POLICY BRIEF

4

Energy Storage Systems and Energy Security

G20 Experiences and Opportunities

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Abstract

As countries progress towards a clean and sustainable future, Energy Storage Systems (ESS) can play a critical role in serving key energy end-uses in an energy secure and environmentally benign manner. The G20 could prove to be an important platform for furthering the agenda of ESS as it comprises of some of the largest energy consumers and energy technology holders in the world. Currently, developments in ESS in India are primarily based on import of batteries with little domestic manufacturing due to four major reasons – low mineral reserves, nascent battery manufacturing industry, lack of co-ordination among stakeholders, and high perceived risk. In meeting these challenges, there are a lot of lessons for India to learn from the development of BESS within the G20 countries such as legislations to encourage its greater uptake along with research and support towards up and coming BESS technologies. This paper analyses the current measures towards energy security and looks at the applicability of ESS for grid-connected renewable power and electric mobility. It also discusses the scope of engagement for India and potential ways of collaboration with other countries.

Keywords: *Energy Security, Energy Storage Systems, Batteries, Intermittent Renewables*

JEL classification: *O13, O14, O31, Q41, Q42*

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Energy Storage Systems and Energy Security
G20 Experiences and Opportunities

Amrita Goldar and Charulata Singhal

Key Messages

- Energy Storage Systems (ESS) could play a critical role in serving key energy end-uses in an energy secure and environmentally benign manner. The following brief looks at the applicability of ESS for grid-connected renewable power and electric mobility.
- G20 could be an important platform for taking the ESS agenda forward as it comprises some of the largest energy consumers and energy technology holders in the world.
- With the government's aim of making India a 100 per cent electric vehicle nation by 2030, a major demand for energy storage would come from the electric mobility sector
- India is expected to contribute more than one-third of the global market for electric vehicles batteries (NITI Aayog and RMI 2017)
- The emphasis in India is not just on the transition to ESS technologies but also on developing an indigenous manufacturing base.
- Currently, developments in ESS in India are primarily based on import of batteries with little domestic manufacturing. To ensure the development of the BESS manufacturing industry in India, four major challenges need to be met – low mineral reserves, nascent battery manufacturing industry, lack of co-ordination among stakeholders, and high perceived risk.
- There are a lot lessons that India can learn from the development of BESS within the G20 countries. Countries within this group have past experience dealing with both supporting up and coming BESS technologies as well as legislations to encourage its greater uptake.
- G20 as a group can also use its power to further the BESS related energy security agenda. Given that it is a new technology, the ESWG can develop a platform for sharing technology insights for batteries and arrive at common parameters for gauging performance.
- Given that climatic conditions vary widely across G20 countries, this will also help identify technologies that can work well for temperate and tropical climates.

1. Background

Energy plays a significant role in the economic transformation of the country and in improving people's quality of life. Thus India, with a population of 1.37 billion is not only one of the fastest growing economies but also the fastest growing energy consumer in the world. Between now and 2040, India's economy is expected to increase to five times its current size and its energy demand is expected to more than double.[1] This along with the

[1] Available at: https://www.iea.org/reports/energy-security-in-asean6. Accessed at June 10, 2020

limited energy reserves that India has at its disposal make India largely dependent on other nations for meeting its energy needs. India has just 0.8 per cent of global oil and gas reserves but oil accounts for 34 per cent of the country's primary energy use (MOSPI, National Statistical Office 2020) leading to import dependency for petroleum, oil and lubricants (POL) products of as high as 80 per cent (NITI Aayog and RMI 2017). As India continues to urbanise and stride towards the objective of universal energy access, the demand for and consumption of energy will continue to increase. India and several such countries envisage fulfilling a large portion of this demand through renewable energy generation. But in the integration and effective usage of the various clean energy alternatives at our disposal, new and distributed technologies such as energy storage systems ought to play an important role.

The International Energy Agency (IEA) defines energy security as uninterrupted availability of energy at an affordable price.[2] Energy security, which has remained one of the top priorities of almost all national governments, involves the adoption of a wide range of energy generation resources along with storage technologies to ensure the durability and efficiency of the energy sector.

