

**IMPERIAL**

# Endogenizing Probabilistic Adequacy Constraints in Power System Capacity Expansion Models

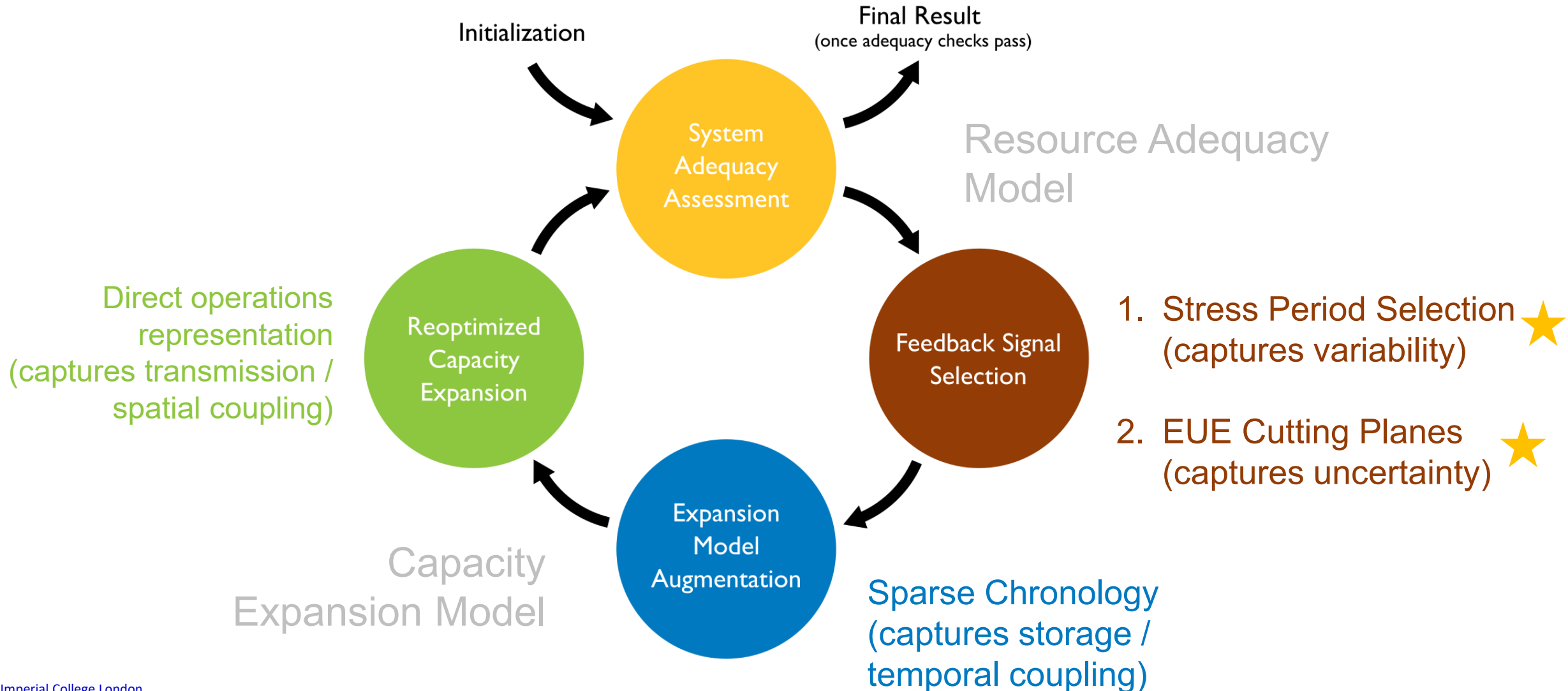
Gord Stephen

Department of Electrical and Electronic Engineering

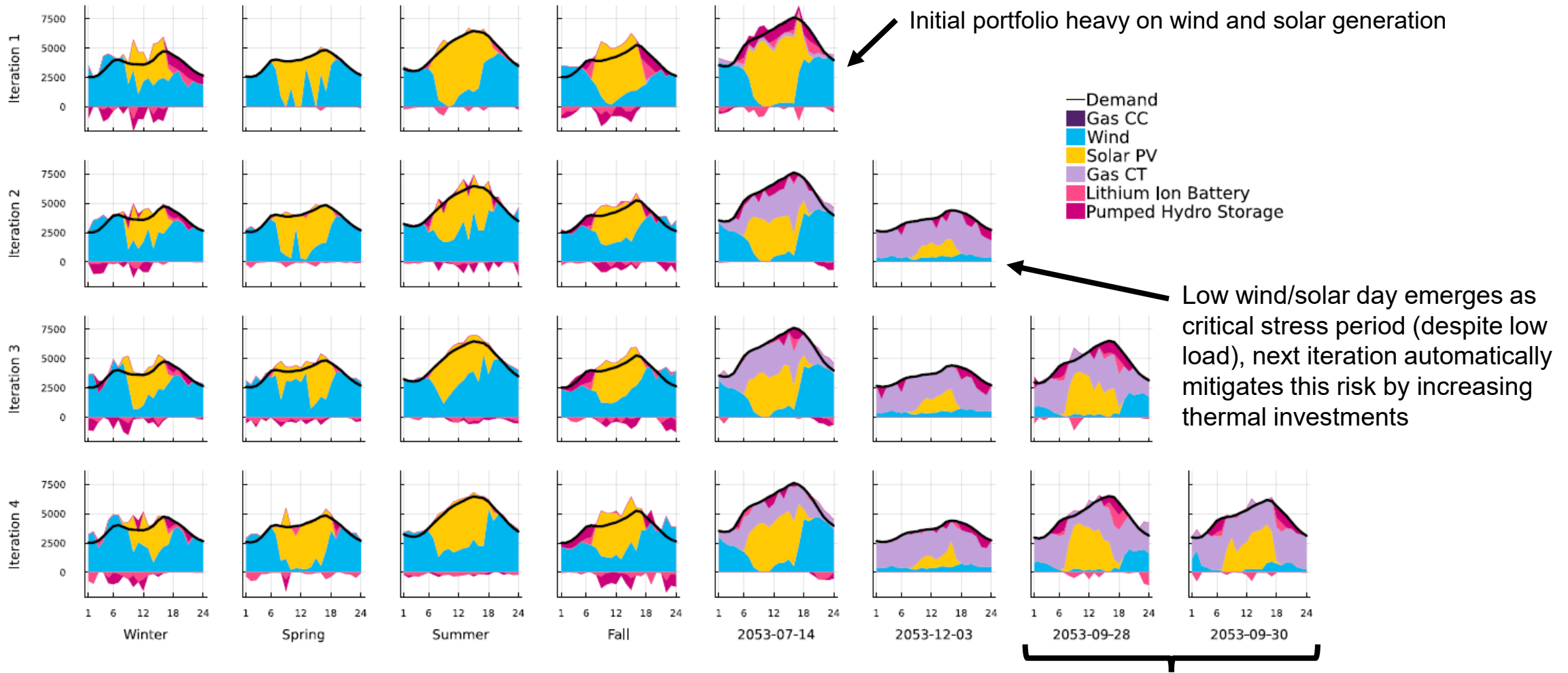
