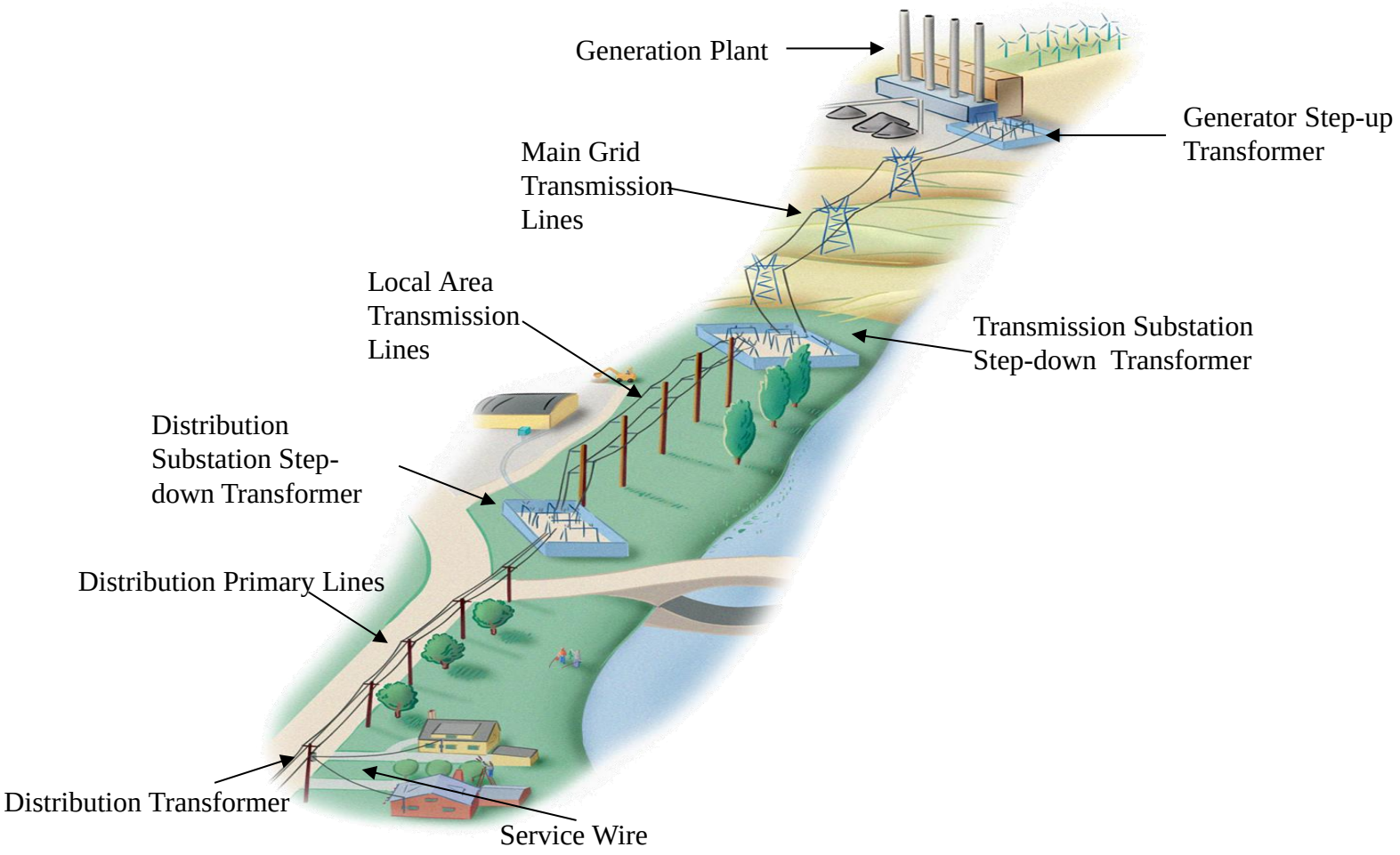
Utah Net Energy Metering Technical Workshop

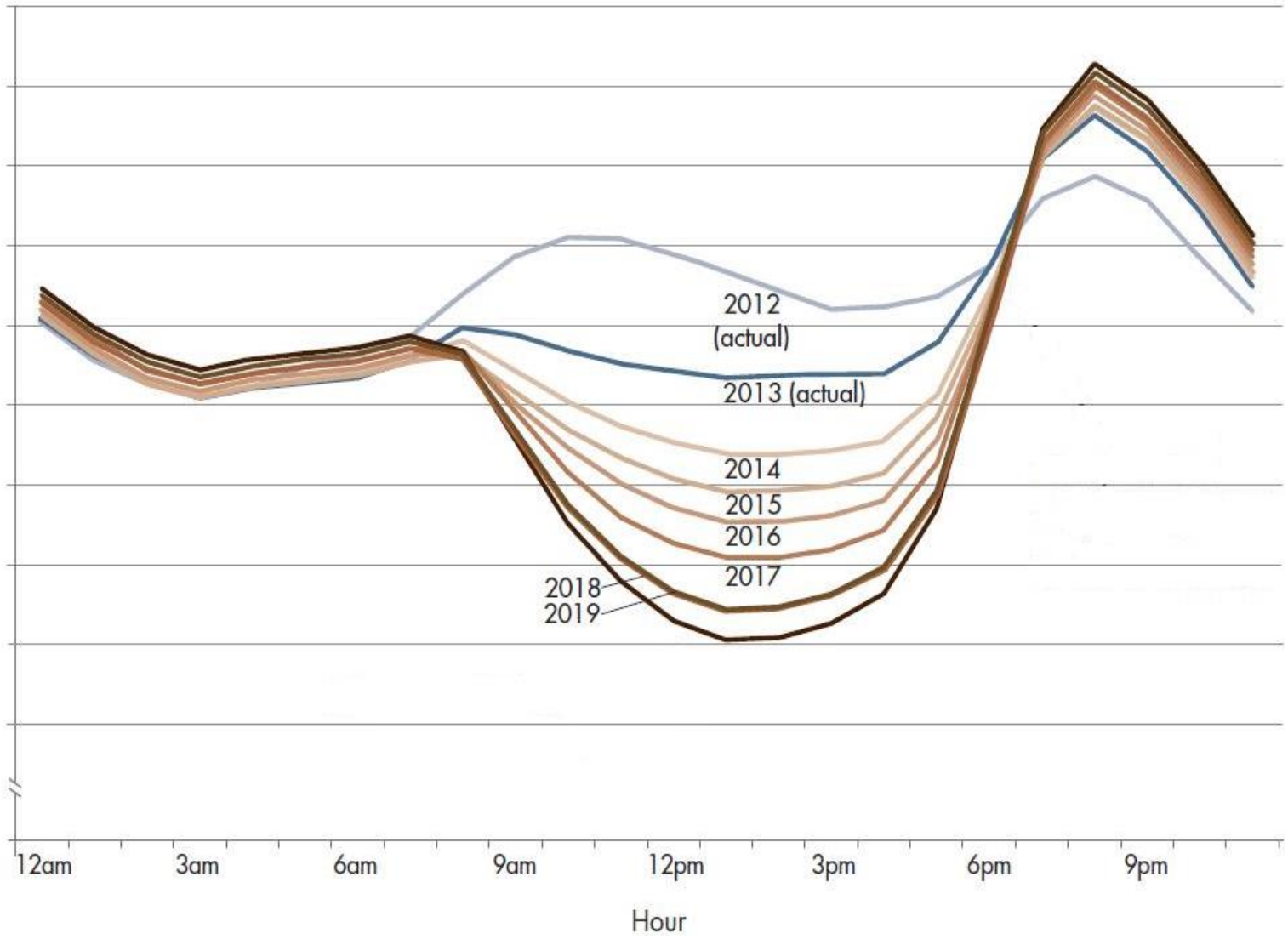
April 27, 2015

ROCKY MOUNTAIN POWER

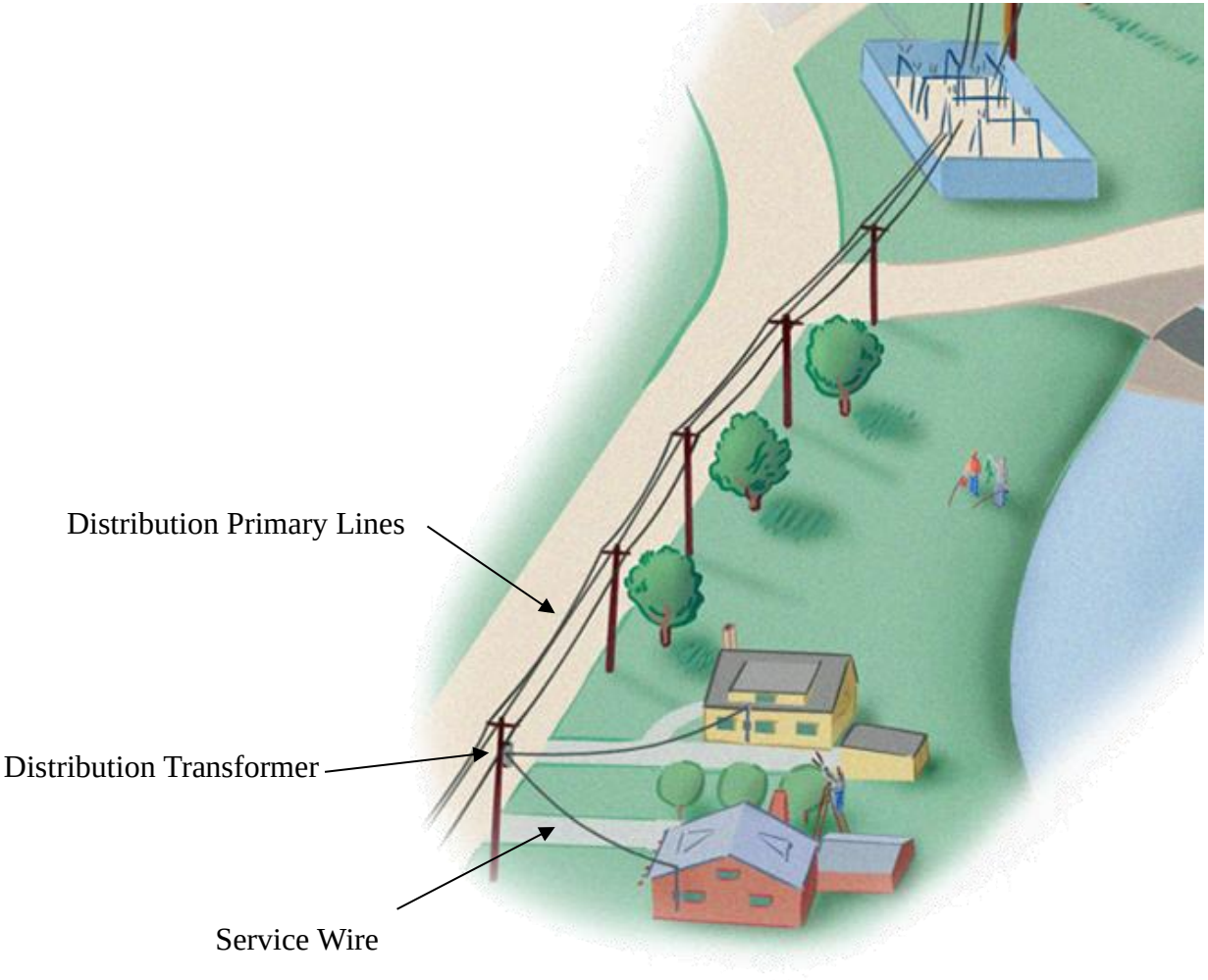
Electrical System Overview



CAISO Net-Load "Duck Curve"



