

Presented by Phil Risner, Jeff Black and Bruce Kester



Persistently Platinum: Dell Children's Medical Center of Central Texas





ASHRAE Research Strategic Plan 2010-2015



Navigation for a Sustainable Future

Goal 1: Maximize the actual operational energy performance of buildings and facilities

ASHRAE Research Strategic Plan 2010-2015

Navigation for a Sustainable Future

Technical Challenges:

Available data strongly suggest that the actual energy use of buildings is often higher than design energy use and/or higher than necessary to deliver the required services.

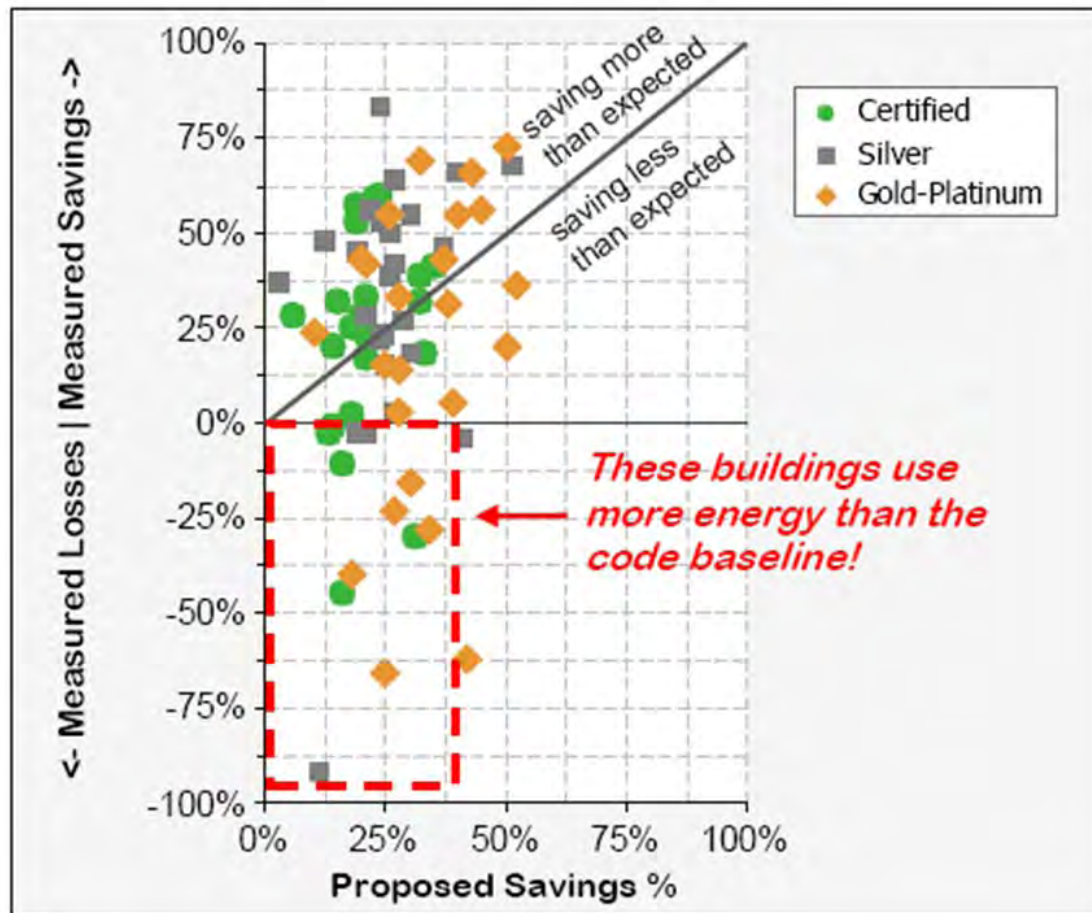
National Research Council Canada – Institute for Research in
Construction **NRCC-51142** *August 2009*

- ▣ On average, LEED buildings used 18-39% less energy per floor area than their conventional counterparts.
- ▣ However, 28-35% of LEED buildings used more energy than their conventional counterparts.

