BELIZE'S ENERGY SECTOR: CHALLENGES AND OPPORTUNITIES[1]

A. Executive Summary

1. Belize's demand for energy has significantly increased in recent years, along with its dependence on imported energy. Energy consumption increased fourfold during 1980–2012, a consequence of a steady expansion of the economy. Imported energy, essentially fuel products and electricity, grew rapidly during the same period. Imported fuel increased 117 percent during 1980–2013 and net imports of electricity rose 47 percent during 2001–13.

2. Belize's dependence on imported energy has also increased its vulnerability to volatile energy prices. This has raised the need to develop and implement a national energy policy that reduces this vulnerability**.** Staff's analysis shows a relationship between GDP growth, energy consumption and energy efficiency. It indicates that improving overall energy efficiency and diversifying energy sources could reduce growth volatility in the short run and raise the potential growth in the long run.

3. The authorities' strategy for the energy sector envisions an improvement in energy efficiency as well as diversification of energy sources. The plan aims at improving energy efficiency by 30 percent by 2033 and reducing the country's dependence on imported fuels by 50 percent by 2020.

4. Implementing the authorities' energy strategy will likely pose challenges. On the upside, Belize has some comparative advantages in the supply of renewable energy, and a supporting regulatory framework for private sector participation in electric power supply. However, the strategy seems too ambitious; its objectives may need to be revisited, perhaps focusing on just a few of them, in light of Belize's financial and capacity constraints. The success of the strategic plan will depend critically on private sector participation and investments.

B. Introduction

5. Belize has seen steady economic growth with an increasing demand for energy in recent years. Annual GDP growth averaged above 5.4 percent during 1981–2007, but declined to about 2.5 percent during 2008–13. Growth accounting estimates suggest that slower total factor productivity (TFP) growth and less investment in fixed capital are the main drivers of the slowdown of GDP growth after 2008. At the same time, high energy costs, fossil fuel dependence, outdated energy infrastructure, and vulnerability to adverse weather and oil market developments continue to constrain higher and sustainable growth. The government is developing a national strategy to

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promote energy efficiency in all sectors of the economy. The strategy will deepen domestic renewable sources of energy.

6. The authorities' strategy for the energy sector contemplates improving energy efficiency and conservation across all sectors of the economy as well as diversification of energy sources. The plan aims at reducing per capita energy consumption by at least 30 percent by 2033, and cutting the country's dependence on imported fuels by 50 percent by 2020. These targets would be achieved by increasing the production of domestic renewable energy resources and improving energy efficiency and conservation.

7. If well implemented, the national energy strategy could help to support growth, including through attracting private investment. Staff estimates that a 10 percent improvement in overall energy efficiency could raise real GDP by 9 percentage points over 10 years.

8. Nonetheless, implementing the authorities' energy strategy will likely pose challenges. On the upside, Belize has some comparative advantages in the supply of renewable energy, and a regulatory framework that supports private sector participation in electric power supply. Nonetheless, the authorities' strategy seems too ambitious; its objectives may need to be revisited, perhaps focusing only on fewer objectives, in light of Belize's financial and capacity constraints. The success of the strategic plan will depend critically on the extent of private sector participation and investments. Regulatory reforms and an improved business environment are necessary to attract private sector investors to the energy sector.

9. The strategic plan's objective of replacing most of the fossil fuel may be too costly and alternative options should be considered. The plan could seek reliability of energy supply by improving dependability and resilience of the electric power grid, and diversifying the electric power generation mix by expanding renewable sources such as biomass. Some renewable energy sources such as solar and wind may be relevant for some remote regions. However, they are unlikely to provide most of the base load electric power as they are still comparatively expensive and there are technical limits to the amount of intermittent sources of energy such wind and solar energy can contribute without jeopardizing the reliability of the electric grid.

10. This remainder of the note is organized as follows. Section C presents an overview of Belize's energy sector including the energy matrix, the electricity sector, and the institutional and regulatory framework. Section D examines the macroeconomic effects of energy prices and energy consumption in Belize**.** Section E reviews the challenges and opportunities facing the energy sector. Section F sums up the discussions and provides some recommendations.

