Battery Swapping Technology Including the Implementation of Station-2-Grid

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What is **Battery Swapping?**

- Alternative approach to fast charging
- Customers exchange their discharged battery with a fully charged one either by automatic or manual swapping
- Batteries are prepared at battery swapping stations (BSS) in large numbers and can be charged slower, more controlled and with a lower impact on the grid

What is **Station2Grid?**

- Vehicle2Grid concepts applied to battery swapping
- Batteries can be aggregated to produce more significant and useable capacities for ancillary services in the power grid
- BSSs would operate as storage providers and respond to frequency regulation demands, power outages and peak shifting

What are the **benefits & incentives?**

Battery swapping could benefit:

- **Public urban busses:** BSSs at central stops and depots can decrease dwell times and make fast charging obsolete
- **Urban scooter applications:** smaller stations can provide smaller batteries in subscription-based price models
- **Long distance trucks:** BSSs along highways would reduce downtime and provide energy storage and rural back-up

Charging vehicles within minutes

5…11% Fleet ownership cost reduction (1)

90$...4000$ Profit from S2G per. bat. & year (1)

S2G services the BSS could provide to the grid include:

- **Peak shifting** or valley filling
- **Frequency regulation**
- **Renewable energy storage** & back-up supply

These services could help make BSSs profitable for station operators, by generating additional revenue on top of battery swapping fees or reduce ownership cost for fleet owners.

What are the **challenges & barriers?**

- One of the main challenges battery swapping systems face is the **infrastructure planning,** since these stations are meant to hold, charge and swap a large number of batteries
- Some aspects to consider include:

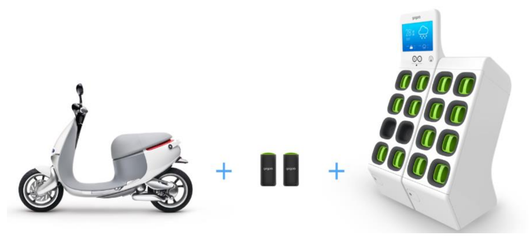
BSS placement
BSS cost
No. of batteries
Swapping time
Swapping process
Scheduling

- The biggest concern with S2G is **battery degradation.** Studies show different results, with some suggesting that battery lifetime could be increased by using optimized V2G/S2G (2) (3)

Battery lifetime decrease up to 10%

- Another challenge is **standardisation**: S2G requires communication channels between all parties, standardised batteries, statistically predictable capacity availability etc.

Example Projects: **BEGINS & Gogoro**



Korean company BEGINS introduced battery swapping public buses on the island Jeju. The pilot station succeeded, but not all planned BSSs were actually built. (4)

Capacity	51 kWh	No. of Busses	119
Range	76 km	No. of Batteries	290
No. of BSS	14	Swapping Time	1 min, Automatic

Battery swapping scooters are the field of Taiwanese company Gogoro. In Taiwan, one “GoStation” per km offers manual, fast swapping of two battery packs. (5)

Capacity	2 x 1,3 kWh	Cell Type	NCR18650
Bat. Weight	2 x 9 kg	No. of BSS	521
Range	110 km	Swapping Time	6 s, Manual

Results & Conclusions

- Growing need for higher storage capacities and ancillary services, which BSSs could provide
- S2G could make battery swapping economical for BSS operators and fleet owners
- Load/peak shifting as well as optimized charging methods can significantly reduce energy costs for large consumers
- Battery degradation, future storage needs and lucrative business cases for battery swapping stations are subjects in need of further research
- Busses are the most promising option for S2G applications, while scooters are the most feasible for battery swapping

Sources:
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