Report: Trends in the energy storage market in India and entry points for Swiss companies

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Executive summary

Not only is energy storage one of the key puzzle pieces in India's energy transition, it also offers companies and startups ample opportunity to do business. Both grid-scale and household storage solutions, in addition to battery packs for two- and three-wheelers, are attracting great interest from a range of investors, established energy players, and the government of India. Yet, the energy storage sector is still in its nascency in absolute terms, with few domestic production facilities present and only a handful of research institutions currently working on energy storage technology. While this might be perceived as a barrier, however, it is precisely because of this current vacuum, in addition to the sheer necessity of energy storage solutions to take India's energy transition to the next level, that we see a large upside to the Indian energy storage sector. It is ready to be explored by Swiss players.

1. The case for energy storage in India

Promising news came out of India at the beginning of 2020. In January 2020, Hyderabad-based Greenko and Delhi-based ReNew Power secured a total of 1.2 GW renewable-cum-storage firm supply at a 25-year fixed price quoting weighted average tariffs of $ Cents 5.61/kWh and $ Cents 5.97/kWh respectively[1]. Compared to the price range of recent thermal tenders of $ Cents 6.3/kWh – 8.4kWh, these newest numbers show that renewable power is rapidly becoming competitive in India. What stands out most is that these two renewable energy (RE) tenders both include energy storage systems (ESS), something that has so far been missing from RE tenders due to costs concerns. Add to this the benefit of price certainty of long-term RE supply deals for Indian distribution companies and the continued falling of battery prices and you will arrive at the inevitable conclusion that renewable power is here to stay in India.

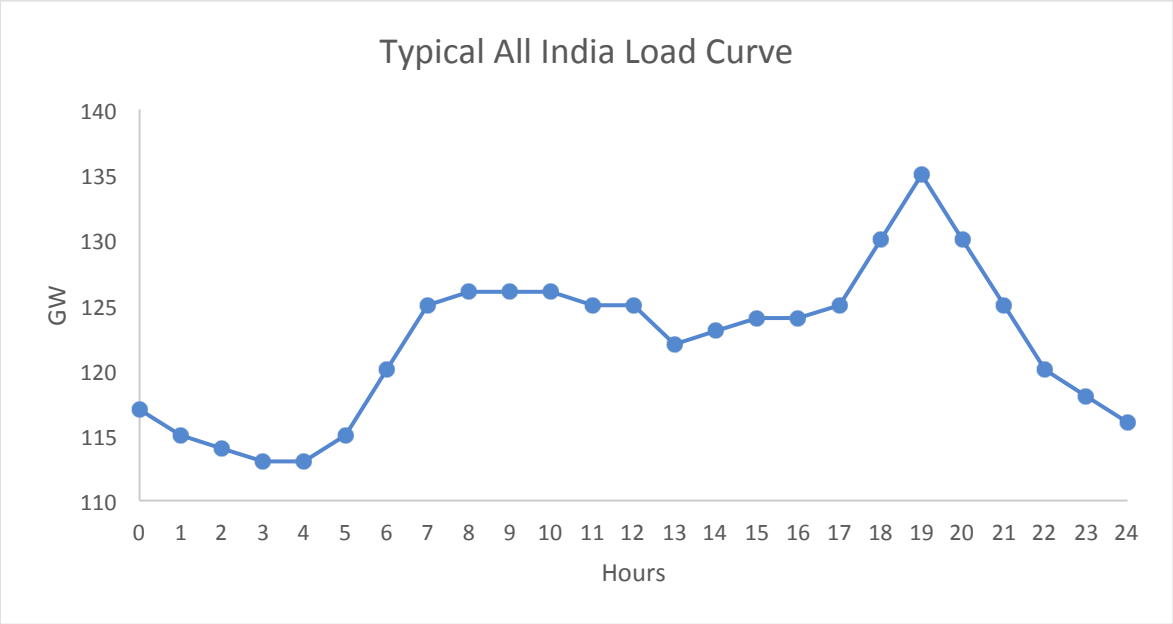
And yet, India is likely to miss its government target of having 175 GW capacity, including 100 GW from solar and 60 GW from wind[2], installed by March 2022. In a recent report, the rating agency CRISIL expects that India will not meet its targets before 2024, citing policy uncertainty and low/unattractive tariff caps for RE. The COVID-19-induced economic slowdown further dampens RE short-term prospects. Similarly, while the installed capacity of solar and wind has in fact increased substantially over the past decade as highlighted in IRENA Renewable Capacity Statistics 2019[3], the added capacity falls well short of achieving the government's goals. In

[1] https://economictimes.indiatimes.com/small-biz/productline/power-generation/seci-concludes-worlds-largest-renewable-cum-storage-based-firm-supply-tender-at-rs-4-04/kwh/articleshow/73830234.cms
[2] https://sustainabledevelopment.un.org/partnership/?p=34566
[3] https://www.irena.org/publications/2019/Mar/Renewable-Capacity-Statistics-2019

addition, with growing penetration of renewable energy into the grid experts[4] highlight the challenges of upgrading the complementary infrastructure needed to handle larger sums of RE in terms of generation, storage, and consumption, especially once India moves past the "low-hanging fruit of variable renewable energy"[5] of roughly 20% share of RE in India's energy mix.[6] 20% is the threshold at which a lack of adequate energy storage solutions will negatively affect overall grid performance. Consequently, providing adequate and large enough energy storage capacity is the make-or-break task of India to achieve its energy transition.