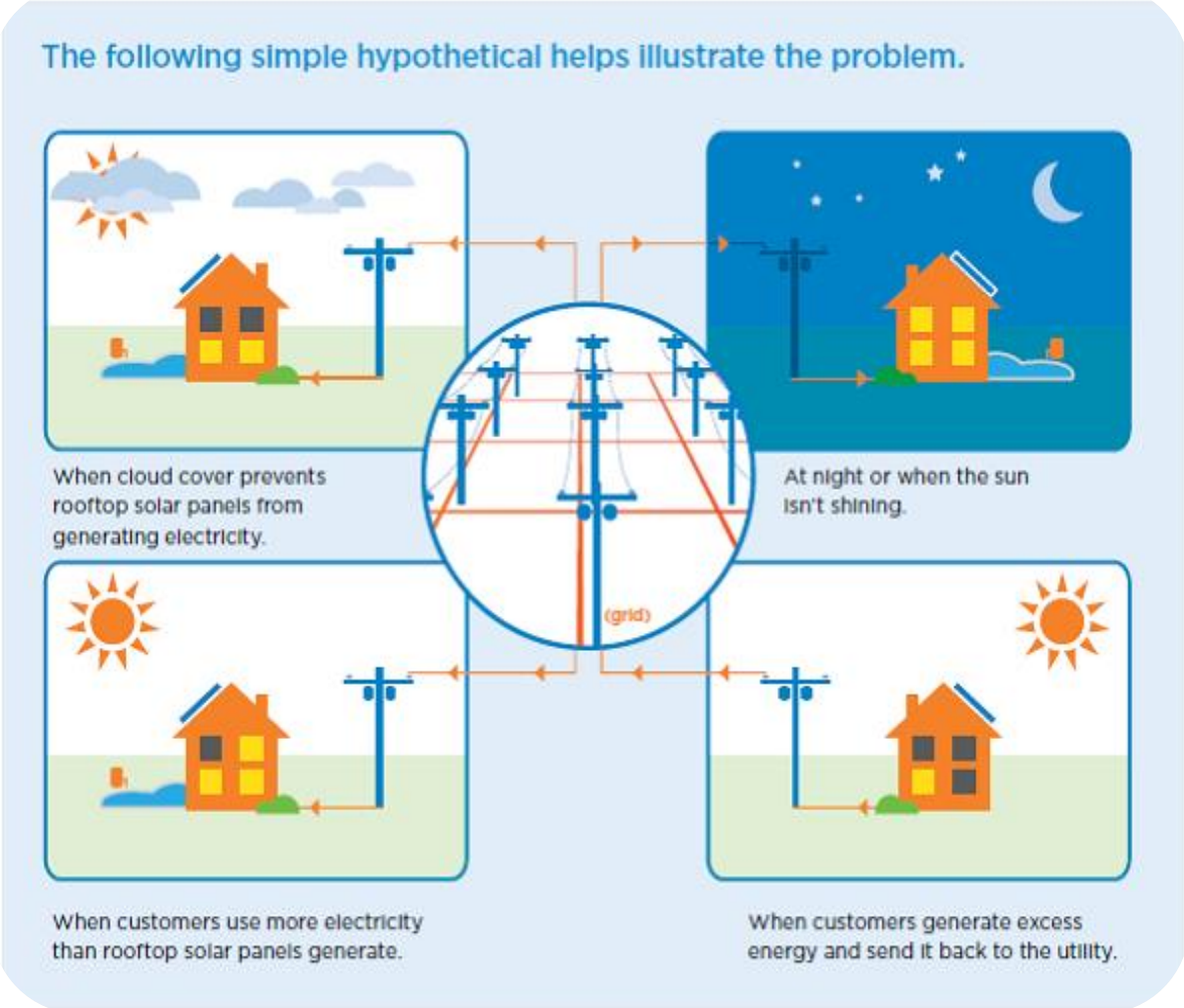
Distribution System



Distributed Energy Resources

- A distributed energy resource (DER) is a small power generator located at any point on the distribution system
  - Photovoltaic systems
  - Wind systems
  - Fuel cells

Customer Generated Power

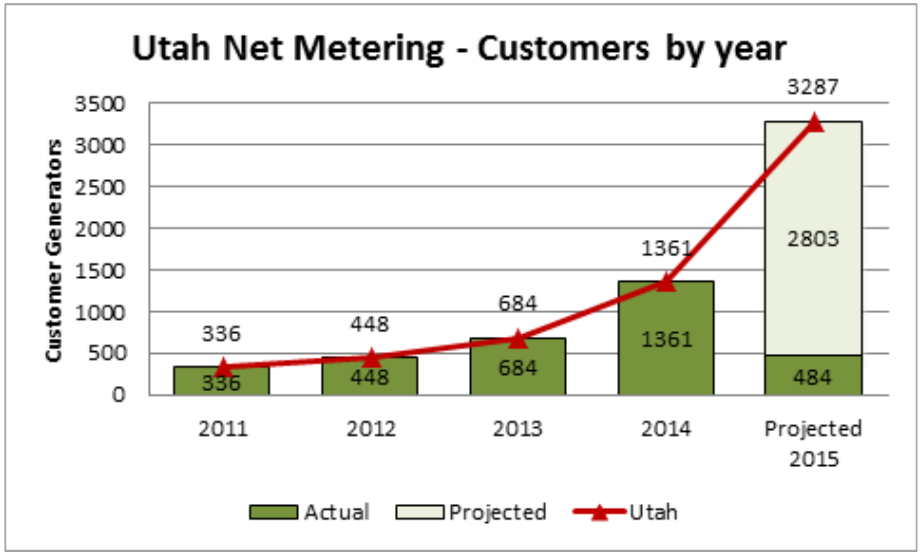


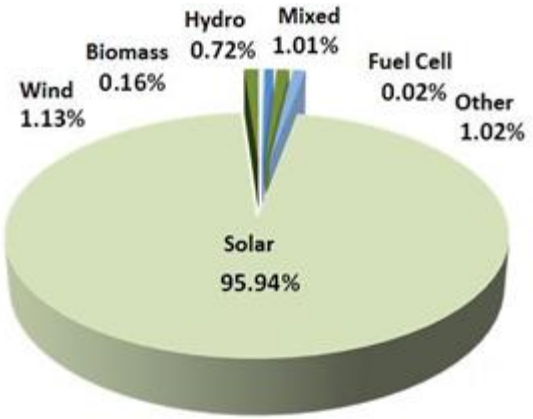
Basics of Net Metering

1. Utility provides reliable AC power and stabilizes the voltage
2. Solar panels convert energy from the sun into DC power
3. Inverter converts DC power to AC for use by the customer
4. A bi-directional meter measures energy flowing to the customer and excess energy flowing from customer
5. Excess energy is fed back to the grid for the utility to manage

Growth in Net Metering in Utah

- Over 4,000 net metering customers in Utah by the end of 2015
- Forecasted 45.3 megawatts of generating capacity in 2015
- 96% of net metering generation is from solar