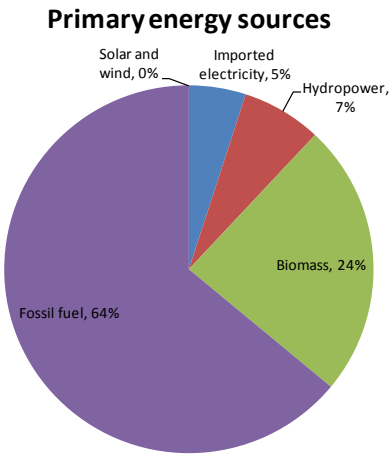
C. Overview of the Belize Energy Sector

Energy matrix and efficiency

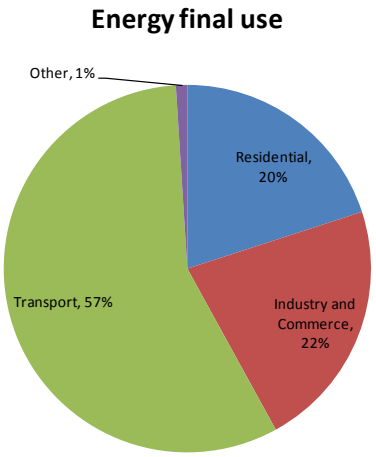
11. Belize relies heavily on imported fuel and electricity for its increasing energy needs (Figure 1). The primary energy sources comprise imported fossil fuel, imported electricity, hydroelectric power, and biomass from sugarcane bagasse. The shares of wind and solar energy are negligible. In 2010, the main consumer of energy was the transport sector (47 percent of total energy consumption, essentially fuel products), followed by the industrial sector (27 percent, mostly electricity). The residential, commercial, and service sectors accounted for the remaining energy consumption (mostly electricity). All refined oil products (gasoline, diesel, kerosene, and aviation gasoline) are imported from Venezuela under the Petro-Caribe Agreement and transported to Belize via ocean tankers. Small quantities of gasoline and diesel are also imported from neighbouring countries.

Figure. 1. Belize: Energy Matrix and Consumption

Belize is highly dependent on imported fossil fuel for its energy needs …



…transport consumes most of the energy, followed by industry, commercial and households

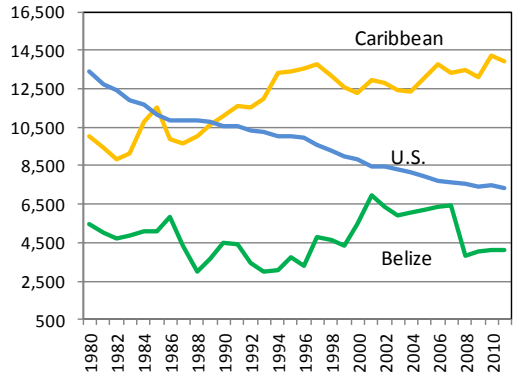


Source: Belize National Energy Policy Framework, 2011.

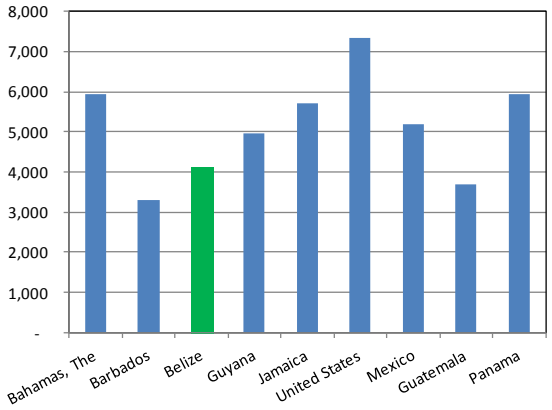
12. Belize's use of energy per unit of output has remained relatively stable at about 4,000 BTUs per unit of GDP, well below the Caribbean average. Belize's energy efficiency also compares well with other Caribbean and Central American countries. However, it remains higher than in countries such as Guatemala and Barbados, suggesting room for improvement and a cost effective option to meet the increasing demand of energy.

