World® Utility Summit

SUSTAINABLE PRACTICES TOWARDS NET ZERO UTILITIES

Knowledge Partner

CEEW THE COUNCIL

Founding Partners

ieema your link to electricity | IEEE Advancing Technology for Humanity | IEEE PES Power & Energy Society®

15th Edition ELECRAMA Powering the Future of Energy

18-22 February, 2023

INDIA EXPO MART, GREATER NOIDA, DELHI NCR, INDIA

4th Edition
World® Utility Summit
20-21 February 2023
Delhi NCR, India

SUSTAINABLE TRANSFORMATION OF UTILITIES

THE THEME

The theme of the World Utility Summit, (WUS) is “Sustainable Transformation of Utilities”.

This summit would bring in thought leaders across the globe to deliberate the preparedness of utilities to deal with the transformational changes. Regulators, technology providers, consultants, government bodies and utility leaders are expected to share their views on the various challenging and exciting scenarios and help shape the roadmap of the future utilities.

SUMMIT TRACKS:

Accelerating Digital Journey of Energy Ecosystem

Utilities get their revenues primarily via billing the customers for their demand and energy usage. New energy ecosystem, with multiple options for consumers to meet their electricity demand, will pose stiff competition to the utilities. Earlier for paying electricity bills a long que has to be made but in today's era the process has been digitized. With the use of smart meters, every process is digitized and simple. The questions arise in what manner digitization of energy ecosystem will affect the consumers?

Best Practices in Asset Management

Proper asset management allows company to effectively provide their service to the nation. Any breakdown in this process brings the potential for catastrophic failure in the nation infrastructure. Proper asset management allows you to:

- Enhance the life of assets through proper maintenance
- Allows you to respond efficient during emergency situation
- Reduce operating cost in long term.

The four main pillar of the asset management are:

- Evaluate your system's asset
- Assess your current service level
- Identify your most critical component
- Map out your life cycle cost
- Develop maintenance plan

Enhancing the Utility System Resiliency

In this environment, the utilities, Government and others stakeholders needs to take longer and deeper look at building resilience to limit and mitigate the risk to customers. Protecting them from risk that threaten life, property and economic activities that can be costly. We would like to suggest important pillars in the effort to improve our Nations grid resilience.

- Smartening the Grid
- Hardening the Grid
- Distributed Generation
- Building resilience on demand

Distribution Utilities of Future: Advanced Technologies for Business Transformation

The Indian power sector is evolving at a fast pace and has undergone some major transformations in recent past aimed at improving grid efficiency, security, stability, and consumer experience. However, the distribution utilities remain the weakest link in power sector value chain. The deployment of advanced technologies such as smart-grids can reduce pilferage, enhance consumer participation, and realize more revenues through losses reduction, lower energy costs, and eliminate manual intervention. Further, the combination of advanced technologies, innovative market models and consumer engagement strategies can support solutions like grid interactive buildings and enable consumers to support the distribution utilities in managing the demand supply balance. Together, such technologies and solutions have the potential to transform the distribution utilities and accelerate the use of clean energy resources in power grids.

Sustainable Practices towards Net Zero Utilities

In current scenario, Energy and Utilities executives are working towards sustainable practices. Almost half of the energy and utilities respondents have committed to a net zero goal. The major driving factors for sustainable utilities are upcoming government policies favorable to consumers and industry, increasing consumer and shareholder demand, and Decreasing cost of renewable energy. The important question arises how the Utilities are building a sustainable future.

New Energies (Common track with eTECHnxt)

The Indian renewable energy sector is the fourth most attractive renewable energy market in the world. As of May 2022, India's installed renewable energy capacity stood at 159.94 GW which is 39.70 % of the overall installed power capacity. People everywhere are looking for new energy ideas to help them make energy smart decisions for the future. We believe in renewable Energy and changing the attitude and practices about the way people generate and use energy. Central to this is the discovery and development of alternative energy sources. This track will cover the latest developments in technologies, novel business ideas, grid dynamics, learnings from pilot demonstrations and working considerations associated with these technologies. The topic will emphasis on Green Hydrogen, Electrification of Transportation, Nuclear & Biomass.

MESSAGE FROM KNOWLEDGE PARTNER

Shalu Agrawal
Senior Programme Lead
Council on Energy Environment and Water

As countries pursue the clean energy transition, the role of power utilities is rapidly evolving. From pursuing the policy and organisational objectives of providing reliable and affordable power services for consumers, new policy goals of energy sustainability and security will require a rethink and reorientation of utility business and operations.

Research by the Council on Energy, Environment, and Water indicates that the pursuit of a Net-Zero vision will result in multiple new business opportunities across the supply chain of power utilities. This is a perfect opportunity to realise the trifecta of Jobs, Growth, and Sustainability. For this, we need utilities to demonstrate leadership by setting ambitious goals along with tangible transition plans and positioning themselves as changemakers.

‘Utilities of the Future’ will require concerted efforts and investment in business process re-engineering, digitalising network and operations, capacity building, and most importantly, embracing the new avatar of consumers as prosumers.

The World Utility Summit’s role in bringing together all key actors on one platform to deliberate on these opportunities and avenues for collaboration is a commendable and much-needed effort towards achieving the vision of a clean energy future.

TABLE OF CONTENT

1 Introduction

The 2015 Paris Agreement, signed at the COP21, alluded to the concept of net zero (NZ) emissions. Under it, nearly 200 countries agreed "to achieve a balance between anthropogenic emissions by sources by sinks of greenhouse gases in the second half of this century". In other words, to achieve net zero emissions between 2050and2100. In 2018, the Intergovernmental Panel on Climate Change (IPCC) mentioned in its report that "global net anthropogenic carbon dioxide emissions must decline by 45 per cent from 2010 levels by 2030, reaching net zero around 2050" to limit global warming to 1.5ºC. Following this, several countries started pledging to attainnet zero emissions. By November 2022, nearly 140 countries, which collectively account for nearly 90 per cent of global emissions, had either announced or considered adopting netzero targets.

The 2021 Glasgow Climate Pact, signed at the COP26, welcomed efforts by countries to communicate new or updated nationally determined contributions (NDCs) and long-term low greenhouse gas (GHG) emissions development strategies (LT-LEDS). This prompted countries to identify the policies, technologies, and finances required to transition towards net zero emissions. Relevant policies took shape asbroader country-level and sector-specific commitments and strategies. These commitments included reducing GHG emissions by increasing the share of renewables in the electricity mix and phasing down conventional energy sources. Sectoral commitments and strategies outlined decarbonisation targets and pathways forkey energy-consuming sectors such as transport, industries, and buildings. The IPCC Special Report also projectedthat renewables wouldsupply 70–85 per cent of the electricity in 2050 and ensure faster electrification of energy end-use sectors, consistent with a1.5ºC pathway.

