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Integrating Wind Energy as form of Eco-Energy in Building Design

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Abstract—*India's ambitious renewable energy programme targets on all renewable sources of eco-Energy including wind, solar, hydro and biomass to achieve its target of 175 GW of installed capacity by 2022. Enhancing energy efficiency is main concern to reduce emission intensity. Wind energy is clean energy which is not yet augmented in North East India. Increasing awareness towards climate change will have impact on burning fossil fuel – drive for eco-friendly and affordable product.*

Inclusion of eco- energy in building design demands special focus that is contemplated in spatial designs. Revamping of energy efficiency of power active building, rely on a form, overall composition. Endeavour of designers and urban planners are inclined towards collaborative ideas of use of alternative energy sources, function of the building and art of creation of a perfect architectural form, to receive compatible objective and function. Analysis is diverted towards on a option of shape and architectural designs, which will promote enhance amount of the transformed energy. As there is a dearth of conventional energy, planners are looking for sustainable development in the field of energy consumption. And there are ample scope of conceiving energy-efficient structures. Integrating small wind turbine on terrace, building edges and punctures that turns energy production into an art form and aesthetics. Architectural feature remains prominent in Assam, but there is general awareness of cross ventilation and passive cooling in slopping roofs. With innumerable studies conducted on the performances of wind energy in this region often adopting a low carbon growth path that passive air movement inside buildings improve air quality and reduces inside temperatures.

Progressive inclusion of wind energy in structures and energy-efficient technologies will enhance linked social and lucrative benefits too. The study is focussed on the integration of wind energy into architectural design through implementation and presents few successful case studies.

Keywords*: Renewable energy, Architectural Design, Energy-efficient technologies, Vertical axis wind turbines, Silent wind tree.*

1. Introduction

Clean energy recovered from the force of wind is called wind energy. The energy possessed by wind is due to its high speed. India is the 4th largest producer of wind energy in the world. In India wind speed lies between 5km/hr to 20 km/hr. Wind speed in Guwahati lies between 2.5 km/hr to 9 km/hr. The low velocity and seasonal winds can be augmented for clean wind energy

There are lots of social and economical challenges with conventional energy. India is one of the largest consumer of energy. There has been a extensive search during last three decades for non conventional energy that would ensure energy security and eco-friendly sustainable development. The world is focussing towards sustainable

development in the field of energy sector. Our challenge is to harness the lower wind speeds in Guwahati region and other parts of North East India.

The aim of the study is to develop new knowledge, integrated solutions, and technologies of small wind turbines in architectural design. The study will help in analysing possibilities for use of small wind turbines and starts with a review of wind turbine technology projects where small wind turbines can be integrated into the building design. Available secondary data was reviewed with respect to building design, technologies applied and other significant experiences. Further the project should develop more knowledge of the acceptance of integrated solutions of wind turbine technology or otherwise use of wind as alternative source of energy to cool and ventilate our houses. Principle of wind catchers, stack effect and cross ventilations can be incorporated in modern building designs without addition of any mechanical devices. It should review the barriers and potential for such wind turbine technology. Where needed, additional investigations were to be carried out in order to establish a thorough understanding of the performance and challenges to be faced.

2. Overview

There is potential for small wind turbines in residential, commercial, landscaping and urban environments in Guwahati. The so-called distributed wind applications are projected for growth in response to continuing energy crisis and increased demand for alternative source. However, in order wind energy to reach its mainstream market potential, we must overcome several hurdles, primarily in system costs, quality of design, grid interconnection, and installation restrictions. As well as the installation of wind turbines around and on buildings, there is also interest in building integrated wind turbines where the where the turbine is part of the building structure or façade. The design of the building in this case are augmented in order to get the optimum out of the wind power from low velocity seasonal wind. For these applications, acceptance of building owners and neighbours is required prior to installation. Moreover eco friendly designs have been around North East India for longer than the public debut of our modern environmental crisis. Since the early British period, the people of this region has been using houses which are cross ventilated and had stack ventilation effect. Attention of architects and designers is to revive this principle and apply in modern buildings which can become successful example of the adoption of early energy saving technologies.

