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Renewable and Non-Renewable Resources, Inclusive Growth, and Energy Poverty: An Empirical Investigation for BRI Countries

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ABSTRACT

Energy poverty is a main challenge to attain sustainable development goals (SDG). Global policymakers focused on renewable and non-renewable resources to combat rising energy poverty. This research analyses the effect of non-renewable and renewable resources and inclusive growth overall as well as rural and urban EP for BRI countries from 2000 to 2020. This study uses generalized methods of moments (GMM) for empirical analysis. According to the results, (i) electricity production from coal, natural gas, and water resources significantly decreases energy poverty by increasing electricity accessibility but for rural energy poverty, coal resources contribute more than all other sources. (ii) For the accessibility of clean fuel technology for cooking, coal natural gas, and water resources are significant contributors but for rural and urban accessibility, the share of hydroelectric resources is greater than all other resources. (iii) Inclusive growth is used as an indirect channel and is a highly significant factor for accessibility to electricity and clean fuel technology. These findings recommend separate policies to overcome rural and urban energy poverty for selected BRI countries.

Introduction and Background

Energy poverty (EP) is a significant indicator of the welfare of people. The problem of EP prevails particularly in urban areas in terms of accessibility and affordability. The world's fastest growing population has created a huge gap between energy supply and energy demand and in such a situation majority of BRI nations are also susceptible to severe EP (Che et al., 2021). Therefore, EP eradication is an important agenda of the Sustainable Development Goals (SDG) of the UN to achieve high-quality development until 2020 (Guterres, 2020). The energy poverty's concept emerged in the literature in early 1970s UK fuel use rights initiatives. This concept attained more importance in 1980's when the British government highlighted this issue and included it as a part of academia (Li *et al.,* 2014). UNDP has defined EP as "a scenario in which there are insufficient options to employ consistent, high-quality, and clean energy to achieve sustainable development." Earlier studies defined energy poverty as a situation where people are unable to fulfil their heating and living expenses. According to the International energy agency, energy poverty is described by a shortage of hydroelectric and wind power and a greater dependence on conventional biomass (IEA, (2002).) When a person's household energy needs, such as those for basic heating, cooking, lighting, and communication, are not met, this is referred to as being in an energy-poor scenario (Nussbaumer et al., 2012).

EP is an important issue to be addressed because the World Bank report 2017 indicates that 980 million people over the globe have no access to clean energy for cooking and lighting. Although most of the population in developing nations has access to renewable energy but they primarily use traditional energy sources such as burning coal, charcoal, and animal waste, which has damaging health effects (Reinhardt, 2006). Recently, World Bank statistics highlighted this issue as a crucial one as according to the recent report 11% population in the world have no electricity access in 2018 (WDI, 2020). Moreover, regional statistics for Africa reported that 580 million people have no access to electricity and forecasts of these statistics seem to increase more soon (Cozzi et al., 2020).

Renewable and non-renewable energy are important to overcome energy poverty. The necessities of human life like cooking, heating, lighting, and mobility are met with electrical energy utilization. The share of electric energy consumption will increase from 20 % to 50 % by 2050 (Agency, 2009). At present, global electricity generation from various resources is 36.5 % coal, 22.2 % natural gas, 28.3 % renewable resources 9.9 % nuclear and 3.2 % from oil resources (IEA 2021).

Emerging BRI countries are also in traps of energy poverty. Pakistan is also one of these emerging nations with widespread energy poverty. (Sher et al., 2014) conducted household survey analysis for four districts in Pakistan (Punjab, Sindh, Khyber Pakhtunkhwa, and Baluchistan). Findings showed that households in these provinces suffered from energy poverty at rates of 47, 51, 69, and 66 percent respectively. (Sambodo & Novandra, 2019) computed that 53% of Indonesia's population suffers from energy poverty. According to these studies energy poverty is a significant concern to developing countries, but it is unclear what factors will be necessary to combat it. Recently, some important factors were identified by (Barkat et al., 2023) to overcome energy poverty in 105 developing countries which include poverty, income inequality, GDP growth urbanization and financial development. (Kocak & Baglitas, 2022) conducted empirical analysis for 92 countries and found that renewable and non-renewable resources are significant factors for declining energy poverty in lower, middle income and high-income countries. Considering these two studies as baseline, the current research incorporates the effect of renewable and non-renewable resources on energy poverty for overall population as well as rural and urban population. Extending the factors indicated by (Barkat et al., 2023) this research incorporated an inclusive growth index consisting of four dimensions which are poverty and inequality, growth and employment, accessibility, and social security.

