

# DPWG Meeting

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## **Today's Objective:**

Discussion on how the LoadSEER tool will be utilized to generate circuit level forecasts for use in the distribution planning process to identify grid needs.

## **Next Meetings:**

Soft Launch Debriefing Session and Next Steps, March 9, 2020

Review DPWG Deliverable Comments, End of March



# Soft Launch Update and Next Steps

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Next Meeting:

Hawaiian Electric Integrated Grid Planning (IGP) "Soft Launch" RFP Debriefing Session

Monday, March 9, 2 p.m. - 4 p.m. HST

American Savings Bank – 8th floor (Conference Room - ASB 2)

1001 Bishop Street

Honolulu, HI 96813

Please contact Isaac Kawahara at [isaac.kawahara@hawaiianelectric.com](mailto:isaac.kawahara@hawaiianelectric.com) for webex registration information.





# Hawaiian Electric LoadSEER 2020

*Forecast and Data Review*

*3/5/2020*

# Presentation Outline




### DPWG Meeting

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Discussion on how the LoadSEER tool will be utilized to generate circuit level forecasts for use in the distribution planning process to identify grid needs.

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### LoadSEER Platform & Framework



### Multiple Methods for Better Forecasts



### LoadSEER Framework and Process



### Data Sources



### Bottom-up Load Shape Library



### Geospatial Load and DER Growth

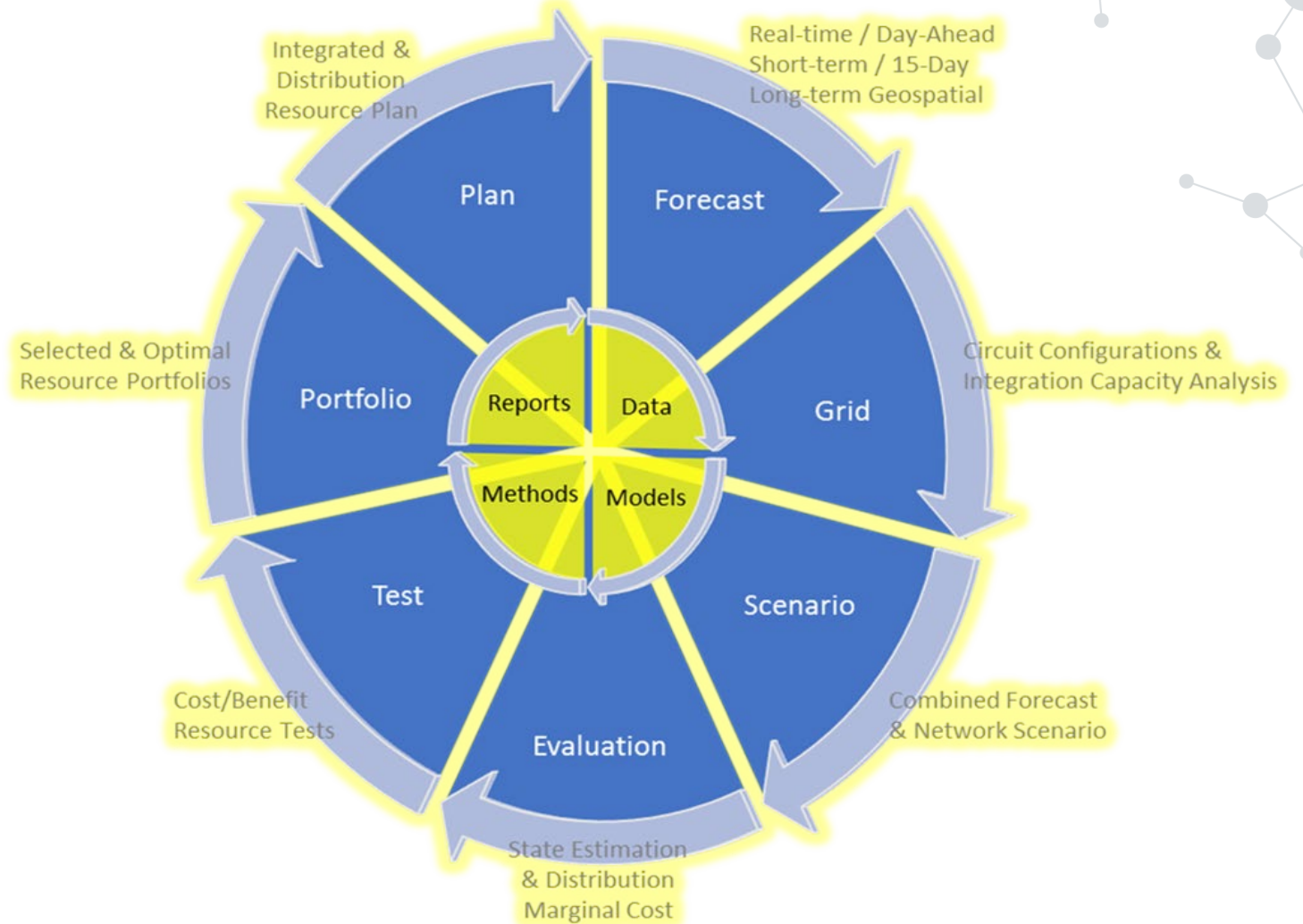


### N-1 Contingency Analysis



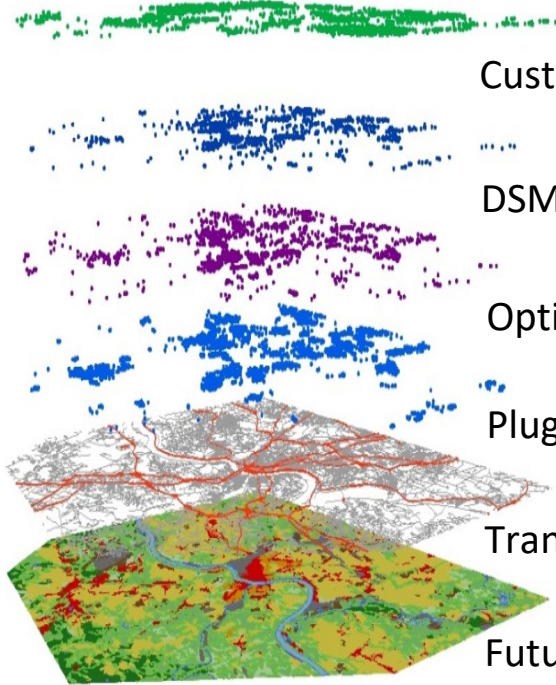
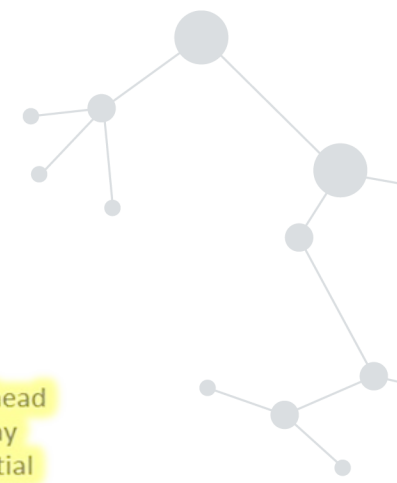


# LoadSEER Platform & Framework

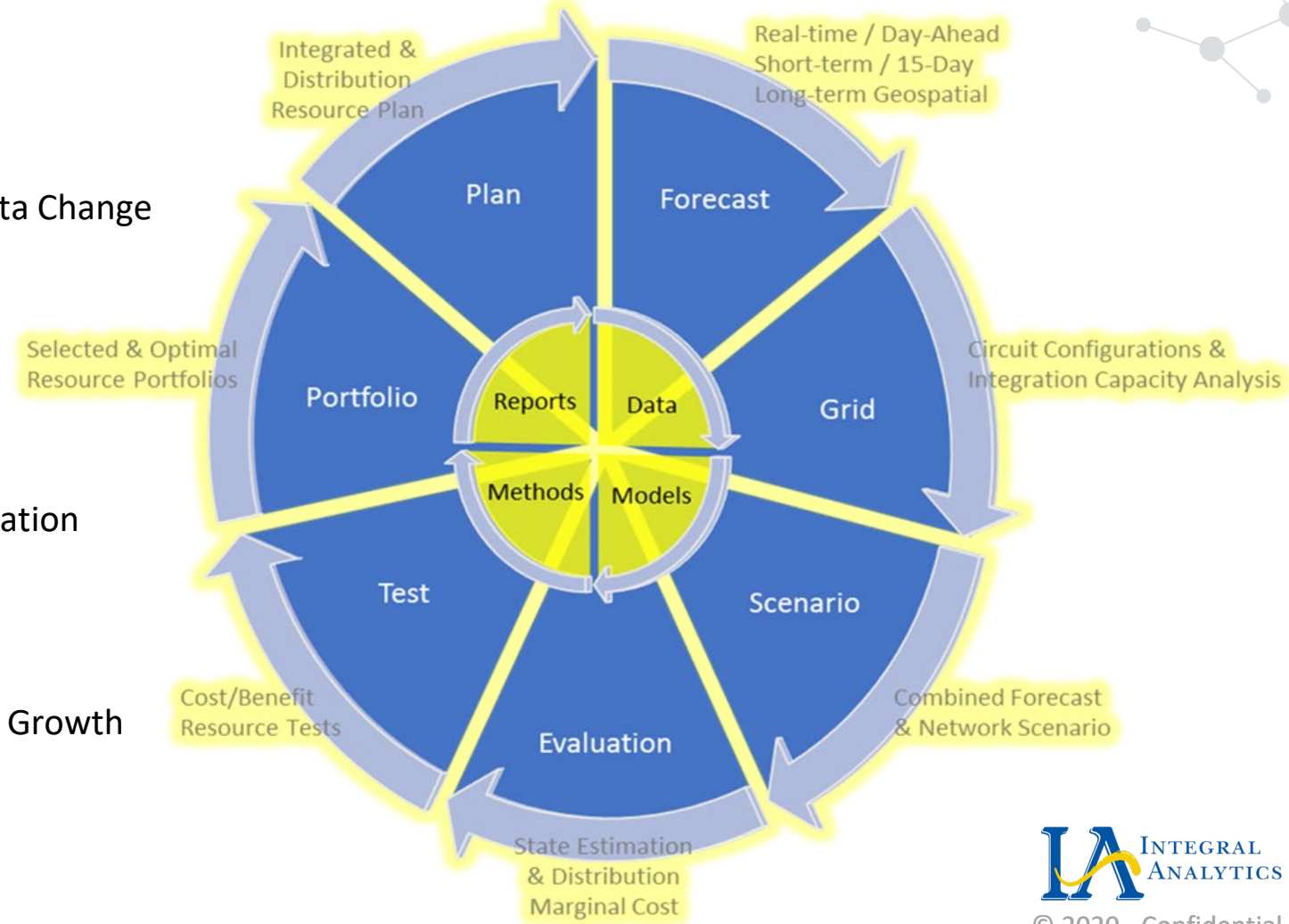


# DER Forecasting: A New Market Discipline

Blending Forecasting, Planning and Operations ...  
 ... where *will* and where *ought* DERs show up ?



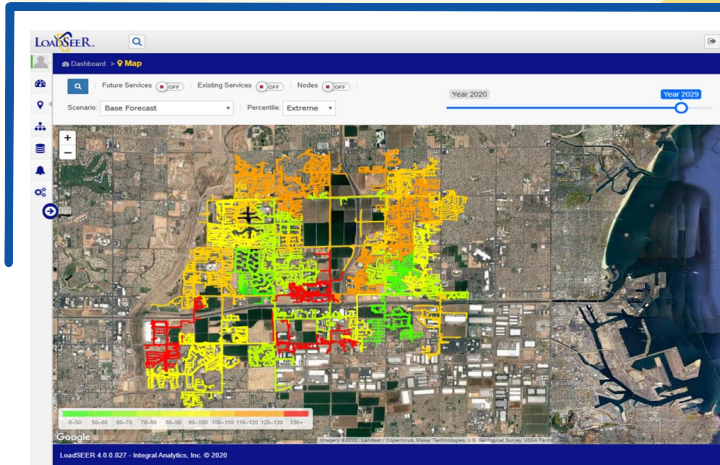
- Customer Locations / Per Capita Change
- DSM / Load Control
- Optimal Solar/Storage Sites
- Plug-in Electric Vehicle Penetration
- Transportation Infrastructure
- Future Land Use/Econometric Growth



# IA Product Suite Integrates Planning and Operations



## Distribution Planning/IRP



**Objective: 20-Year Hourly Load and DER Forecasts**

- Aggregate to Feeder / Substation / Planning Area
- OR granular down to Line Section and Premise

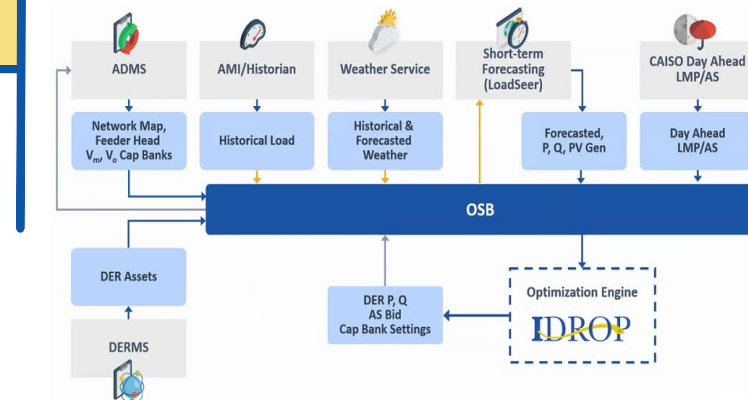
## DER Integration/DRP



**Objective: Scenarios Cost Effectiveness for DER & Capital Optimization**

- Year by Year 8760 Optimized DER Portfolio
- Optimized on load profile and marker parameters

## Operations/Port Ops

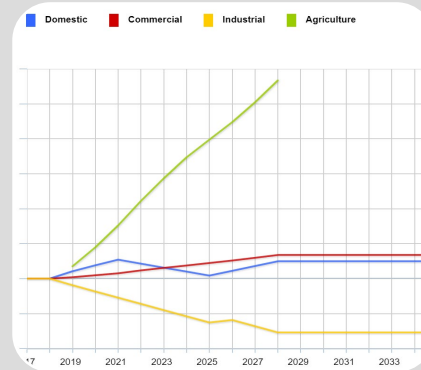
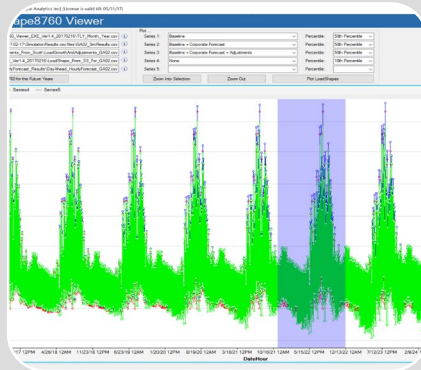


**Objective: Optimize DER Dispatch Schedules**

- Set of near-real time Distribution Network Wide Optimizations
- Optimized on economics and network analysis
- Add-on to ADMS/DERMS



# Forecast Modules Currently Available



## SCADA Scrubber

- Forecasts weather sensitivity of existing load
- Analyzes historic SCADA/AMI against weather station data

## Monthly Energy Forecasting

- Forecasts economic effect on growth
- Analyzes consumption data against economic data
- Goes down to customer Benefit / Cost analysis for DER

## Spatial Agent Based Modeling

- Forecasts social behavior of adopting new technology
- Analyzes customer data against spatial data
- A bottoms-up forecast, constrained to not exceed user defined limit.

## Adjustments

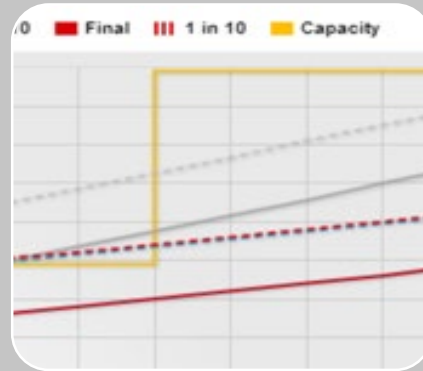
- Adds specific known new spot loads to the model
- Add specific new known customers and assign load shapes to account for how that customer's behavior

# Planning Modules Currently Available



## Create Transfers

- Transfers load across grid elements such as feeders and switches
- Used to see impact transfers have on forecast shapes



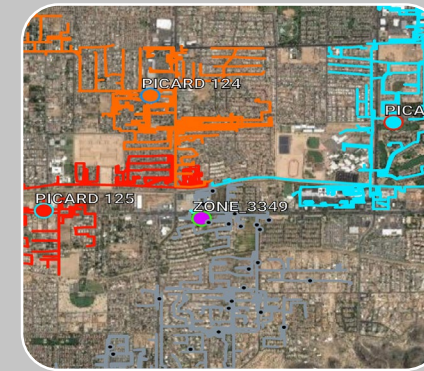
## Capacity Projects

- Create capacity additions in future years that represent new project work
- Adds capacity to relieve flagged conditions due to abnormal / overloaded states



## DER Optimization

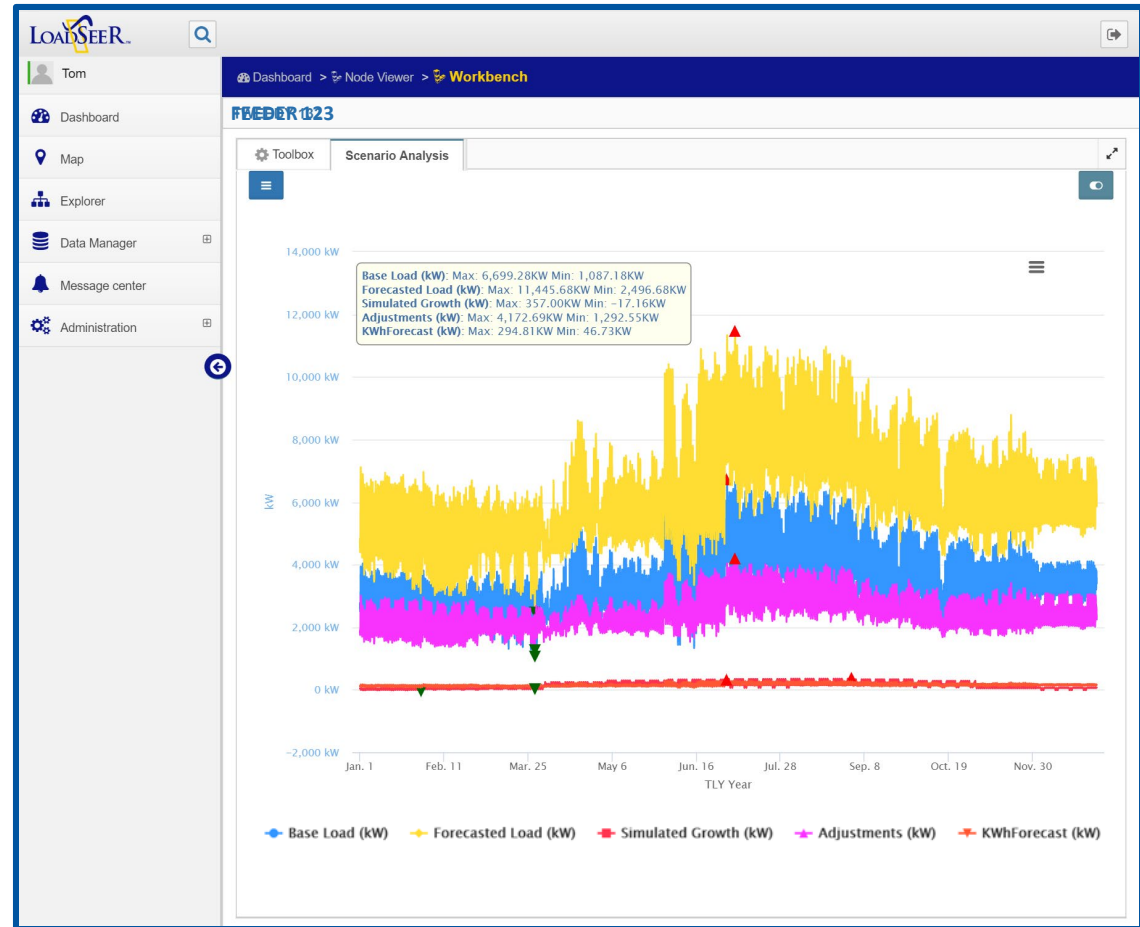
- Simulate optimal mix of DER on a node
- Mainly optimizes cost effectiveness, but can force constraint management to ensure reliability
- *Only available in v4*



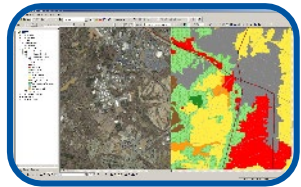
## Contingency

- Evaluate N-1 / Contingency event impacts to forecast
- Analyze in different scenario to not disrupt base forecast
  - *Only available in v4*

# Multiple Methods for Better Forecasts



# Multiple Method Approach for Convergent Validity



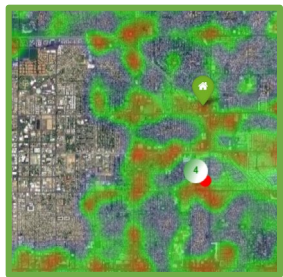
## Land Use Simulation

Model/simulate customer growth based on land-use/urban planning concepts and historical satellite imagery.



