Integration of Electro-Mobility Solutions into Off-Grid PV Systems for Sustainable Development of Rural Areas in Sub-Sahara Africa

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Background

Today, rural communities in Sub-Sahara Africa (SSA) lack access to adequate and reliable transportation. The majority of SSA's rural settlers rely on bicycle taxis, animal-driven carts and old vehicles that mostly run inefficiently at low speed with high fuel consumption and greenhouse gas (GHG) emissions. Most of the young people walk over long distances to schools or tend to use poor transport services, which contributes to late enrolment or early drop-out (Bloemen, 2018). Women and children have to walk over a long distance to fetch (untreated) water from the lakes or wells for domestic usages. As a result, this makes them vulnerable to diseases, poverty and gender inequality (Sewell, 2016; Porter, 2014).

Compared to conventional systems (typically diesel generators), stand-alone and / or hybrid PV systems provide a reliable electricity supply at reasonable costs. Complementing off-grid PV systems with battery electric vehicles (BEVs) such as electric boats, cars, and (cargo) bikes can be a socio-economic development strategy for SSA's rural communities (Mueller and Mueller, 2014). As the energy for operating BEVs is generated within the rural communities, a further development of the local economy can be achieved.

Current status and perspective of Water-Energy Hubs

Currently, so-called *Water-Energy Hubs* (WE!Hubs) operated by *We!Hub Victoria Ltd* (owned by the *Siemens Stiftung*) enable the Kenyan population around *Lake Victoria* access to sustainably generated electricity and clean

drinking water. PV-generated electricity is used for water purification as well as for charging special, floatable lanterns for night fishing. In order to expand the effective radius of the *WE!Hubs* and to open up new recovery paths for the generated electricity, the *Institute of new Energy Systems* together with the *Siemens Stiftung* aims at integrating a holistic e-mobility concept into the existing infrastructure of the *WE!Hubs*. The mobility solutions range from electric cargo bikes and vehicles (for the distribution of purified drinking water and local transportation) to electrically operated fishing boats.

Figure 2: Typical *WE!Hub* located at Lake Victoria. © *Siemens Stiftung*

Methodology

The *Institute of new Energy Systems* together with the *Siemens Stiftung* develops a technical concept for implementing the above-mentioned mobility solution into the existing *WE!Hub* at Mbita. This concept should serve as a blue-print for other *WE!Hubs.* In a first step, current load profiles were determined, as the energy demand depends on daily routines of the local community and is strongly linked with the fishing-season at *Lake Victoria*. These load profiles together with the technical specification of the system were used to simulate the annual electricity consumption and production. Subsequently, the potential for integrating further consumers within the context of e-mobility was determined. A best possible distribution of the different consumers throughout the day is of major importance for an economic feasible extension of the investigated *WE!Hub*. Therefore, an appropriate control-strategy will be developed.

References

[1] Bloemen, S. (2018), “Mobility for Africa”, available at: https://www.mobilityforafrica.com/new-blog/ (accessed 8 February 2019).

[2] Mueller, O.M. and Mueller, E.K. (2014), “Off-grid, low-cost, electrical sun-car system for developing countries.”, IEEE Global Humanitarian Technology Conference (GHTC 2014), Vol. 34 No. 1, pp. 14–17.

[3] Porter, G. (2014), “Transport Services and Their Impact on Poverty and Growth in Rural Sub-Saharan Africa: A Review of Recent Research and Future Research Needs”, *Transport Reviews*, Vol. 34 No. 1, pp. 25–45.

[4] Sewell, S.J. (2016), “The impacts of undeveloped roads on the livelihoods of rural women”, *Review of Social Sciences*, Vol. 1 No. 8.