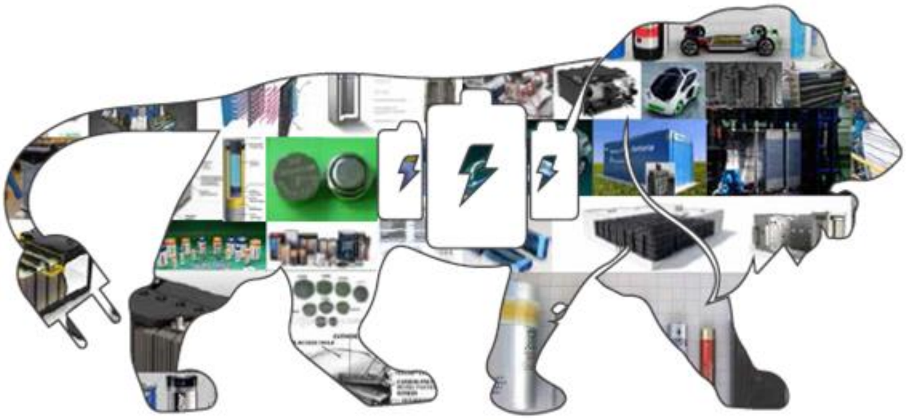
IESA
India Energy Storage Alliance

Recommendations for encouraging advanced Energy Storage technology manufacturing in India



Prepared for

NITI Aayog
(National Institution for Transforming India)
Government of India

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Contents

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The India Energy Storage Alliance (IESA) was launched in 2012 by Customized Energy Solutions to promote energy storage & micro grid technologies and their applications in India. IESA's vision to make India a global leader in energy storage & microgrid technology adoption and hub for manufacturing of these emerging technologies by 2020. IESA's mission is to make energy sector in India more competitive and efficient by creating awareness among various stakeholders in the industry and by promoting information exchange with the end users. IESA also provides insights to technology developers, original equipment manufacturers, policymakers, renewable players and system integrators on the policy landscape and business opportunities in India through frequent interaction with all key stakeholders. As estimated by IESA, the Indian energy storage market is expected to grow to 70 GW by 2022. Please find more information on IESA at http://www.indiaesa.info/

Introduction

India is emerging as the most strategic energy storage market for battery and inverter OEMs across the globe. Unlike in the Western and developed countries, where ESS market is driven by newer applications like frequency regulation, renewable integration at grid scale and electric vehicles, in India the market is currently driven by need for backup power due to supply demand mismatch on electric grid, electric transportation such as e-rickshaws, telecom towers and energy access. With the support from policy makers, alongside these traditional applications, newer applications like frequency regulation, solar PV and wind integration, Transmission &Distribution deferral, electric vehicles (other than e-rickshaws) and diesel replacement are likely to drive ESS market growth in India.

