

IMPACTS OF ECONOMIC GROWTH ON CO₂ EMISSIONS TRINIDAD CASE STUDY

1. Introduction

Small islands, whether located in the tropics or higher latitudes, have characteristics which make them especially vulnerable to the effects of climate change, sea-level rise, and extreme events. According to the International Panel on Climate Change (IPCC) Third Assessment Report (2001) their limited size, proneness to natural hazards and external shocks intensify this vulnerability. In most cases these islands have low adaptive capacity, as adaptation costs are high relative to gross domestic product (GDP). As a consequence, small islands have legitimate concerns about their future, based on observational records, experience with current patterns and consequences of climate variability, and climate model projections (Mimura *et al*, 2007). Economic growth is therefore imperative if the Caribbean is to implement adaptive or mitigating strategies. Although emitting less than 1% of global greenhouse gases (GHGs), many small islands have already perceived a need to reallocate scarce resources away from economic development and poverty alleviation, and towards the implementation of strategies to adapt to the growing threats posed by global warming (Nurse and Moore, 2005). These island systems experience both internal and external pressures which add to their vulnerability. These include but are not limited to energy costs, population movements, increasing debt, rapid population growth, exploitation of natural resources such as forests, fisheries and beaches for economic gain and rapid urbanization.

Reconciling economic growth with greenhouse gas emission caps is an enormous challenge for developing nations. It would be politically futile to expect countries struggling to achieve basic levels of development, to abandon their growth aspirations in order to improve their people's living standards (Browne, 2004). Economic activity, however, comes at a price, as it is intrinsically linked to the environment. Their ecological impacts can occur at various stages within the process and can be either direct-clearing of land for buildings, depletion of natural resources, air emissions- or indirect through consumption and disposal of products. It would be equally wrong therefore to ignore the fact that by 2025, energy-related carbon dioxide emissions from developing countries are likely to exceed those from the member states of the Organization of Economic Cooperation and Development (OECD).

In the arena of carbon dioxide (CO₂) emissions, the Caribbean island of Trinidad seems to be an exception to the rule. Like the rest of the Caribbean its total contribution to CO₂ emissions is less than 1%, however, per capita emissions are estimated at 35.51 tonnes of CO₂. The primary human source of CO₂ in the atmosphere worldwide is from the burning of fossil fuels for energy production and transport, and Trinidad is no exception. The country has transitioned from an oil-based economy to a natural gas based economy and in 2007 alone natural gas production averaged 4 billion standard cubic feet per day (mmscf/d). Further diversification into energy intensive industries such as steel, methanol and ammonia production has led to financial independence and prosperity for its citizens and ultimately the associated consequences, inclusive of increased consumption patterns. Since the 1970's carbon emissions have been steadily increasing, Trinidad went from being ranked 69th in 1971 to 3rd in 2008 with regards to per capita emissions. This leads to the question of how sustainable is the economic growth of Trinidad in environmental terms. This paper seeks to investigate the drivers behind these high carbon emissions and discuss the potential strategies that can be adopted to balance economic growth, while reducing the countries carbon footprint.

1.1 The Trinidad Experience

Background

The Republic of Trinidad and Tobago, the most southerly of the Caribbean chain of islands is located just off the South American main land. A former British colony, Trinidad and Tobago gained independence on August 31st, 1962 and later became a republic on September 24th, 1976. Trinidad is the larger and more populous of the two major islands with an area of approximately 4768km². The island comprises one of the most diverse and productive ecosystems in the Caribbean with its tropical forests, fertile flood plains, swamps and abundant streams. The richness of its natural environment, unique blend of the world's major cultures, thriving industrial base and expanding population combine to present major challenges to the sustainability of a quality environment. Due to the country's limited land space, increasing levels of development have and continue to alter the environmental integrity from a land, sea and air perspective. Only nine percent of Trinidad's available land bank is flat and non-agricultural, which drives major competition among the various land use categories.



Source: Trinidad & Tobago Ministry of Tourism

Trinidad falls within the developing countries grouping in the Kyoto Protocol, therefore they are not expected to de-carbonize their economy unless developed countries supply enough funding and technology hence setting no immediate restrictions. As far as CO₂ emissions are concerned, Trinidad is setting the precedent for the impacts of small island developing nations. In addition to its current per capita CO₂ ranking, Trinidad's energy consumption has also placed it high on the list among other nations. These statistics when combined with the relatively small population of 1.3 million people raises concerns for the sustainability of its present development path. The country's industrial economic base, growing wealth and urban development patterns have been attributed to many of these ills. Urbanisation in Trinidad is characterized by unlimited outward expansion of growth, relatively low density residential and commercial development, leap-frog development into far-out sites, heavy reliance on private automotive vehicles for travel, spatial segregation of different land uses, and fragmented policy control over land-use among many localities.

