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Article

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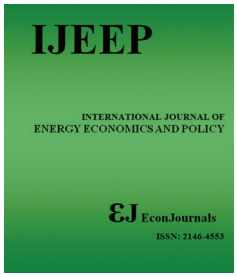

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Exploring the Dependency between Energy Access and other Sustainable Development Goals: Global Evidence

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ABSTRACT

This paper examines the interlinkage between energy access and other Sustainable Development Goals (SDGs) in the global context. For this purpose, we have calculated the indices for all 17 SDGs and use correlation and path analysis under structural equation modelling framework. Empirical results confirm that SDG 7 has positive and significant correlation with goal 4 and goal 12 indicating that ensuring access to modern energy resources enables women and girls to spend more time on education and gainful employment than gathering fuel. Further, energy access fosters sustainable production and consumption pattern and also promotes food security and promoting sustainable agriculture.

Keywords: Sustainable Development Goals, Energy Access, Indices, Path Analysis, Structural Equations Modelling
JEL Classification: Q01, Q40.

1. INTRODUCTION

Leaders from 193 countries came together in 2015 and set an ambitious plan known as Sustainable Development Goals (SDGs) to address 17 fundamental challenges faced by humanity by 2030 with 169 targets (UN 2015). Ensuring access to affordable, reliable, sustainable and modern energy for all is one of the goals (SDG 7) and hence it marked a new level of political recognition of the importance of energy for social and economic development (Nerini et al., 2018). SDGs, unlike previous global initiatives like Rio Declaration 1992 or the UN Millennium Development Goal (MDGs), marked a universal recognition that access to modern energy is at the centre of achieving several other SDGs like health and well-being, education, gender equality, clean water and sanitation, etc (UN, 2015, IEA, 2017, IEA, 2018a, Birol, 2018 and McCollum et al., 2018).

The provision of affordable energy services in an environmentally benign manner to achieve sustainable development goals is well recognised[1] (Chaturvedi and Shukla, 2014, Vera and Langlois, 2007 and Santika et al., 2019). Nilsson et al. (2016), for example, termed the SDGs as an "indivisible whole" and goals depend on each other[2]. Likewise, António Guterres, UN General Secretary, reiterated that "Energy is the golden thread that links all of the SDGs." (SE for All, 2018 and Smith et al., 2017). Thus, SDGs being a systemic endeavour, identification of mutual interactions and interdependencies between relevant SDGs and possible outcomes are, therefore, crucial to achieving the goals by 2030 (Boas et al., 2016, IEA and WB, 2017 and Rao and Pachauri, 2017). Because, as a systemic endeavour, interactions of various goals is bound to produce both positive as well as negative outcomes with trade-offs (Griggs, et al. 2014; Lu, et al., 2015; Mainali, et al. 2018 and Singh et al., 2018). Hence, the pace of achievement of SDGs

1 According to Rojelj et al. (2013) UN initiative of Sustainable Energy for All by 2030 can be achieved without global temperature raising beyond 2^0C.

2 Also see ICS (2017) for a systematic description of interaction between SDG 7 and other goals.

can be intensified by accelerating the interactions that produce larger positive outcomes over negatives like the expansion of sustainable energy access shall promote education and healthcare. (Waage et al., 2015 and Nilsson et al., 2016). Of late, appreciating the interaction between goals, the United Nations has presented a package clubbing 17 individual goals into six SDG transformations in which the third transformation associated with energy is shown to be linked with almost all other goals (Sachs, et al., 2019).

However, the implicit dependence between SDG 7 (access to modern energy) and other SDGs is not fully explored empirically using real data in the literature (Boas, et al., 2016 and Rao and Pachauri, 2017). Studies like Nerini et al. (2018) and McCollum et al. (2018) who have mapped the underlying interactions between SDG 7 and other goals have limitations in comparison to the scope and methodology of the present paper. Their method centred on content analysis was subjective as it reviewed certain published research papers chosen based on individual assessment. Notwithstanding these shortcomings, both Nerini et al. (2018) and McCollum et al. (2018) have pointed out that the nature of linkages between SDG 7 and other goals are context-specific and case-specific such as geography, culture, the extent of technological advancement and quality of governance calling for further research on the issue in the light of divergence on those grounds across the globe[3]. Further, SDGs being a globally integrated plan of action for systemic change, insights from global studies are warranted and useful for holistic policy-making (Boas et al., 2016, Smith et al., 2017 and Sachs, et al., 2019).

