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Prospect of low-cost energy conservation in residential energy consumption

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ABSTRACT

The energy sector of trinidad and tobago (T&T), with its nationally determined contributions (NDCs), is still struggling for its place in mainstream academic literature. The review paper aims to identify the prospects of low-cost energy conservation measures in the residential sector of T&T. The review follows a four-step review methodology to serve as a basis for creating policy and practice guidelines. First, review articles are checked for their quality on a 5-point scale on the mixed methods appraisal tool (MMAT) to check the quality of review articles. Second, Microsoft Excel, R (RQDA) package, and Voyant tools have been used to index code, analyse, and visualise data. The research trends on small islands developing states (SIDS) energy aspect in general and T&T specifically highlight the critical role of energy challenges related to economic and social development, emphasising technology, infrastructure development, and funds availability. Awareness of low-cost energy conservation measures has a high prospect in reducing residential consumption and balancing demand-side management. This paper contributes to facilitating policy direction on energy efficiency and energy conservation for T&T and other SIDS.

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1. INTRODUCTION

There is a strong correlation between the total economic output of nations (measured by their GDP) and their CO_2 emissions [1]. Higher energy consumption helps boost economic growth but at the cost of environmental degradation [2]-[4]. Economic analysts familiar with T&T insist that economic development is necessary for attaining sustainable development and climate change [5]-[7]. However, the reality of the Caribbean, on the "Economic Periphery of the World Capitalist Economy", is limited economic development opportunities [8]. The economic model for lesser developed countries concludes limited options as "A low initial level of environmental quality forces resource users to discount the future heavily ... poor people faced with marginal environmental conditions have no choice but to opt for immediate benefits at the expense of the long-run sustainability of their livelihoods". 60% of the world's population will live in cities by 2030, up from about 50% today. Modern cities account for 70% of global energy use and energy-related GHG emissions. The building sector accounts for around one-third of the final energy consumption globally and more than half of electricity demand. Its energy demand could be shrunk by, for instance, retrofitting existing buildings with more efficient heating and cooling technology and switching to efficient lighting and other

electrical appliances. This energy efficiency initiative will potentially result in an annual savings of US$ 555-770 billion [9]-[11], which is 40% of the global energy consumption and more than 30% of the global carbon dioxide [12]. The decrease in peak demand and carbon emission reduction go hand in hand with low residential electricity consumption [13]. Air-conditioning systems, lights, water heating systems, receptacle mount loads used in the building should be energy efficient [14]. T&T, in response to Paris Agreement, has set its NDCs on low carbon development. Around 34.9% of T&T's GDP is from the energy sector. Further, it accounts for about 80% of exports. The energy sector is integral to the long-term economic growth and development of T&T, contributing significantly to government revenue, export earnings, and GDP [15]. The energy consumption at T&T is a significant contributor to government revenue. Table 1 presents an overview of the T & T electricity sector per the Caribbean Center for Renewable Energy and Energy Efficiency.

Table 1. Trinidad & Tobago electricity sector overview (2020)

Total Installed Capacity	Peak Demand	Total Generation	Renewable Share	Transmission & Distribution Losses	Energy Access
75 MW (T&TEC) 2080 MW (IPPs)	1319 MW (2018)	9324 GWh (2018)	0%	8%	100%

The Trinidad and Tobago electricity commission (T&TEC) is the sole transmission and distribution company serving Trinidad and Tobago. Projections on revenue from energy are increasing as T&TEC's total customer base is growing on an average annual compounded rate of 1.7 %, from 503,871 customers in 2020 to 539,685 in 2024 and 584,453 in 2029. The increase is marginally less than the growth rate of 1.8 % reported in 2019's forecast. In 2020, the commission expects to serve almost 503,871 customers, of which 443,411 willbe residential, 60,376 will be commercial and small industrial, and 39 will be large industrial. By 2029 these customer numbers are expected to be 584,453, out of which 512,160 residential, 72,209 commercial and small industrial and 39 large industrial. The forecast window is consistent with 2019's forecast, there are no new large industrial customers, but the residential customers are growing exponentially within the forecast window. Therefore, there is a fair chance of energy conservation in the residential sector. However, the dearth of literature on energy conservation measures landscape in relevance to T&T derives the need for review. This review paper aims to explore the possibilities for low energy conservation measures in the residential sector of Trinidad and Tobago on the above background.

2. RESEARCH METHOD

The literature reviewer collects information representing the data making it equivalent to a research study [16]. Review Methodology functions as a source to create recommendations for policy and practice [17]. Literature Review Methodology Process flowchart includes review design, review of content, analysis of findings and writing discussion, conclusion and implication from review [17]. The four-step review methodology befits the paper's purpose of identifying the prospects of low-cost energy conservation measures as a basis for knowledge development in energy consumption and create energy conservation guidelines for policy and practice [18], [19]. The MMAT tool assessment of included literature highlights the quality of literature review for method, scope and sequence [20]. The search selection process and exclusion inclusion criterion are established. Authors used two separate search strings- (i) "T&T" (title), “Energy Consumption” (abstract), (ii) "Energy Conservation Measures" (title), and "T&T" (abstract). Table 2 abstracts the guiding question to retain review quality [17]. Figure 1 summarises upon review process. Predominantly 3083 publications appeared, leading to a sample of 19 publications fulfilling the criterion of inclusion and exclusion.

The year wise split of 19 study in [22]-[40] under review is as follows: 03 (2020) + 02 (2019) + 06 (2018) + 02 (2017) + 03 (2016) + 02 (2014) + 01 (2013).

Quality of the articles under review; mixed methods appraisal tool (MMAT) is a reliable content evaluation tool [20]. Division of studies is on the methods used, further into descriptive, random, and non-random studies shows in Tables 3, 4, 5. The final evaluation is done on "Yes (Y), No (N) and Cannot tell (C)" rating evaluation is done on the scoring scale of five, discouraging the calculation of the total score. The assessment report on the quality of qualitative and quantitative methods was appropriate to address the coherence between data source, analysis, interpretation, and samples' substantial representation of the target population [41]. In mixed method publications, qualitative and quantitative components are appropriately integrated. However, one publication has shown inconsistency and divergence between the qualitative and quantitative results.