2. The Price of Growth

Growth in wealth and population increases has been attributed to increasing GHGs worldwide. The Intergovernmental Panel on Climate Change's (IPCC) 4th Assessment (2007) main summary report on "Mitigation" states: "GDP/per capita and population growth were the main drivers of the increase in global emissions during the last three decades of the 20th century. ... At the global scale, declining carbon and energy intensities have been unable to offset income effects and population growth, and, consequently, carbon emissions have risen." (p.107)

Economic growth, is an increase in the production and consumption of goods and services, which occur as a result of an increase in the multiplied product of population and per capita consumption, operating in a free competitive market. Economic growth is a perpetual goal of governments and society; it is seen as the Rosetta stone of progress and development, but at what cost? Some schools of thought believe that that there is no limit to economic growth, particularly in light of technological advancement, which allows us to use fewer resources for greater returns, while reducing ecological impacts. Research has shown however that an immutable law of socioeconomic development as it pertains to energy has been that use of energy services grows at a faster pace than improvement in efficiency (Wilkinson *et al*,

2007), technological improvements therefore becomes a moot point. It is unlikely that technology alone will prove to be sufficient for sustainability (Rees, 1999).

The relationship between economic growth and rising carbon dioxide (CO₂) emissions is the chicken or the egg question of the climate change debate. A growth in industry, and hence emissions, will no doubt stimulate a country's Gross Domestic Product (GDP). Conversely, a higher GDP will often lead to a greater disposable income and higher standards of living, which could manifest in more cars, more residential energy use and more consumption, all of which will impact on a country's total emissions. This relationship is evident when trends in GDP and emissions for Brazil and India - considered to be two emerging economies - are analysed. Brazil has seen a very steady growth in both emissions and GDP since 1960 with a 6-fold increase in both. While India between 1960 and 2004, have increased emissions by a factor of 10 whilst GDP has also increased by a factor of 6. The same trend seems to be occurring in the Trinidad case, as can be seen from in the figure below. Trinidad has managed to increase its carbon footprint by 79% from 1990 (dashed line) to 2007 (solid line), as GDP has grown, so has the carbon intensity of the economy.

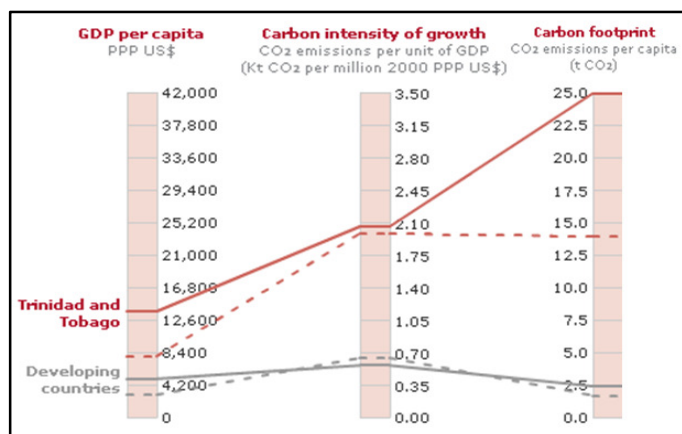


Figure 1.0: Carbon intensity of Trinidad compared with other developing countries
 Source: UNDP
<http://hdr.undp.org/en/statistics/data/climatechange/growth/>

This last tendency is a point of major contention. Great debate occurs as to the roles and responsibilities of developing countries in the fight to reduce CO₂ emissions. A significant global trend is the change in the share of emissions between the developed and developing world. In 1950, the developed/developing share was 89 percent/11 percent, and by 1985 it had shifted to 71 percent/29 percent (WRI, 1994). By 1995, the most recent year for which comprehensive data are available, the developed-country Kyoto signatories accounted for 56 percent (3.6 billion metric tons) of the estimated 6.2 billion metric

tons of global carbon emissions (Andres et al, 1999). Developing-country emissions (44 percent as of 1995) are projected to surpass developed-country emissions in the first few decades of the twenty-first century, if pre-Kyoto trajectories continue. Non Annex I countries have no commitment with regards to reducing emissions, yet their share of CO₂ outputs have been on the rise, figure 1.1 shows the outputs of CO₂ for Trinidad versus other developing nations. The arguments for this course of action involve the presumption that, while pollution increases with GDP growth, there comes a point after which pollution levels off. This relationship between economic development and environmental impacts is known as the environmental Kuznets curve (EKC), named after economist Simon Kuznet (1955).

Several studies have been carried out analysing EKC relationships. Dietz and Rosa (1996) carried out one such study to estimate the effects of population, affluence and technology on national CO₂ emissions developing a stochastic version of the IPAT model. The IPAT equation is one of the earliest attempts to describe the role of multiple factors in determining environmental degradation (Commoner, 1972). It describes the multiplicative contribution of population (P), affluence (A) and technology (T) to environmental impact (I). Environmental impact (I) may be expressed in terms of resource depletion or waste accumulation; population (P) refers to the size of the human population; affluence (A) refers to the level of consumption by that population; and technology (T) refers to the processes used to obtain

resources and transform them into useful goods and wastes. The results indicated that the effects of affluence on CO₂ emissions level off and even decline somewhat, at the very highest levels of GDP (above U\$10,000). It is suggested that this shift is as a result of (i) diverting to service based economies and (ii) the ability of the more affluent economies to invest in energy efficiency. This phenomenon is found throughout the literature and is explained by environmental economists. It is deemed economic modernisation and acknowledges that economic development has generated environmental problems, however they argue that further economic development can solve these problems rather than adding to them (Grossman and Krueger, 1995). Of the 111 nations sampled in the research by Dietz and Rosa (1996) seventy five-percent had GDP's below \$5000. It can therefore be inferred that for the majority of nations, economic growth that can be anticipated for the next quarter century will produce increasing, rather than declining CO₂ emissions.

