EXECUTIVE SUMMARY

THE ECONOMICS OF CLEAN ENERGY PORTFOLIOS

HOW RENEWABLE AND DISTRIBUTED ENERGY RESOURCES ARE OUTCOMPETING AND CAN STRAND INVESTMENT IN NATURAL GAS-FIRED GENERATION

BY MARK DYSON, ALEXANDER ENGEL, AND JAMIL FARBES

AUTHORS & ACKNOWLEDGMENTS

Authors

Mark Dyson, Alexander Engel, and Jamil Farbes

** Authors listed alphabetically. All authors from Rocky Mountain Institute unless otherwise noted.*

Contacts

Mark Dyson, **mdyson@rmi.org**
Alexander Engel, **aengel@rmi.org**

Suggested Citation

Dyson, Mark, Jamil Farbes, and Alexander Engel. *The Economics of Clean Energy Portfolios: How Renewable and Distributed Energy Resources Are Outcompeting and Can Strand Investment in Natural Gas-Fired Generation*. Rocky Mountain Institute, 2018.
www.rmi.org/insights/reports/economics-clean-energy-portfolios/

Editorial/Design

Editorial Director: Cindie Baker
Editor: David Labrador
Creative Director: Romy Purshouse
Design: Marijke Jongbloed

Images courtesy of iStock unless otherwise noted.

Acknowledgments

The authors thank the following individuals/organizations for offering their insights and perspectives on this work:

- Sonia Aggarwal, Energy Innovation
- Steven Corneli
- Jeremy Fisher, Sierra Club
- Leia Guccione, Rocky Mountain Institute
- Ray Hohenstein, Fluence
- Audrey Lee, Sunrun
- Jamie Mandel, Rocky Mountain Institute
- James Newcomb, Rocky Mountain Institute
- Ric O'Connell, GridLab
- Brendan Pierpont, Climate Policy Initiative
- Jake Young, Stanford University

ABOUT US

About Rocky Mountain Institute

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. In 2014, RMI merged with Carbon War Room (CWR), whose business-led market interventions advance a low-carbon economy. The combined organization has offices in Basalt and Boulder, Colorado; New York City; Washington, D.C.; and Beijing.

01 EXECUTIVE SUMMARY

EXECUTIVE SUMMARY

The current rush to gas in the US electricity system could lock in $1 trillion of cost through 2030

The US power grid is the largest, most complicated, most expensive, and likely the oldest continually operating machine in the world, but it is not aging gracefully. The grid has fueled the US economy for over a century, but requires significant reinvestment to maintain the same level of cost-effective, reliable service for the next century. In particular, the fleet of thermal power plants that convert fuel to electricity is aging, with over half of thermal capacity more than 30 years old and expected to reach retirement age by 2030.

Recent advances in power plant technology and the currently low price of natural gas mean that new natural gas-fired turbines are more efficient and less costly to run than aging power plants. This has led to a "rush to gas," with utilities and independent power plant developers having announced plans to invest over $110 billion in new gas-fired power plants through 2025. Extrapolating this trend to 2030 suggests that over $500 billion will be required to replace all retiring power plants with new natural gas-fired capacity. This will lock in another $480 billion in fuel costs and 5 billion tons of CO_2 emissions through 2030, and up to 16 billion tons through 2050.

50%
of US thermal power plant capacity is likely to retire by 2030

$520 BILLION
is required for natural gas-fired power plants to replace retiring capacity

$480 BILLION
is required for fuel to run those power plants through 2030

"Clean energy portfolios" represent a promising alternative to new gas-fired power plants

Natural gas-fired power plants are not the only resource options capable of replacing retiring capacity. Renewable energy, including wind and solar, and distributed energy resources, including batteries, have fallen precipitously in price in the last 10 years. At the same time, developer and grid-operator experience with these resources has demonstrated their ability to provide many, if not all, of the grid services typically provided by thermal power plants. Together, these technologies can be combined into "clean energy portfolios" of resources that can provide the same services as power plants, often at net cost savings.

