The 2023 IERE-CSRIO Brisbane Hydrogen Workshop
May 22–25, 2023

# Hydrogen transition: opportunities for step changes in energy efficiency of national and regional infrastructure

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**Keywords**: Rewiring the Nation; Supergrid; Superconductivity; systems integration

## Abstract

Australia's energy policy settings at State and Federal level offer an opportunity to deliver a power transformation that matches the impact of debates on electricity transmission over 100 years ago. A $20b "*Rewiring the Nation*" fund along with other aligned incentives suggest that by the 2040–2050 period regional communities may enjoy access to energy resources orders of magnitude greater than today. However, efficient use of energy generated by low emissions technologies is at high risk if planning resorts to last century's business as usual.

Effective use of energy can be measured across a network by the cumulative losses at the furthest extent – a concept well understood by Australia's regional communities; of which some are hundreds of kilometers distant from points of existing conventional generation with AC grid transmission. Projections for renewable energy generation in Australia by 2050–2060 suggest increases between 8 and 40 times existing network market capacity [1]. Uncertainty in these range of values depends on the risk profile and approach taken to moderate Australia's scope 3 emissions *via* energy exports. Hydrogen production, storage, distribution and use are expected to play significant roles in this energy transformation. "*Rewiring*" plans allow for an additional 10,000km of transmission lines by the next decade.

Two well established technologies may greatly assist Australia's energy transformation if deployed with careful thought. Best use of DC power and DC-DC conversion is a simple and effective first step in pathways to energy efficiency [2]. The rise in power electronics and of DC loads in many applications (consumer electronics, data centers, EV chargers, LED lights) imply that continuation of AC-DC conversion may be less effective in the future [2].

Superconductivity (SC) for transmission/distribution of electricity or motors and generators is also key to an energy efficient power system for Australia's rewired grids whether macro or micro. Superconducting (SC) cables for transmission show minimal losses, high current densities (by 100x–200x), enable grid resilience, reduce ancillary installations (*e.g.* transformers) and minimize congestion (physical easements and power) [3]. Underground and/or overhead cables are viable planning options. The combination of DC transmission/distribution and SC use in power engineering – for data centers, smelters and transport – are key to efficient power systems and Australia's energy transformation.

[1] Net Zero Australia, Final Results Summary, April 19th, 2023; [2] Ertugrul, N. and D. Abbott, *Proc. IEEE.*, 108(5) 651-624. [3] Mackinnon, I.D.R., and R.R. Taylor, *The Conversation*, February 7th, 2023.