Conceptualisation process; qualitative researchers think conceptually via an examination of the qualitative methodological literature [41], [42]. Figure 2 illustrates the conceptual lens using open-source software-voyant tool. Table 6 shows the conceptualisation process [42]. The Microsoft Excel summary sheet of 19 studies under methodological review to derive the core concept included 163 transcripts. That led to 142 preliminary thoughts generating 103 Open Codes, Forming 58 initial and 28 Final categories, ten sub-themes, four themes, two Potential Concepts and a Core-Concept. The association's indexing code is analysed using open-source software R (RQDA package) [43].

Table 2. Review process and guiding questions

Process	
Step 1. Design	Step 2. Conduct
- If this review on LCECM is needed, will it increase awareness of sustainable development goals, particularly CO_2 emissions and climate change in the residential sector? - Is there a prospect to reduce carbon footprint by LCECM? - Does the review identify recent research trends on energy aspects and explores how literature addresses the literature. - Set the search inclusion criteria from 2013 to 2021 for peer-reviewed academic journals available online in English. The article's relevance to energy conservation measures to search in SDG7, energy conservation, energy efficiency, clean technology, sustainability, social science, and the environmental science area	- At the outset of search design, we search using two distinct sets of search strings. - The electronic database of 3083 using funnel strategy (Figure 1) leads to a sample size of 19 publications. - Check of included study for final exclusion and quality over MMAT tool. Step 3. Analysis - Abstraction and Indexing Codes as per review aim - Pointwise presentation of findings and discussion given relevant study, expert opinion, and government reports [21]. Step 4. Forming and writing the review - The review concludes on the discussion in application to the purpose of the review. - The implications on the subject matter, available research literature and policy is the contribution of the review

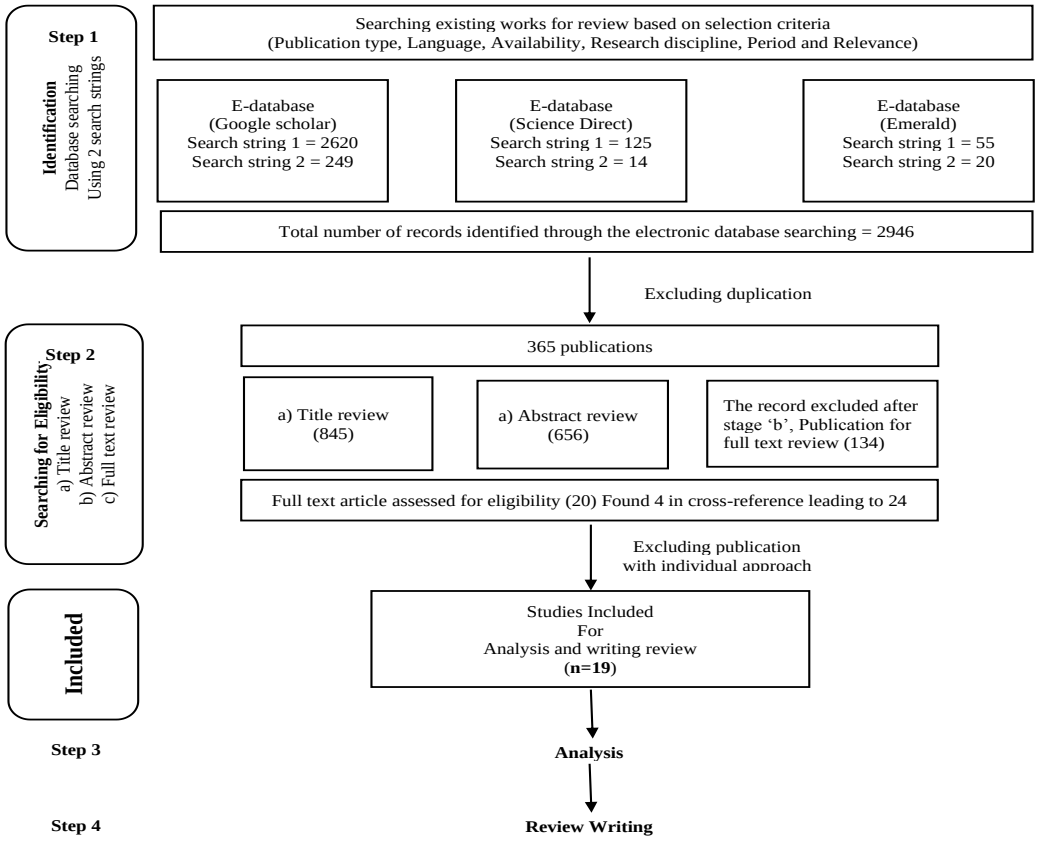

Figure 1. The review process

Table 3. MMAT quality assessment table (qualitative methods) (n=9)

Ref No	1. Is the qualitative approach appropriate to answer the research question?	2. Are qualitative data collection methods adequate to address the research question?	3. Are findings derived substantially from the data.	4. Is the interpretation of results demonstrated by the data?	5. Is there coherence between data source, data collection, analysis and interpretation
30	Y	Y	Y	Y	Y
33	Y	Y	Y	Y	Y
22	Y	Y	Y	Y	Y
23	Y	Y	Y	Y	Y
28	Y	Y	Y	Y	Y
31	Y	Y	Y	Y	Y
35	Y	Y	Y	Y	Y
37	Y	Y	Y	Y	Y
40	Y	Y	Y	Y	Y

Table 4. MMAT quality assessment table (quantitative methods) (n=7)