Greater share of RE equals greater intermittency

Particularly as the share of RE grows, the intermittency of RE in general and solar polar specifically will be felt much more. As banal as it sounds, the sun only shines during part of the day and unfortunately, it does not shine in the evenings when India's electricity demand spikes, as sim. As the share of RE grows, so will the drop in renewable power provided during peak times of demand. This drop will either have to be compensated by flexible and responsive thermal power – as is the case with coal today (and hydropower to a certain extent)[7] – or by massively improving ESS and making the grid more flexible. By storing excess power during the day when generation is high and consumption is low, this surplus power can be fed back into the grid during the evening peaks. This process is commonly known as grid balancing or demand shaving and is aimed at smoothing out what is now commonly referred to as the duck curve as shown in the figure below.



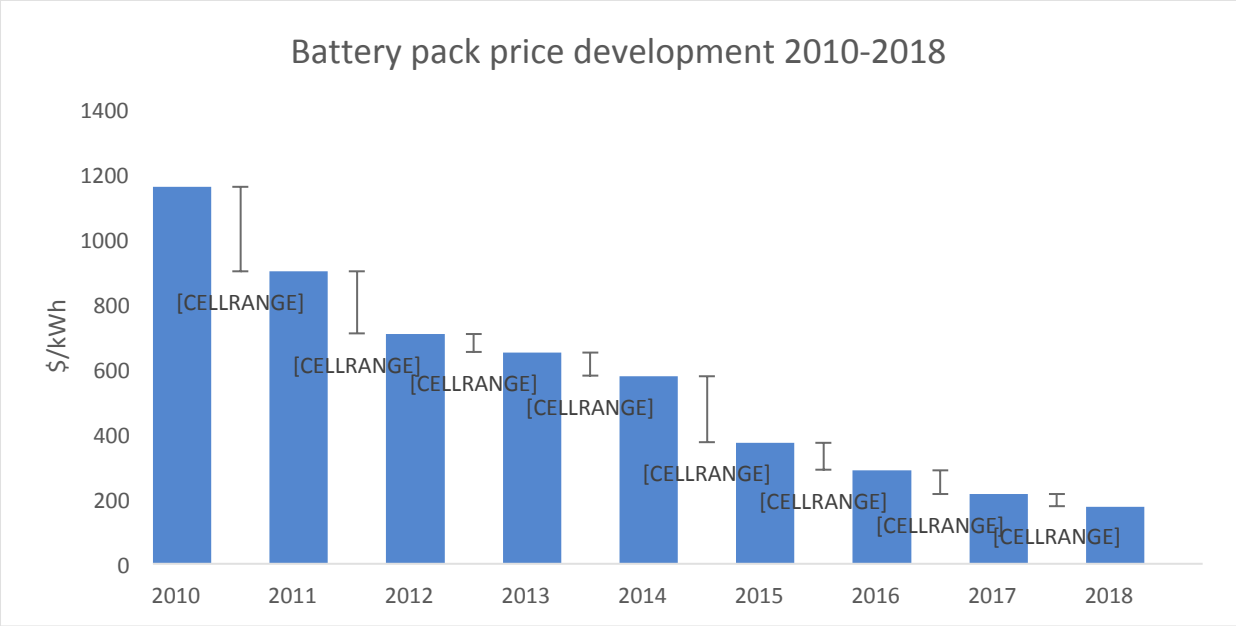
[4] https://www.dw.com/en/can-india-realize-its-ambitious-renewable-energy-targets/a-51085629
[5] https://www.brookings.edu/research/complexities-of-integrating-renewable-energy-into-indias-grid/
[6] https://www.brookings.edu/research/renewable-energy-versus-coal-in-india-a-false-framing-as-both-have-a-role-to-play/
[7] https://carbontracker.in/

Adapted from: Power System Operation Corporation Ltd[8], IEEFA[9]

Current challenges to greater storage uptake in India

However, while the theoretical solution appears to be simple enough, there are a number of general and India-specific barriers related to storage that are frequently cited as reasons why greater RE penetration into the Indian grid, as highlighted in this 2016 Council on Energy, Environment and Water (CEEW) report.[10] At the same time, most of them also require caveats, particularly in such a fast-moving environment like energy storage. The points mentioned below often represent both a challenge and an opportunity.

The most important one is the cost of battery technologies (electrochemical, thermal or mechanical), increasing the initial cost of installation by up to 50% as per the CEEW. At the same time, a recent survey on Lithium-ion battery (LIB) prices by Bloomberg New Energy Finance shows an 85% fall in prices from 2010-18[11], averaging a 20.5% annual learning rate. This suggests that the cost of batteries might become less of a factor soon. Similarly, the Greenko and ReNew story clearly shows that RE including storage can be cost-competitive in India, at



least at a grid-scale level.

Adapted from: BNEF[12]

[8] https://posoco.in/download/all-india/?wpdmdl=8873
[9] https://ieefa.org/wp-content/uploads/2019/01/India_Time-of-Day-Pricing_January-2019.pdf
[10] https://www.ceew.in/sites/default/files/CEEW_Energy_Storage_in_India_Report_03Nov16.pdf
[11] https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/
[12] https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/

Further, a point often mentioned is that the introduction of batteries to an otherwise largely self-reliant PV-system increases maintenance requirements due the variability in battery performance and the resulting need for battery replacements. Again, while this is a valid concern, particularly given India's hot climate and the negative effect on battery performance[13], technological advancement will eventually overcome this hurdle.

