McKinsey & Company

Oil & Gas

March 2018 | Article

By Sébastien Léger, Bram Smeets, Tristan Swysen, Christer Tryggestad, Jerry van Houten, and Frithjof Wodarg

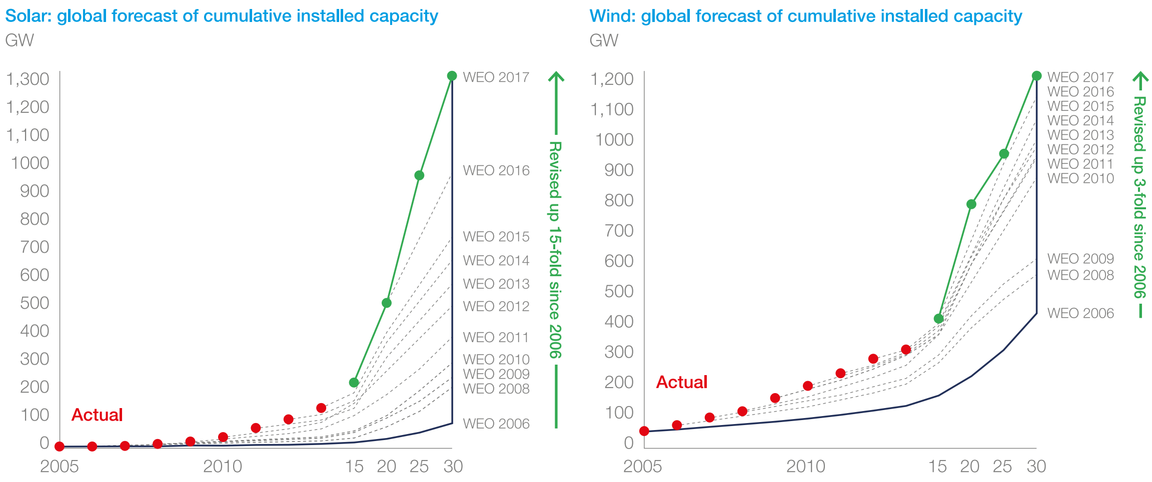
With ever lower auction results being reported, the question arises: what would the effect be on our power markets if the average cost trajectory followed the auction results?

Power auctions have accelerated the energy transition and the rise of renewables. With ever lower auction results being reported, the question arises: what would the effect be on our power markets if the average cost trajectory followed the auction results? We used the Global Power Model to analyze the implication of such a scenario.

The fast-paced energy transition toward renewable energy sources has been accelerated by power auctions

The transition of our power systems toward higher shares of renewable energy sources (RES) is happening at an ever-increasing pace. Forecasting agencies have had to revise up their RES projections every year over the past decade. Projections for solar PV in 2030 have increased by a factor of 15 since 2006 (see exhibit 1). A key driver for this trend is the rise of power auctions.

Exhibit 1: Expert forecasts revised PV projections upward 15-fold in 10 years
to keep up with trend.



Source: IEA World Energy Outlook – New Policy Scenario

McKinsey&Company

In a power auction, the tendering entity calls for the lowest bid to produce electricity in a given location and timeframe. There are countless variations of these power auctions, some being technology specific, some rendering attractive land accessible (eg, for solar installations). Over the past several years, power auctions have become a popular tool to enhance cost transparency and increase competition—especially in contrast to predefined feed-in tariffs.

Auctions have contributed to driving down margins in the value chain. Auction results have frequently undercut prevailing price assumptions and, thereby, accelerated the ongoing transition. With ever lower auction results being reported, the question arises: what would the effect be on our power markets if the average cost trajectory followed the auction results?

Before using auction results as indicators for real cost developments, it is important to recognize some limitations to their indicative power:

- *"Sweet spots" increase value.* Many geographies auction specific RES projects at favorable sites, featuring prime conditions i.e., high capacity factors, assessed and pre-analyzed by independent (public) authorities
- *Expected future cost declines.* Auction bids factor in speculation on a future cost decline. Since projects are auctioned off several years before they are built and go online, bids are based on assumptions of their future cost structures
- *Reduced risk.* Transparent auction procedures themselves reduce risk, eg, tendering agencies prepare detailed site assessments or even exclude risky elements from the bid eg, connection cables from offshore wind
- *Potential "winner's curse."* Auction results might be unprofitable for the bidder. Due to incomplete information, the bidder may only win because they overestimate profitability more than anyone else intentionally or unintentionally—a.k.a. the winner's curse

- *Auction design* Different auction types are not always comparable: some auction types only represent price floors—with additional revenue possible—some allow for parts of the possible electricity generated to be sold separately, eg, to industry clients or in the spot market, and some include special price increases over time that lift the realized auction price

Despite acknowledging those limitations, an "auctions-as-reality" scenario still sheds useful light on the future developments of our power markets.

