Current Barriers to Renewable Energy Development In Trinidad and Tobago

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ABSTRACT

The Republic of Trinidad and Tobago is a two island country located in the southernmost part of the Caribbean, just 11 km off the coast of Venezuela. The economy is essentially hydrocarbon based with the energy industry contributing approximately 45% of the country's gross domestic product (GDP). However, this tropical country faces a number of challenges. These include suppressed oil and natural gas prices, falling hydrocarbon production, and gas curtailment in its petrochemical sector. The latest Ryder Scott hydrocarbon audit indicated that the country has proven natural gas reserves to last to only 2019. It is imperative that the country diversifies its economy including its power sector. This article discusses the primary barriers to renewable energy (RE) development and implementation in Trinidad and Tobago. It also identifies the hurdles the country must overcome in order to formulate a sustainable strategy to deal with these problems in the context of renewable energy, energy efficiency and greenhouse gas emissions reductions.

INTRODUCTION

Trinidad and Tobago (T&T) has the second highest gross domestic per capita income in its region [1]. The country's economy is driven by its energy sector which includes activities from crude oil production, natural gas production, liquefied natural gas production, asphalt production, petrochemicals, compressed natural gas and electric power [1]. The energy sector of Trinidad and Tobago is the largest and important contributor to the country's government revenues, foreign exchange and gross domestic product (GDP) [2]. Figure 1 shows the contribu-

tion of the energy sector to Trinidad and Tobago's economy in 2012. It accounts for approximately 45% of GDP, 50% of total revenues, 80% of exports but just 1% of employment [3].

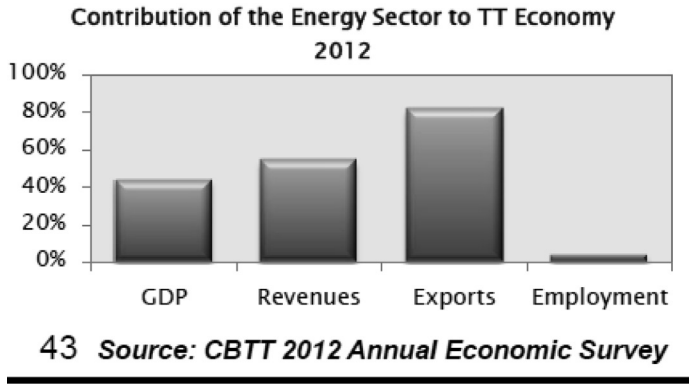

Figure 1. Energy sector contribution to Trinidad and Tobago's economy in 2012 [3].

Trinidad and Tobago has a rich history in oil production traversing some 100 years. Its economy has evolved from an oil-based to a natural gas-based economy. This has fueled its development and is responsible for T&T having one of the highest growth rates in Latin America. Other island nations in the region have pursued renewable energy as a means of meeting their energy demands and easing the burden of high petroleum imports. These countries have higher electricity rates, higher fuel prices and higher costs for imported oil and gas.

However, Trinidad and Tobago is a net exporter of petroleum products and enjoys low electricity rates and low fuel subsidies. Thus, Trinidad and Tobago has lacked the economic motivation to introduce and develop RE technologies.

The main barriers to RE development and implementation in Trinidad and Tobago are noted in Table 1. Afterwards suitable strategies are recommended to overcome these barriers.

DRIVERS FOR DEVELOPING RENEWABLE ENERGY

There are many reasons for Trinidad and Tobago to adopt RE technologies into its energy mix. Some of the drivers [4] for encouraging RE in T&T are:

- To provide energy security.
- T&T is rich in underutilized natural resources (solar, wave, tidal, geothermal).
- To mitigate impacts of climate change.
- Access to a reliable source of energy.
- To generate employment.
- Economic diversification and improving energy alternatives.
- National and industrial development.
- Reduced dependence on finite fossil fuels for energy.
- Conservation of petroleum resources.

BARRIERS TO RENEWABLE ENERGY INVESTMENTS

Though there are many advantages for including RE in T&T's energy matrix, the introduction and development of RE technologies has been lacking due to numerous barriers. Barriers affecting RE development in T&T include:

Table 1. Primary barriers to RE development in Trinidad and Tobago.

Type of Barrier	Description
Institutional	Limitations (research and development), demonstration and implementation.
Market	Small size of market, limited access to markets, limited involvement of private sector.
Awareness/Information	Lack of awareness, lack of access to information on RE and energy efficiency (EE).
Financial	Inadequate financing available (local, national, international) for RE projects.
Economic	Unfavorable costs, taxes (local and import). Government subsidies offer cheap electricity and fuel.
Technical	Lack of access to technology and inadequate. maintenance facilities.
Capacity	Lack of skilled labor force and training facilities.
Social	Lack of social acceptance and local interest and participation.
Legislative	Lack of formal policy, regulatory and legal frameworks necessary for RE development.

