Enabling Energy Sustainability

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7.1 Introduction

Access to equitable, affordable, reliable and environmentally sustainable modern energy services is at the helm of human development (Gaye 2007) and key to achievement of inclusive social development, poverty alleviation and economic empowerment of the deprived and marginalised populations. It is, therefore, 'energy resources and services' and has been accorded with uttermost priority under the 2030 agenda as a dedicated and stand-alone goal (SDG 7) (United Nations Department of Economic and Social Affairs (UNDESA) 2019). Furthermore, SDG-7 compliance is linked to the achievement of 125 of 169 targets of other 16 SDGs (International Bank for Reconstruction and Development 2017), aimed at fuelling human development, addressing the heightened challenge of social inequality, resource starvation, climate change and compliance of NDC commitment (UNFCC 2015).

This article aims at assessing strategic governance approach adopted in implementing of specific SDGs and its compliance, identifying key challenges and propose enabling framework for transition from incremental progress to transformational acceleration in adoption of 2030 agenda and its objective. In addition to the introduction, the article has six more sections. Sections 7.2, 7.3 and 7.4 assess the approach in which Goals 7.1, 7.2 and 7.3 are being institutionalised. Section 7.5 focuses on projected energy scenario and pathways. Section 7.6 focuses on the key strategies to be adopted for implementing of SDG agenda.

7.2 Access to Energy Services

7.2.1 Electricity Access

From nearly 240 million population, without access to electricity (IEA 2015) in 2014, to 18,734 unelectrified households, GoI has made an enormous stride in ensuring last mile electrification. 'Pradhan Mantri Sahaj Bijli Har Ghar Yojana—Saubhagya' has been instrumental in ensuring electricity access to 26.2 million unelectrified rural households (Pradhan Mantri Sahaj Bijli Har Ghar Yojana—'Saubhagya' 2019), in addition to 0.85 million marginalised urban households (BPL families) (Lok Sabha Question No 3721 2019) (Table 7.1).

The strategic shift, from the approach of village electrification (village deemed to be electrified with 10% households being electrified) to total household electrification under 'Saubhagya' by means of extending free electricity connec-

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Table 7.1 Percentage of HH electrification

SDG baseline (October 2018)	Target by 2030	Achievement (March 2019)
94.57%	100%	99.99%

Source: Saubhagya; SDG India Index, NITI Aayog

tions to unelectrified rural households and urban BPL families (REC India 2019), colossal expansion of the distribution network, off-grid DRE (HLS) or micro-grid applications, has resulted in the transformational achievement. The massive leap in electrification has in turn reduced the consumption of highly subsidised PDS kerosene, use of diesel in diesel-micro-grid or stand-alone genset (Abhishek Jain, November 2018), thereby addressing the concern over energy security, oil import dependency and energy subsidy budget. **In line with the SDG target (100% electrified population), compliance to SDG 7.1.1. can already be deemed to be achieved**.

Paradoxically, the enhanced access is yet to address the pervasive energy poverty, with India significantly lagging behind global average in terms of energy consumption (Ministry of Finance 2019) and the disparity in the per capita electricity consumption across the states. Disparity in electricity usage also exists across urban and rural areas, including uneven spatial dispersion across different income groups (Ministry of Finance 2019). Specific to rural areas, electricity access is yet to result in social upliftment and livelihood sustainability (Rockefeller Foundation, Smart Power India, ISEP 2019) and thus far from realising the SDG objective of fulfilling the 'essential needs of the world's poor (Wikisource n.d.)', inequality and discriminations. Jeopardised with the persistent challenges of reliability, affordability and unintentional prioritisation of households over enterprise has forced rural enterprises to stack upon alternate source for electricity (Rockefeller Foundation, Smart Power India, ISEP 2019), impacting their growth possibilities and sustainability.

> India needs to increase its per capita energy consumption by four times to reach the HDI level of 0.8.

7.2.1.1 Reliability of Supply

The roll out of the flagship programme '24 × 7 Affordable and Quality Power for All' (PIB, GoI, MoP 2017) is yet to address the reeling challenges of unscheduled power cuts and poor-quality supply in many of the rural and peri-urban areas coupled with irrational consumer burden of high electricity tariff, impacting industrialisation and societal upliftment. Studies (Abhishek Jain, November 2018) (Rockefeller Foundation, Smart Power India, ISEP 2019) across rural areas of Bihar, Jharkhand, Madhya Pradesh, Uttar Pradesh, Odisha and West Bengal reflected the criticality of power supply. MoP also substantiates the aforesaid claim, declaring 13 states with supply below 20 h/day (National Power Portal 2019) (Fig. 7.1).

7.2.1.2 Affordability of Supply

Affordability of electricity services is a major bottleneck for the economically disadvantaged in post-adoption consistent usage. While subsidised connectivity (under Saubhagya) has ensured accessibility and adoptions, its consistent use has still been a constraint. With 4% of the economically disadvantaged household's expenditure on electricity considered as affordable (Abhishek Jain, November 2018), households subjected to unmetered fixed billing and non-periodic billing cycle face the challenge of inflated electricity expenditure (Rockefeller Foundation, Smart Power India, ISEP 2019) and envisage electricity services as unviable commodity (Fig. 7.2).

7.2.1.3 Equitability of Access

Electricity access to 0.5 million household in remotest areas under Saubhagya and previously under remote village electrification programme were provisioned through solar-powered home lighting system of 200–300 kWp (Palit, April 2018). These are in addition to households electrified through DRE grid (more than 14,000

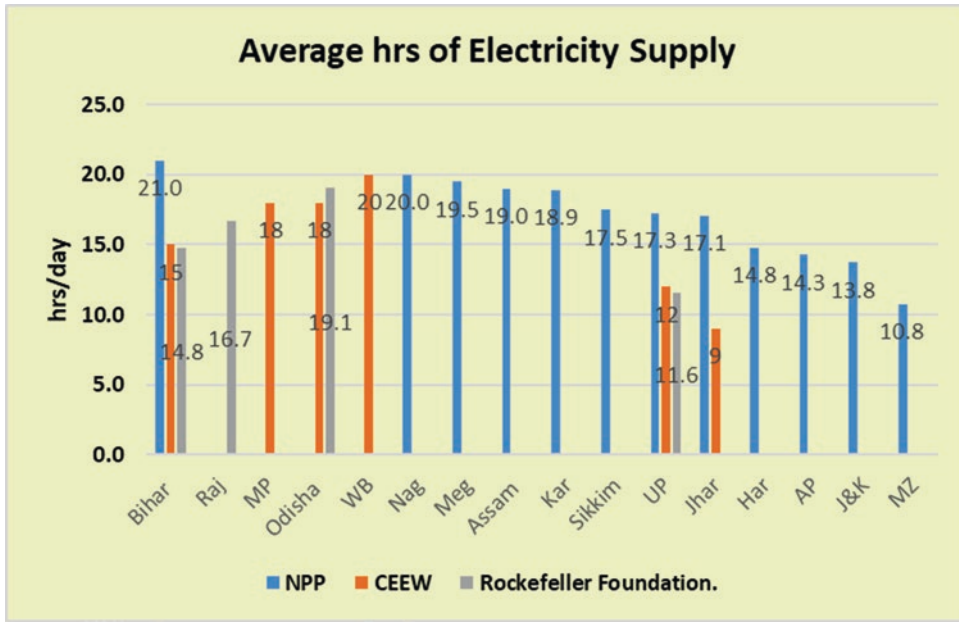

Fig. 7.1 Average hours of electricity supply. (Source: NPP, CEEW and Rockefeller Foundation)