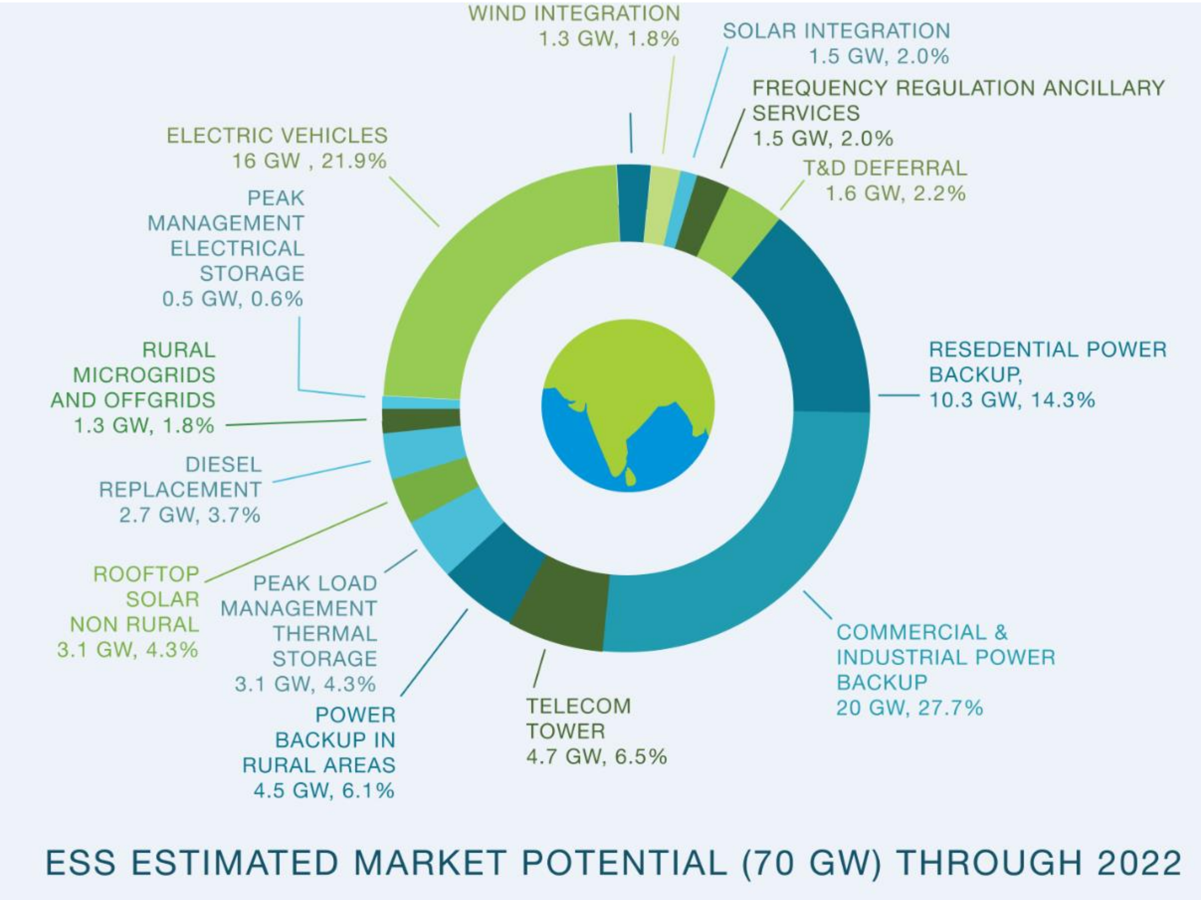

Figure 1: India Energy storage Market Potential (2015-22): 70 GW

The total energy storage market between 2015 and 2022, in India is estimated by India Energy Storage Alliance (IESA) which is close to 70 GW and 200 GWh. Out of 70 GW, over 35 GW of demand is expected from newer applications like wind and solar integration, frequency regulation, peak management, T&D deferral, diesel replacement and electric vehicles. Hence there is a sizable opportunity for advanced storage technologies in the new applications itself apart from opportunity for existing technologies to improve their performance for traditional applications.

Challenges and Opportunities

Indian market is slowly gaining understanding of both the newer energy storage technologies and their applications. The market stakeholders want to witness the proof of concept. For this to happen, the policy makers and the government need to step in with demonstration projects and incentives like Viability Gap Funding (VGF), Accelerated Depreciation (AD) benefits, etc. for the energy storage projects. For the last four years IESA has worked with all the key stakeholders in the market to educate them on many opportunities that energy storage can provide. We are anticipating that over 50 MW of demonstration projects will get announced in 2016 for advanced energy storage technologies. Many of the RFPs for energy storage projects are either out or will be out soon from institutions like Solar Energy Corporation of India (SECI), National Thermal Power Corporation (NTPC), Gujrat International Finance Tech (GIFT) City, Ministry of New and Renewable Energy (MNRE) and Power Grid Corporation of India ltd. (PGCIL).