Net zeropresents significant opportunities for electricity utilities across the value chain (generation, transmission, and distribution) to scale up operations and fulfil the growing demand. However, a net zero transition for utilities also poses major challenges, given the current dependence on conventional emission-intensive energy sources for electricity generation. Across the globe, power utilities are innovating to navigate the transition to a net zero system. This paper highlights the complexities associated with the journey towards a net zero scenario and discusses key practices that could help utilities operating in different contexts chart their own transitions.

The paper is structured as follows. Section2 elaborates on the implications of a net zero future for electricity and its end-use sectors,considering India as a case study. Section3 presents the opportunities and challenges a net zero transition entails for power sector utilities, and illustrates select good practices or innovations being pursued in different parts of the world. These could be implementedthrough supply-side interventions,for instance, setting specific emission-reduction targets using mechanisms such as the Science Based Target initiative (SBTi), or through demand-side interventions that incentivise and empower electricity consumers to move towards cleaner electricity sources.

---

[1] https://unfccc.int/sites/default/files/english_paris_agreement.pdf.

[2] https://www.ipcc.ch/sr15/chapter/spm/spm-c/.

[3] https://climateactiontracker.org/global/cat-net-zero-target-evaluations/.

[4] https://unfccc.int/sites/default/files/resource/cma2021_L16_adv.pdf.

[5] https://www.ipcc.ch/sr15/chapter/spm/spm-c/spm3b/.

2

The net zero transition and electricity sector: India’s case study

Along with several other countries, India announced its aim to achieve net zero emissions by 2070 at the COP26, held in Glasgow in 2021. According to India'slatest NDCs under the Paris Agreement, the countryseeks to "achieve 50 per cent cumulative electric power installed capacity from non-fossil fuel-based energy resources by 2030", among others. With India'ssteadily rising population, growing economy, and increasing level of urbanisation, itselectricity demand is expected to significantly increase in the future across all end-use sectors, such as transport, industries, and buildings.

India's electricity generation and consumption trends of the last decade (2010–20) indicate what the future might hold. Presently, India is the third largest producer and consumer of electricity, with an installed power capacity of 409 GW (including an installed renewable energy [RE] and hydropower capacity of 167 GW). India's electricity generation increased from 850 terawatt hours (TWh) in 2010–11 to 1,389 TWh in 2019–20, a 63 per cent increase in the span of one decade. Final and per-capita electricity consumption rose by 56 per cent and 48 per cent, respectively, during 2010-20. Final electricity consumption went up from 670 TWh in 2010–11 to 1,052 TWh in 2019–20, while per-capita electricity consumption increased from 819 kilowatt hours (kWh) to 1,208 kWh in the same timeframe. As per the 20th Electric Power Survey of India published by the Central Electricity Authority (CEA), annual electricity demand in 2031–32 will bearound 2,474 TWh (including transmission and distribution losses).

While coal, oil, and other fossil-based energy sources have formed the bedrock of the country's energy needs, it is imperative that India decarbonise its energy production and consumption to achieve its stated netzero targets. As of 2020, despite RE sources accounting for 42 per cent of the total installed capacity, the share of electricity generated bythese sources in total generation was only around 10 per cent. There is abundant scope for ramping up the RE share in India's power generation.

2.1 What does India's future electricity demand look like?

The following section illustrates the future electricity demand intwo key policy scenarios for the transport, industry, and buildings sectors, based on a combination of technology availability scenarios related to carbon capture and storage (CCS) and hydrogen. These are useful combinations to explore, from the perspective of power utilities, since their availability (or lack thereof) affects the electricity demand across sectors. The key insights presented in this section highlight the scale and speed at which utilities must evolve in the future.

---

[6] https://unfccc.int/sites/default/files/NDC/2022-08/India%20Updated%20First%20Nationally%20Determined%20Contrib.pdf.

[7] https://powermin.gov.in/en/content/power-sector-glance-all-india.

[8] https://powermin.gov.in/en/content/power-sector-glance-all-india.

[9] https://cea.nic.in/dashboard/?lang=en.

[10] https://cea.nic.in/wp-content/uploads/general/2020/General_Review_2021.pdf.

The two key policy scenarios are as follow:

Business as usual (BAU): The BAU scenario assumes existing policies and technologies continue to remain in place. It also includes an inherently defined improvement in energy efficiencies and a reduction in the costs of technologies.

Net zero (NZ): The NZ scenario imposes a carbon constraint on the BAU, which follows India's ambition of reaching NZ emissions by 2070. For India to reach NZ by 2070, the peak year for emissions is 2040.

The following table summarises the various scenarios based on a combination of technology availability scenarios related to CCS and hydrogen. These scenarios assume 2070 as the target year by which to achieve net zero emissions. For instance, a 'High hydrogen w CCS'scenario assumes the commercial availability of both hydrogen and CCS.

Table 1: Different combinations of technology availability scenarios to achieve net zero by 2070

Scenarios	Net Zero Year	Commercial availability of Hydrogen	Commercial availability of Carbon Capture and Storage (CCS)
High Hydrogen w CCS	2070	✔	✔
High Hydrogen w/o CCS		✔	✖
Low Hydrogen w CCS		✖	✔
Low Hydrogen w/o CCS		✖	✖

