Rethinking the role of capacity expansion modeling

An alternative approach for reliable and economic portfolio design under uncertainty

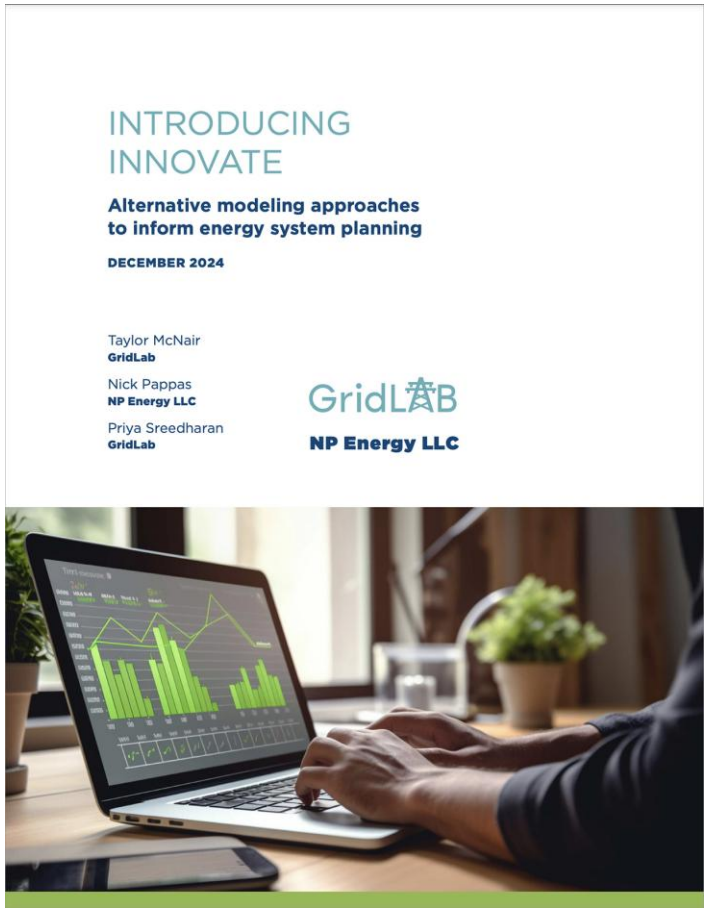
Derek Stenclik

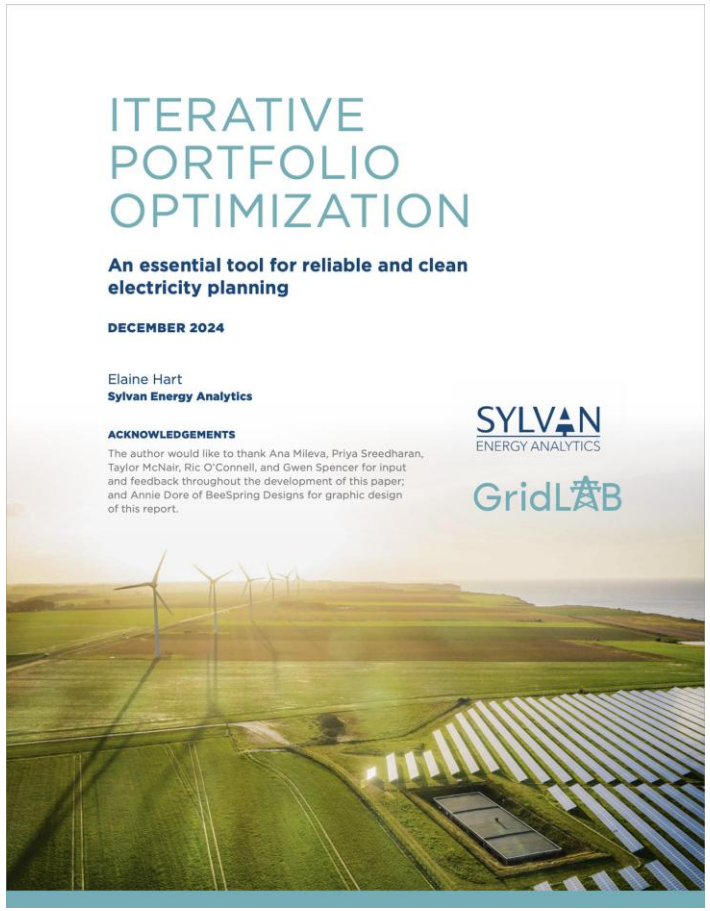
Telos Energy, Inc.

