Interconnection Study Criteria

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Introduction and Agenda

Part 1	Terminology & Definitions
Part 2	Dispatch Methodologies (SPP and MISO)
Part 3	NOPR Proposals

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Terminology & Definitions

ERIS & NRIS

- Energy Resource Interconnection Service (ERIS) shall mean an Interconnection Service that allows the Interconnection Customer to connect its Generating Facility to the Transmission Provider's Transmission System to be eligible to deliver the Generating Facility's electric output using the existing firm or non-firm capacity of the Transmission Provider's Transmission System on an as available basis. Energy Resource Interconnection Service in and of itself does not convey transmission service

- Network Resource Interconnection Service (NRIS) shall mean an Interconnection Service that allows the Interconnection Customer to integrate its Large Generating Facility with the Transmission Provider's Transmission System (1) in a manner comparable to that in which the Transmission Provider integrates its generating facilities to serve native load customers; or (2) in an RTO or ISO with market based congestion management, in the same manner as Network Resources. Network Resource Interconnection Service in and of itself does not convey transmission service.

https://www.ferc.gov/sites/default/files/2020-04/LGIP-procedures_0.pdf

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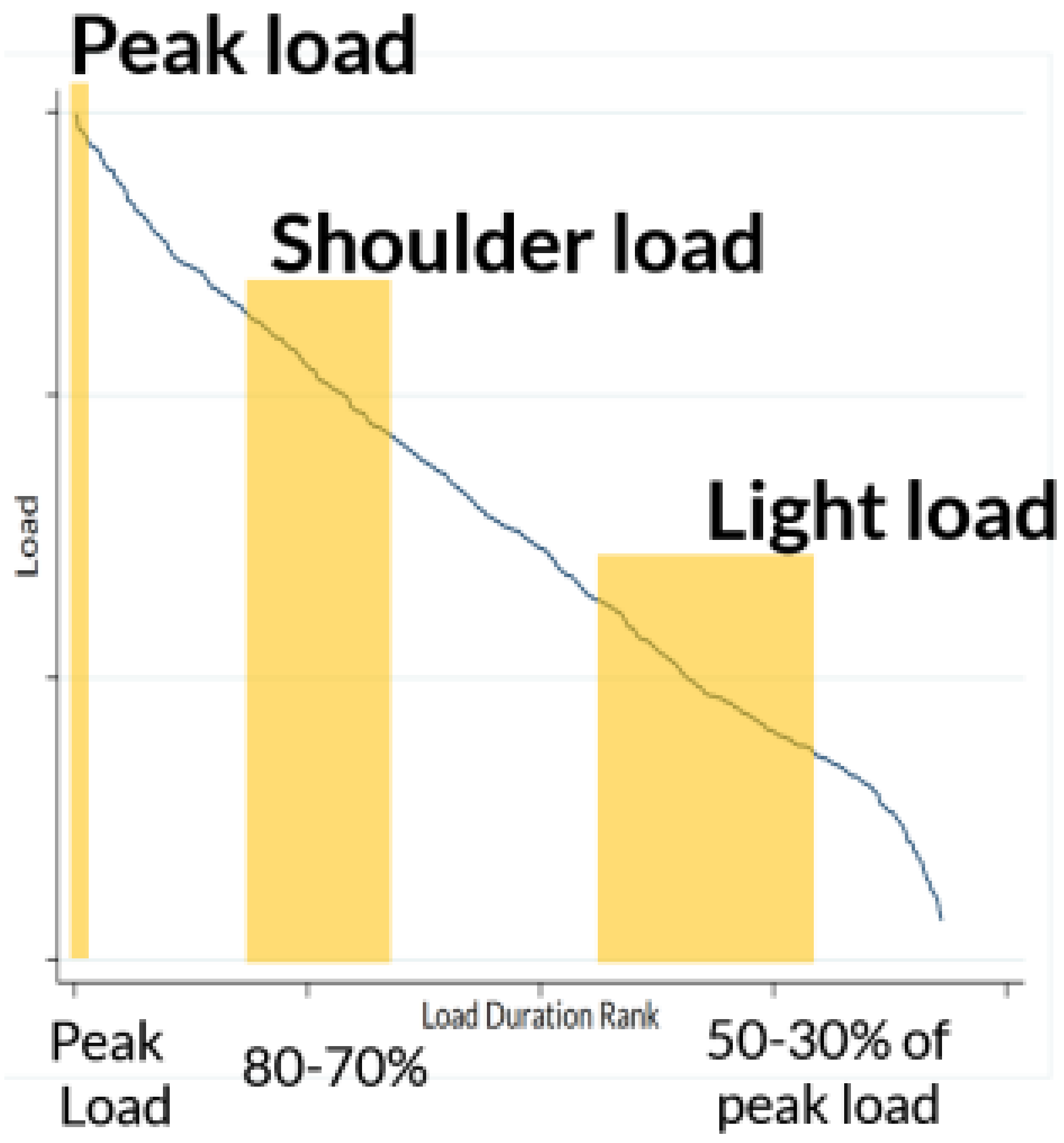
Fuel Based Dispatch & Flowgate Screening

