Biomimicr-E: Nature-Inspired Energy Systems

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Biomimicry (also known as biomimetics) is the process of using natural-world mechanisms, many of which have evolved over billions of years, to inspire man-made designs and technological innovations. The following examples highlight pioneering energy ideas and active areas of research, all inspired by nature.

Energy Efficiency

- **Termite mounds** inspired regulated airflow for temperature control of large structures, preventing wasteful air conditioning and saving 10% energy.[1] (http://http//bioinspiration.sandiegozoo.org/content/bioinspiration-story)
- **Whale fins shapes** informed the design of new-age wind turbine blades, with bumps/tubercles reducing drag by 30% and boosting power by 20%.[2] (http://www.pratt.duke.edu/news/mimicking-humpback-whale-flippers-may-improve-airplane-wing-design)[3] (http://bioinspiration.sandiegozoo.org/content/bioinspiration-story)[4] (http://www.whalepower.com/drupal/?q=node/1)
- **Stingray motion** has motivated studies on this type of low-effort flapping glide, which takes advantage of the leading edge vortex, for new-age underwater robots and submarines.[5] (http://www.popsci.com/article/technology/why-underwater-robots-should-swim-stingrays?dom=PSC&loc=recent&lnk=5&con=why-underwater-robots-should-swim-like-stingrays)[6] (http://www.mnn.com/earth-matters/animals/stories/what-submarines-can-learn-from-stingrays)

- Studies of microstructures found on **shark skin** that decrease drag and prevent accumulation of algae, barnacles, and mussels attached to their body have led to “anti-biofouling” technologies meant to address the 15% of marine vessel fuel use due to drag.[7] (http://money.cnn.com/2013/05/31/technology/innovation/sharklet/)[8] (http://www.nasa.gov/centers/langley/news/factsheets/Riblets.html)[9] (http://news.nationalgeographic.com/news/2005/07/0722_050722_sharkskin.html)[10] (http://bioinspiration.sandiegozoo.org/content/bioinspiration-story)

Energy Generation

- Passive heliotropism exhibited by **sunflowers** has inspired research on a liquid crystalline elastomer and carbon nanotube system that improves the efficiency of solar panels by 10%, without using GPS and active repositioning panels to track the sun.[11] (http://www.theengineer.co.uk/sectors/energy-and-environment/news/sunflower-heliotropism-could-inspire-design-of-solar-panels/1013611.article)[12] (http://www.ted.com/talks/bill_gross_on_new_energy.html)[13] (http://www.news.wisc.edu/20967)
- Mimicking the fluid dynamics principles utilized by **schools of fish** could help to optimize the arrangement of individual wind turbines in wind farms.[14] (http://www.macfound.org/fellows/30/)
- The nanoscale anti-reflection structures found on certain **butterfly wings** has led to a model to effectively harness solar energy.[15] (http://www.nytimes.com/2012/04/03/science/solar-energy-inspiration-from-butterflies.html?_r=0)[16] (http://pubs.rsc.org/en/Content/ArticleLanding/2011/SM/C1SM06167D#!divAbstract)[17] (http://pubs.rsc.org/en/Content/ArticleLanding/2011/CP/c1cp20787c#!divAbstract)

Energy Storage

- Inspired by the sunlight-to-energy conversion in plants, researchers are utilizing a **protein in spinach** to create a sort of photovoltaic cell that generates hydrogen from water (i.e. hydrogen fuel cell).[18] (http://cleantechnica.com/2011/02/06/popeye-would-love-this-sustainable-hydrogen-fuel-made-from-sunlight-and-spinach/)[19] (http://video.mit.edu/watch/daniel-nocera-describes-new-process-for-storing-solar-energy-2959/)
- Utilizing a property of **genetically-engineered viruses**, specifically their ability to recognize and bind to certain materials (carbon nanotubes in this case), researchers have developed virus-based “scaffolds” that could enable assembly of high-power lithium-ion batteries.[20] (http://www.greencarcongress.com/2009/04/mit-team-uses-genetically-engineered-viruses-to-build-cathode-material-for-liion-battery.html)[21] (http://www.sciencemag.org/content/324/5930/1051)

