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How Solar Power and EVs can go hand in hand?

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India's solar targets

India has set an ambitious target to attain net-zero carbon emissions by the year 2070. As part of this endeavor, the nation is actively promoting the electrification of its transportation systems and the expansion of renewable power infrastructure. Presently, India boasts approximately 74 gigawatts (GW) of installed solar power capacity. Looking ahead, the country is aiming to significantly scale up its renewable energy capacity, with a goal of achieving 500 GW of installed renewable energy capacity by 2030. Notably, this ambitious target includes an expected 292 GW from solar energy sources alone.

Challenges with solar power

One of the fundamental challenges associated with solar power is its inherent variability in generation. Solar production is heavily influenced by weather patterns, which can significantly impact output. This variability poses a considerable challenge when integrating large amounts of solar energy into the electric grid. Typically, the peak solar generation occurs during the daytime, particularly between 11 am and 4 pm, as electricity generation is directly correlated with the solar irradiance received by the panels. Managing this variability is crucial for effectively harnessing solar energy and ensuring reliable electricity supply from solar sources.

India's EV story

Electric vehicles (EVs) are rapidly gaining traction in India, with all major automotive Original Equipment Manufacturers (OEMs) preparing to introduce their own EV models in the near future. In 2030, the country saw sales of approximately 73,000 EV passenger cars. Demonstrating a strong commitment to promoting EV adoption, the government has set an ambitious target of achieving a 30% penetration rate of EVs in the passenger vehicle market by 2030. This equates to an estimated 12-13 million electric vehicles on Indian roads by the end of the decade.

What is Time-of-use tariffs?

Time-of-use tariffs represent a significant measure aimed at incentivizing system-friendly EV charging behaviors. This pricing structure is designed to influence the pattern of electricity consumption by varying the price of electricity based on the time of day it is used. Unlike flat-rate pricing models, time-of-use tariffs adjust electricity prices according to peak and off-peak hours. By implementing this approach, utilities seek to encourage consumers to shift their electricity usage away from peak times toward off-peak periods. This strategic adjustment helps utilities more effectively manage their resources and alleviate strain on the grid during times of heightened demand. Time-of-use tariffs play a vital role in promoting sustainable energy practices and enhancing grid stability.

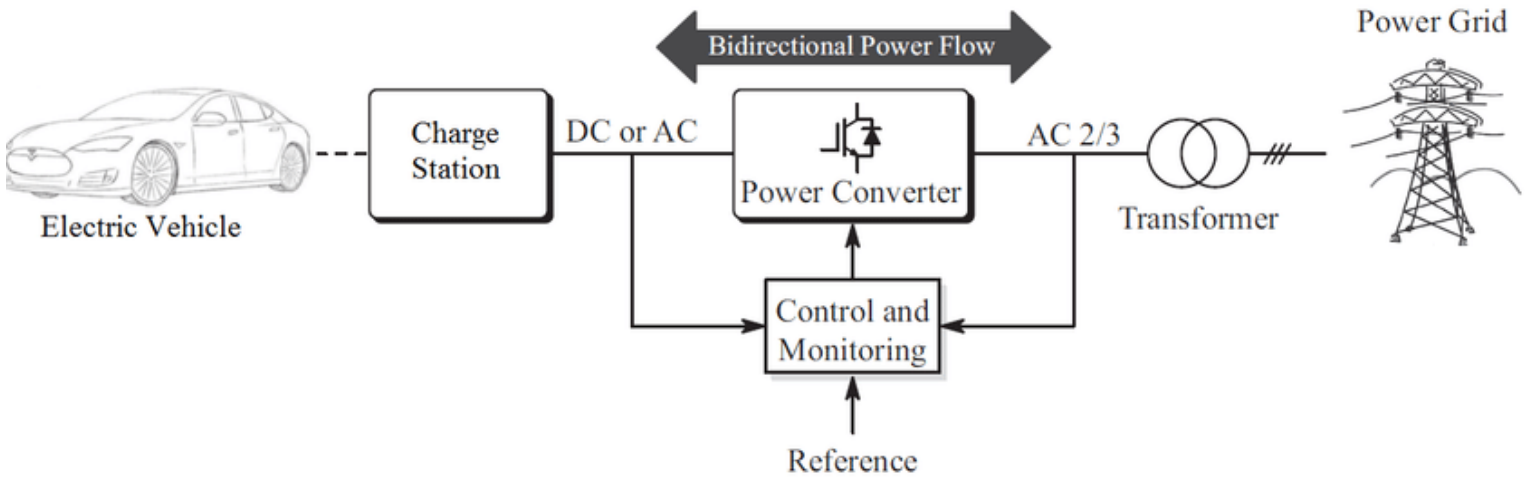
How can EVs and solar power complement each other?

