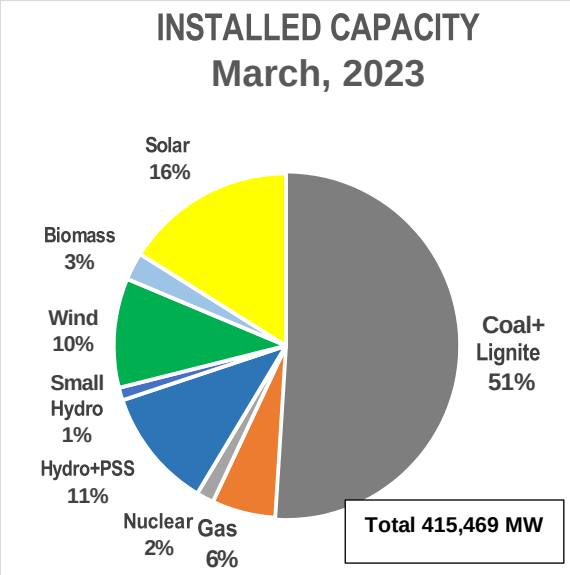
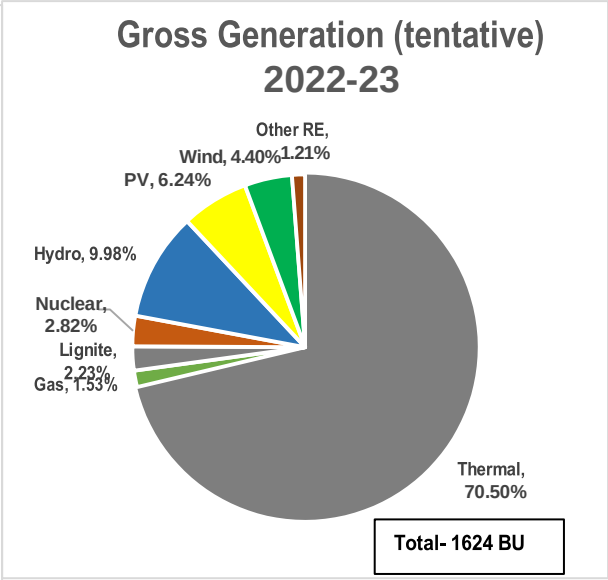
GRIDPRO VENTURES PVT LTD

White paper on India's energy transition- opportunities and considerations

India has embarked upon a very ambitious, albeit much needed, plan to increase the renewable energy (RE) capacity from 168 GW to 530 GW by 2030 . The total installed generation capacity is expected to go up from 415 GW to about 778 GW within the same time frame. This is predominantly an indication that we are moving decidedly towards a green economy with due recognition of our climate commitments. The polluting low capacity fossil based power plant would be retired by their EoL (end of life) and the additional capacity will be created with ultra-super-critical thermal, RE , essentially Solar, Wind and some hydro power plants.
CEA (Central electricity authority) has laid out plans to be able to carry out this mammoth task for our country. *Below graphs/data are taken from a CEA report issued in 2023*





Likely Installed capacity (MW) in 2029-30 Resource	All India	Percentage of Total IC (%)
Hydro	53860	6.93%
Small Hydro	5350	0.69%
PSP	18986	2.44%
Solar PV	292566	37.65%
Wind	99895	12.85%
Biomass	14500	1.87%
Nuclear	15480	1.99%
Coal+ Lignite	251683	32.38%
Gas	24824	3.19%
Total#	**777144**	100%
BESS(MW/MWh)	41650/208250	

With the addition of capacity as planned above, non-fossil based in the installed capacity will go up from being about 40% in 2023 to about 65% in 2030. Considering the planning

