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RESEARCH PAPER

Company perspectives from Trinidad and Tobago on renewable energy management systems and energy efficiencies

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Abstract. The global energy market is currently undergoing a transformation at all levels within their supply chains as there is a gradual shift from the fossil fuel paradigm towards sustainable renewable energy (RE) sources and energy efficiencies (EEs). This research study examines this issue by employing an empirical research process. A survey was undertaken with fifty companies operating in Trinidad and Tobago and investigated their interest in adopting RE management systems and EEs. The research revealed that most of the companies have a low level of interest in RE management systems primarily because of current low energy costs for their operations and limited knowledge about current public sector energy incentives. To ameliorate this situation, educational campaigns, training package development, and complementary energy workshops are suggested to motivate and encourage business enterprises to consider the EE pathway.

Keywords: renewable energy; energy efficiency; energy costs; energy training packages

1. Introduction

The global energy market has evolved and shifted from an economy powered by fossil fuels and resource exploitation to a market economy based on reliability, sustainability, and innovation. However, the Caribbean countries rely more on fossil fuel and most of them were net importer of fossil fuel (Guerra, 2016) from Trinidad and Tobago and Venezuela (Harrison & Popke, 2018). A study conducted by Lapillone (2019) emphasizes that high energy costs and fossil fuel dependency contribute to decreasing Caribbean competitiveness and economic growth. High energy costs reduce profit margins in business enterprises and contribute to a ripple effect that decreases developmental strategies. El-Ashram (2017) argues that implementing renewable energy (RE) and energy efficiency (EE) increased cost-saving because the import cost of fossil fuel could be reduced.

The Caribbean region has a wide variety of RE sources such as wind (Chadee & Clarke, 2018), solar (Asci & Williams, 2020; Manickchand, 2011), and geothermal (Patihk et al., 2021). While the

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supply suggests that there is a promising potential for these resources to be harnessed sustainably, Samuel (2013) proposes that the current situation reveals that the rate of resource utilization is low and most business enterprises in the Caribbean countries did not exploit RE. Moreover, EE in the Caribbean was very low (Guerra, 2016). In transportation the sector, Trinidad and Tobago has the lowest EE among other Caribbean and Latin American countries (Llorca et al., 2017).

Concerning RE in Trinidad and Tobago, energy consumption growth was higher than its economic growth (Pablo-Romero & De Jesús, 2016). Meanwhile, Khan and Khan (2019) explain that Trinidad and Tobago has the third-highest energy consumption per capita. This country's high reliance on natural gas to generate electric needs. Although natural gas is the cleanest of all fossil fuels, Khan and Khan (2019) said that it still produces atmospheric greenhouse gases. Along with the CO₂ emissions, they have been increasing the local carbon footprint by 79%. Llorca et al. (2017) found that EE in Trinidad and Tobago was the lowest among other Caribbean countries. They have put a stance emphasizing the necessity for the country to expand on the utilization of RE and improve its EE initiatives (Martin, 2015). EE strategies provide some advantages, such as energy cost savings and energy security, reduced greenhouse gas emissions, higher production in EE sectors, increased investment in EE, country attractiveness improvement, and economic output increase (Cazaubon, 2019). It is expected to lead to decreased levels of energy consumption and reduced cost, increased performance and efficiency in electricity generation, the development of new power generation infrastructure which can provide job opportunities in research and development to operations and manufacturing.

However, there are several barriers to implement of the deployment of local RE and EE strategies in Trinidad and Tobago. Those barriers are the capital intensive requirements, the current low/competitive cost of electricity and fuel due to existing energy subsidies, a weak regulatory and legislative framework, and a general lack of public awareness of the benefits of RE resources and EEs. The lower electricity cost in Trinidad and Tobago than other Caribbean nations acts as a disincentive to the growth and utilization of RE and EE strategies. It is also uneconomical for these strategies to gain a foothold in the national energy market.

The Energy Chamber of Trinidad and Tobago (2020) has articulated that the overall attitudes towards energy have led to a high degree of wastage because of its low cost. A national culture of waste and inefficient use of natural gas, which generates electricity, has been underpinned by a lack of education on the importance of RE and EE. Reform is needed at the national level, at both the domestic and business enterprise levels. The Energy Chamber of Trinidad and Tobago (2020) further argues that there are several low-hanging fruits that could improve local EE levels such as analyzing operational levels for energy generation to improve performance, having greater access to the energy grid by RE generators, making concerted efforts to reduce emissions, creating strategies to increase efficiency of Liquid National Gas production and implementing energy-saving opportunities.

In discussing the EE landscape in Trinidad and Tobago, from a public sector perspective, the Ministry of Energy and Energy Industries The Republic of Trinidad and Tobago (2020) has revealed that the energy sector is one of the main drivers of the Trinidad and Tobago economy. It has contributed to 35% of the real Gross National Product and almost 39% of the government's revenue. However, there has been no recent research on the perspectives of business enterprises on their current energy management strategies, interest in adopting RE technologies within an energy management system that is geared towards EE. This type of evaluation is critical to be undertaken thereby knowledge generated will allow for an understanding of the interest of firms in these areas and what incentives they may need to adopt a greener approach in business operations. The value of this research is that the findings can be cross-fertilized with other companies in the Caribbean region and allow it to achieve its full potential to RE and EEs. To pivot into an operational space where the advantages of embracing RE sources and developing a

strategic orientation towards EEs are adopted, there needs to be research into the situational framework for energy management of companies at the firm level.

This research study addressed this issue by examining the current perspectives of companies in Trinidad and Tobago with respect to their current energy management strategies and their interest in adopting RE technologies within an energy management system that is geared towards EEs. The knowledge provided will create an understanding of the interest of firms in these areas and what incentives they may need to adopt a greener approach in business operations. The value of this research is that the findings can be cross-fertilized with other companies in the Caribbean region and allow it to achieve its full potential concerning RE and EEs.