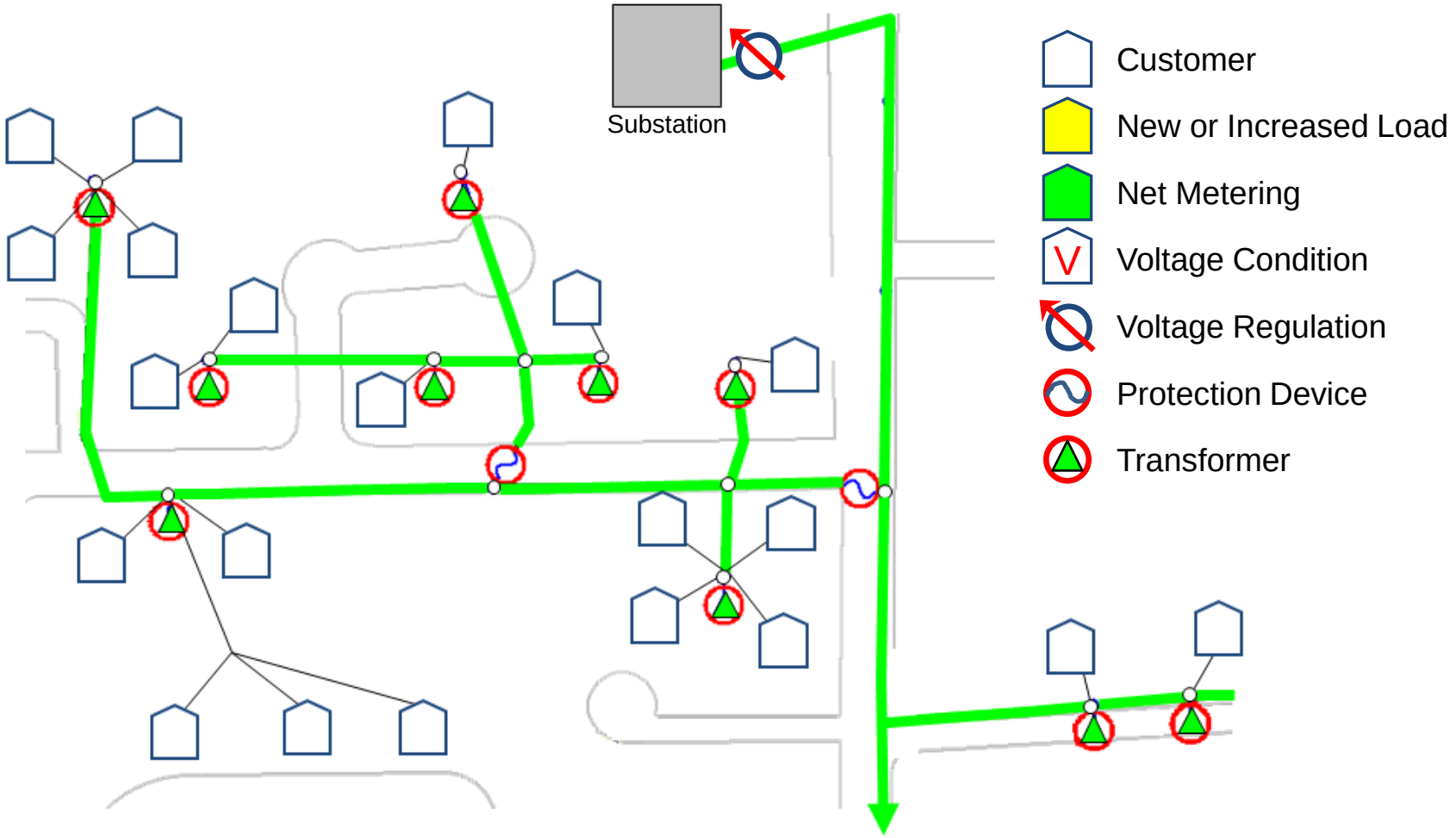


Distribution Planning

- **Identify:**
  - Reliability issues
  - Overload equipment
  - Voltage issues

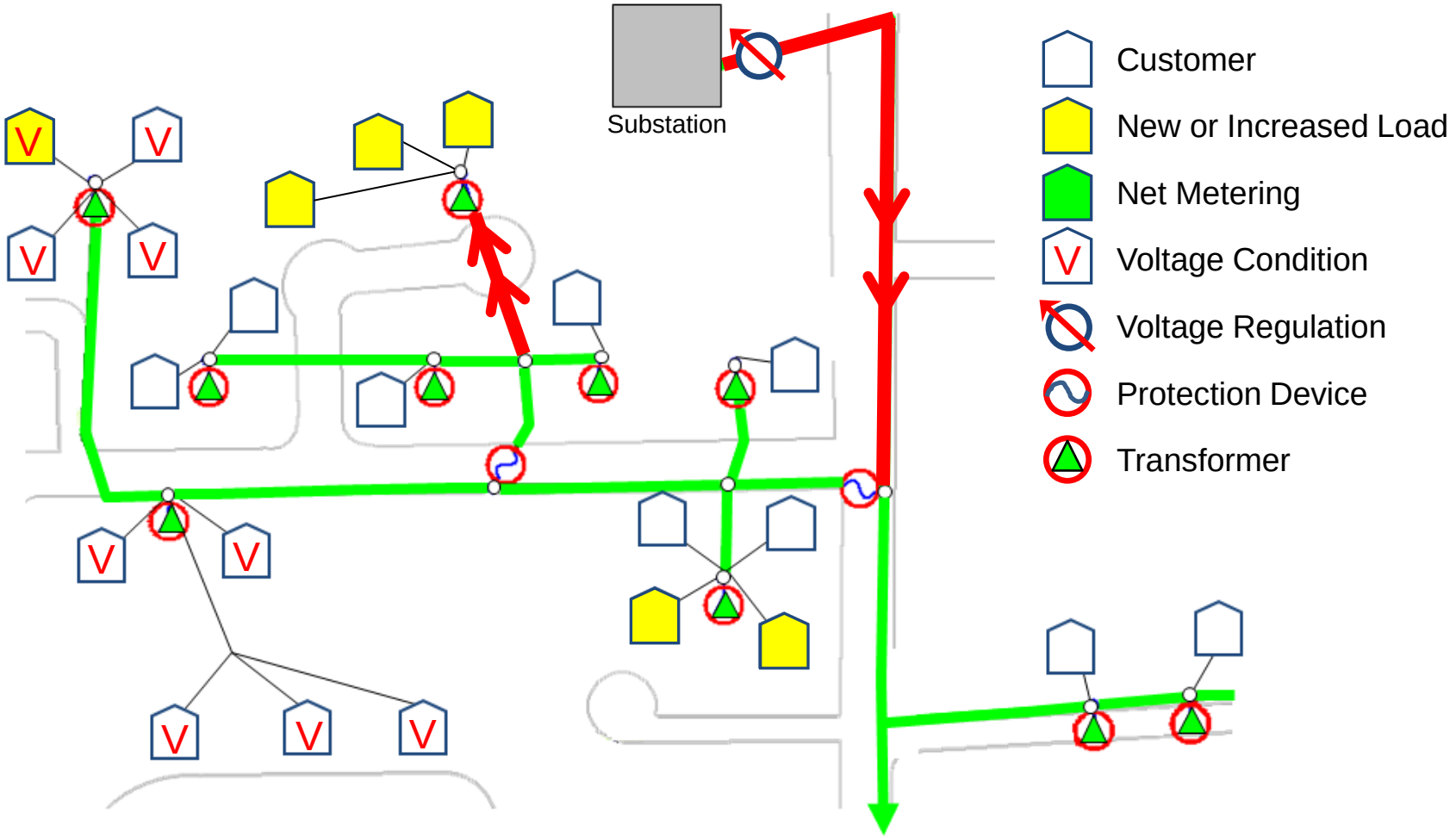
- **Design:**
  - Solutions to ensure safe and reliable electric service for our customers

