Role of Advanced Building Façade System Considering Sustanaibility & Renewabale energy Practices: Analyzing the need of sustainibility with Technology

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***Abstract*— The External building facade plays an essential role in saving or consuming energy, depending on the type of the covering and design. Architects and engineers have to study many concerns when working with facade designs, including ecofriendly issues, aesthetic presence, and inhabitant luxury, and view; these aspects make the façade a sustainable component. The purpose of this paper is to review the current practice and development of the sustainable features for façade system and to explore its role in the improvement of energy performance in buildings thru renewable energy techniques. Another important factor is the rising global stress to reduce carbon footprint and concerns for creating sustainable environments, where an effort are being construct innovative solutions and emerging trends in tall building designs for environmental sustainability. This paper discusses environmental sustainability in various buildings with special reference to the application of renewable energy technologies. This article presents an innovative façade system designed to increase the thermal comfort inside building. Renewable energy and considering sustainable aspects might reduce the load of various mechanical energy sources.**

***Keywords*—Sustainability; Renewable energy; Innovative façade system; Environment; Technology.**

I. Introduction

In accordance with building standards, massive changes in the field of energy-efficient buildings have occurred in the last ten years. The goal of such changes is to develop plus energy buildings (residential and non-residential) and the vision behind them is to build plus-energy districts and cities. Their primary focus is the energy efficiency of buildings.

For the renovation of existing building a net-zero energy balance is not mandatory. But the reduction of annual primary energy balance is the target. In order to achieve this goal, we have to do two things:

- Increase the efficiency, especially in case of energy buildings.
- Cover the remaining energy demand with renewable sources.

In case of single family houses and large single or double story factory buildings with flat roof and all sided façade, it might be sufficient to use only the roof of the building for renewable energy conservation. But for many others building especially with small roof it will be necessary to also the façade for energy conservation in addition to roof in order to achieve a net zero energy balance. This is specially the case of high rise buildings. It is agreed that the primary energy demand for heating, ventilation, cooling and lighting has to be considered in the energy balance.

In the 21st century, the major problem is the availability of Mechanical energy resources which cause is the limited existence of man-made energy which ultimately enhanced the problem of running of high running cost and might have slow down the energy conservation possibilities for high rise buildings. In this crucial time of energy demand and to use of resources at optimum level, we have to move toward the renewable source of energy. But recently there has now been a paradigm shift with a new generation of high rise buildings that have been designed with reference to sustainable architecture especially towards renewable sources of energy. Therefore, the onus has now shifted to the built environment to ensure that new structures reduce energy consumption and increase efficiency through the use of renewable energy sources, innovative and green construction materials and technologies, recycling and waste management systems etc.

II. RESEARCH METHODOLOGY

In this paper qualitative method is used. A qualitative analysis of environmental sustainability in buildings with special reference to the application of renewable energy & advanced façade technologies. Further the paper also validates the application of renewable energy technologies by one detailed case study namely BIQ House at International Building Exhibition (IBA) in Hamburg.

III. NEED OF BUILDING FAÇADE AS SUSTAINABLE COMPONENT

The architecture in present scenario is transformable, dynamic, including environmental considerations, human comfort, social environment, and sense of space. Any technological advancement is considerable for moderating response to changes between human needs and environmental conditions. Building should be more designed and flexible and should be oriented toward a high efficient building, because the building will be more flexible to adapt its envelop for the external weather, which mainly considered in a sun glare and a direct heat gain. The façade is the most important protection structure from the harsh weather, in the outer environment, thus the advanced of this system will help to adopt to integrate of photovoltaic cells, to generate energy rather than just save energy. The sustainability and renewable sources will help to utilize the optimum sources of energy in designing any building where high rise buildings provide very high potential with very large surface area that could be utilized to harness solar rays for heating, lighting, buoyancy cooling/ventilation and electricity generation.

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IV. VARIOUS TYPE OF BUILDING FAÇADE SYSTEMS BASED ON SUSTAINABLE COMPONENT/RENEWABLE ENERGY TECHNOLOGIES

A. Glazing Integrated solar thermal façade collector

A new transparent solar thermal façade collector based on low cost window technology. This new façade component will at the same time allow visual contact to the exterior, provide solar and glare control and it will generate heat. In summer the collector will be used as a heat source for solar cooling system. The approach is to integrate apertus with angular selective transmittance into the absorber of aa solar thermal collector which is integrated in the transparent part of the facade. These apertus will selectively shield the direct irradiation of the sun (coming from directions with higher solar altitude angles) while retaining visibility through the window horizontally or downwards as shown in virtual image (Figure1)

Fig.1- Glazing Integrated solar thermal façade collector

Fig.2- Façade collector with air-heating vacuum tubes

B. Façade collector with air-heating vacuum tubes

A new solar thermal façade collector with air-heating vacuum tubes. The heated air will be used in combination with solar heating and cooling systems. Since the concept is based on air instead of water, no damage due to leakage, no stagnation problems and no frost problems have to be handled, which offers the possibility of reliable, efficient and cost-effective solutions. figure 2 shows a picture of an air-heating vacuum tube collector.

C. *Building integrated PV-component with improved glare protection, solar control and electrical efficiency*

A new transparent building integrated PV (BIPV) component. It will simultaneously provide solar control, glare protection and electricity and it will allow visual contact to the exterior. It is possible to see outwards horizontally and downwards through the new angle-selective PV configurations while direct irradiation by the sun is blocked. It will be possible to reach very low total solar energy transmittances (g < 0.10). A visual mock-up (without PV-functionality) is shown in figure 3.

