

## Increasing Energy Efficiency in Existing Buildings

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***Abstract:** In the paper are observed the energy loses and energy efficiency of existing buildings. The different types of insulation are described. Some systems for capturing the sun's energy and energy efficient technologies are discussed – solar panels, special light bulbs, air conditioners, radiant heaters etc. Building Management Systems are proposed.*

***Key words:** building, energy saving, efficiency, sustainability, cost-effective*

### **Introduction**

Buildings are one of world's most energy consuming objects and are responsible for more than 40 percent of global energy used and up to one third of the world's

greenhouse gas emissions, according to the United Nations Environment Program. Today, “green” architects and designers try to develop building’s energy efficiency, from retrofitting older buildings to reduce their energy usage to building new ones that create more energy than they require.

Sustainable architecture has come a long way in the last few decades. The challenge is turning old buildings to energy efficient ones by reducing utility and operational costs.

We will take a closer look of the most popular methods for reducing energy consumption and increasing the sustainability of older buildings.

### **Insulation**

Insulation is the most practical and cost effective way to make a house more energy efficient in many ways. Keeping the space cooler in summer and warmer in winter saves 40 percent energy and reduces heating and cooling bills. It also reduces condensation in the surrounding surfaces. This provides health benefits by reducing mold and damp and decrease respiratory problems.

Generally there are two main types of insulation — bulk and reflective:

— Bulk insulation that acts as a barrier to heat flow between the outside and the inside, keeping heat out of the building in summer and in during winter. It can be made from materials like glass wool, polyester, natural wool or recycled paper and comes in batts, rolls and boards. It is more common for countries with cooler climate

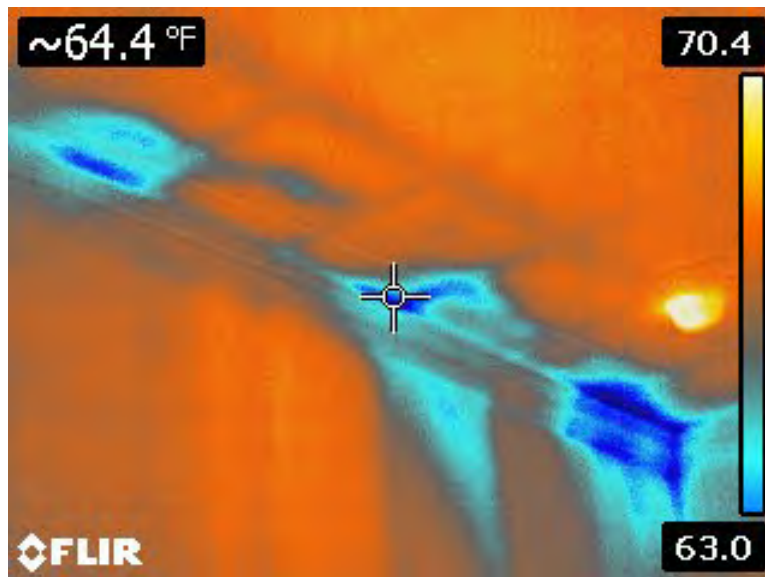
— Reflective insulation is mainly used to keep your home cool in summer by deflecting radiant heat. It is most likely shiny aluminum foil laminated onto paper or plastic. Reflective insulation is more popular for buildings located in hot and very sunny climate zones.

Some insulation products combine features of both bulk and reflective insulation.

The type and quantity of insulation that is best for a building is precisely calculated depending on seasonal climate, architectural design, building materials, orientation and insulation's ability to resist heat flow (prevent heat leaking in or out) described as its 'R-value'.

Incorrect installation, such as compressing or damaging insulation, or leaving gaps between sheets or batts for example, can result in not achieving product’s specified R-value, which leads to thermal-bridges and heat leakage. Insulation products with the same R-value will provide the same level of insulation if installed correctly (Fig.1). [1]

For best performance, the windows and other openings should be completed in energy efficient way as well. Improving the energy efficiency of existing windows with adding storm windows, caulking and using window treatments or coverings.