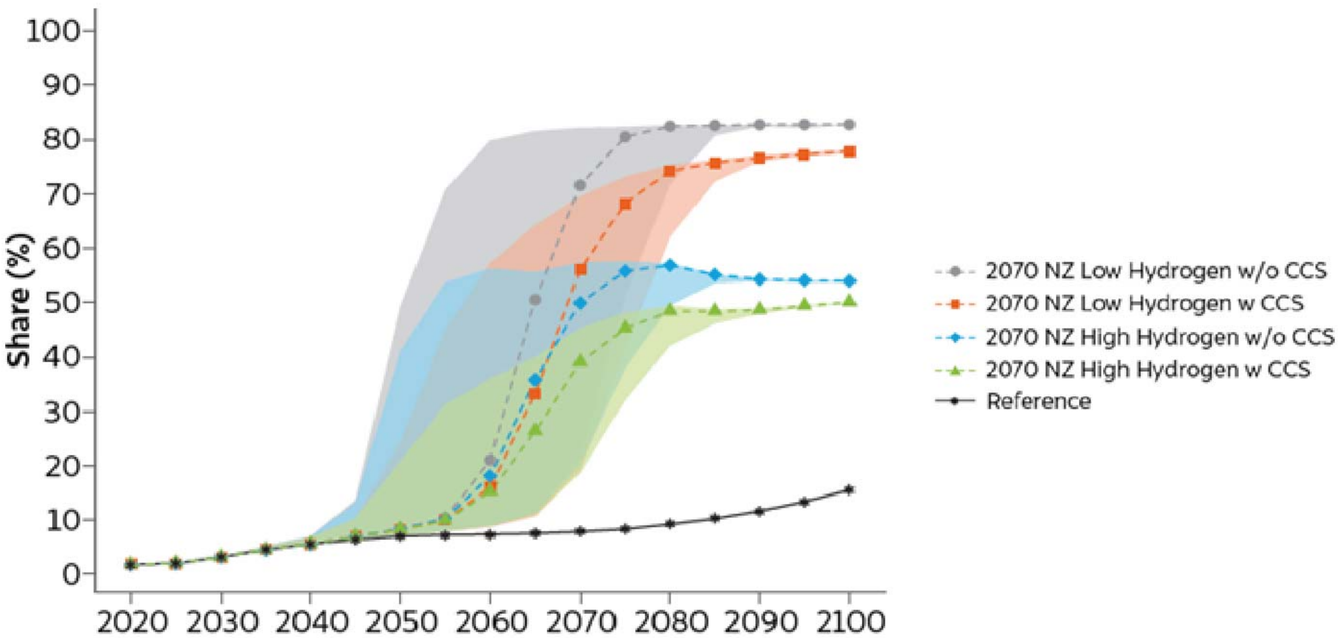
Source: CEEW analysis

Note: The modelling exercise to assess future electricity demand was carried out using the Global Change Analysis Model (GCAM),an energy sector–focused model used extensively for energy and climate policy analyses. This model was chosen as it can project beyond the mid-century and into the future. Thisfacilitates exploring net zero scenarios for India and understanding the implications of its target to achieve economy-wide net zero emissions by 2070. The modelling results are based on a CEEW study titled *'Implications of a Net-Zero Target for India's Sectoral Energy Transitions and Climate Policy', by Vaibhav Chaturvedi and Ankur Malyan,* published in October 2021.

2.1.1 Transport sector

An increase in per-capita income and urbanisation levels are expected to drive up the mobility needs across both the passenger and freight transport segments. While hydrogen uptake for mobility presently remains uncertain, national and state-level Electric Vehicle (EV) policies indicate an increased electricity demand to cater to passenger transport. This section presents certain key insights about the future of the transport sector.

Figure 1: Electricity share in the transport sector



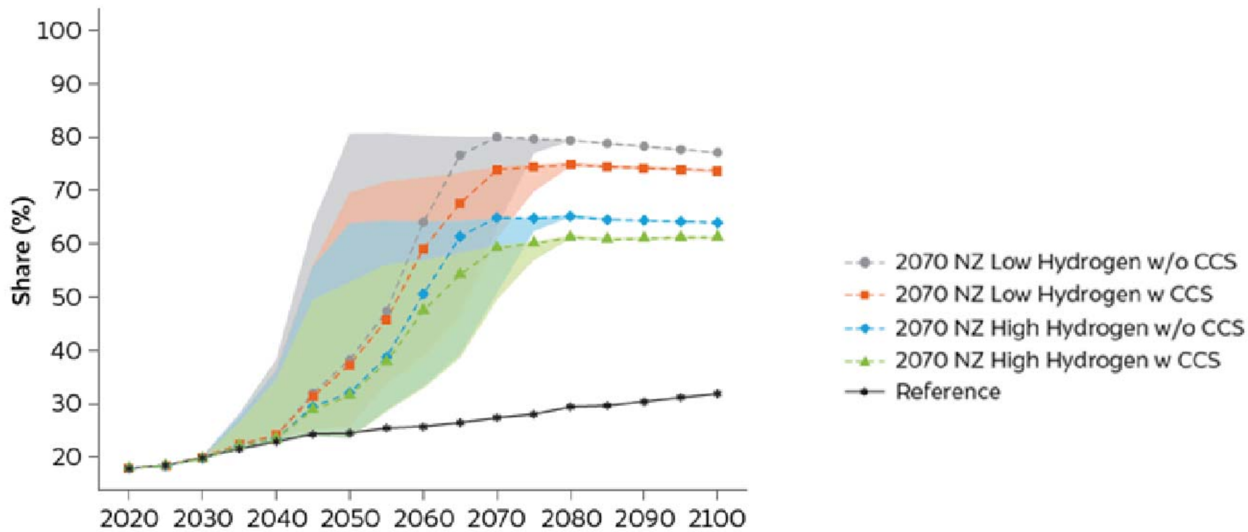
Source: Chaturvedi and Malyan (2021)

Key Insights: Figure 1 illustrates thelarge-scale electrification of the transport sector invarious NZ scenarios. Transport sector electrification is primarily driven by the increased penetration of electric vehicles inboth the passenger (including 2W/3W/4W) and freight segments (including trucks and rail). However, the commercial availability of hydrogen significantly reduces the transport-related electricity demand in the 'high hydrogen' NZ scenarios to around 50 per cent, from 80 per cent in the 'low hydrogen' NZ scenarios. This indicates an uptake of hydrogen fuel cells for transportation. The transport-related electricity demand inthe BAU scenario remains low, indicating the continued dependence on diesel and petrol as primary energy sources.

2.1.2 Industry sector

Higher economic growth at the back of robust industrial sector growth is expected to drive up industrial energy demand. National-level schemes such as 'Make in India' and state-level policies to boost manufacturing indicate significant electricity demand for India's industries.This section presents key insights about the future of India's industrial sector.

Figure 2: Electricity share in the industry sector



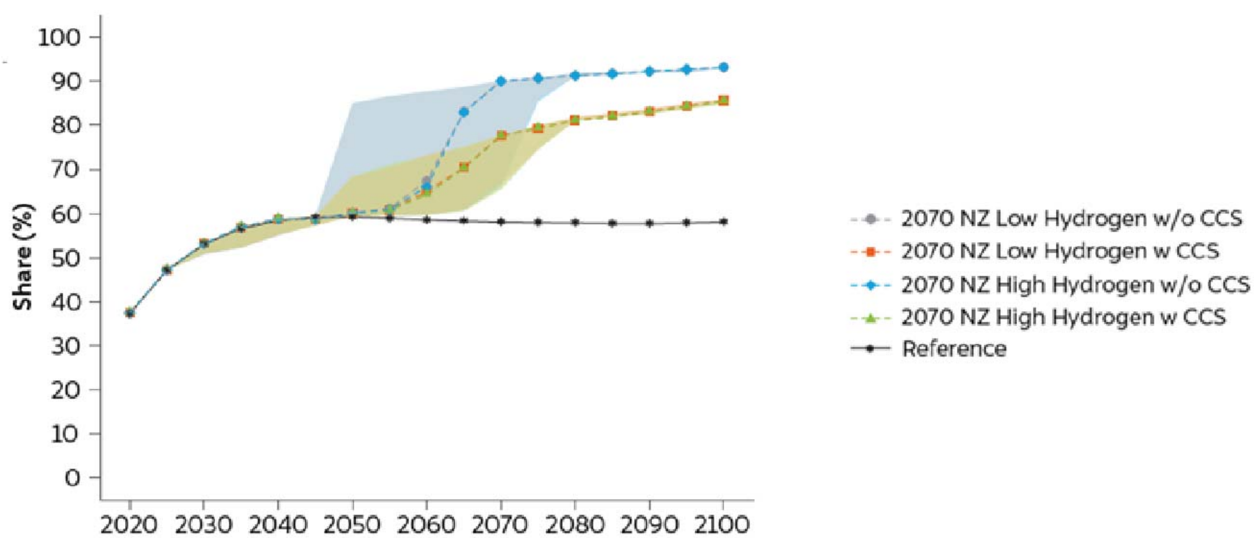
Source: Chaturvedi and Malyan (2021)

Key Insights: As Figure 2 demonstrates, the industries sector also massivelyincreasesits electricity consumption inall NZ scenarios. Here too, hydrogen availability changes the majority in the final energy mix from electricity to hydrogen. CCS availability also reduces the electricity demand ofthe industrial sector, albeit not significantly. In the absence of both CCS and hydrogen, over 80 per cent of the industrial energy demand has to be met by electricity. The BAU results indicate continued usage of coal, gas, and oil in the industrial energy mix, leading to lower levels of electrification in the future.

