CHALLENGES OF INTEGRATING ELECTRIC VEHICLE CHARGING INFRASTRUCTURE INTO ENERGY SYSTEMS WITH A HIGH SHARE OF RENEWABLE ENERGY SOURCES

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The rapid increase in the number of electric vehicles (EVs), especially in Europe, is reshaping the structure of electricity consumption. According to forecasts, by 2030 the number of EVs will reach tens of millions, placing additional strain on local and distributed energy systems [1]. At the same time, the share of renewable energy sources (RES) - primarily solar and wind - is steadily growing. These two trends- electrification of transport and the rise of «green» energy - pose new challenges for the stability of power grids.

The main issue is the inconsistency of energy consumption by EVs and the high volatility of RES generation, which heavily depends on weather conditions [2]. This overlap of two variable factors demands fundamentally new approaches to network planning and management, particularly regarding the integration of charging infrastructure.

Firstly, new peak loads are emerging. EVs are typically charged in the evening and at night, coinciding with residential peak demand, while solar generation is unavailable during this time. This increases the risk of transformer and distribution line overloads. Secondly, there is a mismatch between generation and consumption profiles: wind and solar power are inherently unstable, necessitating either large-scale energy storage or dynamic charging control strategies. Thirdly, existing distribution networks were not designed to handle such high variability in load. The connection of high-power charging stations without grid upgrades leads to significant operational limitations. Another critical issue is load forecasting: the combination of variable generation and consumption requires the development of adaptive, localized control and prediction systems.

Additionally, local energy storage systems are essential. These can accumulate RES surpluses during low demand periods and release them during peak hours.

In conclusion, integrating EV charging infrastructure into energy systems with a high share of renewables is a complex but solvable task. It requires coordinated solutions in forecasting, smart charging management, energy storage, and grid planning. The sustainable development of both electromobility and renewable energy depends on a comprehensive and adaptive approach.

References:

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