Analysis of the targets and progress toward meeting the 2030 agenda for SDG 7 on affordable and clean energy: Evidence from India

Abstract:

The success of the SDGs has been a major challenge for governments around the world in recent years. This research focuses specifically on progress toward SDG 7, which aims to ensure that everyone has access to affordable and clean energy. The primary goal of this paper was to assess progress toward SDG 7 objectives in India and Indian states and UTs. Using SDG Index reports for 2018, 2019 and 2020, we assess the progress made in terms of SDG 7. The findings revealed that for SDG 7, the SDG Index Score ranges between 50 and 100 for States and 71 to 100 for UTs. There are fifteen states and five UTs in the class of Achievers (*with an Index score of 100*) and twelve states and three UTs in the class of Front Runners (*with an Index score ranges between 65 and 99*). The paper raises various policy issues, including drafting of regulations that benefit the poor and marginalized sections of the society, as well as states and areas that lack access. The importance of formal education, especially for rural women, cannot be overstated, which impacts their decisions about the type of fuel used for cooking. Through strong collaboration between non-state organizations and the government in rural communities within the country, the SDG 7 goals can be achieved through effective planning and delivery of reforms, thereby reducing the harmful effects of the lack of access to clean and affordable energy. It will be crucial in the long run for effective participation of local institutions (PRIs) to carry out reforms in the energy sectors to have adequate budgetary allocations for providing access to affordable energy services.

Keywords: *sustainable development goals, progress, affordable and clean energy, SDG 7.*

1. Introduction

Millennium Development Goals (MDGs), which covered the period 2000-2015, demonstrate how the entire world has worked together to achieve policies and initiatives that address poverty, hunger, diseases, illicit education, gender equality, and environmental degradation [1]. To simplify these priorities still further, the world leader held an international summit on 25th September, 2015 to discuss the Sustainable Development Goals (SDGs) focused on economic growth, social inclusion, and environmental protection [2]. They finalized 17 SDGs that will be implemented and achieved within 2016-2030 in all the countries [3]. Among the SDGs for 2015–2030 based on the UN's MDGs, goals dedicated to clean water, sanitation and clean energy have recently been endorsed by the United Nations General Assembly. Clean and affordable energy (SDG 7) is particularly gaining importance because of the growing awareness about hygiene and health [4] [5].

In the past decade, a greater proportion of the global populace has gained access to electricity than ever before, but the number of people living without electricity in sub-Saharan Africa has certainly risen. According to the report of the International Energy Agency (IEA), considerable progress has been made in various aspects of SDG 7, but progress has been uneven. In spite of the fact that multiple billion people gained access to energy over the past decade, COVID's economic impact has made primary energy unaffordable for 30 million more people, most of whom live in Africa - Nigeria, the Democratic Republic of Congo and Ethiopia. Across the globe, 1.2 billion people lack access to power in 2010, compared to 759 million in 2019. Decentralized renewable-based power solutions have gained in popularity and the number of individuals connected to mini grids has doubled between 2010 and 2019, growing from five to eleven million. As a result of modern-day and planned rules, coupled with the COVID-19 catastrophe, 660 million humans may still be without access by 2030, the majority in Sub-Saharan Africa [6].

There is no doubt that energy is a very significant input to boost economic development; however, it degrades the environment as well, so clean energy can promote sustainable development and environmental conservation at the same time [7]. While emerging nations have made rapid financial advances, families still face serious challenges when it comes to accessing clean energy. More than 33% of the world's population cooks with biomass, excrement cake, and kindling, which are harmful to their health [8] and the environment [9]. As a result, safeguarding the climate and improving the prosperity of individuals in emerging countries depends on ensuring a sufficient stockpile of non-dirty fuel sources. By 2030, according to the SDGs of the United Nations, everyone should have access to reasonable and non-contaminating fuel.

Cooking with clean fuel is directly related to the education level of the household members. As an example, studies [10] [9] conducted in India indicates that schooling increases awareness about the damaging effects of dirty fuels on health, thereby encouraging the use of clean fuels. Further, the study revealed that the use of electricity and LPG increases as the education of the household head increases. With 1.35 billion people living in remote areas, India also has high expectations for everyday comforts. The energy demand is continuously rising as a result of modern exercises meant to boost the economy and changing lifestyles. Almost all of its electricity needs are met by fossil fuels. Because of the hilly and mountainous terrain in the north and north-eastern regions of the country having huge potential for electricity generation, only 53% of village residents have access to electricity for less than 12 hours a day. A country like India, with its remote regions, benefits from the development of small hydropower plants

[11], solar, wind and biomass [12], which create energy for remote rural households, thereby enhancing local livelihoods and the environment.