2. Literature Review

2.1. Renewable energy and energy efficiency

The awareness in RE utilization has been traced by Turner (1999) that interest in RE arose from the knowledge about the apparent risks of using fossil fuels. He further explains that in the 1980s, the risks associated with pollution were a starting point for research and development to design strategies to avoid or remedy environmental damage from fossil fuel extraction, processing, and transportation. It led to measures that were developed to provide ways to use fossil fuels and reduce their negative environmental impact. Global warming also sparked global dialogue on the continued utilization of fossil fuels as opposed to renewable and green energy sources. Turner (1999) concludes his research by suggesting that there should be an emphasis on the design and development of RE technologies in conjunction with an increased level of manufacturing capabilities that would work together to create a long-lasting energy infrastructure for future generations. The research conducted by Lund (2007) explains that to successfully integrate RE from wind, solar, wave, and biomass, strategies that comprise three major technological components are needed. These components are energy savings on the demand side, efficiency improvements in energy production, and replacement of fossil fuels by different forms of RE. In discussing the role of RE sources in protecting the environment, Panwar et al. (2011) argue that renewable technologies are clean sources of energy. The research study of Vine et al. (2000) proposes that since there have been developments in the field of RE technologies and processes, companies can reap significant benefits. These benefits include opportunities for companies to increase the levels of EEs and allow them to access several RE channels. They further argue that these measures provide firms with a new pathway to energy management that can promote financial saving in the forms of insurance loss reduction and prevention.

RE provides benefits in the reduction in environmental damage, a decrease in the production of secondary waste, and alignment with the current decreasing supply of fossil fuels (Panwar et al., 2011). They further explain that RE technologies provide a method to reduce the levels of greenhouse gas emissions and can play a role in reducing the rates of global warming due to traditional energy sources.

In describing the current global energy scene, Freris and Infield (2008) suggest that electricity can be regarded as a premium type of energy because of its flexibility and ease of distribution in many geographic regions. They also explain that the global electricity demand is expanding due to the high utilization of consumer electronics, increased industrial activity, and higher levels of international consumption. This situation has caused a sharp increase in the demand for oil and gas especially in countries such as China and India which are experiencing waves of industrialization due to increasing access to consumers. They further propose that energy security in unstable regions should be investigated to develop mitigating strategies while promoting the utilization of RE. Some strategies can include increasing the efficient use of current energy levels, trading rules to encourage the pivoting to low carbon development paths, supporting the utilization of renewable and low carbon technologies, and decreasing deforestation. In explaining the current energy environment, Winston and Favaloro (2017)

propose that energy management is receiving increasing attention on the corporate agenda primarily because of changes in environmental, social, and business developments. These changes include climate change, global carbon regulation, and demands on natural resource expansion. The emphasis on firms taking up their roles as green corporate citizens and energy-technology innovations.

2.2. The challenges of implementing EE and RE in the companies

EE innovation is imperative to solve the problem of global warming (Solnørdal & Thyholdt, 2019). The research study conducted by Luca and Park (2018) further reveals to deal with challenges in the implementation process of EE measures within industries and companies' best practices can be utilized. These practices include national educational programs and initiatives to promote EE, the creation of an energy culture within companies, and the development of the process, and systems to measure energy utilization.

However, the results of research conducted by Adewunmi et al. (2019) show that the significant challenge in the implementation of energy-efficient systems was the cost factors which have the potential to decrease uptake. They recommend that management should be educated on the benefits of EE and the utilization of energy conservation measures to change their views on the cost impact of implementing energy management systems. Samuel (2013) further explains that there are barriers that hinder the exploitation of EE mechanisms. These barriers include unclear government policy and a pool of human resource skills in this field, a lack of awareness, confidence, and acceptance of RE technologies, limited capital that supports the investment in RE projects, and the competitive energy costs in the developed Caribbean countries which can act as a disincentive to embarking on RE management systems.

Based on their study in Germany, Ireland, and United Kingdom, Sorrell et al. (2000) found eight barriers to EE. Those eight barriers are hidden costs, access to capital, risk, imperfect information, split incentives, bounded rationality, power, heterogeneity, principal-agent, adverse selection, a form of information, credibility and trust, and value and organizational culture. Meanwhile, Altomonte et al. (2003) argue that the main barrier to RE and EE implementation all around the world are caused by the energy market, financial donors, and political support. In addition, price distortion, lack of financial support, environmental concerns also hinder the adoption of RE (Sharma & Aiyejina, 2010).

A study by Trianni and Cagno (2012) shows that lack of capital was the major barrier of EE adoption followed by the lack of information regarding EE. By 2013, ECLAC (2014) found the barrier of EE implementation in Latin America and the Caribbean countries were lack of promotion of EE in the institution or organization which influences insufficient knowledge on EE. Indar (2019) has a similar argument with ECLAC (2014) that, in the case of Trinidad and Tobago, the barrier of EE was mainly due to the high subsidy of oil, gas, and electricity. Moreover, lack of regulatory framework and inconsistent energy policy are also inhibiting the adoption of RE in Tobago and Trinidad (McGuire, 2016). He also found that education to EE which influences awareness could be the barriers of RE implementation.

A study of Boretta and Al-Zubaidy (2019) in Germany and Sweden has proven that lack of financial support and capital to EE was the most relevant barrier to EE effort. It supports Lawrence et al. (2018). However, a study by Rohdin and Thollander (2006) shows that that lack of capital was in the ninth rank of EE barriers. At that time, manufacturing industries in Sweden tend to put the high priority on the cost of productions in comparison to EE issues.

McGuire (2016) proposes four barriers to RE implementation in the Caribbean region. They are regulatory frameworks and policies, informal institutions, lack of knowledge and awareness and the high dependency on the use of fossil fuel, costs and financing of RE, and market barriers.

However, his study found that policies barriers were not more affect to the implementation of RE than financial barriers. In the meantime, Rambarath-Parasram et al. (2018) found that lack of legal and institutional framework, lack of market-based measures, lack of existing technology, insufficient technology transfer, high cost of initial installation of RE are the barriers of RE implementation. There are current challenges that reduce the success of EE strategies such as subsidized energy/electricity prices, low levels of public awareness, lack of EE policy and legal frameworks, lack of finance mechanisms and financial support, and a regulatory framework to allow for access to incentives (Cazaubon, 2019).

To support the thrust into EE, Johansson and Thollander (2018) propose that reduced energy utilization or enhanced EE can have an impact on profitability even for companies with low energy costs. They explain that reduced energy costs directly lead to increased profits and should be embraced by all organizations. Financial incentive to support EE and provide an environment that enables uptake of EE measures (Rambarath-Parasram et al., 2018). Meanwhile, a strategy to boost the industry's use of RE through energy and environmental pollution auditing and the use of more efficient steam technology is being developed.