- Fuel Based Dispatch – Resource are dispatched at predefined levels based on technology type and the load levels of cases used (e.g. wind resources will be dispatched at different levels compared to solar resources depending on the season and loading level of the case used)

- Flowgate Screening – Dynamic dispatch whereby generators are re-dispatched in order to overload a flowgate (monitored element / contingency pair). Several methods available (harmers to reference, harmers to helpers, etc).

Load Levels


Peak load
Shoulder load
Light load
Load
Load Duration Rank
Peak
Load
80-70%
50-30% of
peak load

Cases & Dispatch Methodologies

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SPP

Request Types and Cases Used

- Interconnection Requests can be studied for Energy Resource Interconnection Service (ERIS) and/or Network Resource Interconnection Service (NRIS)
  - All new projects must be studied for ERIS but do not need to request NRIS

- SPP runs thermal and voltage analysis for both ERIS and NRIS requests

- Prior Queued (PQ) and Current Queue (CQ) models are created to study these requests. These models are created for the following years and seasons:
  - **Year 2** – Summer Peak
  - **Year 5** – Light Load, Summer Peak & Winter Peak

Request Types and Cases Used

- To simulate and analyze the variety of generation and service types included in a DISIS cluster, three dispatch scenarios are developed for both the prior-queued and current-queued model sets.

High-Variable Energy Resource (HVER)

Reflect scenarios in which Variable Energy Resources are generating at high levels and conventional resources are at relatively low levels. HVER scenarios are developed for summer and winter peak and light load seasons and evaluate both ERIS-only and NRIS requests

Low-Variable Energy Resource (LVER)

Reflect scenarios in which Variable Energy Resources are generating at low levels and conventional resources are at relatively high levels. LVER scenarios are developed for summer and winter peak seasons only and evaluate both ERIS-only and NRIS requests

Network Resource (NR)

Reflect scenarios in which NRIS generator output is maximized and ERIS-only generator output is minimized. NR scenarios are developed for summer and winter peak and light load seasons and evaluate only NRIS requests

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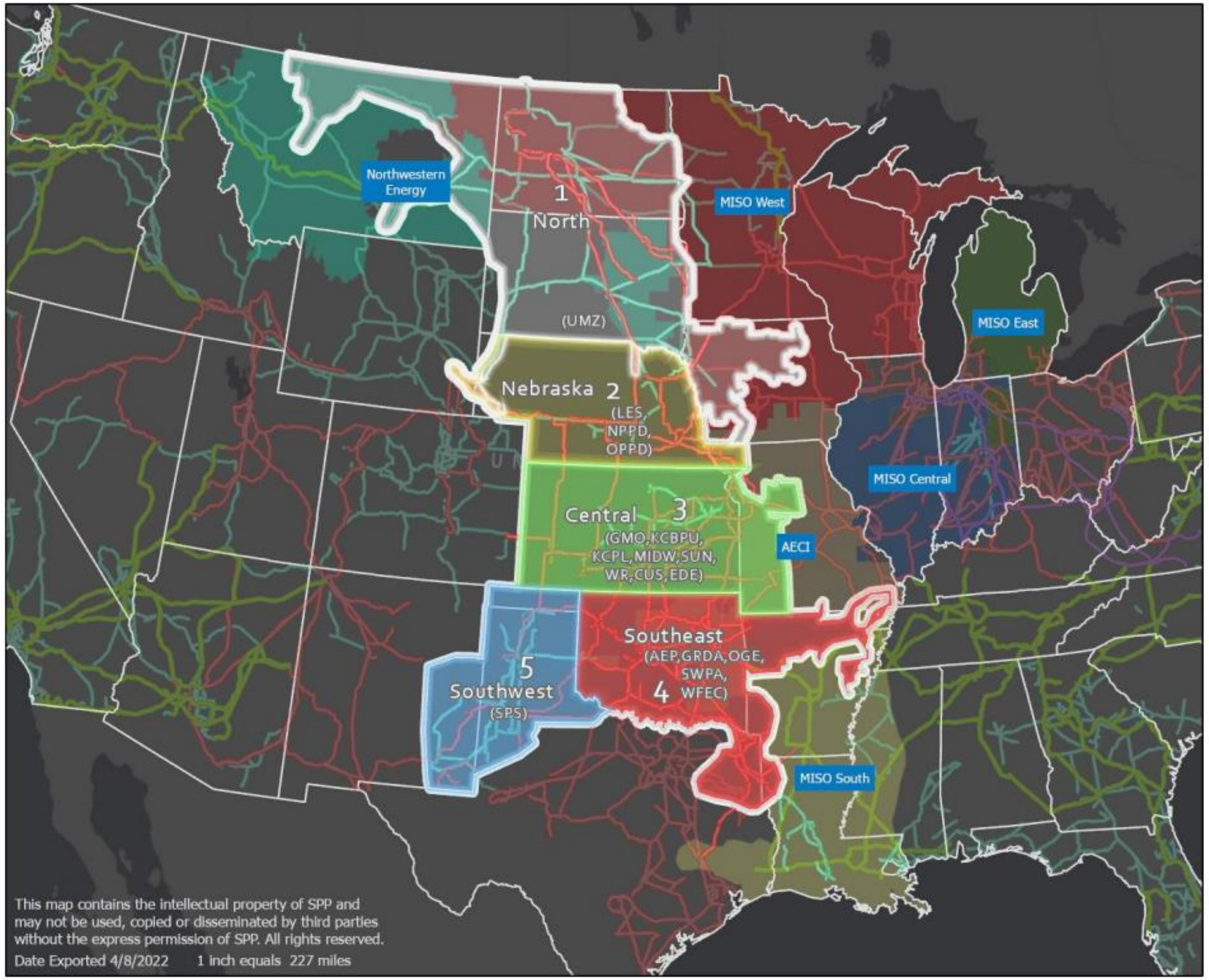
SPP Grouping

