Distribution Planning Processes and Methodologies to Identify Grid Needs

Distribution Planning Working Group

November 18, 2019

Hawaiian Electric
Maui Electric
Hawai'i Electric Light

DPWG – Meeting Topics & Schedule

Completed

- February 27, 2019
  - Intro and overview of DPWG and Grid Services, and soft launch
- March 26, 2019
  - Surveyed best practices across U.S. for NWA processes and methods for opportunity, identification, and procurements
- April 25, 2019
  - Grid needs assessment methodology and process and candidate NWA opportunities for Soft Launch
- June 19, 2019
  - High-level review of Soft Launch RFP
- July 17, 2019
  - Develop ongoing NWA process for identifying and evaluating opportunities, sourcing approaches and evaluation methods
- August 8, 2019
  - Detailed review of Soft Launch Opportunities
- September 9, 2019
  - Draft Soft Launch RFP released – review of RFP w/ stakeholder
- October 9, 2019
  - 2020 NWA Opportunities & Proposed Opportunity Evaluation Screen & Stakeholder information requirements

Upcoming (tentative)

- **November 18, 2020**
  - **Proposed distribution planning methodology enhancements for 2020 IGP**
  - **Issue Soft Launch RFP**
- December
  - Distribution planning integration with Resource & Transmission planning process
  - 2020 NWA Opportunities & Opportunity Evaluation Screen Guidelines
  - Final Documentation of Deliverables Posted to Hawaiian Electric Companies' Website w/stakeholder outstanding comments noted
- January
  - Distribution planning load scenarios and sensitivities methodology
  - Soft Launch RFP proposals due
- February
  - Proposed distribution planning load scenarios and sensitivity methodology

DPWG Nov. 18th Meeting Objectives

- Present the Hawaiian Electric Company (HECO) planning process for the distribution system and identifying grid needs
- Obtain stakeholder feedback on distribution planning process
- Begin discussion on Distribution Grid Needs document components

Agenda

- Distribution Planning Overview
- Distribution Planning Process
  - Forecast
  - Analysis
  - Solution
- Future Planning Next Steps
- Stakeholder Feedback

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- **Distribution Planning Overview**
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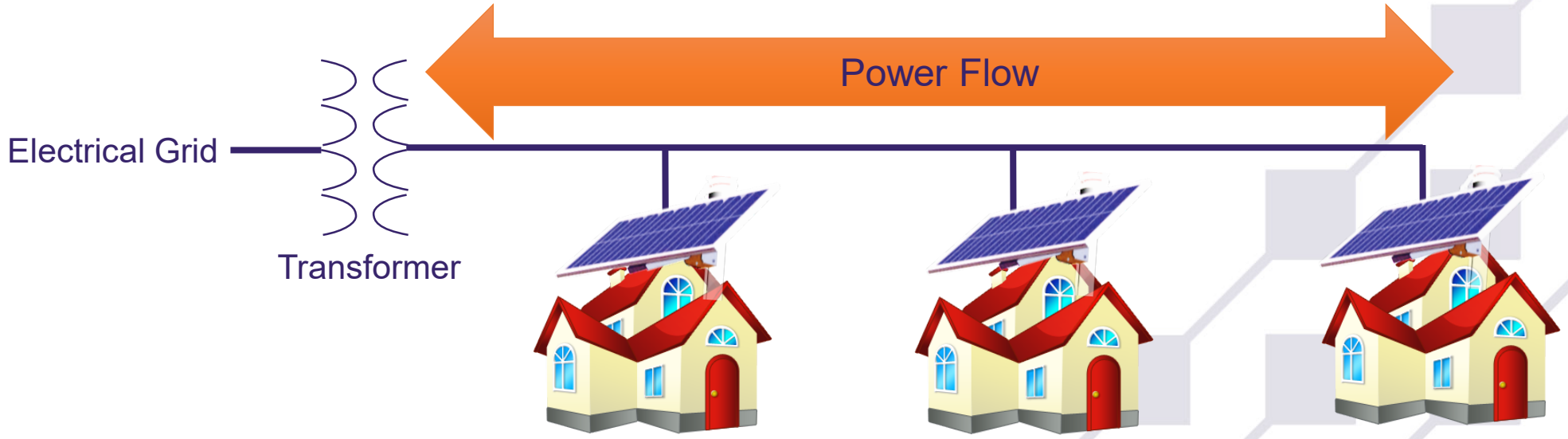
Distribution Planning has two core functions

1. Plan the Distribution system's capability to serve new and future electrical load – process required to provide power to customers
2. Safely interconnect DER (PV, DR, EV, ESS, etc.) and transmit distributed power across system (2-way flow) while maintaining power quality and reliability for all customers



Distribution Planning's Scope of Work

- Distribution Planning is responsible for the orderly expansion of the electrical distribution system:
  - Forecasting electrical demand on the substation transformers and circuits of the distribution system, incorporating new service requests and renewable generation systems
  - Analyzing the present state of the electrical system to ensure there is adequate capacity and reliability to serve our customers
  - Studying alternative solutions and making recommendations to meet grid needs
- Not involved in:
  - Power plant generation or transmission line issues
  - Asset management programs and strategies

Distribution Planning (with DER)

Traditional Planning (Without DER)	Current Planning (With DER)
Distribution Voltage Levels	Distribution and Secondary Voltage Levels
Primarily concerned with thermal overloading and undervoltage	Concerned with thermal overloading, undervoltage, overvoltage, and dynamic power quality impacts
Analytical techniques and equipment specified have been used for 40+ years	Studying equipment and customer assets that are constantly evolving
Desktop computing and SynerGI® modeling tools are utilized for studies	Advanced computer modeling tools are utilized for the studies (PSSE, PSCAD)
	Load forecasting and hosting capacity analyses

The dynamic nature of loads and DER creates a need for more granular analysis

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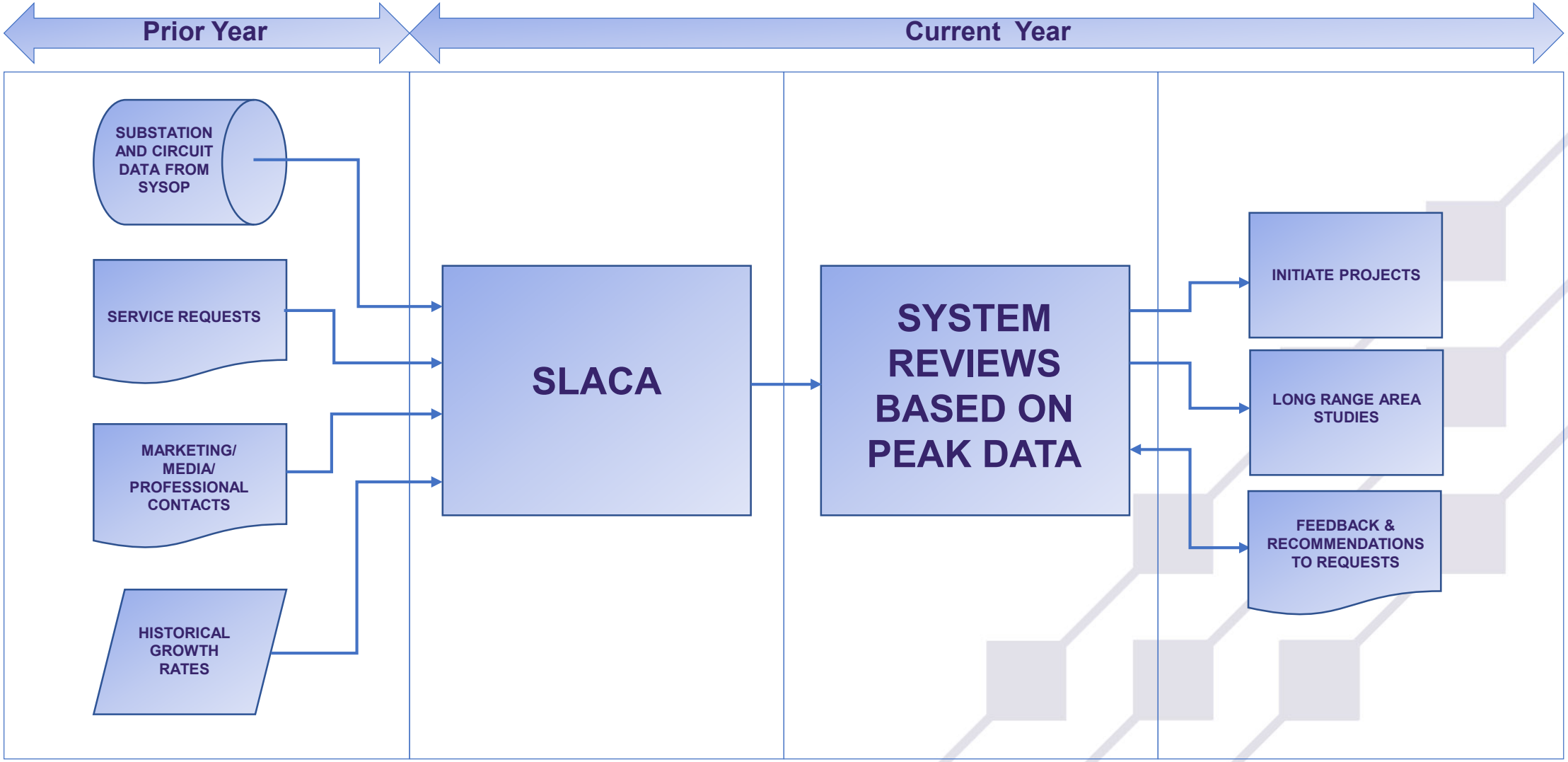
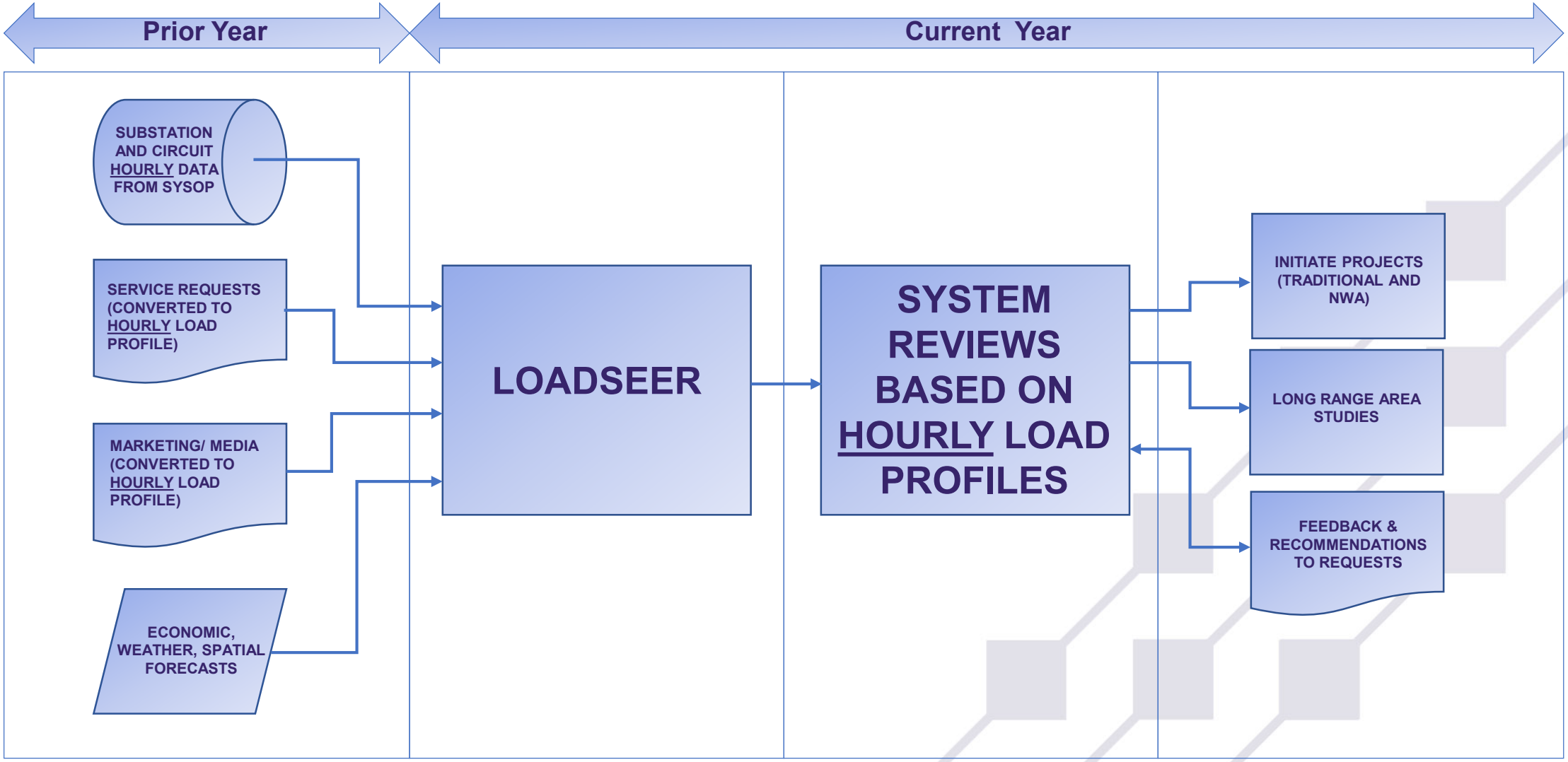
Traditional Distribution Planning Process