The market for advanced storage is developing quickly for applications like telecom infrastructure and e-vehicles. Leading telecom companies have already announcement deployment of Li-Ion batteries for reducing diesel consumption for over 100,000 telecom towers and there is additional anticipated demand of similar solutions for 400,000+ towers over next 5 years. While the main stream market for electric vehicles is yet to take off, according to various estimates over 500,000 e-rickshaws are already on Indian roads in 2nd tier cities. It will very important to have proper policy framework for facilitating fast growth of this market and encouraging Indian and international companies to set up manufacturing infrastructure in India. The biggest driver for such investment decision will be sustained demand creation and this should be one of the key focus areas for Niti Aayog. In addition, appropriate performance and safety standards should be adopted for this market, else the failure of low quality batteries will create uncertainties for potential buyers and can derail growth of this market.

Electric vehicles play an important role in integration of renewable energies into the grid. Negligible charging infrastructure, lower ranges and low awareness are the key reasons for the slow paced development of e-vehicles in India. The Faster Adoption and Manufacturing of Electric & Hybrid Vehicles in India (FAME) subsidy for EV manufacturers in India under the National Electric Mobility Mission Plan (NEMMP) is one of the key reasons for development of the market.

It is estimated that over 50 GW of installed capacity of Diesel Generators (DG) in India, consumes over 7% - 9% of the total diesel consumption in India. Per unit DG costs are around Rs.15 to Rs.40 per kWh, whereas the utility tariff is nearly Rs.4 to Rs.10 per kWh for most of the customer categories. This provides lucrative opportunity for deploying Energy Storage technologies as power backup solution and reducing diesel import burden for the Indian Government .

Technology Overview

There are several types of energy storage technologies, broadly classified as mechanical, thermal, electrochemical, electrical and chemical storage systems. Mechanical storage technologies include Pumped Storage Hydro (PSH), Compressed Air Energy Storage (CAES) and Flywheels. Within the electrochemical category, which includes technologies that use different chemical compounds to store electricity, the most common are lead acid batteries, high temperature sodium batteries, flow batteries, zinc-based batteries and Li-ion batteries. Electrical storage systems include supercapacitors and Superconducting Magnetic Energy Storage (SMES), while chemical storage typically utilizes electrolysis to produce hydrogen as a storage medium which can subsequently be converted to energy in various modes including electricity (via fuel cells or engines), heat and transportation fuel.

Each technology type has different characteristics such as energy efficiency, power-to-energy (P/E) ratio, cycle life, depth-of-discharge (DOD), self-discharge, energy density, space footprint, and suitability for various size ranges (in MW and MWh). The individual performance characteristics of any particular type of energy storage makes it more or less suitable for a particular application.

An increased pace of solar photovoltaic and wind installations in India also provides an opportunity for additional energy storage deployment. Storage can help smooth out the intermittency and uncertainty of renewable energy output resulting in a higher value from the renewable generators. Use and manufacturing of energy storage in India would very well complement the India's solar and wind installation mission.

	Lead Acid	Li –Ion	NaS	Flow Batteries	Flywheel	CAES	Pumped Hydro
Round Trip Energy Efficiency (DC-DC)	70-85%	85-95%	70-80%	60-75%	60-80%	50-65%	70-80%
Typical Discharge Duration	2 - 6 Hours	15 min - 4 Hours	6 - 8 Hours	4 - 6 Hours	15 mins	4 - 10 Hours	6 - 20 Hours
Cost range ($/kWh)*	100-300	400-1000	400-600	500-1000	1000-4000	>150	50-150
Development & Construction Period	6 months - 1 year	6 months - 1 year	6 months - 1.5 year	6 months - 1 year	1-2 years	3-10 years	5-15 years
Operating Cost	High	Low	Moderate	Moderate	Low	Moderate	Low
Space Required	Large	Small	Moderate	Moderate	Small	Moderate	Large
Life (cycles)	500-2000	2000 -6000+	3000-5000	5000 - 8000+	100,000	10,000+	10,000+
Maturity of Technology	Mature	Commercial	Commercial	Early - moderate	Early - moderate	Moderate	Mature

*Cost only includes price of storage. Other components such as battery management system add to the overall cost.

