

## Testing e-vehicle fleets

imc participates in the research project "Fleets Go Green"



## E-fleets on the test track

“Fleets Go Green” is a project designed to analyze and evaluate the efficiency of electric vehicles in everyday use with a factory fleet as the test subjects. imc Meßsysteme GmbH is participating in this research project sponsored by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMU). The research results will form the basis for the decision to convert regular vehicle fleets to electric cars in the future.



imc Meßsysteme GmbH, together with the Technical University of Braunschweig, the Fraunhofer Institute, Volkswagen AG and other partners, is investigating by means of field tests and mathematical models the potential of electro-mobility with regard to the reduction of harmful environmental impacts of road traffic. Based on this research, a holistic ecological assessment will be conducted.

## Scope of the project

The project includes a total of five modules which cover the analysis and evaluation, as well as the applications of the e-vehicle fleet focusing on the following:

- Measurement, modeling, simulation and evaluation of component-specific

energy consumption of the vehicles (module 1)

- Investigation of business model-specific and segment-specific driving factors for user acceptance, as well as the procurement behavior of fleet operators, especially for electric vehicles (module 2)
- Consideration of interactions with the power grid and the testing of innovative concepts for reducing the feedback and for the coupling of electric mobility to renewable energy sources (module 3)
- Integrated ecological assessment of fleet operation and analysis of the factors involved (module 4)
- Derivation of recommendations for political and economic decision makers, among other things, in the form of decision support for the ecologically-oriented fleet management of electric vehicles (module 5)



## imc C-SERIES measurement device

For the data acquisition of mobile tests, the electric vehicles were equipped with the imc C-SERIES measurement system. These powerful and compact data acquisition systems are ideally suited for universal measurement tasks. They can be both computer-assisted and autarkic and are light and robust.

The imc C-SERIES effectively met all requirements of the project.

#### Requirements:

- Digital measurement data acquisition via fieldbus
- High-performance analog data acquisition
- Compact and robust design
- Weather resistant
- Wireless transmission of measurement data
- UPS battery back-up for power interruptions
- Autarkic operation



Compact & versatile: imc C-SERIES measurement system

The imc C-SERIES is equipped with differential and isolated universal measurement amplifiers with analog anti-aliasing filters. The universal measurement amplifiers offer a high degree of dynamics, precision, low-noise and flexibility. They are suitable for the direct connection of:

- Voltage and current signals

- Any thermocouple and resistance thermometer
- Strain gauge bridges with excitation and cable sensing
- Current-fed sensors (ICP)
- ... and offers a sensor supply as well as TEDS

Depending on the model, the imc C-SERIES provides sampling rates of up to 100 kHz and a bandwidth of 49 kHz per channel.

The project team records electrical and mechanical variables as well as the travel route via GPS, thus allowing for evaluations of route profiles and conditions. In addition, the data from the charging stations are recorded and stored so that the energy storage devices (batteries) can also be evaluated with regards to charging capacity.

#### Data analysis with imc FAMOS



The analysis and evaluation of the acquired measurement data plays a decisive role in the "Fleets Go Green" project. The imc FAMOS signal analysis software was used as part of the project and provided a solution for the following tasks:

- Control and automation of the process chain – from measurement data acquisition and analysis to data storage in the database
- Measurement data visualization and evaluation tool in the backend area for all project members with appropriate imc FAMOS license
- Database interface
- Realization of import filter for external data formats



imc FAMOS offers the possibility to load and store a wide range of data formats, to create comprehensive automation, to choose the most varied display possibilities and to search hundreds of measurements in the shortest possible time.

With help from imc tools, automated evaluations with weekly, monthly and annual reports concerning the individual vehicles contribute to the timely evaluation of driving profiles and vehicle usage.

### Automatic measurement data transfer

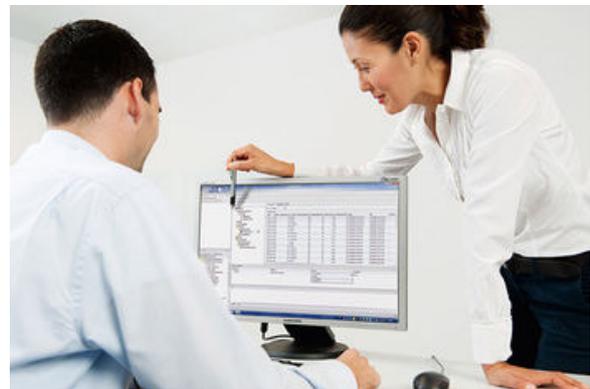
In the “Fleets Go Green” project, an automated data transfer was required. imc LINK is a software specifically designed for remote access to imc devices and enables automatic copying or transferring of recorded data to a PC or server. It ensures a seamless and secure automated data transfer from measurement devices which are not directly connected to a computer.

imc LINK was used in this project to acquire the measurement data that were stored locally in the measurement device with an existing WLAN connection, to copy them to a local memory and to trigger the subsequent process of data evaluation and storage in the central database using imc FAMOS.



