

W I N D

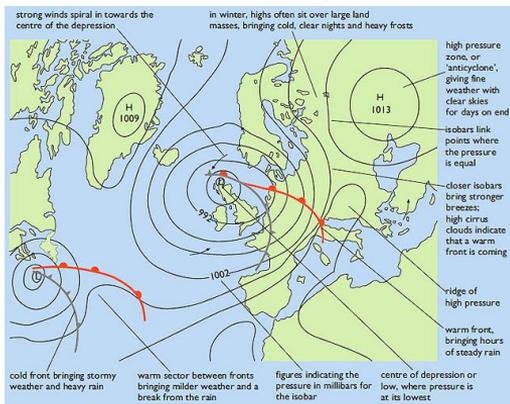


The power in the wind passing through a wind turbine rotor is proportional to the density of the air, the area of the rotor and the cube of the wind velocity.

$$\text{kinetic energy} = \frac{\text{kilograms} \times \text{metres per second (ms}^{-1}\text{)}^2}{2} = 0.5mV^2$$

The density of air is lower at higher elevations such as mountains, and average densities in cold climates may be significantly higher than in hot regions. Wind velocity has a very strong influence on power output because of the 'cube law'. For example, a wind velocity increase from 6 metres per second (6 ms<sup>-1</sup>) to 8 ms<sup>-1</sup> will more than double the power in the wind. But the power in the wind is not in practice the power that can be extracted by a wind turbine, because of losses in the energy extraction/conversion process.

## Wind energy has been used for thousands of years for milling grain, pumping water and other mechanical power applications.



In this Presentation we look at modern wind technology, at the environmental impact of turbines, and the economics and future potential of wind technology.

**On the positive side, the generation of electricity by wind turbines does not involve:**

- **the release of carbon dioxide**
- **pollutants that cause acid rain or smog**
- **Radioactivity**
- **contamination of land, sea or water courses**
- **the consumption of water – unlike many conventional (and some renewable) energy sources.**
- Large-scale implementation of wind energy would probably be one of the most economic and rapid means of reducing carbon dioxide emissions. Over its working lifetime, a wind turbine can generate approximately 40 to 80 times the energy required to produce it (Everett et al., 2012).



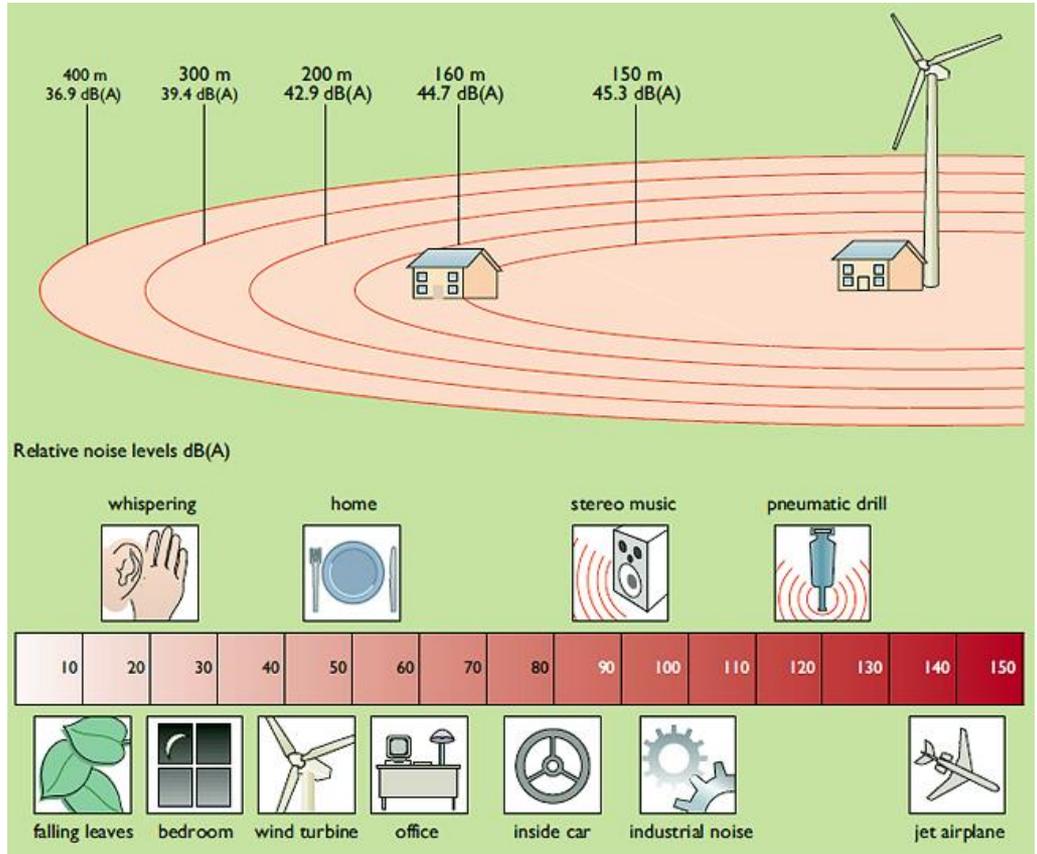
**There are concerns over some possible negative impacts of wind power.**

Wind turbines are often described as noisy, but they are not especially noisy compared with other machines of similar power rating.

Noise can be reduced significantly by using acoustic enclosures for the machinery and also using slower rotational speeds to reduce aerodynamic noise.

