Engage Echo - Utilities & Power Equipment

Interaction with Mr RP Singh, IAS; An energy policy expert

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We had the privilege of hosting the highly respected energy policy expert, Mr Raj Pratap Singh, IAS. He is the former Chairman of the UP Electricity Regulatory Commission, has served as the Private Secretary to the Prime Minister, and is currently the Election Commissioner of Uttar Pradesh. India will require a huge quantity of energy to become a developed nation by 2047; the ask rate for electricity per capita is 5,000-6,000kWh from the existing 1,400kWh. Presuming that all the non-fossil power generation capacities are harnessed along with zero thermal power by 2047, India can reach a per capita generation of 3,209kWh only. Hence, RE is not sufficient and coal-fired power plants cannot be avoided. However, any breakthrough in efficiency of solar PV can change the perspective on thermal power. Nuclear energy is the most land-efficient and cleanest source of power and some positive developments are anticipated with the participation of the private sector. RE has provided only sustenance not growth across the countries with high penetration. The country has to decarbonise the grid first rather than shift to EV. As the share of RE is increasing, power system is changing from base load and variable load to flexible load and flexible generation.

- **Which is the best and cleanest source?** Nuclear energy is the most land-efficient and cleanest source of power. In contrast, solar energy is the least land efficient.
- **Nuclear power:** The goal, 100GW by 2047, is quite ambitious. But some positive developments are anticipated, as there are no alternative solutions.
- **Which is the cheapest source?** Coal is less expensive than Solar+Storage. As % of variable RE increases, the LCOE also increases, as seen in California (CAISO) and Texas (ERCOT).
- **Energy transition in India:** Thermal contributes 52% to the installed capacity, but has 75% share in generation. RE with 36% capacity contributes just 14% to generation.
- **Energy trilemma:** India has committed to net zero by 2070. Several countries have pledged for 2050 or earlier - a 20-year gap for India. None of these countries (UK, USA, Australia) had reached the 14% share of RE in 2000 that India currently has today.
- **RE has provided only sustenance not growth, globally:** Major countries (UK, Germany, France) with a high level of RE penetration have experienced nil or stagnant demand in the recent past. India needs a 7% growth in energy terms for at least the next 25 years.
- **Power demand by 2047 and need for coal:** India will require a lot of energy to become a developed nation by 2047; the ask rate for electricity per capita is 5,000-6,000kWh from the existing 1,400kWh. Presuming that all the non-fossil power capacities are harnessed (100GW nuclear, 1,164GW wind, 748GW solar, 100GW hydro and others) along with zero thermal power by 2047, India can reach a per capita generation of 3,209kWh. Hence, RE is not sufficient for India's growth ambition. Coal-fired power plants cannot be avoided.
- **Target for coal beyond current 100GW:** Currently, solar CUF is around 24%. If some breakthrough happens in CUF, it can change the perspective on thermal power. But, even after that, at least 300GW coal-fired power capacities are needed.
- **Shift to EVs:** In transition, non-electric energy is to shift to grid electricity. Currently, 18% of energy is met through the grid, which has to increase to 40-50% in 20-25 years. Emission factor for grid is higher than that of petrol. So the general concepts that shift to EV is more clean is wrong. We have to decarbonise the grid first rather than shift to EV.
- **Power market coupling:** The implementation of market coupling entails significant costs, which may only yield marginal reductions in pricing.
- **Changing power systems:** Power system is changing from base load and variable load to flexible load and flexible generation. Presently, the technical minimum PLF for thermal power plants is set at 55%, which is expected to decrease to 45%.

Interaction with Mr Raj Pratap Singh, IAS; An energy policy expert

Recently, we had the privilege of hosting Mr Raj Pratap Singh, IAS. Mr. Singh is the former chairman of the Uttar Pradesh Electricity Regulatory Commission and is a passionate and highly respected expert in India's power sector. He holds a postgraduate degree in electrical engineering from IIT Delhi and has had a diverse and distinguished 40-year career. During this time, he also served as Private Secretary to the Prime Minister of India and as a Senior Advisor (board level) at the World Bank in Washington, D.C. Mr Singh has played a pivotal role in shaping India's electricity regulations, with a focus on energy security, tariff design, clean energy transition, peer-to-peer energy trading, and power market development. Currently, he serves as the Election Commissioner of Uttar Pradesh and is also the Honorary President of the Indian Association of Energy Economics and a Distinguished Fellow at FSR Global, a global forum of energy experts.

