

Rethinking the role of capacity expansion modeling

An alternative approach for reliable and economic portfolio design under uncertainty

Derek Stenclik

Telos Energy, Inc.

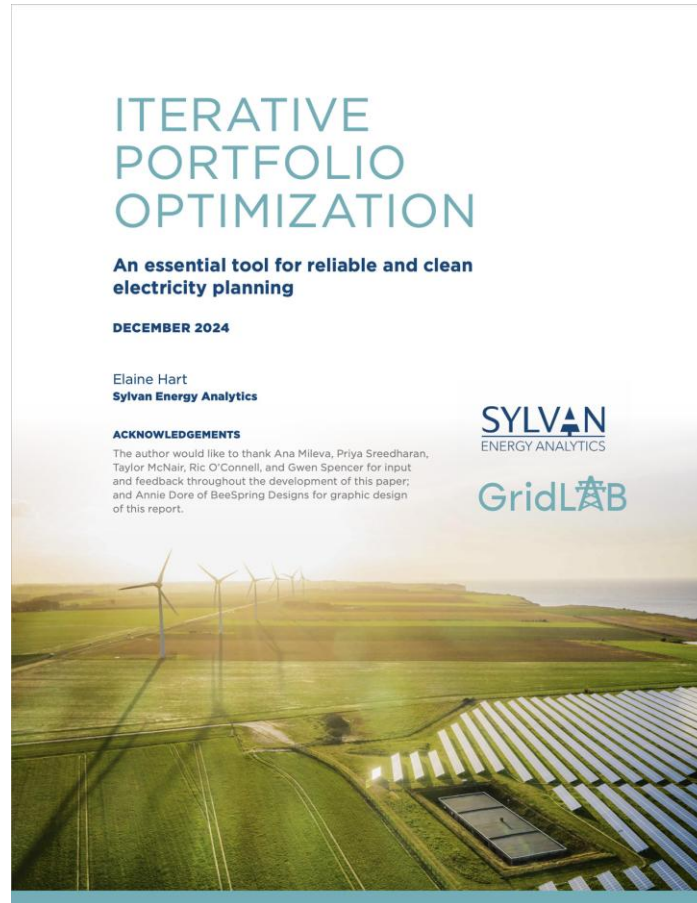
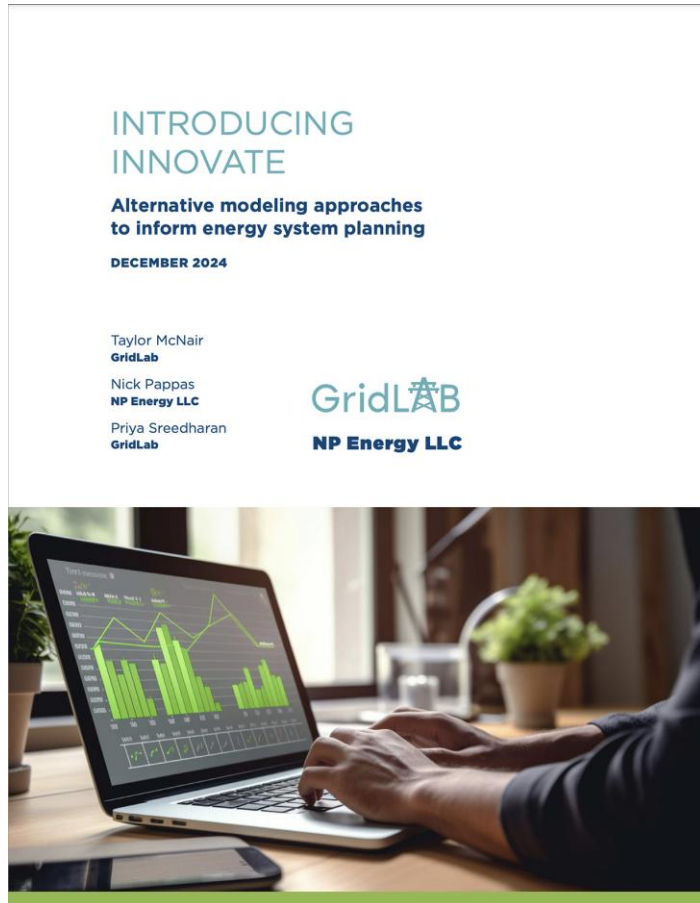
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T E L O S E N E R G Y