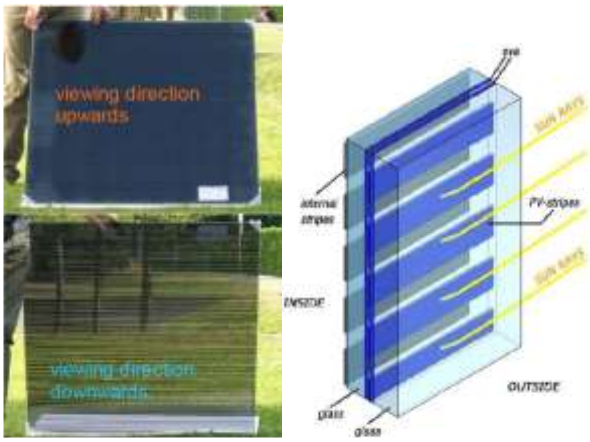

Fig.3- *Building integrated PV-component*

D. *SolarLeaf – bioreactor façade*

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Fig.4- *SolarLeaf – bioreactor façade*

V. CASE STUDY – BIQ HOUSE AT INTERNATIONAL BUILDING EXHIBITION (IBA) IN HAMBURG IN 2013

a) Location - Hamburg, IBA Wilhelmsburg
b) Country/Region - Germany
c) Client - Federal Ministry of Transport, Building and Urban Development, Germany

Overview

The world´s first bio-reactive façade generates renewable energy from algal biomass and solar thermal heat. The integrated system, which is suitable for both new and existing buildings, was developed collaboratively by Strategic Science Consult of Germany (SSC), Colt International and Arup

The biomass and heat generated by the façade are transported by a closed loop system to the building's energy management Centre, where the biomass is harvested through floatation and the heat by a heat exchanger. Because the system is fully integrated with the building services, the excess heat from the photobioreactors (PBRs) can be used to help supply hot water or heat the building, or stored for later use

Multple Benefits

The advantage of biomass is that it can be used flexibly for power and heat generation, and it can be stored with virtually no energy loss. Moreover, cultivating microalgae in flat panel PBRs requires no additional land-use and isn't unduly affected by weather conditions. In addition, the carbon required to feed the algae can be taken from any nearby combustion process (such as a boiler in a nearby building. This implements a short carbon cycle and prevents carbon emissions entering the atmosphere and contributing to climate change. Because microalgae absorb daylight, bioreactors can also be used as dynamic shading devices.

The cell density inside the bioreactors depends on available light and the harvesting regime. When there is more daylight available, more algae grows – providing more shading for the building Solar Leaf façade was installed for the first time on the BIQ house at the IBA in Hamburg in 2013. In total, 129 bioreactors measuring 2.5m x 0.7m have been installed on the south-west and south-east faces of the four-storey residential building to form a secondary façade. Solar Leaf provides around one third of the total heat demand of the 15 residential units in the BIQ house.

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Fig.5- *Case Study BIQ House - Views*

How SolarLeaf Works

The flat photobioreactors are highly efficient for algal growth and need minimal maintenance.

SolarLeaf's bioreactors have four glass layers. The two inner panes have a 24-litre capacity cavity for circulating the growing medium. Either side of these panes, insulating argon-filled cavities help to minimise heat loss. The front glass panel consists of white antireflective glass, while the glass on the back can integrate decorative glass treatments.

Compressed air is introduced to the bottom of each bioreactor at intervals. The gas emerges as large air bubbles and generates an upstream water flow and turbulence to stimulate the algae to take in CO2 and light. At the same time, a mixture of water, air and small plastic scrubbers washes the inner surfaces of the panels. SolarLeaf integrates all servicing pipes for the inflow and outflow of the culture medium and the air into the frames of its elements

Fig.5- *Detail View of SolarLeaf façade at BIQ House, Germany*

VI - CONCLUSION

In the future building concepts will become more important which not only show a significantly reduced energy consumption but which include the production of energy using locally available renewable energy resources, mainly solar energy. A true integration of systems which convert solar radiation into useful energy – electricity, heat or cold into the building envelope are needed for this purpose. Different appropriate solutions are required for existing houses and for new buildings. First examples are entering the market. However, there is still a large potential for new solutions and both, enhanced performance and cost reduction is necessary in order to allow for a broad market deployment.

This paper focuses on the environmental performance of kinetic façades in buildings by reviewing current practices. The process involved an investigation of literature studies that conducted research to evaluate the performance of kinetic façade systems from numerous perspectives. The kinetic façade proves to be an effective approach to designing a building envelope, as shown by figures of reduced energy consumption, making the kinetic façade an optimal method to address harsh climates, particularly in the case of sun shading, and to provide convenient natural lighting and fresh air.

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REFERENCES

[1] Active Solar Facades (PV and solar thermal).*Tilmann E. Kuhn, Sebastian Herkel and Hans-Martin Henning, Fraunhofer*, Institute for Solar Energy Systems ISE, Freiburg, Germany

[2] Kensek K, Hansanuwat R (2011) Environment Control Systems for Sustainable Design: A Methodology for Testing, Simulating and Comparing Kinetic Façade Systems. Journal of Creative Sustainable Architecture and Built Environment 1: 27-46.

[3] Moloney J (2011) Designing Kinetics for Architectural Facades: State Change. Routledge, Abingdon, New York, USA.

[4] Charles Linn (2013) Kinetic Architecture, Design for Active Envelopes –Images Publishing Group, Mulgrave, Australia.

[5] Climate Change, Online available from http://ases.org/ climatechange/climate_change.pdf

[6] Liberali R, Renewable Energy Technologies: Long Term Research in the 6th Framework Programme 2002 - 2006, Online available fromhttp://ftp.cordis.europa.eu/pub/fp7/energy/docs/synopses_res_en.pdf

[7] http://www.arup.com/Projects/SolarLeaf.aspx

