IS REDUCING ENERGY CONSUMPTION A SOLUTION FOR SUSTAINABLE ECONOMIC GROWTH?

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Abstract: In this paper, a granger causality approach is used to examine the causality between economic growth and energy consumption in five north eastern states of India. The study attempts to reveal the implications on how the nexus can affect long term sustainability of the states. The direction of causality can throw light on the possible conservation policies that can be implemented (Jin et. al.2009).The study has taken energy consumption indicators of both traditional and renewable energy consumption from Energy Statistics, 2018. We have examined multiple situations to find out this direction of causation, with respect to certain types of energy consumption. The study deploys six different categories of energy consumption to address this issue. The findings indicate assorted evidence on the relationship between energy consumption and economic growth. In some instances, energy consumption leads to economic growth, lending support to supply-leading hypothesis of energy-growth nexus (Caraini et. al. 2015). On other cases, it is the economic growth that leads to energy consumption, lending support to demand-following hypothesis of energy-growth nexus. There are also cases, where energy consumption and economic growth are mutually interdependent, the situation where both are self-reinforcing and offer support to feedback hypothesis of energy-growth nexus (Pradhan, 2010).Conventional sources or non-renewable energy like coal, petrol, lignite and natural gas are not only causing adverse effect on the environment but are also limited for use as an engine of growth (Abbas and Choudhury, 2013).

Keywords: Energy Consumption, Sustainability, causality

I. INTRODUCTION:

While there is enough rationale to withdraw support from the fossil fuel energy industry, there are equally pressing reasons not to support the sustainablemovement unequivocally.It is high time to identify the need for changing the energy model based ontraditional fuel, to the emerging renewable energy model. Current environment is just one of the reasons, but the need is even more pressing due to reasons of inter-generational economic sustainability. Unless we modifythe old energy model, we put the future of India's north eastern region and India's economy as a wholein jeopardy**.** For instance,while Assam has substantial reservesof oil and natural gas, it is imperative to curb excavation ofthese exhaustive resourcesand create alternatives for the core business model.

On the other hand, random and sporadic conservation measures have led to an over drive yielding economic backwardness in several pockets of the North-Eastern states of India. Overdrawing the picture is just preaching with no representation of valid alternatives. Only policy measures indicating concrete directioncan produce hands-on solution. The only way the fossil fuel consumption is headed is downward as the economically viable reserves are already exploited**.** But a state-wise study of the relationship between different forms of energy consumption and economic growth indicates whether energy conservation measures are feasible or if they will hamper the economic prosperity of the region.For instance, states like Tripura and Manipur have not been doing so well economically and undertaking conservation policy measures can further affect the areas negatively**.**

The transformation in atmosphere leads to changes in weather patterns which we choose to ignore for the sake of industrialisation and rapid urbanisation. However, the north east states have neither been able to compete with rest of India in terms of economic prowess, nor with pro-environmental measures. There still exist unchartered natural territories with medieval warmth fringe states like Tripura, Nagaland and Mizoram. Even Meghalaya can boast of rich coal and limestone deposits. This paper conveys a state-wise policy directionto decide whether or not conservation measures can be feasible. The transition in energy consumption pattern will only be affordable if the state is economically strong enough to ride through a changing investment situation.The need is identified, the new investment models are also replacing the old ones but long term linkage patterns between economic growth and traditional energyconsumption can impact the performance of individual states. Assam has already geared up for solar power installation projects. But Tripura with its poor economic state of affairs cannot immediately move to alternative sources before commercially exploiting the huge natural gas that it is endowed with.There is a lack of adequate road or rail infrastructure and weak transmission infrastructure that hampers growth in this sense. It is imperative to understand which sector(Gregorio and Guidotti, 1995); whether economic growth or transition of energy consumption requires governmental support and formulate incentive measures accordingly.