Ref. No	1. Is the sampling strategy appropriate to address the research question?	2. Do samples substantially represent the target population?	3. Are the measurement methods fitting?	4. Is the risk of non-bias response low?	5. Is the analysis (a statistical tool used) suitable to answer the research question?
27	Y	Y	Y	Y	Y
24	Y	Y	Y	Y	Y
34	Y	Y	Y	Y	Y
36	Y	Y	Y	Y	Y
38	Y	Y	Y	Y	Y
29	Y	Y	Y	Y	Y
26	Y	Y	Y	Y	Y

Table 5. MMAT quality assessment table (mixed methods) (n=3)

Ref. No	1. Rationale to use mixed approach design is appropriate to answer the research question.	2. Are the qualitative and quantitative components appropriately integrated to answer the research question?	3. Are Findings of the integration of qualitative and quantitative components substantially addressed?	4. Is inconsistency and divergence between the qualitative and quantitative results demonstrated in the study?	5. Do the different components of qualitative and quantitative methods involved adhere to the quality criterion?
25	Y	Y	Y	Y	Y
32	Y	Y	Y	C	Y
39	Y	Y	Y	Y	Y

Table 6. Data familiarisation of study under review for concept derivation

S No	Stage	Codes
1	Transcript	163
2	Preliminary thought	142
3	Open Code	103
4	Initial Category	58
5	Refined Category	40
6	Final Category	28
7	Sub-Theme	10
8	Themes	8
9	Concept	4
10	Core Concept	1

3. RESULTS AND DISCUSSION

In Figure 2, an association of term energy with supply and sustainable with technologies means these words are used in such combinations to derive inference from the association. Climate is associated with displacement, vulnerability, disaster and migration. Terms such as measures, allowances, companies, incentives, and usage were linking to the item efficiency. Small island developing states (SIDS) is associated with securities, adaptation, change, support, need, and lack, pinpointing SIDS' energy challenges and characteristics. Building sustainable development links to sustainable energy technologies through regulation on sustainable development, which is further related to subsidised electricity tariffs through renewable energy. The disbursement of various energy factors, energy challenges, policies, measures, SDG 7 challenge,

connects to SIDS' energy challenge, T&T energy challenge, Climate change challenge, which connects to energy conservation through energy conservation measures. Further, energy conservation steps lines to Sustainable development and Lifelong learning through Building sustainable development. Other than that, these Feed-in tariffs are associated with promoting sustainable energy development and adding a feed-in tariff rate. In contrast, an association of the policy-based tariff to electricity grid simulation, policy-based tariff structure and power generation and fuel dependency highlights the connectivity of electricity price with electricity consumption rates.

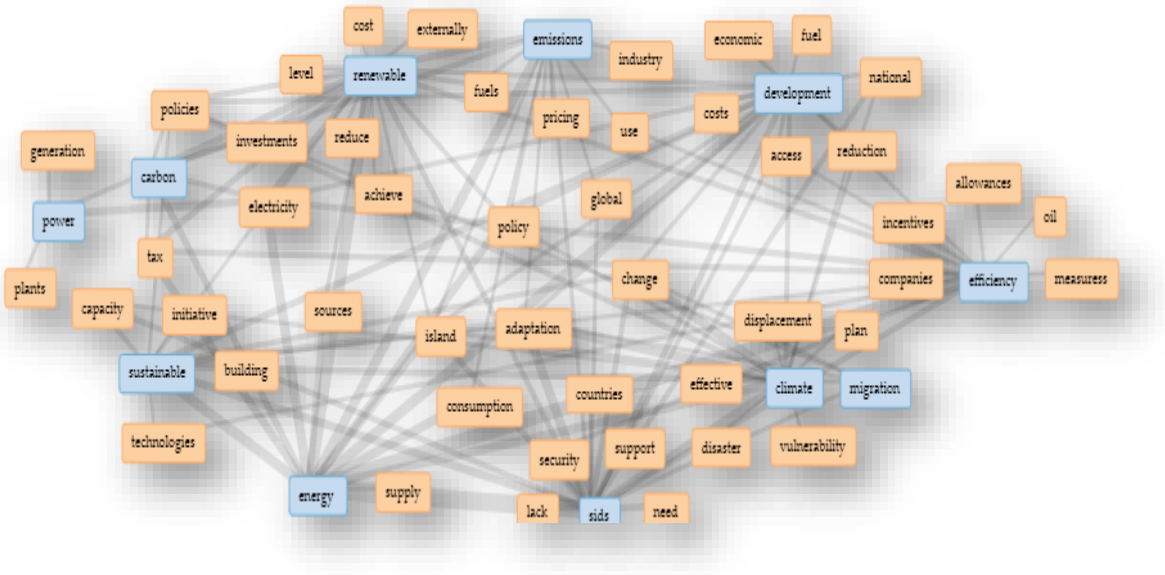

Figure 2. The conceptual lens (Voyant tools output)

In Figure 2 and Table 7, SIDS challenges link to SIDS sustainable development, Energy conservation challenges, focus on reducing greenhouse gas emissions, the carbon footprint for sustainable development, Capability building and sustainable development, and Barriers to renewable energy in SIDS. In addition, SIDS' energy challenge links to SIDS' energy efficiency sources which are further connected to the climate change challenge through SIDS' SDG challenges and are associated with institutionalising energy challenges. Table 7 quotes the most frequently used items during conceptualisation given the review objective. The items are energy-efficiency-conservation-measures (402+57+36+41), residential-electricity-consumption (45+157+ 74), renewable (94), climate (54), emissions (48), SIDS-Trinidad and Tobago (118+30+27) with challenges, pricing and tariff sharing an equal frequency score of 40 each.

Figure 3 shows connectivity between final categories (marked with yellow vertices) and sub-theme (marked with green vertices). As can be seen, Sustainable energy policy (SEP) is associated with Sustainable policy, Energy conservation and building code, Future energy policy, Efficiency increasing policy, SDG 7 policy challenge and consumption-based sustainable energy policy. In addition, the SEP connects to SDG7 challenges through Energy mix policy, Sustainable development goal through Sustainable development, Sustainable development goal 7 through policy for renewable energy, and sustainable energy resources through Sustainable generation resources. Another vital linkage is between Tariff structure and Tariff policy structure through Tariff policy design. The tariff structure is associated with subsidy based tariff, policy-based tariff, domestic tariff, tariff structure and consumption, feed-in tariff rate. Few other connectives are iterated and shown in Figure 4.