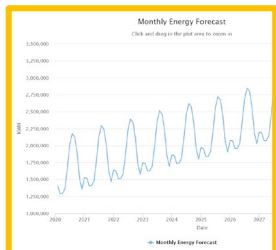
## Hybrid Methods

Combines features of trending and simulation. In general, trending methods are more accurate in the short-term whereas simulation methods are more accurate in the long-term.

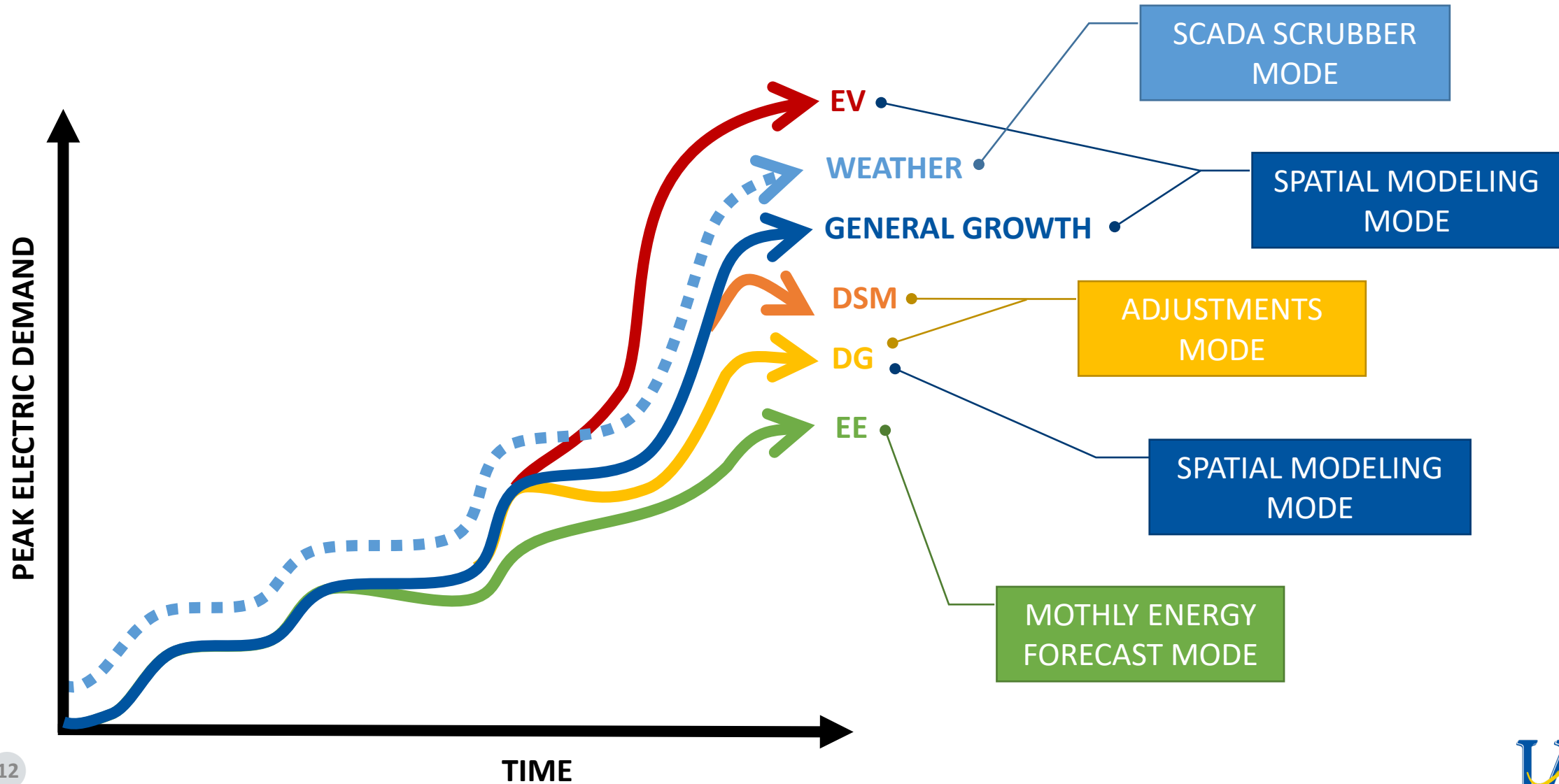


## Trending

Extrapolate past trends in energy consumption (kwh) on a distribution circuit and bank using economic and weather variable forecasts.



# Forecasting Positive and Negative Growth using Multiple Toolsets

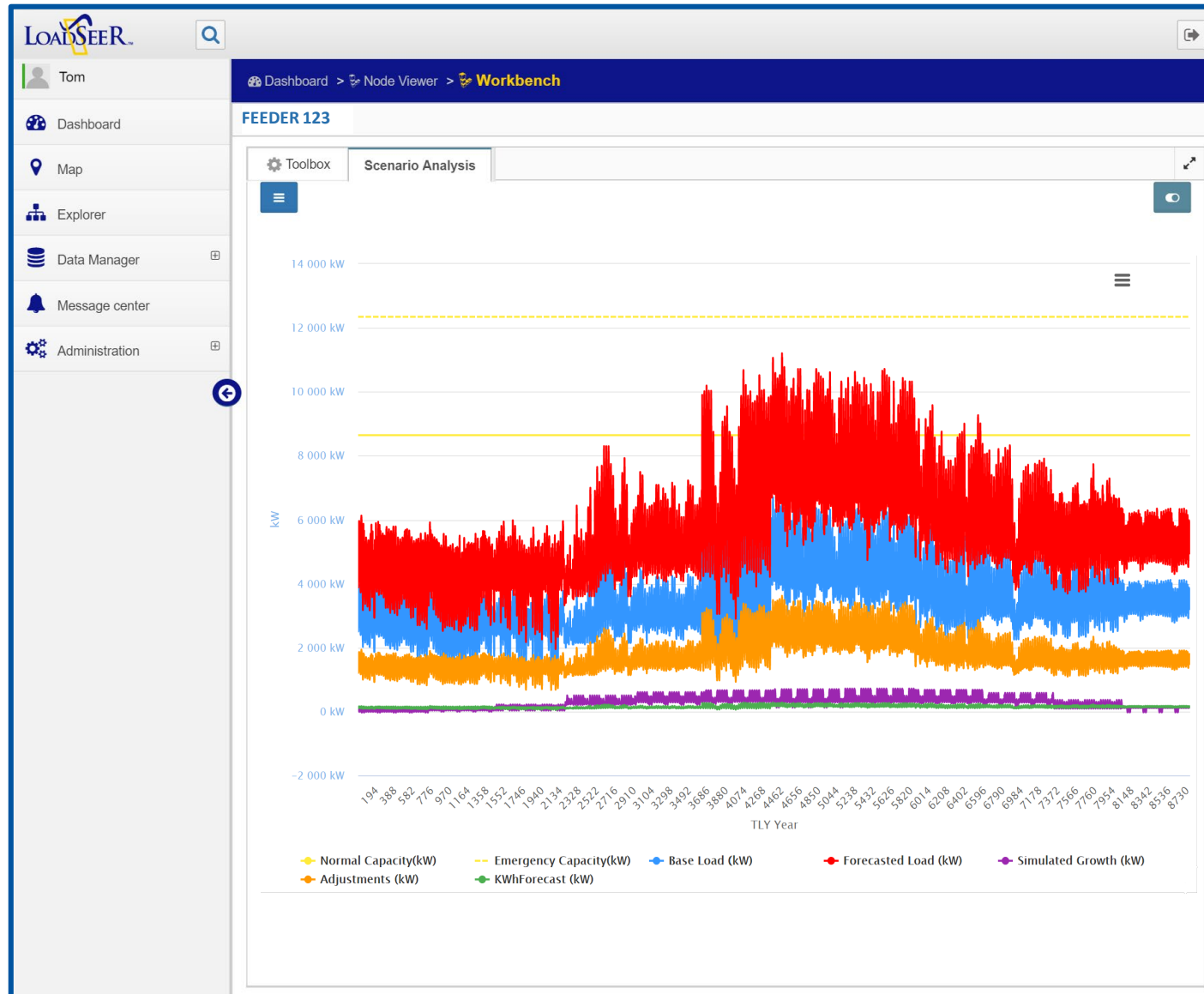




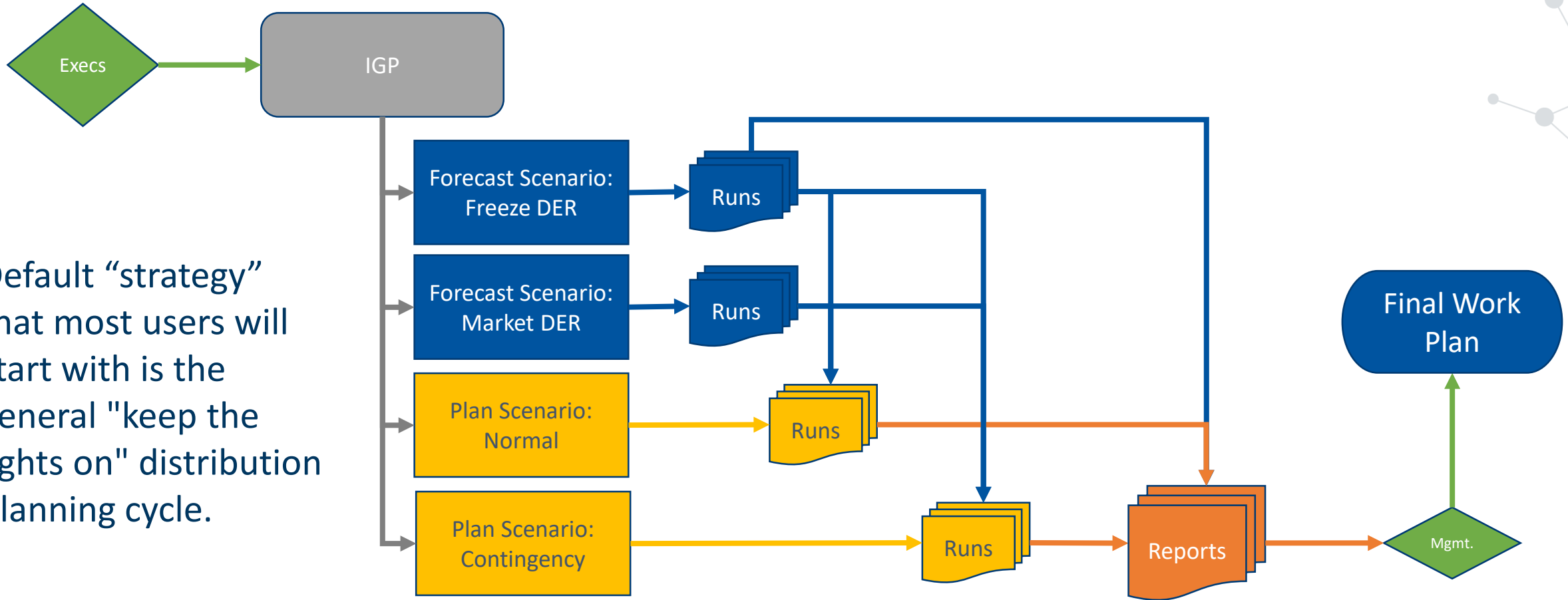
# Each Layer's Load Shape is Stacked to Create a Final Forecast



- Each layer evaluated for impact to base shape
- All layers exportable

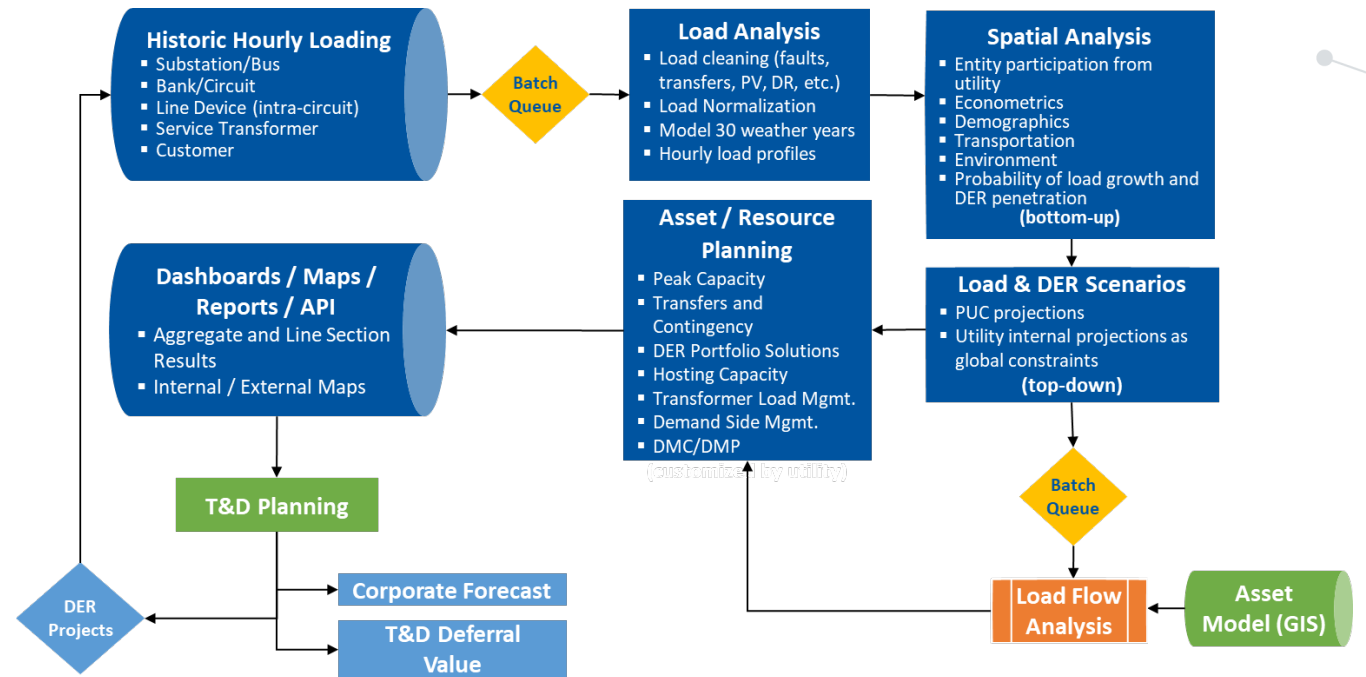


# Strategies, Scenarios, and Runs

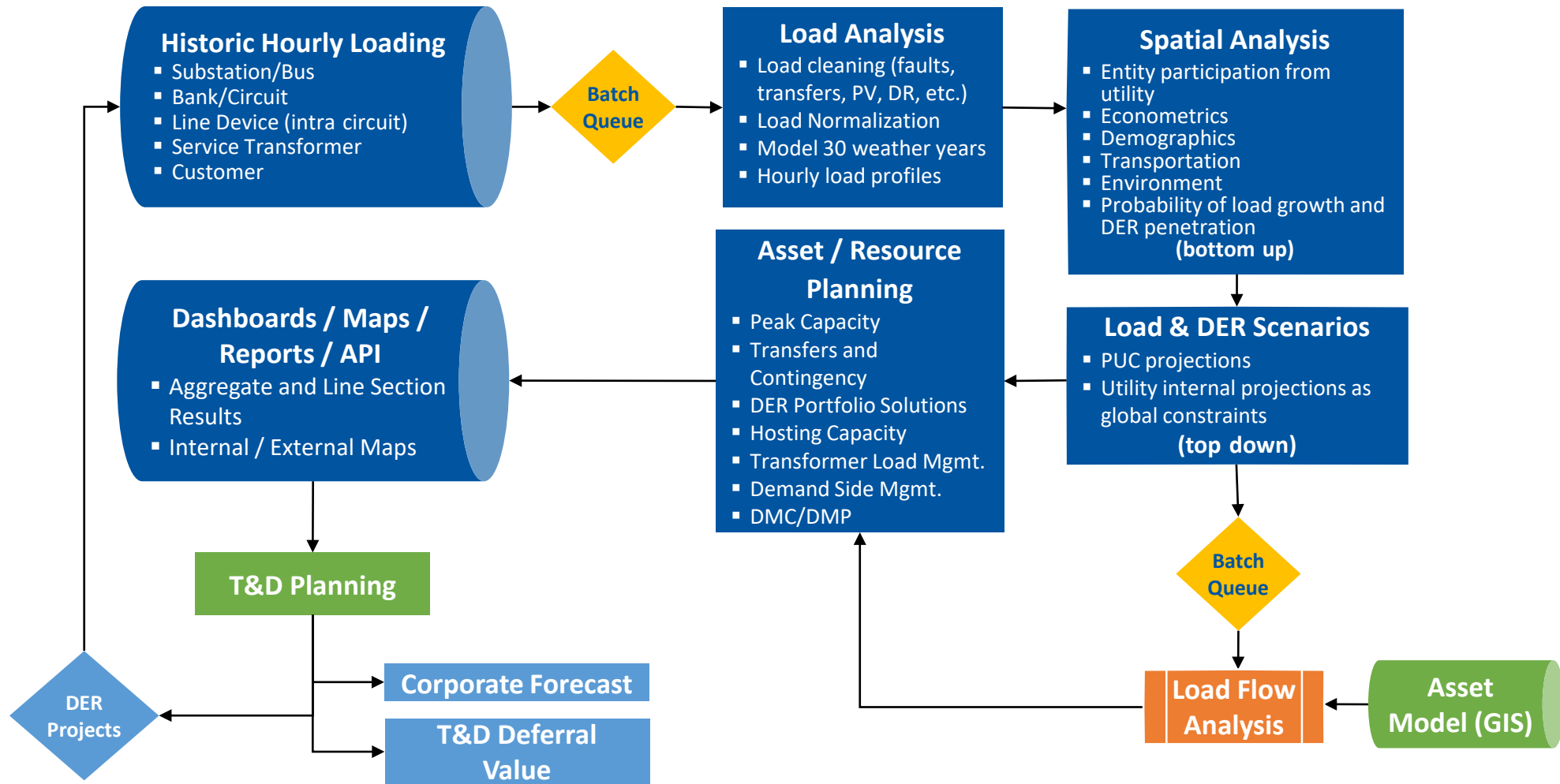


Default “strategy” that most users will start with is the general “keep the lights on” distribution planning cycle.