Today we live in contemporary world where consumption of electricity is the crucial parameter of advancement. In present day scenario, Assamalone supplies26% of India's crude oil and 12% of India's natural gas. Meanwhile, the State of Tripura has abundant endowments of natural gas. Out of the two major sources, while thermal power accounts for 94%, the remaining 6% is generated from Hydroelectric Power.The point in question is, unless the consumption patterns shift more towards the renewable sources, this incessant mining for oil and gas will cause havoc for the environment. There have been more natural disastersrecently, the Assam and Mizoram flood in 2017, the cyclone Mora, the landslide in Arunachal Pradesh, and recorded earthquake that shook the entire area. While there might be other reasons also, but one cannot deny the role of energy depletion as a major factor responsible for such environmental misbalances. It is imperative to understand how these calamities can threaten the infrastructural growth path.

Various Policy initiatives have been taken by the Indian Government on account of energy conservation (Ghosh, 2002). North Eastern States account for about 17.78 MW of solar energy in India. The Government of India has revised projects based on National Solar Mission target of Grid Connected Solar Power from 20,000 MW to 1,00,000 MW by the year 2022. Further, the Ministry of New and Renewable Energy has sanctioned master plan for developing 50 solar cities of the proposed 60 cities. The Union Cabinet has approved the National Offshore Wind Energy Policy.The Government is also planning to use marketing platforms such as Flip-kart, Snap-deal and Amazon for promoting solar energy in India. But how much of these windfall gains can be utilised by the North-eastern states is a question still unanswered.

Researchers haveevidence suggesting India has a huge potential to move into electricity generation powered by the renewable sources by 2050. The global economic superpowers are all taking measures towards alternative sources. For instance, United States has asked for accountability from entities consuming in excess of one million GJ/A (100) to report their energy consumption to the Department of Energy. The department in turn assist the companies in excess consumption awarenessand greater efficiency of use. The British Government is becoming increasingly engaged in energy technology and conservation measures.Canada depends very much on its imported oil, for which reason the 1973 oil crisis prompted the Government into establishing a Renewable Energy branch within the Department of Energy, Mines and Resources. Similarly, India too has to take necessary measures and propagate it towards the untapped areas of the north east.

The energy requirement of the north eastern states are comparatively less than that of rest of India yet with excessive dependence on the exhaustive resources such as coal, oil and natural gas is not only not sustainable in the long-run, but also has its adverse impact on the rich natural environment and ecology inherent to this part of the country.This is how non-conventional or renewable sources of energy needs to attract national attention towards the east and evoked interest among economists, policy makers, and environmental activists as a viable option to achieve the goal of sustainable development (Mozumdar and Marathe, 2007).India would need to follow the direction of causation and take necessary policy steps. If the supply leading hypothesis comes into play, it will be difficult to take direct conservation measures as that would affect the current economic growth. On the other hand, if economic growth shows causality towards energy consumption, curbing consumption of traditional and increasing alternative power sources will be comparatively easier. The model in my paper discusses the implications of such diverging situations depending on the direction of causation. Ultimately contribution towards conservation of resources may not be effective on a micro level, but collectively as a state government policyone can produce a valuable impact towards leading the region'seconomic scenario a sustainable place to live in.

As an alternative to such rampant excavation of exhaustive fuels, renewable power source is the answer (Behmiri and Manso, 2012). Some of the most important renewable resources considered for this study are hydroelectric, solar, geothermal, biomass, bio-fuel and wind. Hydropower Power is harnessed from water accounts. Geothermal Energy is thermal energy generated and stored in the Earth.Solar energy is radiant light and heat from the Sun.Bio-energy is the heat derived from directly burning wood.Wind Power is the power generated from wind by converting its energy into electricity.Bio-fuel is a fuel that is produced through contemporary biological processes, such as agriculture and anaerobic digestion, rather than a fuel produced by geological processes such as those involved in the formation of fossil fuels, such as coal and petroleum, from prehistoric biological matter.