2.1 Trinidad's Energy Consumption

With urban and industrial development comes growing demands for energy and rising expectations of material goods. The built environment is where most is where most energy services are used, in the UK context, half of the carbon emissions come from buildings, a quarter of these from our homes, when transport is factored in the connection becomes clear (Amos, 2008). The statistics for Trinidad paints the picture quite clearly, 66% of carbon dioxide emissions come from energy and 34% from industrial processes (EMA, 2000). Energy needs are therefore the majority producer of CO₂ emissions in the country. According to data compiled by the International Energy Agency (IEA) Trinidad is ranked among the top 20 nations for its energy intensity, which is the ratio of energy consumption to GDP. This figure showed a 37% increase from 1990-1997.

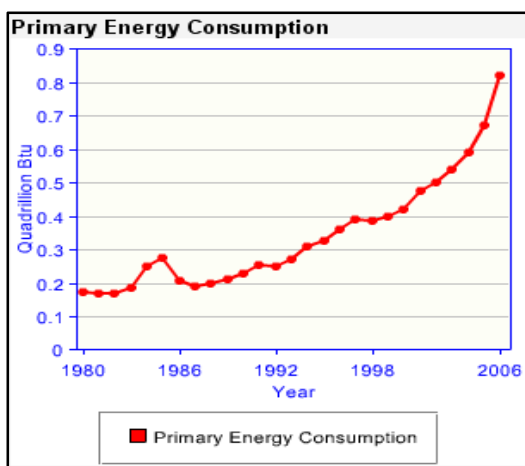


Figure 1.1: Primary Energy Consumption
Source: Energy Information Agency (EIA)

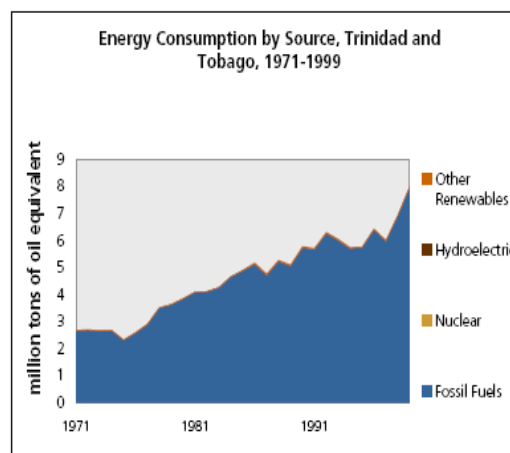


Figure 1.2: Energy Consumption by Source
Source: WRI

It can be seen from figure 1.1 that primary energy consumption has steadily been increasing since the 1980's, with the major source of energy coming from fossil fuels (Figure 1.2). The data shows vast amounts of energy are being used by the population, however the question remains as to which sectors are the likely culprits. The data available for the year 1999 from the IEA states that 85% of energy is utilized by industry, 12% by transportation, 2% for residential and the remaining 1% for commercial and public services.

Energy consumption is closely correlated to the size of a country's economy, and kilowatt hours of electricity consumed has often been used as a proxy for Gross National Product (Cook 1971). Since 1999 energy usage has risen rapidly, the proportion of energy used per sector has potentially changed. Increased usage of air conditioning in residential/commercial buildings, electronics and appliances may not be reflected in these values. This change may

be evidenced when the electricity usage for the various sectors is analysed (Table 1.0). According to the table the industry sector and the residential sector were the main consumers of electricity. According to the IEA, the second largest emitter of CO₂ for Trinidad behind manufacturing and construction (47%) is electricity and heat production with a 25% share.

Table 1.0: Electricity Generation and Distribution, 2000-2003

Year	Distribution of Electricity					
	Domestic Use		Commercial Use		Industrial Use	
	Consumer Number	KWH 000	Consumer Number	KWH 000	Consumer Number	KWH 000
2001	299,652	1,285,000	30,631	522,911	2,235	3,158,388
2002	303,901	1,398,664	31,281	520,224	2,338	3,706,752
2003	312,805	1,541,567	32,419	581,389	2,409	3,941,961

Source: National Accounts (CSO)

Apart from electricity, energy is also utilised within the transportation sector. Private vehicle purchases have been on the rise, from January 1, 2008-2009, over 30,000 motor vehicles have

been registered. Car ownership has grown so rapidly, it is now the highest per capita in Central America and the Caribbean giving rise to increased congestion and air pollution (CSO, 2000). The industrious nature of private enterprise has also created a large 'foreign used' vehicle market, which has enabled a larger percentage of the population to purchase vehicles. More automobiles lead to a subsequent increase in demand for motor gasoline. Trinidad has some of the lowest gasoline prices/litre in the western hemisphere; leaded gasoline (US40cents), unleaded (US66cents) and diesel (US25cents). Gasoline consumption per person in 2000 outstripped that of the world (Figure 1.3). Trinidad being a producer of fossil fuels have been able to subsidise gasoline prices, in 2008 alone the government provided US\$360 million

