Integration of Renewables and the High Penetration PV Initiative

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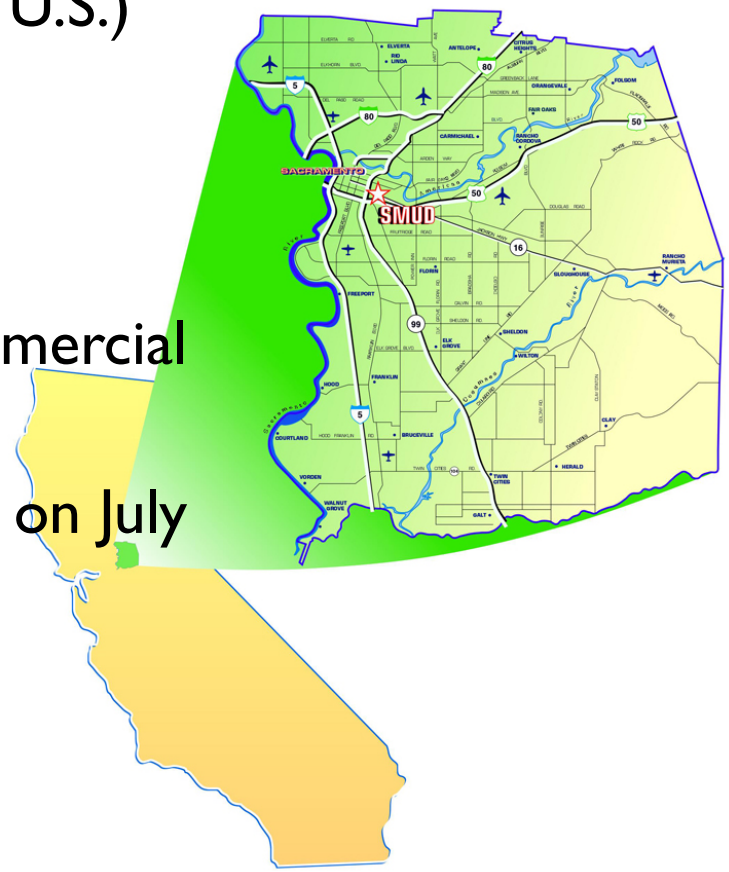
SMUD
SACRAMENTO MUNICIPAL UTILITY DISTRICT
The Power To Do More.℠

Sacramento Municipal Utility District

- Publicly Owned (Sixth Largest in U.S.)
- Service area of 900 square miles, serving 1.45 Million (Sacramento County and parts of Placer)
- Nearly 600,000 Residential, Commercial and Industrial customers
- Record peak demand-3,299 MW on July 24, 2006
- Over 24% of Retail Sales from Renewable Energy in 2010



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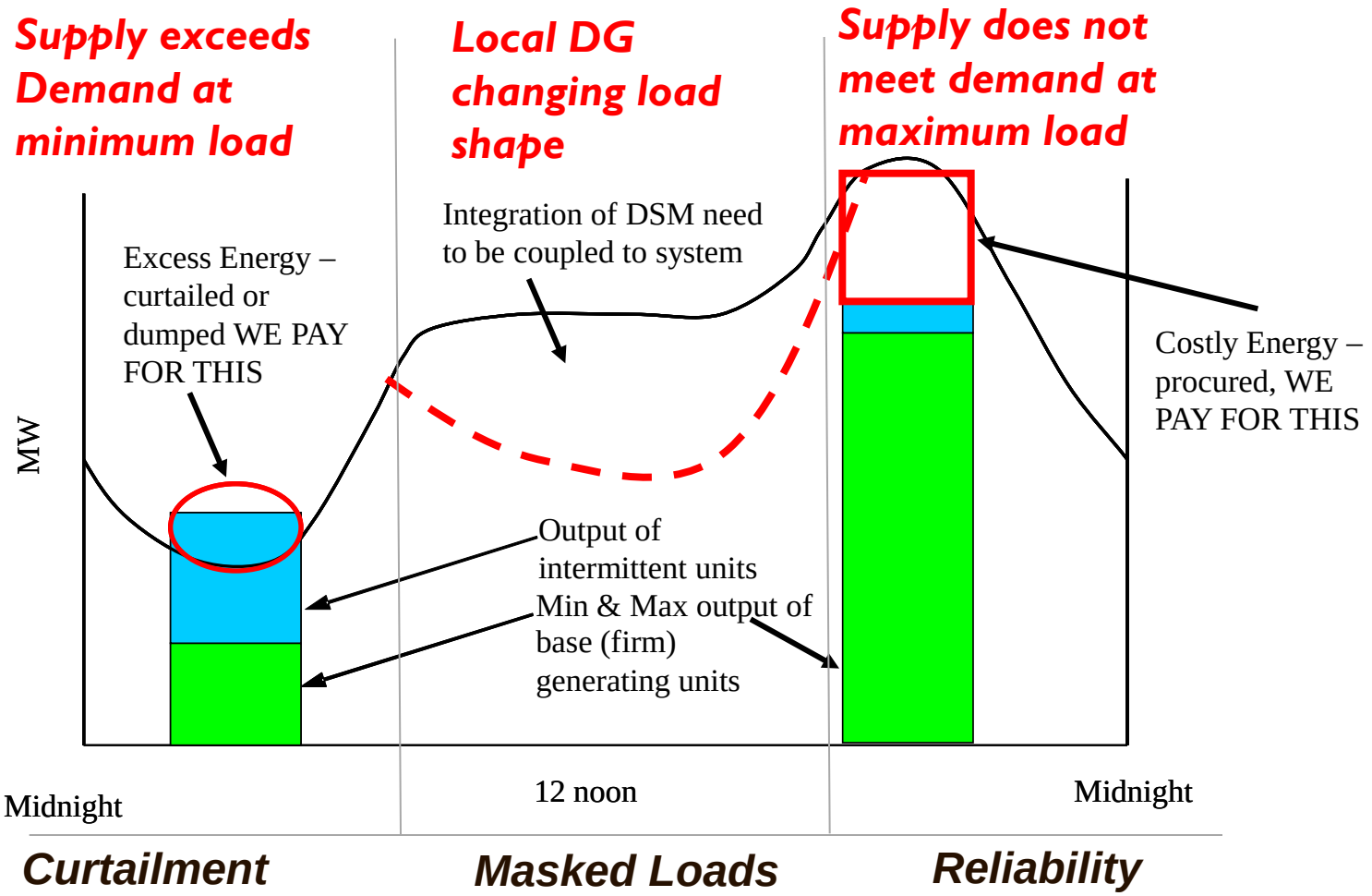
Issues Being Encountered as Penetration Increases



