

SOLAR-IMPACTING THE GAS STORY?

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Background

Natural gas and renewable energy including solar were for long considered to have a synergetic relationship – each complimenting the other. In fact the world over, energy leaders expressed support for new natural gas capacity to facilitate the development of renewable power, specially as back up generation source. This had been the general perception - natural gas operating cooperatively with solar and wind energy to support a renewable energy future. However, lately, speedy technological development in renewable power generation as well as storage has started to put a question mark on the collateral development of the gas based generation. We now have solar generation at very competitive price and in combination with better grid

management and storage capabilities; it is putting pressure on gas based generation.

More importantly, let us just look back on the Intergovernmental Panel on Climate Change report which concludes that global greenhouse gas emissions would need to decline by 50-85% by 2050 from its 1990 levels. Implication - the use of fossil fuel including natural gas will need to be checked. This would also require us to meaningfully reduce our national reliance on imported oil for transportation and full deployment of one or more alternative fuels. Faced with projections of stagnant demand, specially in the power sector, the gas industry is pinning its hopes for growth on road and waterborne transport. Earlier we use to talk about changing to natural gas vehicles to make

International Perspective

In 2016, global coal consumption fell by 53 MMT0E, a drop of 1.7%, the second successive annual decrease with China, USA and UK leading the decline. China which consumes more than half of the coal in the world has considerably reduced coal use and is aggressively pursuing its replacement.

Oil continues to remain the world's leading energy source, accounting for almost a third of global energy consumption. After 15 years of decline from 1999 to 2014, oil's share has increased in the last two years on the back of growth in gasoline and jet fuel demand but diesel consumption has declined since 2009. Oil's close cousin natural gas consumption grew by 1.5%, slower than the last 10-year average of 2.3% with Europe and China leading the growth.

Overall, most developed countries have been showing a declining trend in fossil fuel consumption. The big gainer of this development has been renewable. Countries around the world are seeing double digit growth in their renewable consumption and its share in primary energy are increasing at the expense of fossil fuels (Table 7).

Against this fossil fuel scenario, renewable power consumption grew by 14.1% in 2016, providing 7.5% of the world's electricity. The rapid growth of non-hydro renewable power generation continued in 2016. It was the 13th successive year of double-digit growth. As

per BP, renewable accounted for nearly 40% of the growth in global power generation in 2016, and contributed 31% of world primary energy growth. The share of renewable power in global power generation almost doubled in five years from 4.0% in 2011. Countries where renewable contribute more than 20% of the power generated include: Germany, Spain, UK, Italy, Portugal, Denmark, Finland, Norway, Ireland and New Zealand.

Solar power generation enjoyed another year of very rapid growth in 2016, with a 29.6% increase. Solar has clearly caught the attention of policy makers around the globe including India with a noticeable impact on power generation growth, contributing more than 20% of the growth of global power in 2016. According to BP, new installations totaling more than 75 GW in 2016 took global solar PV power generating capacity to 301 GW by year-end, a 33.2% increase versus the end of 2015. The new installation figures for 2017 have not been confirmed yet but reports say they are over 100GW taking the global solar capacity at end of 2017 to over 400 GW.

Country-wise, India ranks fifth in solar capacity after China, Japan, US and Germany. However, both India and China are growing their solar capacities at a CAGR of about 100% since 2010. China leads in terms of cumulative installed capacity (130 GW), with more than a quarter of the global total. Japan (50 GW) moved past US (50 GW) to take second place, with Germany (43 GW) now close behind US.

Table 1: Installed Solar PV capacity in Select Countries

MW	2010	2011	2012	2013	2014	2015	2016	2017*	CAGR (%)
US	2040	3959	7328	12079	18317	25570	40300	50,000	57.93
Germany	17944	25429	33033	36337	38343	39799	41275	42800	13.22
Italy	3504	12808	16456	18202	18606	18906	19279	19600	27.88
China	850	3550	6750	17740	28380	43530	78070	130370	105.23
India	177	481	1176	2320	3062	5040	9010	20000	96.47
Japan	3618	4914	6632	13599	23339	34151	42750	50750	45.83

Source: BP,
*NGS Research

Table 2: Installed Solar PV capacity in India

Table 2: Installed solar PV capacity (MW) as on March 31	
2010	161
2011	461
2012	1205
2013	2319
2014	2632
2015	3744
2016	6763
2017	12289

