Integration of Probabilistic Forecasts into the EMS and MMS – Status & Prospects

2022 Meteorology and Market Design for Grid Services Workshop
June 08, 2022, Denver, CO

Sankaran Rajagopal
Siemens Grid Software, Minnetonka, MN
Sankaran Rajagopal@Siemens.com

Agenda

1. Overview – Managing Uncertainty in Energy Markets (MMS and EMS)
2. Current Solutions View
3. Four Drivers of Influence – MMS and EMS
4. Six Year Journey Overview – California ISO
5. Example – Application use cases of variability forecast
6. Conclusion

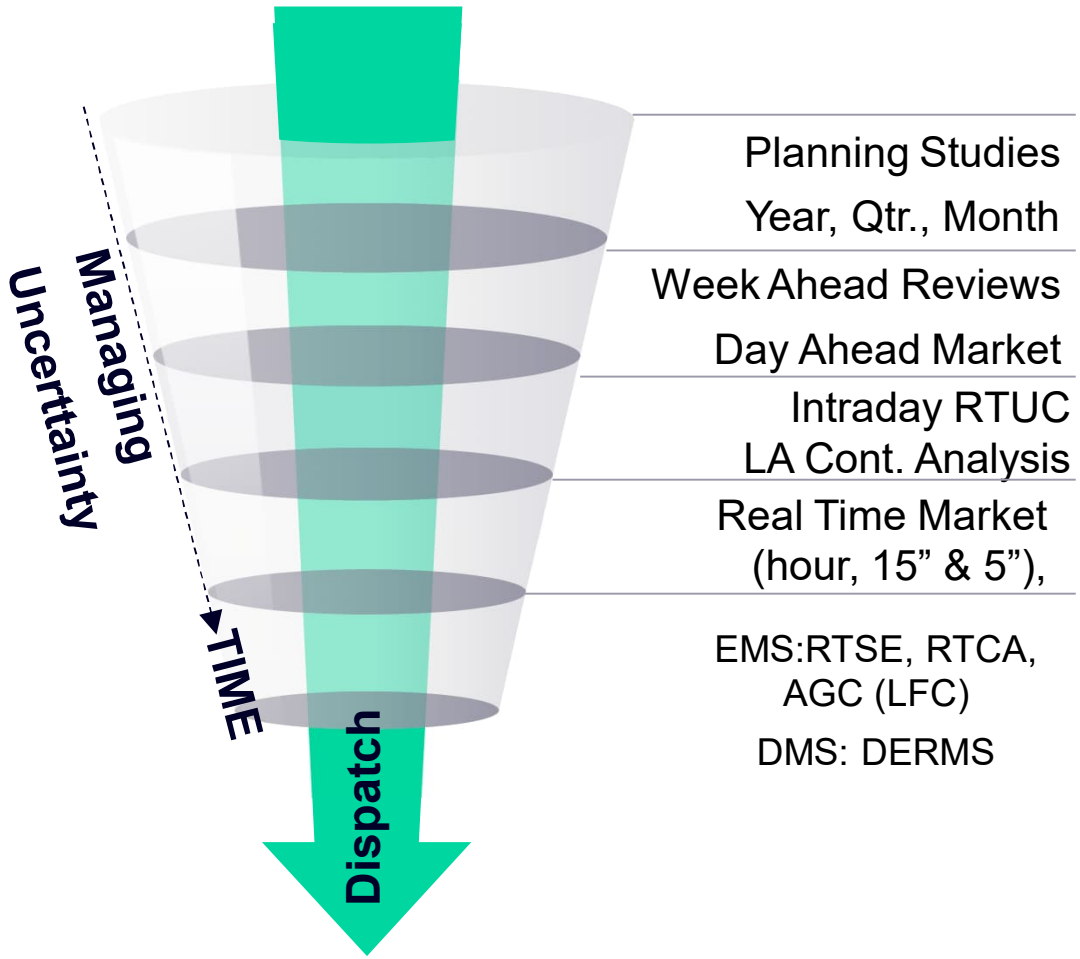
SIEMENS

Overview of Managing Uncertainty in Energy Markets

Average values - interval forecasts:
- Demand and Renewable for Net Load basis
- Dispatch readiness at-all-times over a given network & selected resources by a competitive market

