UNIVERSITY of GUYANA

Institute for Energy Diplomacy

AN INSTITUTE OF THE UNIVERSITY OF GUYANA

University of Guyana's Institute for Energy Diplomacy

ENERGY COMMENTS

NATURAL GAS: A BRIDGE FUEL

AUGUST 2020

WWW.UGIED.COM

Natural Gas: A Bridge Fuel

By Alex Armogan

LLB MBA MSc International Economics and Finance (Distinction, BU Business School)

MSc Energy, Trade and Finance (Merit, Cass Business School, City, UoL)

Founding Director

University of Guyana's Institute for Energy Diplomacy

University of Guyana's Energy Think Tank

The need to shift away from fossil fuels to a low carbon energy system is high on the global policy agenda. Renewable energy sources are deemed axiomatic to the fight against climate change and the achievement of sustainable development. However, some may argue that to cast all types of fossil fuels into the same category at the least from a mid-term perspective will result in a misnomer for natural gas. To understand the viewpoint, an awareness of the power sector's emissions contribution and the technological shift from open-cycle gas-turbines to closed-cycle gas-turbines are necessary.

The power sector is the first end-use sector increasingly targeted for a carbon dioxide shave due to its role as the single largest source of emissions. In a 2020 report, IRENA notes that 100% renewable energy (RE) targets exist in 61 countries- broken down into Asia and Oceania (25), Africa (19), Central America and the Caribbean (8), Europe (7) and South America (2). Many countries have set vague targets, but 18 out of the 61 specifically refine their focus on renewable electricity. At a sub-national level, half of the 318 cities or regions with a 100% RE target identify electricity. In the renewable energy transformation of the power sector, natural gas is currently labeled as the "bridge fuel." The term "bridge fuel" is controversial. A renewable energy purist would balk at its implied message, to transition to a 100% renewable energy, we must first use natural gas to defeat coal or heavy fuel oil before shifting to a renewable energy state.

The leading source for power generation is coal, responsible for 10100.5 TWh in 2018, followed by natural gas at 6182.8 TWh. Gauged by the 2018 fossil fuel make-up of electricity, above 60%, the gap between grey and green is expansive. The scale-up of renewable energy capacity from 754 GW to 2537 GW (2010-2019) and the growth of non-hydro renewable energy generation from 2% to 9% (2010-2018) is impressive. Yet, renewables are growing from a low base. The low base is driven home by China's and India's greater than 50% coal reliance in its fuel mix; coal accounted for 66.5% and 75.35% of the 2018

electricity mix, respectively. Coal has been extensively relied on to meet increasing electricity demand in these growth areas. India has one of the largest electrification success stories, giving access to electricity to over 500 million from the turn of the 21st century. The country's gain in access to electricity is also a downfall in the battle against emissions since coal was the driver.

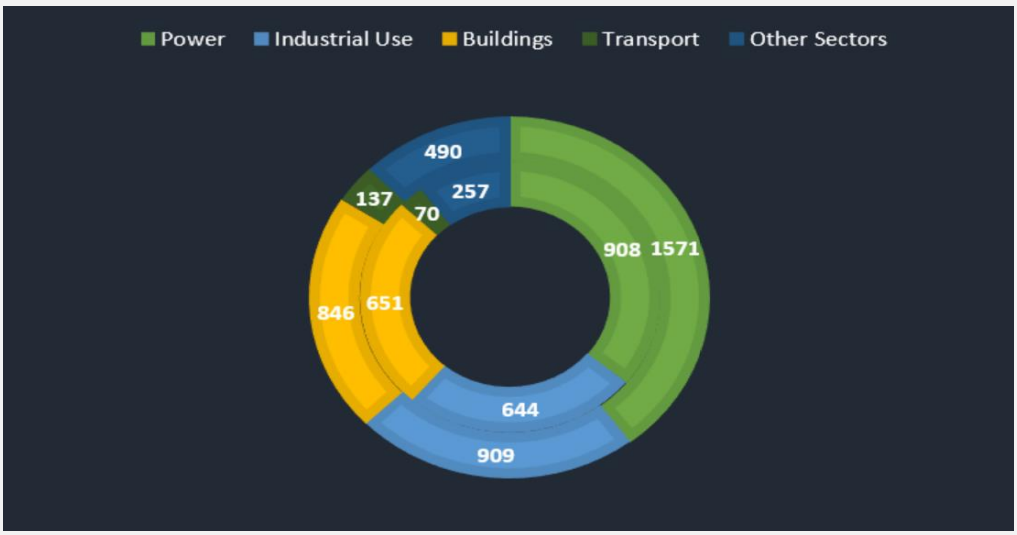

Diagram 1: Natural Gas Demand (billion cubic meters) by End-Use Sectors in 2000 (inner circle) and 2018 (outer circle) | Source: WEO (2019)

Coal's future is dependent on China and India. The rebound of coal use in 2017 aligned with the end of three flat years of global carbon dioxide emissions and an increase to 2018. Both countries have committed on the policy front to the shift away from coal, evidenced by their mid-2010s UNFCCC Nationally Determined Contribution.

