MARKETS, POLICY AND REGULATIONS

Chaired by Dr Tania Urmee
Murdoch University

DAY TWO, 15 FEBRUARY
SESSION # 2
ROOM 434B

ERICA
ENERGY RESEARCH INSTITUTES
COUNCIL FOR AUSTRALIA

CCS renaissance: Why hub and cluster models matter for implementing low emissions infrastructure

Linda Stalker[1]
Andrew Ross[1]
[1] CSIRO

With new commitments to Net Zero both domestically and abroad, and a range of economic and legislative levers coming in to play, the landscape for decarbonisation has changed. Industry has considered new and alternative models for reaching financial investment decisions for emerging projects and markets. Increased investment in hydrogen and renewable energy will bring low emissions energy and industrial processes to the fore. However, hard-to-abate industries may have to rely on other mitigation strategies, and strategic decisions are required to evaluate the best (or least worst) approach to reducing emissions. In the case of carbon capture, utilisation and storage (CCUS), previous attempts at implementation for a range of sectors have often been via single source-to-sink models which are typically more costly and risky for a single industry proponent. Many have subsequently "failed"; that is not reaching positive decisions on those financial investment decisions. So why not share risk and cost by developing hubs or clusters?

Hubs and clusters bring together a whole range of industrial ecosystem contributors to effectively share project risk. Examples include Net Zero Teeside, HyNet, ACORN (UK based), Northern Lights (Norway), Porthos, Aramis (Netherlands), Project Greensand (Denmark), Northern Territory Low Emissions Hub (Australia) and new hubs in the US. So how do they and why are they emerging as a more sustainable approach to decarbonisation?

By having a portfolio of storage options, the risk of injection down-time will reduce. Shared costs and shared infrastructure (for example through shared compression facilities, shared pipelines etc.) can help reduce costs, while industries may be able to share waste heat or products to develop novel industries that support the total cost of mitigation of emissions. This could generate a new industrial ecosystem that can develop low cost, low emissions products in the future from non-fossil fuel building blocks. Not only will this contribute to an improvement in emissions abatement, but also identify opportunities for circular economy design and sector coupling.

A shared vision of an industrial hub or cluster can make communication of the impacts, risks and benefits of a new industry more straightforward and palatable for local communities. These communities may well be wondering what activities might replace oil and gas sector jobs. The evolution of sustainable development hubs are anticipated to go beyond traditional product making or resource recovery industries. As hubs and clusters evolve new developments can be evaluated more holistically and front-end engineering design will be used to help demonstrate how sector coupling can enable future industry for new jobs and growth. By working together these hubs or clusters can also address stakeholder and community groups more effectively with a shared vision for the future and consideration of environmental, social and governance roles brought to the fore.

Global and local examples of these emerging hubs and clusters will be discussed together with the benefits and risks that could impact their development.

System-level impacts of 24/7 carbon-free electricity procurement in Australia

Dylan McConnell[1]
Anna Bruce[1], Iain Macgill[1] and George Furrer[1]
[1] UNSW Sydney

Voluntary renewable energy commitments from the private sector continue to drive investment in renewable energy, beyond policy requirements. This is typically achieved through the Renewable Energy Target, with 4.5 million certificates voluntarily surrendered from the private sector in the last 12 months. Through this approach, buyers typically match their consumption with an equivalent amount of renewable generation, on an annual basis and from anywhere in Australia. On an hourly basis the buyers still rely on generation from their local electricity system, and the carbon emissions associated with it. The current approach does not align the spatial and temporal characteristics of renewable production with consumption profiles.

The misalignment of spatial and temporal profiles creates perverse incentives and presents some challenges for both procurement and the longer term development of the electricity system. Meeting voluntary renewable energy goals at lowest cost may result in sub-optimal deployment of new capacity: low cost certificates may come from projects that are poorly matched to consumption profiles and location, and the system more broadly. This has emissions and cost implications for both the system and the buyer. Reliability, as defined as capacity adequacy, and any associated emissions are essentially outsourced to the broader electricity system. In addition, electricity consumers remain exposed to both price and volume risks. The mismatch between production and generation also means that consumers still have to cover the difference, which can be challenging and expensive. While voluntary procurement of renewable generation has been an important driver of deployment, it is limited and also outsources important system requirements.

There is growing interest in the private sector meeting their consumption with carbon-free energy (CFE) supply on a truly a truly 24/7 basis (CFE 24/7). This approach involves matching a buyer's electricity demand, hour-by-hour, with corresponding electricity generation from within the same region. Studies in the United States and the European Union have analysed the system impact of 24/7 CFE procurement. These studies suggest that 24/7 CFE can enable deeper reductions in carbon emissions for both buyers and the system than simple 100% annual matching, with varying degrees of cost premium. They also find that the mix of procured resources moves beyond wind and solar to other technologies, such as storage. This helps deliver system reliability, and drives early deployment of resources important to the future energy system. This approach was also found to provide more efficient hedging, limiting the purchaser's exposure to price volatility.