2.1.3 Building sector

An increase in population and urbanisation levels are expected to drive up demand for the built environment across residential and commercial categories. This means higher electricity consumption to cater to increased cooling and heating requirements in commercial buildings and electrical appliances usage in residential buildings. This section presents certain key insights about the future of the built environment.

Figure 3: Electricity share in the building sector



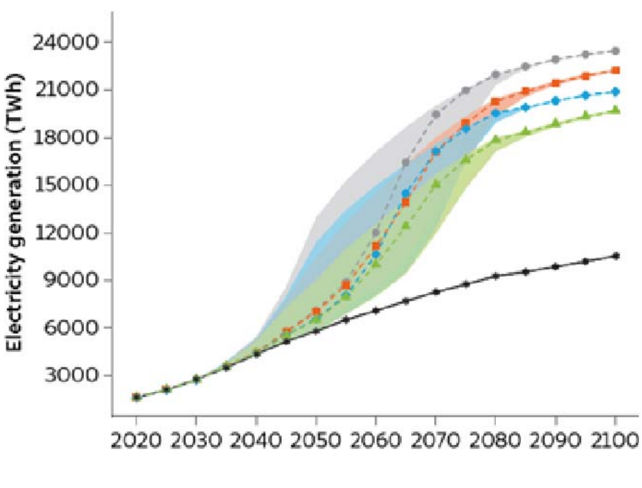
Source: Chaturvedi and Malyan (2021)

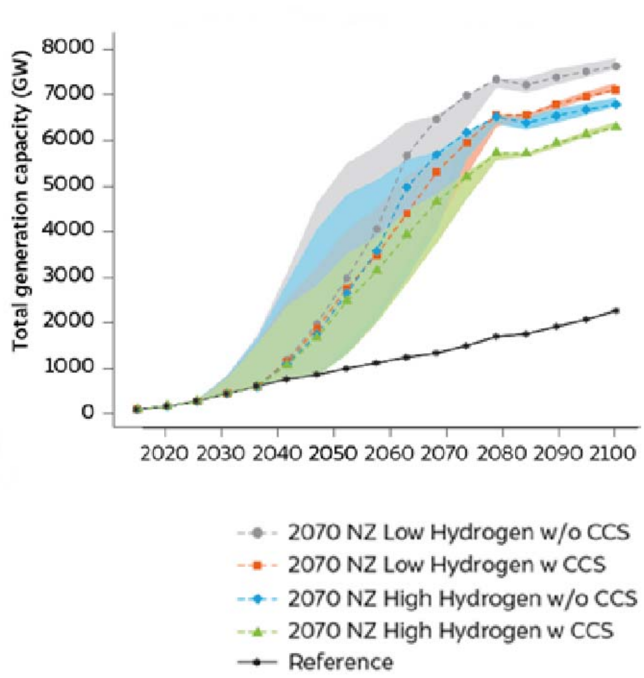
Key Insights: As seen inFigure 3, the share of electricity in buildings (commercial and residential) remains high, at around 59 per cent in 2070, even ina BAU scenario. This is possibly owing to increased usage of electrical appliances due to higher income and urbanisation levels. Invarious NZ scenarios, large-scale electrification of cooking, cooling, and lighting results in a much higher share of electricity (around 90 per cent) in the building sector.

2.1.4 Electricity generation in BAU and NZ scenarios

Key insights: Figure 4 illustrates significant electrification in both the BAU and NZ scenarios. Between 2020 and 2070, the total electricity generation is expected to increase nearly sixfold (from 1,389 TWh in 2020 to approximately 8,000 TWh in 2070) inthe BAU scenario. However, the NZ scenario predictsa twelvefold increase in electricity generation (from 1,389 TWh in 2020 to approximately 17,000 TWh in 2070) is expected. The significant jump in electricity generation is reflective of increased demand across end-use sectors due to high levels of economic growth, population, and urbanisation inthe BAU scenario. Carbon constraints imposed on emissions drive the electricity demand towards renewables inthe NZ scenario. Given the rapid decarbonisation of electricity generation to achieve the net zero target, the bulk of the electricity in the future will be generated by solar (around 5,600 GW installed capacity), accounting for a 60–70 per cent share in the electricity mix by 2070 (as shown in Figure 5), followed by wind and nuclear energy.

Figures 4 and 5: Total electricity generation and total solar generation capacity





Source: Chaturvedi andMalyan (2021)

2.2 Implications for power utilities

The quantum and mix of the electricity demand across end-use sectors highlight that the power sector is set to play a pivotal role in India's energy transition; major emission reductions could occur, with utilities leapfrogging from coal to RE. Renewables offer a diverse portfolio of options topower generation companies, including solar, wind (offshore and onshore), biomass, and other emerging technologies.

Based on the trends observed inelectricity consumption and production,the implications for utilities are clear:

- Utilities must scale up operations to meet the rising electricity demand across key end-use sectors, more so inan NZ scenario,in whichthe scale of electrification is massive.
- In addition, utilities must be nimble enough to adapt to an evolving energy mix. This implies shifting to newer energy sources to generate electricity and adopting sustainable practices to decarbonise the power utilities' systems.
- As indicated by the modelling projections, the future of electricity is renewable. This has major ramifications for power generation utilities, as it would require a complete overhaul of existingoperations and business models. Therefore, generation companies must createa long-term plan to progressively transition their systems, in order to remain competitive.

Section 3 details how power sector utilities across the value chain can adapt to these changing dynamics while decarbonising their own systems.