3. Methodology

This study addresses the company perspectives on RE and EE in Tobago and Trinidad. A mixed method was adopted for this study since we used mixed data of qualitative and quantitative (Johnson et al., 2007). A quantitative approach was deemed appropriate for this study since Firestone (1987) reveals that quantitative study helps convince the reader by deemphasizing individual judgments and emphasizes the use of established procedures leading to results that can be generalizable to populations. The sample size and random sampling method were used to select companies from the Trinidad and Tobago Manufacturers Association to generate a sampling quota of 50 companies to participate in the survey. Meanwhile, the qualitative approach in the form of an interview was implemented to explain the data in more detail.

Data was taken by secondary and primary research processes. The secondary research was undertaken to construct a snapshot of the macro-environmental landscape on the RE services in Trinidad and Tobago. It also aimed to inform the development of a survey instrument for the primary research process. The sources of secondary research materials included research articles from peer-reviewed journals, industry and technical reports, and public sector publications. The secondary research process also spanned across themes such as the global energy market, the RE eco-system in the Caribbean, barriers to RE system implementation, strategies to incorporate RE systems, and a situational analysis of the RE landscape in Trinidad and Tobago.

In terms of the research design, for the primary aspect, a survey comprises of 25 closed-ended questions. The survey was constructed to capture relevant information such as the profile of the company, a situational or gap analysis of the level of energy usage by companies, the proportion of energy cost relative to other production costs, the level to which companies monitor their energy usage, the desire of companies to reduce their operating cost by improving energy management practices, barriers to investing in EE strategies, measures undertaken by companies to improve EE usage, and action taken by companies to reduce their carbon footprint.

In terms of developing the company profile, participants were asked to indicate their sector of operations, year of establishment, number of employees, and export levels. Regarding situational analysis of energy use, participants were asked to consider if their operations were energy intensive, their strategies for monitoring energy usage, their inclination towards the outsourcing of energy management services, and budget considerations for energy management services. The questionnaire also sought to identify the demand for sustainable energy services and whether the companies would be willing to engage and participate in energy services with different platforms at selected price points. Finally, participants were asked to indicate the most appropriate marketing or communication channels to disseminate information about energy

management services and were also asked to indicate their level of knowledge on energy management incentives at the public sector level.

An interview schedule was made by contacting via direct phone call and follow-up e-mails with the selected companies. Upon confirmation of interest and agreement of participation, these interviews were conducted on-site at the companies with the Manager who consented to serve as the representative. In most cases, these Managers were either the Operations, Marketing, or Project Managers. The interviews took an average of one hour. The data received from the survey process was archived into Microsoft Excel to assist with the computation and analysis. The data was checked twice to ensure accuracy in inputs. The use of Microsoft Excel was considered as appropriate for the study since according to Neyeloff et al. (2012), it is possible to analyze data directly using Excel and it is usually factory installed and available in most hardware devices such as desktops and laptops where it is bundled with the standard Microsoft Office package.

4. Results

4.1. Data analysis

There were 50 companies that participated in the survey with 60% being involved in the manufacturing industry and 40% from the service industry. A breakdown of the sub-sectors of the manufacturing industry that participated in the survey is represented in Figure 1(a). Those seven sectors represented an appropriate cross-section of sectors of overall business activity in Trinidad and Tobago. Meanwhile, the sub-sector breakdown of services companies that participated in the survey is represented in Figure 1(b).

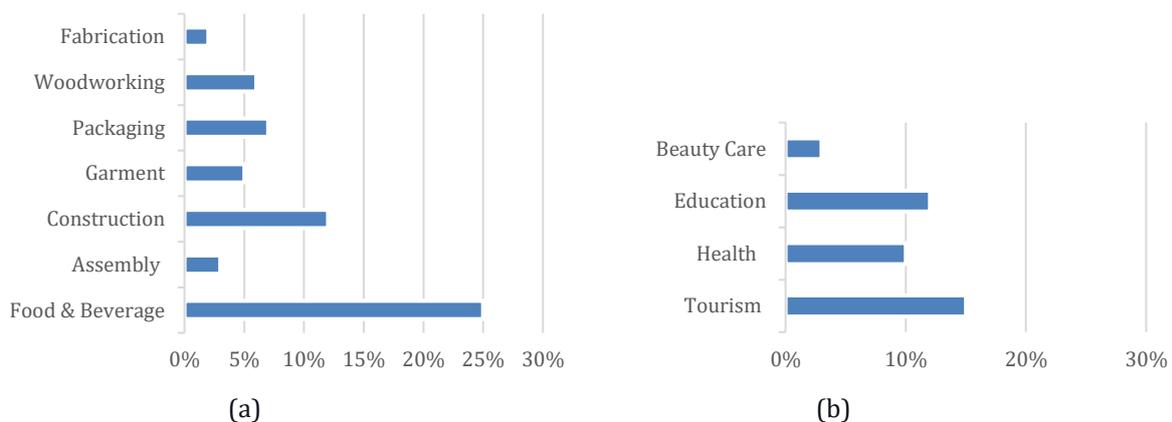


Figure 1. Company profile (a) manufacturing sub-sector and (b) service sub-sector

The companies had been in operation for an average of twenty years and the years of operations are illustrated in Table 1. Most of the company has 25-250 members. In addition, 80% of the companies confirmed that their operational times were oriented on an 8-12-hour shift. This study also found that a quarter of the companies surveyed indicated that they are currently exporting their products to the regional Caribbean Markets, The United States of America, and Canada. No companies were exporting to Latin America, the European Union, the United Kingdom, or Asia.

One of the questions sought to determine how the companies viewed their current energy consumption cost. The results are presented in Table 2. It was revealed that 85% indicated that their current levels were high and expressed an interest in reducing their overall energy cost. This is a positive viewpoint when it comes to introducing energy management services to businesses. It was suggested that developing cost-based incentives can attract take up. It was noted that 15%

expressed the view that their current energy cost was moderate, while the remaining 5% revealed that it was low.