Group #	Area
1	SPP North
2	SPP North Central
3	SPP Central
4	SPP Southeast
5	SPP Southwest



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Case Development and Dispatch Assumptions

- Integrated Transmission Planning (ITP) base reliability powerflow models serve as the starting point for all steady-state interconnection studies
- To maintain generation-load balance, generation dispatched per fuel-based dispatch must be displaced by online generation within SPP.
- For HVER and LVER scenarios additional generation is offset by reducing the dispatch of ITP Generators across the entire SPP footprint based on the load-ratio share of the TO powerflow modeling areas
- For NRIS light load scenarios additional generation is offset by reducing the dispatch of ITP Generators excluding the respective host zone of each request
- For NRIS summer and winter peak scenarios additional generation is offset by reducing the dispatch of ITP Generators across the entire SPP footprint based on the load-ratio share of the powerflow areas
- For non-SPP footprints additional generation is offset using a uniform scale across all non-queued, dispatched units in the target footprint

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Load Ratio Share (LRS) Calculations

- Light Load Calculations:
  - Calculate the total SPP load in each applicable case
  - For the following areas, use load/2 in the following steps
    - 531, 524, 544, 545, 650
  - Calculate total load for current SPP control area
  - Reduce the SPP load by the amount of the control areas load
  - Calculate LRS for all other SPP areas by the following formula:

$$Load\ Ratio\ Share\ (per\ area) = \frac{\sum Area\ Load}{\sum Host\ System\ Load\ -\ \sum Local\ Area\ Load}$$

- Summer and Winter Calculations:
  - Calculate the total SPP load in each applicable case
  - Calculate LRS for all other SPP areas by the following formula:

$$Load\ Ratio\ Share\ (per\ area) = \frac{\sum Area\ Load}{\sum Host\ System\ Load}$$

Case Development – Fuel Based Dispatch

HVER Dispatch

Fuel Type	In-Group						Out-Group					
	Summer Peak		Winter Peak		Light Load		Summer Peak		Winter Peak		Light Load	
	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ
Combined Cycle	0%	0%	0%	0%	0%	0%	NC	0%	NC	0%	NC	0%
Combustion Turbine	0%	0%	0%	0%	0%	0%	NC	0%	NC	0%	NC	0%
Diesel Engine	0%	0%	0%	0%	0%	0%	NC	0%	NC	0%	NC	0%
Hydro	50%	50%	50%	50%	50%	100%	NC	0%	NC	0%	NC	0%
Nuclear	100%	100%	100%	100%	100%	100%	NC	0%	NC	0%	NC	0%
Storage	0%	100%	0%	100%	0%	0%	NC	0%	NC	0%	NC	0%
Coal	0%	0%	0%	0%	0%	0%	NC	0%	NC	0%	NC	0%
Oil	0%	0%	0%	0%	0%	0%	NC	0%	NC	0%	NC	0%
Waste Heat	0%	0%	0%	0%	0%	0%	NC	0%	NC	0%	NC	0%
Wind	40%	100%	45%	100%	75%	100%	NC	20%	NC	20%	NC	60%
Solar	40%	100%	10%	100%	0%	0%	NC	40%	NC	10%	NC	0%
Hybrid	See Hybrid Example											

