Rondo Energy, Inc.
1960 North Loop
Alameda, CA 94502
rondo.com

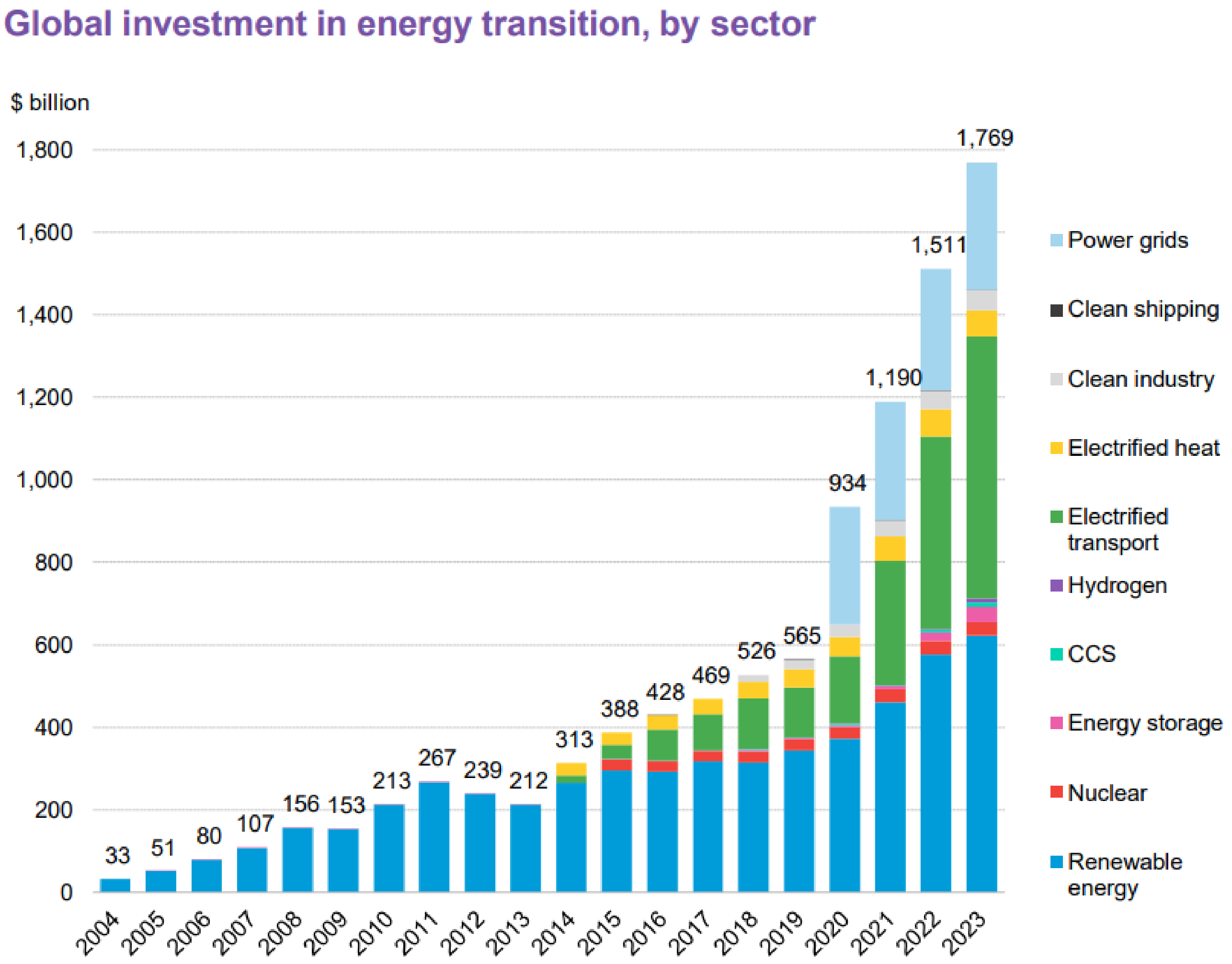
Date: 9 Feb 2024

Submission to 2024 Forecasting Assumptions Update Consultation

Thank you for the opportunity to contribute to the consultation on forecasting assumptions.
Rondo Energy is a supplier of electric thermal energy storage (ETES, or “heat batteries”), for industrial heat decarbonisation.

We would like to raise two topics with regard to the forecasting assumptions: the inclusion of heat batteries in the GenCost technologies, and a review of what we regard to be overly optimistic assumptions on hydrogen.
These are related topics and the implications of optimism on hydrogen is that the total cost of the ISP is higher than necessary. Hydrogen is simply a higher cost and lower efficiency technology than the alternatives, and requires much more generation infrastructure to be built than is optimal.