Using the McKinsey Energy Insights Global Power Model, we have modeled the implications of this auctions scenario and compared it to our 2018 Global Energy Perspective reference case[1] . We focused on three archetypal countries: Germany, Mexico, and India (see Sidebar "Methodology: Approach to model the auctions scenario").

In the auctions scenario, the penetration of renewable sources is accelerated, increasing the pressure on fossil generation and capacity investments

In the auctions scenario, the role of gas as a transitory fuel is reduced and fossil generation in moderate-growth countries declines rapidly, while investments in new fossil generation capacity in high-growth countries are not required. At the same time, emissions reduce drastically and preparing grids for high RES environments moves to the center of attention.

Comparing the scenario results with the 2018 GEP reference case, there are several overarching trends that impact market outlooks and investment decisions:

- The penetration of solar and wind power generation in the power sector is accelerated by up to 20 years—varying by technology and geography
- Gas loses its role as a transitory fuel in countries with low demand growth and gas generation capacity becomes uneconomical earlier eg, in Germany, ~55 percent less total cumulative generation from gas until 2050
- Fossil capacities in countries with moderate growth become uneconomical earlier than expected eg, in Mexico, annual power generation from gas is already 60 percent lower by 2030
- Additional fossil capacities currently projected in high-growth countries is not needed eg, in India, all additional power demand is provided by RES
- Overall, power grids have to be adapted for high renewables environments much earlier, as high levels of intermittent generation levels are reached up to 20 years earlier
- CO_2 savings are significant—in the three country archetypes, total cumulative emissions from the power sector between 2018 and 2050 are reduced by ~25 percent or ~16,000 Mt CO_2e, while annual emissions in 2050 are ~50 percent or ~1,000 Mt CO_2e lower for the three countries

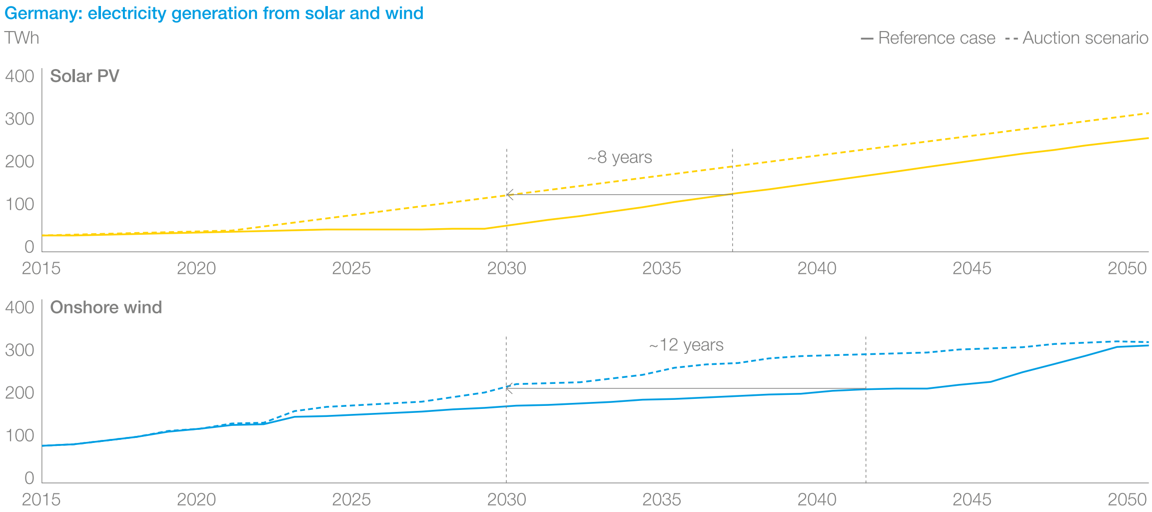
These trends manifest themselves differently in the three archetypal countries, which are described in more detail in the following sections.

1. Germany: faster uptake of solar and wind limit the role of gas as a transitory fuel

RES penetration levels are preponed by ~10 years, which reduces total cumulative gas generation until 2050 by over 50 percent and total cumulative CO_2e emissions by ~15 percent. The emissions target for the power sector in 2030 is met.

In Germany, RES penetration levels are accelerated by ~10 years in the auctions scenario: solar reaches similar generation levels to the reference case 8 years earlier i.e., ~150 TWh in 2030 instead of 2038, while wind onshore generation is 12 years ahead of the reference case i.e., ~200 TWh in 2030 instead of 2042 (see exhibit 2).

Exhibit 2: In Germany, renewables penetration in the German generation mix is accelerated by roughly a decade.