Table 1: Energy Storage Technology Comparison

The Indian market is currently dominated by lead acid batteries and total lead acid battery market is estimated to be ~$4billion / year growing at 12%+ year on year. However, Indian market also provides opportunities for other emerging technologies for applications where lead acid batteries may have limitations due to limitation on cycle life and fast charge/discharge capability. Li-ion technologies are gaining penetration in applications like telecom infrastructure sector and electric vehicles. It is anticipated that other technologies like flow batteries and sodium chemistries can also find a market for longer duration energy intensive applications such as microgrids and islands in the near future.

Recommendations to NITI Aayog by India Energy Storage Alliance

1. Investment in R&D and Innovation

It would be prudent for the Government of India to work on subsidy and concessional tax structure for industries which can support the R & D and test facilities for energy storage system.

Various Indian research universities have shown interest in R&D related to energy storage technologies. E.g. IIT Bombay is working on setting up Center of Excellence on Energy Storage, TERI has set up Center of Excellence on Thermal Energy Storage, CMET Thrissur has received funding for setting up manufacturing doe aerogel materials for ultra-capacitors, CECRI Chennai unit has set up a lithium ion battery manufacturing facility, Also NCL and CECRI, IIT Bombay working on Fuel Cell research.

Also from industrial side lot of activities are going on Electrical vehicles (EVs) and fuel cell technologies. Tata Motors delivered India's 1st Fuel Cell Bus and recently in Auto Expo Tata Group has shown 1 st indigenized fuel cell Vehicle (Magic Iris), Mahindra Reva shown long rang sports electric vehicle. Ashok Leyland working on Hybrid supercapacitor bus. KPIT as a service company delivered electric buses. At the same time, there is a big gap in commercialization of this innovation as well as linking this R&D to needs and timelines required by industry. Hence, most of the local manufacturing companies if interested in setting up energy storage plant in India would be licensing technologies from counties like Korea, Japan, China, Germany, the US, Canada, the UK or Australia. This has been also the case in the lead acid industry, where leading lead acid providers have traditionally licensed intellectual property from US, Japanese or Chinese companies. R&D in some of key areas for energy storage including battery performance, grid integration, power electronics devices, advanced e-vehicles testing, battery testing etc., should be encouraged.

This scenario cannot change overnight, and given the critical stage of the industry growth, GOI needs to allow import/transfer of technology, arrangement on royalty without any extra tax, or service tax. India already has a program for facilitating such technology transfer under Technology Acquisition & Development Fund (TADF), Department of Industrial Policy & Promotion (DIPP), Ministry of Commerce & Industry, and Govt. of India. This program should be extended and if required sector specific incentives could be added.

I the past 2 years India has witnessed creation of 100s of Accelerators / Incubators that are focusing on information technology / healthcare area. There is a need for a special incubator to nurture early stage energy storage technology startups and provide them suitable facilities for accelerating their progress from lab to commercialization. IESA has been working on creation of such Incubator for energy storage sector, and would be happy to discuss this in further with Niti Aayog.

Apart from this, we need to consider creation of program similar to US Department of Energy's ARPA-E program that has funded 100s of early stage energy storage technologies in past 5 years. There are also international collaboration opportunities for building on the existing research being done around the globe, given India's strategic importance and huge market potential.

2. Tax and Duty Structure

Since energy storage is an emerging sector as well as can have strategic importance for India's energy security and clean energy future, existing tax incentives offered for clean energy technologies or other similar sectors should be extended to this sector. Lowering of import duties can help in reducing barriers for adoption of emerging storage technologies and create demand that is critical for investments in manufacturing in India to take place. Such benefits could help not only electrochemical storage technologies such as Li-Ion, but also thermal storage technologies and fuel cells.

As an example, Li-ion based energy storage systems in India are imported from pouch level to complete system level. Till last year total duties on energy storage systems were marked up to 29.44% which included Basic Duty (up to 10.0%), Special Additional Duty (SAD), Counter-veiling Duty (CVD) and CESS.