II. PROPOSED HYPOTHESES AND MODEL

In this study, we use Granger causality test to study the relationship between energy consumption development and economic growth using a sample of six states over the period 2000 to 2017 taken from the Economic Survey. We also use co-integration tests to reveal whether these variables are co-integrated, that is, whether there is a long-run equilibrium relationship between them. The main features of this study are that: (a) it uses an unconventional sample of the states which has been disregarded so far, and (b) over a current span of time; to answer questions concerning the nature of the causal relationship between the variables in the context of North-eastern states of India. The study(Masih and Masih, 1996) intends to test the following hypotheses:

Model I: We use an autoregressive distributed lag approach to define the supply-led equation between Energy Consumption and Economic Growth.

H1: Energy consumption (EC) in any year granger causes economic growth. This is termed the supply led economic growth hypothesis.

$$EG_t = f[EG_{t-i}, EC_{t-j}] \quad (1)$$

Where, EG_t is economic growth at time t; EC is Energy Consumption at t-j time period.

(for all i,j=1….t-1)

Model II: We use an autoregressive distributed lag approach to define the demand-led equation between Economic Growth and Energy Consumption

H2: Economic growth (EG) in any year Granger causes energy consumption. This is termed the demand led EC hypothesis.

$EC_t = f[EC_{t-i}, EG_{t-i}]$ (2)

Where, $EG_{t-i}$is economic growth at time t-i; EC is Energy Consumption at t-j time period.

(for all i,j=1….t-1)

EC is used here in two forms --- by composite indices TEC (total energy consumption is computed by summation of individual measures of energy consumption), REC (renewable energy consumptionis computed by summation of individual hydroelectric, solar and any other type of clean energy available) and its individual energy consumption indicators such as EEC (electricity energy consumption), CEC (coal energy consumption), OEC (oil energy consumption), and GEC (natural gas energy consumption).EG is measured in terms of GSDP (gross state domestic product) for each state over the mentioned time-period.

III. ANALYSIS AND RESULTS:

The analysis initiates from checking the stationarity of the series followed by co-integration between economic growth (EG) and energy consumption (EC).In the first step, ADF test is used at individual state level to check the unit root test(Joyeux and Ripple, 2011).The summary of the results of the test is reported in Table 1.

Table 1: Unit Root Test Results

	Variables					
CEC	**OEC**	**GEC**	**EEC**	**REC**	**TEC**	
	LD/ FD	**LD/ FD**	**LD/ FD**	**LD/ FD**	**LD/FD**	**LD/FD**
Assam	-0.56/-6.05*	1.45/-6.05*	-0.56/-6.05*	-0.59/-4.92*	0.27/-8.16*	0.08/-5.18
Nagaland	-1.18/-7.40*	-2.80/-1.67***	-1.23/-7.09*	-2.47/-7.06*	0.98/-3.98*	-0.46/-3.62*
Meghalaya	-2.13/-3.15*	-0.17/-6.79*	-2.90/-3.02	-0.05/-2.05**	0.22/-2.19**	3.38/-5.20*
Mizoram	1.45/-6.05*	-1.65/-2.70*	1.59/-6.30*	2.17/-2.45**	-1.13/-5.49*	-1.20/-3.69*
Tripura	-1.25/-6.76*	0.16/-1.37	2.86/-6.47*	-5.86/-3.34*	-3.61/-7.98*	0.24/-3.14*

With these results, we can declare that the variables of energy consumption (CEC, OEC, GEC, EEC, REC and TEC) and economic growth (EG) are non-stationary at the level data(LD) but are stationary at the first difference (FD).

