

# Battery Storage and Green Hydrogen: The Next Chapter in India's Clean Energy Story

## *A Discussion of Promising Developments in Utility-Scale Batteries and Green Hydrogen*

### Introduction

In August 2021, India crossed a milestone of 100 gigawatts (GW) of installed renewable energy capacity. Solar (45GW) and wind power (40GW) comprise the majority of the installed renewables capacity. A transition in India's electricity sector is underway with growth of low-cost renewable energy capacity, targeted to be 450GW by the end of this decade.

The challenge of installing 450GW of variable renewables by 2030 will be accompanied by another big challenge of integrating them into the grid.

In our report<sup>1</sup> from February 2021, we highlighted three key technology solutions that should be looked at to support integration of large-scale variable renewables – flexible operation of coal-fired power plants, battery storage and green hydrogen.

The flexible operation of the coal power fleet is a solution that would make optimal use of the country's existing coal-fired generation resources of 210GW, whilst implementing batteries and green hydrogen would entail the setting up of entirely new industry value chains.

But IEEFA observes a very positive trend of the declining cost of battery storage globally. The cost curve in battery storage globally has come down dramatically, from US\$1,100/kWh in 2011 to US\$137/kWh in 2020 for a stand-alone lithium-ion battery system. It is further projected to drop by another 55% to US\$58/kWh by 2030.

Although for India the cost of utility-scale battery storage has remained prohibitive in the absence of a domestic manufacturing value chain and the right price signals in the electricity market, there are strong indications that the market is shaping up for utility-scale batteries.

### *Momentum in Battery Development*

Tata Power's 10MW/10MWh (1-hour storage) battery in its Delhi distribution network is currently the only grid-scale battery operating in India. During a recent visit to Tata's battery storage facility, Delhi's Power Minister, Satyendra Jain, talked

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<sup>1</sup> IEEFA. [Renewable Energy Integration: India's Next Big Challenge](#). February 2021.

about a plan to create storage capacity of 600MW in Delhi in the form of 'power banks'.<sup>2</sup> This would be a huge step up from the city's existing 10MW/10MWh battery storage capacity.

Tata Power bagged another big battery storage project in the city of Leh (in the newly formed Union Territory of Ladakh) comprising 50MWh of storage capacity co-located with 50MW of solar capacity. Planned to be commissioned by March 2023, this will be India's largest grid-scale battery.<sup>3</sup> Tata's 50MWh battery will be part of the planned mega 13GWh grid-scale battery storage system in Ladakh.<sup>4</sup>

India's state-owned entities have now also come into the fold for facilitating grid-scale battery storage development.

In the last couple of months, the Solar Energy Corporation of India (SECI) and NTPC have rolled out tenders for developing 2,000MWh<sup>5</sup> and 1,000MWh<sup>6</sup> of battery storage capacity, respectively. SECI and NTPC have built strong track records as credible counter parties by enabling renewable energy capacity development of more than 40GW. IEEFA deems the involvement of credible government-owned counter parties vital to enabling capital deployment in the development of battery storage.

R.K. Singh, the Indian Power Minister, talked about doing a mega 4,000MWh tender for battery storage in Leh and scaling the capacity to 12,000MWh in future.<sup>7</sup> The Minister previously also indicated that 4,000 MWh of storage will be used for ancillary services at four Regional Load Dispatch Centres (RLDCs) – 1,000 MWh each for grid balancing and frequency regulation requirements.

The first few utility-scale battery storage projects will incur material teething costs. These include the costs of learning from the testing, deployment and commissioning aspects of the projects. Also, there will be important lessons to be learnt from the contracting side of battery storage systems. Contracts will need to be designed to incorporate equipment degradation, temperature concerns and associated liquidated damages (LDs).<sup>8</sup> On the testing side, the system will need to be tested for Automatic Generation Controls (AGC), up frequency support, down frequency support and voltage protocols.

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<sup>2</sup> ET Energy World. [Delhi government to create 600 MW network of 'power banks'](#). 30 August 2021.

<sup>3</sup> Business Standard. [Tata Power Solar bags Rs 386 cr battery storage system project at Leh](#). 14 August 2021.

