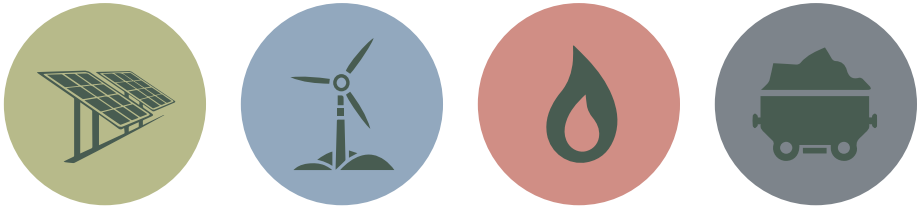
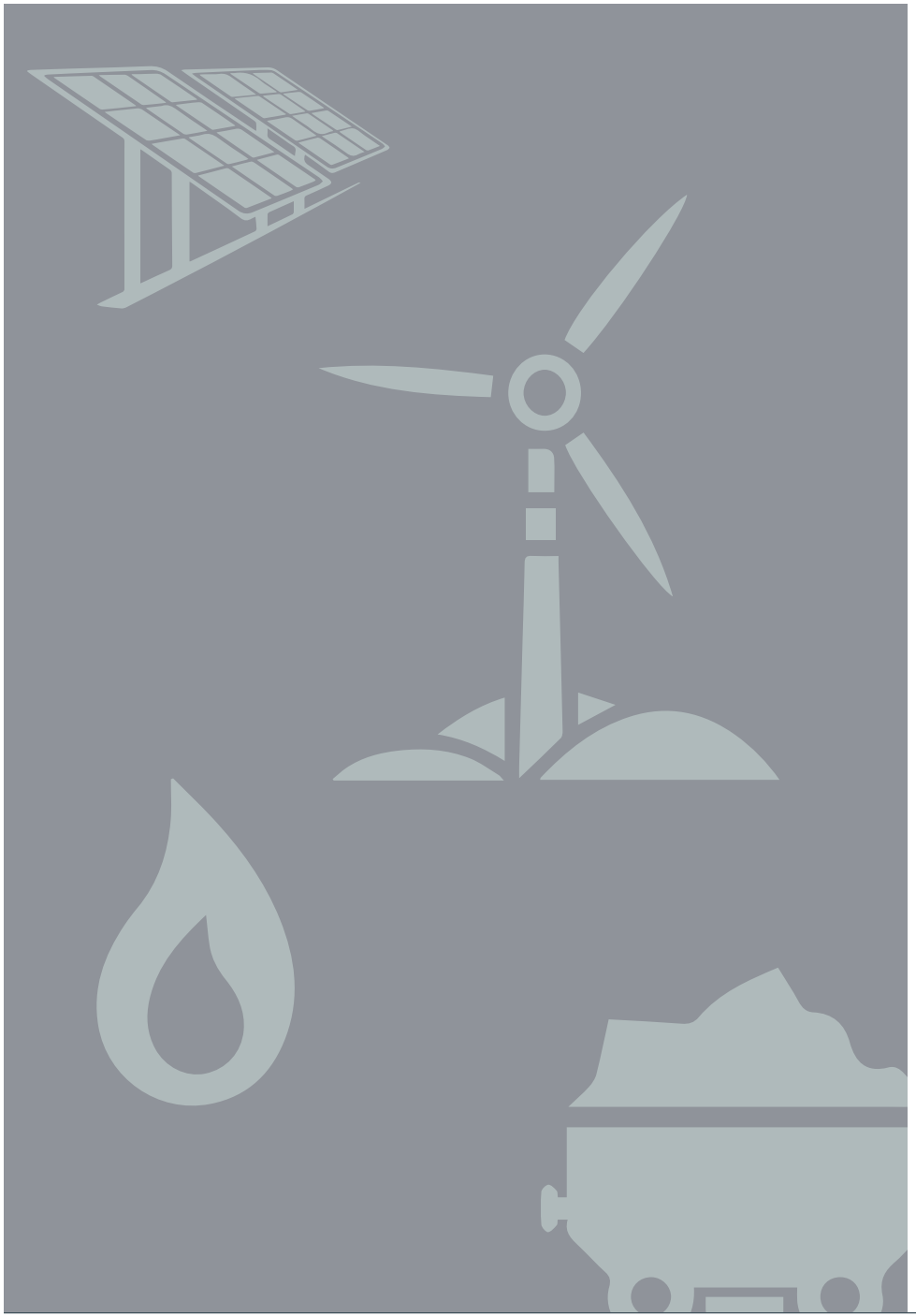
Carbon Tracker Initiative

