NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Are We Prepared?

Planning a Grid with Increasing Energy Storage

Ryan D. Quint, PhD, PE
Senior Manager, NERC
NERC/NAGF/ESIG Workshop on Energy Storage
September 17, 2019

RELIABILITY | RESILIENCE | SECURITY




Talking About Energy Storage?

Step 0:
Where is the energy storage located?

BPS-Connected

Source: ElectraNet

Distribution-Connected

Source: SMA

Source: ReVision Energy

Available Models

Do we have adequate models to be able to capture the behaviors of inverter-based resources?

Modeling Practices

Are we correctly/reasonably using the models to capture the critical characteristics of inverter-based resources?

Interconnection Studies

Are sufficient studies being performed to adequately capture potential reliability risks?

Reliable Operation

Are interconnection studies serving to ensure reliable operation of BPS?

Available Models

Do we have adequate models to be able to capture the behaviors of inverter-based resources?

Modeling Practices

~~Are we correctly/reasonably~~ using the models to capture the critical characteristics of inverter-based resources?

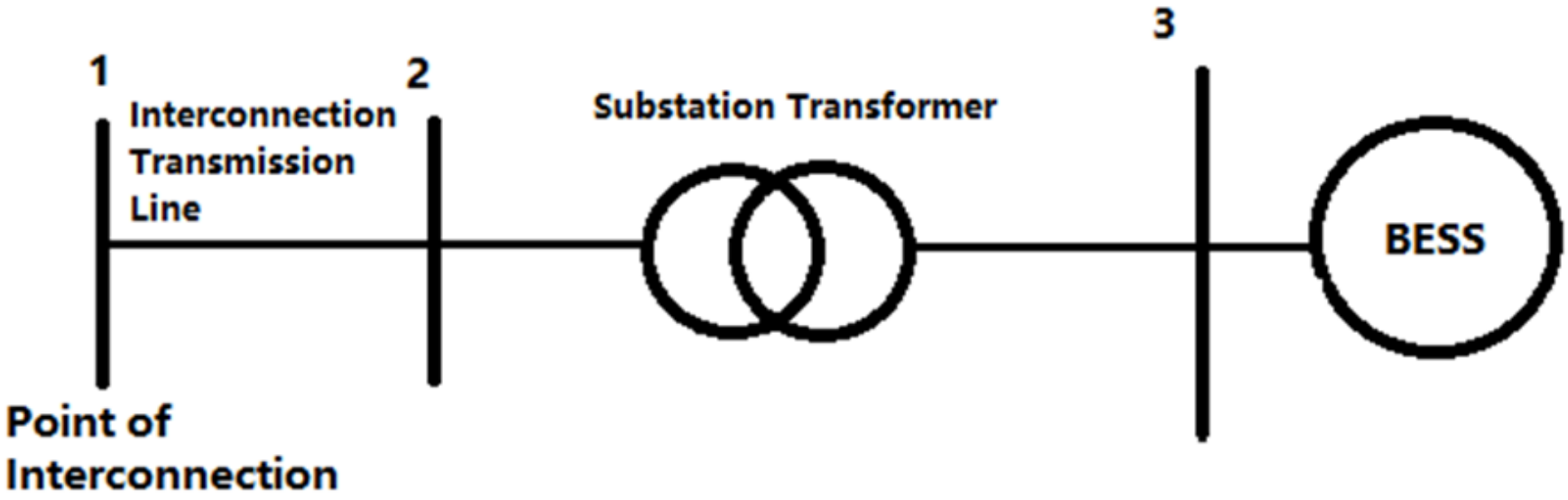
Interconnection Studies

~~Are sufficient studies being performed~~ to adequately capture potential reliability risks?

Reliable Operation

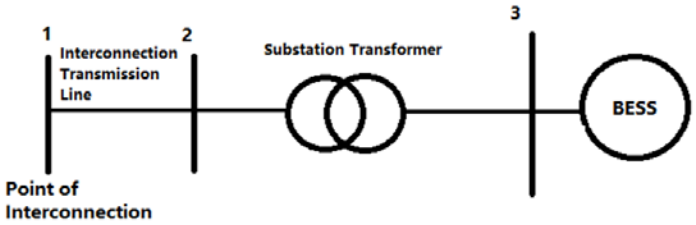
Are interconnection studies serving to ensure reliable operation of BPS?