3. Aim of the study

The overall objective of the study is to adopt new ideas, integrated solutions and sustainable solution of small/micro wind turbines and productive building designs for reduction of environmental impacts. More significantly, this should accomplish:

- Developing sustainable designs augmented for Maximum wind movement in buildings.
- Substantiate an overview of current best practice of building accelerated micro/small wind turbines.
- Upgrading perception of social acceptance of building augmented micro/small wind turbines.
- Upgrading perception of threshold and probable of building augmented micro/small wind turbines.

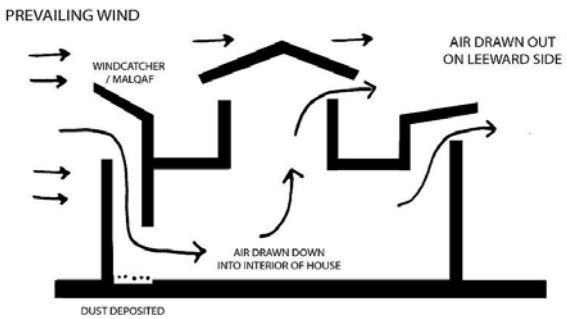
4. Methodology

A organized study is carried out on secondary data. The secondary data is reviewed from published case studies, journals, newspapers and internet. For studying and reviewing notable number of documents are selected.

5. Architecture can grab Wind Energy

Energy efficient buildings were there in Iran in the early 19th century. Persians used wind as an renewable energy source for cooling their houses during mid summers. A '*Badgir*' (the windcatcher) is a primitive Iranian architectural feature used in couple cities in Iran. In arid land, the temperature fluctuate tremendously, with Badgir becoming essential for maintaining homes at a constant comfortable temperature. Windcatchers in Iran are normally multi-directional with punctures at the top to

Badgir found in Iran



Function of typical Badgir

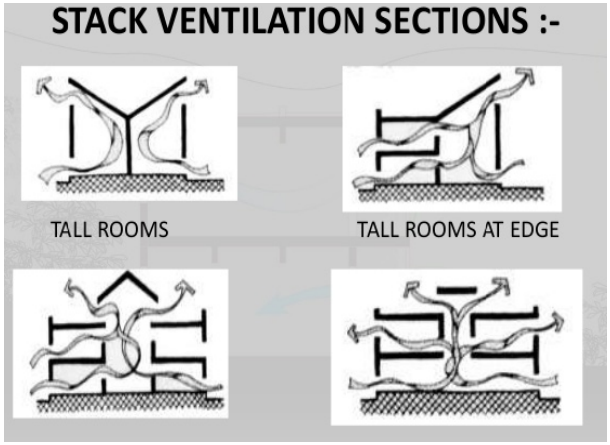
Fig. 1: Wind catcher grab the breeze from all direction (Fig. 1) .

Windcatchers have various functions, but one of the most common includes combination of a tall-copped tower with a basement tunnel to store the wind power in addition to being a cooling system.

Besides their unique architecture, they act as an innovative energy-efficient system for regulating the temperature of water storage tanks. This architectural element remains vogue among eastern cultures, but there is also an increasing awareness of the application of passive cooling and natural ventilation in few countries, with numerous studies conducted on the performances of windcatchers, often finding that passive air movement inside buildings enhance air quality. And creating new designs and details for grabbing wind can show that reinterpretation of the principles of the Iranian windcatcher can turn ancient method into a purposeful method for making modern buildings more sustainable.

6. Integrating Architectural Strategies

6.1 Stack ventilation and Cross ventilation



Cross ventilation in plan

Fig. 2a: Spatial arrangement for stack Ventilation (section)

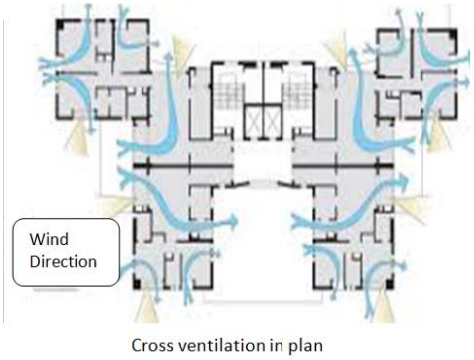
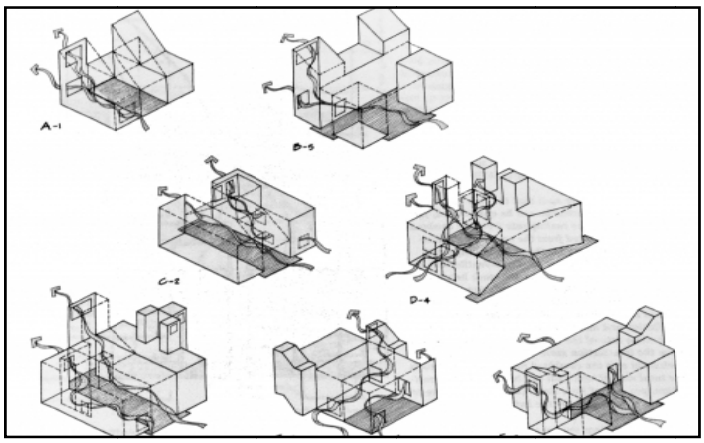


