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An Analysis of the Impact of Balancing Area Cooperation on the Operation of the Western Interconnection with Wind and Solar Generation

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WINDPOWER 2011
May 22-25, 2011

NREL/PR-5500-51546

Outline

- Overview/Objective
- Operating Reserves
- Ramping
- Production Simulation
- Conclusions

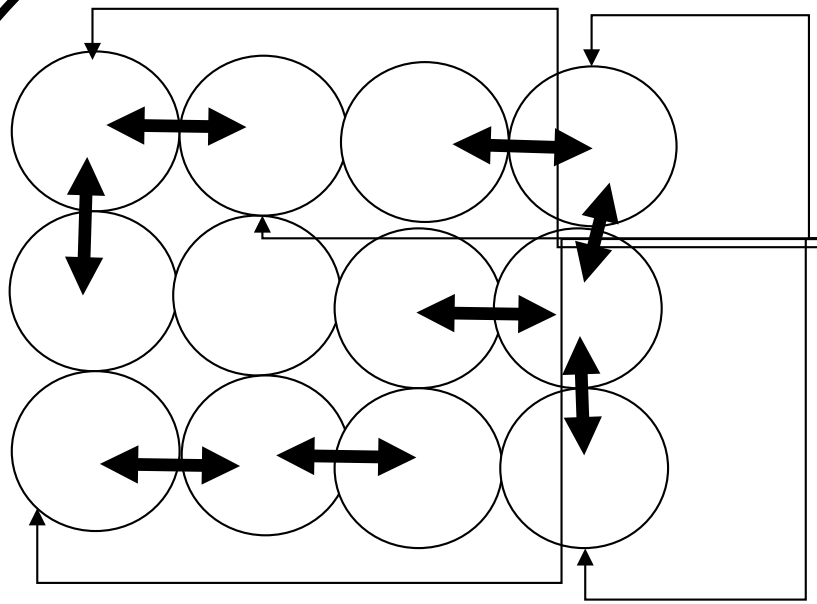
Photo by Pat Corkery, NREL/PIX16571

Objective

- Analysis of alternative BA configurations in the Western Interconnection
- Proposed Energy Imbalance Market
- Flexibility reserve analysis utilizing method from Eastern Wind Integration and Transmission Study (EWITS)
- Production simulations using GE-MAPS
  - Alternative levels of transactional "friction" for
    - Unit commitment
    - Economic dispatch.

Imbalance Market Overview

EIM Footprint

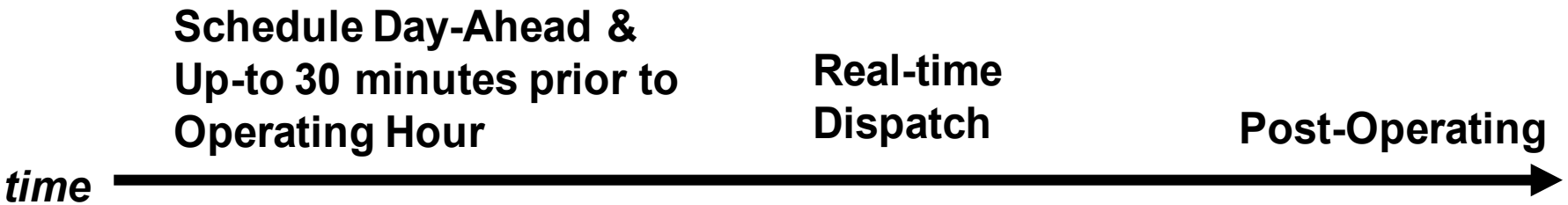


EIM Tool: SCED

Intra-hour variability is captured and allocated in real-time within the entire region, limited by the physical capability of the wires.

Diversity benefit reduces operating costs for balancing.

Imbalance Market Overview



Market Participant:

- ✓Forecast and unit Commit
- ✓Generators self-schedule
- ✓Generators voluntary submit offers
- ✓DSM resources voluntary submit offers
- ✓Prepare and finalize pre-dispatch schedules

WECC EIM Market Operator:

- ✓Perform security-constrained economic dispatch to keep balance
- ✓Provide redispatch if any congestion occurs
- ✓Send dispatch set points to generators
- ✓Coordinate any contingency reserve deployments With EIS dispatch

- ✓Gather meter data to support settlements
- ✓Provide settlement statement and invoices

Transmission Provider:

- ✓Provide meter data to support settlements

Imbalance Market Is Not Full Coordination

- Does not include framework for unit commitment coordination
- Voluntary participation at the BA level
- All generators may not choose to participate
- Will some level of coordination of unit commitment evolve over time?