<sup>4</sup> Live Mint. [Tata Power Solar gets ₹386 cr Leh Project](#). 12 August 2021.

<sup>5</sup> Mercom India. [SECI Floats Tender for 2,000 MWh of Standalone Energy Storage Systems](#). 31 August 2021.

<sup>6</sup> Mercom India. [NTPC Floats Tender for 1,000 MWh of Battery Energy Storage Systems](#). 29 June 2021.

<sup>7</sup> ET Energy World. [Bids for 4,000 MWhr battery storage projects to be invited soon: Power Minister R K Singh](#). 17 September 2021.

<sup>8</sup> Liquidated damages are presented in certain legal contracts as an estimate of otherwise intangible or hard-to-define losses to one of the parties. It is a provision that allows for the payment of a specified sum should one of the parties be in [breach of contract](#).

Working through these things will potentially lead to some delays and additional costs for the developers or solution providers. Accelerating the first few projects in our grid would enable a more robust set-up for the Indian market. However, the initial projects might require flexibility on foreign content in terms of equipment for the first few projects and localisation of the industry could then follow.

The Government of India is progressing towards creating a localised value chain for the battery industry.

Battery manufacturing, critical to the battery value chain, is now aided by the government's production-linked incentive (PLI) scheme. In May this year, the government approved an outlay of Rs18,100 crore (US\$2.5bn) to facilitate battery manufacturing capacity of 50GWh.

In another policy development, the Central Electricity Regulatory Authority (CERC) aims to reform the frequency control and ancillary services (FCAS) market by bringing battery storage and pumped hydro storage (PHS) into the ambit of FCAS regulations. This will value the speed and accuracy of grid balancing services that batteries and PHS could provide at competitive market prices, allowing a clear revenue stream for the asset owners of these storage systems.

Also, interstate transmission charges have now been waived for battery storage and PHS systems commissioned until June 2025, in addition to solar and wind assets.<sup>9</sup> This will allow storage systems to operate viably to support interstate grid networks.

India's market potential, aided by the government's ambition and policy support to decarbonise India's power sector, is driving momentum in battery manufacturing in India.

Reportedly, Indian automotive electrical components manufacturer Lucas TVS and U.S.-based 24M Technologies in a joint venture plan to set up a Rs2,500 crore (US\$340m) battery manufacturing plant near Chennai for lithium-ion (Li-ion) battery cells based on SemiSolid platform technology.<sup>10</sup>

The U.S. battery giant Tesla and China's Contemporary Amperex Technology Co. Limited (CATL) are other leading battery developers interested in building gigafactories in India.<sup>11</sup>

## *Energy Storage Tenders Need Regulatory Framework*

In countries that have successfully developed Battery Energy Storage Systems (BESS), like the U.S., the UK, Europe, Australia and Japan, policy and regulatory interventions by governments have played a pivotal role in developing the battery

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<sup>9</sup> Ministry of Power India. [Waiver of inter-state transmission charges on transmission of the electricity generated from solar and wind sources of energy Amendment thereof](#). 21 June 2021.

<sup>10</sup> Mercom India. [Giga Factory for Lithium-Ion Battery With ₹25 Billion Investment to Come Up in Chennai](#). 3 September 2021.

<sup>11</sup> Livemint. [Tesla shows interest in India's plans to build battery plants](#). 18 August 2019.

storage industry. Specifically, the interventions of the Federal Energy Regulatory Commission in the U.S. and the Australian Energy Market Commission (AEMC) helped create demand for BESS services and a level playing field for BESS alongside the conventional resources available in the sector.

The lack of proper regulatory framework in India for BESS prevents development of battery storage. To remedy this, the Ministry of Power and regulatory bodies of India need to establish regulatory measures that clarify the commercial contract framework, the medium- to long-term roadmap for BESS requirement, inclusion of BESS in power and network planning, proper bid/tender frameworks, etc. Such an intervention from the Indian government and regulators would enable sustained development of the battery energy storage sector.

