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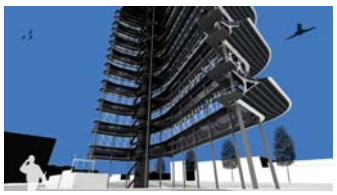
Sustainability

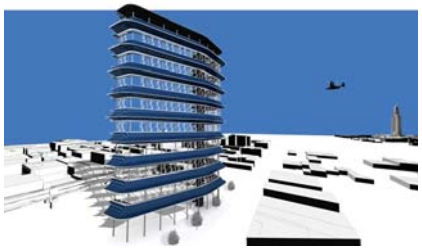
Upjohn Research Initiative: Renewable Energy Generation on an Industrial Scale

Renewable Energy Infrastructures could allow power utilities to harness all the renewable energy potential the earth allows

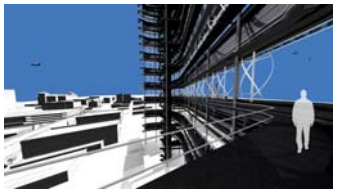
by Zach Mortice, Associate Editor



A central stair core connects the levels of the REI. Image courtesy of Chris Ford.



Parrallel layers of photovoltaic panels are stacked on each level of the structure. Image courtesy of Chris Ford.



Twenty-two vertical axis wind generators are on each level. Image courtesy of Chris Ford.

It's an oft repeated truism in the contemporary sustainable design movement that an 'all of the above' approac that embraces multiple types of renewable energy sources is best when confronting the need to transition the economy away from fossil fuels. Unfortunately, the local utilities that generate renewable energy haven't approached it this way. They've preferred instead to rely on the single most promising renewable energy sour in their area (solar in the desert, wind in the Great Plains, etc.) and leave other options unexplored. As of yet, there has been no way for power utilities to buy into diverse, integrated renewable power generation at an industrial scale.

Providing this kind of solution has been the work of University of Nebraska—Lincoln architecture professor Chris Ford, Assoc. AIA. His research into Renewable Energy Infrastructures (REIs) integrates geothermal, wi and solar power generation systems all within a single structure—essentially creating renewable energy factories. This technology is diametrically opposed to the piecemeal solar photovoltaic roof panel approach t architects are typically concerned with, and with the help of a $15,000 2009 AIA Upjohn research grant, Ford will use it to gives utilities a new way access renewable energy markets.

Today, not tomorrow

Ford envisions the REIs to be placed in urban settings, and he's selected a hypothetical site in downtown Lincoln, Nebr. This preliminary test case design would take up half a city block next to an existing electric transformer station. It would eight be levels tall (approximately 400 feet) and have a separate geothermal ener building at its base. The REI has a thin vertical profile. Horizontally, the footprint of the solar photovoltaic panels form curving, elongated-Us on each level. There is no programmable, enclosed space, but a pillar-like staircase core runs through the middle of the structure so maintenance workers can access it. Each level contains 22 vertical axis wind generators. PV panels slope downward and outward on each level to catch sunlight at ideal angles. Its vertical organization runs contrary to most solar power arrays, which tend to simpl be vast horizontal expanses, and to most applications of PV panels on buildings, which generally place them o flat roofs. Ford says that the most important factor in effective photovoltaic panel design (horizontal or vertica is matching their position with the angle of the sunlight at the given latitude. "It doesn't really matter if that photovoltaic array is one foot above the ground or if it's 100 feet above the ground," he says.

The Upjohn grant money will allow Ford to hire research assistants from the university MArch program, pay f travel expenses, and purchase model-building materials and design software. This infrastructural expression o renewable energy will lend itself well to modular, pre-fabricated kit-of-parts construction, he says, and can be expanded or decreased in size and scale. Furthermore, it's a proposal that's grounded in current-day technolog not speculative possibilities. The bulk of the work Ford will do will deal with how to integrate existing technologies and make them attractive investments in the energy marketplace, not to develop new renewable energy systems themselves.