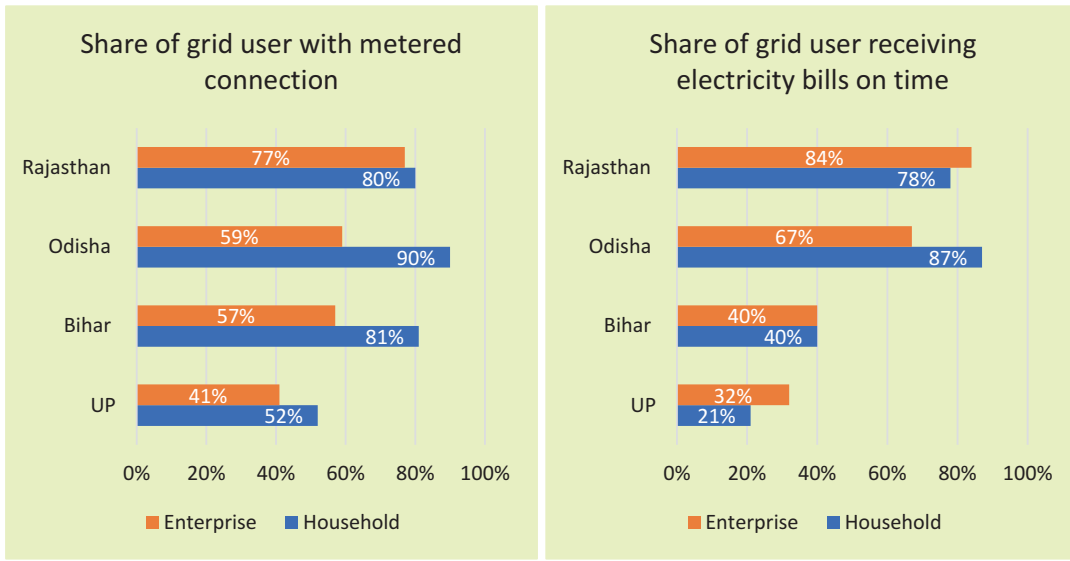

Fig. 7.2 State-wise share of unmetered connection and timely billing. (Source: Rockefeller Foundation, Smart Power India, ISEP. (2019). Rural Electrification in India)

micro-/mini-grid (Rajarshi 2018)) and over two million stand-alone system (Rockefeller Foundation, Smart Power India, ISEP 2019). Although the stand-alone system has ensured the access but has eclipsed the need to provide quality access, equitable supply and required services and critical access for rural micro-enterprises restrict rural economic empowerment (Rockefeller Foundation, Smart Power India, ISEP 2019).

7.2.1.4 Operational and Institutional Challenges

Chronic operational and functional inefficiencies coupled with rising indebtedness and poor financials (cumulative book losses of ₹ 150.49 billion) are jeopardising DISCOM's functionality. UDAY adopted by 27 states and 5 UTs except WB, Odisha, Chandigarh and Delhi with the objective of improving DSICOM's functionality has brought about some fundamental reformation but is yet to achieve the transformational target planned.

AT&C Losses (DISCOM)

As against the overarching target of reducing AT&C losses to 15% by FY-2019 from 20.8% during FY-2016, only 2% reduction to 18.72% has been achieved by FY-2018 at the nationally resulting in estimated savings of ₹ 90 billion (MoP, January 2019). The national AT&C loss trajectory is a mix of high-performing states achieving the loss reduction target of 15% and other low-performing states with existing loss of more than 20% (Fig. 7.3).

ACS–ARR Gap (DISCOM)

Supplying electricity at a tariff (ARR) lower than the average cost of supply (ACS), resulting from delay in tariff revision and politically and socially mediated tariff fixation, results in financial loss for DISCOM. As against the target of neutralising ACS-ARR gap under UDAY, the average gap at national level could only be reduced by Rs. 0.42/unit between FY-2016 and FY-2018 (Fig. 7.4).

Financial Loss of DISCOMs

Poor financial health with aggregate debt of Rs 4.3 trillion and annual loss of Rs 0.6 trillion March 2015 (Agarwal 2018) had cluttered the operational and functional efficiency of DISCOMs. UDAY institutionalised as transformative scheme has brought about sectoral reform and bailed out DISCOMs from its loss regime with book loss reduced from Rs 0.51 trillion in FY-2016 to Rs 0.15 trillion by FY-2018 and total outstanding to Generation Companies of Rs 0.4 trillion (MoP, January 2019) (Fig. 7.5).

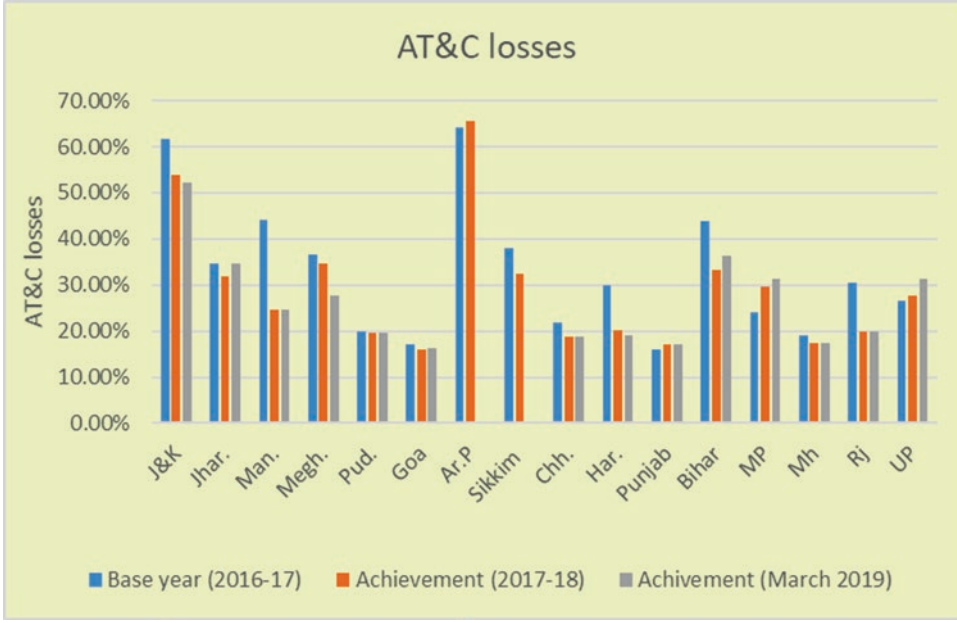

Fig. 7.3 AT&C loss trajectory. (Source: UDAY portal)

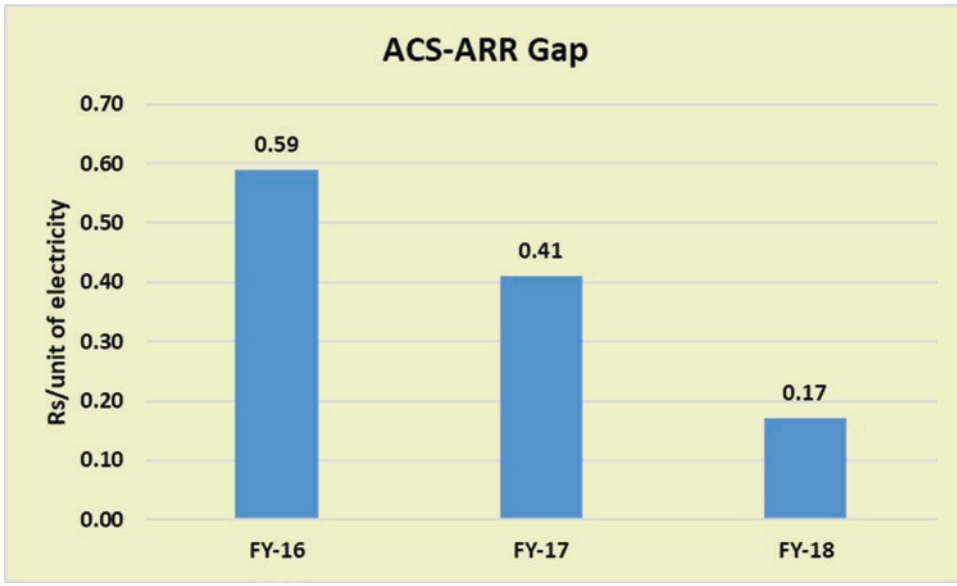

Fig. 7.4 ACS-ARR gap. (Source: UDAY newsletter)