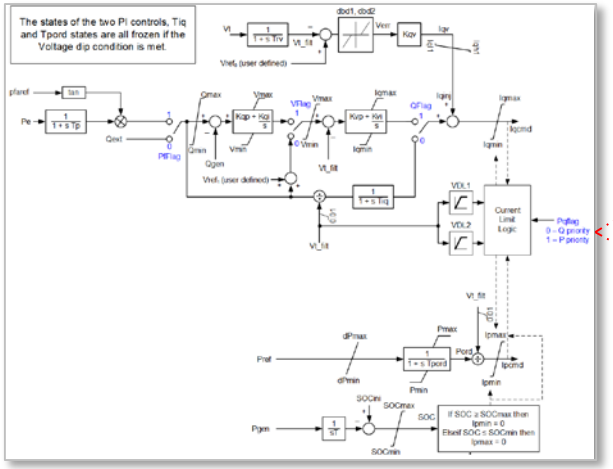
BPS-Connected Energy Storage Modeling

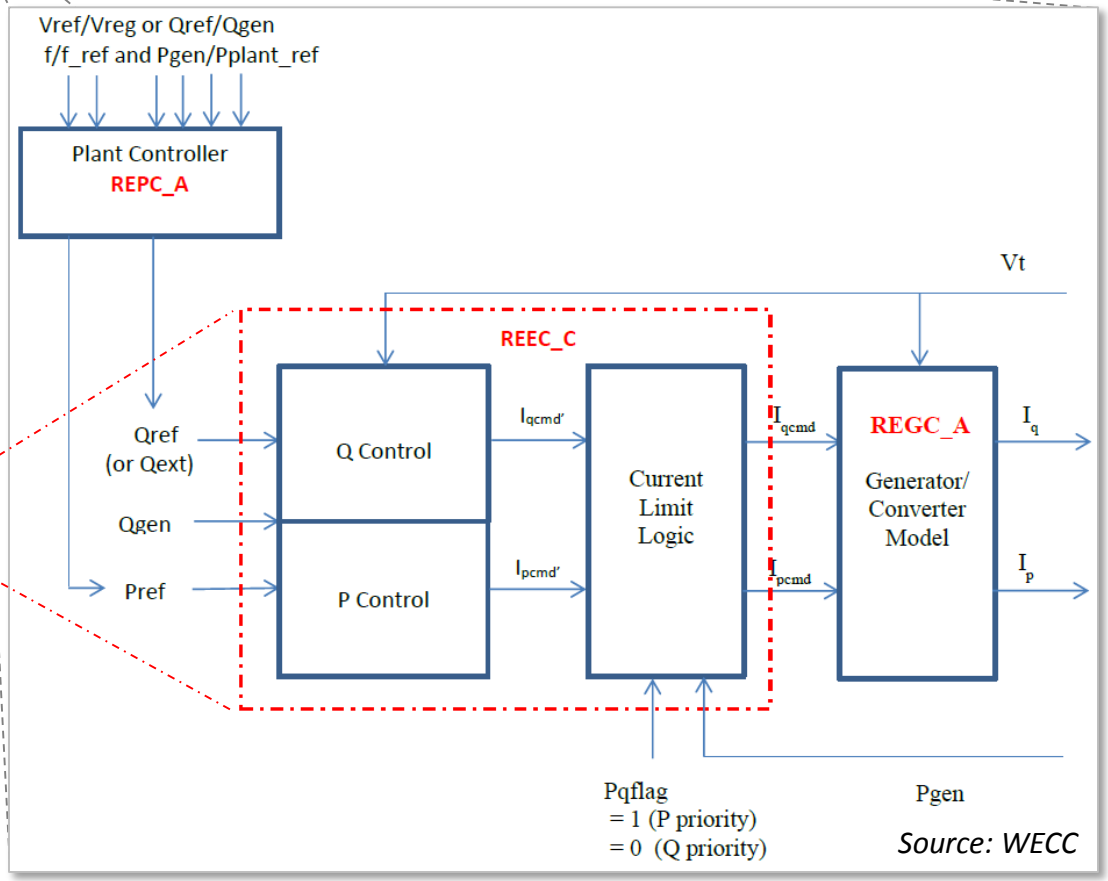


Source: WECC

Dynamic Simulation Modeling
Overview of Dynamic Models







Source: WECC

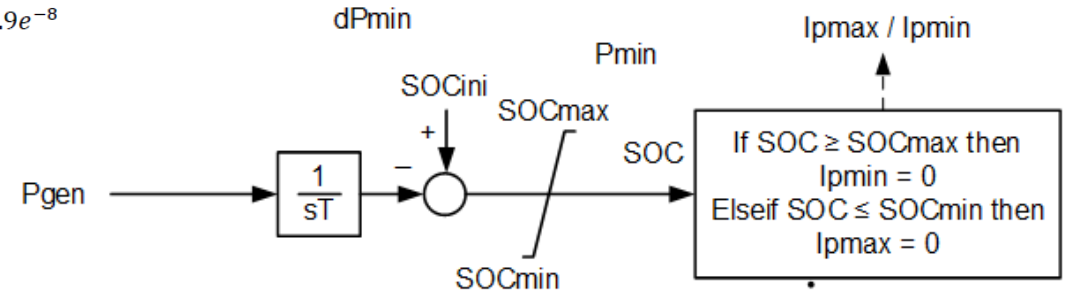
Dynamic Simulation Modeling
State of Charge Modeling

Added Parameter Values:

- SOCini – initial state of charge; user-entered
- SOCmax – max state of charge
- SOCmin – min state of charge
- T – discharge time [sec]
- Paux – auxiliary input for supplemental controls

$$\Delta SOC = \frac{P_{gen}(t_0) \times \Delta t}{P_{Rated} \times T_{Rated\ Charging\ or\ DisCharging}} = \frac{0.5 \times 1.0e^{-3}}{1.0 \times 7200} = 6.9e^{-8}$$

$$SOC = \frac{E_{available}}{E_{Rated}} = \frac{P_{available} \times T_{Charging\ or\ DisCharging}}{P_{Rated} \times T_{Rated\ Charging\ or\ DisCharging}}$$