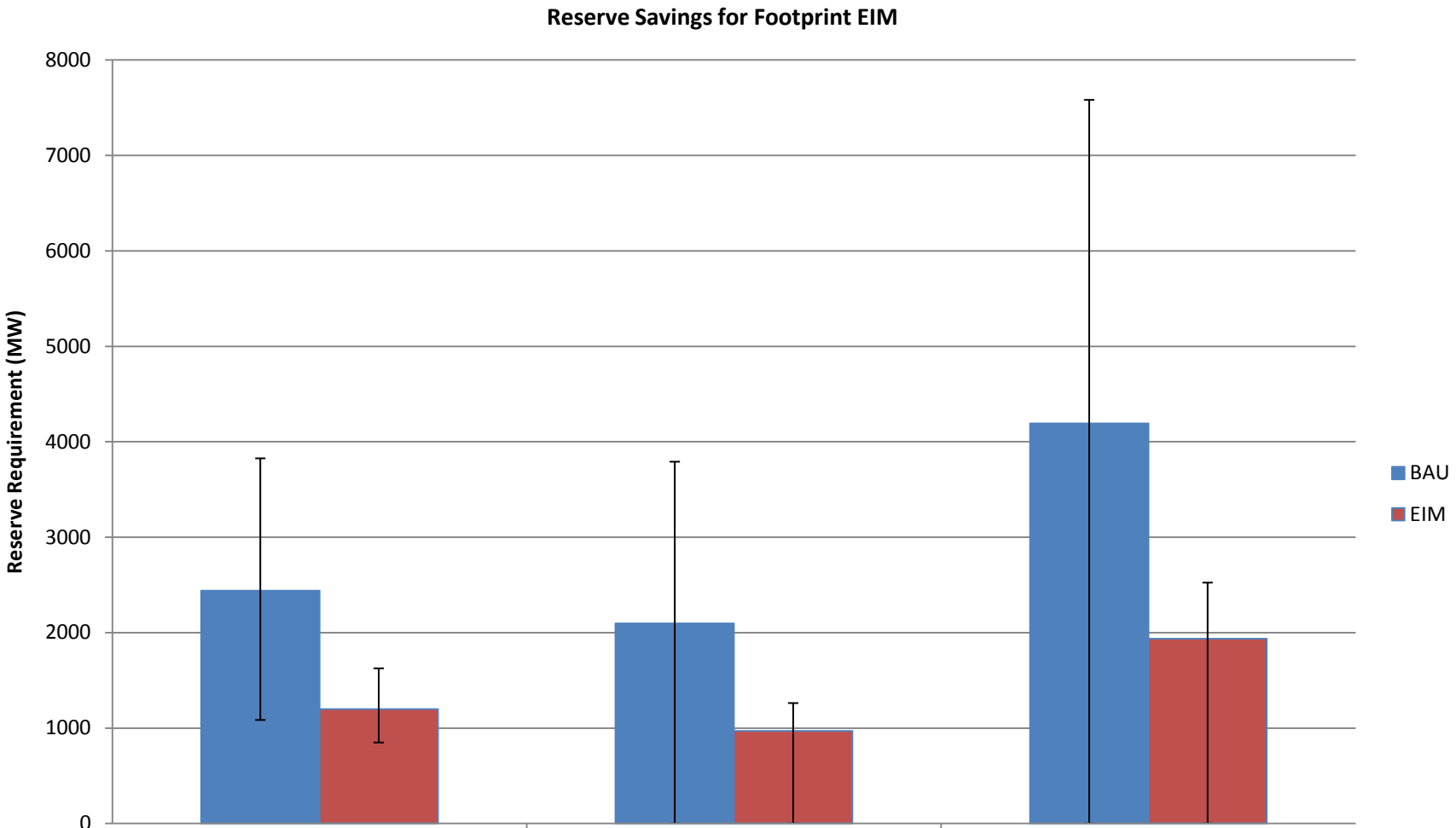
Data

- Data from the Western Wind and Solar Integration Study (WWSIS)
- Wind data developed by 3Tier and described in *Development of Regional Wind Resource and Wind Plant Output Datasets* available at http://www.nrel.gov/wind/integrationdatasets/pdfs/western/2010/3tier_final_report.pdf
- Generation and transmission data from WWSIS as described in http://www.nrel.gov/wind/systemsintegration/pdfs/2010/wwsis_final_report.pdf