Innovate: Alternative Modeling Approaches to Inform Power System Planning



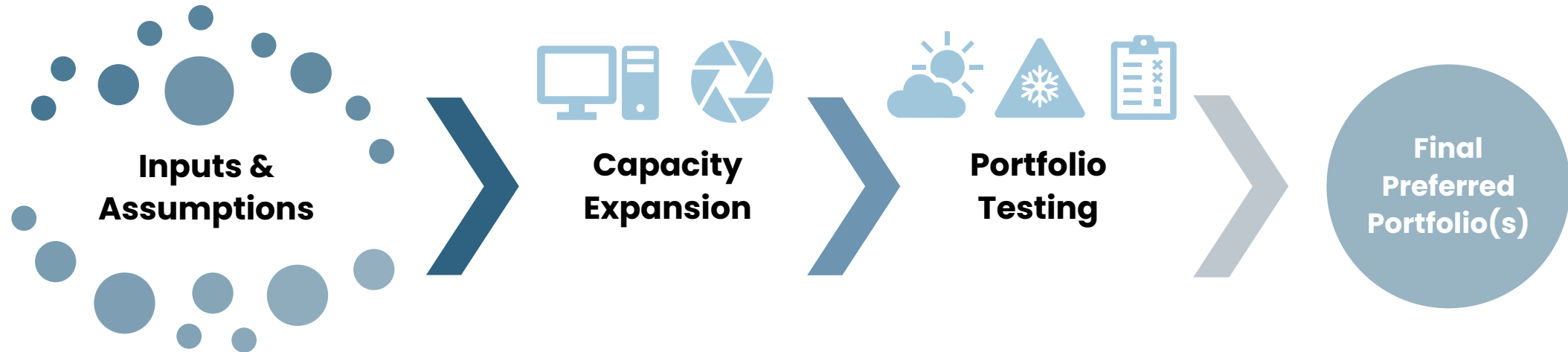
<https://gridlab.org/innovate-modeling-series/>



Today's process for capacity expansion modeling



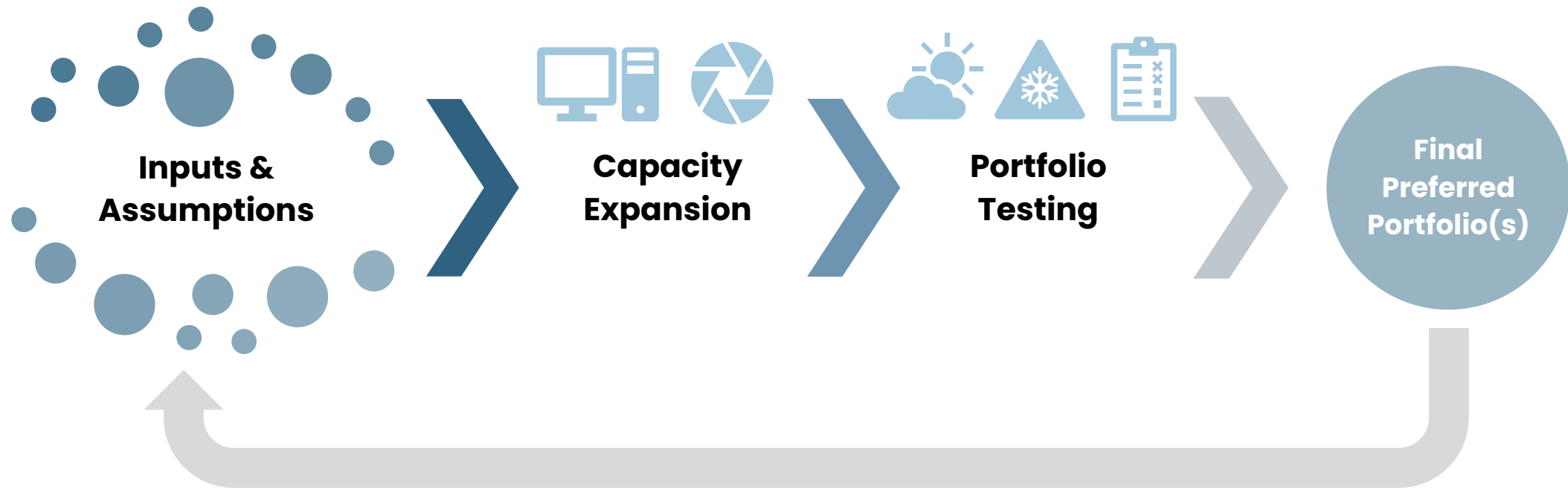
Stakeholder input along the way, but disagreements about inputs lead to disagreements about final preferred portfolios