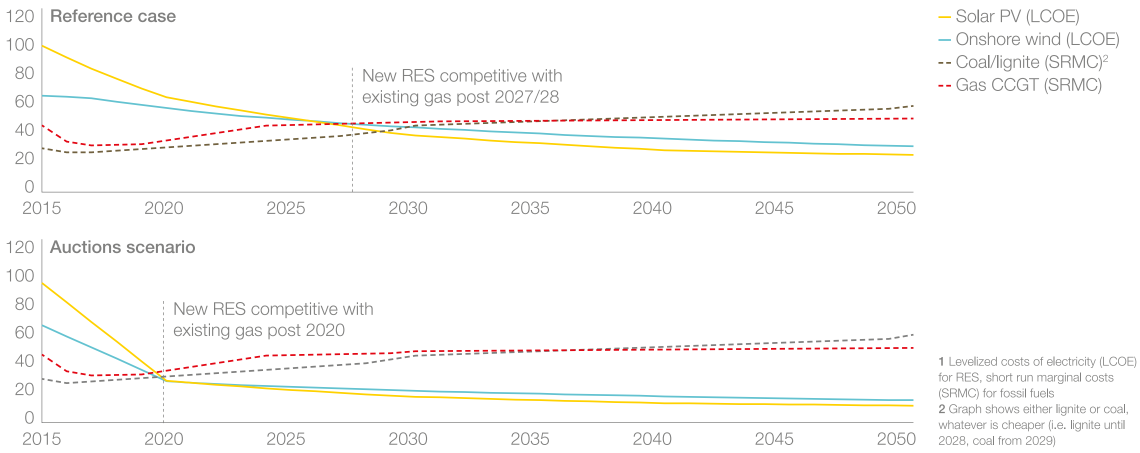
McKinsey&Company

This acceleration is driven by wind and solar LCOEs becoming cost-competitive against existing coal and gas generation (LCOEs vs SRMC) ~8 years earlier (2020 vs 2028) than in the reference case (see exhibit 3). The uptake of RES is then limited by the system's capacity to absorb new additions.

Exhibit 3: In Germany, renewables are cost-competitive against fossils already by 2020.

Germany: electricity costs, LCOEs of solar and wind as well as marginal costs for fossil fuels[1]

Cost of electricity in 2015 USD/MWh



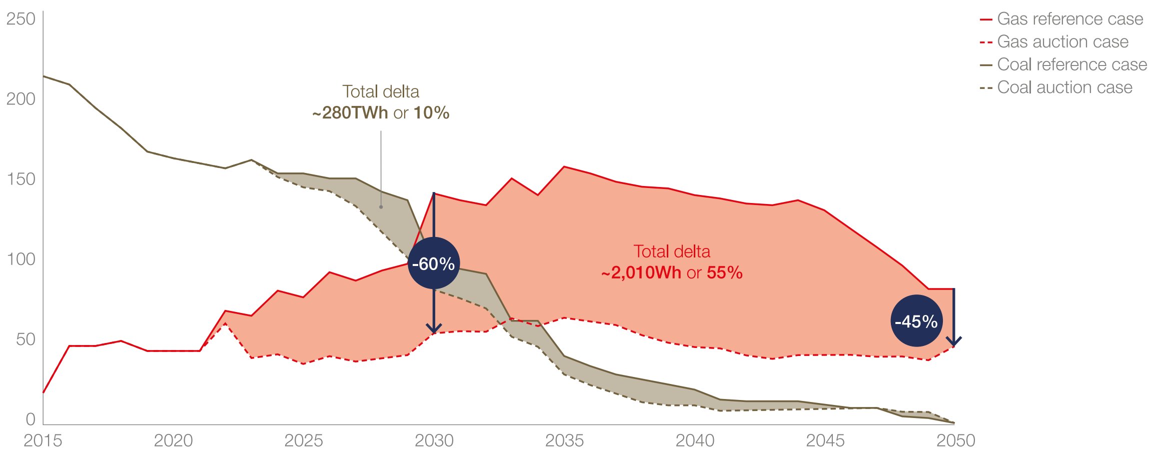
McKinsey&Company

The accelerated uptake of RES in Germany only slightly impacts coal generation, while significantly reducing the role of gas as a transitory fuel: total coal generation is ~10 percent (280 TWh) lower until 2050 in the auctions scenario, while total gas generation is over 50 percent lower (~2,010 TWh) and stagnates at around 50 TWh/yr over the entire period (see exhibit 4).

Exhibit 4: In Germany, total cumulative generation from gas until 2050 is reduced by over 50%.

