Economic Planning Manual: Energy Deliverability

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Agenda

- **System & Resource Outlook Components**

- **Economic Planning Manual Update**

- **Example System**

  - Congestion Analysis

  - Constraint "Relief" Evaluation

  - Renewable Pocket Identification

  - Energy Deliverability Calculations

- **Next Steps**

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System & Resource Outlook

Study Components

- Relevant Planning Study Summary

- Reference Case Development

- Economic Planning Model Development

- Historic & Future Transmission Congestion

- Congestion Relief Analysis

- Renewable Pocket Formation

- Energy Deliverability Analysis

- Projected Operations & Market Impact Analysis

- Sensitivity Simulations

- Study Report

- Generic Dataset & Model Posting

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Economic Planning Manual Update

- **Draft Manual Sections Posted for**
  - Historic & Future Transmission Congestion
  - Congestion Relief Analysis
  - Renewable Generation Pocket Formation
  - Energy Deliverability Analysis

- **Numeric example included in manual and presented hereafter to show calculations as part of the analyses**

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Example System

- Wind "W" Generator = 500 MW

- Solar "S" Generator = 250 MW

- Load = 100 MW

- Line Ratings All = 100 MW

- Line Impedances All Equal

- Rest of System Supplies or Absorbs Energy Balance
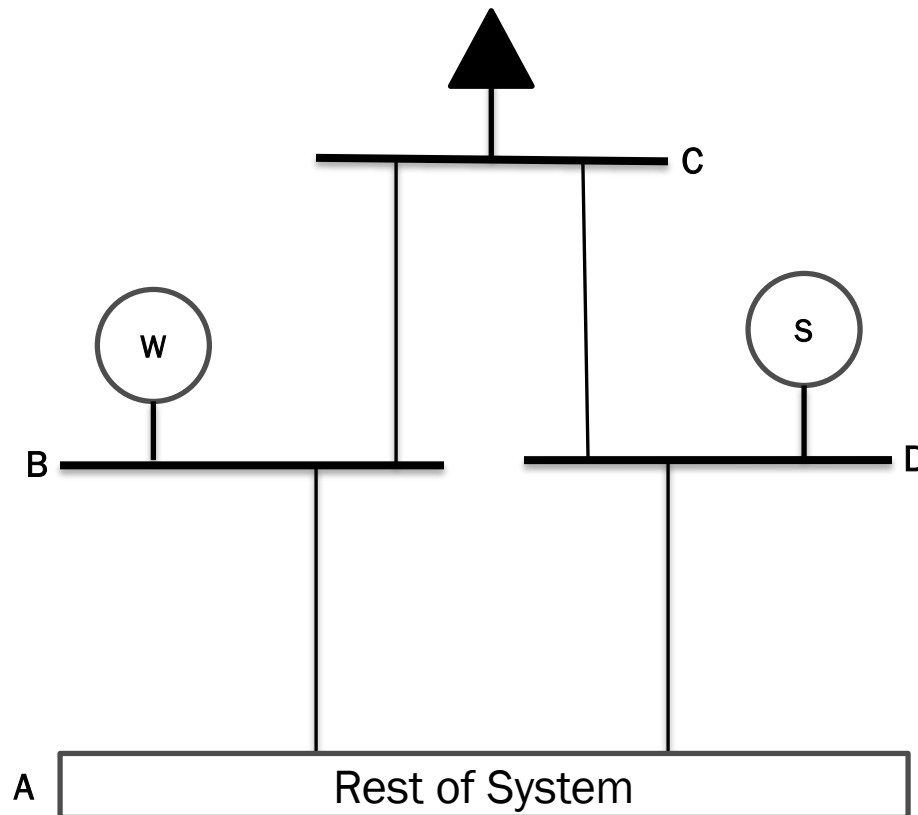
Generation Shift Factors (GSFs)

- GSFs quantify the incremental impact of generation on the flow of transmission facilities

- Assuming the Rest of System acts as the reference location, the GSF matrix for the example system is:

GSF Matrix	A-B	B-C	C-D	D-A
Wind	-0.75	0.25	0.25	0.25
Solar	-0.25	-0.25	-0.25	0.75
Load	0.5	0.5	-0.5	-0.5

Example System Flows

- Assume Wind "W" Generator = 1 MW
- Line Impedances All Equal
- Rest of System Supplies or Absorbs Energy Balance
- Rest of System Acts As Reference

| GSF Matrix	A-B	B-C	C-D	D-A
Wind	-0.75	0.25	0.25	0.25
Solar	-0.25	-0.25	-0.25	0.75
Load	0.5	0.5	-0.5	-0.5
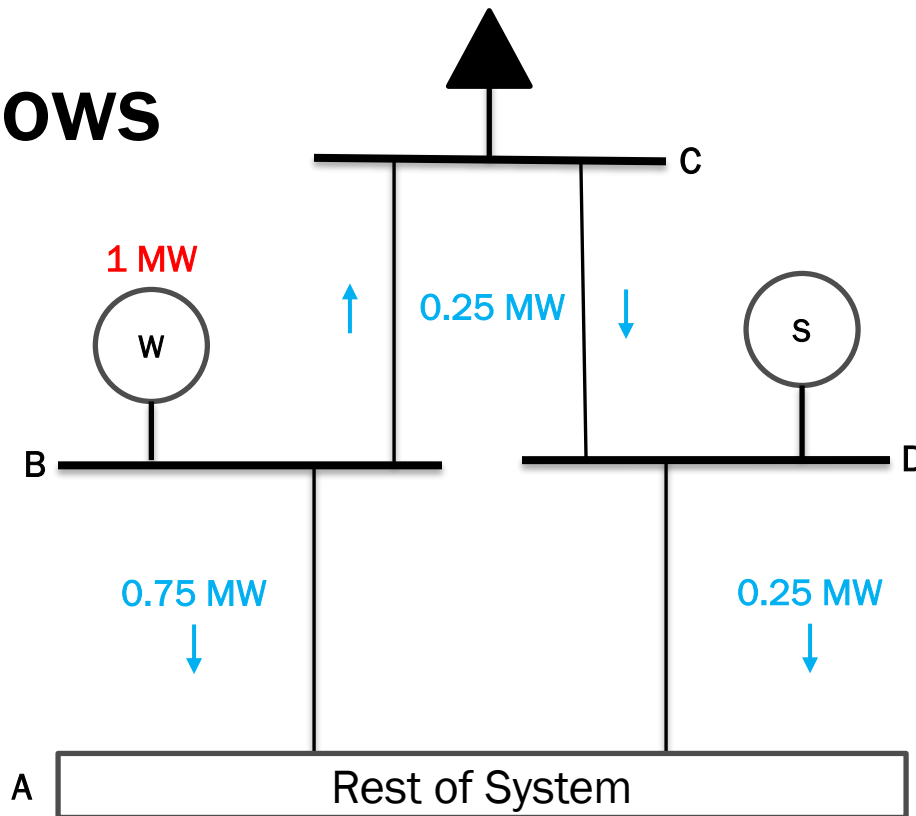
Example System Hourly Profile Creation