The outbreak of COVID-19 has reaffirmed this importance. The importance of energy security and maintenance of energy reserves in order to independently meet national needs has never been felt so strongly before. The occurrence of COVID-19 has exposed us to a new energy paradigm in many aspects. To secure continuous energy supply, countries will now look towards less distant energy sources. Further, given the economic setback being experienced globally, getting domestic energy production back on track while reducing import dependency seems to be the best way forward. India, therefore, must secure an uninterrupted, affordable and a well-integrated grid energy system to recover its growth rate and rejuvenate its manufacturing sector. This brief examines the potential role that energy storage systems (ESS) could play in securing India's energy needs and how prepared India is for its adoption.

Currently, there are two major components that dominate India's energy mix – coal for electricity generation and crude oil for the industrial sector and mobility. While India largely uses its own coal reserves, India's import dependency for POL has already been mentioned. In this context, ESS could play a critical role in serving these end-uses in an energy secure and environmentally benign manner. While renewables can be an answer to the need of sustainable electricity generation, electric vehicles could be an answer to reduce crude oil imports for vehicle fuel. We discuss the benefits on integration of ESS with both of these in greater detail below.

The brief also looks at the role that the G20 can play in taking the ESS technology forward at an international level. The group comprises the major economies of the world that are both some of the largest energy consumers as well as key energy technology holders. The group has in the past acted in a co-ordinated manner to ameliorate the ill-effects of economic crises. Given the criticality of ESS technologies in furthering both the climate mitigation and

2 Available at: https://www.iea.org/topics/energy-security. Accessed at June 3, 2020

sustainable development agenda, there is a lot of good that could come about from the group deliberating on and working towards promoting ESS technologies in the current round.

2. Introduction to Energy Storage Systems

ESS are technological systems in which electrical energy can be stored and later discharged into a network based on user requirement. These storage solutions can be a response to a wide variety of challenges that are experienced in diversifying the energy sector and in transitioning to cleaner energy alternatives.

ESS forms part of the key supportive energy infrastructure for renewables to emerge not as a supporter but as an alternative to fossil fuels. The variable power from renewable sources such as wind and solar needs to be carefully integrated to ensure the stability and security of energy systems. In this regard, ESS can be a one-stop solution to provide energy systems flexibility, as they can be deployed quickly and modularly when and where flexibility is needed. Energy storage eases intermittent power disruptions by storing excess power generated by renewable resources at times of low demand and distributing the power in periods of high demand. This helps balance the load on the energy grid and reduces reliance on non-renewable resources. Hence, ESS, if combined with renewable resources, could ensure uninterrupted, environmentally friendly and low cost energy supply. Besides, improvement in power quality through the usage of ESS by residential, commercial and industrial consumers, in conjunction with renewable energy, could also potentially improve India's energy access, boosting overall demand and economic growth.

Another sector where ESS have an important role to play is electric mobility. Electric vehicles (EV) have the capacity to transform the mobility sector and secure the energy mix all by itself. There have been continuing efforts towards harnessing electric mobility to reduce oil import dependency. Although the EV fleet is yet limited in India, constant policy push from the government is expected to expand the EV market share soon. However, for this deployment to be sustainable, an uninterrupted supply of electricity along with access to affordable EV batteries would be crucial. Energy storage, i.e., batteries in this case, have been identified as the main component of EVs both in terms of cost and performance determination. Hence, electric mobility that utilises indigenous, modern and reliable energy storage will significantly help in reducing the country's dependence on imported fossil fuels and EV batteries.

Besides, some of the other applications where energy storage can be useful are: supporting smart grids, relieving congestion in the transmission and distribution system, creating dynamic electricity markets, and providing for energy self-sufficiency. ESS could play a critical role not only in every countries' transition to renewable energy and electric mobility but also in making the electricity sector more efficient and advanced.

The type and quantum of energy storage required for a nation is generally dependent on the combination of energy resources available, availability of physical infrastructure, energy supply, demand trends, regulatory framework and population trends. The known ESS technologies can be classified as in Figure 1:

Figure 1: Type of ESS

Mechanical

Pumped Hydro Storage – stores electrical energy as potential energy of water. Global capacity over 180 GW, but capacity seldom realised

Compressed Air Energy Storage – coverts excess/cheap electrical energy into compressed air. When required, compressed air directed to modified gas turbine to obtain electrical energy

Flywheels – store electrical energy as rotational energy in heavy mass. Low maintenance and low environmental impact

Electro-chemical

Batteries – Chemical compounds are used to store electrical energy. Numerous categories under 1). Solid rechargeable 2). Flow batteries

Fuel Cells – Chemical energy stored in fuels (ethanol, hydrogen or natural gas) can be converted into electrical energy

Power to Gas – Excess electrical energy is used for electrolysis of water to produce hydrogen and oxygen. Hydrogen is stored to be used as a fuel for later use.