Figure. 2. Belize: Energy Consumption Efficiency
(Consumption of enertgy in BTUs per unit of GDP)

Belize use of energy per unit of output has remained below the Caribbean average.



Belize consumption of energy per unit of output also compares well with other countries.



Source: EIA.

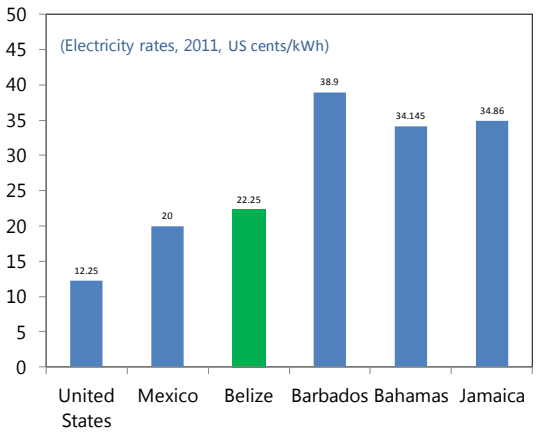
Electricity sector

13. Electric power has been essential for economic growth, particularly in the two most important sectors of the economy (tourism and agribusiness). Electric power generation is provided by a number of independent suppliers, including Mexico. In 2012, 45 percent of the electricity generation output was purchased on the spot market from Mexico's Federal Energy Commission (CFE). Electricity distribution is mainly through a 115 kV transmission line that covers the entire northern and western parts of the country, while the southern areas are partly covered by a 69 kV transmission line. The national electric grid connects all the districts and is interconnected with Mexico. In some remote locations, consumers self-generate electricity. In 2011, the government nationalized the Belize Electricity Company (BEL), acquiring 70 percent of its shares. Currently, BEL is the sole buyer of electricity from public and private generators and the only distributor of electricity to final users.

14. Belize's electricity rates are low by Caribbean standards, but high by U.S. and Latin American standards. Electricity is not subsidized. The average electricity tariff was broadly stable at about 0.22 US$/kWh from 2007 to 2012. Since 2012, the average tariff in Belize fell to 0.20 US$/kWh as result of cheaper electricity from Mexico and fossil fuels. The price is mainly determined by generation costs and BEL's transmission and distribution costs, which include taxes. Generation costs are determined by the electricity generation mix, which mainly comprised CFE's imports, low-cost hydroelectric energy, and cogeneration using biomass. However, these hydroelectric resources greatly vary depending on rainfall. Moreover, the electricity imported from Mexico is tied to the international price of crude oil. Compared with the region, Belize's transmission and distribution losses are not substantial at 12 percent.

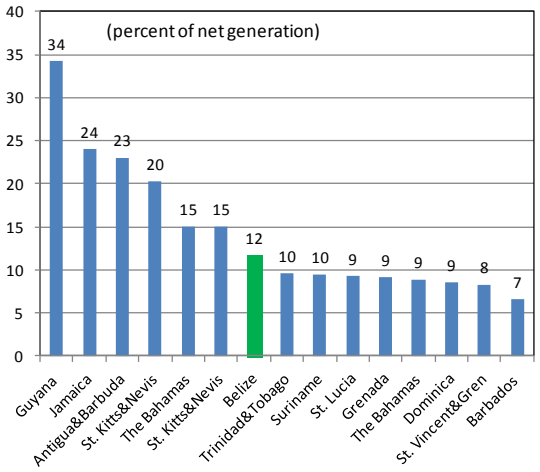
Figure. 3. Belize: Electricity Sector at Glance

Belize rates are lower than Mexico and most of Caribbean, but still 50% higher than the U.S. …



Source: CARILEC and EIA.

… transmission and distribution losses are not substantial.



Sources: CARILEC, EIA, and CARICOM.

Institutional and regulatory framework

15. Belize has a transparent institutional and regulatory framework for energy:

- In March 2012, the government created the Ministry of Energy, Science, Technology, and Public Utilities (MESTPU) to supervise and regulate the electricity and gas and petroleum hydrocarbons subsectors.