- Evaluate prior years loading data to create SLACA (Substation Loading And Capability Analysis)
- SLACA is a 10 year load projection tool which utilizes a linear load growth rate
- Forecasts are adjusted throughout the year as new service requests are received
- Spreadsheets are used for conducting area analysis to ensure that N-1 distribution planning criteria is met
- Initiate projects as necessary

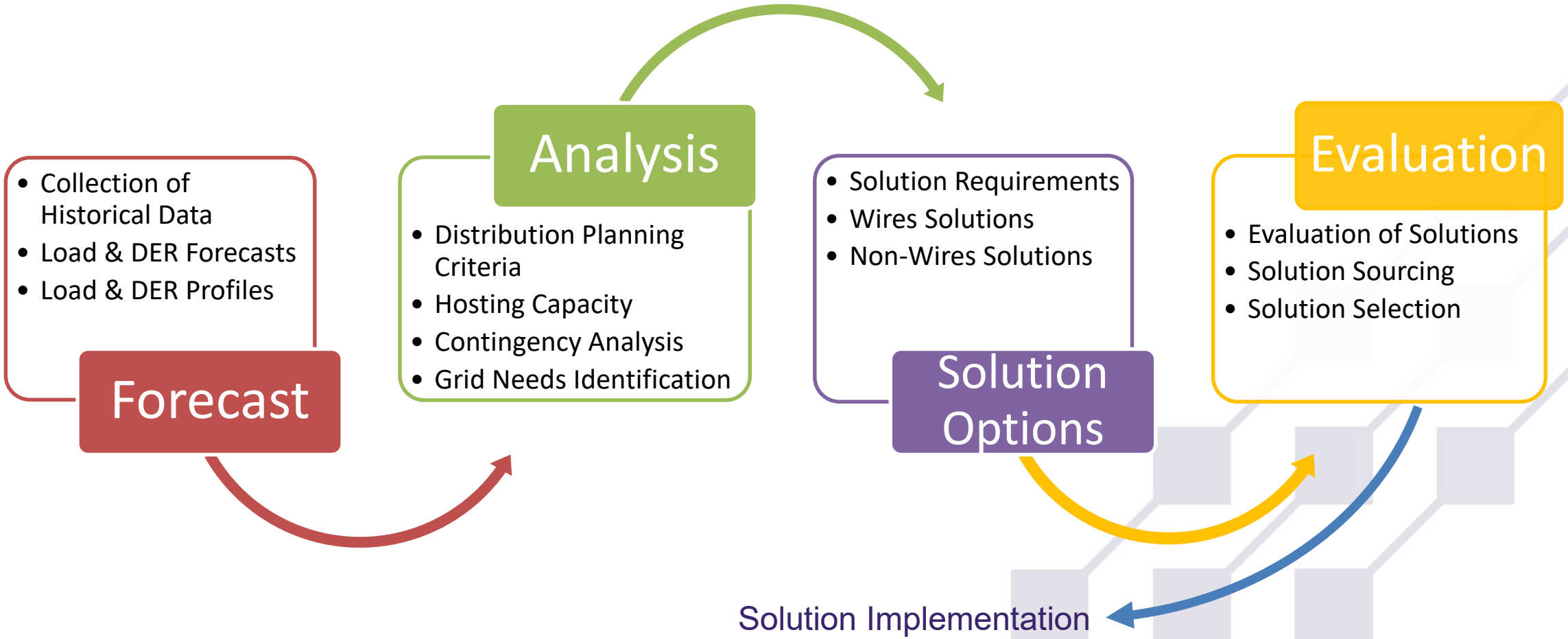
Traditional Distribution Planning Process



Current Distribution Planning Process



Current Distribution Planning Process



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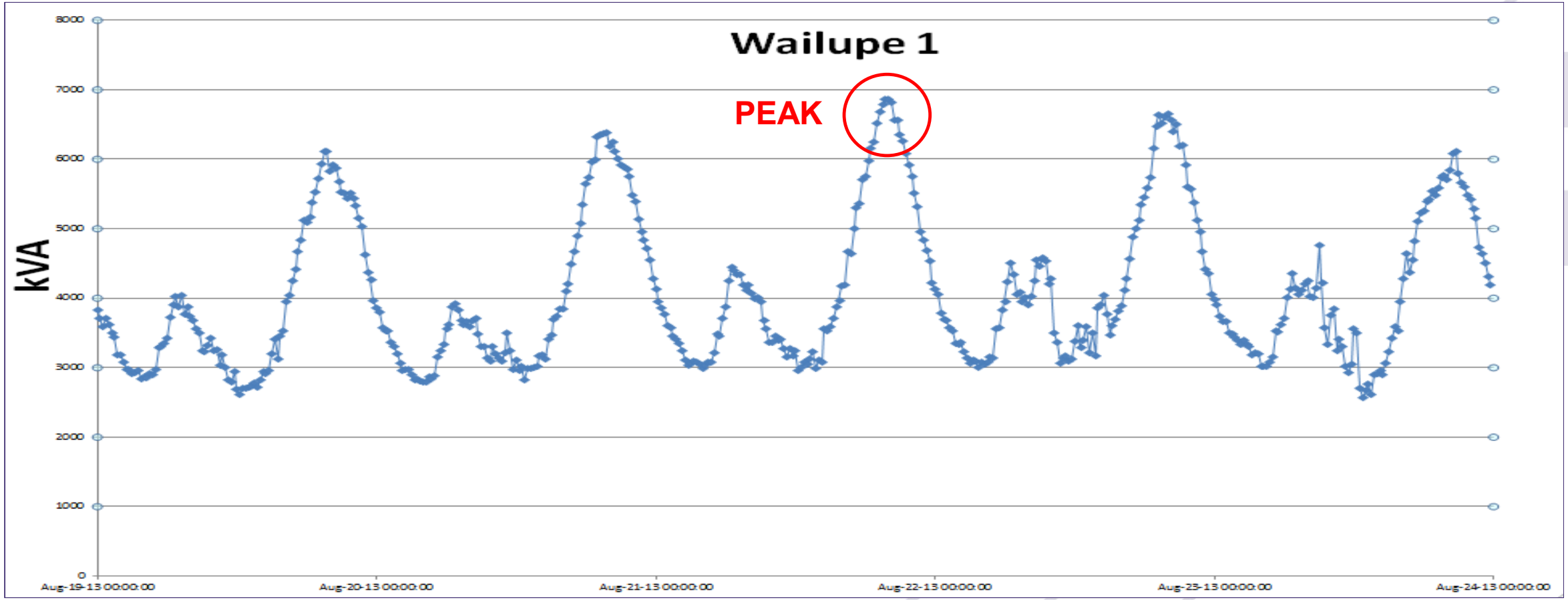
SLACA – Substation Loading And Capability Analysis