Our interaction with Mr. Singh focused on understanding the energy transition in India, the future of thermal power (coal), and the evolving landscape of power markets, including virtual PPAs, derivatives, and more.

Energy Transition (ET)

ET refers to the structural transformation of energy systems from traditional carbon-intensive sources, such as coal, oil, and gas, to cleaner, sustainable, and renewable energy sources.

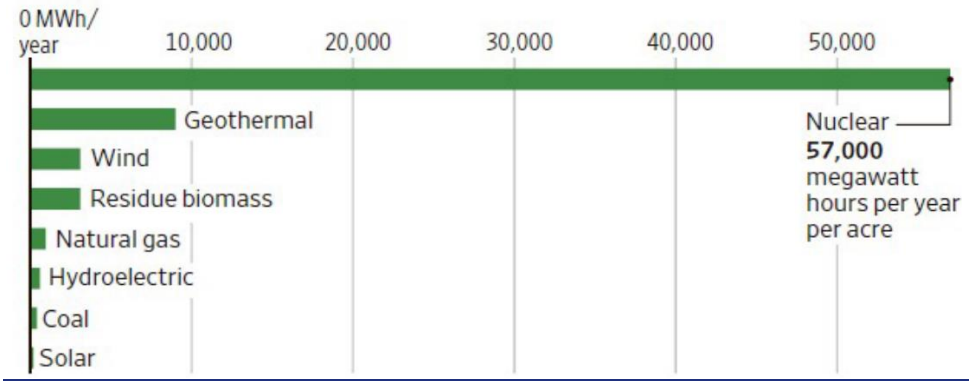
ET from the perspective of India

India is one of the fastest-growing economies and is also the third-largest emitter of carbon emissions. To meet the rapidly rising energy demand of the growing economy, emissions may increase. A focus on renewable energy is essential for enhancing energy security and reducing emissions. The increased labour intensity also contributes to job creation. India has established a target to achieve net-zero emissions by 2070.

Which is the best source?

We can create many things, such as batteries, but we cannot create land. Nuclear energy is the most land-efficient source of power, although the land required for establishing exclusion and sterile zones around nuclear power plants can be substantial. In contrast, solar energy is the least efficient in terms of land use.

Exhibit 1. Electricity generation per acre, by energy source

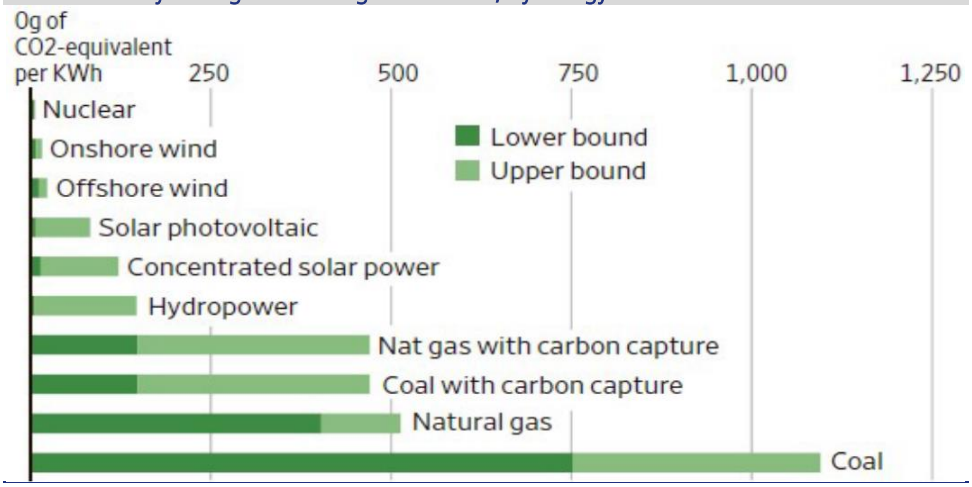


Source: Expert, JM Financial

Which is truly clean?

We must consider greenhouse gas (GHG) emissions throughout the entire life cycle. In this context, nuclear energy is the most advantageous option.