Table 1. Company profile

Percentage		Percentage	
Number of staff		Operational time	
Less than 25 members	35%	Less than 8 hours	15 %
25-250 members	40%	8 – 12 hours	80%
More than 250 members	25%	More than 12 hours	5%
Operational time		Years in operating	
Less than 8 hours	15 %	< 10 years	0%
8 – 12 hours	80%	10-20 years	24%
More than 12 hours	5%	21-40 years	47%
		41-60 years	24%
		> 60 years	2%

Table 2. Company behavior in EE

Percentage (%)		Percentage (%)	
Perception on energy cost		Energy usage monitoring activities	
High	85	Yes	75
Moderate	15	No	25
Low	5		
Energy monitoring for reducing cost/carbon footprint		Favour of reducing cost	
Yes	10	Yes	95
No	90	No	5

A high percentage (75%) of the companies surveyed monitor their energy (electricity/natural gas) usage monthly. In all cases, this monitoring is done in-house and mainly via the bills received from the service provider. The monitoring process for most of these companies is done with the main objective of ensuring that there is no major increase in operations costs. About 25% of the companies revealed that they did not monitor their consumption of energy either because they are charged a fixed amount by the Trinidad and Tobago Electricity Commission regardless of the number of kilowatts utilized or because of the expense is not a significant part of their overall operating cost. Only one company in the sample had a specific software for measuring electricity usage, cost, and carbon footprint in real-time daily which points to the need for increased utilization or leveraging of technologies to assist in energy management systems.

The monitoring process for most of these companies is done with the main objective of ensuring that there is no major increase in operations costs. However, only 10 % of the companies examine this information to reduce cost and carbon footprint. The remaining 90% viewed it as a pure and standard operating procedure and was not based on any strategic energy management policy.

Ninety five percent of the companies surveyed would welcome any measure to reduce their energy cost as long as the benefit outweighs the cost to implement the measure. Just 5% of the companies showed no interest in reducing their energy costs. They indicated that their energy cost was already low or they were paying a fixed sum to T&TEC and will not benefit from greater efficiency methods.

Additionally, 95% of those companies who were interested in measures to reduce their energy cost after a positive cost-benefit analysis were asked what factors in order of priority will determine their decision to implement energy management practices. For this aspect, a weighting system was utilized to score the different factors and determine an order of priority. The weighting system allocated eight points to a factor stated as 1st priority by a respondent followed by six points for 2nd priority, four points for 3rd priority, and two points for 4th priority. Price received a score of 232 points (38% of the total points) and was the number-one factor in determining whether a company will implement improved energy management practices. The second factor was the reputation of the service provider followed by government incentives. This is illustrated in Figure 2.

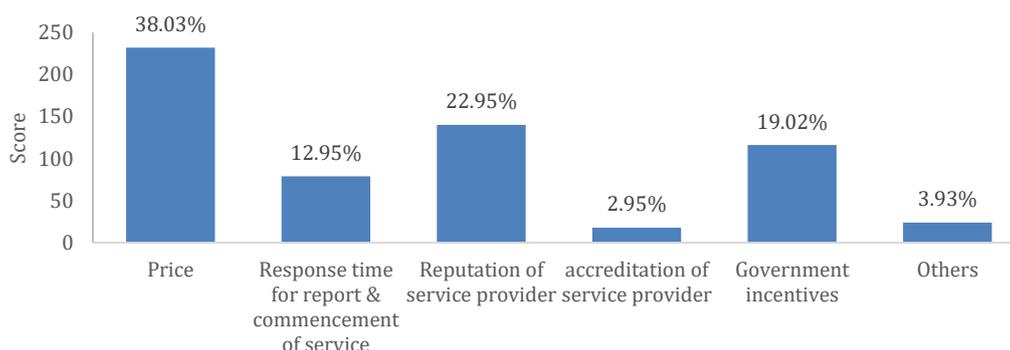


Figure 2. The factor's score of the decision to implement energy management

In terms of the ratio between energy cost and production cost, 65% of the companies surveyed indicated that their energy cost is less than 25% of their total production cost (see Figure 3). Most of these companies stated that the cost of energy in Trinidad and Tobago is comparatively low and this is something that they do not think would change soon. Furthermore, 20% of the companies stated that their energy cost is between 25% to 50%. 15% did not know or were not sure of the amount. This suggests the low significance or priority that is placed on the analysis and management of overall energy costs at the strategic level. In addition, it also represents a low level of energy consumption awareness and willingness to explore an energy management system and EE strategies. As a soft sell into this process, complementary energy surveys or workshops can be undertaken to highlight the importance of monitoring the energy spend to increase efficiency.

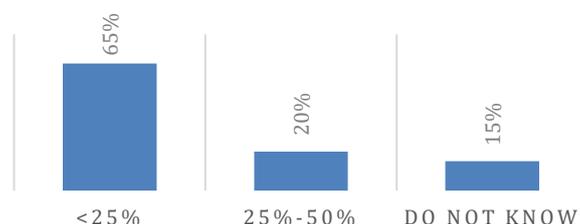


Figure 3. Ratio of energy cost to production cost

Concerning which activity consumed the most of their energy the survey 75% of the companies indicated that the use of machinery and equipment is the major component of their energy cost. This is to be expected given that 60% of those surveyed were involved in the manufacturing industry. Air conditioning is the second major user of energy with 50% of the companies indicating that this activity utilizes much electricity. Also, 40% of the companies identified Lighting as a major user of electricity and 35% of the companies stated that

refrigeration was a major user of electricity. Companies also indicated that 20% of their energy cost was used for other purposes. This information is illustrated in Figure 4.

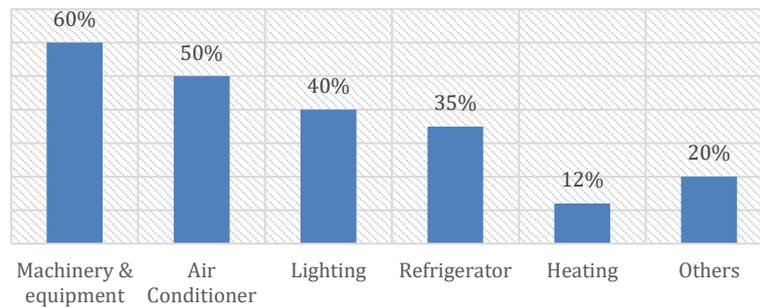


Figure 4. Energy consumption

This information is useful in providing insights related to energy activity factors and the configuration of a service and program menu for EE and can form the basis of developing possible EE audits for companies.

As a result, even if overall energy prices are low and competitive, companies are still interested in lowering these expenses as long as the financial investment to do so is not at a high level. Strategies developed to persuade companies to invest in energy management services should therefore incorporate some level of a cost-benefit analysis to map EE costs versus the implementation of energy-efficient measures. Furthermore, the linkages between increasing EE and overall profits should be highlighted.