TABLE ES-1

GRID SERVICES AVAILABLE FROM CLEAN ENERGY PORTFOLIO RESOURCES

RESOURCE	SERVICE			
	Energy	Peak Capacity	Flexibility	Additional Network Stability*
Energy Efficiency	Reduces consumption	Reduces peak load	Flattens ramps	n/a
Demand Response	n/a	Reduces peak load	Can actively respond to ramp events, in both directions	Current-generation active load-management technologies can provide reserves and frequency regulation
Distributed and Utility-Scale Battery Energy Storage**	n/a	Provides active power injection		Can provide reserves, frequency support (including synthetic inertia), voltage support, and black start
Distributed Renewable Energy**	Energy generator	Can reliably produce at "capacity credit" during peak hours	Balanced portfolios can reduce ramp rates	When renewable resource is available, can provide reserves, frequency regulation, and voltage support
Utility-Scale Renewable Energy				

* includes distribution-level voltage support and other ancillary services
** includes behind-the-meter and front-of-the-meter deployments

Source: RMI analysis, adapted from EPRI

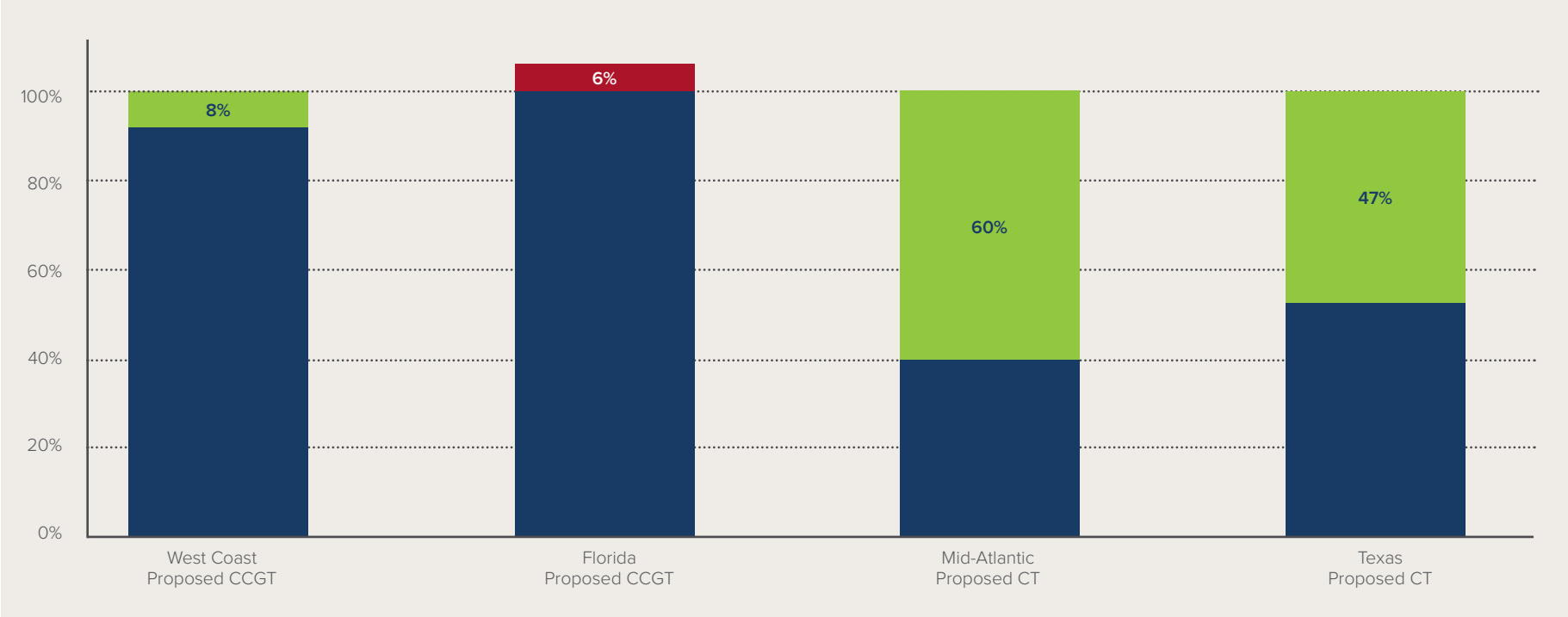
Clean energy portfolios are cost-competitive with proposed natural gas-fired power plants in four diverse case studies from across the US

This study compares the costs of four natural gas-fired power plants currently proposed for construction across the US against optimized, region-specific clean energy portfolios of renewable energy and distributed energy resources (DERs) that can provide the same services. We analyzed two announced combined-cycle gas turbine (CCGT) power plants, planned for high capacity-factor operation, and two announced combustion turbine (CT) power plants, planned for peak-hour operation.