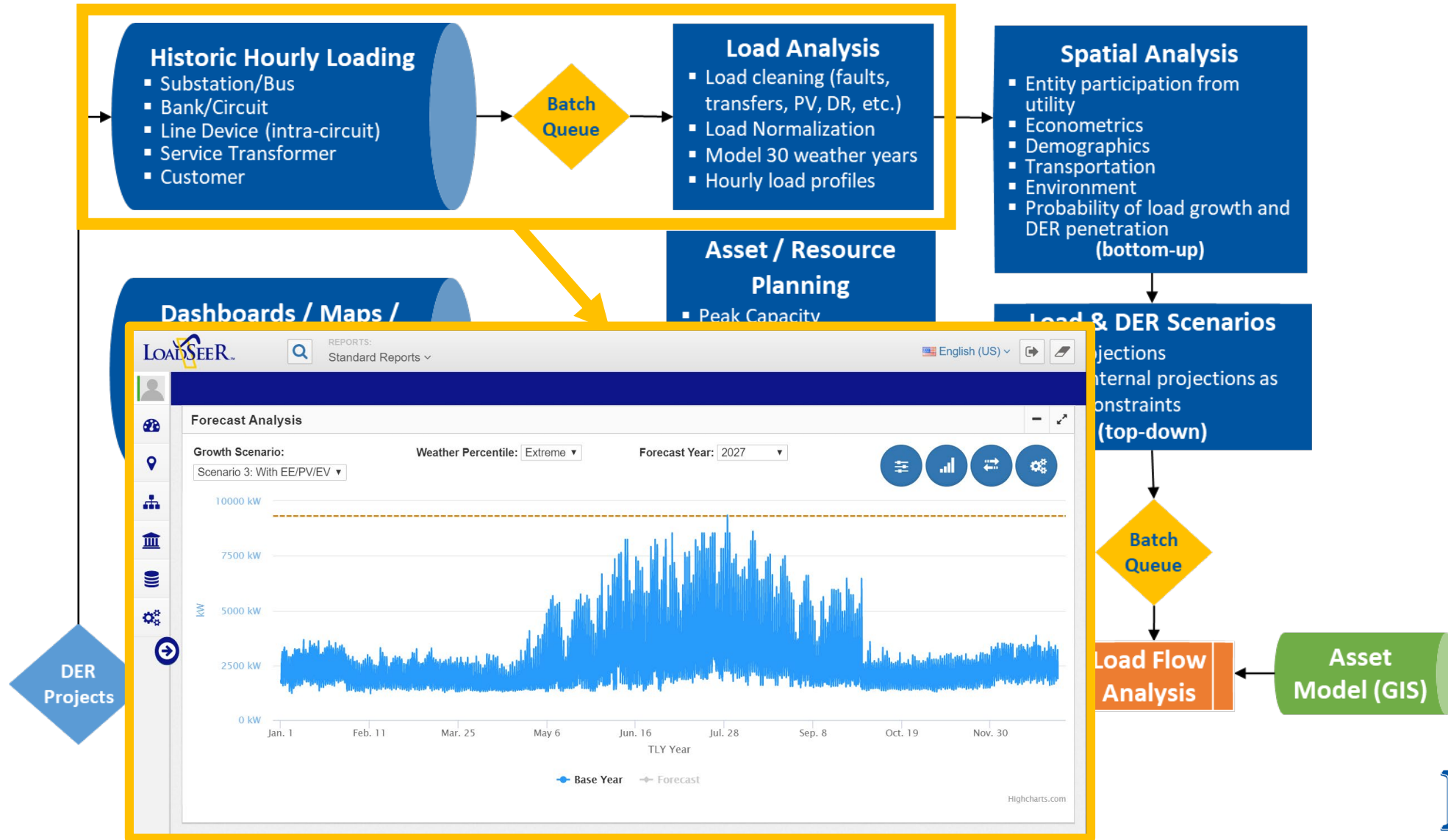
# LoadSEER Framework and Process



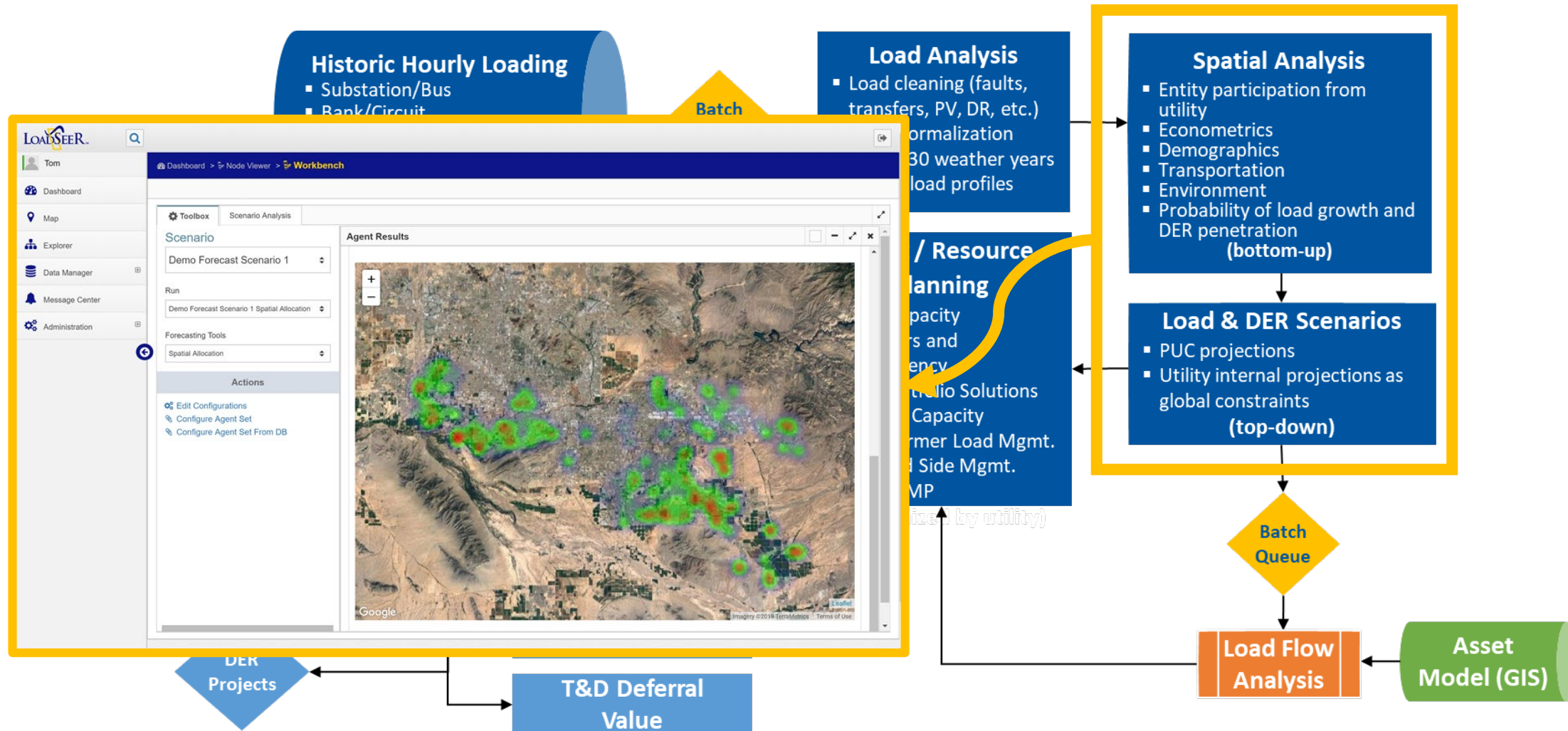
# Integrated Planning LoadSEER-Enabled Flow



# Weather Normalize and Build Hourly Base Shapes



# Forecast Scenarios of Growth (or lack there of) and DER Adoption



# Export Feeder or Line Section Forecasts into Power Flow Tools



SynId	SynYear	SynKw	SynPf
3756744	2018	0	0.9
3786124	2018	0	0.9
3790292	2018	3.4	0.9
5137580	2018	21.1	0.9
5137662	2018	26	0.9
5137911	2018	12	0.9
5137924	2018	11.1	0.9
6492447	2018	21.4	0.9
6492448	2018	36.5	0.9
11734575	2018	0.1	0.9
17181046	2018	5.4	0.9
17181047	2018	42.2	0.9

**Load Analysis**  
 Load cleaning (faults, transfers, PV, DR, etc.)  
 Load Normalization  
 Model 30 weather years  
 Hourly load profiles

**Spatial Analysis**

- Entity participation from utility
- Econometrics
- Demographics
- Transportation
- Environment
- Probability of load growth and DER penetration

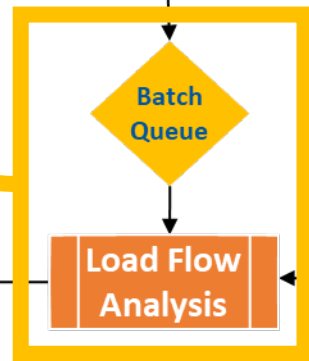
**(bottom-up)**

**Asset / Resource Planning**  
 Peak Capacity  
 Transfers and  
 Agency  
 DER Portfolio Solutions  
 Hosting Capacity  
 Transformer Load Mgmt.  
 Demand Side Mgmt.  
 MC/DMP

**Load & DER Scenarios**

- PUC projections
- Utility internal projections as global constraints

**(top-down)**

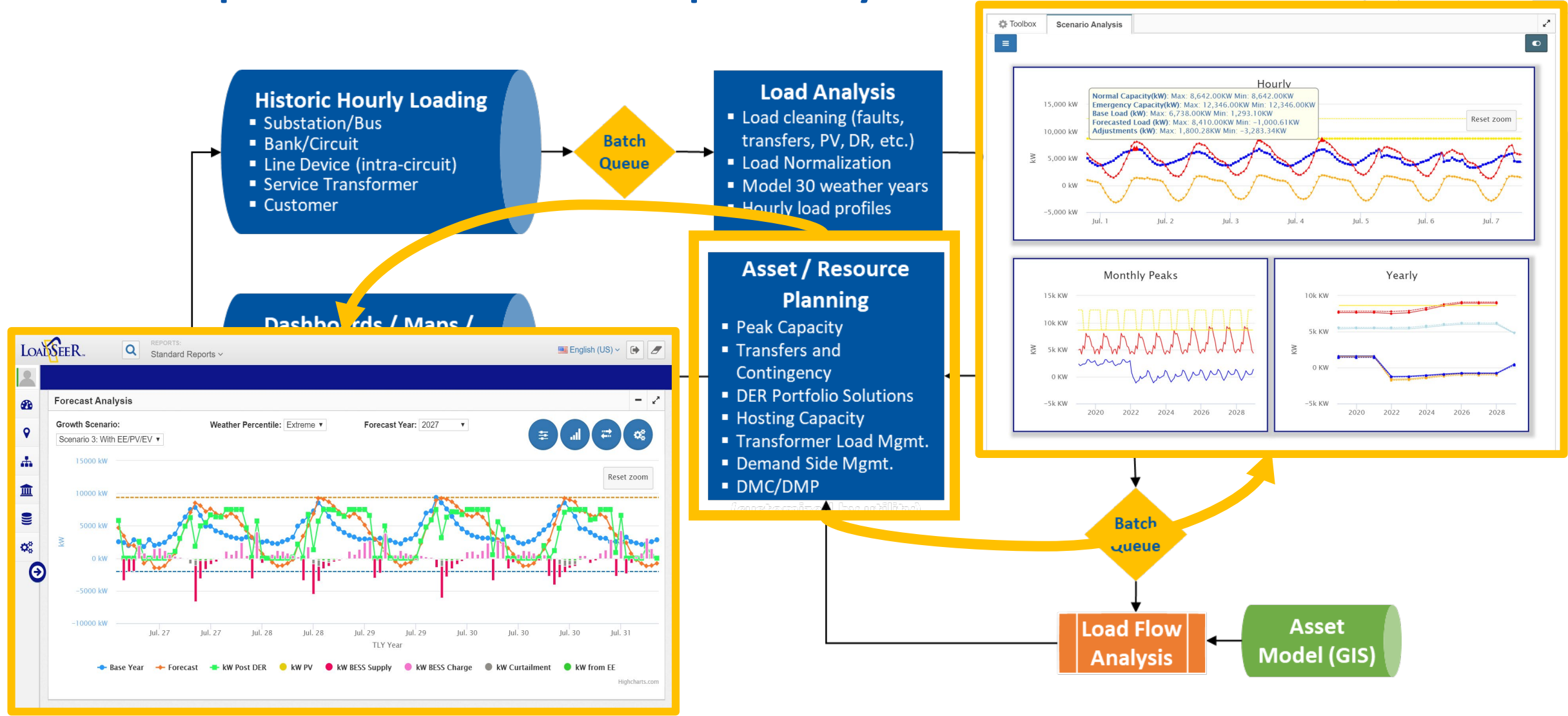


Asset Model (GIS)

Value



# Plan and Optimize for Forecast's Impact to System





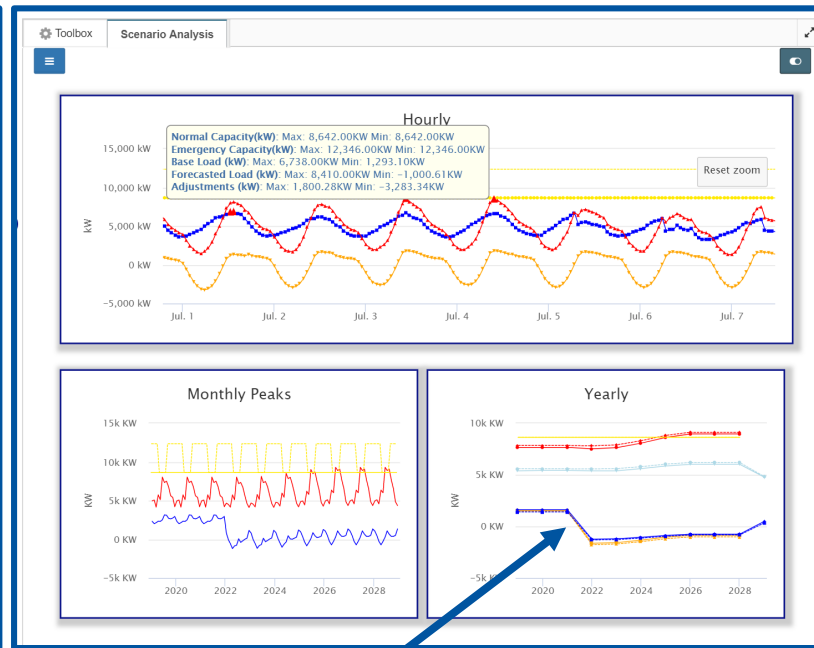
# Scenarios and Multiple Forecast Methods for Better Confidence

Scenario Engine allows for easier management of multiple forecasts and plan

## General Growth and Adjustments

## + 4MW PV Forecast

## + 4MW EV Forecast



4MW PV forecast does not change peak, while drastically changing minimum load

4MW EV add to peak and have little effect on PV minimum load

Load Analysis

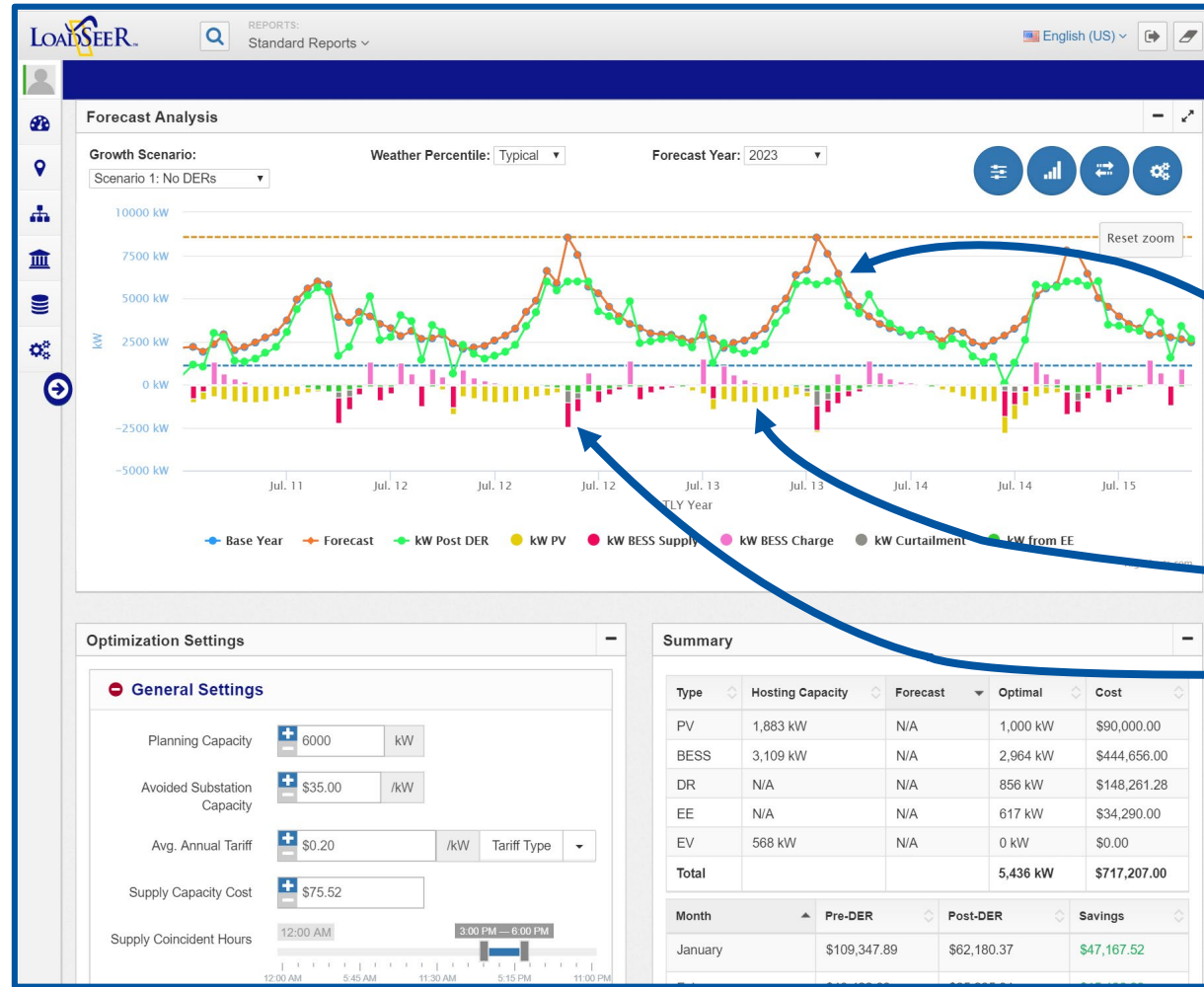
Spatial Analysis

Forecast Scenarios

Plan Scenarios

Export Forecasts

# Plan Transfers, Capacity, or Build DER Portfolios



- Analyze Transfer and Capacity Scenario Adjustments
- Build DER Portfolios
  - Add DER capacity limitations
  - Forecast constrained to 6MW (Hosting Capacity)
  - PV constrained to 1MW
  - Storage Charge/Discharge responds
  - Optimizes on single asset load shape