Traditional Planning



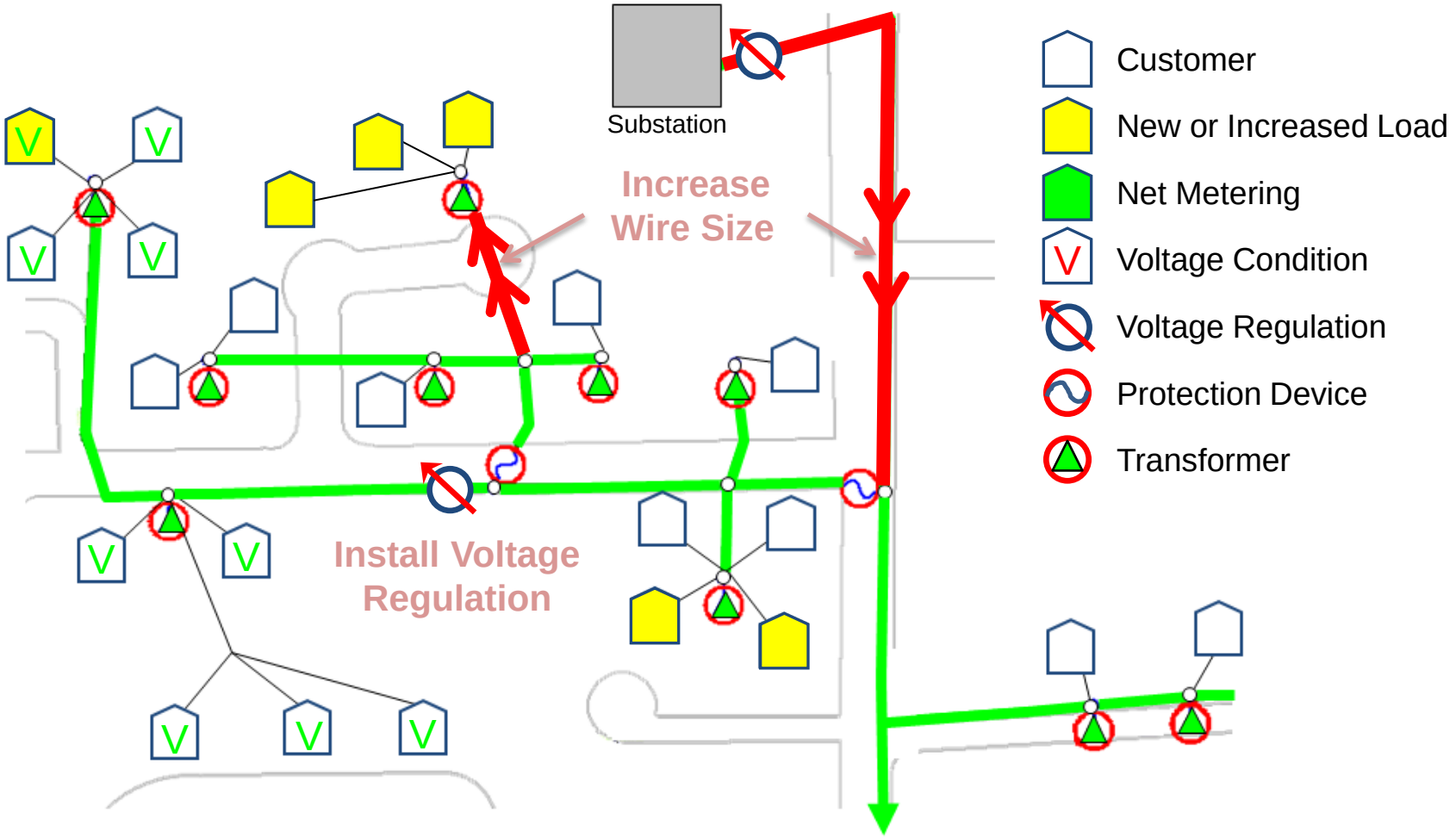
Traditional Planning

Adding New Customer Loads



Traditional Planning

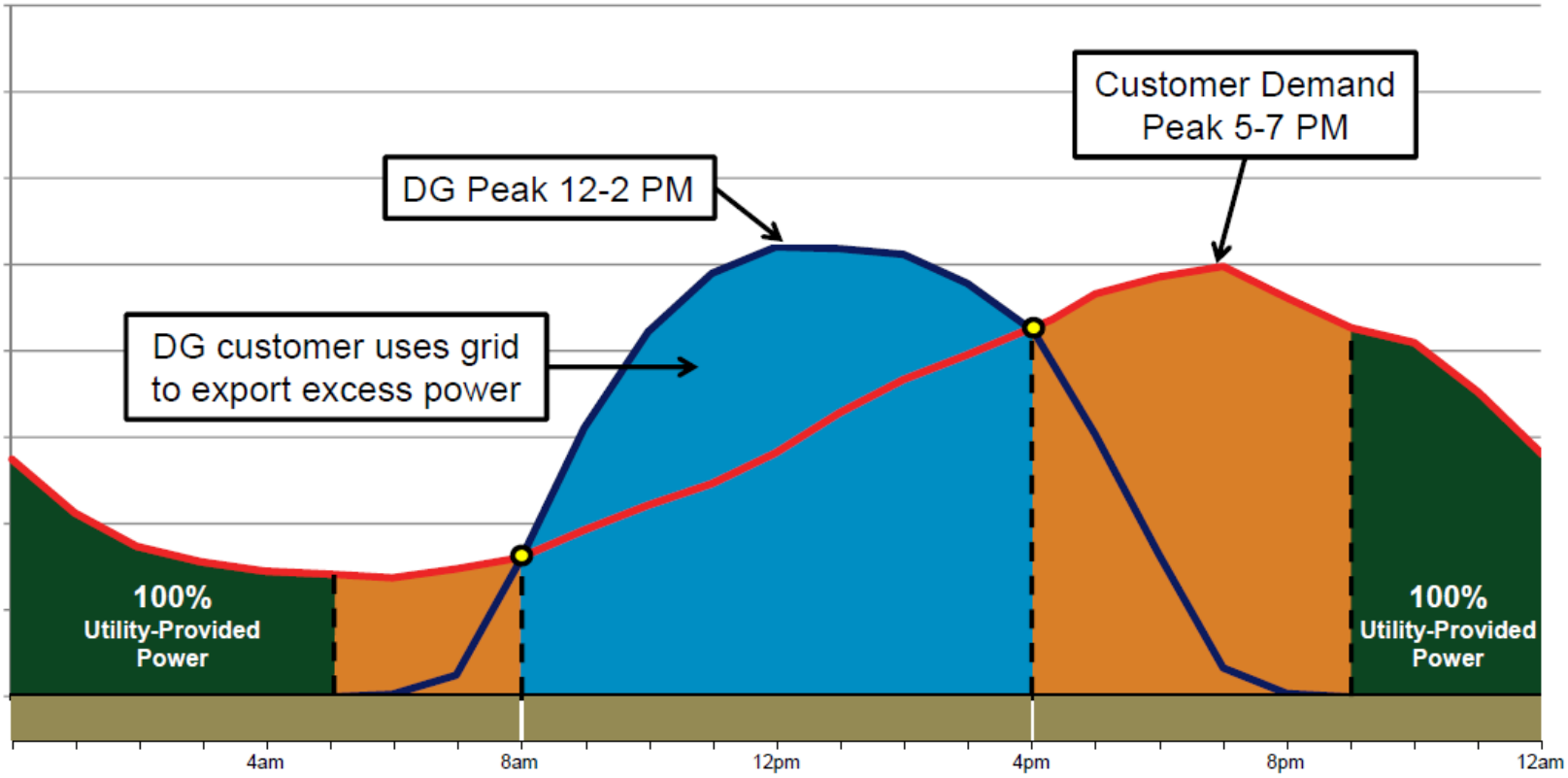
Potential Solution for Increased Loading



Distribution System with DER

- Without Distributed Energy Resources
  - Energy Flows from utility to the customer
- With Distributed Energy Resources
  - Energy flows to and from the customer depending on the time of day and their consumption

Load and Solar Characteristics



Customer Demand

DG Generation

Utility-Provided Power
8 hours/day utility provides 100% of power needed

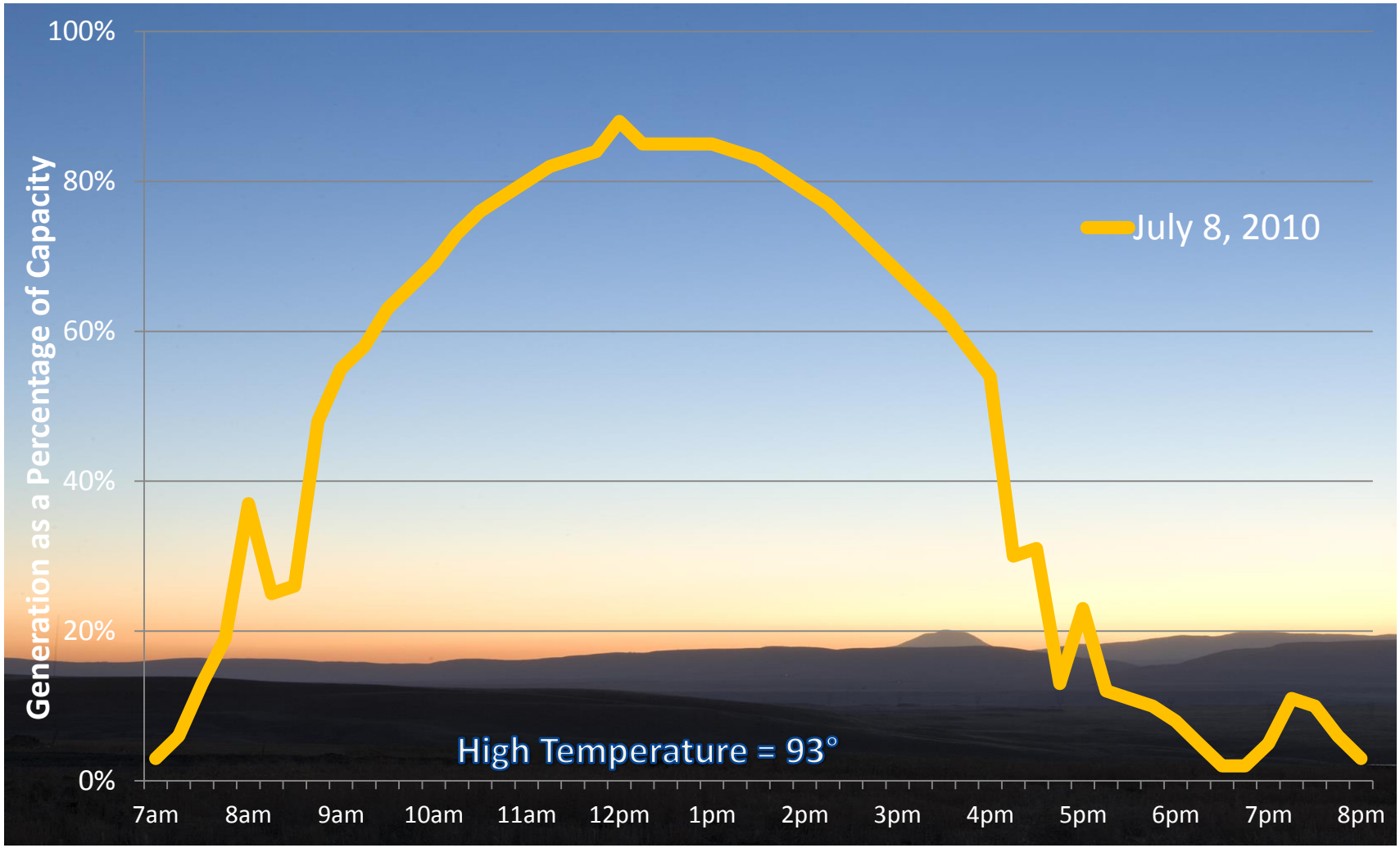
Utility and DG System-Provided Power
8 hours/day both utility and DG system provides power

DG System-Provided Power
8 hours/day DG system provides 100% of power needed

Utility-Provided Grid Services
23.99 hours/day utility provides all grid services