Literature Review

Resources and Energy Poverty Debate

Many researchers explored the economic aspects of energy poverty like economic growth, (Doğanalp et al., 2021). Their findings indicated the adverse effects of energy poverty on economic growth in BRICS countries. Another economic aspect of energy poverty and financial development nexus were explored by (Mohsin et al., 2022) for Latin America. Findings showed that financial development significantly decreases energy poverty by increasing affordability and accessibility of end users. (Shahidur et al., 2010) percent of an empirical analysis for Pakistan and found that 57 percent of rural households are facing energy poverty and 22 percent households are facing income poverty. In comparison, households are facing 28% of EP and 20% of income poverty in urban areas.

Other studies focused on socio-economic indicators of EP like gender discrimination, poverty, inequality, and crime ratios (Nguyen & Nagase, 2019; Wang et al., 2021). Another research study has identified seventy composite indicators indicating economic as well as socioeconomic indicators (Siksnelyte-Butkiene et al., 2021). The third group of studies explored the nexus between health, education, and energy poverty. (Banerjee et al., 2021) studied the adverse effects of EP in developing countries and similar findings were computed by (Apergis et al., 2022) for developing economies. Household surveys data analysis in Europe reported that traditional ways of cooking, heating, and lighting particularly through burning coal, charcoal and animal wastes exhibit higher carbon emission and decreases lungs performance and increases tuberculosis patients (Oliveras et al., 2021). EP has also been determined to be a significant factor for higher CO2 emissions. (Zhao et al., 2022) conducted empirical analysis for China and determined a downward trend of energy poverty at national level. Moreover, they determined a unidirectional causal effect from energy poverty to CO2 emission and regional level analysis for China identified higher CO_2 emission with higher energy poverty. (Khan et al., 2018) shown an empirical analysis for Pakistan while investigating the effect of renewable energy and agricultural output on greenhouses gasses emissions. Results showed that increases in agricultural output and renewable energy significantly decrease greenhouse gases emission.

Renewable energy sources are another crucial factor in reducing energy poverty. (Wang et al., 2015) emphasized that renewable energy is preferred to fossil fuels and other traditional resources regarding environmental sustainability and energy poverty. (Okushima, 2019) also indicates renewable energy as an important factor to ensure energy justice for rural and urban population. (Biernat-Jarka et al., 2021) studied the impact of government investment on EP and findings indicates that although slow but govt. investment significantly decreases EP in Poland. (Adom et al., 2021) conducted analysis for renewable energy and short run, long run nexus and the results indicate that energy poverty significantly decreases income, life expectancy, education, and employment level while it significantly increases poverty, income inequality and percentage of population having unsafe drinking water.

Some recent studies in this context have pointed out that the use of conventional fossil fuels for heating, lighting, and cooking to overcome energy poverty have positive effect on global warming and greenhouse gasses emissions. (Crentsil et al., 2019) investigated the multidimensional determinants of poverty reduction in Ghana. They have found a declining trend in energy poverty from 2008 to 2014. Moreover, household characteristics and energy poverty have found positive and significant relationship and structural changes to shift the consumers to liquefied petroleum gas (LPG) can decrease energy poverty. (Dong et al., 2021) discovered the effects of low carbon evolution on energy poverty for 30 provinces in China. (Karpinska & Śmiech, 2021) examined the analysis of substituting policy on energy poverty from coal to natural gas. Results indicated that such a type of switching policy increases energy poverty. The research also pointed out that such transitions varied across ethnic groups and regions and different levels of well-being. Other studies also found that the use of renewable energy sources has a positive association with economic development and greenhouse gasses emissions (Khan et al., 2018). Their findings indicated that coal energy increases carbon emission and significantly affects energy poverty. Natural gas resources have significantly negative effects on energy poverty while carbon emission showed mixed results. More importantly, hydroelectric resources and other renewable energy resources significantly reduce carbon emission and decrease energy poverty.