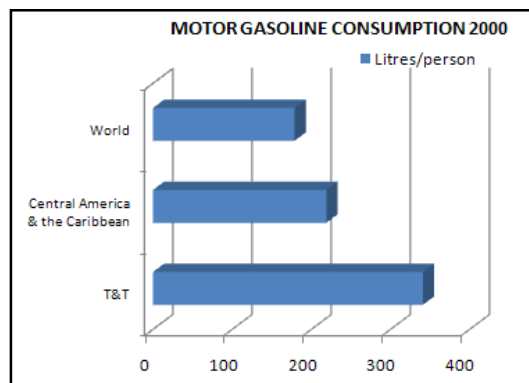


Figure 1.3: gasoline consumption
Source: compiled using WRI data

in fuel subsidies (GoTT, 2009)

The demographic make-up of the population is one variable that should not be disregarded, as the major driving forces of past and future energy demand can be linked to demography (Price *et al*, 2006). Trinidad and Tobago's population has aged significantly in the past 10 years – and the trend will continue through 2050. In terms of median age, Trinidad and Tobago is right in the middle of the road, at 29 years old – between the young countries of Latin America and older countries of North America and Europe. This means there is a good chance we will see significant changes in saving and investment balances, because younger populations tend to consume and borrow more and save less. Young people, as they enter the economic sector, consume. They will buy the latest high tech appliances and electronics – then cars and finally homes. (Pitfield, 2006). The demographic element highlights the fact that energy usage will continue to increase in the future unless significant changes are made producing a subsequent increase in CO₂ emissions.

3. The Economics of Development

3.1 Economy of Trinidad

Trinidad went into the twentieth century with the unexpected discovery of oil in 1907. The discovery altered Trinidad's patterns of economic development and further differentiated it from other English-speaking islands in the Caribbean. This progress saw the main economic output change from traditional agriculture (sugarcane, cocoa) to oil production. Oil was exported for the first time in 1909, but this did not cause an increase in production levels, until the British Royal Navy converted to oil during the following decade. During World War I, Trinidad and Tobago became the major source of oil for the navy. Oil output skyrocketed during the period 1910-1920 from 125,000 barrels a year in to over 2 million barrels, consequently, so did the number of foreign oil companies competing for control of the valuable resource

Table 1.1: Selected Macro Economic variables 1999

Macro Economic Variables	1999	2000	2003	2004
Mid Year Population (000)	1,258.2	1,262.4	1,282.4	1,290.6
Per Capita GDP – US\$	5,437	6,480	8,809	9,865
Per Capita GNI – US\$	5,117	5,982	8,278	9,402

Source: Central Statistical Office, National Income Division, 2000

During the 1980s, Trinidad was considered an upper-middle-income oil-exporting country, which was highly dependent on the world price of oil for its economic growth. The nation exhibited the largest GDP of the Commonwealth Caribbean, one of the highest per capita GDPs among the nations of the Western Hemisphere, and one of

the highest standards of living in the developing world, table 1.1 highlights selected macro economic variables from 1999-2004. The country's GDP in 1985 stood at roughly US\$7.7 billion at current prices, or about US\$6,000 per capita.

The discovery of natural gas fuelled new petrochemical plants, which came on-stream in the early 1980s and included ammonia, urea, and methanol. These massive industrial projects were located at the newly built Point Lisas industrial park, which, along with the park's new iron and steel plant, provided Trinidad and Tobago with an industrial base that was unmatched throughout the Caribbean. Today GDP has almost tripled from US\$9 billion in 2001 to US\$24 billion in 2008. It is projected to rise to over TT\$165 billion in 2009 (GoTT, 2009). Currently Trinidad is the world's fifth largest exporter of liquefied natural gas, supplying more than 70 percent of US domestic needs and the world's largest exporter of methanol and ammonia. Their share of global energy business now stands at 3 percent, a remarkable accomplishment given that Trinidad and Tobago has only 0.3 percent of the world's gas reserves.

3.2 Urbanisation and Economic Growth

Interest in the urbanisation process arises due to the basic fact that urbanisation and growth appear so entwined. Economic development usually involves the transformation of a country from a rural agricultural based economy, to an industrial based economy, this releases labour from agriculture, as labour saving technologies are introduced (Henderson, 2003), this sectoral conversion involves urbanisation. Henderson goes on to state that urbanisation is a 'by product' of the move out of agriculture and the effective development of a modern manufacturing sector, as economic development proceeds, rather than a growth stimulus *per se*. Government policies and economic agendas also have implications for the urbanisation process, favouring the urban-industrial sector using trade protection policies or discriminating against the rural sector with agricultural price controls (Renaud, 1981), both lead to workers migrating to cities and eventual land use changes. The literature on economic development within an urban context hypothesizes that a high degree of spatial or urban concentration in the early stages of economic development is helpful (Hansen, 1990).

It is based on the premise that when industrialisation is concentrated, the economy conserves on “economic infrastructure” such as transport and telecommunications and other vital resources. However, as development proceeds economies should be able to decentralise infrastructure and resources to hinterland areas.