LVER Dispatch

Fuel Type	In-Group						Out-Group					
	Summer Peak		Winter Peak		Light Load		Summer Peak		Winter Peak		Light Load	
	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ
Combined Cycle	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Combustion Turbine	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Diesel Engine	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hydro	50%	50%	50%	50%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Nuclear	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Storage	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Coal	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Oil	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Waste Heat	100%	100%	100%	100%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Wind	20%	20%	20%	20%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Solar	40%	40%	10%	10%	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Hybrid	See Hybrid Example											

Case Development – Fuel Based Dispatch

NRIS Dispatch

Fuel Type	In-Group						Out-Group					
	Summer Peak		Winter Peak		Light Load		Summer Peak		Winter Peak		Light Load	
	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ	PQ	CQ
Combined Cycle	100%	100%	100%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Combustion Turbine	100%	100%	100%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Diesel Engine	100%	100%	100%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Hydro	50%	50%	50%	50%	50%	100%	N/A	N/A	N/A	N/A	NC	0%
Nuclear	100%	100%	100%	100%	100%	100%	N/A	N/A	N/A	N/A	NC	0%
Storage	100%	100%	100%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Coal	100%	100%	100%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Oil	100%	100%	100%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Waste Heat	100%	100%	100%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Wind	20%	100%	20%	100%	60%	100%	N/A	N/A	N/A	N/A	NC	60%
Solar	40%	100%	10%	100%	0%	0%	N/A	N/A	N/A	N/A	NC	0%
Hybrid	See Hybrid Example											

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Case Development – Hybrid Example

Prior-Queued Hybrid Example (HVER Model)

Hybrid Request	Hybrid Request Capacity	Type	Installed Capacity (MW)	Summer Peak (MW)	Winter Peak (MW)	Light Load (MW)
1	100 MW	Solar	50	40%*50 = 20	10%*50 = 5	0%*50 = 0
		Wind	100	40%*100 = 40	45%*100 = 45	75%*100 = 75
		Total	**150**	**60**	**50**	**75**
2	190 MW	Storage	100	0%*100 = 0	0%*100 = 0	0%*100 = 0
		Wind	200	40*200 = 80	45%*200 = 90	75*200 = 120
		Total	**300**	**80**	**90**	**150**

Study Hybrid Example (HVER Model)

Hybrid Request	Hybrid Request Capacity	Type	Installed Capacity (MW)	Summer Peak (MW)	Winter Peak (MW)	Light Load (MW)
1	100 MW	Solar	50	100%*50 = 50 → 33	100%*50 = 50 → 33	0%*50 = 0
		Wind	100	100%*100 = 100 → 67	100%*100 = 100 → 67	100%*100 = 100
		Total	**150**	**150 → 100**	**150 → 100**	**100**
2	190 MW	Storage	100	100%*100 = 100 → 63	100%*100 = 100 → 63	0%*100 = 0
		Wind	200	100%*200 = 200 → 127	100%*200 = 200 → 127	100*200 = 200 → 190
		Total	**300**	**300 → 190**	**300 → 190**	**200 → 190**

MISO

Request Types, Cases Used and Analysis

- Developers can request ERIS, NRIS or partial NRIS. NRIS can never exceed the ERIS value for a plant
- MISO runs thermal and voltage analysis for ERIS requests and a deliverability analysis for NRIS requests.
  - Deliverability analysis based on "flowgate screening" which includes a dynamic dispatch for each flowgate (monitored element / contingency pair) to identify worst possible dispatch (criteria discussed in later slides)
- Bench and Study cases are created for the ERIS analysis based on two loading scenarios (Summer Peak and Shoulder). The NRIS model used is based on a Summer Peak loading scenario.

