Network Consulting for CO2-Neutral Masdar City

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Building a carbon-neutral city from the ground up that uses 100 percent renewable energy is a major challenge and requires a wide range of engineering expertise. Siemens PTI has developed an innovative network concept for Masdar City.

In this project for the Abu Dhabi Future Energy Company, or “Masdar”, Siemens has developed an innovative concept for the electrical energy supply network – a key component for realizing the vision of Masdar City, an environmentally friendly metropolis that Abu Dhabi will present to the world in 2016 as living proof that life based on renewable energies is possible without sacrificing quality. This new development for 100,000 residents and commuters, constructed on a desert site near Abu Dhabi, will be powered by 100 percent carbon-neutral, renewable energy. The key objectives are sustainability and the integration of advanced energy generation and consumption technologies.

To achieve carbon neutrality on an area of about 3 km by 3 km, renewable energy sources are used for generation of electric power; for example, most buildings are equipped with photovoltaic generation. By increasing efficiency and through load management, all potential means for decreasing consumption will be employed to reduce total peak load from the normal Abu Dhabi standard by the factor of three. To achieve this goal, the latest technologies and equipment will be merged into one system.

In the first step of the project, the preliminary network design was analyzed. Until recently, distribution networks in the United Arab Emirates as well as all over the world were typically designed to distribute electrical power, which is produced by large power plants connected to the transmission systems and then fed into the distribution levels, to the loads on the medium-voltage (MV) and low-voltage (LV) levels. For this structure and operational condition, network concepts and planning standards have been specified and used for years.

In the study it was shown that the conventional network design is not suitable to account for Masdar City’s special characteristics and needs. Masdar called upon the consulting department of Siemens PTI to develop a suitable network concept for Masdar City that would take into account the unique possibilities of the complete system.

The main considerations for developing the optimal network concept for Masdar City were:

- Extensive usage of renewable energy sources
- Power flow in two directions – from the transmission grid into the distribution network or the other way – as the main amount of renewable generation is distributed and connected close to the consumer
- Development of optimal network structure and substation layouts from the high voltage (HV) connection down to the LV network
- Reduction of consumption by increasing efficiency and by influencing consumers’ behavior, e.g. through smart metering and changing tariffs
- Minimization of power losses over the network while ensuring high performance and flexibility criteria, as a key target of the development is sustainability
- Integration of new technologies and equipment, such as provision of an energy management system and Smart Grid and smart metering technologies
- Development of a protection concept using intelligent design and the most up-to-date protection devices and communication technologies to ensure safe and secure operation.
Additionally, the network concept should be highly flexible and allow for changes in load and generation behavior, location and technology during the development of the city to ensure future technologies can easily be connected and integrated into the grid.

Meeting the above described requirements, while complying with high network planning and operation standards, was a challenge. The consultants of PTI were able to meet this challenge by uncovering new paths for distribution network design.

As a result, the aims to create an optimized concept for Masdar City’s electrical network were achieved. The outstanding performance of the network design has been proven with very high reliability, improved voltage profile and short-circuit levels, as well as harmonic distortion well within the given limits and component ratings.

One of the major challenges of this prestigious consulting project was not only creating an optimal structure for the electrical supply network, but also integrating a range of technologies from the Infrastructure & Cities, Energy and Industry sectors within Siemens. Siemens was able to offer a complete solution that included renewable power generation, an intelligent protection system, information and communication technology (ICT), an energy management system and energy automation, demand side management including intelligent household appliances and smart metering, smart building technologies, electrical public transport, water and waste treatment.

The operation of the distribution network will further be improved by integrating several Building Management Systems (BMS) and vertically linking them to an advanced energy Distribution Management System (DMS). By joining a number of buildings and consumer types (residential, commercial and educational) across a “district” BMS, Masdar and Siemens will be able to track and influence energy consumption. By connecting this “district” BMS to the DMS, the ability to implement end-to-end demand response from the utility direct to consumers will be created. In this way, a true Smart Grid is formed.

After presenting an elaborate outline of Siemens’ ideas of proposed network design in October 2009, Masdar City developers adopted the basic ideas of the concept, and in 2010 a strategic framework agreement for cooperation between Masdar and Siemens was signed to provide integrated building automation technologies and jointly develop Smart Grid applications for the initial phase of Masdar City as elementary parts for the city’s infrastructure to realize an efficient and sustainable energy supply. In late October of this year, Siemens broke ground on its regional headquarters in Masdar City, as part of the strategic partnership.

![Figure 1 - Overview of Masdar City](image-url)