**Electromagnetic interference** can sometimes occur if turbines are positioned between some types of radio transmitter, due to reflection of some of the waves. The extent of this depends mainly on the turbine blade construction material and surface shape.

**Aviation** bodies have expressed concern about the interference with military radar from turbines situated in certain low flying areas. Turbine blades are now being adapted to include radar absorbing materials.



**Wildlife** – Wind farms have a significant impact on birds.

Wind farms tend to be placed in upland areas with strong wind currents that have a lot of potential to generate energy. Birds use these currents as highways – and so are likely to come into contact with the turbines.

It's not just the turbine blades that pose a risk to birds; research indicates that wind developments can disrupt migration routes.

In the case of offshore wind, there are concerns about the possible impact on fish, crustaceans, marine mammals, marine birds and migratory birds. These are the subject of ongoing research.



**1. Horizontal axis wind turbines (HAWTs)**, examples of which are shown in the figure on the right. They can be multi-bladed like those which have been used since the nineteenth century for water pumping on farms. Modern HAWTs usually have two or three blades and work at much higher rotational speeds, making them attractive for electricity generation. They range in size from very small machines producing a few tens of watts to very large turbines producing 7.5 MW or more.

**2. Vertical axis wind turbines (VAWTs)** can harness winds from any direction without having to reposition the rotor. But they have found little commercial success, in part due to issues with power quality, cyclic loads on the tower systems and the lower efficiency of some VAWT designs.



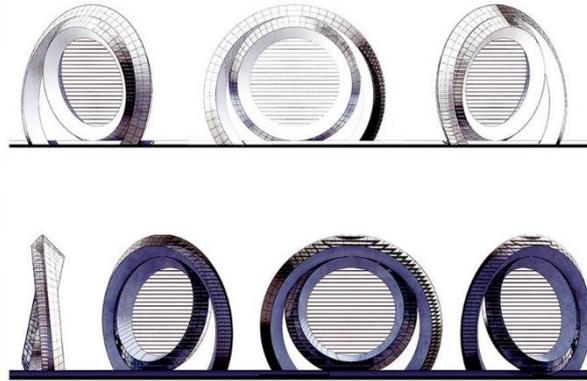
# Innovative new wind turbine from Iceland

- Iceland already runs on 100 percent renewable energy. Most of it comes from geothermal sources, but researchers have been working on ways to harness the incredibly powerful winds in the region as well. Traditional wind turbines would spin out of control in the high winds common to the small country, but one bright inventor realized that an entirely different type of wind turbine could withstand the winds. In fact, IceWind's CW1000 wind turbine may be even better than its skinny counterparts.
- Traditional wind turbines just don't fare very well when the winds really pick up, which can be up to 40 miles per hour on an average day. In stormy weather, wind speeds average 112mph.
- The only way to address this problem was to create a different kind of wind turbine, so that's what inventor Saethor Asgeirsson did. Rather than being long and thin with blades fanning out, his CW1000 turbine stands vertically on a wide base and features curved blades. The unique blade shape allows the turbine to catch the wind in such a way that it can't possibly spin too fast, which is the main problem with the traditional design. The CW1000 can thus endure Iceland's consistently high wind speeds.

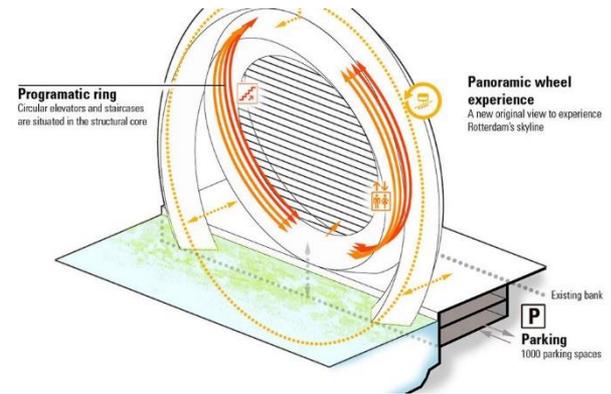
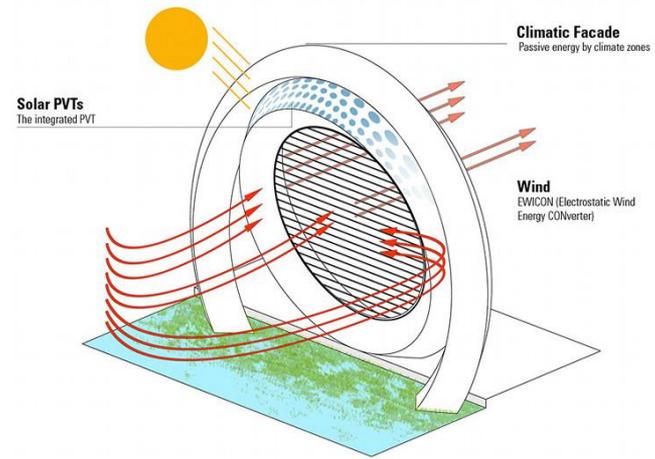


# The Dutch Wind-wheel is not only a silent wind turbine – it's also an incredible circular apartment building

- Designed for the port city of Rotterdam, the Dutch Windwheel is a concept for a sustainable landmark that would be able to house 72 apartments within a circular steel and glass frame, while also serving as a silent, motionless wind turbine. In addition to harvesting energy from the wind, the structure would be equipped with facilities to capture rainwater, recycle tap water and also produce biogas from the residents' organic waste.