- 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

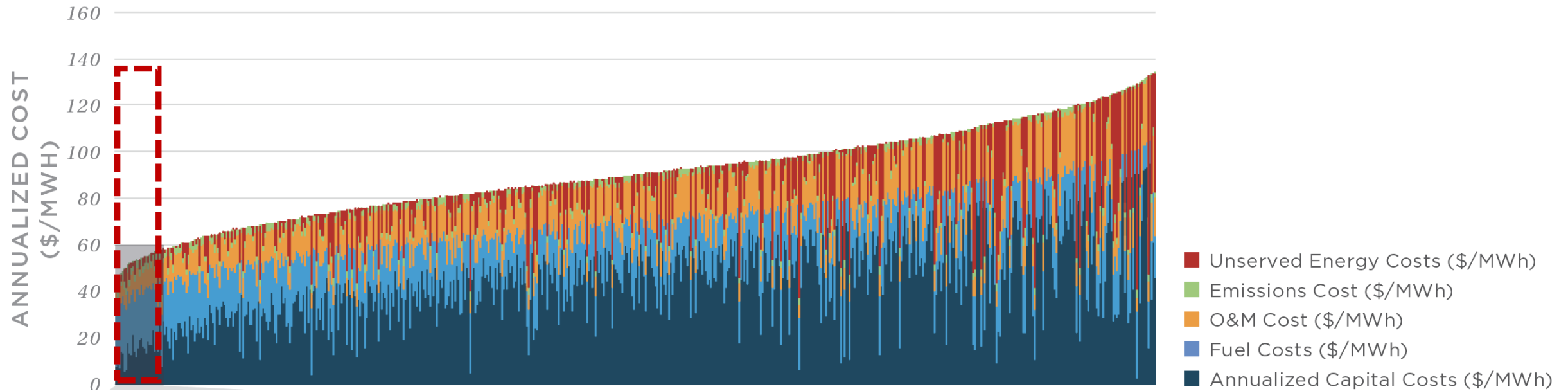
Tabulate results and recalculate with different assumptions

STEP 6

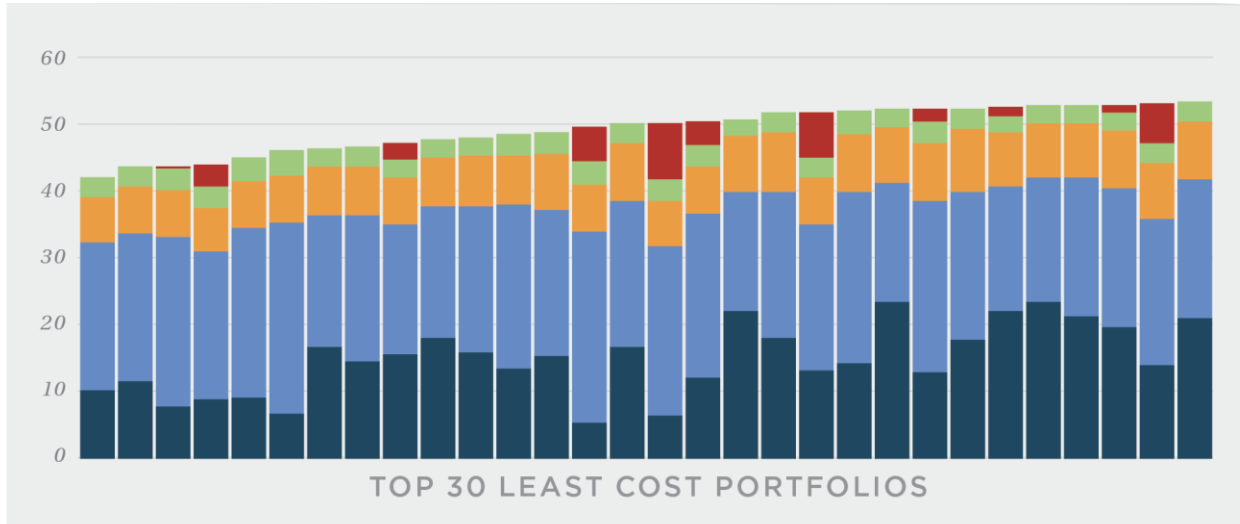
Visualize portfolios and make preferred selections