Exhibit 2. Lifecycle of greenhouse gas emissions, by energy source

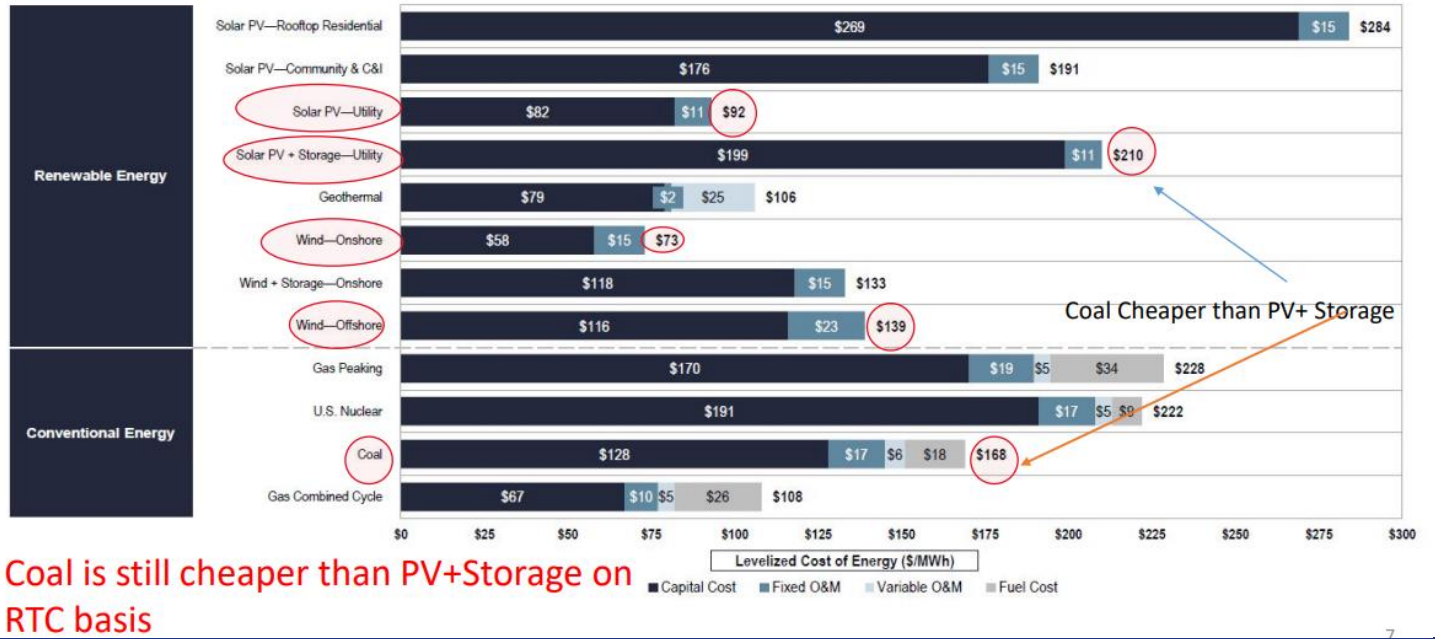


Source: Expert, JM Financial

Which is the cheapest source?

According to Lazard's Levelised Cost of Energy (LCOE) study (Jun'24), coal is less expensive than solar energy combined with storage. Although the study is based on cost estimates from the United States, it provides a valuable perspective on the relative positioning of these energy sources.

Exhibit 3. Lazard's Levelised Cost of Energy (LCOE) Jun'24 (USD/MWh)



