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Distributed PV Forecasting, Load Forecasting and System Operations

Energy Systems Integration Group (ESIG) 2018 Forecasting Workshop

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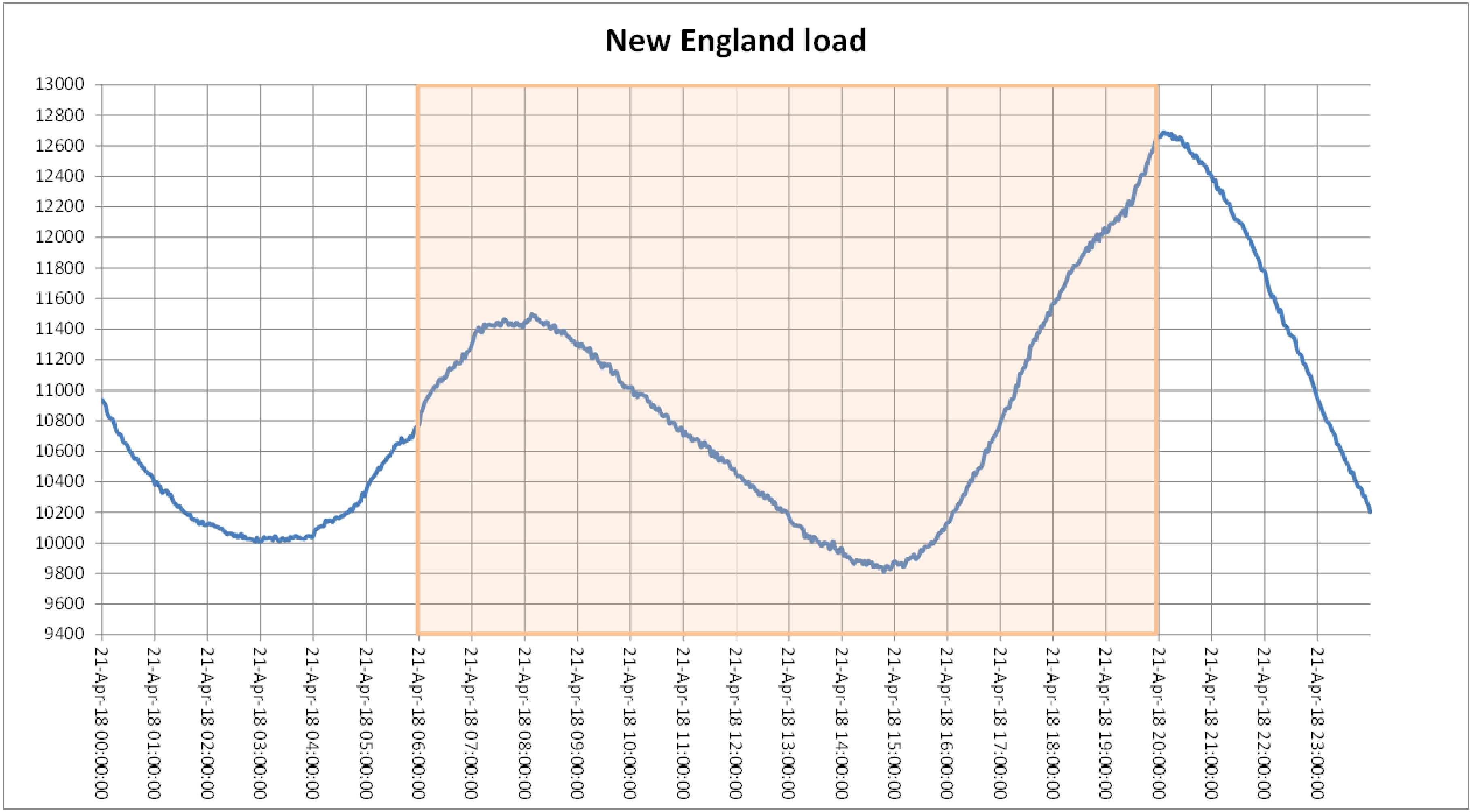
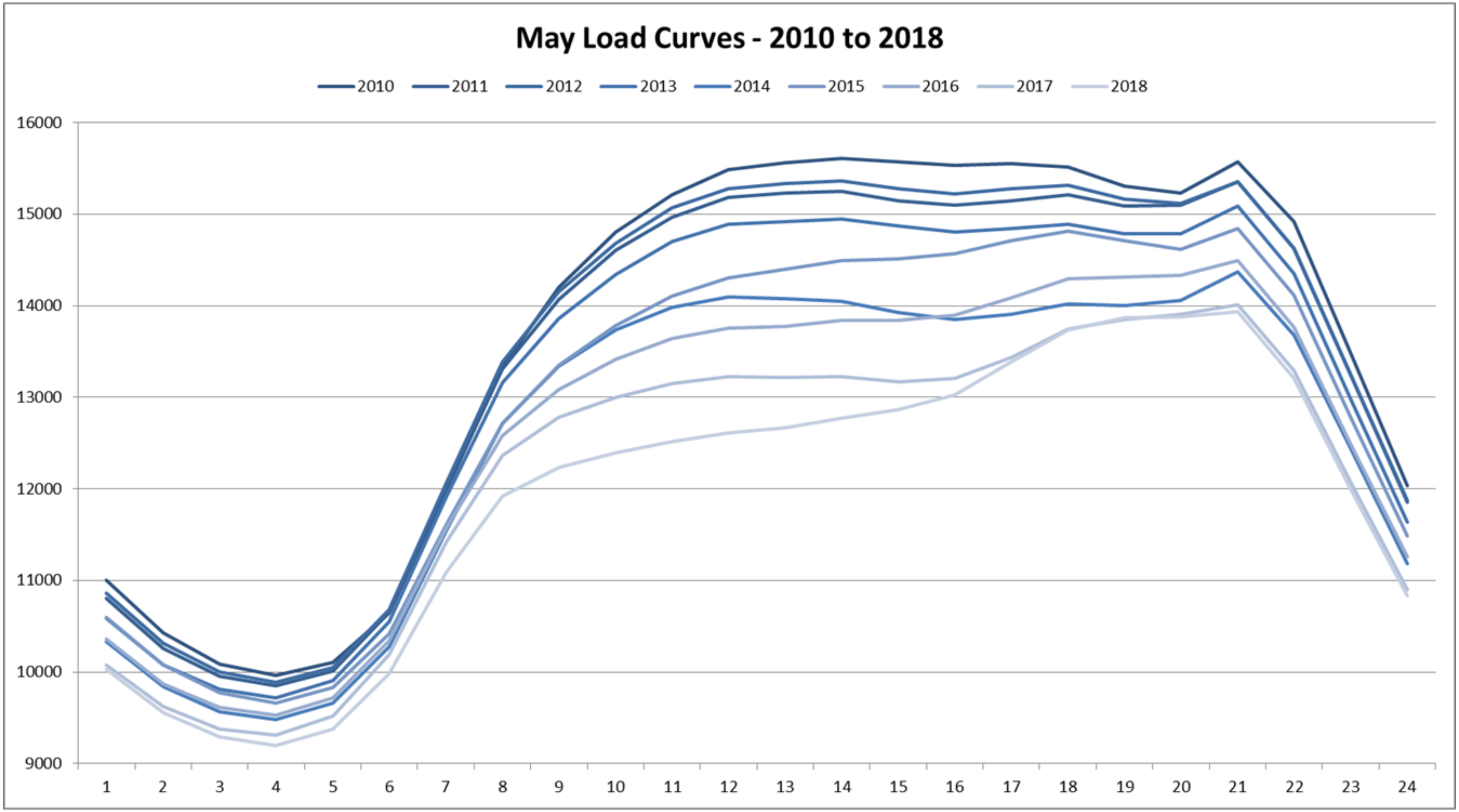
Forecast Utilization