Integration Questions

- Policy: RPS and climate goals
- Market: Emergence of *Variable renewable* resources and distributed resource incentives
- Interoperability of the Grid: Infrastructure and process changes to accommodate higher levels of variable and distributed resources

Requires Alignment of Policy, Market & Technology

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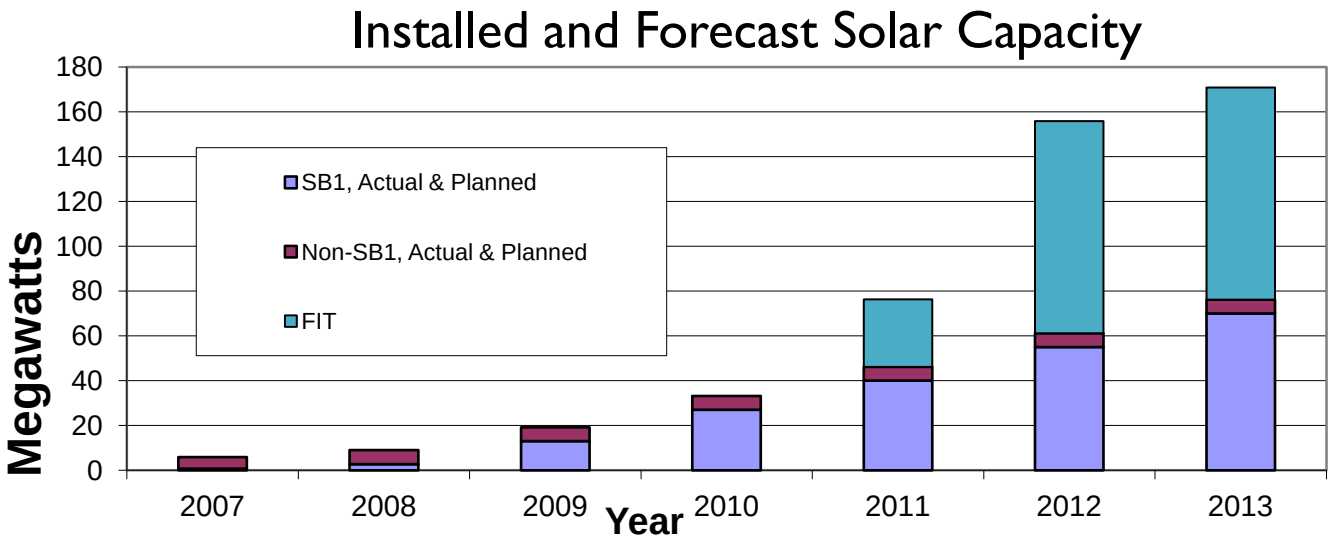
Solar Energy Growth at SMUD



Preserve Utility Guiding Principles

- Reliability of Service
- Maintain cost-effectiveness for Customers
- Ensure robust & secure infrastructure
- Sustainable resources
  - Diverse, flexible and balanced portfolio
  - Knowledgeable workforce
  - Tools to do things "in house"

Why model the distribution?