- Competition from fossil fuels subsidized by government (low cost fuel and electricity).
- Lack of legal framework, policy and instruments to encourage RE development.
- Limited access to capital, fiscal incentives and enabling financial environment.
- Commercialization barriers.
- High initial cost of technologies and implementation.
- Lack of education and awareness.
- Lack of locally available RE resource data.
- Inadequate institutional capacity.
- Environmental concerns with RE technologies.
- Lack of political will.

These barriers tend to increase the financial risks associated with RE investments. The primary ones that will be discussed are economic, legislative, financial, market, technical, institutional, awareness/information, capacity and social barriers.

Economic Barriers

According to the International Energy Agency (IEA), energy subsidies are "any governmental action that primarily concerns the energy sector which lowers the cost of energy production, raises the price received by energy producers or lowers the price paid by energy consumers" [5].

Fuel subsidies were introduced in the 1970's under the Petroleum Production Levy and Subsidy Act of 1974. This Act was amended in 1992 to limit the levies paid by producing companies to a maximum of 3% of gross income. The Act was amended again in 2003 to 4% of the company's gross income. The remainder of the subsidy is paid by the government and these payments have become burdensome in recent years. In the 2014 budget, the government allocated $7 billion dollars for fuel subsidies, accounting for 36% of total expenditures in 2014 [6]. Figure 2 shows that the allocation of fuel subsidies since 2010 has substantially increased with 2014 having the greatest allocation to date.

Heavily subsidized fuel and electricity creates an uncompetitive economic environment for renewable energy technologies. It is a huge barrier against RE market penetration since there is inadequate economic incentive to invest in RE technology development. It limits the

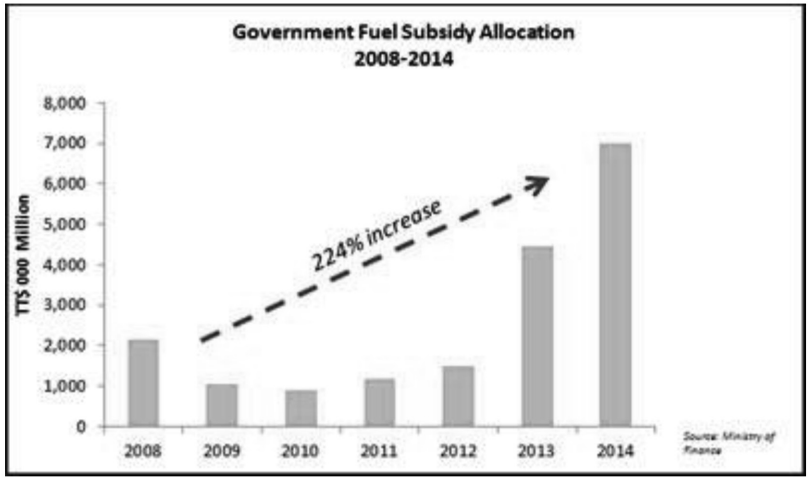

Figure 2. Fuel subsidy allocations for 2008-2014 [6].

market for RE since inexpensive fossil fuels are readily available, thus preventing the demand for cleaner more expensive forms of energy from developing. Fuel subsidies have also led to an influx of vehicles for such a small country [7]. Diesel fuel enjoys the greatest share of the fuel subsidy followed by gasoline. This has encouraged greater vehicle use in the country causing traffic and environmental problems. T&T has approximately 650,000 vehicles, far too many for a country with population of only 1.4 million [7].

Trinidad and Tobago currently use natural gas to generate most of its electricity [2]. Low electricity rates have helped develop the country and its economy. In 2014, T&T was recognized in the World Bank Doing Business Report as the 10th highest ranked of 189 countries for its ease of electricity connectivity [8].

Trinidad and Tobago Electricity Commission (T&TEC), the state owned utility company, is the country's sole retailer of electrical power which is supplied to customers via a single electricity grid [2]. The company has evolved from power generation, transmission and distribution to include generation by independent power producers (IPPs) [2]. The current IPPs are The Power Generation Company of Trinidad and Tobago (Powergen), Trinity Power Limited (TPL) and Trinidad Generation Unlimited (TGU).