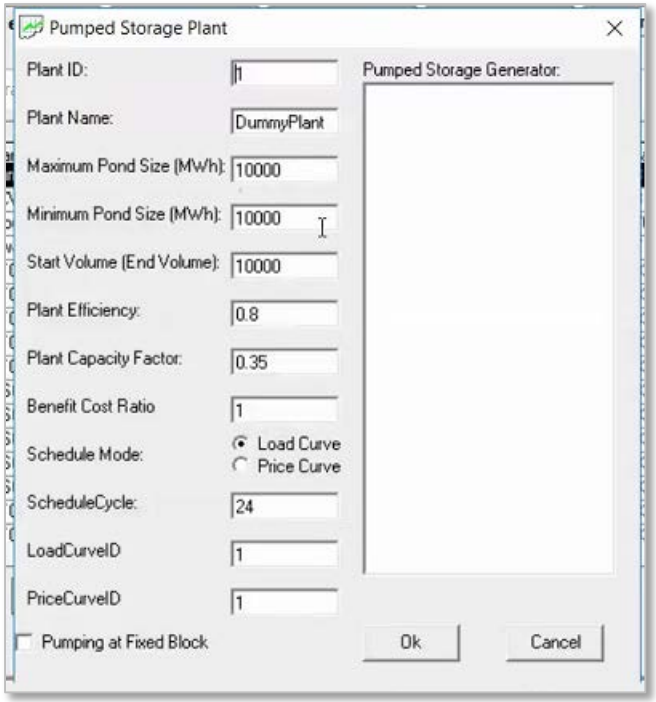
Source: WECC

Short-Circuit Modeling

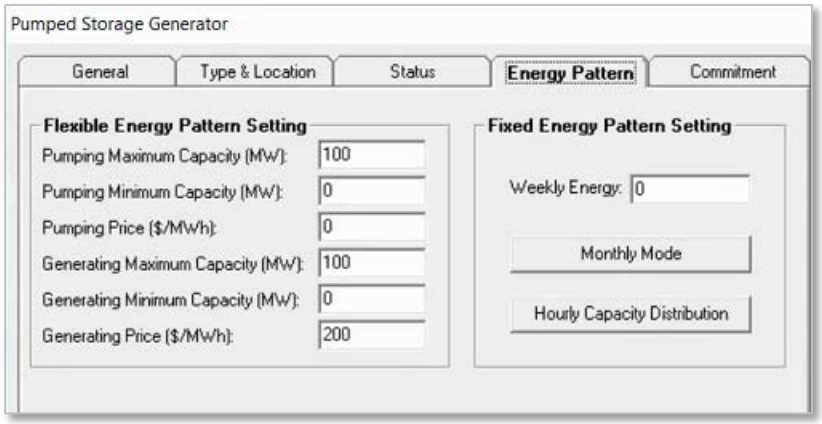
- Fundamentally…
  - Voltage dependent current injection model likely “best bet”
- Pragmatically…
  - Added complexities – more complicated
  - Charging/discharging operating states
  - Controls during and across operating states
  - Short-term inverter-based capabilities
  - Mid-term dynamic response of controls
  - No specifications or grid requirements on behavior on-fault