Participants were asked to indicate what factors they would consider before decided to implement a formal energy management system. The price or cost to implement was the number one factor at 45 % followed by the provision of government incentives 16% and timeframe/logistics of designing and implementing such a system within their company operations at 17%.

Another factor included changes in National Energy Legislation and Regulation or changes in current energy costs at 12%. A minority of the companies (10%) cited a desire to be viewed as more environmentally friendly or “green” would act as a trigger to invest in energy management. Most of the companies stated that Trinidad and Tobago has one of the lowest rates for electricity internationally and as long these rates remain low the net benefit to be derived from investing in alternative sources of energy may not be adequate to encourage them to make the required capital investment. Once again, the low price of energy costs mitigates against companies seeking to improve energy usage and consumption. This is illustrated in Figure 5.

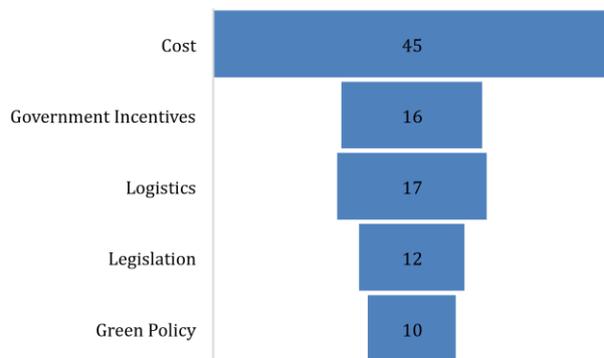


Figure 5. Factors companies consider for the implementation of energy management systems

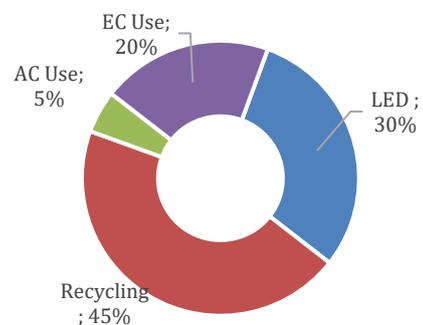


Figure 6. Energy usage improvement strategies

As a follow-up companies were asked if on their own initiative, they decided to undertake any energy usage improvements. 30% responded in the positive while the rest indicated they had not yet started any such strategies or systems. A description of the energy usage revealed that they focused on the conversion of lightening to light-emitting diode (LED) systems (30%), recycling papers and other resources where possible (45%), having increased monitoring concerning air conditioning (5%) and overall electrical use (20%). This is illustrated in Figure 6. A matrix of detailed strategies utilized by selected companies is displayed in Table 3 in Appendix.

On the issue of recycling, 62.5% of the companies recycled part of their waste consistently and 22.5% of the companies recycled part of their waste on an inconsistent basis. 15% of the companies did not undertake any recycling for some reason. First, all of the companies that did not recycle indicated that there was no financial incentive to recycle. Second, the high cost involved in recycling was stated as the 2nd most important reason. Third, local recycling facilities are set up in inconvenient areas. The last, sorting the different types of rubbish is time-consuming. A matrix describing specific recycling initiatives undertaken by selected companies is provided in Table 4 in Appendix.

The companies were also asked about their perspective to utilizing guidelines that provide environmental benefits and target better EE such as the ISO 50001 and ISO 14001 Standards. It was revealed that only two companies in the Food and Beverage sector are ISO 14001 certified. None of the other companies surveyed had ISO 50001 or ISO 14001 certifications but another Food & Beverage company and a Printing and Packaging Company indicated that they are ISO 14001 compliant. 83% of the companies surveyed indicated that their organization would embrace guidelines providing environmental benefits and target better EE such as the ISO 50001 and ISO 14001 standards. One of these companies, operating in the Food and Beverage sector indicated that it is currently working towards compliance with ISO 14001 Environmental Management System. 10% of the companies surveyed indicated that they were currently more interested in focusing on standards related to customers' requirements such as ISO 9001 and HACCP. However, one company in this category, which does Printing and Packaging stated that the company has developed its own internal environmental best practices and does not necessarily adhere to ISO standards. 7% of the companies did not show much interest in ISO 50001 or ISO14001 because they felt that the cost of implementing such standards would far exceed the benefits to be derived.

Companies were asked to indicate potential barriers to investment in EE and 60% stated that the Priority of Funds could be a major barrier to investment in greater EE. This means that companies will consider the various urgent/important uses for funding and will then make a decision about investing in EE. Lack of a clear-cut financial case for EE investments as a barrier to investing in greater EE was also mentioned by 55% of the companies surveyed. From the survey, 45% of the companies further suggested that a barrier to investing in EE is a lack of information about EE options. Finally, 20% cited insufficient commitment by Executive Management as another potential barrier. This is represented in Figure 7.

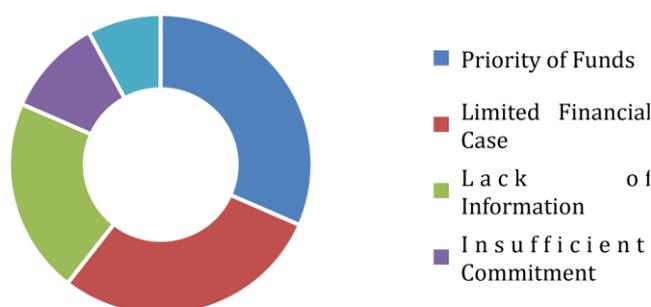


Figure 7. Barriers to investment in EE systems

On the issue of greenhouse gas emissions, 60% of those surveyed state that they were aware of activities that emitted greenhouse gas emissions. The main activities identified by companies for emitting greenhouse gas are extraction, processing, production, transportation (usually a fleet of diesel trucks), air conditioning, heating, refrigeration, use of backup generators, and consumption of purchased electricity. However, a substantial percentage (40%) did not know which of their activities emitted greenhouse gas and needed to be educated about this area so that energy conservation decisions can be made. Indeed, only 5% of companies indicated that they took the step to formally measure the level of greenhouse gas emissions. This represents a significant opportunity gap to introduce these energy management metrics in company operations.

Forty five percent of the companies expressed an interest in having their greenhouse gas emissions measured. However, the rest of the sample declined due to minimal emissions levels, the need for government incentives to offset any cost associated and being assessed as a low priority issue.

A total of 65% sampled indicated that they would be interested in a complementary energy review of their operations as a first step in dealing with the issue of energy management. The rest of the respondents suggested that they had no interest in doing any interventions or improvements in energy management.