GridLAB

TELOS ENERGY

Innovate: Alternative Modeling Approaches to Inform Power System Planning

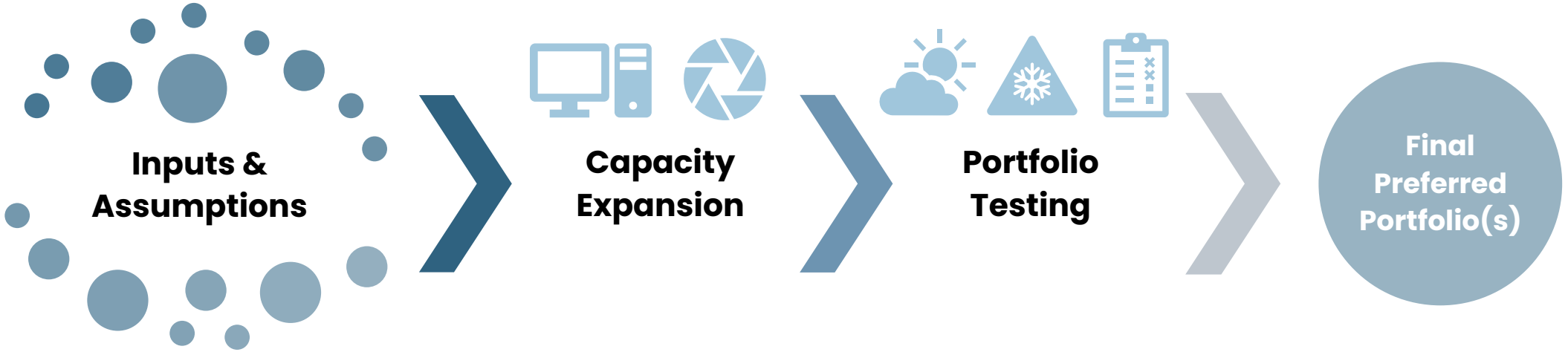




https://gridlab.org/innovate-modeling-series/

Today's process for capacity expansion modeling

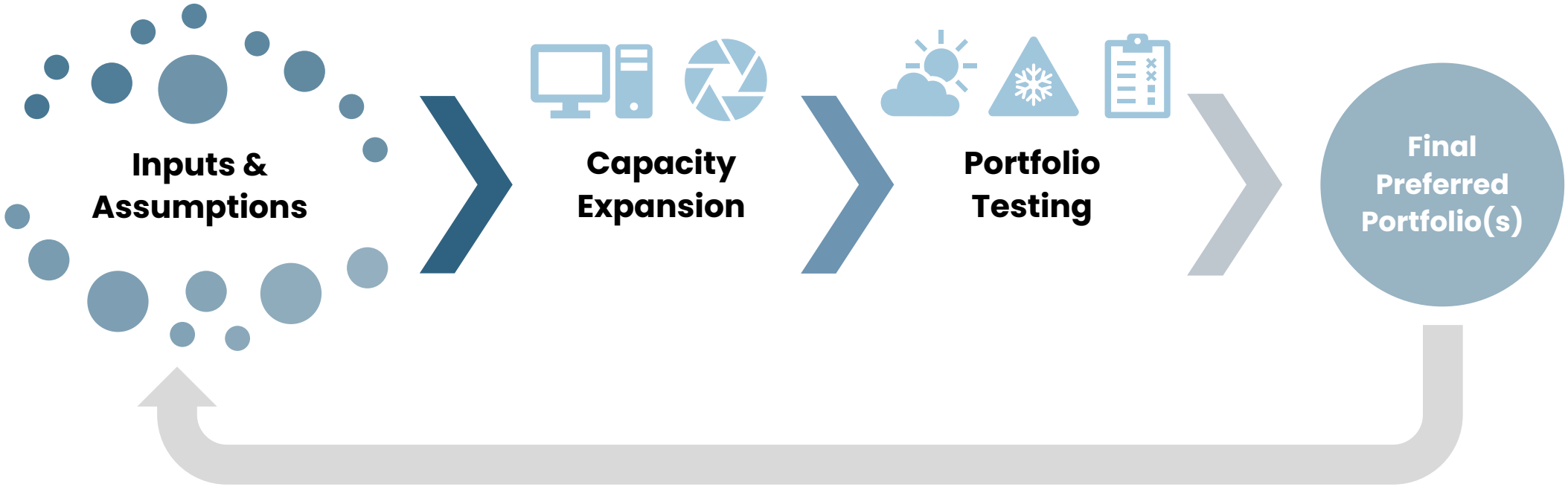
Stakeholder input along the way, but disagreements about inputs lead to disagreements about final preferred portfolios



- Load Forecast
- Fuel Forecast
- Resource Candidates
- Resource Costs
- PRM & ELCC Study
- Retirement Plans

- Production Cost Modeling
- Ex-Post Resource Adequacy
- Transmission Needs

Inputs and assumptions are not static, by the time we finish, they need to be updated.



