Dynamic Load Aggregation

Improving Capacity Analysis, System Planning & Asset Management

OVERVIEW

Itron Grid Planning is a solution that unifies data validation, grid operations, analytics and system planning in a common platform. A fundamental feature within the system is its ability to collect load data from individual assets and aggregate the data to a common node along the feeder, such as distribution transformers, reclosers and circuit breakers at the substation. This functionality is foundational in allowing utilities to effectively leverage telemetry data to make informed decisions to improve system reliability, system planning and asset health management.

Load aggregation, in its simplest definition, is a summation of load data. However, given the dynamic nature of the power grid, complexities of system topologies and the prolific availability of measurement data from today's smart grid assets, load aggregation is more than just summing data. It's a complex process that requires intelligent pre- and post-data handling and analytics to convert single load measurement points to a composite measurement profile that is accurate enough to use for critical grid operations and system planning activities. Itron Grid Planning's core platform was purposely built to excel in data aggregation given its foundational need for the rest of the analytics platform. The following highlights key features included in Grid Planning's load aggregation functionality.

- » **System Model Reconciliation** – As part of the pre-processing step to load aggregation, Grid Planning reconciles system model discrepancies to generate an accurate asset relationship model to match in-field conditions. This is an integral step to ensure accurate data aggregation between connected assets. Inaccurate asset relationships result in unusable load profiles.
- » **Data Quality Handling** – The system will identify data quality issues with interval data and flag errors that require immediate mitigation. Such data quality issues include missing intervals (gaps) and erroneous measurement data. This data handling task prevents faulty measurement data from being included in the aggregate profile, thereby improving accuracy and dependability in the combined data.
- » **Machine Learning** – In cases where a representative load profile is needed, the system includes a machine-learning framework to normalize load data in order to identify and reconcile atypical load patterns due to planned and unplanned maintenance activities (e.g. load transfer), and severe weather conditions. These representative load profiles allow utilities to improve capacity forecasting and load flow analysis in system modeling.
- » **Interval Time Synchronization** – Given that measurement devices will have varying interval configurations, the system will auto detect these data conditions and adjust load aggregation calculations accordingly.
- » **Advance ETL System** – The data collection and processing engine was designed from the ground-up to handle interval data from millions of endpoints. This allows the system to scale and output results in an efficient manner, allowing utilities to derive value from measurement data as quickly as possible. The system has proven its efficacy in scale at up to 5 million endpoints.

LOAD AGGREGATION VALUE PROPOSITION

With the ability to aggregate load data at strategic nodes along the feeder, utilities are equipped with new information that enhances its ability to manage the grid and modernize the way it plans for the future. Grid Planning's load aggregation functionality has proven to enhance capacity planning, system modeling and transformer health management. The following highlights the derived value from deployed systems at Southern California Edison and National Grid.

Capacity Planning

Southern California Edison (SCE) uses Grid Planning's load aggregation functionality to modernize their load modeling and forecasting process. It uses Grid Planning's System Planning application and machine learning framework to generate a representative load profile at each substation bank and/or a strategic node on the feeder. The system dynamically aggregates measurement data and uses machine learning and an integrated load curve library to normalize the profile and reconcile load anomalies due to grid maintenance activities and weather conditions. Using the same framework, the system also deconstructs the composite profile to characterize net and gross loads, where distributed generation is present along the feeder. This ability allows SCE to improve its forecast for both energy usage and generation.