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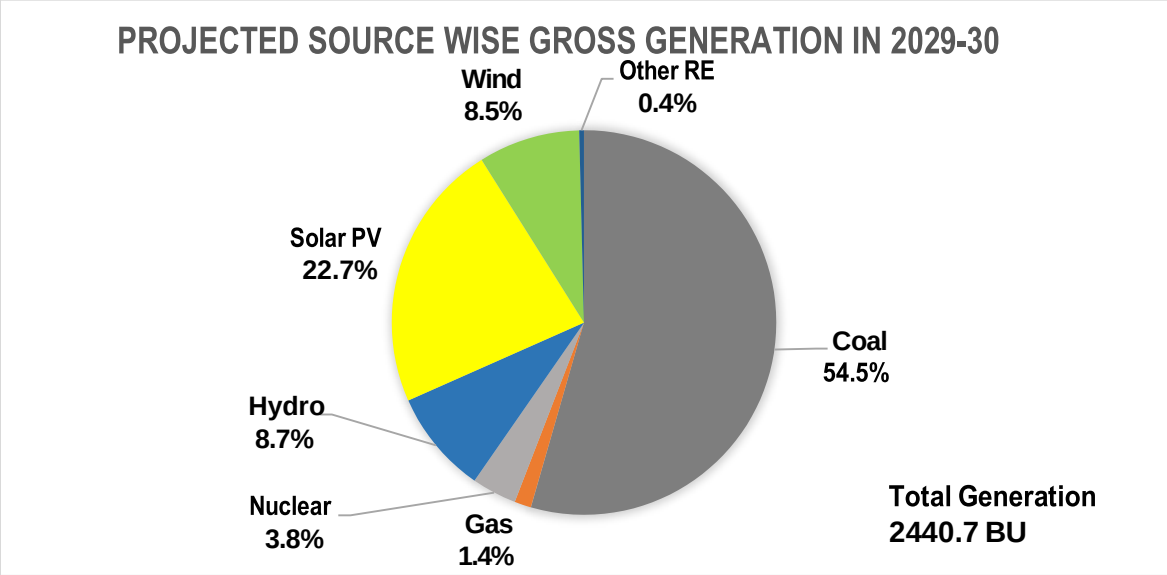
and efficiency factors considered in the planning, we will likely get the below result in the energy mix scenario 2030.



This is clearly indicative that we will have a dramatic change in the type of energy source between now and scenario 2029-30.

Increasing the renewable energy (RE) mix in this order will mean a lot of considerations including the CAPEX and OPEX costs which have been also stated in the CEA report. Here are a few which I feel should be highlighted.

Total CAPEX planned to be spent between 2022 and 2027 is of the order of 40 lac crores (approx. 450 BUSD). One has to have a careful orchestration and implementation of the scheme at the central level. CEA can give a plan but is not necessarily in-charge of the implementation of it. The RE energy supply chain market is flooded with sub-standard equipment, so there has to be due diligence on the approved list of vendors to get a good balance on price and quality. RE implementation has happened on a very large scale in Europe, China and the US over the last 15 years which definitely has helped to get the prices and cost towards parity with the conventional energy sources. India stands to gain from this. However, as mentioned earlier, we will need to demand the best in price and quality.

Further, implementation of RE in the existing grid would require due respect to the following considerations;

1. **Grid Capacity and Stability**: As the share of renewable energy increases, grid operators must ensure that the grid can handle the additional capacity and maintain stability. This may require upgrades to transmission infrastructure, grid balancing mechanisms, and energy storage to accommodate the variability of renewable generation. Grid infrastructure upgrade will involve building additional power handling capacity, inter-regional power evacuation infrastructure allowing optimal utilization of the RE and storage solutions and also capitalizing on the regional variations in the load patterns. RE sources inherently lack the “inertia” that thermal generation machines provide in turn helping the grid stability under fault conditions.

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Therefore, there is a need for creating virtual inertia with static solutions using power semiconductor devices and advanced control systems used in STATCOM (Static compensation used in FLEXIBLE AC transmission) and HVDC (High Voltage Direct Current) transmissions. HVDC will allow for cost effective long distance energy highways bringing energy from remote locations such as LEH, LADAKH which are rich in Solar, to the load centres in the North and the western regions. STATCOM solutions will support the existing substations to better integrate the RE injected in the grid.