- Current models discount DG PV generation (treats as negative load) so utilities will never be able to separate and account for contributions in models
- Distributed feeder PV over a wide area can not be treated like a large central PV site
  - Lack of smoothing and averaging of power output
  - Less predictable due to climate and utility control
- Quantification of detailed feeder impacts on a per-feeder basis
  - Protection/Fault Current
  - Harmonics
  - LTC/Capacitor/Inverter interactions
  - Voltage and regulation implications
  - Seasonal impacts of high penetrations on the distribution side
- Distribution results transferred to transmission grid
  - Reduces data set size and run time
  - Provides detailed DG impacts to be considered
  - Allows for continued distribution studies with bi-directional flow of information and data consistency

Goal of Dynamic/Transient Stability Studies from a distribution perspective

- To assess the ability of generators to remain synchronized, in the event of a large disturbance
- At what level is PV impact considered a large disturbance?
  - Generally fault + line tripping, major conventional generator fault + trip, bus fault are considered large events
  - At some point the combination of all PV units on the system, will contribute to the large event and could impact the system more significantly

What benefits to transmission and generation planning?

- Determine major events or operations on distribution that could impact total system
- Simulate high risk case scenarios, to inform new operations and emergency plans for most efficient system recovery with high penetration
- Consistent methodology to address PV penetration limits before impact is more severe
- Get head start with tools to create remediation plans, for larger PV penetrations
  - Equipment replacement/upgrades

High Penetration PV Initiative Team

Team	Primary Staff
SMUD SACRAMENTO MUNICIPAL UTILITY DISTRICT The Power To Do More.SM	Elaine Sison-Lebrilla, Obadiah Bartholomy and David Brown
Hawaiian Electric Company	Tom Aukai, Dora Nakafuji (HECO) Laura Rogers, Hal Kamigaki (HELCO) Chris Reynolds (MECO)
B=W ENGINEERING	Ron Davis, Emma Stewart, Billy Quach
NEO Virtus Engineering, Inc	James Bing
SUNPOWER	Matt Galland

GO solar CALIFORNIA Itron

High Penetration PV Initiative

Goal:

Enable appropriate capability to reliably plan and operate with high penetration of variable renewable resources on the grid especially during high impact conditions (e.g. variable weather, peak loads, minimum loads, contingencies)

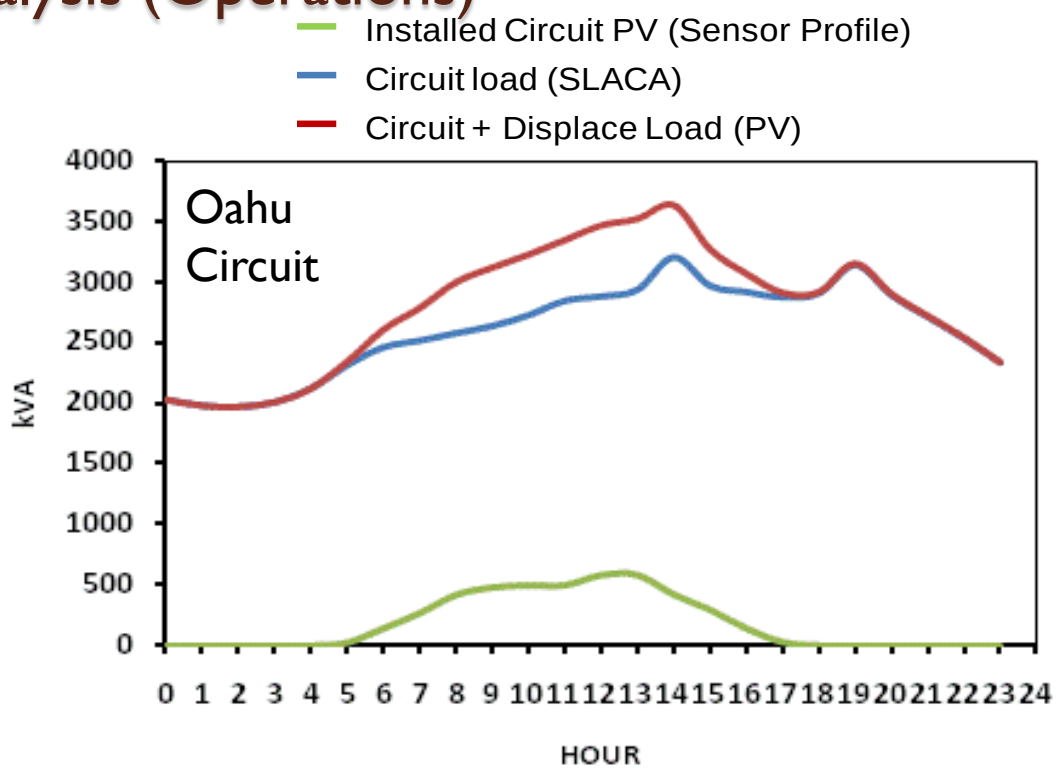
Objectives:

- Inform and pilot the development of visual tracking, field measurement and validated analytical capability including hardware and software to evaluate the impact of high penetrations of PV systems on our grid
- Transfer of lessons learned to other utilities