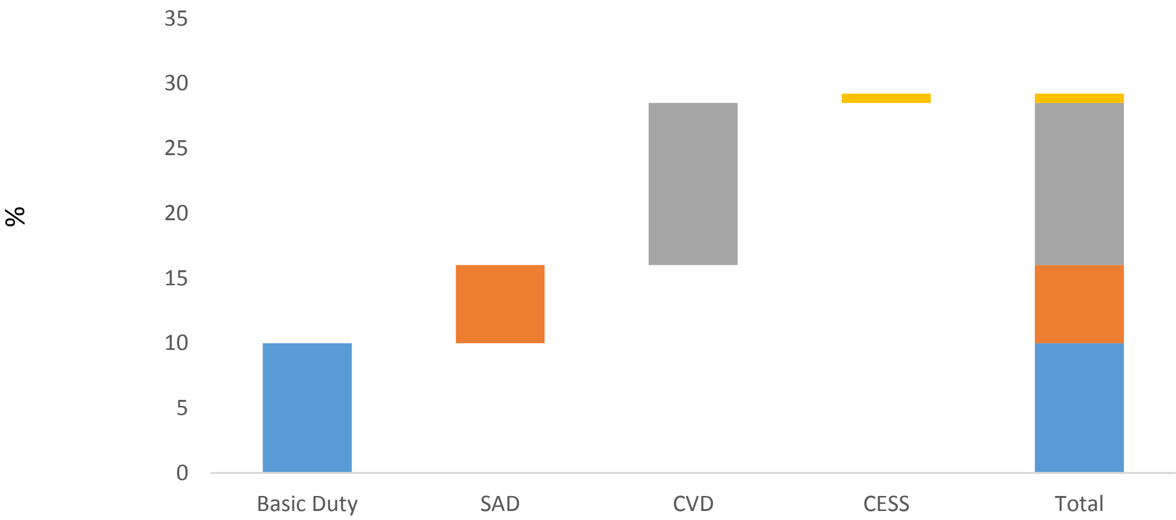

Figure 2 Maximum Import Duty on Li-ion in 2014-15 (Source: CES & IESA Research)

The basic duty of 10.0% in the previous year varied from country to country. For example basic duty for import from Japan was at 7.5%, 10.0% for China, and 5.5% for Malaysia. In the current financial year the basic duties for most of these countries except China has been slashed to 0.0%. Hence, the difference of cost for assembling the system in India and importing the complete system has been slashed by a maximum of 10.0%. This is a good step for market creation. Similar tax relief should also be extended to electronics component to bring down costs of BMS (Batter Management System) and inverters.

For encouraging domestic manufacturing a clear timeline for reduction in such duty waivers could be established with at least 3 years of lead time, so that companies can plan to scale up their investments in India, while consumers can also benefit for lower priced products immediately due to lower duties immediately. As the manufacturing in India grows, prices for such products will drop further, thus fueling faster market growth.

E-vehicles can be exempt from taxes such as Value added tax (VAT), road tax and registration tax, which would significantly bring down the net cost of ownership of EVs, making them a viable option for car buyers in India. Maharashtra government has already committed to waive off the above mentioned taxes, steps should be taken for implementing the tax waiver for electric vehicles by the union government.

Manufacturing

There is tremendous potential for India to become global hub for manufacturing for advanced energy storage technologies. India is already a major hub for lead acid battery manufacturing. Also number of companies have already started setting up India operations for localization of Li-Ion and other advanced storage solutions including power electronics and inverters.

There should be provision of some grant by the DeitY/MNRE to such manufacturers who have been doing manufacturing in the country. Country has very good manufacturing base of UPS/Inverters/Drives and lead acid batteries. However, in MW size solar inverters, the percentage of imports is over 90% (unless we consider companies like ABB, Bonfiglioli, TMEIC (formerly AEG), Schneider etc. which still import whole of the intelligence with Power Electronics module from their European facilities and just assemble the cabinet in India).