After successfully getting through the process, we're left with a handful of potential portfolios, but the inputs and assumptions have changed by the time we finish

Alternative Portfolio Design

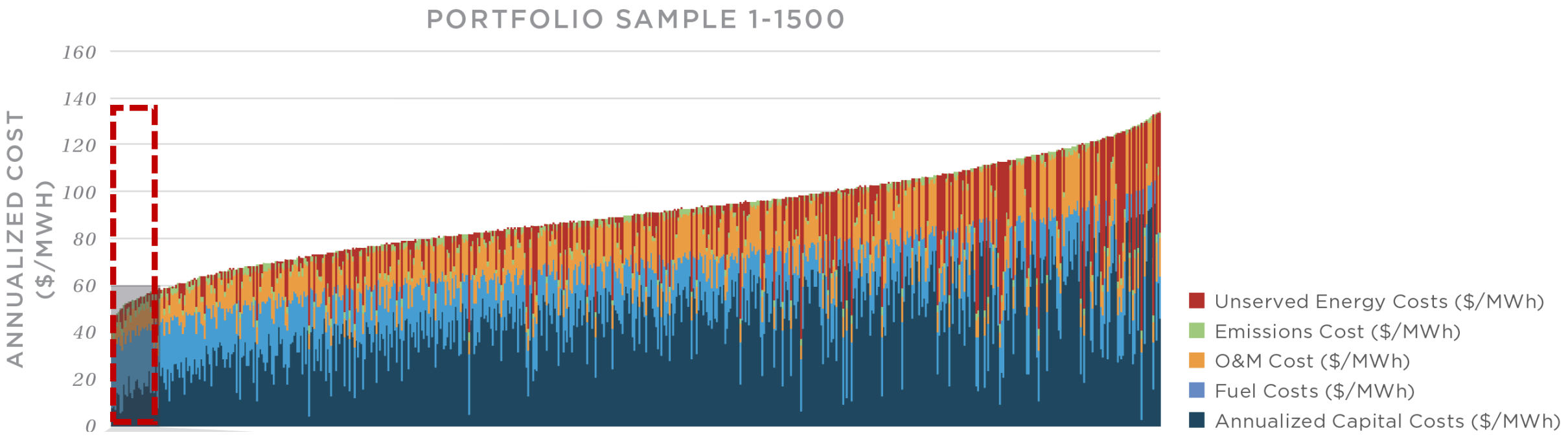
Use alternative portfolio design to evaluate thousands of unique resource portfolios for future power system planning, and adjust assumptions ***after*** model runs

- ✓ **Faster**
- ✓ **More transparent**
- ✓ **Multiple objectives**
- ✓ **Robust to uncertainty**
- ✓ **Accessible**

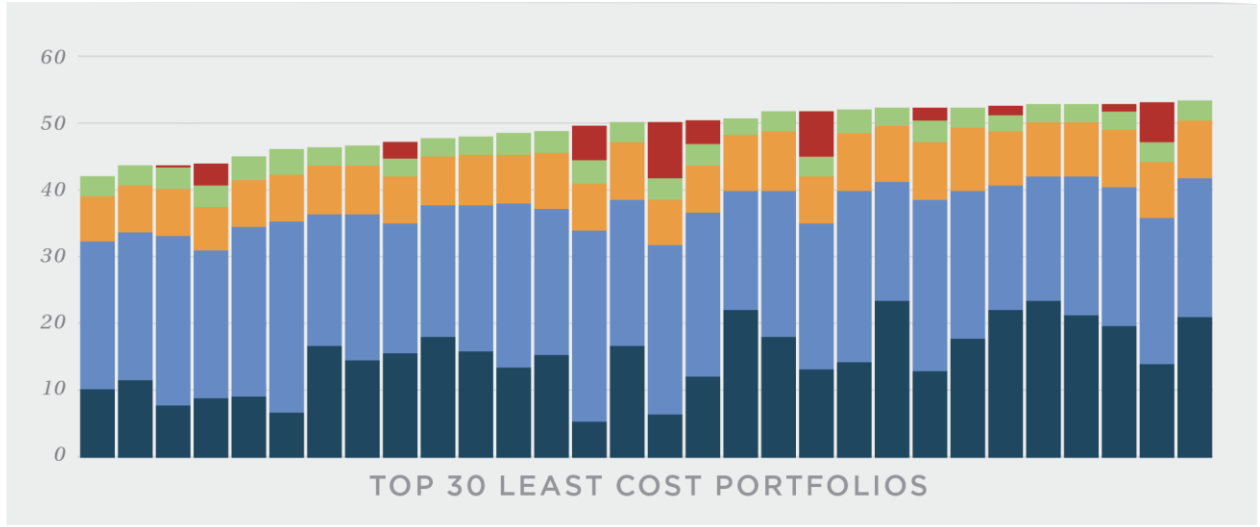
An alternative approach for reliable and economic portfolio design under uncertainty