"I'm not interested in this being featured in *Popular Science* or *Popular Mechanics*," he says. "I'm really interested in grounding it in today, not tomorrow."

Performative beauty

Ford says there is much untapped potential in how local utilities approach investing in renewable energy. Just across the Missouri River in Iowa, wind energy turbines regularly dot the Interstate 80 corridor that runs throu the state. Iowa, like Nebraska and other Great Plains states, is blessed with abundant wind energy generation (and solar energy) potential. It is second only to Texas in wind energy generation, according to the *Wall Street Journal*. Iowa also has above average solar energy generation potential, but it's largely unrealized. Ford says exclusionary and proprietary commercial practices prevent utilities from diversifying their renewable energy investment strategies. His REI design allows power companies to buy into at least three modes of renewable energy generation with one facility.

Ford has designed the REIs for urban areas to lessen the electrical transmission degradation typically seen wh energy is generated on rural sites and sent to far away consumers in densely populated urban areas. By makin transmission degradation less of an issue, the need for new and expensive smart grid electricity technology is reduced. "The dollar amounts associated with laying a mile worth of electric cable is staggering," he says.

It's not uncommon for the public to object to wind energy farms and other renewable energy infrastructures in rural, sparsely populated areas, to say nothing of their presence in highly visible, urban locations. And make r mistake, the REI isn't a formally driven design tailored to please the eye. "The REI is not concerned with its own aesthetic," Ford says. "I don't see this as sustainable architectural design. I see this very much as energy infrastructure design."

As part of his renewable energy research, Ford has examined past introductions of urban utility infrastructure, and says that the common pattern is of eventual acceptance following the understanding of service benefits. Once people came to understand and expect the benefits of good water pressure and a strong mobile phone signal, the NIMBYist objections to water and cell phone towers disappeared.

In previous iterations of the REI model, Ford did try to create a more aesthetically driven design and resisted basing the work entirely on analytical performance metrics. He found that these more formally driven designs produced less energy, thus making them less attractive to energy utilities, which Ford regarded as the ultimate measure of success for the project. "As soon as we relaxed on any type of aesthetic expectations for this infrastructure," Ford says, "what we found was that, 1) it produced more, so public power companies would value it because they're not too concerned with the aesthetic, and, 2) the aesthetic is really a side effect of thi larger scientific determinism."

This performance-driven way of designing can reveal its own subtle aesthetic refinement even, without a

conscious preoccupation with form. “There are lots of things that we have in our built environment that were designed with a higher level of analytical thinking in which aesthetics were not a primary concern,” he says. “And yet, the still have some beauty to them.”

Example of such structures cover a range of hidden urban gems, often steeped in industrial folklore. Bridges a rarely formally driven structures, but their elemental, gravity-defying presence consistently makes them powerful visual objects. Factories can hold similar appeal. The Domino Sugar factories in post-industrial Brooklyn and Baltimore have stamped their iconic presence on both cities with towering smoke stacks and an abstract, geometric jumble of hearty brick and concrete. In the case of the Brooklyn factory, idleness adds to this mystique. It hasn’t processed sugar since 2004, but it’s been a meaningful enough symbol of Brooklyn’s industrial past to keep redevelopment plans swirling. Closer to home, Ford considers the grace of grain silos, omnipresent Great Plains sentries. “They have an incredible physical presence to them,” he says. “I find [then beautiful.”

Sustainable credibility

Ford is the project’s primary researcher, but he’ll be joined by a trio of engineers for the REI project. One is a renewable energy expert that works for a private architecture and engineering firm. The other two engineers work for local Nebraska electricity utilities. Ford’s experiences have taught him that architects must form thes kinds of collaborations and demonstrate both creative and analytical thinking in order to solve performance- a research-based design problems. Answering these kinds of questions with authority and accuracy, he says, is t key to ensuring that architects are perceived as credible voices in the public debates over renewable energy, sustainability, and the entire built environment.

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