Value of Technology in the Electric Power Sector

Full portfolios and advanced technologies lower costs of future emissions reductions in the power sector.

The analysis shows how:

- The costs of future emissions reductions are highly sensitive to the availability and cost of system resources
- No individual technology is necessary, but many will prove useful to create and preserve optionality given uncertainties about the future
- Dispatchable low-carbon resources play a critical decarbonization role
- Impacts can vary by region and by company-specific considerations

Using the U.S. Regional Economy, Greenhouse Gas, and Energy (**US-REGEN**) model, EPRI research examines impacts of technological availability and advanced generation options on electricity market outcomes like generation, costs, and emissions.

Model results suggest that policy costs are significantly higher as technological options are removed from consideration, as shown in Figure 1 (left). For a 95% CO_2 cap by 2050, incremental compliance **costs are roughly twice as high with a "limited" portfolio** (i.e., without new nuclear, carbon-capture-equipped units, or transmission) compared with a "full" portfolio. The economic and technical implications of limited portfolios depend on which technologies are removed as well as the costs and capabilities of the remaining options.

Additionally, the analysis quantifies how RD&D-induced technological advances can lower the costs of emissions reductions (right panel of Figure 1). These **advanced generation options drive down costs by at least 70%** relative to the full portfolio scenario.

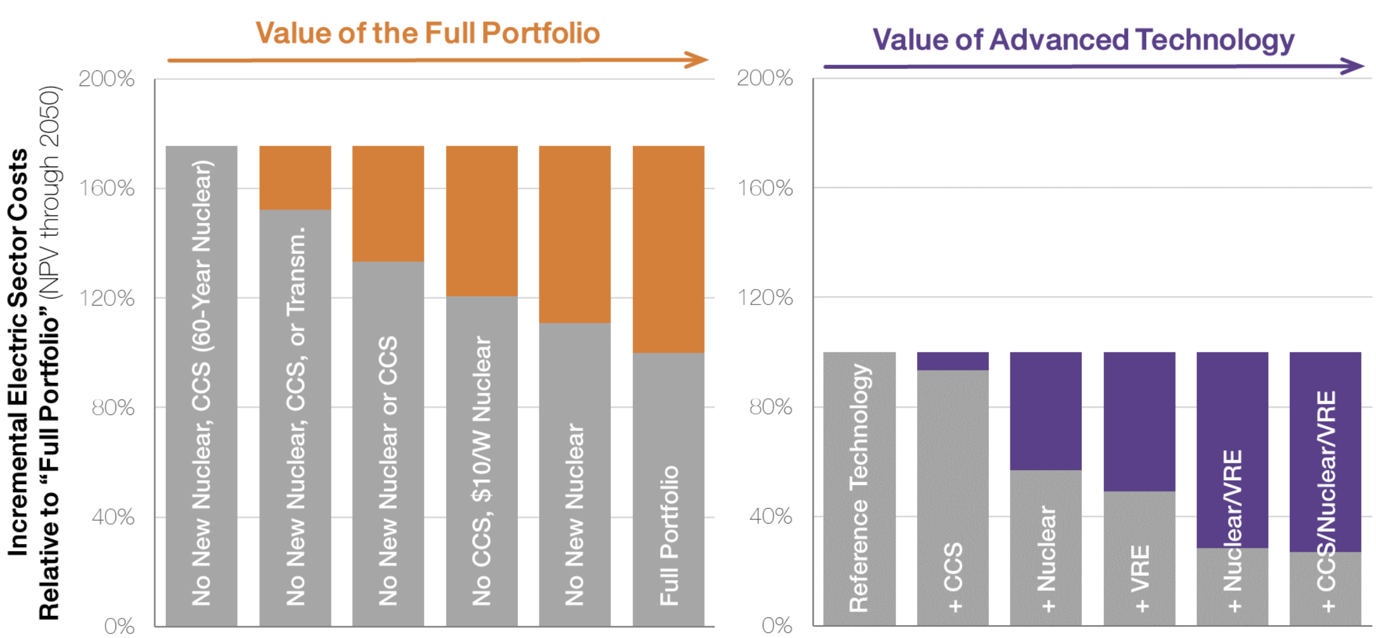

Figure 1: Change in the net present value (NPV) of electric sector costs (including capital, fuel, O&M, transmission) under a 95% CO_2 cap by 2050 relative to a "Full Portfolio" reference. The scenarios show the cost impact of limited portfolios (left) and advanced technology RD&D (right). Results come from analysis using the US-REGEN model (http://eea.epri.com).