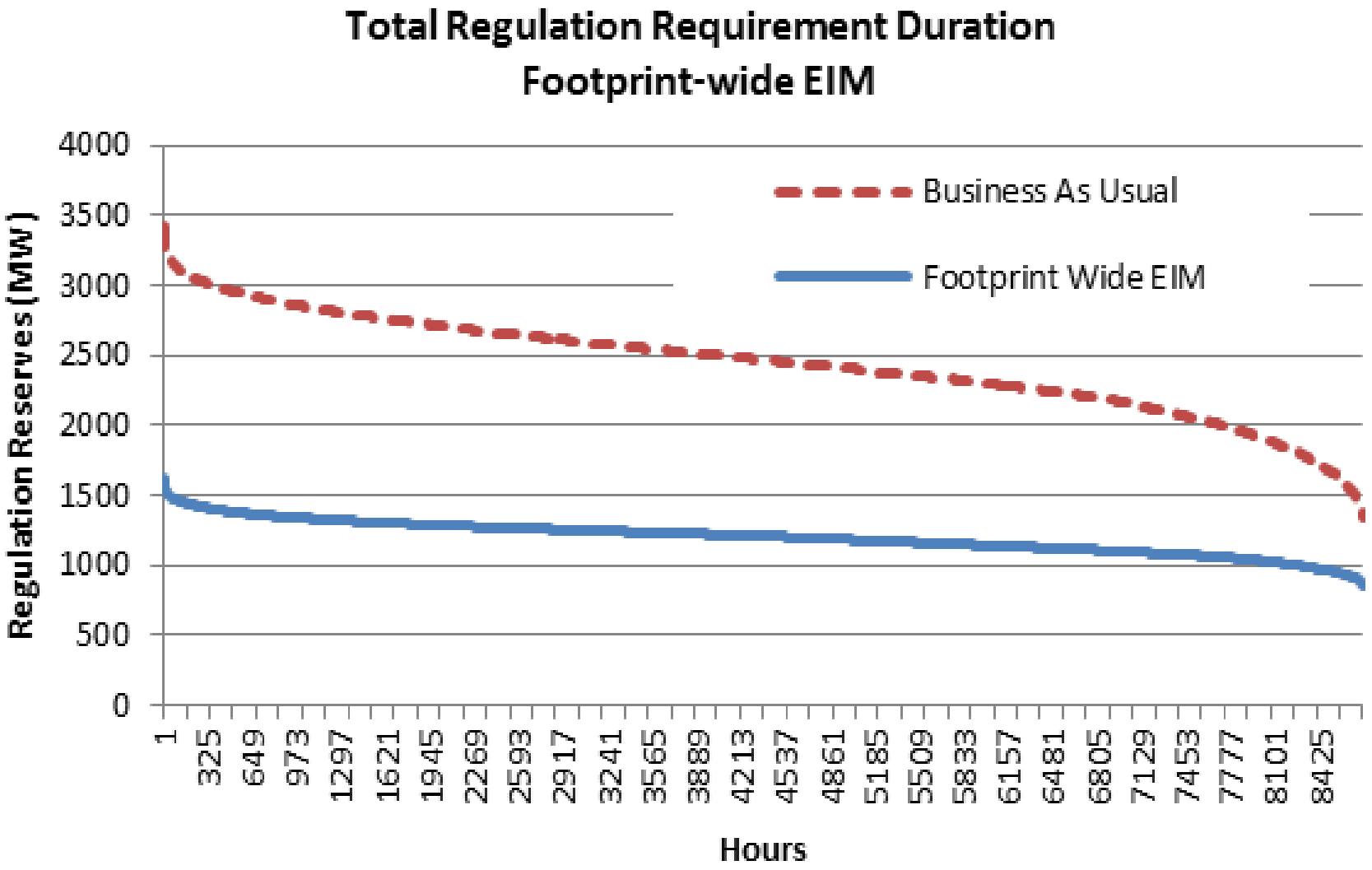
Flexibility Reserve/Operating Reserve

- Wide-area pooling of variability analyzed using extension of EWITS approach
- Described in prior work
  - Milligan, M.; Kirby, B.; King, J.; Beuning, S. (2010). Benefit of Regional Energy Balancing Service on Wind Integration in the Western Interconnection of the United States: Preprint. 10 pp.; NREL Report No. CP-5500-49076.
- Contingency reserve not affected
- Wind and solar increase the dispatch range and ramping speed required from conventional generation→focus of part 1 of the analysis.