- Leverage Actual Data to Develop Hourly Profiles

- Solar: NYISO BTM-PV Profiles

- Wind: NREL Wind Toolkit Profiles

- Load: Historic NYISO Hourly Load

- Data was per-unitized and compiled on an hourly basis

- 12 average hourly profiles for each resource (solar, wind, load) for each month were created
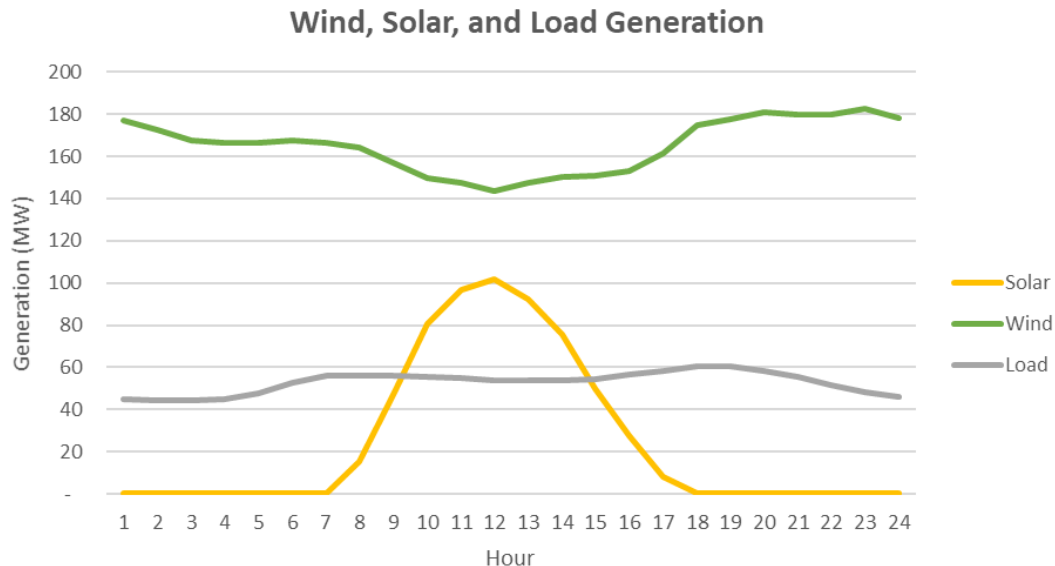
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Example System Profiles
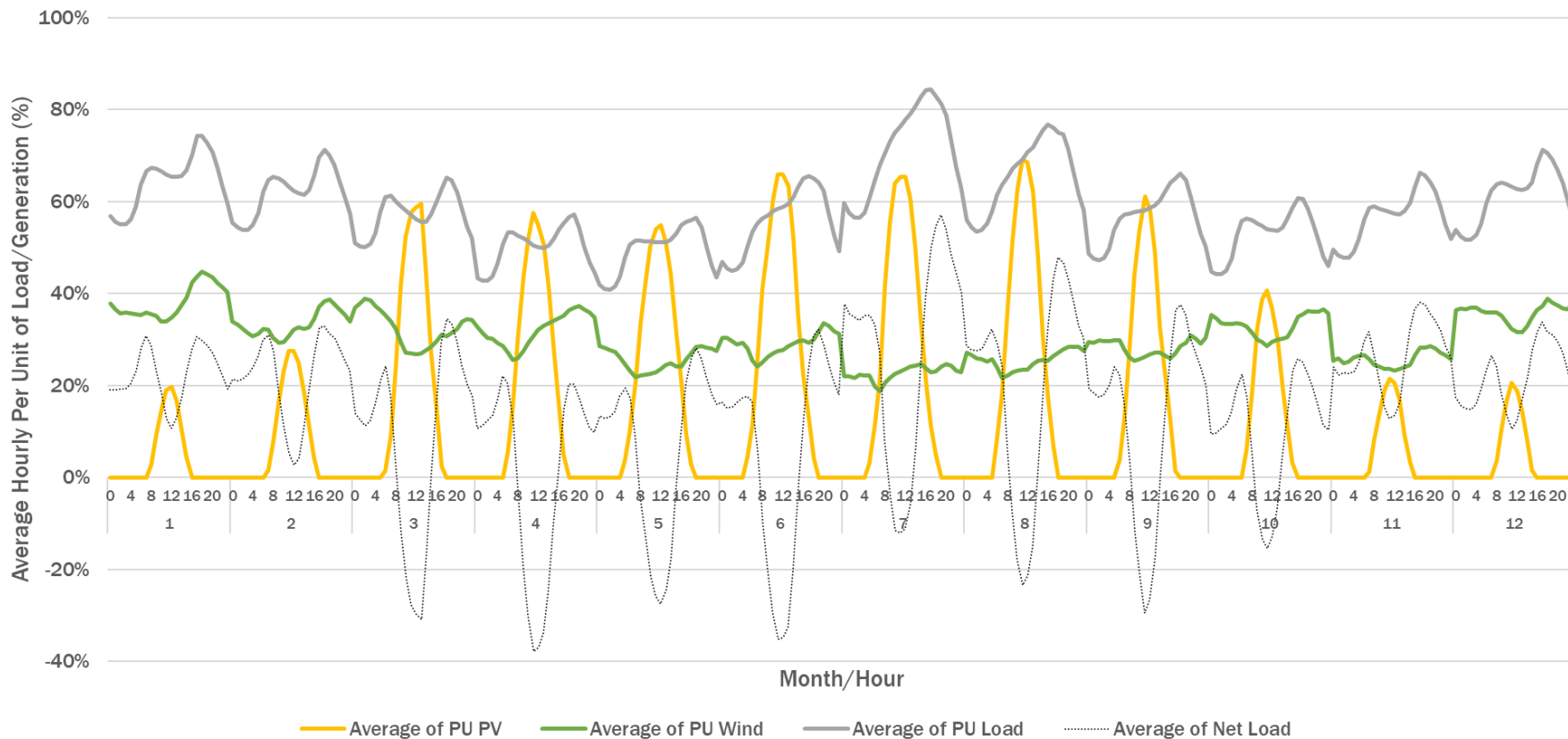
Example System Single Day Profile