Imperial College London

# Resource Adequacy – Capacity Expansion Feedback Loop

## Combining Complementary Approaches

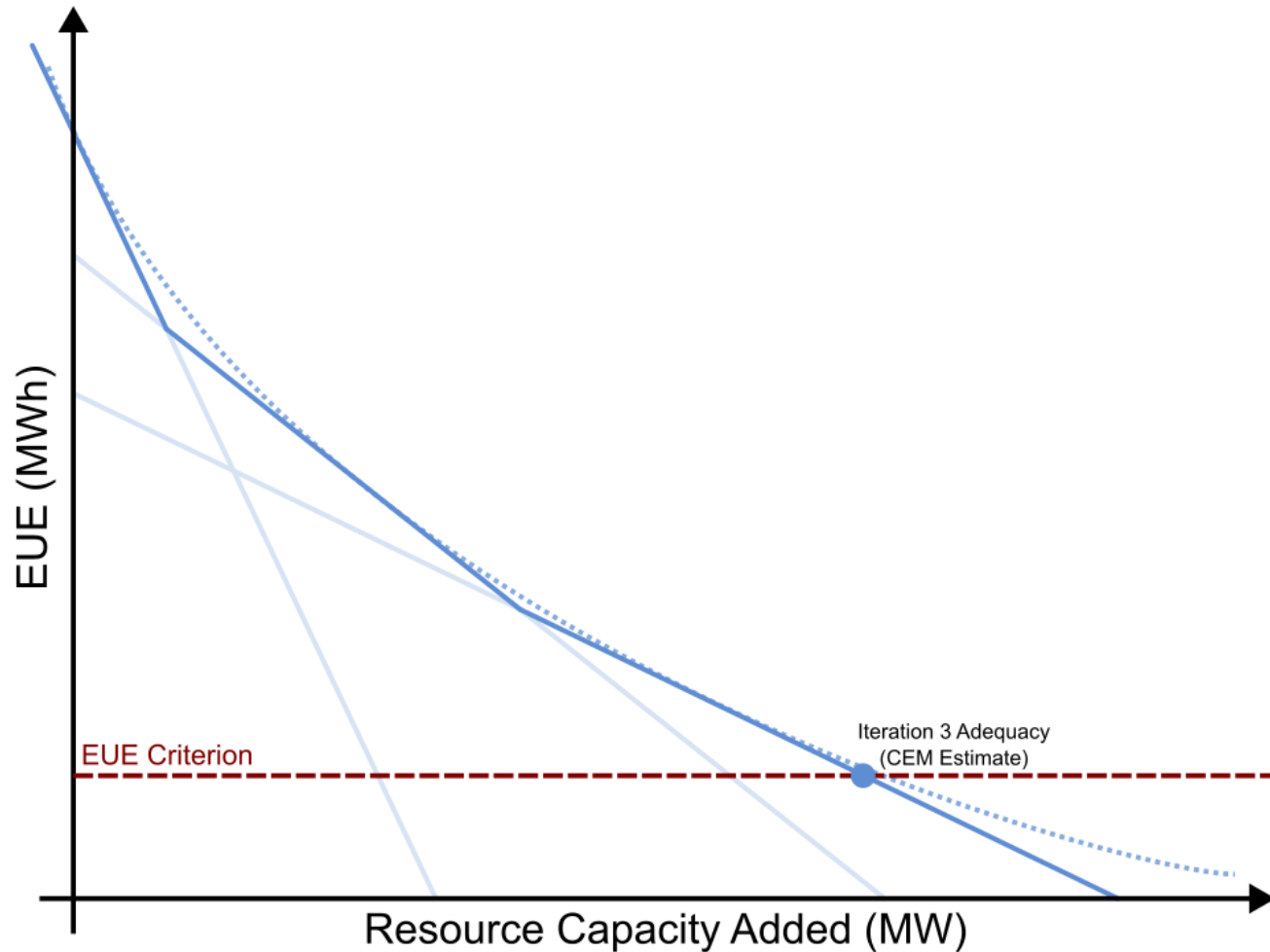


# Adaptive Stress Period Planning



*Illustrative example, does not represent SRP or TVA results*

# EUE Cutting Planes



Cutting plane approach uses resource adequacy assessment results to incrementally build an endogenous EUE estimation surface while improving (greatly!) on our previous endogenous risk curves approach