Energy Delivery

- Mimicking the sharp, jagged scales found on **fireflies** by implementing radiance-amplifying geometry has been shown to increase LED brightness by 55%.[22] (http://www.popsci.com/science/article/2013-01/researchers-reverse-engineer-fireflies-make-more-efficient-leds)[23] (http://vmconnection.com/biomimicry-design-lessons-from-nature/)
- The distributed **social structure of ants and bees**, specifically for communication and activity scheduling, is influencing the complex and adaptive control systems required for smart grids.[24] (http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6497880&url=http%3A//ieeexplore.ieee.org/xpls/abs_all.jsp%3Farnumber%3D6497880)[25]

(http://www.greenbiz.com/blog/2013/11/05/5-tech-trends-mingling-bio-inspired-design)

- Neural networks found in the **human brain** are inspiring intelligent control systems for future electrical grid designs.[26] (http://www.livescience.com/27879-bio-inspired-neural-networks-power-grids-brain-awareness-nsf.html)

*[Part 2 of this series on biomimicry is posted as "*Biomimicry for Energy Systems: What's Next? (https://pfellowsqaweb02.aaas.org/sci-fly/biomimicry-energy-systems-whats-next)*"]*

NOTE: If you would be willing to share additional examples of biomimicry in the energy world or would like to collaborate on future work, please reach out to Noël and Kristen. Please direct interest in co-authoring grants/proposals on biomimicry research for energy systems to Andrea (http://www.cs.rug.nl/~andrea/projects/biomimicry/Biomimicry_in_energy.html).

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- http://www.nasa.gov/centers/langley/news/factsheets/Riblets.html
- http://news.nationalgeographic.com/news/2005/07/0722_050722_sharkskin.html
- http://www.theengineer.co.uk/sectors/energy-and-environment/news/sunflower-heliotropism-could-inspire-design-of-solar-panels/1013611.article
- http://www.ted.com/talks/bill_gross_on_new_energy.html
- http://www.news.wisc.edu/20967
- http://www.macfound.org/fellows/30/
- http://www.nytimes.com/2012/04/03/science/solar-energy-inspiration-from-butterflies.html?_r=0
- http://pubs.rsc.org/en/Content/ArticleLanding/2011/SM/C1SM06167D#!divAbstract
- http://pubs.rsc.org/en/Content/ArticleLanding/2011/CP/c1cp20787c#!divAbstract
- http://cleantechnica.com/2011/02/06/popeye-would-love-this-sustainable-hydrogen-fuel-made-from-sunlight-and-spinach/
- http://video.mit.edu/watch/daniel-nocera-describes-new-process-for-storing-solar-energy-2959/
- http://www.greencarcongress.com/2009/04/mit-team-uses-genetically-engineered-viruses-to-

build-cathode-material-for-liion-battery.html
- http://www.sciencemag.org/content/324/5930/1051
- http://www.popsci.com/science/article/2013-01/researchers-reverse-engineer-fireflies-make-more-efficient-leds
- http://vmconnection.com/biomimicry-design-lessons-from-nature/
- http://ieeexplore.ieee.org/xpl/login.jsp?tp=&arnumber=6497880&url=http%3A//ieeexplore.ieee.org/xpls/abs_all.jsp%3Farnumber%3D6497880
- http://www.greenbiz.com/blog/2013/11/05/5-tech-trends-mingling-bio-inspired-design
- http://www.livescience.com/27879-bio-inspired-neural-networks-power-grids-brain-awareness-nsf.html
- https://pfellowsqaweb02.aaas.org/sci-fly/biomimicry-energy-systems-whats-next
- http://www.cs.rug.nl/~andrea/projects/biomimicry/Biomimicry_in_energy.html