To compete with global Li ion giga-factories, Indian manufacturers would need to build up cell manufacturing plants of capacity close to 1 million cells per month. Such an establishment can cost over $ 600 million. Such high capital investment would require incentives in terms of taxation from the central government. Interested manufacturing companies in India have recommended AD benefits for three years for setting up of the plant and five years of tax holidays as it was provided under the initiative of *Start-up India*.

Availability of skilled labors would not be a huge bottle-neck as these manufacturing processes are highly automated. At the same time, we need to focus on skill building for the entire eco system including installation, commissioning and O&M.

Apart from electrochemical batteries and associated power electronics, India could also play a major role in mechanical storage systems such as flywheels or Compressed Air Energy Storage, as companies such as Siemens & Dresser Rand (which owns key IP on CAES technology) already has significant manufacturing presence in India.

Materials account for more than 50% of the total cost of Li-ion battery production. Hence it will be key to understand import duty structure for these components and optimize it to bring down the overall costs. Secondly, to overcome any supply chain risks, the government must enforce a trade agreement with the sourcing nation.

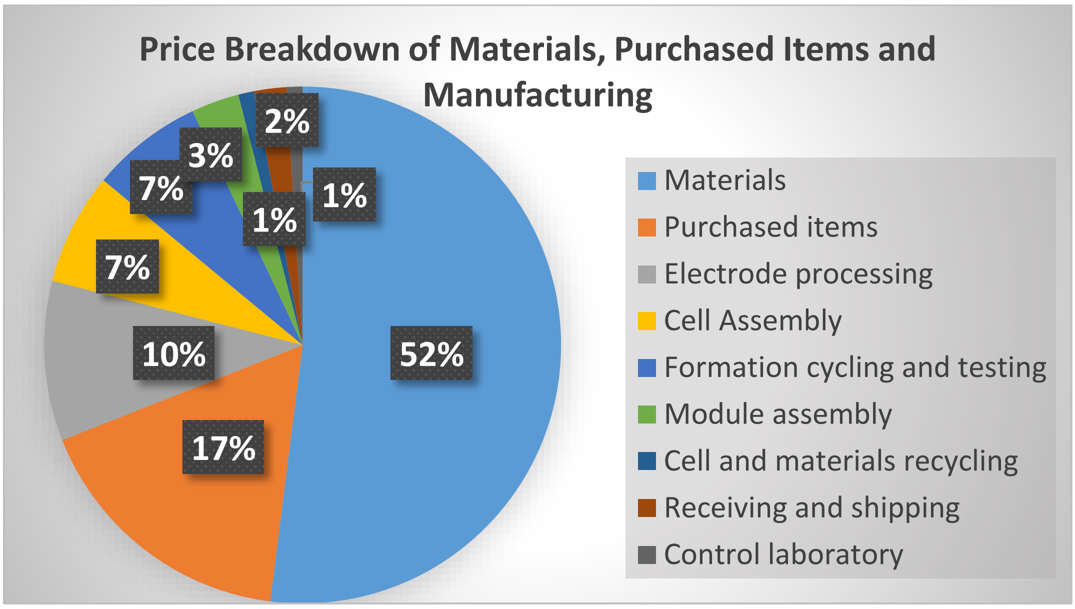

Figure 3: Price Breakdown of Materials, Purchased Items and Manufacturing (Source: CES & IESA Research)

Apart from the material supply chain, we may also need to provide special Energy Storage Manufacturing Clusters, where supporting ancillary units could be located, similar to automotive and textile clusters already in operation across country.

While government focuses on policies for supporting new technologies, it is important to also encourage existing lead acid industry which currently does over $4Billion in annual sales to stay competitive. We believe that Lead Acid and Advanced Lead Acid chemistries will continue to play a major role in meeting the needs of India consumers for decades to come. There are number of innovations that could be commercialized with in lead Acid chemistry that can address current limitations of the century old technology, but the industry is facing classic innovator's dilemma. Niti Aayog should consider training and market transitioning assistance for existing stakeholders.