Inclusive Growth and EP

In a recent study, (Barkat et al., 2023) conducted analysis for 105 developing countries exploring the effects of remittances on energy poverty for rural and urban population. Results showed that GDP growth significantly decreases energy poverty. While the increase in income inequality increases energy poverty in all income-based groups. Following the recent study by (Kocak & Baglitas, 2022) this study uses renewable and non-renewable resources but instead of using energy poverty index, this study uses access to clean fuel technology and access to electricity as proxies of energy poverty following (Barkat et al., 2023). This study contributes to the impact of renewable and non-renewable resources on energy poverty for rural and urban poverty separately for BRI countries. It is important because six hundred million people in BRI countries have no access to clean energy and the majority of these consists of rural population (World Bank 2020). Moreover, in existing literature, poverty, inequality, employment, economic growth, and infrastructure development have been identified as important factors to overcome energy poverty. Therefore, instead of using these variables individually, a complete inclusive growth index has been constructed containing its four important proportions of growth and employment, accessibility, and social security. This is the rationality to conduct this research and identify facts and figures for rural and urban population separately so that it will be easier for policy makers to take initiatives.

Methodology and Data

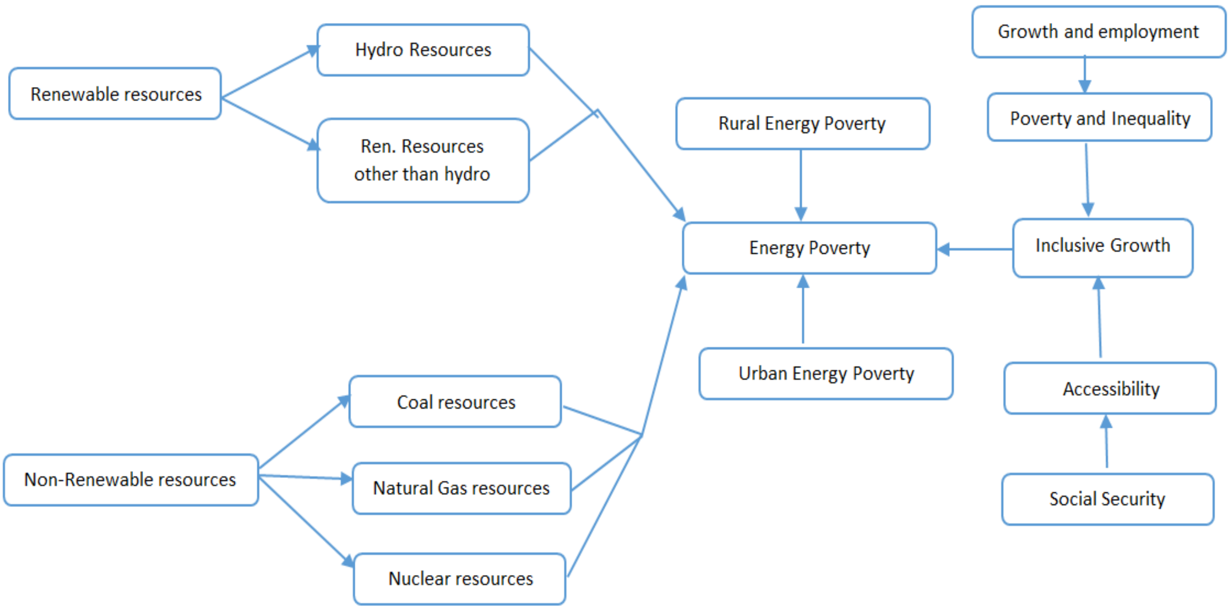
Conceptual Framework

This study focused on analyzing the impact of renewable and non-renewable resources and inclusive growth energy poverty for selected BRI countries. Inclusive growth is a broader concept including economic and socioeconomic aspects and, in this study, the four important dimensions of inclusive growth are focused. These are:

Rise in economic growth with rise in employment and infrastructure; Decrease in poverty and income inequality; Accessibility and Social security. In the existing literature regarding energy poverty these selected dimensions have been used separately as determining factors of energy poverty. (Murtaza & Faridi, 2015) developed energy development index and results reported that poverty, income poverty and income inequality increase energy poverty while economic growth significantly decreases energy poverty in Pakistan.

