



# The importance of electrical energy for economic growth in Barbados

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## ABSTRACT

Using a neo-classical aggregate production model where capital, labour, technology, and energy are treated as separate inputs, this paper tests for the existence and direction of causality between output growth and electrical energy use in Barbados, analysed as a whole and in sectors respectively. Results indicate the presence of a long-run relationship between growth and electricity consumption; specifically we find that the non-residential sector is a key driver of growth. In addition, the evidence reveals a bidirectional causal relationship between electrical energy consumption and real GDP in the long run, but only a unidirectional causal relationship from energy to output in the short run. Forecasts indicate increasing consumption of electrical energy, particularly by the residential sector. We suggest that plans by the Government to liberalise the sector should encourage efficiency and innovation in production and distribution which should result in lower prices, as independent suppliers compete to maintain their market shares. Changes in the regulatory environment will also be necessary if such plans materialise. Policymakers will need to pay greater attention to the expected increase in the rate of consumption by the residential sector, as this will help to reduce the imports of oil and depletion of scarce foreign exchange resources by a sector that does not spur economic growth. An increase in energy capacity should be encouraged as contingency planning in the event of a technical or political disruption to fuel imports will be critical, notwithstanding the drive to use more renewable sources of energy.

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## 1. Introduction

Over the last four decades, the demand for energy in Barbados—a small developing country in the Caribbean—has grown, as it has pursued policies geared towards greater economic growth and social development. However, its mounting debt burden coupled with the high cost of energy has large economic and financial implications for the country's capacity to achieve its goals in both the near and long terms. First, there is the fact that Barbados, a net importer of not only energy, but food and other vital raw materials, has to devote a growing fraction of its foreign reserves to satisfy its demand for energy. Second, there is a greater recognition that alternative sources of energy and the financing necessary to develop and/or exploit such sources will have to be pursued.

Against this background, the Government of Barbados has begun to place greater focus on energy conservation and renewable energy sources. It has designed a course of action, the Barbados Energy Policy (BEP), which outlines how it plans to address issues such as energy efficiency, conservation, energy security and other critical elements

that will need to be brought to the fore in Barbados' long-term strategic plans. The BEP includes strategies to mitigate the negative impacts of oil prices and to take advantage of national renewable and non-renewable resources; for example, offering fiscal incentives to encourage the efficient generation of energy from alternative sources; a waste-to-energy project; and implementation of building standards which will encourage energy conservation, among others. It is important, therefore, to ascertain whether there is a causal link between energy and economic growth, given that any constraints placed on energy consumption would have an adverse effect on growth and development if causality runs from energy to GDP only.

Although the existence of a relationship between energy consumption and economic growth is now reasonably established in the literature, the direction of causation, that is, whether economic growth leads to energy consumption or energy consumption leads to economic growth, remains an unsettled issue. Determination of the specific direction of causality is not merely an issue of empirical interest, but one that has significant policy implications.

Four possible relationships have been emphasised in the literature between energy consumption and economic growth: growth; conservation; neutrality; and feedback hypotheses. As noted by *Jumbe (2004)*, among others, if causality runs from energy consumption to economic growth and the relationship is positive—the growth hypothesis—this suggests that an economy is energy-dependent and

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hence energy consumption leads to growth. On the other hand, a shortage of energy may negatively affect economic performance, leading to a fall in income and employment.

If, instead, causality runs from economic growth to energy consumption and the relationship is positive, this implies that an economy is not energy-dependent and hence energy conservation policies may be implemented with no adverse effect on growth and employment (Masih and Masih, 1997). However, it is possible that a growing economy constrained by politics, weak infrastructure, or mismanagement of resources could generate inefficiencies and the reduction in the demand for goods and services, including energy consumption (Squalli, 2007).

The feedback hypothesis suggests that energy consumption and real GDP are interrelated and may very well serve as complements to each other. Should this result hold, then shocks, positive or negative, to either one of these variables would have effects, possibly permanent, on the other. Finally, if there is no causality in either direction—the neutrality hypothesis—this implies that changes in energy consumption are not associated with changes in GDP, so that energy conservation policies may be pursued without adversely affecting the economy (Jumbe, 2004).

While it would be perhaps ideal, to investigate the interaction between total energy consumption (and its components) and real GDP, the required series, except for the electrical component, are unavailable after 1997, which is insufficient for our empirical purposes. However, Mahadevan and Asafu-Adjaye (2007) suggest that the use of electricity consumption (see studies such as Jumbe, 2004; Shiu and Lam, 2004; Yoo, 2006) may be appropriate for economies which are heavily reliant on electricity for their energy. Moreover, Ferguson et al. (2000) find that there is a stronger correlation between electricity use and wealth creation for the global economy as a whole than there is for total energy use and wealth creation. Further evidence on the importance of electricity for growth is provided by Enflo et al. (2009). The authors demonstrate that the electrification of Sweden has had a significant impact on long-run energy productivity, particularly in industries which employed electricity for multiple purposes (machinery and chemical industries).