- The Wind-wheel is composed of two rings built on an underground foundation and surrounded by wetlands so as to give the structure the appearance of floating. The outer ring houses 40 rotating cabins to provide visitors with impressive views of Rotterdam—much as the London Eye does in the UK—while the inner ring houses 72 apartments, 160 hotel rooms, commercial outlets and is topped off with a restaurant.
- Perhaps the most striking detail of the Wind-wheel, other than its appearance, is the turbine that fills the inner ring of the building. The electrostatic wind energy converter (EWICON) is a technology that was developed at TU Delft and “converts wind energy with a framework of steel tubes into electricity without moving mechanical parts.” This means no noise and much easier maintenance.
- Related: TU Delft and Mecanoo Unveil New Bladeless Bird-Friendly Wind Turbine Design
- The proposed Wind-wheel is also equipped with solar PVs and a climactic facade to make the best use of natural resources. The building’s water usage is also carefully managed, with rainwater captured atop the structure, and tap water fed into the wetlands that surround the Wind-wheel. Furthermore, biogas is also produced from the residents’ waste.
- The developers of the design, a consortium made up of Rotterdam-based companies BLOC, DoepelStrijkers, Meysters and NBTC Holland Marketing, intend the structure to be a “dynamic showcase for Dutch Clean Technology [that] provides a continuous platform to demonstrate technical and technological innovations,” and in the process, creates a very modern update on the traditional windmills of the Netherlands.



## New Bird-Safe Turbine

- Safaei has created a wind turbine that can be installed on skyscrapers or large apartment buildings and can generate energy even safer, quieter and more affordably than current turbines.
- Safaei's turbine is called the PowerWINDow, and instead of using large, rotating blades, it is made up of gently moving panels, which blend in with architecture. It can even be painted to match the building that it is installed on. "I wanted to create a wind turbine that better integrated with living environments, [and it] looks like a window with a sparse venetian blind – the blades move vertically up and down," says Safaei. Because there are no large blades, it is safer for humans and birds and it doesn't generate the same noise.
- PowerWINDows are in the testing phase right now, and the university has signed a deal with Birdon, an Australian engineering company, to build a commercially viable prototype for further testing and evaluation. If all goes well, it could mean a whole new way for bringing clean energy to cities.



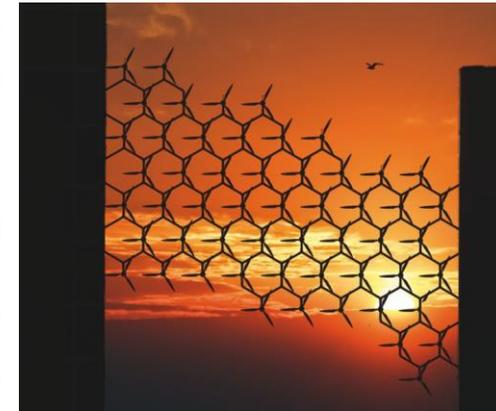
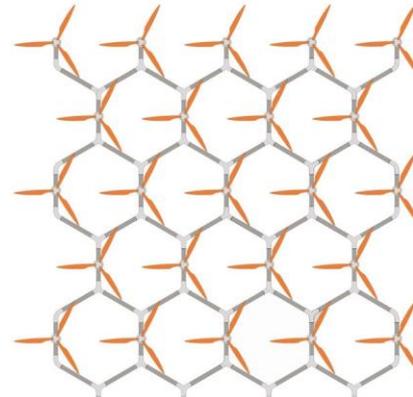
# TU Delft and Mecanoo Unveil New Bladeless Bird-Friendly Wind Turbine Design

- Researchers at TU Delft recently teamed up with Dutch architecture firm Mecanoo to design a bird-friendly wind turbine that can transform wind energy into electricity without any mechanical moving parts. The turbine, dubbed the EWICON, was installed at the Delft University of Technology in March.
- The Electrostatic Windenergy Convertor (EWICON) is a wind turbine that has no moving parts. Designed by Mecanoo, the prototype uses the technology developed by the EWI faculty in collaboration with Wageningen University and several companies involved in a government ecology project. The bladeless wind turbine uses the movement of electrically charged water droplets to generate power. It can be installed both onshore and offshore, or mounted on a roof.
- **The EWICON's steel fram supports a framework of horizontal steel tubes. Within the framework, electrically charged droplets are created and blown away by the wind. Their movement creates an electric current that is then passed on to the grid.** The remarkable wind turbine produces zero noise pollution; it doesn't cast shadows, and because there are no moving parts, it has much lower maintenance costs than conventional wind turbines.



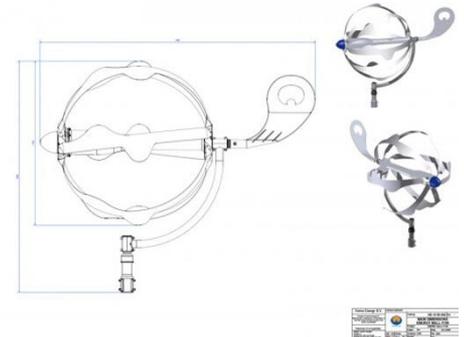
## Interlocking windmills make green energy as easy as assembling LEGOs

- The German company EMAMIDESIGN has developed an innovative way to harness the power of wind. Interlocking, compact windmills combine to make the Windflock energy system capable of powering devices and buildings large and small.
- The three dimensional system can be modified to accommodate all sorts of differing shapes and volumes required by users. Assembly is described to be as simple as putting together LEGOs, which makes the units widely accessible for buyers of varying skill levels. And the final display is quite stunning, resembling the synchronized formation of birds overhead.
- Related: Meet LIAM: A mini windmill ideal for any home
- The best part of the Windflock system, aside from its sharp design, is its success in making green energy more attainable. Hopefully this system will soon take flight and become a symbol of practical, sustainable energy near and far.