3. Reuse and Recycling

The Government of India has laid down several guidelines for lead acid battery recycling. The Batteries (Management and Handling) Rules, 2001 is the law governing battery regulation in India. It was issued by the Ministry of Environment and Forests (MoEF) and provided regulations for the management and handling of lead-acid batteries. Batteries (Management and Handling) Rules, 2001 are the rules applicable to all the manufacturer, importer, re-conditioner, assembler, dealer, recycler, auctioneer, consumer and bulk consumer involved in manufacture, processing, sale, purchase and use of batteries or components thereof to ensure no damage to environment happens during the production, distribution, usage and disposal of batteries. But this rule is only limited to large scale lead acid companies.

While for other advanced technologies, some electrical storage devices have high-recycled value, there are some others, which are not very viable commercially, to be recycled. Hence, a recycling policy for all energy storage devices needs to be framed right from start.

Given the large volume of Li-Ion batteries being already used in consumer electronics such as cell phones and laptops as well as upcoming demand for EVs and stationary applications, government should create regulations for Li-Ion handling rules/licence policy to handle it in C&I premises to take safety measures.

Apart from recycling, there may be a huge opportunity for reuse of old Li-Ion batteries as different applications require different performance. This is commonly referred as "2nd life" use of batteries and it is anticipated that EV batteries as well as batteries from laptops could be used for stationary applications before being sent for recycling. We recommend that Niti Ayog should get inputs from automotive as well as energy storage companies on how we can create a framework for facilitating such utilization and to set up appropriate facilities for collection and processing of used batteries.

4. Market Creation for Energy Storage Solutions

With the vision of reducing the greenhouse gas emissions and transitioning existing transportation sector to electric mobility market, India needs to create a vibrant market for energy storage technologies integrated across the complete automotive value chain. Attracting and encouraging manufacturers, tax incentives for customers, Setting goals for electric vehicles and hybrid vehicles, creation of charging infrastructure across categories such as street, residential, workplace, fleet, highway, public places (malls/parks/beaches), setting targets and incentives for EV public bus to state/metropolitan bus transport etc. are the key steps that needs to be undertaken to create a vibrant electric mobility market.

The integration of variable and intermittent renewable energies into the electricity grid demands innovative storage solutions. Substantial and fast reacting storage capacities are needed to balance out fluctuations. Recently, MoP has released a Report of the Large Scale integration of renewable energy and also launched Ancillary Services Operations in the Country. This report contains 15 actionable points, which must be implemented fast track to ensure the integration of renewable energy into the grid. The key imperatives that need to be undertaken to create a vibrant Utility scale (front of meter Energy Storage segment) include technical & policy pathways, introducing of energy storage procurement standards, financial incentives etc.

Currently only option available for consumers is fossil fuel based backup power generation. Reducing utilization of diesel for such backup operations with efficient energy storage solutions will create the market for behind the meter energy storage installations. This will benefit energy consumers who are exposed to high energy and peak demand charges, and high fossil fuel costs for backup power. Telecom sector has already started adopting such solutions in past 2 years. Initiatives to discourage diesel usage and subsidy for usage of diesel for power backup purposes should be undertaken. A regulation to be drafted that identifies energy storage solutions as an asset that interacts with the grid, by both consuming and supplying power to the grid.

5. Requirement of testing standards and certifications

Different energy storage technologies involve unique challenges for ensuring safety and reliability. This necessitates implementation of standards ascertaining safety based on the technology involved in the product. Globally, there has already been a lot of work done on this subject which can be of immense utilization in this regard. IEC (International Electro technical Commission) & UL (Underwriters Laboratories) has published a variety of standards in this segment. Many of the standards are also under development at this instant and would be published shortly.

