RFAB: Green Design

Green Design Overview

The World's First LEED Gold Certified Fab

In 2004, Texas Instruments embarked on an ambitious project to build the world's first "green," LEED-certified (Leadership in Energy and Environmental Design) semiconductor manufacturing facility in an effort to reduce construction and operating costs and the company's impact on the environment.

After collaboration with the Rocky Mountain Institute, months of research, careful planning and innovative design, construction of the company's first high-efficiency, million-square-foot chip fab was initiated. The office building and the manufacturing facility were both awarded a Gold LEED Certification.

Although building "green" required some additional investment to realize long-term operating benefits, it added up to less than 1 percent of the construction budget. In addition, the plant was successfully built for an estimated 30 percent less in cost than a similar TI manufacturing plant constructed just 6 miles away only a few years earlier. This latter achievement increased the building's cost competitiveness among other semiconductor manufacturing facilities being built outside of the U.S.

Design Process

A brief narrative on how RFAB came to be

In 2003, Texas Instruments announced it had selected a location in Richardson, Texas as the site for its next major semiconductor manufacturing plant. This site came to be known as RFAB , short for Richardson Fabrication. Before any design funding was approved for the construction of the facility, a small group of employees (TIers) began investigating sustainable design. They gathered information, compiled data and brainstormed ideas. The team generated a number of "white papers" on various topics related to sustainability. These papers looked beyond the surface of the simple payback economic analysis to understand the true overall return on investment.

TI defines sustainability as:

"Development that meets the needs of the present without compromising the ability of future generations to meet their own needs by considering long-term economic, environmental and social impact in the way we operate today."

Or simply, according to the World Business Council for Sustainable Development: "Development that balances people, profit, and the planet."

Garnering support by starting small

As the research team began to understand what was possible in their drive toward sustainable design, they knew they needed to solicit management support. A research team member offered TI's senior vice president of manufacturing a tour of his passive/active solar house. While the tour provided a good primer on sustainable design, it was the low operating cost that really caught the executive's attention. He wanted to know first and foremost, "How much of this design process scales up to a large facility?" The answer: "All of it!" The conversation ended with one last question, "What do you need to make this happen?"

Addressing cost challenges through innovation

In parallel with the drive to design a sustainable facility, the TI Worldwide Construction organization was challenged with trimming the cost of the new facility by 30 percent over the previous 300mm wafer fab. This turned out to be an advantage for the sustainability team because it required a new fab concept instead of just duplicating previous designs. This meant that sustainable features could be incorporated into the site plans from the start.

About a month before design funds were approved, more than 30 TIers convened with a dozen folks brought in by Amory Lovins and the Rocky Mountain Institute (RMI). The team held a 3-day design charrette to brainstorm ideas, then analyze and prioritize them. This list was dubbed the "Big Honkin' Ideas." It was also during the charrette that the team first seriously considered using the Leadership in Energy and Environmental Design (LEED) Green Building Rating System™.

Making concept a reality

The LEED documents served as a template and people rallied around the idea of scoring points for sustainable design. When the TI design team was named a month later, they had a general blueprint from which to work. A concept drawing was developed by the AMA Group, with many of the important sustainable architectural goals integrated into the concept.

In the end, most of the Big Honkin' Ideas were incorporated along with dozens of other items that came from the charrette.

Site Features

Incorporating sustainable features at the 92-acre site, land that was used to farm wheat in prior decades, required that special measures be taken before, during and after construction. TI's aim in the design was to restore the native prairie grassland on a large portion of the property, reduce consumption of natural resources, reduce pollution and generally lower environmental and community impact in many other ways.

Features of the site:

- *Compost-based silt fence*

Construction projects are required to install fences around the perimeter of the site to keep silt from running off into the street and storm sewers (and eventually the creeks and rivers). Most projects use a synthetic fabric material which is thrown away at the completion of the project.

TI chose a compost sock fence (right) for its 1.5 miles of perimeter. The material for the fence, a mixture of yard debris and other organic materials from neighborhood homes and businesses, is collected from a local city municipal composting facility. The "sock" material is a biodegradable plastic.