Table 2: Test of Co-integration (Johansen- Julius Co-Integration Test-Max Test) between Energy Consumption and Economic Growth

	Variables (with EG)					
	CEC	OEC	GEC	EEC	REC	TEC
Assam	18.1*/2.27	16.7*/1.54	18.9*/2.71	31.8*/925	18.1*/1.50	22.2*/0.07
Nagaland	24.8*/6.82	20.9*/1.24	20.9*/3.63	20.4*/0.99	22.2*/0.07	15.5*/0.01
Meghalaya	14.1**/1.30	11.9/1.53	18.7*/1.01	24.1*/6.67	13.8***/0.01	16.8*/2.49
Mizoram	18.9*/3.32	17.8*/0.43	16.6*/1.62	22.7*/7.50	15.5*/0.01	28.3*/2.33
Tripura	14.2**/0.20	20.7*/0.10	26.9*/8.77	10.6/0.17	26.7*/7.85	17.8*/0.43

This suggests that both energy consumption development and economic growth are integrated of order one I[1]) leading to feasibility of co-integration betweenthem. Moving forward, using Johansen Maximum Likelihood co-integration test at the individual country level(Johansen, 1995), we establish the existence of long term co-integration(Engel & Granger, 1987)between per capita economic growth and energy consumption development.The summary of the results for the tests is reported in Table 2.

Next, after confirming the existenceof long-term relationship between per capita economicgrowth and energy consumption, we estimate theassociated parameters by deploying granger causality analysis. The summary of the direction of causality is reflected in Table 3.

Table 3: Granger Causality Test Results for Energy Consumption and Economic Growth

Granger Causality Test between

	CEC -EG	OEC -EG	GEC -EG	EEC- EG	REC -EG	TEC-EG
Assam	-2.90**/-1.24	1.94/0.53	-3.76*/0.54	4.11*/0.72	-3.49*/-1.97	0.83/9.30*
Nagaland	--/--	2.21***/7.01*	-4.88*/-0.50	10.9*/9.98*	-3.01*/-0.10	2.46***/1.60
Meghalaya	-3.82*/-0.33	5.65*/0.68	-2.13***/-0.34	2.91**/9.74*	-0.50/-5.55	0.31/1.81
Mizoram	-1.06/2.48	6.75*/2.66	-2.40***/-0.39	21.3*/0.05	-0.71/-2.10	6.57*/4.72*
Tripura	-6.90*/-1.23	35.1*/2.57	-4.35*/-1.52	4.82*/4.06*	--/--	1.84/1.64

Study reveals mixed results on the relationship between Energy Consumption and economic growth. In some cases, economic growth leads to energy consumption, lending support of demand-following hypothesis of energy-growth nexus mostly conspicuous in case of GEC, NBC, REC. This is in line with the findings of Onuong (2012).Some cases reveal the causality from energy consumption to economic growth, lending support supply-leading hypothesis of Energy Consumption-growth nexus prominently present in cases of CEC and OEC. This is in line with the findings Lee and Chang (2005), Mahadevan and Asafu-Adjaye(2007) and Bloch et al (2012). There are also cases, where energy Consumption and economic growth show bidirectional causality. That is the situation where they augment each other supporting the feedback hypothesis of energy-growth nexus especially observable in EEC and NREC, TEC and BEC. This is in line with the findings of Jumbe (2004), Ciarreta and Zarraga (2010) and Shahiduzzaman and Aman (2014).In addition, there are also cases, where energy consumption and economic growth are independent of each other.

Table 4: Supply-led Economic Growth

EC→EG						
	CEC	OEC	GEC	EEC	REC	TEC
Assam	Y	Y	Y	Y	N	Y
Meghalaya	N	N	N	Y	N	Y
Nagaland	N	N	N	Y	N	N
Mizoram	N	N	Y	Y	Y	Y
Tripura	N	N	Y	Y	N	Y

Table 5: Demand-led Energy Consumption

EG→EC						
	CEC	OEC	GEC	EEC	REC	TEC
Assam	N	Y	Y	N	Y	N
Meghalaya	Y	Y	N	Y	Y	N
Nagaland	Y	N	Y	Y	N	Y
Mizoram	N	Y	Y	Y	Y	N
Tripura	Y	Y	Y	N	Y	N