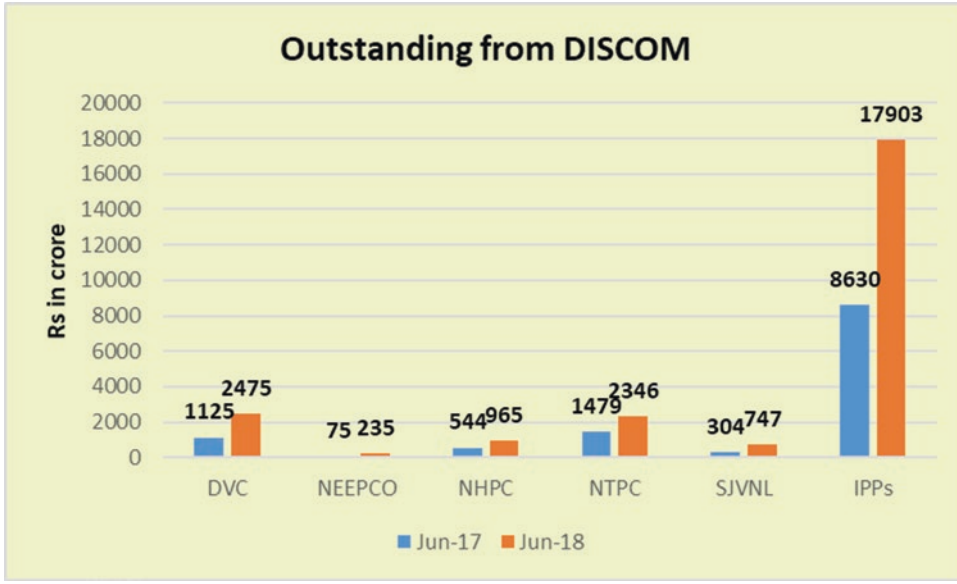

Fig. 7.5 Outstanding from DISCOM [20]

Energy Deficit and Deteriorating Operational Efficiency of Generating Stations

In spite of being a power surplus country and substantial reduction in demand supply gap from 3095 MU (3.6%) during March 2014, gap still persists in range of 884 MU (0.4%) during March 2019 (Fig. 7.6).

Stressed Generation Sector

The predominant coal-based generating units are stressed by multiple constraints like (a) coal sup-

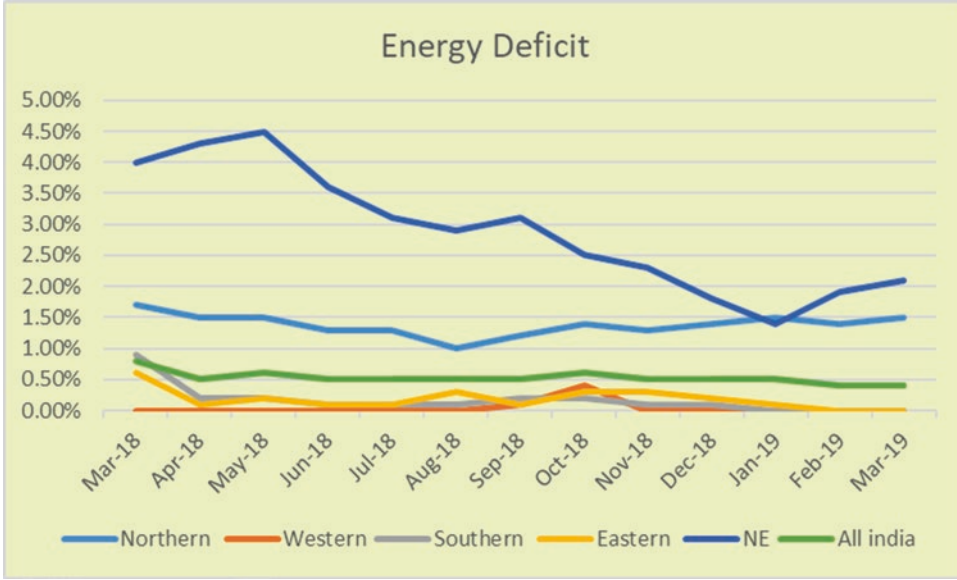

Fig. 7.6 Energy deficit. (Source: CEA)

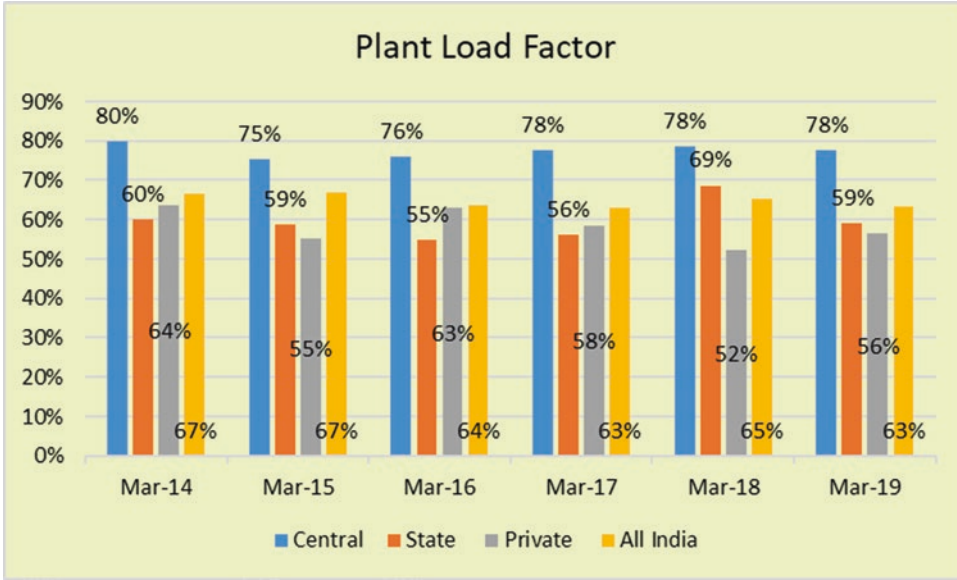

Fig. 7.7 Plant load factor. (Source: CEA)

ply and legal issues with auctioned coal mines, (b) delay/inability of DISCOM in payment, (c) dishonoured PPA and low offtake, (d) regulatory and contractual disputes leading to poor operational efficiency and (e) increased evacuation of unscheduled variable renewable energy to the grid (Fig. 7.7).