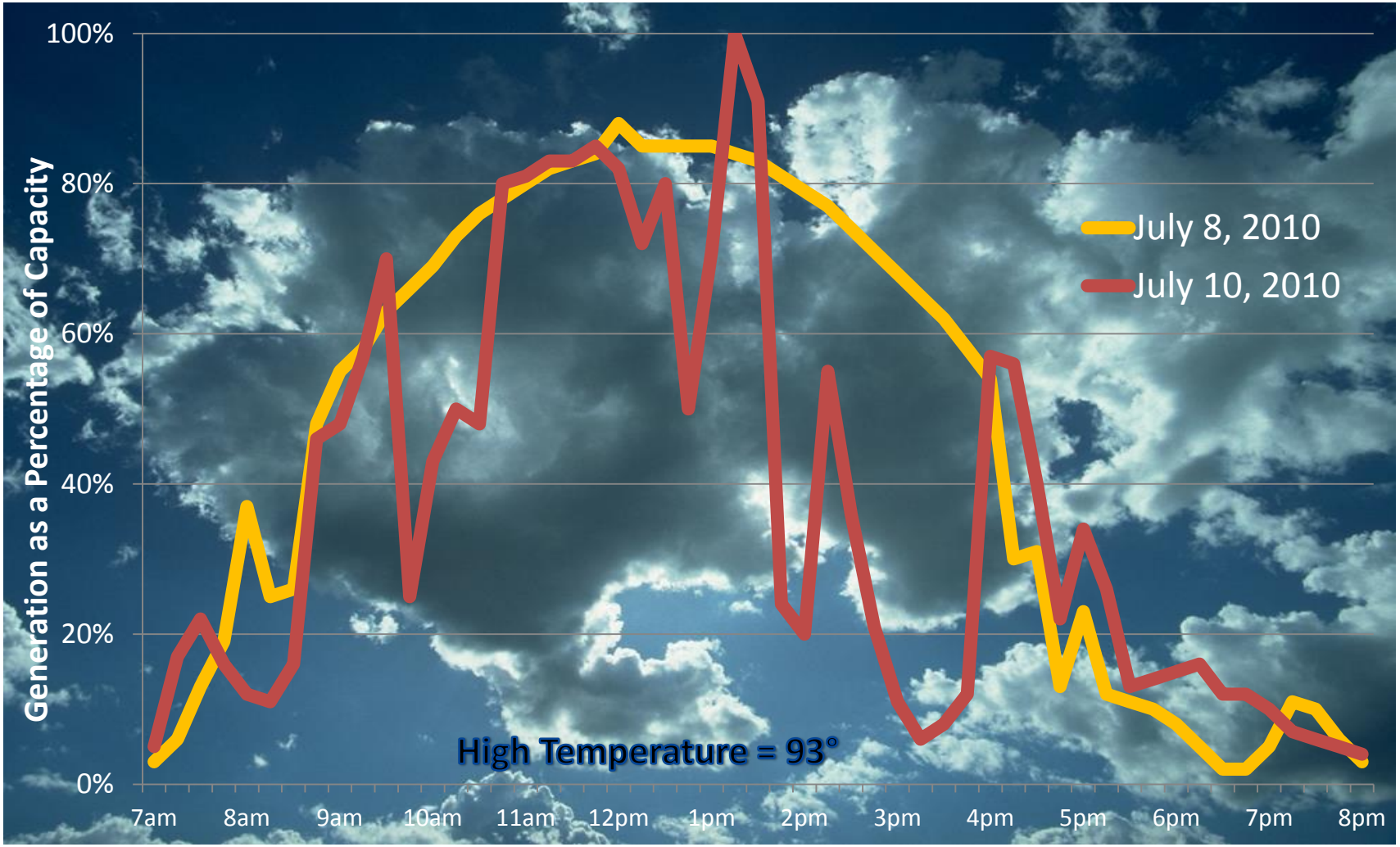
Solar Generation Profile

Sunny Conditions

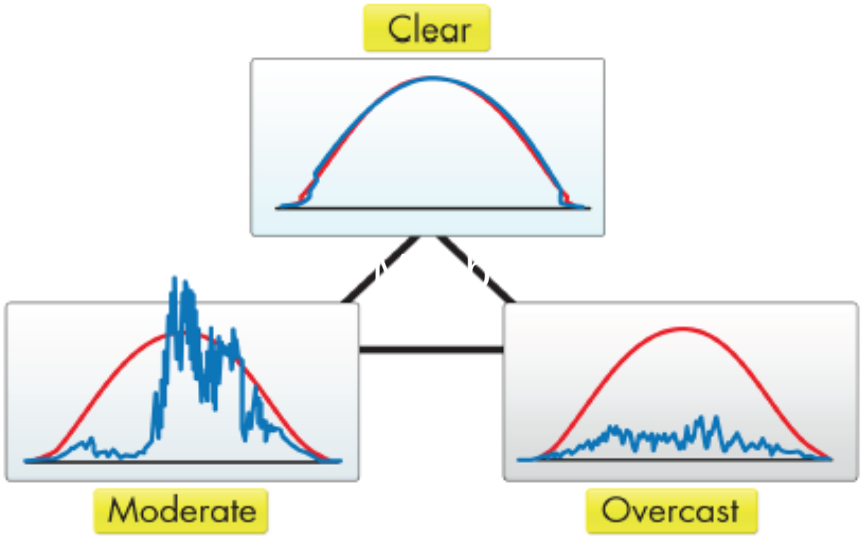


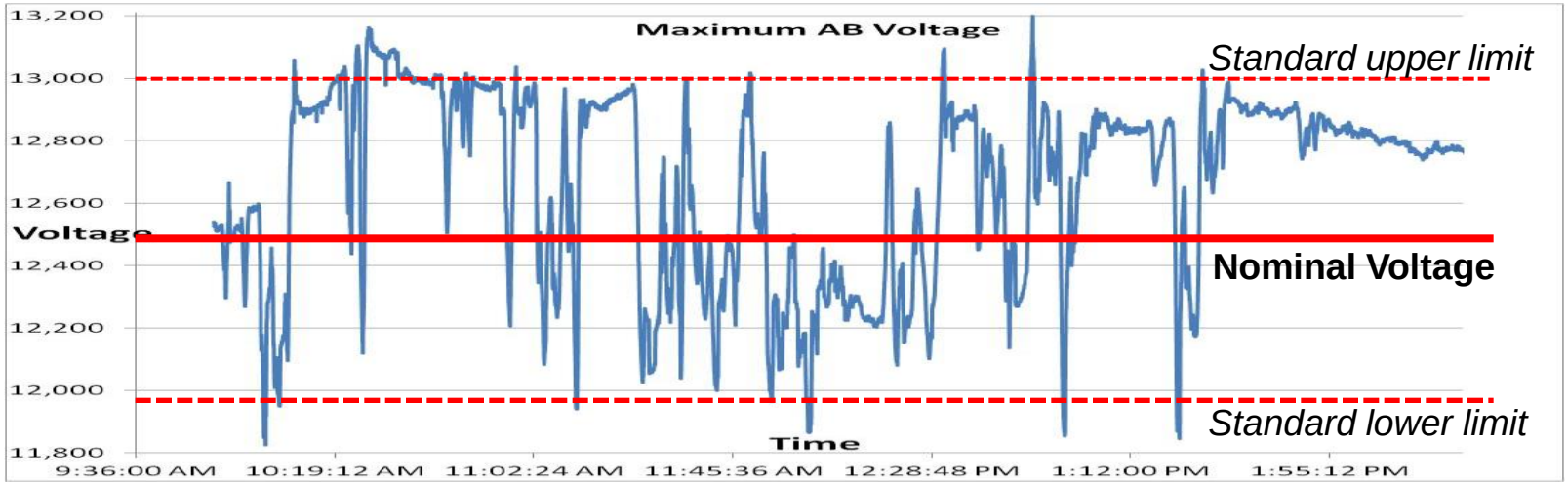
Solar Generation Profile

Intermittent Cloudy Conditions



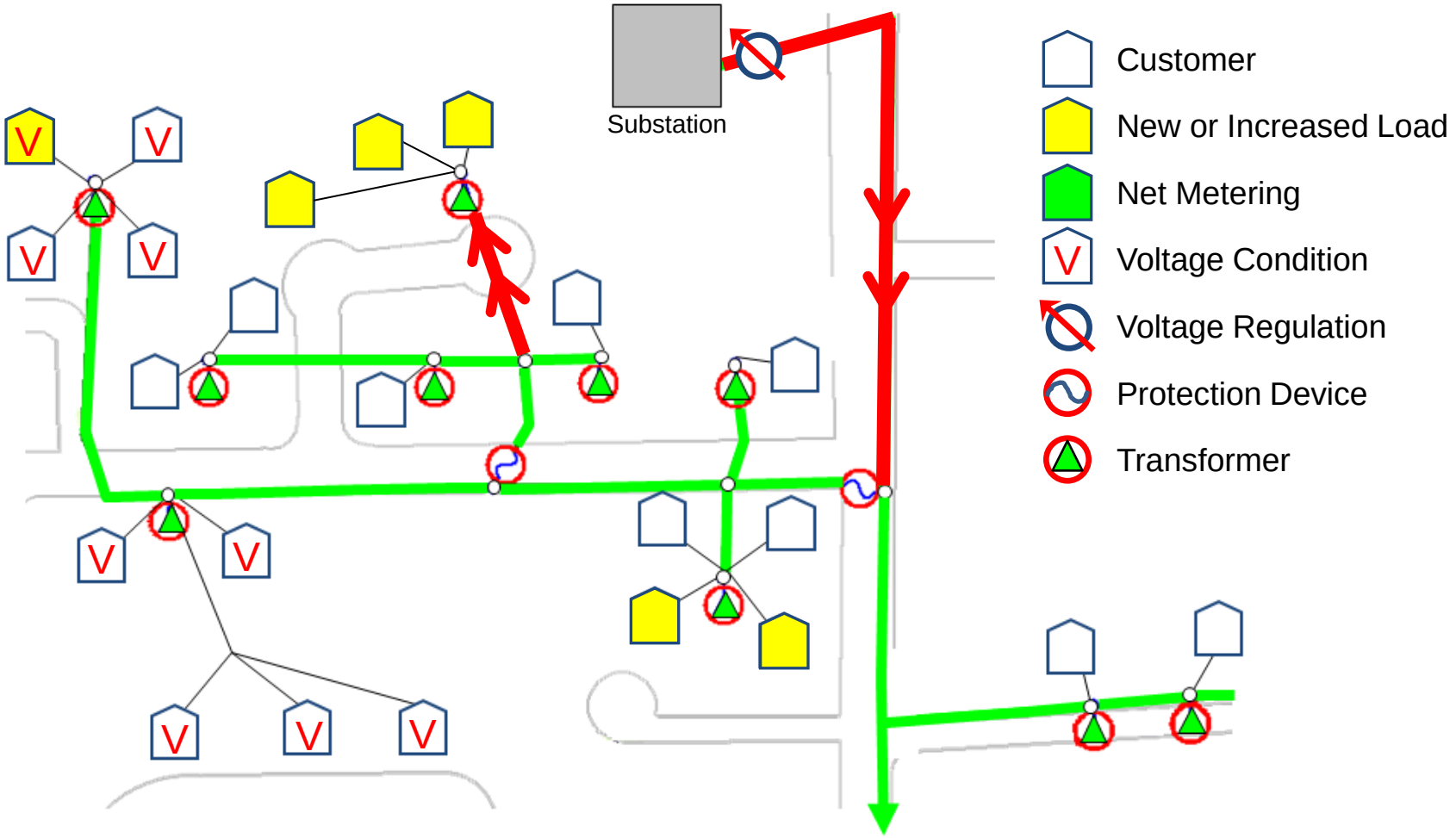
Intermittent Solar Conditions





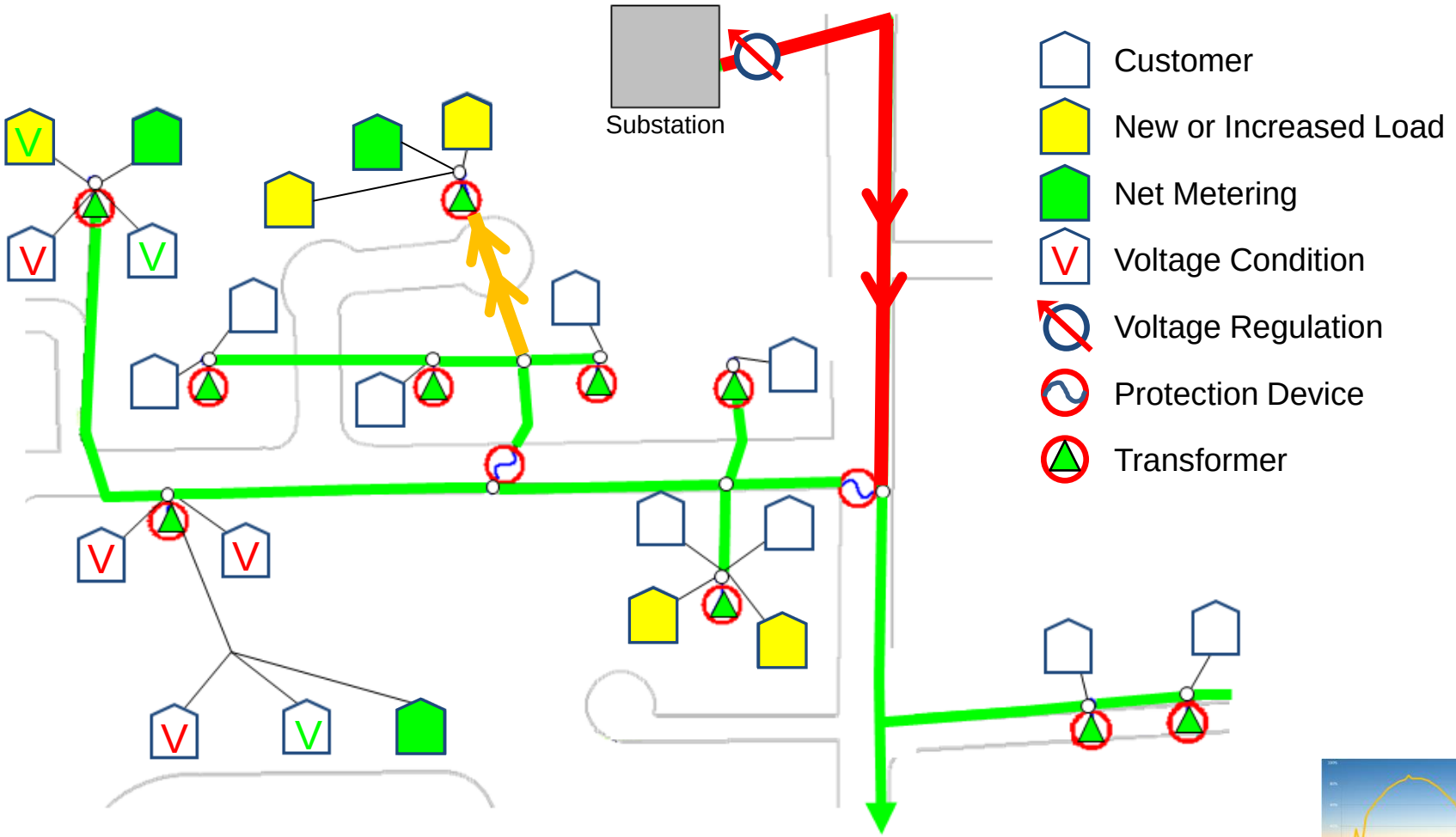
Traditional Planning

