May 2024

The Rickshaw VPP

A Discussion Basis White Paper for Bangladesh's Light Electric Vehicle-Based Virtual-Power-Plant

solshare

May 2024

Bangladesh has more EVs on its roads today than Tesla has sold globally to date.

When we think about the electric vehicle (EV) revolution, we often think Tesla, or at least cars. However, the latest Bloomberg New Energy Finance research suggests that the real drivers of the EV revolution are two- and three-wheelers in emerging markets. As an example, Bangladesh has more EVs on the road at present than Tesla has sold globally to date. In this White Paper, we explore how by adding the Internet of Things to the equation, we can unlock vast potentials, enabling two market participations for these vehicles. For the primary market, this means empowering the 4 million and counting electric three-wheeler drivers of Bangladesh, and the secondary market by converting their batteries into flexible, bundled, and smartly connected storage units in support of the national grid. With the right energy policy incentives in place, it will facilitate more aggressive renewable energy pathways. This is the future of energy, today.

Content

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Anisha Hassan, Hannes Kirchhoff, Madiha Athar Khan, and Sebastian Groh, The Rickshaw VPP — A discussion basis White Paper for Bangladesh's Light Electric Vehicle-Based Virtual-Power-Plant. SOLshare, May 2023.
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About SOLshare

SOLshare is a climatetech company building the energy utility of the future through a network of smart, distributed solar-powered storage assets.

Based out of Bangladesh, SOLshare is a climate tech company working with disruptive innovations that empower underserved communities. In 2014, the company was born by creating the world's first solar peer-to-peer microgrid where users can sell their excess solar energy to earn an additional income through smart meters with PAYG tech using mobile money. What began as a sharing grid to solve the problem of excess solar generation for poor villagers, has grown into a sophisticated ecosystem of interconnected distributed generation and storage assets that help solve today's complex energy and environmental challenges. By expanding its technology stack to smart battery tech for EVs and rooftop solar for commerce and industrial customers, SOLshare is doubling down on its synergetic potential facilitating a more aggressive renewable energy pathway for Bangladesh and the rest of the world.

The Brief

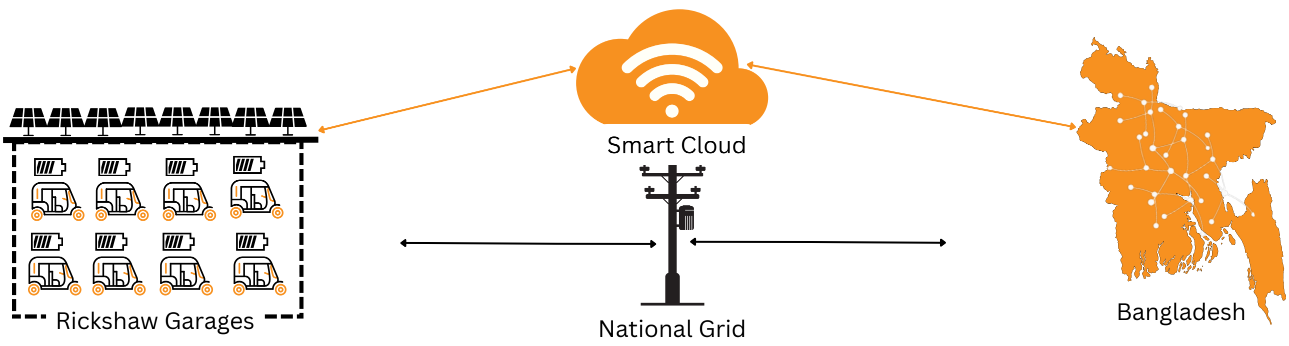
Increasing access to high quality electricity supply and addressing climate change are two of today's concurrent challenges. Increasing the share of volatile renewable energies is required to address the urgent challenges of climate change, reduce greenhouse gas emissions, ensure energy security and foster sustainable economic growth. This means a transformation of the way we move, heat, cool, process, and manufacture while maintaining reliability in services. Latest Bloomberg data shows that micromobility is really what's driving an electric vehicle (EV) revolution.

In the specific case of Bangladesh, the widespread adoption of light electric vehicles (LEVs) across the country, offers a unique opportunity to unleash the power of the many. These vehicles run on small batteries, i.e. storage units, that are numbered in the millions. Making these resources available, visible, and dispatchable at an aggregated level is explored in this White Paper. Such aggregation of small storage units to system-level is referred to as a virtual power plant. Virtual power plants (VPPs) are a cutting-edge technology that a) harvests the potential of distributed assets, b) provides aggregation and control of networked distributed assets, and c) facilitates the acceleration of renewable energies as the foundation of a sustainable energy infrastructure. Similar to how a traditional power plant has one central control room, so does a virtual power plant (VPP).

Virtual power plants (VPPs) are a cutting-edge technology that a) harvests the potential of distributed assets, b) provides aggregation and control of networked distributed assets, and c) facilitates the acceleration of renewable energies as the foundation of a sustainable energy infrastructure.

