ESRI
RESEARCH
BULLETIN
OCTOBER
2021

GREEN HYDROGEN FOR RESIDENTIAL HEATING?

GENARO LONGORIA, MUIREANN LYNCH AND JOHN CURTIS

ESRI ECONOMIC & SOCIAL RESEARCH INSTITUTE

Green hydrogen for residential heating?[1]

Genaro Longoria, Muireann Lynch, and John Curtis*

ESRI Research Bulletins provide short summaries of work published by ESRI researchers and overviews of thematic areas covered by ESRI programmes of research. Bulletins are designed to be easily accessible to a wide readership.

OVERVIEW

Hydrogen is attracting increasing attention as an energy source across several sectors where decarbonisation options are either limited or relatively expensive. Residential heating is one example. Ireland's National Energy & Climate Plan 2021-2030 considers green hydrogen to be an enabler of the transition to a low carbon economy. The term "Green Hydrogen" refers to hydrogen whose extraction does not depend on burning fossil fuels and thus it is advocated as a policy option for decarbonisation. One mechanism to produce hydrogen is through the electrolysis of water, powered by electricity from renewable energy. Hydrogen produced in this way can decarbonise residential heating by blending it with natural gas.

The emissions performance of the electricity system depends on a complex interaction of factors such as thermal and renewable electricity generation, electricity demand, weather conditions, electricity market characteristics, as well as the constraints of the transmission and distribution networks. Given that complexity, the impact of a large-scale deployment of electrolysers within the Irish electricity network either on emissions or other sector metrics, such as electricity prices, is not immediately obvious and is the focus of this research.

METHODS

The analysis is undertaken using a computer model of the electricity system on the island of Ireland. The model is designed to simultaneously determine optimal investments in generation and transmission infrastructures at least cost while respecting the constraints of the power system. Constraints include that sufficient electricity supply must be available at every moment to meet customer demand, not just in aggregate but spatially across the network whilst respecting the power flow capacities of the grid. Renewable power generation expansion must also meet

[1] This Bulletin summaries the findings from: Longoria, G., Lynch, M., and Curtis, J. (2021). Green hydrogen for heating and its impact on the power system. *International Journal of Hydrogen Energy*, 46(53):26725–26740. https://doi.org/10.1016/j.ijhydene.2021.05.171.

*john.curtis@esri.ie

policy targets. Scenarios were developed around the policy target of achieving 70% renewable electricity generation by 2030 and the use of electrolysers and hydrogen storage to supply residential heating demand.

FINDINGS

The emissions performance in the residential heating sector unambiguously improves, as hydrogen displaces natural gas. However, emissions in the electricity sector increase due to the additional thermal generation necessary to meet the extra load from electrolysers. In the scenario examined, net emissions are higher, which means emissions essentially switch from the residential sector to the electricity sector.

The scale deployment of electrolysers necessitates additional power system investment in the transmission network, as well as additional generation capacity (thermal and renewable). While electrolyser deployment facilitates some (minor) expansion in renewable generation capacity, most growth in renewable generation capacity is driven by the 70% renewable electricity policy target for 2030.

The deployment of electrolysers provides benefits to the wider electricity system. Electrolysers reduce curtailment of wind generation, a situation that arises when power from wind turbines is not utilised due to excess electricity supply compared to electricity demand. However, in the context of the policy target to roughly double renewable electricity generation to 70% by 2030, wind curtailment is anticipated to increase 7-fold and the ratio of average wind power output compared to its maximum potential, termed capacity factors, is anticipated to decline by five percentage points to 30%.

POLICY IMPLICATIONS

Hydrogen at the point of use, whether for residential heating as in this study or for transport or industrial purposes, has the potential to displace fossil fuels and reduce emissions. While power-to-hydrogen based on surplus or curtailed wind generation is often nominally labelled as 'green' hydrogen, this research shows that 'green' hydrogen production is not an unambiguous outcome of the deployment of electrolysers on the Irish electricity system. Individual projects should be carefully assessed, recognising the complex interaction of electrolysers and the electricity system.

Hydrogen has a potential role to play in decarbonising the economy particularly in instances where decarbonisation alternatives are challenging. In the example considered here, where hydrogen is used for residential heating, carbon emissions from residential heating decline. In contrast to other policies such as home retrofits, there are no costs or hassle imposed on the residential sector thereby circumventing a critical barrier to reducing emissions in the residential sector. However, if hydrogen production is associated with additional carbon emissions, consideration needs to be given to whether decarbonisation in one sector is simply shifting emissions to elsewhere in the economy.

Whitaker Square,
Sir John Rogerson's Quay,
Dublin 2
Telephone **+353 1 863 2000**
Email **admin@esri.ie**
Web **www.esri.ie**
Twitter **@ESRIDublin**

ESRI ECONOMIC & SOCIAL RESEARCH INSTITUTE