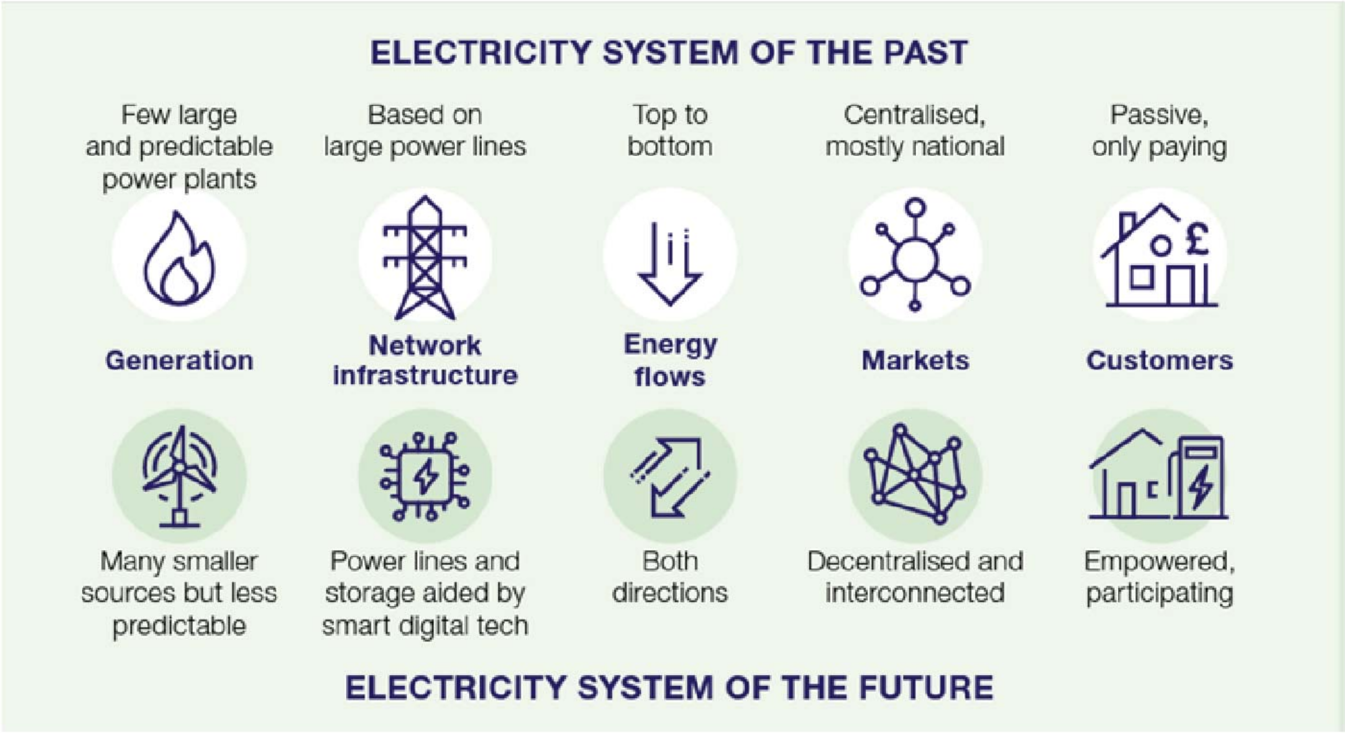
3

Utilities in a net zero scenario

For India to achieve net zero by 2070, electricity will need to form a significant chunk of the energy mix in the coming decades. This will be driven primarily by electrification in the transport and industries sectors (as discussed in Section 2). The variable RE will dominate the electricity supply.

It is essential to ensure that future upgrades to the energy system align with the vision of a net zero world. The electricity market is more efficient, consumers and businesses are incentivised to adopt clean energy solutions, and the energy system policy, associated rules, and regulations are flexible and agileenough to accommodate new technologies. As decentralised clean electricity penetration increases, the energy consumer's experience will transform. Smart technologies will revolutionise the way users engage with the electricity system. Smart meters and smart appliances, with dynamic tariffs, will give users control over their electricity consumption and bills. Figure 6 depicts how electricity systems are evolving.

Figure 6: Evolution of the electricity system



Source:Adapted from Energy White Paper, powering our net zero future, HMGovernment (2020)

Addressing the challenges of RE integration, reducing fossil-based generation in a just manner, and having operationally efficient and financially viable power distribution companies (discoms) will continue to play a critical and evolving role on the road to net zero, and help to provide a reliable, resilient, and affordable energy system. A few practices that would enable generation and distribution utilities to facilitate the accelerated energy transition are discussed next.

---

[11] https://fsr.eui.eu/publications/?handle=1814/75020.

[12] HM Government. 2020. "Energy White Paper: Powering Our Net Zero Future." https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/945899/201216_BEIS_EWP_Command_Paper_Accessible.pdf.

3.1 Cost-effective grid integration of renewable energy

Solar PV and wind are the dominant technologies deployed to decarbonize the power system across the globe. In India, solar and wind power plants account for 25 per cent of the total generation capacity and around 11 per cent of the generation mix. The picture is quite diverse at the sub-national level. The RE-rich states – Andhra Pradesh, Gujarat, Karnataka, Rajasthan, Tamil Nadu, and Telangana –each have a 12–24 per cent share of RE in the generation mix. These states have started to face system integration challenges.

Key challenges for states with high RE penetration include (i) accommodating greater variability in net load and changes in power flow patterns and (ii) ensuring a robust power supply during periods of high RE generation. As the share of RE grows, the need for power system flexibility will increase.

Various power system modelling studies have identified ways to address renewable integration challenges. Some key options and strategies include

1. **Improving supply-side flexibility:** This is likely to come from existing coal plants and flexible resources like battery energy storage systems (BESS) and pumped-hydro.
   1.1. Improving flexibility in thermal generation: Generators must invest in existing power plants to improve ramping capabilities and lower the technical minimum of the plants. Regulators and off-takers should support the required capital expenditure.
   1.2. Proliferatingbattery and pumped storage systems: Policies must support the increased deployment of inherently fast-ramping resources to ensure sufficient balancing and flexibility capabilities. States, with the support of system operators, must conduct pilot studies and deploy resources that provide the required balancing capability.[16]
2. **Improving the forecasting of renewables:** Improved forecasting and scheduling can help manage balancing costs by reducing error margins. India has set up 11renewable energy management centres (REMCs) to manage RE generation and data sharing among various entities. There is a need to strengthen the forecasting capacity of generators, including small generators and state system operators. The national system operator has taken steps to introduce forecasting models that use artificial intelligence (AI) and machine learning (ML),to increase forecasting accuracy.
3. **Factoringin system integration costs:** Solar and wind projects are cheaper than conventional coal-based power plants on a levelised cost of per unit electricity (LCOE) basis. However, the LCOE does not factor in the cost of RE integration and keeping firm power on standby,therefore, its costs are stranded assets'. Hence, further capacity expansion must account for these costs, and regulators and buyers must price the generated power accordingly, with the costsfairly distributed across consumers. Focusing solely on the LCOE metric makes it harder for other technologies to compete on the same basis and for generators to find buyers. It isalso important to note that making conventional power available for when variable RE is unavailable comes with the risk of increasing emissions, since the plants run at lower capacity factors that make them inefficient.
4. **Diversifying the generation mix:** Grid integration requirements create opportunities to develop the capacities ofvarious RE technologies, some of which arecomplementary. Technologies like floating solar, offshore wind, and distributed renewables (including rooftop solar) have enough potential, but still need to be tapped. Floating PV solar has a potential of more than 280 GW. Similarly, offshore wind has a potential of 36 GW in Gujarat and 35 GW in Tamil Nadu, as assessed by the Ministry of New and Renewable Energy (MNRE)and National Institute of Wind Energy (NIWE). Policies must support the deployment of diversified RE technologies with improved tender design, subsidy supports, and incentives to discoms that will sign off-take agreements forthese projects.