The chart below from BNEF, shows global investment in the energy transition. This is where people are actively putting money, making a good proxy for the amount of attention GenCost and the ISP should dedicate to each technology. On the supply side, renewables, grids, and energy storage are deservedly given the most attention. Arguably nuclear has more attention than it deserves, but I understand this has more to do with misguided nuclear exuberance in the public than CSIRO & AEMO.
On the demand side, EVs dominate global investment and are already garnering fair levels of attention. This is an evolving sector, and we support the continued studies by AEMO/CSIRO.
Hydrogen is receiving far more attention than its relatively miniscule level of investment deserves.
Clean industry and electrified heat are each much larger than hydrogen and these segments lack the needed attention and awareness.

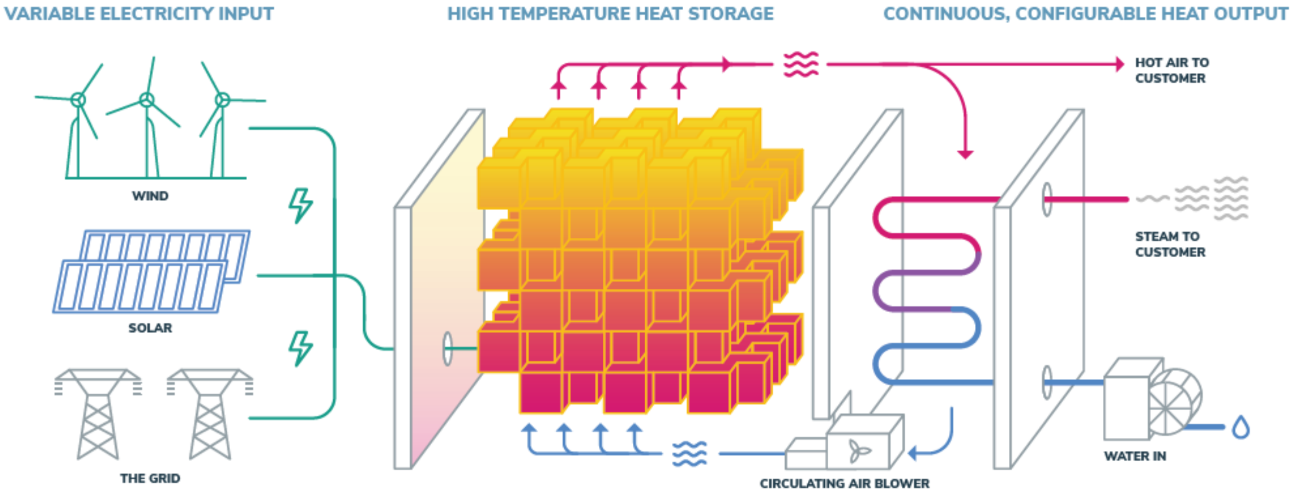


Source: BloombergNEF. Note: Start years differ by sector but all sectors are present from 2020 onwards; see Methodology for more detail. Most notably, nuclear figures start in 2015 and power grids in 2020. CCS refers to carbon capture and storage.

Inclusion of Heat Batteries

Globally, process heat makes up around a quarter of final energy use. This figure is about a fifth for Australia. Decarbonisation of heat is the most important sector after electricity and transport.

Heat batteries are a relatively novel asset class that has come about due to the recent availability of electricity cheaper than fossil fuels on an intermittent basis. Despite their novelty, the technology readiness is high, being built on the back of well understood materials and concepts. Rondo's own technology is based on ceramic bricks used for 200 years in the steel industry as high temperature heat storage. The resistors that convert electricity to heat are similar to what you might find in a toaster or oven and used at large scale in industrial kilns.



Although a young company, Rondo's manufacturing capacity is equivalent to 10 times the global electrolyser deployment in 2022 on a useful work basis[1]. Our expansion plans would mean we overtake hydrogen electrolysis in actual deployments in a few years. What's more, we have other heat battery competitors also preparing to scale up. That's not to say that Rondo is especially productive, merely that hydrogen hype is gargantuan compared to real world deployments. Heat batteries are as relevant, if not more relevant to Australia's transition than hydrogen production. This sudden relevance is due to the fundamental commercial aspects of industrial decarbonisation. Recent increases in the frequency of near zero wholesale electricity prices in most Australian states, provides heat batteries an operating cost advantage that is needed as a heat battery costs more than a pre-existing gas boiler. However, these low prices are not continuously available, so direct electrification without thermal storage will experience much higher operating costs.