Electrical

Super Capacitors – Store and release energy by reversible adsorption and desorption of ions at the interface between electrode materials and electrolytes

Superconducting Magnetic Energy Storage – Store electricity in electric and electromagnetic fields with minimal loss.

Thermal

Sensible Heat Storage – Excess thermal energy is stored in the form of increase/decrease in temperature of a material. Some examples are Molten Salt, Chilled Water

Latent Heat Storage – Energy stored in material that undergoes phase change as it stores/releases energy, e.g. Ice Storage, Phase Change Materials

Thermochemical Storage – Reversible chemical reactions used to store thermal energy in the form of chemical energy

These energy storage technologies differ on account of commercial viability based on parameters such as the C-rate, operating costs, technology maturity, construction period, energy density etc. However, the price competitiveness and the fast pace of development in battery technologies along with the limitations of other storage systems has put battery energy storage systems (BESS) as the first choice globally.

There has been exponential growth in BESS in the past two decades. Due to a dramatic increase in the installation of BESS, a reduction of 70 per cent in battery costs since 2012 has already been achieved.[3] As global battery manufacturing continues to soar, many nations and companies have expressed their intent to setup more gigafactory-scale plants. This is expected to not only expand generation capacity globally but also pave the way for more sophisticated battery technologies and a further reduction in battery costs. Further, industry experts expect global battery manufacturing capacity to more than double from 2017 to 2021, rising from 119GWh/y to 273GWh/y over the period (NITI Aayog and RMI 2017). IEA, however, projects an even greater three-fold increase in manufacturing capacity of lithium ion batteries by 2022 (IEA 2019).

While there is wide consensus over the rapid growth of energy storage as a whole, the projection of growth in terms of numbers widely vary across reports. One report estimates that the energy storage market could reach an annual sales of more than $26 billion by 2022 with a CAGR of 46.5 per cent,[4] while another widely read analysis estimates a more modest growth at CAGR 16 per cent, reaching $7 billion by 2025.[5] The divergence in projections mainly stems from the varying definitions of storage systems. Bloomberg New Energy Finance predicts a 122-fold boom in stationary energy storage over the next two decades, requiring an investment of $662 billion with the individual growth story of countries as presented in Figure 2.[6]

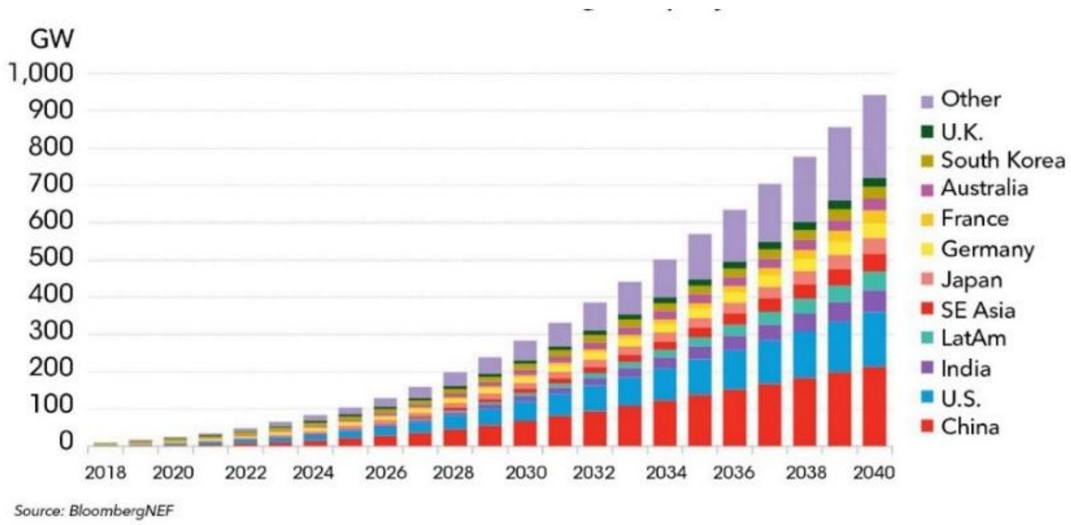
[3] Available at: https://www.utilitydive.com/news/global-energy-storage-market-to-hit-88-gw-by-2025-ihs-markit-says/448606/. Accessed at May 10, 2020

