The Role of Structural Engineers in Clean Energy Supply

By Ashvin A. Shah, P.E., F. ASCE

The ASCE Code of Ethics includes "enhancement of the environment" in its first fundamental principle and "sustainable development" in its first fundamental canon. The SEI Sustainability Committee has issued *Sustainability Guidelines for the Structural Engineer*. Structural engineers are active in "green" building design and in working with material producers to reduce the energy embodied in structures.

Much of this activity is in support of the pioneering work by the U.S. Green Building Council (USGBC) to promote energy conservation in buildings, beginning in 1994 with its LEED Green Building Rating System. ASCE has recently announced its own program for establishing a similar rating system for "green" infrastructure. An energy efficiency drive exists in all sectors of the U.S. economy, often supported by the Department of Energy (DOE) and the American Council for an Energy-Efficient Economy (ACEEE).

In contrast to these well-developed efficiency initiatives that began over thirty years ago, the issue of clean energy supply lags far behind but deserves the attention of engineers in general, and structural engineers in particular, as energy systems integrators.

In 2002, the Architecture 2030 Challenge was initiated by architect Edward Mazria with a goal for buildings to become carbon-neutral by 2030 "…by implementing innovative sustainable design strategies, generating on-site renewable power and/or purchasing (20% maximum) renewable energy".

There are some who believe that this is possible by a combination of energy efficiency and clean energy supply. There are others who aim for a lesser goal of eliminating coal-fired power globally by 2030 and reducing gas- and oil-based power more gradually to become carbon-neutral by 2050.

While debates on greenhouse gas reduction scenarios may go on among science-based independent organizations, President Barack Obama's State of the Union address on January 25, 2011 issued a specific challenge:

> *"We're telling America's scientists and engineers that if they assemble teams of the best minds in their fields, and focus on the hardest problems in clean energy, we'll fund the Apollo projects of our time."*

In light of this, along with specific policy direction from leaders of America's scientists and engineers for "accelerating the development of renewable energy resources," it is worthwhile for structural engineers to define their role in the clean energy supply effort.

Wind energy serves as one example. Today, wind energy has become competitive with fossil fuel energy primarily because of domestic commercial development, even though other countries – such as Denmark, Germany, China, and India – started at least a decade sooner. In four years (2005-2009), the installed wind energy capacity in the U.S. has grown from less than 5,000 MW to 35,000 MW. By contrast, the total installed capacity of photovoltaic (PV) energy in the U.S. is only 11,000 MW after more than thirty years of heavily subsidized efforts in product development and commercialization. A DOE report states: "U.S. is on a trajectory that may lead to 20% of electricity coming from wind but ramping up further to ~16 GW/year and maintaining that pace for a decade is an enormous challenge, and is far from pre-determined."

The involvement of structural engineers in wind energy development is evident from three recent articles: on wind tower foundations (Malhotra, 2010), on wind tower structures (Hansen, 2010), and on wind turbine blade testing (Hines et al, 2011). Structural engineers have a major role in meeting this "enormous challenge" of maintaining wind energy growth, primarily due to: an increasing number of wind turbine suppliers in global and U.S. markets; the increasing size of turbines, towers, and wind blades; increasingly contentious debates on social and environmental impacts of utility-scale wind turbines (on- and off-shore); and, increasing awareness of distributed-scale wind energy.

The potential of wind energy for the fabricated steel market is substantial. The structural steel required for wind turbine support is about 113 tons/MW, so the total steel required for 16,000 MW/year is about 1.8 million tons/year, which is comparable with the mature fabricated steel markets for bridge construction (0.36 million tons/year), building construction (1.89 million tons/year), and industrial construction (1.46 million tons/year). Unlike the wind energy market, these mature fabricated steel markets are supported by well-established teams of design professionals (architects and engineers), steel suppliers, fabricators, and erectors operating with well-developed standards and regulations adopted by various trade associations and permitting authorities. Consequently, the DOE statement that maintaining a pace of 16,000 MW/year of wind energy development "… for a decade is an enormous challenge…" is entirely valid, and structural engineers have an opportunity to work with other stakeholders to support this ambitious pace.

Wind energy is distributed-scale clean energy and serves as an example for scientists and engineers to emulate for developing other technologies such as combined heat and power (CHP) plants, solar PV, concentrated solar PV (with CHP), concentrated solar thermal (with CHP and hybrid with biomass or natural gas), biomass/bioenergy, thermal energy storage and heat pumps, electrical energy storage, and smart grid. These technologies have unresolved technical, commercial, social, and environmental issues that require multidisciplinary engineering effort which may be led by structural engineers in their natural role as system integrators.

The push for clean energy supply is taking shape globally, but not in as organized a fashion as the energy efficiency effort in the U.S. The opportunity exists for structural engineers to reach out to other design professionals and collectively respond to President Obama's clean energy challenge by implementing the policy direction from America's leaders in science and engineering for "accelerating the development of renewable energy resources."▪

*Ashvin A. Shah, P.E. (**ashvinshah@aol.com**), is a structural engineer in Scarsdale, New York. He is active in voluntary work in clean energy technologies with engineers in India and the U.S.*

References:

Sustainability Guidelines for the Structural Engineer, edited by Dirk M. Kestner, Jennifer Goupil, Emily Lorenz, 2009, ASCE Press.

Sustainability: Thinking Beyond the Checklist, by Dirk M. Kestner, STRUCTURE magazine, June 2009.

Sustainable Design for Structural Engineers, by Michael Teller and Jillian Bergman, STRUCTURE magazine, December 2010.

Sustainability and the Structural Engineer – A Dialectic of the Structural Engineer's Role in Sustainable Building Practice, by Zak Kostura and Jennifer Pazdon, STRUCTURE magazine, January 2011.

Structural Engineers as Sustainable Designers, by Mark Webster, STRUCTURE magazine, March 2011. [STRUCTURE is published by Structural Engineering Institute (SEI) of the American Society of Civil Engineers jointly with NCSEA and CASE].

Tools for Reducing Carbon Emissions Due to Cement Consumption, by Dr. P. Kumar Mehta and Helena Meryman, STRUCTURE magazine, January 2009.

Creating an Alternative for Performance Concrete, by Jack Gibbons and Mark F. Chrzanowski, STRUCTURE magazine, February 2011.

American Council for an Energy-Efficient Economy, 529 14th Street N.W., Suite 600 Washington, D.C. 20045-1000. **www.aceee.org**

Architecture 2030, 607 Cerrillos Road, Santa Fe, New Mexico 87505, **http://architecture2030.org**.

Limiting the Magnitude of Future Climate Change, 2010, The National Academies Press, 500 Fifth Street, NW, Washington, DC 20001. **www.nap.edu**.

2009 Wind Technologies Market Report (August 2010), The Lawrence Berkeley National Lab, the US Department of Energy.

Supporting the Winds of Change, by Sanjeev Malhotra, Civil Engineering magazine, August 2010.

More Wind Power Requires Taller Towers – Taller Tower Require Innovation, by Peder Hansen, STRUCTURE magazine, November 2010.

Testing Tomorrow's Turbines, by Eric M. Hines and Mysore V. Ravindra, Civil Engineering magazine, July 2011

China Sets Rules and Wins Wind Power Game, The New York Times, December 15, 2010.

An Environmentally Friendly Investment – Lifecycle Assessment of a V80-2.0MW Onshore Wind Turbine, Vestas Wind Systems Brochure, Denmark

Structural Steel Utilization, Steel Interchange, Modern Steel Construction, September 2010, American Institute of Steel Construction, Chicago.