# Ground-breaking Energy Ball Wind Turbine for Home Power

- Swedish company Home Energy recently revealed an innovative wind turbine that spins in a spherical formation. Eschewing traditional rotors for a sleek orb structure, this beautiful rethinking of conventional wind turbine design utilizes the Venturi principle, which funnels wind within the turbine's blades. The resulting spherical wind turbine features increased efficiency and lower noise levels – making it ideal for small scale energy needs such as personal home use.
- Most modern wind turbines utilize a flat three-blade design, wherein the head of the windmill is directed into drafts by a computer. The tips of these windmills can reach up to six times the speed of the wind. By contrast, the Energy Ball is designed to take advantage of the the Venturi effect, which was originally a measurement of pressure created by channeling an incompressible liquid through a restricted section of pipe. This spherical Energy Ball takes those principles and uses them to channel air through its six blades and around its generator.
- This results in highly efficient turbine that can take advantage of very low wind speeds. Home Energy primarily designs small-scale energy solutions for homes, communities, businesses and public facilities. In my opinion they should also be designing for amusement parks: perhaps these fun pinwheels could help offset the carbon impact of all those funnel cakes.



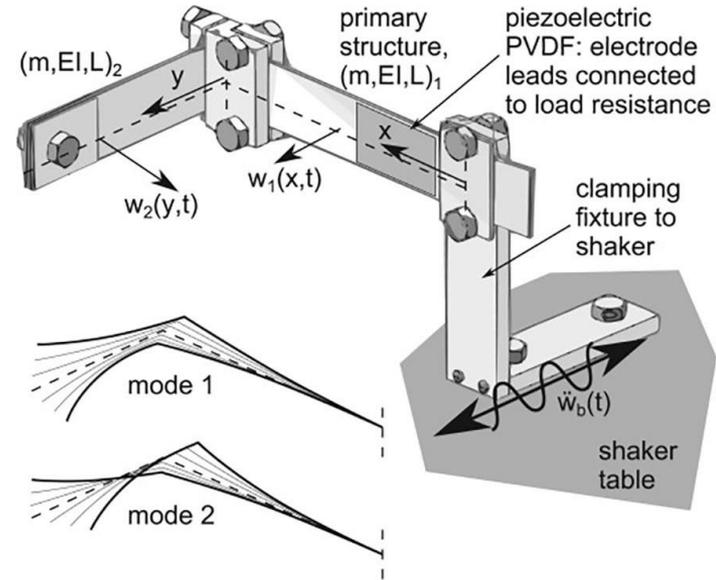
# Festo's Dual Wing Generator Catches the Wind Like Flapping Bird Wings

- Windmills offer a great way to harness renewable energy, and they've been around for almost two centuries – but who says that's the only way you can catch the wind? Festo, a supplier of automation technology, is trying to shake things up with a new type of wind harvesting technology called the DualWingGenerator that replaces rotor blades with bird-like wings.
- Just like a bird that flaps its wings up and down to create enough power for flight, the wind will push DualWingGenerator's wings up and down to generate electricity. Festo claims that the system can generate electricity constantly – even when the winds are as weak as four meters per second. DualWingGenerator is supposedly self-optimizing with the ability to adjust the frequency, amplitude, and angle of its flapping wings. Because of this adaptability, it can be used in a variety of conditions.
- RELATED: Wind Power Costs are Almost Exactly the Same as Natural Gas, New Study Shows
- Festo likens its DualWingGenerator system to an airplane's wings as it will bend with the wind for the most efficient angle to catch the greatest amount of airflow and create more electricity.
- Wind energy can provide a great renewable and emission-free source of energy, but it has a few caveats. Thanks to the large rotors, windmills need plenty of space and although there are vertical windmills with a smaller profile, they all require constant and strong winds to work. If Festo's DualWingGenerator really works as promised it could bring in a lot more wind energy even from the calmest parts the world.



# WIND ENERGY FROM TREES

- According to a new report in the Journal of Sound and Vibration, the movement of trees in the wind produces vibrations that could be successfully converted into energy.
- The study, administered by engineers at Ohio State's Laboratory of Sound and Vibration Research, found that it is possible to convert a random range of vibrations into a viable energy source through the natural vibrational energy of tree-like structures. The natural frequency is like a wall that absorbs and stores the energy from higher frequencies, just like a small ripple of water that accumulates into a large swell.
- RELATED: Virginia Tech's New Piezoelectric Charger Can Power Your Cell Phone With a Simple Shake
- This complex science is dependent upon wind (which as we know, can be completely random) turbulently whipping a leaf or small branch around and that power being contained into a larger, powerful low-frequency sway of the tree itself. The engineers tested tiny artificial forests using small tree-like L-shaped steel beams wrapped with polyvinylidene fluoride (PVDF), a piezoelectric material. The researchers were able to produce about 2 Volts of energy.
- Piezoelectricity can be produced from a variety of materials — from tapping on a keyboard to a swaying skyscraper. In fact, the concept has already been patented using keyboard covers. It's a huge step forward in renewable energy, and we're anxious to see how it folds.