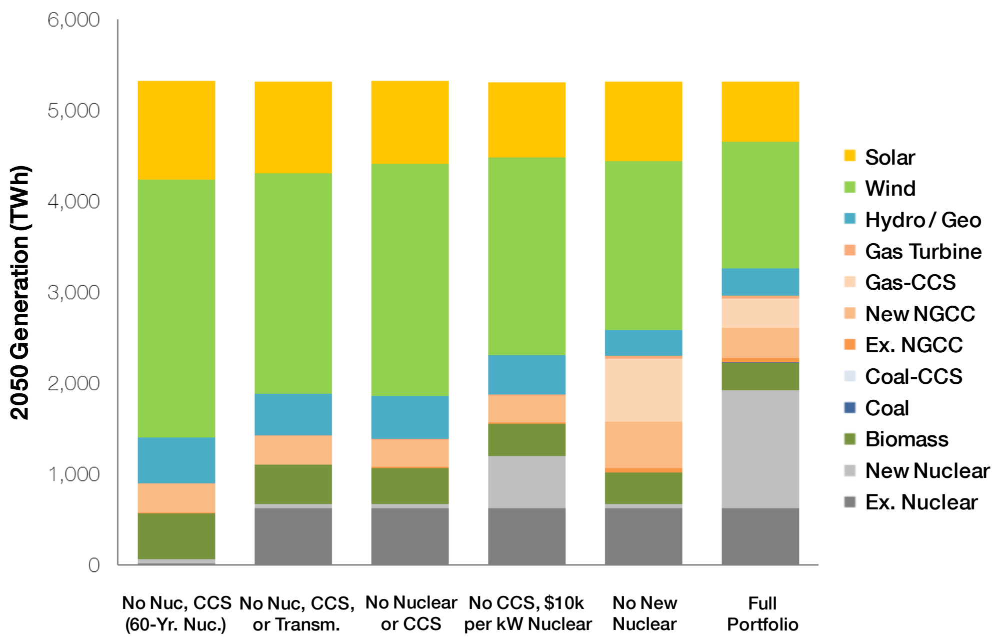

Figure 2: U.S. generation mix by technology in 2050. The "Full Portfolio" scenario has no constraints on the deployment of nuclear, carbon capture, transmission, or other technologies. Technologies become restricted moving from right to left.

The scenarios (from left to right on Figure 2) assume:

- No new nuclear or CCS-equipped units, and existing nuclear units retire after 60 years
- No new nuclear, CCS, or transmission
- No new nuclear or CCS
- No new CCS and high capital costs for advanced nuclear reactors ($10,000/kW)
- No new nuclear units
- Full portfolio with no constraints on deployment of nuclear CCS, or other technologies

The model solves for the least-cost mix in each scenario. The analysis illustrates that diverse technological portfolios are optimal under a range of conditions, though the cost and emissions **impacts of limited portfolios depend on the market and policy contexts**. For instance, costs of limited portfolios are higher with stringent CO_2 targets and lower gas prices.

Without constraints on deployment, the "Full Portfolio" scenario entails a range of technologies to meet deep decarbonization targets, including significant shares of wind, nuclear, solar, and CCS-equipped units. Although changes in capital and fuel costs can shift the relative competitiveness of technologies, the decreasing economic value of variable renewable energy at higher penetration levels increases the cost of very high renewables systems, even with low-cost battery storage, and leaves room for other generation options.*

Dispatchable low-carbon resources (like advanced nuclear, CCS, and others) reduce costs associated with deep decarbonization, even when they have higher levelized costs than other options. Constraints on these resources are especially expensive in regions with lower renewable resource quality or lower-cost dispatchable technologies (e.g., low-cost natural gas).

The value of individual technological classes (and of RD&D to lower costs) depends on the state of the system, including the generation mix, fuel costs, and connectivity with neighboring regions. For example, the analysis indicates that emissions reductions are costlier without the existing nuclear fleet.

Contact Information

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* EPRI (2015), "Decreasing Returns to Renewable Energy," EPRI Product #3002003946

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