(Amin et al., 2020) examined that rise in level of employment education and per-capita income reduces energy poverty while increase in inflation significantly increases energy poverty. (Katarzyna, 2017) has reported theoretical research in the context of social security and energy poverty nexus. He pointed out that to ensure social justice for individuals, it is important to provide ease and access to public and private resources, and this dimension can overcome energy poverty in terms of accessibility and affordability. Considering all these existing studies, the present study develops an inclusive growth index that indirectly affects the level of energy poverty. This relationship is further expressed in the figure 1 given below:

Figure 1:



This diagram shows that two important resources of electricity production are renewable and non-renewable. In this study renewable resources include hydro resources and electricity production other than hydro resources. Non-renewable resources include coal, natural gas, and nuclear resources. This study explores the role of inclusive growth as an indirect channel to influence energy poverty overall as well as rural and urban population.

Theoretical Framework

This study follows the following theories of development as baseline:

a) **Vicious circle of poverty theory:**

Vicious circle of poverty theory was presented by Ragnar Nurkse in 1953 which indicates why countries are poor and remain in poverty and this research extend it by incorporating energy poverty and explains why countries face energy poverty and continuously remain in the situation of energy poverty.

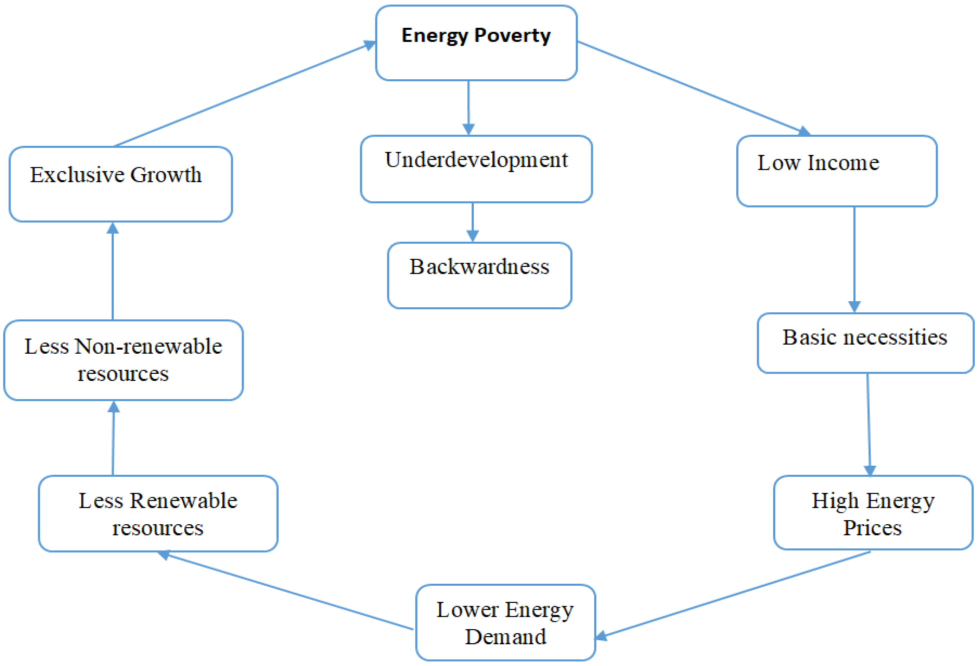
This study extends Nurkse's model of Vicious Circle of poverty which says that "A country is poor because it is poor". However, according to Nurkse, this poverty is divided into two types:

1). Demand side Vicious circle

2). Supply side Vicious circle

In the supply side vicious circle, in the case of under developing countries, individuals have lower level of savings due to lower income. This lower income leads to a lower level of investment which reflects lower total productivity and in turn this phenomenon is largely due to lack of capital. The demand side of the vicious circle of poverty reflects the purchasing power of the people which is again lower due to lower productivity. This lower level of productivity is related to the lower level of capital utilized in the production process. Due to lower income, demand will be lower and again the circle of vicious poverty will be repeated. Following this model as the baseline, the present study incorporates a vicious circle of energy poverty and determined some exogenous and endogenous factors to break the vicious circle of energy poverty. Based on existing literature on energy poverty, a country is energy poor because it has lower levels of remittances (Barkat et al., 2023) which leads to lower economic growth (Safdar et al., 2022). Such lower economic growth enhances lower level of income (Gaaliche & Gaaliche, 2014) and increased income inequality (Satti et al., 2016). This situation of poverty and inequality pushes the individuals not to afford energy facilities and hence energy poverty prevails.