In the Rickshaw VPP, a large fleet of electric vehicles is orchestrated to jointly provide services for the grid. We elaborate on the working mechanisms and the potential of linking the distributed storage of LEVs to the national grid. This will fundamentally alter the status quo in markets such as Bangladesh where EVs are currently perceived as a threat to grid reliability, to an improved situation where these same EVs support the grid. This Paper outlines key mechanisms that will pave the way towards making load-shedding history and renewable energy generation to be the foundation for everything we seek to do with energy. With an estimated 4 million units operating in Bangladesh at present, LEVs currently have a VPP-potential of 4 GW. This figure represents more than 25% of Bangladesh's peak load, reported to have amounted to 16 GW in 2023[1].

In summary, this White Paper substantiates that the Rickshaw VPP has the potential to be the missing piece in the puzzle of how to reach clean energy by 2050. Bangladesh is well-positioned to develop a network of distributed storage assets, provided the right energy policy incentives are in place, at a scale that we believe is currently not feasible in any other market around the world.



Motivation: The User Story of Sohor Ali

Sohor Ali started working at an early age, right after graduating with a diploma in engineering from Bangladesh's Polytechnic Institute in 1994. He then worked as a labor migrant abroad, gaining valuable experience in light engineering and foremanship. The remittances he earned working in countries like Singapore, Malaysia and Saudi Arabia supported his family of four throughout the years. As the Covid-19 pandemic reverberated across the globe, migrant workers' fortunes suffered in particular. Sohor Ali was forced to leave his job and return home to Bangladesh. To him, this substantial professional setback was but another barrier to overcome as he put his well-honed craftsmanship to work and started assembling electric vehicles.

Sohor Ali set up his own garage from which he rented out the EVs he produced, providing supporting mechanical services on the side. However, despite his experience and expertise, Ali has been unable to scale up his business and faces significant challenges brought on by unscrupulous practices for example — taking loans from unlicensed moneylenders, and high upfront costs for lead acid batteries, paired with rising electricity costs. Having manufactured 26 electric vehicles, he is unable to reach his goal of adding another 10 vehicles to his fleet. The primary constraint on this expansion is a required upfront payment of BDT 500,000 (USD 4,500) for EV batteries, with a substantial remainder to be settled in installments. Sohor Ali's challenges also extend to the rising electricity costs in Bangladesh, since all of his electric vehicles run on energy-hungry lead-acid batteries, which still constitute the industry standard in the country. Typically, electric vehicle operators engage in vehicle rental agreements wherein a fixed tariff is charged, and the cost of recharging the vehicles is borne by the proprietor of the garage. Presently, the garage owner finds it increasingly challenging to sustain the monthly expenditure of BDT 46,000, as it has become economically unfeasible for him to do so.

To fully appreciate the uniquely challenging situation that Sohor Ali finds himself in, one must also consider the nature of his business. Sohor Ali's monthly income relies on renting out his EVs to electric three-wheeler operators, who have the flexibility to change garages based on their convenience, without being bound to a specific location like regular employees. Thus, they exhibit characteristics similar to freelancers or transient workers. These drivers then offer transportation services to passengers and freight recipients in exchange for monetary compensation. Upon completing their trips, the drivers remunerate Sohor Ali, who owns the vehicles they lease, on a weekly basis, as part of their leasing agreement. These drivers' ability to pay the full vehicle rent on time crucially depends on vehicle performance. When modern batteries [2], instead of the prevailing lead-acid kind, are used in a technologically smart way, empowered by an IoT device for remote control, both drivers and Sohor Ali benefit significantly. Modern batteries are lighter, faster, require less maintenance, while requiring vastly less electricity, thus reducing bills. Given prevailing budget constraints, pay-as-you-go services furthermore are ideally suited to help both parties in clearing payments in time.

A holistic approach of this kind therefore goes a long way for Sohor Ali. It allows him to acquire the additional batteries against a lease, instead of having to allocate substantial capital. This means that such a solution brings down his utility bills and increases repayment as drivers are enabled to earn more money with the modern batteries. But there is more in store for Sohor Ali.

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The use of smart batteries allows Sohor Ali to earn an additional income via a so-called virtual power plant (VPP). Through this VPP, Sohor Ali can resell energy stored in his batteries to Bangladesh's national grid at a high rate when electricity demand is high, and charge those batteries at a reduced rate when household and industry energy demand is low (super off-peak rate). This is made possible by the fact that at the end of a driver's day, an estimated 25%–30% charge is left in lithium-ion batteries. On a typical evening, with no VPP in place, one of Sohor Ali's freelance drivers returns the EV to the garage and plugs his drained battery into the outlet to charge overnight.

Under the innovative VPP approach, these same batteries would sell electricity to the grid during evening peak demand hours, and buy it back, recharging late into the night when other electricity demand plummets. The IoT technology employed ensures that batteries are fully charged by the next morning, at a much lower rate than is currently the case. With such a smart charging solution, Sohor Ali not only saves on electric bills, he also helps improve grid stability and reliability by feeding energy back into the grid when it is most needed. There are tens of thousands of Sohor Alis in Bangladesh today.