- **Long-term forecast** used as part of **future capacity** expansion needs assessment
- **Short-term forecast** used as part of **day-ahead and real-time** resource commitment
- What happens in between these timeframes?
  - **Maintenance**: Evaluating maintenance requests which requires use of an accurate load forecast

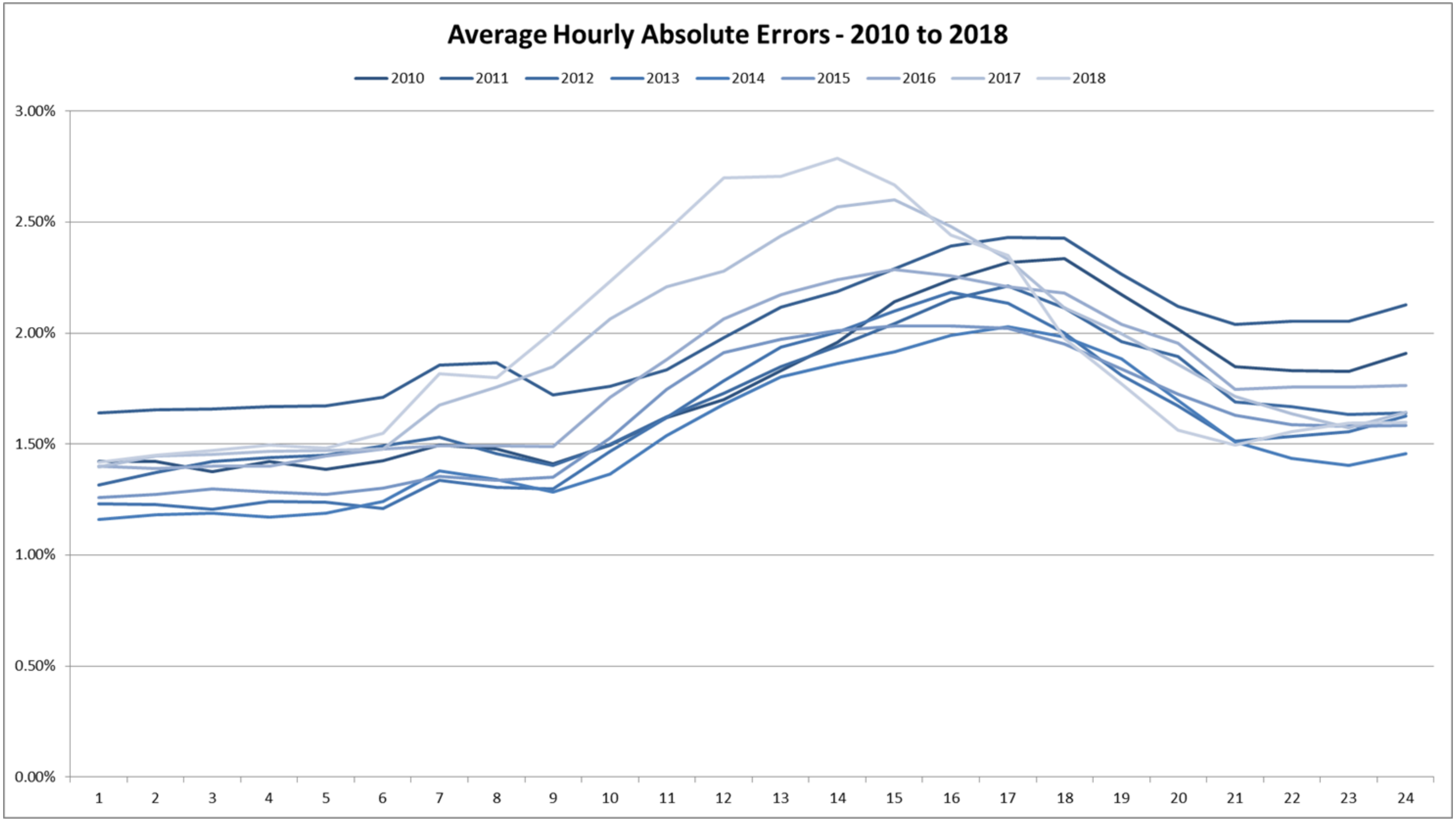
Spring 2018 Light Load Day



May Load Curves



Yearly Mean Average % Error by Hour



Anticipated Changes in ISO-NE Resources

2017

- 28820 MW Gross Load Summer 50/50 Peak (1)
- 2430 MW EE (1)
- 2390 MW nameplate roof top & behind the meter solar (<5 MW) (1)
- 53 MW solar nameplate
- 20 MW batteries
- 1350 MW on-shore wind (nameplate) (1)