7.2.2 Clean Fuels and Technologies

Dependence on traditional fuel like coal, charcoal, wood and animal dung and its incomplete combustion in inefficient and highly polluting stoves for cooking is the most prevalent practice amongst the lower income groups (UN India n.d.;

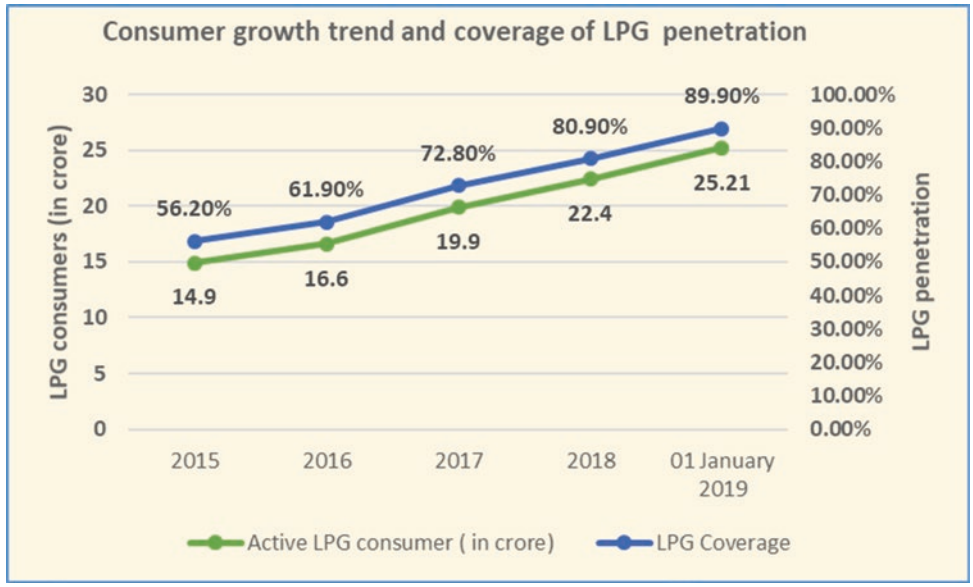

Fig. 7.8 LPG penetration and growth trajectory

World Health Organisation 2018). Such practice is a critical contributor to HAP and drivers of global environmental health risk. HAP in India alone has been the major cause of chronic cardiovascular and respiratory diseases and acute lung and respiratory infections in children resulting in over one million deaths per year (World Health Organisation 2018; Balakrishnan and Sambandam 2004) and has been regarded amongst one of the ten most important risk factors for mortality and morbidity (The Institute for Health Metrics and Evaluation (IHME) 2019). Use of wood specially entails drudgery of women and children spending about 5–8 h or more in a week and carrying head loads of 20–30 kg over a long distance, resulting in reduced available time for education and alternate economic activities (UN India n.d.). Access to clean cooking fuel has, therefore, been considered imperative for achieving the human development priorities. Through introduction and institutionalisation of several promotional schemes by the Union Government, the LPG coverage has increased to 89.9% household[1] by 2019 (Petroleum Planning & Analysis Cell 2019) as compared to 56.2% during 2015 (Fig. 7.8).

The schemes such as (1) PAHAL, (2) PMUY (59.41 million BPL consumers covered till January 2019) followed by Ujjwala Plus Scheme, (3) 'Give It Up' or 'Giveback' and (4) SAHAJ have acted as a transformative drivers in mainstreaming adoption of LPG across the country. Strengthening of the supply chain network through increased distribution network and introduction of extended service network like 'Rurban Vitrak', 'Gramin Vitrak' and 'Durgam Kshetriya Vitrak' (Petroleum Planning and Analysis Cell 2018) has further ensured the reliability of supply (Table 7.2).

Ironically, the aforesaid penetration does not resemble the true picture of accessibility in terms of (1) equitable distribution, (2) equitable adoption amongst all economic class and (3) sustained usage?

The penetration of LPG across the landlocked north-eastern states of Meghalaya (44.3%), Nagaland (60.6%) and Tripura (69.4%), eastern states of Bihar (68.2%), Jharkhand (66.6%), Odisha (67.9%), and western states of Chhattisgarh (72.1%), Madhya Pradesh (74.7%) and Gujarat (67.2%) is comparatively lower than the national average.

[1]As on 1 January 2019. Disclaimer: The content of this paper does not reflect the views or policy of UNDP

Table 7.2 Disparity in LPG usage

Category	No of households (in million)	No of active LPG consumers (in million)	Per capita cons. in kg/year
Urban	85.28	101.04	10.07
Rural	183.28	65.21	8.05

Table 7.3 Household expenditure on cooking

% of Population obtaining cooking fuel for free	Monthly exp. on cooking fuel	Monthly spending capacity across diff income group	Cost of LPG/14.2 kg cylinder (Delhi)
35% (37% rural and 25% urban)	Rs 358 (Rural—Rs 354 and Urban—Rs 372)	Less than Rs 2250/ month—Rs 334	Rs 419–Rs 432/14.2 kg cylinder in 2016 increased to Rs 495/14.2 kg cylinder in 2019
		Between Rs 2250–5000/ month—Rs 356	
		More than Rs 5000/ month—Rs 396	

Moreover, disparity also exists in terms of penetration and usage of LPG across the rural and urban areas in each state (Abhishek Jain, November 2018) (Lok Sabha 2016). Accelerated by subsidised upfront distribution under PMUY, the adoption rate amongst the economically disadvantaged class has been remarkable. However, ensuring its sustained usage has emerged as a challenge with only 80% of the beneficiaries opting for second refill in the first year itself (Lok Sabha 2018).

Mindset of prolonging LPG usage, possibly due to 'stacking' phenomenon, restricting instant transition from one fuel to another (Smith and Sagar 2014), affordability and availability of cheaper fuel are identified as the major drawbacks towards sustained LPG usage (Pandey 2018).

Affordability Increasing household expenditure and availability of free fuel led reluctance amongst the rural and BPL consumers forbid sustained LPG usage (CRISIL, June 2016) (IOCL, Product_Previous Price 2016; IOCL, Products 2019). Expenditure on LPG for a BPL family estimates to 9.5% of the monthly income in contrast to 6% of the monthly budget expenditure on cooking fuel as per NSSO (Kundan Pandey 2019) (Table 7.3).

7.3 Share of Renewable Energy in Energy Mix

7.3.1 Renewable Energy Share

Electricity production alone from conventional source accounts for 42% of the entire GHG emission (in 2014) (MoEFCC 2018). Reducing the emission footprint and sustainability of energy sector, GoI has been proactively pursuing the imperative of enhancing the share of renewable. As against the installed generation capacity of 360.78 GW (CEA, April 2019b), renewable installed capacity accounts for 22.34% (80.63 GW without large-scale hydro) (MNRE, April 2019) and 34.93% (126.03 GW with large-scale hydro) (PIB, March 2019) (Figs. 7.9 and 7.10).

Of the renewable capacity, addition wind and solar-based units account for the key share followed by biomass and small hydro. Buoyed by strong policy, regulatory, financial and fiscal initiatives and decline in the cost of solar PV and wind-based generation capacity has significantly increased during last 5 years (Table 7.4).

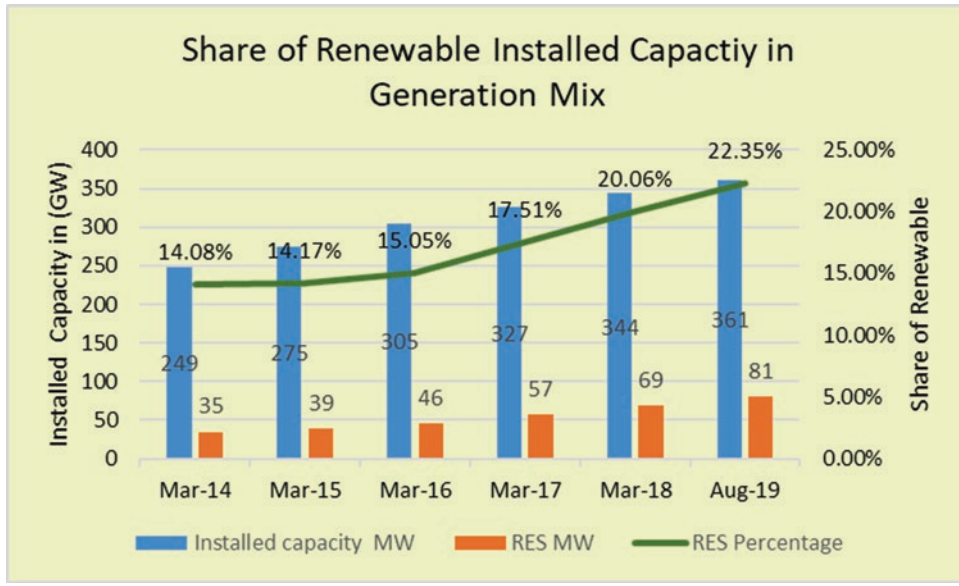

Fig. 7.9 Share of renewable. (Source: CEA)