Main Activities

- Baseline Modeling of SMUD and HECO Systems
- Field Monitoring and Analysis
- Visualization Effort
- Solar Resource Data Collection & Forecasting Results

Hi-Pen PV Impact on the Grid - Substation Circuit Monitoring & Analysis (Operations)



- Low-cost capability to account for PV load and actual system load for planning & forecasting
- Correlate grid conditions with solar variability to assess impacts (max load, light load, storm conditions, contingencies, reserve plans)

Preliminary Results: Field sensor deployments and results are helping to increase visibility at the distribution level

TJD-1 mobile solar irradiance sensors

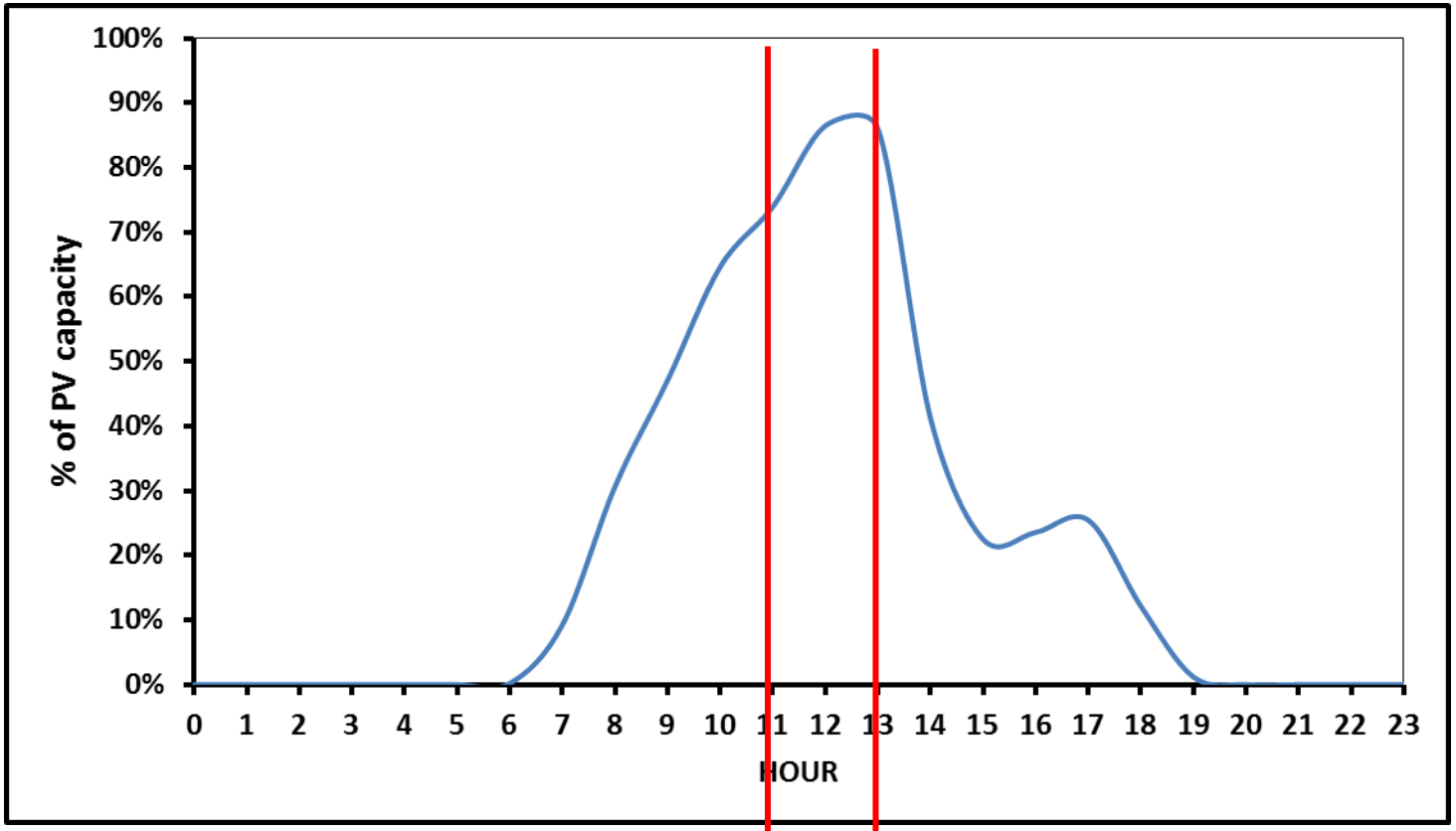
LM-1 solar availability sensors

April Minimum Day – measured demand data

- On April 4th 2011, the minimum daytime load of all measured data was observed
- Using Anatolia PV data as a proxy on this day profiles are developed in SynerGEE Electric
- There is a dairy digester on E-B Ckt – 225 kW also being measured
  - Generally the dairy digester is either ON or OFF
- 1 to 3 MW of PV is proposed on E-B Ckt
- Load flow and voltage analysis is completed to determine the impact of the proposed PV on this minimum daytime (i.e. when PV is generating) day