- The petroleum sector is governed by the Petroleum Act (2000). The Act reserves the Government the right to extract hydrocarbons, or to award contracts to the private sector to do so. Petroleum contracts are issued to qualified petroleum companies to explore and produce petroleum. Existing contracts in Belize are exploration and production contracts. Each contract requires the Contractor to pay a royalty, production share and income tax to the Government. A petroleum surcharge fixed to oil prices was recently introduced in 2008 and is payable according to oil prices. The royalty, production share and working interest is negotiable with a minimum royalty of 7.5 percent for oil and 5 percent for natural gas. The income tax is fixed at 40 percent on net income. The contractor can recover 100 percent of all expenditures before payment of production share and has the right to claim several tax exemptions. No customs duties are to be paid for the importation of physical capital, no export tax on any product, or any additional import or export tax on household goods used by the working crew.

- The Electricity Act (1992), its amendments (1999 and 2007), and the Electricity Bylaws (2005) are the main pieces of legislation that provide the legal framework for the electricity subsector. The bylaws govern the tariffs, rates, charges, and fees for the transmission and supply of electricity and

for existing and new services to be charged by a licensee to consumers in Belize. In addition, the bylaws establish the formulas, and procedures for calculating and determining these tariffs, rates, charges, and fees, as well as the methodology for periodic review proceedings as well as the quality of service (service reliability standards). The Public Utilities Commission (PUC), created in 1999, regulates tariffs and the quality of the electricity service. It also grants licenses for generation, transmission, and distribution, and ensures that all reasonable electricity needs are met.

D. Macroeconomic Effects of Energy prices and Energy Consumption in Belize

16. Staff's analysis quantified the impact of oil price volatility on the macroeconomic performance of the Belizean economy using various econometric techniques. For the short-run analysis, a vector autoregressive (VAR) model was used with block exogeneity restrictions in line with the spillovers effects literature.[2] The analysis also quantified the roles of energy consumption and efficiency strategies in output growth in the long-run using a dynamic cointegration model in line with energy-growth nexus literature.[3]

17. The short-run analysis indicates that a positive shock to real oil price reduces output in Belize (see Annex I). Real oil shocks explain on average 8.6 percent of business cycle fluctuations in Belize (Table A1.1). Figure A1.1 shows the dynamic response of growth to a one-percent shock to real oil price: output growth decreases, with effects lasting one to three years, and the largest response typically occurring within one year after the shock. Elasticities derived from the impulse response functions indicate that a 10 percentage point increase in real oil price reduces Belize's real GDP growth by about 0.7 percentage point over three years.

18. A positive shock to real oil price appreciates the REER, reducing Belize's external competitiveness. Figure A1.1 also shows the dynamic response of the real effective exchange rate change (REER) for Belize to a one-percent shock to real oil price. Again, elasticities derived from the impulse response functions, indicate that a 10 percentage point could appreciates the REER by 0.2 percentage points over 3 years. After three years, the REER stops appreciating but stays at its more appreciated level.

19. The long-run analysis indicates that energy consumption, energy efficiency, and gross capital formation play a significant role in determining GDP over the long run (see Annex I). In the long-term, the results show that an increase of 1 percent of energy use per capita could increase GDP per capita by about 0.37 percent on average, while an increase in 1 percent of gross capital formation could increase GDP per capita by 0.46 percentage points, and an improvement of 1 percent in energy efficiency could increase GDP per capita by 0.94 percentage points.

[2] See Cashin and Sosa (2013) and Osterholm and Zettelmeyer (2008).

[3] See Pesaran, Shin and Smith (1998), Giraud and Kahraman (2014), and Stern and Kander (2012).

20. In summary, staff's quantitative analysis underlines the vulnerability of Belize's economy to imported energy prices and the need to develop an energy policy to mitigate the undesirable effects. In particular, it shows a relationship between GDP growth and energy consumption and energy efficiency, indicating that improving overall energy efficiency and diversifying the energy mix could reduce growth volatility in the short run and raise output growth in the long run.