This paper, therefore, empirically examines the link between energy access and achievement of select SDGs at the global level by classifying the countries into developed and developing countries (to capture the role of factors like technology, quality of governance, etc.) and also classifying countries along continents (to capture the role of factors like culture, geography, etc.) Specifically, we have examined how the provision of sustainable energy access shall complement the achievements of other sustainable development goals. The results of this research have huge policy implications since unearthing the implicit interdependencies between energy access and other related SDGs will enable to figure out the pragmatic hindrances of achieving a particular goal (say, poverty eradication) without other. For example, widespread energy poverty among backward social groups like Dalits and Adivasis in India coincides with their socio-economic backwardness (Sadath and Acharya, 2017).

At the global level, while about 1 billion people lack access to electricity, a staggering 2.7 billion people do not have access to clean cooking (IEA, 2018b). These statistics amply make it clear that the world has a long way to go to ensure the achievement of SDGs by 2030. Also understanding the interactions between various targets is essential to prioritize effective policy options to achieve the targets by 2030 (Wagge et al., 2015 and Singh et al., 2018). Failure to appreciate and account for the trade-offs and synergies between various goals would result in incoherent policies with adverse impact on the efforts to achieve sustainable development (Blanc, 2015 and Rasul, 2016).

2. ENERGY AND SUSTAINABLE DEVELOPMENT GOALS

Energy access is defined as the uninterrupted availability of energy sources at an affordable price. SDGs aim at, among other goals, ending poverty, improving health and gender equality, protecting the planet, and ensuring peace and prosperity for all. Sustainability being the core principle of SDGs, promotion of access to modern and clean energy resources is indispensable to achieving the 2030 agenda (Schwerhoff and Sy, 2017). It is so because the climate is a global common good and the consequences of the failures such as lack of access to clean energy in some part of the globe will have to be borne by whole globe in a variety of ways (Nordhaus, 1994).

Access to modern energy services such as electricity is essential in human development which, in turn, expedites the achievement of goals such as SDG 4, SDG 5 and SDG 8 (HDR, 2016, Collste, et al., 2017 Acharya and Sadath, 2019). For example, in traditional societies with gender-defined roles and cultural prejudices, the provision of LPG is of great of assistance to women to cook food with ease and rescue them from indoor pollution caused by burning biomass in open stoves (SDG 5). According to IEA (2017) 2.8 million people die prematurely yearly due to indoor pollution. In addition to improving the lives of women and children by reducing the burden of household chores related to fuel collection and cooking, the provision of clean cooking can also help deliver other goals such as SDG13 by reducing greenhouse gas (GHG) emissions. Ample evidences are reported in the literature showing that access to electricity and proper lighting facilities has a profound impact on the educational attainments of children (SDG4).

Similarly, educational achievements are instrumental in finding out a decent job; contributing to the economic performance of an economy (SDG8), eradicating poverty (SDG1), hunger (SDG2) and inequalities (SDG 10) (Vera and Langlois, 2007 and Griggs, 2016). Improving access to electricity can facilitate better irrigation and improvement in agriculture productivity (Weitz et al., 2014 and Schwerhoff and Sy, 2017). Agriculture production has increased by about 35% in India since 2000 due to, among other things, increased use of electric pumps for irrigation (IEA, 2017). It is needless to state that the performance of the industrial sector, research and innovation (SDG9) entirely depends on providing 24 × 7 uninterrupted power of the desired quality (Arlet, et al., 2017 and World Bank, 2017).