Accounting for Net Load Uncertainty:
- Use of probability forecast
- BTM DER variations – Forecast
- Uncertainty products
- Reg. and Ramp reserve management

Combine with other types of uncertainties:
- Scheduled outages' drift in time
- Unscheduled outages (NERC N-1)
- Spin and Non-Spin – contingency reserve management



SIEMENS

Current Solutions Market and System Operators – Context of Renewable/Demand Forecast

Year, Month → Week, Day → Hour, Minutes, Seconds

1 Planning (G, T, D)

Monte Carlo simulations

- Retirement & new gen.'s
- Integrated resource plan (GT&D)
- Hi RE and Lo RE cases
- Resource adequacy
- System strength
- Stability assessment

2 Operations Planning

EN & AS - forward market clearing schedules & prices

- Split the problem: Energy (expected) and Reserve (prepare for uncertainty)
- Selected reserves - use of probabilistic forecast for req's
- Scenarios – in unit commitment evaluation
- Outage evaluation, coordination & optimization

3 Real Time Op's

Real time market clearing of EN and AS by co-optimization

- Probability basis for selected reserves
- Dispatch of EN & AS: refinements by LA SCED -5" EN and 15" AS prices

EMS

- LFC: 6 seconds secondary control for balancing
- Network Analysis: LACA
- BTM DER – MDMS & probabilistic forecast of roof top clusters

SIEMENS

Four Drivers of Influences for MMS, EMS and DMS Evolution

Balancing

Energy Balancing (< 6 sec.) for Energy Quality.

NERC CPS Criteria for Freq. & ACE: penalty for non-compliance.

Forecast accuracy & resource readiness matter to face uncertainty

Products for Flexibility

Supply side evolved by emerging needs, market value & prices, incentives and climate

(e.g., FERC mandates: 755, 841, 2222, Investment & production tax incentives, IIJA, Net-zero)

Tech. Assist for Net-zero

EIM, Storages & DER: Levers to keep it firm across a 5' period (manage interval averages excursion)

Batteries & CC plants: Levers to manage variability in 6 seconds cycles

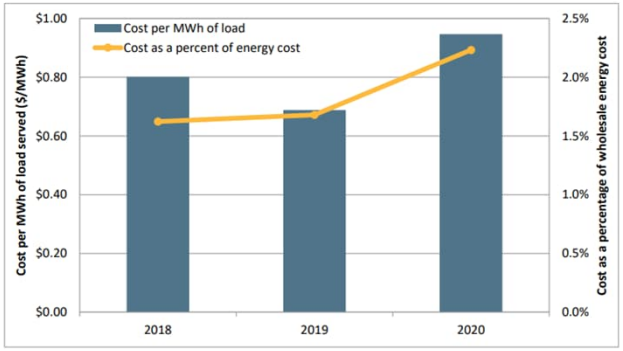
Reserve Management

Determination of time varying reserves is a high priority (prob. forecasts matter) in facing uncertainty

Assess and replenish flexible capacity ahead (dynamic ramping assessment, state of charge management)

Six-year Journey of California ISO Net Load and Implications

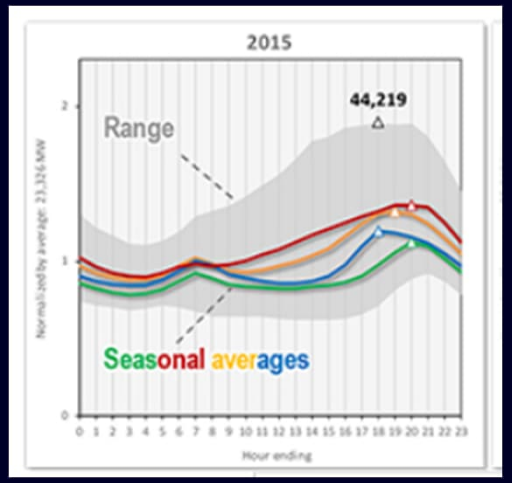
Figure E.5 Ancillary service cost as a percentage of wholesale energy cost