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

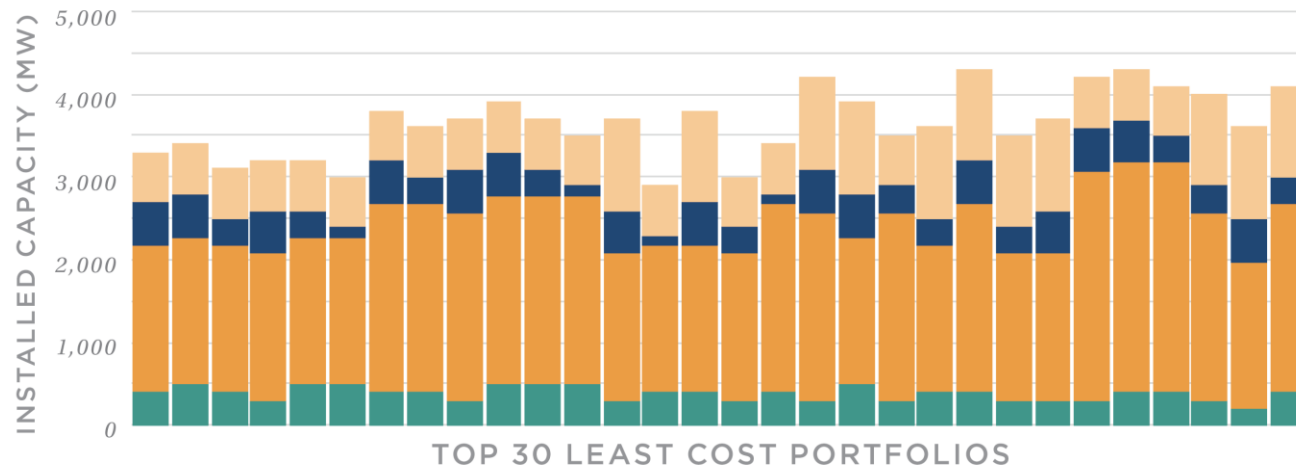
PORTFOLIO SAMPLE 1-1500



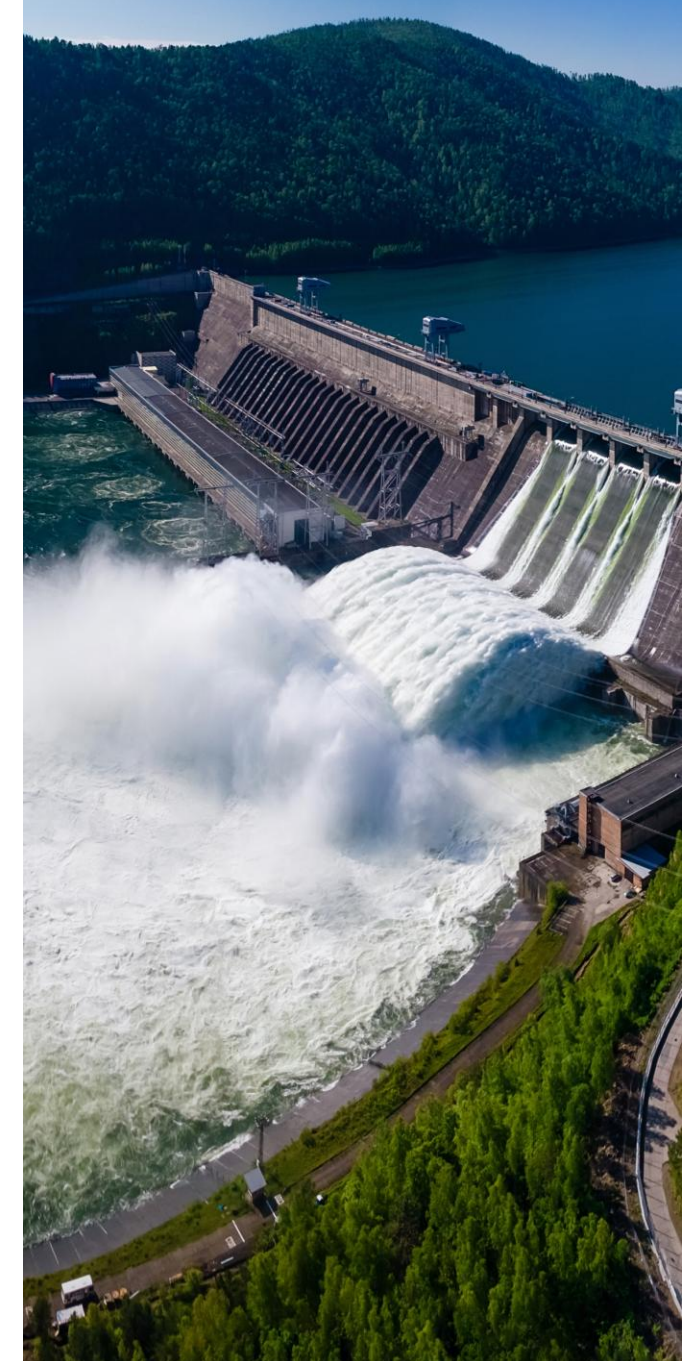
Filter to top performing portfolios,