To ensure good health and wellbeing (SDG3) electricity and clean cooking are indispensable. Health centres and hospitals cannot provide reliable services without an uninterrupted electricity supply. For example, 60% of refrigerators used in clinics in Africa suffer from power failure resulting in a loss of almost half of vaccines and power failure is one of the major reasons for the failure of 70% of the medical devices in Africa (UNEP, 2017). With the rapid growth of population and its density especially in poor

3 To quote Nerini et al. (2018) "These synergies and trade-offs will manifest differently in different settings, and the impacts for different social groups will need to be understood and accommodated"

and developing countries, the supply of electricity is fundamental to ensure clean water and sanitation (SDG6) because toilets are mandatory in such circumstances to eliminate major unhygienic practices like open defecation and hygienic maintenance of toilets requires adequate water supply for which electricity should be available to pump water to rooftops (Weitz et al., 2014 and Roy and Pramanick, 2019). Renewable sources of energy, being at the centre of sustainable energy system, have a critical role to play in the promotion of sustainable cities and responsible consumption and production (SDG 11 and SDG 12). Sustainable development goals (SDGs) are, thus, an integrated and systemic approach to the development and access to modern energy sources have a very crucial role to play in the achievements of these goals (Weitz et al., 2014, Blanc, 2015 and ICS, 2017).

3. LITERATURE SURVEY

As mentioned above, although the interaction between SDG 7 and other SDGs using real data at the global level is yet to be investigated, limited studies available on the interaction between certain other SDGs are reviewed here. To map the interconnection between SDGs, Blanc (2015) found out that goals such as SDG 12 (Sustainable consumption and production), SDG 10 (Reduce inequality, SDG 1 (End poverty) are highly linked with other goals. Nilsson et al. (2016) developed a seven-point scale to document interactions among different SDGs. This could help the policymakers to devise policies which maximise the synergies and minimise the trade-offs. Since SDGs are globally applicable, policymakers can learn from each other by comparing different policy actions by different countries over time.

Highlighting the importance of protection of oceans, Singh, et al. (2018) found evidence of 16 SDGs evaluated associated with SDG 14 (Life below water) in varying degrees. Most relationships between Oceans targets and other SDG targets are found to be co-benefits indicating compatibilities between the Oceans and other SDG targets. Roy and Pramanick (2019) found that improved access to water and sanitation in India has improved the health of people especially children under the age of five, decreased open defecation and decreased the number of annual deaths from diarrheal diseases. According to Renzaho et al. (2017), notwithstanding the challenges posed by the diversion of food crops to produce bio-fuels, bio-fuels offer significant opportunities for the transformation of poor regions such as Sub-Saharan Africa economies from low to middle-income countries. Schwerhoff and Sy (2017) also reiterated the importance of renewable energy for the achievement of about ten SDGs in Sub-Saharan Africa where more than 70% of the population still relies on traditional biomass. Similar findings are reported by Collste et al. (2017) from Tanzania where investments in photovoltaics improve educational attainment, health and life expectancy. ICS (2017) also documents the extensive interlinkage between energy access and other SDGs like poverty eradication, employment generation, increase in farm productivity, better health, etc.

Several studies examined the policy action needed to achieve SDGs. For e. g., Delina and Sovacool (2018) argued that providing energy access through sustainable energy transition is crucial for achieving SDGs. The study highlighted the need for speeding up the action and plurality in the governance agenda to achieve SDGs. Mulugetta et al. (2019) emphasised the need for achieving SDG 7 to achieve various other SDGs. They highlighted the role of the min-grid and off-grid electricity system to achieve SDG 7 which in turn could help to achieve several other SDGs. Building on this line of research, Bisaga et al. (2021) examined the role of off-grid solar networks in achieving SDGs in Rwanda. The study found that there is synergy between 80 SDGs and off-grid solar networks.

Using content analysis of existing literature, Nerini et al. (2018) has found that provision of modern energy services under the auspices of UN 2030 agenda is vital for the wellbeing of the people and has identified profound synergies and trade-offs between SDG 7 and various other goals like SDG 1-4, SDG 6, SDG 8and SDG 11 (end poverty, end hunger, good health and well-being, quality education and clean water and sanitation, reliable source of income for households and resilient urban livelihoods). Also, energy is an essential element of the social and economic infrastructure to address basic challenges like poverty and the promotion of economic development with sustainable production and consumption (SDG 9 and SDG 12). According to a similar study by McCollum et al. (2018), there is considerable agreement among existing scientific evidence on the interactions between SDG7 (Universal access to energy) and other SDGS that the provision of adequate and affordable modern energy services to all would aid to achieve other goals such as poverty alleviation (SDG 1), health and wellbeing (SDG3), clean water (SDG 6), sustainable cities (SDG 11), protection of natural resources (SDG 12), reduction of climate change (SDG 13) and peace, justice and strong institutions (SDG 16). Santika et al. (2019) also reported that energy access is a key enabler for the achievement of SDGs as it increases productivity, transforms economies and societies, and improves human life in terms of economic growth, food production, well-being and healthy lifestyles, education, gender equality and empowerment, water supply and sanitation, as well as employment. Continuing further, Santika et al. (2020) examined the implications of SDGs on energy demand in Indonesia. The study's findings revealed that achieving 18 SDG indicators needs additional energy, indicating the interrelationship between energy goal and other SDGs.