The United Nations' SDGs provide a guideline for humanity to respond to an array of pressing challenges. SDG 7 strives to ensure access to affordable and clean energy as a result of our growing demand for energy and stricter environmental standards. [13]. Sustainable development cannot be achieved without access to sustainable energy. In countries like India, providing sustainable power to remote and far-flung areas can be a challenge and that can be overcome by utilizing the potential of renewable energy technologies such as solar power [14]. Using clean energy reduces air pollution and has a variety of other benefits for the environment, health, education, and economy.

2. Major themes and targets in SDG-6

Energy security is a prerequisite for socio-economic development. Access to energy enables people to augment their income and productivity, enhance access to healthcare, water and education, and improve their overall well-being. Goal 7 is aimed at ensuring universal access to affordable, reliable and efficient energy services by 2030. Expanding infrastructure and upgrading technology to provide clean and efficient energy is critical to this endeavour.

The energy arena is making progress towards SDG-7, with encouraging signs that energy is becoming more sustainable and accessible. Power access in poorer nations is on the rise, power efficiency continues to evolve, and renewable energy is making surprising gains. Extra focused effort is needed to improve access to smooth and secure cooking fuels and technologies for the betterment of the people, to increase the use of renewable energy in industries, and to increase electrification particularly in remote and far-flung areas. Table 1 explain the major themes and targets of SDG-7

Table 1 Theme and major targets of SDG - 7

Goal 7: Ensure access to clean and affordable energy	
7.1	By 2030, ensure that all energy services are affordable, reliable, and modern
7.2	By 2030, the global energy mix must be substantially dominated by renewable energy

7.3	By 2030, double the global rate of energy efficiency improvement
7.A	By 2030, promoting international cooperation to improve access to clean energy research, technology, and investment, including renewable energy, energy efficiency, and advanced fossil fuel technologies.
7.B	By 2030, in accordance with their respective support programmes, develop infrastructure and upgrade technology to provide modern and sustainable energy services to all in developing countries, including the least developed countries, small island developing states, and landlocked developing countries.

Source: UNO, 2022) [15] accessed from webpage on June 9th, 2022

3. Objectives

The present study aims to achieve the following objectives:

- To assess the progress in terms of providing clean and affordable energy in India
- To discuss the key learning and suggest policy implications emerging from the study.

4. Materials and Method

This paper aims to evaluate the progress made in India and Indian states and UTs with regard to SDG 7. The SDG Index reports published by NITI Aayog were used to assess the progress. SDG Index reports, which were first released in 2018, provide detailed information on progress on SDGs. For every country, a position is provided that emphasizes the country's social, economic, and environmental aspects. Overall, the SDG India Index report shows that 28 States and 8 UTs are making progress towards achieving the SDGs in three aspects. Since the principal gauge report was delivered in 2018 until the third report was delivered in 2020, three versions of the SDG record report have been released in India. Every one of the 17 SDGs is represented in these observing reports. A noteworthy point to note is that the targets well defined for the SDGs have been expanding every year from 39 to 54, and as of now around 70 targets have been identified.

We utilize the data in respect of index scores of each State and UT from the three reports published till date and put it in a comparative table to compare the scores across the States and UTs. Based on rank achieved in SDG 7, inferences were drawn about progress made.

5. Results and discussion

Clean and affordable energy is perhaps the nation's largest challenge, and it is being tended by the public authority on fundamentally important grounds. By 2022, the Government of India wants all homes to have access to clean and affordable energy for sterilization. Public drives have given the essential push to India's responsibility for giving widespread access to clean and affordable energy to all. In order to improve socioeconomic status, people must have access to energy. Energy facilitates the improvement of profits and productivity, as well as improving access to healthcare, water, and education. It was found that SDG 7 improves access to education, information, communication, and health services [14]. India has identified three national level indicators to assess its achievement of the 2030 targets for affordable and clean energy, as outlined in the SDGs agenda. They were chosen based on the availability of data at the national level and to ensure that they are comparable across states and union territories.