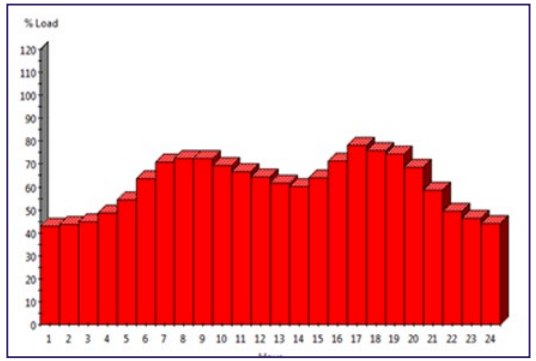
- Prior year actual load data from distribution substation transformers and circuits are analyzed to determine the peak loading
- Holdoffs (planned maintenance) and system interruptions are taken into consideration to determine the peak



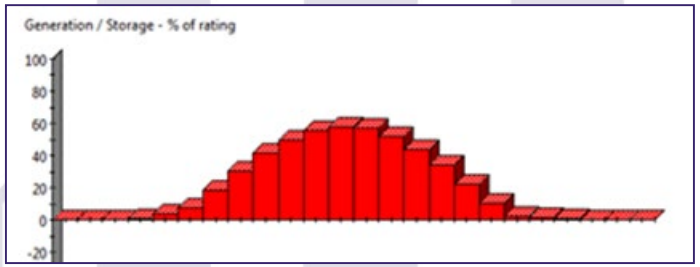
LoadSEER: Time Series Load/DER Forecasts

- LoadSEER has replaced SLACA and produces load forecast profiles that include:
  - DER programs forecasts
  - Electric Vehicle forecasts
  - Economic variables to forecast load growth
- Traditionally, non-coincident peak loading was used which may lead to conservative load projections (i.e., peak load for new service is added to peak load for feeder to obtain projected feeder peak load)
- Load profiles provide more granular projections and provide the basis to analyze both traditional and non-wire solutions

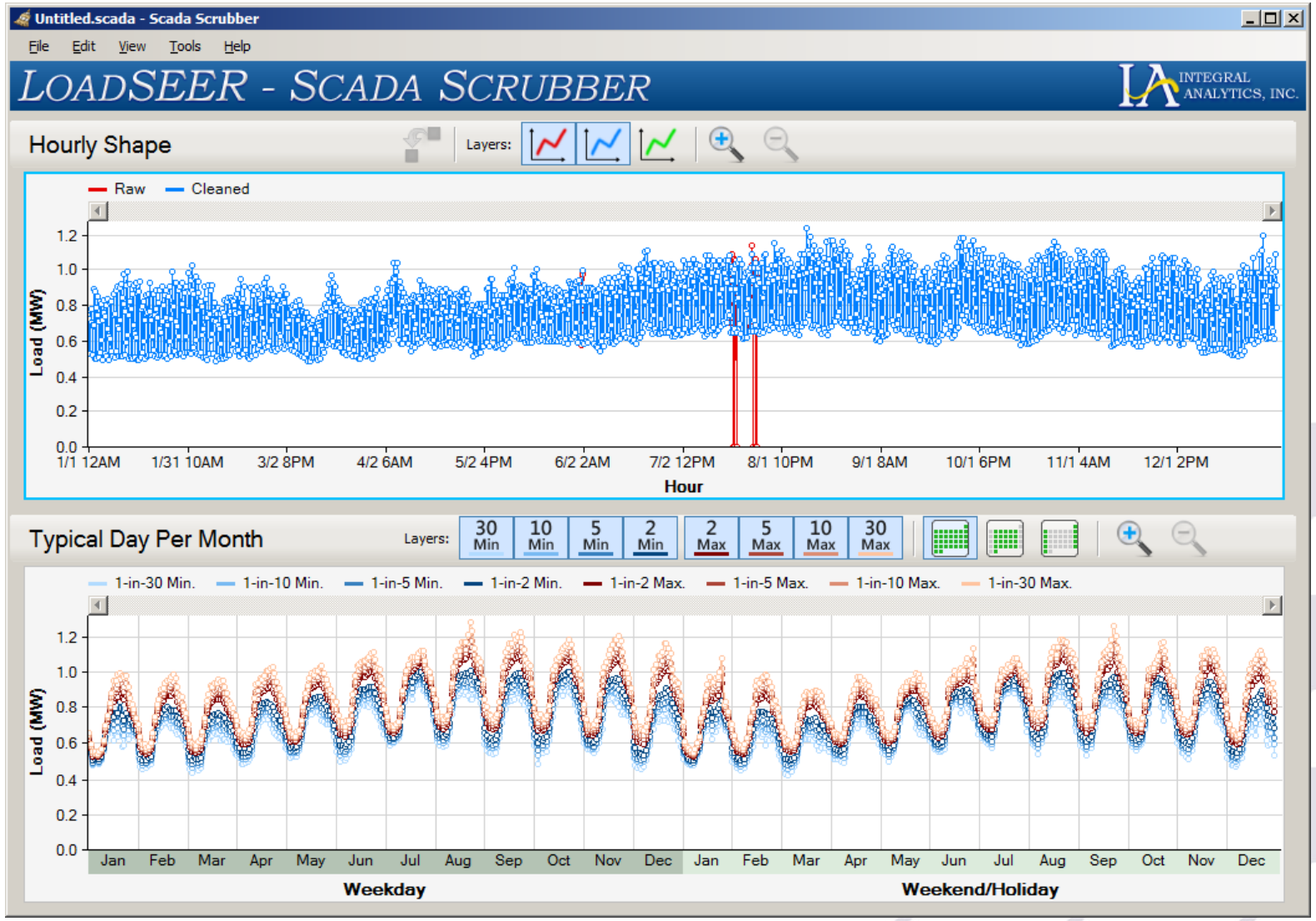
Load forecast profiles



DER forecast profiles



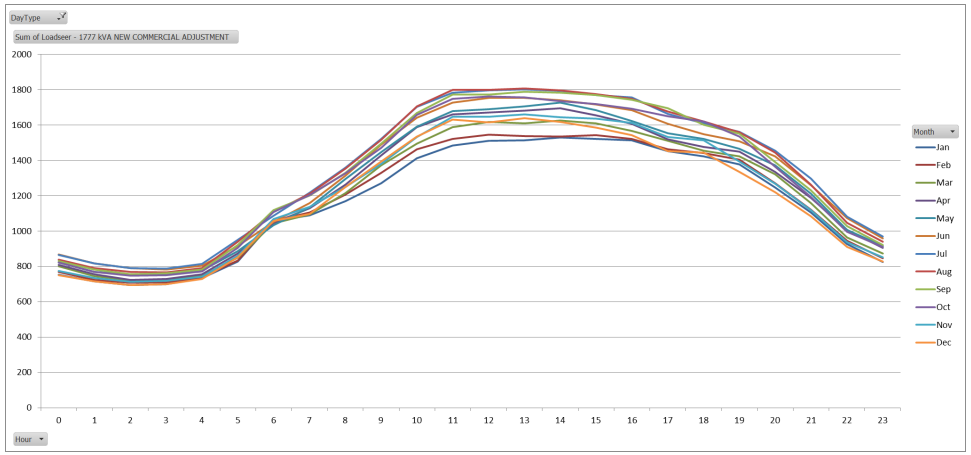
LoadSEER - SCADAScrubber



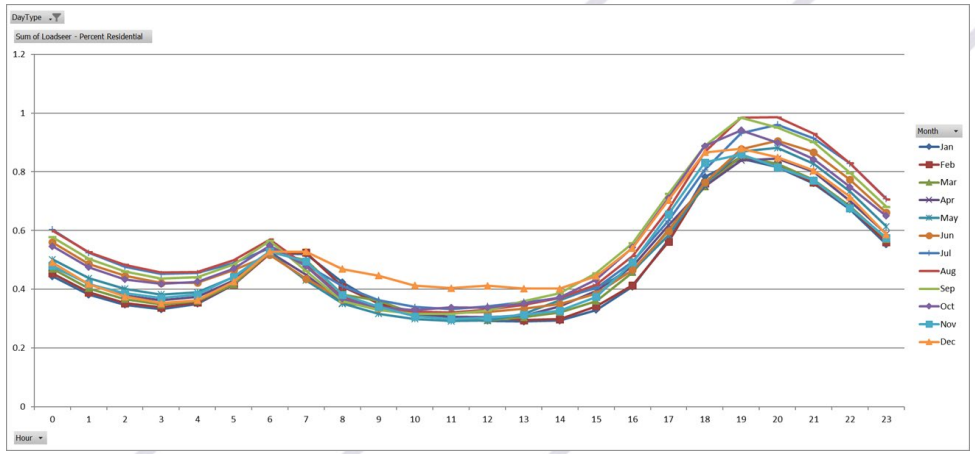
LoadSEER Load Profiles

- LoadSEER produces load profiles for new load addition (services) based on default or actual load shapes and can be shown as a 576 profile (24 hour, monthly profile for weekday and weekend) 24x12x2 = 576
- Commercial and residential load profile have been created based on actual HECO commercial and residential customer load profiles
- These “default” load profiles are scalable and may create new profiles given a peak value