... Then adjust parameters, and instantly reevaluate low-cost options



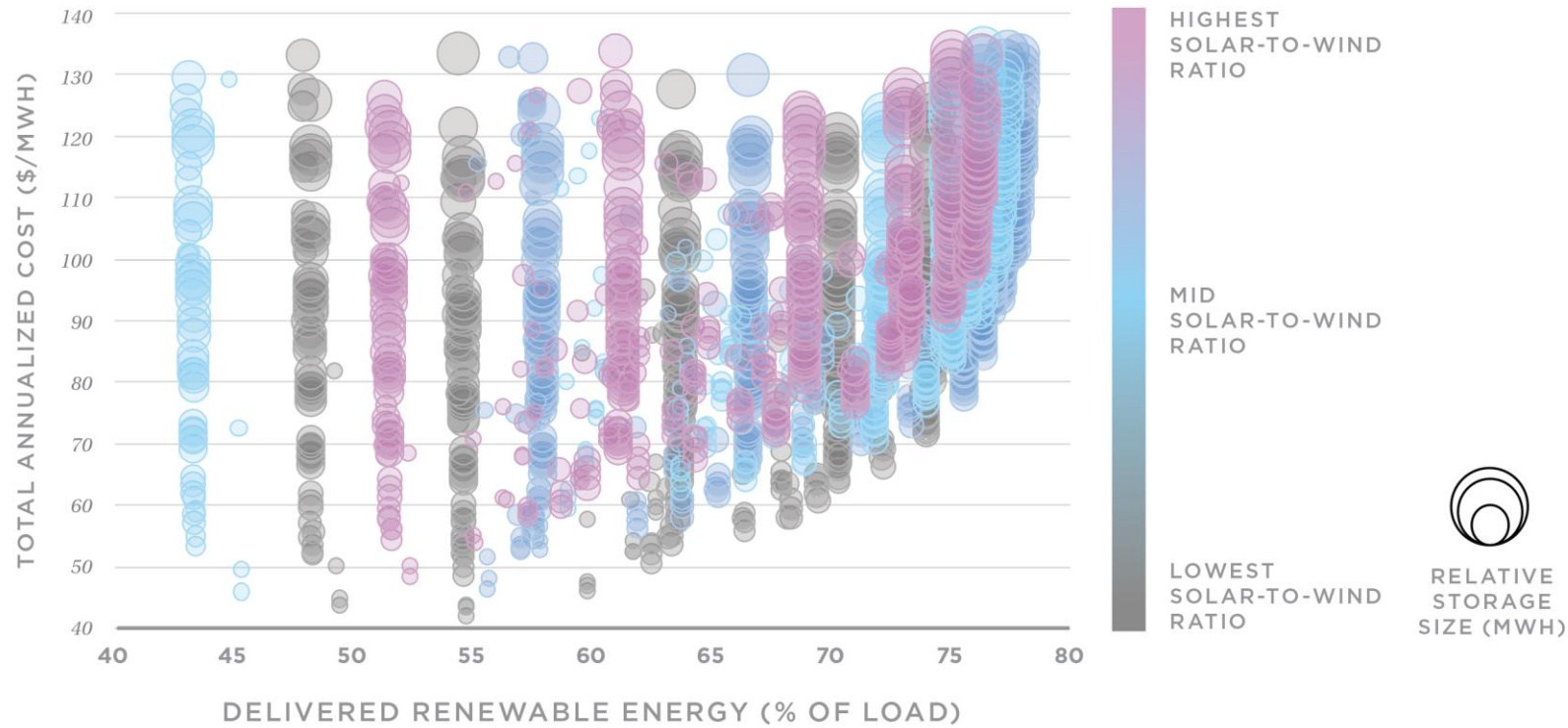
- Unserved Energy Costs (\$/MWh)
- Emissions Cost (\$/MWh)
- O&M Cost (\$/MWh)
- Fuel Costs (\$/MWh)
- Annualized Capital Costs (\$/MWh)