Background and Structure

Energy access in Bangladesh has drastically improved in recent years, at least in the share of grid-connected households and businesses [3]. The challenge today mainly lies in ensuring reliable electricity provision for those connections at an affordable cost to industry, households, and the government [4]. Load-shedding, i.e. regular area-wide scheduled power cuts, has become a frequent phenomenon, with the rate of occurrence having drastically increased in the second half of 2022 [5].

In Bangladesh, the issue of load-shedding is increasing with the deployment of additional energy-hungry electric vehicles. While the share of renewables in the energy mix rises slowly, adoption rates fall far short of their potential. Renewable energy at present accounts for less than 3% of total energy generation capacity [6]. The current situation may thus be characterized to feature a number of concurrent challenges, remedies to which would benefit from improved coordination.

An ideal coordinated remedy to tackle these challenges in Bangladesh's electricity sector is presented in the virtual power plant (VPP) technology. This technology constitutes a digital bundling of energy production and storage resources into a central dispatchable entity, for example, managing the integration of power feed-in from numerous smart batteries into the electricity grid, simulating the effect of incorporating a traditional power plant [7]. This enables distributed resources, typically privately held, to be visible, controllable, and dispatchable to serve the larger energy system.

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VPPs are being deployed in economies around the globe including the US, the UK, Germany, and Australia [8],[9]. VPP technology holds significant potential for Bangladesh, too, since it could be rapidly adopted and scaled up based on a fleet of millions of LEV batteries [10]. This White Paper aims to illustrate the VPP potential for Bangladesh by analyzing the technology's three key pillars: a) the potential of distributed storage asset deployment, b) the projected output from aggregation and control when these are networked, and c) the enabling of accelerated adoption of renewable energies as the foundation of a sustainable energy infrastructure. We briefly discuss these three key pillars below.

First, thanks to widespread deployment of distributed assets, in particular battery storage systems, Bangladesh exhibits significant potential for the utilization and expansion of VPP Technology. This extensive adoption of privately-held energy assets is evidenced by, for instance, the renowned solar home system rollout, a huge success that saw more than 6 million rural households invest in what later was referred to as a core element of national infrastructure [11]. Furthermore, investments in battery storage units have been ramped up to prepare for frequent load-shedding, with storage units deployed to power offices and homes across the country.

Another sizable share of storage asset investment has gone into transportation units, an estimated 4 million LEVs having been deployed to date [12]. This figure means that today more electric three-wheelers are on the streets of Bangladesh than Tesla has sold cars globally to date [10].

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The EV revolution so far may have been primarily driven by the Global South's electric two- and three-wheelers, rather than electric cars in industrialized countries [13]. Therefore, taking a closer look at the latent potential in these emerging markets appears prudent.

To date, however, that potential in deployed assets is merely latent, with batteries in particular serving only the local application they were initially purchased for, primarily to provide power backup or to power LEVs.

These storage units are, under the current system, charged from the national electricity grid at suboptimal rates and times, and subsequently unplugged from the grid to provide electricity for transportation services in a particular area.

The second pillar of the VPP potential concerns the projected output from aggregation and control of networked distributed assets. Bangladesh has recently started to provide countrywide aggregation and control capability through a supervisory control and data acquisition (SCADA) system [11], [14].

On the renewable energy generation side, data of installed units for the full range of sizes are conveniently tracked and reported through the central sustainable and renewable energy development agency [15]. In addition, the Powercell national agency, under the Ministry of Power and Mineral Resources, provides updates on the energy generation mix of the country [16]. However, these efforts predominantly concern output projections on the macro level and, with the exception of SCADA, are not reported in real-time. Therefore, the full scale of the VPP potential cannot yet be appreciated, and its huge potential is unavailable to the electricity sector to date.

Thirdly, Bangladesh has already undertaken important first steps towards accelerated adoption of sustainable energy infrastructure, the third pillar of the VPP technology's potential outlined in this White Paper. This includes digital services, such as the adoption of internet-connected smart meters, [17], [18], efforts to improve the reliability and quality of electricity supply (*Power System Reliability and Efficiency Improvement Project*, 2022) [19], and the increased adoption of renewable energy technologies, in particular for manufacturing entities [20]. However, an increased focus on market-driven solutions is needed, to push forward and incentivise private sector investments into deployment of small units at large scale, particularly into a) renewable electricity generation capacity, b) distributed storage assets such as batteries, and c) flexible loads.

This White Paper provides a concise overview on how the so-called *Rickshaw VPPs* can significantly improve the energy and transportation infrastructure in Bangladesh. We show how a *Rickshaw VPP,* operating as a virtual power plant, orchestrates grid-connected light electric vehicles (LEVs) to provide electricity grid services, easing constraints on boosting the adoption of renewables while increasing reliability of electricity provision.