Load Analysis

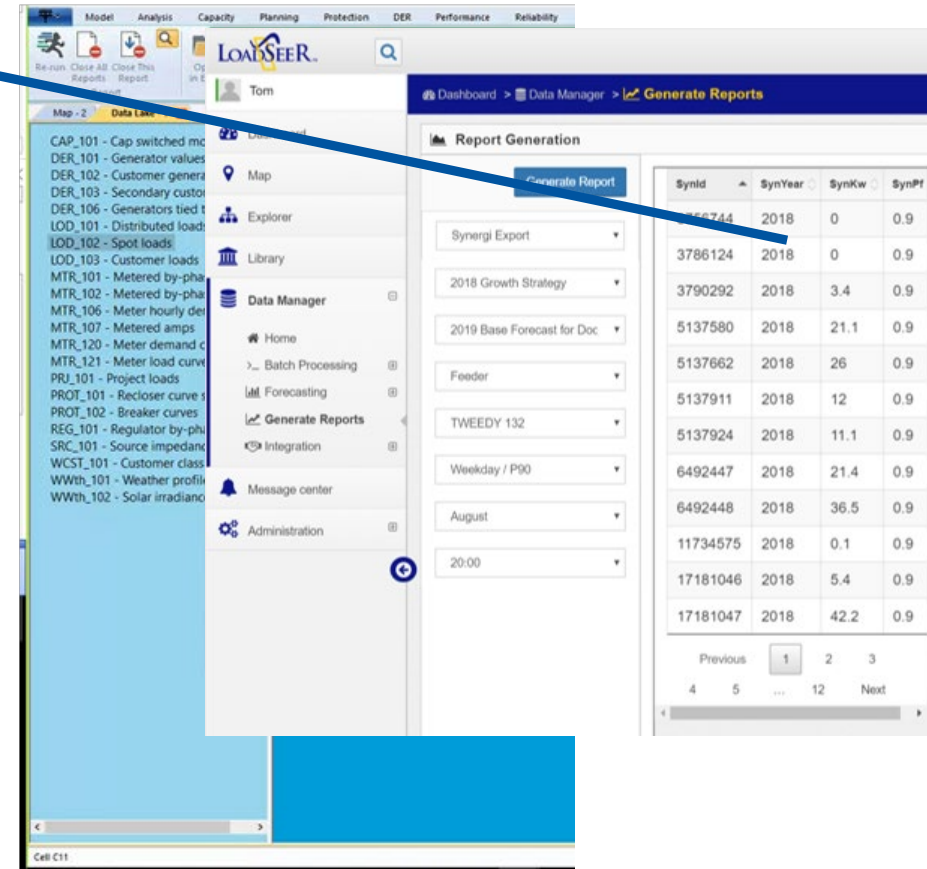
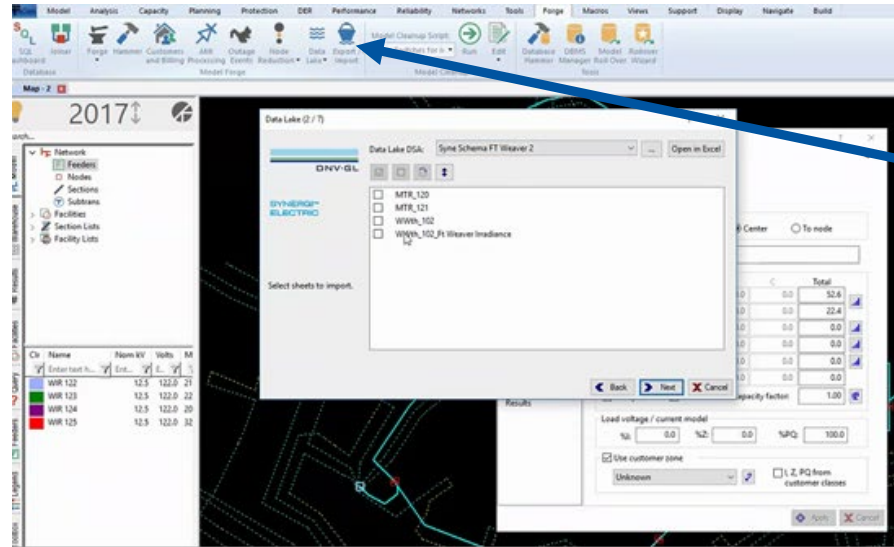
Spatial Analysis

Forecast Scenarios

Plan Scenarios

Export Forecasts

# LoadSEER -> Synergi



- Export LoadSEER forecast and growth data to Synergi
- Synced to Synergi connectivity model
- Aggregated to feeder or exported directly per line section

Load Analysis

Spatial Analysis

Forecast Scenarios

Plan Scenarios

Export Forecasts

# Data Sources





# Hawaiian Electric LoadSEER 2020 Overview – Bottom-up Map Layers

- Infrastructure

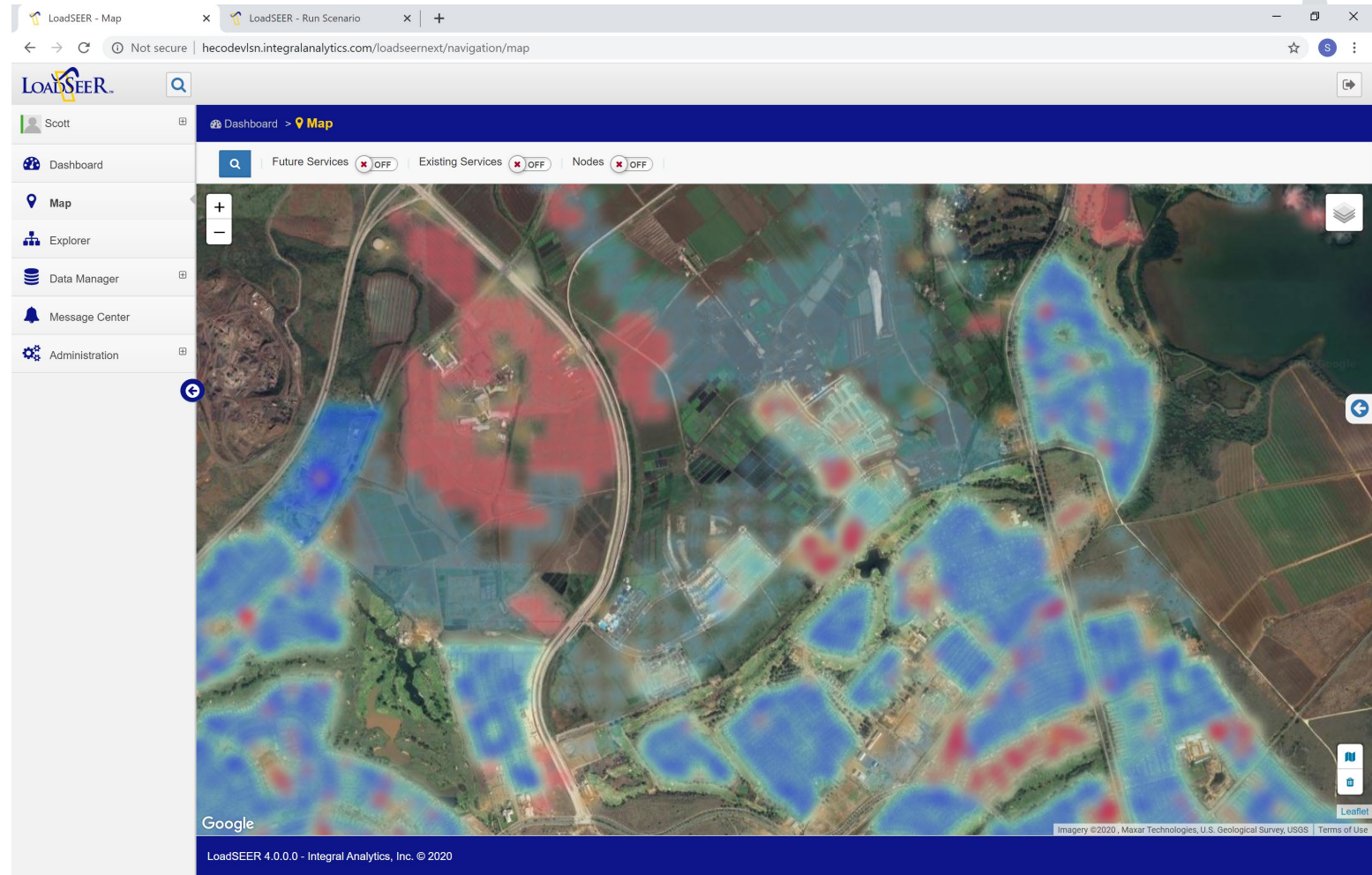
- Transportation
- Land use and zoning
- Electric T&D model (HECO)

- Existing Service Points

- Monthly consumption history
- DER adoption / participation
- Hourly load shapes (MV90, PI, AMI, Grid 2020)

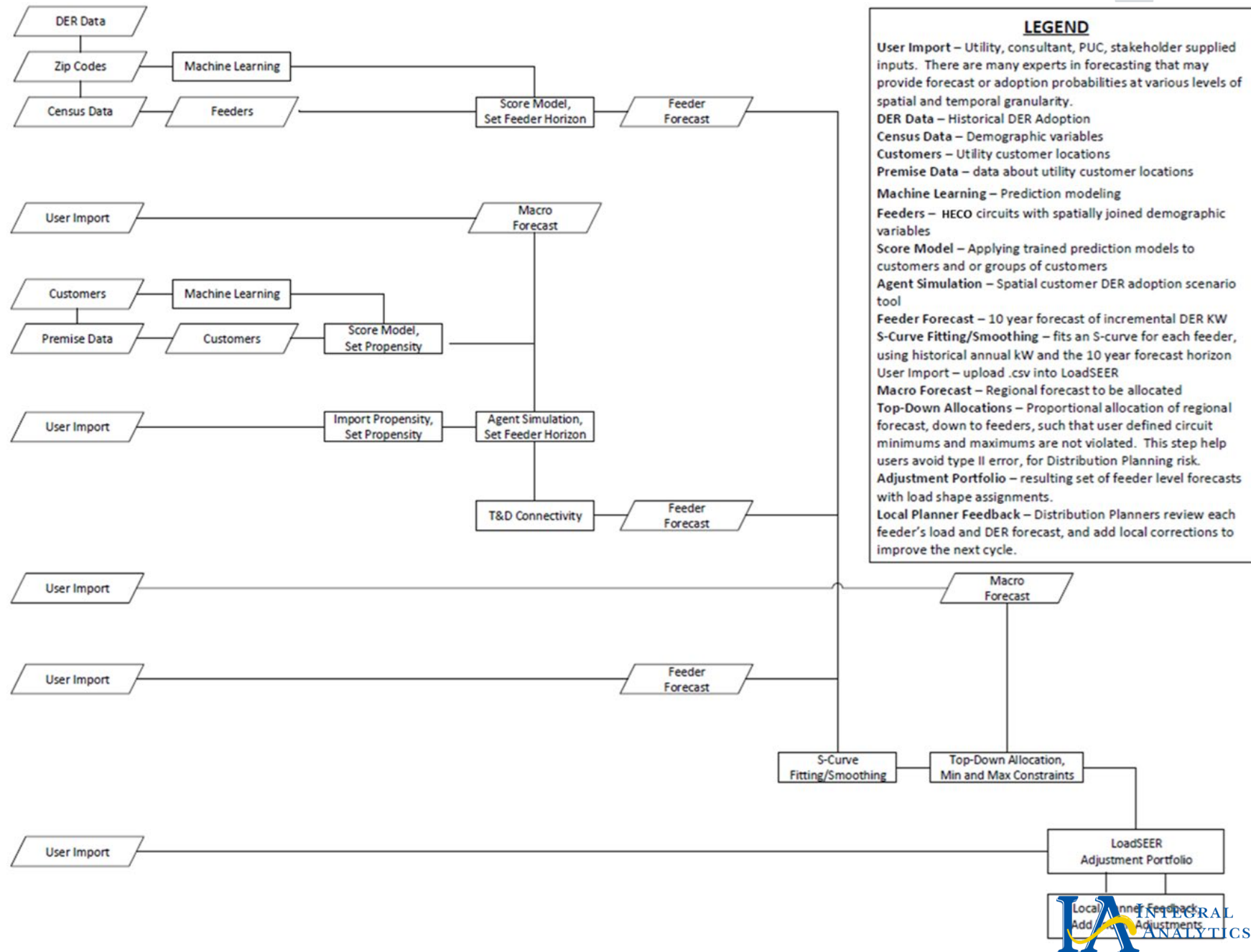
- Future Service Points

- Satellite Imagery (NASA, USGS)
- Parcel metadata (Oahu)
- Google Solar Roof Project
- HECO forecasting group Census Tract Models
- Continuous map updates by user
- DER interconnection queue



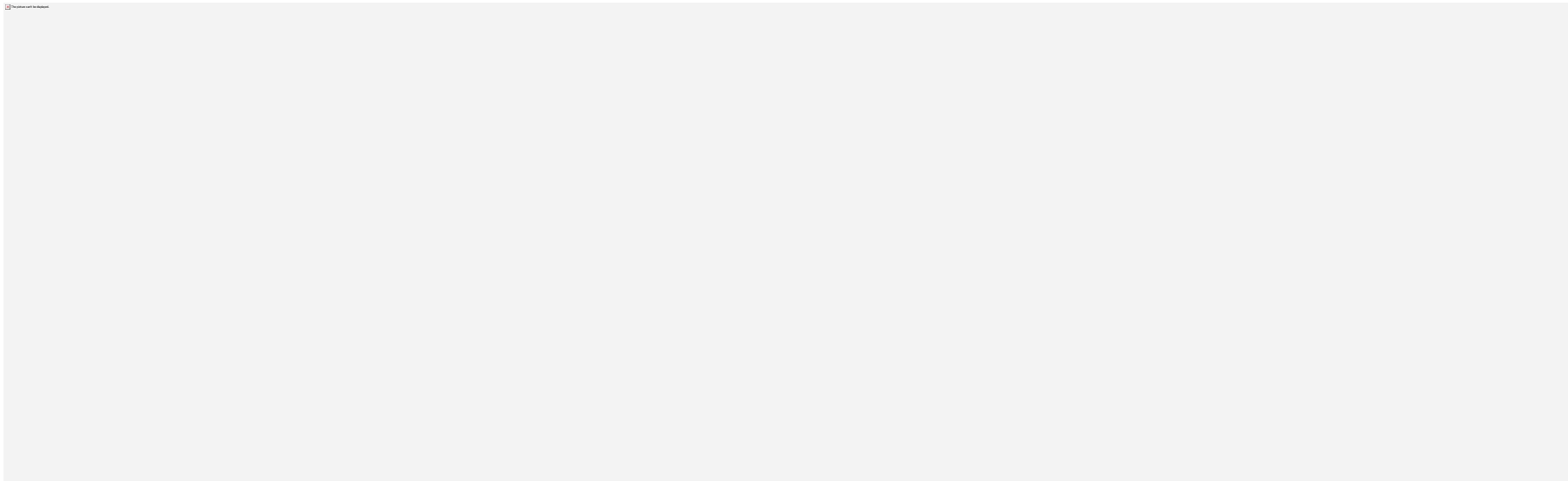
# Hawaiian Electric LoadSEER Allocation Framework

- HECO's allocation methodology supports various sources of micro and macro level forecasts.
- New methods will emerge over time
- Different DER technologies may require different forecast allocation methods
- A single DER technology can be forecasted and allocated with multiple methods
- Internal and external experts build multiple propensity and forecast models for a single DER
- Management may want to include multiple forecasts and allocation methods, from both internal and external experts
- Different internal and external stakeholders have different objectives and use cases
- Different objectives and use cases may justify different forecast allocation methods

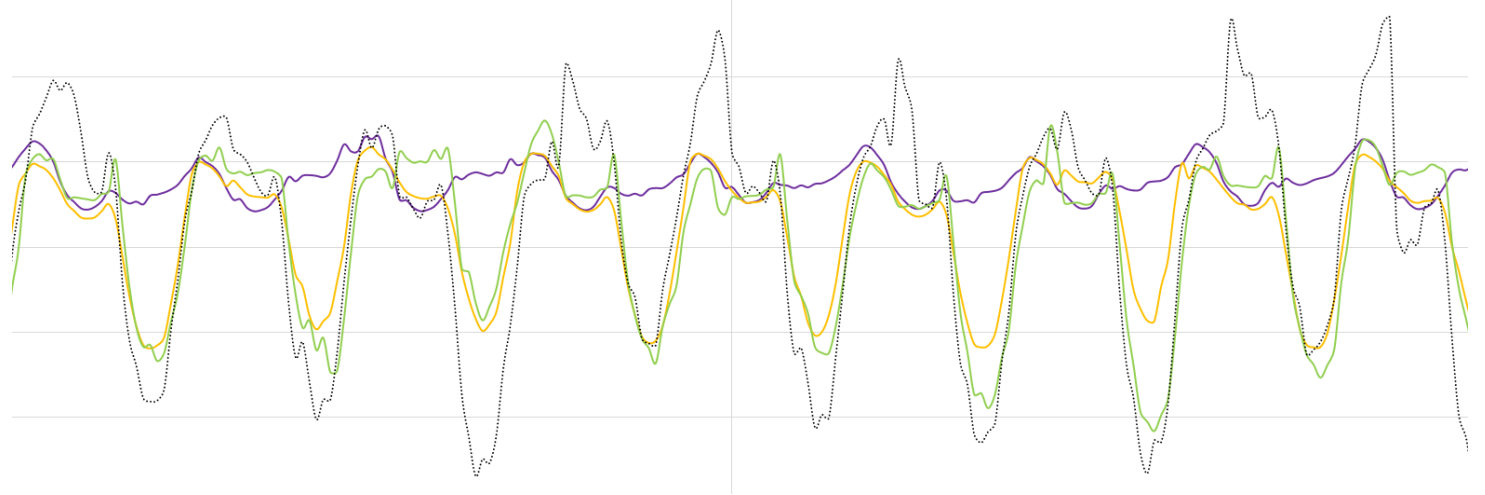


# HECO LoadSEER Constrained Bottom-up Example (stylized)

- Step1 (blue box) – Unconstrained Horizon forecast
  - This is a forecast using customer and or census level variables and predictive adoption modeling
- Step2 (red box) – Historical DER penetration
  - This is a data collection step, that is automated in loadseer
- Step3 (yellow box) – Curve fitting
  - This is an s-curve fitting process that connects the historical penetration (red) up to the unconstrained horizon forecast (blue)
  - These curves get transformed into incremental values, as preparation for a top-down allocation.
- Step4 (green box) – Allocation
  - The macro forecasts (mw) are transformed into incremental annual values, and allocated proportionally to the feeders in that climate zone, respectively.



