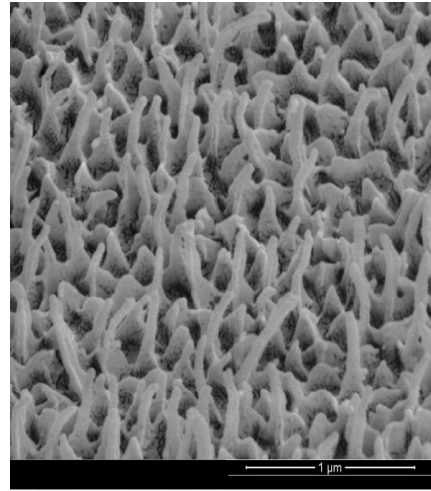
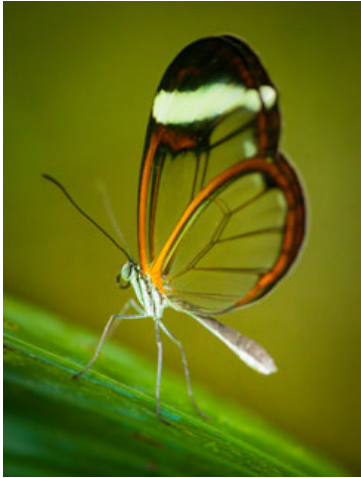




# BIOMIMICRY IN PHOTOVOLTAICS



# Glasswings

By Alexandra Sourakov and Ahmed Al-Obeidi

- MADMEC is an annual team-based student competition held within Massachusetts Institute of Technology (MIT) that aims to create and present prototypes that offer innovative and scientific solutions for sustainability.

- In 2015 the winning invention of the competition was the project titled *Glasswings* by Alexandra Sourakov and Ahmed Al-Obeidi who are pictured to the left with the director of MADMEC, Michael Tarkanian (photo by Tara Fadenrecht).

- The project recognized that for many photovoltaic systems, reflection can be a major issue towards the system's ability to absorb solar energy. Typical commercial solar panels are coated with silicon which can reflect up to 30% of light, reducing its efficiency.

- Alexandra Sourakov and Ahmed Al-Obeidi as a response to this challenge looked to Nature for inspiration and discovered that the wings of the Glasswing Butterfly are covered in nanostructures that appear like “tapered pillars on pedestals” and this anti-reflective coating only reflects 2 to 5% of light. (shown to the left).

- Sourakov and Al-Obeidi simplified and physically recreated the tapered nanostructures using commercial photovoltaic materials and depositing oxide on a glass film, applying a patterned mask of silver, and etching the surface using etching gases to create their customized pillar-like texture. This process is much more effective than commercial anti-reflection coatings and it is much more economical.



○ In intense solar conditions commercial silicon solar panels can have surface temperatures up to 80- 90°C, which results in a 1/3rd decrease in efficiency. These panels can also deteriorate over time due to the green house effect that occurs behind the front glass pane which then causes “undesired photochemical damage” or discoloration which can be seen in the two images to the left.

○ To address these faults Authors and Experimenters Matthias Zähr, Dennis Friedrich, Tanja Y. Kloth, Gerhard Goldmann, and Helmut Tributsch were inspired by the Australian Palm Fan.

○ Leaves are nature's solar panels and their shape and form have optimized properties for absorbing solar energy, therefore by following their example we can make our own solar panels more efficient. The challenge that the Experimenters (as mentioned above) had undertaken was finding a leaf form that allowed for ventilation while also having a large solar absorbing area and could be flexible enough to withstand heavy storms. The fan palm *Licuala ramsayi* from northeastern Australia, and featured to the far-left, fits this description.