Historically, settlement and population growth in Trinidad was related primarily to the labour needs and commercial development of the plantation economy. Port of Spain as the colonial capital, main port, and commercial centre, along with the ‘sugar rich’ western counties, were the main areas of population concentration with the eastern rural counties less densely populated (Conway, 1984). The States industrialization thrust in the early decades of the 20th century, contributed to population shifts southwards and San Fernando grew as the country’s second city. Rapid suburbanisation and conurbation of the St George County (the area surrounding Port of Spain) occurred from 1946 -1960. The decade 1960-1970 saw the continued growth of St George, however simultaneous suburbanisation was also occurring within the oil belt of Victoria and St Patrick counties.



Figure 1.4: East-West Corridor

Table 1.2: Population and Population density for selected Municipalities

Municipality	Population	Square kilometers	Population density
Port of Spain	49,031	12	4,086
Arima	32,278	12	2,690
Diego Martin	105,720	126	839
San Juan/Laventille	157,295	239	658
Tunapuna/Piarco	203,975	510	400

Source: National Accounts CSO, 2000

Since the early development years, Trinidad’s urbanisation has been associated with upward mobility and a mushrooming middle class, such that social aspirations and spatial mobility tend to coincide. Port of Spain has remained the country’s commercial, administrative and cultural hub and represents the beacon of improving one’s standard of living, a typical characteristic of a primate city. Sixty one percent of Trinidad’s employment opportunities in services are concentrated in the Capital region and this estimate reflects only participation in the formal sector of the services economy, and a total of 25% of all employment in the country (Halcrow, 2000). The population of the City of Port of Spain, however, has been declining since mid-1960, with losses most distinct in the downtown area, where commercial land use is replacing residential land use. On the other hand residential proximity to the city has been on the rise. This migration into Port of Spain and its environs has contributed to many problems which have overwhelmed regional planning efforts, inflated housing/land prices and increased traffic congestion resulting in CO₂ emissions and air pollution.

Almost 75% of the population of Trinidad live in urban areas (UNCHS,2001). The urban region of Port of Spain extends far beyond the administrative boundaries of the city and includes the Regional corporations of Diego Martin to the west and San Juan/Laventille to the east. More than 300,000 people reside in these areas together. Still the full urban sprawl in Northern Trinidad stretches from Chaguaramas in the west to Arima in the east (Figure 1.4). This area has been coined as the ‘East-West corridor’ and consists of villages, towns and suburbs along the Eastern Main road and provides living space to nearly half a million Trinidadians (Lloyd, Evan & Potter, 2002). Analysing urban development is an important step in understanding CO₂ emissions. The future trajectory of development and associated levels of affluence and technological and social change will strongly influence key aspects of urban form such as residence size, vehicle miles travelled, and investment in urban infrastructure,

along with fossil-fuel emissions. The First State of the Carbon Cycle Report (2007), states that the density and development patterns of human settlements are drivers of fossil-fuel emissions, especially in the transportation and residential sectors. An understanding of settlement types and the economic drivers will therefore determine how future urban policy and planning may impact the magnitude of CO₂ sources and sinks.

3.2.1 Government Stimulus

Changes in land use, land cover, spatial distribution of settlement and their subsequent infrastructure all impact on CO₂ emissions and the environment's ability to absorb excessive GHG's. As mentioned previously, the policies of government have a profound impact on the dynamics of urban expansion, transportation, economic development and ultimately environmental sustainability. Trinidad's government has practiced a form of state capitalism since its independence in 1962 being the major driver of development and the country's main employer. Development decisions taken today will leave a legacy for the future and this is particularly the case with investments that have long life spans, such as housing stock and transport infrastructure. With the State being the major investor in these arenas, their actions are of particular importance to the analysis on CO₂ emissions. A significant portion of government savings (i.e., surplus on the current account) is used to undertake major public capital works projects. For example, total government capital expenditure as a share of GDP increased from 5% in 1973 to 19.4% in 1981, as of 2000 this figure stood at 23.2% (CSO, 2000). Current expenditure more than doubled between 2002 and 2007, and capital expenditure multiplied ten times, from US\$116 million to US\$1.2 billion.

Oil revenues have contributed to improving the road networks throughout the island, and the Capital Region has reaped a king's share. The newest addition to its transportation arsenal was the completion of the Uriah Butler Interchange in 2009. It is an attempt to alleviate the gridlock that commuters experienced on their way to 'dormitory' suburbs. Additionally, a hugely expensive rapid rail system is in the early planning stages. Two lines, running north/south and east/west, will cover about 105 kilometres, linking the capital with east Trinidad and San Fernando. Constant widening of arterial roads has also been characteristic of the government's transportation policies. A water taxi service was successfully introduced in 2009 from the city of San Fernando to the capital Port of Spain, and additional investments in public transportation have been made. Minor strides have been made in the mass public transit forum, whilst public transportation has remained largely ineffective, as is reflected in the number of private vehicles being purchased. It is noteworthy to mention the marked preference shown by the travelling public for individual private transportation and private commercial transport (taxis and maxi-taxis) relative to the use of available public systems such as buses. For example, customer levels for the public bus service decreased from 16.3 million in 1990 to 6.4 million passengers in 1998 (CSO, 2000). Transportation plans seem to be land based with little thought to alternative modes of transport such as bicycles and creating pedestrian friendly zones. Infrastructure has only sought to make Trinidad society one that is automobile dependent.