END OF THE LOAD FOR COAL AND GAS?

EXECUTIVE SUMMARY





What is the cheapest technology?

Carbon Tracker's work on the energy transition has already demonstrated the value in challenging traditional energy model assumptions. There is a confusing picture in the energy debate about which technologies are the cheapest option, yet the world is clearly at a point where more renewables are getting built and there is uncertainty about new coal and gas plants. Levelised Costs of Electricity (LCOEs) provide one way of comparing the costs of technologies, although it is widely recognized that there are large ranges of values for each technology, and that other important factors such as daily peak pricing and the system value of wind and solar also come in to play. It is clear that the answer to the question "Which is the cheapest?" is: "It depends". This analysis is an attempt to demonstrate why it is useful for those using LCOEs to make investment or policy decisions to challenge the underlying assumptions, and understand how the landscape is changing. This research highlights how a series of modest incremental changes to average LCOE assumptions can have a profound cumulative impact on the affordability of power generation technologies.

Our approach

The analysis uses a simplified LCOE calculator provided by the US National Renewable Energy Laboratory (NREL), that includes the standard factors which determine a global average LCOE. We compare four new-build utility scale plants: coal, gas, wind, and solar. We then vary some of the fundamental assumptions based on three key scenarios, and track how the relative LCOEs respond. The three scenarios are:

2016 reference scenario to provide a reference point based on widely used technical assumptions from which to show relative LCOE sensitivity.

2016 updated scenario to show the impact of a series of updated assumptions that may be used for an actual investment decision today, based on real world inputs as seen in today's electricity markets. The updated scenario includes updated assumptions on (i) the cost of capital for renewable energy (ii) the load factors for fossil fuel plants (iii) the lifetimes from premature retirements of fossil fuel plants and (iv) carbon pricing for fossil fuels plants.

2020 2D pathway scenario uses assumptions for an investment decision made in 2020 in an electricity system that is moving towards keeping global average temperatures to 2D. The 2D pathway scenario includes updated assumptions on (i) the capex costs of renewable energy (ii) the load factors for fossil fuel plants (iii) the financing costs of fossil fuels and (iv) carbon pricing for fossil plants. The assumptions of each scenario are detailed in the table below.

	Technology	Capex	Lifetime	Discount rate	Load factor	Carbon price
		million US$/MW	years	%	%	US$/ tCO_2
2016 Reference	Solar	1.1	25	9%	18%	-
	Wind	1.7	25	9%	30%	-
	Gas	0.9	35	9%	60%	$0
	Coal	2.0	40	9%	80%	$0
2016 Updated	Solar	1.1	25	8%	18%	-
	Wind	1.7	25	8%	30%	-
	Gas	0.9	25	9%	38%	$5
	Coal	2.0	20	9%	59%	$5
2020 2D	Solar	0.8	25	8%	20%	-
	Wind	1.6	25	8%	40%	-
	Gas	0.9	25	10%	31%	$10
	Coal	2.0	20	10%	42%	$10