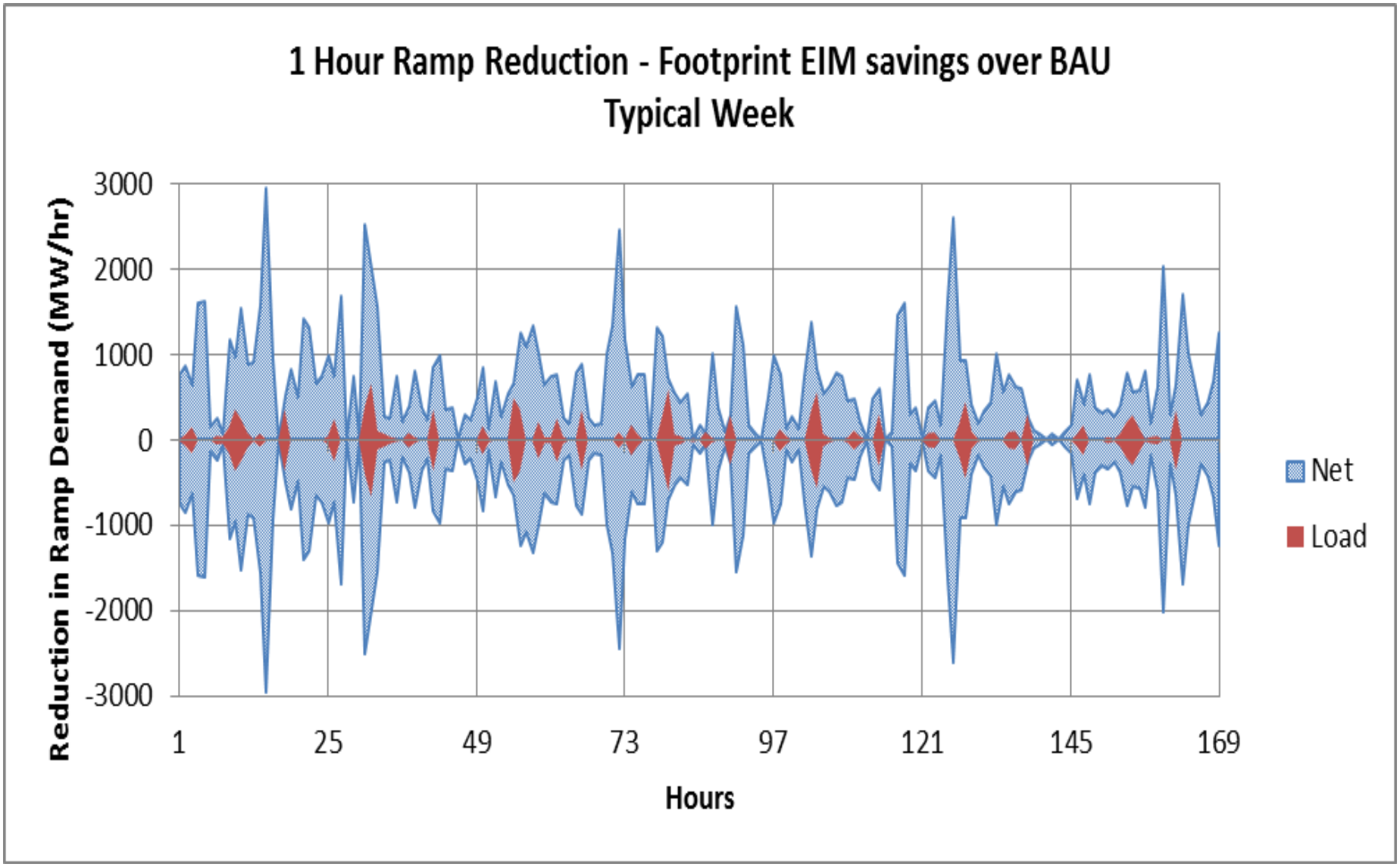
Full Footprint EIM



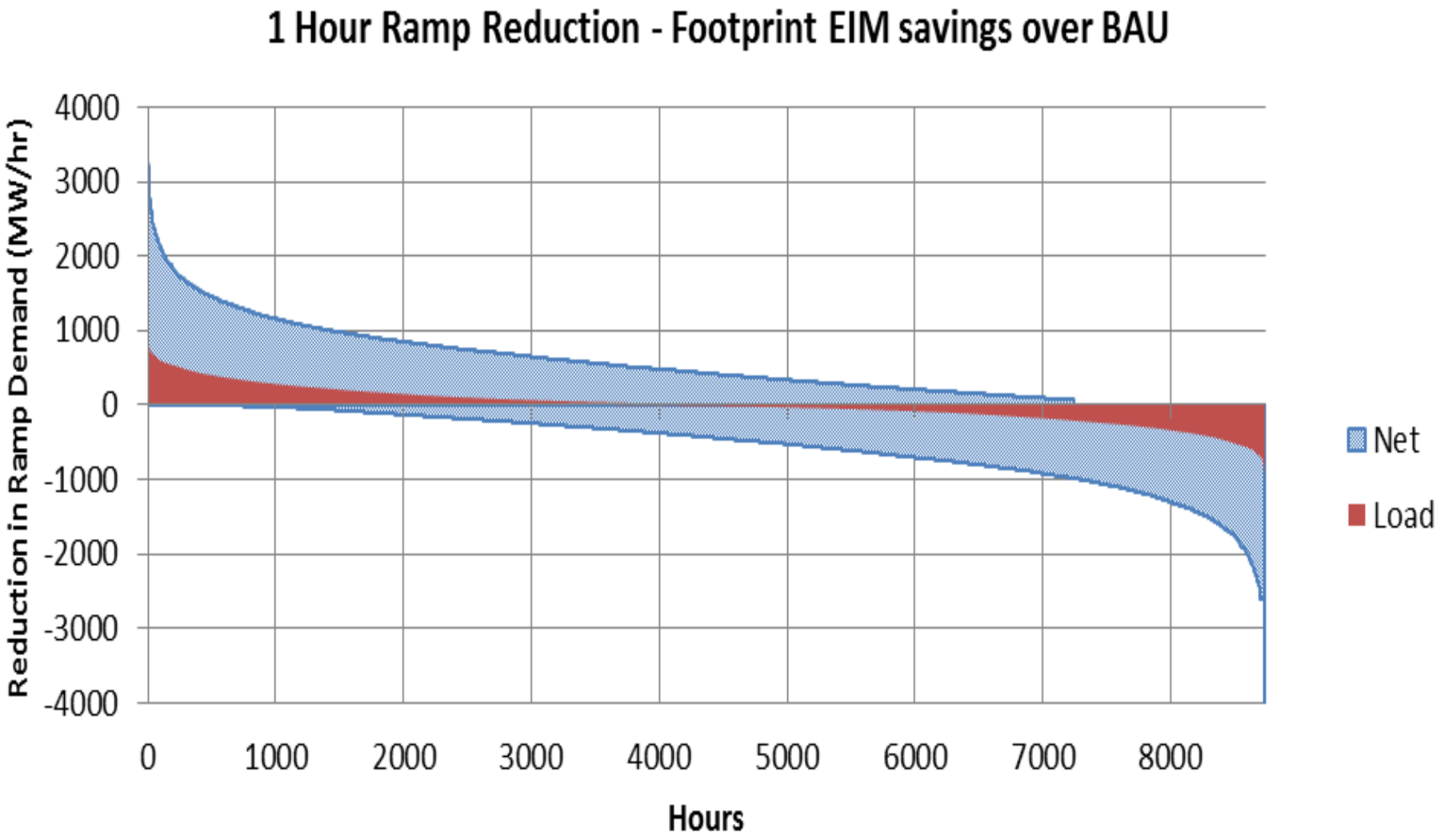
	Total Reg	Spin	Supplemental
BAU	2440	2096	4192
EIM	1198	969	1938


