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. The aim of the endeavor was to reduce construction and operating costs and to minimize impact to surrounding communities and 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 LEED Gold.

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.

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 simple economic payback to understand the true overall return on investment, including social and environmental benefits.

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."

Starting small

As the research team began to understand what was possible in their drive toward sustainable design, they knew they needed management support. One of the team members subsequently 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?"

Reducing cost through innovation

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 experts from the Rocky Mountain Institute (RMI), including Amory Lovins, a renowned environmental scientist and RMI co-founder. 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 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 site 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.

Sustainable features

Incorporating sustainable features at the 92-acre site, land used to farm wheat in prior decades, required 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, reduce operating costs and generally lower environmental and community impact in many other ways.

Site Features

- *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 after completion of the project.

  TI chose a compost sock fence 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. After 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 release it 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 1-inch rainfall will supply more than a million gallons of refill water. The site facilities' air conditioning condensate also drains into the pond.

- *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.

- *Reflective concrete*

  Concrete, and especially darker-colored asphalt, absorb solar heat during the day and release it slowly overnight. This contributes to the urban heat island (UHI) effect. Large cities, as a result, have a much hotter evening temperatures than the surrounding countryside.

  Asphalt road surfaces can easily reach 150F in the sun. Concrete can reach 130F. 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.

  - Material reuse —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 CO_2 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*

  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 cut-off 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 minimized unwanted heat gain from sunlight
  - Exterior shade screen minimizes summer heat
  - Light shelves reduce the need for indoor lighting by bouncing daylight deeper indoors
  - Reflective roofing reduces the UHI effect
  - Quality window glazing provides a balance of good insulation and good visible light transmission
  - Smart lighting with built-in motion and photo sensors 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 each save 40,000 gallons of water per year

- *Improved air quality*
  - CO_2 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 reduce shipping pollution
  - Shuttle buses, subsidized mass transit passes, a carpool matching program and other benefits are available to employees to discourage single occupant commuting
  - Covered parking for bicycles and showers/lockers are provided

- *Reduced material use*
  - The recycled content of all materials used in building construction is greater than 35 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
  - Recycling centers make it easy for employees to minimize and sort wastes
  - Certified wood and wheatboard used throughout the building supports sustainable timber harvesting and productive use of agricultural waste products
  - High-velocity hand dryers reduce paper towel use

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 airtight 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 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 2008. The system, developed by the U.S. Green Building Council, assesses building practices in five areas – site development, water efficiency, energy and atmosphere, materials and resources, 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.

Other LEED certifications

Following the success and lessons learned from the construction of RFAB, all new TI facilities are now built to LEED standards. TI currently has four LEED-certified buildings. In addition to the two RFAB certifications, TI has one additional LEED Gold certification in the Philippines, as well as one LEED Silver-certified facility, also in the Philippines.

Texas Instruments