



# Growing trend of network-based, smart green buildings towards automatic energy-saving performance: A study based on Advantech's energy-saving system

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**Abstract:** The concept of smart green buildings — buildings based on energy saving and environmental protection, combined with smart living technologies — is catching on globally. These buildings have an average lifespan of several decades and a great deal of energy intensive facilities. Such scientific solutions to energy conservation can have an enormous impact on global carbon reduction. Additionally, there may also be huge market benefits, as most smart green buildings require input from ICTs (information and communication technologies) and construction industries for high-level, cross-sector integration.

**Keywords:** smart green buildings; energy-saving; Standards

The concept of a green building sprung up in 1970s when an oil crisis first struck the world economy. Since then, the concept of energy-saving, environmental design intended for sustainable development has swept the world, where there are currently more than 20 green building assessment systems. In 2005, Taiwan joined the World Green Building Council with more than 2,500 cases of approved green buildings. Furthermore, the developed information technologies and network environment have also realized the idea of smart buildings with sensors, recognition, judgment and control devices.

Today, a smart green building featuring safety, convenience, healthfulness, comfort, and energy saving has become a model of a living environment, into which the ideas of “smart” and “green” are incorporated.

## Definition of a smart green building and its market size

A smart green building generally refers to a construction body that integrates green building design and the applications of intelligent high-tech skills, materials, and products. This makes the building safer, healthier, as well as more convenient, comfortable, energy-saving and environmentally friendly. As such, a green building includes the following factors: 1) A building structure made from green materials; 2) Energy management (advanced metering systems, including intelligent water/electricity/gas meters); 3) Safety monitoring (gas detection, gas shutoff, etc.); 4) Energy-saving home appliances; 5) Automatic control (control components/modules and systems); 6) Air



conditioning; 7) Indoor air quality (monitoring devices for carbon monoxide, carbon dioxide, temperature, humidity, etc.); 8) Water saving system; and 9) Energy-saving lighting (automatic power on/off, infrared control, etc.).

It is the proactive energy-saving system that differentiates a smart green building from its traditional counterpart. Take windows for instance. Conventional green buildings used to have environmentally friendly windows with heat insulation/dissipation functions. Today's green buildings, on the other hand, have integrated sensors and transmission modules. The latter not only can automatically control the opening/shutting of windows according to the sensor-detected temperature, humidity, and levels of wind and rain as indices but also may connect to air conditioners for operation at the optimum energy-saving mode. This requires seamless integration of technical standards among various sensor terminals, fiber devices for bulk data transmission, and cloud computing for data storage.

This wide scope of smart green buildings translates into a huge market in the world. USGBC, an American research firm, estimates that the market size was about US \$25.5 billion in 2010 and may grow to US \$70 billion by the year 2013. Taiwan's related industry has long focused on the development of components and modules of sensors and communication devices, as well as on the supply of subsystems to world-leading brands (e.g. Bosch, GE). Local product value in 2010 was about US \$2.5 billion, accounting for 10% of the global market share, and had reached a compound annual growth rate of 17.7% between the years 2005 to 2010.

## Standards of smart green buildings

As shown in Table 1, many institutions worldwide have set specifications and standards for smart green buildings. Take the ISO 50001, for example, which is a full set of specifications to provide necessary energy management system and procedures. Further, it allows for the understanding of internal energy consumption status, applicable laws and regulations, and energy baseline. Energy performance indicators are defined, and short-, mid-, and long-term improvement goals are set in a bid to achieve better energy performance.

The KNX association also created a set of open standards. The standards can be applied to such fields as

the shutoff control of lighting and security systems, heating, ventilation, air conditioning, surveillance, alarms, water usage control, energy management, measurement, audio devices, etc. KNX has been approved as part of ISO/IEC 14543-3 (global), GB/Z 20965 (China), ANSI/ASHRAE 135 (U.S.) and CEN EN 13321-1 (EU).

The LEED standard created by USGBC (U.S. Green Building Council) is now adopted by each state government of the U.S. as the green building assessment criterion. LEED-certified buildings can be seen now in 120 countries. The standard applies to various devices used for energy saving/air conditioning, lighting, energy monitoring, water recycling, sewage purification, water-saving irrigation and green roofing.

Table 1. Applicable standards and regulations for smart green buildings.

| Standards              | Description  |
|------------------------|--|
| ISO 50001              | Energy management system flow  |
| ANSI/ASHRAE 189.1-2009 | Standard for the Design of High-Performance Green Buildings          |
| ICC 700                | National Green Building Standard                                     |
| LEED                   | Defining the assessment system for "high-efficiency green buildings" |
| KNX                    | Global control standards for buildings and residences                |
| ANSI/GBI 01-2010       | Green Building Assessment Protocol for Commercial Buildings          |

## A case study on Advantech's energy-saving system

The automatic energy-saving system for buildings developed by Advantech, the leading automation equipment supplier in Taiwan, is a network-based platform. Based on Modbus, BACnet, and LonWork smart building communication standards, it features integrated remote access and management systems, open database management, and the use of various Direct Digital Controller (DDC) hardware and HMI/SCADA and WebAccess software products from Advantech.

Seamless integration is essential to meeting consumer requirements. This is why comprehensive integration is required for hardware interface, communication protocol and automation software. Advantech's open structure enables back-end system integrators to connect to sensors and transmitters (e.g. water/electricity meters) at low cost. It can then send collected data to the management center for monitoring. For users, they may connect the management center via browsers for data monitoring.

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With respect to power-saving control, this system combines sensors with automation devices. Data are sent to the monitoring center and connected to the power system. By analyzing the usage frequency and power cost, the control mode can save the most energy possible.

As far as renewable energy is concerned, power used to be transmitted only from the power plant uni-directionally to the residence. Surplus power generated by residential wind or solar generators could not be returned into municipal power grids. Advantech's system features bi-directional transmission. The smart power meter can not only establish the optimum power usage model by collecting and analyzing power consumption data, but can also sell back surplus power to the power plant.

Advantech's energy-saving system has been adopted by plants, office buildings and schools. In Yuan Ze University, the power costs of up to tens of millions dollars in NTD are saved every year just this system was launched. It is also planned to reduce the EUI from 140.6 degree/m<sup>2</sup>.yr in 2007 to 98.2 degree/m<sup>2</sup>.yr by 2015, which accounts for up to 30% of power consumption.

## Taiwan's advantages in developing smart green buildings

1. Competitive ICTs: Taiwan has long been developing intelligent sensor networks and boasts full-fledged sensing, network transmission, and

computing technologies required by various applications. This has made Taiwan competitive in terms of the development of components, modules and platforms. The advantages are widely applied via the system platform to the monitoring of field environment, security and transportation. Therefore, when combined with efforts by construction experts, the existing technology base can provide effective support for constructions, making considerable contribution to the development of smart green buildings.

2. Compliance with international standards: As mentioned earlier, standards are the key to promoting smart green buildings and the bridge to international communities. Taiwan has been among those setting major standards. Take LEED verification standards for example. There have been more than 20 LEED-certified construction projects. Taiwan is also the first to have a KNX training and certification center in Asia.

3. Manifold effects of strategic alliance: Huge overflow effects of the smart green building market is attracting not only construction firms but also many non-construction firms to enter this market. This includes Advantech, Touchlife Technology and its parent company, Chunghwa Telecom (CHT). CHT even invested in the Light Era Development to reach a synergistic effect of the smart green building business based on the strength of the parent company.