Fig. 2b : Spatial arrangement for Cross Ventilation (plan)

Applying theory of windcatchers we can perceive combination of cross ventilation and stack effect in architectural and interior designs and enhance air quality in building block.

Combination of Horizontal pathways and Vertical axis pathways



Arrangements of space to facilitate both cross and stack ventilation

Fig. 3 Spatial arrangement for for cross and stack ventillation

Elevation treatment for walls

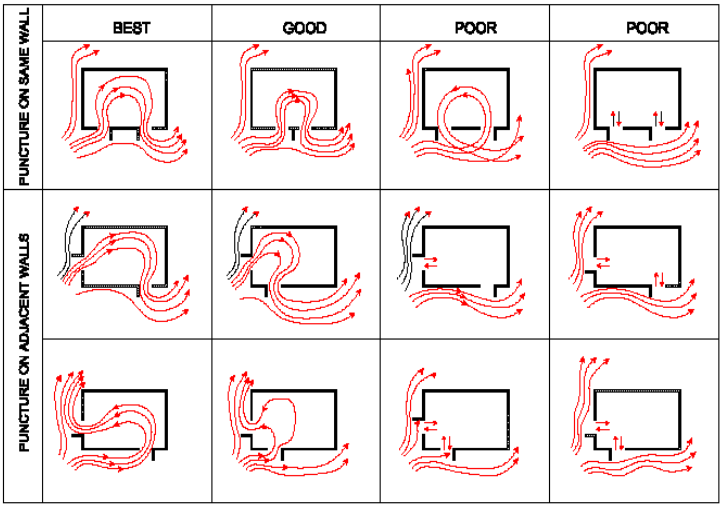
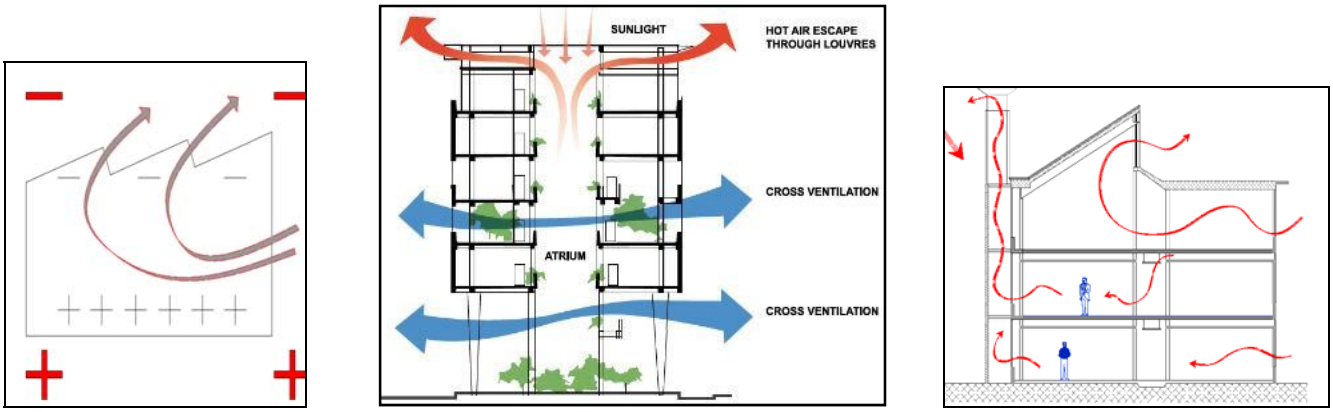


Fig. 4 Positioning vertical Fin walls for better s effectiveness air circulation, on same side and adjacent sid



a) Less pressure at greater heights b) Stack effect in high rise building c) Stack effect hot air arises & can passively pull air from a bldg. (using glazing on top of the structure.) the low pressure sucks fresh air in