3.2 Planning a just transition away from fossil-based generation

Transitioning from a thermal-based economy to aRE-based one requires fundamentally reshaping the power markets and the value chain. There is risk for people whose livelihoods directly and indirectly depend on the thermal economy. Putting people at the centre can make the transitionmore inclusive and equitable, andmay reduce conflict.

Utilities have a significant role to play in ensuring a just transition. However, they must receive support from the government and the communities they operate in. The case study of ØrstedUtility, Denmark, traces thecompany's transition from being a coal-intensive utility to being a leader in offshore wind energy. Phasing down or phasing out coal must be planned, gradually implemented in phases, and be a consultative process. Such a shift will include[21]

- Repurposing and closure costs.
- Pay-outs to coal-based mine and power plant owners.
- Revenue losses to the government.
- The rehabilitation and reskilling of workers facing job losses.
- Regional economic regeneration.

The next section covers practices that distribution utilities must undertake (in collaboration with system operators and regulators) to improve their operational efficiency and financial health.

Case study:Ørsted Utility, Denmark

Around 50 per cent of the electricity in Denmark is supplied by wind and solar power.Ørsted, a Danish state-owned power utility, transitioned from being one of Europe's most coal-intensive utilities to being a leader in offshore wind energy. A mix of internal and external policies and decisions supported this transition:

Internal policies: These includedtangible long-term goals for RE addition and the phasing out of coal power; using non-conventional sources of funding (hybrid capital, sale of non-core assets, and recycled capital from de-risked wind assets) for offshore wind; employing economies of scale to reduce the cost of electricity and ensuring transparency in environmental, social, and governance (ESG) disclosures.

External policies: These involved R&D spending by the government, tradeable green certificates for RE-based power, priority grid access and fixed feed-in tariffs for revenue stability.

Factors that assisted in grid integration of high RE include

- Integration with the NordPool power exchange and grids of Europe;
- Technical retrofits forthermal power plants to allow for increased generation flexibility;
- The incorporation of advanced wind forecasting in the operations of power systems; and
- The development of ancillary markets.

Source: Ministry of Foreign Affairs of Denmark (n.d.)

[18] https://solarquarter.com/2021/05/24/10-gw-of-floating-solar-by-2022-current-status-and-steps-needed-to-achieve-the-target/.
[19] https://mnre.gov.in/wind/offshore-wind/.
[20] https://www.ceew.in/blogs/challenges-and-way-forward-for-transitioning-indias-coal-economy.
[21] https://www.ceew.in/cef/solutions-factory/publications/mapping-costs-for-early-coal-decommissioning-in-india.

3.3 Robust demand forecasting

Accurate electricity demand forecasting is essential for decision-making by system operators and discoms. In the short term, demand is influenced by exogenous variables such as weather, agricultural patterns, holidays, and outages. The complexity and non-linearity of demand render the conventional statistical approaches ineffective. To makerobust demand forecasts, utilities across the globeneed to keep pacewith the continuous advancement in forecasting techniques, use AI and ML tools, employ better computing power, maintain quality data, and improve weather forecasting.

The California Independent System Operator (CAISO) command and control centre has invested considerable resources in sophisticating its infrastructure to ensure accurate forecasting. In India, to promote innovation and understand the AI- and ML-based forecasting techniques available today, the Ministry of Power, REC Limited, and SINE IITBombay organised a Powerthon,inviting technology solution providers (TSPs) to address critical problems faced by discoms, including demand and load forecasting. , The platform is an excellent example of innovation and a testbed for implementing practical, workable solutions for discoms.

Discoms and system operators should establish state-of-the-art infrastructure to conduct periodic demand forecasting at a granular level in order to inform optimal power procurement decisions. Forecasting should account for the changing mix of the generation capacity, new drivers of electricity demand (e.g., electric vehicles, electric cooking and cooling), and the expected impact of demand-side management (DSM) measures at scale.

---

[22] https://recindia.nic.in/uploads/files/Powerthon-Booklet.pdf.

[23] https://www.ge.com/power/transform/article.transform.articles.2017.

3.4 Digitalising the distribution grid for operational efficiency and demand flexibility

To reap the benefits of the progressive digitalisation of the energy market, the European Union is aiming for77 per cent of its electricity consumers (~225 million) and 44 per cent of its gas consumers (51 million) to have smart meters by 2024. Discoms in India, under the Smart Meter National Programme and the recent Reformed Distribution Sector Scheme (RDSS), plan to replace 250 million conventional meters with prepaid smart onesacross consumer categories. , As of January 2023, 5.4 million smart meters have been deployed in India.

Advanced metering infrastructure (AMI)can offer more control, choice, and flexibility in consumers' energy consumption. Smart meters mayenable consumers to play a more significant role in the energy system through theapplication of dynamic tariffs. Dynamic tariffs, with incentives and penalties,mightallowconsumers to use less electricity duringpeak times and to consume more when surplus generation is available and demand is low.Case studies on 'connected home' and 'domestic and small-scale storage (social storage)' highlighted in the boxes below demonstrate how households in the UK are using battery storage and smart meters for demand flexibility and to optimise electricity bills.

Modern digital infrastructure enables discoms to optimise physical networks. Information onthe nature and scale of demand, network capacity, generation sources, and storage capacity will allowfor optimal use of assets across the system. Smart meter data can allowdiscoms to map system constraints and make investment decisionsmore efficiently.

Discoms must seize this opportunity to establish robust and transparent accounting mechanisms to accurately capture and communicate energy flows (and losses) and the cost and quality of supply to different consumer categories. Further, discoms should leverage AMI data to effectively manage and maintain the distribution network, and provide a high-quality and reliable power supply. At the same time, theymust: introduce new technologies to empower consumers and protect their data and take measures to address cyber security issues.

---

24 https://www.nerc.com/pa/RAPA/ra/Reliability.
25 https://energy.ec.europa.eu/topics/markets-and-consumers/smart-grids-and-meters.
26 https://eeslindia.org/en/smart-meters.
27 https://recindia.nic.in/rdss-guidelines.
28 https://www.nsgm.gov.in/en/sm-stats-all.
29 https://www.ceew.in/publications/smart-meter-data-enabled-transition-energy-efficient-cooling.
30 https://www.ceew.in/publications/what-smart-meters-can-tell-us.

"Through the 'Core4Grid' trial, battery storage and smart meters have been installed in 24 houses in the UK that already had solar panels, electric heating, or electric vehicle chargers. Using Core – its 'energy brain' – the technologies have been integrated to run a whole system within each home.

Core responds to signals from the electricity system to decide when to use energy or charge the batteries, using either excess solar generated by the household's panels or grid electricity imported during cheaper periods.

Participating homes sourced over half the energy from their solar and batteries. The houses have generated almost 30 MWh of local generation (equivalent to 10 times a typical dual-fuel household's annual electricity use) for the trial period."