E. Challenges and Opportunities

21. The authorities' strategy for the energy sector indeed contemplates improving energy efficiency as well as diversification of energy sources (Box 1).[4] In 2011, the government launched the National Energy Policy (NEP), which contained an extensive list of policy recommendations to address the problems of the energy sector in Belize. The NEP's two main strategies are promoting energy efficiency in all sectors of the economy and developing domestic dependable domestic renewable sources of energy. In 2012, the MESTPU released its National Strategic Plan for 2012–17. The Plan's objective is to integrate energy, science, and technology into national development planning and decision making to catalyze sustainable development.

Box. 1. Belize: The Main Objectives of the Energy Strategic Plan

- Improve energy efficiency and conservation across all sectors: transport, industry, and commercial and residential buildings with a view of reducing per capita energy intensity by at least 30 percent by 2033
- Reduce the country's dependence on imported fuels by 50 percent by 2020, from one million barrels to one-half million barrels, by increasing the production of domestic renewable energy resources, coupled with improving energy efficiency and conservation.
- Triple the amount of modern energy carriers derived from waste material. Depending on the technology choices, electricity, liquid fuels, and gaseous fuels could be produced.
- Turn Belize into a net electricity exporter by 2020.
- Build the Ministry of Energy, Science, Technology, and Public Utilities institutional capacity to accomplish its mandate (MESTPU, 2012).
- Promote and encourage science, technology, and innovation promotion strategies.

22. The authorities have taken steps to reduce dependence on imported electricity and fossil fuels. In 2013, the PUC issued a request for proposals (RFP) for new generation capacity to increase by 40 percent the current electric power installed capacity of 156 MW. The RFP called for the addition of 50MW of firm generation capacity (biomass, hydro, or fossil fuel) and 15MW of

[4] There is no definitive costing of the investment required for the energy strategy plan. For the electric sector, the cost is estimated at about US$133 million (8 percent of GDP). Power generation would require private sector investments of about US$59 million (3.6 percent of GDP) according to the IDB, and an additional US$74 million (4.3 percent of GDP) to upgrade the transmission and distribution grid according to BEL.

intermittent renewable generation (most likely wind) to be installed in Belize between 2013 and 2023.

23. Implementing the authorities' national energy strategy will likely be a challenge given Belize's financial and capacity constraints, and thus alternative options must be considered. The success of the strategy depends vitally in private sector participation and investments. Improving energy efficiency (both production and consumption of energy) across all sectors of the economy seems to be the best alternative for reducing energy costs in the short term. They would require less investment and rely more on regulatory reforms and building codes ("low hanging fruit"). On the production side, there is room to reduce substantially technical and commercial losses in electric power generation and transmission. On the energy consumption side, there is scope to make buildings more energy efficient. The design and quality (of the construction) of the building envelope are the major determinants of how much light, cooling and heating are used. Over the last two decades, developing countries, following in the footsteps of Europe and the U.S., have become aware of the need to design energy efficiency into buildings. Ways to promote more efficient use of energy in buildings include introducing new building energy efficiency codes, promoting energy auditing, and retrofitting existing buildings with more efficient lighting and cooling systems. In the public sector, major energy saving could be achieved by using more efficient street lighting. Although BEL seems to be operating at acceptable levels, it could improve its operational performance by reducing technical and commercial losses.

24. Diversifying the electric power generation mix by expanding renewable sources of energy is appropriate, where commercially viable. Two promising sources of renewable energy in Belize are wind and biomass. The country has some wind resource potential, both offshore and onshore. The National Renewable Energy Laboratory of the United States estimated in 2008 that the country had 737 sq km of moderate to excellent wind resource potential (class 3–7 wind) at 50 m. A study carried out for the government estimated the undeveloped hydroelectric potential of the country to be approximately 75 to 100 MW. Currently biomass accounts for 14 percent of total electricity output, and it could be substantially increased in a relatively short time. According to Belize Co-Generation Energy Limited, the country has additional bagasse resources that could be used for electricity generation.