Field Validation Locations & Devices

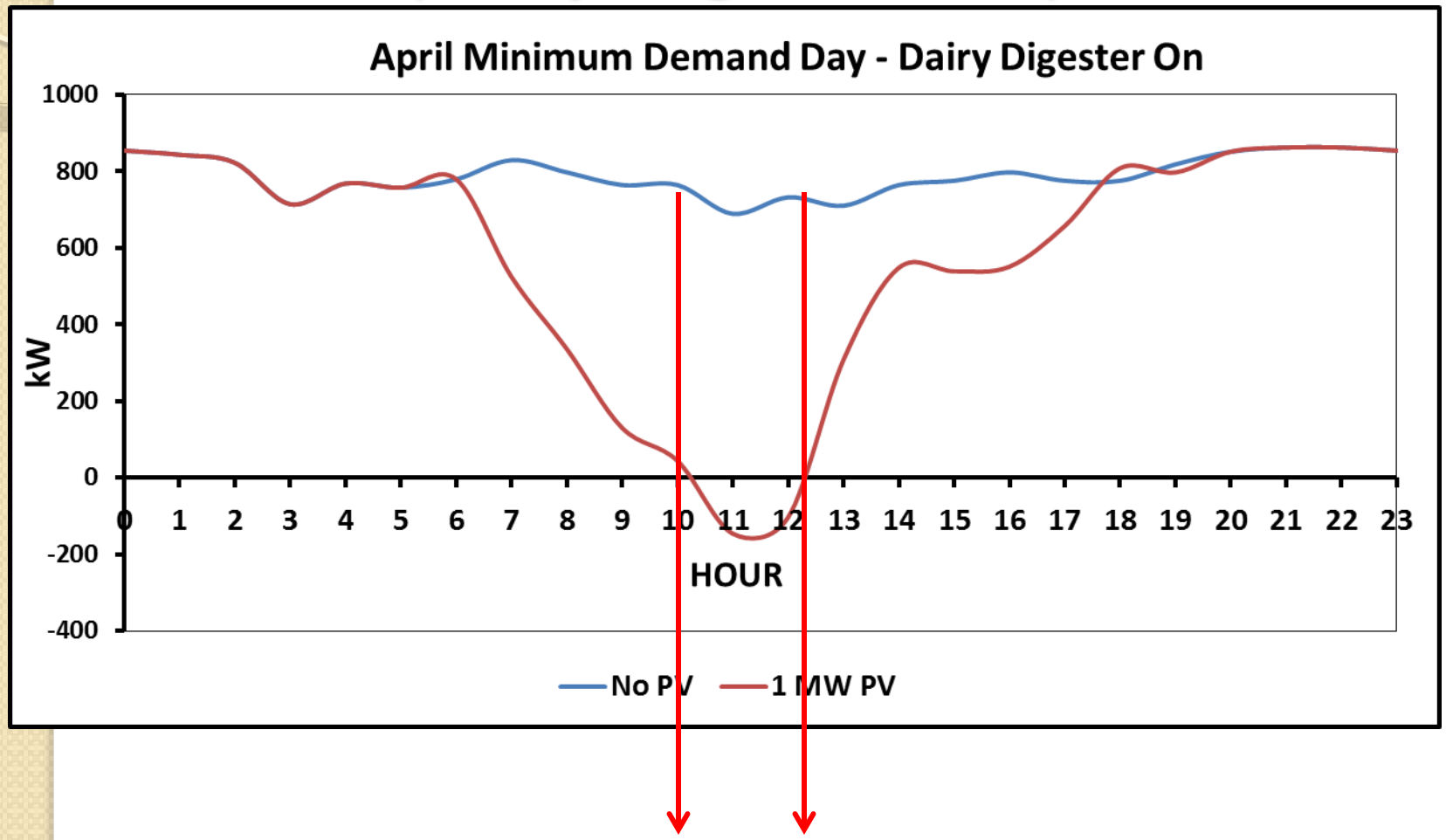
PV generation profile April 4th 2011 Substituted from Anatolia data