In only one case did we find that the net cost of the optimized clean energy portfolio is slightly (~6%) greater than the proposed power plant; in the other three cases, an optimized clean energy portfolio would cost 5–60% less than the announced power plant. Factoring in expected further cost reductions in distributed solar and/or a $7.50/ton price on CO_2 emissions, all four cases show that an optimized clean energy portfolio is more cost-effective and lower in risk than the proposed gas plant.

FIGURE ES-1

NET COST OF CLEAN ENERGY PORTFOLIOS ACROSS FOUR CASE STUDIES, RELATIVE TO PROPOSED GAS-FIRED POWER PLANTS

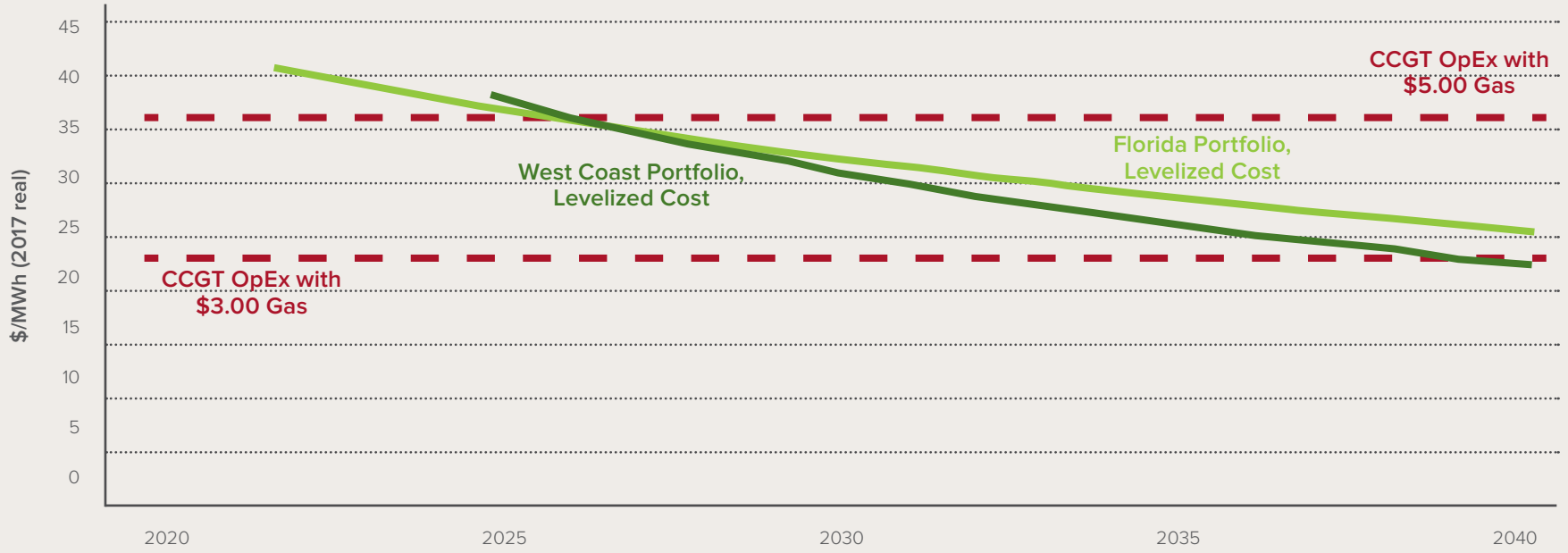


Low-cost clean energy portfolios threaten to strand investments in natural gas-fired power plants

In addition to competing with proposed gas-fired power plants on a levelized cost basis, clean energy portfolios will also increasingly threaten the profitability of existing power plants. Comparing the future operating costs of the two proposed CCGTs in this study against new-build clean energy portfolios, we find that, depending on gas price forecasts, the clean energy portfolio's levelized, all-in costs will fall below marginal operating costs of the CCGTs well within the planned operating lifetime of the proposed plants. In other words, the same technological innovations and price declines in renewable energy that have already contributed to early coal-plant retirement are now threatening to strand investments in natural gas.