Source: Expert, JM Financial

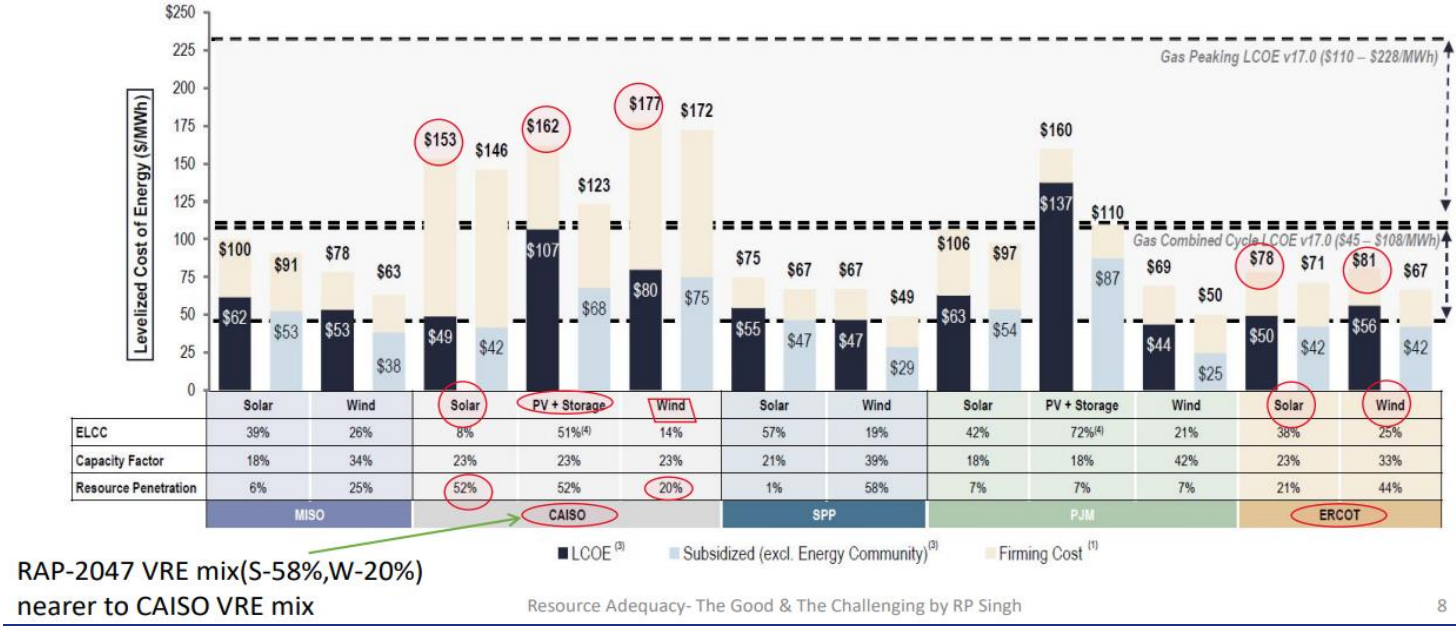
As the share of variable renewable energy (VRE)—specifically solar and wind—continues to increase, the overall LCOE for these sources is also rising, as per the California Independent System Operator (CAISO) and the Electric Reliability Council of Texas (ERCOT).

The LCOE for photovoltaic (PV) systems combined with storage in the CAISO region rose from USD 117 per MWh in 2023 to USD 162 per MWh in 2024, as the share of VRE increased from 32% to 52%.

Similarly, in 2024, the LCOE for solar power was significantly higher in the CAISO at USD 153 per MWh compared to USD 78 per MWh in the ERCOT. The share of solar energy in CAISO was 52%, while it was only 21% in ERCOT.

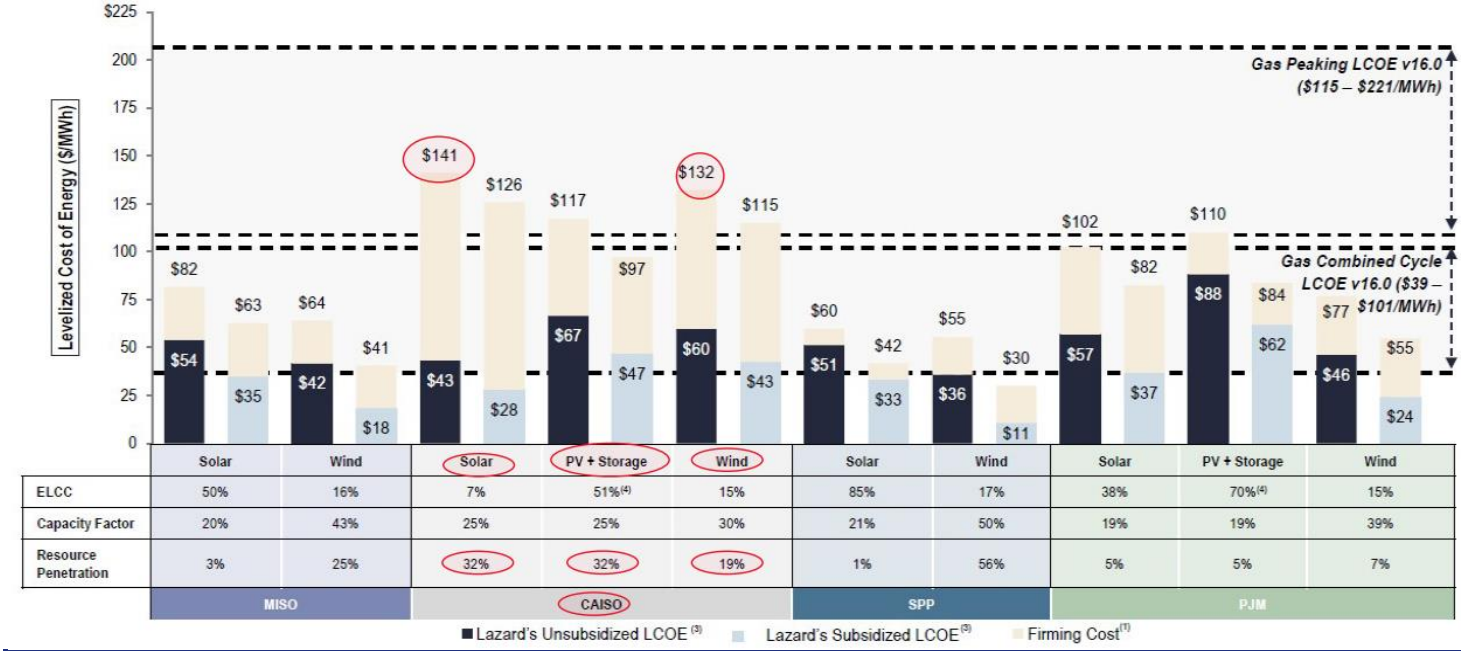
The most significant increase is observed in wind energy. The LCOE, including firming costs for wind, is USD 177 per MWh with only 20% penetration in the CAISO for 2024.