# New Silent Wind Tree Turbines Make Energy Production Beautiful

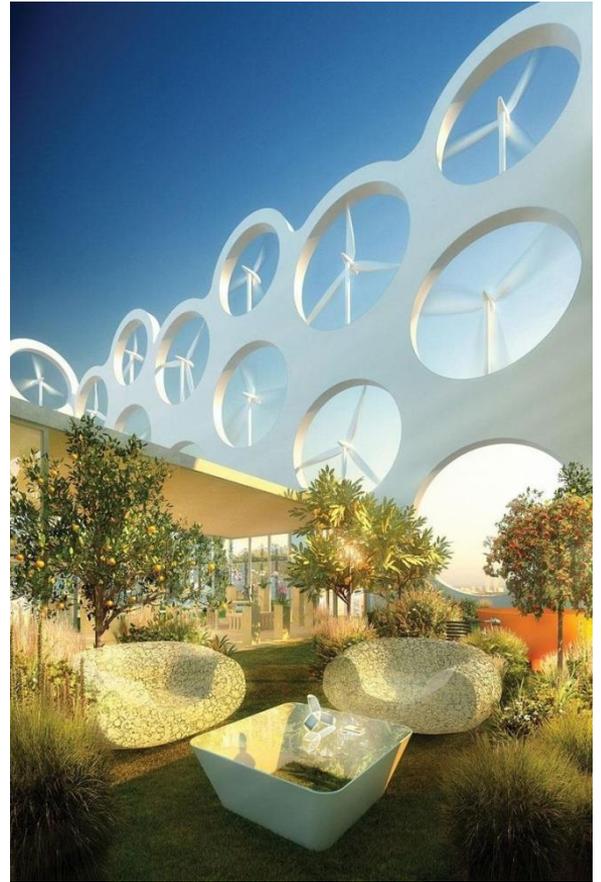
- Three years of research have led a team of French engineers to produce their interpretation of wind energy for urban locations. The Wind Tree stands at 26 feet tall, and its branches adorn the Pleumeur-Bodou commune in Brittany in northwestern France. Hit the jump to learn more about this new breed of silent wind turbine that turns energy production into an art form.
- Jérôme Michaud-Larivière, the founder of the company New Wind, says that “The idea came to me in a square where I saw the leaves tremble when there was not a breath of air.” He went on to hypothesize that the energy “had to come from somewhere and be translatable into watts.” Other turbine ideas have hit the headlines, but the wind tree is the first that fully integrates form and function rather than being an add on. The Wind tree will be on display in Paris Place de Concorde in May 2015.
- Related: Semtiives Wind Turbines are Ideal Home Scale Energy Generators
- The Wind tree uses tiny blades that are housed in the leaf units. The blades turn inwards, which enables the units to turn in the wind, regardless of wind direction. Jerome told Microsoft the units respond to wind as low as 2 meters per second. The units are silent, which is a bonus, as other wind turbine technology can be very noisy and unsuitable for urban areas. The team therefore claim the wind tree is less obtrusive than other designs and could be used in many locations such as gardens, squares, parks and shopping centers. The units will cost around £23,000 and can be linked together. Since they look like sculptures, the trees could be used as street art that also powers the city.



1) The COR Building / Chad Oppenheim / Miami

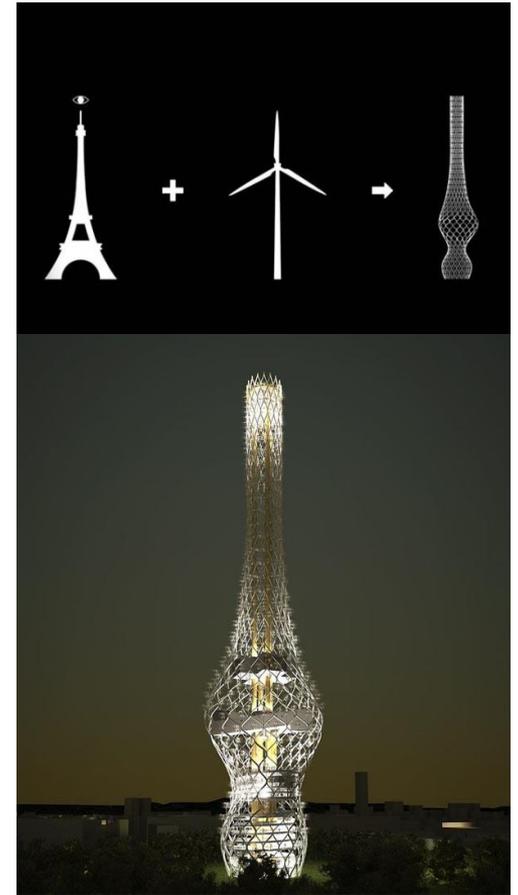
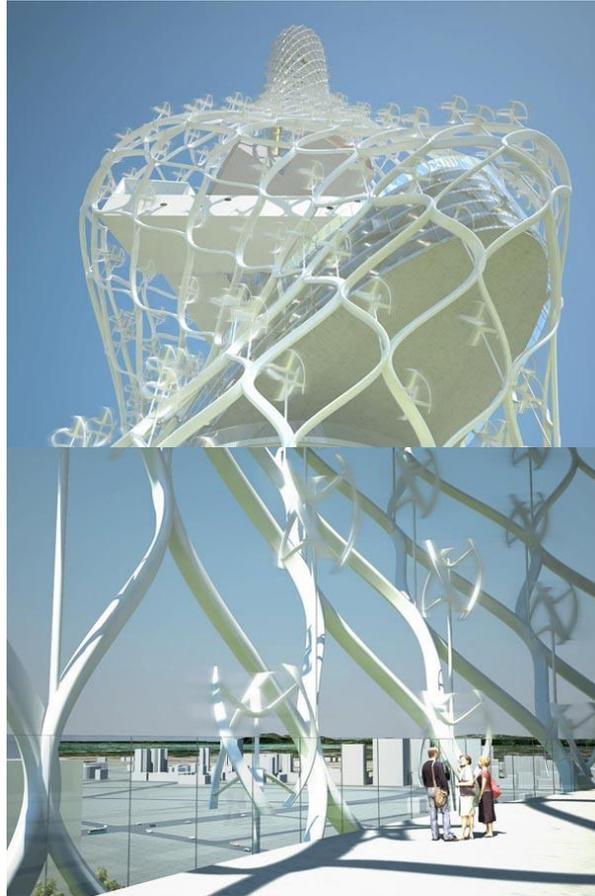
COR, the first sustainable, mixed-use condominium in Miami, Florida represents a dynamic synergy between architecture, structural engineering and ecology. Rising 400' above the Design District, Cor extracts power from its environment utilizing the latest advancements in wind turbines, photovoltaic's, and solar hot water generation – while integrating them into its architectural identity.