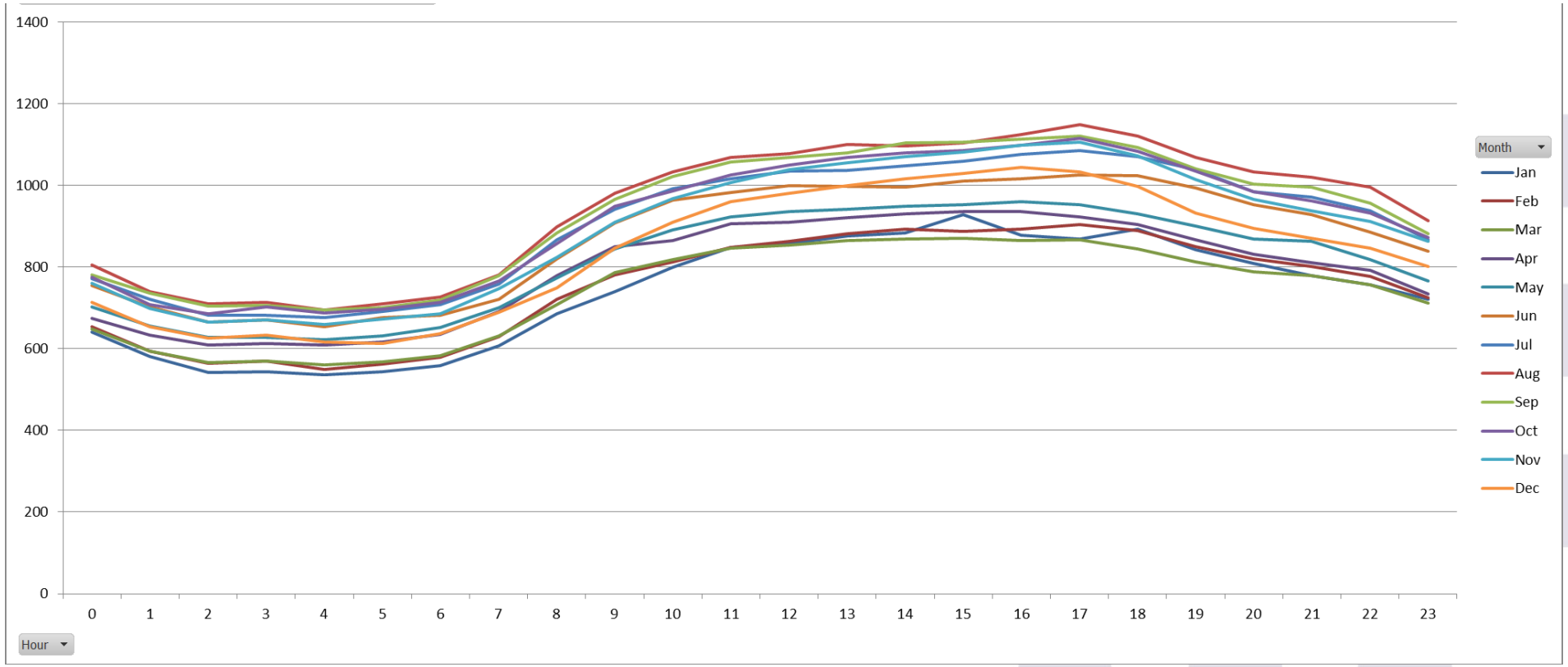
New Commercial



Residential



LoadSEER Profile Example
(Actual Honolulu Condo Load Shape)

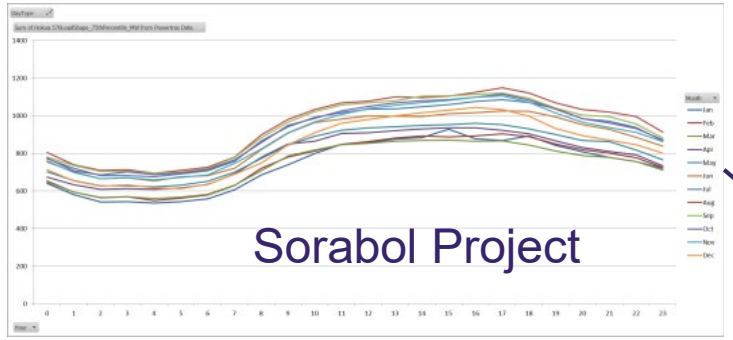


Similarly, load profiles for an existing customer may also be used to create scalable load profiles

LoadSEER: Ala Moana ToD Example

- Load profiles may be created for potential developments using existing load profile shapes
- The proposed development at the existing Keeaumoku International Village site (Sorabol site) is expected to have both residential and commercial development that is similar to the Hokua condo
- The proposed Kapiolani Development, that will be built next to the existing Samkoo Development, is mainly residential so the load profile for the existing Ko'olani condo, which is primarily residential, may be applied

Loading for the Two Developments



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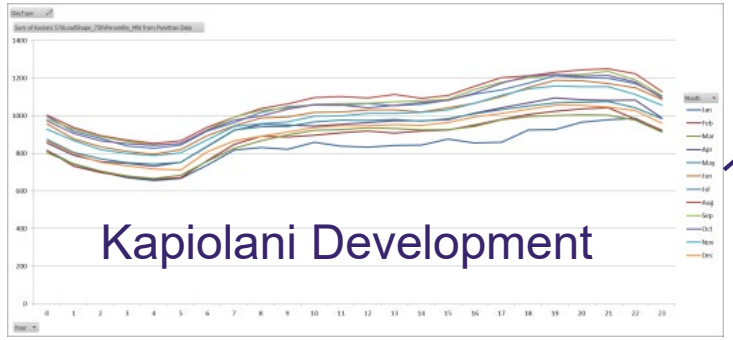

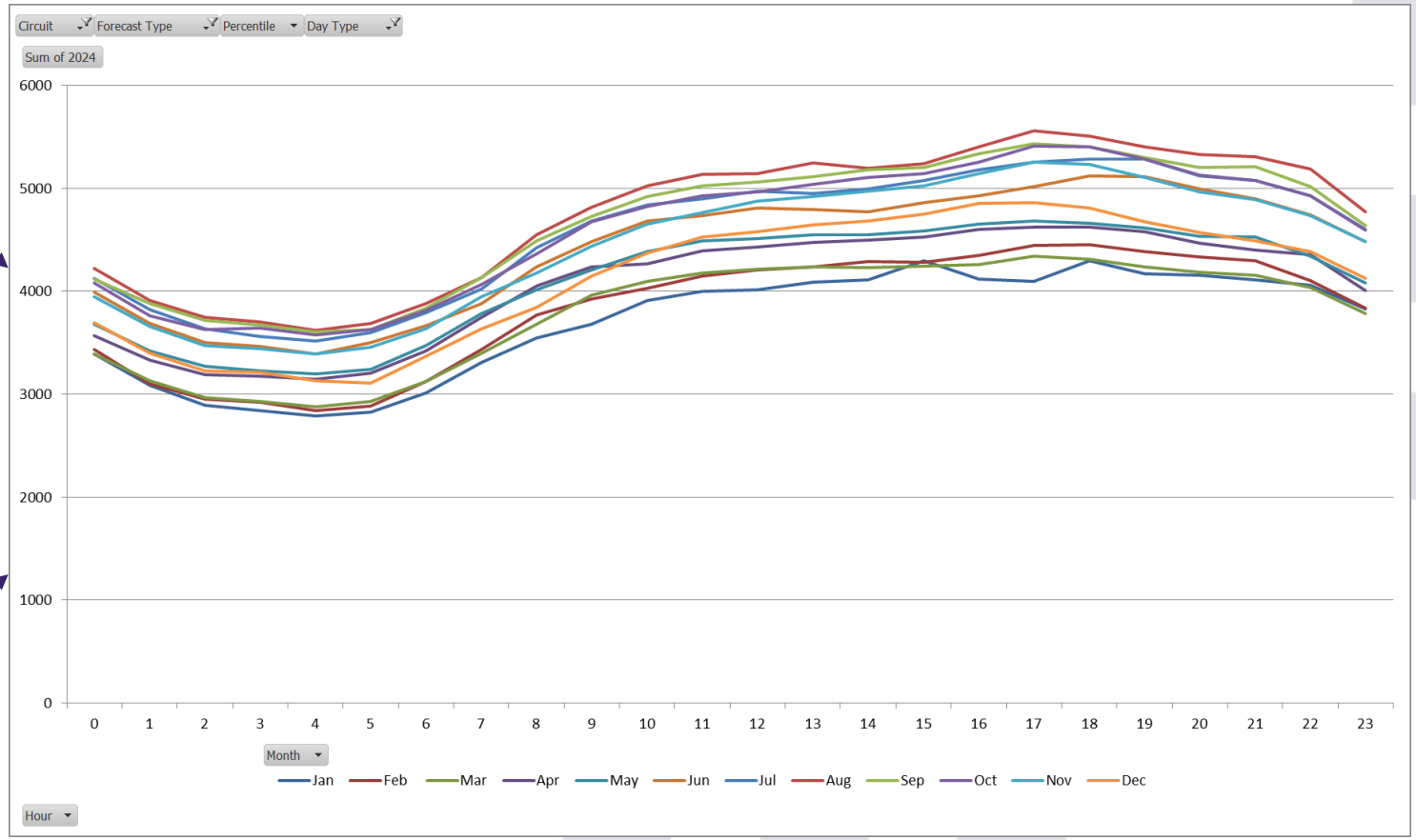

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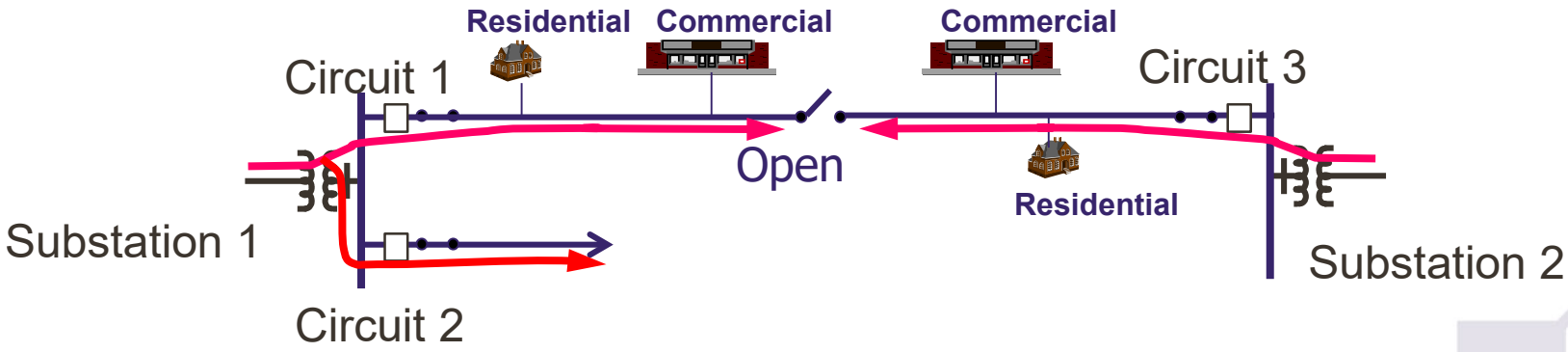
Distribution Planning Criteria