A total of 60% suggested that they would also be interested in participating in workshops geared towards energy management orientation, sustainable energy training as well as increasing knowledge concerning greenhouse gas emissions. This represents a good channel to open the pathway for energy management. Other requests for specific services included the following. First, an information session on government incentives and how to access them (88% of companies surveyed). Second, complementary energy review (75% of companies surveyed). Third, support to develop a budget for EE management services (58% of companies surveyed), Fourth, training session on measurement of energy systems management (70% of companies surveyed).

Respondents were also asked to indicate where they receive and interpret information for energy management and 65% of the companies surveyed revealed that the Internet is their main source for information on sustainable energy followed by 25 % suggesting newspapers while the last 10% revealed other sources such as seminars, networks, and conferences.

With the majority of information being sourced from the Internet, this puts a question on the reliability, validity, and integrity of the knowledge being received by companies that are guiding them to make their energy management decisions. There is a need to design and create more robust communication channels to impart strategic information about energy management services.

As a follow-up question, only 35% of companies were aware of government services available for companies wishing to convert to green energy and technology and to implement energy management programs. This indicates an educational and information gap to incentives and corporate advantages that can be gained by accessing public sector support for energy management services. Finally, most of the companies (70%) indicated that they do not perceive renewable energies being deployed in a logistically and efficiently in their business enterprises in the near future.

4.2. Discussion

Trinidad and Tobago have implemented fiscal incentives for supporting RE implementation such as tax credit, tax reduction, an exemption, as well as was developing feed-in tariff (McGuire, 2016). Guerra (2016) found that Trinidad and Tobago was the country with the highest effort to implement EE. However, it must be noted that there are various barriers that do not incentivize the implementation of Energy Efficient measures and technologies; one of these is the existing low tariffs for electricity. Due to the subsidized rates for local gas consumption, electricity

customers in Trinidad and Tobago enjoy very low tariffs in comparison to other countries in the region, with prices seven times lower than the Caribbean average. Negative consequences of these low tariffs include potential discouragement of supply-side and demand-side efficiency improvements, the promotion of non-economic consumption of energy, and fossil fuel energy subsidies hinder the development of RE technologies by making them economically uncompetitive. This is supported by the research undertaken in which the majority of companies while having some level of interest in EE and management have not elevated this at the strategic level of the company's decision-making process. Thus, the educational and financial campaigns to soft sell the benefits of executing such systems supported by a robust cost-benefit analysis is required.

From a policy perspective, to increase demand for EE services in the country, electricity tariffs need to be increased. Other policy recommendations that could have a major impact on EE demand include the enactment of an Energy Efficiency Law, as well as demand-side-management programs, a market ban of inefficient consumer products, such as incandescent light bulbs, the development of minimum efficiency standards and labeling programs, as well as the introduction of energy-related building standards, including the mandatory use of solar water heaters at least in specific cases. It is also recommended to expand the infrastructure in a way that SMEs can benefit from a direct supply of natural gas and to install smart meters.

An interesting aspect of the research revealed that there are opportunities for collaboration with companies to allow for cross fertilization of competencies in the sustainable energy services sector. Two reputable companies in the survey, are actively involved in selling energy-efficient products to industries in this country and other Caribbean islands. They are often required to undertake EE audits/reviews as part of their marketing process, but this is not one of their core services.

Another company involved in construction has trained staff members externally to review energy consumption (EE10) and expressed a desire to collaborate with other companies on projects. Another company in the Food & Beverage sector also expressed a desire to partner with other companies to participate in seminars and offer energy reviews since they have the in-house expertise in energy audits/reviews and configuration of LED systems.

Furthermore, a Printing and Packaging Company and an Educational Services Provider proposed that since they have undertaken much technology research and in-house organizational improvements, they would be willing to share this information with other firms. These fledging opportunities represent a start/hope on the journey of the implementation of EE systems in the business enterprise eco-system of Trinidad and Tobago.

4.3. Recommendation

The research has revealed that there is potential for companies to explore RE and EEs. However, this issue is on the back burner of the strategic thinking and orientation of most firms but there needs to be a holistic approach to drive positive changes in this direction. There is also the issue of cost drivers which is a significant factor in the decision-making process in terms of trying to transition into energy management strategies even though a reduction in overall energy costs yields the advantage at a higher profit level. The approach would have to involve diverse stakeholders at different angles to develop scenarios or suggested frameworks by which financial or moral persuasion can be used as leverage to spark an interest in follow-up action concerning renewable energies and EEs. Several recommendations arising from the research are as follows.

First of all, a research study should be commissioned to conduct a market assessment on the viability of establishing an energy services support mechanism for companies working in the public, commercial, small and large industrial business enterprise sectors in Trinidad and Tobago. The main objective of this study should be to identify the number and size of potential clients in each sector, identify the top EE measures and estimated costs in each sector and conduct an

economic and technical analysis to develop cost-effective energy management plans. This study can also generate insights into the implementation process of introducing energy systems supported by the encouragement of a vibrant organizational energy culture.

Second, there should be a national RE and EEs campaign to raise awareness of these issues. It should also highlight the incentives that are currently in place to encourage progress in these areas. This would increase the knowledge base of companies about incentives available and encourage them to adopt energy-saving initiatives. Such incentives related to solar energy adopted by the Government of Trinidad and Tobago include import duty reduction to 0% on regional imports of solar water heaters (SWHs) 0% VAT rating on SWHs, 25% tax allowance on the value of SWHs up to a maximum of \$10,000. A 150% wear and tear allowance on the cost of SWHs and 150% wear and tear allowance on plant, machinery, and equipment used to manufacture SWHs and solar photovoltaics (SPVs). The government has also adopted energy-efficient incentives such as 150% tax allowance on the cost of undergoing energy audits and the design and installation of energy-saving systems, accelerated depreciation of 75% on acquisition of smart energy-efficient systems, and 25% wear and tear allowance on plant, machinery and equipment procurement. The government can also conduct further research into the creation of other incentive programs that involve other sources of renewable energies and the process of utilization of technologies to promote EEs. Other components of the educational awareness campaign can include a national customer energy awareness and education program which incorporates end-use statistics on EE awareness and will seek to change current cultural attitudes towards energy utilization. The dissemination of this information along credible channels can increase the validity and advantages of EE and will support uptake in this area.