Santika et al. (2020) examined the implications of SDGs on energy demand in Indonesia. The study's findings revealed that achieving 18 SDG indicators needs additional energy, indicating the interrelationship between energy goal and other SDGs. Sarkodie (2022) examined the role of energy sustainability in achieving environmental sustainability across 217 countries and territories from 1960 to 2019. The study observed that energy and environmental performance has improved after promulgating the 2030 SDG agenda compared to MDGs. However, low-income countries are finding it challenging to meet several SDGs.

4. DATA AND METHODOLOGY

The study collects data on all 17 indicators of SDGs from the United Nations (UN) global SDG database. Table 1 presents 17 SDGs and description of each of these goals.

Table 1: Sustainable development goals (SDGs)

Goal	Description
Goal 1	End poverty in all its forms everywhere
Goal 2	End hunger, achieve food security and improved nutrition and promote sustainable agriculture
Goal 3	Ensure healthy lives and promote well-being for all at all ages
Goal 4	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5	Achieve gender equality and empower all women and girls
Goal 6	Ensure availability and sustainable management of water and sanitation for all
Goal 7	Ensure access to affordable, reliable, sustainable and modern energy for all
Goal 8	Promote sustained, inclusive and sustainable economic growth, full and productive employment and decent work for all
Goal 9	Build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation
Goal 10	Reduce inequality within and among countries
Goal 11	Make cities and human settlements inclusive, safe, resilient and sustainable
Goal 12	Ensure sustainable consumption and production patterns
Goal 13	Take urgent action to combat climate change and its impacts
Goal 14	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

Raw data is available on various dimensions of the SDGs. However, data on several dimensions across several countries are not available. Depending on the data availability, we construct an index for each of the 17 SDGs. We fix the goalposts for each of the indicators by taking the observed maximum and minimum values to construct the indices which range from value zero to one. We construct the index in such a way that a high value represents a higher level of sustainable development compared with a low value. For example, if a high value in a given dimension indicates a higher level of sustainable development, we use the following formula:

$$(\text{Actual} - \text{Minimum})/(\text{Maximum} - \text{Minimum}) \quad (1)$$

On the contrary, if a lower value represents a higher level of development, we use the following formula:

$$(\text{Maximum} - \text{Actual})/(\text{Maximum} - \text{Minimum}) \quad (2)$$

As each of the SDGs has sub-dimensions and multiple indicators for each sub-dimension, we take the arithmetic average of multiple indicators to arrive at an index for each sub-dimension. Further, a geometric average of all sub-dimensions is used to calculate the index at the level of each SDG. For example, SDG 7 is "ensure access to affordable, reliable, sustainable and modern energy for all" and sub-dimension 7.1 states that "by 2030, ensure universal access to affordable, reliable and modern energy services." Sub-dimension 7.1 has two indicators namely, 7.1.1 states "proportion of the population with access to electricity" and 7.1.2 states "proportion of the population with primary reliance on clean fuels and technology." We use formula (1) for both 7.1.1 and 7.1.2 to arrive at indices for both individually. Further, we calculate the arithmetic average of these two indices to arrive at 7.1 sub-dimension. In the same way, by calculating the indices for 7.2 and 7.3, we calculate the geometric mean of 7.1, 7.2 and 7.3 to arrive at an index for SDG 7. The study includes a total of 193 countries and independent administrative regions. Indices are calculated by using the latest available data for each indicator.