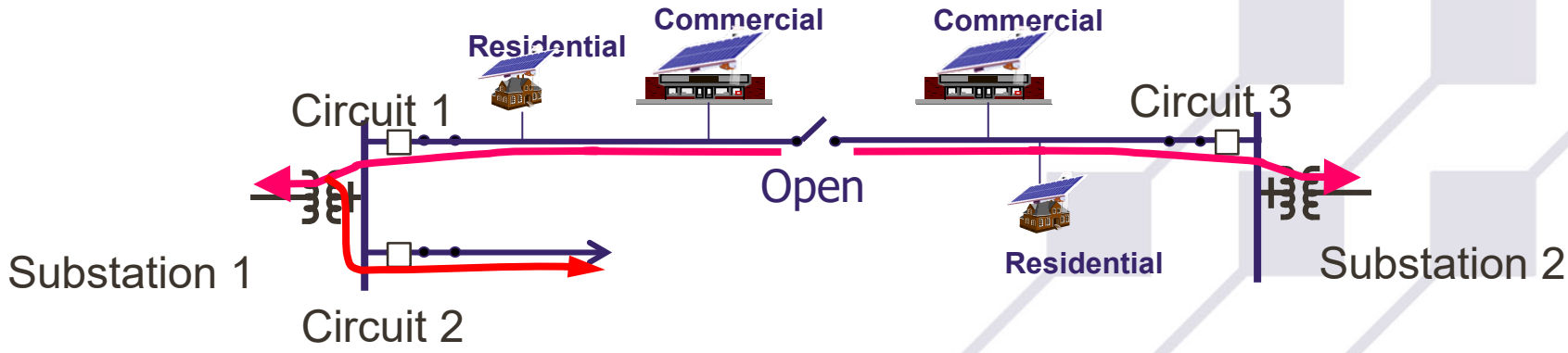
- The purpose of the Distribution Planning Criteria is to establish technical guidelines to ensure the distribution system has adequate capacity and reliability for our customers
- The distribution system is planned to serve the peak KVA on any part of the system (**normal condition**)
- The distribution system is also planned to provide service if there is a failure or de-energization of a distribution circuit or substation transformer (**contingency or N-1 condition**)
- N-1 Examples include:
  - Main circuit breaker opens due to a fault on the line (mylar balloon in an overhead line)
  - Substation transformer is taken out of service for planned maintenance

Normal Operating Condition Example

- The transformer and circuit is planned to have adequate capacity to serve the electrical load:

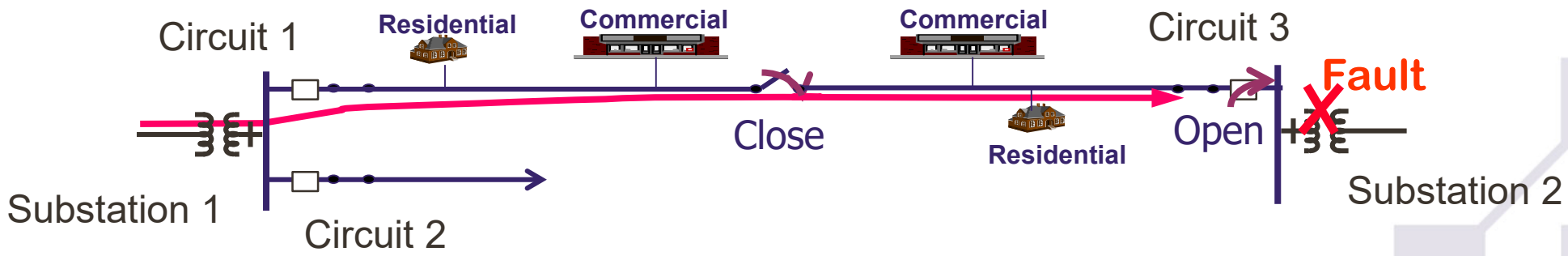


- With DER, the transformer and circuit is also planned to be adequate for the backflow of generation from PV during the daytime:

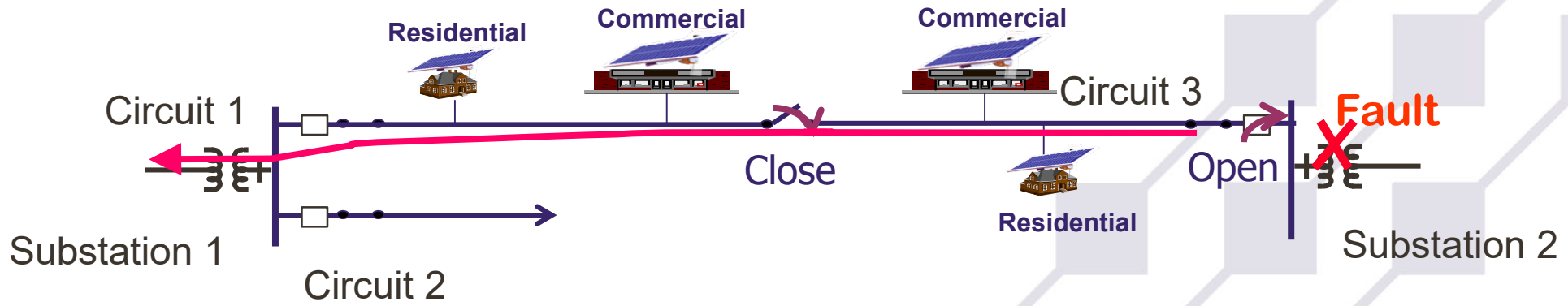


Contingency (N-1) Operating Condition Example

- The transformer and circuit is planned to have adequate capacity to serve the electrical load of adjacent transformer or circuit customers (substation 1 and circuit 1 will serve more load in this situation):



- With DER, the transformer and circuit is also planned to be adequate to backup adjacent line customers with PV during the daytime.



Distribution Planning Criteria

- Thermal Limits
  - Normal current carrying capacity of any distribution system component will not be exceeded under normal conditions
  - Contingency current carrying capacity of any distribution system component will not be exceeded during any contingency or planned outage conditions
- Voltage Limits
  - Voltage level is maintained within 5% of the associated nominal voltage at any point on the distribution system (primary and secondary)

Distribution Planning Criteria – Ratings

- Distribution substation transformer loading limits are based on:
  - Expected hourly loading
  - Oil and ambient temperature
  - Allowable insulation degradation (loss-of-life limits)
- Distribution circuit loading limits are based on:
  - Conductor size
  - Conductor material
  - Number of conductors in a duct bank
  - Temperature
  - Type of insulation
  - Conductor construction

Distribution Planning Criteria - Voltage

- Voltage kept within 5% of the appropriate nominal voltage at any point on the distribution system
- An example on a 120V basis: 114V ≤ Acceptable Voltage Range ≤ 126V

Why are these capacity and voltage limits important?

- Thermal (capacity) overloads may cause damage to our equipment which may lead to extended service interruptions and high maintenance expenses
- Low or high voltage has the potential to cause damage to customer equipment

Traditional Spreadsheet N-1 Analysis Example

- The distribution system is reviewed for both normal and contingency conditions
- Spreadsheets are used to simulate single contingency failure or outage of each transformer and/or circuit within an area (contingency conditions)
- Analysis uses peaks and does not consider time varying nature of the demand

