

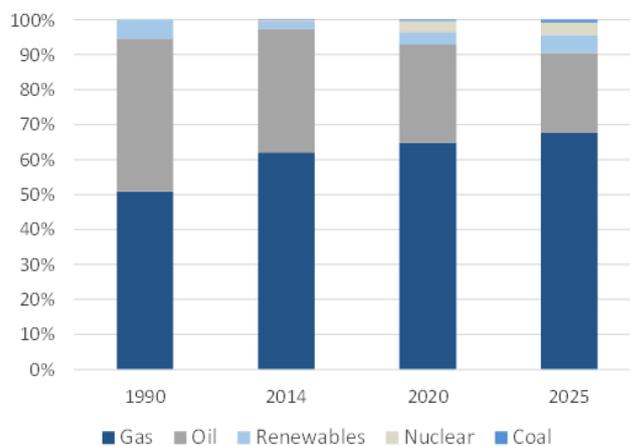


## The future of coal in the MENA power mix

While governments in the region have long relied on oil and gas-fired power plants to add capacity, efforts to diversify the power mix are gaining momentum with renewable energy and nuclear at the forefront. Nonetheless, countries such as Morocco still depend on coal for much of their power generation, and construction of the GCC's first coal-fired power plant is in progress in the UAE. Studies are also underway in Egypt to add significant coal capacity. There are several reasons governments are looking at coal, but the most important is to diversify the energy mix and enhance energy security. Despite this, coal is likely to only play a marginal role in the future of the region's power sector.

Coal continues to be the dominant fuel in the global power mix. As of 2014, its share represented 41%, whereas gas and renewables amounted to 22% and 6%. This is an increase compared to the year 2000, when coal stood at 39%, and gas and renewables at 18% and 2%. As the global community substitutes coal with gas and renewable energy to meet its climate change commitments, a downward trend of the share of coal in electricity generation is almost inevitable.

### MENA power mix



Source: IEA

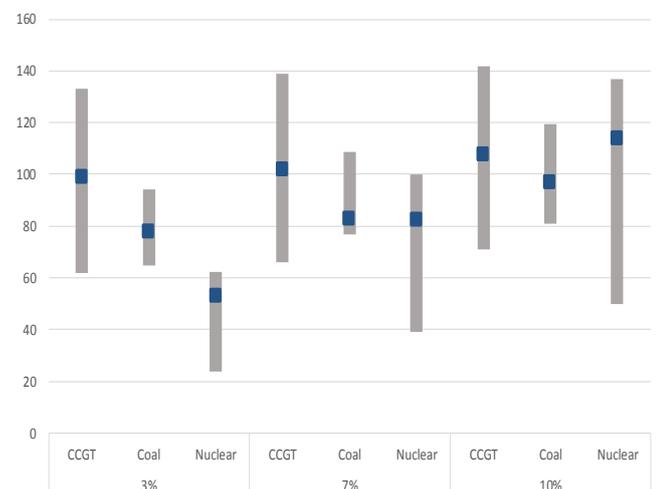
MENA countries – with the exception of Morocco – do not consume coal in their power sectors. Coal was never really part of governments' strategies to tackle demand growth, due to the very low coal reserves in the region. These countries have been relying on oil and gas-fired power plants to meet most of their demand needs. The oil and gas rich GCC region depends on its vast cheap-to-extract resources, while energy poor countries in the region have relied on fuel imports to feed their plants. However, the substantial growth in demand for electricity and the resulting strain on existing capacity has forced governments in the region to diversify their energy mix, and in some cases coal has started to feature in their planning. For example, the UAE has included coal in its 2050 Energy Strategy and is currently building its first clean coal power plant, while Egypt is studying plans to add significant coal capacity next decade. Coal's relatively low operational costs, technological advances in power plant design, concerns over reliability of gas supply and China's role in the financing, construction and development

of plants are all contributory factors; but climate change considerations will mean that overall, the share of coal in the power mix will remain very small.

### Coal can be competitive

Coal projects – and particularly clean coal – require substantial upfront capital but exhibit lower operational and fuel costs over their lifetime, typically over 40 years. Upfront capital costs range from \$1.2bn-3bn/GW of installed capacity, significantly less than nuclear and comparable with gas-fired plants. Investment decisions are therefore heavily dependent on the availability of finance, government support, and coal supplies.