- Storage Capacity (MW)
- Wind Capacity (MW)
- Solar Capacity (MW)
- Firm Capacity (MW)



This process allows for multi-objective decision making





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

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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

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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

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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.)

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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

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Conventional
capacity expansion
modeling

**Requires a PRM and
multi-dimensional
ELCC surfaces**

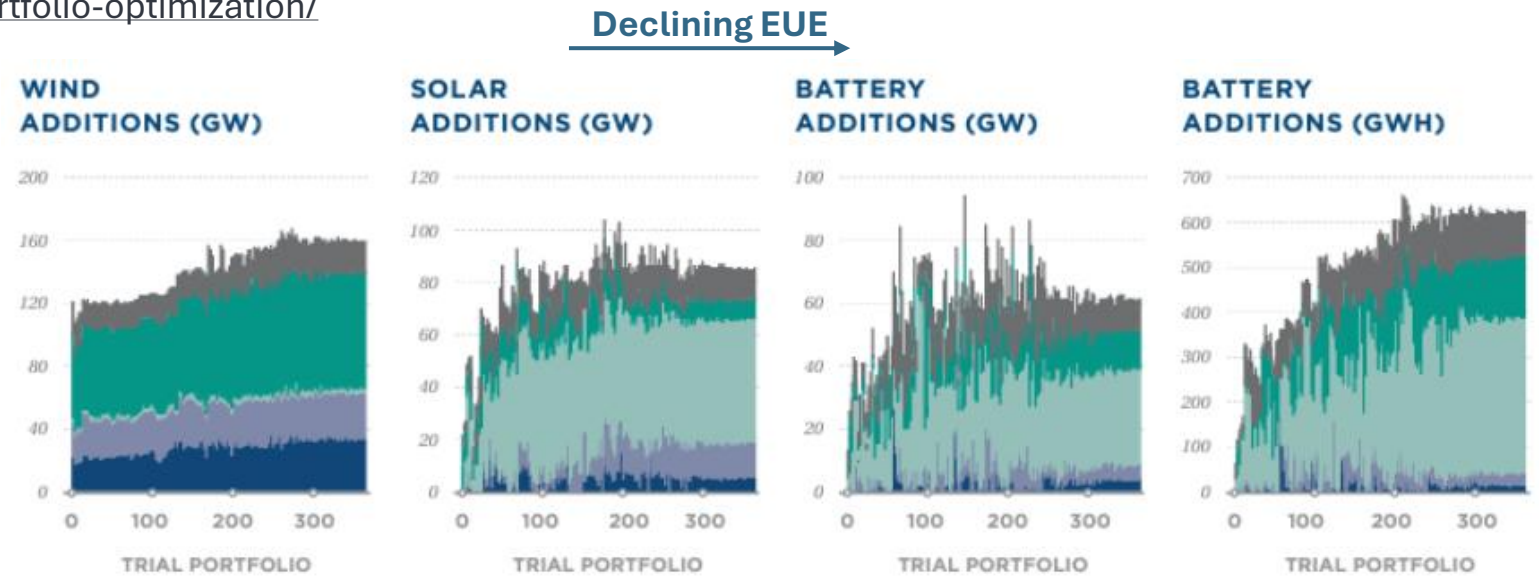
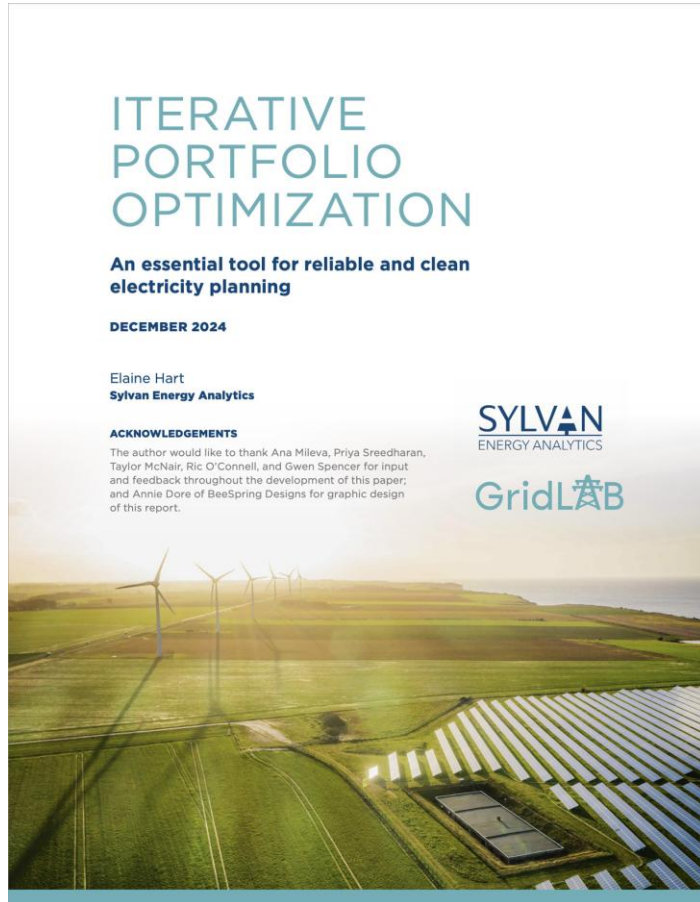
Alternative Portfolio Design