Example Simplified Area Review

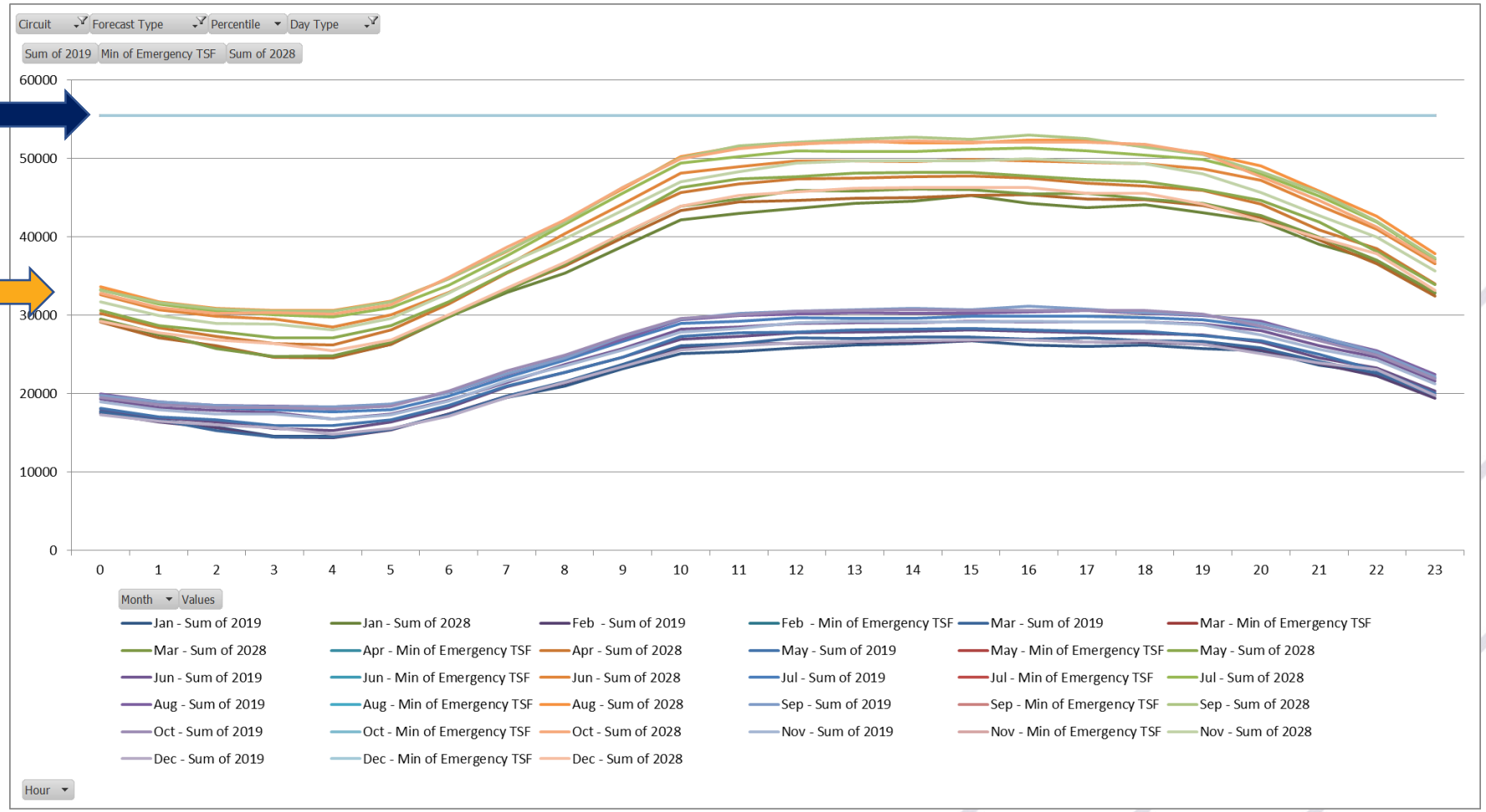
Load in YEAR (a2018):	2019		381	1001	1382	1376	1859	3235
Condition			Circuit 1	Circuit 2	TSF 1	Circuit 3	Circuit 4	TSF 2
Emergency Ratings (KVA)			3257	3257	7580	2169	2284	6657
Normal Ratings (KVA)			2745	2745	5580	1837	1801	5214
Norm Loads (KVA)	Load		381	1001	1382	1376	1859	3235
If Transformer 1 fails:								
1. Circuit 1								
Close SW 1	100%	381	-381		-381		381	381
2. Circuit 2								
Open SW 2 & Close SW 3	100%	1001		-1001	-1001	1001		1001
Emergency Load			0	0	0	2377	2240	4617
% Normal Overload			0	0	0	0	3	0
% Emergency Overload			0.0	0.0	0.0	9.6	0.0	0.0
Year of Normal Overload			n/a	n/a	n/a	2019	2019	n/a
If Transformer 2 fails:								
1. Circuit 3								
Close SW 4	100%	1376		1376	1376	-1376		-1376
2. Circuit 4								
Close SW 5	100%	1859	1859		1859		-1859	-1859
Emergency Load			2240	2377	4617	0	0	0
% Emergency Overload			0.0	0.0	0.0	0.0	0.0	0.0
Year of Emergency Overload			39447	33511	51597	#DIV/0!	#DIV/0!	#DIV/0!

LoadSEER N-1 Analysis Example:
Kewalo T3 Transformer Load Transfer to Kamoku T2 Transformer

Rating

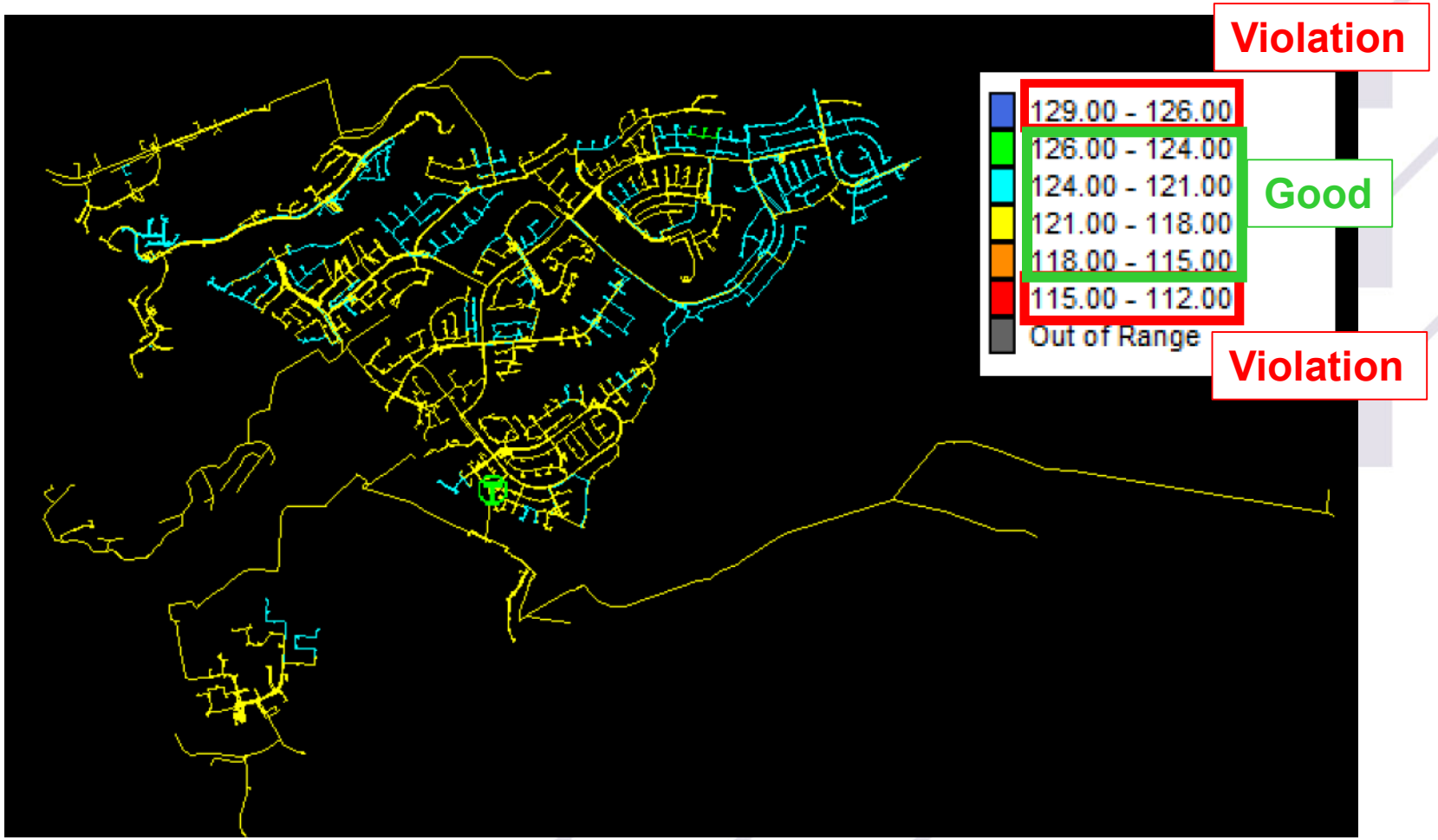
With new developments

Existing

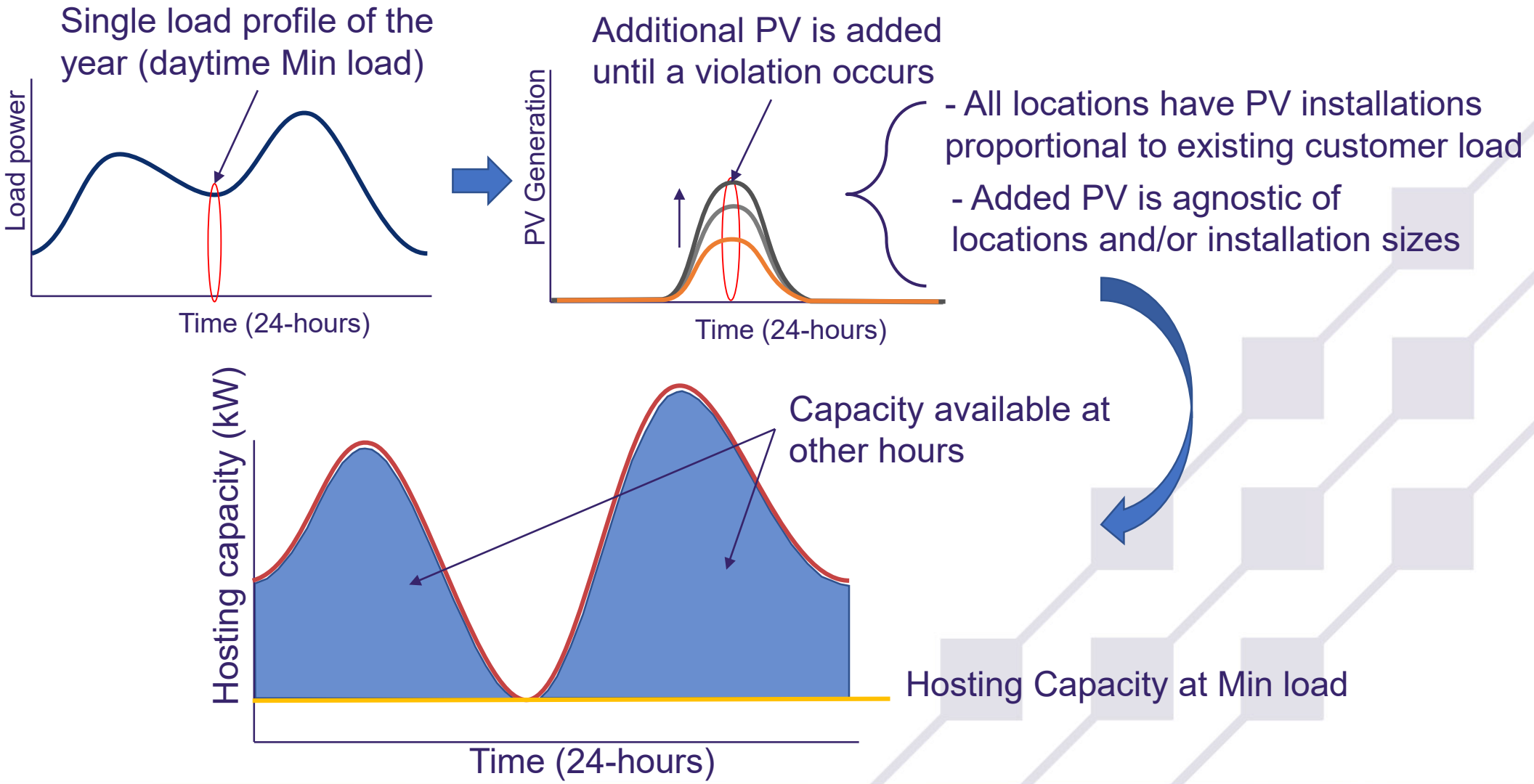


Current Hosting Capacity Method

- Model using Synergi
- Daytime minimum load
- Existing PV scaled until voltage or thermal violation occurs
- Hosting capacity value used as screening threshold
- If existing DER is greater than hosting capacity new DER requires more analysis