Third, advances in net-metering, essentially feeding excess power produced on the household-level directly into the grid and thereby circumventing storage requirements, can dampen prospects for storage systems. However, while the Indian government claims that all of India has now been electrified as of the end of 2019, making storage systems potentially less important, the major caveat is that a village is already declared electrified if 10% of the households have access to power. This still leaves plenty of space for micro-grids and accompanying storage systems to play a major role, even if the grid becomes more efficient at allocating excess power.

The business promise of ESS

While challenges exist, the sheer size of India, the ambitious climate and RE government targets, and the falling cost of generation will translate into an immense business opportunity in the energy storage market in India. In fact, the India Energy Storage Alliance (IESA) states in its latest edition of the India Energy Storage market report that the Indian energy storage market in 2018 totaled USD 2.8 billion and that it is set to grow by 6.1% CAGR until 2026. It projects total storage capacity to reach 64.5 GWh by 2026 and that the cumulative demand of ESS will exceed 2400 GWh by 2032.[14] Along the same lines, the International Energy Agency (IEA) projects under stated policies for India to make up for more than a third of all battery storage deployment by 2040.[15] Bloomberg New Energy Finance expects ESS to attract $662bn of investments by 2040 globally and India will be one of the main recipients of global ESS investment.[16]

Even more exciting, assuming a case in which battery costs in India fall below a third of today's prices, it would set up renewables to compete with new coal plants, if not already existing ones.[17] One promising development is the recent publication of safety and performance requirements for grid-interactive energy storage systems and battery management systems by the Bureau of Indian

[13] https://www.indiaesa.info/resources/storage-101/2495-understanding-the-performance-degradation-of-batteries-main-considerations-for-pack-developers

[14] https://indiaesa.info/buzz/news/iesa-news/2818-india-likely-to-require-energy-storage-capacity-of-2-400-gigawatt-hour-by-2032

[15] https://www.iea.org/commentaries/india-is-going-to-need-more-battery-storage-than-any-other-country-for-its-ambitious-renewables-push

[16] https://energy.economictimes.indiatimes.com/news/power/energy-storage-will-attract-662-bn-investments-through-2040-china-us-india-to-lead-the-pack/70467747

[17] https://energy.economictimes.indiatimes.com/news/coal/opinion-coal-fired-power-is-losing-unfair-fight-in-india-to-renewables-russell/74221697

Standards, the first of its kind in the world.[18] It could be one of many more policy changes that would truly open up the ESS market in India. Regardless, the ESS market in India already promises immense potential that Swiss startups and companies can tap into. Given India's size, even a niche market is a multi-million opportunity that should not be overlooked

2. Main categories of ESS technologies and ESS applications

While storage is often talked about in abstract terms and associated with the popular notion of an electrochemical battery, technically speaking, a battery is any device that stores energy which can be used to produce electricity during time of need. In order to contextualize the trends discussed later in this report and to identify what energy storage technology is most appropriate to serve which storage function, the three main categories of ESS and the three main ESS functions are briefly explained below.

Electrochemical, mechanical, and thermal energy storage systems

Broadly speaking, we can differentiate between three distinct ESS technologies: Mechanical, Electrochemical, and Thermal.

Electrochemical energy storage – Electrochemical batteries use chemical compounds to store electricity. The main contenders in this field are Lead Acid batteries, for a long time dominating the market due to its cost advantage, Lithium Ion Batteries (LIB), a currently still expensive but very powerful alternative to Lead Acid, and Flow-Batteries, a relatively untested, but heavy-metal-free and thus promising newcomer. [19]

Mechanical energy storage – Mechanical systems make use of basic principles of physics by storing electrical energy in potential mechanical energy, be it water at high elevation in pumped-storage hydropower (PSH) systems, Compressed Air Energy Storage (CAES), or other gravity-based systems like the one currently being piloted by Swiss startup Energy Vault. Energy Vault for example is purchasing low-priced electricity to stack up blocks of concrete using cranes. The blocks are then lowered again to generate electricity during times of demand.

Thermal energy storage – Thermal energy can be stored in two ways. Energy is either stored by using power to heat materials like rocks, salts, water or other materials. The materials are then kept in an insulated state to prevent them from losing heat. Electricity is generated by heating up water and capturing the released steam in steam turbines. Alternatively, one can also store energy by using electricity to cool materials overnight. This stored cooling capacity in suitable material

[18] https://www.pv-magazine-india.com/2020/03/02/a-plug-and-play-solar-powered-battery-backup-solution-for-homes/

[19] https://blogs.dnvgl.com/energy/can-flow-batteries-compete-with-li-ion
https://www.energysage.com/solar/solar-energy-storage/what-are-the-best-batteries-for-solar-panels/

is then deployed during the day in cooling applications like cooling systems for buildings or refrigerators.

Main areas of application for ESS

There are three main areas of application for ESS – electricity grid management, behind-the-meter storage, and mobility.

Electricity grid management – While there are other electricity grid management tools that deal with higher variable RE penetration like "improved power plant flexibility, improved grid interconnections between India's 5 subregions, and demand-side management"[20], battery storage is often seen as the main source of greater flexibility in the Indian power sector, if not in the world. Battery storage, assuming continuous technological advances and cost reductions, allows for an immediate and effective dispatch response while its modular nature allows for multiple use cases in diverse geographical locations. Thermal and mechanical storage are also viable solutions, but they still need to prove themselves to be effective at large scale. Pumped-storage hydropower provides 90% of India's current storage capacity and has a lot of potential, but its increasingly high investment costs and greater environmental awareness limit the further expansion of pumped-storage systems for grid management.