[4] Available at: https://www.globenewswire.com/news-release/2017/07/07/1041306/0/en/Energy-Storage-Market-to-Reach-26-137-Million-by-2022-P-S-Market-Research.html. Accessed at June 5, 2020

[5] Available at: https://www.utilitydive.com/news/global-energy-storage-market-to-hit-88-gw-by-2025-ihs-markit-says/448606/. Accessed at May 25, 2020

[6] Available at: https://about.bnef.com/blog/energy-storage-investments-boom-battery-costs-halve-next-decade/. Accessed at June 3, 2020

Figure 2: Global Cumulative storage deployments



However, despite the range of benefits that ESS offers, there have been several barriers during its deployment globally. These include lack of understanding of storage technologies, high upfront investments, lack of incentives and policy support, and limited availability of skilled personnel and experienced work-force to manage the systems. Hence, in order to achieve the growth numbers projected earlier, at least in India, initial handholding would be crucial. The common practice to incentivise deployment of energy storage has been direct support for storage through mandates and policies. Later in the brief, we review the steps taken by India and other countries in their transition to renewables, EVs and ESS to allow for the use of diversified sources of energy.

3. Status of ESS in India

India is committed towards reducing greenhouse gas emission intensity by between 33 to 35 per cent by 2030 from the 2005 level and has set an ambitious target of ensuring 40 per cent non-fossil based electricity generation in the electricity mix. In line with these broad goals, India has set specific target of 175GW of renewable energy capacity by 2022, of which 100GW will come from solar and 40GW of this solar capacity will be from solar rooftops. A capacity of 85.9 GW of renewables had been set up as of December 2019, with grid connected solar roof top capacity of 2.3 GW (Ministry of New and Renewable Energy 2020). However, in order to achieve the 40 per cent non-fossil based energy mark, India not only needs to ramp up its progress towards achieving the set goals but needs to set even higher goals, scaling up renewables considerably above the present target. This along with the awaited surge in EVs as a result of immense policy push by the government and NITI Aayog are set to pose a grave challenge to grid operators in maintaining the reliability, flexibility and stability of distribution networks. Energy storage systems, as discussed above, could play a key role in providing this flexibility (Figure 3). The time is ripe for India to push for renewables and storage as a package and not renewables alone, paving the way for the deployment of energy storage for grid support. Besides, the development of a national energy storage ecosystem represents a huge economic opportunity for India, providing for a reduction of crude oil imports and avoiding import dependency in the case of battery packs and cells.

Figure 3: Key areas for energy storage application in the India

Key areas for energy storage application in the Indian context could include	
1.	Integration of renewable energy with distribution and transmission grids, and balancing variable renewable energy
2.	Setting micro grids in rural and hilly regions with diversified loads or stand-alone systems
3.	Development of the storage component of electric mobility plans

To acquaint policy makers and trigger a discussion on ESS in India, the India Smart Grid Forum (ISGF) and India Energy Storage Alliance (IESA) have laid a comprehensive energy storage roadmap from 2019-2032 for India (India Smart Grid Forum 2019). The report analyses the viability of different energy storage technologies, and opined that in India as well, lithium ion batteries would gain traction owing to its versatile applications and declining costs. The report provides estimates of future energy storage needs for renewables in India based on annual energy requirements (Table 1)

Table 1: Projections for Energy Storage for Renewables

Estimates	2019	2022	2027	2032
Battery for LV* Grid (MWh)	241	5908	14617	21484
Battery for MV Grid(MWh)**	1054	3482	8393	11191
Total Storage (MWh)	**1295**	**9390**	**23010**	**32675**

