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While visitors conserve, residents splurge: Patterns and changes in energy consumption, 1997-2007

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ABSTRACT

This study analyzes changes in energy consumption in Hawai'i between 1997 and 2007 using input-output analysis. Residents increase their energy use by 33% in electricity and 18% in fuel, largely due to direct consumption. In contrast, visitors contract energy demand by 9% and 4% in electricity and fuel, respectively. The findings are robust at per-capita levels. Key drivers are the significant drops in energy intensity of primarily three industries: air transportation, hotels, and restaurants. Further analysis decomposes the change to evaluate the underlying factors.

1. Introduction

Hawai'i features a modern service-oriented economy focused largely on tourism, military, healthcare, and professional services. Tourism in particular contributes significantly to the Hawaiian economy. Each year, over seven millions visitors enjoy the pristine environment and unique culture of the Hawaiian Islands. For example, in 2010 Hawai'i tourism industry produced 11.2 billion or 17.3% of Gross State Product (Hawai'i Tourism Authority (HTA), 2010). At the same time, visitors' activities require the services of the most energy-intensive industries. In 2007, the electricity consumption of an average visitor is about 2.5 times higher than that of an average resident on a daily basis. Part of energy consumption is directly tied to consumer decisions such as the purchase of electricity, highway fuel, and natural gas utilities. A significant component of consumer demand for energy, however, is indirect and is determined by purchases of goods and services that require energy in the production process. With consumption of fuels and electricity relatively higher for visitors than for a typical resident, there is a need to benchmark energy usage by demand sectors and align existing energy efficiency and conservation (EC&E) programs to target performance that can provide benefit to better grid.

The study uses input-output analysis methodology to analyze patterns and changes in fuel and electricity consumption for residents and visitors in Hawaii for the base years 1997 and 2007. A growing number of studies have successfully applied input-output methodology in the analysis of energy issues. Examples are Park (1982), Lenzen (1998), Wu and Chen (1990), Gowdy and Miller (1991), Hawdon and Pearson (1995), Park and Heo (2007), Pachauri and Spreng (2002), Ukidwe and Bakshi (2007), Nässén et al. (2007), Carballo Penela and Sebastián Villasante (2008), Yuan et al. (2010).

In particular, this study expands on a previous contribution by Konan and Chan (2010) that used input-output data and energy consumption data, in an applied general equilibrium framework to model greenhouse gas emission (GHG) associated with economic activity in Hawai'i. Konan and Chan (2010) identify air transportation, electricity, and other transportation forms as the main economic activity responsible for GHG emission associated with fuel use. In addition, visitors contribute to more than 20% of the total emission and on per person per annual basis emission rates generated by visitors are relatively higher than those of the residents.

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This study uses a condensed version of input-output data and consumption data to compare fuel and electricity demand of residents and visitors for 1997 and 2007 in Hawai'i.[3] This study is unique in that it develops a methodology to consider structural changes in the economy as captured through input output analysis. Our findings are striking and easy to summarize. First, the results indicate differences in indirect demand for electricity from the industry sectors. On per-capita basis, residents tend to consume more electricity through spending on health services, real estate rentals, professional services, and trade (shopping). Top visitor electricity-intensive expenditures include hotel, restaurants, trade (shopping), and tourism services (museums, tours and travel agencies). Second, when comparing data of 1997 and 2007, the differences are remarkable. Total demand for fuels and electricity increased by 18% and 33%, respectively for residents, but fell both by 4% and 9%, respectively for visitors.

On a person-per-daily basis, the change in energy use is striking over the decade. For residents, fuel use increases by 9% and electricity by 23%. In sharp contrast, energy use by visitors actually falls dramatically, by 21% in fuels and 24% in electricity. Thus, tourism industry has improved efficiency in both fuel and electricity usages by decreasing energy intensity of their activities over the observed decade. Whereas in 1997 a Hawai'i visitor consumed 3.5 times as much fuel as an average resident, by 2007 the fuel use factor dropped to 2.5. Likewise, the 1997 visitor required 2.4 times the electricity as a resident to support their consumption bundle. By 2007, the electricity-use differential dropped to 1.5.

To assess the underlying driving forces influencing the observed changes in energy consumption in Hawai'i a decomposition methodology is used to evaluate industrial energy consumption based on activity, structure, and intensity effects. The findings indicate that the activity effect contributed greatly to the observed growth in energy consumption, that the structural effect was insignificant, and that the reduction in energy intensity by sector was a clear signal of improvement in energy efficiency.