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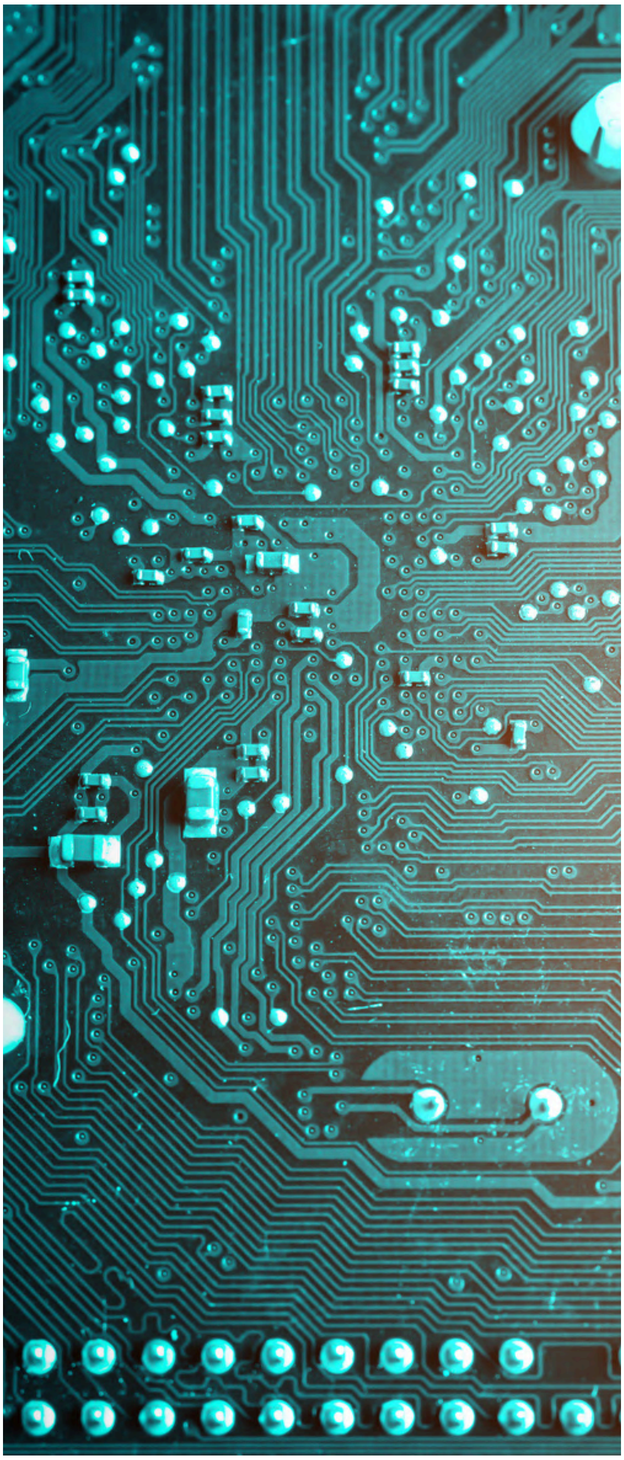
The remainder of this document is structured as follows. In the subsequent section, we discuss the technology toolbox of Virtual Power Plants, highlighting key mechanisms and the technology's impact on transmission and distribution systems. Next, in Section 4, we assess the Bangladesh-specific potential in terms of storage asset prevalence stemming from the light electric vehicle market across the country. Section 5 outlines the concrete case of a Bangladesh specific *Rickshaw VPP*. Conclusions are provided at the end of this document.

Technology Toolbox of Virtual Power Plants (VPPs)



Virtual power plants (VPPs) are a cutting edge technology that a) harvests the feed-in potential of distributed assets such as batteries or solar panels, b) provides aggregation and control of such networked distributed assets, and c) facilitates the adoption of renewable energies as the foundation of a sustainable energy infrastructure [8]. In this section we provide an overview of the working principle of VPPs and services that VPPs provide.

The working principle of VPPs centers on the aggregation of distributed assets into one manageable entity. The core benefit of the aggregation of VPPs is the technology's ability to deliver a unique flexibility [21]. Large power plants, such as nuclear and coal power plants, typically have ramp-up and ramp-down times of several hours [22]. In contrast, small and distributed units aggregated in a VPP are typically designed to provide full power at intervals of seconds.