A hyper-efficient exoskeleton shell simultaneously provides building structure, thermal mass for insulation, shading for natural cooling, enclosure for terraces, armatures for turbines, and loggias for congregating on the ground. Comprising commercial, office, fitness, live/work, and pure residential spaces – COR provides a uniquely flexible platform for lifestyle enhancement.



## 2) Power Tower – Competition entry for an Observation Tower in Taichung, Taiwan / NL Architects

Designed by Amsterdam-based NL Architects as one of their two proposals for the Taiwan Tower Competition, the design tries to explore the means of integrating sustainable technologies into high-rise architecture. By combining the two typologies, windmill and observation tower, the project aspires to affect the content of the new generation of tourist towers and at the same time alter the appearance of future wind energy generators. It is an attempt to give technology an aesthetic dimension and turn it into objects of beauty, while taking renewable energy production to new heights. The building is an exo-skeleton, a structural net wrapped around the segmented and ever-changing floor plans, assuming the role of support as well as generator of sustainable energy. The functionality of the required program -lobby, parking, museum, offices, conference center and observatory- results in a specific shape for each unit. The program is stacked and positioned on specific heights. The weaving of the structure creates an intricate pattern. A new category of wind turbines occupies the empty spaces in between, a variation of the Vertical Axis Wind Turbine. Their flower-like shapes create an effect of sculptural treatment. Strong, affordable and most importantly-silent, they can produce energy with wind coming from any direction.



### 3) Bahrain World Trade Center / Atkins

The design firm of Atkins did not believe that the look of the project was enough, and felt that it was important to incorporate sustainability features into this design. They first attempted to bring in solar panels into the project, but found that the extreme heat conditions of Bahrain made it an unfeasible proposition. So they turned to a second option, and came up with an even more striking image, that of the three 29 meter wind turbines, each supported by a 30-meter bridge spanning between the two towers.

The floorplan was key in making this feature work. The wing-like towers help to funnel and accelerate the wind velocity between them. Furthermore, the difference in the vertical shape of the towers should help reduce the pressure differences between the bridges, which, when combined with an increased wind speed at the higher levels, should provide an equal velocity amongst the turbines. All this will provide for an even greater efficiency in the powering of the generators.

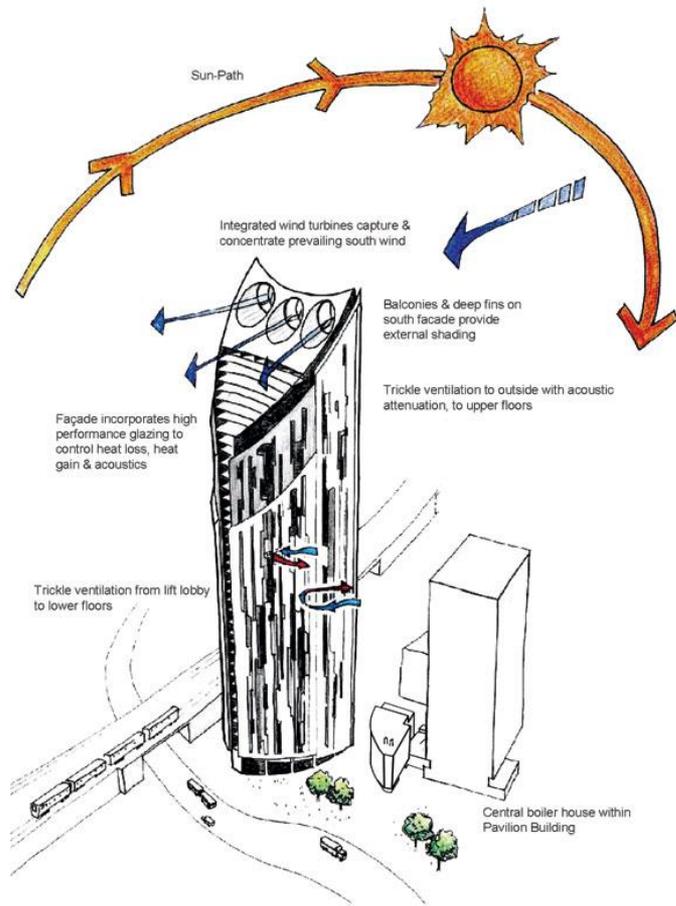




#### 4) Strata SE1 / BFLS / London

Strata SE1 is one of the first buildings in the world to incorporate wind turbines as part of its structure. Randall, the engineering consultancy involved with the Bahrain World Trade Center, which also features wind turbines, was involved in the project.