Since the major objective of the study is to find the relationship between SDG 7 with each of the remaining 16 SDGs, we use a correlation between SDG 7 and each of the rest of 16 SDGs. Further, we use "path analysis" under the structural equations modelling framework as we have only observed variables and not latent variables. We group 17 SDGs into four groups as economic, social, energy and environment. Category indices constructed by taking the geometric means of the SDGs are mapped under a particular category and a composite goal measuring sustainable development is constructed by taking the geometric mean of all 17 SDGs. The economic category represents the goals that are directly related to the Gross Domestic Product and variables which are generally understood in the context of economic development. SDG 1 to SDG 3 and SDG 8 to SDG 10 are grouped under economic category.

The social category represents the goals related to education and gender-related SDGs. SDG 4 to SDG 6 are grouped under the social category. However, there is a very close relation between economic and social categories. There is only one SDG in the energy category represented by SDG 7. The environment category represents the SDGs which are related to conserving and restoring the environmental quality as well as SDGs quantifying the impact of adverse climatic events. From SDG 11 to SDG 17 are grouped under environment category. The study recognises the close relationship between different categories and measures the cross-correlations among the four categories. Figure 1 shows the path diagram which indicates the link between different SDGs and four categories leading to sustainable development.

5. RESULTS

In this section, we present the empirical results of the study. Table 2 presents the mean, standard deviation, kurtosis, skewness, maximum and minimum of the SDGs. The values of the indices range between zero to one by construction. Among the 17 goals, the highest value of 0.942 is recorded in the case of goal 13 which tracks taking urgent action to combat climate change policies and

Figure 1: Path Diagram of SDGs

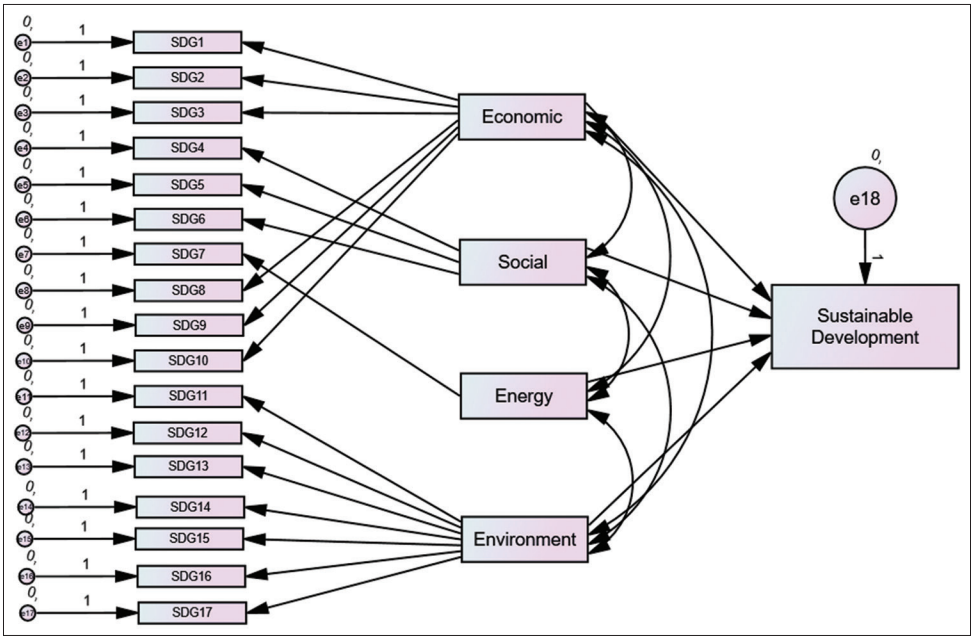

Table 2: Summary statistics of sustainable development goals (SDGS)