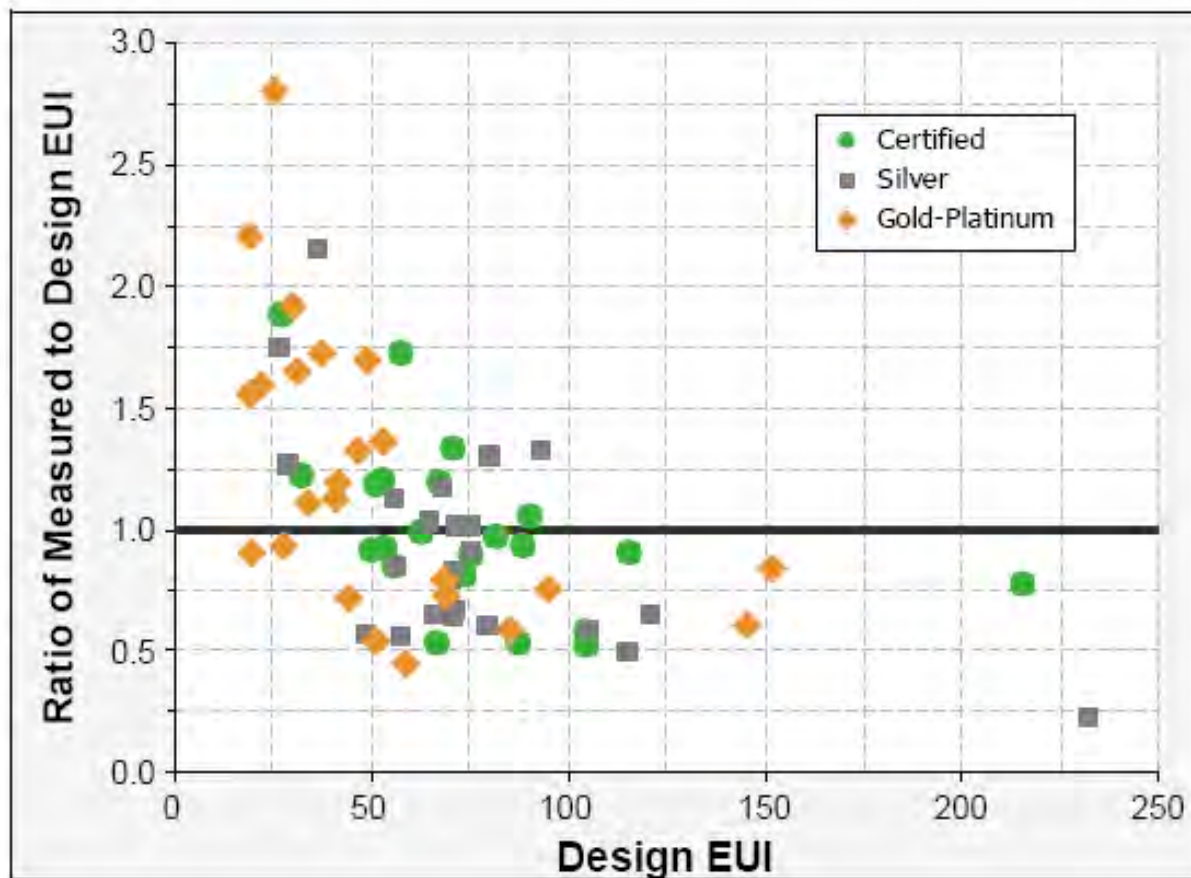
Measurement and Verification

- ❑ As critical as M&V is it is often undervalued and misunderstood.
- ❑ To illustrate the point: In 2008, the New Buildings Institute issued a report on the energy performance of LEED-NC certified buildings.
- ❑ Their sample pool was 522 buildings.
- ❑ **Only 121 buildings or 22% of the buildings were able to provide at least one full year of measured post-occupancy energy usage data.**
- ❑ On top of that was the finding that approximately 50% exceeded the design expectations but fully 50% did not meet design expectations with a portion of the buildings performing worse than the ASHRAE baseline.

Measured v. Proposed Savings Percentages



Energy Use Intensities (EUI)



LEED 2012 Measurement and Verification

- One of the changes incorporated in LEED Version 3 is the re-weighting of measurement and verification from 1 point to 3 points and the requirement to provide a process for corrective action if the M&V plan shows energy savings are not being achieved.
- Include a Building Sustainability Dashboard

DCMCCT Hospital Statistics

- ❑ 515,907 SF
- ❑ 176 licensed beds
- ❑ \$130M Construction Cost (257\$/sf)
- ❑ \$206M Capital Budget (408\$/sf)
- ❑ 32.2 acres of a 722-acre Brownfield Site
- ❑ LEED Platinum Certification
- ❑ AEGB 5 Star Certification
- ❑ Combined Cooling/Heating Power Plant
- ❑ 35,500 SF
- ❑ \$18M Construction Cost



LEED Scorecard

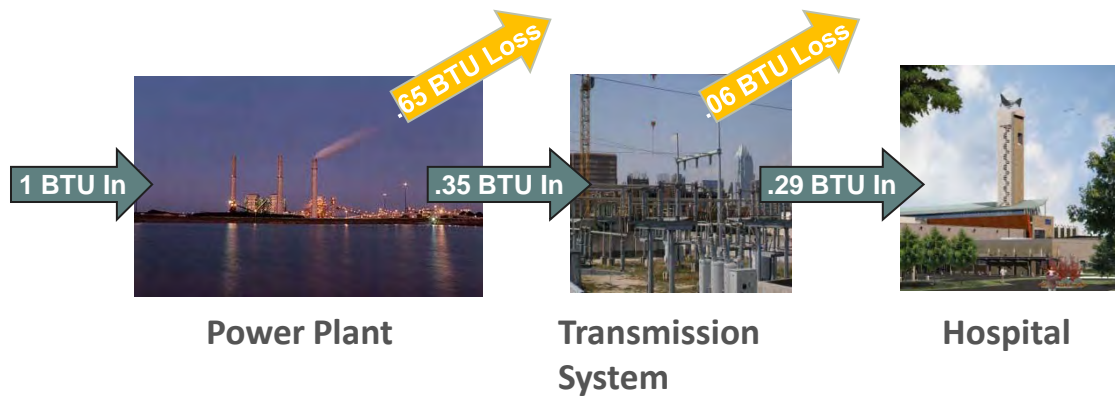
- ▣ Sustainable Sites 13 of 14
- ▣ Water Efficiency 4 of 5
- ▣ Energy and Atmosphere 14 of 17
- ▣ Materials and Resources 7 of 13
- ▣ Indoor Enviro Quality 11 of 15
- ▣ Innovation & Design 5 of 5