---

# Bionic Photovoltaic Panels

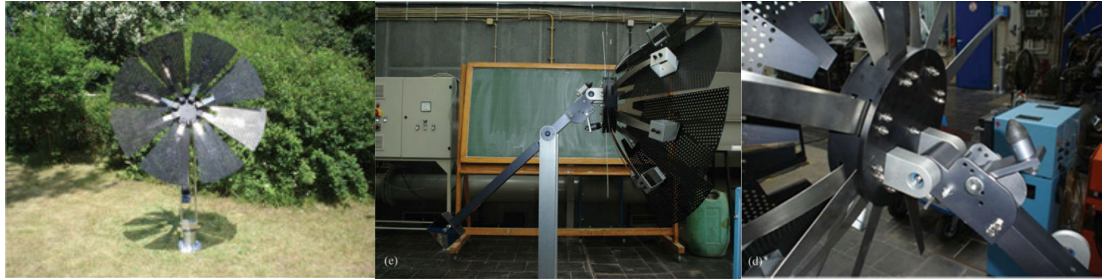
## Bio-Inspired by Green Leaves



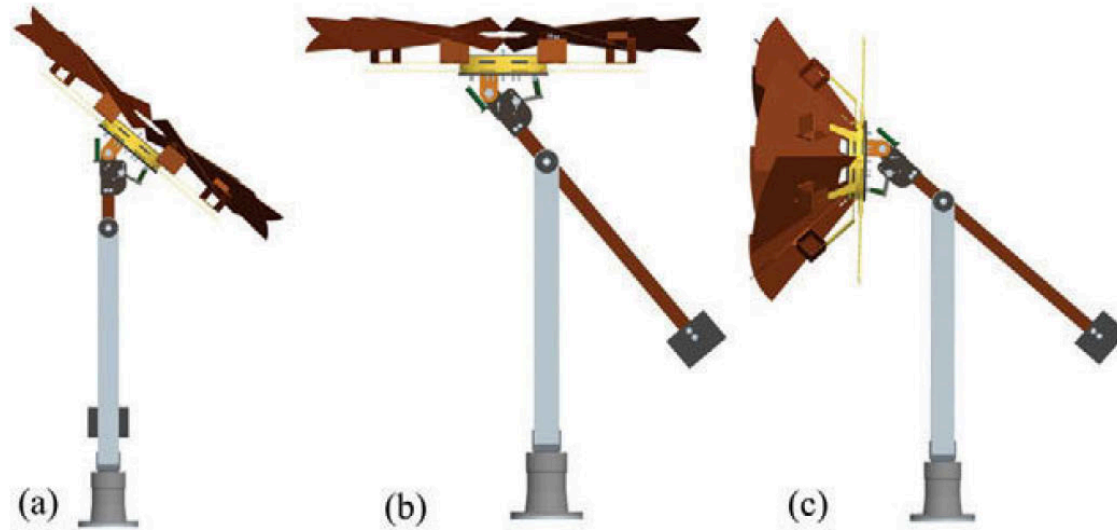
○“Its leaf fan provides a large solar absorber area. However, the leaf is cut into segments, which are tilted in such a way that the air can pass freely through the fan transporting off heat. In addition, during a heavy storm, the fan follows the wind and the segments reorganize to a streamlined pattern from which they recover unharmed.”

---

## Bionic Photovoltaic Panels Bio-Inspired by Green Leaves



○ After examining and analyzing the fan palm *Licuala ramsayi* the Authors created their own bionic photovoltaic panel model that had similar characteristics to the leaf. The model, shown to the left, is a very large round form that has been divided into segments that can tilt and bend along with the pull of the wind. It is light-weight, fitted with long leaf-like springs, three rotation axes, and its panels are also perforated to prevent overheating.



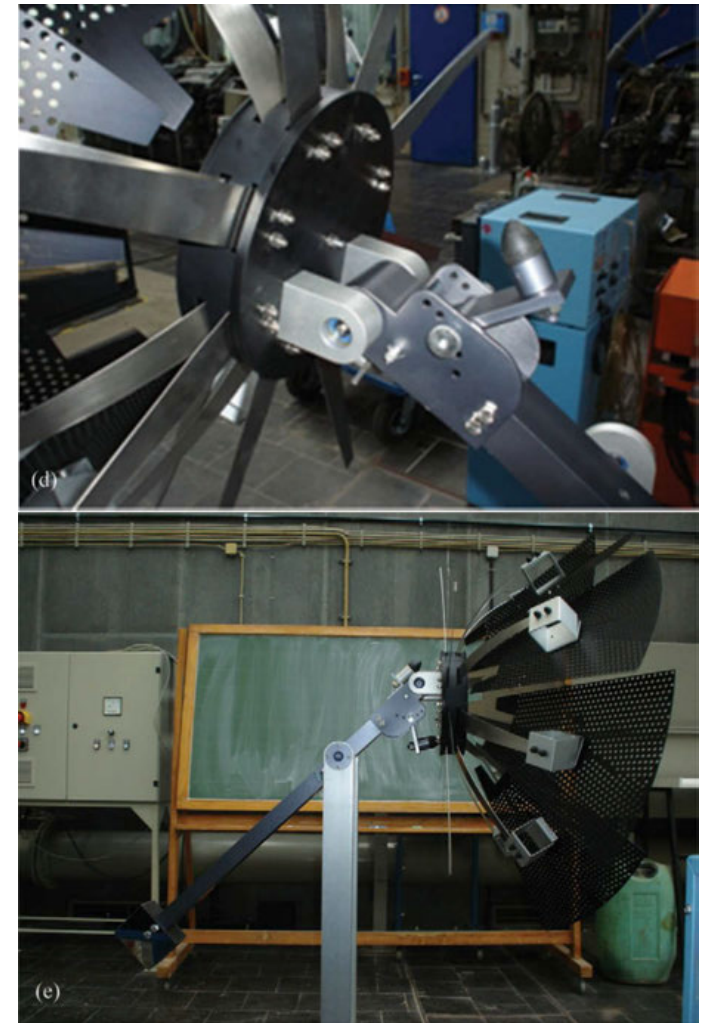
○ The Authors tested and recreated their model for a couple of iterations but overall their experiment “turned out to be very satisfactory and [they would] characterize the model now as a lightweight transportable photovoltaic panel, which can easily be taken apart and reassembled.”