Source: CEA, NGS Research

Table 3: India solar generation (MU)

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Year	Total
2014-15	4599.01
2015-16	7447.93
2016-17	13499.41
2017-18 (Apr 17-Jan 18)	19850

Source: CEA, NGS Research

Table 4: Growth in electricity generation in India

Year	Growth in conventional generation (%)	Growth in renewable generation (%)	Growth in total generation (%)
2015-16	5.64	6.47	5.69
2016-17	4.72	23.97	5.8
2017-18 (Upto December 2017)	3.8	21.07	4.98

Source: Ministry of Power

it possible to reach the 2030 target of 30% greenhouse gas emissions reduction but now the global focus is on e-mobility. The renewable including solar scenario had been lurking on the horizon for quite some time and, therefore, we thought it fit to take a peek into the solar world.

Without doubt, the Paris Climate Agreement was the turning point for Renewables. After the Agreement, countries around the world made serious commitments to reduce greenhouse gas emissions and as usual the fossil fuel industry started to get worried, whether as a direct consequence or related to this agreement, coal consumption has been declining and the oil and gas sector is flat or marginally up.

Global coal consumption has fallen, though oil share in global consumption has increased marginally. Diesel consumption has declined. Growth in natural gas consumption at 1.5% is slower than last 10-year average of 2.3%. Contrast this with double digit growth in several countries in renewable consumption and the increasing share in primary energy. Among the renewables, solar seems to lead the path with an

almost 30% increase in growth in 2016. (see box *International Perspective*, page 7)

India Solar Story

As of January 31, 2018 India's solar capacity stood at 20 GW. This was initially targeted for 2022. The solar generation too has more than quadrupled since 2014-15. During 2016-17, thermal generation increased by 5.34%, hydro reduced by 0.82%, nuclear increased by 1.34%, imports from Bhutan increased by 7.11% while it was renewable (including solar) which saw a growth of whopping 24%. Most of the new generation capacity in India is renewable. NTPC emerged as the primary driver of renewable and has a target of 36 GW by 2032 for its generation fleet. This initiative of NTPC has come at the cost of gas based generation and decline in growth of coal based generation.

So why is solar rising in India? For one, it definitely has government's attention. All government plan documents talk big about its plans and targets for renewables and solar in particular. In January 2015 the Indian government expanded its solar plans, targeting US\$100 billion in investment and 100 GW of solar capacity (including 40 GW from only rooftop solar) by 2022. India is a signatory to Paris Agreement and is therefore committed to reduce emissions in which renewable including solar could play a key role. We need to all agree that electric vehicles charged with power from renewable are the only zero emission vehicle. Therefore, combination of solar power and e-mobility is expected to impact fossil fuel use in the long run.

The improvements in solar thermal storage power technology in recent years has made this task achievable as the

Table 5: Falling solar costs

Year	Benchmark capital cost /MW (Rscore)		Generic total levelled tariff/unit (Rs)	
	Solar PV	Solar thermal	Solar PV	Solar thermal
2010-11	17	13	17.91	15.31
2011-12	14.42	15		
2012-13	10	13		
2013-14	8	12	8.75	11.9
2014-15	6.91	12	7.72	11.88
2015-16	6.06	12	7.04	12.05
2016-17	5.3	12	5.68	12.07

Source: CERC, NGS Research

cheaper solar power need not depend on costly and less clean coal/gas/nuclear based power generation for ensuring stable grid operation. And, in addition to its large-scale grid-connected solar PV initiative, India is developing off-grid solar power for local energy needs too.