2027

- 31190 MW Gross Load Summer 50/50 Peak (1)
- 5230 MW (Δ 2830 MW) EE(1)
- 5830 MW (Δ 3440 MW) nameplate roof top & behind the meter solar (<5 MW) (1)
- 1900 MW (Δ 1850 MW) solar nameplate in the interconnection queue (2)
- 710 MW (Δ 690 MW) batteries nameplate in the interconnection queue (2)
- 5680 MW (Δ 4330 MW) on-shore wind nameplate in the interconnection queue (2)
- Δ 3280 MW off-shore wind nameplate in the interconnection queue (2)
- Δ 3905 MW Natural Gas (2)
- Δ -1735 MW Retirements (known but could add expected ≈5400 MW)

(1) ISO-NE 2018 CELT Report
(2) ISO-NE Interconnection Queue

Anticipated Changes in ISO-NE Resources - *cont.*

- The level of **proposed resources** far outstrips **load growth**
- Potentially **adding over 20325 MW** of additional new resources with only 2370 MW of load growth and 1735 MW of planned retirements
- What do the **future spring** and **fall load duration curves** look like?
- How will this **impact system-wide maintenance**?
- Is there an **impact** on **reliability and markets**?

System Maintenance in New England

- **Planned outages** of generation and transmission span 7 to 8 months depending on nature of the work
- ISO-NE processes on average **15,000 generation and transmission outage requests** per year
- Requests can be submitted up to **2 years in advance of the start date** (start date is critical to outage priority)
- Outage requests are **evaluated** relative to **impact on reliability** and potential **congestion cost increases**

System Maintenance in New England – *cont.*

- The **reliability of the system** must be maintained at all times
- The **evaluation of outage requests** considers thermal, voltage and stability impact of facilities being taken out which must rely on a **realistic load forecast**
- The **amount and electrical make up** of the load can impact thermal, voltage and stability performance, therefore, the **accuracy** of the forecast affects the evaluation and resultant operational actions that must be taken

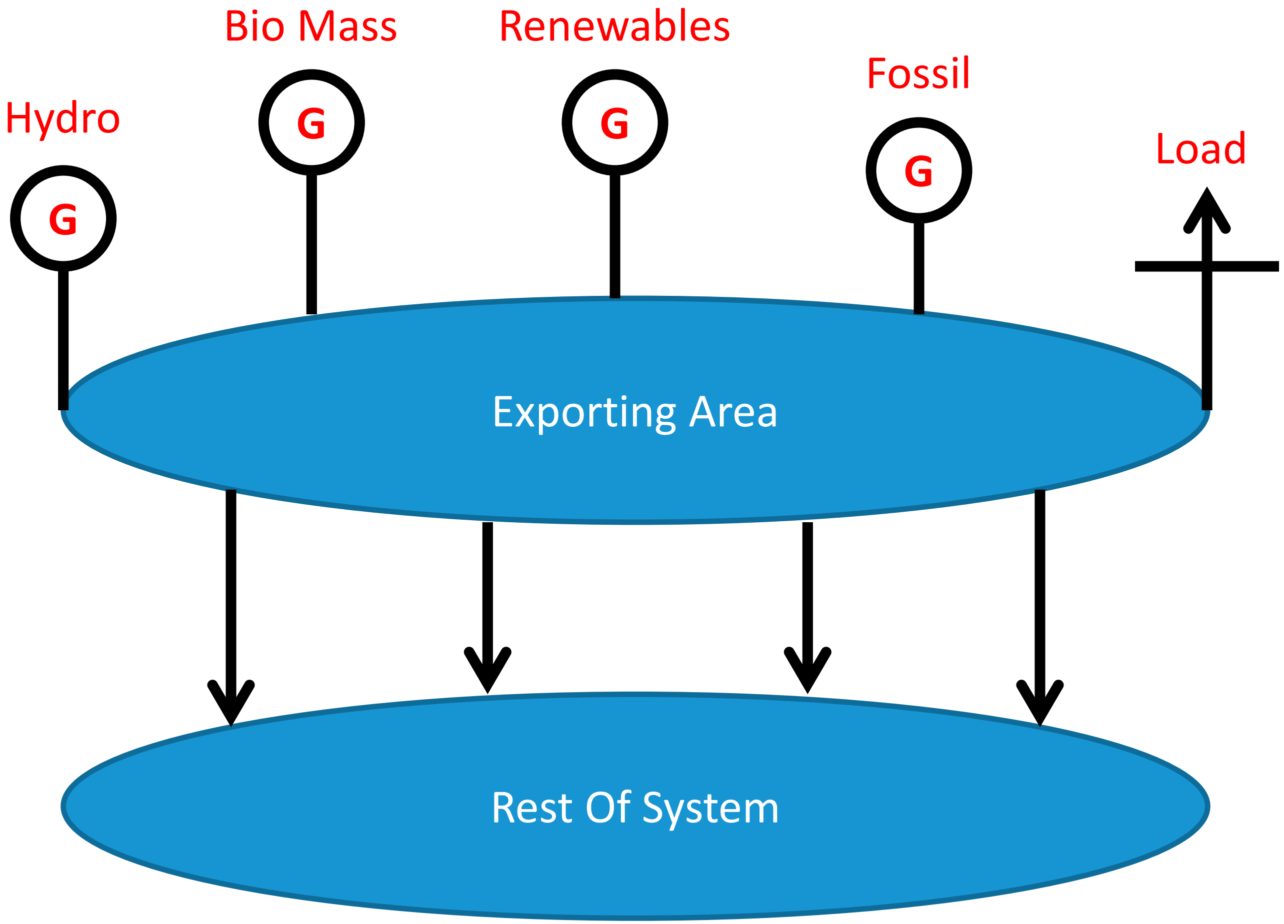
System Maintenance in New England – *cont.*