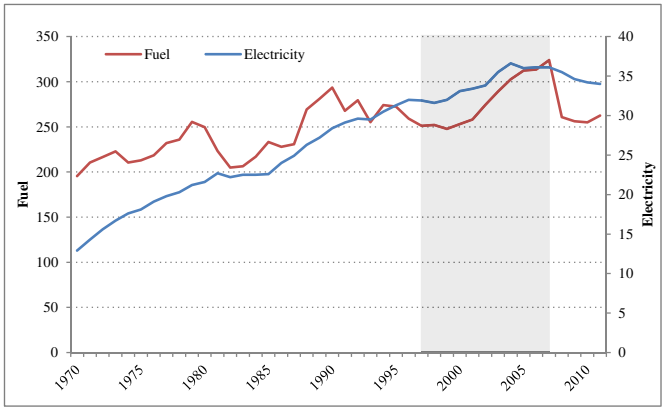
The study is organized as follows. Section 2 provides an overview of fuels (coal, petroleum products, and natural gas) and electricity consumption in Hawai'i. Section 3 presents the input-output analysis methodology derived from Konan and Chan (2010) and decomposition methodology based on Ang (2005) as well. These methodologies are applied to the 2007 energy and economic data in Section 4. Section 5 presents the empirical results. Finally, Section 6 offers summary and concluding remarks.

2. Overview

Hawai'i's economy depends heavily upon petroleum and its energy sector is the most petroleum intensive among U.S. states. Imported crude oil accounts for 85% of the total primary energy supply in 2009. Coal imports comprise 7% of total primary energy. The remaining 8% is supplied from renewable resources (biomass, wind, and solar) and some imported liquefied petroleum gas (LPG).

Primary energy carriers are converted into secondary energy carriers to supply the final demand through power plants, oil refineries, and petroleum-based synthetic natural gas (SNG) plant. Hawai'i has no fossil fuel reserves; the renewable energy portfolio is relatively small, representing about 7.4% of total energy demand. Thus, Hawai'i's energy demand is supplied largely by imported crude oil, 90% of which originates from foreign sources.

Energy is primarily used for transportation and power sectors, which account for 60% and 30% of fuels, respectively. The remaining 10% of energy use is divided between residential, commercial, and industrial sectors. Likewise, electricity is evenly distributed across residential, commercial, and industrial consumers.



Data Source: U.S. Energy Information Administration, SEDS: Hawaii (EIA, 2013).

Fig. 1. Change in Hawai'i Energy Consumption (Trillion BTU); 1970-2011. Data Source: U.S. Energy Information Administration, SEDS: Hawaii (EIA, 2013).

Fig. 1 depicts trends in Hawaii's fuel and electricity consumption from 1970 to 2011. Overall, consumption for both electricity and fuel has drifted upwardly, while the former exhibits a relatively smoother trend than the latter. Electricity consumption consistently grew by an annual average rate of 3% until 2004, when it peaked at 36.1 trillion BTUs (10.73 TWh). Since then, however, it has been decreasing annually by 1%.

Fuel demand, on the other hand, experienced ups and downs during the past four decades. Before it spiked in 2007 to its ever-high record of 324 trillion BTUs, fuel consumption grew on average 2% annually. The uptick in fuel demand in 2007 is specifically caused by a very high demand for marine transportation fuels, although the air and ground transportations also contributed to high fuel demand in 2007. Lower fuel demand by industrial and electric power sectors than those in 1997, however, put the total 2007 fuel demand at 30% above 1997 (19% in per-capita terms).

Alarmed by the high energy demand and its detrimental effects on the economy and energy security, the State of Hawaii in 2008 announced its "Hawaii Clean Energy Initiative"[4] consisting of measures to curtail its overall energy consumption. Policies were targeted at reducing the heavy reliance on fossil fuels, improving conservation and efficiency in energy use, and promoting alternative renewable energy deployment. From this perspective, although in 2008 the 30% worldwide increase in energy price led to a global recession, it concomitantly resulted in a major drop in fuel and energy consumption in Hawaii by 19%. Fig. 2 shows average fuel and electricity prices between 1970 and 2011, in both real and current dollars.

3. Methodology

In this section, we present a methodology for attributing energy consumption (fuels or electricity) to end-use agents (residents and visitors) based on intermediate and final demand. Changes in energy use over time are then decomposed to evaluate sources of change.

[3] Whereas this paper uses 14-sector level of input-output data, the Original 1997 and 2007 input-output tables for Hawai'i consisted of 131 sectors 68 sectors, respectively.

[4] State of Hawai'i signed an MOU with the U.S. Department of Energy for the Hawai'i Clean Energy Initiative (HCEI) with the goal of decreasing energy consumption by means of increased energy efficiency (up to 30%) and increased share of renewable energies (up to 40%) in Hawai'i's energy supply in order to meet 70% clean energy target of Hawai'i's projected demand by 2030. Hawai'i legislatures passed the renewable and efficiency targets into law, called RPS and EEPS.