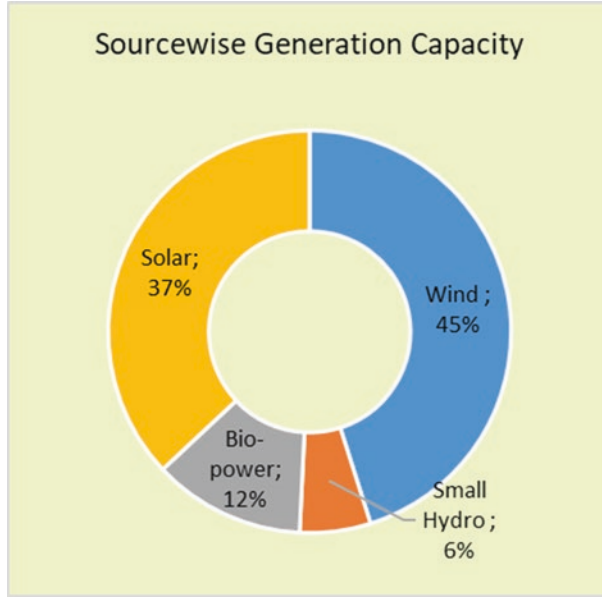

Fig. 7.10 Source-wise Renewable Energy Generation mix. (Source: MNRE)

Although the global indicator for Goal 7.2 is set towards 'Renewable energy share in the total final energy consumption', the monitoring indicator proposed by NITI Aayog in its indexing report pertains to share in generation mix.

Increase in renewable energy capacity has resulted in addressing energy security, reduce fuel import and reduction in environmental degradation in addition to the GHG avoidance (around 335.5 $MtCO_2$ between 2014 and 2018) (MoEFCC 2018).

Table 7.4 Source-wise RE generation capacity growth trajectory

Source	March 2014	March 2019	CAGR (%)
Solar	2631.93	28,180.71	60.67
Wind	21,042.58	35,625.97	11.10
Small hydro	3803.68	4593.15	3.84
Bio-power	7509.81	9916.61	5.72
Total	**29,462.55**	**78,316.44**	**21.60**

7.3.2 Issues

(a) **Regionaldisparity**: Alarmingly around 95% of the entire capacity addition is concentrated across few state like Karnataka, Tamil Nadu, Maharashtra, Gujarat, Andhra Pradesh, Rajasthan, Madhya Pradesh, Telangana, Uttar Pradesh, Punjab and Himachal Pradesh (with share of installed capacity of over 1%).

(b) **Lower renewable energy consumption**: With over 20% share energy mix, the average contribution of energy generated from renewable during FY2018–2019 is lower than 10% (Figs. 7.11 and 7.12).

7.3.3 Challenges

Operationalisation of world's largest RE programme of 175 GW by 2022 (NITI Aayog 2015) (presently escalated to 450 GW (Singh 2019)) could be jeopardised by the plethora of challenges addition if not addressed.

1. Limited financial resources of the federal government with strong priority towards providing basic amenities and meeting of the developmental aspiration limit capital intensive infrastructure development and enabling market ecosystem (including basic amenities like land and evacuation facilities) required for harnessing of renewable energy potential.
2. Improper forecasting and scheduling facilities coupled with the variability of RE generation and absence of adequate flexible peaking units (gas based, pump storage, etc.) and storage facilities impacts the stability of the grid.
3. Achieving of 175 GW of RE addition might force coal-based generating unit to operate as low as 26% PLF, impacting their operational and financial viability.
4. Curtailment of RE generation[2] (1% curtailment of current RE capacity corresponds to minimum loss of Rs. 6.58 billion (CEA 2019a)) can impact developers investment interest.
5. Changes in regulatory norms towards safeguard duties have driven cost and time although marginally boosting the domestic manufacturing (Aggarwal and Dutt 2018), with domestic content requirement might impact KUSUM implementation (Bajaj 2019).
6. Lack of access to preferential consumer finance for RTS across residential, C&I sector lacking creditworthiness due to perceived risk by financial institutions and variance in understanding and comfort of lenders with RE projects (CRISIL and Shakti n.d.).
7. Reluctance of DISCOMs for RTS adoption across C&I segment, delayed mobilisation of net metering facilities (Aggarwal and Dutt 2018), poor offtake of renewable power (CEEW n.d.), hankering for lowest possible tariffs, deliberate disregard for committed PPA and delayed payment (payment due of Rs 97.36 billion) (Singh 2019).
8. Disorganised and underdeveloped supply chain operators for O&M of RTS and DRE units.

[2]Curtailment relates to situation where power grid operators instruct to limit the power output of specific RE generators.

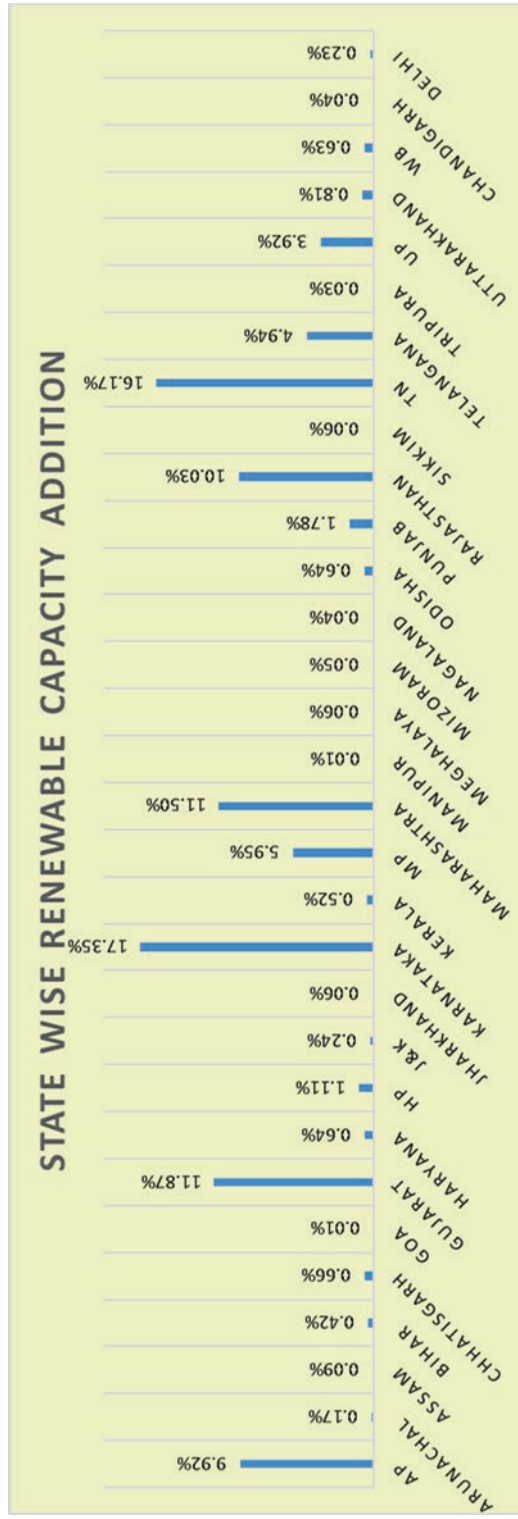

Fig. 7.11 State-wise renewable capacity addition. (Source: MNRE, August (2019))

