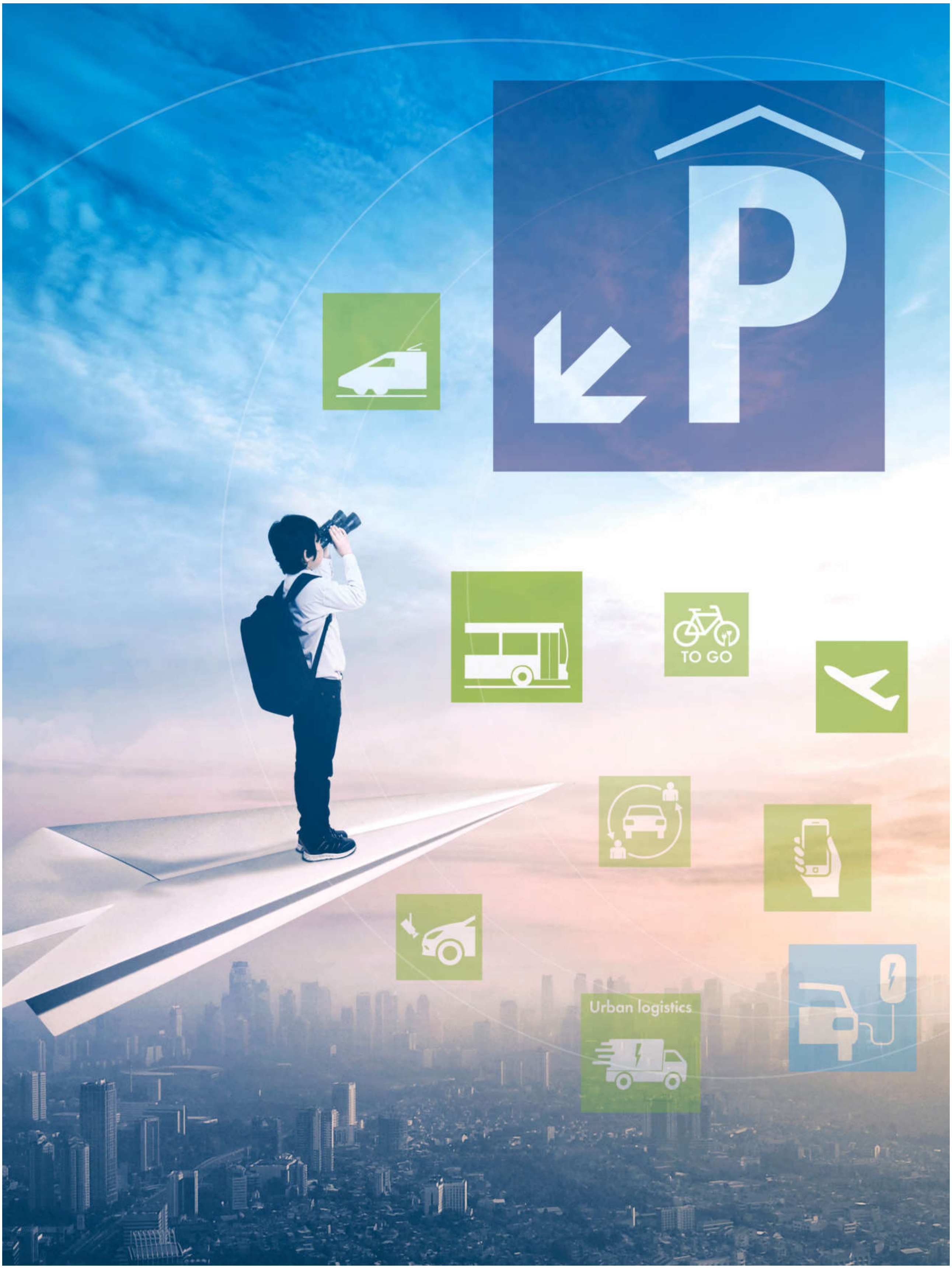
STUDENT AWARDS



Q PARK Quality in parking

CHARGING EVS AT THE WORKPLACE

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Advancing sustainable transportation by charging EVs with PV power at the workplace: an optimal charging strategy

Arguably, the most important challenge of our time is climate change. In The Netherlands in 2014, 30% and 21.5% of total CO_2 emissions were emitted by the electricity producing and transportation sector, respectively.

Electric vehicles (EVs) have therefore gained interest as they do not emit carbon dioxide whilst driving and therefore do not pollute, at least directly.

Nevertheless, when EVs are charged with electricity produced by a fossil-fuel power plant there are indirect emissions. Additionally, high penetration of EVs will inevitably lead to increased stress on the grid and consequently capital expenditure.

A viable solution to mitigate both these disadvantages is by charging EVs at the workplace with locally produced photovoltaic (PV) power. The high level of coincidence between parking time and solar power paves way to charge EVs in a sustainable and cost-efficient manner.

Energy Management System

The thesis work presents the design of an energy management system (EMS) capable of forecasting PV power production and optimising power flows between PV system, grid and EVs at the workplace.

The aim is to reduce energy demand on the grid by increasing PV self-consumption while minimising charging costs and consequently increasing sustainability of the EV fleet.

The developed EMS consists of two components: an autoregressive integrated moving average (ARIMA) model to predict PV power production and a mixed integer linear programming (MILP) framework that optimally allocates power to minimise charging costs.

The EMS is designed such that it can be implemented in practice and moreover, is versatile, implying that it can be utilised for alternative purposes as well. Additionally, the predictive quality of the system enables it to anticipate and act accordingly, rather than solely react.

In order to perform sensitivity analyses, case studies will be formulated in which the effectiveness of the system can be ascertained.

The results show that the developed EMS is able to reduce charging costs significantly, while simultaneously increasing PV self-consumption and reducing energy demand from the grid.

Furthermore, during a case study analogous to one repeatedly considered in literature, i.e. dynamic grid tariff and dynamic feed-in tariff (FIT), the EMS reduces charging costs by 118.44% and 427.45% in case of one and two charging points, respectively.

Moreover, stress on the grid is alleviated through both load shifting and power injection during peak demand. In addition, the EMS proves that vehicle-to-grid (V2G) leads to optimality only in extraordinary cases.

The optimisation problem is modelled in GAMS, whereas the ARIMA process is modelled in Matlab and subsequently, the EMS is simulated in Matlab.

SOLAR CHARGING ELECTRIC VEHICLES