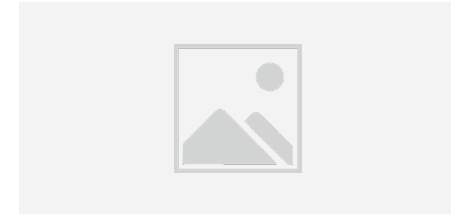
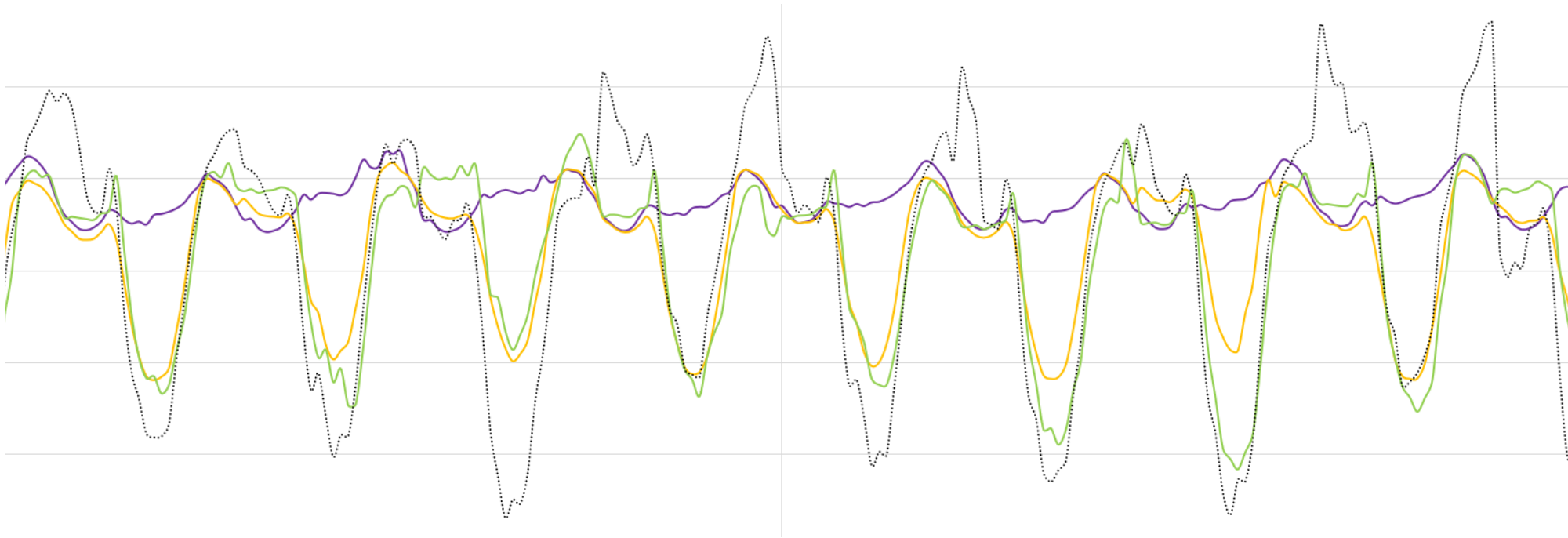
# Bottom-up Load Shape Library





# Hourly Shape Normalization and Covariance Analysis

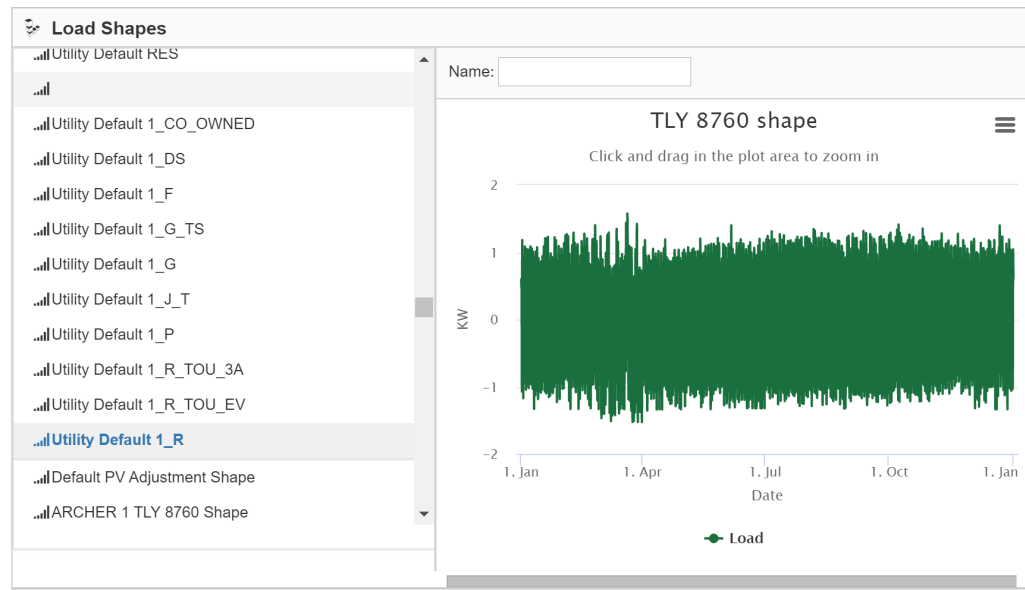
LoadSEER's normalization and covariance analysis helps build load shape library. Customers evolve from purple line into dotted black line.



# Customer Class/Rate R

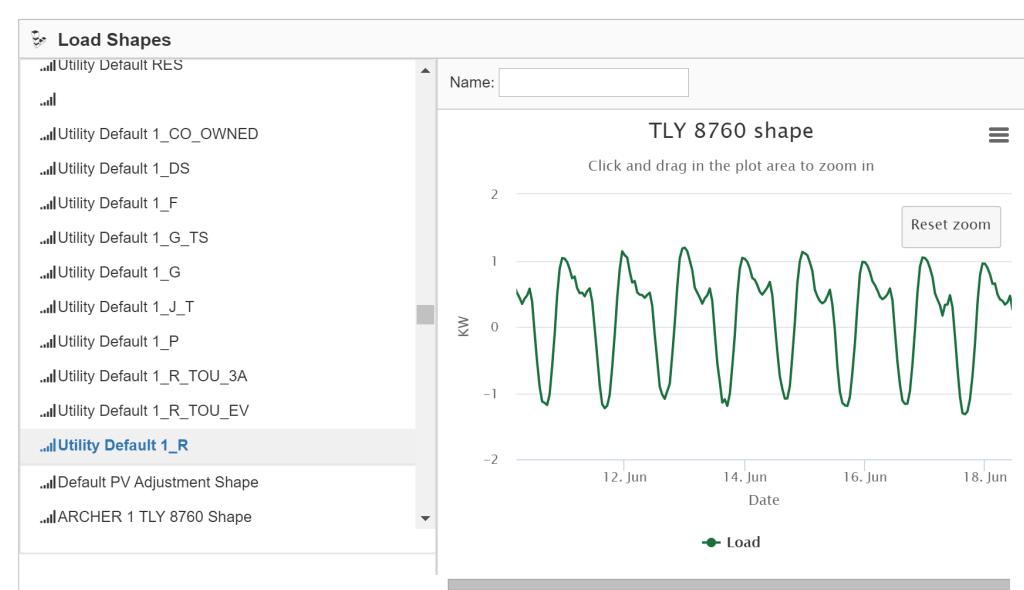


Load Shape Manager



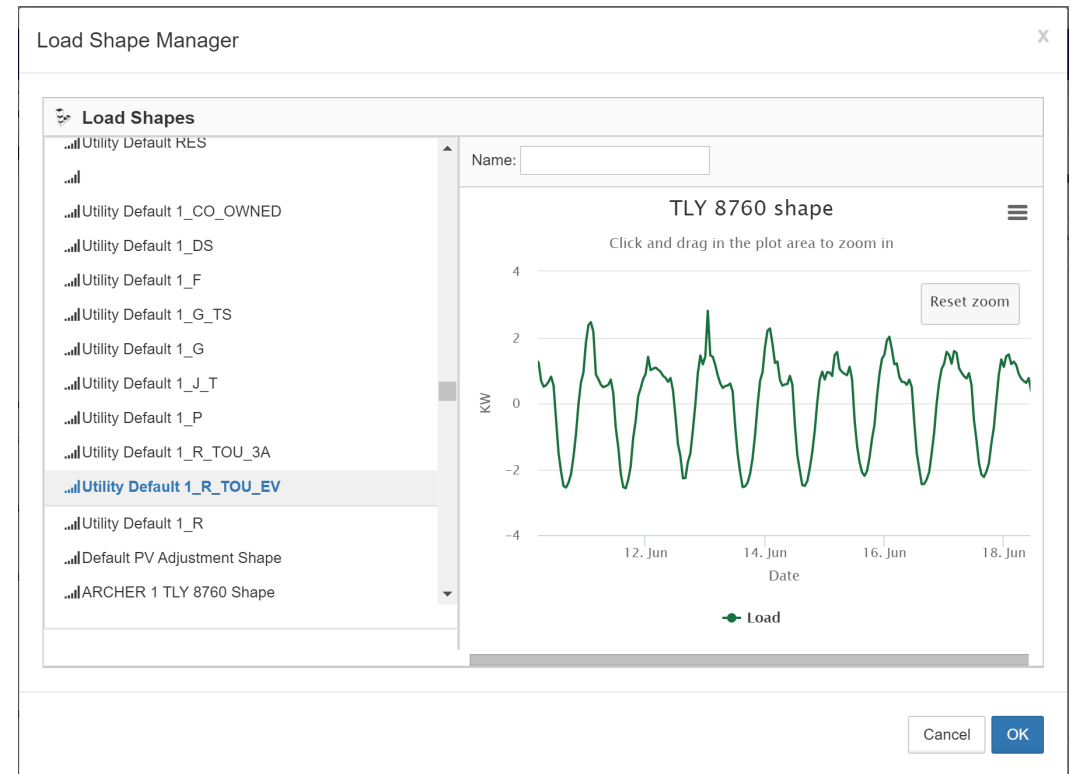
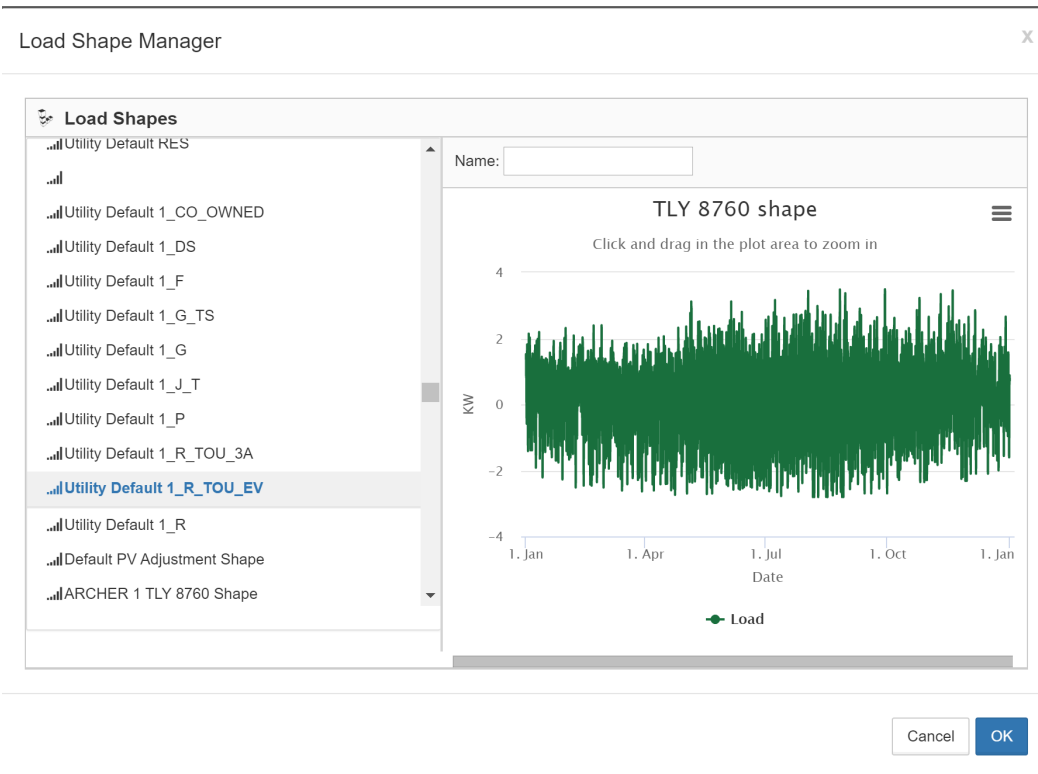
Cancel OK

Load Shape Manager

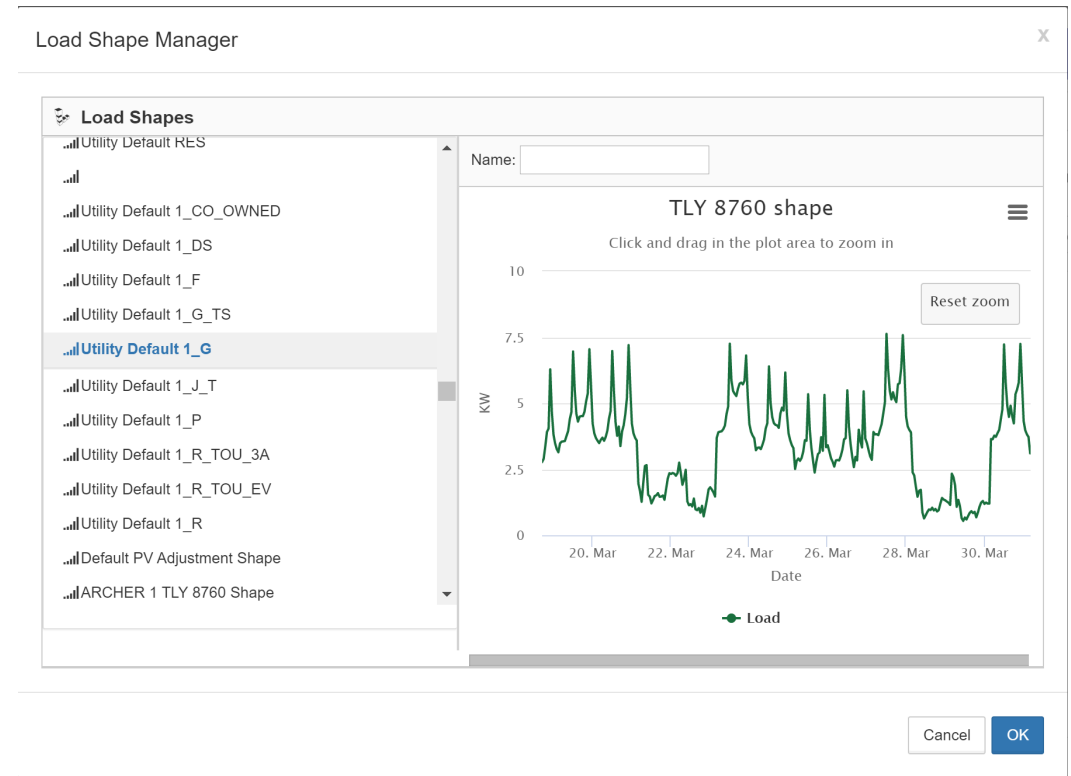
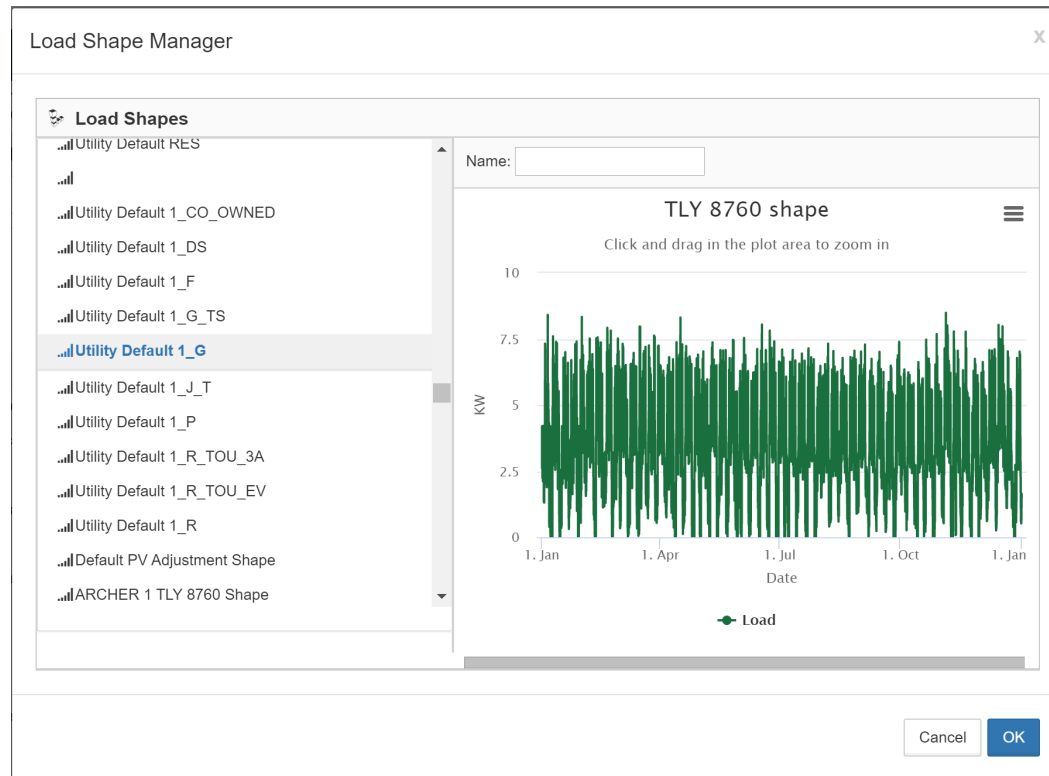