Third, most companies revealed that they would be interested in complementary energy reviews and sensitization sessions as a first step in exploring or changing their current energy management systems. To encourage this, a collaboration can be made with the public sector Ministry of Energy and Energy Services of Trinidad and Tobago and the Chamber of Energy to host these proposed energy reviews and sensitization sessions every quarter to entice companies to take the first step to implement energy management systems and EEs to shape an EE culture.

Forth, training packages, materials, and resources can be designed and developed as a one-stop toolkit for companies who are desirous of making changes to their energy management systems. These training packages can be a soft sell to encourage companies to take a step in this direction. The training materials can be subsidized since the cost is an overriding factor when it comes to decisions of this nature and if the companies seek to progress further, they can outsource technical expertise for support.

Fifth, there can be financing instruments for companies that are willing to invest in RE because while green energy technologies are becoming more accessible it is not always feasible or easy for organizations to take advantage of them. There may be barriers such as a lack of understanding of the financial and risk implications of various energy purchasing options since this would be a new suite of decisions for them. In addition, since the companies are operating from a cost-sensitive position, the added cushion of access to financial resources for this purpose can spur interest and action in this area.

Last but not least, there can be an educational campaign to promote the intangible benefits of RE adoption in companies. Since current low energy costs act as a disincentive other advantages of RE can be disseminated to pivot business enterprise attitudes. Such benefits include reputational goodwill as a corporate green citizen and increased levels of employee harmonization and company aesthetics.

5. Conclusion

The research has revealed that on an international scale, the issue of incorporating RE and having a strategic orientation towards EE is consistently playing an increased role in business

enterprise operations. However, the Caribbean regions appear to be falling behind on this pathway notwithstanding the availability of varied RE resources. The perspectives of companies operating in Trinidad and Tobago reflect this position primarily because the current low energy costs have acted as an internal barrier for businesses to explore the adoption of RE and energy management systems in their operations. Nonetheless, there is a kernel of interest to be exploited via public and private sector collaborations in the spheres of research and market development, education, creating of energy training resources, and a financing mechanism.

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Table 3. Strategy for improving EE

Company by sector	Measures undertaken to improve EE usage or energy efficient processes
Companies which made improvements	
Assembly	<p>Turn off lights (EE01-1) at the end of the workday; Turn off air conditioner (EE02-1) at the end of the workday; Changed from paper towels in the bathrooms to a low energy hand dryer (EE03)</p> <p>Practice EE01-1 when not in use; Air conditioner units have an energy-saving system (NEST thermostats) (EE02-2); Insulation of building (EE04); Contemplating using an application to identify most effective routes for distribution trucks (EE05); Considered Compressed Natural Gas (CNG) (EE06) for their distribution trucks but the limited number of filling stations is a deterrent; Contemplating adapting ISO 9001 standard (EE07-1).</p> <p>Implement EE01-1 and EE02-1 at 5:00 p.m. except for security lights; Use LEDs for lighting (EE01-2); Use efficient production methods that require less machinery and manpower (EE08).</p> <p>Implement EE01-1; EE02-2; Installed air conditioner sensors to cut off units (EE02-3) at 6:00 p.m.; Presently moving from physical servers to cloud-based servers (EE09); Certain staff members were trained externally to review energy consumption and they have subsequently trained in-house staff (EE10).</p> <p>Implement EE01-2; install only energy-saving lights (EE01-3), implement EE02-2 and EE02-3; install energy-efficient (possibly solar-powered) water pumps (EE11-1); consider energy-star-rated pumps (EE11-2); Man-made trees that absorb carbon dioxide (EE12) are also being considered.</p>
Construction	Installed EE01-2 and EE02-2.
Education	Implement EE02-2, EE01-1, and EE02-1 are not in use; The campus shuts down at 10:00 p.m. and is no longer open for 24 hours (EE13).
Fabrication	<p>Implement EE01-2</p> <p>Implement EE01-2; Conducted energy audit on one building as a pilot project (EE14); LED flood-lighting in the yard (EE15); Plan to implement EE02-3 and installed soft start controls on manufacturing equipment and contemplating water recycling (EE16); Currently tendering for a wind farm project in Antigua (EE17-1).</p>
Food & Beverage Manufacturer	<p>Upgraded to EE08; Improved equipment start-up (EE18); General improvement in human practices for EE (EE19); Built water wells to facilitate production process (EE20); Adhering to EMA regulations (EE21).</p> <p>Implement EE01-1 and EE02-1; Contemplating EE01-2 but the cost is high versus the benefits; Recently purchased hybrid vehicles for management (EE22-1). Plan to convert shuttle bus to CNG (EE22-2) but the challenge is the limited number of filling stations;</p> <p>Gradually replacing halogen and fluorescent bulbs (EE01-2)</p> <p>Developed a culture of EE01-1 when not in use; implementing EE02-2 and EE02-3</p> <p>Records and monitors electricity, natural gas, and water use monthly (EE23); Examines energy lines and connections for leakages and efficiency (EE24); Currently liaising with Energy Dynamics Ltd. to undertake EE14;</p> <p>Implement EE04</p> <p>Implement EE01-2. There are plans to reduce energy costs by undertaking a holistic EE14.</p> <p>Implement EE01-2; The company has the capacity to install SPV cells on the roof (EE17-2) but wants Government incentives especially allowing excess energy to be fed into T&TEC Grid for a fee; Implement EE06.</p> <p>Practice EE01-1 when not in use; Gradually implementing EE01-2; Programming of EE02-2 to reduce energy consumption.</p> <p>Implementing EE02-3</p> <p>Gradually converting EE01-2; Implementing EE02-3.</p>

Table 3. Strategy for improving EE (Ctd)