FIGURE ES-2

COMPARISON OF COMBINED CYCLE OPERATING COSTS VS. CLEAN ENERGY PORTFOLIO LEVELIZED COSTS, 2020–2040



- **Assuming gas prices between $3–5/MMBtu, combined-cycle operating costs will vary between $23/MWh and $36/MWh**
- **Optimized clean energy portfolios, depending on location and technology mix, will cost less to build than CCGTs cost to run by 2026 (assuming $5/MMBtu gas) or ~2040 (assuming $3/MMBtu gas)**

To mitigate stranded asset risk and minimize ratepayer costs, investors and regulators should carefully reexamine planned natural gas infrastructure investment

Our analysis reveals that across a wide range of case studies, regionally specific clean energy portfolios already outcompete proposed gas-fired generators, and/or threaten to erode their revenue within the next 10 years. Thus, the $112 billion of gas-fired power plants currently proposed or under construction, along with $32 billion of proposed gas pipelines to serve these power plants, are already at risk of becoming stranded assets. This has significant implications for investors in gas projects (both utilities and independent power producers) as well as regulators responsible for approving investment in vertically integrated territories.

- **$93 billion of proposed investment is at risk for merchant gas power plant developers**
  - Approximately 83% of announced gas projects are proposed for restructured markets, where independent power producers bear market risk if these assets see their revenue fall under competition from renewables and DERs.
  - Investors should reassess the risk profiles of gas projects and, in particular, consider the reduced useful lifetimes of gas-fired power plants under competition from clean energy resources, to mitigate the erosion of shareholder value.

- **Ratepayers face $19 billion of locked-in costs**
  - The remaining 17% of gas-fired power plants proposed are in vertically integrated jurisdictions, where state-level regulators are responsible for approving proposals to build new gas plants and for allowing utilities to recover costs through customer rates.
  - To avoid the risk of locking in significant ratepayer costs for gas-fired resources that are increasingly uneconomic, regulators should carefully consider alternatives to new gas power plant construction before allowing recovery of costs in rates.

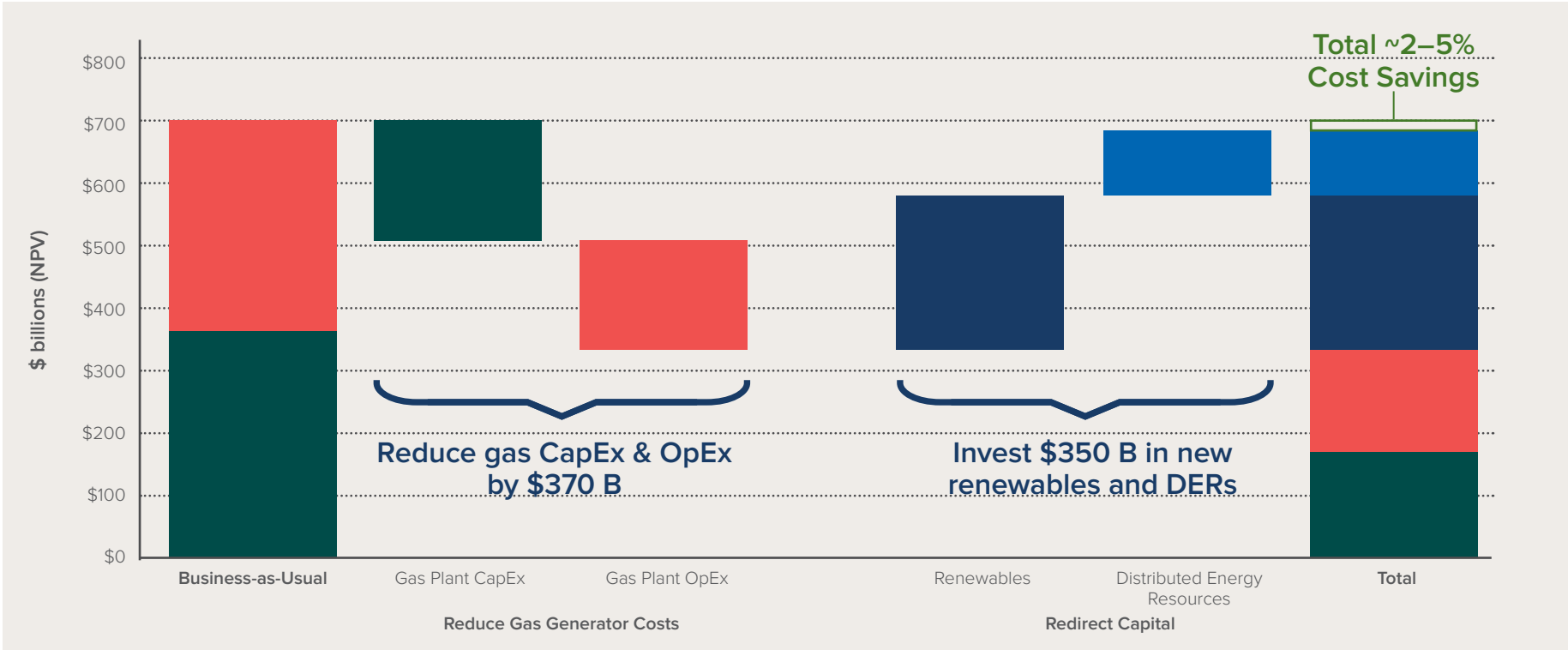
In both regulated and restructured electricity markets, there is a significant opportunity to redirect capital from uneconomic, risky investment in new gas toward clean energy portfolio resources, at a net cost savings.