ERIS Cases and Dispatch

- MISO Transmission Expansion Plan (MTEP) models used as starting point. Existing generators and generators with signed IA dispatched based on MTEP 5 year out LBA Dispatch

- Bench Case – DPP higher queued projects without a GIA added to case & dispatched based on their fuel type such that higher queued projects in MISO Classic are sunk into MISO Classic and higher queued projects in MISO South are sunk in MISO South (MTEP existing units scaled down)

- Study Case (post DPP projects) – based on bench case with study generators dispatched based on fuel type scaling down non-study generators in MISO South and MISO Classic by the MW amount added (MTEP existing units and prior queued generation)

NRIS Cases and Dispatch

- Based on ERIS model with upgrades included
- ERIS only generators turned off and NRIS generation set to at least pgen = 0 such that total generation in MISO Classic and South in the deliverability model is equal to the total generation in these regions for the study model
- ERIS generators with firm transmission treated as NRIS generators
- NRIS units ramped up automatically based on flowgate screening approach (5% DFAX and Top 30 cutoff) with 8000 MW cap. To compensate for the increase in system generation, the rest of MISO system is uniformly scaled down

MTEP 5 year out LBA dispatch

- Hydro: 5-year seasonal average (EIA 923)
- Renewables (Wind, Solar): Dispatched to Seasonal level or Capacity Credit Level. Currently both are capacity credit level by unit, unless information is unavailable for said unit, where the system wide capacity credit level is used.
- Dispatch algorithm will maintain desired Area Interchange.
- Firm Resources (NR, ER w/ TSR), dispatched by LBA Tier Order to satisfy each areas generation requirement. Area swing last unit committed

ERIS Fuel Based Dispatch

Table 6-1 Dispatch per Fuel Type for Study and Higher Queued Generators (without a GIA)

Fuel Type under Study and Higher Queued	Summer Peak Dispatched as % of Interconnection Service	Shoulder Peak Dispatched as % of Interconnection Service
Combined Cycle	**100%**	**50%**
Combustion Turbine	**100%**	**0%**
Diesel Engines	**100%**	**0%**
Hydro	**100%**	**100%**
Nuclear	**100%**	**100%**
Storage[9]	**100%**[10]	**+/- 100%**
Steam – Coal	**100%**	**100%**
Oil	**100%**	**0%**
Waste Heat	**100%**	**100%**
Wind	**15.6%**[11]	**100%**
Solar	**100%**	**0%**[12]
Hybrid Facility[13] (Any combination of the above fuel types)	**Based on above dispatch assumptions of each fuel type with any adjustment based on requested interconnection Service**[14]	**Based on above dispatch assumptions of each fuel type with any adjustment based on requested interconnection Service**[15]

Example: Generic Dispatch Assumptions for Hybrid Facility

Scenario	Existing Generator 1 (Wind, Solar, CC etc.)	Study Generator 2 (Wind, Solar, CC etc.)	Study Generator 3 (Wind, Solar, CC etc.)	Study Generator 4 (Storage)	Interconnection Service Requested	Steady State (Shoulder Peak)[27]	Steady State (Summer Peak)[28]	NRIS or Deliverability (Summer Peak)
1	0	50	100	0	120	MIN (fuel type dispatch of both study generators, 120)		MIN (max. MW output of both study generators, 120)
2	0	100	0	+/-50	120	Discharging: MIN (fuel type dispatch of both study generators, 120) Charging: – fuel type dispatch of storage (non-storage offline)		Discharging: MIN (max. MW output of both study generators, 120)
3	100	0	0	+/-50	120	Discharging: MIN (fuel type dispatch of existing gen. + fuel type dispatch of storage, 120) Charging: – fuel type dispatch of storage (non-storage offline)		Discharging: MIN (max. existing gen. MW + max. storage MW, 120)
4	0	100	0	+/-50	150	Discharging: Fuel type dispatch of both study generators Charging: – fuel type dispatch of storage (non-storage offline)		Discharging: Max. MW output of both study generators
5	0	50	100	0	150	Fuel type dispatch of both study generators		Max. MW output of both study generators

NOPR Dispatch Proposals

NOPR Dispatch Proposals

- A lot of focus on how storage and hybrid projects are treated in interconnection studies
- FERC found that unrealistic operating assumptions can result in excessive and unnecessary upgrades
- Proposal to require transmission provider to use operating assumptions for interconnection studies if interconnection customers request this (e.g. whether a resource will charge or not during peak load)
- The proposal does include a provision which allows transmission providers to hold interconnection customers to intended operation of their plant
- NOPR also seeks comments on whether the Commission should:
  - ➢Expand proposal to tackle transmission providers studying scenarios that are not physically possible (solar on at night)
  - ➢Define the peak load period
  - ➢Define firm and non-firm charging and require defined study criteria

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Thank you

Contact for questions/information

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