Exhibit 4. LCOE including Levelised Firming Cost (USD/MWh), 2024



Source: Expert, JM Financial

Exhibit 5. LCOE including Levelised Firming Cost (USD/MWh), 2023



Source: Expert, JM Financial

ERCOT has a solar LCOE of USD 78 per MWh, which includes a balancing cost of USD 28 per MWh from natural gas. Hence, the mode of balancing (BESS, gas, etc.) becomes an important driver in determining the LCOE.

Energy transition in India context

India's primary energy sources are dominated by fossil fuels:

- Coal: 49% (largest but not clean)
- Oil: 22% (second-largest source by largely imported and, hence, has economic concerns)
- Biomass: 20%
- Natural gas: 5% (cleanest but limited domestic supply)
- Primary electricity (hydro, nuclear, solar, wind): 4%

While the share of RE is growing, coal is still dominant.

Thermal contributes 52% to the installed capacity but has 75% share in generation. Similarly, RE with 36% share in capacity contributes just 14% to generation.

Exhibit 6. Electricity generation capacity mix FY25

Source	Capacity	Share in Total Capacity	Generation in 24-25	Share in Total Generation
	(MW)	(%)	(MU)	(%)
Coal	215193.01	45.28%	1298872.20	71.22%
Lignite	6620.00	1.39%	32994.77	1.81%
Gas	25178.00	5.30%	31580.00	1.73%
Thermal	246991.01	51.97%	1363446.97	74.76%
Nuclear	8180.00	1.72%	56680.83	3.11%
Wind	50037.82	10.53%	83347.00	4.57%
Solar	105646.49	22.23%	144150.00	7.90%
Bio-Mass+ Bagasse	10743.11	2.26%	13073.00	0.72%
Small Hydro	5100.55	1.07%	11568.00	0.63%
Other RE	840.21	0.18%	2863.00	0.16%
Hydro	47728.16	10.04%	148633.00	8.15%
Total RE (With Large Hydro)	220096.34	46.31%	403634.00	22.13%
Total RE (Without Large Hydro)	172368.18	36.27%	255001	13.98%
Total VRE	155684.31	32.76%	227497.00	12.47%
Total Installed Capacity	475267.35		1823761.80	
Per Capita Electricity			1302.687	

Source: Expert, JM Financial

RCO (renewable consumption obligations) has been set as 29.91% for FY25 vs. 14% actuals. Hence, there is a supply side shortage. India has kept its targets much higher than realities. For long, it has neglected wind and relied excessively on solar.

RCO has been at 43% by 2030. For this, the country needs 67% of installed capacity from RE. So, it needs to plan for high level of RE integration, which is very ambitious.

Exhibit 7. Renewable consumption obligation

Sl No.	Year	Wind renewable energy	Hydro renewable energy	Distributed renewable energy	Other non-fossil energy	Total non-fossil energy
1	2024-25	0.67%	0.38%	1.50%	27.35%	29.91%
2	2025-26	1.45%	1.22%	2.10%	28.24%	33.01%
3	2026-27	1.97%	1.34%	2.70%	29.94%	35.95%
4	2027-28	2.45%	1.42%	3.30%	31.64%	38.81%
5	2028-29	2.95%	1.42%	3.90%	33.10%	41.36%
6	2029-30	3.48%	1.33%	4.50%	34.02%	43.33%

Source: Expert, JM Financial

Energy trilemma

The trilemma of security, equity, and sustainability poses the biggest challenge in the transition. Despite significantly increasing its renewable energy capacities, India ranks 63rd in the World Economic Forum's trilemma index.