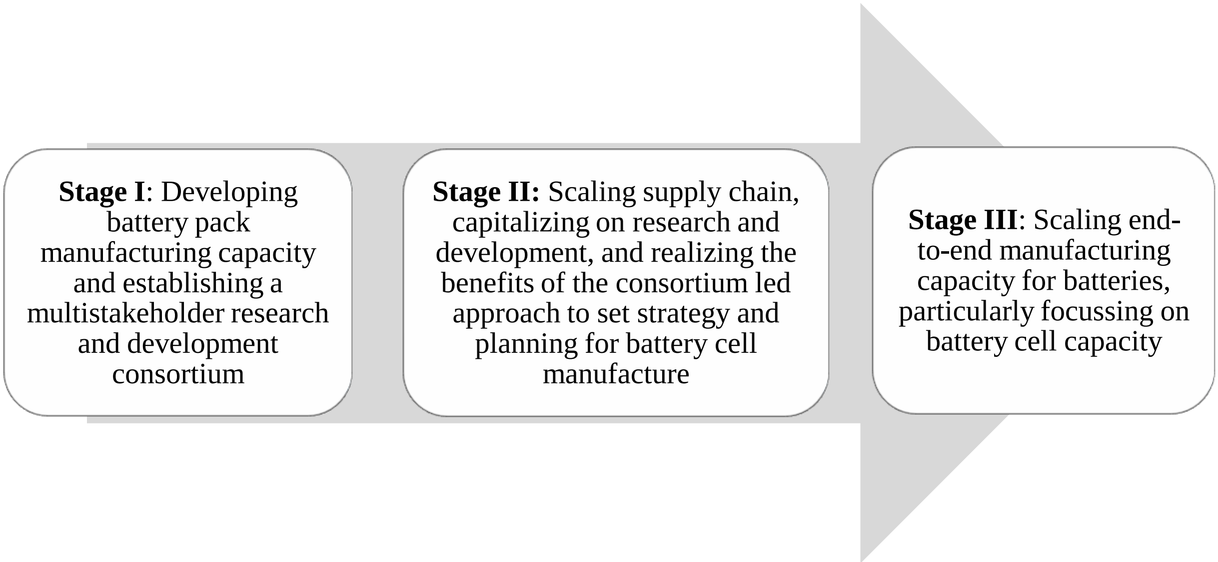
Source: Energy Storage Systems - Roadmap for India 2019-2032 (ISGF)

**LV – Low voltage; **MV – Medium voltage*

However, this reflects only a part of India's actual energy storage requirements. With the government's aim of making India a 100 per cent electric vehicle nation by 2030, a major demand for energy storage will come from the electric mobility sector. The energy storage requirements for electric mobility and grid support will be 57 GWh by 2022 and up to 1625 GWh by 2032 using estimates from the same report. Along with this, the Central Electricity Authority (CEA) also modelled the installed capacity of the BESS needed to support 40 per cent non-fossil fuel power capacity by 2030; it estimated that BESS capacity of 34GW or 136 GWh must be installed by 2029-2030 (Central Electricity Authority 2019). From all these accounts, India is expected to contribute more than one-third of the global market for batteries of electric vehicles (NITI Aayog and RMI 2017). Having analysed the energy storage requirements in the future, we look at how equipped India is to meet this demand and how much India has already achieved.

In 2017, NITI Aayog and Rocky Mountain Institute suggested that there are three stages of development of the battery manufacturing industry (Figure 4) (NITI Aayog and RMI 2017). Advancing Make in India while India and the world shifts to electric vehicles and batteries would allow India to become its own supplier of energy for transportation and a leading manufacturer of batteries for energy storage and transportation.

Figure 4: Stage of Energy Storage Scaling



In March 2019, the Government of India and NITI Aayog launched the 'National Mission on Transformative Mobility and Energy Storage' with the formation of an inter-ministerial steering committee that would be responsible for designing policy guidelines and ensuring compliance. The mission highlighted the importance of battery cells and energy storage solutions in electric mobility, complementing new and renewable energy generation, grid stabilisation, etc. and led to the formulation and launch of a phased manufacturing programme, with focus on indigenous battery manufacturing. The mission encourages research on raw materials, electrochemistry, and end of life treatment along with greater participation by industry in realizing Giga scale manufacturing (NITI Aayog 2019). With the launch of this mission, India has taken the first step towards developing energy storage in the country.