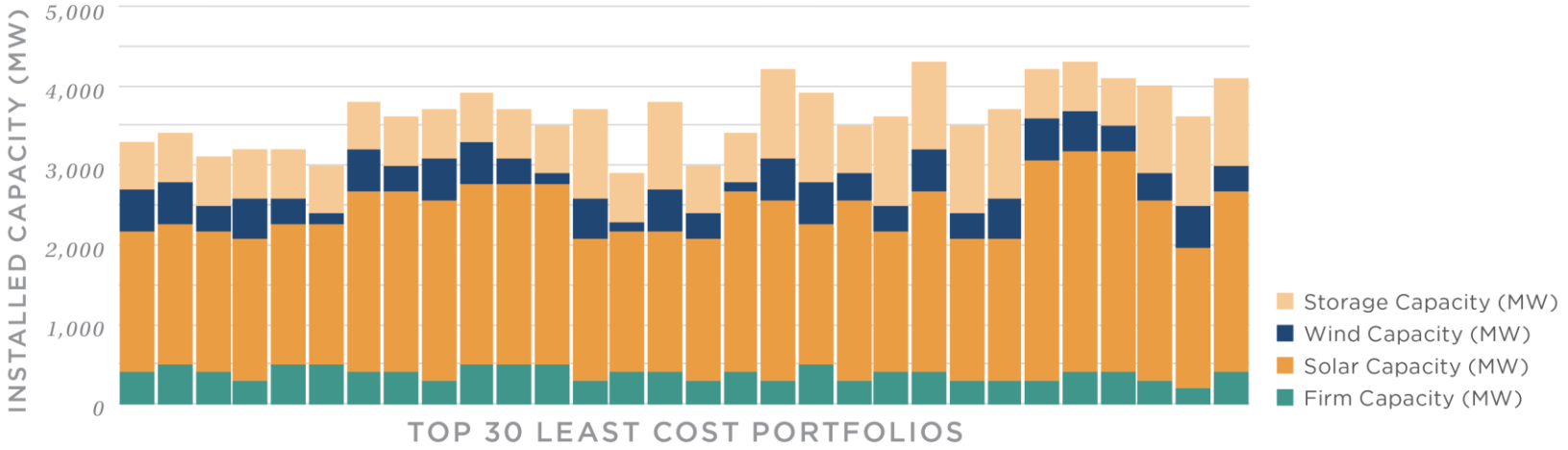
STEP 1	Develop select baseline model years (e.g., 2030, 2040, 2050)
STEP 2	Identify new resource or specific retirement candidates
STEP 3	Develop hundreds of unique portfolios, either through random sampling of parameter distributions or deterministically
STEP 4	Conduct 8760-hour production cost simulations across multiple weather years
STEP 5	Tabulate results and recalculate with different assumptions
STEP 6	Visualize portfolios and make preferred selections

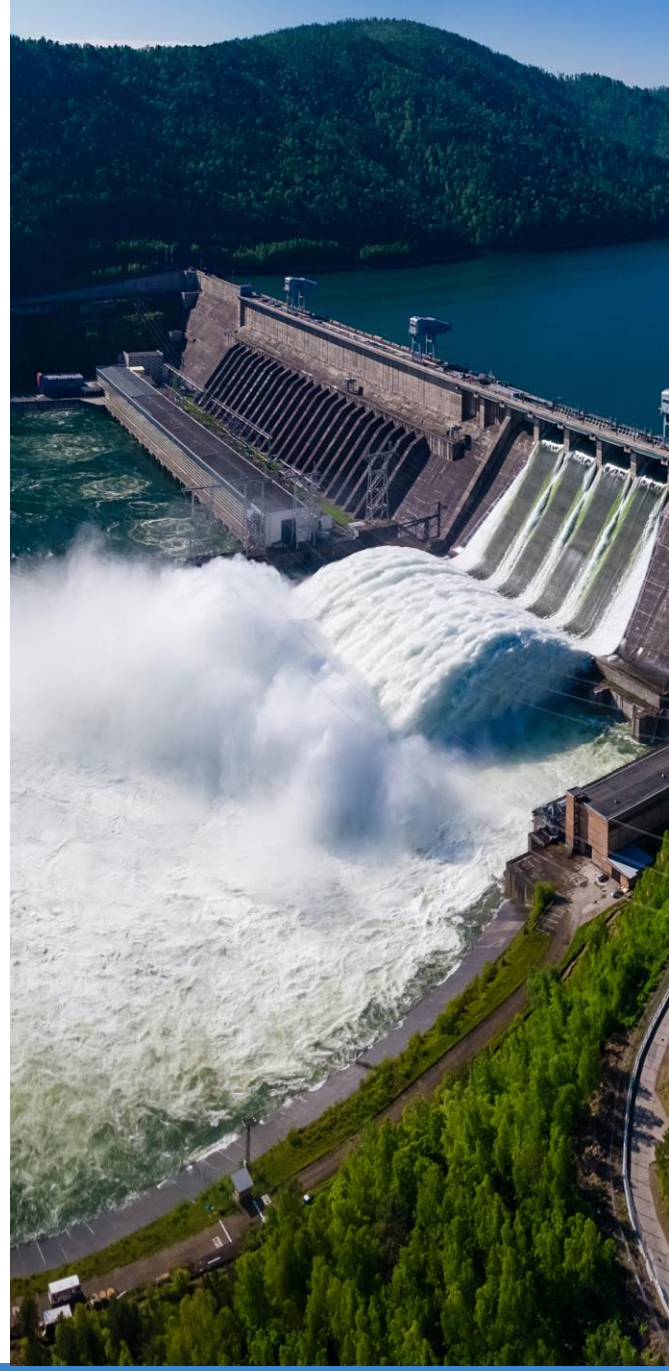
Develop hundreds of unique portfolios and back-calculate costs after the modeling