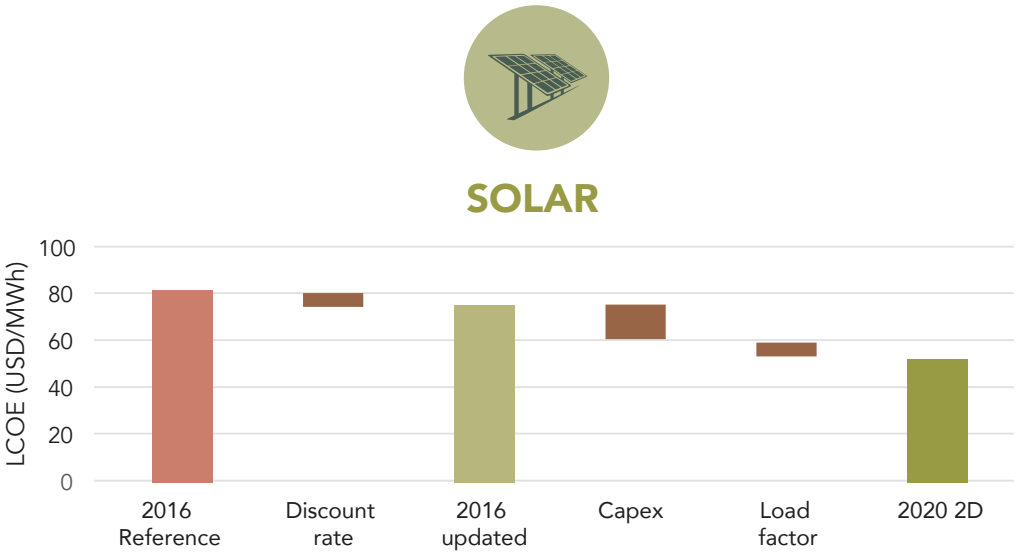
Assumes fuel prices of $80/t for coal and $7/mmbtu for gas, and solar panel degradation of 0.6% per annum for all scenarios. All other variables are consistent throughout – see full report.

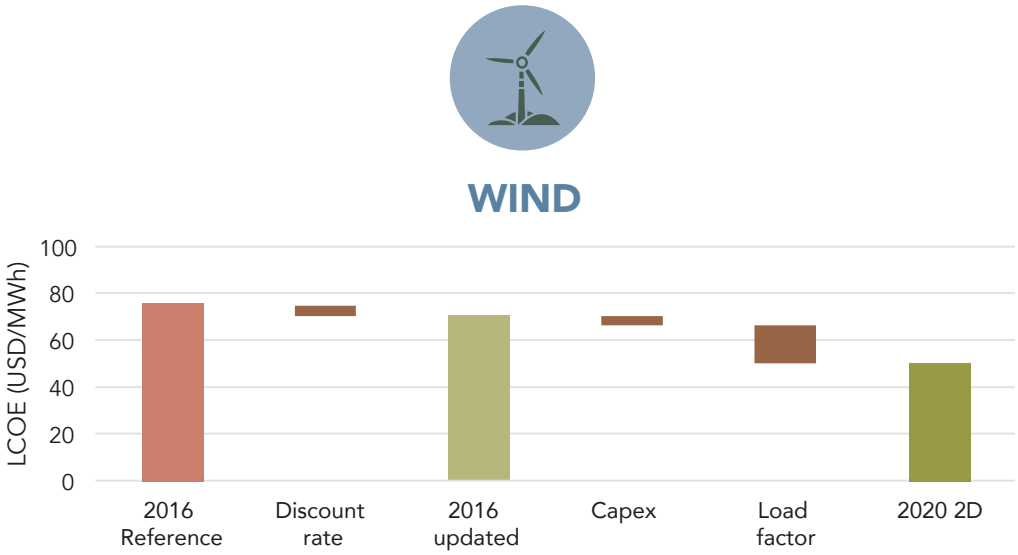
Starting point – technical assumptions (2016 reference)

A number of energy institutions provide the reference technical assumptions that make up the default values assigned to theoretical electricity generation plants. For example, coal plants are designed to run at high load factors, so this would be the standard industry reference point. There are also typical assumptions in financial analysis based on historical performance, such as the lifetime of a plant. An LCOE comparison using these reference points makes the average fossil fuel plants cheaper, but reflects the electricity system of the past, rather than that of today, let alone tomorrow. The waterfall charts below show how the LCOEs are progressing through this time series, and the key factors that are contributing.