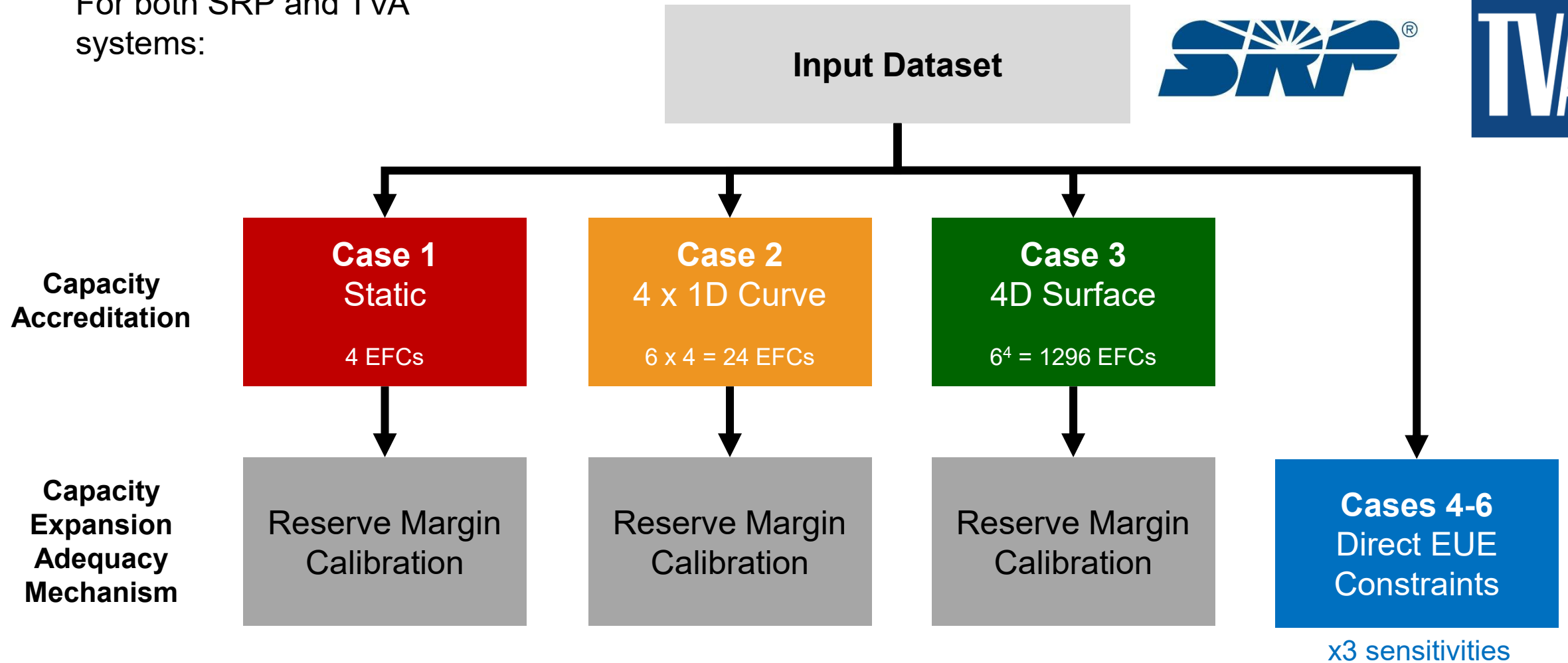
For clarity, example shown is for a single-dimensional expansion problem: real applications generalize this into a multidimensional EUE surface (one input dimension per thermal generation class, wind/solar site, storage capacity, storage energy, transmission, etc)

**Previous approach:** "Endogenizing probabilistic resource adequacy risks in deterministic capacity expansion models", <https://ieeexplore.ieee.org/abstract/document/10667201>

**Related cutting planes work:** "Iterative Portfolio Optimization", Elaine Hart / Sylvan Energy Analytics, [https://gridlab.org/wp-content/uploads/2024/12/GridLab-Sylvan\\_Iterative-Portfolio-Optimization.pdf](https://gridlab.org/wp-content/uploads/2024/12/GridLab-Sylvan_Iterative-Portfolio-Optimization.pdf)