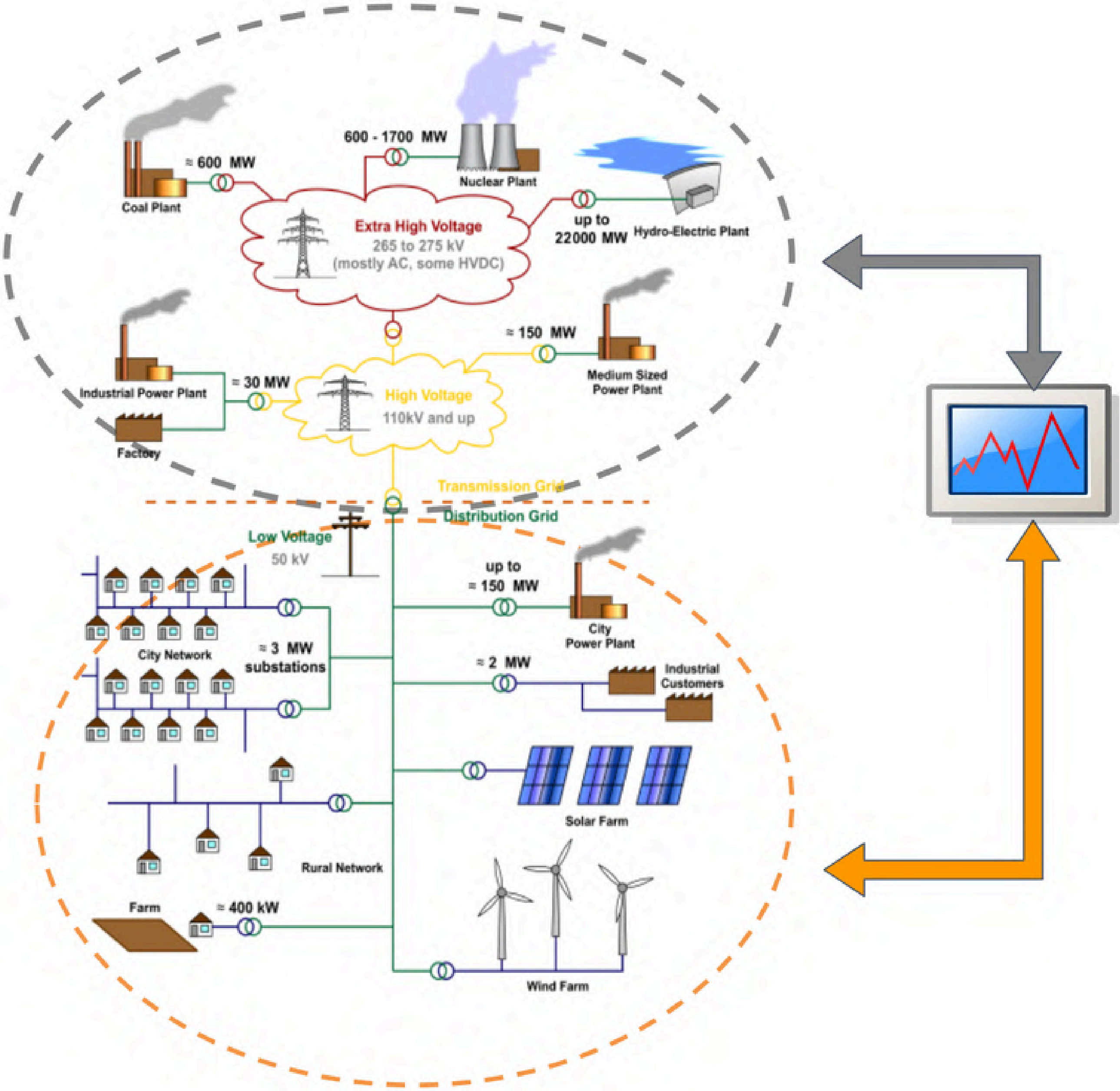


Fig. 1: Virtual Power Plants (VPPs) expand the traditional transmission system control (gray, dotted) to also encompass distribution level assets (orange, dashed).

The aggregation in a VPP is illustrated in Fig. 1 above. Here, the dashed orange line highlights that a VPP creates a control bridge from the national electricity transmission level down to the local low voltage distribution system [8].

The aggregation of power assets through a VPP can encompass a range of resources, in particular a) generation such as solar panels or entire power plants, b) storage such as batteries, and c) flexible load assets. Making these assets visible on an aggregate level is key to delivering energy-related services such as reliable and high quality electricity provision.

Using the aggregation capability of VPPs and the ability to flexibly respond to changes unlocks many local services with larger system impact. An overview of such services that VPPs can provide is summarized in Table 1. The services can be segregated into a) services that concern power drain assets, and b) services that utilize power providing assets. Both types of services are discussed as follows.

ID	Service	Transmission grid impact potential	Distribution grid impact potential	Key expected benefits
1	Peak shaving	Reducing aggregate load during peak hours	Reduction in peak power, allowing for lower cost cabling	Low system costs. Stable grid. High quality of power. High share of renewable energies.
2	Load shifting	Shifting of load to peak generation times	Avoidance of load shedding	
3	Load curtailment	Reducing aggregate load		
4	Distributed generation with DSO-curtailment	Congestion management	Reduction in peak power, allowing for lower cost cabling	
5	Voltage regulation	No direct impact	Local voltage stabilization, reactive power balance	
6	Energy routing	Reduction of peak power and system stress	Reduction of peak power and system stress	

Table 1: Key methods of VPPs providing grid-level flexibility services [8],[23],[24].

The first set of key services provided by VPPs (ID1 to ID3) in Table 1 concern the technology's ability to control assets drawing power from the grid, i.e. loads such as industrial or household appliances, batteries to be charged etc. As such, these features center around the ability to reduce load when required, without creating any noticeable shortfalls in electricity service delivery to users.