Assumptions based on today's operating environment (2016 updated)

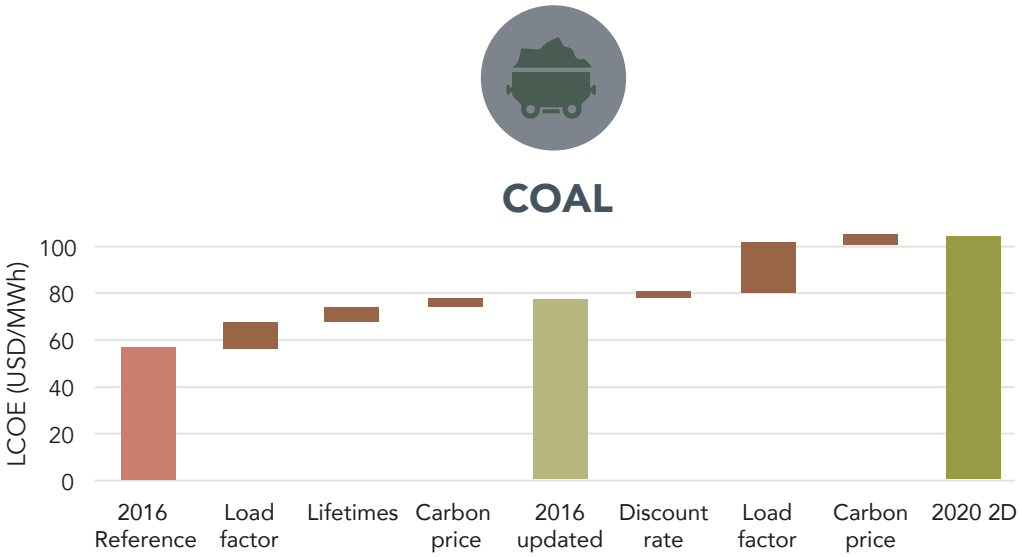
When you start looking at the actual situation for new utility-scale generation options being considered today, the picture can be very different to the reference technical specifications seen initially. Putting aside the ranges, even the averages can be significantly different. For example, the average load factor for global coal generation in 2013 was 59% and for gas 38% – each over 20 percentage points below the typical reference utilisation levels published. The expected lifetimes have also been shortened to 25 years for gas and 20 years for coal, which reflects the fact that average carbon intensity has to fall to get to lower emissions levels. The unique characteristics of renewables projects are also bringing new players into the equation, who have new business models and lower capital costs, which tend to benefit renewables options due to preferential dispatch and higher capex costs.