Germany: electricity generation from gas and coal/lignite

TWh

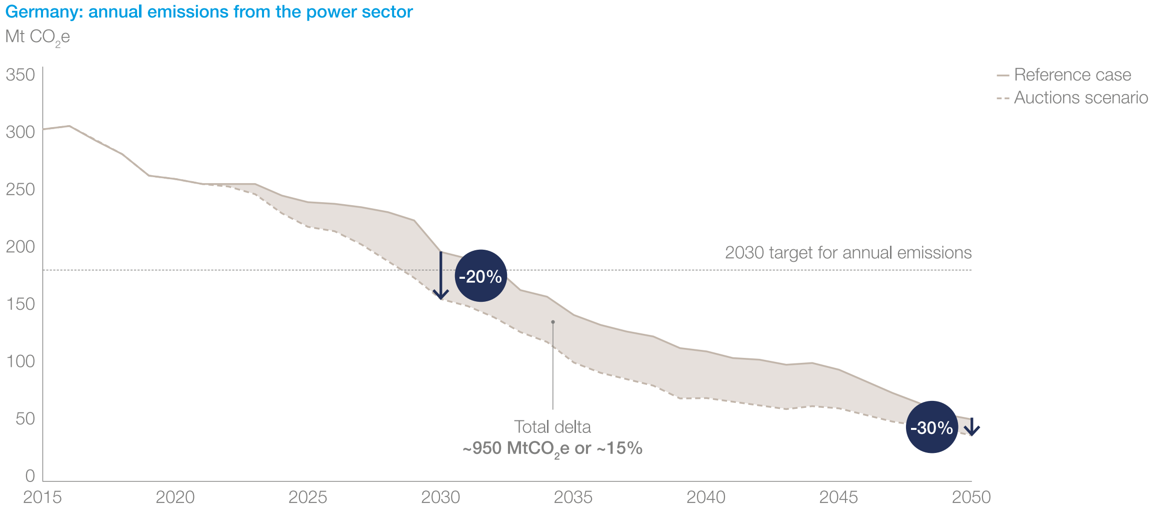


McKinsey&Company

The reference case assumes carbon prices within the EU ETS to rise to above 30 2015$/ton CO_2e until 2040, which leads to a steady replacement of coal by gas. In the auctions scenario, RES are sufficiently cost-competitive in the 2020s (see exhibit 3) to replace coal generation directly: gas as a transitory fuel is leapfrogged.

The replacement of fossil fuels by more cost-competitive RES also significantly reduces CO_2 emissions: in the auctions scenario, total emissions until 2050 are ~15 percent (~950 Mt CO_2e) lower than in the reference case. As a side effect, the 2030 government target of 180 Mt CO_2e/yr emissions from the power sector is met (see exhibit 5).

Exhibit 5: Total cumulative emissions until 2050 from the German power sector are reduced by ~15% and the 2030 target for annual emissions is met.



McKinsey&Company

Mexico: wind substitutes gas in the short run

Wind penetration levels are preponed by ~20 years, replacing ~40 percent of total cumulative gas generation until 2050. Already in 2030, annual gas generation levels are ~60 percent lower, leading to total cumulative CO_2 emission reductions until 2050 of ~30 percent.

In Mexico, the accelerated uptake of RES is particularly strong for onshore wind. Preponed by 20 years, wind generation reaches ~150 TWh by 2030 instead of ~2050 (see exhibit 6). This is primarily driven by onshore wind becoming cost-competitive with existing gas ~28 years earlier in 2020, instead of in 2048 (see exhibit 7). The uptake of Solar PV is preponed by ~5 years reaching cost competitiveness against existing gas in 2020, instead of in 2032.

Exhibit 6: In Mexico, wind penetration in the generation share is accelerated by 20 years and solar by 5 years.