F. Conclusion

25. Belize's increasing demand for energy and its heavy reliance on imported energy has made the country vulnerable to energy price volatility with non-negligible impact on both Belize's short-term and long-term growth. Staff's quantitative assessment of the macroeconomic effects of energy prices and energy consumption in Belize showed a potential relationship between growth and energy consumption and energy efficiency, indicating that improving overall energy efficiency and diversifying the energy mix could reduce growth volatility in the short run and raise the potential growth in the long run.

26. The authorities' strategy for the energy sector rightly contemplates improving energy efficiency as well as diversification of energy sources but its implementation could pose

challenges given Belize's financial and capacity constraints. On the upside, Belize has some comparative advantages in the supply of renewable energy, and a regulatory framework that supports private sector participation in electric power supply. The Strategic Plan has correctly identified strategies and policies for the energy sector. However, it seems too ambitious. In particular, its objectives may need to be revisited in light of Belize's financial and capacity constraints. The success of the strategic plan will depend critically on private sector participation and investments. Regulatory reforms and improved business environment are necessary to attract private sector investors to the energy sector.

27. The authorities could also consider alternative options for the energy sector. The strategic plan's objective of replacing most of the fossil fuel may be an elusive and costly strategy. Reducing the country's dependence on imported fuels by 50 percent may not be feasible in the foreseeable future. Instead, the plan could seek reliability of energy supply such as building a second transmission line linking to Mexico's grid, improving the dependability and resilience of Belize's electric power grid, and diversifying the electric power generation mix by expanding renewable sources such as biomass. Some renewable energies such as solar and wind may have some relevance for some remote regions. However, they are unlikely to provide most of the electric power as they are still comparatively expensive and there are technical limits to the amount of energy such sources can produce and intermittently inject in the national electric grid. More generally, the strategic plan could perhaps focus more on fewer objectives and projects corresponding to the authorities' implementation capacity. Energy saving measures would require less investment. Priority could be given to new energy efficient building codes, more efficient street lighting, better road infrastructure, reduction of electric transmission losses, and adoption of more efficient household appliances.

Annex I. Quantitative Assessment of the Effects of Energy Prices and Energy Consumption in Belize

Quantitative Assessment: Short-run

In order to quantify the oil price impact on output and real exchange rate, the analysis in Reynaud and Mejia (2015) is used. Reynaud and Mejia estimated a Belize-specific vector autoregressive (VAR) model with block exogeneity restrictions. The model contains an external block including foreign economic variables—the real oil price growth rate, advanced economies real GDP growth rates, and the advanced economies real interest rate; and a domestic economy block—including real GDP growth rates and the real effective exchange rate (REER) growth rates. The specification of the model incorporates the small open economy assumption that foreign variables are completely exogenous to the domestic economy. Using variance decomposition analysis, the relative contribution of each of the external factors to the variance of real GDP growth is quantified. Impulse responses, in turn, illustrate how domestic output growth has reacted to each of these external shocks. The model is estimated using annual data from 1976 through 2013.[1]

The main objective of the model is to evaluate the impact of oil prices shocks on Belize business cycle fluctuations and is achieved through two standard tools of VAR analysis: forecast error variance decompositions and impulse response functions. Variance decomposition analysis is used to quantify the relative importance of each type of shock as a source of output fluctuations over the sample. Impulse responses constitute a practical way to illustrate how growth has tended to react to oil price shocks, taking into account not only the direct effects, but also the indirect effect through reactions of other variables.

[1] GDP data is taken from the IMF World Economic Outlook database, data on the Real Effective Exchange Rate (REER) from the IMF Information Notice System, oil price data from the IMF Primary Commodity Prices database The natural disaster dummy variable is constructed as in Acevedo (2014) and accounts for natural disasters of all types (storms, floods, earthquakes, volcanic activity, and droughts).

Table A1.1. Belize: Variance Decomposition and Elasticity to 10% Oil Price Shock

Real oil shocks explain on average 8.6 percent of business cycle fluctuations in Belize.

Variance decomposition of impact on GDP

GDP	58.6
World demand	16.5
Oil price	8.6
Real effective exchange rate	15.5
World real interest rate	1.0

A positive shock to real oil price reduces real GDP and appreciates the REER.