Figure 2: Vicious Circle of Energy Poverty



This diagram indicates that energy poverty is because of lower income as it decreases the buying power of consumers particularly for modern reliable energy resources. People having lower incomes focus more on the necessities of life like food and shelter. Countries facing energy poverty face higher energy prices due to less availability and domestic production and have lower energy demand. Such lower energy demand leads to lower concentration of renewable and non-renewable resources. More importantly, energy poor countries face exclusive growth in the sense that increasing GDP growth doesn't decrease poverty and income inequality, on the other side, accessibility and social security are not enhanced with GDP growth.

Econometric Model

To examine the impact of renewable and non-renewable resources and inclusive growth on energy poverty an econometric model is constructed for empirical analysis:

$$EP_{it} = \beta o + \beta 1RE_{it} + \beta 2NRE_{it} + \beta 3IG_{it} + \beta 4Z_{it} + \epsilon_{it} \text{ ------------------- (1)}$$

Where EP is the measure of energy poverty using two major proxies i) Access to electricity and ii) Access to clean fuel technology for cooking. RE presents electricity production from renewable resources and NRE indicates non-renewable resources. IG is the inclusive growth, and Z indicates control variable used and $\in_{it}$ indicates error term and "i" is number of cross sections and "t" denotes time.

By further expanding renewable and non-renewable resources, this model is written as:

$$EP_{it} = \beta o + \beta 1COAL_{it} + \beta 2HYDRO_{it} + \beta 3REN_{it} + \beta 4NUC_{it} + \beta 5NAT_{it} + \beta 6EPLOSS_{it} + \beta 7IG_{it} + \in_{it} \quad \text{----------------- (2)}$$

Where EP presents energy poverty taken as dependent variable, COAL indicates electricity production from using coal, HYDRO presents electricity production using hydropower, REN indicates electricity production from renewable resources other than water resources, NUC indicates electricity production from nuclear resources, NAT indicates electricity generation from natural resources. Control variables include electric power transmission and distribution loss (EP. LOSS). In this study, two individual proxies for energy poverty are used as access to clean fuel technology for cooking (ACT) and access to electricity (AE). These proxies are further separated for rural and urban population to conduct overall and separate analysis.

1.1 Index used.

This study aimed to analyze the role of inclusive growth as an indirect channel to overcome energy poverty through renewable and non-renewable resources. A detailed inclusive growth is constructed for which details are given below in table 1.

Table 1: Inclusive Growth Index

Variables	Area of Index	Indicators
Inclusive Growth Indicators Economic Growth Employment Infrastructure	Economic Growth (EG) Employment (EMP) Infrastructure (INF)	Constant GDP US$2015 Employment in industry Employment in services Energy consumption (EC)
Poverty and Inequality	Poverty headcount ratio (PHR) Gini coefficient (GC)	Less than $2.15 per day earning population Respective income shares and measure of population
Accessibility	Life expectancy at birth Access to safe drinking water Adolescence illiterateness	Expected years of life at birth % age of population access to safe drinking water % age of young people out of education
Social security	Public resource ratings equity Human resource ratings equity social protection rating	Scale from (1-6) indicating lower to higher range

Source: Author's calculation

Empirical Analysis

To conduct empirical analysis for the models written in chapter 3, this study uses generalized methods of moments system (GMM) estimation technique. This technique is preferred to simple OLS, Panel ARDL and other techniques as it gives more efficient estimates of parameters. It considers several instrumental variables simultaneously to overcome the endogeneity problem. System GMM provides some diagnostics to detect autocorrelation and identify the validity of instruments from checking over and under identification following (Kocak & Baglitas, 2022).