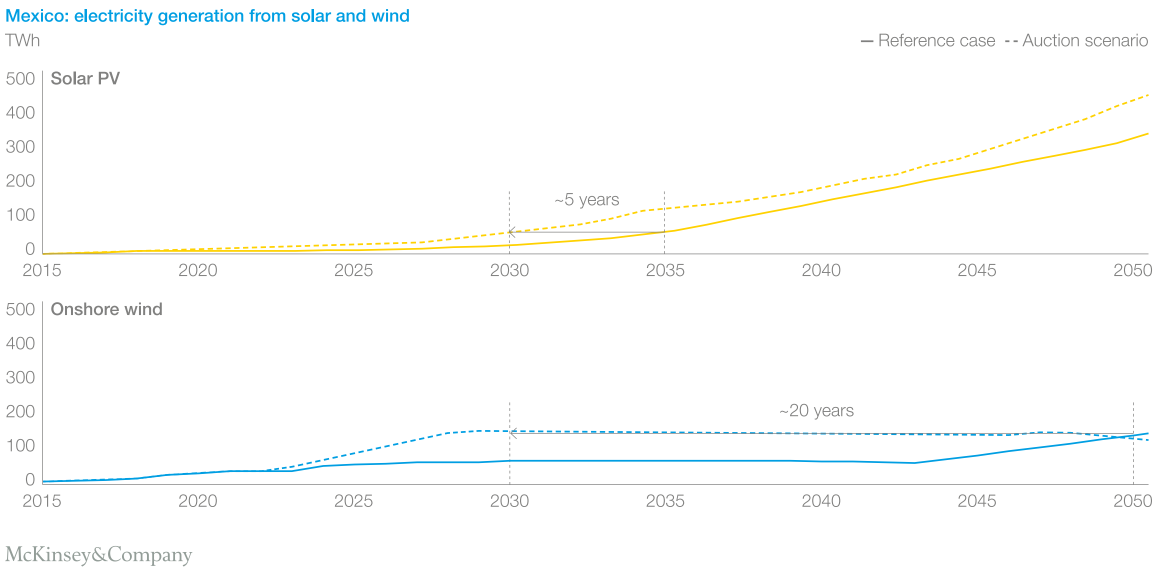
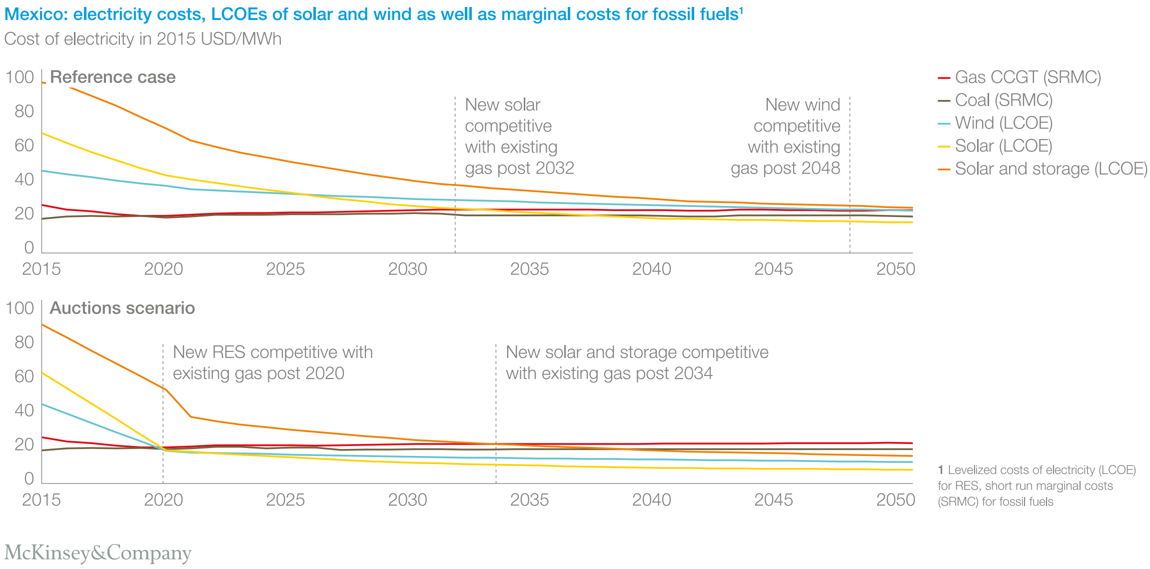


Exhibit 7: In Mexico, renewables are cost-competitive against existing gas already in 2020.



As a result, the uptake of wind is very strong in the years until 2030, tripling generation compared to the GEP reference case (~150 TWh vs ~50 TWh in 2030). Wind generation then stagnates at ~150 TWh, primarily driven by saturation and solar being better complemented by battery storage which becomes economical by 2030.

Solar generation increases more rapidly post 2030, accelerated by the combination of solar and storage becoming cost-competitive against existing gas post 2034 (see exhibit 7).

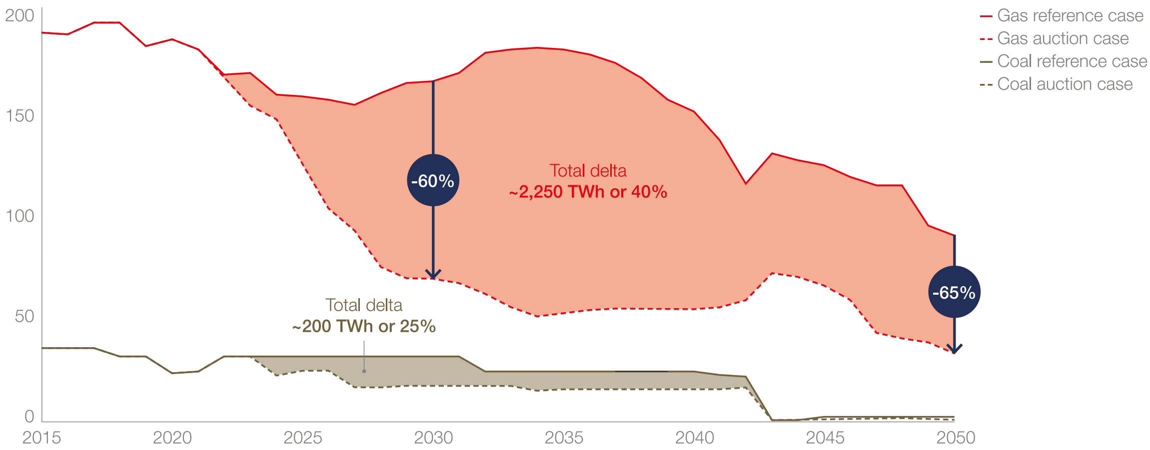
As a consequence, Mexico's predominant gas generation is significantly challenged. In the auctions scenario, total gas generation until 2050 is ~40 percent (~2,240 TWh) lower than in the reference case. In the auctions scenario, gas generation drops so rapidly that by 2030 annual generation is ~60 percent lower than in the reference case (~165 TWh vs ~65 TWh), putting significant pressure on the gas generation portfolio.