### *Reliance's Grand Entry*

India's biggest industrial house, Reliance Group, has made a belated but grand entry into India's clean energy scene. After disrupting the telecom market, Reliance Group now aims to propel India's renewable energy targets by building 100GW of clean energy capacity by the end of this decade.

In addition to its 2030 renewables target, Reliance aims to enter into battery manufacturing and green hydrogen production to play a key role in transforming India's energy market.

The group entered the market by investing in established foreign entities in recent months.

Reliance will partner with the Bill Gates-owned investment management firm Paulson & Co to invest a total of US\$142m into US-based battery development company Ambri Inc.<sup>12</sup> which is exploring development of alternatives to Li-ion for longer duration (4-24 hours) battery storage systems. Reliance will acquire 42.3 million shares for US\$50m. Currently, grid-scale battery storage systems globally are only capable of providing storage capacity of up to 4 hours. Investing in proliferation of longer duration battery storage systems looks to be part of Reliance's long-term strategy to dominate the clean energy industry in India.

Reliance is closing in on three big acquisitions to build its solar portfolio to include polysilicon, wafers, cells, modules and engineering procurement and construction (EPC).

The group has acquired a Norwegian solar manufacturing company, REC group for US\$771m.<sup>13</sup> REC is a long-established solar module manufacturer with three manufacturing facilities – two in Norway making solar-grade polysilicon and one in Singapore making PV cells and modules.

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<sup>12</sup> Reuters. [Reliance joins Bill Gates, others to invest \\$144 mln in U.S. energy storage co.](#) 10 August 2021.

<sup>13</sup> Live Mint. [REC is a well-established solar module manufacturer.](#) 10 October 2021.

Reliance has further invested US\$29m in Germany's solar wafer manufacturer NexWafe GmbH and is entering a strategic partnership to commercialise NexWafe's product in India.<sup>14</sup>

Reliance is now in the process of buying a 40% stake in India's leading solar EPC and operations & maintenance (O&M) company, Sterling and Wilson Solar Ltd (SWSL).<sup>15</sup>

Reliance is also looking to build significant domestic capacity to support the Government of India's 'Atmanirbhar Bharat' (self-reliant India) mission.

Mukesh Ambani, Chairman of Reliance Industries, recently unveiled a plan to develop four gigafactories on 5,000 acres in Jamnagar, Gujarat. If commissioned as per the stated plan, this would be by far the largest clean energy hub in the world.

The plan includes an integrated solar photovoltaic module factory, an advanced energy storage battery factory, an electrolyser factory for the production of green hydrogen, and a fuel cell factory for converting hydrogen into motive and stationary power.

Reliance have partnered with a Danish company Stiesdal to develop and manufacture hydrogen electrolysers. Reliance will look to scale up Stiesdal's commercially proven technology in India.<sup>16</sup>

The group aims to invest Rs75,000 crore (US\$10bn) in the next three years into this facility.

The Reliance Group has a track record of disrupting the market by bringing prices down. Their ambition will bring a critical mass of investment into India's clean energy industry which has not been able to achieve consistent momentum in the last 3-4 years.

The costs range between US\$2.5/kg for fossil hydrogen and US\$7/kg for green hydrogen. The group aims to bring the green hydrogen production cost down to US\$1/kg from in a decade.

## *Green Hydrogen Fever in India*

Another Indian billionaire is interested in India's clean energy potential and is likely to deploy an investment of US\$9.4bn into the states of Rajasthan and Gujarat.

Recently, Lakshmi Mittal, chairman of steel manufacturing giant ArcelorMittal, met with the Chief Ministers of the states of Rajasthan and Gujarat<sup>17</sup> to discuss a plan to build 4.5GW of solar capacity in Rajasthan and green hydrogen production capacity

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<sup>14</sup> The Hindu. [Reliance New Energy to invest \\$29 million in NexWafe](#). 13 October 2021.

<sup>15</sup> Business Standard. [RIL to buy 40% stake in Sterling & Wilson Solar for Rs 2,850 crore](#). 11 October 2021.