Table 2 National Indicators used for the construction of SDG 7 Index

SDG Global Targets	Indicators selected for SDG India Index	National Targets for 2030	Achievement up to 2021
7.1 By 2030, ensure that all energy services are affordable, reliable, and modern	1. Percentage of household electrified	100	96.7
7.2 By 2030, the global energy mix must be substantially dominated by renewable energy	2. The percentage of households that use clean cooking fuel	100	71.0
	3. Renewable share of installed generating capacity (%)	40	41.4

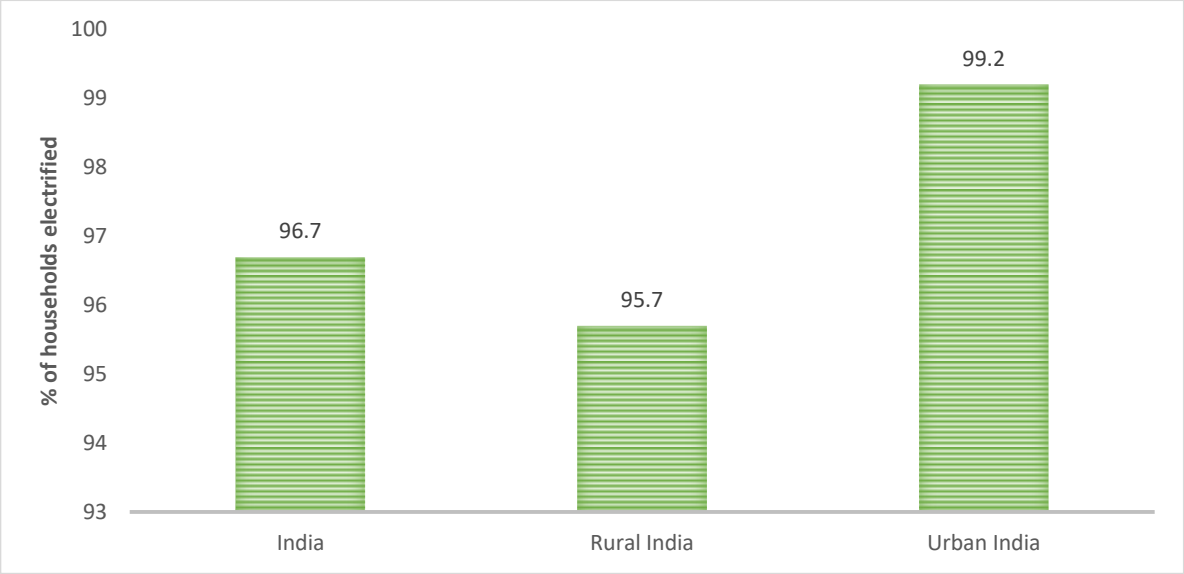
Source: NITI Aayog, 2018 [16]

5.1 Progress in electrification

The use of electricity comes with a wide range of economic and social benefits for households. Electrification using renewable energies provides more opportunities for people to live a healthier, more fulfilling life, facilitates community services, supports health, education, and

enables rural businesses to function. Electrification of rural areas is essential for alleviating poverty and promoting rural growth [17]. As per National Electricity Policy 2005, as a key driver of rapid economic growth and poverty alleviation, electricity is essential to all aspects of our lives. There is no doubt that it is a basic human need and a critical infrastructure that determines the economic development of a country. In order for rural India to develop fully, it is therefore essential to provide electricity at a reasonable rate. [18].

Fig. 1 Household electrification in India till 2020



Source: NITI Aayog, 2021 [19]

It is estimated that 96.7% of Indian households (95.7% rural India and 99.2% Urban India) are now connected to the grid, while 0.33% still use off-grid electricity sources and 2.4% remain unconnected [19]. The majority of them live in rural areas of Uttar Pradesh, Madhya Pradesh, Rajasthan, and Bihar [20].