Goal	Mean	SD	Kurtosis	Skewness	Minimum	Maximum
Goal 1	0.517	0.184	−0.481	−0.356	0.064	1
Goal 2	0.179	0.162	5.102	1.951	0.000	0.850
Goal 3	0.609	0.147	0.083	−0.043	0.191	0.990
Goal 4	0.284	0.182	0.297	0.910	0.001	1
Goal 5	0.547	0.156	0.627	−0.741	0.038	0.920
Goal 6	0.287	0.255	0.178	1.135	0.001	1
Goal 7	0.495	0.173	0.186	−0.127	0.032	0.936
Goal 8	0.291	0.149	1.187	0.917	0.033	0.802
Goal 9	0.126	0.118	1.295	1.252	0.001	0.629
Goal 10	0.219	0.162	3.169	1.487	0.002	1
Goal 11	0.752	0.195	0.923	−1.079	0.065	1
Goal 12	0.330	0.137	5.172	1.040	0.040	1
Goal 13	0.942	0.150	22.915	−4.552	0.000	1
Goal 14	0.279	0.283	−0.189	0.939	0.000	1
Goal 15	0.110	0.110	5.770	2.074	0.001	0.631
Goal 16	0.405	0.170	1.042	0.787	0.063	0.982
Goal 17	0.043	0.054	56.423	5.952	0.000	0.596

its impacts. However, it has a very high value of kurtosis and negative skewness due to the non-availability of data for many countries.

Further, data is available on only one indicator relating to the number of deaths, missing persons and directly affected persons attributed to disasters per 100,000 persons. Therefore, it is difficult to infer much from the very high mean value of goal 13. Goal 11 (Making cities and human settlements inclusive, safe, resilient and sustainable), Goal 3 (Ensuring healthy lives and promoting well-being for all at all ages), goal 5 (Achieving gender equality and empowering women and girls), and Goal 1 (Ending poverty in all its forms everywhere) also have more than 0.5 index value. Once again, all these goals have negative skewness and goal 3 has a kurtosis value close to zero. Goal 17 representing strengthening the means of implementation and revitalising the global partnership for sustainable development has the lowest mean value. The highest positive skewness value indicates that most countries record lower values in this goal. Ideally, this goal should have been the highest but it holds a mirror to the global attitude towards sustainable development.

Goal 15 (protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss), goal 9 (build resilient infrastructure, promote inclusive and sustainable industrialization and foster innovation) and goal 2 (end hunger, achieve food security and improved nutrition and promote sustainable agriculture) which are very crucial for sustainable development also have index values <0.2. Positive skewness in the case of all three goals indicates that most countries figure in the lower half which represents less progress in these goals. Remaining goals namely, goal 4 (ensure inclusive and equitable quality education and promote lifelong learning opportunities for all), goal 6 (ensure availability and sustainable management of water and sanitation for all), goal 8 (promote sustained, inclusive

and sustainable economic growth, full and productive employment and decent work for all), goal 10 (reduce inequality within and among countries), goal 12 (ensure sustainable consumption and production patterns), and goal 14 (conserve and sustainably use the oceans, seas and marine resources for sustainable development) record mean index values between 0.2 and 0.3. Overall, a total 10 goals have index values of 0.3 or less.

To assess the strength of the relationship between SDG 7 with rest of 16 SDGs, we estimate correlation and report the results in Table 3.

As seen from the table, SDG 7 has a positive and significant correlation at 10% level of significance with goal 4 and goal 12. It can be argued that ensuring access to modern energy resources enables women and girls to spend more time on education and gainful employment than gathering fuel. Further, a positive relation with goal 12 is very encouraging that energy access fosters sustainable production and consumption pattern. Goal 7 is positively related to goal 2 with a probability value little over 10% level. It further reinforces the role of energy access in promoting food security and promoting sustainable agriculture. At 20% significance level, goal 7 has a weak positive relationship with goal 9, goal 15 and goal 16.

Path analysis results under the SEM framework is presented in Table 4. We use all variables as observed variables and estimate the relationship between SDGs, SDG groups and overall sustainable development.

The relationship between different SDGs and their SDG groups are positive and statistically significant. The direction of the relationship is as expected due to the nature of the construction of the index. Under the economic category, all goals except Goal 8 have coefficients above 0.6 which indicates a strong connection between each SDG and economic development. Further, all SDGs under the social category are once again strongly related to it. The environment category has SDGs which are quite diverse in nature. SDG 12, SDG 13 and SDG 1 have relatively smaller coefficients compared to goals 14-16. The relationship between economic, social, energy and environment categories with sustainable development is very crucial. The goals clubbed under environment have the highest impact on sustainable development followed by the economic category. Social and energy categories have a relatively smaller impact on sustainable development. Overall, all the four variables are statistically significant.