Behind-the-meter-storage – Most of the growth in the ESS will take place in the behind-the-meter (BTM) sector, making up 70% of the overall ESS market from 2018 – 2026.[21] In contrast to utility-operated batteries on the grid, on-site batteries close to the energy customer and behind the utility meter of consumers, allow the customer to store electricity either produced by on-site PV systems or purchased cheaply off the gird and to discharge when they are in need of power or prices are high. This lowers their electricity bills, but also provides the system operators with additional storage capacity that they, depending on the policy framework, can deploy in times of need.[22] While the initial value of BTM was to provide back-up power during outages, its main contribution in the future is its ability to increase the grid's overall resilience with regards to variable renewable energy. As distributed solar PVs expand, so will BTM storage.

Mobility – The third large area of application for ESS is mobility. Gaining certainly the most attention in the media, electrochemical battery storage options allows for the electrification of the mobility sector. Substituting fuels for batteries, it enables cars to run on electricity instead of fossil fuels. Ideally, this electricity comes from RE sources. Within the sector for batteries for mobility, the areas of application fall broadly within two categories. One can either swap a modular empty battery for a new one or one can charge his or her in-vehicle battery at a charging

[20] https://www.iea.org/commentaries/india-is-going-to-need-more-battery-storage-than-any-other-country-for-its-ambitious-renewables-push
[21] https://www.electricalindia.in/indias-energy-storage-market-opportunities/
[22] https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2019/Sep/IRENA_BTM_Batteries_2019.pdf?la=en&hash=86DF5CFBEDB71EB9A00A5E3680D72D6E346BD23A

station. Both options come with their respective challenges, but combined they present a viable pathway for India towards electrifying its transportation sector.

3. Industry Trends

Having gone over the main categories of energy storage technologies and their use cases, this next part will focus on the most recent trends and developments in the ESS sector in India and what the most promising areas of progress are. Underlining all of these trends is one basic principle – different forms of storage for different forms of usage.

While much of the talk (and VC investment[23]) has focused on the emergence of Lithium-Ion Batteries and how their costs have declined steadily, promising a substantial uptake in the near future, experts caution against singling out one ESS storage as the frontrunner in India's energy transition. There is no one silver bullet to solving the challenges of the energy transition. ESS are highly use-case specific and can serve several purposes, but there is no one ESS technology that is equally well-suited to perform all storage functions. The following trends, identified through a combination of research reports, industry news articles, expert interviews, and conferences, reflect this principle.

Long-duration energy storage systems take center stage

While most of the excitement in the storage sector has focused on LIBs, their limited duration before having to be recharged has led to the storage conversation now slowly shifting towards questions of long(er)-duration ESS. LIB and most other batteries either serve 1 hour, 2, hour, or up to 4-hour cycles. However, with growing extreme weather patterns, changing demand needs, and greater RE penetration, longer-duration load shifting such as seasonal shifts will become more important. For example, the system needs to be able to store larger amount of energy during months-long periods of sunshine and high-generation such as in the months leading up to the monsoon, and to then be able to discharge for an extended amount of time during the monsoon itself when solar PV production is low.

Pumped-storage hydropower has long held an advantage in the long-duration energy storage systems, making up more than 90% of today's electricity storage capacity worldwide. While other, newer forms of storage might dominate current debates, the straightforward application of utility-scale gravity mechanical energy storage has proven to very efficient in responding to significant load changes and in performing balancing services.[24] However, the high upfront costs

[23] https://www.utilitydive.com/news/vc-funds-are-increasingly-investing-in-energy-storage/570817/

[24] One inverse example of pumped-storage hydropower's flexibility occurred at the beginning of April 2020 when PM Modi called for a sign of national unity and solidarity during the COVID-19 crisis. His request for all citizens to turn off their lights for 9 minutes and light candles instead caused, within minutes, a substantial 32 GW load reduction, threatening the grid frequency and the voltage stability of the grid. The main reason why the grid did not

of building a pumped hydro storage plant, specific siting requirements, lack of policy clarity, and the social and environmental costs often associated with this mature technology have stalled any progress on this front for several years now in India[25]. While recent positive developments like ReNew Power and Greenko tenders might provide a much-needed boost for PHS installments, its limitations also highlight the need for alternative long-duration storage systems.

Sodium-sulfur (NAS) batteries are one such alternative. Introduced by the Japanese firm NGK, large-scale sodium-sulfur batteries have a six-hour discharge at rated power and can discharge for 14-18 hours at one-third of rated output. NGK offers two set-ups, either a plug-and-play system of four containers each containing six NAS battery modules each rated at 33kw/200kWh, or a package made up of 40 NAS modules each rated at 30kw/216kWh.[26] While NGK remains the industry leader with two projects already installed in the UAE, the recent announcement by IIT Madras that its researcher have designed a new NAS capable of operating at room temperature, addressing safety concerns of current NAS that operate at 300-350°C, signals that India is catching up fast.[27]

Another contender for the long duration energy storage market are flow batteries, storing electricity in in external tanks of liquid electrolyte that are separate from the actual electrochemical battery cell. They get their name from how the electrolyte flows through the cell, creating an ion exchange and the generation of electricity. Similar to how you increase the range of a combustion engine vehicle by increasing the size of the gas tank, increasing the duration of a flow battery breaks down to increasing the size of the external electrolyte tank. While this is a drastic simplification, experts are excited about this ability to scale up, in addition to the durability of the flow battery system, potentially giving it an edge over the otherwise cheaper LIB batteries. One estimate has put one technology of flow batteries, redox batteries, at 10 hours of discharge time.[28]