- The **electric make up of load** refers to its inherent electrical properties as determined by the type of load (**Note:** this includes all the imbedded DER)
- These properties can affect **voltage and stability performance** of the system
- The **reliability actions** that must be taken can have **dispatch** and **market impacts**
- Forward looking **dispatch actions** may cause resource owners to **factor in** market impact in their strategy to mitigate financial risk

Exporting Area Example: *Electrical Pocket Within an RC Footprint*

- The pocket is **connected** to the "rest of system" via four transmission tie lines
- The **resources** within the pocket **exceed** the load served within the pocket
- In this pocket, if all resources are in operation, there is **excess generation** which can be "exported" to the "rest of system"
- The "all-lines-in" transmission system **can support** the full export for N-1 events

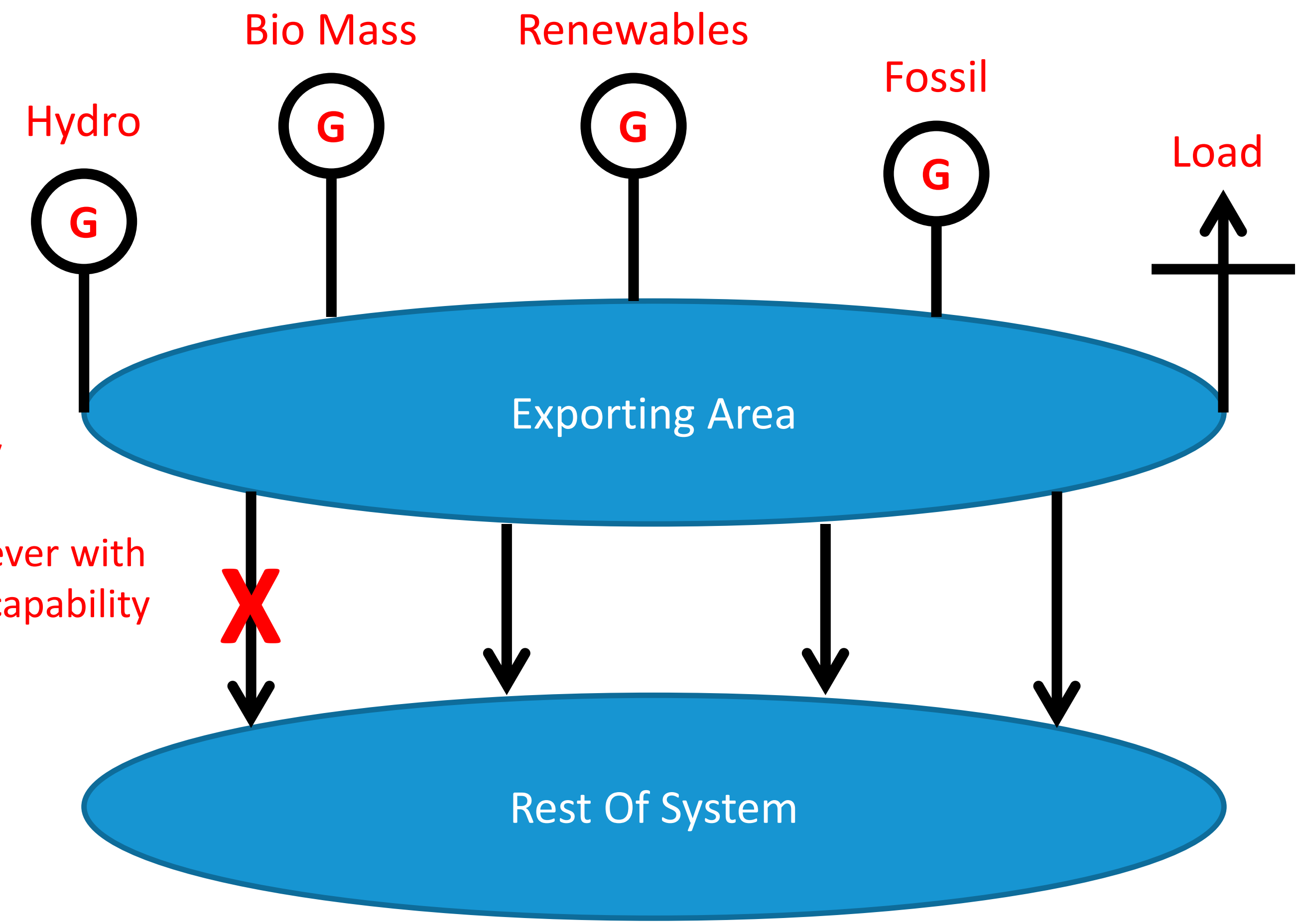
Exporting Area Example – *cont.*



Exporting Area Example: *Take One Transmission Tie Line Out for a Lengthy Maintenance Outage*

- RC will study **reliability impacts** of the outage
- Study will evaluate the **thermal, voltage** and **stability impact** of the system for N-1 with the facility out
- One **critical component** of the study is the **load assumed** within the pocket
- **Study results** based on topology, load level, contingencies studied, etc., **reveal all excess MW cannot be exported**, i.e., some generation may not be able to run
- RC will notify all the resources within the pocket of **potential restrictions** during the outage

Exporting Area Example – *cont.*



Transfer capability 1000MW for "all-lines-in" however with line out, transfer capability drops to 700MW

Exporting Area Example: *Possible Outcomes*

- Resources within the pocket will **take their chances in the market** and hope they are **more economic** than their competitors (security constrained dispatch)
- Resources may opt to **manage risk** by **arranging for their own maintenance** during the transmission outage
- Resources may opt to **manage risk** by **utilizing financial hedging market mechanisms**