Table 2: Descriptive statistics

Variables	Obs.	Mean	Std. Dev.	Min.	Max.
ACT	336	39.036	33.399	0.5	97.8
ACTU	336	55.089	38.659	0.9	99.5
ACTR	336	24.206	30.448	0.1	95.1
AE	336	59.547	31.735	6	100
AEU	336	81.096	21.649	20	100
AER	336	44.529	37.141	0.646	100
EP. COAL	336	9.6186	24.429	0	97.172
EP. NGAS	336	23.70	28.255	0	95.087
EP. NUCL	336	1.934	8.0093	0	44.43
EP. HYDRO	336	46.60	32.541	0	100
EP. RENEW	336	0.588	1.126	0	7.272
EP. LOSS	336	22.579	16.555	2.432	88.023
IG	336	0.125	1.021	-2.334	0.732

These statistics show that the mean value of ACT is 39.036 which is lower, and the value of ACTU is 55.089 and ACTR is 24.206 indicates that access to clean fuel technology for cooking is higher in urban areas while it is much lower in rural areas pointing out that rural energy poverty is more crucial than urban energy poverty. Similarly, the mean value of access to electricity is 59.54 which seems better in comparison with accessibility to clean fuel technology. In urban population, AE is 81.09 which seems better that majority of the population have accessibility to electricity but still there is a huge space to be covered and in rural population AE average value is 44.52 indicates that access to electricity is severe in rural areas as compared to urban areas. Statistics for renewable and non-renewable resources indicate that electricity contribution from hydro resources is greater than all with an average value of 46.60 while the contribution of renewable resources other than water is lowest with an average value of 0.588. Similarly, the mean value of electricity production from nuclear resources is 1.93 which is lower in comparison with other resources. The mean value of inclusive growth index is 0.125 which shows that in the selected countries, growth process is less inclusive.

Table 3: Correlation Matrix

	1	2	3	4	5	6	7	8	9
ACT	1.000								
AE	0.0196	1.000							
EP. COAL	0.0413	0.0091	1.000						
EP. NGAS	0.2318	0.0354	-0.273	1.000					
EP. NUCL	0.126	-0.014	-0.096	0.047	1.000				
EP. HYDRO	0.053	-0.087	-0.473	-0.397	-0.109	1.000			
EP. RENEW	-0.201	0.061	-0.031	-0.116	-0.122	-0.096	1.000		
EP. LOSS	0.026	0.011	-0.034	-0.094	-0.102	0.109	0.212	1.000	
IG	0.345	0.046	0.049	0.0111	0.281	-0.165	0.006	-0.241	1.000

VIF= 1.75 and 2.71 respectively for ACT and AE

These results show that variables selected in these models do not have the problem of multicollinearity, as none of the correlation is higher than 50 percent. Variance inflation factor is another criterion to identify the correlation analysis, and the rule of thumb is that it should be less than 5 for overall as well as individual variables. In our selected variables, VIF value is 1.75 and 2.71 respectively for ACT and AE which shows no multicollinearity in the model. The next step is to investigate the system GMM estimates of access to electricity for overall, rural, and urban population. Before evaluating these estimates, it should be noted that any positive value of the dependent variables increases accessibility and hence decreases energy poverty and vice versa. Table.3 presents the results of system GMM for access to electricity (AE) for overall, rural, and urban population.

Table 4: GMM estimates of Access to electricity (Overall, Urban and Rural Population)

Variables	**AE**	**AEU**	**AER**
L1.AE	0.721***	0.7989***	0.809***
EP. COAL	0.4925*	0.258*	1.272**
EP. NGAS	0.342*	0.163*	0.517**
EP. NUCLAER	0.255	0.088	0.267
EP. HYDRO	0.261**	0.127*	0.528*
EP. RENEW	-0.745	-0.688	-3.298
EP. LOSS	0.359	0.267	0.00461
IG	8.85***	4.15***	9.210*
Constant	-15.882***	-0.2655***	-33.22**
Obs.	315	315	315
No. of countries	21	21	21
No of instruments	12	12	19
AR (1) test. P-value	0.016	0.012	0.035
AR (2) test. P-value	0.472	0.752	0.62
Hansen test P-value	0.82	0.90	0.638