Rechargeable zinc-based batteries are the third long-duration energy storage system that has received substantial attention, especially due to the abundant availability of zink compared to lithium and thus doing away with potential supply chain concerns. Zinc-air batteries, a combination of a zinc metal anode and an air cathode, have in some early projects proven to be capable of providing energy for up to 15 hours while theoretically possessing an energy density multiple times higher than LIBs while also being safer. [29] However, the current challenge is their

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collapse, other than having expert engineers, was the hydropower stations' ability to reduce generation by 17.5 GW in 25 minutes and to ramp up generation by 11 GW in 17 minutes, an incredible feat. https://www.livemint.com/news/india/those-long-9-minutes-when-india-s-power-grid-operators-held-their-breath-11586143504936.html

[25] https://ieefa.org/wp-content/uploads/2019/03/IEEFA-India_Pumped-Hydro-Storage_Mar-2019.pdf

[26] https://www.energy-storage.news/blogs/contenders-long-duration-energy-storage-technologies-and-whos-behind-them

[27] https://www.thehindu.com/sci-tech/science/iit-m-designs-room-temperature-sodium-sulphur-battery/article30544366.ece

[28] https://www.pv-magazine-india.com/2019/09/28/the-long-read-flow-batteries-scale-up-to-gw-production/

[29] https://www.energy-storage.news/news/new-york-to-host-second-15-hour-duration-zinc-battery-energy-storage-system

short lifetime because the electrolyte degrades from CO_2 absorption, leading to the change of the shape of zinc-air batteries over time.[30] Still, of what could be an indicator of future developments in the Indian market, Indian Oil Corporation, India's largest fuel retailers, has set its eyes on developing metal-air batteries using indigenous metals. India happens to hold the world's seventh largest zinc reserves at 5% of the worldwide share and was the fourth largest producer of raw zinc in 2019 and could be well-placed to manufacture zinc-based batteries itself. [31][32]

Finally, there is a range of other technologies and approaches that have yet to hit the commercialization phase but have shown early signs of potential. This includes copper-zinc rechargeable batteries, liquid metal batteries, heated 650oC steel, raised concrete blocks, liquid air & advanced compressed air, and many more applications.[33]

What this overview shows is that there is a multitude of long-term energy storage systems available that are competing to gain a stake in India's energy market. While not all of them are on the same level of maturity, the lively global competition will force the current market leader LIB (PHS excluded) to innovate further. At the same time, it shows that the market is open for new and creative solutions. Switzerland's Energy Vault is the example for how Indian players are willing to engage with innovative ideas and grant access to India's vast playground.

Air conditioning as a driver for future storage needs

The increasing need for energy arising from growing air conditioning needs has arrived on the main stage of the energy transition debate and is without a doubt a hot topic in India. Following the pathbreaking IEA report on cooling[34] two years ago decisionmakers and the public alike are more aware than ever that the combination of population growth, economic development, changing consumption patterns, and most importantly, climate change and global warming, will result in substantial increases in the use of cooling appliances around the world, but especially in the Global South.

In India, while diverse in geography, the majority of the population lives in warm to hot climates, with the increasing summer heat affecting more and more people every year.[35] The IEA is projecting that India, who unlike China has yet to achieve a comprehensive coverage of cooling appliances across its population[36], will drive the demand for cooling in the world. Currently still relying heavily on coal-fired power, this cooling-driven electricity demand rise could trap India

[30] https://eera-es.eu/wp-content/uploads/2018/12/ZAB_Factsheet.pdf
[31] https://www.statista.com/statistics/604668/distribution-of-zinc-reserves-worldwide-by-country/
[32] https://www.statista.com/statistics/264634/zinc-production-by-country/
[33] https://www.energy-storage.news/blogs/contenders-long-duration-energy-storage-technologies-and-whos-behind-them
[34] https://www.iea.org/reports/the-future-of-cooling
[35] https://www.aljazeera.com/ajimpact/indian-summer-heat-waves-bad-people-economy-190705104727560.html
[36] https://www.iea.org/reports/the-future-of-cooling

in a fossil-fuel dominated energy future.[37] However, the ongoing energy transition provides ways for India to avoid such an outcome.

The above-discussed combination of greater RE generation and better long-term energy storage to power air conditioners during the day is one option. However, thermal energy storage, namely cool thermal energy storage, might offer a targeted solution in commercial and residential buildings that matches the characteristics of this storage technology with the use case at hand.

Unlike the heating storage system where a material is heated up with off-peak power to generate power using steam turbines, cooling thermal energy storage uses off-peak power to extract heat from a storage material, mainly performed during the night when power prices and temperatures are lower, to provide cooling capacity during the day. Viable material are ice, chilled-water, and phase-change materials[38]. One of the major advantage cooling ESS brings compared to using traditional energy storage is cost efficiency. Heat is generally removed during the night, benefitting from both lower electricity prices and lower starting temperatures of the cooling medium. This is deemed a more efficient way of providing cooling than to store energy in batteries to then power air conditioners during the hottest and most expensive time of the day.

While cooling storage remains a niche market both in the world and in India, in part due to its inability to capture the public's imagination like other technologies do, DEZA's engagement in India in the building sector over the past ten years could provide for a great avenue for Swiss startup to stake out a claim in India's future cooling storage market. The upside is large, and though there exist a number of challenges such as competing with the ease of purchasing an air conditioners and achieving the buy-in from architects/real-estate developers, even capturing 1% of the AC market in the Asia-Pacific region (India being the main driver of growth) by 2025 would represent a $ billion business opportunity.[39] In addition, the Indian government actively supports this line of research, having established the "Centre of Excellence in Thermal Energy Storage" at TERI University in New Delhi. While largely flying under the radar, the bolder predictions say that this sector will experience a large growth soon in the future.