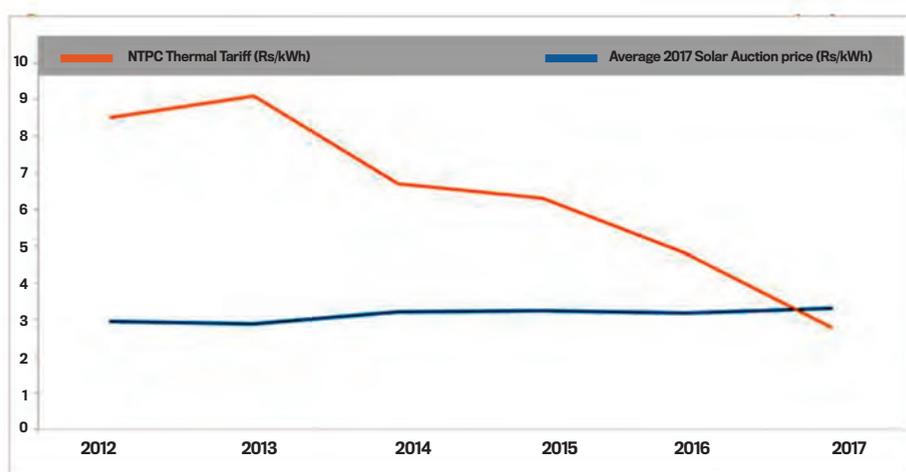
The increase of solar has mostly been enabled by its falling price consequent to technological development. The price of solar energy is now lower than the price of thermal and nuclear energy. This was reflected in the price of average bid in reverse auctions in April 2017 of Rs 3.15/kWh, compared with Rs 12.16/ kWh in 2010, a 73% drop. The tariff for the latest 500 MW solar park has fallen to Rs 2.44 per kWh from Rs 2.97 per kWh in early 2017. The tariff is lower than NTPC's average coal power tariff of Rs 3.20/kWh. The levelized cost of solar PV electricity fell below 1.77¢ US per kWh in November 2017, cheaper than fuel cost of any pit head coal-based power plants in India.

However, there is still lot of ambiguity. One, a large percentage of India's electricity needs is still met by non-renewable sources thus immediate lower consumer prices are unlikely. Two, the number of solar auctions dropped in the

second half of 2017 primarily because of sudden increase in Chinese panel prices in third quarter of 2017 after years of steadily dropping prices. Three, the government introduced a new general sales tax increasing the rate on solar panels from zero in most states to 5 per cent while also reducing the rate for coal. This would make domestic panel cost higher. At the same time, in January 2018 to safeguard domestic solar panel manufacturers, the government recommended a 70 per cent duty on solar cells and panels from China and Malaysia for 200 days (India imported photovoltaic modules and cells worth \$3.3 billion in 2017 (until November) and 90 percent of it came from China, according to Bloomberg New Energy Finance). Four, the lower solar auction prices was also a result of aggressive bidding by companies to counter cut throat competition.

Also, though it may be eating away into fossil fuel-based power generation, for transport, commercial and residential segments, gas is still more competitive than electricity supplied through the grid. But the advantage may disappear in the long run with low cost solar power and development of high efficiency cooking and heating equipments on electricity (See Table 6, on page 10).

India coal power prices compared to solar auction prices 2012-2017



Source: NTPC, Bloomberg New Energy Finance, Livemint, Bloomberg Gadfly

Solar & Rural

Solar products have increasingly helped to meet rural needs; by the end of 2015, under one million solar lanterns were sold in the country, reducing the need for kerosene and grid electricity. That year, 118,700 solar home lighting systems were installed and 46,655 solar street lighting installations were provided under a national program; over 1.4 million solar cookers were distributed in India. These initiatives have the potential to significant impact not only rural electrification but also future potential use of alternate fuel, like gas and LPG in rural areas.

Table 6: Cost of alternate fuels

Fuel	Unit Commonly Used	Calorific Value	Quantity Required for 1 MMBtu	Unit Rate (INR)	Rate per MMBtu (INR)
Electricity	Kwh	860 Kcal/Kwh	293 KWH	5.00	1465.00
LPG (Subsidized)	Kg	11600 Kcal/Kg	22.10 Kg	34.90	771.38
LPG (Non subsidized)	Kg	11600 Kcal/Kg	22.10 Kg	52.18	1153.25
LPG (Automotive)	Litre	7000 Kcal/ltr	36.44 litre	44.81	990.30
Diesel	Litre	9300 Kcal/Litre	27.58 Ltr	59.81	1649.56
Gasoline	Litre	9500 Kcal/Litre	27.00 Ltr	70.03	1890.81
CNG	Kg	13158 Kcal/Kg	22.98 Kg	39.71	912.54
PNG	SCM	9000 Kcal/SCM	28.50 SCM	25.99	740.72

Source: NGS Research

Solar will impact - Industry needs to innovate

The gas industry has been claiming that combining gas with solar is the most practical way to achieve the low carbon emissions. However, the shift away from gas in developing economies may soon find a foothold in developed economies. The global trend in the growth of renewable as compared to fossil fuel is proof of the focus on renewable. Further, there is also an increasing trend of installing rooftop solar panels on a high number of commercial establishments including homes which has been impacting both gas and grid electricity consumption in developed countries. According to the Australian Energy Market Operator (AEMO) new technologies and changing consumer behaviour are behind the flat forecasts for residential and commercial gas consumption over the next five years in Australia. This could be true for other developed regions too.