Currently, India has 70MWh capacity of BESS projects completed or on the verge of completion at various locations in India (India Smart Grid Forum 2019). The Solar Energy Corporation of India (SECI) has also concluded what is known as the world's largest renewables plus energy storage capacity tender in early 2020. It awarded the contract for a total 1.2GW capacity with 900MW of pumped storage to Greenko and 300MW of battery storage to ReNew Power at a highly competitive bid of approximately Rs.4/KWh (lowest globally). Besides, the mission of fossil fuel free Lakshadweep and Andaman & Nicobar (A&N) Islands has given way to storage integrated renewable projects with an aggregate capacity 52MW in the islands (Ministry of New and Renewable Energy 2020). One of these projects with 8MWh BESS in A&N islands and another with 2.15MWh in Lakshadweep islands are in an advanced stage of implementation. Along with increasing installed capacity, Ministry of New and Renewable Energy has also been aggressively undertaking research on the development of advanced and more efficient battery technologies and battery packs. Potential of ESS to balance power from renewables and thermal plants which cannot be shut-down immediately, is being explored by CEA. In 2019, the first grid scale ESS project was completed by Tata Power, AES Corporation and Mitsubishi Corporation at the Rohini substation in New Delhi with a capacity of 10MW for applications such as peak load management, frequency regulation etc.[7] Besides, other utilities like BSES Rajdhani – Yamuna, Adani electricity and CESC Kolkata are also planning to install ESS at the sub-station level in the electricity grid.

However, developments in ESS in India are primarily based on import of batteries with very little domestic manufacturing. To ensure development of BESS manufacturing industry in India as envisaged by the National Mission on Transformative Mobility and Energy Storage, there are four major challenges that need be addressed (NITI Aayog and RMI 2017) (Figure 5)

Figure 5: Four challenges to Energy Storage

Low mineral reserves	India lacks reserves of important raw materials and processed functional materials such as LIB components including lithium, cobalt, nickel, copper, etc.
Nascent battery manufacturing industry	India currently lacks state-of-the-art manufacturing facilities and the desired capability
Lack of co-ordination among stakeholders	Absence of co-ordination among key stakeholders such as material suppliers, battery manufacturers, vehicle manufacturers, local and central governments, research institute etc., is a key barrier in streamlining efforts.
High perceived risk hindering investments	Due to the uncertainty in battery technologies and the absence of long-term policies for manufacturing by the government, investment risks in this sector are currently very high

As energy storage is one of the most crucial and critical components of India's energy infrastructure strategy, these challenges need to be addressed at the earliest. In addressing these, India's relations with other countries have an important role to play. Learning from the experiences of other countries and engaging in an effective dialogue with national governments and alliances across the world will help India meet these challenges. TIFAC (Technology Information, Forecasting and Assessment Council), an autonomous technology think tank under Department of Science & Technology, also points out in its 'Technology Vision 2035' report that much more research would be required in battery management systems, battery technologies and other storage systems in India. It emphasises the constant push that the sector needs for the next four to five years to achieve the targets set. There are several research areas that TIFAC highlights such as battery thermal management, which could improve battery performance, life and safety, and improved modules and pack designs. India can collaborate with other countries through knowledge exchange on these issues. The

[7] Available at: https://www.tatapower.com/media/PressReleaseDetails/1617/tata-power-collaborates-with-aes-and-mitsubishi-corporation-to-power-up-south-asias-largest-grid-scale-energy-storage-system-in-india

following section highlights the ways in which India could collaborate and learn from other countries and leverage international fora such as the G20 as well as bilateral engagements to push the ESS agenda forward.

4. Progress of ESS across Other Countries

IEA projects that 2018 had been a bumper year for energy storage globally as annual deployment almost doubled since 2017 to reach 8GWh. Countries that led the deployment include Korea, China, United States, Germany and Australia (IEA 2019). However, in absolute terms, China is dominant in the battery supply chain with unparalleled control over necessary domestic and foreign raw materials and processing facilities, according to BloombergNEF. Recognising the importance of ESS, policy makers worldwide are enacting regulations that will accelerate the adoption of ESS for grid support in the coming years. Where in 2017, there was scepticism towards the establishment of 1st Tesla Giga factory, today there are more than 10 Giga factories being set up across the world with individual capacity of over 10GWh per year.[8] There is a lot that India can learn from the growth stories of all these countries. To begin with, we look at the potential for collaboration and learning on the four challenges highlighted above (Figure 6).