A list of various series of international standards for different categories include:

Series of Standard	Categories Included
UL 9540	Energy Storage Systems (ESS)
Draft IEC 62933	Electrical energy storage (EES) systems
UL 1989	Standby Batteries
UL 2743	portable power packs
IEC 60896	Stationary lead-acid batteries
IEC 61427	Secondary cells and batteries for renewable energy storage
IEC 62485	Secondary batteries and battery installations
Draft IEC 62932-1 Draft IEC 62932-2-1 Draft IEC 62932-2-2	Flow Battery Systems for Stationary applications
UL 1642	Lithium batteries
Draft IEC 62619	Large format Li-Ion secondary cells and batteries for Industrial application
Draft IEC 62897	Stationary Energy Storage Systems with Lithium Batteries: Safety Requirements
UL 810A	Electrochemical Capacitors
UL 991 and UL 1998	Tests for Safety-Related Controls Employing Solid-State Devices; and Standard for Software in Programmable Components
UL 2271	Light Electric Vehicles (LEV)
UL 2580	Electric Vehicles (EV)
UL 1973	Batteries for use in Light Electric Rail (LER) and Stationary Applications

Table 2: IEC Standards relevant to energy storage technologies

We recommend that, rapid adoption and enforcement of these standards with "only" necessary deviations depending on regional specific requirements would be a much more realistic approach for the industry. This practice is also being regularly followed by BIS for all the other industry segments and has been very successful & suits Indian requirements completely.

Apart from this, there is a need for having suitable testing facilities in India for these emerging technologies and systems. Currently there are number of testing facilities such as ARAI, BEL, BHEL, CECRI, ERDA, ERTL etc. But they have limited abilities for larger system testing such as performing nail penetration test for Li-Ion battery packs. We believe that enforcement of standards is critical for providing incentives to invest in the infrastructure necessary for such testing facilities.

The results of these applied research for validation will provide benefit in three ways:

A. Generate complete guidelines for testing & certification for these products by joint efforts of these laboratories, Bureau of Indian Standards & Industry
B. Prove the suitability of application of these products & systems in specific application areas
C. Start-up basic research initiative for this technology in our country.

Conclusion

It has to be noted that supply follows demand and hence primary need is demand creation for the targeted product. Demand creation depends on value proposition & reliability of product. To grow the market, both aspects can be tackled simultaneously, although validation of reliability should precede value creation.
India has a huge potential for paying a key role in global energy storage innovation ecosystem with excellent R&D facilities being created at existing academic and research institutes. What is needed is for setting up accelerators / incubators with close ties to industry, so that these efforts can be aligned with needs of industry. Also there is excellent opportunity to synchronize these efforts with global R&D community through programs such as Glob al Innovation and Technology Alliance (GITA)

Safety norms in general, for installation of electrical storage devices & special safety norms for any particular technology & applications are required. In pat 4-5 years significant work has taken place through international standards organizations such as IEC and UL. India needs to piggy back on these standards rather than creating new standards or modifying these standards as the supply chain is global. Harmonizing and adopting existing standards can help India fast track adoption and grow the market faster, while giving opportunity for India manufacturers to play a critical role in global supply chain. There is a need for upgrading existing or adding new testing facilities as safety and performance valuation is very critical for giving confidence to consumers. For this existing standards need to be enforced else just the drive for cheaper products could lead to some safety violations such as fire accidents that could derail adoption of these technologies.

Subsequent to technology validation, there will .be need for policy support for setting up manufacturing bases. It is proposed that special import duty, CVD & Excise duty support be provided for capital equipment sourcing for electrical energy storage manufacturing units, both existing & upcoming (a level playing field). Defining advanced energy storage systems / products/ technology will be difficult and even if done, will lead to unending debate about which is advanced technology and which is not & hence, it will be difficult to earmark any specific raw material for any particular storage technology for a special concession. Hence the term could be plain “electrical energy storage technology” while providing concession for the capital equipment (plant & machinery).

The same support may be provided to the ancillary industries, which will form the supply chain for these manufacturing units. The decision on accepting the technical advantage and its consequent value proposition (pricing) for any product in a particular usage should be left to the customer & manufacturer.

In the process of preparing the Recommendations, IESA Team organised IESA Working Group meeting in the first week of April as well as conducted one on one calls with members to gather inputs from various stakeholders from the industry. IESA is also thankful to all its member companies for providing feedback and suggestions

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