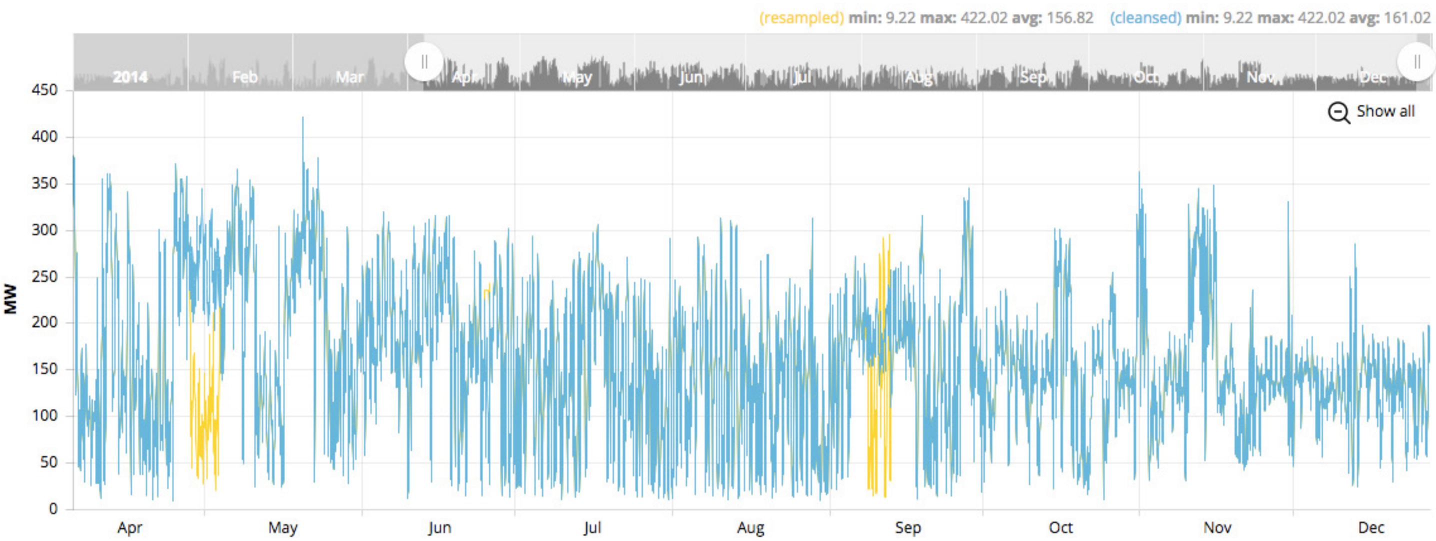

Figure 1: Representative Aggregate Load Profile
Yellow measurement highlights identified load anomalies
Blue measurement represents fully reconciled load profile

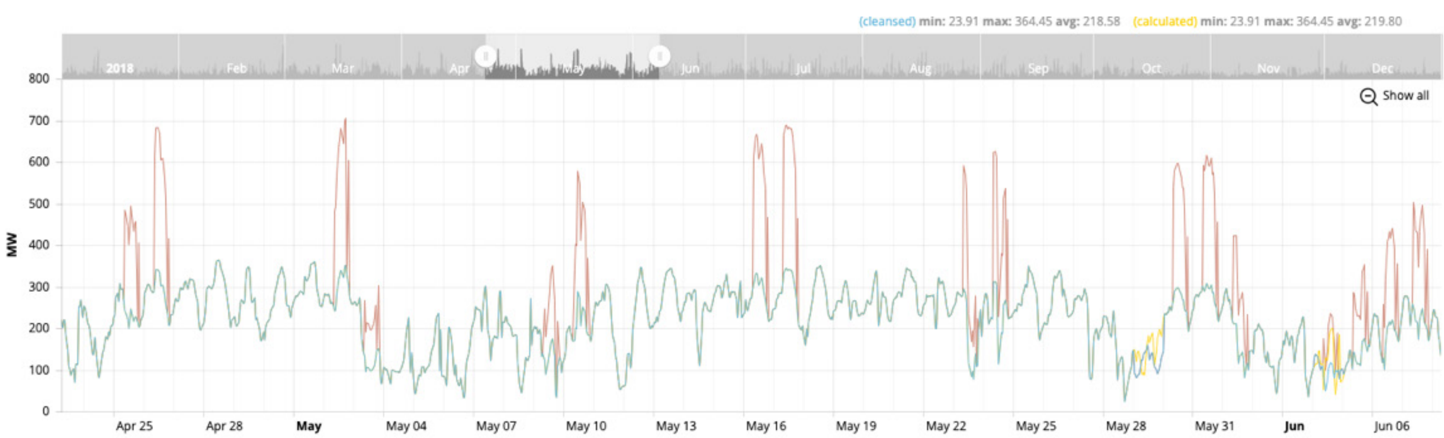

Figure 2: Deconstructed Gross and Net Load
Red measurement represents reconciled gross load
Green measurement represents reconciled net load
Yellow measurement highlights load anomalies