**Fig. 1.** Thermal leakage in insulation made with FLIR thermal camera

### **Solar panels**

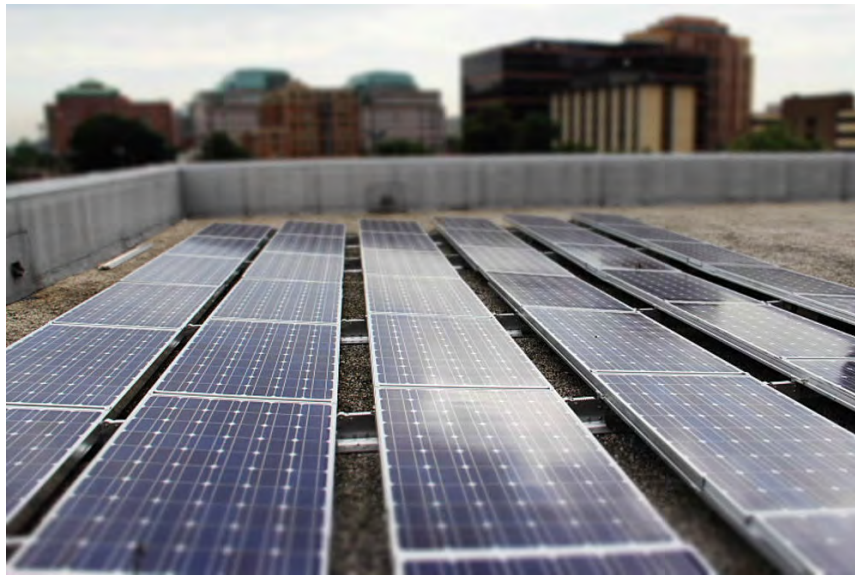
Solar panel electricity systems capture the sun's energy using photovoltaic cells; they are also known as photovoltaic panels (PV). The cells convert the sunlight into electricity, which can be used to run different kind of appliances and lighting. They don't need direct sunlight to work – they can generate some electricity on a cloudy day and are usually mounted on building's rooftop (Fig. 2).

There are lots of benefits of solar electricity but the most important one is the carbon free usage — solar electricity is green renewable energy and doesn't release any harmful carbon dioxide or other pollutants. A typical home solar PV system could save nearly two tones of carbon per year. [2]

The electricity generated by solar panels first supplies on-site needs, with the grid supplying additional electricity as needed. When the building generates more electricity than it consumes, the electricity is fed back into the grid. It is very effective for administrative buildings, big stores and production factories.

The biggest benefit that solar panels provide is that it produces electricity when—and where—the power is most valuable. In many regions, for example, the demand on electricity system peaks is in the afternoon on hot, sunny days, when air conditioning use is high and when rooftop solar is performing strongly. Such systems therefore help utilities meet peak demand without firing up seldom-used power plants that are both expensive and more polluting than most other options.

Photovoltaic systems also reduce strain on electricity distribution and transmission equipment by allowing homes and businesses to first draw power on-site instead of relying completely on the electricity grid. The benefits are twofold: the use of on-site power avoids the inefficiencies of transporting electricity over long distances, and on-site systems potentially allow the utility to postpone expensive upgrades to its infrastructure. [3]



**Fig. 2.** Rooftop solar panels

### **Energy efficient appliances**

#### **— Energy efficient light bulbs**

Traditional incandescent bulbs are no longer manufactured since they use a lot of energy to produce light and 90 percent of the energy is given off as heat.

In 2012 new lighting standards took effect worldwide, and thus a money-saving options such as LED, halogen incandescent and CFL light bulbs appeared. Although they can initially cost more than traditional incandescent bulbs, during their lifetime they save money, because they use less energy.

- Halogen incandescent — have a capsule inside that holds gas around a filament to increase bulb efficiency. They are available in a wide range of shapes and colors, and they can be used with dimmers.
- CFL — Compact fluorescent lamps (CFL) are simply curly versions of the long tube fluorescent lights. They use less electricity than traditional incandescent and usually return the investment in less than nine months. An EnergyStar® — qualified (international standard for energy efficient consumer products originated in the United States) CFL uses about one-fourth the energy and lasts ten times longer than a comparable traditional incandescent bulb that puts out the same amount of light. Fluorescent bulbs contain a small amount of mercury, and they should always be recycled at the end of their lifespan.
- LED — light emitting diodes (LEDs) are a type of solid-state lighting — semiconductors that convert electricity into light. Although once known mainly for indicator and traffic lights, LED's in white light, general illumination applications are one of today's most energy-efficient and rapidly developing technologies. An EnergyStar® — qualified LED's use only 20–25 percent of the energy and last up to 25 times longer than the traditional incandescent bulbs they replace. [4]