Urban regeneration and gentrification have also been on the States development agenda. The Greater Port of Spain Development Plan was created to guide development of the Greater Port of Spain area. The Capital within the last few decades has seen an upsurge in low income and illegal settlements. The plan includes strategies for increasing housing stock, employment opportunities, infrastructural improvements and attracting more affluent residents to the City. One of the major recommendations of the plan included a commercial waterfront redevelopment. This project is now nearing completion and includes several multi-story buildings intended to house offices and commercial space alongside the 428 room Hyatt Regency, with the largest conference centre in the English-speaking Caribbean. Opposite the waterfront, a new "government campus" is taking shape (US\$200million) to house ministries and state agencies; a mile or so away, on the southern side of the Queen's Park Savannah, a massive Performing Arts Academy (US\$82 million) should be complete

this year or early in 2010. This infrastructure is wholly owned by the Government and people of Trinidad and Tobago. Such massive undertakings however will continue the historical pattern of Port of Spain's centrality and primacy.

Home ownership in Trinidad ranks high among developing countries, in the years 1980-1990 there has been an increase from 65%-74% respectively (GoTT, 2000). Rising real-estate prices however have placed a strain on the ability of households to afford housing on the open market. The 2002 housing policy estimated that 115,000 new housing units would be required during the period 1995-2005 and that a significant proportion of these would be needed in the already densely populated 'east-west corridor'. It is the government's intention in this policy to find this residential land by either acquiring private lands or utilizing agricultural lands (subject to planning approvals) (GoTT, 2000). However, government's intervention into the housing arena has created more problems. In 1977 a new settlement was created in Arima, owing to government and private housing projects coordinated with industrial estate development. The town of Arima remained the same size but the rest of the ward grew by over 50% reaching 33,000 persons in 1980 (Conway, 1984). Malabar, site of government initiated housing projects grew 72% and other projects built since 1981 have augmented the population still further. The government had hoped that growth in and around Arima in the late 1970s early 1980's would contribute to decentralization and draw migrants away from denser urbanised areas nearer the city, but this did not happen. Instead residential development in Arima ward has merely extended the urbanised corridor farther eastward and created a larger population catchment area of the Capital Region's commuter zone. This continued concentration of residential housing can be attributed to the fact that 'dormitory' suburbs are being created. These settlements lack the required social services and employment opportunities, hence access to Port of Spain has remained the major criterion for settlement. This one example shows clearly that though well intentioned, governments spending proved to exacerbate the existing urban sprawl phenomenon.

It is the intention of capital expenditure to have some future benefit, however the large scale undertakings of the government of Trinidad seems to lack creative foresight. The built environment which includes the buildings in which people live and work, and the spaces and infrastructure in cities, towns, and villages, is where most human activity takes place. It is where most energy services are used, and where many of the advantages and disadvantages of energy use arise. Investments in a greater quantum of commercial and retail buildings, public housing that lacks the requisite services and road networks, intensify the issues of urban sprawl and hence congestion. Increasing construction activities will produce no benefit unless the proper management framework exists, the State cannot simply build its way out of the country's problems.

4. CO₂ Reduction Initiatives

Needless to say Trinidad has taken certain steps with regards to improving environmental quality. The development and expansion of the Environmental Management Authority (EMA) and implementation of the Green Fund where Companies pay a percentage (0.1 per cent) of their gross income into a trust fund (the Green Fund) which was intended to be used by community groups and NGOs to address issues related to the environment are two initiatives being undertaken. In the field of CO₂ reductions, the major projects in the works are the Nariva Wetland Restoration and Carbon Sequestration Project and conversion to compressed natural gas in automobiles. CNG conversion has been slow to catch on, with economy of usage the main concern. It would cost a motorist nearly US\$1700 (TT\$10,000) to convert to CNG today, though with subsidies and an alleviation of customs duty and VAT this figure could be reduced to US\$1000 (TT\$7000), though this is still a hefty amount: the bottom line for most people will be finance. The infrastructure also needs to be put in place, filling stations, retrofitting cars, to encourage people to convert. The Nariva project, however, is now gaining recognition and is being perceived as a model emission reduction project that can be utilized by other countries both regionally and globally (Agard, 2009). The objective

of the Nariva project is to contribute to efforts to restore and conserve the Nariva wetlands, through recognition of the services it provides as a carbon sink and a biodiverse ecosystem. The restoration of the natural drainage regime and natural and induced recovery of the original vegetation cover will cause carbon to be sequestered and emission reductions to be caused.