SYSTEM MODELING

National Grid uses load aggregation from Itron Grid Planning to modernize its approach to load flow analysis and improve its efficacy in system modeling. Using smart meter load data, Grid Planning aggregates the measurements to each distribution transformer to generate a load profile for each secondary network. This aggregation, similar to the SCE use case, is a representative load model that is fully reconciled and normalized. This load model at each distribution transformer allows National Grid to characterize load dynamically across any time period and import the data to their distribution modeling system (CYME) to enhance load flow analysis. This dynamic load model improves system modelling in that it uses real load behavior instead of nameplate load to calculate voltage drop from substation to end of line. In addition, it allows National Grid to improve how it safeguards its system against unexpected load growth and distributed generation.

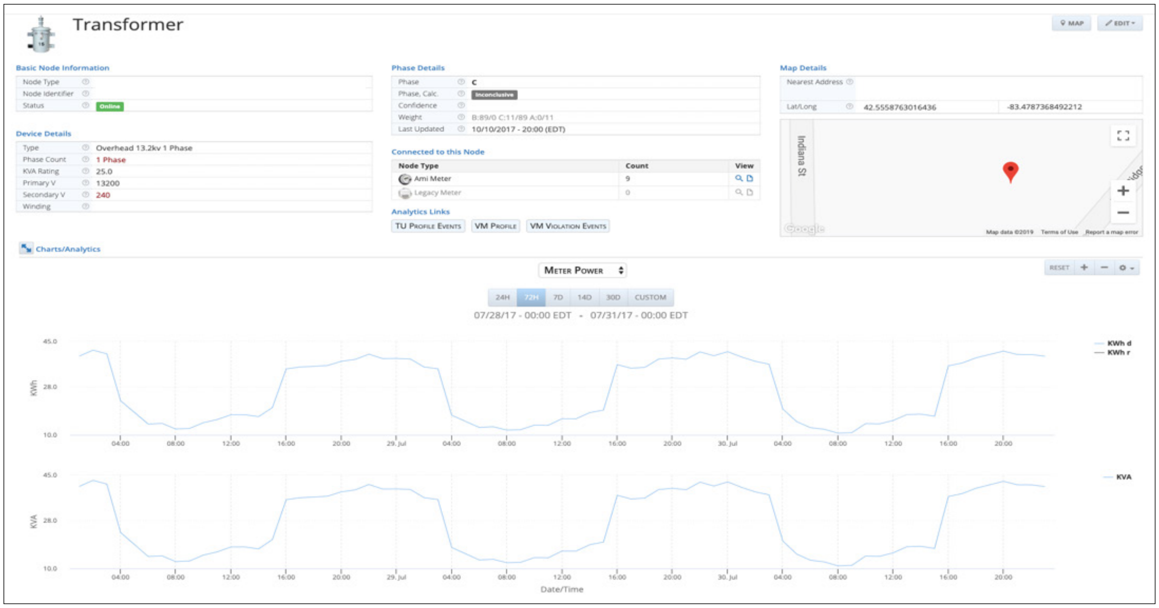

Figure 3: Transformer Load Profile
KVA and KWH Aggregate Load Profile From Connected AMI Meters

Figure 4: Circuit Model Load Flow Analysis
Dynamic Transformer Load Profile for Power Flow Analysis

TRANSFORMER UTILIZATION

With the ability to aggregate load at a common node, such as a distribution transformer, utilities are able to proactively monitor asset health and prioritize upgrades before failures occur. With today's growing demand from EV chargers and DER generation, it has become more important to understand the impacts of load growth (forward and reverse) to the sustainability of the power grid and the assets connected to it. National Grid and Southern California Edison have both capitalized on load aggregation functionalities from Grid Planning to monitor transformer load and identify undersized transformers that are frequently plagued by overload conditions. Overload conditions reduce asset life and therefore the ability to identify these conditions allow both utilities to replace transformers before they fail and result in power outages and safety hazards to the public. Itron's Grid Planning Transformer Utilization (TU) application leverages aggregate load data from connected meters to assess the health of each transformer relative to load magnitude and duration at each overload state. Using the aggregate load profile, the system self generates critical events that differentiate between sustained and momentary overload – given that each has a different impact to transformer life. Each transformer is characterized by a severity index and is prioritized at each substation to help in infrastructure replacement planning.