There are concerns associated with power generation in T&T. While natural gas is the cleanest of all the fossil fuels, it emits atmo-

spheric greenhouse gases such as CO_2 and CO when combusted [9]. Natural gas is a non-renewable resource with exhaustible reserves. T&T is wholly dependent on natural gas for electricity generation which creates dependency problems. Services are unreliable at times when there are shortages of natural gas or gas leaks in the pipelines. The country's infrastructure is aged, resulting in low conversion efficiencies. Due to low electricity rates consumers tend to make inefficient use of electricity.

Table 2. Fossil fuel emission levels 1998 [9].

Pollutant	Natural Gas	Oil	Coal
Carbon Dioxide	117,000	164,000	208,000
Carbon Monoxide	40	33	208
Nitrogen Oxides	92	448	457
Sulfur Dioxide	1	1,122	2,591
Particulates	7	84	2,744
Mercury	0.000	0.007	0.016

Trinidad & Tobago enjoy one of the region's lowest electricity rates. Table 3 shows the average tariffs for the period 2012 for selected countries in the region with Trinidad and Tobago (US$0.06/kWh) and Suriname (US$0.05/kWh) having the lowest average tariffs [10].

Low electricity rates have made RE technologies noncompetitive for electricity generation. Technical, institutional and legislative changes are needed for RE technologies to be widely implemented.

Renewable energy technologies are made unattractive due to their higher upfront costs and transaction costs when compared to the cost of traditional fossil fuel energy. For example, the installed cost for a solar water heater ranges from $7,500 to $13,000 [11]. Recently, costs for renewable energy technologies have declined making them more competitive today [12]. For example, the International Renewable Energy Agency (IRENA) estimates that "onshore wind costs US$0.06/kWh in Asia and US$0.07/kWh in North America" [13]. In the 'Renewable Power Generation Costs in 2014 Report', renewables such as biomass,

Table 3. Utility retail tariffs in 2012 [10].

AVERAGE RETAIL TARIFFS PER UTILITY		
COUNTRY	AVERAGE TARIFF (2012)	
Antigua and Barbuda	$ 0.43	
Bahamas	$ 0.26	(2010)
Barbados	$ 0.32	
Dominica	$ 0.43	
Dominican Republic (east)	$ 0.20	
Dominican Republic (north)	$ 0.20	
Dominican Republic (south)	$ 0.22	
Grenada	$ 0.40	
Guyana	$ 0.32	(2011)
Jamaica	$ 0.36	
Haiti	$ 0.38	
St. Lucia	$ 0.38	
St. Vincent and the Grenadines	$ 0.36	(2011)
Suriname	$ 0.05	(2011)
Trinidad and Tobago	$ 0.06	(2011)
AVERAGE	$ 0.33	

hydropower, onshore wind, and geothermal are mentioned as being competitive with or less expensive than fossil fuels without subsidy support [13].

Legislative Barriers

While there are no formal policies for renewable energy and energy efficiency, there has been a framework for the development of a renewable energy policy in T&T since 2011 [2]. However, the Trinidad and Tobago Electricity (T&TEC) Act Chapter 54:70 does not enable the licensing of independent power producers (IPPs) to produce renewable electricity to sell to the national grid [2]. The Regulated Industries Com-

mission (RIC) Act Chapter 54:73 lacks provisions for IPPs to connect to the electricity grid. This lack of connectivity precludes open access, net-metering and feed-in-tariffs [2]. The Ministry of Public Utilities needs to review existing legislation to enable open access, net metering, grid interconnection, feed-in-tariffs, and net billing so that renewables such as solar power can make an impact.

Financial Barriers

One of the major barriers is the lack of financing available for those willing to invest in RE development as entrepreneurs or consumers. An embracing financial environment is vital to RE financing and investment. International banking has been credited with the success of RE in the Bahamas [14]. There is need for efficient and effective investment for RE projects by both local and international institutions. For example, the Inter-American Development Bank (IDB) and the International Finance Corporation (IFC) have both committed funds to help develop RE projects in island nations. The IDB has provided $70 million dollars for the development of RE projects in that country. The IFC has partnered with BHD (the largest bank in Dominican Republic) to develop RE investment programs and lines of credit to finance RE projects.

Incentives are used to lower costs, reduce risk, and help create favorable market conditions as well as address concerns such as greenhouse gas emissions. The government of Trinidad and Tobago has provided incentives which include tax credits, tax allowances, wear and tear allowances, and exemptions from conditional duty and value added tax (VAT) for solar, wind and energy efficiency (Table 4). Examples include the removal of tax on commercial vehicles which are manufactured to use compressed natural gas (CNG) and removal of customs duties on certain CNG kits with cylinders. Individuals using CNG kits and cylinders may be eligible for a tax credit of as much as $10,000. In the most recent budget, the government introduced the removal of import duties and value added tax (VAT) on hybrid electric vehicles. Incentives were provided for energy efficiency improvements when certified energy services companies (ESCOs) acquire equipment to conduct energy assessments. Tax allowances are available to companies for the design and installation of energy saving systems.