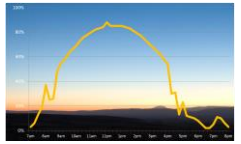
Adding New Customer Loads



Distribution Planning

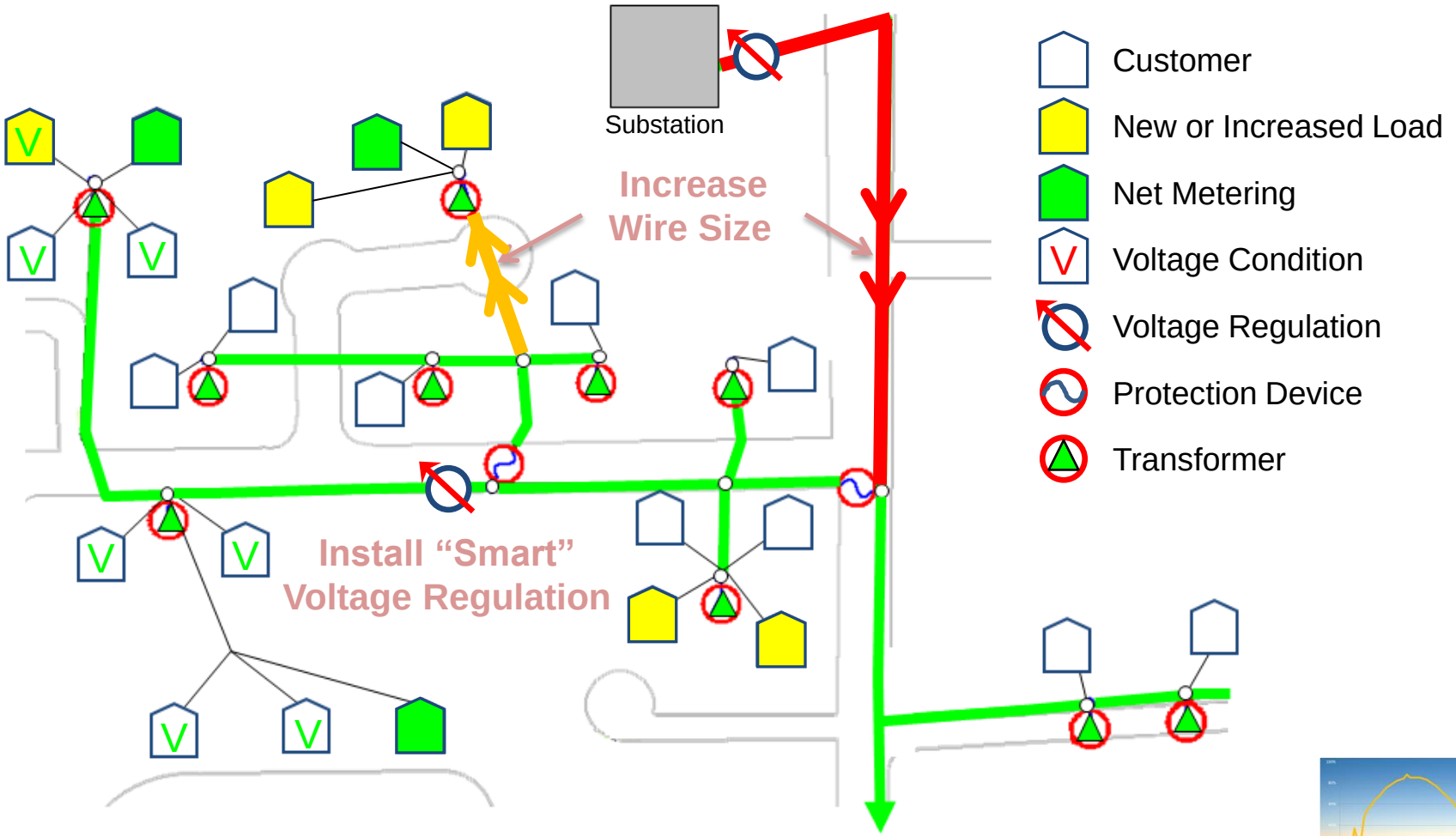
With Distributed Energy Resources

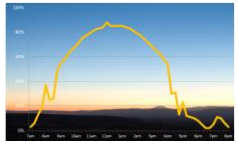




Distribution Planning

Potential Solutions with Distributed Energy Resources





Distribution Planning

With Increasing Levels of Distributed Energy Resources