4.1 Recommendations

There is still much more that can be done however to break the link between economic activity and environmental pressures, thereby reducing the carbon intensity of the Trinidadian economy. A reduction that amounts to around 25 billion tons per year in 2050 as required by the Kyoto Protocol, will require more than just efficiency improvements. Given the world's rising demand for energy, transformation must occur within the energy system itself, making fuller use of low-carbon fuels as well as carbon-free energy systems. Paradigm shifts must occur across the economy: transportation accounts for 20 percent of total emissions, industry contributes another 20 percent, the domestic and commercial sectors emit around 25 percent, and power-generation accounts for another 35 percent. A wide-ranging set of policies is thus called for (Browne, 2004), this can be achieved through:

- The promotion of renewable forms of energy as a significant portion of the country's energy budget. This would entail developing the indigenous sources of energy such as wind, solar, hydro, geothermal and oceanic sources. Identification and development of policy instruments for mainstreaming renewable energy and alternative fuels in the energy, transport and agricultural sectors. Barbados has been successful in implementing solar water heaters.
- Outward expansion can be limited through more compact development, thereby increasing the density in both new growth areas and built-up areas. More mixed-use growth patterns should also be created, thus eliminating the need to commute to the city of Port of Spain for basic services. Patterns of urban development that support sustainable transport including public transport, cycling and walking, and the reduction of car use and sustainable energy infrastructure should be adopted.
- Urban revitalization and gentrification: The population of the capital has been reducing over the past twenty years, yet the jobs created within the city limits have been on the rise. Improving the appeal of the city whilst increasing residential land use will draw people back into the Capital Region, thereby reducing commuting needs.
- Mass Transit: Increasing the efficiency and reliability of the public transport system will shift the emphasis from private automotive vehicles to public transit. Mass Public transit will allow cater to the movement of larger volumes of people leading to a decrease in the need for roads to be built.
- Forward Planning: The preparation of local forward plans provides an important arena for innovation and creativity. The plans presently being used by the Town & Country Planning Division for its rapid urbanisation is outdated and in desperate need of revision. The last five-year plan (1974-78) was never completed, as expectations of continued oil wealth apparently precluded the need for further plans (Conway, 1984). The early stages of plan preparation and sustainability appraisal, or of strategic environmental assessment processes, are vital to scoping and identifying opportunities. As stressed by Tidd *et al.* (2005), 'innovation is driven by the ability to see connections, to spot opportunities and to take advantage of them'. The State cannot plan, far less provide, proper infrastructure without quality information on present demand as well as the likely nature and level of future requirements. That is the rationale behind the regulatory framework.

Conclusion

There is a strong correlation between the total economic output of nations (measured by their GDP) and their CO₂ emissions (Roberts *et al.*, 2003). As countries undergo industrial development, they move through a period of intensive, and often inefficient, use of fossil fuel.

Efficiencies improve along this development trajectory, but eventually tend to level off (Raupach *et al*, 2007). This relationship, however, is not linear and deviations from trends highlight other aspects such the organisation of production and consumption within the country. The data analysis shows that Trinidad is very 'inefficient' at producing 'wealth', from the production and consumption standpoint. Amongst other developing countries Trinidad produced 12 times the CO₂ per unit as did Uruguay and Kenya, and over 20 times more than Sri Lanka and Uganda (World Bank, 2001). Rapid movement of capital through an expanding industrial base, improved standards of living, and construction booms seem to be affecting the countries CO₂ emissions. The unsustainability of government capital expenditure is fast becoming a problem, Schnaiberg (1980) alludes to this point with the hypothesis that governments are on a "treadmill of production" which requires economic growth for their support and legitimation, a course of action which is inevitably unsustainable.

Apart from environmental extremists, it is accepted that economic growth is desirable. Looking holistically at the economic growth of Trinidad however, it becomes quite glaringly obvious that it is energy intensive exhibiting the resultant increasing CO₂ emissions. If Trinidad's population was as large as that of America or China it would easily surpass their total CO₂ emissions. Trinidad therefore cannot continue to hide behind the guise of non Annex I countries as a reason for inaction; it is part of the problem and must be part of the solution. Trinidad's GDP has exceeded the US\$10000 marker which Dietz and Rosa (1996) stated environmental impact should level off, this however has not happened. This is in support of the research which posits that the highest polluters per unit of GDP will neither be the richest nor the poorest countries, but instead those in the middle. These are the countries that have enough fossil-fuel dependent technology to compete in the world market, but lack the infrastructure to do so efficiently. The natural environment must be better protected and principles of sustainability incorporated into economic growth. Instead of being daunted by the scale of this challenge, policymakers must recognize the scale of the opportunity: developing countries have the potential to leapfrog the developed world's process of industrialization, thereby providing an enormous opportunity to improve energy efficiency and reduce emissions. Smarter organisations, smarter use of buildings, and smarter land use are key to achieving economic growth at less environmental cost, and with a more positive impact on quality of life.

References

- Agard, J (2009) *Press release for Nariva Wetland Restoration and Carbon Sequestration Project*, Port of Spain: EMA.
- Amos, G (2008) Foreword in *Community Energy: Urban Planning for a Low Carbon Future*, UK: TCPA & CHPA.
- Andres, R.J., D.J. Fielding, G. Marland, T.A. Boden, and N. Kumar (1999) "Carbon dioxide emissions from fossil-fuel use". *Tellus* 51B:759-65.
- Energy Information Agency (EIA) website country profiles:
http://tonto.eis.doe.gov/country_energy_data.cfm?fips=TD (accessed July, 15th)
- GoTT. Environmental Management Authority (2001) *Trinidad and Tobago: State of the Environment Report 200*, Port of Spain: GOTT.
- Pitfiel, R (2006) 36th Annual Meeting of Shareholders Scotia Bank Trinidad and Tobago Limited, Crowne Plaza. Port of Spain.
- IPCC. (2001) Third Assessment Report <http://www.ipcc.ch/ipccreports/tar/wg1/index.htm>
- IPCC. (2007) Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change.
http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_synthesis_report.htm (accessed July 20th)
- Browne, J (2004) "Beyond Kyoto", *Foreign Affairs*. Vol. 83, No.4 (July)
- Central Statistical Office (CSO) (2000) *National Accounts*, Port of Spain: GoTT.
- Commoner, Barry (1972) "The Environmental Cost of Economic Growth", *Population, Resources and the Environment*. Washington, DC: Government Printing Office Pp. 339-63.
- Conway, D (1984) "Trinidad's Mismatched Expectations Planning and Development Review", USFI Reports, Nov;(26):1-12.