, ** and * presents P-values at 1, 5 and 10 % respectively*

The results show that electricity production from coal has a positive and significant effect on electricity accessibility for overall population as 1 percent increase in coal electricity increases accessibility by 0.49 percent. These findings are in line with Kocak *et al.,* (2023). In the case of rural and urban population, it reduces more energy poverty in rural areas as compared to urban population. As a 1 percent increase in electricity production from coal increases electricity accessibility by 1.27 percent in rural areas while it is 0.258 percent in urban areas. These findings support the results of (IEA 2020) that urban population rely more on coal and charcoal for energy use. Electricity production from natural gas also has a positive and significant effect on electricity accessibility. As 1 percent increase in electricity production from natural gas increases electricity accessibility by 0.34 percent. In comparison for rural and urban population, it imposes greater effects on rural accessibility by 0.51 percent while for urban it is 0.16 percent. Electricity production from nuclear resources has no significant effect on electricity accessibility for overall, rural, and urban population. The reason might be the least technological advancement in developing BRI countries with high skilled labour force can be an obstacle for installing nuclear plants. The most important source of electricity generation is hydro power generation has a positive and significant effect on electricity accessibility for both rural and urban population. As a 1 percent increase in hydro power production increases electricity accessibility by 0.26 percent. While in urban and rural comparison it is 0.127 and 0.528 percent respectively. This indicates that renewable hydro resources can be more important to overcome energy poverty for selected BRI countries and particularly for urban population facing severe energy poverty. Electricity production from renewable resources other than water resources has no significant impact on energy for overall, rural, and urban population. The possible explanation can be the lack of capital for investment in non-renewable energy projects, lack of advanced technology with less government support. Electricity power transmission and distribution loss also shows an insignificant effect on energy accessibility. It is because BRI emerging countries are already facing energy crisis in the form of production, prices, and availability of energy.

More importantly, inclusive growth is determined as an important factor to overcome energy poverty for overall, rural, and urban population. As a 1 percent increase in inclusive growth increases electricity accessibility by 8.85 percent while for urban and rural population it is 4.15 and 9.210 respectively. This study also incorporated accessibility and social security along with growth, employment, poverty, and inequality. According to these findings, renewable and non-renewable resources are both important to overcome energy poverty by increasing accessibility, but inclusive growth imposes higher effects than all of these. Diagnostic test indicates the presence of no autocorrelation, and the selected instruments are valid with no problem of over or under identification. Now, another proxy for accessibility to clean fuel technology is also analyzed overall as well as rural and urban population separately to identify a clear picture. The results of these estimates are presented in table 4 given below:

Table 5: System GMM estimates of Access to clean fuel technology (Overall, Urban and Rural)

Variables	**ACT**	**ACTU**	**ACTR**
L1.ACT	1.007***	1.0009***	0.964***
EP. COAL	0.312***	0.046**	0.012**
EP. NGAS	0.049**	0.031*	0.015
EP. NUCLAER	0.0047	0.037*	1.128
EP. HYDRO	0.028***	0.0332*	0.118*
EP. RENEW	-0.125	0.659	0.862
EP. LOSS	0.0369	0.065	0.088
IG	0.446*	3.09**	2.413**
Constant	-3.044***	-4.172**	0.115**
Obs.	294	294	294
No. of countries	21	21	21
No of instruments	18	20	19
AR (1) test. P-value	0.053	0.10	0.12
AR (2) test. P-value	0.405	0.17	0.83
Hansen test P-value	0.75	0.887	0.682

, ** and * presents P-values at 1, 5 and 10 % respectively*

These results show that electricity production from coal resources increases access to clean fuel technology for cooking. As a 1 percent increase in coal energy increases accessibility by 0.312 percent. While for urban and rural populations 0.046 and 0.016 respectively which is comparatively lower effect but still positive and significant. Electricity production from natural gas has positive and significant for overall population with smaller effect while for rural population it has no significant effect. Same is the impact of electricity from nuclear resources for rural population. One possible explanation might be the lack of technological advancement, unavailability of skilled labour and capital deficiency for investment in nuclear and natural gas plants. Hydro power generation has a positive and significant effect on the accessibility to clean fuel technology. As a 1 percent increase in hydroelectricity increases accessibility of clean fuel technology by 0.028 percent. Whereas in comparison to urban and rural population, these are 0.032 and 0.118 respectively. This indicates that hydroelectric resources are more significant in removing energy poverty for rural population. Electricity production from renewable resources and electricity transmission and distribution loss seems to have an insignificant relation with dependent variable. A possible explanation can be the unavailability of more resources for developing countries to invest in new projects related to energy creation. Electricity production and distribution loss seems insignificant because due to energy deficiency, there are less chances of theft and overuse of electricity without payment.