Electricity is a complex, regulated and concurrent subject in Indian politics, so both the central government and state governments have a role to play. State level policies are driven by energy or power departments of states and union-territories, while national policies are formulated by the Ministry of Power and Ministry of New & Renewable Energy. In an effort to ensure that everyone has access to electricity, various schemes have been launched by the central and state governments from time to time.

a) The Ministry of Power, Government of India, launched the Integrated Power Development Scheme (IPDS) in 2021 with the aim of strengthening the transmission and distribution networks

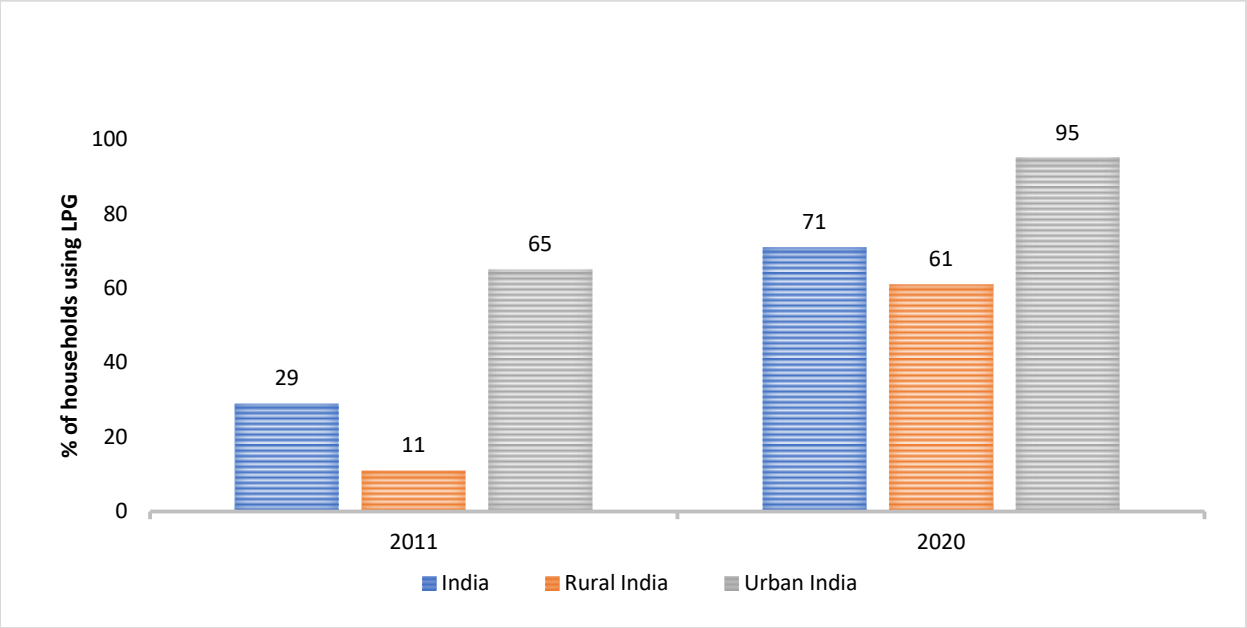
in urban areas and metering transformers, feeders, and consumers. Among the benefits of this scheme are a reduction in AT&C losses, the establishment of an IT-based energy accounting/auditing system, an improvement in the billing of energy based on meter consumption, and an improvement in the collection of electricity.

b) Pradhan Mantri Sahaj Bijli Har Ghar Yojana - Saubhagya launched in 2017, with the objective to providing energy access to all through last mile connectivity and electricity connections to all rural and urban households that are still un-electrified.
c) Another scheme designed to improve the financial efficiency and operational efficiency of power distribution companies (DISCOMs) was launched by the Government of India under the Ujwal DISCOM Assurance Yojana in 2015.
d) Deen Dayal Upadhyaya Gram Jyoti Yojana, was launched in 2014, which was intended to provide continuous power supplies to rural India. This scheme aimed to electrify 18,452 unelectrified villages within 1000 days, by 2018.
e) Power for All launched in 2002, was a joint initiative of the Indian Government and State Governments with the aim of providing 24x7 power supply to all households, industries, businesses, public needs, and other electricity consuming entities as well as adequate power to agriculture consumers as per state policy.

5.2 Progress in the use of LPG as primary cooking fuel

Using clean fuels such as liquefied petroleum gas (LPG) rather than biomass-based fuels for cooking in India would provide several benefits. A clean fuel like LPG releases fewer pollutants than fossil fuels, thus protecting women and children from harmful pollutants. With LPG, wood consumption can be reduced significantly, which reduces deforestation and saves the time of women and children who would otherwise have to collect the wood and risk injury. Almost 70% of Indian households use LPG as their primary source of cooking fuel, with rural India accounting for 61% and urban India accounting for 95% [20], figure 2.