AS cost as a % of energy cost in CAISO 2018-2020: Increasing trend [caiso.com]

(2020 AS payment is 40% more – considering gas prices were 30% less in 2020 – compared to 2018 & 2019)

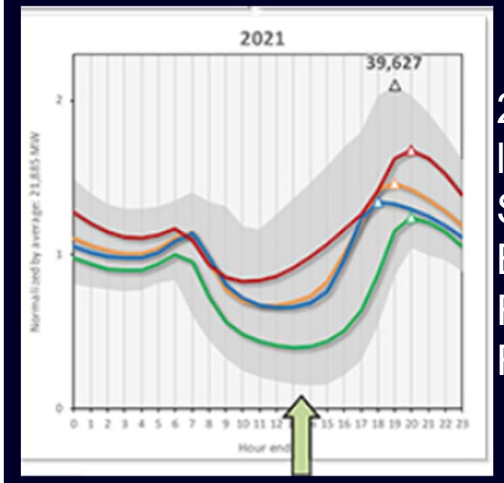
CAISO Net Load Four Seasons 2015 -2021



2015

Solution Development Summary over 8 years

- **Dynamic Ramping models**
- **Detailed CC Plants & Battery SoC and degradation models**
- **Smarter practice of Preventive-Corrective-SCUC: Allow durations when some congestions and RE curtailments are avoidable by assessment of contingency & reserve simulation**
- **Optimization of of flexibility (Storage, CC Plant, DER's): Look Ahead SCED**
- **Smart use of forecast (minute basis inside a 5' & 15' interval)**
- **Uncertainty products and use of probabilistic forecast for flex ramp**
- **EIM - 5" and 15" market - surplus/deficit of RE traded across BA's**
- **Week Ahead Outage Optimization coordination**
- **LACA – Look Ahead Contingency Analysis**



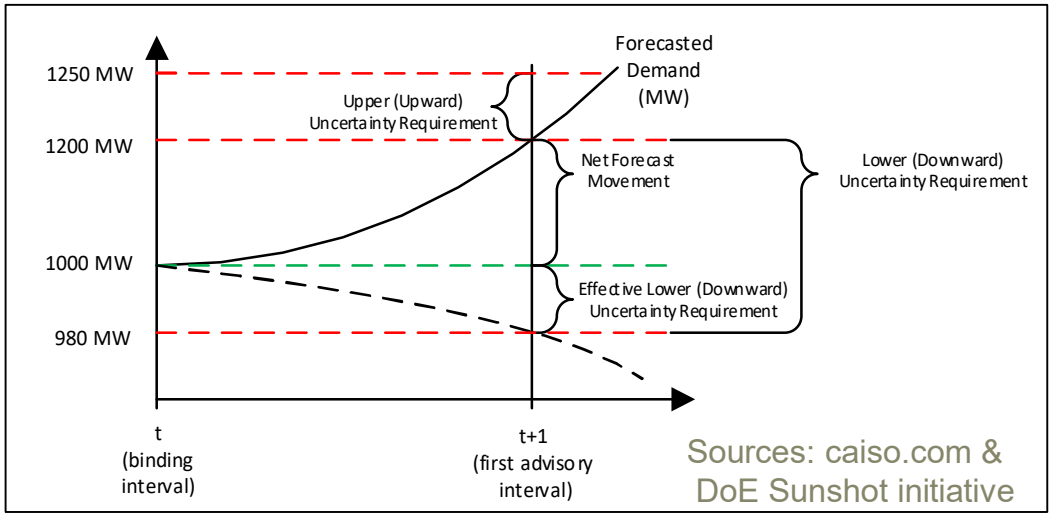
2021: Net load: Sinking Belly and Raising Ramp

Source: Our evolving Grid (caiso.com)

