Reducing trade-offs between Economic growth and Carbon Emissions for Singapore: Promoting Green Energy and Efficiency Policies amidst Constraints and Uncertainties.

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Overview

Singapore is a small nation state of approximately 5.4 million people and 716sq km. With virtually no local supply of energy resources, energy diversification and energy efficiency policies must be subject to security of supply, land limitations, as well as uncertainties with regards to population and economic growth. Despite emphasizing still on economic growth as a tool for sustainable development, the country has taken great strides towards the promotion of cleaner and more sustainable energy behaviour. The increase in electricity supply from solar cells as well as its mandatory green buildings policies, are just some examples of government efforts. The question now hinges on how to strike a balance between green energy policies and economic growth, moving forward into the future.

This paper has constructed multiple energy scenarios and look at the corresponding emissions with the help of dynamic econometrics and forecasts based on different combinations of population, economic growth, and energy policies for each sector in the economy. Particular emphases were placed on the impact of green energy and population policies on the trade-offs between forecasted energy demand and economic growth. The analysis will focus on which scenarios are the most feasible based on the current trends and the government's future efforts.

Methods

Econometric methods, which include the Autoregressive Integrated Moving Average (ARIMA) Process, the lagged endogenous Model and other linear regression models where applicable, are used to explore time-series relationships between both macroeconomic variables with energy demand. [1][2][3] Different energy baseline forecasts are created for multiple economic growth and population assumptions, to explore the impact mainly on Baseline and Business-As-Usual (BAU) scenarios.

Time series data from 1971 to 2012 for energy demand from the International Energy Agency (IEA) [4], as well as economic variables from the Department of Statistics Singapore (DOS) [5] and International Monetary Fund (IMF) [6] are used. The best-fitted models are then taken to conduct sector-specific forecasts in the economy for both the Business-As-Usual (BAU) and alternative energy pathways. Real Prices are obtained from figures provided by the Institute of Energy Economics Japan (IEEJ).

Together with the help of a simulation software; Long-Range Alternatives Planning Model (LEAP) [7], and assumptions on future energy policies based on a combination of official announcements and historical trends, multiple alternative energy pathways [8][9][10] are created based on multiple BAU scenarios constructed to ascertain the benefits of these policies. Suitable diagnostic tests such as autocorrelation, serial correlation and co-integration tests, as well as forecast indicators are utilized to ensure the robustness of the models. Dummy variables and selective data omissions are also imposed to enhance data reliability.

Results

In constructing the baseline (BAS) forecasts of energy demand, it is found that the inclusion of prices do not bring about suitable forecasts for energy demand for most of the sectors except the transport as well as the petrochemical sector. Moving from the low GDP BAS to the high GDP BAS forecasts to 2030, we notice that when GDP increases by 26% keeping population at moderate levels, final energy demand increases by 10.5%, a trade-off ratio of 1:2.5. Carbon emissions trade-off with GDP is at 1:1.7 when the transformation sector is included. In addition, when population is assumed to move from moderate to high levels, carbon trade-offs of accumulated effects increase to 1:1.5. Separately, however, population increase has only marginal impacts, where trade-off is only 1:5.5 when GDP is at moderate levels. In general, carbon emissions will be expected to vary by around 4 million tonnes across BAU scenarios.

These trade-off ratios are reduced when new green energy policies are implemented in the future, based on government interventions. The extent in which they are reduced depends on the type of policies implemented. For example, if the best EE practices in the petrochemical industry and solar power is actively encouraged for high GDP forecasts, trade-off ratio between carbon emissions and GDP goes down to 1:3.25 moving from low GDP BAU to the high GDP-best EE practices forecasts. This causes the absolute energy consumption and emissions gap between these scenarios to be much closer by 2030.

Sensitivity tests for other energy policy scenarios are also tested on various combinations of population and GDP as well. Results are similar, closing the ratio between BAU and those scenarios.

Conclusions

Singapore currently seems to be on track to reach its carbon emission reduction targets by 2020, with annual growth rates expected to decline going forward.

It is possible to reduce trade-offs between GDP and carbon emissions sufficient enough to reduce emissions for the high GDP forecasts to be comparable to the low GDP BAU emissions, if the implementation of green growth policies are intensified for both final energy demand and transformation sector. Economic prosperity is hence not compromised.

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