<sup>16</sup> First Post. [Reliance signs agreement with Danish company Stiesdal to manufacture Hydrogen Electrolysers](#). 14 October 2021

<sup>17</sup> PV Magazine. [Arcelor Mittal plans 4.5GW solar park in India](#). 31 August 2021. 31 August 2021.

backed by solar and wind in Gujarat. With this, ArcelorMittal aims to follow in the footsteps of global steel manufacturers pivoting to green hydrogen for steel production.<sup>18</sup>

ACME Solar, one of India's biggest solar developers, has commissioned the world's first commercial pilot of an integrated green hydrogen and green ammonia production facility in Rajasthan.<sup>19</sup> ACME's desire to establish itself in the green hydrogen business became more evident with its recent announcement of a mega US\$3.5Bn project to develop green hydrogen and green ammonia production in Oman.<sup>20</sup> In August 2021, ACME signed a land agreement in the Special Economic Zone at the Port of Duqm in Oman. The plant will be an integrated facility using 3GW of solar and 0.5GW of wind energy to produce 2,400 tonnes per day of green ammonia with an annual production of about 0.9 million tonnes (MT). The facility is planned to be commissioned by 2022 and would export green ammonia to demand centres in Europe and Asia.

Apart from being industrial feedstock for production of steel, ammonia, methanol and fertilisers, green hydrogen is touted to play a big role in clean mobility and electricity production and storage.

NTPC have called for bids to install a green hydrogen fuel station in Ladakh to develop India's first green hydrogen mobility project.<sup>21</sup> There are other pilot projects being planned by the Ministry of Petroleum and Natural Gas (MOPNG) for using hydrogen for transportation and cooking fuel.<sup>22</sup>

The state-owned IndianOil Corporation also plans to produce green hydrogen at its Mathura refinery using its wind production asset in Rajasthan. The green hydrogen will be used to replace carbon-intensive fuels currently used to produce value-added fuels such as petrol and diesel from crude oil.

Like batteries, the green hydrogen industry will require the building of a domestic hydrogen production value chain. The most important part of this value chain is the electrolyzers for which the costs have come down across the globe, led by U.S., China and Nordic-based electrolyser manufacturers.

Currently, the cost of electrolyzers forms 45% of the system cost for green hydrogen production.

There is already significant interest from foreign private entities in manufacturing electrolyzers in India. A U.S.-based electrolyser start-up Ohmium International recently announced a gigafactory to manufacture 500MW of electrolyser capacity

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<sup>18</sup> Mining.com. [The race to green steel is on — will the US take on the challenge?](#) 13 June 2021.

<sup>19</sup> ACME. [World's First Green Hydrogen and Green Ammonia Plant](#).

<sup>20</sup> Business Standard. [ACME Group to set up green ammonia, green hydrogen facility in Oman](#). 23 August 2021.

<sup>21</sup> NTPC. Press release: [NTPC invites tender to set up India's first green hydrogen fuelling station in Leh](#). 29 July 2021.

<sup>22</sup> MOPNG. [Hydrogen initiatives of the Ministry of Petroleum and Natural Gas](#).

annually in Bengaluru.<sup>23</sup> This is a big commitment from a start-up with no experience of the Indian hydrogen market which is still in its infancy.

The Ministry of Power is planning for a 4GW electrolyser manufacturing tender in the next 3-4 months.<sup>24</sup>

Domestically produced, cheaper electrolysers combined with ultra-low cost renewables along with clear policy support will help realise India's green hydrogen potential.

In addition to a technology scale-up to have reliable supply of the fuel, India's green hydrogen mission needs a strong offtake arrangement for the value chain to prosper.

To support this, the government plans to implement a green hydrogen consumption obligation (GHCO) mechanism in fertiliser production and petroleum refining, similar to renewable purchase obligations (RPO).<sup>25</sup>

To further encourage usage of green hydrogen by industries, the fuel has been included under the RPO regulations.<sup>26</sup> The usage of green hydrogen by industrial consumers will be accounted for in their RPO and it will be calculated based on renewable energy used to produce the quantity of green hydrogen consumed by the user.

