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Bibliotheekgegevens rapport:

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Meer informatie over de studie is te verkrijgen bij de projectleider Huib van Essen.

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Summary

Background

The transition from fossil fuels to renewable sources of energy is ongoing and has benefits for our climate, air quality and energy security. The strong growth in electric vehicles (EVs) in the transport sector does increase the existing peak demand for electricity in the evening. At the same time, the growth in solar PV and wind energy causes larger fluctuations in the supply of electricity.

Separately, these trends can result in higher costs, but when the two are combined in a smart way, synergies gains can be realised. However, the type and scale of potential synergy gains are unclear.
Therefore, RVO has asked CE Delft to investigate this topic and to provide a first estimate of the potential value of these synergies for the Netherlands in 2025. In addition, the additional costs of the expected growth in the number of EVs for the electricity sector have been estimated.

Overview of synergy gains EVs and renewable energy production

Three synergy gains between EVs and solar-PV/wind energy have been identified with an extensive literature review and interviews with five experts, concerning:

- **Cost savings in electricity production**
  These cost savings result from:
  - less fluctuation in the demand for energy, which would normally be compensated with conventional coal and/or gas plants;
  - less curtailment of renewable energy production (particularly wind);
  - avoiding or postponing investments in peak capacity power production;
  - cancelling short term fluctuations in electricity demand and supply to guarantee the (frequency) balance of the power grid.
- **Cost savings in local energy infrastructure**
  These consist of avoided investments in strengthening local electricity grids as a result of better matching supply and demand, which in turn can result in a lower peak demand.
- **Acceleration of EVs and solar-PV as a result of growth in one or the other**
  This is for example due to sustainability considerations and/or financial benefits. The latter is mainly relevant when net metering is no longer allowed, as this improves the return on investment from solar panels for home owners who also buy an EV. This benefit has not been quantified in this study, but is important according to the interviewed experts.

Method for estimating the value of synergy gains

CE Delft has used two of her models (CEGRID and CEFLEX) to provide a first estimate of the first two mentioned synergy gains in six scenarios with different assumptions about developments in the number of EVs, solar-PV/wind energy, battery capacity and of the level of smart charging.

The value of the synergy gains have been determined by comparing the costs in a scenario with regular charging (no synergies) and with a smart charging concept (synergy effects) – either with smart charging or vehicle-to-grid (V2G). Of the four mentioned types of potential cost savings in electricity production, only the first type (less fluctuation in the demand for energy, which would normally be compensated with conventional coal and/or gas plants) has been quantified by the modelling; the other three type have not been quantified in this study.

The value of cost savings in electricity production

The value of this synergy gain has been estimated at 75 to 132 million euro per year with smart charging and from 17 to 176 million euro per year with vehicle-to-grid. This results in a value of 89 to 172 euro per EV per year. The total benefits are larger (particularly in the case of vehicle-to-grid), as some synergy gains could not be quantified. Foreign studies show that benefits of avoiding curtailment can be significant (e.g. 50 to 60 euro per EV per year in the UK). Benefits of vehicle-to-grid for short-term frequency balancing may be even much larger (e.g. up to more than 1,000 euro per EV per year in a case study in Denmark). It is unclear whether these estimates could also be representative for the Netherlands.

The value of cost savings in local energy infrastructure

By combining EVs and solar-PV in a smart way, a reduction in the annual peak demand can be achieved. This can result in lower investments in the local energy grid of about 50 to 240 euro in total. Due the long depreciation period of these infrastructures, the value of this synergy gain are much lower, from 3 to 12 million euro per year in 2025, which is 10 to 12 euro per EV, depending on the scenario.

The total value of synergy gains between EVs and renewable energy

The total value of the potential synergy gains as modelled in this study ranges from **20 to 200 million euro per year**. This corresponds to **100 to 200 euro per EV per year**. Note that also these numbers are underestimates, particularly in the case of vehicle-to-grid, as some synergy gains could not be quantified. On the other hand, the technical costs of enabling smart charging and/or vehicle-to-grid and the impacts on the EV battery capacity and life time have also not yet been quantified, the analysis of which requires further research.

Conditions for realising the synergy gains

There are a number of important conditions for realising the above-presented synergy gains. The diffusion of smart charging concepts, such as smart charging and vehicle-to-grid, and the ability to provide price incentives to EV-owners are particularly important. The latter requires an adjustment of existing legislation. In addition, uncertainty in the costs of accelerated battery deprecation when discharging the battery (vehicle-to-grid) may hamper the application of this smart charging concept.

Costs of EVs for the electricity sector

In addition to the synergies, also the total cost of the growth of EVs for the Dutch electricity generation and networks has been estimated, under the condition of smart charging. This analysis shows that the additional costs for the electricity system amount (rounded) about 100 to 300 euros per EV per year (including the electricity use of the EVs themselves). These costs are the sum of the cost of investments in the grid and additional electricity use both caused by the EVs, minus the potential savings due to the synergies that can be harvested by applying smart charging and/or *vehicle-to-grid*. Note that these costs may be lower (and perhaps in some cases even negative) because of the potential cost savings that have not been quantified (particularly in the case of vehicle-to-grid).

Recommendations for follow-up research

There are several recommendations for further research:

- Determining the value of synergy gains for electricity production in the imbalance market (for scenarios with vehicle-to-grid), avoided curtailment of wind mills and due to avoiding or postponing investments in peak capacity.
- Electricity price effects (e.g. using the POWERFLEX model).
- Distributional impacts and synergies with the business case of renewable energy.
- The barriers and costs that impede the realization of the synergy gains and policies to remove these barriers.
- Finally, a complete cost -benefit analysis of smart charging concepts.