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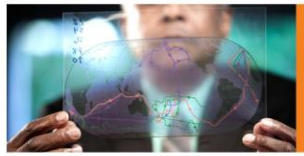

Hedging Supply-Side Risks with Energy Efficiency

Hossein Haeri

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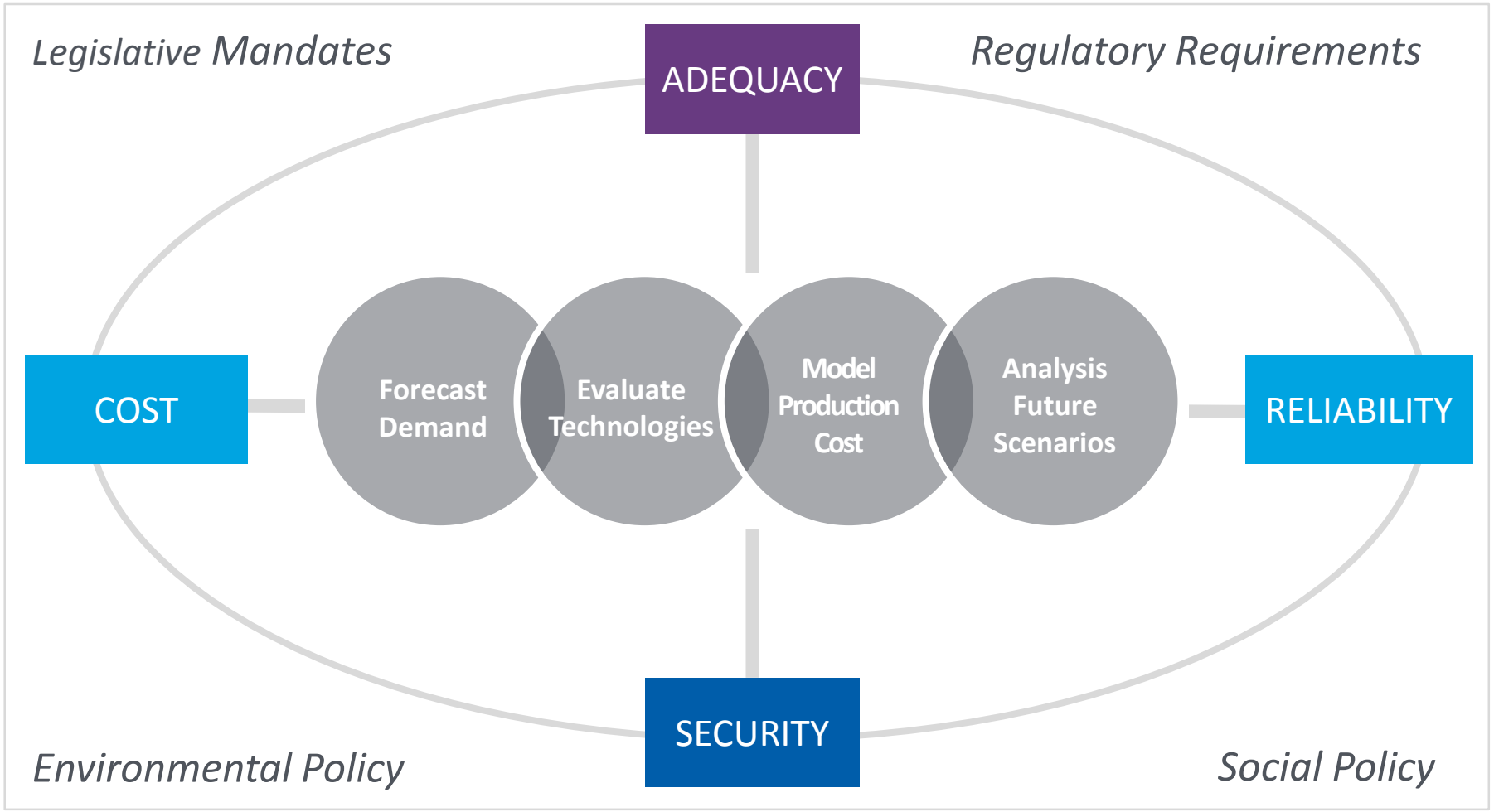
Energy efficiency avoids waste, lowers energy service costs, and helps protects the environment.