Major objective of the study is to assess the relationship among different SDGs and specifically concerning energy goal with other goals. Table 5 presents the results of the correlation between economic, social, energy and environmental goals. As seen in the table, there is a strong relationship between economic and social goals.

It is clear from the SDGs under these two categories which are very closely related. Further, economic and environmental goals are also strongly correlated. This finding is contrary to the popular perception of various countries that environmental protection may lower economic development which has led to the developing countries bargaining for the inclusion of Common but Differentiated Responsibilities (CBDR) in the international climate agreements. Therefore, findings should be encouraging for countries all over the globe to cooperate with each other.

Table 3: Correlation between Goal 7 and Rest of the Sustainable Development Goals (SDGs)

Goals	Correlation	Significance
Goal1	0.050	0.488
Goal2	0.116	0.112
Goal3	−0.048	0.511
Goal4	0.124	0.089
Goal5	0.055	0.453
Goal6	0.065	0.369
Goal8	0.030	0.681
Goal9	0.094	0.192
Goal10	−0.028	0.705
Goal11	0.035	0.640
Goal12	0.139	0.059
Goal13	0.060	0.528
Goal14	−0.013	0.870
Goal15	0.099	0.173
Goal16	−0.094	0.193
Goal17	−0.073	0.310

Table 4: Path analysis result

Indicators	Category	Estimate	SE	P-value
SDG 1	Economic	0.772	0.093	0
SDG 2	Economic	0.812	0.08	0
SDG 3	Economic	0.646	0.076	0
SDG 4	Social	0.678	0.076	0
SDG 5	Social	0.845	0.037	0
SDG 6	Social	1.042	0.067	0
SDG 7	Energy	0.868	0.034	0
SDG 8	Economic	0.421	0.052	0
SDG 9	Economic	1.252	0.031	0
SDG 10	Economic	0.999	0.001	0
SDG 11	Environment	0.521	0.157	0
SDG 12	Environment	0.344	0.11	0.002
SDG 13	Environment	0.224	0.126	0.076
SDG 14	Environment	1.788	0.208	0
SDG 15	Environment	0.715	0.072	0
SDG 16	Environment	0.694	0.127	0
SDG 17	Environment	0.186	0.041	0
Economic	Sustainable Development	0.372	0.022	0
Social	Sustainable Development	0.089	0.012	0
Energy	Sustainable Development	0.052	0.009	0
Environment	Sustainable Development	0.564	0.02	0

Table 5: Correlation between different sustainable development groups

Goals		Estimate
Economic Goal	Social Goal	0.74
Economic Goal	Energy Goal	0.112
Economic Goal	Environmental Goal	0.447
Social Goal	Energy Goal	0.085
Social Goal	Environmental Goal	0.169
Energy Goal	Environmental Goal	0.17

Environmental and social goals are also positively related to each other. The main variable of interest in this study is the energy goal relationship with other goals. Energy goal is weakly related to economic, social and environmental goals. Energy goal's strongest relationship is with the environmental goal, which is on expected lines. Access to modern clean energy resources is very much necessary for protecting the environment. This is even though the provision of energy itself leads to environmental degradation. However, in comparison with the use of biomass, access to modern clean energy resources reduces environmental degradation. Further, energy goal is positively related to economic and social goals as well. It should not be surprising that energy is a key input in production and access to electricity and LPG are crucial to achieve the socioeconomic development of the masses. Though the relationship is weak, nonetheless it is encouraging to find that they are positively related.

6. CONCLUSION

This paper examines the relationship between energy access and sustainable development. Ensuring access to affordable, reliable, sustainable and modern energy for all is the goal 7 among 17 SDGs. We estimate the impact of goal 7 on other SDGs in furthering the overall sustainable development of the planet. For this purpose, we have estimated the correlation matrix and path analysis.

The empirical results confirm that ensuring access to affordable and reliable energy resources positively influences inclusive and equitable quality education and promotes lifelong learning opportunities for all. Further energy access also ensures sustainable consumption and production patterns. Energy access plays a major role in ending hunger, achieving food security and improving nutrition and promoting sustainable agriculture.

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