Cancel OK

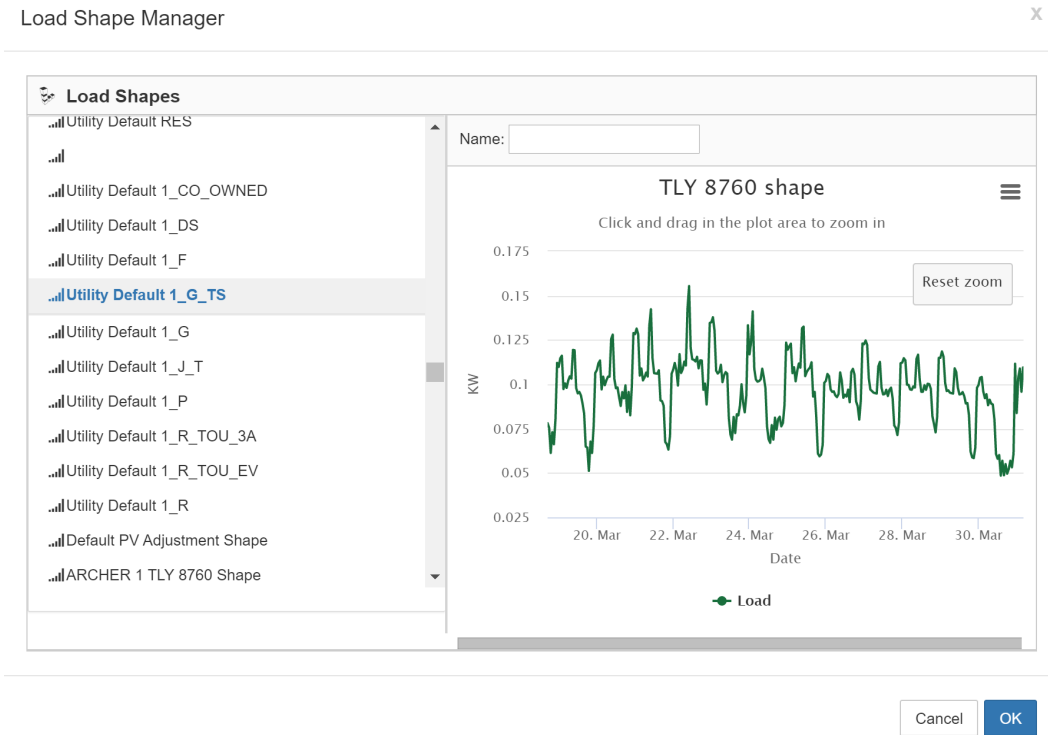
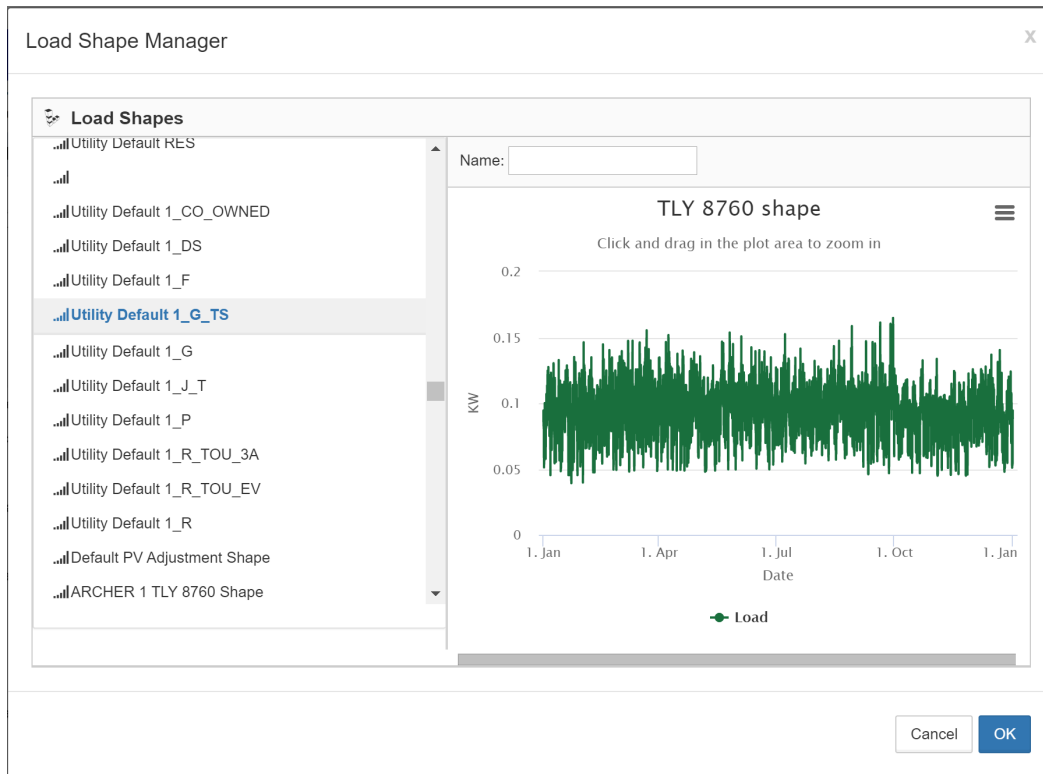
# Customer Class/Rate R\_TOU\_EV



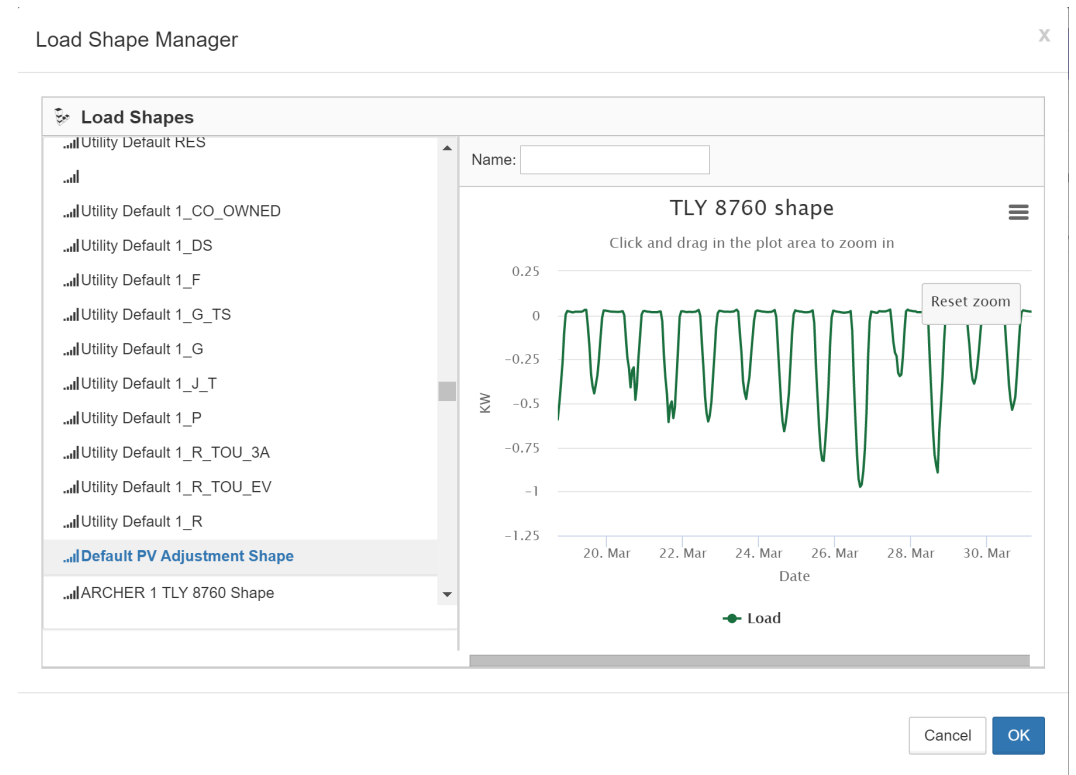
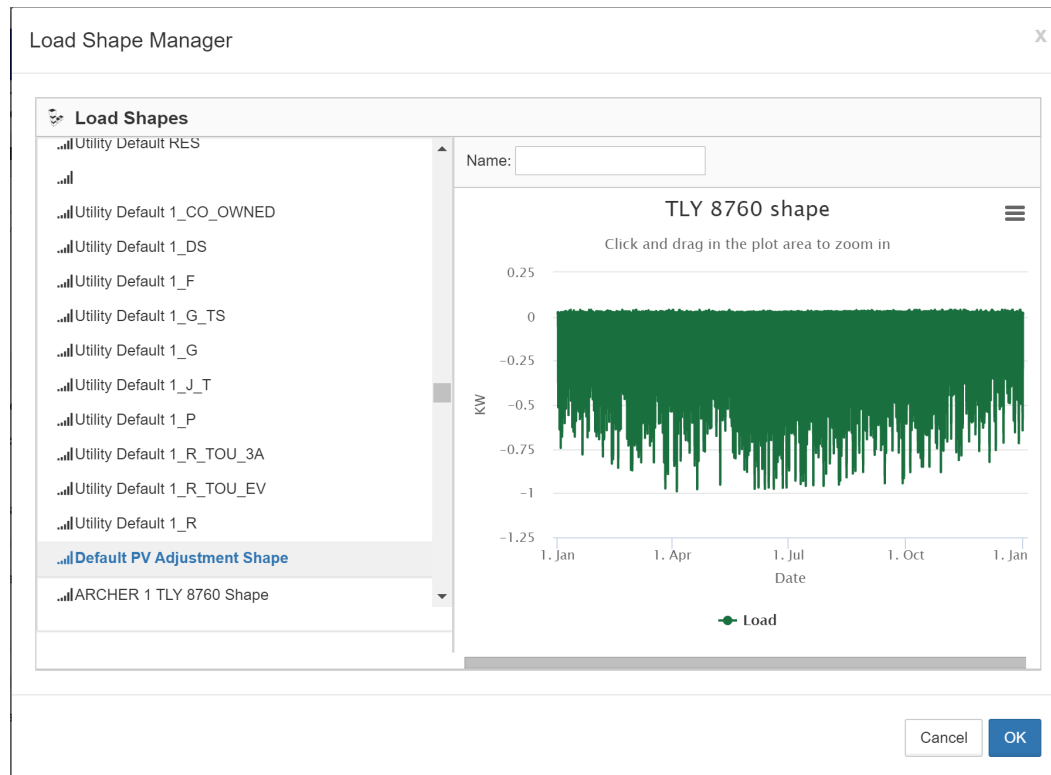
# Customer Class/Rate G



# Customer Class/Rate G\_TS



# Default PV



# EV Charging Options

These charts show the first 48 hours of an 8760 aggregate charging profile (white line).

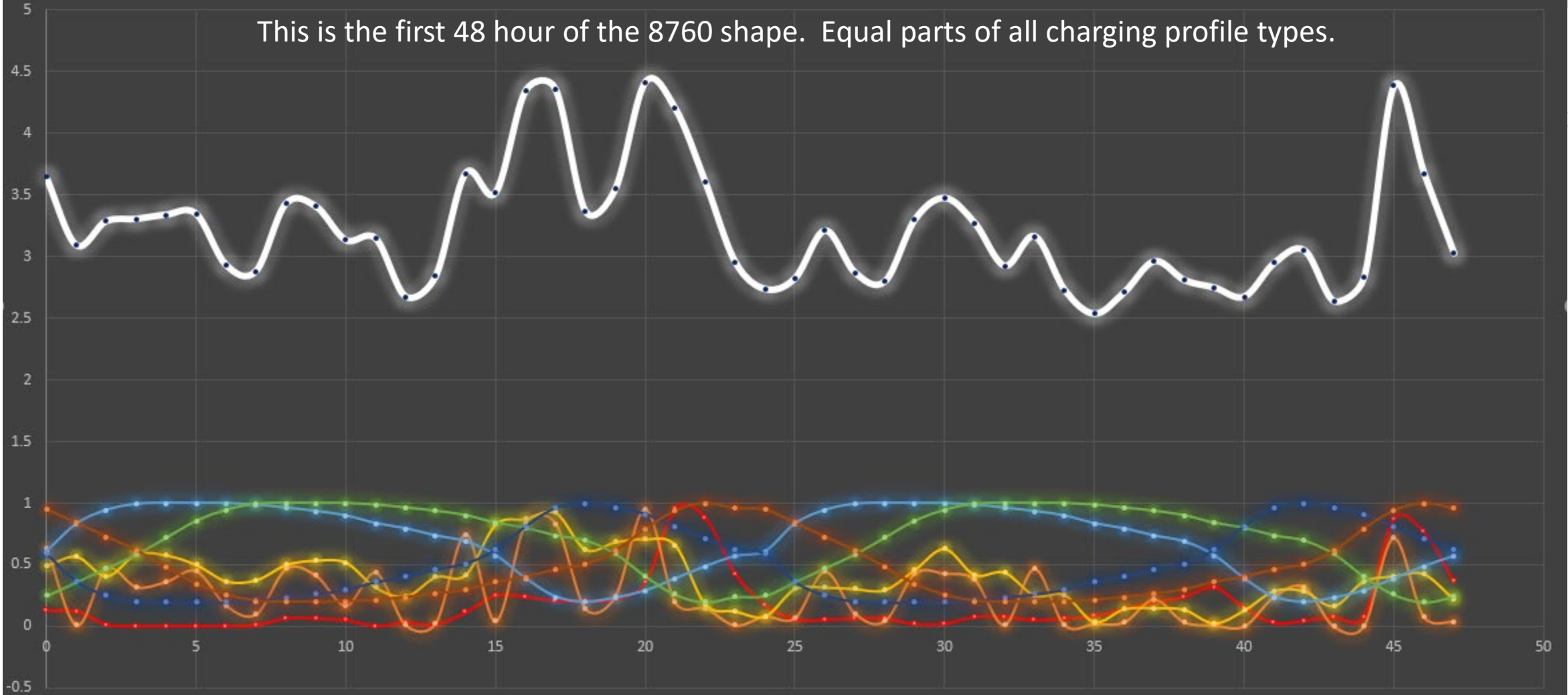
- Home = Home charging
- Station-Opp = Shorter opportunity charging at a station
- Station-Bulk = Longer bulk charging at a station
- Morning = generic diversified morning charge profile
- Day = generic diversified day charge profile
- Evening = generic diversified evening charge profile
- Night = generic diversified night charge profile



# Island Chargin

Aggregate Home Station-Opp Station-Bulk Morning Day Evening Night

This is the first 48 hour of the 8760 shape. Equal parts of all charging profile types.

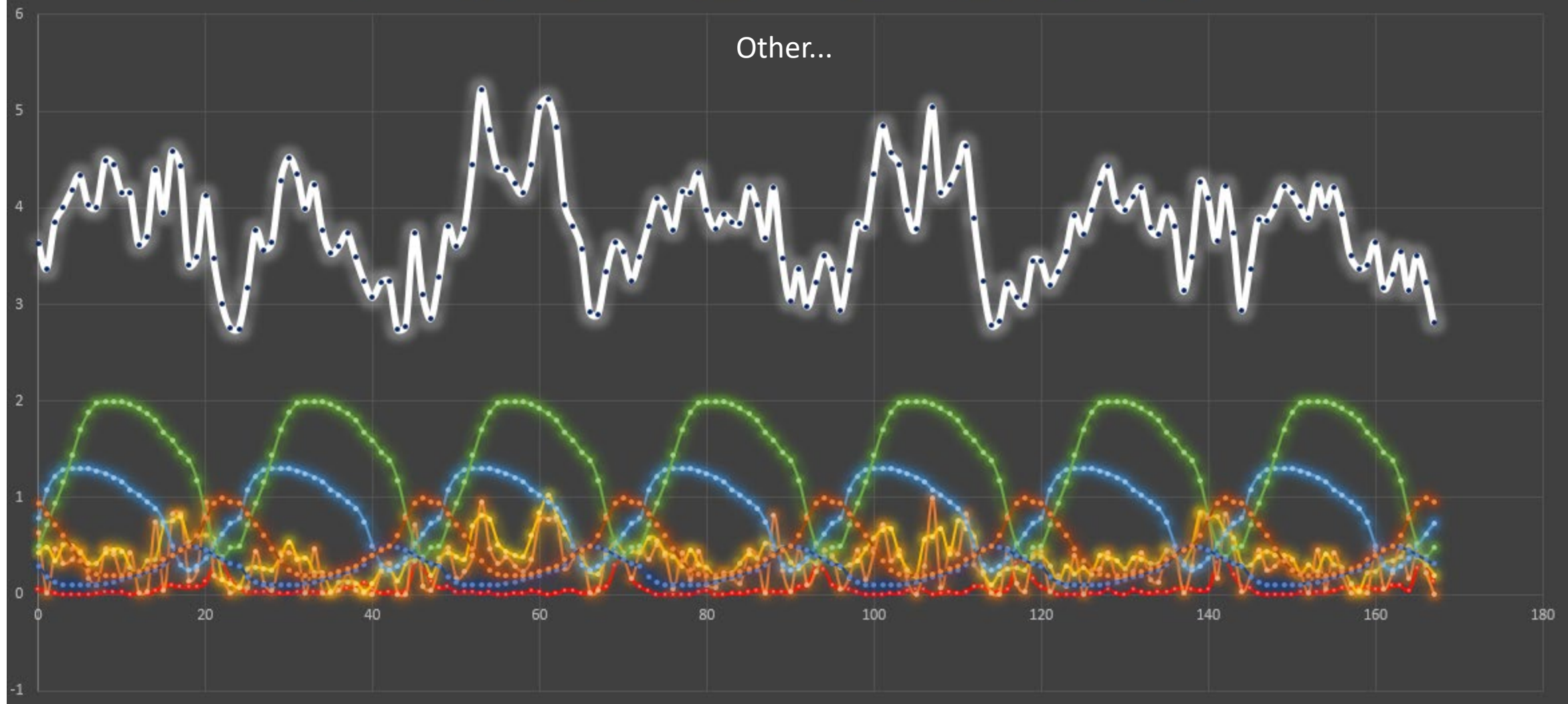




# Island Chargin

Aggregate Home Station-Opp Station-Bulk Morning Day Evening Night

Other...



