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PARKING AND ELECTRIC VEHICLES

CAR PARK POWER PLANT

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Exploring the operation of a Car Park Power Plant - Formalising the operation of a system innovation with the Actor-Option Framework

The Car Park Power Plant (CPPP) concept is in its essence a parking garage in which parked fuel cell vehicles (FCVs) are used for the generation of electricity.

On-site hydrogen production

By including on-site hydrogen production methods, the CPPPs could purchase electricity when it is cheap, store it, and convert it back to electricity when the electricity price is high.

System innovations such as the CPPP concept lead to large scale changes in infrastructure systems such as the electricity and the passenger transport infrastructure.

The infrastructural systems are complex systems in which designers of new elements are unable to control the use of these elements once deployed.

Knowledge is currently lacking concerning the influence of CPPP design choices and environmental uncertainties, on the possible future operational performance of the installation.

In order to aid in the delineation of the possible design space of CPPPs, we have set the objective of providing an approach that is capable of identifying possible barriers for the successful operation of a CPPP.

To structure our research we have used the following research question:

Which Car Park Power Plant design elements or environmental factors could form barriers for the successful operation of an introduced CPPP installation?

To answer this question a literature study was conducted to find an appropriate theory to guide the identification of a relevant but delineated system representation. The Actor Option Framework was selected to serve this purpose.

Six factors form possible barriers

The system delineation was used to construct an agent based model that has been explored for possible behaviours of the CPPP and its surroundings. With the aid of the model we identified six factors that in sets of three form possible barriers for a successful operation of a CPPP:

- The usage of simple CPPP operation tactics will result in CPPPs to produce electricity at all moments that satisfy the selected use-case. As a result the CPPP desires to produce electricity during many hours of the day.
- FCVs are expected to have production capacities of around 100 kW. If the conversion efficiencies of FCVs remain in the range of what they are now, the FCVs could require an amount of hydrogen per hour that comes close to the daily capacities of today's on-site hydrogen production devices. Combined with the desire to produce electricity during many hours a day, an unsatisfiable hydrogen demand and a continuous hydrogen production emerges.
- Without the possibility to determine profitable hours of hydrogen production, the possibility of making use of the price differences of electricity during a day will no longer be present. As a result the value of storage becomes too small to compensate for the conversion losses within the

CPPP. In these cases the CPPP can be expected to make operational losses due to the absence of a positive profit margin.

- Choosing to reward motorists who park at a CPPP with a free refill of hydrogen is unlikely to have significant effects on their perceptions. Due to the fact that FCVs consume a small amount hydrogen per driven kilometre, the perceived monetary value of the received free hydrogen is insufficient to structurally persuade motorists to park at the CPPP.
- Also the effect of the existence of a CPPP on the decision of a motorist with respect to the choice between purchasing an FCV or a conventional vehicle could be limited. Benefits that a CPPP could offer for FCV owners are a reduction in fuel costs and an improved environmental performance of their vehicle. The valuation of these benefits by motorists is however insignificant when compared to the valuation of the purchase price of vehicles.
- If both the share of motorists with an FCV and the share of these motorists that park their car at a CPPP are low, the CPPP will have to rely on a very large motorist population. This would make it difficult to find a suitable location that such a large base population would consider to use as a daily parking location.

We observe that the approach as we have used it is capable of identifying possible operational barriers for CPPPs and possibly for system innovations in general.

The knowledge gained from this study can be used as a base to further explore the possible operation of CPPPs, as a base for discussion concerning possible CPPP designs or as substantiation for research towards the identified factors.