- Cook, E (1971). "The Flow of Energy in an Industrial Society", *Energy and Power: A Scientific American Book*, Vol.224(3) Pp. 83-91
- Dietz, T & Rosa, EA (1997) "*Effects of Population and Affluence on CO₂ Emissions*", Proceedings of the National Academy of Sciences of the USA 94:175-9.
- Kuznets, Simon. 1955. "*Economic Growth and Income Inequality*," American Economic Review, Vol.45:pp1-28.
- First State of the Carbon Cycle Report (SOCCR). 2007.
<http://www.climate-science.gov/Library/sap/sap2-2/final-report/sap2-2-final-all.pdf> (accessed July 10th)
- GoTT. Ministry of Finance (2009) *Budget Statement 2008/2009*, Port of Spain: GoTT.
- GoTT. Ministry of Housing (2002) *Showing Trinidad & Tobago A New Way Home: A Policy for Shelter*, Port of Spain: GoTT.
- Grossman, G & Krueger A (1995) "*Economic Growth and the Environment*," Quarterly Journal of Economics, Vol.110: pp353-77.
- Halcrow Group Ltd (2000) *Greater Port of Spain Local Area Plan*. Port of Spain: Urban Development Corporation of Trinidad & Tobago (UDECO). GoTT.
- Hansen, N (1990) "*Impacts of Small and Intermediate-Sized Cities on Population Distribution: Issues and Responses*". Regional Development Dialogue, Vol.11: 60-76.
- Henderson, V (2003) "*The Urbanization Process and Economic Growth: The So-What Question*", Journal of Economic Growth, Vol.8:47-71
- Lloyd-Evans, S & Potter, BR (2002) *Gender, ethnicity and the Informal sector in Trinidad*, Burlington: Ashgate.
- Marland, G., and R.M. Rotty (1984) *Carbon dioxide emissions from fossil fuels: A procedure for estimation and results for 1950-82*, Tellus, 36(B):232-61.
- Mimura, N., L. Nurse, R.F. McLean, J. Agard, L. Briguglio, P. Lefale, R. Payet and G. Sem, (2007) *Small islands. Climate Change 2007: Impacts, Adaptation and Vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge: Cambridge University Press.
- Nurse, L. & Moore, R (2005) *Adaptation to global climate change: an urgent requirement for Small Island Developing States*, Review of European Community and International Environmental Law, 14, 100-107.
- Price, L., de la Rue du Can (2006) "*Sectoral Trends in Global energy Use and Greenhouse Gas Emissions*", Energy Policy, Vol. 36:1386-1403.
- Rees, W (1999) "*The built environment and the ecosphere: a global perspective*", In Building Research & Information, Vol. 27: 206-220.
- Raupach MR et al (2007) "*Global and regional drivers of accelerating CO₂ emissions*", Proceedings of the National Academy of Sciences, Vol.104: pp. 10288–10293.
- Renaud, B (1981), *National Urbanisation Policy in Developing Countries*, New York: Oxford University Press.
- Roberts, JT., Grimes, PE & J L. Manale (2003). "*Social Roots of Global Environmental Change: A World-Systems Analysis of Carbon Dioxide Emissions*", Journal of World-Systems Research, IX: 277-315.
- Schnaiberg, Allan (1980) *The Environment: From Surplus to Scarcity*. New York: Oxford University Press.
- Tidd J; Bessant J. and K. Pavitt. (2005) *Managing Innovation: Integrating Technological, Market and Organizational Change (third ed)*, London: Wiley
- UNCHS (2001) *Cities in a Globalising World: Global Report on Human Settlements 2001*, United Nations Centre for Human Settlements (HABITAT), London: Earthscan
- World Bank (2001). *World Development Indicators*. Washington, DC: World Bank.
- Wilkinson, P., Smith KR, Beevers S, Tonne C and Oreszczyn (2007) "*Energy, energy efficiency, and the built environment*," The Lancet, Vol 370 No. 9593 (September)
- World Resources Institute (WRI) (1994) *People and the Environment: Resource Consumption, Population Growth and Women*, New York: Oxford University Press.
- World Resources Institute (WRI) website, country profiles.
<http://earthtrends.wri.org/text/energy-resources/country-profile-182.html> (accessed July 19th)
- United Nations (2008) . *2006 Energy Statistics Yearbook*. United Nations Department for Economic and Social Information and Policy Analysis, Statistics Division, New York.
- UNDP. Human Development Indicators.
<http://hdr.undp.org/en/statistics/data/climatechange/growth/> (accessed July 21st)