Although financing remains a problem in the region, the cost of solar power has been falling rapidly [13]. The cost of solar photovoltaic (PV) plants has decreased by half since 2010 and installation costs have

Table 4. Incentives for solar and wind technologies.

Finance Act No. 13 of 2010 - Renewable Energy				
	Import Duty Exemption	0-Rated VAT	Tax Credit	Wear and Tear Allowance
Solar Water Heater (SWH) (usage)	From Caricom Sources	Fully assembled SWH	25% on the acquisition of SWH by H/Hold (Max. $2500.00)	on 150% of the cost of acquisition of SWHs
SWH (manufacture/ assembly)	SWH industry declared "Approved Industry" subject to conditional duty exemption	NA	NA	on 150 % of cost of plant, machinery, parts & materials for use in the manufacture of solar water heaters
Solar PV	PV cells, whether or not assembled in modules or made up into panels	PV cells, whether or not assembled in modules or made up into panels	NA	on 150% of the cost of acquisition of PV systems
Wind Energy	Wind turbines & supporting equipment	Wind turbines & supporting equipment	NA	on 150% of the cost of acquisition of wind turbines

fallen by 65% [13]. Research and development into newer technologies will further decrease the cost for solar power in the future.

Market Barriers

Renewable energy technologies are uncompetitive due to imperfect market conditions set by subsidized fuel and electricity. The two major barriers to commercialization are the lack of economies of scale and undeveloped infrastructure [15]. The T&T RE market is in an early stage of development due to present policies and legislation. Grenada overcome this barrier when GrenSol, a private company, and GRENLEC, Grenada's sole utility company, agreed to new requirements for RE grid connections. This opened the market for RE in Grenada, allowing producers a limit of 5 MW [14]. Trinidad & Tobago needs to allow grid interconnections in order for RE to be successful.

Technical Barriers

There is a lack of technical programs and specialized training programs available in renewable energy technologies. There are also limited certification schemes both for energy efficiency equipment and renewable energy technologies. In Trinidad and Tobago there is a lack of trained personnel and a shortage of technical and managerial expertise to effectively develop and implement RE technologies.

Within the last few years, the Trinidad and Tobago Bureau of Standards (TTBS) and the Ministry of Energy and Energy Affairs (MEEA) started working to establish the following Standards [2]:

- Development of Technical Standards for Solar Water Heaters (SWHs) Standard TTS 106:2012, Solar water heater systems—Design and installation requirements.
- Standard TTS/EN 12975-1:2012: Thermal solar systems and components—Solar collectors.

However, these technical barriers need to be overcome in order for RE to be successful in Trinidad and Tobago. Technical skills must be developed for RE assessments, installation and system maintenance. Training should be provided from high school to tertiary levels.

Institutional Barriers

There is need for a coordinating agency under the Ministry of Energy for RE introduction and development. There are limitations in

the amount of research and development for RE technologies and for the demonstration and implementation of RE projects. There have been successful small scale solar and wind projects. Since 2011 T&TEC has been researching the integration of renewable energy. Testing is being conducted at three renewable energy project sites. These projects include: the photovoltaic (solar panels) installed at the Stanley P. Ottley Building at Mount Hope, University of Trinidad and Tobago's O'Meara Campus (UTT), and the T&TEC/Powergen hybrid solar and wind systems located at the Islamic Children's Home in Gasparillo [16]. These RE projects are fully operational and interconnected with the T&TEC grid. They have an installed capacity of approximately 2.0-2.4 kW [16]. More RE projects like these should be encouraged by both public and private institutions.

Awareness and Informational Barriers

In Trinidad and Tobago, there is a lack of awareness and education concerning renewable energy. There are varying levels of awareness of the benefits, costs and applications of renewable energy among policymakers, the local private sector, finance institutions and prospective customers. Information regarding RE development in Trinidad and Tobago is not widely disseminated and is not readily available. Such information should be made available to consumers and include available technology options and expertise for installation and maintenance.