Table 6: Feedback hypothesis for Energy and Economic growth

EG←→EC						
	CEC	OEC	GEC	EEC	REC	TEC
Assam	Y	Y	N	Y	N	Y
Meghalaya	Y	N	N	Y	N	Y
Nagaland	Y	N	N	Y	N	N
Mizoram	N	N	N	Y	Y	Y
Tripura	N	N	N	Y	N	Y

Case 1: Between CEC and EG: For Tripura and Meghalaya, there is a unidirectional causality from per capita economic growth (EG) to coal energy consumption (EG → CEC): therefore undertaking energy conservation measures will hamper the economic prospects of the region(Jinkeet.al., 2009). For Assam and Mizoram, energy consumption Granger causes economic growth (EG ← CEC)implying conservation measures are more affordable compared to the neighbouring states.Furthermore, for Arunachal Pradesh, there is bidirectional causalitybetween energy consumption development and economic growth(EG ↔ TEC).

Case 2: Between OEC and EG: For Assam, Meghalaya, Nagaland, there is a unidirectional causality from oil energy consumption to economic growth (OEC→EG): therefore undertaking energy conservation measures will hamper the economic prospects of the state. Furthermore, for Tripura, there is bidirectional causality between energy consumption development and economic growth (EG ↔ OEC). For Mizoram, economic growth causes oil energy consumption (EG ← OEC) implying switching to alternative fuel sources is more affordable compared to the other states.

Case 3: Between GEC and EG: Similar results are observed for natural gas consumption.For Assam, Meghalaya andTripura, natural gas energy consumption Granger causes economic growth (EG ← GEC). Natural Gas is too crucial for the economy and is infeasible to cut down on the consumption right away.For Tripura and Nagaland there is a unidirectional causality from per capita economic growth (EG) to energy consumption (EG → GEC): therefore economic processes should be able to withstand the change of fossil-fuel energy model.(Bildirici and Bakirtas, 2013).

Case 4: Between EEC and EG: For Assam, Tripura, Meghalaya and Mizoram there is a bidirectional causality from per capita economic growth (EG) to energy consumption (EG ↔ EEC) showing how crucially the economy and power consumption are co-dependent on each other. Only Nagaland shows unidirectional causation from consumption of electricity towards economic growth (EG ← EEC) implying it is at a nascent stage of economic growth and electricity holds a potential to improve infrastructure in the state.(Abosedra et.al, 2009).

Case 5: Between REC and EG: Renewable energy is difficult to traceas their presence is very new and evolving in the region**.** For most states, Tripura, Meghalaya and Nagaland there is a unidirectional causality from per capita economic growth (EG) to renewable energy consumption (EG → REC): therefore undertaking energy conservation measures will be possible (Halicioglu, 2009). But in order to make that happen, the states need to equip themselves with strong economic foundation. For Assam and Mizoram, renewable energy consumption Granger causes economic growth (EG ← REC) which shows the solar power installations can have the potential to improve the state's economic infrastructure.

Case 6: Between TEC and EG: Total energy is a reflection of the major fuel consumption pattern in the states. For most states there is bidirectional causality between per capita economic growth (EG) and total energy consumption (EG ↔ TEC): therefore immediately undertaking conservation policy measures will hamper the economic growth prospects of the region. For Nagaland, economic growth Granger causes (EG ← TEC)energy consumption implying conservation measures is more affordable compared to the remaining states.