Min Daytime Demand time

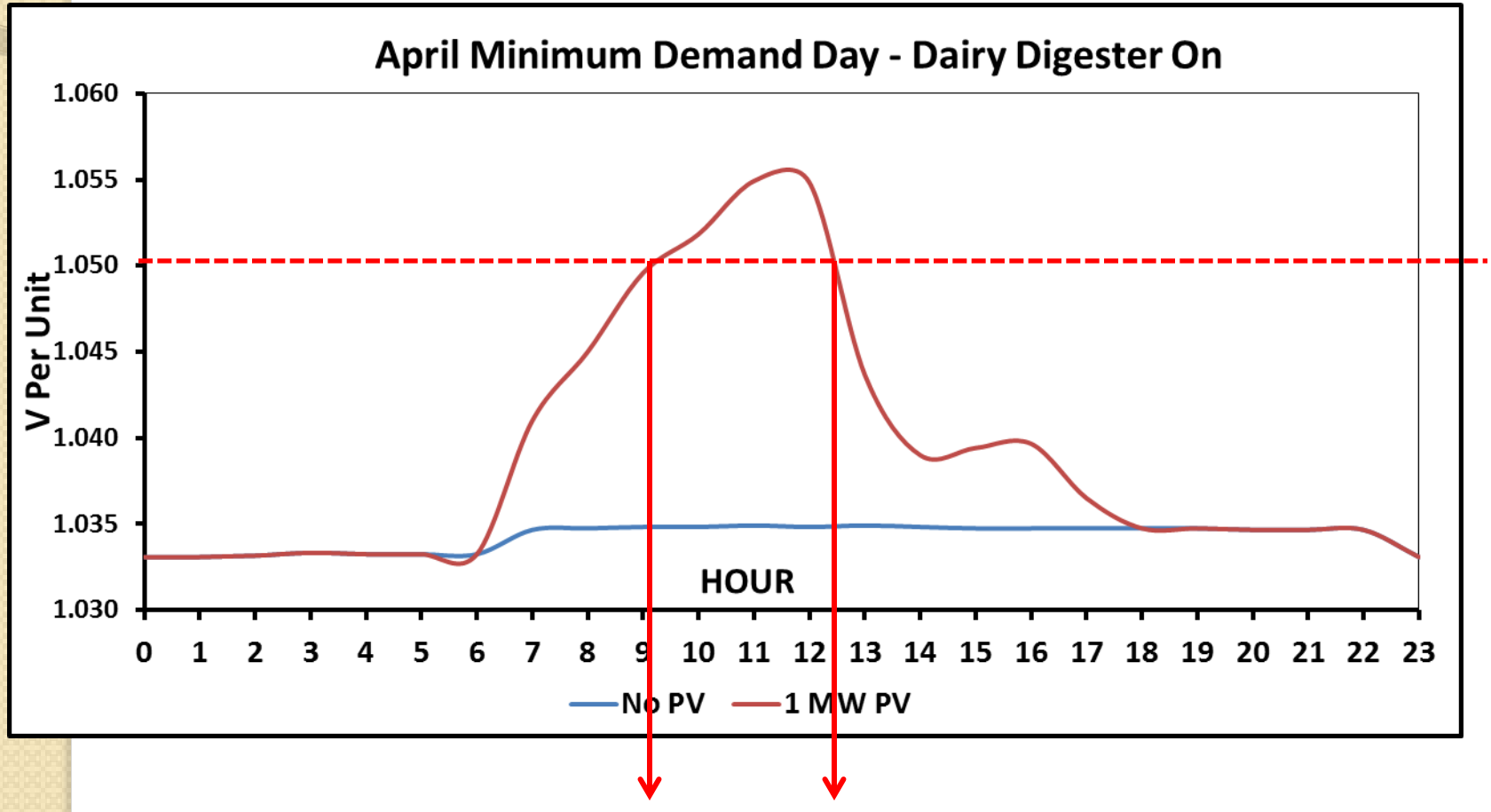
Peak PV Generation Time

Load Flow Results – 1 MW of PV vs no PV (dairy digester on)