A VPP provides grid operators with real-time information on dispatchable and controllable loads. Currently, load shedding, i.e. managed temporary interruptions of electricity provision, is undertaken by turning off an entire feeder and disconnecting all customers on that feeder. In a VPP, load can be dynamically reduced rather than disconnected. As such, the aggregate load will reduce without impacting grid availability.

The second range of services (ID4 to ID6) refers to services related to distributed assets feeding power into the grid, such as solar PV plants. These services allow grid operators to adjust grid-feeding from these distributed assets directly. For example, DSO curtailment refers to the ability of the distribution grid operator to reduce the renewable energy feed-in and as such reduce the stress on the distribution system. A financial compensation needs to be designed for the delivery of these services so that investment into new energy generation and storage assets remains lucrative. It is important to note that most of these services are best executed with storage assets, such as batteries, as they provide high power density at 24/7 dispatchability.

In summary, a core benefit of implementing VPPs is the enabling of accelerated penetration of renewable energies. The grid-level flexibility provided by VPPs is vital to responding to the fluctuating power generation of renewables. In this context, aggregating storage units to meet the shortfall when solar and wind are at low injections is critical. The implementation of VPP approaches around the world has shown that VPPs can deliver on this promise. Already today, VPPs support renewable energy generation capacity at a large scale. One of the market leaders, Next Kraftwerke, has aggregated more than 9.8 GW into a VPP [25].

The International Energy Agency (IEA) lists VPPs as one of the most crucial elements in reaching a carbon-neutral economy, or net-zero. Electric vehicles have been integrated successfully into VPPs in a number of projects around the globe: Examples include California, UK, and Germany [8]. Recent studies show that power system costs can be halved when integrating electric vehicles into a VPP, adding to the range of benefits outlined throughout this section [26].

The Potential of Light Electric Vehicles (LEVs)

Virtual power plants (VPPs) depend on the deployment of distributed assets, such as batteries for energy storage or solar panels for generation. Private sector investments into these distributed assets can be incentivized through the electricity market itself. EVs in general constitute a prime example for a good fit for VPPs. Though their primary use is in transport, EVs can provide additional services through a secondary market when leveraged via a VPP.

Whereas only a negligible number of electric four-wheeler EVs ply Bangladesh's roads, the LEV market has reached colossal scale. In this vein, Bloomberg argues that micromobility is the EV revolution's real driving force globally [13].

Micromobility encompasses a range of LEVs. In Bangladesh, only unofficial estimates on the total number of LEVs exist. According to a joint study by the Asia Foundation and Rahimafrooz Ltd., these vehicles were transporting around 100 million people across the country in 2017 [27]. In terms of the overall number of vehicles, estimates range from two to five million across Bangladesh, all of which are primarily deployed to transport people rather than goods. This ubiquity of LEVs has led to a rapid transformation of the transportation sector, accompanied by an array of challenges for the country's electricity systems [28].

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Fig. 2: Three wheeler Garages provide excellent aggregation points for VPPs.

The time of recharging LEV batteries typically coincides with demand peaks in the system, owing to households' increased energy use in the evenings. Regulators have therefore adopted a restrictive approach to EV regulation, leading to outright bans on LEVs in several regions of the country.

Updating the existing fleet of vehicles with high-power density (lithium-ion) and IoT-enabled batteries will pave the way to inclusion in a VPP, turning LEVs from a strain on the electricity grid into a support mechanism for it [29].

As exemplified in Fig. 2, LEVs are typically stored and charged overnight at garages. Such an LEV garage caters to between 20 to 150 vehicles [30]. This aggregation of vehicles, and therefore battery power, provides an excellent starting point for virtual power aggregation, with a conservatively expected 50 units per garage on average. A garage typically has a smart-metered, three phase grid connection with a power capacity of around 50 kW. As such, a single garage makes a significant demand-side impact on the local electricity feeder.

Each individual LEV has a power delivery capacity of at least 1 kW. With the estimated 4 million LEVs available in the country today [12], all these LEVs combined have a VPP potential of 4 GW today. This figure represents more than 25% of Bangladesh's 2023 peak load [1]. This vast scale demonstrates the huge potential of *Rickshaw VPPs*, not only making these storage units controllable for the grid, by optimizing recharge timing, but turning them into a dispatchable unit to help stabilize it through appropriately timed feed-in. Additionally, it can be expected that the number of LEVs and battery units is set to increase, once the positive impact of their VPP-linked deployment has been proven. Providing such convincing proof will be possible when a currently proposed policy regulating these electric-three wheelers comes into effect.

Outline of The Rickshaw VPP

The *Rickshaw VPP* brings together the might of the VPP technology with the potential of the vast scale of deployment of LEVs across Bangladesh. The technology builds on what is readily available today. In this section, we explore the components and mechanisms of the *Rickshaw VPP* in detail, and outline the VPP's climate change mitigation potential.

The VPP technologically consists of five main components, as highlighted in Fig. 3. The components (COMP) are:

- COMP1: Each LEV contains one battery storage unit
- COMP2: Smart communication interfaces within these storage units allow for continuous monitoring.
- COMP3: Mobile app technologies for garage operators and drivers enable real-time services for these batteries.
- COMP4: Power electronic interfaces at garages with dependable telecommunication capabilities facilitate the bi-directional power exchange with the distribution electricity grid.
- COMP5: Cloud services with secure interfaces provide central control and management for distribution and transmission by grid operators.