Fig. 5 Stack and cross ventilation

By penetrating solar radiation into the space (by applying equator facing glazing), that can warm up the interior surface areas and increase the temperature inside , which will speed up stack ventilation between the above and bottom openings in tall building (**Fig. 5)**

6.2 Site planning for wind energy utilization

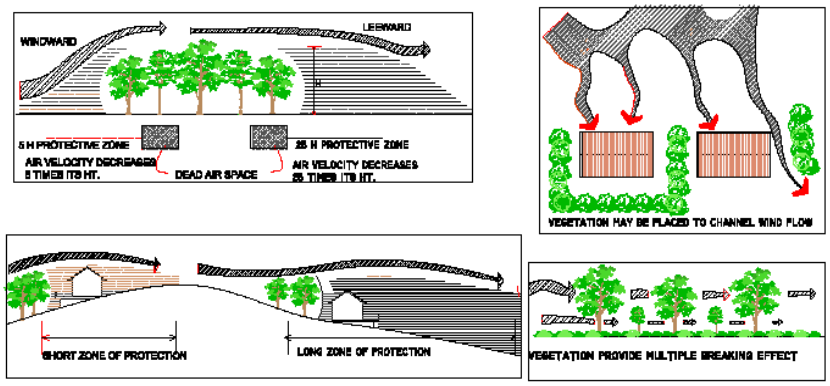


Fig. 5 Site selection and planning for channelling wind energy.

6.3 Site suggestion for enhancing wind power

Areas suitable for wind turbine are coastal areas, hill tops, valleys and plains where wind is reliable.

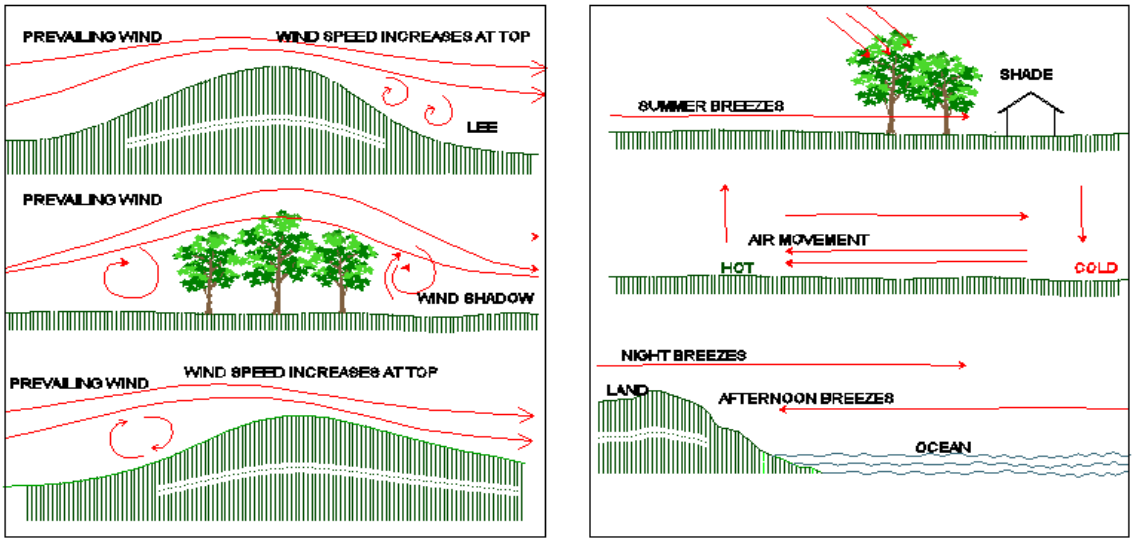
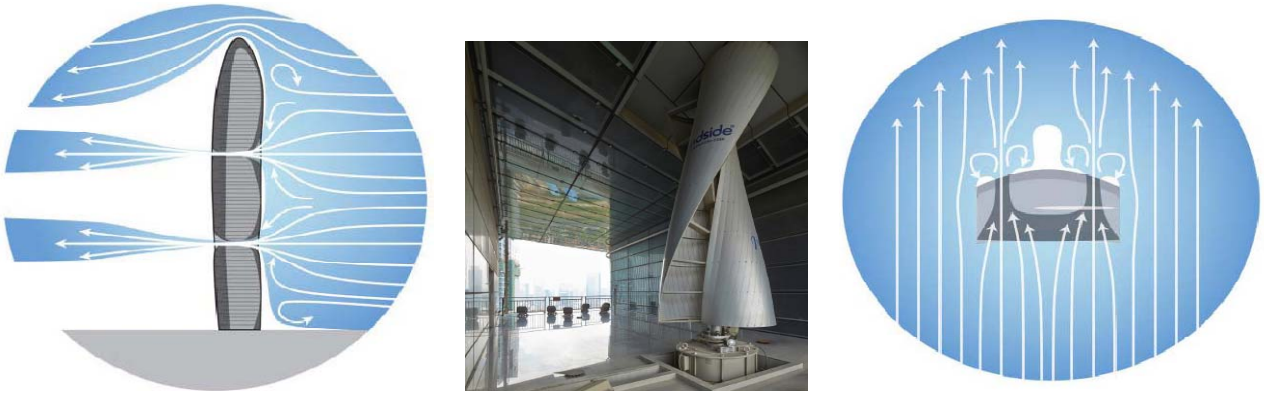