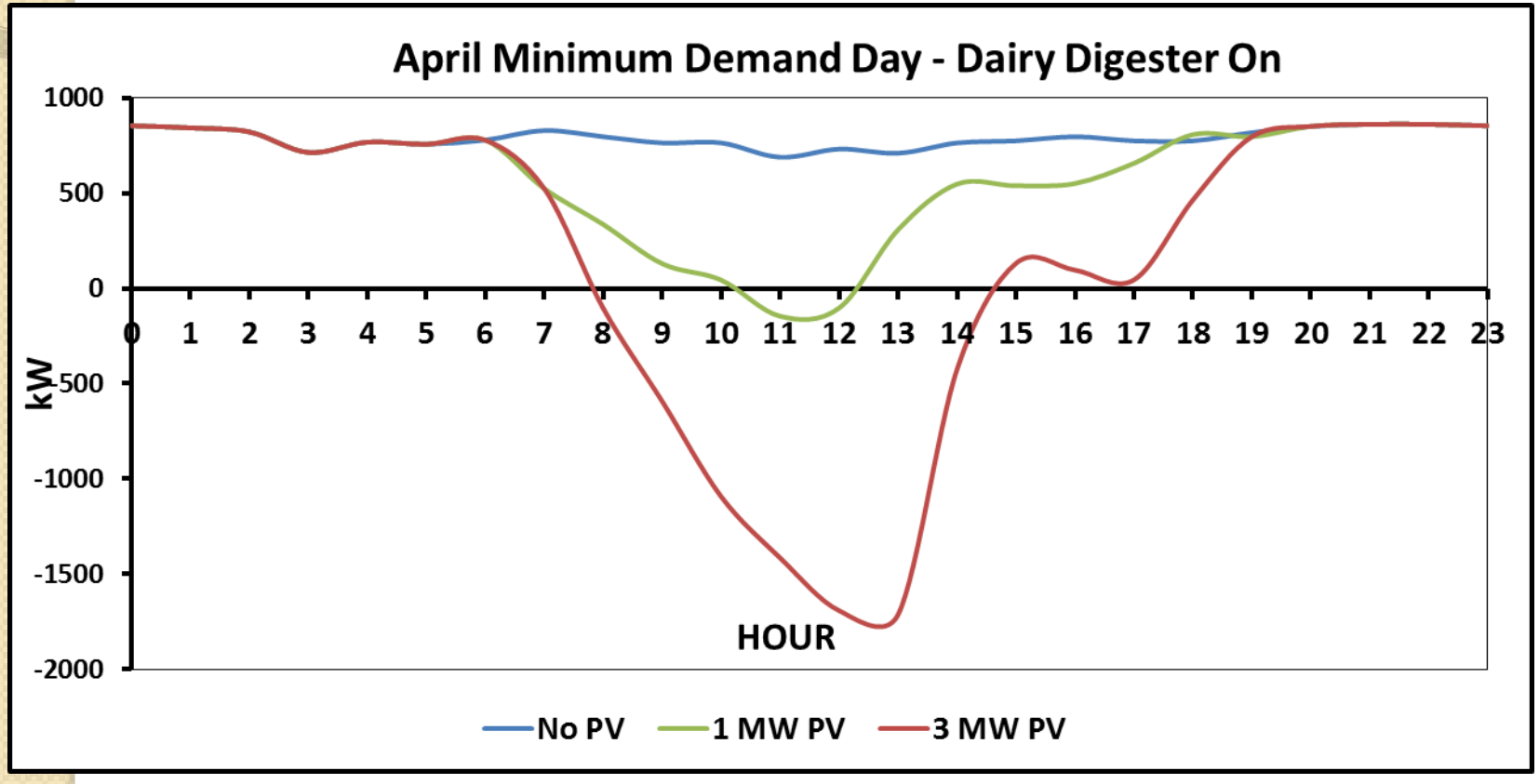
2 hours of back-feed into the substation at peak PV generation hour

Maximum Voltage Results – 1 MW of PV vs no PV (dairy digester on)