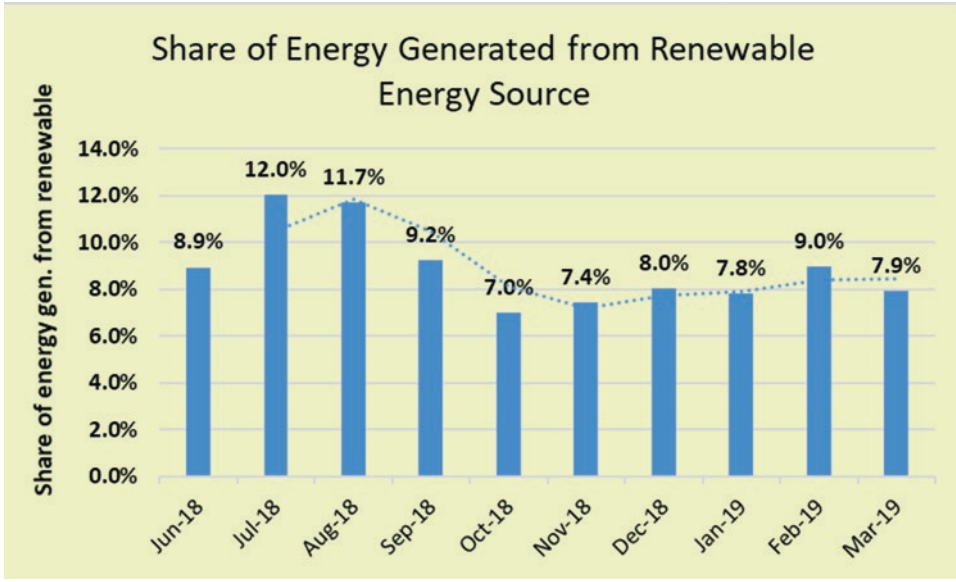

Fig. 7.12 Share of renewable energy generation. (Source: CEA)

7.4 Adoption of Energy Efficiency

7.4.1 Energy Intensity

Institutionalisation of stringent energy conservation measures fostered by institutionalisation of enabling environment for its adoption has resulted in reduction of emission intensity by 21% over the period of 2005–2014 (MoEFCC 2018) (Fig. 7.13).

Institutionalisation of key programmes like UJALA, SLN, S&L, ECBC and Building Star rating programme, CCT, PAT (for large industry) and SME programme (BEE, multilateral and bilateral programme, MDBs), DSM (Agriculture and Municipal DSM) and Smart City Mission has reformed the energy use scenario, resulting in electricity saving of 7.21% of the net electricity consumption and 2.7% of the total thermal energy consumption during 2017–2018 with overall monetary saving of Rs 530 billion and GHG avoidance of 108 million tCO_{2e} (Ministry of Finance 2019). Considering the current level of resource efficiency and technological advancement, the energy consumption (BEE 2019) and energy conservation potential across different demand sector and scenario[3] are presented in the following tables (Tables 7.5 and 7.6).

7.4.2 Issues

Energy intensity (EI) conceived as the indicator for adoption of energy efficiency cannot alone be considered as the sole indicator (IEA 2018a, b) because of the fundamental difference between the engineering concept of energy efficiency and the macroeconomic statistic of energy intensity

[3]Moderate effort will refer to Moderate/Business as Usual (BAU) technological improvements and technology penetration as per government/other agencies target as well as Moderate/BAU fuel mix shift from fossil fuel to Renewable Energy (RE)/electricity-based consumption.

Aspirational effort will refer to aggressive technological improvements and penetration over government/other agencies target as well as aggressive fuel mix shift towards RE-based consumption in sector.

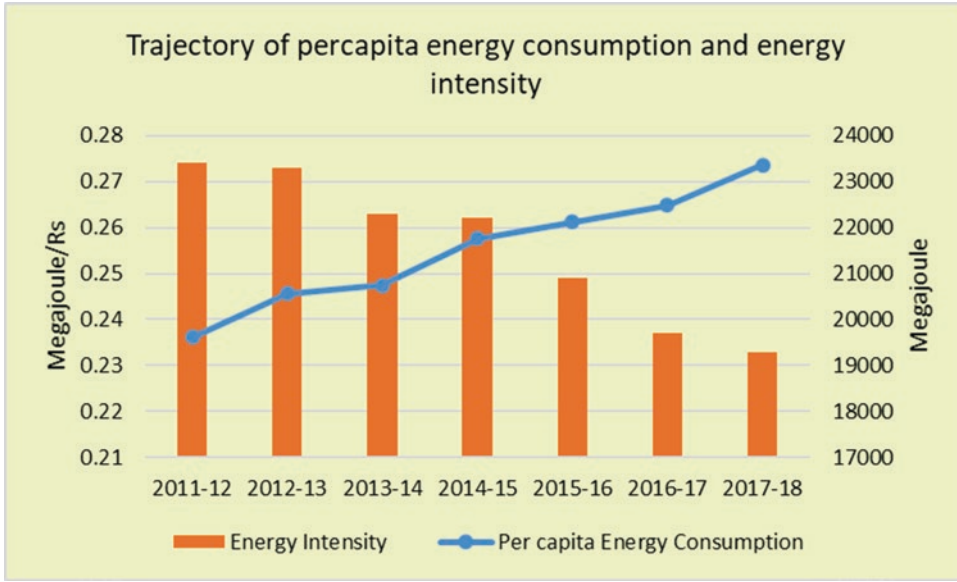

Fig. 7.13 Trajectory of per capita energy consumption and energy intensity

Table 7.5 Sectoral energy consumption

Mtoe (2016–2017)	Domestic	Commercial	Industries	Municipal	Transport	Agriculture	Others	Total
Primary energy excluding electricity	26.8	0	303.8	0	44.1	0.9	73.6	449.1
Electricity	22.3	8.5	36.7	2.6	1.5	16.8	3.3	91.7
Total energy	**49.1**	**8.5**	**340.4**	**2.6**	**45.6**	**17.7**	**76.9**	**540.8**

Table 7.6 Sector-wise and scenario-wise energy saving potential

	Energy consumption 2031 (least effort)	Moderate savings—2031		Aspirational savings—2031	
Sector	Mtoe	Mtoe	%	Mtoe	%
Agriculture	64.4	5.7	9	9.9	15
Transport	232.9	15.8	7	23.8	10
Domestic	98.6	12.1	12	15.1	15
Commercial	29.5	4.9	17	6.4	22
Municipal	8	0.9	12	1.5	19
Industries	443.4	47.5	11	72.3	16
Total (mtoe)	**876.8**	**86.9**	**10**	**129**	**15**

(Proskuryakova and Kovalev 2015). Changes in EI can also be attributed to movement in economic activity from energy intensive heavy industries to less energy intensive service sectors, variation in the trajectory of growth in energy consumption, GDP and others (Fig. 7.14).

7.4.3 Challenges in Adoption of EE Measures

(a) **Industrial and utility sector**: While PAT being institutionalised towards accelerating adoption of EE measures across large-scale