Fig. 2 Households using LPG as primary cooking fuel



Source: NITI Aayog, 2021) [19]

Governments is making every effort to provide access to all people for clean and affordable energy services. Some of the important schemes and initiatives launched recently by the government to make people to access LPG as primary fuel for cooking:

a) The Pradhan Mantri Ujjwala Yojana is a scheme introduced by the Ministry of Petroleum and Natural Gas in 2016 to provide LPG connections to women living below the poverty line (BPL). By replacing traditional cooking fuels, the scheme aimed to improve the health of rural women as well as protect the environment.
b) Another scheme known as PAHAL (Pratyaksh Hanstantrit Labh) was launched in 2013 and modified in 2015 to reduce diversion and eliminate duplicate or bogus LPG connections. Consumers who qualify for this scheme get the subsidy directly deposited into their bank accounts after purchasing LPG cylinders at market rates.

Since, 30 per cent of Indian household don't have an access to clean cooking fuel. Use of biomass cook stoves and biogas can go a long way to provide clean cooking to around 180 million people by 2030, especially in areas where people are resistant to shift to use of LPG or areas where LPG delivery is a challenge. (IEA, 2021).

5.3 Progress in renewable installed generating capacity

With growing population and energy demand of India and consequently as fossil fuel energy is becoming scarce and it is very likely India shall face not only energy crisis but also excessive use of fossil fuel is negatively impacting the environment locally and globally (Kumar, Ashwani et.al., 2010).

As per the report of the Ministry of Power, Government of India, with 13GW of new solar PV capacity added in 2021, India ranked third in the world for solar PV capacity (second in Asia, third in the world). As of 31st March 2022, India has more than 159.96 Giga Watts of installed renewable energy capacity (including large hydro), which is about 40% of its total capacity. Solar energy capacity installed in the last 8 years has grown 19.3 times, to 56.6 GW by the end of 2022. In terms of installed energy capacity, India achieved its SDG 7 target with 159.95 GW of non-fossil-based capacity, which is 41.4% of the total installed capacity [21]. Various initiatives have been taken by the governments to promote solar power in India:

a) The Jawaharlal Nehru National Solar Mission (JNNSM) or National Solar Mission was launched in January 2010 by the Government of India and the State Governments for the promotion of solar power in India and to create the policy conditions for its deployment across the country so that India could become a global leader in solar energy. The scheme aims to install 100 GW of solar PV by 2022.
b) As a part of the Pradhan Mantri Kisan Urja Suraksha evem Utthan Mahabhiyan (PM KUSUM) Scheme which was launched in 2019, the Ministry of New and Renewable Energy (MNRE) has started distributing solar pumps and grid-connected solar plants to farmers across the country. It is aimed at adding 25,750 MW of solar and other renewable energy capacity by 2022 with a total central financial commitment of 38,462 crores, including service charges to the agencies.
c) Grid-connected solar rooftop schemes to be implemented through Power Distribution Companies (DISCOMs), with a cumulative capacity target of 40,000 MW from Rooftop Solar Projects by 2022.
d) The MNRE launched the Atal Jyoti Yojana (AJAY) in 2018 to make dark areas more visible through the establishment of solar street lights. The scheme is under the off-grid and decentralized solar application scheme of the MNRE, Government of India. Rural, semiurban, and urban areas in Uttar Pradesh, Assam, Bihar, Jharkhand, and Odisha that are less than 50%