In the same timeframe, coal generation is reduced by ~25 percent. However, as coal plays a smaller role in Mexican power generation, this represents a much lower absolute reduction (~200 TWh) (see exhibit 8).

Exhibit 8: In Mexico, already in 2030 annual generation from gas is reduced by ~60%.

Mexico: electricity generation from gas and coal

TWh

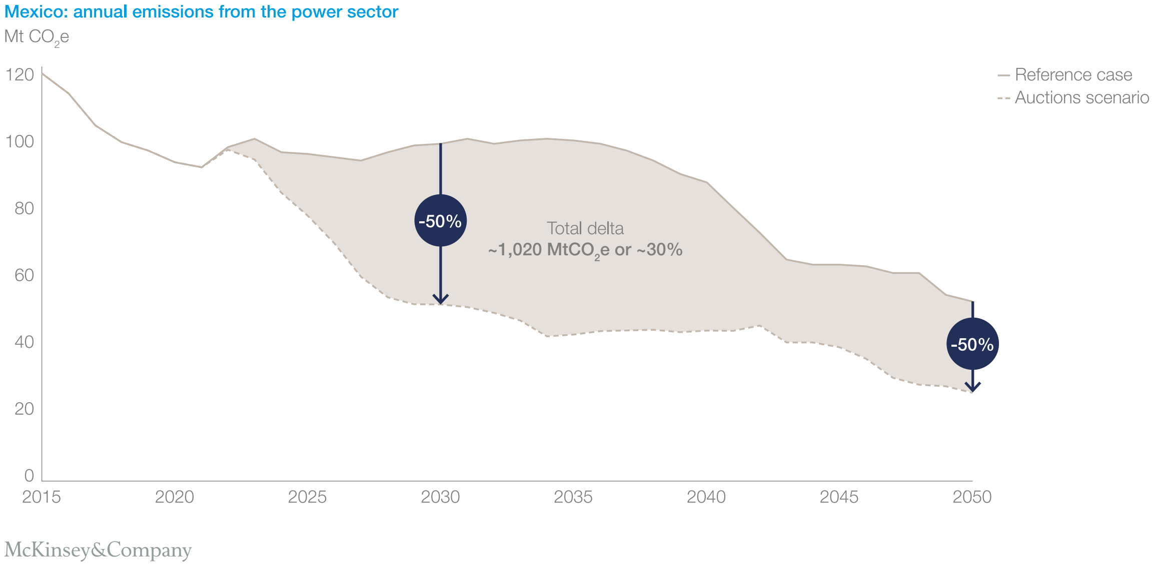


McKinsey&Company

With such low costs, RES absorbs all new demand growth and replaces 40 percent of gas and 25 percent of coal generation.

The large replacement of fossil-based power generation in the auctions scenario yields ~30 percent (~1,020 Mt CO_2e) carbon emissions reductions until 2050. By 2030, annual emissions are nearly 50 percent (~98 Mt/yr vs ~50 Mt/yr) lower than in the reference case (see exhibit 9).

Exhibit 9: In Mexico, total cumulative emissions until 2050 are reduced by 30%.



3. India: renewable sources can cover all additional power demand growth

All new power demand growth is absorbed by RES, reducing total cumulative coal generation until 2050 by 30 percent—stagnating at current levels. Total CO_2e emissions until 2050 are reduced by 25 percent, while annual emissions in 2050 drop by ~50 percent.

In India, the solar uptake is accelerated by ~5 years (reaching ~850 TWh in 2030 instead of 2035), as new solar becomes competitive against existing coal already in 2025, compared to post 2050 as in the reference case (see exhibits 10 and 11). Already in the reference case, solar competes primarily against coal newbuild to cover the power demand growth, where solar is competitive against new coal post 2024. While in the auctions scenario, solar is already competitive against coal newbuild in 2020 and the combination of solar and storage by 2025.

Exhibit 10: In India, wind penetration in power generation is accelerated by ~15 years and solar by 5 years.