- As the pressure for pollution control increases and more renewable power becomes available, the gas industry will need to work harder to beat some of the negativity around it, specially regarding the greenhouse emissions from methane.

- The gas industry needs to innovate and evolve to minimise the challenge expected from the solar sector. For example, according to the Australian Energy Market Operator, gas is not needed for houses with rooftop solar. High efficiency electrical appliances, such as induction cook stoves and reverse-cycle air conditioners for heating and cooling, mean that there is no longer any need to use gas for cooking or for heating. When a home is powered by solar, these cooking and heating appliances can be powered by 100% renewable energy. And high efficiency electrical cooking and heating appliances powered by rooftop solar are likely to be widely available in the future. However, this is not a very likely scenario in India, at least for now as different lifestyles and purchasing power for electrical

appliances are hardly at par. But with growing urbanization and young mobile population, in the longer run, it may be a different matter.

- Natural gas had also been seen as a support for energy security. While a diverse range of energy sources including gas will guarantee energy security, renewable energy is the only one to provide long term energy security in a world that is rapidly decarbonising. All the more so with sustainable and continuous improvement in storage technology, renewable energy

technologies work when the sun isn't shining and the wind isn't blowing. This would be another challenge to the gas industry.

- In developing economies like India, new markets are likely to open up for gas in urban centres as a result of ban on use of furnace oil, petcoke and diesel for small captive power in the near to medium term but in the future renewable and e-mobility is likely to play a dominant role. However, in the short to medium term gas is expected to play a key role in urban transportation as well as in the industry.

- Rooftop solar panels on commercial and residential buildings are likely to impact not only grid electricity consumption but gas consumption (cooking and heating) too in India. This would mostly depend upon the cost competitiveness

- Electric vehicles charged with power coming from renewable energy sources are the only zero emissions vehicles and would ideally fit into the policy makers drive for lower emissions. However, the penetration of e-vehicles is unlikely to be high in the medium term and natural gas segment will continue to grow because of its inherent environmental advantages. In the long term, e-mobility is expected to offer stiff challenges to the gas vehicles, therefore, the gas industry will need to innovate and invent to beat the challenges.

We believe that the world has reached a turning point, and is now adding more power capacity from renewable every year and also growing much faster than fossil fuels. In India too we see a similar trend emerging.

More importantly, in urban transportation, e-mobility is likely offer strong competition to natural gas vehicles. The Indian gas industry will need to factor in the new challenges which are expected to emerge from an ever growing solar story. The gas industry would do well to develop and devise strategies to meet the challenges and dilute the solar impact.