In comparison to hydrogen for heat, heat batteries enjoy a far superior efficiency, and a capital cost many times lower. The combination of these attributes has a flow on effect for the captured wholesale price as electrolysers must run at higher load factors to be viable, which means higher wholesale prices paid.

Heat batteries have three application types in order of importance: heat only, heat & power, and power only. In power applications heat batteries are advantaged by high durations and low capex, but disadvantaged by either low efficiency in power only applications, or finite suitable sites for heat & power. We anticipate heat batteries to play a modest role in power generation but have a substantial impact on power markets as a large controlled load.

Attached to this correspondence is some literature regarding heat batteries and industrial heat. Rondo would be pleased to provide any additional information upon request.

---

[1] https://www.iea.org/energy-system/low-emission-fuels/electrolysers

Hydrogen Assumptions

The hydrogen demand assumptions in the ISP are enormous relative to underlying electricity demand. This increases the spend required under the ISP, and reduces confidence in our ability to deliver it. Furthermore, it helps perpetuates the narrative that governments should invest billions of dollars into hydrogen, rather than recommitting funds to more cost-effective technologies.
There is dissonance in the ISP's fuel price assumptions. Hydrogen is more expensive than fossil gas across the study period. The mechanism by which hydrogen is able to compete is not described, but we would expect our international partners to continue purchasing Australia's LNG instead. Permanent fuel subsidies are incredibly expensive for governments to maintain.

The interaction of the CSIRO assumptions creates a kind of self-fulfilling prophesy. Global hydrogen demand is assumed to be large; Australia's share of hydrogen production is assumed to be large, learning rates are assumed to be strong, therefore electrolysers become very cheap and demand can be met.

Rather than a top-down approach a bottom-up one should be considered. Where is hydrogen viable today and at what volumes? What deployment rates are being realised, and at what installed cost? What size increases are being developed for electrolyser modules? Where will component costs move with inflation and mineral demand?
I have been a part of several hydrogen projects, and they were all quite distant from commercial viability, even with substantial government grants and bargain electricity prices. Exposure to real world projects led to my disillusionment with hydrogen.

I recommend a few paths to investigate:

1. Check installation costs against real world projects in Western nations.
   Chinese install costs are not likely possible here. Literature figures often do not account for many mundane realities in construction and tend to be cheaper than is possible.
   For example, the recently announced Townsville hydrogen project is 3 times more expensive per MW than the CSIRO assumptions for next year.
   The UK's recent hydrogen auctions (HAR1) have a delivered price of A$465/MWh, more than 10 times the cost of fossil gas in Australia.[2] The average install cost is 4 times higher than the CSIRO electrolyser assumptions for 2024.

2. Investigate component level potential for learning rates including the mechanism of cost decline. Many components are mature technologies, e.g. pumps. Scaling benefits are likely at a project level as many balance of plant costs won't increase linearly, even though most of the BOP components are mature.

---

[2] https://www.gov.uk/government/publications/hydrogen-production-business-model-net-zero-hydrogen-fund-shortlisted-projects/hydrogen-production-business-model-net-zero-hydrogen-fund-har1-successful-projects

Electrolysers will not enjoy the same learning rates as wind or solar given their maturity and lack of multiplicative improvements. E.g. wind's power increases by the square of the blade length. Solar's power per unit area doubled several times as it approached theoretical efficiency from a low level. This benefit can't be found by scaling up electrolyser disc size, or the length of the stack – it's the same material cost per unit area and those material costs aren't going to decline.
Don't assume 100 MW modules are likely or viable, nothing of that size is being contemplated. It's easy to imagine why – a 200 metre long pressure vessel is unwieldy, or a 10 metre diameter disc would have high internal resistance and be prone to bending. There are diminishing returns on module scale up.

3. Differentiate between PEM and alkaline in deployment models. PEM requires platinum group metals and cannot meet the grand scale up requirements.
   China has committed to alkaline and has the cheapest electrolysers and largest production capacity (although almost completely idle).
   In each hydrogen study I was a part of, alkaline was the chosen technology in the end.

A bottom-up approach should also be taken with hydrogen fuel cell vehicles. Forecasts showing hundreds of vehicles being bought this year do not line up with the reality that none are for sale and there is a lack of (expensive) refuelling infrastructure.
Fuel cell vehicles are not likely to ever be competitive against EVs or renewable diesel. They simply have higher purchase costs and higher running costs, and these are physically insurmountable barriers.

Please feel free to contact Rondo for further information.

Sincerely,

TG

Tom Geiser
Head of Australia, Rondo Energy