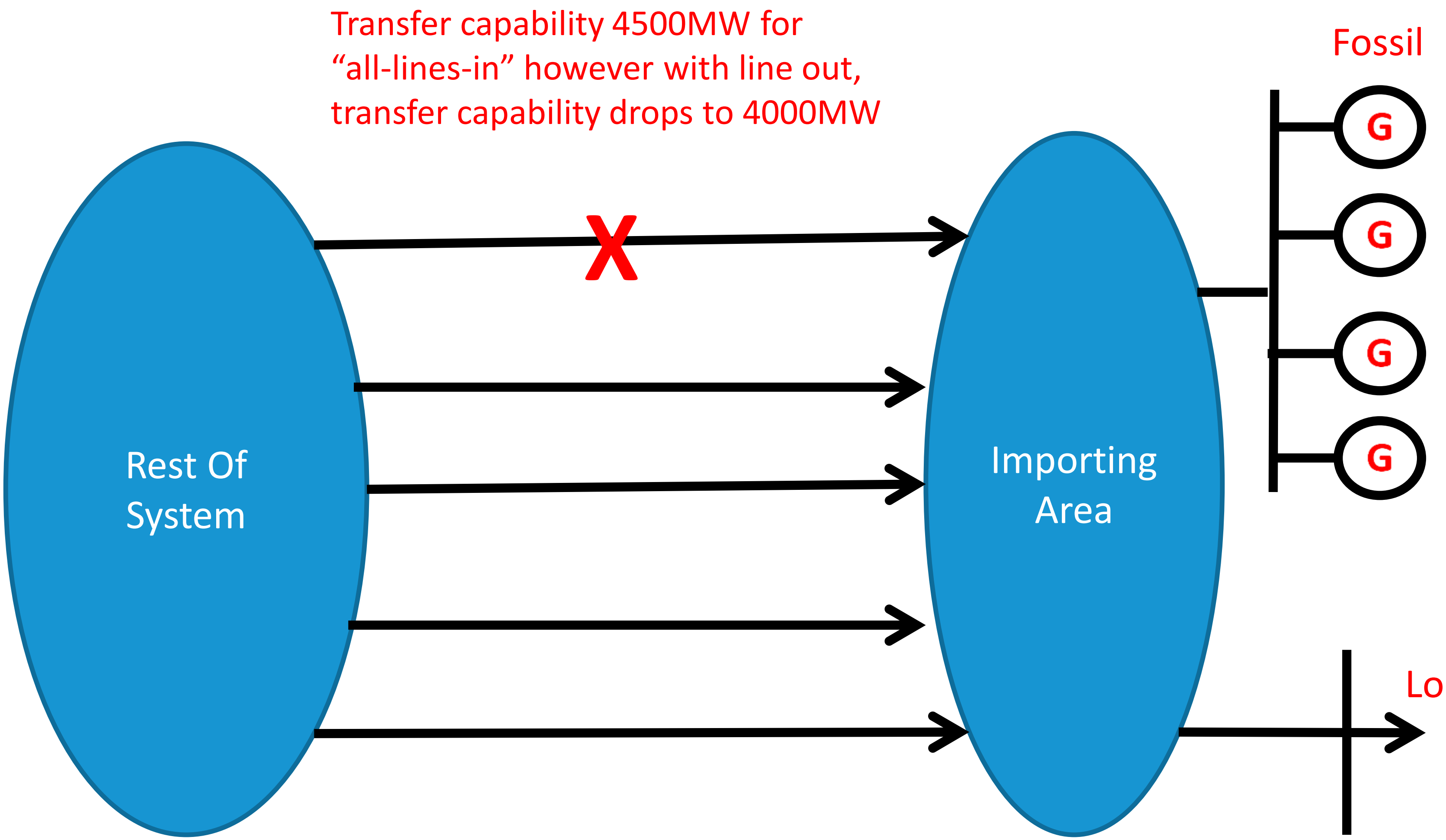
Exporting Area Example: *What if the forecast is wrong?*

- If the actual load is **higher or lower,** it will **impact** the ultimate combination of resources that can run
- Whether **more or less** could have operated may **impact** the advanced decisions that were made to manage risk
- There may also be **reliability consequences** as well

Importing Area Example: *Electrical Pocket within an RC Footprint*

- The pocket is **connected** to the "rest of system" via **multiple** transmission tie lines
- The load within the pocket **exceeds the resources needed** to serve load within the pocket
- If all resources in this pocket are in operation, there is **not enough MW to meet load** and the pocket must "import" additional resources from the "rest of system"
- The "all-lines-in" transmission system **can support** the full import for N-1 events

Importing Area Example – *cont.*



Importing Area Example: *Take One Transmission Tie Line Out for a Lengthy Maintenance Outage*

- In the case of an **importing area** based on topology, load level and contingencies studied, etc., with only a **finite amount** of MW that can be imported, **additional generation** within the pocket must be dispatched
- RC will notify all the resources within the pocket of "**must run**" requirements
- Again, the **amount** and **electrical make up** of the load will **factor in** to the amount of "must run" requirements

Importing Area Example – *What if the Forecast is Wrong?*

- If the **actual load** is higher or lower, it will **impact** the ultimate combination of resources required to maintain reliability, which introduces **concerns** such as:
  - Are they **available**?
  - Can they **start-up** in time?
  - Are there **enough resources**?
  - Can they **operate for the duration** of the transmission outage?
  - Is there a **reliability** or **market impact**?

Summary

- While long-term forecast and short-term forecasts are important, we cannot lose sight of the **importance of intermediate forecasts**
- Load forecast can have a **direct impact** on reliability and markets, so missing the boat can have **significant consequences**
- The **science of forecasting with imbedded DER** must be **improved** and span a **broader spectrum** of conditions and timeframes
- In the interim, we use the best-available forecast data

Questions