IV. CONCLUSION AND POLICY IMPLICATIONS:

The contribution of energy consumption development cannot be ignored since it is a vitalinfrastructure in stimulating economic growth. This study has explored the nexus between energy consumptionwith respect to CEC, OEC, GEC, EEC, REC and TEC. The energy industry be it fossil fuel or renewables dependably has been a capital intensive industry.Indeed, in the traditional energy model based on coal, oil and natural gas, the efficiency is less than that of clean energy business models**.** Sustainable energy framework can founded on renewableresources only when the economy is strong enough to bear the costs of transition and consequently can bring feasible success.With the impending scarcity, renewable energy becomes increasingly relevant. Their adoption has thus gained importance in recent years. Availability of energy and its consumption is a prerogative for the growth of industries as well as over-all economic prosperity of the states (Abanda, et. al.).For the states of Assam, Meghalaya, Mizoram and Tripura, the major demand for energy is from the household, and agriculture sectors but commercial sector usage is still not satisfactory. The paper suggests the policy-makers and researchers to considerthe nexus between thesetwo economic dimensions that guides the futureresearch on this topic. This paperrevealssignificant evidence on the interrelationship between the energy consumption and economicgrowth in the five north-eastern states. Manipur has been excluded from the study due to its poor economic performance compared to other north-eastern states and political unrest. Arunachal Pradesh is different in terms of size for energy consumption and therefore might on some occasions show biased results hence it is also omitted from the study. Study findsin some cases economicgrowth leads to energy consumption development, implying the states can plunge in the renewable energy sector development as economic growth supports such infrastructure development. Also, the result implies that undertaking conservation measures for fossil fuel industry won't hamper the growth as much.In other cases, it is the energy consumption development thatdetermines the level of economic growth, lending supportof supply-leading hypothesis of energy-growth nexus. Thereare also cases, where energy consumption development and economic growth reinforce each other(Levine R., 1997). That is the situation whereboth are subject to the support of bidirectional causality. Furthermore, an establishment of a well-developed energy infrastructure, including well-functioning thermal power plants, hydro-electric power plants and new solar grid installation projects, particularly with reference to Assam can boosteconomic performancein the states. Policies that increase economic growth (such as subsidies to clean fuel investment) would be desirable to bring the desired transition in energy consumption(Liang and Teng, 2006).Finally, the issue this paper has notinvestigated is the relationship between energy consumption development and economic growth in a multivariate frameworkby involving the integration with banks and stock marketdevelopment. Further research is needed on this area in the north-eastern states, as well as in other developing states.From the point of view of the market, the north eastern states are mostly at a developing stage. Sustainable business models will only work in cases where economy is functioning optimally and can afford the transition to wind, solar, hydro-electric, geothermal, biomass or any other form of inexhaustible source of energy.

Thus it is imperative for the government to undertake conservation policies to ride on a sustainable trajectory only after the states have reached a certain stage of economic prosperity. Use of Renewable Resources is such a measure that the states should be economically strong enough to cope with the transition from fossil fuel to sustainable clean energy sources.

References

[1] Abanda, F.H., Ng'ombe, A., Keivani, R., Tah, J.H.M., (2012), The link between Renewable Energy production and gross domestic product in Africa: A comparative study between 1980 and 2008, Renewable and Sustainable Energy Reviews, 16, 2147– 2153.

[2] Abbas, F. and Choudhury, N., (2013), Electricity consumption-economic growth Nexus: An aggregated and disaggregated causality analysis in India and Pakistan Journal of Policy Modeling, 35, 538–553.

[3] Abbas, F.,Choudhury, N., (2013), Electricity Consumption-Economic Growth Nexus: An Aggregated and Disaggregated causality analysis in India and Pakistan, Journal of Policy Modeling, 35, 538–553.

[4] Abosedra, S., Dah, A. and Ghosh, S., (2009), Electricity consumption and economic growth, the case of Lebanon, Applied Energy, 86, 429–432.

[5] Behmiri, N.B., Manso, J. R., (2012), Crude oil conservation policy hypothesis in OECD (organisation for economic cooperation and development) countries: A multivariate panel Granger causality test, Energy, 43, 253-260.

[6] Bildirici, M.E. and Bakirtas, T., (2013), The relationship among oil, natural gas and coal consumption and economic growth in BRICTS (Brazil, Russian, India, China, Turkey and South Africa) countries,Energy, 1-11.

[7] Bloch, H., Rafiq, S., Salim, R., (2012), Coal Consumption, CO2 Emissions and Economic Growth in China: Empirical Evidence and Policy Responses. Energy Economics, 34, 518-528.