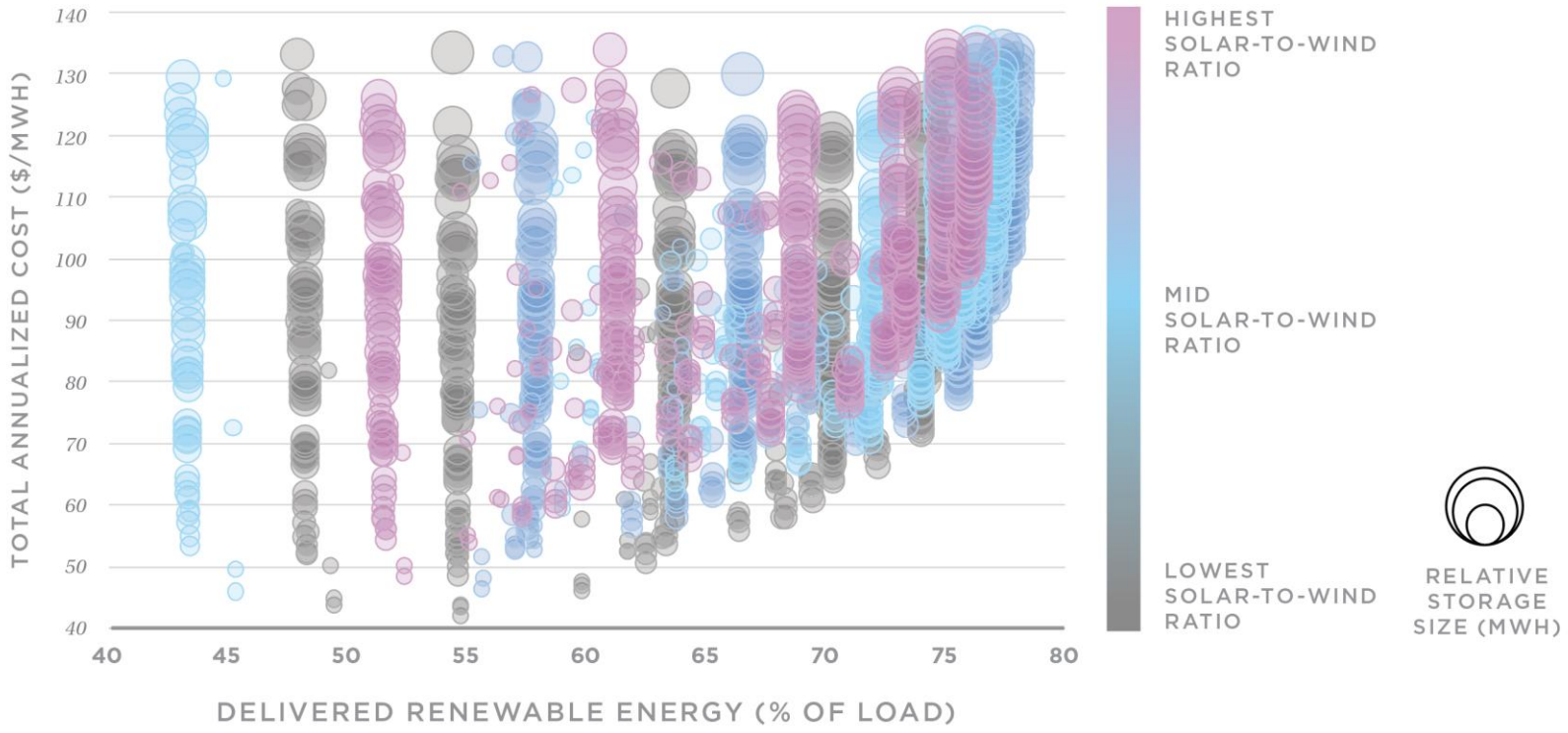
Filter to top performing portfolios,
… Then adjust parameters, and instantly reevaluate low-cost options


60
50
40
30
20
10
0
TOP 30 LEAST COST PORTFOLIOS
Unserved Energy Costs ($/MWh)
Emissions Cost ($/MWh)
O&M Cost ($/MWh)
Fuel Costs ($/MWh)
Annualized Capital Costs ($/MWh)