Total Regulation Requirement Duration
Footprint-wide EIM
Regulation Reserves (MW)
4000
3500
3000
2500
2000
1500
1000
500
0
Business As Usual
Footprint Wide EIM
1
325
649
973
1297
1621
1945
2269
2593
2917
3241
3565
3889
4213
4537
4861
5185
5509
5833
6157
6481
6805
7129
7453
7777
8101
8425
Hours

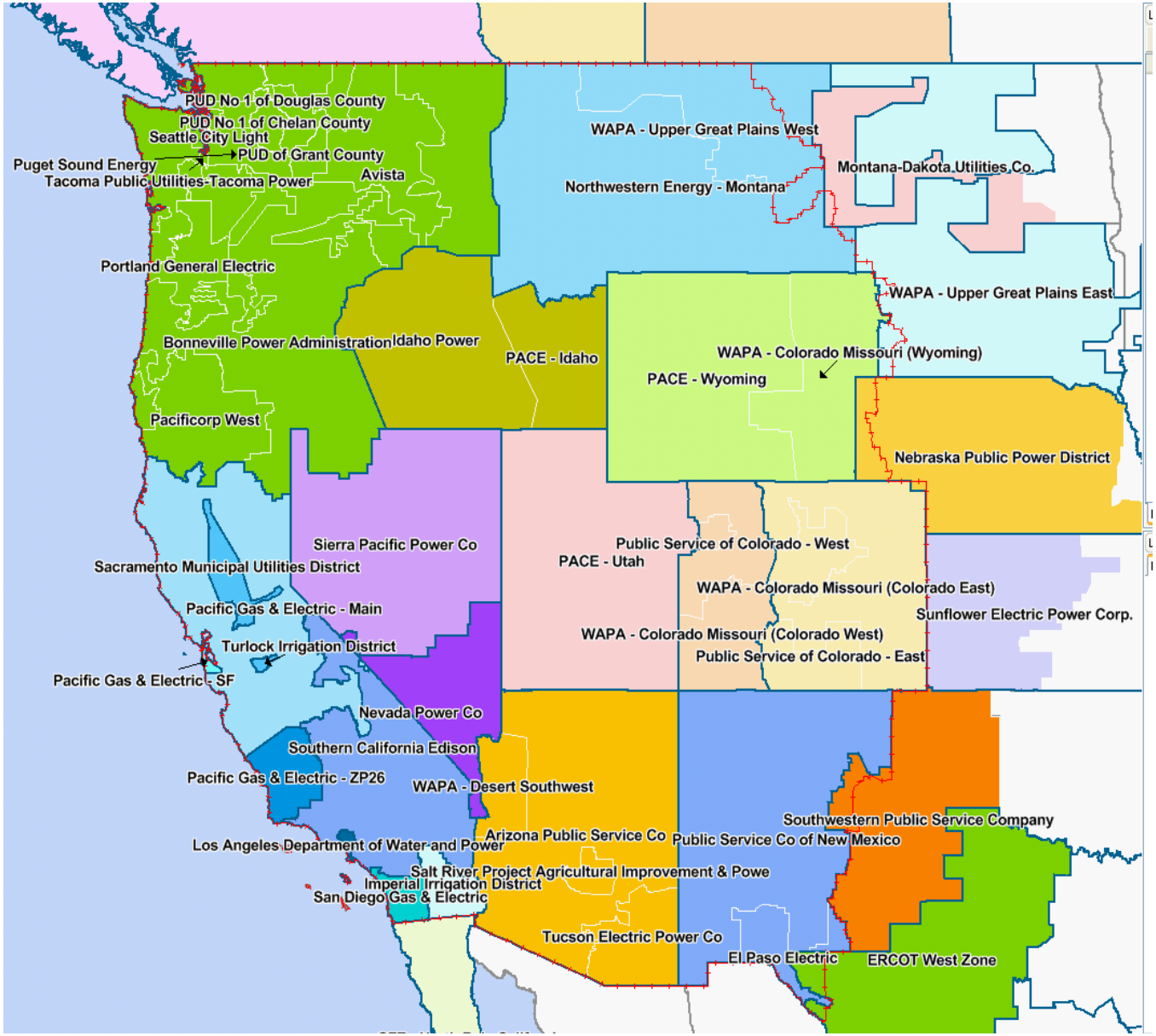
Ramping Requirements Are Reduced, with and without Wind/Solar