# Geospatial Load and DER Growth





- Scott
- Dashboard
- Map
- Explorer
- Data Manager
- Message Center
- Administration

Future Services  OFF | Existing Services  OFF | Nodes  ON

Scenario: --Select Scenario-- | Percentile: Low



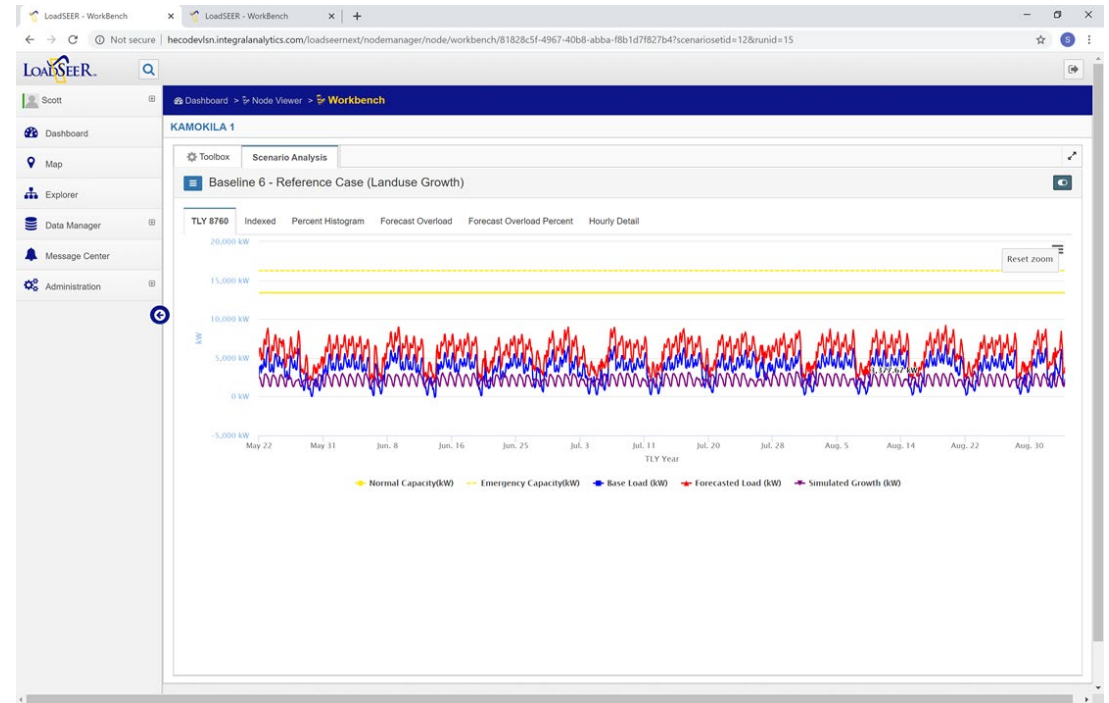


- Scott
- Dashboard
- Map
- Explorer
- Data Manager
- Message Center
- Administration

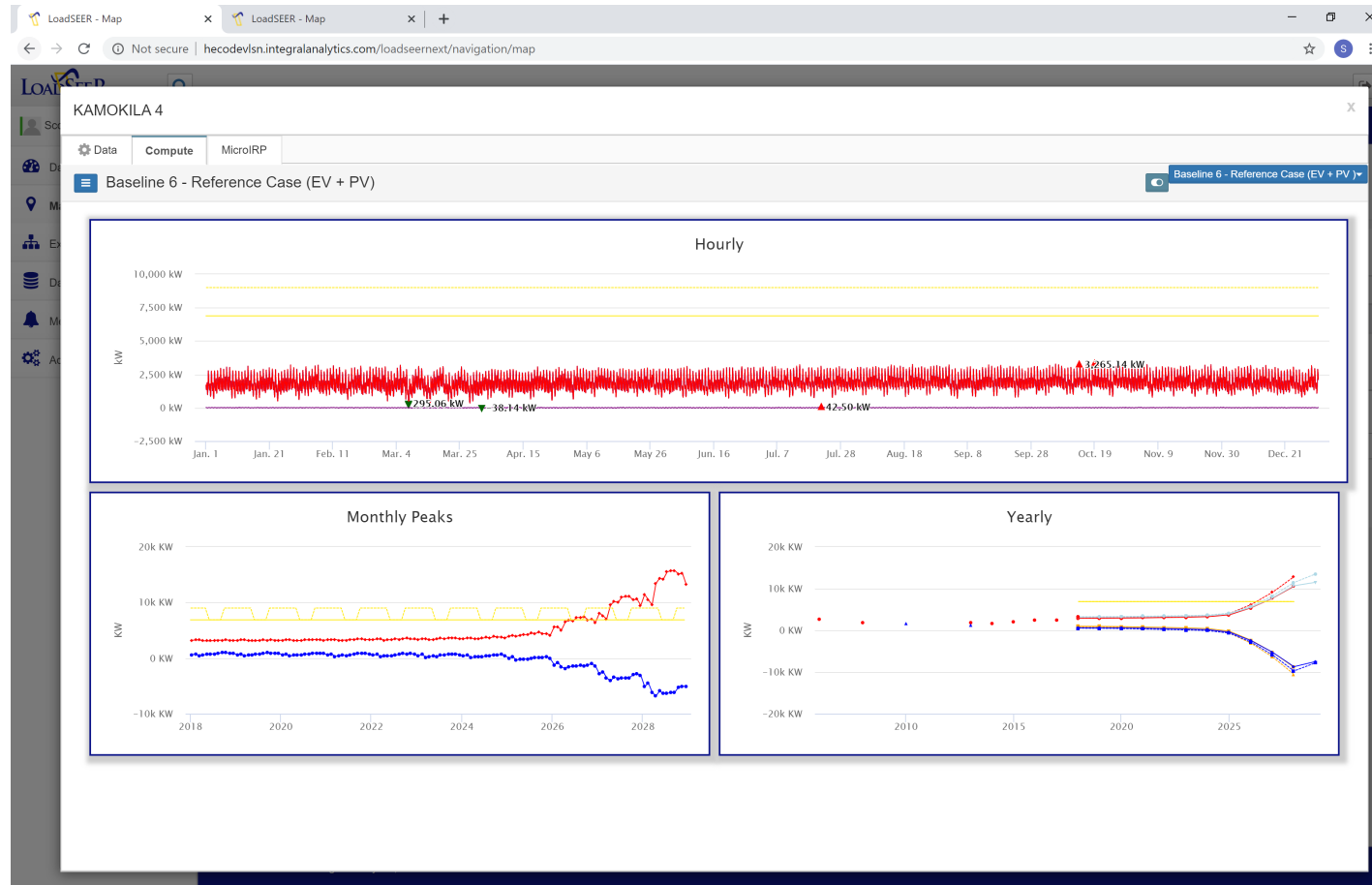
Future Services  OFF | Existing Services  OFF | Nodes  ON



# Hawaiian Electric circuit level forecast example 1 – KAMOKILA 1 Landuse + Freeze DER



# Hawaiian Electric circuit level forecast example 1 – KAMOKILA 4 Landuse + EV + PV Market ... increasing peak, decreasing min





# HECO circuit level forecast example 1 – KAMOKILA 4

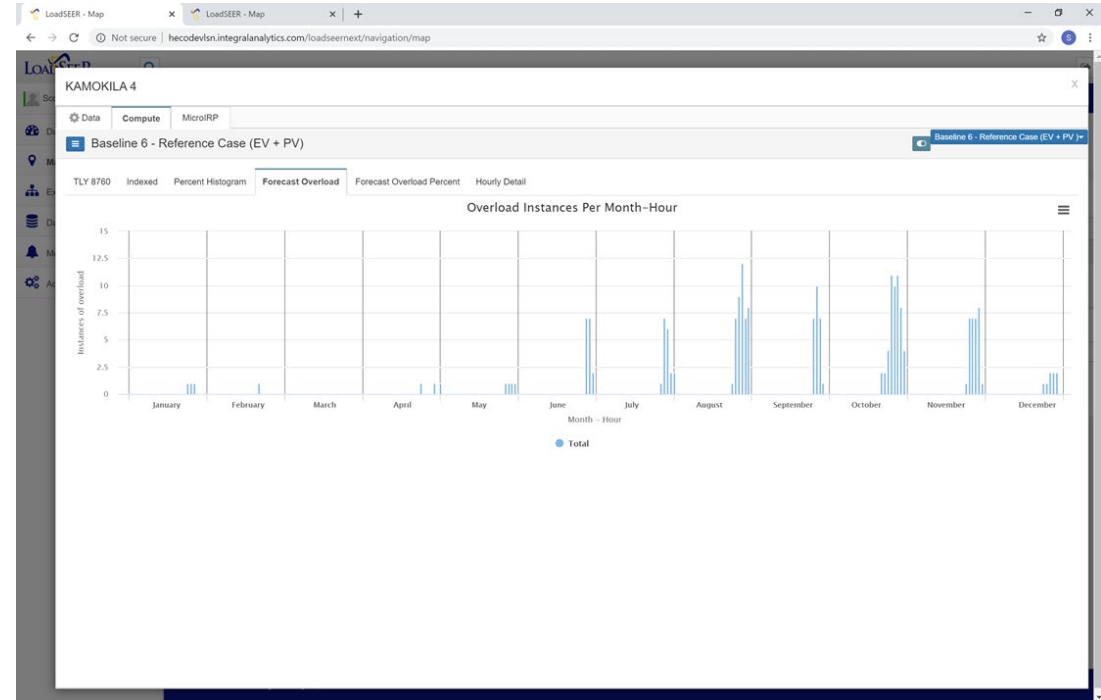
## Landuse + EV + PV Market ... increasing peak, decreasing min



### Bottom-up 8760 Forecast for 2030

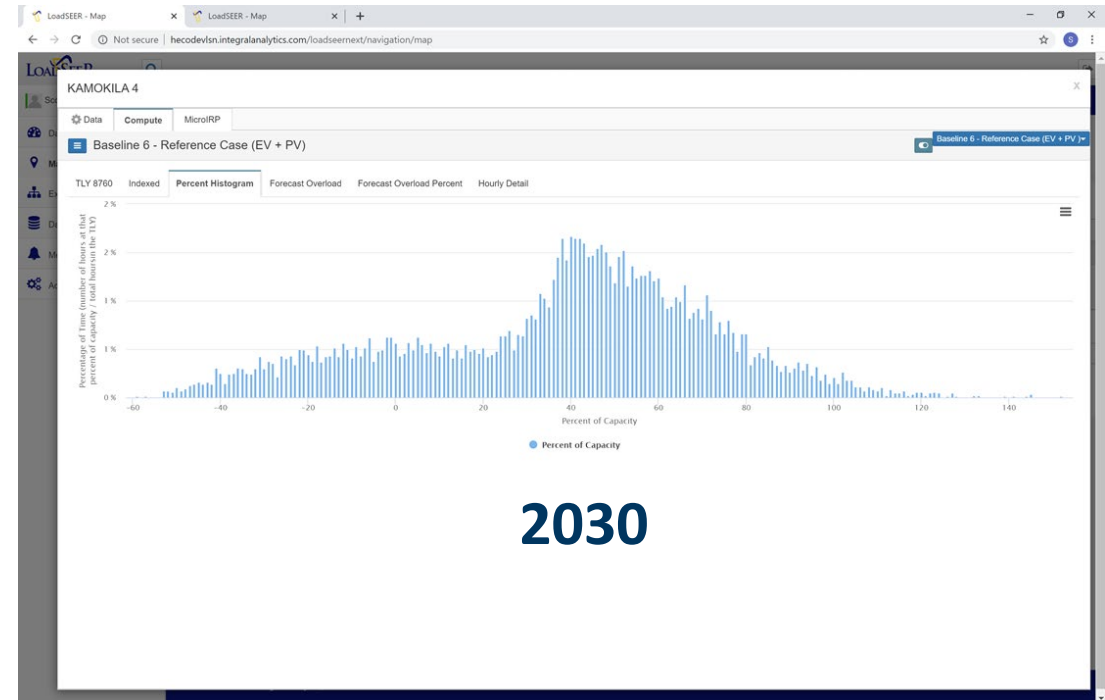
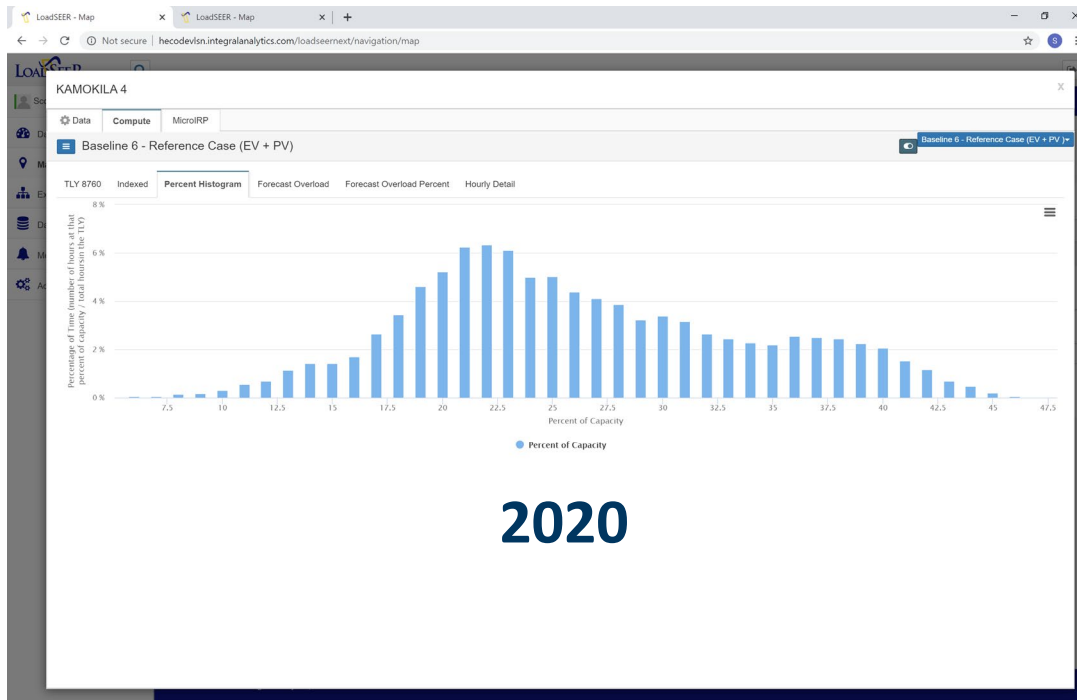
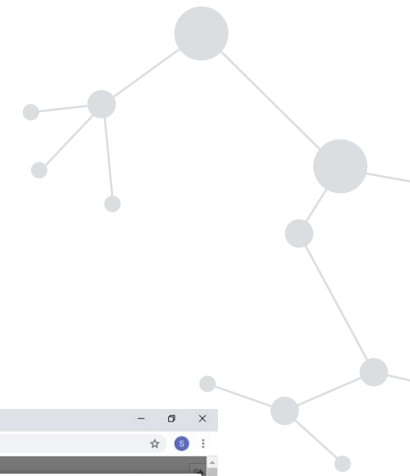


### Overload Frequency and Duration



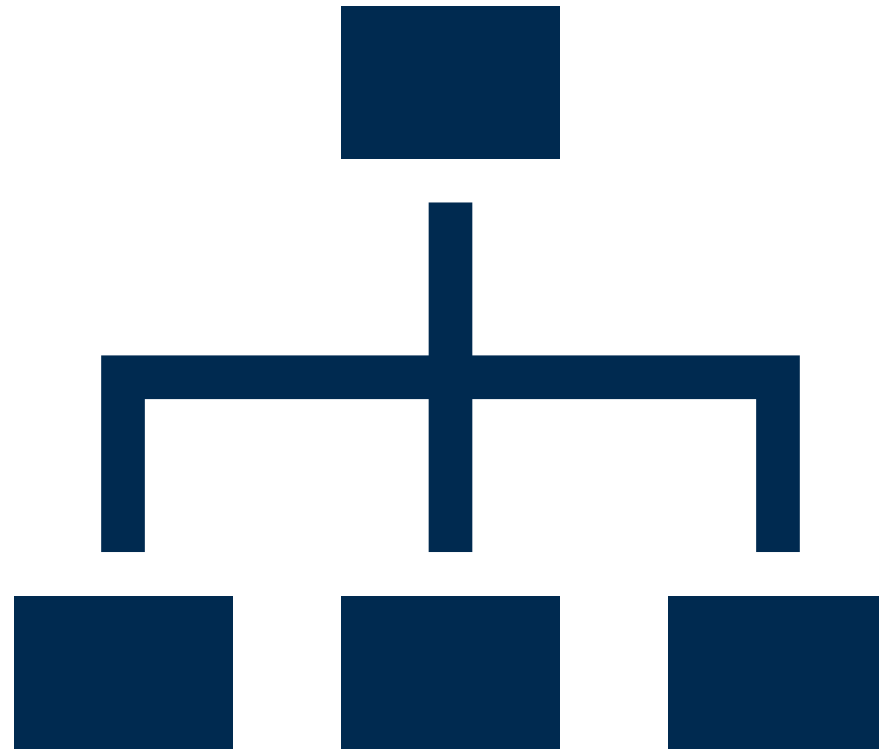
# HECO circuit level forecast example 1 – KAMOKILA 4