○ By discovering a leaf form that matches the needs of their challenge the Experimenters were able to create a more efficient solar panel system in intense solar and wind conditions.

---

# Bionic Photovoltaic Panels

## Bio-Inspired by Green Leaves



Bionic Photovoltaic Panels  
Bio-Inspired by Green Leaves

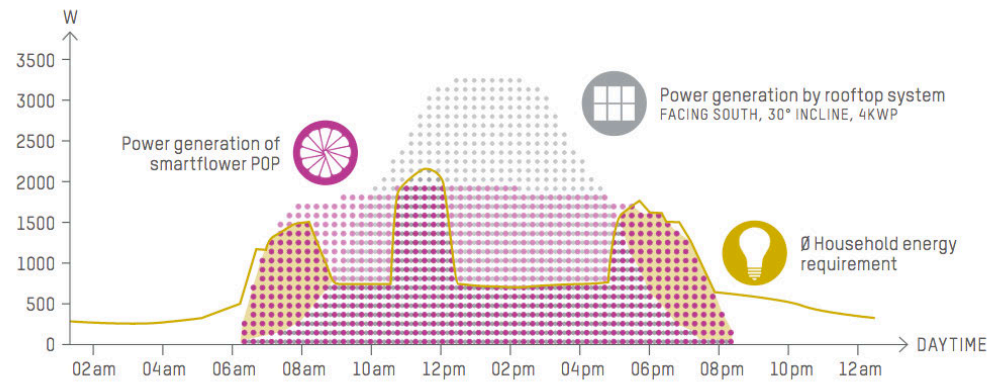


SMARTFLOWER



- o <https://www.smartflower.com/en>
- o <http://www.buildingservicesblog.com/smartflower-photovoltaics-sunflower/>

FOLLOWS THE SUN:  
SMARTFLOWER POP COMPARED WITH A STATIC ROOFTOP SYSTEM\*



# SMARTFLOWER





At 6:00 am, smartflower POP starts automatically and cleans itself

At 12:00 noon, smartflower POP follows the sun

At 8:00 pm, smartflower POP ends the operation and cleans itself

# SMARTFLOWER

## SOURCES FOR IMAGES

- o <https://500px.com/photo/63083387/glasswing-butterfly-on-flower-by-laurie-hernandez>
- o <http://gursesl.deviantart.com/art/Glass-Wing-Butterfly-Greta-Oto-Costa-Rica-315091417>
- o <http://www.sciencemag.org/news/2016/05/sunflowers-show-complex-fibonacci-sequences>
- o <http://slodive.com/inspiration/butterfly-pictures/>
- o <https://www.pond5.com/stock-footage/23111964/fan-palms.html>
- o [https://en.wikipedia.org/wiki/Greta\\_oto](https://en.wikipedia.org/wiki/Greta_oto)

## SOURCES FOR TEXT

- o <http://news.mit.edu/2015/biomimetic-non-reflective-coating-solar-cells-madmec-0929>
  - o <http://madmec.mit.edu/madmec-history>
  - o <https://www.smartflower.com/assets/smartflowerpop-us-aca6f94828c0ced17ad80dd50392ee59.pdf>
  - o <http://www.buildingservicesblog.com/smartflower-photovoltaics-sunflower/>
  - o [https://www.smartflower.com/en/smartflower\\_pop](https://www.smartflower.com/en/smartflower_pop)
- 
- o ZÃ¶hr, Matthias, Dennis Friedrich, Tanja Y. Kloth, Gerhard Goldmann, and Helmut Tributsch. "Bionic Photovoltaic Panels Bio-Inspired by Green Leaves." *Journal of Bionic Engineering* 7.3 (2010): 284-93. Web.

---

# RESOURCES