Hosting Capacity: Current Methodology



Future Hosting Capacity Enhancements

	Current HECO HC analysis	Future HECO HC analysis
Model Unique DER Programs (Non-Export & Smart Export)	✗	✓
Advanced Inverter (VV/VW)	✗	✓
Time Series (576/8760)	✗	✓
Probabilistic model	✗	✓
Add PV in realistic installation sizes	✗	✓
Add PV in locations that make sense	✗	✓

Goal is to increase hosting capacity for all hours of the day

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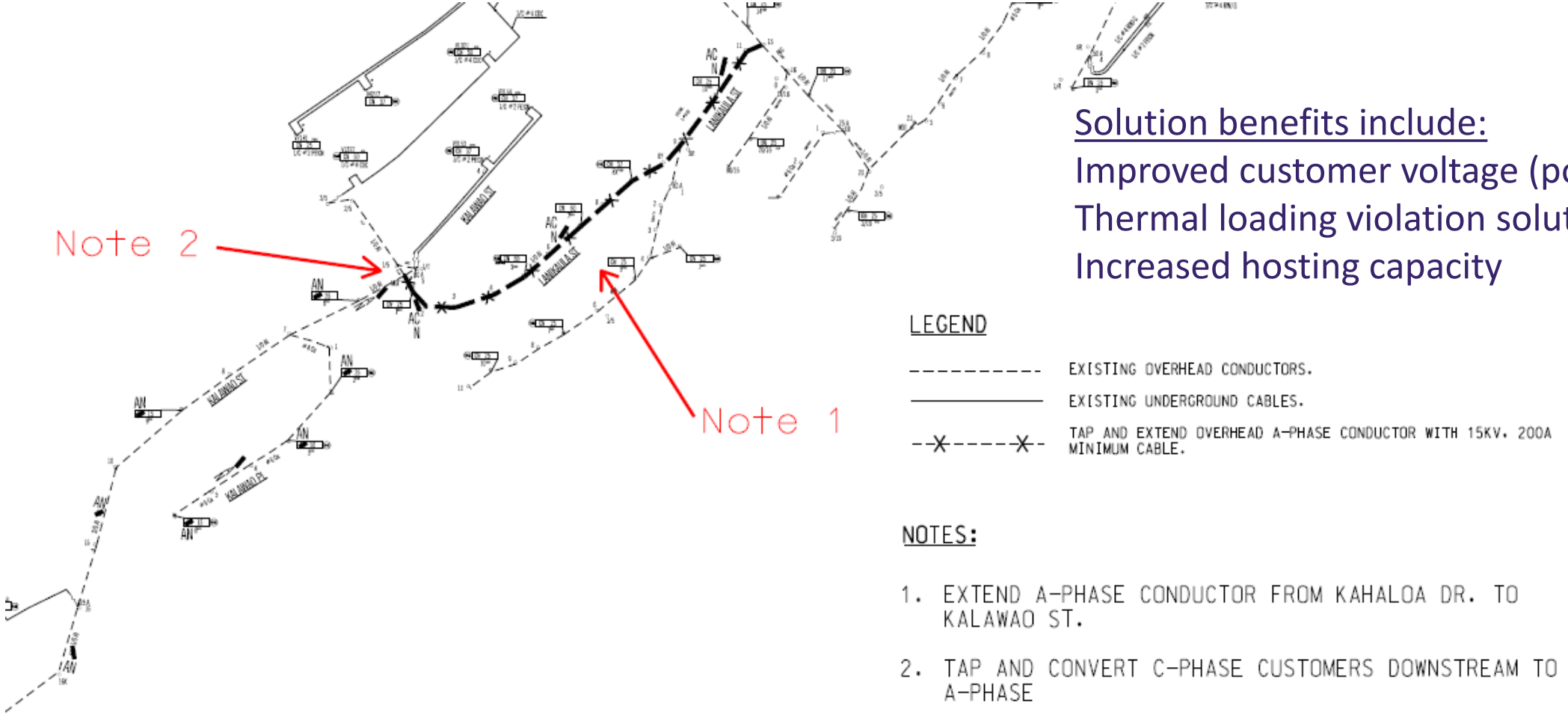
Planning Criteria Violation

- If the analysis shows a thermal or voltage violation, further analysis is done to determine a solution to resolve the planning criteria violation
- Solutions include:
  - Non-wires solution
  - Modify substation LTC or line regulator installation/settings change
  - Reconfigure the circuit
  - Reconductor
  - Reactive compensation – multiple electronic power devices to stabilize circuit voltage
  - Balance loading/DER
  - Line extension
  - New substation
- Develop project scope
  - For a wire solution, work plans are created including planning single-line diagrams
  - For a non-wire solution, time based capacity requirements are determined

Example Solution: Extend Conductor and Rebalance Load/DER



Solution benefits include:

Improved customer voltage (power quality)

Thermal loading violation solution

Increased hosting capacity

LEGEND

---------- EXISTING OVERHEAD CONDUCTORS.

———————— EXISTING UNDERGROUND CABLES.

--X-----X-- TAP AND EXTEND OVERHEAD A-PHASE CONDUCTOR WITH 15KV. 200A MINIMUM CABLE.

NOTES:

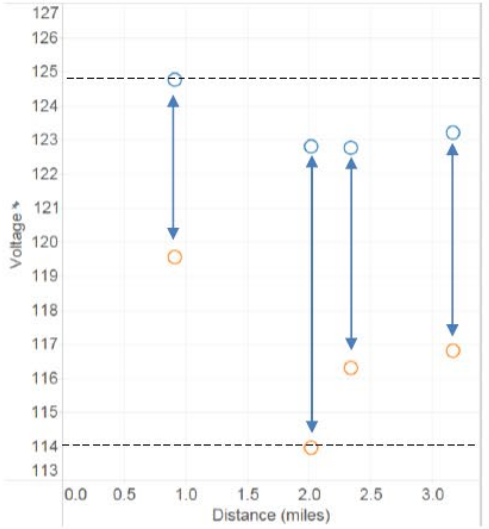
1. EXTEND A-PHASE CONDUCTOR FROM KAHALOA DR. TO KALAWAO ST.
2. TAP AND CONVERT C-PHASE CUSTOMERS DOWNSTREAM TO A-PHASE

Example Solution: Reactive Compensation

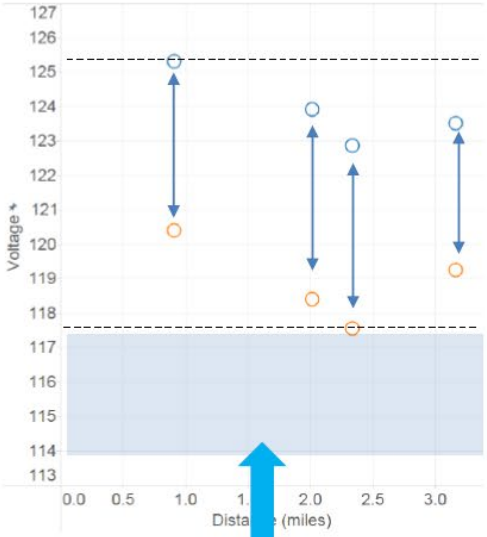
varentec

How ENGO increase PV Hosting Capacity?

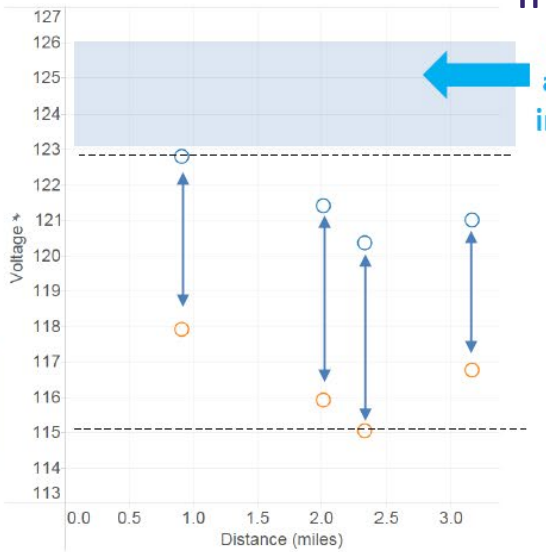
System Voltage without ENGO



System Voltage with ENGO



Permanently reduced the center band of the LTC



Extra Upper margin allow more PV to be installed in the feeder

ENGO Device

Reduced system voltage fluctuation and provide extra lower margin

Solution benefits include:

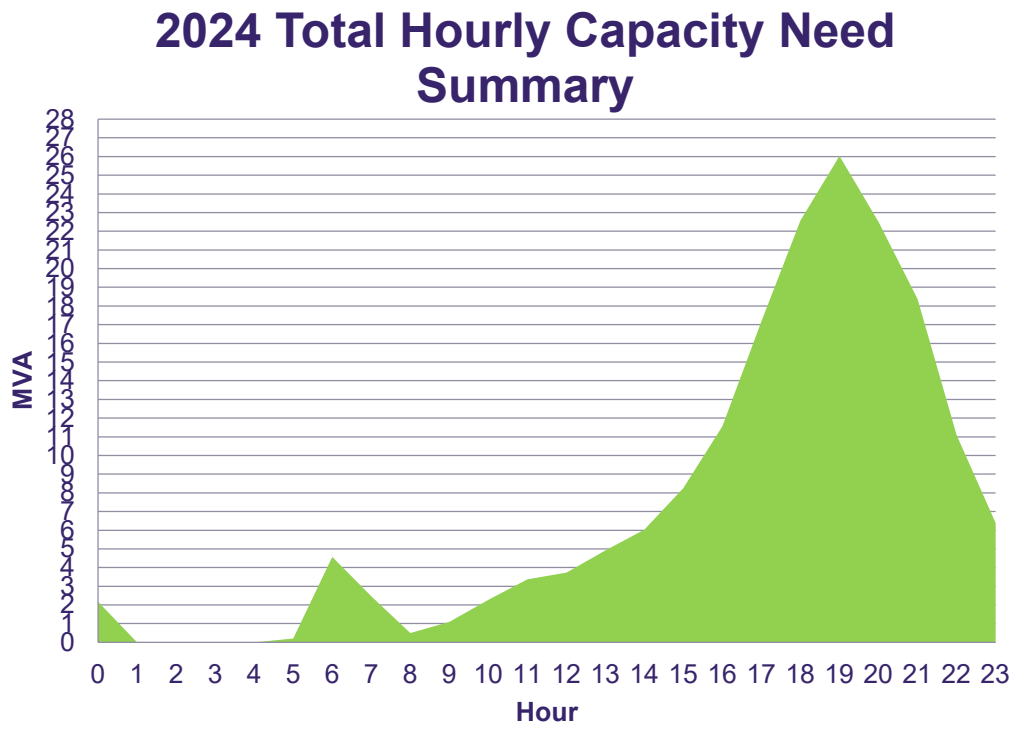
Improved customer voltage

Increased hosting capacity

Example Solution: NWA or Traditional Substation Capacity

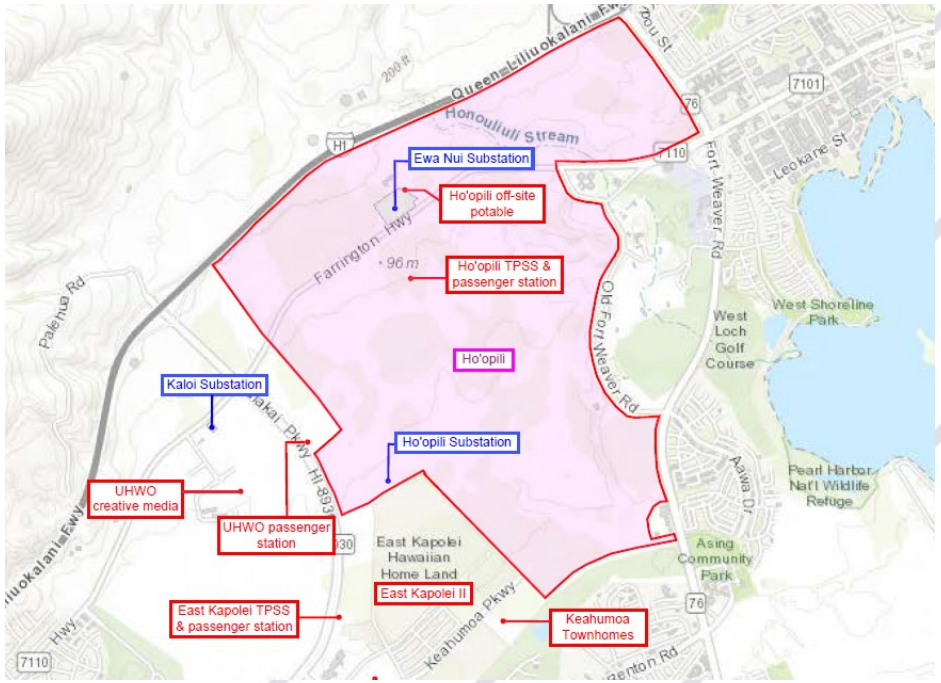
Solution benefits include: Mitigate overloads due to electrical load growth of new subdivision

NWA



Equipment	MVA peak	Delivery Months	Delivery Hours	Hours duration	Max Days	MWH
Normal	8.6	Jan - Dec	1PM - 12AM	11	365	39.6
Contingency	26.1	Jan - Dec	5AM - 1AM	20	365	174.9

New Substation



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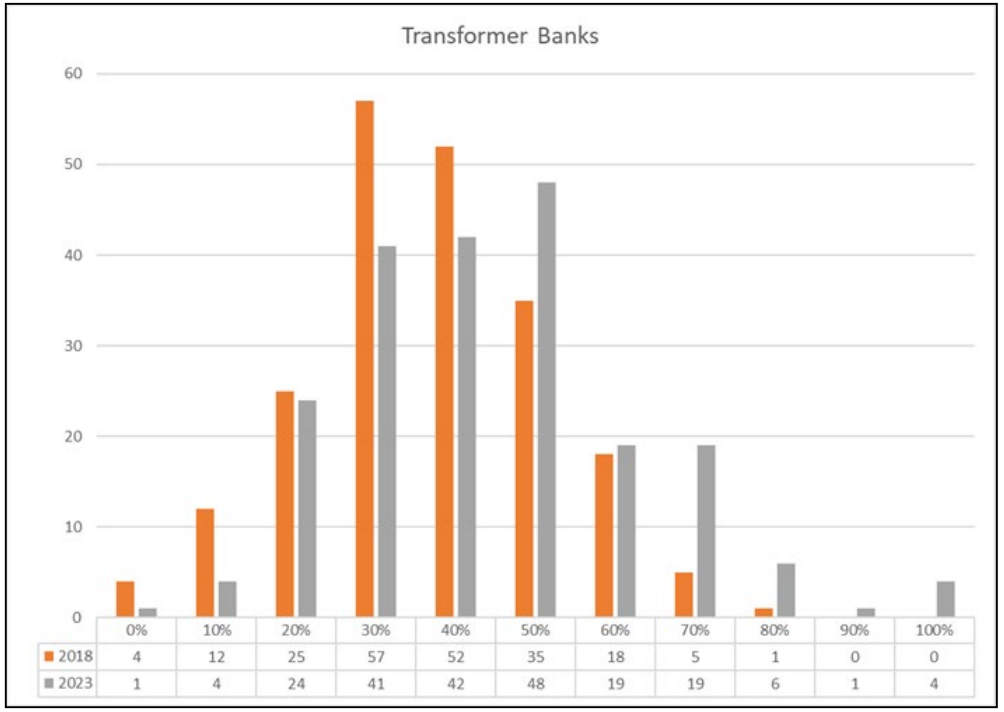
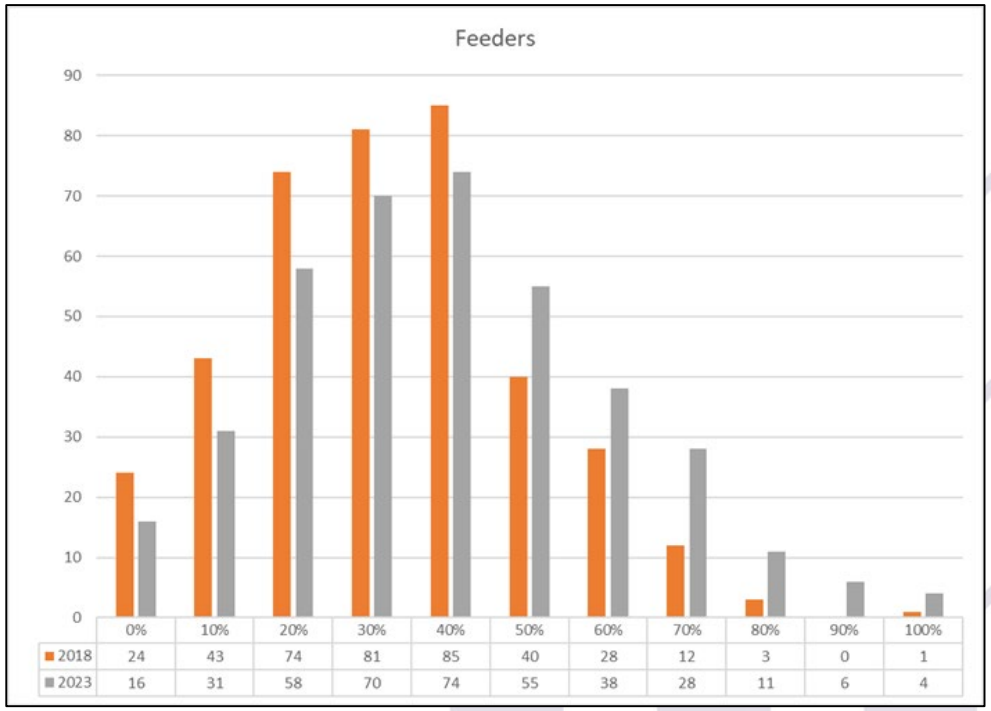
Define Grid Needs Deliverables (Example for Discussion):



Substation Transformer Needs



Circuit Needs

- In 5 years, five distribution substation transformers will be within 10% of ratings
- In 5 years, twenty-one distribution circuits will be within 20% of rating limit

DER Planning Best Practices:

- Utilities should prepare probabilistic forecasts of DER growth on their systems to ensure that plans account for uncertainty of DER adoption rates
- DER plans should provide a long term plan for distribution system investments and an analysis of non-wires alternatives
  - Some NWA may be dependent on customer adoption rates and will need to be procured over time
  - Conversely an NWA resource might be more flexible than an infrastructure investment that may take significant time

Recommendations from Washington Utilities and Transportation Commission: Report on Current Practices in Distributed Energy Resource Planning (12/31/2017)

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MAHALO!

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