Batteries for small vehicles

Making up close to 80% of India's road traffic, two- and three-wheelers such as the infamous rikshaw will be at the center of India's electrification of transport. While there exist already several domestic startups that have begun to manufacture batteries, if not whole mobility systems specifically designed for the two- and three-wheeler sector, the ambitious electrification goals by the government will lead to even greater opportunities for companies able to serve this India-specific market. Similar to other trends discussed in this report, there are several additional

[37] https://energy.economictimes.indiatimes.com/news/power/india-plans-to-cut-cooling-energy-demand-40-per-cent-by-2038/74594897
[38] https://www.nrel.gov/docs/legosti/old/20176.pdf
[39] https://www.grandviewresearch.com/industry-analysis/air-conditioning-systems-industry

aspects to take into account when talking about the electrification of mobility in India. System integration, charging infrastructure, raising awareness, and domestic manufacturing are all important areas, but batteries are key to unlocking electric mobility in India.

However, compared to other countries where the main subject of electrification is the car, energy storage options for the mobility sector for India will have to be adapted to the average Indian driver owning a two- or three-wheeler and the needs of the Indian consumer, meaning that price, above all else, is king. The urban context in which electrification will take place and the different socio-economic make-up of the potential Indian consumer will require non-Indian players to shift their mindsets from serving the well-off customers ready to pay a premium on similar or worse-performing electric cars (as of now) to customers that are particularly price-sensitive.

The electrification of mobility is still at the very early stages in India and other than a few pilot projects we have yet to observe a substantial uptake of electric vehicles. While some notable startups like Sun Mobility[40] or Ather Energy[41] are gaining traction, the sheer size of India and the various business models currently in place suggest ample opportunity for new players.

The second life of EV batteries

Two major concerns that follow electrification of mobility and EV batteries , particularly LIBs, are the reliance on limited resources such as lithium and the disposal of used batteries. One approach that tries to address these concerns is second-life utilization of batteries before they are recycled. One research report states that by 2030 over 6 million battery packs from EVs will be retired a year.[42] These batteries maintain about 80 percent of their original storage capacity at very low self-discharging rates and can still serve less-demanding purposes such as stationary energy storage providers.[43] This allows batteries to go through three cycles (primary use, reutilization, recycling) and be used efficiently.

For India which is only now beginning to manufacture its own batteries at a larger scale and is still dependent on foreign imports from China or the US, its lack of battery resources requires it to make the most out of the limited materials available. Large automotive players like Nissan or BMW are beginning to set up ventures to see how the batteries of their EVs can be reutilized and to identify what the most promising applications are. Assuming that the electrification of mobility in India will in fact take place, we will also see a growing market for second life batteries that companies and startups can explore. For example, Nunam, a Berlin and Bengaluru-based startup and supported by Audi and TERI, is about to pilot their energy storage system in rural areas in

[40] http://www.sunmobility.co.in/
[41] https://www.atherenergy.com/
[42] https://auto.economictimes.indiatimes.com/news/auto-components/finding-life-in-retired-ev-batteries/71359294
[43] https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/second-life-ev-batteries-the-newest-value-pool-in-energy-storage

India that runs on second life batteries.[44] Though they are certainly not the only ones. The Swiss Post already piloted a similar project back in 2017 using old batteries from their scooters[45] and new research and demonstration projects from the Bern University of Applied Sciences showcases Swiss know-how in second-life utilization of batteries[46]. Once the business model of second-life EV batteries is competitive, meaning that they can compete with off-the-shelf and ever cheaper batteries on the market, and scalable, it is not unthinkable that a company like the Swiss Post will want to share its knowledge and technology with India.

The energy storage needs of prosumer [47][48]

Finally, what industry leaders in India are not tired of emphasizing is the emergence of the prosumer in India's energy transition. Especially end-customers mounting their personal PV systems are not only doing so to produce their own power, they often also have the capability to "feed" electricity back into the grid during times of overproduction. While the prosumer already makes up a substantial share of the world's overall solar capacity, prosumers in India are only now starting to make greater impact. The reason for the delay is that the initial growth in solar energy in India was driven by large-scale solar plants, compared to Europe or the US where growth happened mainly in the residential rooftop sector.[49]

This trend again is following the principle of different energy storage technologies for different use cases. Since we are mainly talking about end-consumers producing power, the scale of their PV systems is relatively small compared to grid-scale projects and their energy storage systems are smaller. While the use of energy during peak times of production during the day will somewhat align with greater cooling use (see above), the overall demand curve will remain largely the same and follow the duck curve. Any extra energy that can be stored during the day and discharged during the evening peak, either used by the customer itself or transferred to the grid, will lessen the overall demand on the system and is encouraged. Grid-scale solar & hydro generation + storage projects are already picking up pace, but behind-the-meter/prosumer applications have yet to generate substantial traction in India.[50][51] Being able to provide the infrastructure and services necessary to manage and store the growing amount of rooftop solar in India and targeting the Indian prosumer holds great promise.