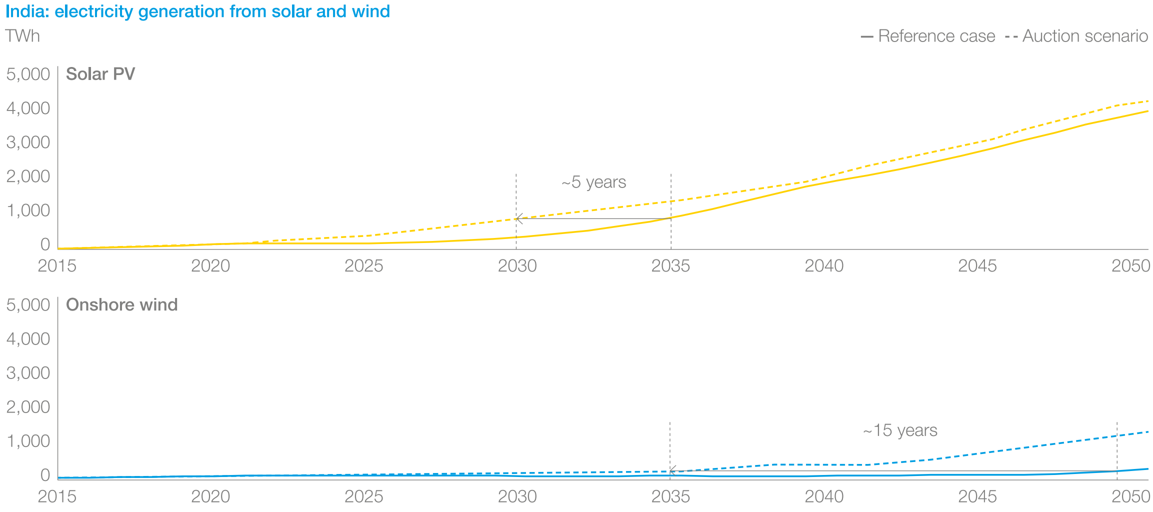
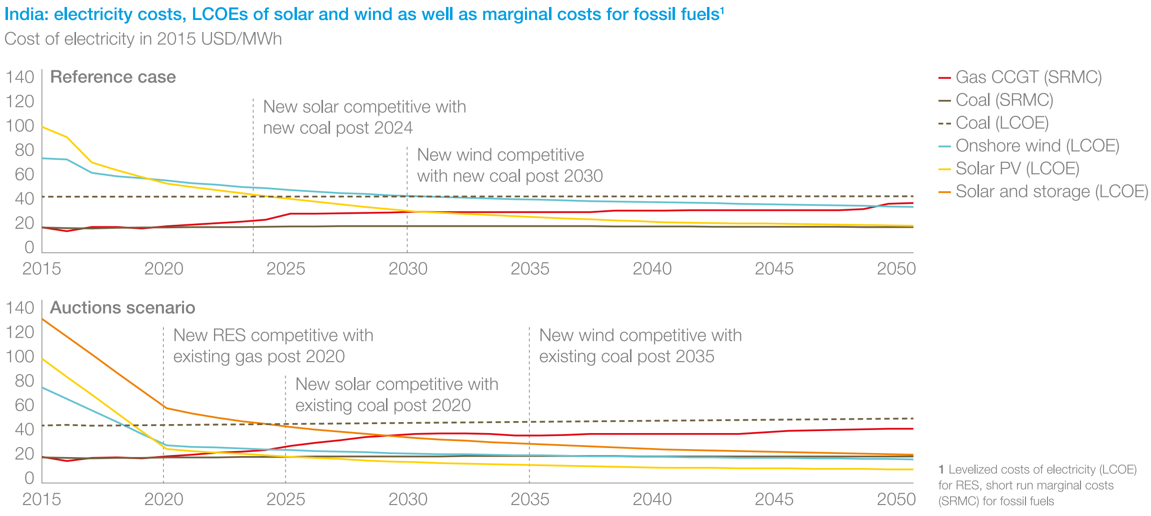


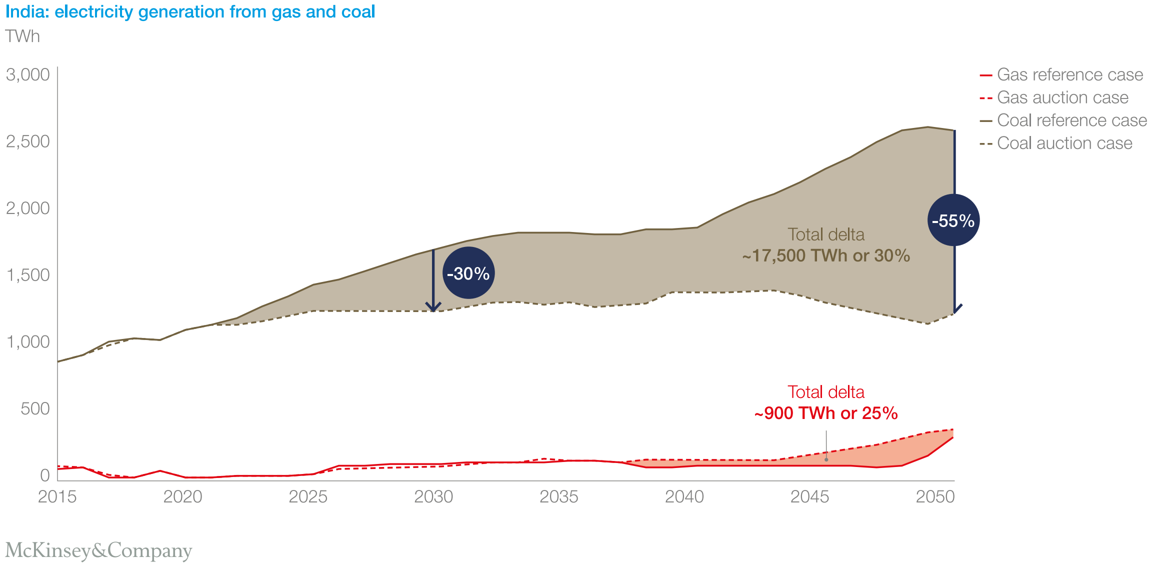
Exhibit 11: In India, solar is cost-competitive against existing coal by 2025 and wind by 2035.