Figure 6: Learnings for India

Nascent Battery Manufacturing Industry

- Overcoming barriers to manufacturing and deployment, such as lack of finances, trade barriers and R&D, could assist new entrants in the sector. The provision of strong warranties by the government has been proven to build confidence in players.
- Developments on the side of supporting infrastructure such as charging infrastructure, electric vehicle models, and technology for grid integration of batteries will create visible demand for energy storage systems, allowing the industry to grow.

High Perceived Risk

- Favourable long-term policy measures and ambitious targets have been the most successful ways to create a positive market sentiment.
- Korea, Germany and the states of New York, California, Massachusetts, Hawaii and New Jersey in the US have passed various favourable legislations to encourage the adoption of ESS.
- Besides policy thrust, investments and an R&D roadmap from the Federal Energy Regulatory Commission (FERC) of the US has also led to the rapid growth of the industry and market in the country.

[8] Available at: https://indiaesa.info/magazine. Accessed at May 28. 2020

Low Mineral Reserves	- In March 2019, India signed an MoU with Bolivia to explore and extract Lithium, a major component in lithium ion batteries. Bolivia has one-fourth of global lithium reserves; hence, agreements like this will greatly help the growing energy storage industry of India. - However, to meet its raw material demand India needs to partner with more such resource rich countries like Chile, Argentina and Australia.

- The US Energy Storage Association was the first to create industry alliances to expedite ESS adoption and since then, other nations have followed suit. - Assembling vehicle manufacturers, battery manufacturers, government, research institutes, think tanks, and material suppliers on a single platform would serve a dual purpose – while it would clearly convey government's enthusiasm and table the concerns of the market, it would also help streamline ESS growth in India	Lack of Co-ordination among Stakeholders

Apart from the above measures to address the challenges to the growth of the energy storage industry in India, there are some other ways, as discussed below, through which India can learn from other countries.

Australia has been leading in the installation of world class energy storage and clean energy technologies and India can learn from the expertise of Australian companies. Besides, another innovative technique adopted by the Australian Energy Market Commission is changing the settlement period for the electricity spot market from 30 minutes to 5 minutes, providing better price signals for investment in fast response technologies such as batteries. Secondly, Europe and United States have seen an increasing trend in co-located facilities of renewable energy production and energy storage assets. This has benefitted the investor as well as he utilities by increasing the value of electricity produced from the project and improving flexibility. India could encourage renewables and storage as a package. Lastly, it is important for India to come up with codes, standards, and regulations (CSR) for all plausible and preferred battery chemistries. CSR, in its entirety, covers rules and regulations that governs design construction, installation, commissioning and operation of storage systems. They become crucial from an investor's point of view as they act as industry benchmarks for any project. In the absence of CSR, investors are unlikely to get the confidence that their systems follow the best available guidelines. In Europe, a dedicated commission, the International Electro-technical Commission has been assigned the responsibility for taking care of the technical features. A similar body needs to be set up in India too, to technically back the policies of the government and to boost investor confidence.

Besides facilitating integration of renewable energy to the grids, ESS is also being explored globally to participate in the ancillary market. Prevention of frequency fluctuations, flattening of the duck curved demand curve as for example in the US, combining ESS with combined cycle power plants to reduce costly down-cycling and up-cycling of running plants are some of the areas of ongoing research.

5. An Opportunity for ESS – The G20 Platform

Deliberation and collective development in the field of ESS needs to start quickly, given the ambitious targets set by nearly all countries in the areas of climate mitigation, greenhouse gas reduction, renewables adoption and transitioning to electric vehicles. The crucial role that ESS would play in this transition has been widely discussed in the sections above. Battery storage and electric vehicles lead the current and planned power technologies in which senior business leaders from G20 have invested in or are committed to investing in, according to international law firm Ashurst report – Powering Change – Energy in Transition. The report analysed the views of more than 2,000 senior business leaders from G20 countries, of which 46 per cent are investing in battery storage and 43 per cent in electric vehicles. This enthusiasm among investors stems from the continued emphasis on ESS in the G20 summits. The importance of energy storage in the decarbonisation of transport and integration of renewables has been discussed in all the preceding summits in Japan, Argentina, Germany and China. However, while standalone developments are being undertaken, there is much larger scope for collective development in the field of ESS that has not yet been explored. The humongous capacity that India hosts in terms of labour, market, investments and scientific expertise are all in favour of India pushing the agenda of ESS and, more importantly, leading the dialogue on the G20 platform. Further, in the run up to the 2023 India G20 presidency, it is important we carve out opportunity areas for India.