Ramp Duration for 1 Year



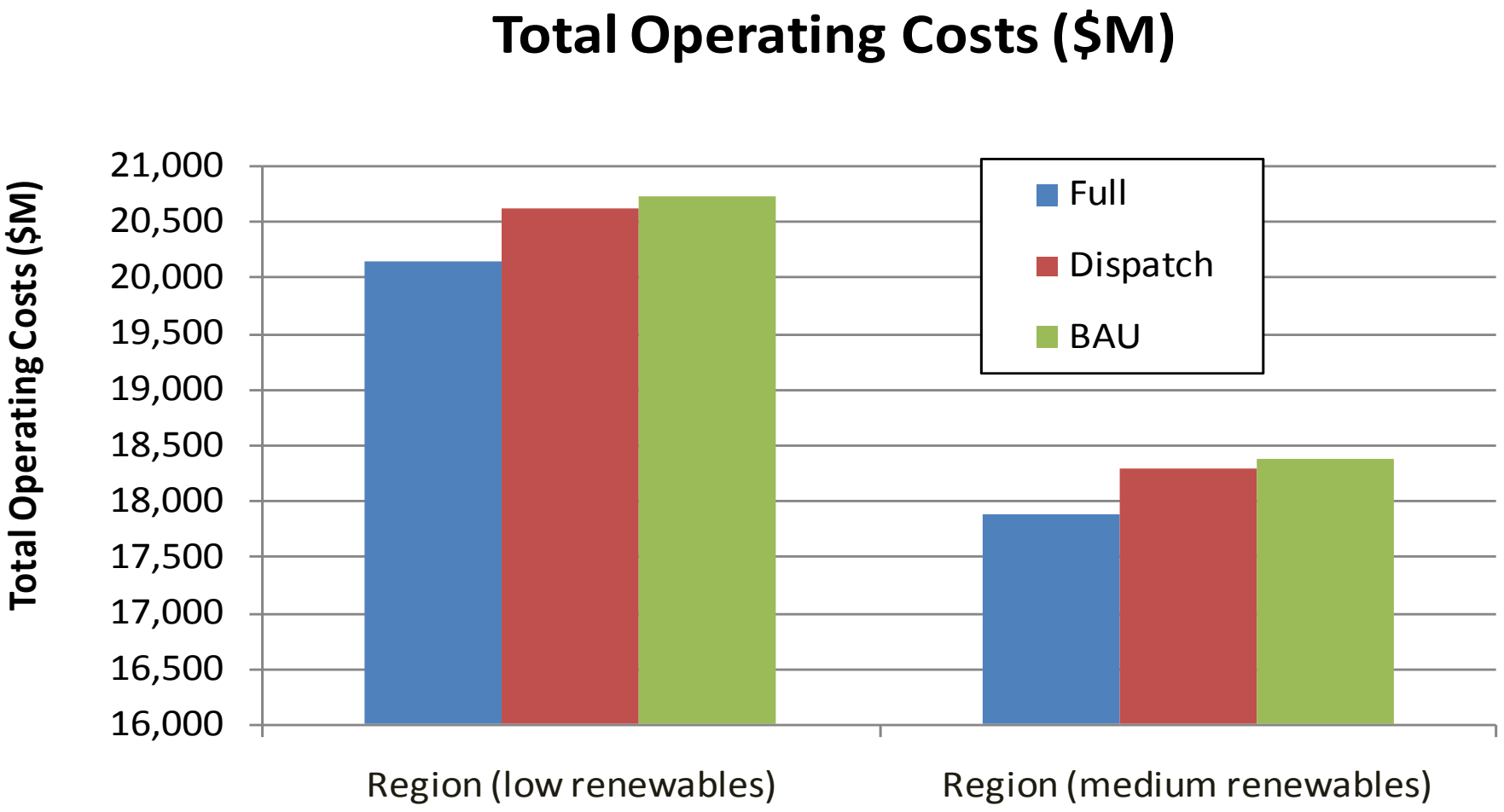
GE-MAPS Analysis: Map of WECC Areas



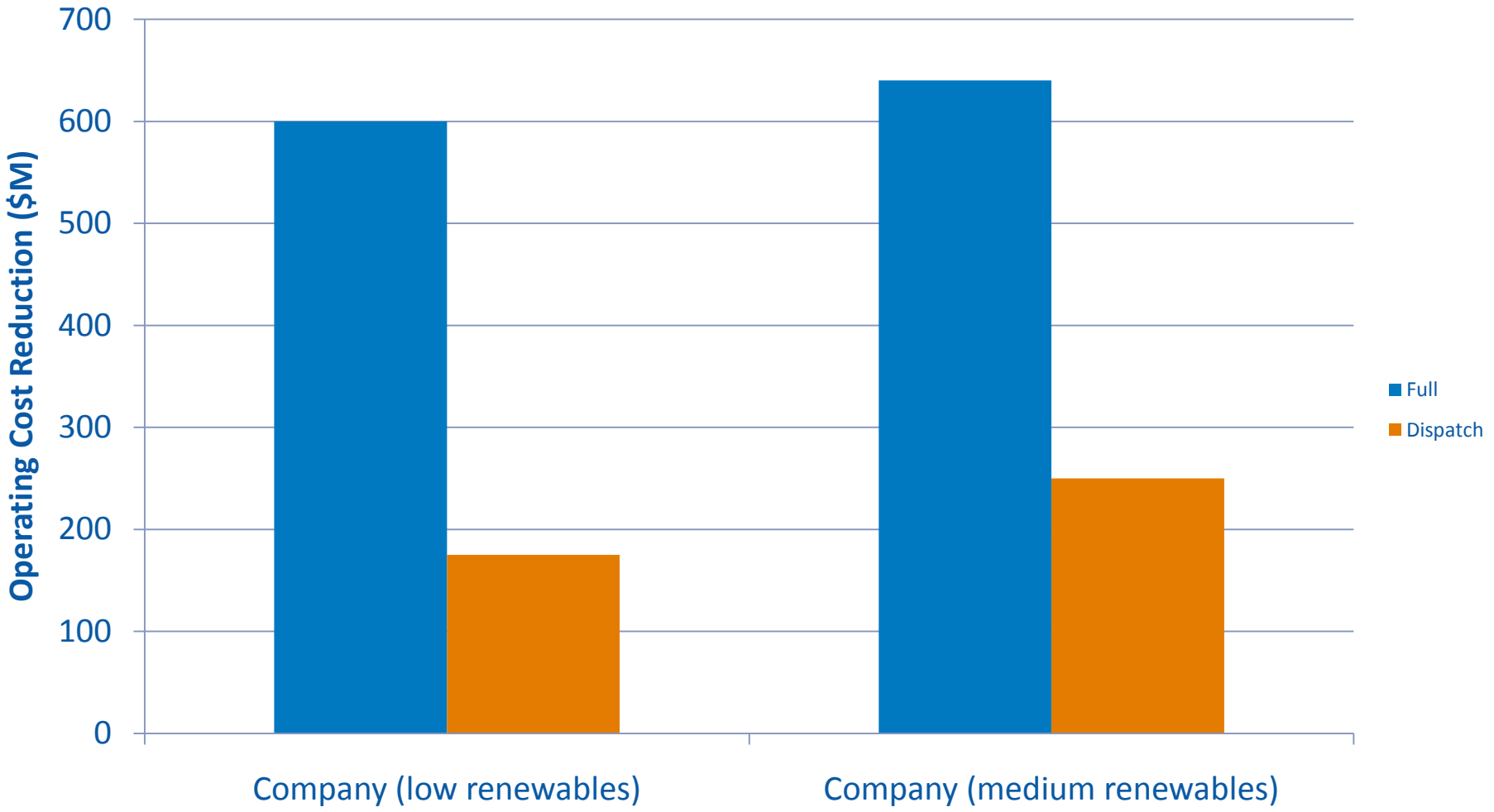
Alternative Levels of Transactional Friction

		Company-Level Operation	
Commitment hurdle rate	Dispatch hurdle rate	Low renewable penetration	Medium renewable penetration
$5/MWh	$5/MWh	X	X
$25/MWh	$5/MWh	X	X
$25/MWh	$25/MWh	X	X

Total Operating Costs



Operating Cost Reductions with Increased Coordination



Conclusions

- Significant reserve reductions are possible.
- Ramping needs are reduced, even without wind/solar energy.
- Existing uncoordinated unit commitment will capture 20%-40% of total operating cost savings potential compared to full coordination.

Photo by Michael Milligan, NREL/PIX13367

The National Renewable Energy Laboratory's Wind Systems Interconnection Analysis work is funded by the Wind and Water Power Program, Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract No. DE-AC02-05CH11231.