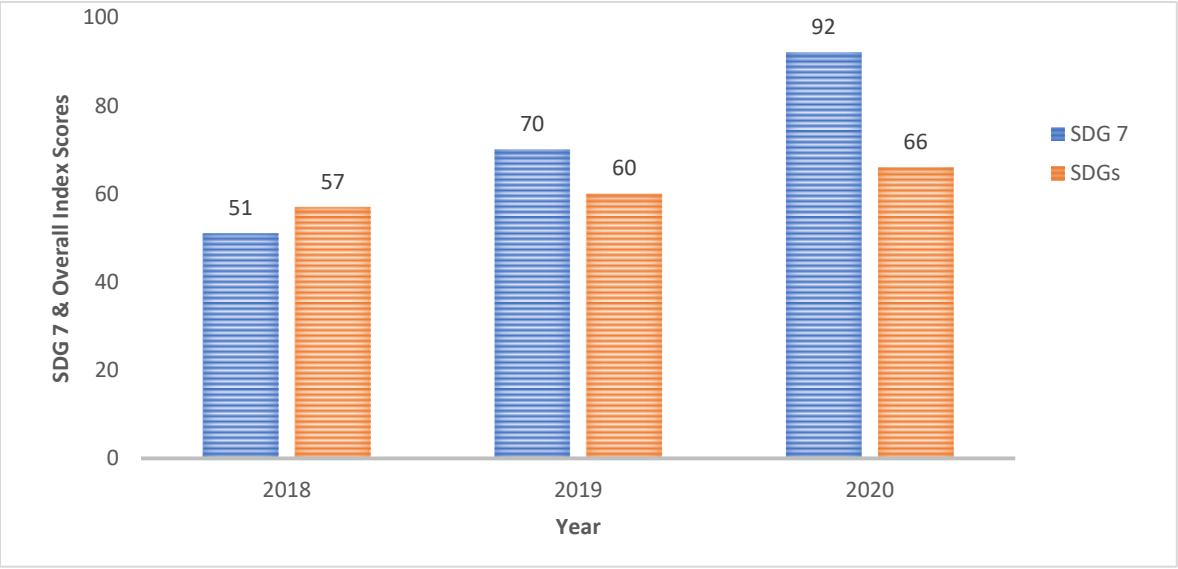
grid connected will be illuminated with solar LED street lights. Throughout remote areas, these solar lights were installed along major roads, markets, and public conveniences in order to sustainably enhance citizens' quality of life.

Though various initiatives have been taken but according to Vibhuti Garg of IEEFA (2022) “investment on renewable would need to be more than double to about US$ 30-40 bn per year for India in order to reach the target of 450 GW of renewable energy capacity by 2030. This clearly means huge investment in an entire ecosystem to boost adoption of renewable energy, including flexible generation like battery storage and pump hydro, expansion of transmission and distribution networks, modernization and digitalization of the grid, domestic manufacturing of solar modules, cells , wafers and electrolysers, and promotion of electric vehicles”.

5.4 Sustainable Development Goal 7: India’s stand

India has made good progress towards achieving the SDG 7 targets outlined in the 2030 Agenda. As a holistic, universal, transformative initiative, the 2030 agenda will have a lasting impact on social, economic, and environmental issues all around the world. Developing nations will benefit from this agenda, as the UN urges the world to work together to fight poverty, hunger, and other socioeconomic and environmental problems. The SDG 7 index scores which was 51 in 2018, increased to 70 in 2019 and in 2020 it reached at 92, reflecting a continuous increase as shown in figure 3. The overall SDGs index also follows the same pattern.

Fig. 3 Trends in SDG 7 and overall SDGs indices



Source: NITI Aayog, 2021 [19]

India's contribution towards the Goal of Affordable and Clean Energy has been measured by two public level markers, which are framed under one of the five SDG focuses for 2030. Choosing these pointers is based on ensuring equal access to information at the sub-public level and ensuring equivalence across states and UTs. A composite score index constructed in firstly in 2018, which is published in reports of NITI Aayog for this Goal and used to measure the progress in terms of SDG 7 and overall SDGs. For SDG 7, the SDG Index Score ranges between 50 and 100 for States and 71 to 100 for UTs. There are fifteen states and five UTs in the class of Achievers (with an Index score of 100) and twelve states and three UTs in the class of Front Runners (with an Index score between 65 and 99) as depicted in table 3 [19].