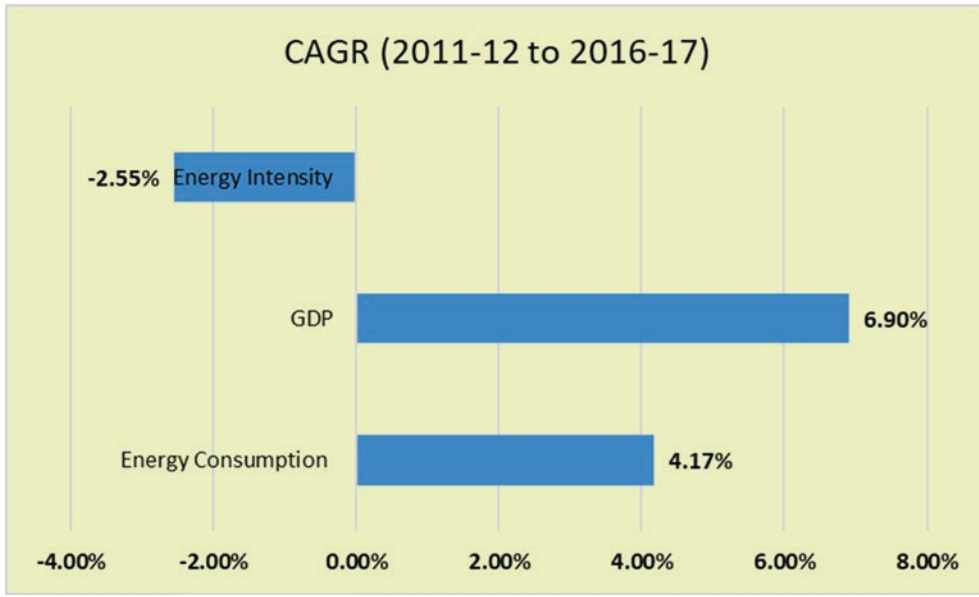

Fig. 7.14 Energy intensity. (Source: [45])

industrial units and utilities, lack of regulatory or policy instruments forbids mainstreaming of EE adoption across the energy guzzling and resource inefficient MSME sector (Industrial and MSME sector has energy saving potential of 47 MToe (BEE 2019)). EE adoptions in MSMEs are, in general, restricted by (1) lack of sensitisation and awareness regarding EE measures and benefits, (2) lack of performance benchmarking info (Biswas et al. 2018), (3) poor vendor and service provider network, (4) unwillingness to revamp existing industrial operation using age-old technologies and practices, (5) unskilled workforce in most cases, (6) poor financial health and lack of business vision and (7) poor access to finance.

(b) **Building sector (residential and commercial)**: Even with energy saving potential in the range of 20–40% (Vasudevan et al. n.d.), adoption of EE measures across building sector has been poor. Lack of regulatory enforcement mechanism (PAT included large commercial buildings only with energy consumption of 1000 MTOE) for EE adoptions, poor institutionalisation of ECBC, lack of energy performance benchmarking and poor adoption of star-rating programme are the major bottlenecks. Although 'UJALA' has mainstreamed adoption of energy efficient lights and fans across domestic sector, poor enforcement of S&L programme and continuation of manufacturing of inefficient products have restricted the market of EE products and services.

(c) **DSM sector**: Poor adoption of DSM measures aimed at reduction and phasing out of energy demand owes to (1) institutional disinterest, capacity and financial strength of the DISCOMs and (2) lack of enforcing regulatory mechanism on accelerating DSM implementation and cost recovery mechanism (Shakti 2013).

(d) **Access to finance**: (1) Lack of non-recourse finance as EE initiatives/products is not considered as stand-alone financing product by Fis, (2) small ticket EE proposals often result in high transaction cost, (3) unpopularised ESCO-based business model and (4) absence of dedicate product line (Table 7.7).

Table 7.7 Investment requirement for sectoral energy efficiency improvement (BEE 2019)

Sector	Investment for moderate savings—2031 (Rs in billion)	Investment for aspirational savings—2031 (Rs in billion)
Agriculture	914.67	1582.29
Transport	811.54	1057.01
Domestic	1202.33	1451.33
Commercial	148.22	241.59
Municipal	3071.37	4637.29
Industries	2260.39	3657.06
Total	**8408.52**	**12,626.56**

7.5 Projected Energy Scenario and Pathways

Electricity demand in India is likely to grow at a CAGR of 6.18% till 2021–2022 from 2016 to 2017 level and at a CAGR of 5.51% between 2021 and 2026 (CEA 2018a, b). In addition, the current per capita energy consumption of 24 Gigajoules in 2017 (Ministry of Finance 2019) needs to be quadrupled to achieve the HDI of 0.8 and enter the group of countries with high human development without invoking multidimensional challenges of energy security, energy equity, environmental sustainability and incremental concerns of climate change. The pathways for achieving energy sustainability are as follows:

(a) Balancing the growth in energy consumption by coupling with clean energy transition (increasing share of renewable in generation mix and reducing energy intensity) to address the concern of energy security and environmental degradation.
(b) Integrated solution towards decarbonisation of the energy consumption and transition in energy ladder from higher to lower specific energy consumption and emission intensity.
(c) Fostering the reliability and equality of energy access at all scale and reach.
(d) Coherent and innovative approach towards regulating energy cost and thereby addressing the heightened challenge of energy equity, energy poverty and deprivation of energy services.
(e) Mainstreaming and localisation of SDGs within centralised and decentralised planning.

7.6 Targeted Strategies Towards SDG Compliance

Considering the existing scenarios and challenges in translating the commitments of 2030 SDG Goal-7 agenda, key catalytic and accountable strategies are proposed below:

Area	Target strategies and recommendation accelerating SDG adoptions
Policy, Foal 7.a.1, 7.b.1	(a) Mainstreaming of SDG agenda under the ambit of decentralised planning and programme formulation
	(b) Integrating customised SDG target within the outcome budget of the federal and central government
	(c) Strong political will towards transit from silo type to converged approach in addressing the interlinked challenges of energy, addressed by different department through different scheme leading to duplication of effort and resources and ensuring ownerships of the targets
	(d) Periodic analysis of gaps and accelerators for adoption of SDG agenda and develop policy insights using customised tools (UNDP)
	(e) Despite of synergies between Goal 7 targets of SDG and quantifiable targets of NDCs, both have been approached separately, other than the recent initiatives of MoEFCC in linking SDG and NDC under the SAPCC (State Action Plan of Climate Change) umbrella. Successful implementation of both the agendas will require for more coordinated effort in terms of amalgamating and mainstreaming the SDG and NDC target into policy planning along with coherent joint responsibility sharing amongst the implementing agencies and integrated fiscal and regulatory reforms for both agendas [60]
	(f) With an estimated budgetary requirement of USD 854 billion between 2015 and 2030 and viability gap of USD 406 billion [61], strong policy advocacy is required in tapping of international financial assistance on a predictable basis (including enhanced allocation under GEF, funding allowance under GCF, bilateral and multilateral funding assistance and market-based mechanism)
	(g) Develop an integrated platform for shift from traditional closed-ended to open-ended governance model for SDG mainstreaming by embedding collectivised approach of federal and sub-national governments and development communities
Monitoring	(a) The existing indicator set out against Goal-7 should be further broadened and incremented to achieve the objective of SDGs and address the challenges of inequality and discrimination 7.1.1: Should include the factor of reliability, equitable access and affordability over and above the access factor Indicator 7.1.2: Should also factor in the sustained usage Indicator 7.2.1: % of RE energy consumption should be the indicator Indicator 7.3.1: Should normalise the factor of GDP and bank upon the actual sectoral savings as a percentage of saving potential, and mapping energy efficiency at physical, technological and other sectoral and demographic level without reference to economic and financial parameters [44]
	(b) Institutionalising SDG review mechanism at the decentralised governance level through aggregation of people-centred and gender-sensitive data and community feedback and establish of both top-down and bottom-up reporting approach. Strengthening of national statistical systems through capacity building, developing indicators in new areas of measurement (UNDP)