[44] https://www.nunam.com/
[45] https://www.empa.ch/web/s604/second-life-batteries
[46] https://www.pv-magsazine.com/2020/03/19/a-second-life-for-disused-modules-and-ev-batteries/
[47] https://thecsrjournal.in/prosumers-in-india/
[48] https://blogs.adb.org/blog/meet-energy-prosumer
[49] https://ieeexplore.ieee.org/document/8397377
[50] https://www.greentechmedia.com/articles/read/indias-energy-storage-market-finally-starts-to-grow
[51] https://bridgetoindia.com/ci-energy-storage-has-a-bright-future/

4. Entering the Indian ESS market

For companies and startups looking to break into the Indian energy storage market and explore future trends, there is ample opportunity and capital to be tapped into. As stated earlier, the overall market potential as projected by the India Energy Storage Alliance stands at $2.8 billion in 2018 and forecasted to grow at a CAGR of 6.1% by 2026.[52] Further accelerating the development of the energy storage market, especially also for smaller companies in India, are initiatives and policies aimed at boosting innovation in this space. The India Energy Storage Alliance, essentially India's ESS trade association, held the country's first startup competition focused on energy storage in 2018[53]. A first too, the EES India, India's leading electrical energy storage exhibition, held its first autonomous exhibition solely dedicated to ESS at the end of 2019. Finally, NITI Aayog, the "think tank" of the Government of India, released a report highlighting ways for India to become a competitive battery manufacturer globally that also includes startup incentives for the ESS sector.[54]

Venture capitalist firms have also shown greater interest in investing in energy storage ventures in recent years.[55] Global VC funding for the ESS sector (including energy efficiency and smart grids) went up to $2.8 billion in 2019 from $1.3 billion in 2018, reflecting the growth trends of the last couple of years. Notably, while LIBs continue to bring in the largest share of capital at $1.4 billion, other ESS technologies have also received substantial funding. This reflects global developments, but the recent examples below show that there is specific VC activity in India in the ESS sector, though currently primarily in the electric vehicle/EV battery sector.

See for some notable recent investments/partnerships in India in the ESS sector below:

Name	Product	Investors	Amount(Year)
LivGuard	EV batteries	ChrysCapital & Ncubate Capital Partners	$32 million (2019)[56]
EnergyVault	Mechanical energy storage system	Tata Powers	Announcement to deploy 35 MWh by 2019 (yet to be build)[57]

[52] https://www.globenewswire.com/news-release/2019/12/11/1959368/0/en/India-s-Energy-Storage-market-to-grow-at-CAGR-of-6-1-by-2026.html
[53] https://inshorts.com/en/news/iesa-to-hold-indias-1st-energy-storage-startup-competition-1515218865807
[54] https://niti.gov.in/writereaddata/files/document_publication/India-Energy-Storage-Mission.pdf
[55] https://www.utilitydive.com/news/vc-funds-are-increasingly-investing-in-energy-storage/570817/
[56] https://www.financialexpress.com/industry/sme/livguard-raises-rs220-crore-from-chryscapital-ncubate-capital/1538544/
[57] https://mercomindia.com/tata-deploy-energy-storage-35mwh-energy-vault/

Numocity Tech	Digital Solution for EV infrastructure	Ideaspring Capital, Rebright Partners, ABB Technology Ventures	Undiclosed amount (2020)[58]
PURE EV	EV batteries	VC Nannapaneni	$35 million (2019)[59]
Ather Energy	EV and EV batteries	Sachin Bansal, Innoven Capital, Hero MotoCorp	$51 million (2019)[60]
Gegadyne Energy	EV batteries	Mumbai Angel Network	Undisclosed amount (2018)[61]

While most of the ESS investments in India are still EV/mobility focused, it will not be long before more foreign ESS startups/companies in the ESS sector will enter the Indian market. Two examples from related fields showcase how such a tech transfer could take place and how Swiss companies could push for and benefit from similar experiences.

Success stories/examples

IElectrix (Indian and European Local Energy CommuniTies for Renewable Integration and Energy Transtion):

Set up as part of a Horizon 2020 Call by the European Commission, IElectrix aims to showcase how local energy communities (using local PV units for self-consumption) can be implemented in different environments. Bringing together 15 European stakeholders and one Indian partner (Tata Power), comprising of distribution system operators, research and development institutions, manufacturers, and service providers, it presents various ways for companies to engage with the Indian market. As E.ON, the technical lead of IElectrix, states, a particular focus of this project is to develop mobile, targeted, and flexible mobile storage units to promote local energy communities.[62] One such pilot project was set up last year in New Delhi. In cooperation with Tata Power DDL, Enedis, a subsidiary of the French electric utility company EDF, this pilot project aims to demonstrates how such a unit can be built and utilized in India.[63] It involves prosumer support in the form of forecasting/scheduling of Distributed Energy Resources, flexible and prosumer-friendly profiles, and grid-forming/islanding capabilities. This government-

[58] https://inc42.com/buzz/ev-solutions-startup-numocity-raises-funds-from-ideaspring-capital-and-others/
[59] https://www.newindianexpress.com/cities/hyderabad/2019/jul/11/iit-hyderabad-start-up-pure-ev-raises-venture-capital-funding-of-usd-35-million-2002388.html
[60] https://inc42.com/buzz/breaking-ather-energy-raises-51-mn-in-round-led-by-sachin-bansal/
[61] https://www.financialexpress.com/industry/sme/energy-startup-gegadyne-energy-raises-investment-from-mumbai-angels-network/1081837/
[62] https://www.eon.com/en/about-us/media/press-release/2019/eon-becomes-technical-director-of-eu-project-ielectrix.html
[63] https://ielectrix-h2020.eu/ielectrix-pilot-sites/india

supported scheme has allowed the involved stakeholders to attract substantial attention and given them exposure to workings of the Indian energy market.

While an ESS startup scene is developing with batteries for EVs leading the way, given that most ESS sectors are only now beginning to emerge, seeking out government-funded/-supported schemes to enter the Indian market is essential and encouraged. The key takeaway from the IElectrix example is that business models should actively aim to 1) pool resources together with other ESS actors aiming to expand to India and 2) apply for government support schemes that allow them to spread operational/financial risks and ease their way into the Indian market.