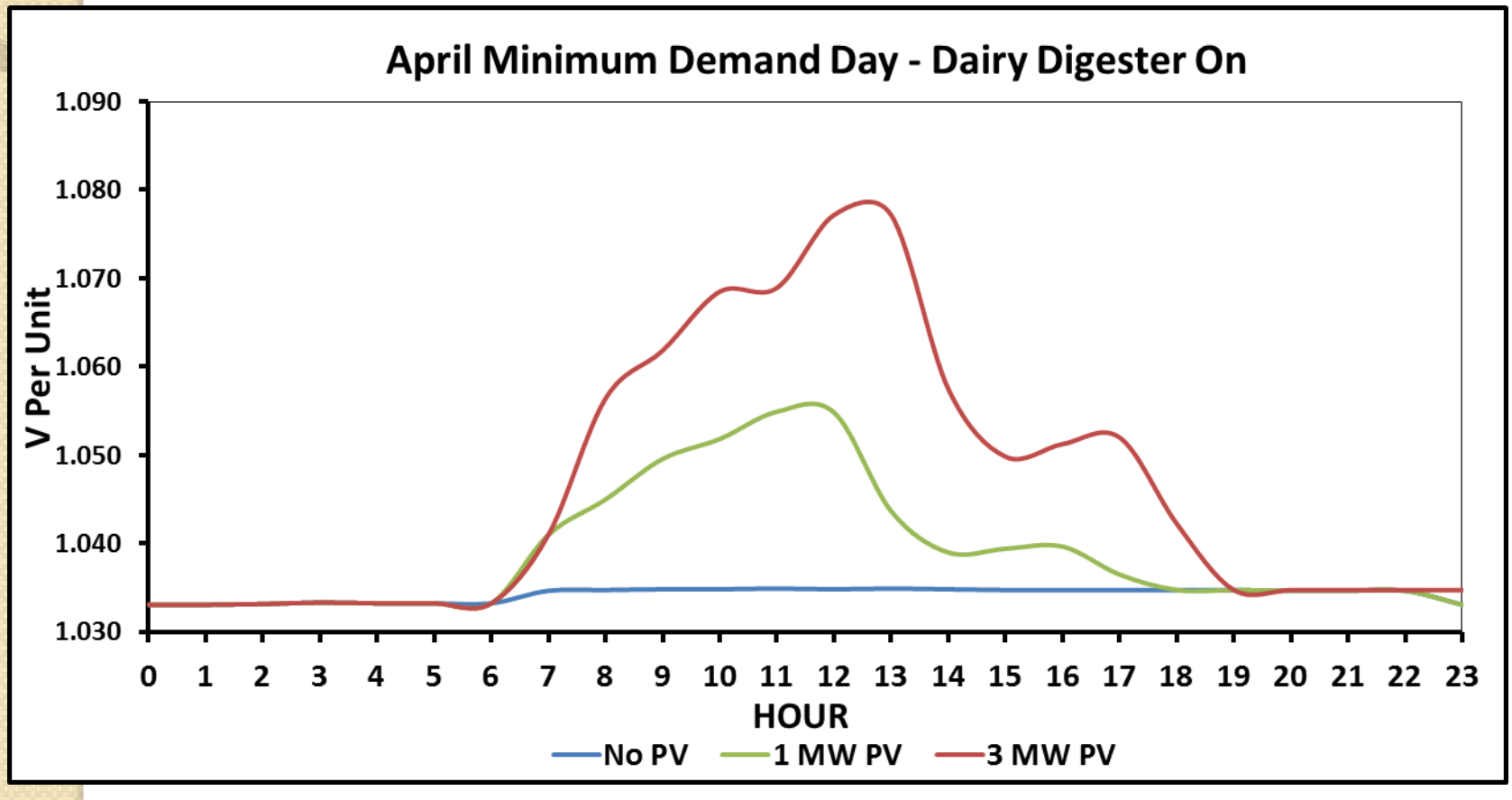


3.5 Hours of high voltage during peak PV generation

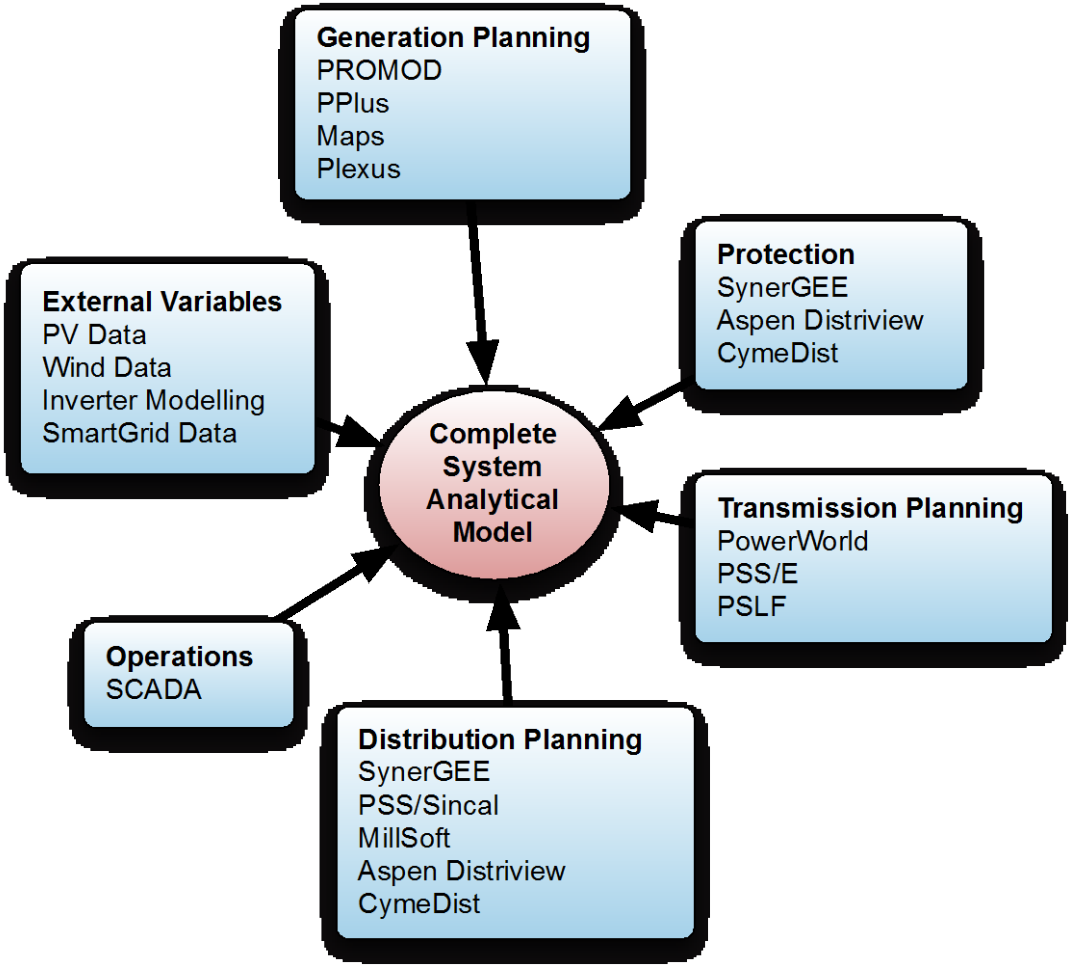
Load Flow Results combined (dairy digester on)



Maximum Voltage Results – combined (dairy digester on)



Graphical Flow of Model Interfaces



Thank You

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