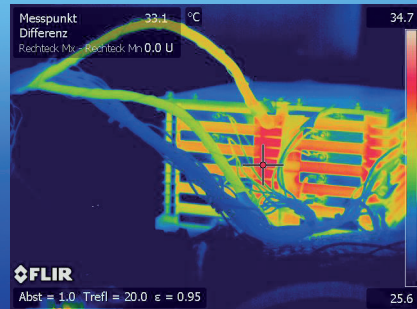


1



2

- 1 Battery module consisting of 12 cells connected in series.
- 2 Analysis of thermally critical areas in a battery module using a thermal imaging camera.
- 4 Decentralized AC-coupled PV battery system.

## PV HOME STORAGE SYSTEMS

In many cases, batteries are suitable for temporarily storing solar energy. Lithium-ion batteries in particular stand out for their high efficiency and long lifespan. However, the initial investment is expensive and the integration into the photovoltaic installation requires additional efforts due to the interfaces. As part of the "urban hybrid energy storage" project, the Fraunhofer Institute for Solar Energy Systems ISE is working on the development of a cost-effective, reliable,

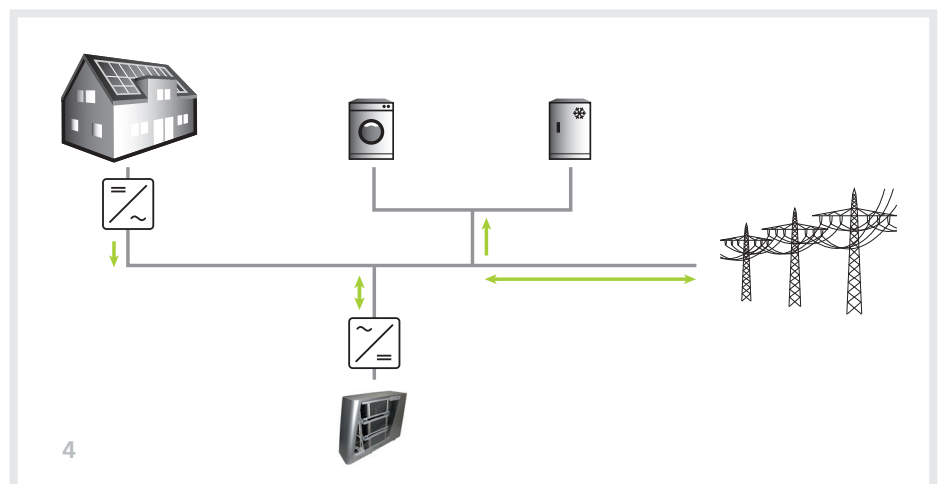
durable and scalable lithium battery system. The institute aims to create a battery system which can be easily integrated into decentralized energy systems by optimizing the module and system design, the battery management as well as the appropriate interfaces. On the system level, an important target is to minimize the efforts related to setting up the battery modules, the monitoring and control electronics as well as the safety installations without loss of function.

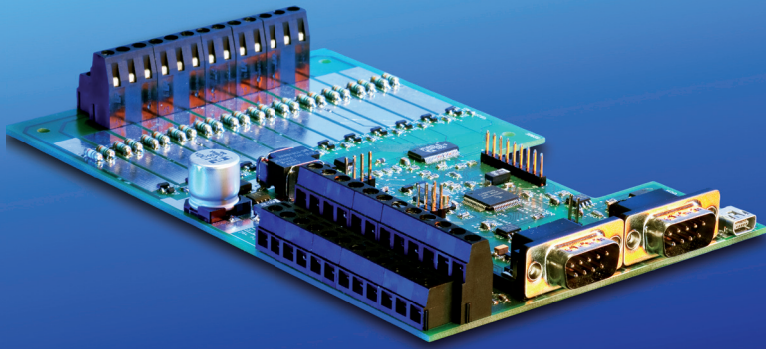
### Fraunhofer Institute for Solar Energy Systems ISE

Heidenhofstr. 2  
79110 Freiburg, Germany

Dr Matthias Vetter  
Phone +49 761 / 4588-5600  
matthias.vetter@ise.fraunhofer.de

[www.ise.fraunhofer.de](http://www.ise.fraunhofer.de)





1

### Battery Systems for Decentralized Building-integrated PV Installations

Integrating battery systems into decentralized PV installations in order to increase the on-site consumption of generated solar power is becoming increasingly attractive for end customers, not least because of rising electricity prices. For this purpose, a lithium-ion battery system was developed as part of the project "urban hybrid energy storage". The system can be connected to 48 volt inverters available on the market. The features are:

- battery size: 5.33 kWh
- number of cells / modules: 36/3
- system capacity: 120 Ah
- rated voltage: 44.4 V
- continuous current / peak current: 100 A / 200 A
- weight: 75 kg
- L x W x H: 790 x 250 x 575 mm
- air cooling system with optimized control
- cycle numbers: more than 2000

### Design and Construction

The lithium-ion battery system is constructed using the latest computerized development and simulation tools. The key features of the battery system are:

- modular set-up
- easy integration into the energy system
- simple to mount and maintain
- compact design
- optimized thermal design using simulation and measurements
- low differences in temperature in the cells and modules

- low transition resistance in the cell contacts
- reduced expenditure for battery management electronics and electronic peripheral components
- highly efficient for a wide range of applications

### Battery Management System

The hardware and software of battery management systems are developed to meet the requirements of each customer and application. Simulation tools and methods are used to ensure that the latest generation of microcontroller-based systems are efficiently improved, implemented and optimized. We work on all development steps from designing the electronic circuit and layout through generating optimized algorithms and control circuits and up to the software implementation. Key features are:

- measures individual cell voltages as well as cell and system temperatures
- integrated high-precision current measurements
- monitors cells, modules and battery pack
- safety management
- precise determination of state-of-charge and state-of-health
- lifespan prognosis
- optimized charging and operating control strategies
- optimized cell balancing
- optimized adaptive control of cooling system
- communication interfaces for external system components, such as inverters and energy management systems



2

### System Integration

System integration plays an important role in lithium-ion battery systems, as in all new battery technologies with integrated battery management. In addition to a safe coupling on the power side, a reliable and quick communication method on the field bus level is required between the battery system and the peripherals, in particular the power electronics. Fraunhofer Institute for Solar Energy Systems ISE supports the integration of components from different manufacturers into battery-linked system technology.

### Solutions For Our Customers

As a competent research and development service provider, we are proud of an extensive performance portfolio on developing and implementing battery system prototypes and products. We work with various power classes to suit each customer's needs and provide all services related to the field of battery systems.

1 *Integrated battery management.*

2 *Lithium-ion battery system.*