- Use single day of hourly results (October) to more easily present energy deliverability calculations

- Multiply capacities by per-unit profiles to create actual profiles
  - Wind Capacity = 500 MW
  - Solar Capacity = 250 MW
  - Load = 100 MW
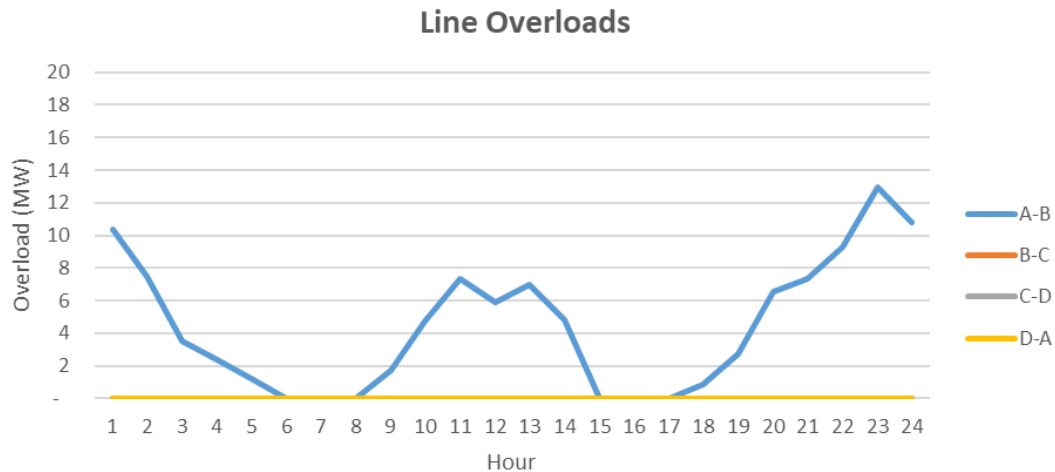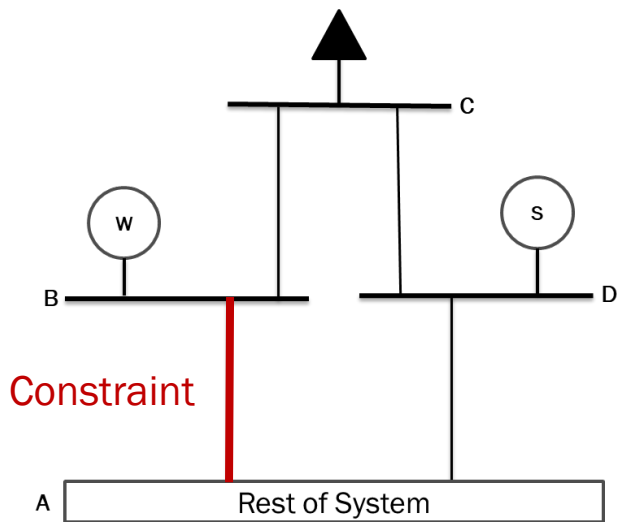