[8] Caraiani, C., Lungu, C.I., Dascălu, C., (2015), Energy Consumption and GDP causality: A three-step analysis for emerging European countries, Renewable and Sustainable Energy Reviews, 44, 198–210.

[9] Ciarreta, A. and Zarraga, A., (2010), Economic Growth-Electricity Consumption Causality in 12 European Countries: A Dynamic Panel Data Approach, Energy Policy, 38, 3790-3796.

[10] Economic Survey of Assam, 2016-17, Government of Assam. Directorate of Economics and Statistics.

[11] Economic Survey 2016-17, Government of Assam. Directorate of Economics and Statistics, Kohima, Nagaland.

[12] Economic Survey 2016-17, Government of Mizoram, Planning and Programme Implementation Department.

[13] Economic Review of Tripura, 2016-17, Government of Tripura.

[14] Engle, R. F., and Granger, C. W., (1987), Co-integration and Error-correction: Representation, Estimation, and Testing, Econometrica: Journal of the Econometric Society, 55 (2), 251-276.

[15] Ghosh, S., (2002), Electricity consumption and Economic Growth in India, Energy Policy, 30, 125–129.

[16] Gregorio, J. D. and Guidotti, P. E., (1995), Financial Development and Economic Growth.World Development,23 (3), 433-448.

[17] Halicioglu, F., (2009),An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey,Energy Policy, 37, 1156–1164.

[18] Jin-ke, L., Feng-hua, W.,Hua-ling, S., (2009), Differences in coal consumption patterns and Economic Growth between developed and developing countries, Procedia Earth and Planetary Science, 1, 1744–1750.

[19] Johansen, S., (1995), Likelihood-Based Inference in Co-integrated Vector Autoregressive Models, Oxford University Press, Oxford.

[20] Joyeux, R. and Ripple, R.D., (2011), Energy Consumption and Real Income: A Panel Cointegration Multi-country Study, The Energy Journal, 32 (2), 107-141.

[21] Jumbe, C. B. L. (2004), Co-integration and Causality between Electricity Consumption and GDP: Empirical Evidence from Malawi, Energy Economics, 26, 61-68.

[22] Lee, C. C. and Chang, C. P., (2005), Structural Breaks, Energy Consumption, and Economic Growth Revisited: Evidence from Taiwan, Energy Economics, 27, 857-872.

[23] Levine R., (1997), Financial Development and Economic Growth: Views and Agenda,Journal of Economic Literature, 35 (2), 688-726.

[24] Liang, Q. and Teng, J. Z. (2006), Financial Development and Economic Growth: Evidence from China,China Economic Review, 17, 395–411.

[25] Mahadevan, R. and Asafu-Adjaye, J., (2007).Energy consumption, economic growth and prices: A reassessment using panel VECM for developed and developing countries,Energy Policy, 35, 2481-2490.

[26] Masih, A.M.M. and Masih, R. (1996). Energy consumption, real income and temporal causality: results from multi-country study based on cointegration and error-correction modeling techniques,Energy Economics, 18, 165-183.

[27] Mozumder, P., Marathe, A., (2007), Causality relationship between electricity consumption and GDP in Bangladesh, Energy Policy, 35, 395–402.

[28] Onuong, S. M. (2012), The Relationship between Commercial Energy Consumption and Gross Domestic Product in Kenya, Journal of Developing Areas, 46 (1), 305-314.

[29] Pradhan, R.P.,(2010), Modeling the Nexus Between Energy Consumption and Economic Growth in India, The IUP Journal of Infrastructure, VIII (1 & 2), 52-58.

[30] Statistical handbook. Meghalaya 2017.Government of Meghalaya.

[31] Shahiduzzaman, M. and Alam, K, (2014), A Reassessment of Energy and GDP Relationship: The Case of Australia, Environment Development and Sustainability, 16, 323-344.