Capacity Barriers

In Trinidad and Tobago, capacity for building RE systems is undeveloped. Capacity building includes training, technical support and resource networking [11]. Capacity building is a long term process in which all stakeholders need to participate. Examples of stakeholders that will need to be part of capacity building include T&TEC, the Ministry of Energy, the Ministry of Finance and the Ministry of Trade. Training is an important part of capacity building. There are many examples. Grenada implemented capacity building by training electricians and engineers in RE. St. George's University in Grenada partnered with the Grenada Solar Power Company to assess the various types of solar modules for use in the Caribbean. The University of Trinidad and Tobago is offering courses in renewable energy. The University of the West Indies has a Master's Program in renewable energy technology. The Arthur Lok Jack Graduate School of Business is offering a MBA program in

sustainable energy management. More programs should be introduced from secondary to tertiary level to help develop capacity building in RE.

Social Barriers

Society seems reluctant to adopt RE and EE. Despite the minimal fiscal incentives introduced by the government since 2010, the wider community remains disinterested. Trinidad and Tobago has a dependency on oil, gas, electricity, and the revenues they generate to preserve our standard of living. It is difficult to change this dependency which has become normative. Most people do not see the need for alternative forms of energy. This may be because they do not believe oil and gas reserves will be soon depleted. Perhaps they believe climate change is a myth. Lack of interest in the RE market detracts investment. A greater challenge is achieving market acceptance of environmentally beneficial clean energy resources as they are typically more expensive to develop than fossil fuels.

Strategies and Recommendations

There are many strategies that help address the barriers discussed:

- Develop strong proactive governmental policies and agencies for RE and EE.
- Create more incentives (e.g., tax credits and rebates).
- Offer disincentives such as a consumption tax on electric water heaters.
- Create innovative financial schemes for purchasing RE equipment and systems.
- Conduct energy-savings assessments.
- Revise T&TEC, RIC and EID Acts to enable IPPs to sell surplus electricity to T&TEC, allow access for net metering, and establish feed-in tariffs. Net metering will allow the IPPs to bank their power on the grid and generate revenue from the surplus electricity generated by RE.
- There should be RE interconnection standards for IPPs linking to the national grid. IPPs will need open access to the national electricity grid and this can only occur when the proper technical and legal requirements are met.
- RE targets should be set and mandated by law.

- Expand product and technical standards.
- Education and training should be offered including specialized training in RE technologies.
- Fuel subsidies should be reduced and gradually phased out.
- Offer subsidies for RE and EE technologies.
- Provide an enabling financial environment.
- Provide greater access to capital.
- Attract and expand private sector involvement.
- Further develop RE capacity building programs by training skilled workers in partnership with technical and vocational schools. Include RE and EE in education curricula of schools, hold workshops to engage personnel who would be directly engaged in the RE industry (e.g., technicians, electricians, T&TEC inspectorate and teachers).
- Provide more relevant RE consumer information in the public domain via information centers and by identifying available services. Establish awareness campaigns including communication fairs, workshops, media, and micro-marketing of incentives for RE and EE, seminars, workshops, and exhibitions.
- Government needs to lead by example. The government might incorporate solar water heaters in government housing schemes and institutions such as schools and hospitals.
- Review and modify current electricity tariff structures.
- Require utilities like TTEC to purchase a portion of their energy from power producers using renewables.
- Emission quotas, emission limits and RE standards should all be clearly stated within policies so that measures can be taken to meet those targets.
- The government should facilitate renewable energy projects which qualify under the Clean Development Mechanism (CDM) for carbon credits by reducing carbon emissions [6].
- Subsidies and soft loans (loans at lower than market rates) encourage investment and can reduce the investment cost. Soft loans provide easier access to credit with the appropriate conditions for financing investment which can help to overcome high upfront

costs. These soft loans can help purchase RE equipment. Microfinancing should be made available to help provide loans for small to medium RE enterprises.

Trinidad and Tobago has great potential for RE Technologies such as wind and solar. There is opportunity for the large scale manufacture of solar panels due to inexpensive energy (compared to other islands in the region), access to abundant raw materials and an established industrial supply chain. Trinidad and Tobago can generate revenue from these new industries and provide renewable energy at a competitive market price. T&T is an ideal location for new plants in Point Lisas to manufacture polysilicon, metallurgic silicon, float glass and solar photovoltaics [17]. Trinidad and Tobago has the opportunity to be a leader in CNG vehicle penetration [6]. This will create jobs for contractors and local mechanics. The National Gas Company (NGC) has invested over two billion dollars to assist in the conversion of CNG vehicles over the next five years [6].

However, for RE technologies to be successful key barriers must be overcome. The technical, legislative, financial, awareness, capacity building, economic, market, institutional and social barriers must be addressed before RE can become a sizeable component of Trinidad and Tobago's energy mix.

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