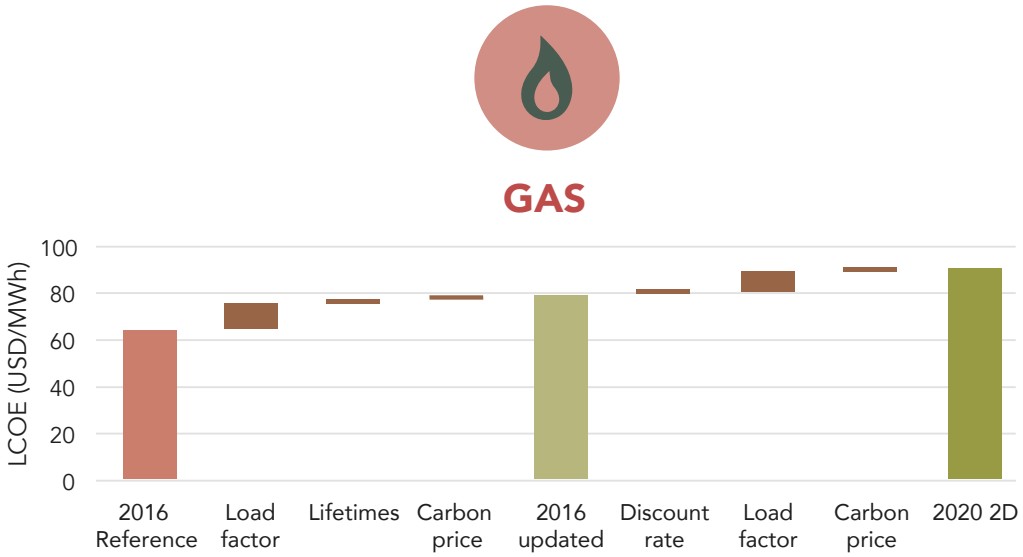




Looking forward to a low carbon future (2020 2D)

The energy transition is clearly underway, driven by an unstoppable confluence of policy momentum, technological advances and new business models. Using static projections for the variables clearly doesn't make sense, yet not all models are structured to include these changes over time. The learning rate for renewables combined with higher than expected rates of deployment combine to provide ongoing reductions in the capital costs of solar and wind. Increased renewables generation then displaces fossil fuel powered generation, further depressing load factors for coal and gas. To show how far this could move, we have applied falling gas and coal utilization rates derived from the IEA's ETP 2D Scenario to the LCOE projections. As the risks of the fossil fuel sector emerge, this will likely push up the costs of financing and refinancing for carbon-intensive activities.