Figure 5 shows the plot diagram between Sub-theme (marked with yellow vertices) and Theme (marked with green vertices). The edges in the black arrow create a loop between Residential energy efficiency, conservation and customer awareness through energy consumption measures and energy consumption behaviour. Another loop is between sustainable energy policy, residential energy efficiency, conservation, SDG 7, Sustainable energy, consumption-based structure and Policy design through SDG7 challenge, Sustainable development goal and Sustainable energy policy. SDG 7 is further associated with

sustainable energy resources and Sustainable Development Goal 7. The final loop between Sustainable energy and Policy design is through Tariff structure. Figure 5 displays the conceptualisation of themes.

Figure 5 shows the link between various Themes (marked with yellow vertices) and Concepts (marked with green vertices). The loop between Sustainable energy policy and Energy policy forms through policy design and sustainable energy. Sustainable energy policy (SEP) is further associated with SDG 7, Energy awareness through consumption-based structure and energy conservation through Residential energy conservation. Energy awareness links to customer awareness, and energy policy links to Tariff structure. The link between the concepts shows that the core concept is energy conservation behaviour (ECB).

It is understandable from Table 8, Figures 4 and 5 that SEP and energy conservation are at the forefront of research in the energy sector at SIDS. While raising the bell for effective energy policies, publications have also underlined the need for energy-saving appliances and their availability at a subsidised price to sensitise the users on energy saving. Table 7 and Figure 5 highlight energy conservation and energy efficiency and their link with energy challenges. Table 9 is an outcome of monitoring the association plots and frequency tables on the energy aspect focus of the study under review.

Table 7. Item frequency (F)

Sr. No	Items	F	**Sr. No**	Items	F	**Sr. No**	Items	F
1.	Energy	402	20.	Conservation	36	39.	Use	21
2.	Electricity	157	21.	Demand	34	40.	Access	20
3.	SIDS	118	22.	Cost	32	41.	Economic	20
4.	Renewable	94	23.	Policies	32	42.	Fuels	20
5.	Consumption	74	24.	Carbon	31	43.	Production	20
6.	Policy	60	25.	Power	30	44.	Country	19
7.	Development	57	26.	Trinidad	30	45.	Low	19
8.	Efficiency	57	27.	Regulatory	28	46.	Reduce	19
9.	Climate	54	28.	Tobago	27	47.	Resources	19
10.	Adaptation	49	29.	Capacity	26	48.	Sources	19
11.	Sustainable	49	30.	Costs	26	49.	National	18
12.	Emissions	48	31.	Island	26	50.	Solar	18
13.	Residential	45	32.	Awareness	25	51.	Challenge	17
14.	Change	43	33.	Supply	25	52.	Lack	17
15.	High	42	34.	Framework	23	53.	Reduction	17
16.	Measures	41	35.	Gas	23	54.	Based	16
17.	Challenges	40	36.	Generation	22	55.	Countries	16
18.	Pricing	40	37.	Government	22	56.	Customers	16
19.	Tariff	40	38.	Need	22	57.	Investments	16