INSTALLED CAPACITY (MW)
5,000
4,000
3,000
2,000
1,000
0
TOP 30 LEAST COST PORTFOLIOS
Storage Capacity (MW)
Wind Capacity (MW)
Solar Capacity (MW)
Firm Capacity (MW)



This process allows for multi-objective decision making



1

Conventional capacity expansion modeling

Provides a single "cost optimum" portfolio

Alternative Portfolio Design

Provides hundreds or thousands of potential portfolios

- ✓ Captures uncertainty
- ✓ Allows for non-cost portfolio rankings (emissions, land use, diversity)
- ✓ Shows portfolios with very similar, but non minimum cost

2

Conventional capacity expansion modeling

Simplified chronology, transmission, and grid operations

Alternative Portfolio Design

Full 8760 chronological modeling and detailed inputs

- ✓ Less simplification required
- ✓ Full 8760 chronology for variable renewables and storage
- ✓ Can incorporate transmission and detailed operating constraints

3

Conventional capacity expansion modeling

Resource and fuel cost must be determined before modeling

Alternative Portfolio Design

Resource and fuel costs are exogenous to the model

- ✓ Allows for sensitivity analysis on key assumptions and uncertainty
- ✓ Does not require year(s) long stakeholder process
- ✓ Stakeholders can use their own inputs and assumptions
- ✓ Allows for flexible changes to policy (ITC/PTC changes) or technology

4

Conventional capacity expansion modeling

Utility-led modeling only, stakeholders can only review outputs

Alternative Portfolio Design

Allows for efficient and collaborative stakeholder process

- ✓ Better stakeholder-utility interaction, less work on both sides
- ✓ Utility can run simulations and provide a simplified tool to stakeholders to develop their own portfolios
- ✓ Stakeholders can filter and sort portfolios by non-cost objectives (land use, renewables, technology exclusions, emissions, etc.)

5

Conventional capacity expansion modeling

Optimization is computationally challenging

Alternative Portfolio Design

Parallelization > Optimization

- ✓ Stochastic processes are better suited for parallel computing
- ✓ Can split simulations across hundreds or thousands of CPU cores
- ✓ Easily compare results across a wide range of scenarios/sensitivities