- Much work needed in this area…

Production Cost Modeling

- Existing modeling capability fairly crude
- Will lead to near-term modeling challenges
  - Need for tool capability advancements
- No capability to model hybrid resources
  - No linkage between gen and battery coordination
- No state of charge modeling explicitly



Source: WECC, GridView



Modeling "Hybrid" Resources

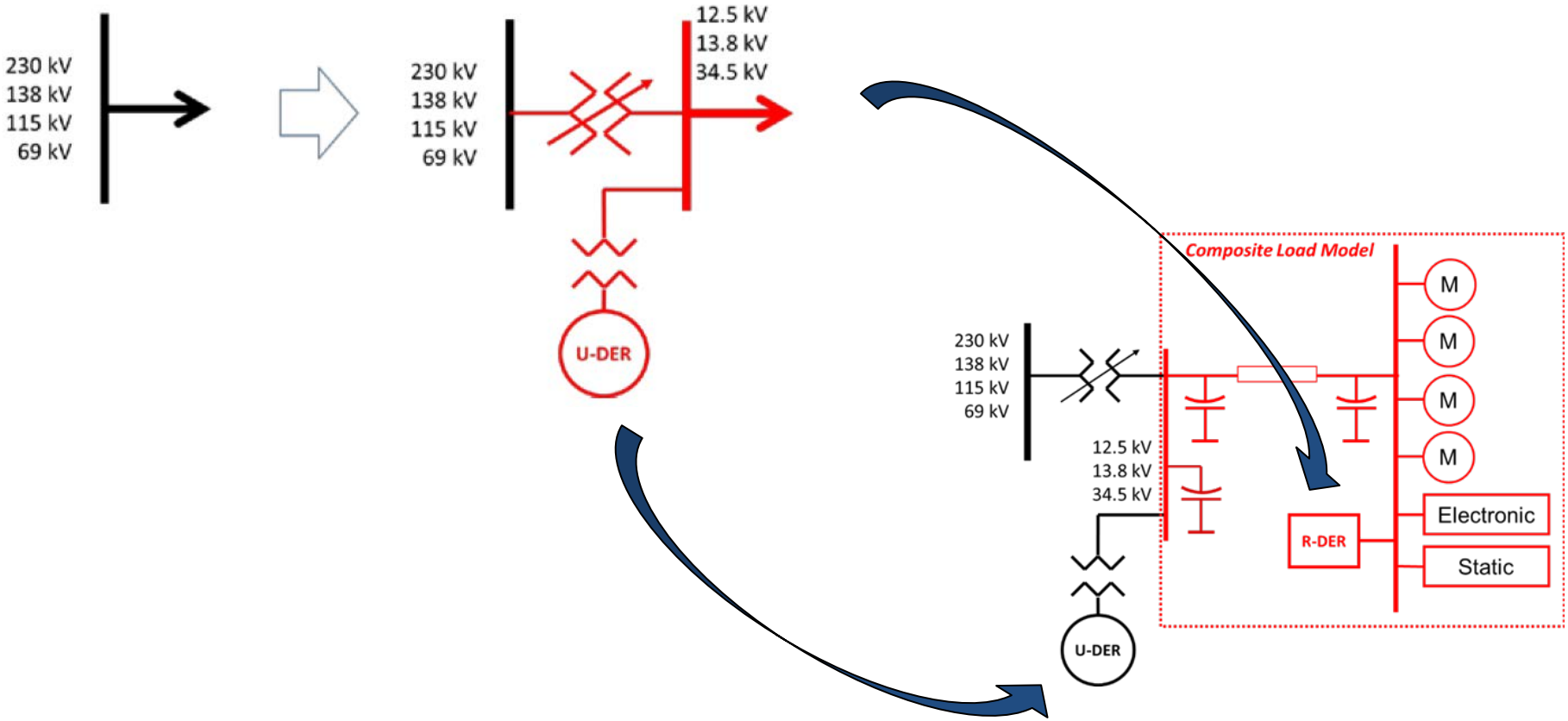
- In a nutshell… Work is needed across the board