India has committed to achieving net zero emissions by 2070. In contrast, several countries, including developed nations, have pledged to reach this goal by 2050 or earlier, creating a 20-year gap for India. It is noteworthy to examine the RE share of these countries in the year 2000: the UK had 3.4%, the USA had 8.8%, and Australia had 8%. None of these countries had reached the 14% share that India currently holds today.

Exhibit 8. VRE share & key parameters of major countries, 2024

Country	VRE Share (%)	Electricity Generation (TWh)	Per Capita Electricity (kWh)	GDP per Capita (USD)	Net Zero Target Year
Denmark	63%	35	6100	68000	2045
Australia	39%	300	11500	65000	2050
Germany	42%	550	6600	52000	2045
UK	35%	330	4900	49000	2050
USA	17+18% Nuclear	4700	13900	76000	2050
China	14%+13% Hydro	9700	6900	13000	2060
Brazil	14%	650	3000	9000	2050
Japan	12%	1050	8300	42000	2050
France	15+65% Nuclear	550	7100	45000	2050
Norway	10+80% Hydro	140	24000	89000	2045
India	13%	1800	1350	2500	2070

Source: Expert, JM Financial

RE has provided only sustenance not growth, globally

Major countries, such as the UK, Germany, France, and Australia, which have achieved a high level of renewable energy in their energy mix, have not experienced any demand growth in the recent past.

UK shut down its coal power plants as electricity demand was experiencing a decline.

Germany has shut down its nuclear power plants and is planning to close its thermal power plants as well, in response to a decrease in energy consumption.

Nuclear energy accounts for 65% of the generation capacity in France. It exports electricity to the UK and Germany. As a result, the UK and Germany have made progress toward achieving net-zero emissions by shutting down their own power plants while importing electricity from France.

Australia has made significant progress in solar energy; however, its scale is relatively small compared to India's growth requirements.

India needs to achieve 7% growth in energy terms, even after accounting for energy efficiency, for at least the next 25 years.

Exhibit 9. Renewables and growth in major countries

Country	Year	Total Generation (TWh)	Renewable Generation (TWh)	Renewable Share (%)	Year-over-Year Change (%)
UK	2022	294.0	138.0	47.0%	-1.0%
UK	2023	292.7	133.0	45.4%	-0.4%
UK	2024	284.9	144.7	50.8%	-2.7% (Shutdown of Coal PP)
Germany	2022	500.0	242.0	48.4%	-1.0%
Germany	2023	450.5	254.9	56.0%	-9.9% (Shutdown of Nuclear PP)
Germany	2024	431.7	256.4	59.4%	-4.2%
France	2022	445.0	120.0	27.0%	-1.5%
France	2023	494.7	148.0	29.9%	+11.2% (Nuclear Export to UK & Germany)
France	2024	536.5	172.0	32.1%	+8.5% (Exports)
Australia	2022	270.0	97.0	35.9%	+1.5%
Australia	2023	273.0	107.6	39.4%	+1.1%
Australia	2024	280.0	112.0	40.0%	+2.6%

Source: Expert, JM Financial

Power demand by 2047 and need for coal

India will require a huge quantity of energy, taking efficiency also into account. To become a developed nation by 2047, the ask rate for electricity per capita is huge.

Presuming that all the non-fossil power generation capacities as targeted (100GW nuclear) and the full potential is harnessed (1,164GW wind at 150 AG height as per NIWE, 748GW solar as per NISE, 100GW hydro and others) along with zero thermal power by 2047, India can generate 4,846BU of electricity. The resultant per capita generation comes to 3,209kWh vs. benchmark of 5,000-6,000kWh per capita consumption for a developed country.

Hence, VRE is not going to help India in its growth ambition. Coal-fired power plants cannot be avoided.