**Fig. 3.** (Left to Right) LED, Halogen Incandescent, CFL light bulb

— **Air conditioners**

Undoubtedly one of most common choices for heating and cooling space is air conditioning, although not every air conditioner is energy efficient. Each air conditioner has an energy efficiency rating that lists how many Btu (British thermal unit) per hour are removed for each watt of power it draws. For room air conditioners, this efficiency rating is the Energy Efficiency Ratio, or EER. For central air conditioners, it is the Seasonal Energy Efficiency Ratio, or SEER. These ratings are posted on an Energy Guide Label, which must be conspicuously attached to all new air conditioners. Many air conditioner manufacturers are participants in 5 EnergyStar® labeling program. Labeled appliances mean that they have high EER and SEER ratings. In general, new air conditioners with higher EERs or SEERs are more expensive, but the initial investment returns several times during product's life span and the saved energy contributes for qualifying the building using them as sustainable and “green”. This is especially important if the air-condition is used frequently. [5]

Other important factors to consider when selecting an air conditioner are local climate, room height, shading, window size etc. The reasonable planning before installing an air conditioner will save energy and money. The unit should be well calculated and leveled when installed, so that the inside drainage system and other mechanisms operate efficiently.

— **Radiant heating**

Radiant heating is a technology for heating indoor and outdoor areas gaining popularity in the last decade, although it is observed everyday:

Sun is the most popular radiant heater. Its infrared rays can travel a long distance without losing much energy. When the infrared rays hit a surface, the energy is converted to heat. Warm objects then heat the surrounding air. Even though the sun

is far away it heats the surface of the Earth, while the space in between remains cold.

The modern radiant heaters keep the same principle — the heat is emitted as soon as the rays hit a surface with no losses on the way and the heat is then transmitted to the air. Radiant heaters also give instant heat.

With radiant heating systems, different zones within the same room can have different temperatures. This means energy can be saved and comfort increased. Radiant heaters also provide efficient and economical protection against cold draughts. The radiated heat "naturally" migrates to where it is most needed, which means that cold surfaces such as windows will attract the radiant heating.

Radiant heaters heat without being seen or heard and are easy to be mounted on ceiling or wall. They are especially useful outdoors, and in buildings that are used occasionally such as sport centers, country houses, concert halls etc.

Radiant heaters heat at floor level, not at the ceiling, which is useful for production factories and storages with high ceilings (Fig. 4). [6]



**Fig. 4.** Zone heating with radiant heater

#### — BMS

BMS (Building Management Systems) or BAS (Building Automation Systems) are helping facilities to meet energy saving and lighting control demand. With programed control systems different energy saving goals can be achieved:

- Dimming and Switched Lighting — timed switching lights ON or OFF when needed (day, night, weekends) is one of the easiest ways to reduce overall electricity consumption.
- Occupancy Detection — Numerous styles of occupancy sensors accommodate a broad range of coverage areas and create patterns of usage that controls the lightning, ventilation and heating/cooling. BMS mainly use timers to automate switching of lights and other loads is a simple way to ensure that devices are only on for a set period of time. Sophisticated relay systems provide advanced load scheduling based on scheduled or astronomical time for optimal energy efficiency. Integrated systems provide superior interoperability as well as

essential function for companies participating in load shedding programs.

- Demand Response — Demand response is an energy conservation strategy that involves reducing lighting loads during peak energy usage.[7]

### **Conclusion**

Energy efficiency is one of the most popular topics in modern world. It takes place in all economic directions including civil engineering. Although many innovative techniques for green building are developed, old buildings and architectural city-sights also need modernization and sustainable improvement. Most popular approach is upgrading the construction — insulation of roof and surrounding walls, changing windows. Other important factor for rising energy efficiency is reducing electricity consumption. Building and managing an entire system of photovoltaic batteries and modern, cost effective appliances is the most productive way of forecasting building's energy consumption and saving.

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## **Повышение энергоэффективности в существующих зданиях**

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### *Резюме*

*В статье описываются потери энергии и энергоэффективность существующих зданий. Описаны различные типы изоляции. Обсуждаются некоторые системы для приема солнечной энергии и энергоэффективных технологий - солнечные панели, специальные лампочки, кондиционеры, радиантные нагреватели и т. д. Предлагаются системы управления зданием.*