Source: Adapted from Ofgem (2020)[31]

Case study: Domestic and small-scale storage (social energy)

"Social Energy has created a community of 6,500+ residential customers with solar and battery storage, generating additional savings by providing flexibility to the system. By operating as both a flexibility provider and energy supplier, Social Energy uses its 'virtual power plant' to optimise a range of household revenue streams, including firm frequency response contracts for the electricity system operator.

The Social Energy Hub in the home captures sub-second data streams, fed into the cloud to forecast generation, demand, and grid behaviour, and optimised against market signals. Savings are made through flexibility services, supplier cost avoidance, and trading arbitrage, with 70 per cent of any revenues passed back to the end consumer on top of savings from generating their own solar power. The Energy Saving Trust has independently verified that Social Energy customers get an average 70 per cent bill reduction. In 2021, installations for new housing developments and social housing were being rolled out."

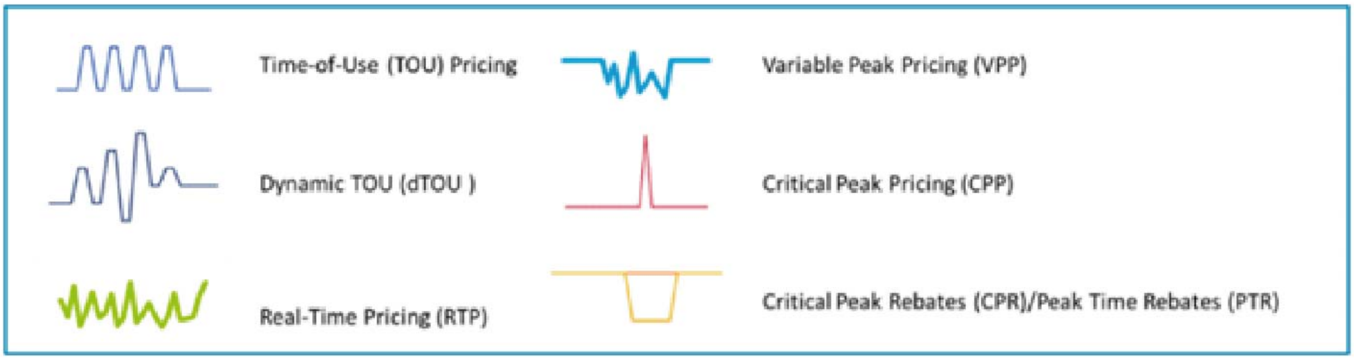
Source: Adapted from Ofgem (2021)[32]

31 https://www.ofgem.gov.uk/gas/retail-market/monitoring-data-and-statistics/typical-domestic-consumption-values, accessed 13/10/2020.
32 https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/1003778/ smart-systems-and-flexibility-plan-2021.pdf.

3.5 Adopting dynamic tariffs

To incentivise cost-effective decarbonisation, the future tariff design process needs to identify system distortionand trade-offs involved in the distribution of electricity. The nature of costs in a clean energy–dominated system will be entirely different. Ensuring that costs are fairly allocated amongall consumers will be a central challenge for regulators and discoms. Progressively moving towards a smart and dynamic tariff design that reflects the cost of supply (at different voltages and times of the day) is the need of the hour. The dynamic tariff will enable optimising the cost of power purchase, which constitutes over 70–80 per cent of the tariff charged toconsumers. It also assumes importance in the process of implementing DSM measures and achieving energy efficiency. Figure 7 illustrates the dynamic pricing options.

Figure 7: Dynamic Tariff options



Source: Adapted from the paper 'The Swedish Experience with dynamic retail tariffs'[34]

Bhagwat and Hadush's (2020) review of 16international case studies notes that5countries –Norway, Sweden, Finland, Estonia, and Great Britain – are the most advanced in terms of the application of dynamic tariffs. These countries offer real-time pricing. The review also offers interesting insights on choices that need to be made before dynamic retail electricity tariffs can be implemented.

1. It is essential to conduct a careful cost–benefit analysis of the effects on consumers, suppliers, and the overall implementation system. Moreover, enabling innovative business models and technologies will facilitatederiving the maximum benefit ofapplying dynamic tariffs.

2. The implementation of dynamic retail tariffs depends on the availability of physical and information and communication technology (ICT) infrastructure, the maturity of the power market design, and consumer behaviour.

3. The application of time-of-use tariffs is generally the first step in dynamic tariffs. With digitalisation and automation of the energy system and the maturity of the electricity market, real-time pricing can be applied.

4. While designing tariffs, two consideration can bemade: a) the time block lengthimplying, the number of distinct tariff levels, and b) the price periodicity implying, the time interval between tariff revisions.

5. Duringimplementation, regulators can makeregulatory interventions to protect vulnerable consumers, and consumers can choose from various dynamic tariff options.

To gauge customers' responses and conduct a cost–benefit analysis, a pilot studyofresidential consumers in urban areas can be completed. This may be the first step to designing and adopting smart and dynamic tariffs in India.

---

[33] https://www.ceew.in/blogs/revisiting-and-resolving-discoms-legacy-issues.

[34] www.fsr.eui.eu/the-swedish-experience-with-dynamic-retail-tariffs/

[35] https://cadmus.eui.eu/bitstream/handle/1814/66851/PB_2020_14_FSR.pdf.

3.6 Evolving electricity markets

Increasing levels of grid-based renewable generation, decentralised RE, electric vehicles, and digitalisation are transforming the electricity industry worldwide and challenging the functioning of existing electricity markets. Recent crises in California (August 2020), Texas (February 2021), and India (August–October 2021) indicatethe criticality of the situation, and call for a reflection on how markets should evolve in the changing environment.

Glachant and Rossetto (2021), statethat the existing open wholesale markets are likely to cope with currently evolving generation mixes inthe short to the medium term,and to accommodate increasing shares of intermittent RE. However,the critical building blocks for the future 'RES-proof' open markets will includea more significant focus on short-term electricity markets and markets for ancillary services, stronger participation of the demand side, and the introduction of dedicated capacity remuneration mechanisms or long-term contracts. The deployment of storage and the expansion of transmission networks, incentivized by volatile prices, will play an essential complementary role in grid integration and support the transition to a different electricity system operational paradigm, where demand is flexible and adjusted to match variable supply.

The authors further propose two contrasting visions for future electricity markets: One of them expands the use of spot nodal prices to the distribution level, possibly up to the level of each individual generation and consumption device. The other vision builds on system operators signing long-term contracts with distributed renewable energy (DRE) owners (or their intermediaries) for flexible control to deal with voltage and congestion problems. Both visions present advantages and disadvantages. Some form of hybrid market design will likely emerge over time, using price signals and non-price-based rationing of available generation to loads in priority orders.

Policymakers, regulators, and discoms should consider the aforementioned points to makeprovisions for the evolving electricity market. However, the immediate priority is to work toward deepening market-based procurement for discoms. Regulators should develop regulatory frameworks that enable discoms to enter short-term contracts (within or outside the power exchange) and harness the system's flexibility.

