

Review Article

Study on the Application of Renewable Energy Sources in Natatorium Building

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Abstract: As a kind of sports building, natatorium is very energy-consuming, because it is large in space and critical in physical environment. The heating of recycled water and the need of air conditioning are the major parts of energy consumption. Traditional energy supply required the combined operation of oil burning boiler and cooling unit. The operating costs were very high. As a major technological means for energy saving, renewable energy source is the development trend. If applied in natatorium, it will help reduce the expense on operation and at the same time it will alleviate environmental pollution. Through a discussion of solar energy, geothermal energy, and wind energy, this paper studies the application of renewable energy sources in natatorium and their effects for energy conservation.

Keywords: environment; climate; ecology

INTRODUCTION

Through the application of inexhaustible energies such as solar energy, geothermal energy, and wind energy, natatorium will be less dependent on traditional energy [1]. In the operational process, the energy consumption of water, electricity, heating, and ventilating will be reduced, and to the advantage of the environment, less pollutant will be discharged. Practice has proved that it is effective to apply renewable energy in natatorium to save energy [2].

The Application of Ground Source Heat Pump [3-4]

Ground source heat pump can get heat from ground and increase its temperature to supply heating in winter, and get the heat from indoor space and release it into ground in summer. Through the combination of water source heat pump technology and energy storage technique, the temperature variation of underground water can be utilized to provide cooling or heating for the buildings. Water source heat pump could meet the demand of room heating, air conditioning and water heating. This technology fully utilizes underground water sources, since it helps the storage and complementation of underground water in summer and

winter. Ground source heat pump is a high efficient and energy saving air conditioning system that provides cooling or heating by using the shallow layer geothermal source. With little premium energy (electric energy) input, ground source heat pump transfers low temperature thermal energy into high temperature thermal. This system is the latest technology in the field of energy conservation. In natatorium, the ground energy source heat pump can provide energy for heating, cooling, air conditioning. It will lower the operating cost of the natatorium as well as save energy.

Natorium of Northeast University (Fig 1) has the largest ground source heat pump system. With a covered area of 6775 square meters and height of 20.49 meters, Northeast University takes good advantage of underground source in building this international standard natatorium. The heat system can provide energy for heating, cooling, air conditioning and shower. The ground source heat pump technology contributes to energy saving and environmental protection. The emission of smoke has been reduced, the environment has been improved, and the cost for cooling and heating has also been decreased.



Fig 1 Natatorium of Northeastern University

The Application of Solar Energy Technology

Solar energy, a clean and inexhaustible energy, has been the focus of attention since the beginning of 21st century [5-6]. United States Department of Energy points out that energy consumption of buildings using solar radiation is 47% lower than that of normal new buildings, and 60% lower than that of old buildings. China is rich in solar energy. According to the survey, 2 thirds of our land has more 2000 hours of sunshine duration. In natatorium, solar energy can be used for the heating of swimming water and shower water as well as for the illuminating system. The use of solar energy is very flexible. Solar energy, radiant light and heat from the sun, can be captured and harnessed through technology.

Solar thermal conversion technology

Natatorium can use solar energy to heat swimming water and shower water [7]. Solar technologies can be divided into passive solar and active solar depending on the way they capture and distribute solar energy. Active solar technique requires powered thermal cycle. It includes the use of solar thermal collector to convert solar energy into heat energy. The heat energy can be harnessed to heat water or generate electricity through circulator. At present, a normal active solar heating system includes collector, pipeline, storage device, circulation pump, and radiator. Active solar technology can provide energy for room heating, water heating and air conditioning in the natatorium. But this technology has very strict requirement for equipments. The investment is high. Besides, its working procedure involves energy consumption as well.

Passive solar techniques capture solar energy directly without any mechanical force. In the daytime, the building components with large thermal capacity absorb sunlight for room heating. At night, heat released from natural convection will preserve the temperature of water and air. The techniques of passive solar are comparatively simply, its operating costs are low since it has little dependence on mechanical system. Its technique mainly requires orienting the building to the sun and selecting materials with favorable thermal mass.

Solar energy photoelectric technology

Solar energy photoelectric technology realizes building integrated photovoltaics in its true sense [8]. Photovoltaic power generation system makes use of photovoltaic effect of solar battery's semiconductor materials to convert solar radiation into electric energy. It can either run independently or run grid-connected. Combining buildings and photovoltaic to the grid is low in cost and short in construction period. It requires no energy storage equipment. Generating electricity at site will decrease the loss during power transmission and distribution. Its operation and maintenance are simple. A good integrated design will give the building a better looking. All in all, this technology has many benefits.

Applying photovoltaic power generation equipments in natatorium has certain contradictions and peculiarities. First, roof, east-side wall and south side-wall of natatorium are too large to ensure sufficient lighting surface. Secondly, in the daytime, natatorium mainly serve for training and public entertainment, the demand for lighting and air conditioning are relatively small. Big events are generally take place in the evening. Electricity used during night cannot be generated directly from solar energy system, additional grid or electric power storage is necessary. It thus loses its advantage of independent of storage and transmission equipments. Therefore, we can apply solar energy photoelectric technology in the landscape design of natatorium. National natatorium center (Water Cube), established photovoltaic panels on the roofs and walls. It uses grid-connected system of photovoltaic power generation to provide electricity. Jinan Olympic Center Natatorium combines solar energy photoelectric design in its landscape design. Street lamps, landscape lighting, garden lamps, and lawn lamps are all powered by electricity generated from photovoltaic technology. It is safe, environmental friendly and economical.

The Application of Wind Energy

Like solar energy and geothermal energy, wind energy is renewable and inexhaustible [9]. Monsoon is common in China, for example, dry monsoon lasts as long as 6 months in North China, and 7 months in Northeast China. As is measured by State Meteorological Administration, annual gross reserves of

wind resources in China are 1.6 billion kilowatt. Therefore, in windy areas, wind power generation is preferable.

One major way of wind power utilization is to convert wind energy into electricity energy. The equipments of wind power generation harness wind to generate power, and then through power supply loop, combined electric control gear, electric heating power supply loop, they supply power to electric heater. The surplus of generated energy can supply power through circuits to the outside. When generated energy is insufficient, it can be supplemented by auxiliary supply circuit.

Whether the utilization of wind energy is stable depends on the local situation of wind resources as well as on the construction scale of grid-connected power plant. Take Inner Mongolia as an example, this place is vast in territory and rich in wind energy resources. Statistics show that the gross reserves of wind energy in Inner Mongolia are 1.01 kilowatts, of which 0.1 kilowatts can be harnessed directly. It is stable and consistent. Its annual effective wind energy density is 400 – 3600kwh/km², annual effective wind energy watt density is 100 -400w/m², annual available duration is 4000-7800hours, annual stability rate of average wind velocity is 86% - 94%. These data proves its potential in the utilization of wind energy. Therefore, natatorium established in this region can take advantage of its rich wind energy to supply power. This will bring both economic benefit and environmental benefit.

CONCLUSION

Renewable energy is clean, green and environmental-friendly. Promoting renewable energy in buildings will contribute to sustainable development as well as to environmental protection, especially for large-scale buildings like natatorium. Natatorium is large in space, and complicated in indoor thermal environment. Its air conditioning requires large amount of energy and high costs of operation. If we can promote the development of renewable energy and related technology, we will enjoy both economic benefits and environmental benefits in the future.

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