Wind, Solar, and Load Generation

Example System Single Day Calculations

Line Flows
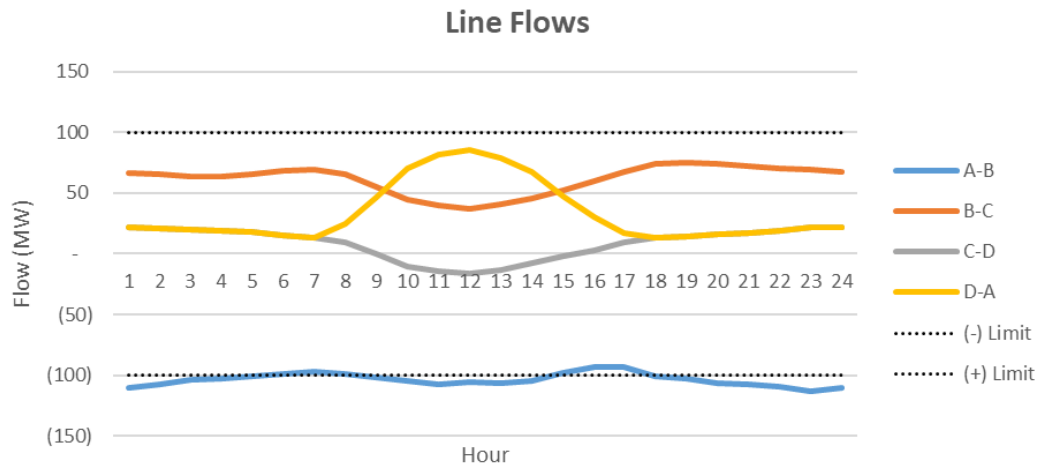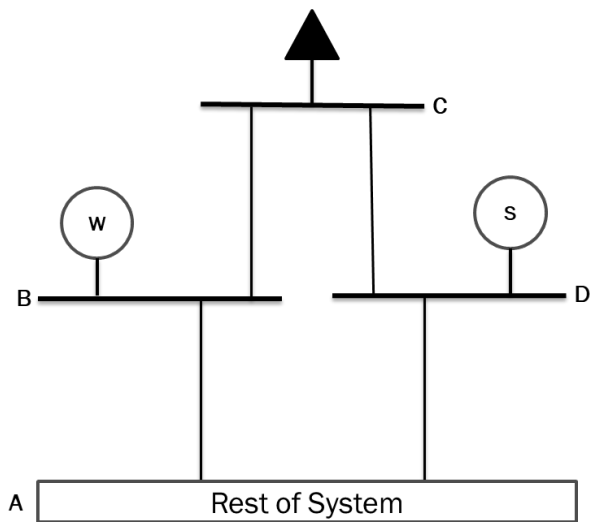
# Example System Single Day Calculations

Line Overloads

Congestion Analyses

- The constraint at line "A-B" would be identified and quantified during the Historic & Future Congestion Analysis
  - Overload duration (Hours)
  - Demand congestion ($)

- The overload energy would be calculated through the Congestion Relief Analysis, which eliminates the line limit to determine the unconstrained flow on the line