Distribution Planning

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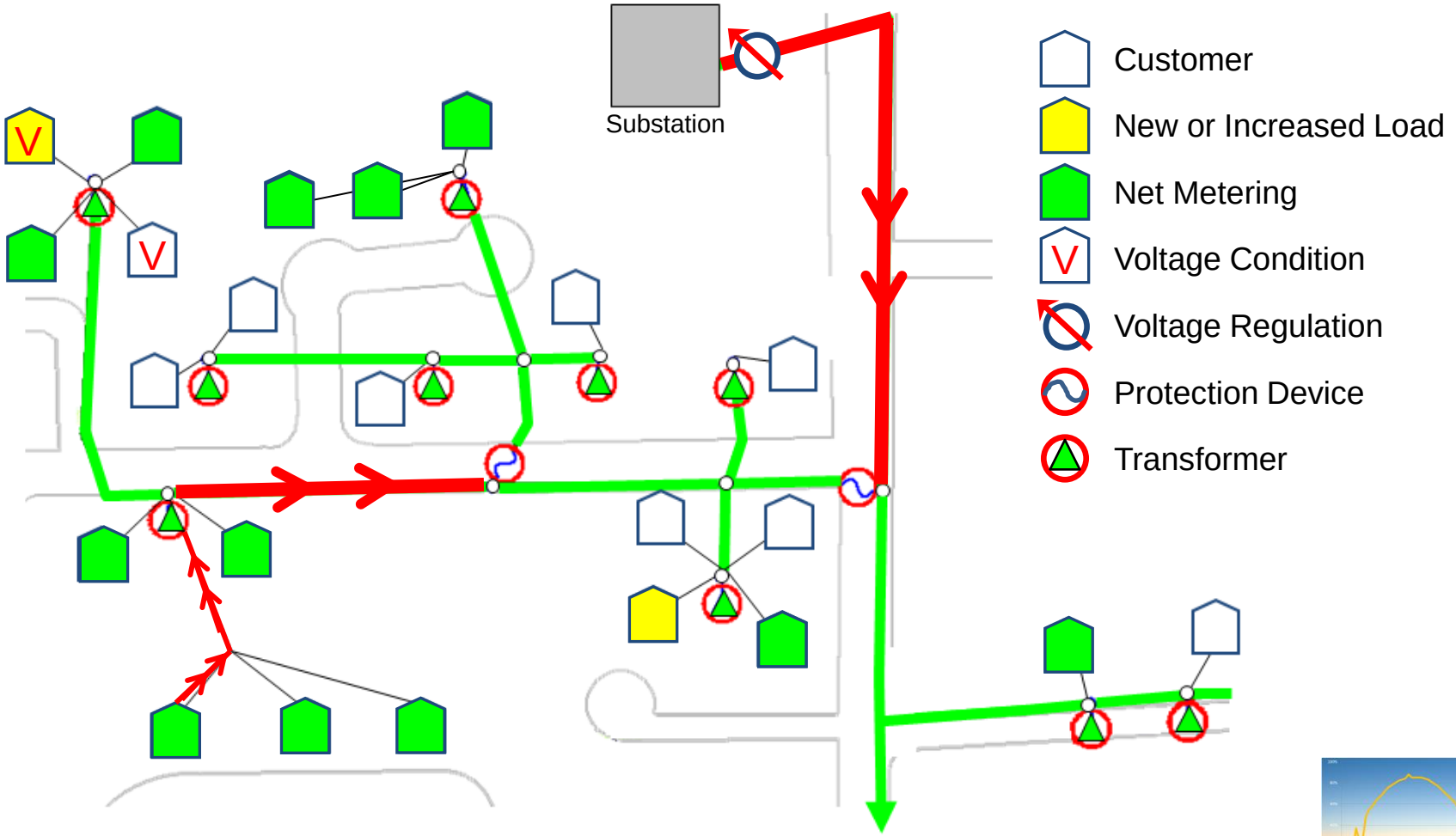
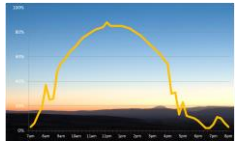
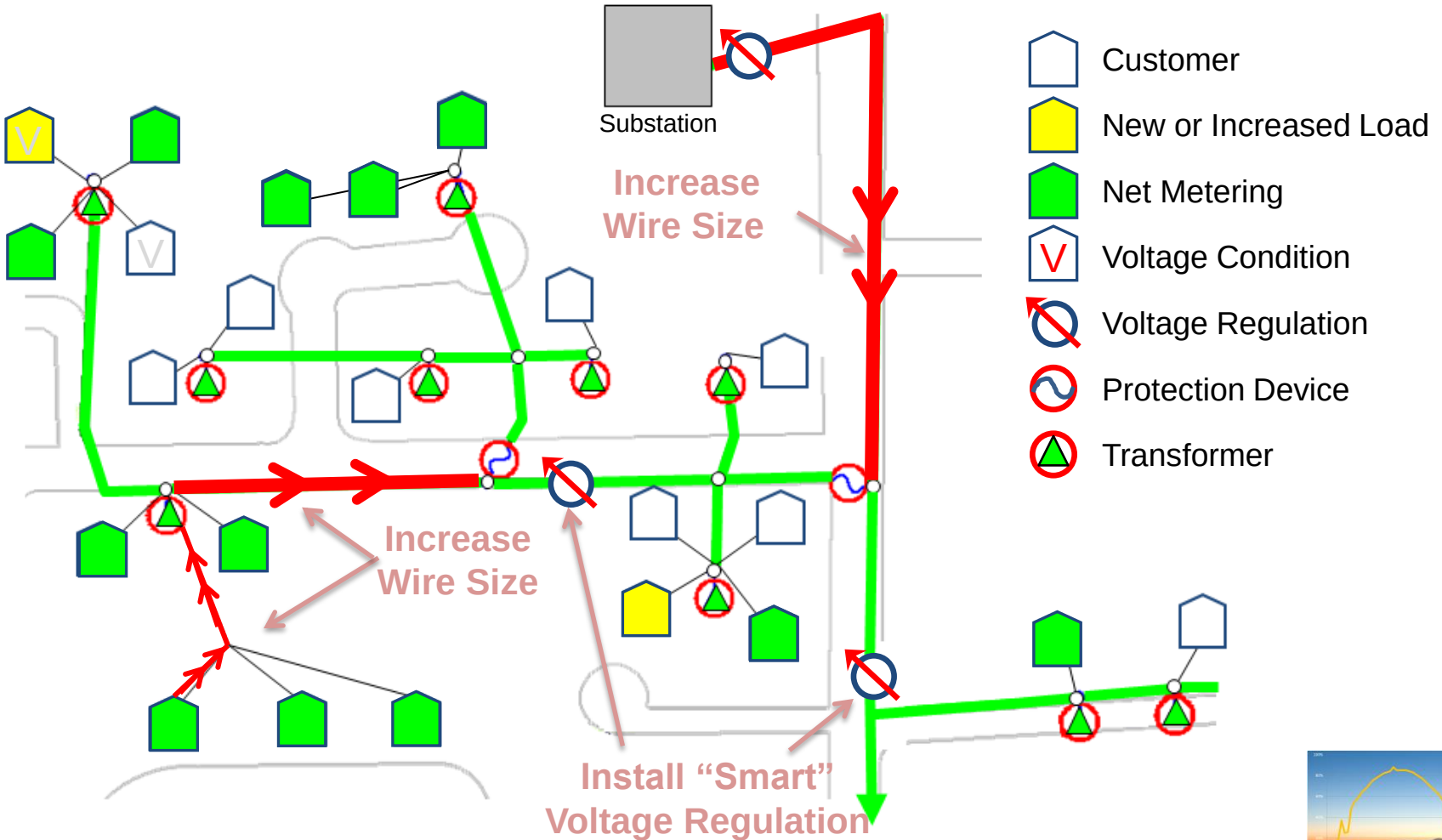
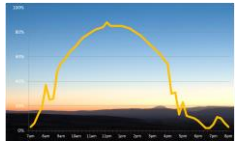




Distribution Planning

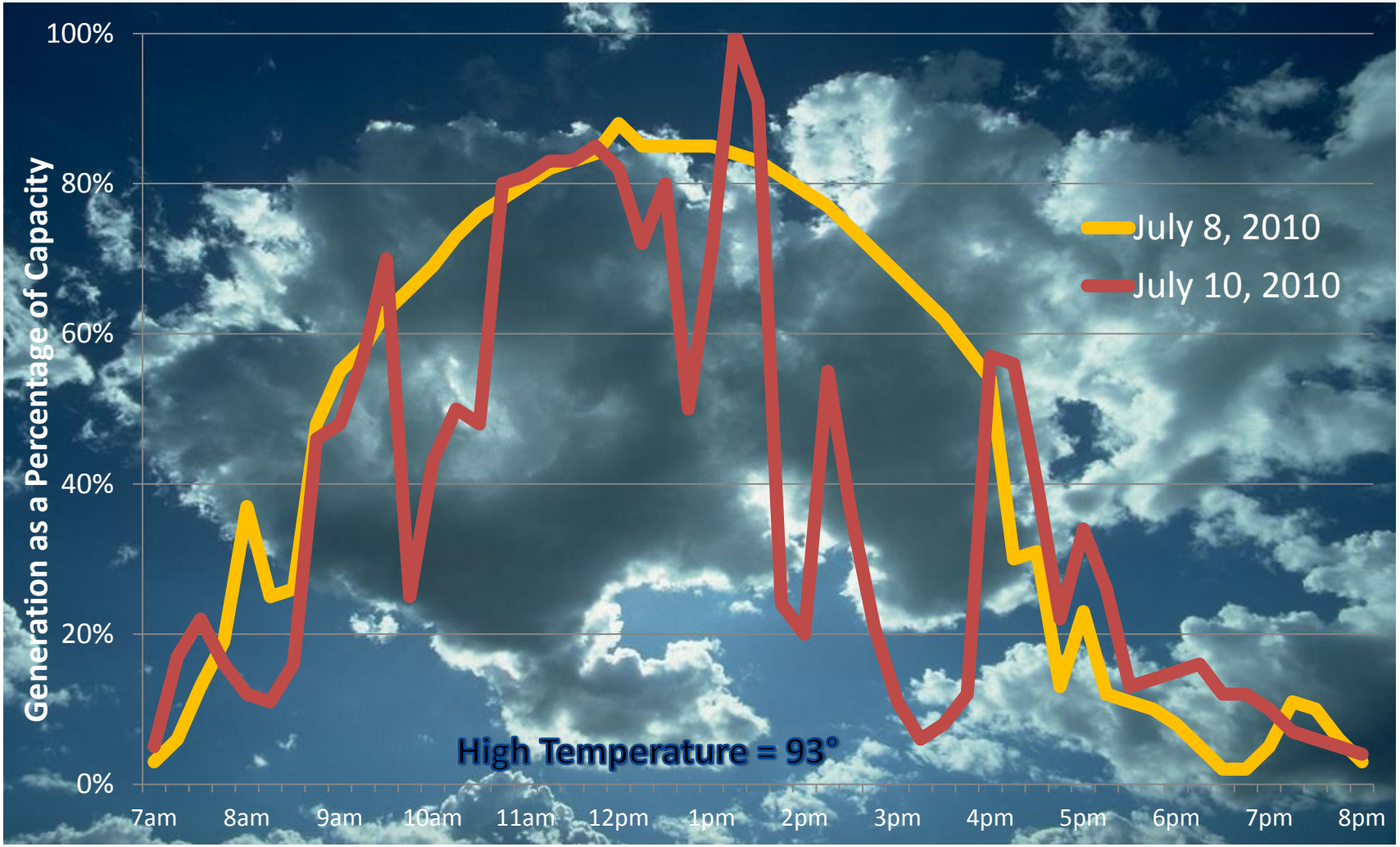
Partial Solution With Increasing Levels of Distributed Energy Resources