A policy brief by FTI Consulting recommended a model to create industrial clusters that enable green hydrogen production as well as its industrial use.<sup>27</sup> The paper identifies industrial clusters that include some of the largest ports, industry-specific hubs of steel, coal, fertiliser, biogas, and heavy duty transport which will all benefit from a transition to green hydrogen. There are industrial clusters for green hydrogen currently being developed in the Netherlands, Germany, the U.K and Australia.<sup>28</sup>

## *Financing Remains a Key Challenge*

On 15 August 2021, Prime Minister Modi of India launched the National Hydrogen Mission with an ambition to make the country a hub for green hydrogen. The overarching ambition to commercialise a green hydrogen economy in India will soon need to be shaped by concrete policy and funding support.

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<sup>23</sup> ET Energy World. [US-based Ohmium launches India's first green hydrogen electrolyzer Gigafactory](#). 24 August 2021.

<sup>24</sup> ET Energy World. [India will conduct auctions for green hydrogen in next 3-4 months: R K Singh](#). 19 February 2021.

<sup>25</sup> Live Mint. [Tracking India's green hydrogen revolution](#). 7 September 2021.

<sup>26</sup> ET Energy World. [Green hydrogen purchase to count as RPO: Power Ministry draft rules](#). 17 August 2021.

<sup>27</sup> FTI Consulting Report. [India's Energy Transition Towards A Green Hydrogen Economy](#). December 2020.

<sup>28</sup> Recharge. [Netherlands, Australia leading markets for green hydrogen rules and policies: Fitch Solutions](#). 13 August 2021.

FTI Consulting's policy brief recommends creating a national hydrogen transition fund for national projects using carbon transition taxes that could provide subsidy or incentive funding.

A leading example of state funding for green hydrogen is the Australian Renewable Energy Agency (ARENA).<sup>29</sup> In May 2021, ARENA topped up its ongoing funding for commercialising green hydrogen projects by AU\$100m (US\$72.3m) for three projects with 10MW electrolyzers.<sup>30</sup> This is in addition to 16 R&D projects, as well as feasibility studies into large-scale projects and smaller-scale demonstrations looking at renewable hydrogen production, power-to-gas (PtG), and hydrogen mobility.

The Indian Renewable Energy Development Agency (IREDA) could look to play a similar role in the proliferation of green hydrogen projects by supporting pilot projects and eventually to commercial scale-up.

Indian renewable energy developers have successfully raised debt funding through the international green bonds market. As numerous developers look to derive value from the synergy of renewables and green hydrogen, the international green bonds market will remain a key avenue for funding.

Sustainability-linked bonds, which force issuers to pay higher coupon rates if they fail to achieve pre-set company-wide targets, are emerging as an alternative instrument to green bonds. Enel of Italy and Total of France are two leading European developers that have accessed green debt funding using sustainability-linked bonds.<sup>31</sup> Both these prominent global energy companies along with numerous others are actively playing a part in India's energy transition – a promising sign for the clean energy sector.

There is substantial activity in the Indian battery storage and green hydrogen markets – both of which are critical for India's clean energy future and energy security. And they could scale up rapidly as has happened in other global markets in the last couple of years.

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<sup>29</sup> ARENA.

<sup>30</sup> Bioenergy. [ARENA approves over AU\\$100 million in funding for green hydrogen](#). 8 May 2021.

<sup>31</sup> Reuters. [Italy's Enel, sustainability-linked bond pioneer, brings record debt sale](#). 8 June 2021.



## About IEEFA

The Institute for Energy Economics and Financial Analysis (IEEFA) examines issues related to energy markets, trends and policies. The Institute's mission is to accelerate the transition to a diverse, sustainable and profitable energy economy. [www.ieefa.org](http://www.ieefa.org)

## About the Author

### Kashish Shah

Kashish Shah, a Research Analyst at IEEFA, has a master's degree in economics from the University of Sydney and an engineering degree from NMIMS University in Mumbai. Kashish has worked in the Global Analytics Division of the Royal Bank of Scotland with a focus on regulatory policies. He has research experiences in India's public sector in his work for a member of the Indian Parliament and a University of Sydney-based research group. [kshah@ieefa.org](mailto:kshah@ieefa.org)

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