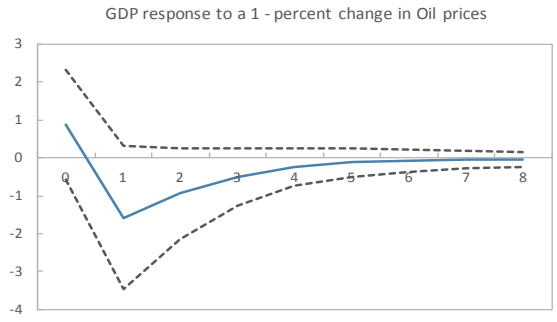
Elasticity to 10% oil shock 1/ 2/

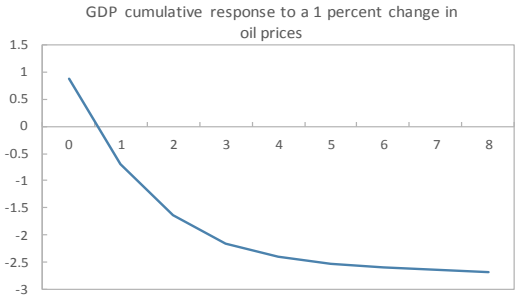
	Year 0	Year 1	Year 2	Year 3
pp. on real GDP y/y	0.27	-0.49	-0.29	-0.16
pp. on REER y/y	-0.09	0.26	0.08	-0.02

1/ Shock is 1 st. dev., or 32,2 percent increase in oil price.
2/ Sample: 1976-2014.

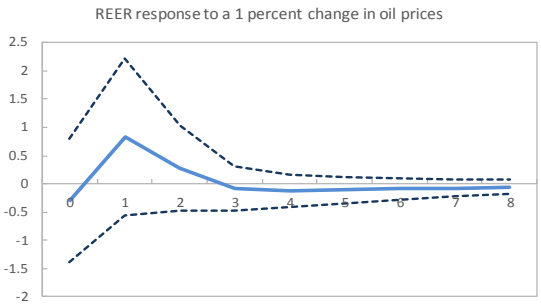
Figure A1.1. Belize: VAR GDP and Real Effective Responses to a Change in Oil Prices

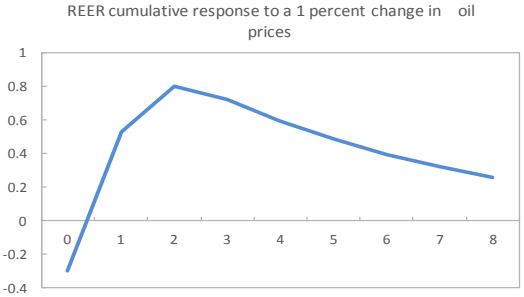
10 percentage point increase in real oil price reduces Belize's real GDP growth by 0.7 percentage point over three years





A positive shock to real oil price appreciates the REER reducing Belize's external competitiveness





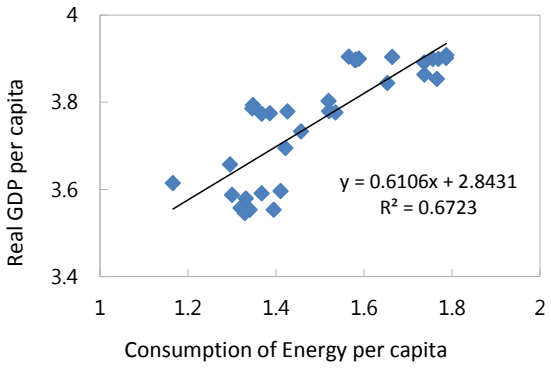
Quantitative Assessment: Long-run

The short run quantitative assessment has shown that oil price shock could have a potential impact on output and external competitiveness that requires an energy policy to mitigate these undesirable effects. Looking into the long-run relationship between growth and energy can provide parameters and recommendations regarding the alternative energy policies.