Orb Energy

Bengalruru-based Orb Energy was founded back in 2006 by the American Damian Miller and the Indian NP Ramesh. After a long stint together at Shell Solar, the two decided to start their own on-grid solar energy business for commercial and industrial SME customers. They secured some initial venture funding and were operational in Karnataka by 2007. They claim to have since installed more than 160'000 solar systems, totaling more than 80MW of rooftop solar system installations. Their business model is unique in that they do not only manufacture their own solar PV panels and solar water heating systems and offer in-house installation services, since 2016 they offer in-house finance packages to their SME customers without collateral[64]. They specifically target the so far underserved SME market, mainly because other providers shy away from SMEs due to their relatively weaker financial indicators compared to large customers.

To address the biggest challenge of SME in buying solar[65], namely upfront capital investments, Orb Energy offers a 25% down payment option where the remaining 75% can be paid back over the next 3-5 years at an interest rate of between 10% - 12% without additional collateral other than the PV system itself (essentially a simple credit mechanism). These interest rates are already competitive with comparable bank rates at around 10%, but since they do not require additional collateral and the credit assessment process proved to be much quicker, they offer customers the ability to access solar energy much quicker. This option facilitates the customer's decision to enter a deal with Orb Energy. Moreover, the payback period aligns with how long it takes the average SME customer to achieve the payback on their initial solar PVs investment, given that power costs are often the second-biggest cost factor for SMEs.[66] After five years the customer is producing electricity essentially for free.

For such a business model to work, access to capital is vital. The pilot projects in Andhra Pradesh and Karnataka have so far proven successful with only one default so far and this model is now

[64] https://www.orbenergy.com/about
[6565] https://shellfoundation.org/learning/unlocking-capital-to-power-smes-the-orb-energy-sme-finance-pilot/
[66] https://www.pv-magazine-india.com/2019/05/02/interview-damian-miller-ceo-of-rooftop-solar-supplier-orb-energy/

slated to expand to Northern India.[67] Having managed to stay and grow sustainably in the Indian market, Orb Energy has proven to investors that their business model holds great potential. While some of the initial funding will have likely come from Shell/Shell Foundation given the founders' previous ties with Shell, other venture funding came from Cleantech Europe, Renewable Capital, Ed Stevenson, and the Singh Family. Orb Energy has since also secured funding from a diverse set of investors. The Dutch development bank FMO, global private equity firm Bamboo Capital Partners, an Swiss/British investment advisor Rianta Capital, non-profit social venture fund Acumen Fund, Pamiga Finance SA B impact investment vehicle from Luxembourg, German development finance institution DEG, and the US government agency Overseas Private Investment Corporation are all reported to have invested in Orb Energy.[68] It goes to show that they were able to attract different types of foreign investors and that different investors are willing to engage with the Indian market.

For Swiss companies wanting to expand to India and set up their ESS business here, Orb Energy showcases how it can be done. It is an iterative process that will take many years to complete, but they managed not only to identify a key business opportunity, but they were able to operationalize it and adapt it to how the Indian market was changing. Through a combination of foreign technical knowledge, local expertise, perseverance, and skilled salesmanship, they have now managed to establish themselves in the Indian market. Now that Shell's New Energies business acquired a 20% stake in Orb Energy[69], they are set to grow further.

5. Conclusions & Recommendations

We are seeing the emergence of a large ESS market in India. While large players have already begun to stake out a claim, EV battery startups/companies showcase how SMEs have a substantial role to play in securing India's future energy storage needs and ultimately, it's successful energy transition towards renewable energy. However, we have yet to observe fierce competition in the ESS sector in India compared to other parts of the world. This is partly due to the wide range of ESS technologies available and partly due to the Indian market not being mature just yet, except for the EV batteries sector. Despite this, given that the Indian government, academia, and the private sector are increasingly setting their sights on ESS, conscious of the fact that India's energy transition will not take place without strong energy storage systems, growth and expansion of the market is bound to happen. Technological advances on many fronts, growing demand for energy storage both on and off-grid, a more suitable policy framework, and the growing availability of capital all make India's ESS environment an exciting market opportunity.

[67] https://www.youtube.com/watch?v=e1WhgnhWZIY&t=854s
[68] https://www.vccircle.com/fmo-to-invest-more-in-shell-backed-solar-power-firm-orb-energy/
[69] https://www.greentechmedia.com/articles/read/shell-takes-stake-in-indian-solar-firm

Swiss companies and startups looking to enter this market are advised to analyze previous success stories of foreign cleantech companies in India. What unites them is both having a long-term strategy that underpins their business model and a sound understanding of the Indian market. Setting up shop in India will require you to understand the specificities of doing business in India, appreciate the multitude of policy frameworks across different states, and be flexible enough to adapt to the rapid technological changes taking place. Relying on local expertise and talent and knowing how to source them will be a key success factor. Similarly, based on the kind of ESS technology you want to introduce, and the business model used, instead of charting their own course companies and startups should consider pooling resources with either a compatible Indian partner or European partners or to seek out government initiatives that allow for greater risk sharing and knowledge exchange.

There is a natural fit between the technical knowledge and entrepreneurial spirit of Switzerland and India's need to innovate in the ESS field. Granted that a sound analysis of the business model and the Indian market was performed, coupled with local guidance and mentorship from organizations like swissnex India, Swiss ESS startups and companies are set up for success in India.