Table 3 Performance of states and UTs in index score for SDG 7 and overall SDGs index score in 2018, 2019 & 2020

S.No	State/UT	SDG 7 Index score	Overall SDGs index score	SDG 7 Index score	Overall SDGs index score	SDG 7 Index score	Overall SDGs index score
		2018-19		2019-20		2020-21	
1	Andhra Pradesh	76	72	86	67	100	72
2	Arunachal Pradesh	44	60	74	53	85	60
3	Assam	18	57	70	55	98	57
4	Bihar	67	52	62	50	78	52
5	Chhattisgarh	36	61	56	56	78	61
6	Goa	61	72	95	65	100	72
7	Gujarat	67	69	75	64	94	69
8	Haryana	50	67	77	57	100	67
9	Himachal Pradesh	62	74	64	69	100	74
10	Jammu & Kashmir	68	66	43	59	100	66
11	Jharkhand	20	56	50	53	77	56
12	Karnataka	77	72	86	66	100	72
13	Kerala	60	75	71	70	100	75
14	Madhya Pradesh	58	62	62	58	86	62
15	Maharashtra	69	70	82	64	100	70
16	Manipur	39	64	72	60	100	64
17	Meghalaya	11	60	52	54	50	60
18	Mizoram	78	68	81	56	100	68
19	Nagaland	45	62	70	57	69	61
20	Odisha	23	61	50	58	80	61
21	Punjab	61	68	89	62	100	68
22	Rajasthan	63	60	61	57	100	60
23	Sikkim	47	71	97	65	100	71
24	Tamil Nadu	89	74	90	67	100	74
25	Telangana	63	69	93	67	100	69
26	Tripura	32	65	56	58	83	65
27	Uttar Pradesh	23	60	63	55	100	60
28	Uttarakhand	55	72	78	64	100	72
29	West Bengal	40	62	58	60	98	62
30	Andaman & Nicobar Islands	56	62	73	61	100	67
31	Chandigarh	96	79	84	70	100	79
32	Dadra & Nagar Haveli	73	62	80	63	71	62
33	Daman and Diu	84	62	81	61	71	62
34	Delhi	51	68	96	61	100	68
35	Lakshadweep	60	68	76	63	83	68
36	Puducherry	61	68	97	66	98	68
	India	**51**	**57**	**70**	**60**	**92**	**66**
	Target	**100**	**100**	**100**	**100**	**100**	**100**

Sources: NITI Aayog, 2018, 2019 & 2021 [19], [16], [22]

Achiever (100) Front Runner (65-99) Performer (50-64) Aspirant (0-49)

Further, clean energy use is influenced by many factors, but ultimately, the success of clean energy interventions in the communities depends not only on the clean energy interventions themselves, but on the community participation; income levels, educational levels, and availability of energy services [23]. It is beneficial for humans to have access to abundant, affordable, secure, safe, and clean energy. However, the extraction, transportation, and use of energy can be harmful to human health, the environment, and the economy. By using clean energy, which does not emit greenhouse gases, air pollution is reduced, global warming is reduced, public health is improved, inexhaustible energy, jobs and economic benefits are provided, energy prices are stable, energy reliability is high, and energy resilience is high [24]. Therefore, if clean and safe energy is provided, nutrition [25], health and education can be boosted on one side, and society and economy would positively be affected on the other [26]. Therefore, it is necessary to increase efforts to provide LPG and electricity connections, to generate and use solar power, and to make the public aware of the benefits of clean energy through education in order to achieve the SDG 7.

6. Conclusion and policy implications

The paper raises a number of policy issues that need to be taken into consideration to achieve smooth achievement of affordable energy (SDG 7) in India. There may be a need to formulate energy regulations that target the poor and marginalized sections of society, as well as deprived areas and states. Solar energy services and small hydro plant strategy for rural and far-flung areas are a great way to help marginalized communities gain 24/7 access to clean, affordable energy services.

Education is becoming increasingly important to women in rural communities, especially when it comes to deciding what kind of fuel to use for cooking and the importance of other energy needs. Despite the fact that advanced energy services like LPG for cooking and electricity for lighting and heating greatly reduce the occurrence of air pollution illness. Education of women and girls increasingly impacts the choices they make about what type of fuel to use for cooking. Through strong collaboration between non-state organizations and the government in rural communities within the country, the SDG 7 goals can be achieved through effective planning and delivery of reforms, thereby reducing the harmful effects of the lack of access to clean and affordable energy. It will be crucial in the long run for effective participation of local institutions (PRIs) to carry out reforms in the energy sectors to have adequate

budgetary allocations for providing access to affordable energy services. For sustainable and secure energy, there is a need to shift to renewable resources that are more innovative.

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Declaration of competing interest

It is declared by the authors that they do not have any competing interests that could affect the work reported in this article.

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