Company by sector	Measures undertaken to improve EE usage or energy efficient processes
Companies which made improvements	
Printing & Packaging	Use energy-efficient motors (EE08) and already conducted research in lean procedures; Adopted automated processes which have resulted in greater EE (EE25); Approached by three companies for undertaking EE14 but no proposal was submitted; Working towards promoting green manufacturing. (EE26)
	Gradually implement EE01-2; Considered using solar energy EE17-2; Considering EE26
	Researching EE17-2 and hydrogen cells (EE17-3). Implement EE01-2; Researching solar water heaters (EE17-4). These are high-cost investments and Government incentives are needed such as allowing excess energy to be fed into T&TEC's Grid for a fee.
Supermarket	Introducing EE01-2 in the supermarkets.
Tourism	Invested and installed a monitoring software that provides real-time information (EE27). Installed devices on all equipment that use large amounts of electricity to reduce the amount of time they cycle on and off (every time they restart high amounts of electricity are consumed (EE28). Gradually use EE01-2.
Woodworking	Radiant barriers have been installed as a form of EE04 to reduce energy costs.
Tourism	Implement EE01-2
Companies which made no improvements	
Beauty Care	Considering EE01-2 and making the batching system more efficient (EE29); The company has an upcoming project to eliminate electricity wastage (EE30); Experimenting with biodiesel (EE31) and also interested in hempcrete and different uses of hemp (EE32).
Food & Beverage	Th electricity cost is comparatively low and not a problem but reliability of supply is sometimes a problem; the company would have liked to use natural gas for its boilers (EE33) and although the supply is on the estate the cost for connection is high.
	The company is receptive to improving EE if it can be shown that benefits exceed costs. It will not reduce the bill which is a flat sum.
Garment	No improvements undertaken.
Health & Wellness	Nothing notable but considering the installation of solar lights (EE01-4). Government incentives will encourage investment in this area. Advice is needed on converting its fleet of diesel trucks to CNG.
	Nothing notable. Government incentives will encourage investment in this area.
Tourism	No improvements undertaken; contemplating using energy-efficient lights and solar panels (EE17-2).
Woodworking	The company is charged a flat sum per month of \$8,000 and indicated that there are no incentives to implement EE measures (as this will not reduce their bill). Incentives are needed for improving EE. The company pays a flat monthly sum as stipulated by T&TEC but based on calculations the company does not utilize that amount of electricity. Requests were made in writing for T&TEC to reduce the monthly amount. The previous bill was \$16,000 to \$20,000 per month and it has been reduced to \$11,000 to \$14,000 per month which is still substantially higher than the actual kilowatts utilized.

Table 4. Recycling initiative by the company

Company by Sector	Types of waste being recycled
Companies which made improvements	
Food & Beverage	Paper is recycled (R01-1), glass is recycled (R02-1), plastic is recycled (R03-1), batteries is recycled (R04), and motor oil.
Beauty care	R01-1 and electrical items are recycled.
	R01-1 and R03 but on an ad-hoc basis.
Construction	R03-1; wastewater either goes into the drains or the company's wells; the water from the well is used for cleaning equipment and housekeeping (not used in production due to quality requirements); old glass products are crushed and used in making concrete and old concrete is crushed and either used to make new concrete or sold to persons for backfilling or paving roads (R02-2)
	R01-1, aluminum, and electrical items. Different methods are being considered to reduce the pollution level such as by planting trees on the compound and the budget for this project is

	<p>\$100,000. Scrap cable is exported to China and scrap copper is exported to India; Other electrical waste is disposed via a local service provider.</p> <p>R01-1; scrap metal sheets sold to scrap merchants</p> <p>Waste paper is collected by ACE Recycling company (R01-2); packing material from containers and motor oil is recycled via other external companies.</p> <p>R03-1 and water and used from refrigeration systems for washing vehicles.</p> <p>Large paint drums are given to individuals, the solvent residue is given to Recycling.</p>
Education	R01-1, R02-1, aluminum, and R03-1
Fabrication	<p>R01-1, aluminum, R03-1, R04; old vehicle oil; tires and fluorescent bulbs are recycled.</p> <p>R01-1; glass old oil (R02-2)</p> <p>Broken concrete blocks are reused to manufacture new blocks.</p> <p>R03-1, the company is close to zero waste. There is a minimal amount of waste from the insulation process and this waste is disposed of via SWMCOL at the Forrest Park Landfill.</p>
Food & Beverage	<p>There is an ICARE in on the compound for collecting plastic (R03-2)</p> <p>R01-1; R02-1 and scrap metal</p> <p>Waste from fish processing is sometimes given to companies making fish meal</p> <p>R01-1; corn dust from production is recycled in the production process</p> <p>R01-1; damaged products (snacks) that can be recycled in the production process without causing contamination.</p> <p>Recycle the waste from the processing of chickens to make animal feed</p> <p>Fish waste is given to Central Farms for conversion to duck feed; cardboard boxes are given Recycling; contemplating recycling water through a filtration process.</p> <p>R02-1; R03-1 and cardboard are currently recycled. There is a plan for the company to recycle water from production to cooling the towers</p> <p>R01-1, lighting tubes, R02-1, and waste cooking oil are sold for recycling. Contemplating establishing a plastic recycling facility and exporting the plastic chips.</p> <p>R01-1; biochar is used as a fertilizer and contemplating manufacturing ink from Rocco.</p> <p>R01-1; incentives are needed for further recycling.</p> <p>Vegetable waste and starch are recovered and reused.</p>
Garment	R01-1
Hotel	R01-1, R02-1, R03-1, and used oil
Printing & Packaging	<p>R01-1, solvents, and other chemicals are recycled; Imported a recycling machine for recycling solvents; the ultimate goal is for zero waste, and only waste at present is cardboard from packaging. Conducting research for E-waste recycling.</p> <p>R01-1; hot air recirculation and water recycled into own wells; used recycled paper (R01-3) that is purchased from local recycling firms.</p> <p>Waste from inks and other chemicals is removed and recycled. The formation of an in-house waste management team is being considered.</p> <p>R01-1 and R03-1. There is a small in-house operation where water is recycled in the plastic manufacturing process via a cooling trough. Mostly biodegradable raw materials (except straws) are utilized in production.</p>

Table 4. Recycling initiative by the company (Ctd)

Company By Sector	Types of waste being recycled
Woodworking	<p>R01; wood waste (sawdust & shaving sold to farmers); currently generates about 50 gallons every two months of chemical waste from lacquers, thinners, and wood stains which are stored in drums. Need to find a recycling company for disposing of this waste.</p> <p>Sawdust is sold to farmers for bedding for animals, plastic is shredded and sent to Ace Recycling Company and old batteries are sold to an individual who passes and collects the batteries.</p>
Education	<p>No recycling is done; all waste is dumped in a compactor and removed by the Solid Waste Disposal Company.</p> <p>No recycling undertaken</p>
Food & Beverage	<p>No recycling undertaken</p> <p>No recycling undertaken</p>
Tourism	<p>No recycling undertaken</p> <p>No recycling is undertaken. Financial incentives are needed for encouraging recycling.</p>