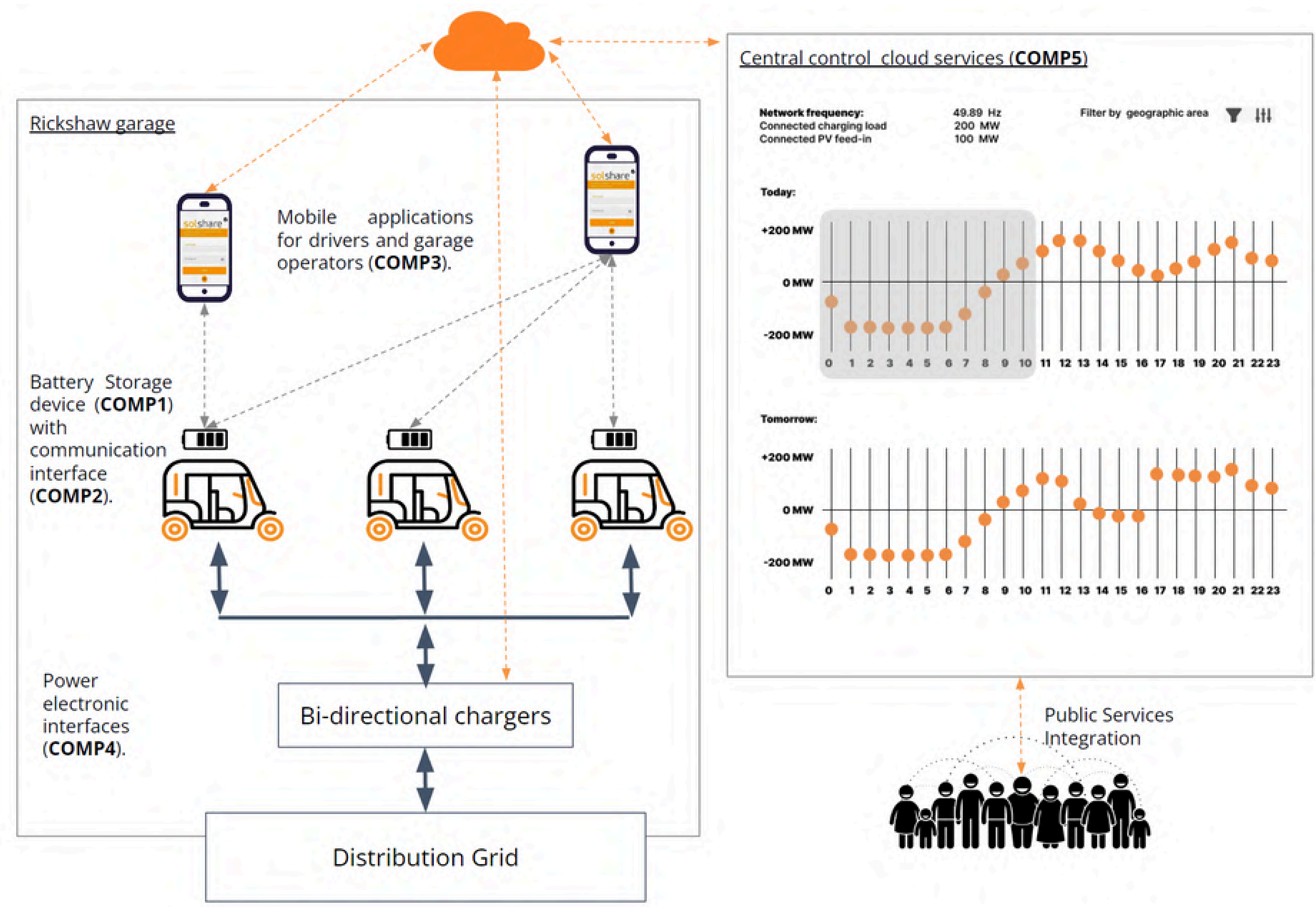

Fig. 3: Critical technological components of the Rickshaw VPP deployment

The primary incentive to purchase smart batteries (COMP1) is their function in producing reliable electricity for transportation services. The communication interface (COMP2) and mobile applications (COMP3) maximize the utility of these batteries for these transportation services. Additionally, COMP2 and COMP3 together also serve as the information collection and transmission interface for vehicles in circulation. The integration of these smart batteries into the electricity grid, when at the EV garage, is undertaken by means of so-called bi-directional chargers, which can be controlled remotely and can implement bi-directional power flow commands issued by the VPP cloud service (COMP5). The VPP cloud service can also be integrated with other public services. Such integration may cover aspects such as energy statistics, but can also serve to provide insights on traffic management and road safety.