Tool/Timeframe	Modeling Capability	Modeling Practices
Short-Circuit	Improvements Needed	Limited Experience
EMT		
Dynamics/Stability		
Steady-State		
Production Cost		

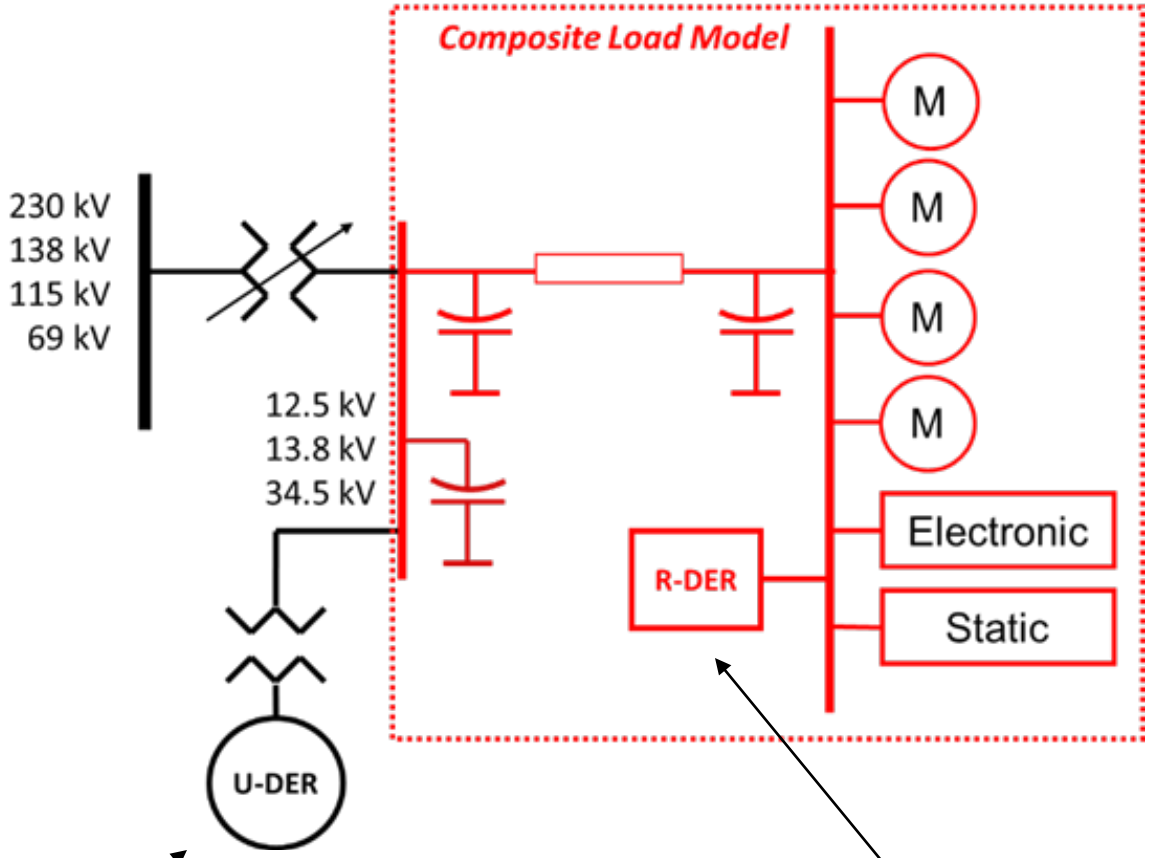
- If we see this as a rapidly emerging resource, we as an industry need to get to work ASAP.