TI found that use of this organic material for erosion control had many benefits over the traditional synthetic materials. The natural wood chip compost not only successfully caught and held the sediment; it was also reusable. At the completion of the project, it was incorporated into landscaping. Overall, the compost sock fence provided a cost savings, reduced waste and exceeded the LEED prerequisite for erosion control.

- *Rainwater storage pond*

The site features a pond that is both functional and serene. The pond is located at the lowest elevation point on the site and successfully accomplishes several sustainable goals.

Site Runoff Reduction

After the completion of development on a piece of property the additional hard surfaces (concrete and roofs) contribute to increased storm water runoff, which can cause flooding downstream during heavy rain events.

TI installed a reservoir large enough to hold 2.7 million gallons of water, which will also buffer an additional 2 million gallons during a heavy rain and meter it out slowly to the adjacent creek. The holding time allows suspended particles to settle out as well. This system not only protects neighboring homes and businesses, but also provides a natural source of water for irrigation

Rainwater Collection for Irrigation

Although irrigation needs were reduced by extensive use of native grasses and plants, some irrigation is still necessary. TI's reservoir is an excellent resource for irrigation and also decreases the site's municipal water consumption. Because the pond is located at the lowest elevation on site, more than 80 percent of the 92-acre site drains into it. A one inch rainfall will supply more than a million gallons of refill water. The site facilities' air conditioning condensate also drains into the pond. During the summer this will provide a stream of 20 gallons per minute of water (864,000 gallons/month).

- *Windmill-driven pond aerator*

One important component in the health of a large pond is the balance of dissolved oxygen in the water, which can also impact plant and animal life.

Most pond aeration systems use an electric-powered pump to spray water into the air to pick up oxygen. This method only oxygenates surface water and results in an increased rate of evaporation.

TI chose a pond aeration solution that requires no electricity to operate, disperses oxygen to all levels of the water, and is in keeping with our Texas heritage - a windmill. The Koenders Windmill uses the wind to run a small air compressor that bubbles up to 1.5 cubic feet per minute of

air through the pond. This gentle stream of air bubbles is the most efficient way to provide oxygen to the water.

- *Landscape restoration and maintenance*

- *Reflective concrete to mitigate the urban island heat effect*

Concrete, and especially darker-colored asphalt, absorb solar heat during the day and release it slowly overnight. This contributes to the Urban Heat Island Effect. Large cities, as a result, have a much hotter evening temperatures than the surrounding countryside.

Asphalt road surfaces can easily reach 150° F in the sun. Concrete can reach 130° F. By using a white concrete with a reflectivity of at least 30 percent we can minimize the amount of heat absorbed and stored in the surface.

Fly Ash

In addition we used approximately 25 percent fly ash in our concrete mixes. Fly ash is one of three general types of wastes produced by coal fired power plants. By using fly ash, we helped lessen environmental impact through reduced waste, conservation of natural resources, and reduced pollution. For example, each ton of fly ash used saved about one barrel of imported oil and equated to about a ton of CO2 savings. Fly ash also improves the performance, strength and quality of concrete. The techniques for working with this type of concrete are standard for the industry and did not impact the project's budget.

- *Full cutoff light fixtures to reduce light pollution*

Light pollution is excessive or obtrusive light created by humans. It is also a sign of wasted lighting energy. Light pollution can make it difficult to see stars in the sky above cities. It can also interfere with astronomical observatories, cause unwanted glare on surrounding neighbors, and disrupt ecosystems. Since the early 1980s, a global movement has been working to curb light pollution. One effective strategy is to use full cutoff light fixtures outdoors. These units have no direct uplight, help eliminate glare, and are more efficient by directing all lighting down to the intended area only.

Office Building Features

The RFAB site office building is a three-story, 220,000 square foot structure. This is where support and administrative teams will work in an office environment. In the concept phase, the design team used an energy model to demonstrate how the orientation and general shape of the building could reduce operating expenses with no additional cost.