Area	Target strategies and recommendation accelerating SDG adoptions
Institutional	(a) Encouraging SDG localisation (sub-national context) to address the equality-focused SDG progress and strengthen governance institutions towards reducing of inequality and exclusions (IPR 2019)
	(b) Fostering localised awareness and stakeholder's sensitisation along with advocacy for SDG implementation (Niti Aayog and United Nations)
	(c) Facilitating technology transfer including manufacturing techniques and facilities along with capacity building of the domestic manufacturing and service sector towards reducing import reliance and managing cost dynamics
	(d) Strengthening of SDA and SNA for institutionalising EE and RE measures and policies
	(e) Strengthening of supply chain
	(f) Capacity building of workforce
Goal 7.1./ Indicator 7.1.1	(a) Improving operational and functional efficiency of DISCOMS: (1) Ensuring 100% metering (consumer, feeder and DT), (2) IT enablement of the distribution sector and mainstreaming smart metering, (3) reducing AT&C losses, (4) offset ACS-ARR gap and non-biased regularity of tariff revision and (5) bailing out of DISCOMs debts
	(b) Augmenting of operational and functional efficiency of generating unit (1) ensuring reliability of coal linkage and rationalisation of coal escalation index, (2) enforcing payment rationalisation and security for government sector and IPPs and (3) reduced generation cost through adoption of energy efficient and technology upgradation initiatives, rigorous fuel quality monitoring [50] and increasing PLF between 80 and 85% [52]
	(c) Augment and strengthen transmission and distribution infrastructure to address capacity addition and grid outreach; development of dedicated energy corridor
	(d) Mandatory institutionalisation of EE and DSM measures
	(e) Enabling policy proposition for differentiation in tariff based on electricity load and electricity consumption so that consumer under lower bracket of electricity usage can be subsidised by consumer under higher load and consumption bracket (IPR 2019)
Goal 7.1./ Indicator 7.1.1	(a) Behaviour embedded in the fabrics of societies plays a significant role in adoption of modern energy options [20]. Information towards health gain of LPG usage, health cost and impact in terms of morbidity and mortality form HAP should, therefore, be communicated towards consumer behavioural change through trustworthy communication channel to gain consumers' confidence leading to accelerated uptake
	(b) Innovative pricing options for LPG such as telescopic pricing, cross-subsidies, promotions of smaller gas cylinders, pre-paid coupons and targeted subsidies could ensure sustained usage [53]
	(c) Introduction of innovative consumer financing options including micro-financing opportunities for refilling of LPG cylinder [20]
	(d) Delay in subsidy realisation under DBT often discourages LPG usages amongst the marginalised consumer and, therefore, requires advocacy towards institutionalising of effective tools for delivering of timely subsidies [20]
	(e) Success of 'Pay-as-you-go' model for LPG in sub-Saharan countries could be a viable model for economically disadvantaged class in India and could be opted for [20]
	(f) Considering the limitation of LPG affordability amongst the marginalised focus should also be on mainstreaming of efficient biomass cook stoves [54]

Area	Target strategies and recommendation accelerating SDG adoptions		
Goal 7.2	Considering the projected generation capacity and proposed RE capacity addition proposition by 2026–2027 (CEA 2018a, b), the compliance to SDG target of 40% generation mix appears to be achievable. The revised RE capacity addition target of 450 GW as proposed by GoI by 2022 will further escalate the RE share in the total generation mix by 2030 and increase the share of RE-based energy in the total energy consumed		
		2021–2022	**2026–2027**
	Installed capacity (GW)	479.41	619.06
	RE capacity (GW)	175.00	275.00
	Hydro (GW)	51.30	63.30
	RE share (without hydro)		
	% RE (generation capacity)	36.5%	44.4%
	% RE (energy generated)	19.24%	23.31%
	RE share (with hydro)		
	RE capacity (with hydro)-GW	226.3	338.3
	% RE (generation capacity)	47.20%	54.65%
	Draft CEA report (Central Electricity Authority (n.d.)) projects of 831.5 GW of installed capacity with share of renewable of 64.9% (540.33 GW) by 2030 with CO_{2e} emission of 1154 million tonnes further substantiating the plan for RE capacity compliance		
	With substantial percentage of the RE capacity addition will be through private sector participation, a series of market enabling strategies has been proposed		
	(a) Institutionalising and mandating letters of credit for RE developers to ensure timely payments by DISCOMs and stronger standard PPA for wind and solar projects enforcing stringent penalties against its dishonouring		
	(b) Enforcement of stronger and reliable forecasting regime and regulation for all interstate grid connected solar and wind power plant developers for day-ahead and week-ahead periods towards ensuring grid stability along with imposition of deviation settlement mechanism. Long- and short-term forecasting has been a challenge considering weak scientific models and unavailability of weather forecast data		
	(c) Provisioning of adequate infrastructure (like land bank, evacuation facilities, dedicated green corridors) and mainstreaming of modalities for ensuring grid stability under high RE scenario through mainstreaming the concept of flexible operation of gas-based and hydro-based power plants, pump storage units, cost-effective storage technologies, flexing operation of coal-based generation unit [43, 58] and use of Automatic Generation Control Mechanism [37]		
	(d) Addressing technical hiccups of net metering, gross metering and curtailment to boost investor confidence for grid interactive DRE applications		
	(e) Mainstreaming of policy instrument like net metering regulation, waiver of interstate transmission charges [38], innovative policy instruments like relaxing of contract demand norms for RTS (e.g. for MSME sector in Gujarat) and adjusting fixed charges of tariff against solar capacity (e.g. for MSME sector in Madhya Pradesh)		
	(f) Institutionalising of financial and fiscal instruments like preferential feed-in-tariff, generation-based incentives, VGF (viability Gap Funding), M-SIPS (Modified Special Incentive Package Schemes), foreign direct investment, capital and interest subsides and fiscal instrument like accelerated tax benefits and back-loaded tariff [59]		

Area	Target strategies and recommendation accelerating SDG adoptions		
Goal 7.3	The primary energy intensity has already declined from 0.0004 toe in 1990 to 0.0002 toe in 2017, with series of energy savings targets been proposed till 2026–2027 with a cumulative saving potential of 337.12 BU (CEA 2018a, b)		
	Programme	**2021–2022**	**2026–2027**
	S&L (BU)	78.49	102.11
	Building (BU)	6.89	8.36
	Agriculture (BU)	2.93	
	Industries (PAT) (BU)	98.9	136.1
	Others (BU)	76.8	90.5
	Total (BU)	**263.92**	**337.12**
	With substantial potential to be realised towards complying to the SDG and NDC target, a series of strategies has been proposed:		
	(a) Augmenting the resource use and specific energy consumption of power utilities and industrial facilities through adoption of energy efficient and technology upgradation measures		
	(b) Energy performance benchmarking and industrial sensitisation		
	(c) Widening and deepening of PAT and its successful operationalisation guided by strong M&V framework		
	(d) Mainstreaming and extending outreach of UJALA, S&L (including enforcement of mandatory provision for restricting manufacture of inefficient products), star rating of building (for existing building) and ECBC (including IT enable building energy management system, etc.)		
	(e) Institutionalisation of Ag-DSM (by facilitating adoption of star-rated EE agriculture pumps, promotion of solar pumps, ensuring metered connection, segregation of agricultural feeder, facilitate Ag-DSM financing in ESCO mode/DSM mode and promotion of water conservation techniques) and Mu-DSM initiatives (bundling of EE initiatives across street lighting and drinking water pumping sector and facilitating its implementation through either ESCO mode or internal finance)		
	(f) Reducing energy usage in transportation sector through adoption of e-mobility, setting of energy consumption norms for vehicle, enhancing reliance on public transport and incorporation of sustainable transport principles into urban design		
	(g) Promotion of energy saving bonds and insurance products for mobilisation of affordable finance and reduce implementer risk		
Goal 7.a and 7.b	(a) Strengthening research and institutionalisation of IoT application, blockchain, embedding artificial intelligence in industrial process management, net zero building, etc.		
Mobilising finance	(1) Fostering concessional finance by allowing long horizon pension funds; insurance companies and sovereign funds to invest in RE and EE projects; support capital raising by RE and EE investors through issuance of tax-free bond; reduction of sovereign guarantee fee and allowance of additional fund flow to financial institutions; opening of government/intermediary guarantees for private sector investors; allowance of funding from Infrastructure Debt Fund for non-PPP-RE or EE projects; (2) sensitisation of the financial institution on risk assessment of RE and EE projects; (3) ensuring regulatory certainty and continuity [40]; (4) promotion of alternate business model like RESCO and ESCO and (5) demand aggregations and clustered approach for financial syndication		

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