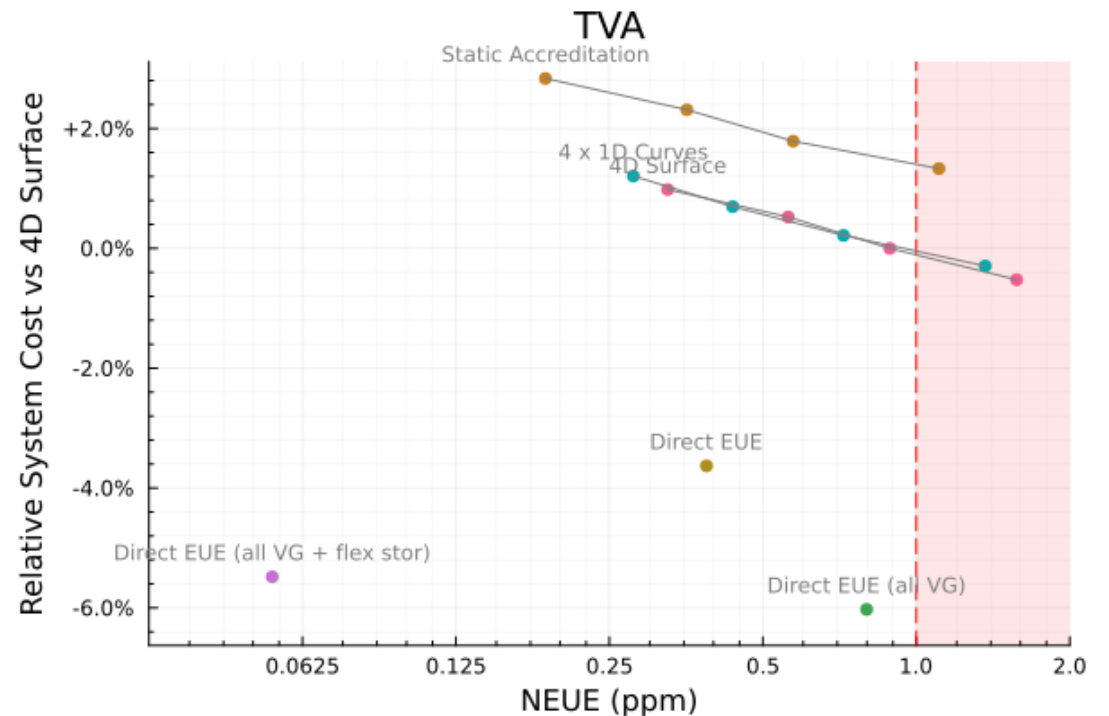
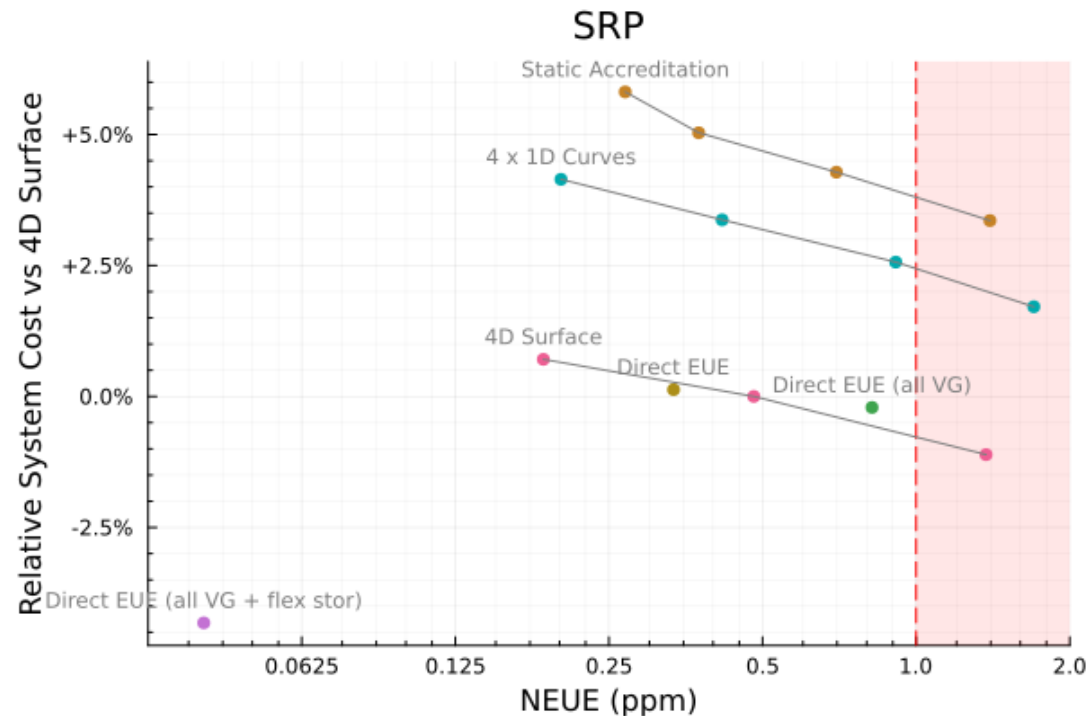
# Utility Case Studies

For both SRP and TVA systems:



# Cost vs Reliability Performance

In both SRP and TVA case studies, the Direct EUE method yields **similar or better system costs** for the same level of reliability, relative to the capacity credit-based methods



# Computational Performance

In both SRP and TVA case studies, the Direct EUE method identifies a cost-effective, resource adequate generation portfolio in **30-60 seconds**, without any capacity accreditation or preprocessing steps

- At 100,000 samples per RA run x 10-15 runs, each capacity accreditation bisection takes 30-45 minutes; Direct EUE results can be produced in a small fraction of the time it takes to perform a *single* capacity accreditation to the required precision for use in optimization surfaces
- Populating a 4D capacity credit surface requires accrediting 1296 portfolios per system - requiring **600-1000 hours** of (parallelizable) compute time to preprocess inputs before solving a single capacity expansion (using supercomputer nodes with 104 processor cores each)

# IMPERIAL

# Thank you

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Materials presented here include work performed at the National Laboratory of the Rockies. Additional details of these methods were presented previously at the July 18, 2025 EPRI Resource Adequacy Forum (“*What Does Effective Integration of RA and Capacity Expansion Planning Look Like?*”) <https://www.epri.com/events/e4f4d328-437a-4049-be69-9e700ebe8779>

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