Can it also help hedge against fuel price volatility?

Evolution of Utility Resource Planning

EARLY DAYS	1990'S	TODAY…
Least-Cost Planning (LCP)	Integrated Res. Planning (IRP)	Resource Portfolio Planning
Meet demand, minimize production cost, lower revenue requirement	Meet demand, manage costs, broaden resource mix, include unconventional sources	Meet demand, manage cost, manage risk, broaden resource mix, meet broad public policy and environmental objectives, public participation

The Setting of the Modern IRP



Dealing With Uncertainty in IRP

Scenario analysis:

Develop alternative visions of the future, identify appropriate combinations of resources that best fit each future, create a unified plan.

Sensitivity analysis:

Evaluate alternative outcomes by changing key inputs and assumptions.

Probabilistic analysis:

Assign probabilities to different values of key variables and evaluate the expected outcomes – usually as a probability distribution.

Portfolio analysis:

Multiple portfolios (i.e., combinations of future resource options) are developed with each meeting a different set of objective.

Resource Portfolio Planning

Low-cost versus efficiency in portfolio design

Efficient portfolio: minimize expected cost for any given level of risk, while minimizing expected risk for every level of expected cost.

The mean-variance portfolio (MVP) theory:

1) $E(r_p) = X_1 E(r_1) + X_2 E(r_2)$

2) $Var_p = X_1 Var_1 + X_2 Var_2 + X_2 X_2 Cov_{12}$

The basic principles:

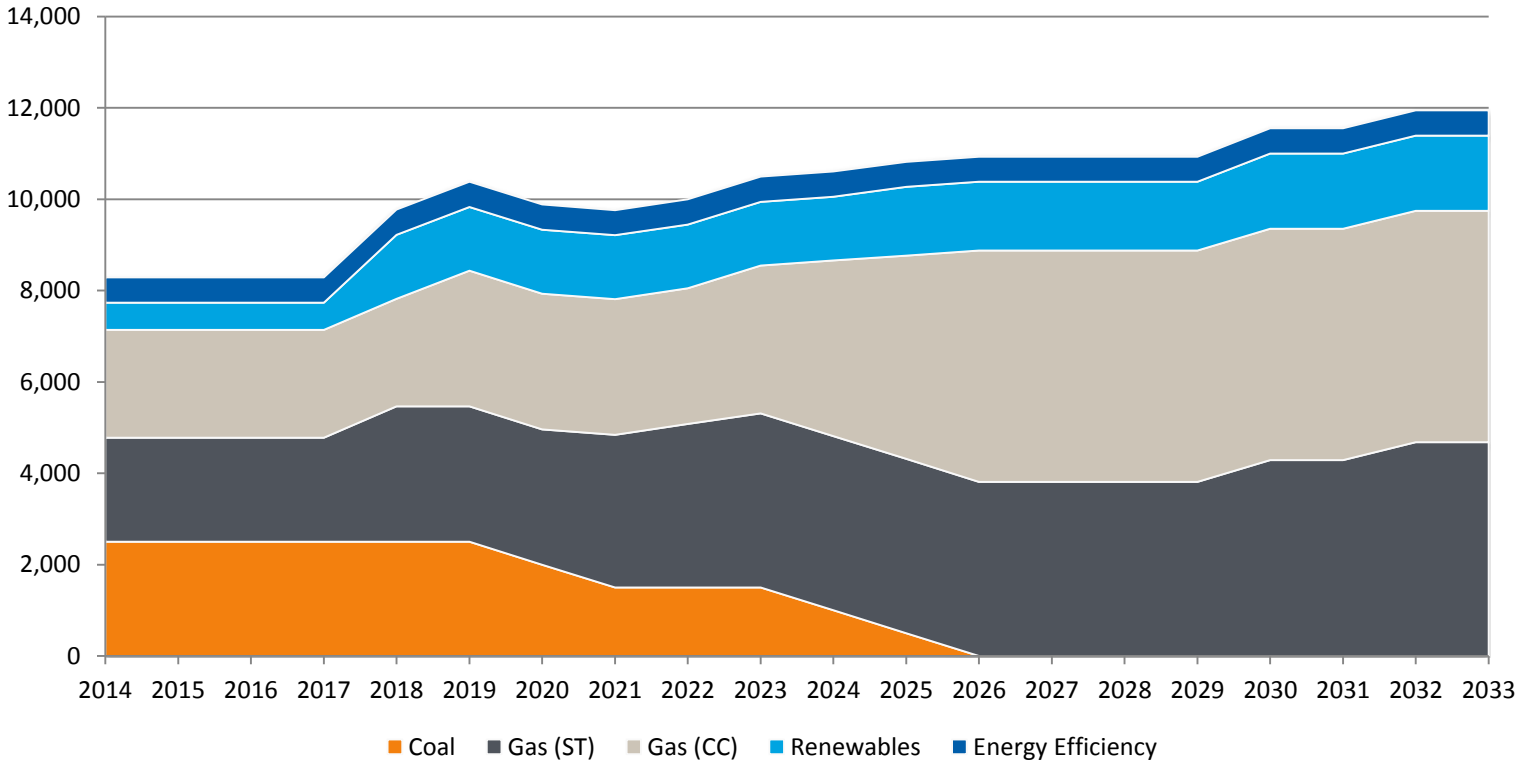
- There is value in certainty.
- Portfolio variance can be reduced by choosing assets with a low or negative correlation.
- Adding assets with a constant cost improves the portfolio's return, even if the initial cost is higher than other assets.