---

[36] https://fsr.eui.eu/what-future-for-electricity-markets/.

[37] Ibid.

[38] Ibid.

4

Framework for emission-reduction targets for power utilities

Reducing emissions from the power sector is typically understood as switching from fossil fuels to RE. However, these trajectories are externally determined and do not impose any actionable requirements on the power generation utilities. While norms have existed since 1994 to limit emissions from thermal power plants, lax standards require that they promote the switch to cleaner fuels. In addition, these norms were introduced only to limit local pollution. The Ministry of Power in India has proposed that thermal generators coming up after 2024 either procure or set up RE capacity at25 per cent of the thermal generation capacity.

Power generating companies can align their business models towards scenarios with loweremissions and set in-house targets to reduce emissions. These scenarios may be modelled based on the specific conditions of the generators. This can also result in generators becoming active partners in national efforts to reach net zero emissions and foster cooperative approaches topolicymaking and implementation. For instance, the SBTi seeks to define and promote best practices in emission reductions and net zero targets in line with climate science. Specifically, SBTis for the power sector provide step-by-step practical guidance for electric utilities toset SBTis. They lay out criteria that cover emissions across the value chain and model emission-reduction targets and trajectories. This clarifies what actions utilities need to take in different time horizons. [40]The case study of NRG Energy showcases how the SBTi was leveraged to design anabsolute emission-reduction trajectory.

Case study: NRG Energy and SBTi based targets

NRG Energy, Inc. is a prominent American energy company, with dualheadquarters in Princeton, New Jersey and Houston, Texas. It has 50 GW of generation capacity and 3 million retail consumers. In the last decade, NRG invested heavily in clean energy to become a leading producer in the US.

NRG's targets:

- A 50 per cent reduction of absolute emissions by 2030 and 90 per cent by 2050, from 2014 levels.
- Reduction in scope 3 emissions related to employee travel.

NRG set its absolute emission-reduction trajectory using the SBTi. The case study highlights key future strategies to meet these ambitious targets. It also underscores other critical elements associated with decarbonising a power plant, such as internal stakeholder engagement, notably with the staff employed at NRG. The NRG case demonstrates that gaining the staff's support and cooperation is a key non-quantitative metric necessary to ensure a successful transition.

Source: Adapted from SBTi case studies

[39] https://mercomindia.com/25-of-generation-capacity-of-coal-plants-must-be-from-renewables.

[40] https://sciencebasedtargets.org/resources/legacy/2020/06/SBTi-Power-Sector-15C-guide-FINAL.pdf.

5 Conclusion

Achieving net zero presents significant challenges toelectricity utilities across the value chain (generation, transmission, and distribution), given the extent of overhaul required foroperations and business models. However, the projected scale of electrification across all energy enduses to meet the decarbonisation targets of the country provides ample opportunities as well. Utilities will need to adapt to the evolving energy mix and pivot their business strategies to align with electricity systems of the future – a future in whichutilities are decarbonised, digitalised, and decentralised to provide reliable, resilient, and affordable electricity to all.

---

[41] https://www.sciencebasedtargets.org/companies-taking-action/case-studies/nrg

Bibliography

Prateek Aggarwal
Programme Lead
Council on Energy Environment and Water

Praveen Chandrasekaran
Engagement Lead
Council on Energy Environment and Water

Chetna Arora
Research Analyst
Council on Energy Environment and Water

Harsha Rao
Programme Associate
Council on Energy Environment and Water

NOTES

NOTES

4th Edition
World®
Utility
Summit
20-21 February 2023
Delhi NCR, India

SUSTAINABLE TRANSFORMATION OF UTILITIES

ABOUT WUS 2023

World Utility Summit was conceptualised to provide a wider forum for utilities to deliberate together on changes that will come, probable ideas and solutions to deal with continuous changes. World Utility Summit is scheduled in 2023 with theme Sustainable Transformation of Utilities. The electricity ecosystem is undergoing an unprecedented transformation with the proliferation of renewables, distributed generation of resources and electric vehicles on one side and consumer activism and regulatory pressures on other. These developments can help utilities to embrace the complexities of the network and to prepare to drive decisions based on probabilities and real-time data.

- Accelerating Digital Journey of Energy Ecosystem
- Best Practices in Asset Management
- Enhancing The Utility System Resiliency
- Distribution Utilities of Future: Advanced Technologies For Business Transformation
- Sustainable Practices Towards Net Zero Utilities
- New Energies (Common Track With eTECH nxt)

SUPPORTED BY

Ministry of Heavy Industries
Ministry of Power
Government of India

COUNTRY PARTNER

INTERNATIONAL PARTNER

FOUNDING PARTNERS

IEEMA is the first ISO certified industry association in India, with 950+ member organizations encompassing the complete value chain in power generation, transmission and distribution equipment. Its membership base ranges from public sector enterprises, multinational companies to small, medium and large companies. IEEMA members have contributed to more than 90% of the power equipment installed in India. Know more @ www.ieema.org

ELECRAMA is the flagship showcase of the Indian Electrical Industry ecosystem and the largest congregation of power sector ecosystem in the geography. ELECRAMA brings together the complete spectrum of solutions that powers the planet from source to socket and everything in between. Featuring not just equipment & technology, but peerless thought leadership platforms for everything electric - from technical conclaves to industry summits. Know more @ www. elecrama.com

IEEE, an association dedicated to advancing innovation and technological excellence for the benefit of humanity, is the world's largest technical professional society. It is designed to serve professionals involved in all aspects of the electrical, electronic, and computing fields and related areas of science and technology that underlie modern civilization. Know more @ http://www.ieee.org/

The Power & Energy Society (PES) provides the world's largest forum for sharing the latest in technological developments in the electric power industry, for developing standards that guide the development and construction of equipment and systems, and for educating members of the industry and the general public. Members of the Power & Energy Society are leaders in this field, and they — and their employers — derive substantial benefits from involvement with this unique and outstanding association. Know more @ www.ieee-pes.org

World® Utility Summit

Knowledge Partner

CEEW THE COUNCIL

Founding Partners

ieema your link to electricity | IEEE Advancing Technology for Humanity | IEEE PES Power & Energy Society®

15th Edition ELECRAMA Powering the Future of Energy

18-22 February, 2023
INDIA EXPO MART, GREATER NOIDA, DELHI NCR, INDIA

Venue:
India Exposition Mart Ltd.
Plot No. 25,27,28,29,
Knowledge Park-II Greater
Noida-201306 Uttar Pradesh, INDIA
www.indiaexpomart.com

Conference Secretariat
Rishyamook Building,
First Floor 85 A,
Panchkuian Road, New Delhi
Delhi 110001
secretariat@worldutilitysummit.org

Uttam Kumar
M: +91 9717518502
E: uttam.kumar@ieema.org

Dr. Saad Faruqui
M: +91 9897031934
E: saad.faruqui@ieema.org