Distribution-Connected Energy Storage Modeling

- Distribution-connected energy storage = DER
- DER modeling practices developing/advancing



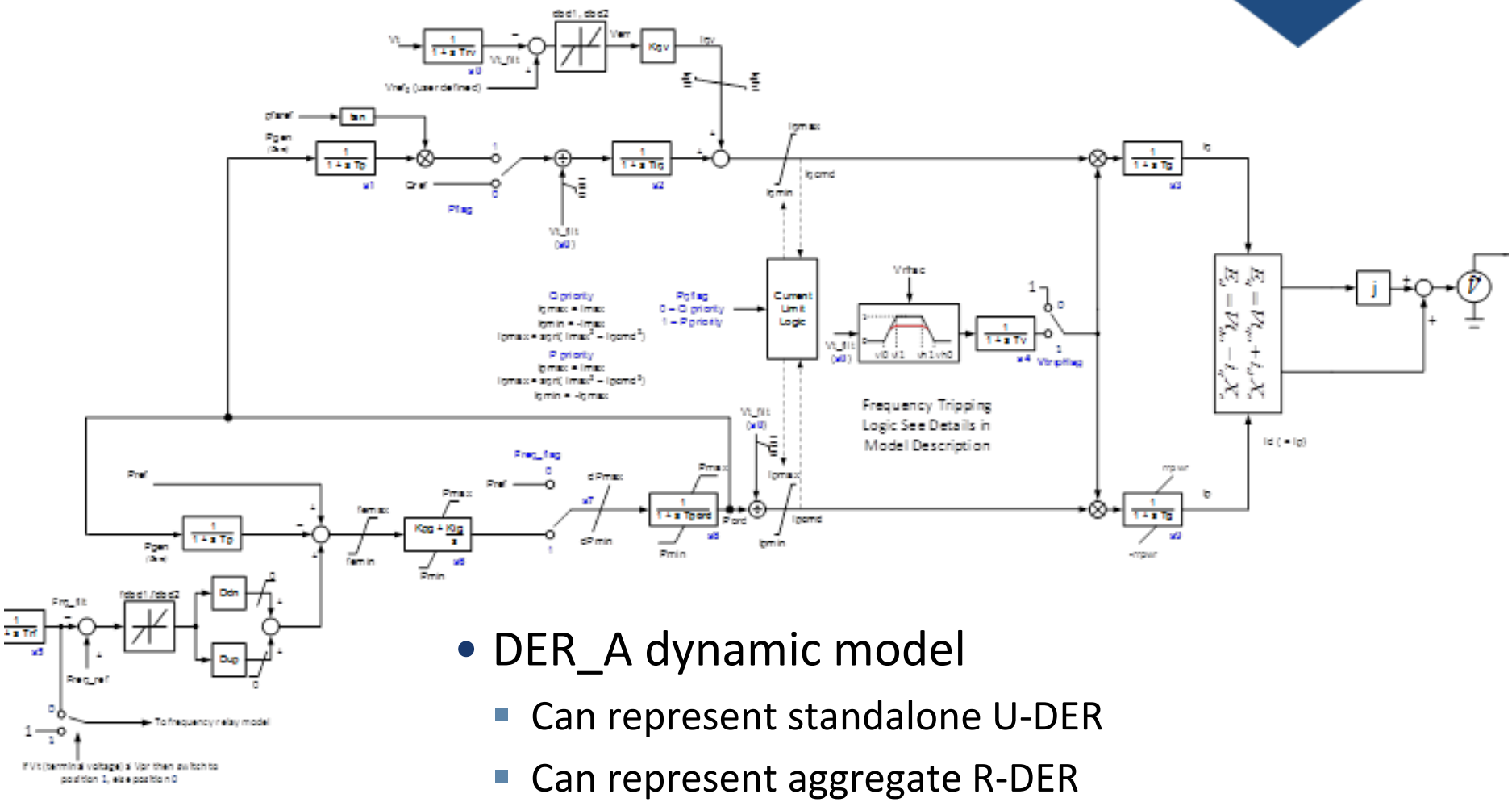
Dynamic Modeling for DER Energy Storage



Large BESS project

Aggregate distributed BESSs

Dynamic Modeling for DER Energy Storage



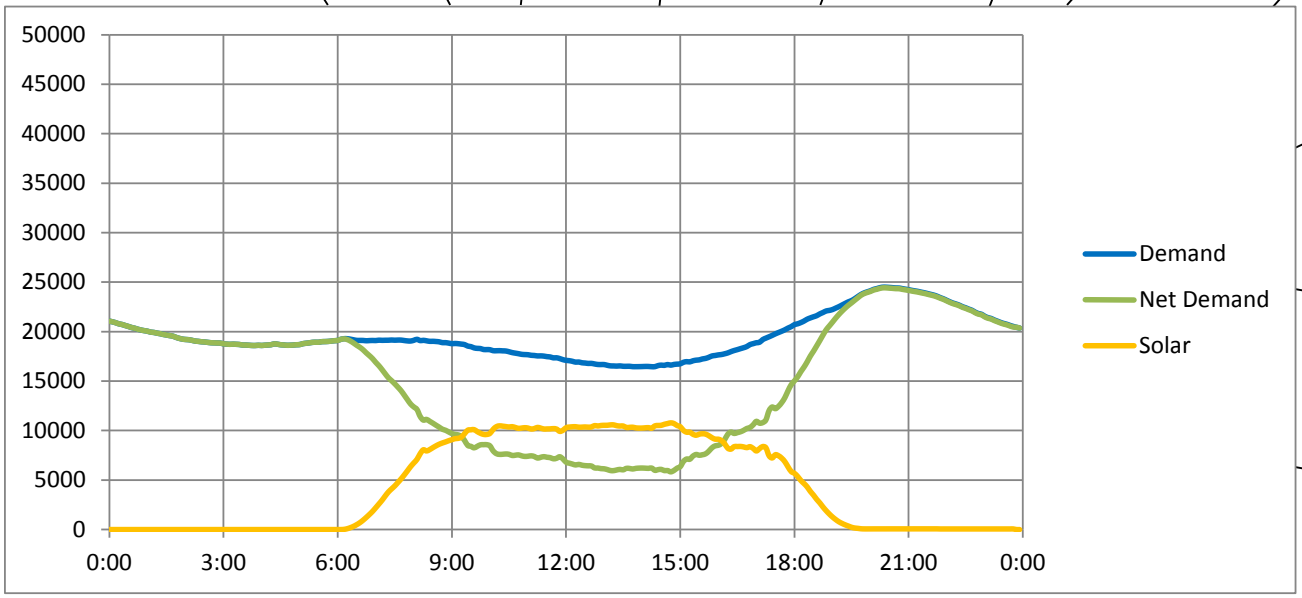
- DER_A dynamic model
  - Can represent standalone U-DER
  - Can represent aggregate R-DER
  - Capability to represent energy storage (*typeflag* param)
  - Does not emulate charge/discharge battery dynamics

DER_A Modeling Energy Storage

- *typeflag* parameter used to represent energy storage
- DER_A does not emulate charging and discharging (as in reec_c)
- DER_A applicability in simulations
  - If energy storage device capable of providing many minutes to hours of output (or charging), then little impact on state-of-charge during a 10–30 sec simulation – model is adequate.
  - If battery only has few seconds of charge/discharge capacity, DER_A not suitable for these types of simulations
  - DER_A may not be suitable for simulations where energy storage changes state (i.e., charge to discharge, vice versa) mid-simulation

BPS Planning Considerations

- Load Profiles
- Ramping Issues
- State of Charge
- IBR Capability
- Resource Variability
- Hybrid Resources
- Market Volatility
- DER Inputs



- DER/IBR Response
- NERC IRPTF
- NERC SPIDERWG

Expected Performance

- Save this for a separate presentation….
  - Four quadrant P-Q capabilities
  - Ability to provide ERSs
- Need for clear guidance on this subject
  - IRPTF: BPS-connected energy storage devices
  - SPIDERWG: Energy storage as growing DER element
- Recommendation: Utilize NERC IRPTF and SPIDERWG to extent possible
  - Industry-wide expertise and perspectives captured in stakeholders
  - Effectively bringing solutions to table quickly
  - Connected to large industry groups very well

NERC
NORTH AMERICAN ELECTRIC RELIABILITY CORPORATION

Questions and Answers

Ryan Quint, PhD, PE
Senior Manager
Advanced System Analytics and Modeling
North American Electric Reliability Corporation
Office (202) 400-3015
Cell (202) 809-3079
ryan.quint@nerc.net