6

Conventional capacity expansion modeling

Requires a PRM and multi-dimensional ELCC surfaces

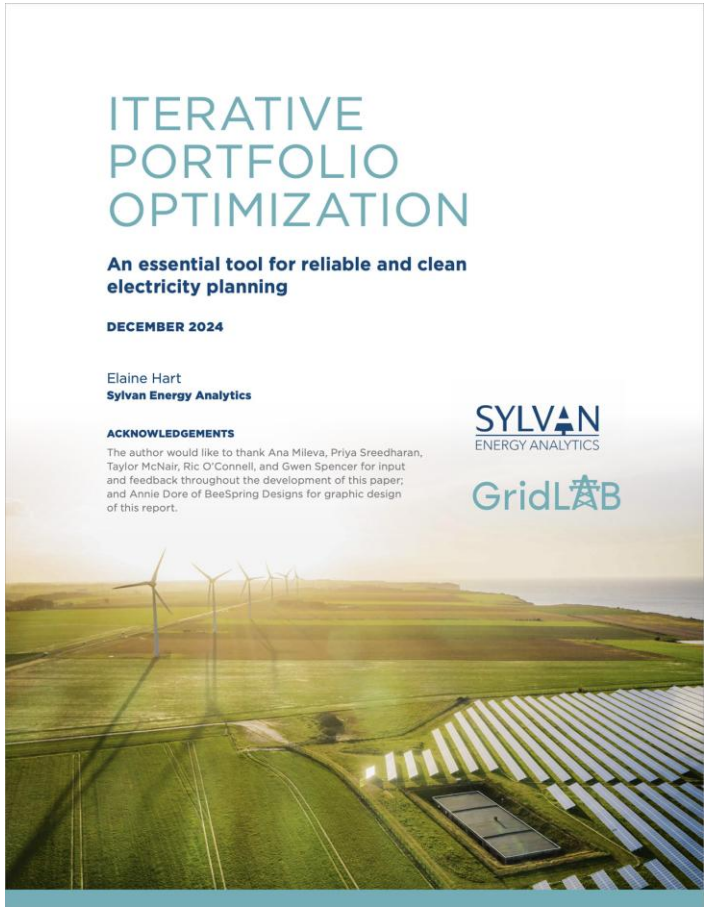
Alternative Portfolio Design

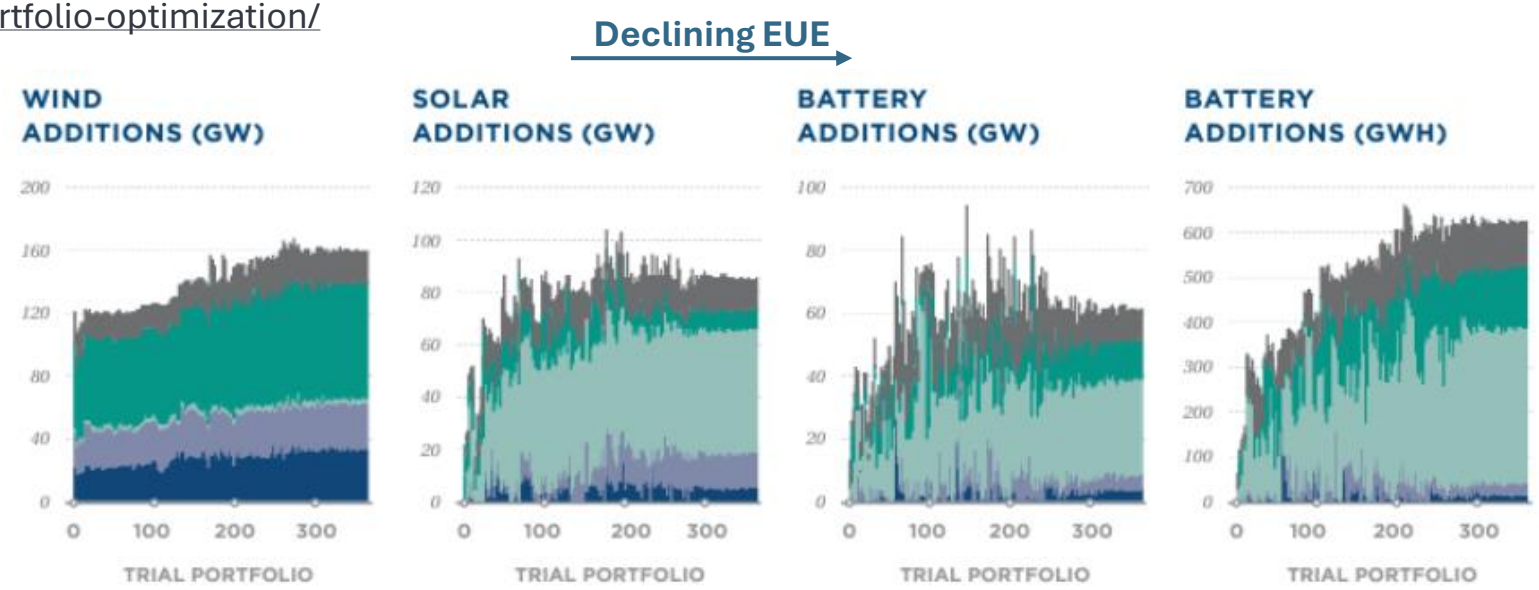
Directly incorporates loss of load risk

- ✓ Does not use PRM or ELCC
- ✓ 8760-hour, chronological dispatch across multiple weather years
- ✓ Includes loss of load as a variable that can be priced by VoLL or filtered out
- ✓ Model is easily reconfigured to run across additional outage draws

Iterative portfolio design with a reliability criterion [Elaine Hart, Sylvan Energy Analytics]