This paper thus aims to empirically investigate the causal association between electrical energy consumption and economic growth in Barbados. Electrical energy consumption will also be disaggregated into two sectors, residential and non-residential respectively, to assess their relationship with GDP. Our empirical work is largely derived from the seminal contribution to the energy literature by Stern (1993). Stern's approach examined the relationship between energy and growth by considering the possibility that the relationship may include more complex interactions with capital and labour. Within this context, we employ the techniques of multivariate cointegration, vector auto-regression (VAR), causality testing and innovation accounting. Finally, we forecast energy consumption within the framework of the VAR.

The remainder of this paper is organised as follows. Section 2 provides a brief profile of energy consumption in Barbados, focusing on electrical energy consumption. Section 3 presents a select review of the pertinent empirical literature on electricity consumption and economic growth. Section 4 introduces the empirical model, econometric methodology and data sources used in this research paper. Section 5 presents the results and analysis. Section 6 discusses the policy implications. The final section summarises the main findings and provides some concluding remarks.

## 2. Overview of Barbados' energy profile

Virtually all of Barbados' sources of energy are from fossil fuels. While Barbados does not have significant crude oil reserves, it produces a small amount of oil, approximately 1000 barrels per day (bpd). However, due to the high costs of refining, it has an arrangement with

neighbouring Trinidad and Tobago, an oil-producing and exporting Caribbean country, to have its crude refined. As payment for refining the crude oil, a fraction of the refined oil is kept by Trinidad and Tobago and the remainder sent back to Barbados. This portion though is insufficient to meet the energy demand of Barbados, as the country consumes about 8000 bpd. Additional oil is thus imported from Trinidad and Tobago to satisfy this demand, which is used mainly for electricity generation (50%) and transportation (33%).

Barbados' economy, which is services-driven (mainly tourism), grew at an average of 2.3% over the last ten years. Like other developing countries, Barbados has faced an electricity demand which has increased over time. In conjunction with economic growth, per capita consumption of electricity has steadily increased over the last few decades ranging from 1331 kW h in 1980 to 3092 kW h in 2004. Over this same period, electricity consumption grew an average of 3.6% per year. Fig. 1 charts how Barbados' energy intensity has evolved over the last 27 years (1980–2006). Over this period, Barbados' energy intensity fluctuated mainly between 5000 and 6000 Btus. Recently this index has declined, which may be a signal that Barbados has become more efficient in its conversion of energy into GDP, even though its per capita consumption has increased.

As indicated in Table 1, the largest single category of users is the residential sector, which accounted for one-third of total consumption in recent years. At present, the electricity sector in Barbados is a government-granted monopoly; only one company is involved in generation, distribution and transmission. Electricity pricing is regulated by a government institution in an effort to shield customers from possible monopoly pricing by the sole provider. This has resulted in stable prices averaging between 30 and 40 BBD cents/kW h.

## 3. Literature review

The relationship between energy consumption and economic growth has been examined for different countries and different periods, utilising various econometric methodologies. Following the seminal work of Kraft and Kraft (1978), a rapidly increasing body of literature has assessed the empirical evidence for both developed and developing countries. Kraft and Kraft found evidence of a unidirectional causal relationship from GNP to energy consumption in the USA for the period 1947–1974. Akarca and Long (1980) using the same data as Kraft and Kraft, but for the 1947–1972 period found no relationship between the variables.

Recent studies have still not arrived at a consensus on the role of energy in economic development (see for example, Lise and Van Montfort, 2007; Mehrara, 2007; Narayan and Singh, 2007; Zamani, 2007). A common characteristic of these studies was the use of a

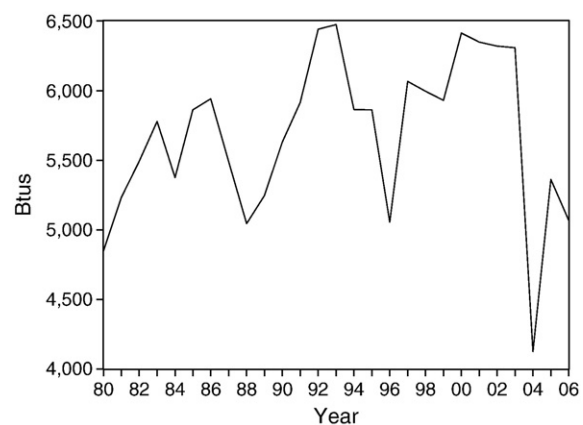


Fig. 1. Barbados' energy intensity (Btus/USD).

Source: Energy Information Administration available online at: <http://www.eia.doe.gov>.

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