Fig. 6: Position buildings on the windward side to capture prevailing wind

7. Built Environment and Wind Energy

System

Architectural element that affects wind turbine in some cases, building geometry can improve turbine performance. The wind profiles can be influenced by designers and planners by taking building design in to account and specifically focusing on the parameters axis height, surrounding topography and wind channelling (Fig. 7). Wind turbine can take advantages of increased velocities at building parapet where wind rises up the facia of tall buildings and curls up over the edge. It is possible to design buildings to suck wind into structures and placing towers to funnel wind into towers. Micro vertical axis wind turbines can be used in built environment, in order to augment the wind energy from frequently changing wind directions.

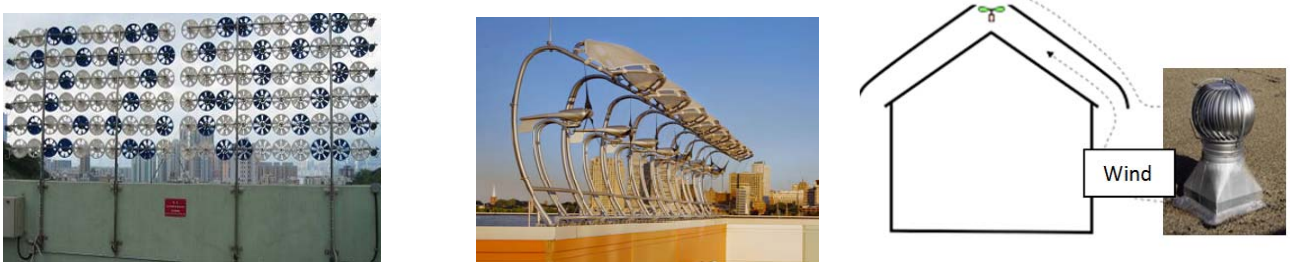


Elevation **Building augmented wind turbine (vertical axis)** **Plan**

Fig. 7: Wind Channelling effect of the Tobacco tower in Guangzho

Architectural design can make smart use of passive as well as active technologies for augmenting natural wind energy flows. Wind turbine take advantages of increased velocities at building parapet where wind rises up the facia of tall buildings and curls up over the edge. It is possible to design buildings to suck wind into structures and placing towers to funnel wind into towers. Micro wind turbines can be used in built environment, in order to augment the wind energy from frequently changing wind directions.

Architectural design can make smart use of passive as well as active technologies for augmenting natural wind energy flows. There's a wonderful synergy in the idea of combining form and function by generating electricity with turbines.