In the basket of fossil fuels, natural gas is the least environmentally damaging. The success of the combined-cycle gas-turbines (CCGT) over the traditional open-cycle gas-turbines (OCGT) has further separated the environmental impact of natural gas generation from coal-fired generation. CCGT uses two turbines and two generators to increase the power produced while reducing

waste. The gas is combusted to drive the first turbine, the power generated is amplified by a generator and the escaping steam is rationalised via propelling a second turbine that is again amplified. A blanket statement on CCGT efficiency over conventional fossil-fired generation resources is its circa 50% less carbon dioxide emissions, sizeable reduction in nitrogen oxides and near elimination of sulfur dioxide.

CCGT technology has made progressive leaps over the last decade. In 2016, GE and EDF unveiled a new-generation CCGT turbine in France that achieved 62.2% efficiency, in contrast to the 58% conventional CCGT and the 37% conventional coal-fired plant. The bar was once again shifted in 2018 by an improvement to 63% by a GE led project in Japan. The disparity in the environmental impact of natural gas and other fossil fuels, its increasing supply due to the shale revolution and the technological developments on carbon capture and storage (pre-combustion, post-combustion and oxy-fuel combustion capture) explains the case for natural gas along the low carbon journey as it seems primed to replace a significant share of coal-fired generation. It is expected to erode coal's place in the power sector and overall assume the second place in the primary energy consumption mix, after oil.

A seminal MIT study in the early 2010s warned that natural gas could not only edge out coal but threaten renewables in the US. Solar and wind generation costs have significantly declined over the 2010-2019 period; solar PV fell by 82% and onshore wind by 40%. One of the best measures of price competitiveness amongst varying energy generation technologies is the concept of Levelised Cost of Electricity (LCOE). The LCOE, is the present value of the total cost incurred in building and operating a power plant for a given financial life and duty cycle. It should be noted that the LCOE varies per region and based on the extent of intermittent RE in the electricity mix. IRENA estimates the 2010 weighted-average LCOE for utility-scale solar PV, in USD per kWh, at 0.378; the LCOE declined to 0.085 in 2018 and in its latest report to 0.068. Onshore

wind has fallen to 0.053 USD per kWh. The United Arab Emirates has received consistently new lows in Independent Power Producer bids for solar PV projects; in April 2020 the current world's lowest price at 1.35 US cents per kWh was reported for a 2 GW Abu Dhabi project. Solar progress can be seen in the US oil and gas hub, Texas, where a quarter of the 2020 industrial-scale US solar capacity installations are centered on; shale has not excluded solar's march in the Permian Basin. A combination of factors has caused the UK to register its longest period of grid operation without coal in the first half of 2020. IRENA's Director-General, in a June 2020 press release, alluded to an inflection point in the energy transition to a state where renewables are the cheapest source of new electricity capacity and undercut all fossil fuel sources.

Renewable energy and natural gas power projects have driven the aggregate power sector investment above oil and gas supply investment. However, the gas-fired power generation market is increasingly under strain from renewables. Gas-turbine sales by generation capacity edged past 70 GW in 2011. It has contracted and is currently hovering around the 30 GW mark, per McCoy Power Reports.

Cost improvement in solar PV and onshore wind is making the case to switch from coal to these variable intermittent sources as opposed to natural gas. The role of natural gas in the mid-term energy system is compelling as a generation source necessary for operational flexibility. Manufacturers are continuously developing their turbines' ability to balance supply and demand. The aforementioned GE and EDF 2016 turbine achieves a ramp-up rate in excess of 50 MW per minute and maximum power in less than 30 minutes.

Flexibility is vital in an energy system characterised by a high share of variable renewable generation. Solar and wind generation are known for their

intermittent supply. The level can be high during bright and breezy days but coincide with a period of low demand (vice versa). A lack of effective storage results in surplus generation to the grid. Natural gas generation can, therefore, be ramped up or down to balance the system. The development of effective storage for utility solar and wind generation may damper the flexibility role.

An important area that must be monitored for its impact on natural gas generation is the possibility of an economic case for hydrogen generation emerging over the coming decades. Technological advancements and carbon pricing policies, among other factors, may establish the feasibility to retrofit natural gas plants for hydrogen generation.

Main takeaways:

- Governments are increasingly aiming for 100% RE generation in the Power Sector.
- Natural gas is often labelled as a bridge fuel to assist the shift away from coal or oil-based generation to a RE state. The role of NG as a bridge fuel is informed by the enhanced efficiency and lower environmental impact compared to conventional generation.
- The cost improvements in RE generation, particularly solar PV, from 2010 have weakened the case of using natural gas as a bridge fuel. While the Levelised Cost of Electricity varies per region, RE generation is referenced by IRENA as the cheapest source for new generation capacity.
- Generation from hydrogen may present a way for countries using natural gas as a medium-term solution to align with a RE target.