### Levelised cost of electricity range for baseload technologies (\$/MWh)



Source: IEA

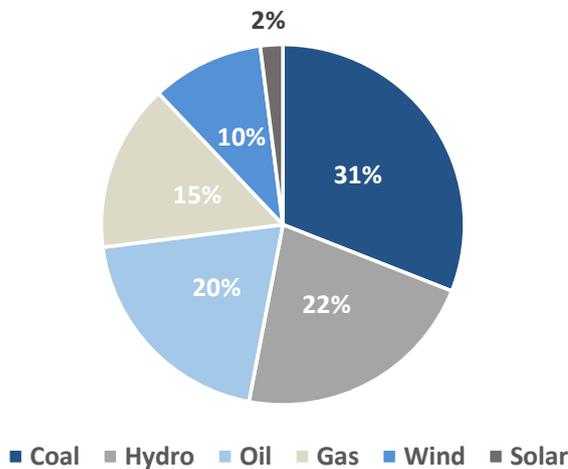
Coal can be competitive against other sources of baseload power. The levelised cost of electricity (LCOE) for coal increases at higher discount rates, given that it is capital intensive. At a discount rate of 3%, coal is less competitive than nuclear but more competitive than gas. At 7% and 10%, coal remains competitive with gas and nuclear.

### Morocco the first to rely on coal

Morocco is a good example of a MENA country that placed coal at the heart of its energy diversification efforts. Despite neighboring gas-rich Algeria, the Kingdom chose to invest in coal plants decades ago to limit its dependence on gas imports, although Algerian gas is passing through Morocco on its way to

Europe. For this reason, Morocco relies significantly on coal imports. In addition, the country is also set to build an LNG import facility while pushing through its ambitious solar and renewable plans, making the country one of the most energy diversified countries in the region.

### 2015 Morocco power mix



Source: Germanwatch

Total power generation capacity in 2016 was 9GW, and is expected to increase to around 12GW by 2021. The country has three coal-fired power plants with a combined capacity of around 2.5GW, with proposals to add two additional plants with a combined capacity of 1.7GW. The existing plants require coal imports of over 11 million tons per year (m t/y), while the two plants being constructed will require an additional 7.8m t/y. The first of the two plants will be the 1.4GW project at Safi – owned by a consortium of Engie, Nareva, and Mitsui. The consortium will construct two 693MW thermal units, which are expected to be operational in 2018. The second project will be the Jerada coal plant – built by China’s SEPCO and expected online this year – with a capacity of 318MW.

### The UAE pushing through diversification efforts

The UAE is pushing strongly to diversify its power mix. There is currently a strong reliance on gas to meet almost all power demand, with significant quantities of gas imported from neighbouring Qatar to supply its power plants, and the country sees energy diversification as a national priority. In the face of growing regional uncertainties, the UAE is looking to reduce its reliance on gas through the Dolphin pipeline which connects Qatar with the UAE and Oman. According to the 2050 UAE Energy Strategy, in a little more than three decades, renewables will constitute 44% of the local power mix, while gas will represent 38%. Clean coal will account for 12%, and 6% will come from nuclear.

The UAE recognises the importance of diversifying its energy mix and sees coal as one of many options. Dubai is currently constructing the 2.4GW Hassyan plant, expected online by 2023. The coal project – along with the country’s ambitious solar and nuclear projects – is significant for the UAE as it marks the imminent push towards energy diversification. Dubai is also on track to reach its ambitious renewables target. Additionally, Abu Dhabi is expected to soon add 5.4GW of nuclear power, with the first reactor coming online in the next 12 months.

Hassyan is being built under the independent power producer (IPP) model. Like most IPP projects in the UAE, the government - through state utilities - will own 51% of the plant, while ACWA (26.95%) and Harbin (22.05%) will own the remaining shares. The EPC contract was awarded to GE and Harbin and will consist of four 600MW units, which will come online in stages between 2020 and 2023. The project secured a 25-year power purchase agreement with the government at a price of \$0.045/kWh. The \$2.47bn financing of the project mostly came from five Chinese government institutions, including the Bank of China, ICBC, Agricultural Bank of China, China Construction Bank, and the Silk Road fund – in addition to First Gulf Bank, Union National Bank, Commercial Bank International and Emirates NBD. Coal supplies will be secured by ACWA and Harbin. Estimates suggest that the plant will need over 10m t/y of coal to operate at full capacity – comparable to 320m cfd of gas in a combined cycle gas turbine.

