

## **Intelligent, integrated energy systems for Smart Cities**

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### **Abstract**

As of 2007, the number of people living in conurbations around the world surpassed that of those living in rural areas. As a consequence of this development, large cities worldwide account for 75% of energy demand and, at the same time, are responsible for a large percentage of carbon dioxide emissions. A number of cities and metropolitan areas have therefore set ambitious goals for increasing the efficiency of their infrastructures to help reduce emissions that impact the environment, while at the same time continuing to provide their growing urban populations with a high quality of life.

A precondition for maintaining a reliable power supply with centralized and distributed production and bidirectional energy flows is the large-scale deployment of information and communications technology to ensure that the necessary intelligence is present in the networks. This applies even more to smart city management, which involves not only the provision of electric power but also the integration and coordination of all other grids such as those for water, wastewater, communications and mobility. Operation of these grids also requires electric power. On the other hand, non-electrical grids and systems often provide energy storage capacities that can be used for holistic energy management. These grids are currently operated and optimized independently of each other.

In the smart city of the future, all grids will be monitored and controlled together within an integrated system with a view to minimizing overall energy requirements and incorporating renewables as efficiently as possible. The special importance placed on cities is justified alone by the fact that buildings consume around 40% of total worldwide energy and are responsible for 21% of greenhouse gas emissions. The opportunities for improving efficiency by using new heating and air conditioning systems, innovative lighting and modern automation technology are equally great however. An important task in this connection will be to actively integrate buildings into the grid as flexible consumers, as producers (e.g. using geothermal energy, heat pumps or solar panels on the roof) and as energy storage facilities. Storage devices for heating and cooling systems can be topped up, for example, whenever surplus solar power is available, and their energy consumption can be throttled as soon as clouds gather in the sky, thus reducing both solar irradiation and cooling demands. Similarly, unused energy from renewable sources can also be employed for driving pumps to fill water reservoirs. Future electric mobility, which integrates the battery storage capacity of vehicles into the power grid, also offers enormous opportunity for smart links – on the one hand by feeding surplus wind energy, for example, into the batteries when the load on the grid is low and, on the other, by using the car batteries to stabilize the grid during times of peak load.