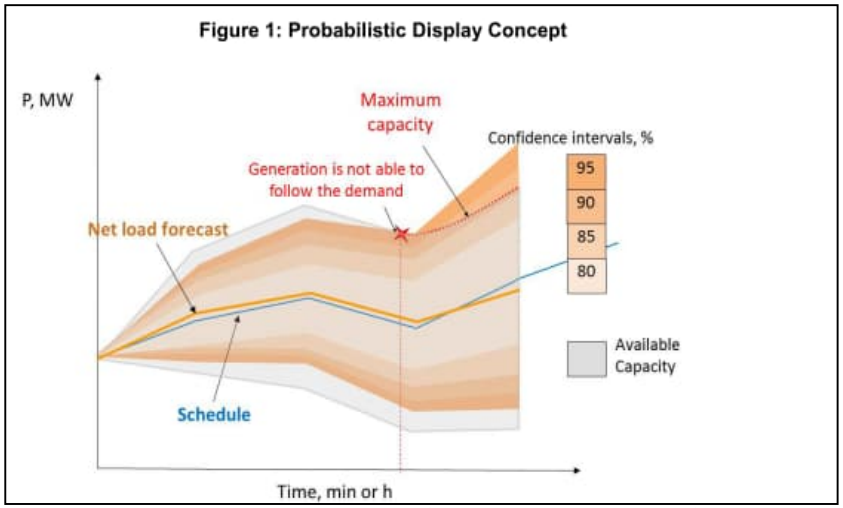
SIEMENS

Examples: Ramp Models and Concepts

Flex Ramp Requirements are dynamic constraints in Look Ahead Intervals



Flex ramp concept - up/down bandwidths



Flex ramp req' basis & probability forecast

Determination of net load forecast in real time dispatch for the next 5-minute period:

- Net load average -Persistence method basis of use of actual recent telemetry
- Flex ramp req' setting - Quantile regression method (conditional median) provides a better assessment

Industry Direction:
Monetizing Variability and Addressing Climate Change by:

- Energy Imbalance Markets
- Net zero programs
- Business & homes, microgrids, campuses, communities: local energy storages & consumption and peer to peer transactions
- FERC 2222 – Shape the demand
- Batteries & long-term storages (e.g., Hydrogen)
- Better pricing schemes of capacities for reliability
- System strength management

"Moving from a world where we forecast Load and schedule Generation, to a world where increasingly we may forecast generation and schedule load!!" [Regulatory Assistance Project, 2018]

Both depend on location and probability forecasts!

Work in Progress

In managing variability

- **Reserve Req' setter – improvements**
- **Quantile regression – Flex ramp req's**
- **Spatial forecast – improvements**
- **Dynamic transmission limits**
- **System strength (IBR impact) & frequency reserve**
- **Storage optimization improvements (hybrids, standalone, SoC & degradation models)**
- **DER in ISO dispatch – FERC 2222**
- **DER Forecast – MDMS & granular spatial –challenge of demand, roof top & storage mix in the forecast**
- **Include long term storage (Hydrogen)**

SIEMENS

Abbreviations

AGC	Automatic Generation Control
AS	Ancillary Service
BA	Balancing Area
BTM	Behind-the-Meter
DER	Distributed Energy Resources
DERMS	DER Management System
DMS	Distribution Management System
EMS	Energy Management System
EN	Energy
LACA	Look Ahead Contingency Analysis

LFC	Load Frequency Control
MDMS	Metered Data Management System
MMS	Market Management System
NERC	North American Electric Reliability Council
RE	Renewable Energy
RTCA	Real Time Contingency Analysis
RTUC	Real Time Unit Commitment
SCDD	Security Constrained Dynamic Dispatch
SCED	Security Constrained Economic Dispatch
SoC	State of Charge

Contact

Sankaran Rajagopal, Ph.D., E.E.
Director, Business Solutions
Siemens Smart Infrastructure - Grid Software
10900, Wayzata Bl., Suite 400
Minnetonka, MN 55305, U.S.A.
Phone +1 (612) 801-9909

E-mail Sankaran.Rajagopal@siemens.com