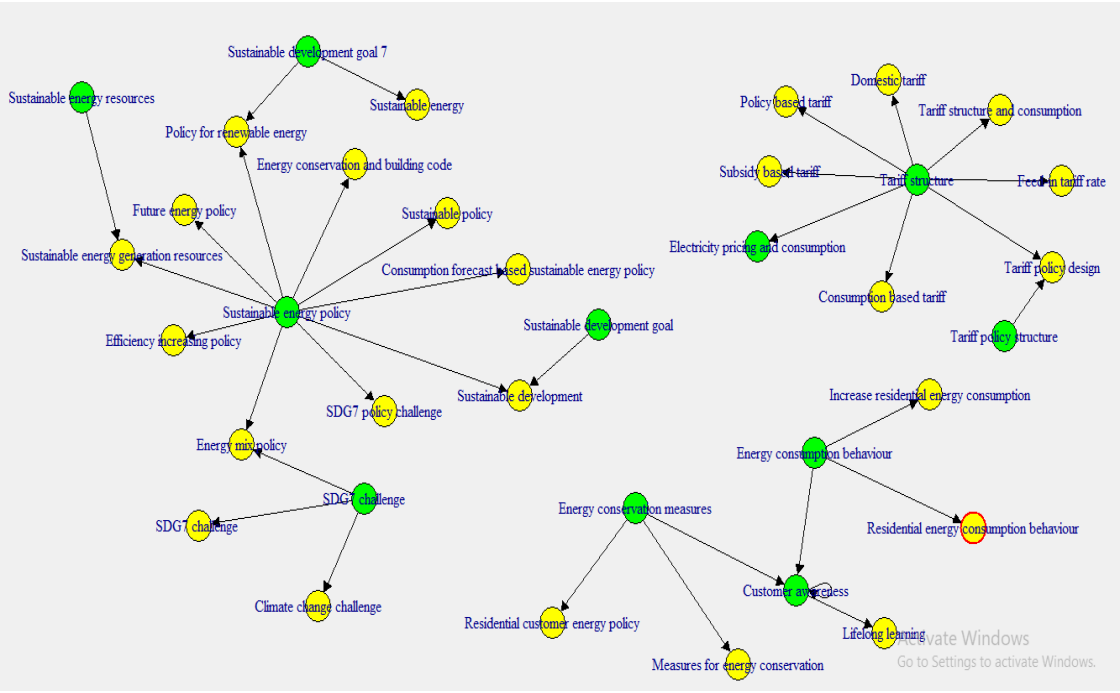

Figure 3. Relationship 1 using the fruchterman reingold layout algorithm

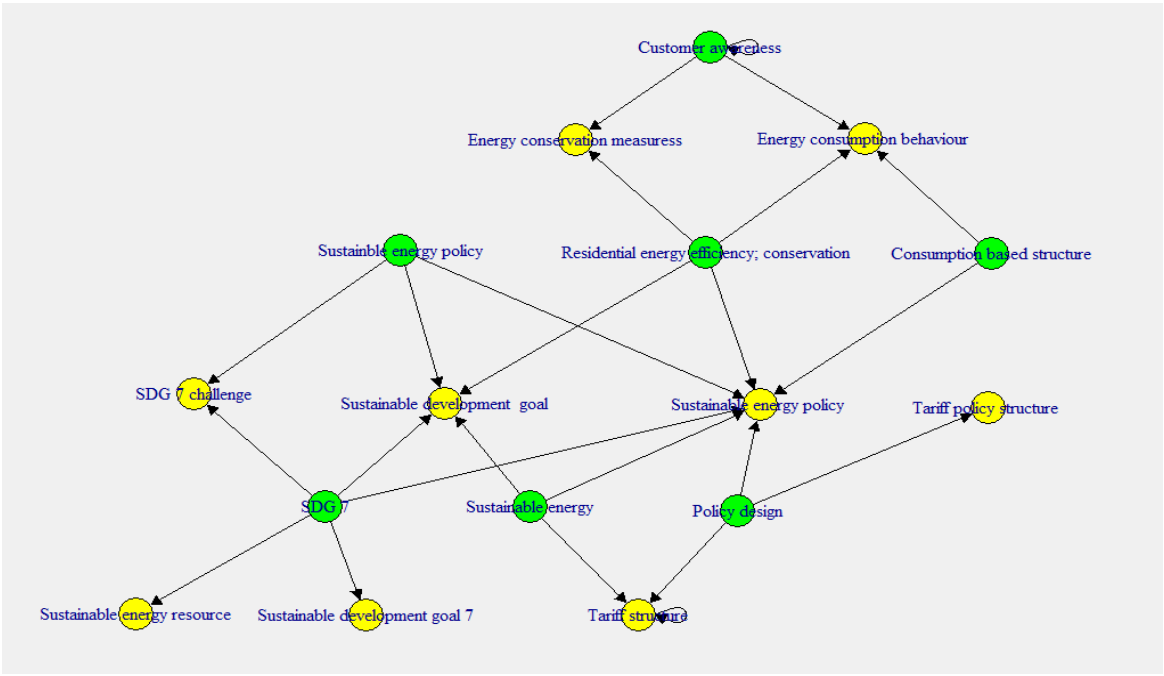

Figure 4. Relationship 2 using the fruchterman reingold layout algorithm

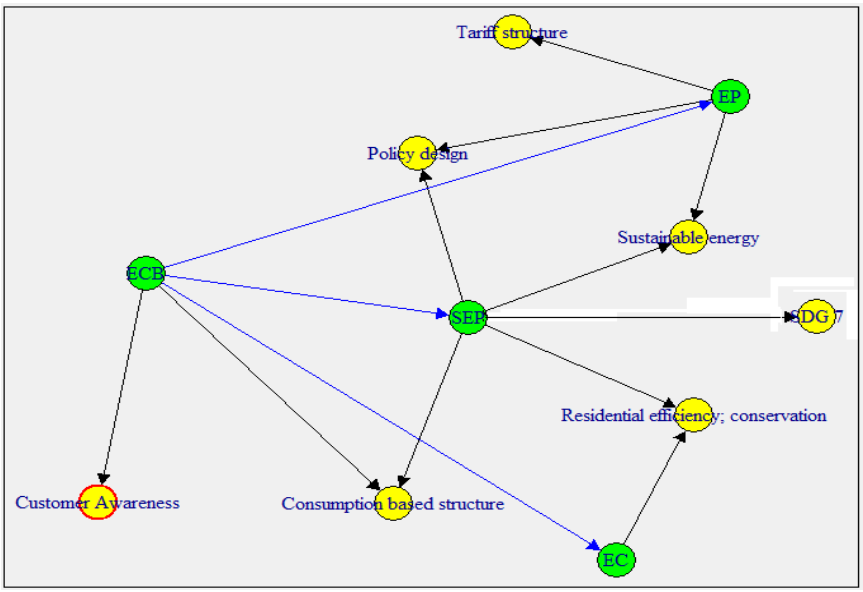

Figure 5. Relationship 3 using the fruchterman reingold layout algorithm

Table 8. Energy conservation behaviour is review core (n=19)

S. No.	Identified Concept	Links Frequency
1	Sustainable Energy Policy	18
2	Energy Conservation	12
3	Energy Policy	11
4	Energy Conservation Behaviour	9
Core: Energy Conservation Behaviour (9)		18+12+11=41
Source Table 7 and Figure 5		