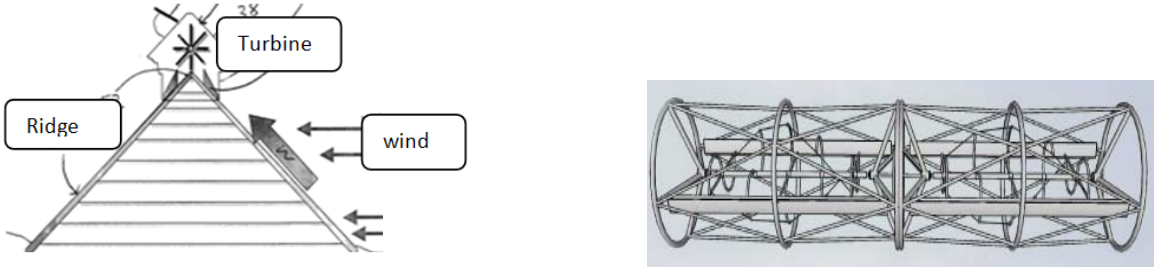
(E) **(F)** **(G)**

Fig. 8 Wind turbine as compliment to architecture (E) & (F) Micro wind turbine can be installed on parapet as attractive compliment to building elevation treatment. (G) Small turbine ventilator on roof can operate. Throughout without consuming electricity.

Building augmented wind turbine (horizontal axis) **Building augmented wind turbine (vertical axis)**

Fig. 9 Horizontal axis and vertical axis turbine

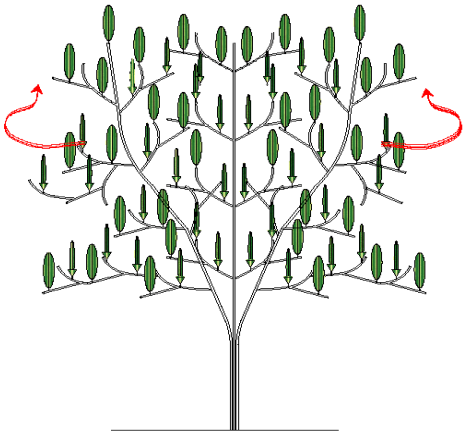
Inclined roof can amalgamate wind turbines into the fabric of a building that can supply to energy consumption and set a new level for sustainable face refurbishment and deliver a highly distinguished commitment to regional sustainable design **(**Fig. 10**)**. It comprises a multiple-bladed wind turbine device enclosed within a low structure to make it visually appealing. The system can be retrofitted to an existing sloping roof.



Enclosed Wind turbine retrofitted to an existing slope **Multiple-bladed Wind Turbine for slopes**

Fig. 10 Retrofitted solution

Wind turbine can be integrated in design which mingles art and science and improves the facia of the building. Retrofitting of wind turbine into existing structures are also possible for improving aesthetic of the building form and chamfering the edges of the building (Fig. 11 **)**. And this improves visual fantasy the area and they catch breezes coming from any direction, and at a variety of speeds. The architecture is shaped by the forces of wind. We can design a structure that allows the wind forces to drive vertical axis turbines incorporated into the building fabric. And besides the micro turbine in the shape of trees can be incorporated in landscaping, shopping malls etc.



Slient Wind Tree

Greenway Garage, Chicago

Vertical turbine superimposed in building facia

Fig. 11 Visually appealing wind turbines

The Wind tree uses tiny blades that are housed in the leaf units. The blades turn inwards, which These silent wind trees (Fig. 11) can be planted in road dividers and road island where these trees can catch wind speed from high speed vehicles. The blades turns inwards,which enables the units to turn in the wind, regardless of wind direction. Since they look like sculptures, the trees could be used as street art that also powers the landscaped area.

8. Conclusions and Recommendations:

"The time is passing out … soon, everything will exhaust and hardly anything left to burn on this globe but planet itself….."

Considering existing energy scenario, we are on pinnacle of using our fossil fuels and our conventional resources are on tip of their use and day will arise ultimately they will be vanish from this universe. So need to review new techniques in building designs and harness low wind speeds that will ensure energy security and eco- friendly sustainable development.

The harnessing wind resource inside urban agglomeration is a relatively new idea. Nevertheless, siting wind energy conversion systems on top of roofs or incorporating them inside the buildings allows designers to take benefit of the local increment of the wind speed and carbon positive. On the other hand, the motivations for integrating renewable energy sources with buildings are not only driven by environmental issues: architecture has always reflected society's craze and one of those craze nowadays certainly concerns the need to use renewable energy for all our tomorrow.

A building integrated with wind turbine are incorporated from constructional point of view, architectural point of view along with energy point of view. Finding is that there is demand for efficient and economical micro wind turbine that requires further initiative and compilation of regional wind data in North East India. Quantitative study shows that aesthetics sense are prime motivator and wind turbines aesthetically pleasing to eyes. Therefore aesthetic component should be especially focused for development of wind energy in built environment and not an eyesore.

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