# *Green Hydrogen and Green Growth - Evaluating the Macroeconomic Impacts of Energy Transitions in Small Open Economies: The Case of Uruguay*

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## Overview

This paper investigates the macroeconomic impacts of adopting green technologies in small open economies (SOEs) reliant on imported fossil fuels. Specifically, it examines the domestic production of green hydrogen as an alternative to fossil fuel imports. Hydrogen is an important Using numerical simulations on a two-sector theoretical model, the paper demonstrates that transitioning to green hydrogen can significantly benefit economic growth, particularly in energy-intensive industrial sectors. The study provides a general framework for analysing energy transition dynamics in SOEs, outlining various pathways for sustainable economic development and decarbonization. Key policy instruments, including optimal carbon pricing and green technology subsidies, are also explored.

Uruguay serves as the perfect case study to analyse the last stages of the energy transition in a SOE, given its recent achievements in renewable energy deployment for electricity generation and its external dependence both for their fossil fuel sources and for financing infrastructure investments. Despite the advances achieved by the first energy transition, the country's energy-intensive sectors, notably transportation and the pulp and paper industry, remain heavily dependent on fossil fuel imports. Uruguay's national strategy for a second energy transition phase prioritizes green hydrogen deployment, exemplified by the "H24U" pilot project (Camus, 2023). This initiative, supported by international development institutions, aims to decarbonize the energy sector.

This paper evaluates the feasibility of Uruguay’s decarbonization plans under the current investment framework and assesses whether green hydrogen deployment can stimulate GDP and employment growth. The findings provide a benchmark for similar economies to assess their potential for industrial development and economic growth through green hydrogen initiatives supported by international funding.

## Methods

This study develops a two-sector theoretical model of economic growth, as depicted in Figure 1. Final goods are produced in an industrial sector using capital, labour, and energy. Energy is supplied by an intermediate sector, either through fossil fuel imports or domestic green hydrogen production. Green hydrogen is produced using an AK-technology, relying on capital stock accumulated via foreign funding.

Methodologically, the model is closely linked to contributions of van der Meijden and Smulders (2018) and Kander and Stern (2014). It extends their models to the context of SOEs and the transition to green hydrogen as a clean energy source. Additionally, the model incorporates insights from Airaudo et al. (2023), accounting for a fossil fuel import dependent economy instead. Numerical simulations calibrate the model using data from Uruguay’s Ministry of Industry, Energy, and Mining to ensure relevance and accuracy.

## Results

The deployment of green hydrogen technologies using domestically available renewable energy resources leads to a substantial decline in energy prices over time. This, in turn, accelerates the growth of macroeconomic variables such as GDP and labour absorption. However, the current investment targets are insufficient to achieve a complete phase-out of fossil fuel imports. Rapidly growing energy demand, driven by lower energy costs, necessitates continued fossil fuel imports to complement green hydrogen production.

As a result, carbon emissions from fossil fuel combustion are likely to persist despite green hydrogen adoption. Introducing a carbon tax as a standalone policy measure can reduce these emissions but at the cost of higher overall

energy prices. Without compensatory measures, such as rebates for green hydrogen producers or households, the carbon tax negatively impacts economic growth rates and delays the energy transition. These findings align with earlier studies by van der Meijden and Smulders (2018) and Airaudo et al. (2023).

## Conclusions

This paper evaluates the potential of green hydrogen infrastructure to replace fossil fuel imports and drive green growth in SOEs. The case of Uruguay demonstrates that leveraging domestic renewable energy and international funding for green hydrogen production can yield significant economic benefits. However, the findings highlight that green hydrogen deployment alone is insufficient for complete decarbonization. Achieving this goal requires greater investment in green technologies and reductions in the energy intensity of production processes. These insights offer valuable lessons for policymakers and stakeholders in other SOEs seeking to transition towards sustainable and resilient energy systems.

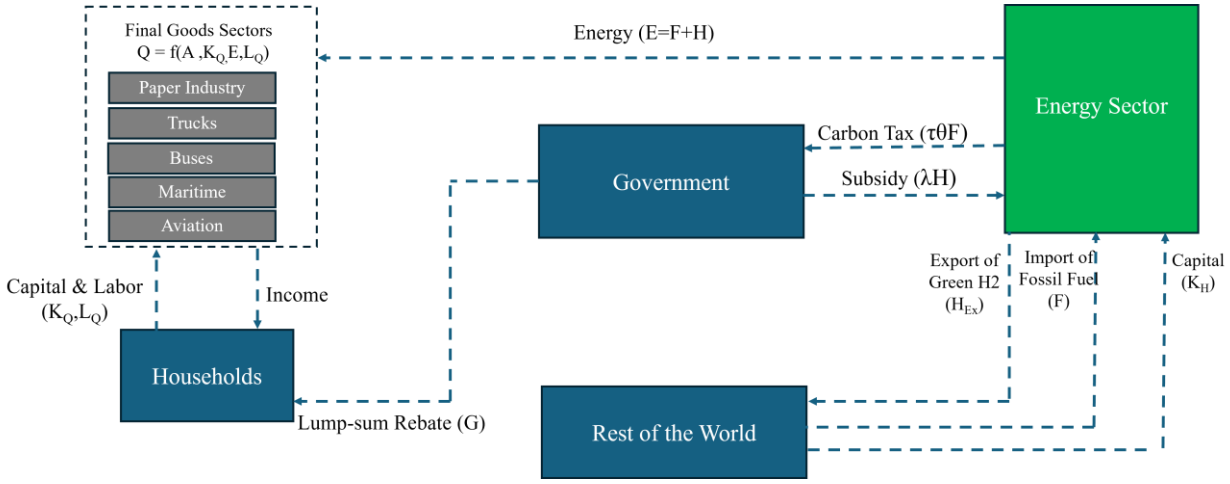


**Figure 1. Two-sector theoretical model of economic growth in a SOE.**

## References


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