Table 9. Energy aspect focus of study under review

Ref No.	Energy Aspect Focus	Policy Aspect Focus	Energy Challenges Focus
[22]	Climate Change; Energy Supply Chain Challenge	Sustainable Energy Policy	Socio- Economic-Environment Challenges; Institutional Challenges; Fund Challenges; Supply Chain Challenge.
[23]	Levelized cost of electricity (LCOE); Energy Pricing Policy	Energy Policy (Electricity Pricing)	Energy Mix Challenges; Renewable Energy Challenges.
[24]	Climate Change; Energy Efficiency; Residential Electricity Demand	Energy Efficiency; Energy Conservation	Challenge on Availability of Alternate Energy Appliances; Challenge of Awareness on Electricity Usage behaviour.
[25]	Energy Pricing Policy; Tariff Structure	Energy Policy (Electricity Pricing)	Energy Mix Challenges.
[26]	Renewable Energy	Renewable Energy	Renewable Energy Challenges; Economic Development Challenges; Energy Mix Challenges; Institutional Challenges
[27]	Energy Mix; Renewable energy	Energy Efficiency; Energy Conservation	Challenge on Availability of Alternate Energy Appliances; Challenge of Awareness on Electricity Usage behaviour.
[28]	Climate Change; Energy Efficiency; Residential Electricity Demand	Energy Efficiency; Energy Conservation	Challenge of Awareness on Electricity Usage behaviour.
[29]	Renewable Energy	Renewable Energy	Fund Challenges.
[30]	Energy Consumption and Emissions per capita	Energy Consumption	Economic Development Challenges
[31]	Renewable Energy	Renewable Energy	Economic Development Challenges
[32]	Energy Consumption and Emissions per capita	Energy Consumption	Economic Development Challenges
[33]	Energy Supply Chain challenge	Energy Efficiency; Energy Conservation	Institutional Challenges
[34]	SIDS Energy Challenges	Sustainable Development	Climate Change Challenges/ Environmental Challenges; Economic Development Challenges; Institutional Challenges
[35]	SIDS Energy Challenges	Sustainable Development	Renewable Energy Challenges
[36]	SIDS Energy Challenges	Sustainable Development	Institutional Challenges
[37]	SIDS Energy Challenges	Sustainable Development	Climate Change Challenges/ Environmental Challenges; Institutional Challenges
[38]	SIDS Energy Challenges	Sustainable Development	Renewable Energy Challenges Institutional Challenges
[39]	Energy Consumption and Carbon Emission	Energy Consumption	Carbon Emission and Economic growth Challenge
[40]	Capability Building; Renewable energy,	Energy Efficiency; Energy Conservation	Socio- Economic-Environment Challenges Technological Challenges; Institutional Challenges.

The institutional hiccups and economic development challenges challenge energy Conservation. Technological challenges confer as a reflection of the inadequacy of funds to develop or buy new technologies, including energy mix [44]. Focus on energy efficiency, energy conservation, and sustainable development goes in conjunction with most studies [45]. Few studies have also advocated focusing on renewable energy electricity pricing in the country's policies [46]. Discussions have also revolved around renewable energy in few studies as one of the policy aspects focuses. Persuasively, the review findings advocate a sustainable energy policy ensuring sustainable development. An invariable concern on climate change and environmental issues anticipating a quality energy mix of renewable energy are necessary to meet the SDG-7. The T&T sustainable energy challenge has a connection to the climate change challenge, policy challenges, environmental and economic development challenges. In addition, the energy policy joining with electricity pricing, residential consumption, energy conservation, and behavioural training shows possibilities for low energy conservation measures in the residential sector of T&T. Comparing the review findings with T&T's electricity consumption shows that the Caribbean average retail electricity price in 2012 was 0.33 USD/kWh. The world's average retail electricity price for the same year was 0.14 USD/kWh. In June 2019, the average price of electricity in the world was 0.14 US dollars per kWh for households and 0.12 US dollars for businesses, while in T&T, it was 0.053 US$ per kWh for households and 0.053 US$ for businesses, including various components such as the cost of power, distribution, and taxes in the electricity bill (Table 10 [46]). Table 11 [15], [46] shows the three consumption categories and tariffs for the residential sector in Trinidad and Tobago.

Table 10. Trinidad and Tobago electricity prices

Trinidad and Tobago electricity prices	Household, kWh	Business, kWh
Trinidad and Tobago Dollar	0.354	0.359
US Dollar	0.053	0.053

Table 11. T&T residential consumption category

Category	Price
1-400 kWh	0.26 TT$
401-1000 kWh	0.32 TT$
>1000kWh	0.37 TT$

T&T has 431,000 household consumers; approximately 120,000 use an average of 1500 kilowatt-hours (kWh) bi-monthly, which is considered high compared to T&Ts CARICOM neighbours. 32,000 households out of 4,31000 use 3000kwh per bi-monthly period. The 2017 energy report card of Trinidad and Tobago point out that the second-largest share of T&Ts energy consumption is residential (28%). Residential consumption is considerably high in comparison to household consumption in many other countries in the region. 43% of homes in T&T have a consumption level that is on par with the average North American home, twice that of the average European home, and three times the global average [44]. Table 12 compares T&T with Jamaica (CARICOM neighbour) on Energy Score [44], [46]. Jamaica, T&T's fellow CARICOM nation, is ahead of T&T in EE and RE focus. Therefore, it is high time that T&T should plan Energy Efficiency efforts and implement them.

Table 12. Energy comparative chart of T&T and Jamaica

Comparison Base	Trinidad & Tobago	Jamaica
COP 15	Y	Y
Population (‘000,000)	1.36	2.89
GDP per capita (‘000 USD)	32.3	9.4
Mature Energy Production Assets	Y	-
Downstream Petrochemical Industry	Y	-
LNG Producer/Exporter	Y	-
Energy Policy Established	-	Y
Implemented Energy Efficiency Initiative	-	Y
Renewable Energy	-	Y
Energy Intensity per capita (MJ/USD 2011 PPP)	19.1	5.2

4. CONCLUSION

The review concludes that the main grounds towards the advancement of an initiative to achieve energy conservation in T&T is on the following counts: (a) reducing household electricity consumption by developing an energy conservation culture, (b) focused energy efficiency policy specifically targeting overcoming energy challenges, implementing renewable energy, and providing awareness and training to develop energy conservation culture. Information on the considerable energy saving potential daily, irrespective of how efficient the facility may be, is essential to develop an energy conservation culture. For example, experience shows that anybody can easily save 50 W of electrical power daily in the air-conditioning application without compromising comfort. If 140000 people living in T&T (about 10% of the population) save 50 W daily, then the total saving will be 7 MW at the consumer end available on the grid for consumption. Going by the Rule of 1 unit saving at the consumer end is equal to 2 units saving at the generation point, it will mean 14 MW savings at the generating stations. Savings of 14 MW is free of cost, instantaneous, and without any environmental impact. The study outcomes are a good reference on LCECM for referencing Building Codes for residential buildings in Trinidad and Tobago with energy conservation. Furthermore, the energy conservation culture can contribute to Trinidad's commitment to attaining SDG-7 through training in awareness and low-cost energy conservation measures.