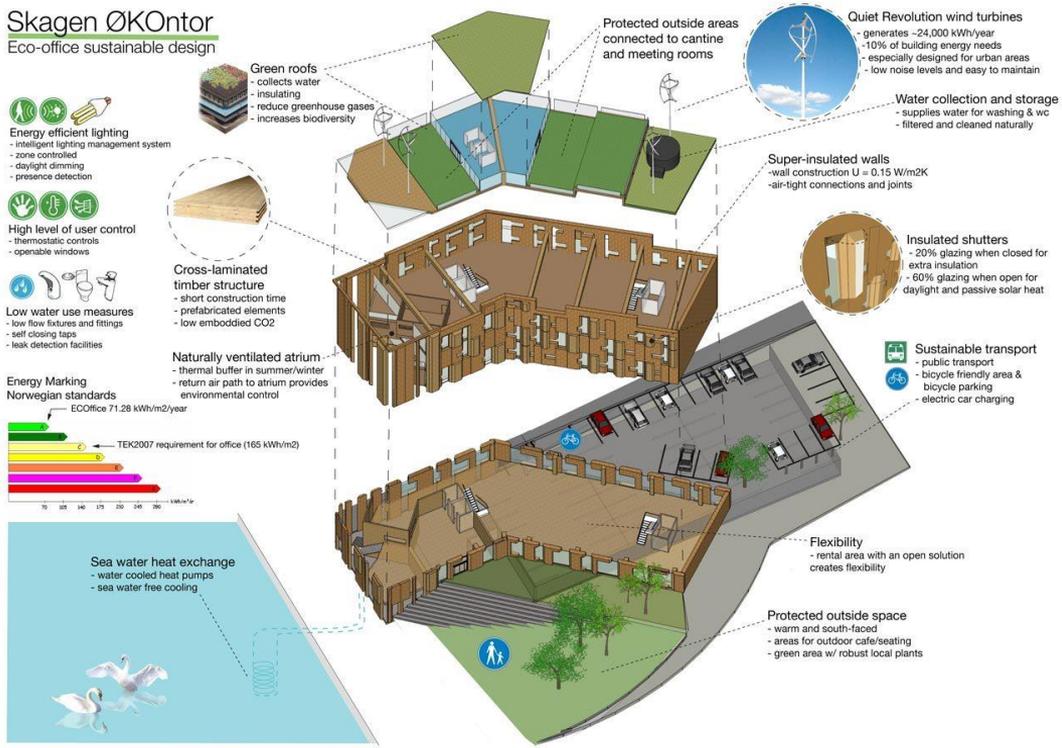
The three 9-metre (30 ft) wind turbines at the top of the building are rated at 19 kW each and are anticipated to produce a combined 50MWh of electricity per year. They are expected to generate sufficient energy to provide power for the common areas of the building (8% of the energy needs of the building), although questions about their real efficiency will remain unanswered until the completion of two years of comprehensive wind data analysis.



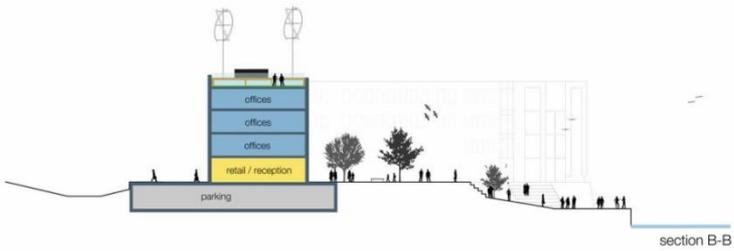
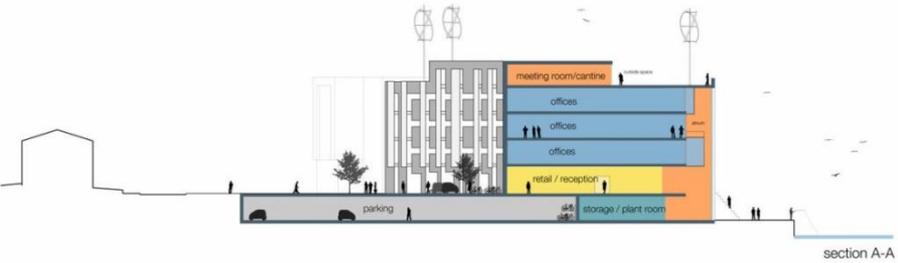
## 5) Skagen ØKOntor / Various Architects

The building's wooden facade of individually operable insulated shutters is its most visible and dynamic feature. Floor height shutters can be opened during the day to allow in daylight and passive solar heat, or closed after sunset on cold days for added insulation. The shutters can transform the facade from 60% to 20% window area. The inside surface of the shutters are tiled with LED lights to produce artificial daylight during the dark winter months to help provide a well-lit and healthy working environment year round. The insulated shutters are calculated to provide an additional 15% savings on heating yearly.