### Database management system

For the collaborative “Fleets Go Green” project, the imc SEARCH database serves as a storage and reference structure for the variety of data acquired, such as driving, charging, weather and tablet. Via the connection to the imc FAMOS analysis software, it is the common platform for measurement data.



The imc SEARCH database application supports regular database management systems such as Oracle, MS SQL and MySQL. It is used for central storage, administration, viewing and browsing of measurement data. It seamlessly combines search results and measurement data processing with the imc FAMOS analysis software.

The data model of imc SEARCH is user-specific and enables task-oriented storage and archiv-

ing. A comfortable administration interface makes it possible to define logical contexts and to transform them into a user-oriented data structure. The model consists not only of individual elements, but also unites the relations of the elements among themselves.

## Tablet data – driver reviews

In selected vehicles, tablets were also installed to allow the driver to participate in surveys before and after each drive. The resulting data had to be assigned to the appropriate trip file in the central database.

The survey data were stored as a .csv file consisting of information regarding the vehicle, start time, end time, charge status, as well as subjective assessments on the comfort and behavior of the electric vehicle. In order to be able to evaluate these data records in a meaningful way, the appropriate trip had to be found in the imc SEARCH database and linked with the tablet data.

Each of the survey files were processed according to the same principle: with the help of an import filter and an imc FAMOS sequence, the .csv file information was imported to imc FAMOS.

## Weather data

In order to be able to analyze the trips with regard to weather-related influences, weather data were recorded at a weather station. The logged data were made available to imc as .csv files that contained the records per month.

They provided information on the following data:

- Global radiation
- Humidity

- Precipitation period
- Precipitation amount
- Temperature
- Maximum wind speed
- Average wind speed
- Wind direction



By means of an implemented import filter, the data were imported into imc FAMOS, converted into respectively scanned data sets and stored in the imc SEARCH database. This entire process was similar to importing of the driving, charging and tablet data using imc FAMOS sequences.

## Conclusion

In the “Fleets Go Green” project, as per module 1, imc successfully equipped and modified three vehicles with imc measurement systems. To provide a useable working package for modelling, among other things, digital fieldbus data were recorded, as well as analog driving data at high sampling rates.

A database based on imc SEARCH was installed and managed for the purpose of central data storage and the distribution of the data to the project participants. All of the data sets acquired in module 1, including data from trips, tablet, weather and charging, were stored there in a uniform manner that allowed

straightforward data analysis with additional software tools.

Due to the variety of data sources in format and provisions (loggers from different manufacturers, weather stations, charging stations, tablets), automated processes were developed that harmonize and homogenize the import and transfer into the database.

Participation from imc in the BMU research project not only demonstrates the company's scientific and ecological commitment, but also positions itself as a competent and innovative test and measurement solution provider in the field of electro-mobility.

## Additional information:

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For over 25 years, imc Meßsysteme GmbH has been developing, manufacturing and selling hardware and software solutions worldwide in the field of physical measurement technology. Whether in a vehicle, on a test bench or monitoring plants and machinery – data acquisition with imc systems is considered productive, user-friendly and profitable. So whether needed in research, development, testing or commissioning, imc offers complete turnkey solutions, as well as standardized measurement devices and software products.

imc measurement systems

work in mechanical and mechatronic applications offering up to 100 kHz per channel with most popular sensors for measuring physical quantities, such as pressure, force, speed, vibration, noise, temperature, voltage or current. The spectrum of imc measurement products and services ranges from simple data recording via integrated real-time calculations, to the integration of models and complete automation of test benches.

Founded in 1988 and headquartered in Berlin, imc Meßsysteme GmbH employs around 160 employees who are continuously working hard to further develop the product portfolio. Internationally, imc products are distributed and sold through our 25 partner companies.

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