Table 7: Renewables increase share across countries at expense of fossil fuels

Consumption (mtoe)	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	CAGR
US											
Renewables	24.8	29.7	33.9	39.3	45.7	51.7	60.2	67.2	71.5	83.8	14.5%
Natural gas	596.3	600.8	590.1	619.3	628.8	657.4	675.5	690.0	710.5	716.3	2.1%
Coal	573.3	564.2	496.2	525.0	495.4	437.9	454.6	453.5	391.8	358.4	-5.1%
Oil	928.8	875.4	833.2	850.1	834.9	817.0	832.1	838.1	856.5	863.1	-0.8%
Nuclear	192.1	192.0	190.3	192.2	188.2	183.2	187.9	189.9	189.9	191.8	♦
Hydroelectric	55.0	56.8	61.4	58.2	71.5	62.0	60.3	57.9	55.8	59.2	0.8%
Brazil											
Renewables	4.2	4.7	5.4	7.6	7.9	9.1	10.6	13.3	16	19	18.3%
Natural gas	19.1	22.4	18.1	24.1	24	28.5	33.6	35.6	37.5	32.9	6.2%
Coal	13.6	13.8	11.1	14.5	15.4	15.3	16.5	17.5	17.7	16.5	2.2%
Oil	107.5	116.2	117	126.8	131.9	134.3	144.2	150.6	146.6	138.8	2.9%
Nuclear	2.8	3.2	2.9	3.3	3.5	3.6	3.5	3.5	3.3	3.6	2.8%
Hydroelectric	84.6	83.6	88.5	91.3	96.9	94	88.5	84.5	81.4	86.9	0.3%
Germany											
Renewables	15.2	16.5	17.2	18.9	23.8	27.2	29	32.1	38.1	37.9	10.7%
Natural gas	76.2	77	72.6	75.7	69.5	69.7	73.1	63.5	66.2	72.4	-0.6%
Coal	86.7	80.1	71.7	77.1	78.3	80.5	82.8	79.6	78.5	75.3	-1.6%
Oil	112.5	118.9	113.9	115.4	112	111.4	113.4	110.4	110	113	♦
Nuclear	31.8	33.7	30.5	31.8	24.4	22.5	22	22	20.8	19.1	-5.5%
Hydroelectric	4.8	4.6	4.3	4.7	4	5	5.2	4.4	4.3	4.8	-
UK											
Renewables	3.3	3.8	4.5	5	6.5	8.1	11	13.3	17.5	17.5	20.4%
Natural gas	81.9	84.4	78.3	84.8	70.3	66.5	65.7	60	61.3	69	-1.9%
Coal	38.4	35.6	29.8	30.9	31.4	39	36.8	29.7	23	11	-13.0%
Oil	80.7	79.5	75.8	74.9	73.6	71.4	70.3	69.8	71.8	73.1	-1.1%
Nuclear	14.3	11.9	15.6	14.1	15.6	15.9	16	14.4	15.9	16.2	1.4%
Hydroelectric	1.1	1.2	1.2	0.8	1.3	1.2	1.1	1.3	1.4	1.2	1.0%
China											
Renewables	3.5	6.4	11	15.9	22.8	29.4	42.3	50.8	64.4	86.1	42.7%
Natural gas	65.7	75.7	83.3	100.1	123.4	135.8	154.7	169.6	175.3	189.3	12.5%
Coal	1584	1609	1686	1749	1904	1928	1969	1955	1914	1888	2.0%
Oil	370.7	378.1	392.8	448.5	465.1	487.1	508.1	528	561.8	578.7	5.1%
Nuclear	14.1	15.5	15.9	16.7	19.5	22	25.3	30	38.6	48.2	14.6%
Hydroelectric	109.8	144.1	139.3	161	155.7	195.2	205.8	237.8	252.2	263.1	10.2%
India											
Renewables	4	4.8	6.3	7.2	8.8	10.4	11.6	12	12.7	16.5	17.1%
Natural gas	36.3	37.4	45.6	54.3	55	64	44.4	43.9	41.2	45.1	2.4%
Coal	240.1	259.3	280.8	290.4	304.8	330	352.8	387.5	396.6	411.9	6.2%
Oil	138.1	144.7	152.6	155.4	163	173.6	175.3	180.8	195.8	212.7	4.9%
Nuclear	4	3.4	3.8	5.2	7.3	7.5	7.5	7.8	8.7	8.6	8.9%
Hydroelectric	27.7	26.1	24.1	24.6	29.8	26.2	29.9	31.5	30.2	29.1	0.5%
Japan											
Renewables	6.2	6.1	6.1	6.7	7	7.7	9.3	11.8	14.8	18.8	13.1%
Natural gas	81.2	84.4	78.7	85.1	95	105.2	105.2	106.2	102.1	100.1	2.4%
Coal	117.7	120.3	101.6	115.7	109.6	115.8	121.2	119.1	119.9	119.9	0.2%
Oil	230.9	224.8	200.3	202.7	203.7	217.7	207.4	197	189	184.3	-2.5%
Nuclear	63.1	57	65	66.2	36.9	4.1	3.3	0	1	4	-26.4%
Hydroelectric	16.9	16.8	15.6	19.7	18.3	17.2	17.7	18.1	19	18.1	0.8%

Table 8: Fuel-wise installed capacity of electricity generation in India as of Dec 17

Fuel	MW	% of Total
Total Thermal	2,18,960	66.20%
Coal	1,92,972	58.30%
Gas	25,150	7.60%
Oil	838	0.30%
Hydro (Renewable)	44,963	13.60%
Nuclear	6,780	2.00%
RES* (MNRE)	60,158	18.20%
Total	330,861	

* Installed capacity in respect of RES (MNRE) as on 30.09.2017. RES (Renewable Energy Sources) include Small Hydro Project, Biomass Gasifier, Biomass Power, Urban & Industrial Waste Power, Solar and Wind Energy. Source: CEA