A real-life use case may be as follows: A driver rents an EV with a fully charged battery, neither of which he owns, from the EV garage owner in the morning and subsequently provides transportation services throughout the day. If required, the EV may be returned to the garage for a brief interim charge during the day, or continue to be operated until the end of the driver's working day. Upon returning to the garage, the battery is physically connected to the electricity grid. At this point, an average lithium-ion battery will still have about 30% of its charge left. The VPP cloud then provides signals on whether to charge or discharge the connected batteries. This may mean, for instance, that the battery initially provides energy to the grid, e.g. to support the evening peak demand. During off-peak hours starting from midnight, the recharging of all batteries commences, ensuring ready-to-go, fully charged batteries in the morning.

Importantly, not all vehicles, and therefore batteries, will be on the road at the same time. There will therefore always be a portion of batteries that may act as power sinks or power sources throughout the day, as required. Additionally, drivers could be asked to connect to the grid to sell electricity during the day, given adequate economic incentive. In such a scenario, additional batteries could be pooled at EV garages to counteract extreme stress on the electricity grid.

As stated, the adoption of VPP approaches may serve as a key enabler in shifting the energy landscape of Bangladesh. Once the *Rickshaw VPP* proves the positive impact of LEVs on the electricity infrastructure at medium scale, additional legalization of LEVs in urban areas will lead to a rapid uptake of garages and units deployed. Assuming a ten-fold fleet expansion to 25 million vehicles by 2050, with a 1kW per-unit power capability, the Rickshaw VPP could pool a country-wide feed-in potential of 25GW. This means that by 2050, the *Rickshaw VPP* could cater to a significant part of the national load.

The climate change mitigation potential of the VPP is significant. The contributing factors are threefold: a) reducing electricity demand peaks, b) balancing renewable energy feed-in throughout the day, and c) the facilitation of increased reliable energy provision, even at night, significantly reducing the need for fossil fuels.

- Creating a peak load reduction
- Balancing renewable energy integration throughout the day
- Facilitation of reliable energy service provision even at night without the need for fossil fuels

In summary, the *Rickshaw VPP* at scale holds the potential to serve as the missing piece of the puzzle in Bangladesh's energy landscape. Primarily, it provides a systematic and controllable bridge between the transportation and energy sectors. Secondly, it closes the mismatch of volatile power generation from renewables and the need for reliable energy services. Thirdy, it provides a centralized market mechanism but simultaneously encourages decentralized organic growth in renewable energy asset deployment and investments in storage assets.

To unlock the vast potential in millions of currently deployed LEVs via VPPs, we need policies that guide the efficient integration and fair compensation of distributed energy resource aggregation. In the specific case of Bangladesh, this will require recognition by the Power Ministry of the need and the compensation for grid ancillary services, such as those provided by a VPP. The present net-metering policy falls short in this regard: It lacks provisions to incentivize aggregated storage solutions in support of the grid. Rather, a time-based feed-in tariff for smart distributed energy storage solutions would serve to unlock the potential of widespread VPP adoption.

Conclusion

The Rickshaw VPP white paper presents a compelling case for leveraging the widespread adoption of light electric vehicles in Bangladesh to address the challenges of unreliable electricity supply and climate change. By bringing together a large fleet of electric vehicles to provide grid services, the paper suggests a transformative approach that turns LEVs from a perceived threat to a valuable asset for grid reliability.

The paper highlights the immense potential of the Rickshaw VPP, with millions of LEVs in operation and a VPP-potential of 4 GW. It emphasizes the three fundamental concepts of the technology: the deployment of distributed storage assets, the aggregation and control of networked vehicles, and the acceleration of renewable energy adoption for a sustainable energy infrastructure.

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Crucial tools include peak shaving, which involves reducing the highest levels of electricity consumption; load shifting, which entails shifting electricity demand to different time periods; and load curtailment, which refers to the deliberate reduction of electricity usage. All three tools will help make unmanaged power cuts, i.e. load shedding, a matter of the past. The ultimate promise of VPP adoption is the flexibility it provides to allow for a 100% renewable energy penetration in the energy system in the long term.

The Rickshaw VPP brings together a primary market that provides local transportation services and a secondary market with country-wide electricity grid services. The Rickshaw VPP provides a remedy to the major stresses the electricity grid faces, and will allow for a departure from regular power interruptions to one of dynamic, automated energy demand and supply management. By incentivizing investments into locally used but networked assets, the Rickshaw VPP enables a 21st century infrastructure that thrives through organic and dynamic growth. This growth in sustainable energy infrastructure has the potential to be a core contribution to Bangladesh reaching a carbon-neutral energy economy by 2050, starting today. Bangladesh is uniquely positioned to develop a network of distributed storage assets at scale which we believe is not possible in any other market in the world right now.

Overall, the white paper substantiates the Rickshaw VPP as a promising solution to overcome the challenges faced by Bangladesh in achieving a clean energy future. By reducing load-shedding and leveraging renewable energy generation, the Rickshaw VPP can play a pivotal role in the country's energy transition and contribute to a greener and more sustainable future.

Bangladesh is uniquely positioned to develop a network of distributed storage assets at scale which we believe is not possible in any other market in the world right now.

Further Reading

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