2. **Flexibility of Conventional Generation**: With a higher penetration of renewable energy, conventional power plants must become more flexible to ramp up or down quickly to balance fluctuations in renewable generation. This may involve investing in flexible gas-fired power plants or retrofitting existing plants with modern control systems. Our existing fossil based thermal power plants are extremely inefficient where the smaller capacity plants run at sub-50% PLF (plant load factors) and are heavily polluting, whereas the super-critical plants run around 60-65% PLF. There is a need to revamp almost all these plants with the advanced technological solutions, which would allow for efficiently ramping down to accommodate the variable RE sources.

3. **Energy Storage Deployment**: Increasing the proportion of renewable energy necessitates the deployment of energy storage systems to mitigate intermittency and ensure a reliable power supply. Investing in battery storage (BESS), pumped hydro storage, or other storage technologies becomes critical to store excess renewable energy for use during periods of low generation. However, as mentioned above, there is clearly a balance to be achieved between efficiently ramping down of conventional generation and investments in energy storage solutions such as BESS. Here with the increase also expected in Electric Vehicles (EVs) , India will have to encourage private public partnerships in creating Energy storage capacities.

4. **Technological Innovation**: Advancements in renewable energy technologies, grid management systems, and energy storage solutions are essential for scaling up the renewable energy mix. Research and development efforts should focus on improving the efficiency, reliability, and cost-effectiveness of renewable energy technologies. A lot of technological advancement is done in Europe in this area. India needs to create a model to attract these companies to invest in India and also at the same time help creating more indigenous companies to conduct complementary R&D to take this to the next level for global use. The model involving just using external technology will not be beneficial for our country. We have a golden opportunity while deploying such a large scale infrastructure which we cannot miss.

5. **Investment and Financing**: Scaling up the renewable energy mix requires significant investment in infrastructure and technology deployment. Access to financing mechanisms, including public-private partnerships, green bonds, and international funding, is crucial for supporting large-scale renewable energy projects. Here again,

the key is how we successfully create a solid MSME base is very crucial. We will need to engage MSMEs and not just the big players in this effort and provide them with the tools and financing models. This will once again need a careful orchestration and implementation at the central level.

6. **Community Engagement and Social Acceptance**: Increasing the renewable energy mix often involves siting new renewable energy projects such as wind farms, solar installations, and transmission lines. Engaging local communities and addressing concerns about land use, visual impacts, and noise pollution is essential for gaining social acceptance and minimizing opposition to renewable energy projects. There is also a need for companies to provide solutions to minimise the impact on agriculture while using the land for RE projects especially solar. These "non-intrusive" solar solutions should be encouraged for use and prioritized over standard solar solutions. There has to be a win-win for the land owners, especially the farmers with smaller pieces of land. There has to be a aggregation approach where societies must be formed with pieces of land and the farmers must be made equity partners in the asset providing with them a sustainable income while keeping their arable land intact as much as possible. This will not only ease their pressure but also ensure faster implementation of the plans.

7. **Workforce Development**: Expanding the renewable energy sector creates opportunities for job growth and economic development. Investing in workforce development programs and training initiatives ensures that the labor force has the skills and expertise needed to support the transition to a higher share of renewable energy. Special skill set requirements have to be identified and dedicated efforts have to be taken to develop these among the people in the regions/districts where the infra projects are being developed. This will ensure local employment and skill development and not encourage mass exodus of labour as we normally see in places like China.

8. **Environmental and Social Impacts**: While renewable energy offers environmental benefits, it is essential to consider potential environmental and social impacts associated with its deployment. This includes biodiversity conservation, habitat protection, water usage, and land use planning to minimize adverse effects on ecosystems and local communities. There has to be a task force, again at the central level, that sets the targets for environmental impacts for each project and then includes that as part of accountability in the contracts for execution.

9. **Integration with Climate Goals**: Increasing the renewable energy mix should align with broader climate goals and commitments to reduce greenhouse gas emissions. Renewable energy deployment should be integrated into national energy and climate strategies to accelerate the transition to a low-carbon economy.

By addressing these considerations holistically, policymakers, grid operators, and stakeholders can effectively manage the transition to a higher share of renewable energy in the energy mix, unlocking its full potential for sustainable development and decarbonization.

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