The international findings are not directly transferable to Australia. The lack of firm, carbon-free energy sources such as nuclear and geothermal, alongside a sparse energy network present unique challenges to the concept. In this study, supported by the RACE for 2030 Cooperative Research Centre, we analyse the impacts of the 24/7 CFE procurement in Australia for the first time, using the PyPSA modelling framework. Similar to the US and European studies, we find 24/7 procurement can beneficially drive deployment of different resources and deliver additional decarbonisation. Hoewer, this comes at a cost premium which can be significant in some cases.

The financial analysis of solar and battery power purchase agreements

Stefan Trueck[1]
[1] Macquarie Business School

Residential solar Photovoltaic (PV) systems have become one of the most popular distributed electricity source to provide clean and sustainable electricity for residents. In this context, solar Power Purchase Agreements (PPA) as a new financing mechanism enable third-party financing of residential solar PV systems, eliminating most financial and technical risks for residents. However, solar-generated electricity is intermittent, enforcing the need for Battery Energy Storage Systems (BESS) onsite PV systems (PV+BESS) for local electricity management and increased electricity self-consumption. The financing of residential PV+BESS under a solar-and-storage PPA is a nearly unexplored field in research. This study provides a framework for the design and structure of solar-and-storage PPAs. It implements a two-step techno-economic model to assess the financial viability of solar-and-storage PPAs both from a third-party and a resident (customer) perspective based on real-world electricity consumption and generation data of Australian households. We find that the residents can economically benefit considerably in terms of electricity bill savings from entering into a solar-and-storage PPA, whereby Time-of-Use tariff customers save more money than flat-rate customers. In contrast, financing a residential PV+BESS under a solar-and-storage PPA is an economically unbeneficial option for the third-party under current electricity tariff constellations in Australia. Nevertheless, the results suggest that BESSs increase electricity self-consumption of households and solar-and-storage PPAs may become a financially viable option in the future. Our results show that PPAs for small BESSs with policy support like subsidies on upfront investment costs of BESSs and high Feed-in Tariffs can even be viable in the current market environment.

Collocating renewables and ore processing accelerates sustainable decarbonization of the metal industry

Bishal Bharadwaj[1]
Eric Lilford[2] and Simon Smart[3]
[1] Curtin Institute for Energy Transition
[2] WASM: Minerals, Energy and Chemical Engineering,Curtin University
[3] School of Chemical Engineering, University of Queensland

The metal industry currently relies on a complex supply chain involving the importation of materials like metal ore and energy sources from various regions. These inputs are processed and exported for end-use. This chain is facilitated by the efficient transportation of energy sources such as coal and fossil fuels. However, the shift to a green hydrogen economy raises concerns for the existing supply chain due to significant energy loss in transforming energy from electrons to molecules, and b) environmental impact of hydrogen and renewables.

This article compares the energy-saving and environmental impact of onshoring green steel production using Australia's iron ore and domestic solar energy versus exporting clean energy and iron ore for processing outside Australia.

This analysis assesses four key inputs: energy, water, land, and the number of ship call required to reduce the 876 million tonnes of iron using direct reduced iron using hydrogen produced from solar in Australia under two scenarios: a) iron ore is processed within the country (Onshore); and b) Australia exports iron ore and clean energy but ore is reduced in Japan(EE scenario). Both scenarios consider the use of direct reduced iron with hydrogen to produce pig iron. The calculation parameters are primarily derived from the Methods, Assumptions, Scenarios & Sensitivities (MASS) report of the Net Zero Australia website. Acknowledging uncertainties tied to conversion efficiency, ore quality, and technological advancements, a comprehensive sensitivity analysis is employed to gauge the potential impact of changes in energy technology on the environmental footprint.

The preliminary findings reveal that the EE necessitates 5.2 million GWh of solar energy, almost double the 2.8 million GWh required in the Onshoring. In terms of land use impact, the EE scenario covers 48 thousand sqkm, whereas Onshoring accounts for 28 thousand sqkm. The water usage varies significantly, with the EE scenario requiring 1552 gigaliters of treated water, in contrast to the Onshoring's demand for 573 gigaliters. Furthermore, the total number of ship calls needed to export energy and process goods for reducing all iron ore in the EE is 5817, while Onshoring requires a comparatively lower number of 1992 ship calls.

The sensitivity analysis reveals energy input and environmental impact depend on technology and input parameters. Under open-air cooling, Onshoring requires about one-third of the water needed in the Energy Export (EE) scenario. In wet cooling scenarios, Onshoring consumes 46.8% of the water demand compared to EE (4168 gigaliters). Improving electrolyzer efficiency from 75% to 85% leads to savings of 6 thousand and 3 thousand sqkm of land in the EE and Onshoring scenarios, respectively.

Improved technology narrows the environmental impact gap between EE and Onshoring. Onshoring stands out for its superior performance in land use, water utilization, and marine pollution (ship call). These findings emphasize the critical role of collocating Variable Renewable Energy (VRE) and ore processing as a pivotal strategy for a more sustainable and accelerated global decarbonization of the energy-intensive metal industry.