REFERENCES

[1] J. T. Roberts, P. E. Grimes and J. L. Manate, “Social Roots of Global Environmental Change: A World-Systems Analysis of CO_2 Emissions,” *Journal of World-Systems Research*, pp. 277-315, 2003, doi: 10.5195/jwsr.2003.238.

[2] R. K. Tyagi, and N. Vasijeviene, “The case of CSR and irresponsible management practices,” *Competitiveness Review*, vol. 23, no. 4/5, pp. 372-383, 2013, doi: 10.1108/CR-03-2013-0031.

[3] R. Tyagi, S. Vishwakarma, K. K. Singh, and C. Syan, “Low-Cost Energy Conservation Measures and Behavioral Change for Sustainable Energy Goal,” *Affordable and Clean Energy, Encyclopedia of the UN Sustainable Development Goals, Springer*, 2020, doi: 10.1007/978-3-319-71057-0155-1.

[4] R. Tyagi, S. Vishwakarma, Z. S. Alexandrovich, and S. Mohammed, “ICT Skills for Sustainable Development Goal 4,” *Quality Education Encyclopedia of the UN Sustainable Development Goals*, 2020.

[5] R. Tyagi, S. Vishwakarma, "Post-reforms training needs of frontline managers in Indian power distribution companies: A top managers' perspective," *International Journal of Energy Sector Management*, vol. 11, no. 3, pp. 416-425, 2017, doi: 10.1108/IJESM-02-2016-0001.
[6] R. Tyagi, S. Vishwakarma, and S. S. Yadav, "Community Self-Help Projects," *Encyclopedia of the UN Sustainable Development Goals, Springer*, 2021, doi: 10.1007/978-3-319-69625-6.
[7] F. K. Donkor, and K. Mearns, "Clean Energy Solutions and Sustainable Development*," Affordable and Clean Energy, Encyclopedia of the UN Sustainable Development Goals*, 2020, doi: 10.1007/978-3-319-71057-084-1.
[8] R. P. Bellany, "Liberalism: Impact on Social Science, "*International Encyclopedia of the Social & Behavioral Sciences*, pp. 8797-8801, 2001, doi: 10.1016/B0-08-043076-7/00107-8.
[9] R. Tyagi, S. Vishwakarma, M, Rishi, and S. Rajiah, "Reducing Inequalities Through Education and Skill Development Courses," *Encyclopedia of the UN Sustainable Development Goals, Springer*, 2020.
[10] IEA, "Transition to Sustainable Buildings: Strategies & Opportunities to 2050," *International Energy Agency*, 2013. [Online]. Available: https://iea.blob.core.windows.net/assets/1e300ab6-44de-41dc-8714-ee12a4800943/Building2013_free.pdf.
[11] Ali S. S., R. Tyagi and Chauhan R, "Energy conservation project funding in commercial building: An expenditure or investment?" *International Journal of Power Electronics and Drive Systems*, 2019, doi: 10.11591/ijpeds.v10.i1.pp504-513 .
[12] S. Goubran, T. Masson and M. Caycedo, "Evolutions in Sustainability and Sustainable Real Estate," *Sustainable Real Estate, Cham (Switzerland): Palgrave Macmillan*, pp: 11-31, 2019, doi: 10.1007/978-3-319-94565-1_3.
[13] K. Bataineh, and A. Alrabee, "Improving the Energy Efficiency of the Residential Buildings in Jordan," *Buildings*, vol. 8, no. 85, pp. 1-16, 2018, doi: 10.3390/buildings8070085.
[14] SS. Ali and T. Ruchi, "The role of Energy Conservation Building Code 2017 in Indian Energy Policy," *International Journal of Recent Technology and Engineering IJRTE*, vol. 9, no. 1, pp. 1799-1806, 2017, doi: 10.35940/ijrte.A2212.059120.
[15] TRIC, "Energy Road Map Series-Advancing Energy Efficiency/ Energy Conservation in Trinidad and Tobago," Trinidad Regulatory Industries Commission, June 2019.
[16] Onwuegbuzie, J. Anthony, L. N. Leech, and M. T. K. C. Kathlee, "Qualitative Analysis Techniques for the Review of the Literature," *The Qualitative Report*, vol. 17, no. 28, pp. 1-28, 2012, doi: 10.46743/2160-3715/2012.1754.
[17] H. Snyder, "Literature review as a research methodology: An overview and guidelines," *Journal of Business Research*, vol. 104, pp. 333-339, 2019, doi: 10.1016/j.jbusres.2019.07.039.
[18] D. Tranfield, D. Denyer and P. Smart, "Towards a methodology for developing evidence-informed management knowledge by means of systematic review," *British Journal of Management*, vol. 14, no. 3, pp. 207-222, 2003.
[19] P. M. Podsakoff, S. B. Mackenzie, D. G. Bachrach, and N. P. Podsakoff, "The Influence of Management Journals in 1980s and 1990s," *Strategic Management Journal*, vol. 26, no. 5, pp. 473-488, doi: 10.1002/smj.454.
[20] H. Q. Nha *et al*., "Mixed Methods Appraisal Tool (MMAT), Version 2018 for information professionals and research," *Education for Information*, vol. 34, no. 4, pp. 285-291, 2018, doi: 10.3233/EFI-180221.
[21] R. Tyagi, "Meerut Embroidery Cluster: A Case Study," *South Asian Journal of Business and Management Cases*, vol. 1, no. 2, pp. 185-202, 2013, doi: 10.1177/2277977912459445.
[22] A. Atteridge, and G. Savvidou, "Development Aid for Energy in Small Island Developing States," *Energy, Sustainability and Society*, vol. 9, no. 10, pp. 1-10, 2019, doi: 10.1186/s13705-019-0194-3.
[23] X. T. Chadee, and R. M. Clarke, "Wind resources and the Levelized cost of wind-generated electricity in the Caribbean islands of Trinidad and Tobago," *Renewable and Sustainable Energy Reviews*, vol. 81, Part 2, pp. 2526-2540, 2018, doi: 10.1016/j.rser.2017.06.059.
[24] A. Chunekar, S. Varshney, and S. Dixit, "Residential Electricity Consumption in India: What do we know?" *Prayas (Energy Group)*, vol. 81, pp. 765-778, 2016, doi: 10.1016/J.ENECO.2019.05.021.
[25] R. Hlendik, and J. Lazar, "Distribution System Pricing for Customers with Distributed Energy Resources," *Future Electric Utility Regulation Series*, Lawrence Berkeley National Laboratory, vol. 4, pp. 1-103, 2016.
[26] Z. Khan, K. Siriram, and K. Greigg, "Fiscal incentives promoting REEE measures in Trinidad and Tobago*," World J. Sci., Tech. and Sustainable Development*, vol. 11, no. 3, pp. 196-213, 2014, doi: 10.1108/wjstsd-06-2014-0013.
[27] C. Klock, and P. D. Nunn, "Adaptation to Climate Change in Small Island Developing States: A Systematic Literature Review of Academic Research," *The Journal of Environment & Development*, vol. 28, no. 2, pp. 196-218, 2019.
[28] A. G. Kok, K. Shang, and S. Yucel, "Impact of electricity pricing policies on renewable energy investments and carbon emissions," *Management Science*, vol. 64, no. 1, pp. 131-148, 2016, doi: 10.1287/mnsc.2016.2576.
[29] F. Krausmann, R. Richter and N. Eisenmenger, "Resource Use in Small Island States," *Journal of Industrial Ecology*, vol. 18, no. 2, pp. 294-305, 2014, doi:10.1111/jiec.12100.
[30] K. K. Perry, "The Dynamics of Industrial Development in a Resource-Rich Developing Society: A Political Economy Analysis," *J. Dev. Soc., SAGE Publication*, vol. 34, no. 3, pp. 264-296, 2018, doi: 10.1177/0169796x18786136.
[31] J. Pillai, and C. Riverol, "Estimation of gas emission and derived electrical power generation from landfills. Trinidad and Tobago as study case," *Sustainable Energy Technologies and Assessments*, vol. 29, pp. 139-146, 2018.
[32] P. Raghoo, D. Surroop, F. Wolf, W. L. Filho, P. Jeetah, B. Deakowitz, "Dimensions of energy security in Small Island Developing States," *Utilities Policy*, vol. 53, pp. 94-101, 2018, doi: 10.1016/j.jup.2018.06.007.