Application to the (Near) Real-World

Hypothetical western utility:

- Coal (30%)
- Natural gas (56%, split between CC and CT units)
- Mix of renewable (7%, including wind, solar, geothermal, hydro, biomass, and waste-heat
- Cost-effective energy efficiency (7%)
- Potential system capacity shortfalls and open positions to be met through market purchases.

Base-Case Resource Stack



Planning Assumptions

Planning horizon: 2014-2033

Base-year operating capacity:

8,300 MW

End-year capacity requirement:

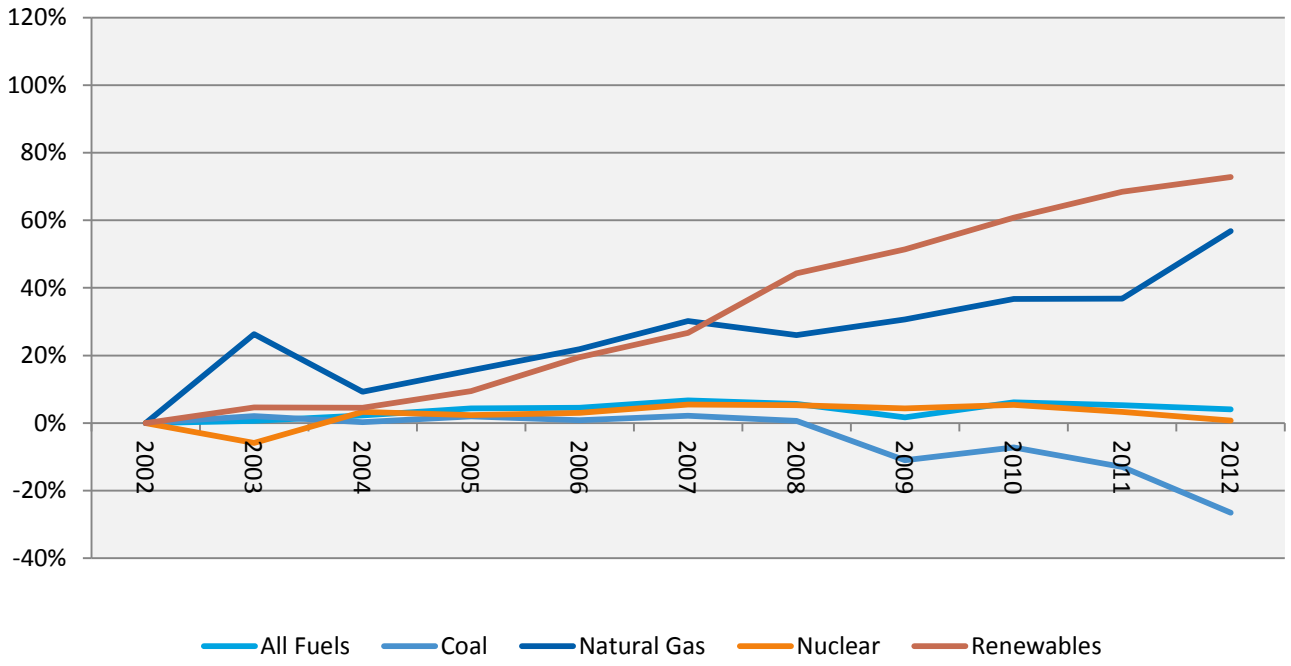
11,950

All coal generation to be retired by 2026, being replaced almost entirely with natural gas generation.

Natural gas generation surges from 4,600 MW to about 9,750 MW to make up 81% of the portfolio's capacity in 2033.

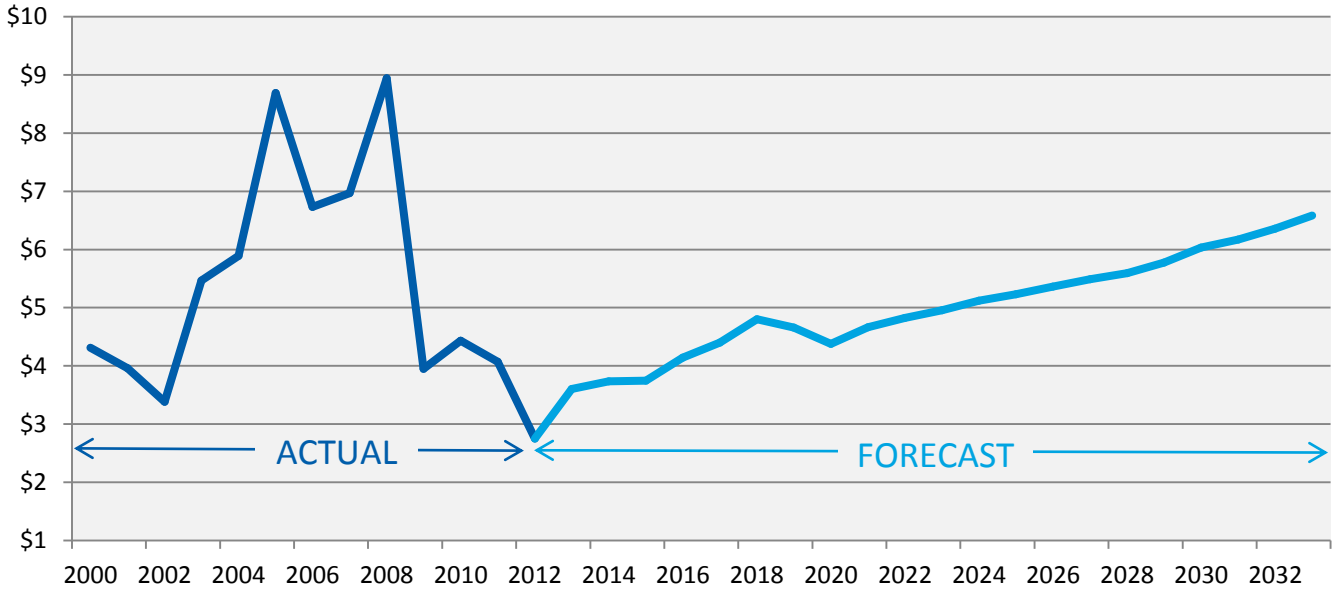
Renewable resources grow from 600 MW in 2014 to 1,400 MW in 2018, and grow gradually to 1,650 MW in 2025, to satisfy Nevada's renewable resource requirement (RPS) of 15%, staying at that level through the end of the planning period.