In our opinion, one of the easiest areas to engage in could be co-ordinating policies that support renewable energy with batteries as bundled technologies. Supportive policies could be in the form of central/state mandates as well as incentives such as preferential tariffs for rooftop solar and ESS bundled technologies, for example. As of yet, there is no consistency in policies among countries or even within India. Another area where co-operation may develop organically could be in the form of a platform that shares technology insights. Battery performance varies depending on climatic conditions and there is a case that could be made for sharing experiences about ESS working under hot and humid conditions. India along with a select group of countries with a similar climate could take a lead on that.

While, in most cases, battery designs are proprietary and companies might not want to share details for fear of competitors, G20 countries could come together to develop common battery performance standards. While India has set for itself the challenging task of both transitioning towards electric mobility as well as developing its indigenous ESS manufacturing, just the shift to electrification is enough for most other countries. Given that there exists a critical mass of battery users within the G20 countries, a commonly agreed upon quality metric (or labelling criteria) could be developed. This would help support the cause of 'battery as a service' proponents as well.

6. Potential Barriers to ESS Adoption

Despite the range of benefits of ESS that the brief has discussed above, there have also been certain barriers that ESS have been facing globally. The biggest, as observed in the US energy market, is the market design, which has been resisting the entry of a new technology such as ESS. As ESS has no shut down and start up time, unlike gas fired or coal fired power plants, there is no clear mechanism to value/compensate the improvement in response and efficiency provided by ESS. Further, ESS is currently concentrated only in a few developed economies due to its high upfront costs, and the need for significant research, resources and expertise for a cost-effective and climate suitable design. Differences in the grid infrastructure and transmission and distribution networks among countries will require an exclusive strategy for commercial adoption of ESS by all countries. While integration of ESS in an already distributed power market can be relatively easy, integration into centralised grid economies can be a challenging task. ESS is also likely to face hindrance from conventional power generators as it not only facilitates integration of renewable energy to the grid but also becomes an energy supplier in times of peak demand, disrupting the capacity markets at the same time. Further, widespread adoption of ESS could also eventually lead to a reduction of its own market in the future as its aim is to reduce the gap between supply and demand, encouraging greater demand when direct supply is available and using ESS as an emergency resort. To be able to provide a huge amount of power in case of outages, the size of ESS would proportionally increase as would its cost. Further research is needed in this regard where inexpensive ESS with greater energy capacity can be made available. Last but certainly not the least, a solution for the huge piles of used storage systems that are expected to flow in the waste economy has not yet been identified. While extensive research on recycling of batteries is underway, no speedy and cost effective method is known. Hazardous BESS waste from electric vehicles has remained the major point of contention on the topic of EV adoption. Thus, significant changes in the energy market to accommodate a distributed energy resource such as ESS, coupled with strong political will and low cost finance, are some pre-requisites for the successful adoption of ESS as observed from global experiences.

7. Conclusion

Energy Storage Systems in general and BESS in particular represents a huge economic opportunity for India. Besides enabling a smooth transition for India from internal combustion engines to electric vehicles and the integration of renewable energy, it offers India the opportunity to emerge as a leading battery manufacturer. As pointed out by NITI Aayog and RMI, ambitious goals, concerted strategies and a collaborative approach could help India with development of this technology. As discussions on international platforms such as G20 have been limited, India must take the lead in shaping deliberations and benefit from the experiences of other countries in their journey towards ESS. In addition to this, stable and long term policies along with the formation of a consortium of stakeholders will be fundamental to boosting market sentiment and investment in the sector. Renewables with storage can decarbonise power systems, expand energy access, improve grid reliability and improve the resilience of energy systems. Energy storage will be a critical factor in creating the grid of the future.

G20 as a group can play a critical role in shaping this grid of the future. Through the sharing of best practices and insights, climate-varying parameters of performance can be arrived at. Previous experience can also help guide the choice of ‘ideal’ technologies that can be developed within the country.

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