The current electricity tariff structure in India favors night-time charging, effectively reducing peak loads on the grid. However, as solar power becomes a more prominent component of the generation mix, there arises a need to incentivize day-time charging to maximize its utilization. This shift can be facilitated through adjustments in time-of-use tariffs, encouraging EV owners to charge their vehicles during daylight hours when solar energy production is at its peak.

Moreover, EV owners can leverage rooftop solar installations on office and commercial buildings to charge their vehicles during the day. By tapping into this renewable energy source, EV charging can align more closely with periods of abundant solar power generation, further optimizing energy usage and reducing reliance on conventional grid electricity.

What is V2G?

Vehicle-to-grid (V2G) represents an innovative concept characterized by the bi-directional exchange of electricity between electric vehicles (EVs) and the power grid. Unlike traditional charging scenarios where EVs solely draw electricity from the grid to replenish their batteries, V2G EVs have the capability to discharge surplus electricity back into the grid when necessary.



Source: Vadi, Seyfettin & Bayindir, R. & Colak, Alperen & Hossain, Eklas. (2019). A Review on Communication Standards and Charging Topologies of V2G and V2H Operation Strategies. Energies. 12. 3748. 10.3390/en12193748.

In response to fluctuations in grid demands, V2G-enabled EVs can optimize their charging cycles, either reaching maximum capacity or adjusting charging rates during periods of abundant supply. Furthermore, the batteries of these EVs can serve as temporary energy reservoirs by injecting excess electricity back into the grid during peak consumption times.

This dual functionality not only enhances the flexibility of the grid but also streamlines the integration of intermittent renewable energy sources, such as solar power. By leveraging V2G technology, **EVs can operate as distributed battery storage units**, particularly during periods conducive to heightened solar energy production.

How can V2G up the game for India?

The prospective sale of **12-13 million EV passenger cars annually**, assuming a 30% EV penetration rate, heralds a significant surge in battery capacity hitting Indian roads in the near future. Conservatively estimating an average **battery pack size of 20 kilowatt-hours (kWh) per vehicle**, this translates to approximately **240 gigawatt-hours (GWh) of battery capacity deployed each year**. Even if only a portion of this capacity is harnessed for energy storage purposes, it holds immense potential for bolstering grid stability, optimizing the utilization of installed solar capacity, and advancing emission reduction efforts. India's National Electricity Plan underscores the need for **236.2 GWh of BEES (Battery Energy Storage System) by 2032.** This would entail a **capital cost of over Rs.5 lakh crores**. The substantial battery capacity inherent in EVs can substantially contribute toward meeting this target, thereby enhancing the reliability and resilience of the country's electricity grid.

Moreover, V2G technology holds promise for revolutionizing solar microgrids in rural areas, where vehicles are predominantly stationary for extended periods. In these contexts, V2G-enabled EVs can serve as invaluable assets, storing surplus electricity generated during the day and subsequently supplying power to rural microgrids during nighttime hours. This innovative application not only maximizes the utilization of solar energy resources but also fosters energy independence and sustainability in remote communities.

Challenges with V2G

- Low EV penetration in India.
- Lack of large-scale cost-effective compatible hardware across the value chain.
- While making V2G EVs is relatively not so costly, V2G compatible chargers are expensive.
- Lack of standardization in the EV ecosystem.
- Need for strong communication networks and protocols for linking with the grid.
- Need for a regulatory regime to allow for integration and aggregation of EVs into the grid.
- Need for tariff structures to change to promote smart charging and allow for bi-directional flow of energy.
- Concerns over battery life and performance.

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