The Changing Complexion of Electricity Generation Market



Source: Energy Information Administration

Natural Gas Prices – Oracle Speaks



Source: Energy Information Administration

Characterizing Generation

Resource Characteristics:

- Availability
- PV of full life-cycle cost (mainly capital, fuel and O&M)
- Discount rate (weighted average cost of capital (WACC), no variability across resources)

Stochastic variables (ranges):

- Load forecast – high, medium, low
- Coal prices – 20-year historical range of 45% - 250%
- Natural gas prices – 20-year historical range of 70% - 140%
- CO_2 and SO_2 emission costs
- Market electricity prices

Characterizing EE Resources

Availability: expected *savings realization*, a common metric for evaluating performance in EE programs, 65% to 100% of planned values.

Resource cost (CCE): 50% to 250% of the planned cost.

Resource Evaluation Scenarios

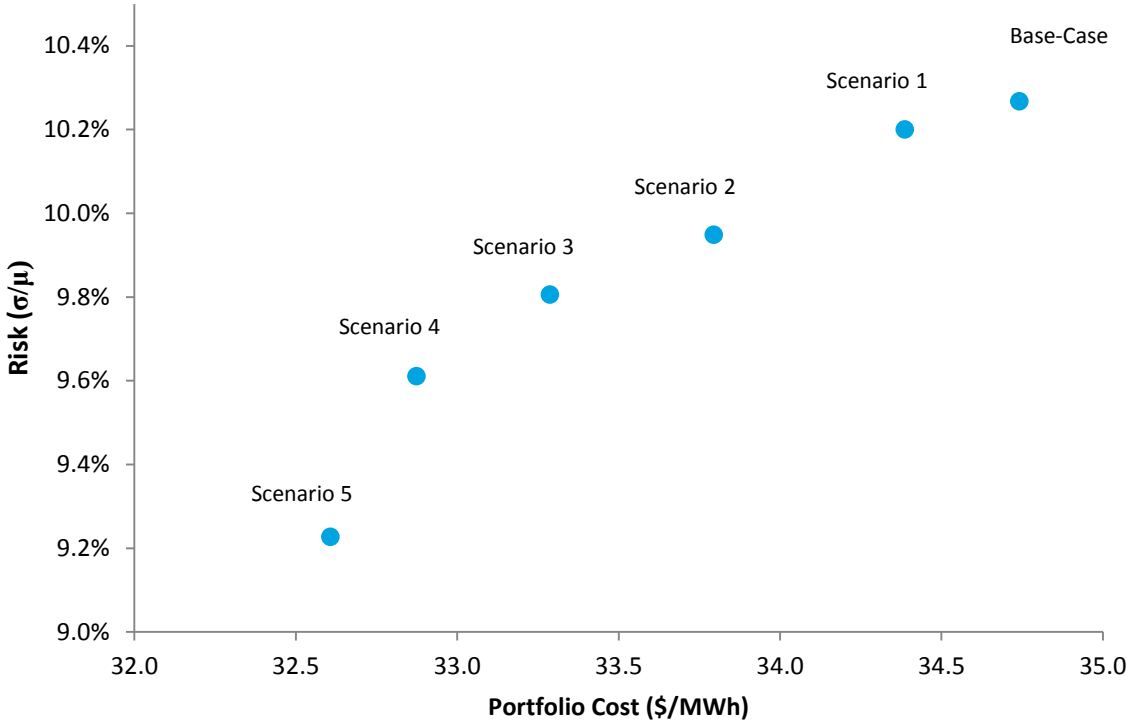
Five scenarios:

- Energy efficiency share:
  - 550 MW (4.5% of portfolio in the base-case)
  - EE progressively replaces natural gas by increments of 250 MW
  - 1,550 MW (12.5%) in the final scenario
  - 1,550 MW (12.5%) in the final scenario

Portfolio performance metrics:

- Per-unit cost of output ($/MWh)
- Risk (coefficient of variation, CV)

EE Measures Up



And So…

Cost-effective EE has the potential to lower portfolio cost and risk (improve return).

Cost-effective EE lowers overall portfolio cost at nearly all tested volumes, but the effect tapers off.

EE helps lower portfolio risk even under conditions of extreme uncertainty in savings realization rates and cost.