Exhibit 10. Hypothetical scenario in 2047 without fossil fuel capacity

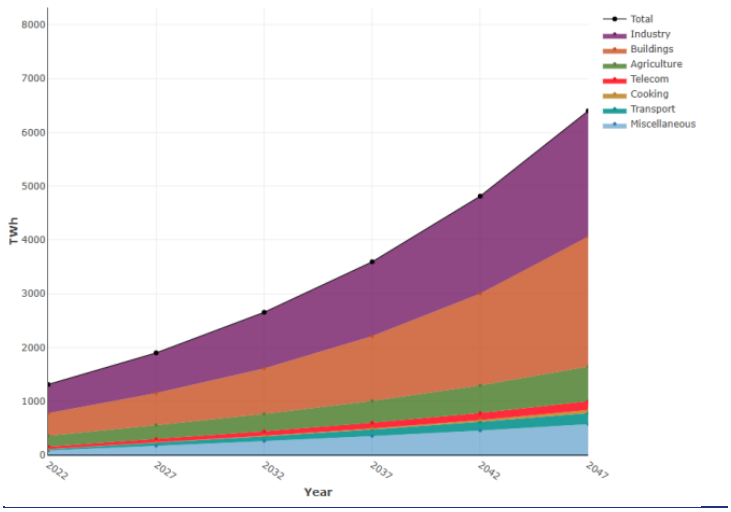
Source	Capacity (GW)	CUF/PLF (%)	Generation in 2047 (TWh/ BU)	
Coal	0	0	0	
Lignite	0	0	0	
Gas	0	0	0	
Thermal	0	0	0	
Nuclear	100	85%	744.6	
Wind	1164	22%	2243.26	
Solar	748	20%	1310.50	
Bio-Mass+ Bagasse	15	50%	65.70	
Small Hydro	10	50%	43.80	
Hydro	100	50%	438.00	
Total Non-Fossil Generation			4845.86	
Projected Population (Billion)			1.51	
Per Capita Electricity (KWh)			3209.18	
Developed Nation Benchmark			5000	6000
% Share of Benchmark with RE			64.18%	53.49%

Source: Expert, JM Financial

NITI Aayog, in its Energy Security Scenario 2047, estimates a generation of 6,111BU with coal and VRE contributing 53% and 37%, respectively.

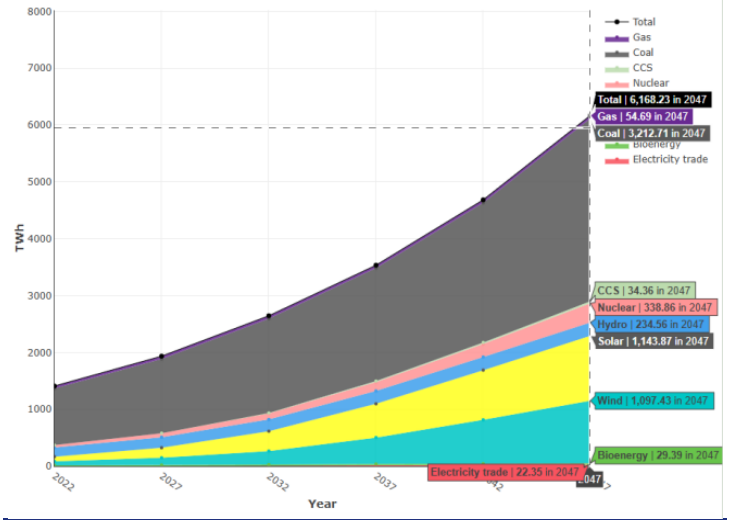
As technology continues to evolve and the timeframes are long, people are often unclear about the pathways available beyond the next 5 to 8 years. This situation is generating uncertainty and confusion.

Exhibit 11. NITI Aayog's electricity demand (incl. captive) (TWh)



Source: Expert, JM Financial

Exhibit 12. NITI Aayog's electricity supply from utilities (TWh)



Source: Expert, JM Financial

Exhibit 13. Source-wise generation as per NITI Aayog, 2047

Source	Total Generation (BU)	Share (%)
Coal	3212.7	52.57%
Gas	54.7	0.90%
Nuclear	338.8	5.54%
Hydro	234.6	3.84%
Solar	1143.8	18.72%
Wind	1097.4	17.96%
Biomass	29.4	0.48%
Total	6111.4	

Source: Expert, JM Financial

Major challenges in energy transition

- High dependence on coal for revenue and employment; only coal cess provide c. INR 300 bn to the government
- Intermittency and low capacity utilisation of RE
- Financial stress in discoms
- Integration of VRE with grid
- Slow RE capacity addition; require around 60GW p.a. for meeting 2030 targets
- Inadequate transmission
- Frequent changes in policy and regulations

Target for coal beyond current 100GW addition by 2032

This is dependent upon technology. Currently, solar CUF is around 24%. If some breakthrough happens, it can change the perspective on thermal power. But, even after that, at least 300GW of coal-fired power capacities is needed.

Nuclear Power

The goal of achieving 100GW of nuclear power capacity by 2047 is quite ambitious. Historically, India's track record in this area has not been good, as construction has typically taken 10 to 12 years.

