To find a novel method to store electric energy on a larger scale with better storage characteristics.

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Problem

- As we have no viable and fast storage method to store the excess electricity produced on the scale required with reasonable efficiency; energy has to be produced and consumed in real time making the problem complex.

- Due to the unreliable nature of wind and solar energy plants the problem worsens.

- Pumped hydroelectricity does provide some storage but it's requires very special geography to construct such a facility.

- Lithium-ion batteries have proven to be the best energy storage solution right now as they have been deployed in the Hornsdale power reserve in Australia, but they tend to degrade in capacity and be costly.[1]

Solution

- We propose a new concept of energy storage based on **liquid metal batteries,** to store the excess energy produced by renewable sources during peak power production hours by reversible alloying reactions.
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- This will help in providing a buffer big enough for renewables to act as a reliable base load source which would help in phasing out coal and nuclear power plants.
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- The solution is focussed to increase the share of renewable sources by providing stability to the electric grid to prevent power blackout incidents due to unreliable grid management as in South Australia's case.[2]

Market Size

- World energy production amounted to 617 EJ in 2019.[3]
- It is a 613 Billion dollar market in 2020.
- Based on available data, the production of foss
- From 2018 to 2019 some renewables increased much more in relative terms as compared to natural gas (+4%) and coal (+2%) (e.g. +14% for solar and +12% for wind). Hydro-electricity production stagnated at 15 EJ. [3].
- As the share of renewables increases the incentive to store electricity increases too.

Market Validation

- California, a state of US; has the goal to use 100 percent renewable sources for power production by 2045 and have achieved significant progress in this field.[4]

- A lot of solar power produced cannot be used during the peak hours of sunny summer days causing wastage of excess electricity.

- Ireland had to prevent more wind installations to ensure grid safety.[5]

- To combat the issue Moss landing power plant installed battery storage capacity of 567 MWh to provide power during the peak load hours.

- Australia constructed Hornsdale power storage facility to store 194MWh of energy to provide stability to the grid.[6]

Product

- We are proposing molten metal batteries that have better efficiency(about 80 percent) as compared to pumped hydro storage that has efficiency of about 70 percent.
- The battery has much higher efficiency and specific energy storage capacity as compared to the pumped hydro solutions.
- The solution may fail to beat the price of pumped hydro solutions in cases when large amounts of energy has to be stored. Although pumped hydro storage would need suitable geography.

Business Model

- The batteries can be sold as a product.
- Sources of revenue
- Sale of batteries
- Services associated to the batteries (installation cost etc)
- Intended customer base
- Government energy establishments made to store electricity.
- Industrial applications where uninterrupted power is necessary for example data server applications.
- Scientific applications where pulsed power output may be needed.

Competition

- ❏ Liquid Metal Batteries, face the most competition from the more developed and derived Lithium-ion Batteries.
- ❏ The failure of the advanced technologies seems to have little to do with the technologies, more with economics. Despite its limitations, lithium-ion remains the top competitor.
- ❏ That’s because its price has been falling precipitously, dropping by nearly half in two years, to $273/KWh in 2016. According to Bloomberg forecasts the price will falling to $109 by 2025, and $73 by 2030.

Financial model and projections

- Government as a policy maker for the renewable energy storage systems have the potential to create an enabling environment that would set the direction for large scale indigenous manufacturing of various types of energy storage systems.
- These actions are prerequisites to communicate to the renewable energy industry and the wider green energy community on the Government's intent and actions to develop India as an emerging hub for Renewable energy technologies. SO, we are looking forward towards funding from GOVT. Of INDIA under the scheme for setting up grid connected SPV power projects.
- As there are no rare earth elements used in Liquid Metal batteries, the cost of components is lower than other commercially viable solutions and it is expected that there will little to no degradation in liquid metal batteries, with continuous operational lifetime in excess of 20 years.[8]
- The proposed solution, if successful has the ability to generate excellent ROI because of the vast market size, low degradation and component cost. [9]

Competitive advantages

- Although the specific energy density of molten metal battery is under 200Wh/kg (lower than Li Ion at about 250Wh/kg) and they require high temperature to operate; they can be well suited for grid energy storage as the manufacturing process is much simpler as compared to that of a Li Ion battery.

- The battery has much higher specific energy density as compared to pumped hydro energy storage solution and can be deployed regardless of the geography of the region.
- The molten metal battery can change its power output faster than pumped hydro storage allowing for better control over the power output quality.

Assumptions and risks

- Calcium-Antimony in one of the most experimented system, but still has a long way to become commercially viable product. Which raises a need to research on other compounds having a significant difference in electronegativity.

- The Na-sulfur (Na–S) battery is a typical molten-salt battery consisting of a liquid Na anode, a sulfur cathode, and a β-Al_2O_3 solid electrolyte (BASE). The first Na–S battery was invented at Ford in 1967. [10] Because of their advantageous features, including high energy density (~760 Wh kg^{-1}), high efficiency, long cycle life, and inexpensive electrode materials, Na–S batteries have been commercialized for stationary energy storage. [11]

- To maintain the high ionic conductivity of the ceramic tube solid electrolyte and good wetting with molten Na, Na–S batteries need to be operated at above 300 °C. The highly corrosive nature of the sodium polysulfides may cause degradation of cell components especially in a harsh environment. More seriously, the violent reaction between molten Na and fluidic S may give rise to major safety risks.[12]

Summary

- Lithium-ion batteries are the most economical, but when it comes to large scale stationary storage for supporting grid fluctuations, they weren't designed for it.
- They were designed to be light and energy dense for portable electronics which are obsolete traits for stationary storage.
- There is a need to design batteries specifically for large scale grid storage, which led to the development of Ca-Sb liquid metal batteries.
- These Batteries have the potential to store energy using reversible alloying reactions with low component cost and degradation constant. According to the Ambri system there is a minimum capacity loss even after 5000 cycles of continual use which corresponds to 20 years of daily use, whereas a typical Li-ion battery loses its 20% capacity within a period of 2 years.
- Liquid metal batteries have overcome the disadvantages of Li-ion batteries in large scale storage, but still haven’t been able to stand out commercially because of economies of scale of Li-ion. Therefore, we propose to develop alternate chemical compounds and identify typical market opportunities to promote and overcome cost factors for storing large scale energy storage.

Q&A

APPENDIX/BACKUP/ References

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