Clean energy portfolios represent a $350 billion market opportunity for renewables and DERs through 2030

The emerging cost-effectiveness of clean energy portfolios versus new gas suggests a significant opportunity to offset a majority of planned spending on new gas plants, and instead prioritize investments in renewables and DERs, at a net cost savings on a present value basis. This investment trajectory would unlock a market for renewables and DERs many times larger than today's, minimize risk to investors, enable net cost savings for American electricity customers, and reduce carbon emissions by 3.5 billion tons through 2030. This estimate excludes any value of DERs to the distribution system beyond peak load reduction, any value of avoided fuel price risk, and any cost on carbon emissions; including these factors could increase the addressable market and savings potential significantly.

FIGURE ES-3

MARKET OPPORTUNITY FOR CLEAN ENERGY PORTFOLIOS IN THE US, 2018–2030



Current regulatory incentives, market rules, and resource planning processes limit the ability to capture the full value offered by clean energy portfolios

Clean energy portfolios represent a cost-effective alternative to investment in new gas-fired power plants, with a potentially accessible market in the hundreds of billions of dollars through 2030, while avoiding the fuel price risks and CO_2 emissions associated with new natural gas power plants. However, the industry is just beginning to recognize and capture the benefits of these resources, and execution of clean energy portfolio projects remains relatively low compared to their potential. Coordinated action by several stakeholder groups can accelerate adoption.

RECOMMENDATIONS

For regulators and market operators: *Study alternatives and level the playing field.*

- **Seek broad input:** Solicit input from alternative-solution providers as part of the approval process for proposed power plant investments
- **Align incentives:** In states with rate-based generation, adjust utility earnings incentives to put clean energy portfolios on a level playing field with traditional capital investments by rewarding least-cost resources more effectively than does the traditional return-on-capital business model
- **Open up market participation:** In restructured markets, allow participation of distributed resources in wholesale market products historically designed with thermal generators in mind

For utilities: *Revolutionize resource planning and procurement processes.*

- **Update planning:** Accurately reflect system needs and the capabilities and potential of clean energy portfolio technologies, including distributed and demand-side options, to meet those needs
- **Scale deployment quickly:** Limit pilots of already-proven technology, and move quickly toward scaled deployment
- **Procure solutions:** Request technology-neutral solutions from the market, and move toward standard tariff- or market-based incentive structures to procure them

For technology providers and project developers: *Offer holistic, low-cost solutions to meet grid needs.*

- **Integrate multiple technologies:** Where utilities seek or markets support turnkey alternatives to gas plants, partner across vendors to optimize bids and deployment accordingly
- **Drive down costs:** Leverage technology to reduce the costs of system design, customer acquisition, operational integration, and other "soft" costs
- **Generate confidence:** Work with planners and system operators to characterize discrete grid service needs, including measurement and verification, and validate performance characteristics of portfolio technologies

22830 Two Rivers Road
Basalt, CO | 81621 USA
www.rmi.org