India relies on Russia and Kazakhstan for its uranium fuel supply.

India must prioritise the acceleration of its thorium-based nuclear energy programme, especially through the advancement of Fast Breeder Reactors (FBRs).

The government has now opened the nuclear sector to private companies and is currently working on amending the Liability Act, which has been a deterrent for foreign investors.

Some positive developments are anticipated in the nuclear sector, as there are no alternative solutions.

Challenges in the grid with increasing RE?

A power grid must be balanced at all times. Solar energy generation fluctuates throughout the day and across seasons. Similarly, wind energy can vary significantly, with a 50-60% difference between maximum and minimum output. To maintain balance, we require a substantial source of balancing power that can quickly ramp up and down. This capability is provided by gas plants and battery energy storage systems (BESS) or pumped storage plants (PSP). However, these solutions can be costly, as they often need to remain on standby.

Ancillary services are the second component. Operators must maintain ancillary services to balance frequency.

Third, large storage is required for the PSP. The capacity the country is targeting will be sufficient for only 10 years. Additionally, there are geological challenges to consider.

The smart grid is the only viable solution.

Shift to Electric Vehicles (EV)

In energy transition, it is important to move from non-electric energy to electricity through the grid. Currently, 18% of energy is met through the grid. This has to increase to 40-50% in the next 20-25 years.

During FY25, India generated 1,823BU and emitted 1,300MT of CO_2. This gives an emission factor of 712 g/KWh, which is very high and is more than petrol/ diesel. Grid emission is higher than petrol.

So the general concept that shifts to EV is more clean is wrong.

Hence, we have to decarbonise the grid first rather than shift to EV. The highest priority should be given to grid decarbonisation.

Exhibit 14. Emission factor of Indian grid, 2024

Source	Generation in 24-25 (BU)	Share in Total Generation (%)	Co2 Emission Factor (Kg Co2/KWh)	Co2 Emission (MT)
Coal	1298.87	71.22%	0.95	1233.93
Lignite	32.994	1.81%	0.95	31.345
Gas	31.58	1.73%	0.54	17.0532
Nuclear	56.68	3.11%	0	0
Wind	83.347	4.57%	0	0
Solar	144.15	7.9%	0	0
Bio-Mass+ Bagasse	13.073	0.72%	1.3	16.9949
Small Hydro	11.568	0.63%	0	0
Other RE	2.863	0.16%	0	0
Hydro	148.633	8.15%	0	0
Total Generation	1823.761			1299.32
Total RE Generation	403.761	22.13%	0.712	

Source: Expert, JM Financial

So, we are nearly equal to oil in terms of emission.

Exhibit 15. Source-wise energy content and CO_2 emission

Energy Source	Energy Content (kcal/kg)	CO2 Emission (kg CO2e/kWh)
Natural Gas	12,500	0.54
Oil (Diesel)	10,000	0.75
Coal	3,500-4,000	0.95
Biomass	3,000-4,500	1.3-1.4

Source: Expert, JM Financial

Power market coupling

The power market in India remains relatively underdeveloped, with only 7% of the total power generated—amounting to less than 140BU—being traded on the power exchange. In contrast, the European Union benefits from a more robust market structure, characterised by distinct zones and areas.

In India, while there is a common market, the zones are differentiated. Several pertinent questions remain unanswered regarding the implementation of market coupling. Specifically, the issue of who will serve as the coupling operator is still unresolved. Although Grid-India has conducted a pilot study, it lacks the authorisation to engage in trading activities. Furthermore, the implementation of market coupling entails significant costs, which may only yield marginal reductions in pricing.

Changing power system; demand and generation

Power system is changing from base load and variable load to flexible load and flexible generation. During daylight hours, energy demand is primarily satisfied through solar power, resulting in a reduction of coal utilisation (PLF). Presently, the technical minimum PLF for thermal power plants is set at 55%, which is expected to decrease to 45%. Consequently, the overall PLF for thermal power generation is anticipated to decline.

Miscellaneous

- There is a need to reevaluate the tariff structure, including the regulatory tariff mechanism as a whole.
- More focus should be placed on demand-side management.

APPENDIX I

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Hold	Price expected to move in the range of 10% downside to 10% upside from the current market price for stocks with market capitalisation in excess of INR 200 billion and REITs* and in the range of 10% downside to 15% upside from the current market price for all other stocks, over the next twelve months.
Sell	Price expected to move downwards by more than 10% from the current market price over the next twelve months.

* REITs refers to Real Estate Investment Trusts.

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