The penetration of wind is accelerated by ~15 years, reaching 250 TWh in 2035 instead of ~2050. Wind generation increases more strongly than solar generation relative to the reference case: wind generation in 2050 is more than 4 times higher in the auctions scenario than in the reference case—solar only 10 percent. The main reason behind this difference is that wind becomes cost-competitive against existing coal by 2035 instead of post 2050 in the reference case (see exhibits 10 and 11).

As a consequence, both solar and wind become sufficiently cost-competitive against newbuild coal to absorb all additional demand growth. Compared to the reference case, total coal generation until 2050 is 30 percent (~17,500 TWh) lower in the auctions scenario, effectively keeping coal generation stable at current levels (see exhibit 12).

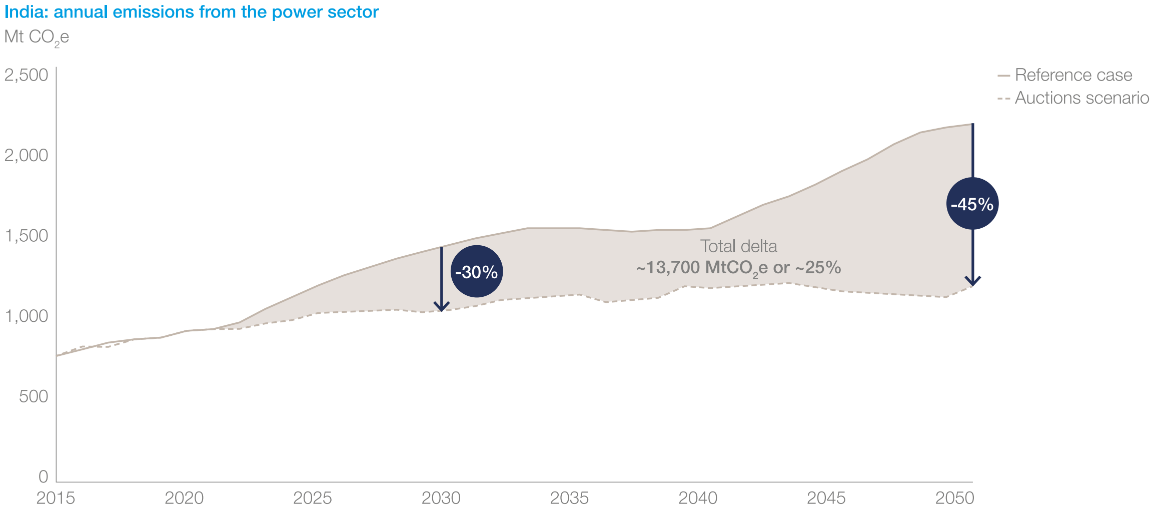
Exhibit 12: In India, all new power generation is covered by RES, coal generation stagnates at current levels.



At the same time, gas generation increases by ~25 percent, primarily driven by the demand for flexible capacity given high RES shares. However, in absolute terms the increase is marginal (~900 TWh).

The reduction in coal generation translates directly into reduced emissions: until 2050, total carbon emissions from the power sector are reduced by ~25 percent (~13,700 Mt CO_2e). In 2050, annual emissions are nearly 50 percent lower than in the reference case (~1,200 Mt/yr vs ~2,200 Mt/yr) (see exhibit 13). The reduction in annual emissions in 2050 of ~1,000 Mt/yr is equivalent to twice the total projected emissions of the EU power sector in that year (~500 Mt/yr)[2].

Exhibit 13: In India, total cumulative emissions are reduced by ~25%.



McKinsey&Company

1. The 2017 bids are for capacity planned to go online in 2020
2. For example, E.g., ~20–25 percent cost reduction with every doubling of installed capacity for solar PV.
3. Get the full report on the GEP reference case 2018 at gep.mckinseyenergyinsights.com.
4. Levelized Cost of Electricity
5. Short-Run Marginal Cost
6. Get the full report on the GEP reference case 2018 at gep.mckinseyenergyinsights.com.
7. According to the European Commission's 2016 EU Reference Scenario for energy, transport and GHG emissions trends to 2050, EU Reference Scenario 2016, "Energy, transport and GHG emissions Trends to 2050."

About the author(s)

Frithjof Wodarg and **Tristan Swysen** are consultants McKinsey's Berlin office, **Christer Tryggestad** is a senior partner in the Oslo office, **Bram Smeets** is an associate partner in the Amsterdam office, **Sebastien Leger** is a partner in the Paris office, and **Jerry van Houten** is a specialist with McKinsey Energy Insights.