## Load duration by percent capacity



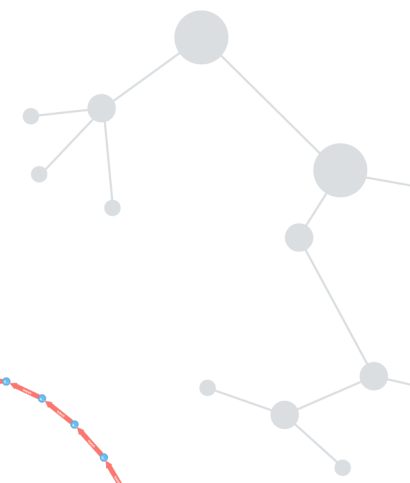
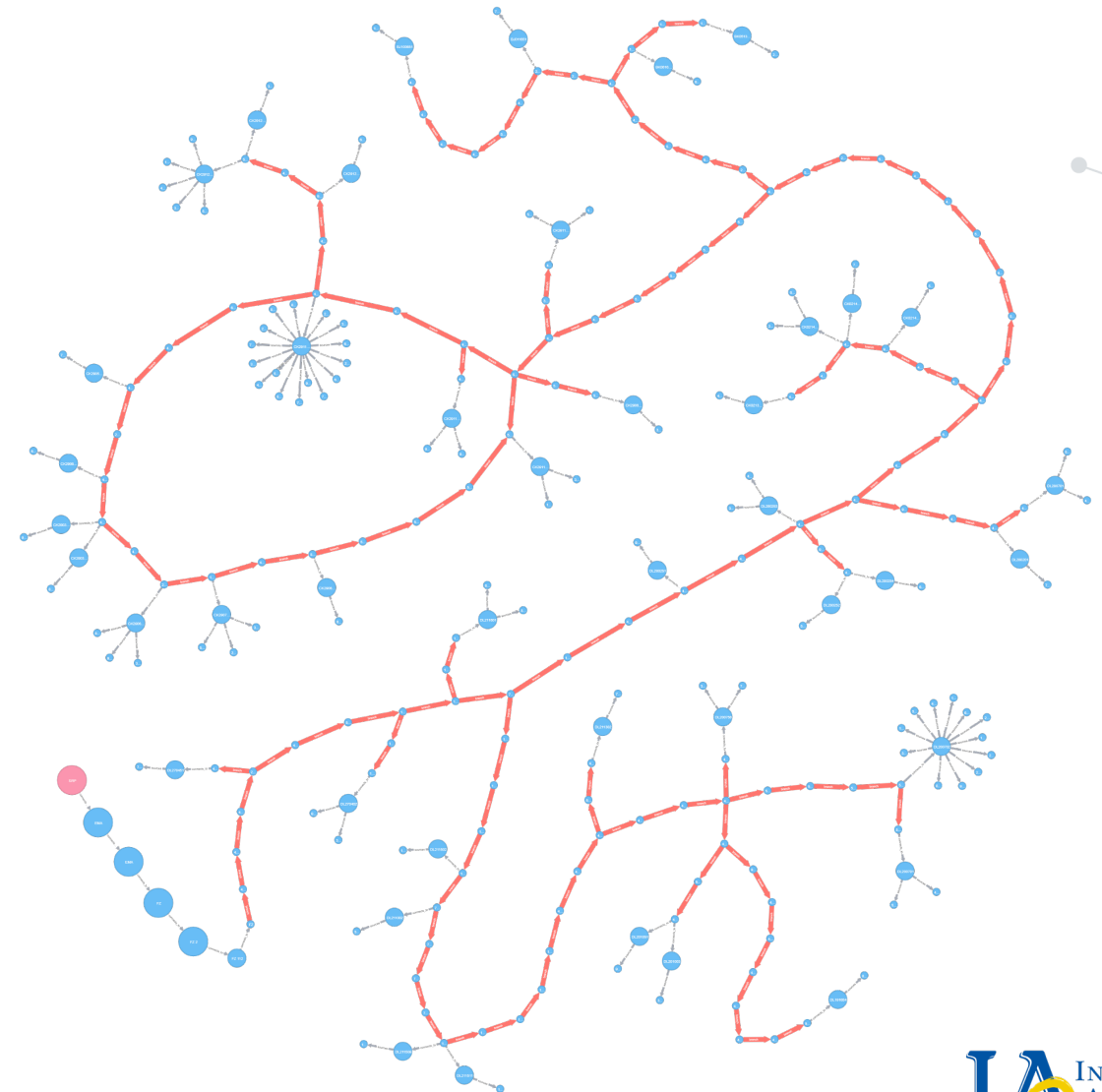
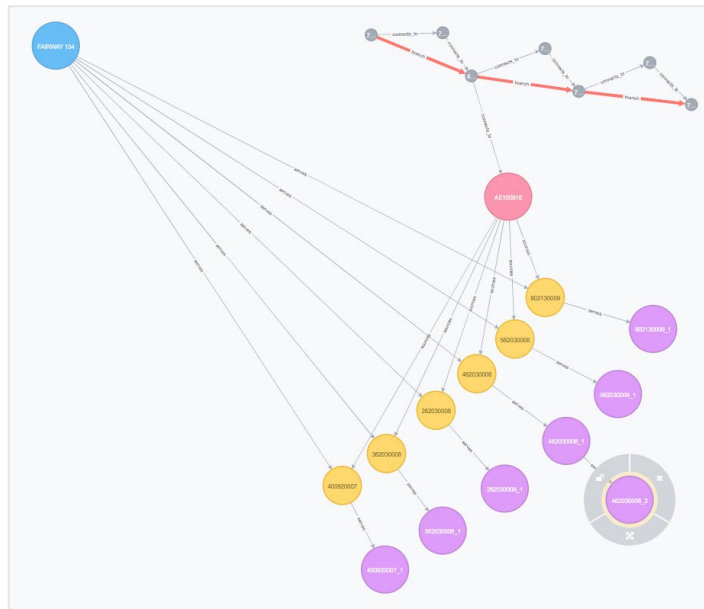


# N-1 Contingency Analysis



# LoadSEER Graph Database and Dynamic Aggregations

- Connectivity from system down to customer
- Can include Tx/Dx models
- Hierarchy is flexible
- Tailored to the customer



# Step 1 – Search map for a specific bank ...

Dashboard > Map

Future Services **OFF** Existing Services

Search/Select Nodes

PIC Any

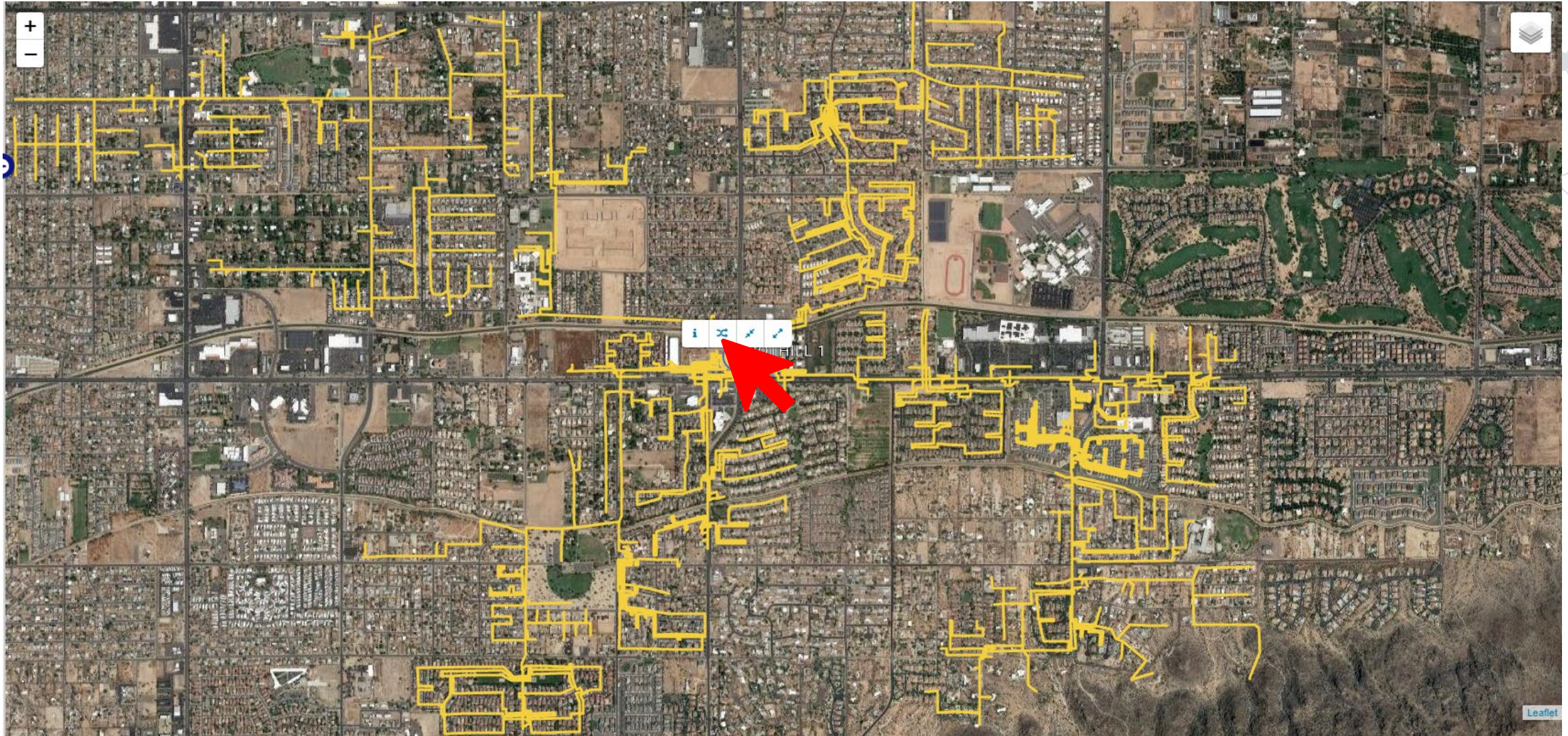
Find Nodes

<input type="checkbox"/>	Type	Name
<input type="checkbox"/>	SU Substation	PICARD
<input type="checkbox"/>	BA Bank	PICARD 1
<input type="checkbox"/>	BA Bank	PICARD 2
<input type="checkbox"/>	FE Feeder	PICARD 122
<input type="checkbox"/>	FE Feeder	PICARD 114
<input type="checkbox"/>	FE Feeder	PICARD 123
<input type="checkbox"/>	FE Feeder	PICARD 125

Cancel Select



## Step 2 – Click the returned map point, then ‘N-1 Analysis’ icon





# Step 3 – Select Forecast and Planning Scenario, and transfer level...

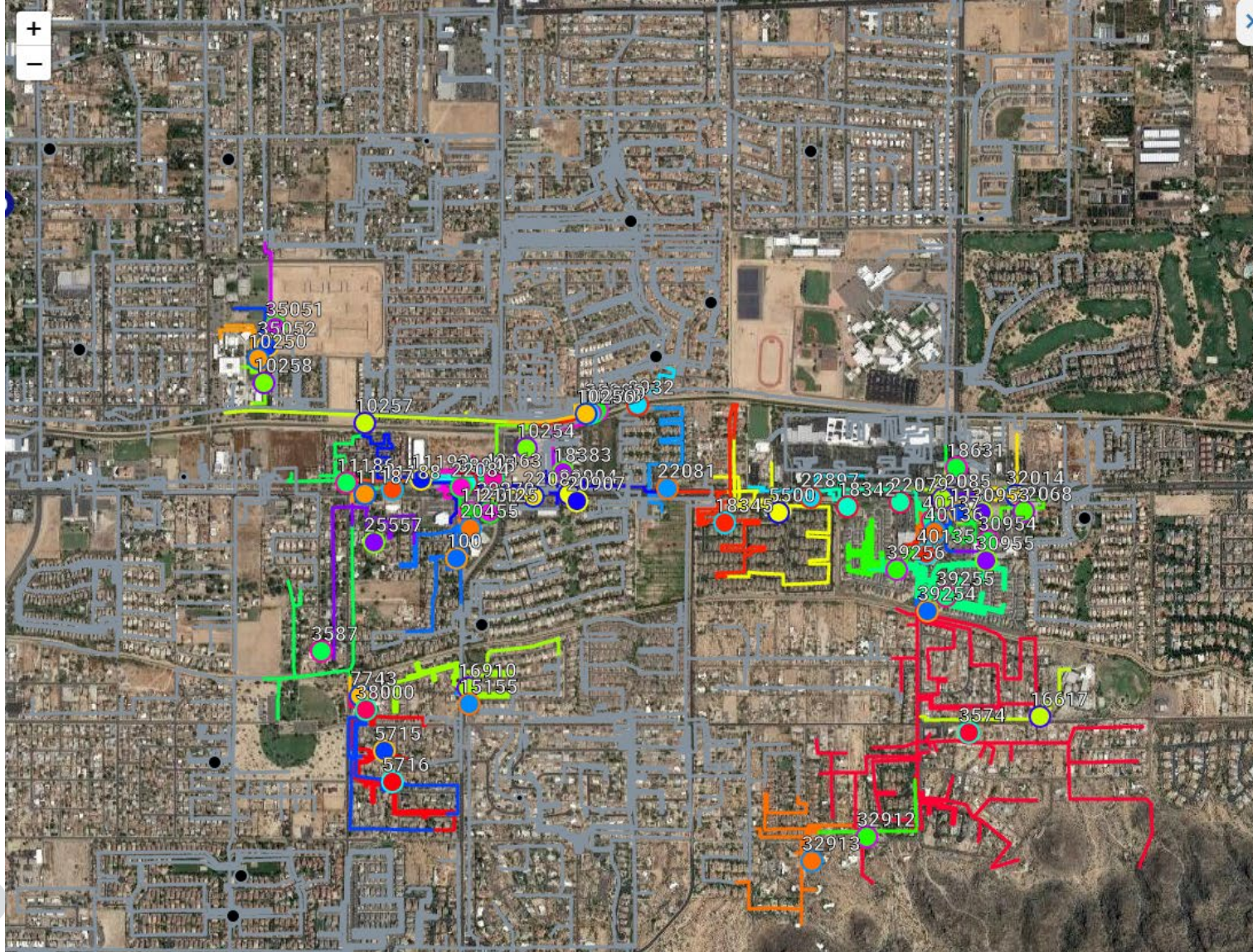
The screenshot displays a GIS application interface. On the left, a satellite map shows a residential area with several colored overlays: orange, red, and blue. These overlays represent different planning or forecast scenarios. Labels on the map include 'FOOTHILL 124', '126', 'FOOTHILL 123', 'FOOTHILL 125', and 'FOOTHILL 122'. On the right, a configuration panel is visible with the following settings:

- Forecast Scenario: N-1 Forecast Scenario 1
- Planning Scenario: Foothill Resource Planning 1 (Run1)
- Saved Events: --Select Events--
- Transfer Level: Feeder
- Transfers: (Empty list)

At the bottom of the configuration panel, there are buttons for 'Save' and 'Cancel'. A small 'x' icon is located in the top right corner of the map area.



# Step 4 – Create the transfer list for this N-1 event. The user clicks on each switching zone (source) in the map, then a chooses feeder or bank (destination) in the map...



Forecast Scenario: N-1 Forecast Scenario 1

Planning Scenario: Foothill Resource Planning 1 (Run1)

Saved Events: --Select Events--

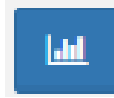
Transfer Level: Feeder

Transfers

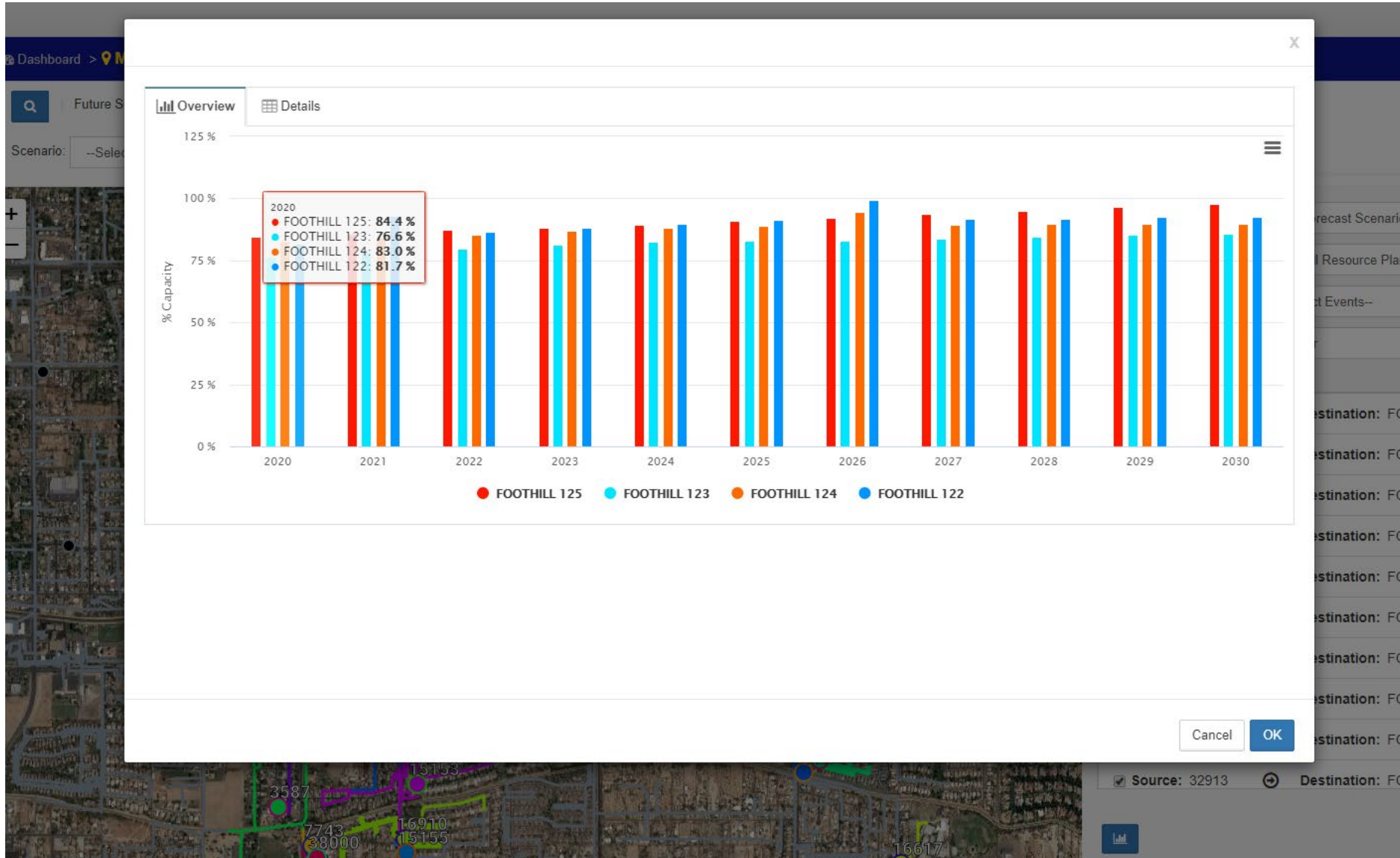
<input checked="" type="checkbox"/> Source: 126	<input checked="" type="radio"/> Destination: FOOHILL 123	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 5666	<input checked="" type="radio"/> Destination: FOOHILL 124	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 8931	<input checked="" type="radio"/> Destination: FOOHILL 124	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 8930	<input checked="" type="radio"/> Destination: FOOHILL 124	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 16272	<input checked="" type="radio"/> Destination: FOOHILL 123	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 128	<input checked="" type="radio"/> Destination: FOOHILL 125	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 997	<input checked="" type="radio"/> Destination: FOOHILL 125	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 125	<input checked="" type="radio"/> Destination: FOOHILL 125	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 10762	<input checked="" type="radio"/> Destination: FOOHILL 125	<input type="button" value="🗑️"/>
<input checked="" type="checkbox"/> Source: 40603	<input checked="" type="radio"/> Destination: FOOHILL 125	<input type="button" value="🗑️"/>



Step 5 – Click the analysis button ...



... resulting chart of impact on destination feeders over 10 year forecast.





# Step 5 – Click the analysis button ... destination feeders over 10 year forecast.

... resulting chart of impact on



Dashboard > Future S  
Scenario: --Select

Overview Details

Search:

Source	Destination	FOOTHILL 123	FOOTHILL 125	FOOTHILL 122	FOOTHILL 124
3574	FOOTHILL 122	N/A	N/A	1,675.38 kW	N/A
18963	FOOTHILL 122	N/A	N/A	894.66 kW	N/A
19670	FOOTHILL 122	N/A	N/A	863.11 kW	N/A
32913	FOOTHILL 122	N/A	N/A	480.75 kW	N/A
126	FOOTHILL 123	1,826.36 kW	N/A	N/A	N/A
16272	FOOTHILL 123	783.75 kW	N/A	N/A	N/A
5666	FOOTHILL 124	N/A	N/A	N/A	2,018.68 kW
8930	FOOTHILL 124	N/A	N/A	N/A	599.14 kW
8931	FOOTHILL 124	N/A	N/A	N/A	388.27 kW
8932	FOOTHILL 124	N/A	N/A	N/A	N/A
10253	FOOTHILL 124	N/A	N/A	N/A	N/A
32984	FOOTHILL 124	N/A	N/A	N/A	365.46 kW
<b>Total</b>		<b>9,926.01 kW</b>	<b>10,933.33 kW</b>	<b>10,589.77 kW</b>	<b>10,753.62 kW</b>
<b>Emergency Capacity</b>		<b>12,959.00 kW</b>	<b>12,959.00 kW</b>	<b>12,959.00 kW</b>	<b>12,959.00 kW</b>
<b>% Loaded</b>		<b>76.60 %</b>	<b>84.37 %</b>	<b>81.72 %</b>	<b>82.98 %</b>

Cancel OK

Source: 32913 Destination: FOOT