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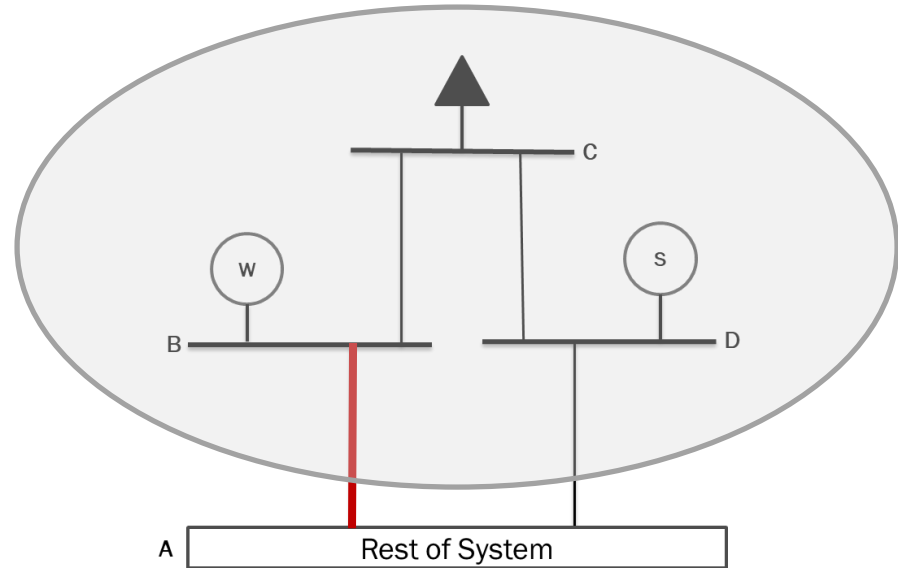# Example System Single Day Calculations

Curtailment
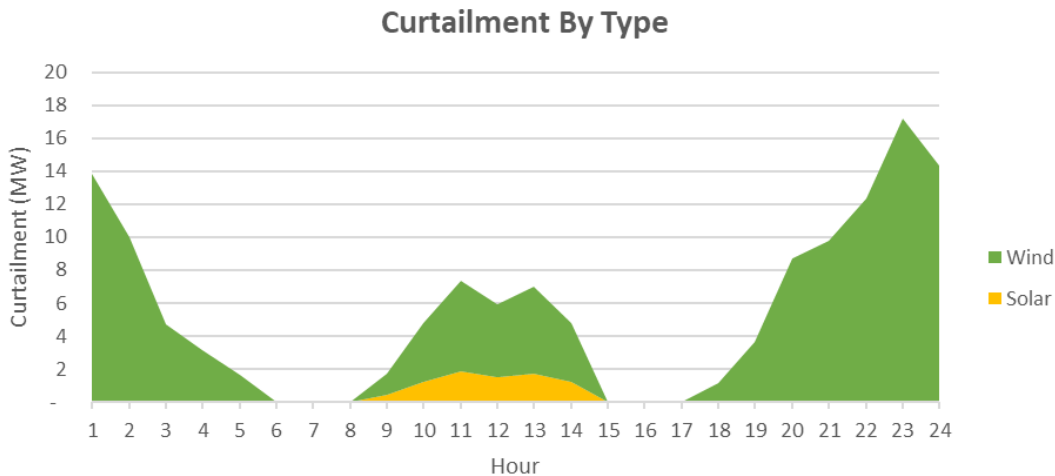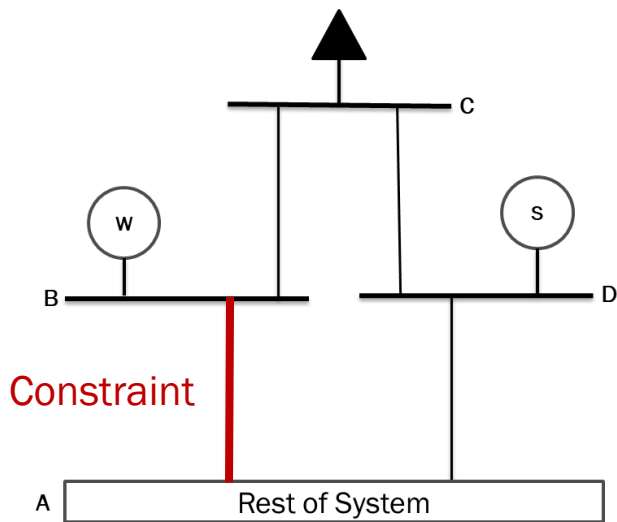
Curtailment