### MENA operational and planned projects

Project	Country	Operator/Developer	GW	Mn T/Y	Status
<b>Operational</b>			<b>2.52</b>	<b>11.47</b>	
Jorf Lasfar	Morocco	ONEE	2.06	9.35	Online
Mohammedia	Morocco	ONEE	0.30	1.37	Online
Jerada	Morocco	ONEE	0.17	0.75	Online
<b>Planned</b>			<b>2.52</b>	<b>11.47</b>	
Jerada	Morocco	Sepco III	0.32	1.45	2017
Safi	Morocco	Engie/Nareva/Mitsui	1.39	6.32	2018
Hassyan 1	Dubai	Acwa/Dewa	2.40	10.92	2020-23
Hassyan 2	Dubai	Dewa	1.20	5.46	Planned
Hassyan 3	Dubai	Dewa	1.20	5.46	Planned
RAK Maritime city	RAK, UAE	Utico/Shanghai Elec	0.60	2.73	Planned
W Matrouh	Egypt	Elsewedy/Marubeni	2.64	12.01	Planned
El Hamarawein	Egypt	Orascom/IPIC	3.00	13.65	Planned
El Hamarawein	Egypt	Shanghai Elec	2.64	12.01	Planned
Ayun Musa	Egypt	Al-Nowais	2.64	12.01	Planned
El Hamarawein	Egypt	Dongfang Electric	1.98	9.01	Planned

Source: MEES

## Egypt has ambitious plans

The Arab world's most populated country is suffering from insufficient power-generating capacity to meet rising demand. The country has recently faced acute gas shortages, although this is expected to change following the discovery of the giant Al-Zohr field. Despite prioritising gas-fired plants to meet future demand, diversification efforts are also taking place with renewable energy, nuclear and coal being pursued at different paces. Renewable energy is at the forefront of energy diversification efforts. Plans for nuclear are still in preliminary phases, while memoranda of understanding with several companies have been signed for the construction of four 14GW of coal plants.

It is worth noting, though, that no coal investment decisions are expected until the end of the decade as the government focuses on its initial plans to build 4.8GW of nuclear and push through the ambitious solar and wind programs. The recent gas discoveries will likely sideline coal as the country's reliance on gas increases.

## China playing an important role

A clear trend in the development of the region's coal sector is the strong Chinese presence. Chinese state-backed banks are playing a pivotal role in financing coal projects as private banks are showing reluctance to fund coal power plants and multilateral development banks are prioritising the funding of renewable-energy projects. In addition to financing, China is also playing an important role in the construction and development of coal plants. As one of the largest global producers and consumers of coal in the power sector, Chinese firms have the technical ability to build complex and clean coal plants and are keen to become global players. Looking ahead, China will likely cement its position and play a key role in developing future coal capacity.

## Coal share in the power mix will remain limited

There are several reasons which justify the decision to include coal in the power mix. First, despite MENA countries' conviction that gas should play the dominant role in adding generation capacity, supply uncertainty in some countries and expensive-to-extract gas in others are forcing governments to diversify their

sources of electricity. For example, the Hassyan coal project in Dubai was first designed to be gas-fired, but the government changed the project to coal due to uncertainties of gas supplies. Reducing dependency on oil and gas in the power sector is strategically important for exporters who are wary of rising domestic oil and gas consumption potentially reducing exports. At the same time, gas importers want to improve their energy security by reducing reliance on imports.

Second, although the regional momentum is with renewable energy, it will take many years to add significant capacity to increase its share in the power mix. Coal plants are a highly reliable source of baseload capacity, making them a good complement to renewable sources. Additionally, coal prices have declined over the past decade, and whilst there has been a recovery more recently, demand is still weak.

Third, the technology is improving. According to estimates, 80% of coal plants globally are sub-critical and have efficiencies between 25-37%. Environmental and efficiency concerns and rising global commitments to tackle climate change have driven coal efficiency standards to improve. Development of new technology such as the advanced ultra-supercritical pulverized coal combustion is allowing efficiencies rates of 50%, with 15% reduction in CO2 emissions compared with supercritical technology.

Recent policy progress concerning emissions and pollution has forced countries to reassess the role of coal in their energy development strategies. This is paving the way for more renewable-energy generation, coming at the expense of fossil fuels, especially coal. For MENA countries, adding capacity quickly to meet demand is pivotal. Governments will continue to prioritise natural gas and renewables in power generation. But the fact is that energy security concerns are rising amidst higher uncertainty, and energy diversification is at the top of policymakers' agenda. While this will push some governments to re-consider coal in their energy mix, coal is not likely to play a significant role in the region's power mix.

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