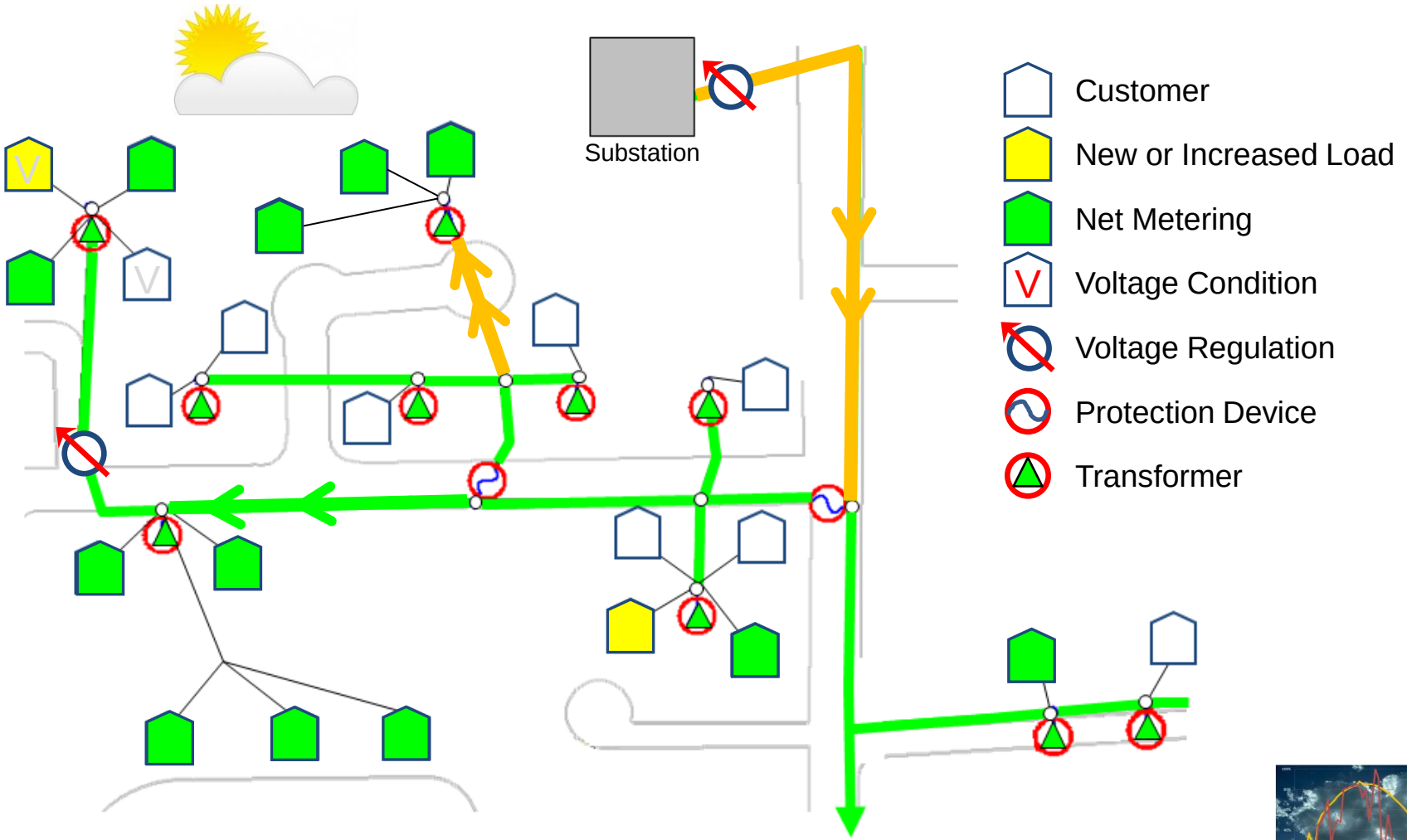
Solar Generation Profile

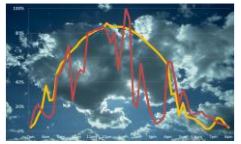
Intermittent Cloudy Conditions



Distribution Planning

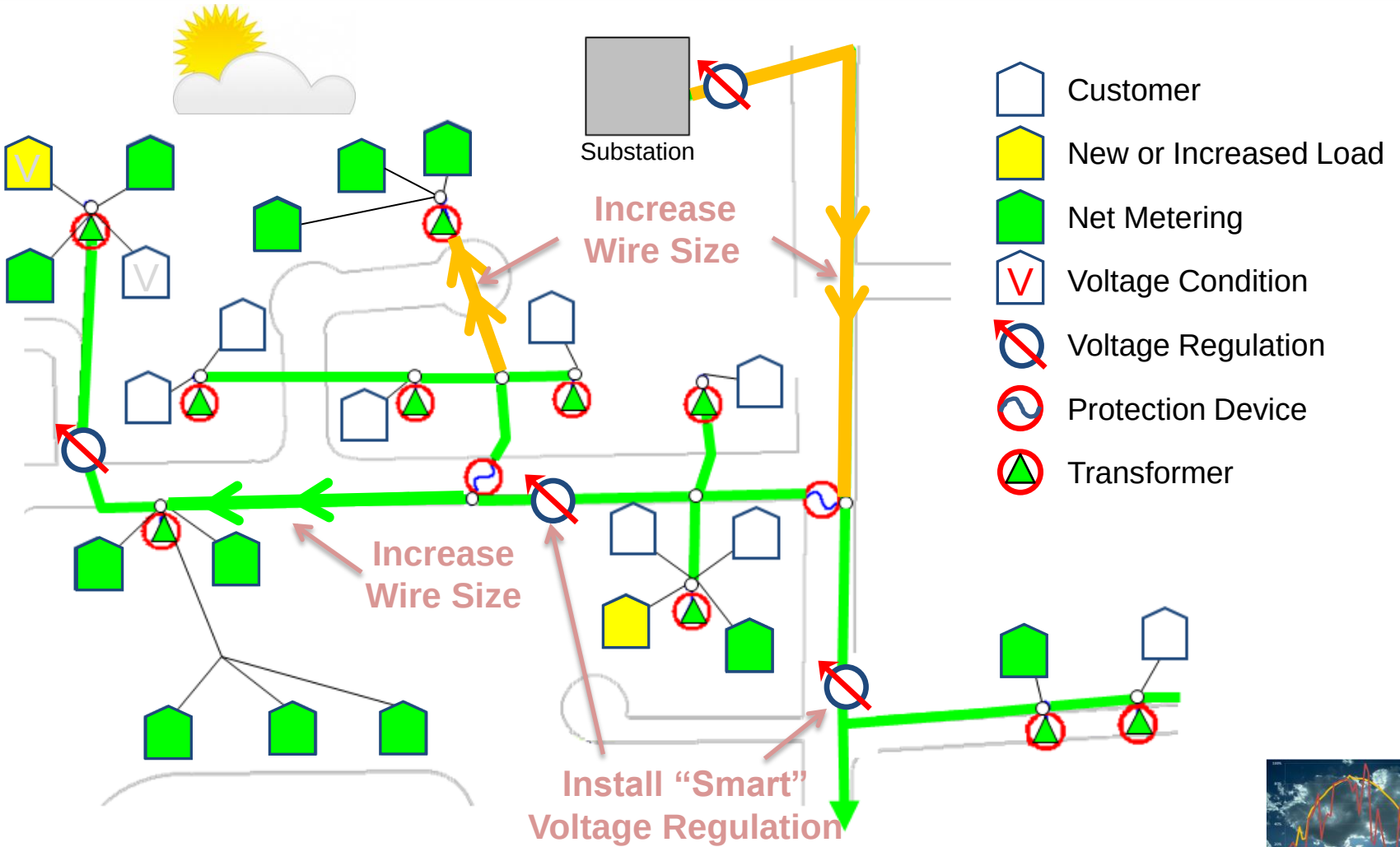
Distributed Energy Resources with Intermittent Conditions





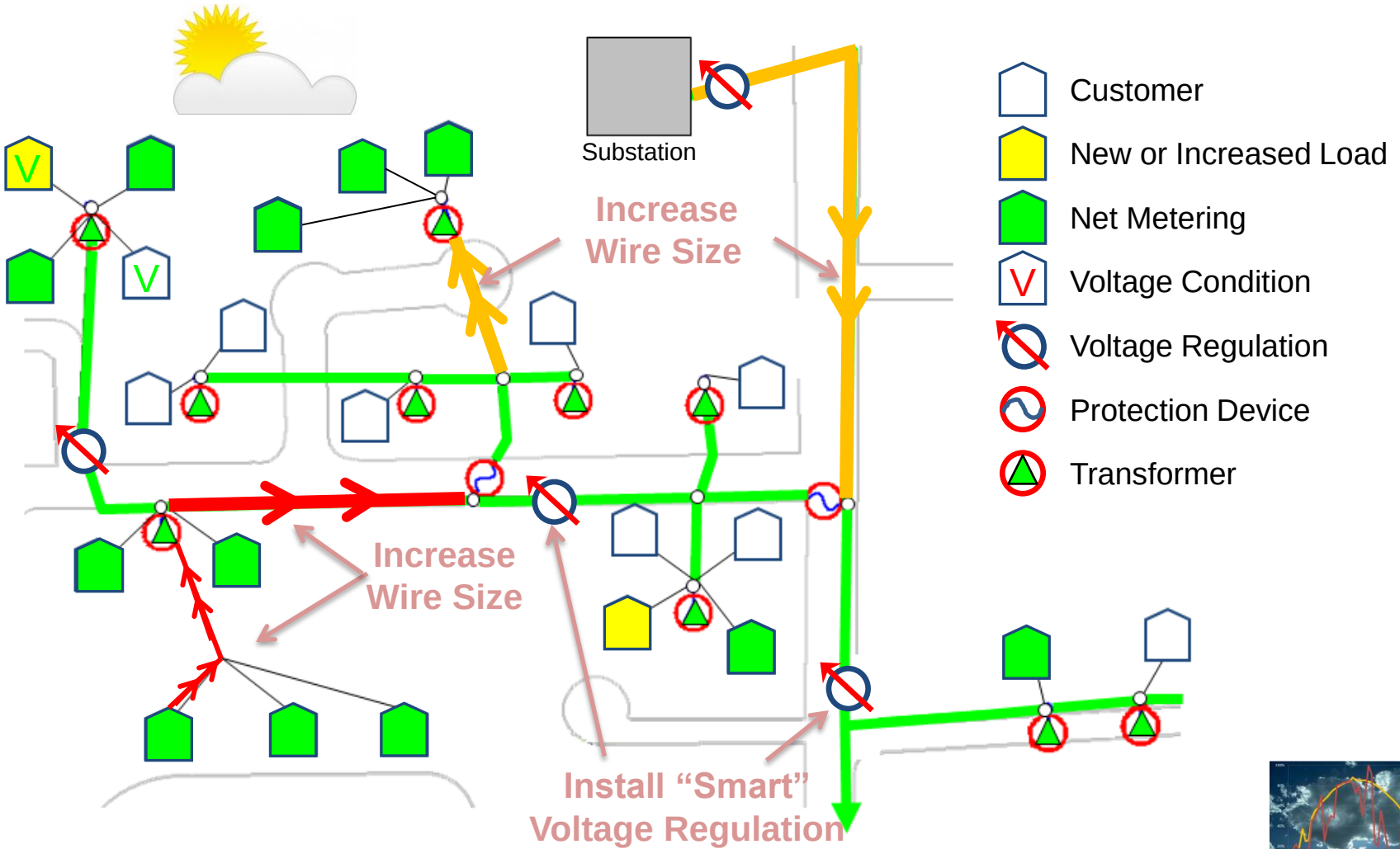
Distribution Planning

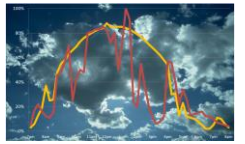
Partial Solution Distributed Energy Resources with Intermittent Conditions



Distribution Planning

Potential Solutions for Intermittent Conditions





Summary

- *High penetrations of distributed energy resource* on distribution systems requires more detailed planning and changes in equipment design and operation.
- Customer generation levels *above 15% of the peak loading* of the circuit *creates power quality and operational concerns.*
- Customer generation *over 100%* of minimum circuit loading *will cause reverse power flow.* The distribution system was not originally designed to accommodate this mode of operation.
- *Intermittency of renewable energy systems* creates additional operational challenges including voltage and power quality issues.

Questions