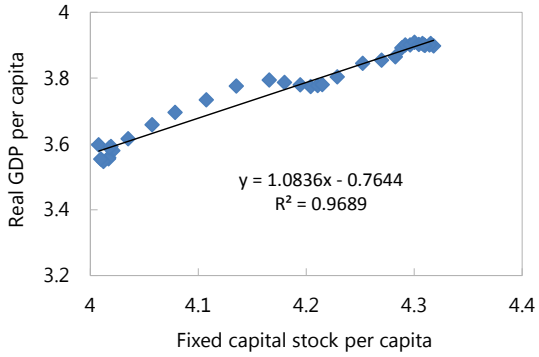
An overview of the data shows that output per capita is positively correlated with capital stock per capita, energy consumption per capita, and energy efficiency defined as energy consumption per unit of carbon emission (Figure A1.2). Energy efficiency has improved significantly since 2008, increasing from an average of 16 million BTU per metric ton of carbon emission during 1980–2007 to 22 million BTU during 2009–12.

Figure A1.2. Belize: GDP, Capital, Energy Consumption and Energy Efficiency

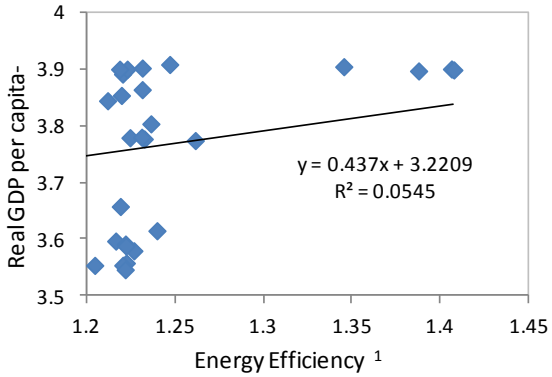
Real GDP per capita is positively correlated with energy consumption per capita …



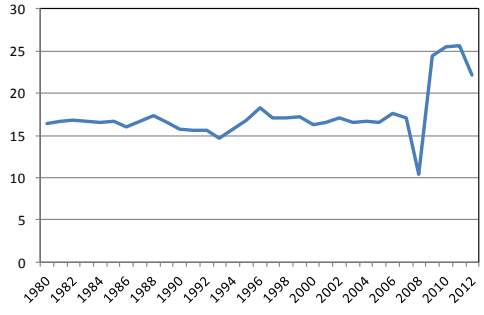
… and fixed stock of capital per capita …..



Real GDP per capita is positively correlated with energy efficiency …



… energy efficiency has improved since 2008.



Cointegration and vector error-correction techniques are used to evaluate the long and short-term relations between energy consumption and GDP in Belize. The model is estimated using annual data from 1980 through 2011.[2] Results indicate that energy consumption, energy efficiency, and gross capital formation play a significant role in determining GDP over the long run (Table A1.2). Cointegration among the variables cannot be rejected at 6 percent significance level. In the long-term, the results show that an increase of 1 percent of energy use per capita increases GDP per capita by about 0.37 percent on average, while an increase of 1 percent of gross capital formation increases GDP per capita by 0.46 percent points, and an improvement of 1 percent in energy efficiency increases GDP per capita by 0.94 percentage points.

Table A1.2. Long-term Elasticities of Real GDP per Capita

	Caribbean 1/	**OECD**	**Belize** 1/
Energy consumption per capita *(c)*	0.38 ***	0.67 ***	0.37**
Energy efficiency *(e)*	0.42 ***	0.60 ***	0.94 **[2/]
Capital formation per capita *(k)*	0.25**	0.12 ***	0.46 **

Sources: Caribbean estimates by Reynaud and Acevedo (2015), OECD estimates by Gaël and Kahraman (2014), Belize estimates by the author.
1/ Sample 1980-2011 as available.
2/ Energy consumption divided by total carbon emissions.
*** significant at 1% ; ** significant at 5%; * significant at 10%.

[2] Energy Consumption from the U.S. Energy Information Administration (EIA) database, Capital Formation data from the Penn World Table (PWT80), and population data from the World Bank's World Development Indicators. Energy efficiency data is computed as energy consumption per unit of GDP and energy consumption per unit of Carbon emissions.

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