https://gridlab.org/portfolio-item/iterative-portfolio-optimization/

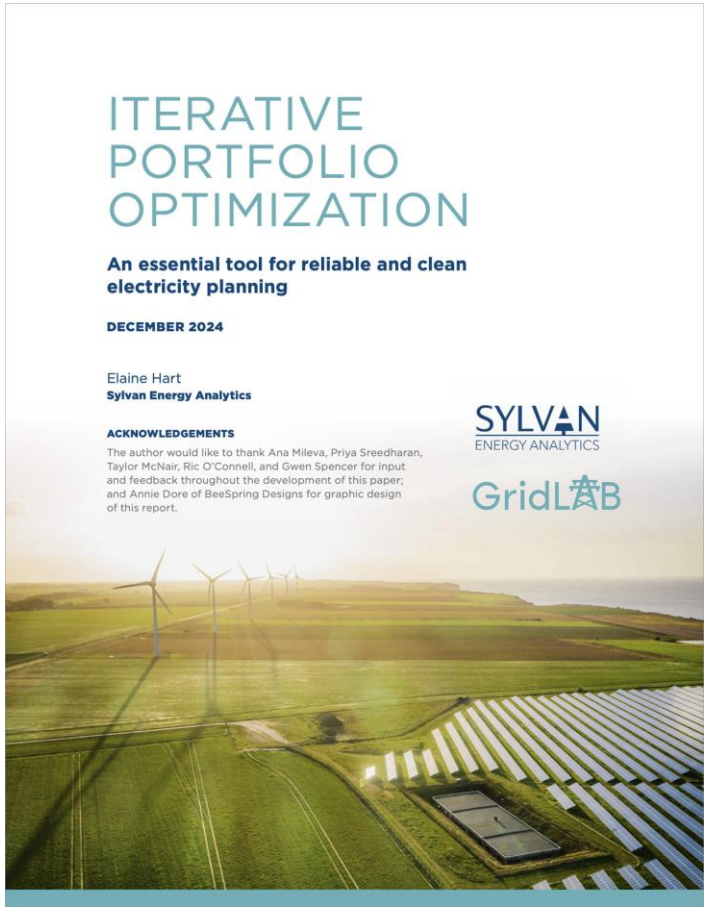


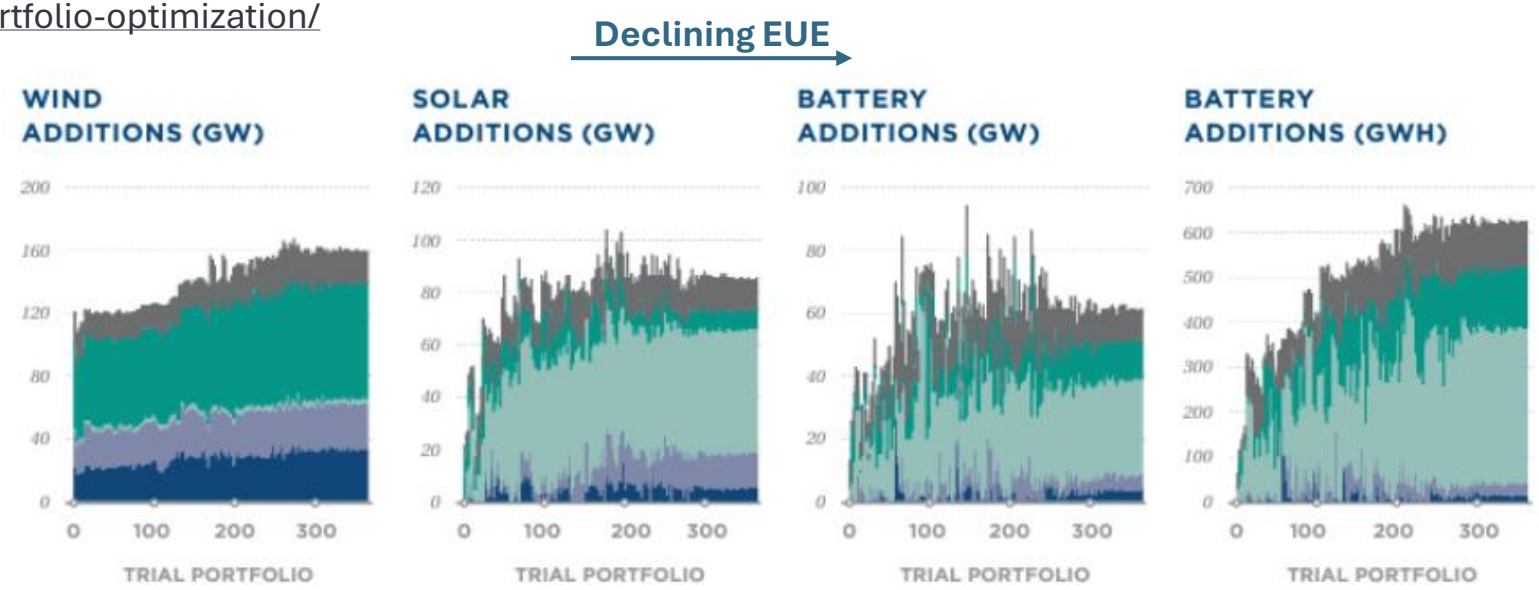


- The model considers an illustrative representation of the Western United States in 2035, all fossil units retired
- The model is allowed to select from 5 different wind resources, 5 different solar resources, and 5 different storage resources (independently selecting the MW and MWh of storage)
- Algorithm must find the least cost portfolio that achieves a target amount of expected unserved energy (EUE) across 100 years of potential weather

Iterative portfolio design with a reliability criterion [Elaine Hart, Sylvan Energy Analytics]

https://gridlab.org/portfolio-item/iterative-portfolio-optimization/





- The model considers an illustrative representation of the Western United States in 2035, all fossil units retired
- The model is allowed to select from 5 different wind resources, 5 different solar resources, and 5 different storage resources (independently selecting the MW and MWh of storage)
- Algorithm must find the least cost portfolio that achieves a target amount of expected unserved energy (EUE) across 100 years of potential weather

Coming Soon!
Open IRP Best Practice Rubric & Reference Guide

GridLAB

TELOS ENERGY

Implementation Options

- **Best** – most comprehensive approach offering greatest detail and accuracy, but often greatest computational and/or data requirements.
- **Better** – balances detail and accuracy with computational and/or data requirements.
- **Good** – sacrifices detail and accuracy, but is most accessible while still allowing planners to fulfill the best practice area.
- **Neutral** – distinct option(s) to fulfill the best practice area, but not relationally better or worse than other options.
- **Emerging** – new or emerging methodologies that shows promise to advance meaningful improvements in planning.

Try it out for yourself,
telos.energy/demo

Thank you!

Derek Stenclik
derek.stenclik@telos.energy

TELOS ENERGY