[33] S. Robinson, "A richness index for baselining climate change adaptations in small island developing states," *Environmental and Sustainability Indicators*, vol. 8, no. 100065, 2020, doi: 10.1016/j.indic.2020.100065.
[34] R. Shirley, and D. Kammen, "Renewable energy sector development in the Caribbean: Current trends and lessons from history," *Energy Policy*, vol. 57, pp. 244-252, 2013, doi: 10.1016/j.enpol.2013.01.049.
[35] D. Surroop, P. Raghoo, F. Wolf, K. U. Shah, and P. Jeetah, "Energy access in Small Island Developing States: Status, barriers and policy measures," *Environmental Development*, vol. 27, pp. 58-69, 2018.
[36] A. Thomas, A. Baptiste, R. M. Koller, P. Pringle, and K. Rhiney, "Climate Change and Small Island Developing States," *Annual Review of Environment and Resources*, vol. 45, no. 1-27, 2020.
[37] A. Thomas, and L. Benjamin, "Policies and mechanisms to address climate-induced migration and displacement in Pacific and Caribbean small island developing states," *International Journal of Climate Change Strategies and Management, Emerald Publication*, vol. 10 no. 1, pp. 86-104, 2018, doi: 10.1108/IJCCSM-03-2017-0055.
[38] R. Waheed, S. Sarwar, and C. Wei, "The survey of economic growth, energy consumption and carbon emission," *Energy Reports*, vol. 5, pp. 1103-1115, 2019, doi: 10.1016/J.EGYR.2019.07.006.
[39] F. Wolf, D. V. Becker, W. Leal, J. Krink, J. Haseberger, and M. Kowald, "Sustainable energy generation and use in SIDS and beyond-introducing the L3EAP online learning approach," *Brazilian Journal of Science and Technology*, vol. 3, no. 2, pp. 1-14, 2016, doi: 10.1186/s40552-016-0021-8.
[40] Q. N. Hong *et al*, "Improving the content validity of the mixed methods appraisal tool: a modified e-Delphi study," *Journal of Clinical Epidemiology*, vol. 111, pp. 49-59, 2019, doi: 10.1016/j.jclinepi.2019.03.008.
[41] L. S. Vygotsky, "Thought and language," The MIT Press, 2012.
[42] J. Smith, and J. Firth, "Qualitative data analysis: application of the framework approach," *Nurse Researcher*, vol. 18, no. 2, pp. 52-62, 2011, doi: 10.7748/nr2011.01.18.2.52.c8284.
[43] R. Huang, "RQDA: R-based Qualitative Data Analysis," R package version 0.2-8, [Online] Available: http://rqda.r-forge.r-project.org
[44] L. Barredo, "Mainstreaming Renewables in the Caribbean Energy Mix," Article dated, 2015, The UN Sustainable Development Solutions Network (SDSN), [Online] Available:https://www.unsdsn.org/news/2015/08/05/mainstreaming-renewables-in-the-caribbean-energy-mix.
[45] Tracking SDG7, "The Energy Progress Report 2018," World Bank Group, 2018.
[46] Caricom, "Caribbean Center for Renewable Energy and Energy Efficiency," 2015, [Online] Avalilable: https://caricom.org/institutions/caribbean-center-for-renewable-energy-and-energy-efficiency-ccreee/.

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