Sustainable features of the office building offer four distinct benefits:

- *Energy Savings*
  - Passive solar orientation—placement of a building's walls, windows and overhangs in a manner that reduces energy requirements—minimizes unwanted sunshine
  - Exterior shade screen minimizes summer heat
  - Light shelves reduce the need for indoor lighting by bouncing daylight deeper indoors
  - Reflective roofing reduces the urban heat island effect
  - Quality window glazing provides a balance of good insulation and good visible light transmission
  - Smart lighting has a built in motion sensor and photo sensors so they can respond to indoor conditions. It also gives employees control of area lighting through their work computer
  - Solar water heating
  - Water turbine-powered hand wash faucet sensors
  - LCD monitors for all computers

- *Water Savings*
  - Waterless urinals save 40,000 gallons of water each per year

- *Improved Air Quality*
  - CO2 sensor controlled ventilation provides the intake of fresh air as needed
  - Ventilated copy rooms
  - Safer building materials, including paints, sealants and adhesives made with more benign materials
  - Locally manufactured materials shipping pollution
  - Shuttle buses, free annual mass transit passes, a carpool matching program and other benefits will be available to employees to discourage single occupant commuting, which contributes to smog in the area

- *Reduced Material Use*
  - The recycled content of all materials used in building construction is greater than 20 percent
  - Ceiling tiles used in the building have a recycled material content greater than 80 percent
  - The carpet is made from recycled materials and has very low emissions
  - Fly ash used in the site's concrete helped conserve energy, saved about one barrel of imported oil, and equated to about a ton of CO2 savings. Fly ash also improves the performance and quality of concrete
  - Recycling centers make it easy for employees to minimize and sort wastes
  - Certified wood and wheatboard used throughout the building ensured the wood we purchased was extracted in a sustainable manner and contribute to the preservation of old growth forests
  - High-velocity hand dryers conserve paper towels

Fab Building Features

The fab (short for fabrication) building is the largest building on the RFAB campus.

Sustainable features of the fab offer many benefits:

- Well insulated and air tight construction help maximize energy efficiency
- High efficiency fan filter units provide air recirculation and cleaning but require less energy than traditional units
- Run-around coils on the make-up air provide free reheat on the discharge side of the unit
- Use of bigger and straighter pipes and ducts reduce pressure loss, which allows smaller, more efficient fans and pumps to be used
- Gravity-driven waste streams eliminate the need for pump stations
- Premium efficiency motors help reduce help reduce energy consumption

Utility Building Features

RFAB's Central Utility Plant, or the CUP, houses all the large support equipment needed to operate the manufacturing facility. Systems include chillers, boilers, cooling towers, exhaust systems, process cooling water, plant vacuum, and deionized (DI) water.

Sustainable features of the CUP:

- Natural ventilation
- A split temperature chiller plant operates more efficiently and enables waste heat recovery
- Heat recovery from chillers and air compressors reduces energy consumption and emissions associated with natural gas fired boilers
- Extensive manufacturing water reuse (approximately 35 percent) reduces city water consumption

Certifications and Awards

LEED® Gold

The Leadership in Energy and Environmental Design (LEED) Green Building Rating System™ is a voluntary, consensus-based national rating system for developing high-performance, sustainable buildings. TI RFAB's administration and wafer fab buildings both achieved LEED Gold certification in 2004. The system, developed by the U.S. Green Building Council, assesses building practices in five areas – site development, water savings, energy efficiency, materials section and indoor environmental quality.

Summit Award

TI received the 2005 Summit Award for Environmental Excellence, which recognizes a company program that demonstrates environmental leadership that also enhances business performance. TI was one of six finalists for the award, which is presented annually by the Leeds School of Business at the University of Colorado at Boulder.

Sustainable Leadership Award

TI was announced as the winner of the 2006 Sustainable Leadership Award in the private sector, multinational company category by CoreNet Global. Texas Instruments was recognized as a leader in sustainable innovation and implementation among its peers.

Topping Out

TI was awarded first place in Topping Out Magazine's "Topping Out Award" for RFAB's innovative design and positive impact on the community.

Texas Instruments