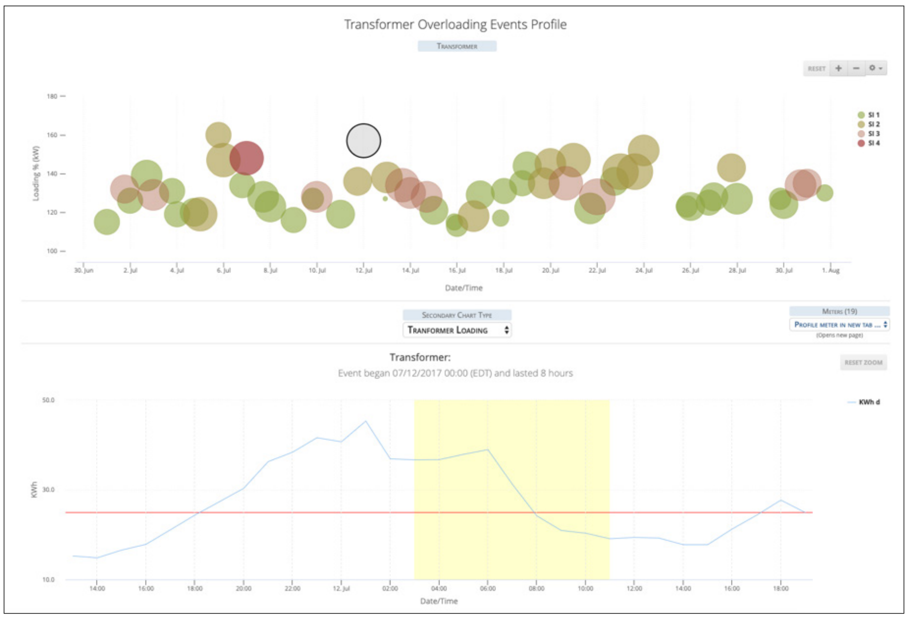

Figure 5: Overload Transformer Event and Aggregate Load Profile
System Generated Events Related to Sustained and Momentary Transformer Overload

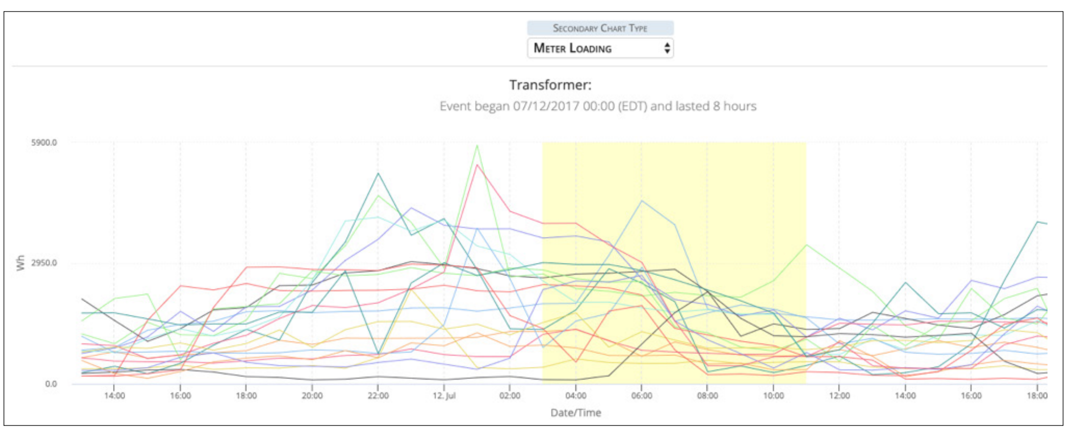

Figure 6: Individualized Meter Load
Breakdown of Each Meter Load Used to Generate the Composite Transformer Load Profile

To learn more visit itron.com

We create a more resourceful world

2111 North Molter Road
Liberty Lake, WA 99019 USA