The natural resources of the seafront site are all carefully utilized by the design. 4 Quiet Revolution wind turbines on the roof provide 24.000 kWhr of clean energy (10% of the building's energy demand). The windy and often overcast weather on the norwegian west coast, combined with long dark winter nights made wind a more efficient alternative to solar panels in this case. The sun is controlled for solar shading and passive heat in the west facing atrium space, and through the many south facing windows. Sea water is used as an energy source for both heating and cooling via water cooled heat pumps and sea water free cooling. This, coupled with high efficiency air heat recovery, demand led controls, and high levels of thermal insulation have significantly reduced the thermal plant demand. Natural ventilation is possible for most of the year, with cooling through refrigeration only necessary when sea water temperatures are at their peak (no more than 4-8 weeks a year). Green roof surfaces collect and filter the area's prodigious rainfall in rooftop water tanks for use in low-water fixtures and fittings, reducing the need to waste treated water.



# References



6) "Solar Wind" / Francesco Colarossi



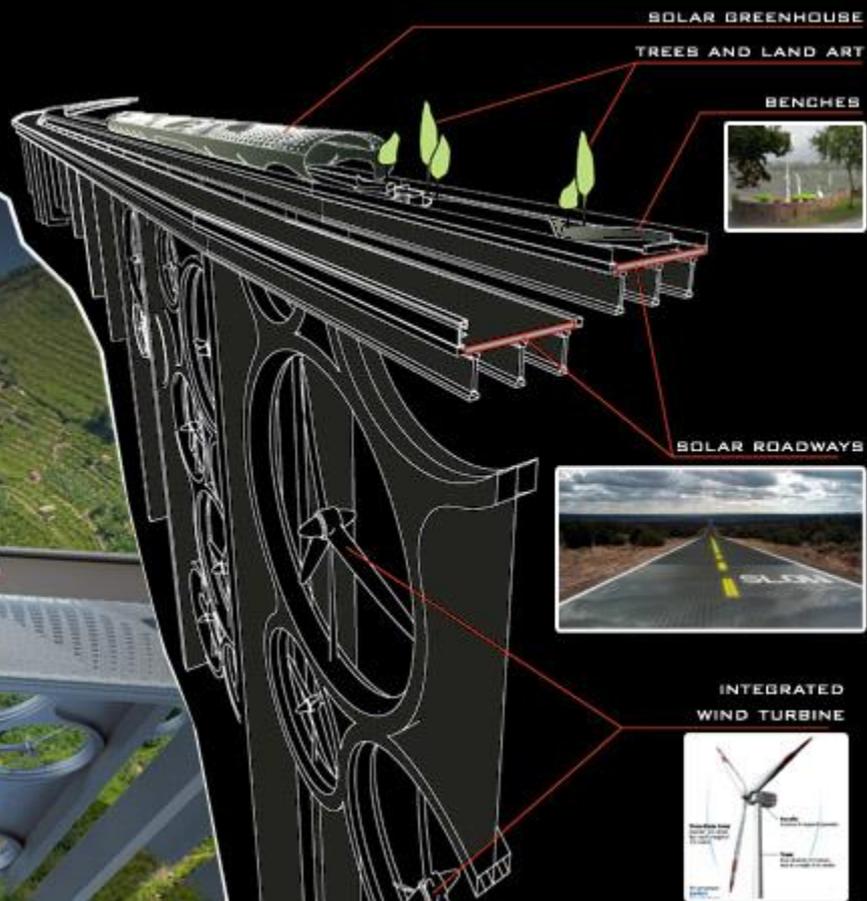
**"SOLAR WIND"**  
THE HYBRID SYSTEM PROPOSED (COMBINING SOLAR AND WIND POWER) ALLOWS FOR A CONTINUOUS PRODUCTION OF ENERGY. THE PROJECT IS BASED ON THE IDEA OF UTILIZING THE SPACE BETWEEN THE PILLARS OF THE EXISTING VIADUCTS TO HOUSE A SYSTEM OF WIND-POWERED TURBINES WHICH WILL BE INTEGRATED INTO THE STRUCTURE. THIS ENSURES CONTAINED LAND USE AND THEREFORE A REDUCED IMPACT ON BOTH LANDSCAPE AND ENVIRONMENT IN ADDITION TO RE-DESIGNING THE VISUAL PROFILE OF THE VIADUCT.  
THE SOLAR PARK PROPOSED IN THE COMPETITION WILL STRETCH THE FULL LENGTH OF THE INNER CARRIAGEWAY, WITH THE OUTER CARRIAGEWAY REMAINING RESERVED FOR THE TRANSIT OF VEHICLES.



THE SOLAR PARK IS CONCEIVED AS A GREEN "PROMENADE", ALONG WHICH THERE ALTERNATE PANDRAMIC VIEWING POINTS AND ENTIRELY SELF-SUFFICIENT SOLAR GREENHOUSES. AS WITH CITY FARMS, VISITORS TO THE PARK WILL BE ABLE TO STOP AND BUY THE LOCAL PRODUCE GROW IN THESE GREENHOUSES.

THE ASPHALT WILL BE SUBSTITUTED WITH A TECHNOLOGICAL ROAD SURFACE OF A KIND ALREADY IN USE IN THE USA ("SOLAR ROADWAYS"). THE ROAD SURFACE ITSELF WILL, THEREFORE, COLLECT ENERGY AS A PART OF A POWER-GENERATING SYSTEM COMPOSED OF A DENSE GRID OF SOLAR CELLS COATED WITH A TRANSPARENT AND HIGHLY RESISTANT FORM OF PLASTIC.

THE ENTIRE SYSTEM IS CAPABLE OF PRODUCING AROUND 40 MILLION KWH PER ANNUM – ENOUGH ENERGY TO PROVIDE POWER FOR APPROXIMATELY 15.000 FAMILIES.



THANK YOU!



"The only problem with this wind turbine power, is that it plays havoc with my hair!"