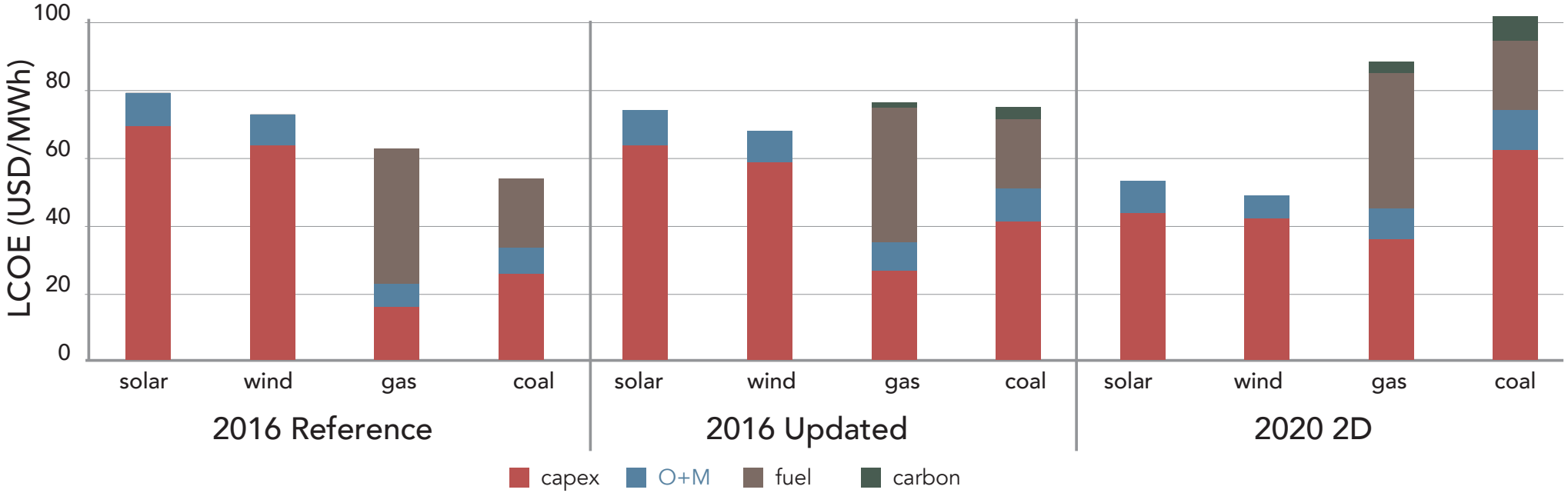


Renewables better on average in 2016 – with or without a carbon price

It is worth reiterating that there are a range of LCOEs for any technology, and global LCOE averages cannot give a definitive answer as to what is the better investment in a specific situation. However, what the global averages with real world 2016 assumptions tell us is that already the average LCOEs for solar and wind are lower than their coal and gas competitors. The 2016 updated and 2020 2D scenarios apply a conservative carbon price of US$5/ton and US$10/ton, respectively. These carbon price levels and other environmental policies (such as air pollution regulations) may in fact be higher in some regions.

Importantly, the LCOEs for wind and solar in the 2016 updated scenario are not dependent on our carbon pricing assumptions to make renewables competitive with fossil fuels. It should also be noted that fuel prices for coal ($80/t) and gas ($7/mmbtu) plants could decline significantly in the future, potentially compromising the competitiveness of wind and solar. However, in our 2020 2D scenario it is clear that on average, even very low fuel prices would not tip the advantage back to fossil fuels.

This suggests that the tide has turned, and is borne out by the growing number of locations where unsubsidized renewables are being built. It also shows why any investors basing their investment decisions on coal and gas continuing to be the cheapest source of electricity could be deeply misguided, given the relative shifts this LCOE sensitivity shows.



Other important factors beyond LCOE

LCOE analysis is a limited metric as it does not consider revenues from generation and the system value of wind and solar. Different technologies are supported in different ways around the world for different reasons. For example, new renewables plants are more likely to benefit from favourable congestion payments than new fossil fuel plants, as suitable renewable sites are typically more distributed than fossil fuel plant sites. The potential for higher revenues can boost renewables' competitiveness as they can avoid grid congested locations and solar can match peak demand attracting a price premium. Going forward, the challenge for policymakers is no longer whether wind and solar will become competitive with fossil fuel plants, but rather how to integrate variable renewable energy (VRE) to maximize system value. According to the IEA, the best way to integrate VRE is to transform the overall power system through system-friendly deployment, improved operating strategies and investment in additional flexible resources. Flexible resources include better located generation, grid infrastructure, storage and demand side integration.

Direction of travel

Our 2020 2D scenario demonstrates how it can become a self-fulfilling prophecy, as growth in renewables brings their costs down and raises the costs of coal and gas. Not all will be ready to base decisions on this scenario yet – but it shows that the economic logic of a renewable energy + balancing services future increases the closer we get to this electricity generation mix. The end of high load factors for coal and gas make it very challenging to continue backing new plants where this situation is emerging.

Checklist for challenging LCOE assumptions:

- Use a starting point which reflects the current reality of operation, not technical specifications
- Use dynamic projections to understand how variables such as utilisation rates may change over time
- Consider how lifetimes may be shorter than expected given decarbonisation trends
- Review how fossil fuel risk premiums may increase the cost of capital for coal and gas
- Identify how new business models and lower cost-of-capital project owners and developers can lower the costs for renewables
- Ensure the virtuous circle of increased renewables installation and learning rates feeds into capex cost assumptions
- Identify other key market factors, e.g. electricity price premiums, grid congestion payments.

About Carbon Tracker

The Carbon Tracker Initiative is a team of financial specialists making climate risk real in today's financial markets. Our research to date on unburnable carbon and stranded assets has started a new debate on how to align the financial system with the energy transition to a low carbon future.

This report was authored and edited by: Paul Dowling, Matt Gray, and James Leaton.

The authors would like to acknowledge the contributions of Mark Fulton, Luke Sussams, and Andrew Grant.

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