- The constraint on line "A-B" causes curtailment of both wind and solar generation to reduce flows on the line to a value at or below the limit of 100 MW

- Note that due to the GSF relationship between the generators and line flow, individual generators may need to curtail more than the overload to reduce flows to reach limit

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Renewable Generation Pockets

- **A renewable generation pocket can be defined around the example system due to:**

  - The localized constraint at line "A-B"

  - Curtailment on renewable generators within pocket due to constraint

  - High GSFs between generators and constraint

Renewable Generation Pocket

Example System Single Day Calculations
Energy Deliverability

- Using the hourly results for generation and curtailment, energy deliverability can be calculated for the renewable generators and the renewable generation pocket over the sample day

$$Energy\ Deliverability\ (\%) = \frac{Energy\ Production}{Energy\ Production\ Capability}\ x\ 100$$

Energy (MWh)	Potential	Curtailment	Actual	Energy Deliverability (%)
Solar	595	8	587	99%
Wind	3,963	124	3,839	97%
Pocket	4,558	132	4,426	97%

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Example System Single Day Calculations

Energy Headroom

- Using hourly flow results from the simulations and congestion relief analyses, an energy headroom calculation can also be performed

A-B Overload **A-B Headroom**

Line Flow Duration
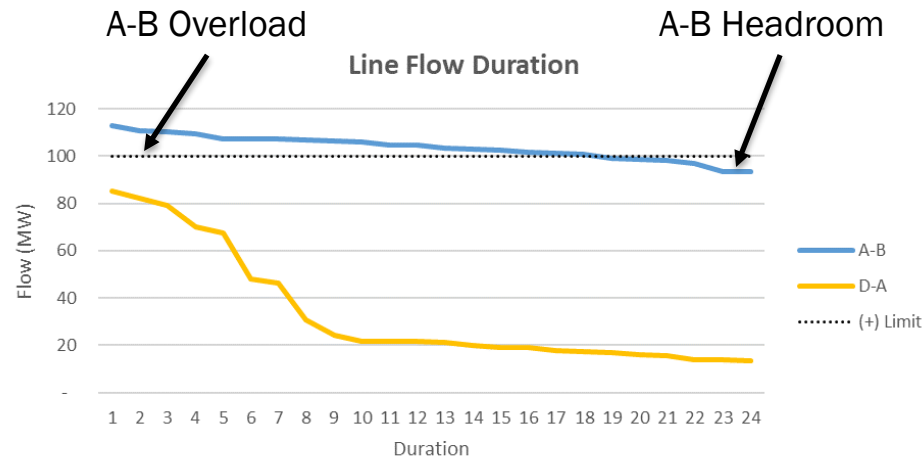
Energy (MWh)	Max Flow	Actual Flow	Overload	Headroom	Headroom (%)
Line A-B	2,400	2,487	107	20	1%
Line D-A	2,400	803	0	1,597	67%

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Next Steps

- Incorporate comments into draft manual sections presented

- Submit comments by June 30th to jfrasier@nyiso.com

- Prepare draft manual sections for:

  - Relevant Planning Study Summary

  - Reference Case Development

  - Economic Planning Model Development

- Next presentation at July 1st TPAS/ESPWG

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Our mission, in collaboration with our stakeholders, is to serve the public interest and provide benefit to consumers by:

- Maintaining and enhancing regional reliability

- Operating open, fair and competitive wholesale electricity markets

- Planning the power system for the future

- Providing factual information to policymakers, stakeholders and investors in the power system

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Questions?

DRAFT – FOR DISCUSSION PURPOSES ONLY

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