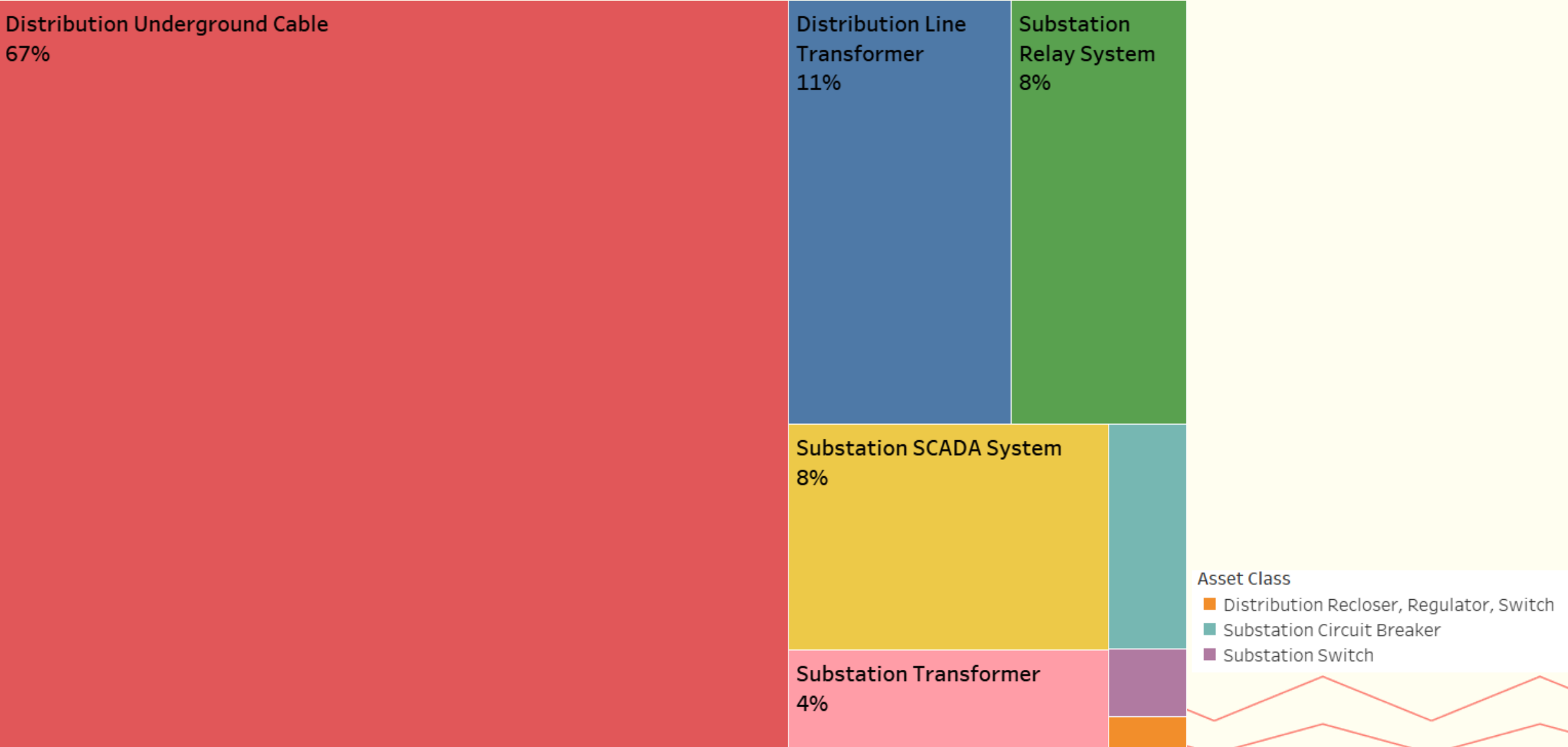
# Risk Concentrations

# T&D Aging Asset Risk Concentration (2)



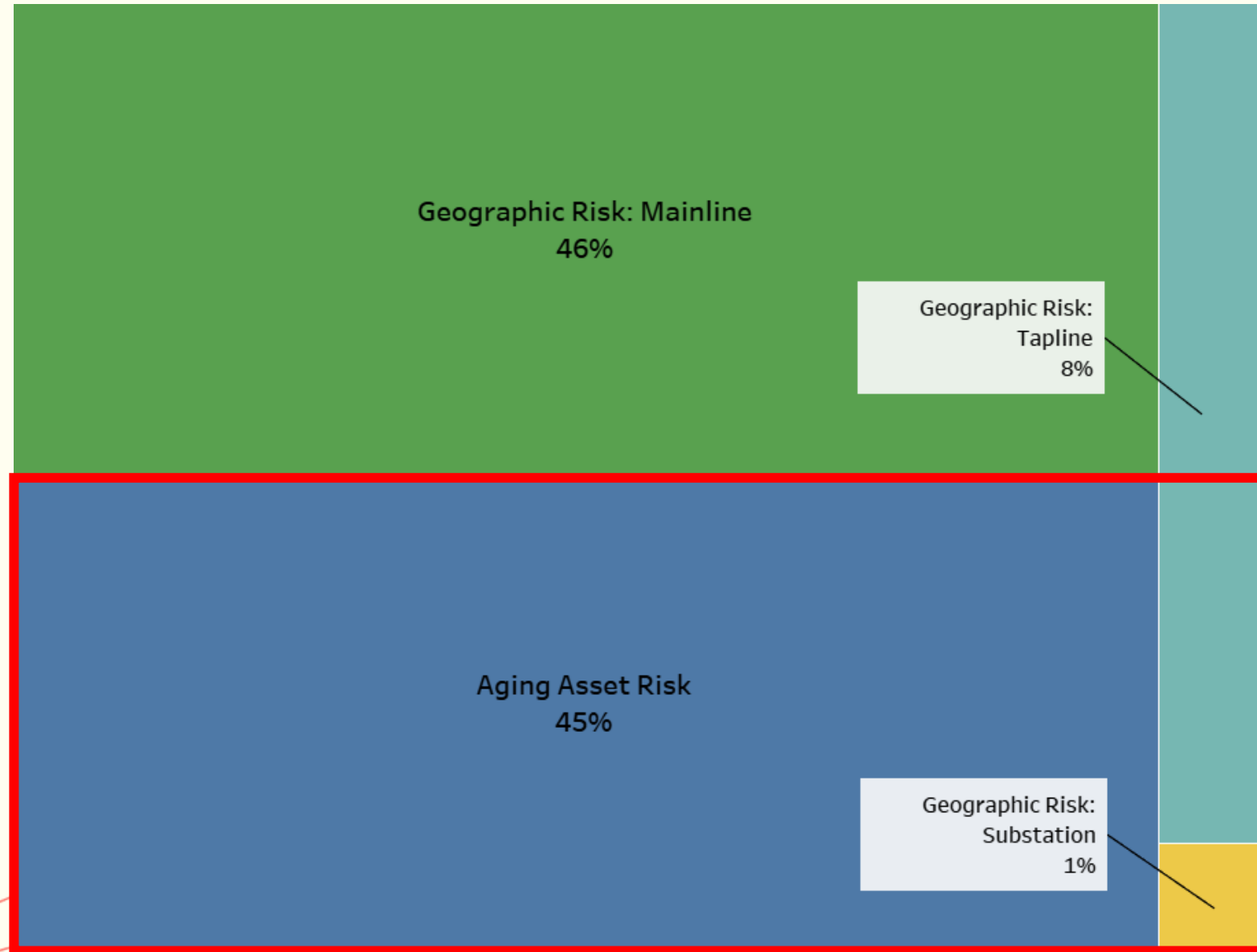
- 1) Does not include risk that can be mitigated by reconfiguration or geographic risk
- 2) 2020/2021 values; does not reflect 2022 model updates April 2022

# T&D Aging Asset Risk % by Class (1)



1) 2020/2021 values; does not reflect 2022 model updates occurring April 2022

# T&D Risk Proportions (1)



Includes 3 types of geographic risk: vegetation + weather, wildlife, other.

**Let's  
meet the  
future  
together.**