**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

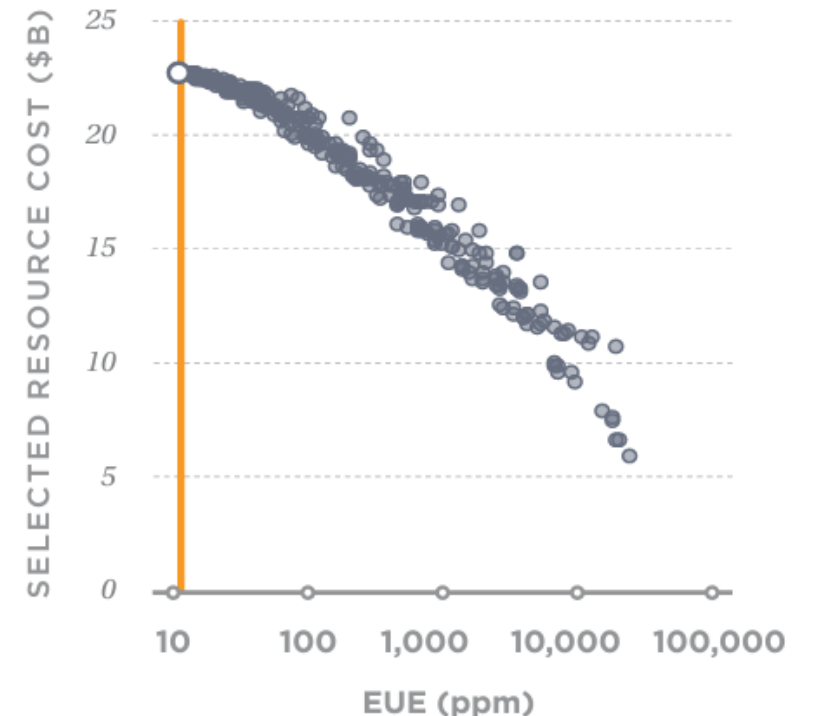
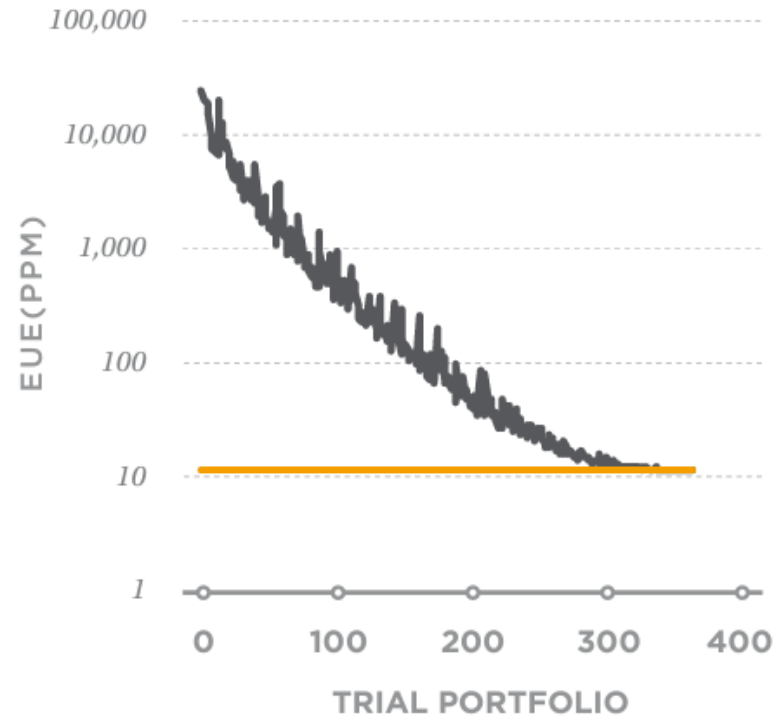
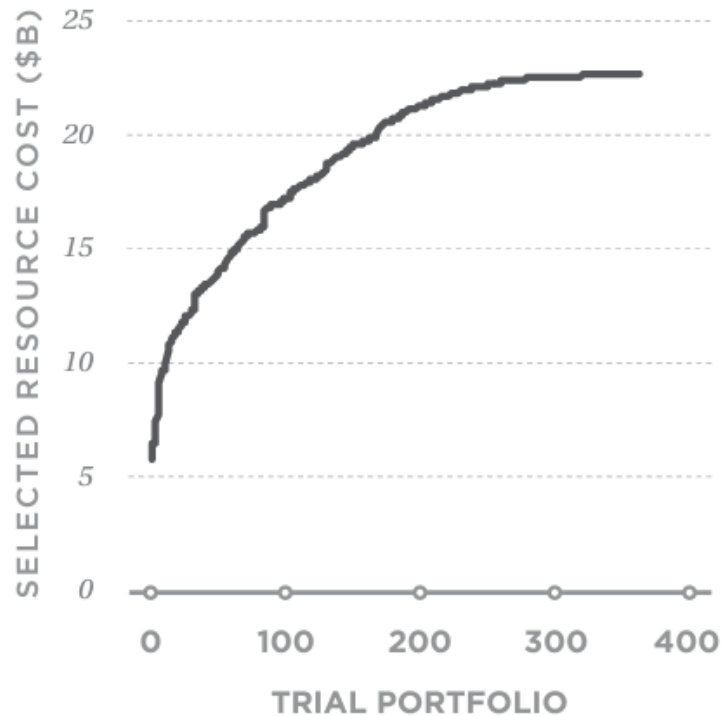
Iterative portfolio design with a reliability criterion [Elaine Hart, Sylvan Energy Analytics]

<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

Exploring the tradeoff between reliability and cost



● Trial portfolios ● Optimized portfolio — Target EUE

Try it out for yourself,
telos.energy/demo

Thank you!

Derek Stenclik

derek.stenclik@telos.energy



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