Which Hydrogen to X application/pathway needs more R&D focus in the next couple of years and why?

Rob Dickinson's "position statement"

Here we present the need for R&D upstream: integrated electricity and H2 production markets.

1) We need to dispel the myth still perpetuated by some that the viability of powerfuels is a function of the input power cost expressed as a single number: often the Levelized Cost of Electricity (LCOE). c.f. for example, what was once the world's largest battery: Hornsdale Power Reserve (HPR). The original investment intent was to profit from arbitrage: buy low sell high in the wholesale market. In practice HPR now loses in the arbitrage market because the Frequency Control Services (FCAS) market is vastly more lucrative, and to optimally play in the FCAS market HPR needs to maintain its storage level near 50% of capacity most of the time, in order to provide short term corrections to either supply or consumption.

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2) We need to dispel the myth that hydrogen is just another fuel or energy carrier. It is fundamentally new from an energy systems modeling perspective relative to both electricity and conventional fuels. This has many affects on optimal energy market design. 20th Century power system markets in which there is effectively no demand-side participation (no ability to directly influence prices) are no longer fit for purpose. Emerging demand response market designs are chipping away at the top end of the daily price cycles. But far more crucially, valley filling market designs will be increasingly fundamental to grids with many times 100% VRE relative to operational energy consumption, and intermittent powerfuel production.

Consider the SA Region of Australia's NEM, in which there is already enough data to model price dynamics as follows:

1998-2010	$RRP_{SA} = f$ (*OpDemand*)
2010-2017	$RRP_{SA} = f$ (*OpDemand - VRE production*)
2018-2025	$RRP_{SA} = f$ (*OpDemand - VRE production - VRE curtailment*)
Post 2025	***Market Design :***
2025-2050	$RRP_{SA} = f$ (*OpDemand - VRE production - VRE curtailment* + ***DemandMarket***)

Towards certifiability of grid-connected powerfuels

This graph shows that there is a clear statistically robust relationship between dmwcs, price, and VRE proportion. In turn, this provides clear unambiguous basis for computing CO_2-e inheritance in powerfuels regardless of wholesale or retail contract arrangements: all that is needed is a trustworthy accountable record of a powerfuel plant's consumption with respect to time.