More importantly, inclusive growth has a positive and highly significant effect on accessibility to clean fuel technology for cooking. This is because inclusive growth promotes an increase in GDP growth with a level of employment and a decline in poverty and inequality. As an increase in economic growth increases investment and financial development for energy projects to provide ease and accessibility for energy. Moreover, the increase in employment level increases the affordability range of consumers to pay for modern and clean energy technology and hence reduces energy poverty. Similarly, increase in accessibility and social security increases the accessibility and awareness about energy demand, energy prices and accordingly budget allocation for energy payment and hence reduction in energy poverty.

Conclusion and Policy Implications

This paper estimates the impact of electricity production from renewable and non-renewable resources and inclusive growth on energy poverty in 21 BRI countries. This article uses GMM estimates for empirical analysis. These results can be described as follows:

1. Coal, natural gas, and hydro electricity production significantly increases electricity accessibility and hence decreases energy poverty. While in comparison of rural and urban energy poverty, coal, natural gas, and hydroelectricity reduces more rural energy poverty than urban poverty but share of coal resources in eliminating rural energy poverty is higher than all other resources.
2. Inclusive growth taken as indirect channel in alleviating energy poverty from selected BRI countries. Inclusive growth is an important factor in reducing energy poverty for the overall population as well as rural and urban population. It means that inclusive growth can also play an important role in overcoming the existing energy gap for rural and urban areas. These findings also suggest that along with direct resources in the form of renewable and non-renewable resources, indirect factors can also play an important role to eradicate energy poverty. Increase in the level of employment increases income level and purchasing power of the households and energy affordability capacity also increases. Moreover, if poverty and income inequality decrease, mode of transactions shifts to poor, and they make themselves capable of using modern and clean energy. Likewise, the increase in accessibility and social security in the form of equity to public resources, household's accessibility, affordability, and reliability increases and hence energy poverty decreases.
3. For the accessibility to clean fuel technology, Coal natural gas and hydroelectric resources are significant factors. Nuclear resources are not significant in explaining energy poverty for the selected countries. For this proxy, the share of hydroelectricity is higher for rural population than urban. Inclusive growth as an indirect channel is significant in explaining the accessibility to clean fuel technology for cooking. In comparison, it increases accessibility of urban population more than rural population. This study recommends that some renewable and non-renewable resources like coal and hydro resources are important

to eliminate energy poverty for BRI countries. In case of rural energy poverty renewable electric resources i.e. hydro resources are more important to alleviate energy poverty and attain the welfare of people in rural areas. These empirical findings offer discussion and facts-based policy implications for sustainability and welfare of the people.

Despite its contribution to existing literature, this study has some limitations. First, this study randomly selected BRI countries from different regions based on the availability of the data, electricity resources are different across the regions therefore regional analysis can provide better results. Second, this study investigates macro level data to attain specific objectives. Future studies can be conducted through household survey data for more reliable results. Thirdly, data for renewable and non-renewable resources in World Bank resources is available only until 2015 and unavailability of recent data is a question mark. Future research can address energy poverty with the role of governance, industrialization, labor migration, oil price shocks and financial development to overcome rural and urban energy poverty.

Description of variables Table. 1A

Variables	Definition	Source
ACT (Dep. Var)	Access to clean fuel tech. for cooking	WDI
ACTU (Dep. Var)	Access to clean fuel tech. Urban population	WDI
ACTR (Dep. Var)	Access to clean fuel tech. rural population	WDI
AE (Dep. Var)	Access to electricity	WDI
AEU (Dep. Var)	Access to electricity urban population	WDI
AER (Dep. Var)	Access to electricity rural population	WDI
COAL	Electricity production from coal sources (% age)	WDI
NAT.G	Electricity production from natural gas (% age)	WDI
NUC.RES	Electricity production from nuclear resources (% age)	WDI
HYD.E	Electricity production from water resources (% age)	WDI
REN.SO	Electricity production from renewable sources other than hydroelectricity	WDI
LOSS	Electric power and transmission loss (% age)	WDI

Table 2 A (List of Countries)

1) Angola	12) Kyrgyz Rep
2) Armenia	13) Moldova
3) Bolivia	14) Mongolia
4) Congo Dem	15) Niger
5) Congo Rep	16) Nigeria
6) Cote D, Lvoir	17) Pakistan
7) Dominica	18) Senegal
8) Ecuador	19) Tanzania
9) Ethiopia	20) Togo
10) Georgia	21) Vietnam
11) Ghana	

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