Energy Conservation Measures Implemented

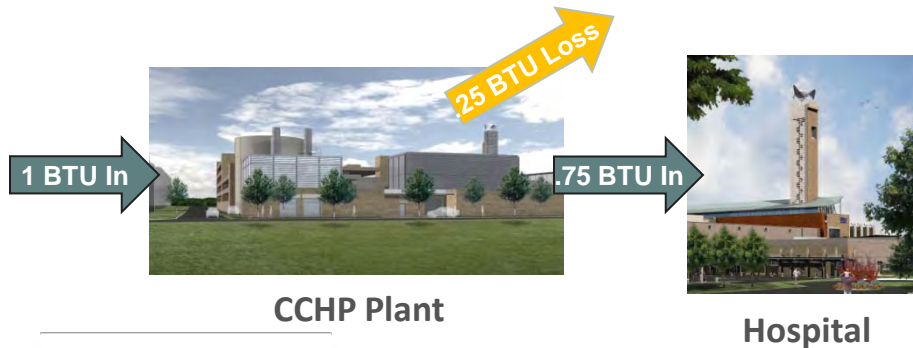
- ▣ Dedicated OA Units w/ Exhaust Heat Recovery
- ▣ CO₂ Ventilation Control in Public Areas
- ▣ High Performance Shading and Glazing
- ▣ High Efficiency Lighting
- ▣ Lighting and Daylighting Controls
- ▣ UFAD in Administration Area
- ▣ Night & Unoccupied setback inc ORs – all areas except patient wings
- ▣ Economizer cycles on AHUs serving Admin and Public areas
- ▣ Low Pressure Drop Ductwork and Piping
- ▣ High End Monitoring and Control System

CCHP – Comparative Efficiency



Typical Power Delivery:

At Austin Energy's Fayette Power Station, about 35% of the primary fuel is converted into electricity; the remainder is lost "up the stack". An additional 6% efficiency drop occurs in transmission to the site. Overall, at the Hospital's meter, the result is roughly a *29% efficient primary fuel conversion to useful energy.*



Dell Children's Power Delivery:

Austin Energy's Building Combined Cooling, Heating and Power Plant at the Dell CMCCT will be *75% efficient at primary fuel conversion to useful energy.*

This is a *46% savings in primary energy utilization* compared to the Typical Power Service Model.

Significant Emission Reduction (AE's Traditional Power Sources vs. CHP)

Austin Energy's Fleet
Central Power Plants
(including nuclear)



- ▣ CO2 1162 lbs/MWh
- ▣ SO2 2.33 lbs/MWh
- ▣ NOx 0.6 lbs/MWh

CHP Plant



- ▣ CO2 615 lbs/MWh
- ▣ SO2 0.003 lbs/MWh
- ▣ NOx .043 lbs/MWh

Carbon Dioxide: 47% reduction

Sulphur Oxide: 99% reduction

NOx: 93% reduction

Design Load Iterations (Peak)

	ELECTRIC (kW)	HVAC (tons)	STEAM (lb/hr)
Dec-03	2,500	2,000	22,000
May-04	2,500	1,800	18,400
Nov-04	2,077	1,537	11,496
Jul-06	2,361	1,230	10,714

CCHP

Enhanced quality of power, assuring smooth, continuous operation of clinical equipment

- ❑ 2 Electrical feeds from different substations in the surrounding power grid provide 100% electrical redundancy.
- ❑ Emergency generator provided for the CCHP black start up provides a third back-up for Life Safety Systems.
- ❑ Allowed building to go from 17.2 to 61% better than ASHRAE 90.1



Efficiency measures save enough power to fuel about 1,800 homes.

CCHP cont.

- ❑ 4.3 MW Mercury 50 Solar Gas Turbine
- ❑ 930 ton 2-stage Absorption Chiller
- ❑ Heat Recovery Steam Generator (HRSG)
- ❑ 900,000 gallon 8,000 ton-hour Chilled Water Storage tank
- ❑ 1,500 ton dual compressor centrifugal chiller
- ❑ 24,500 lb/hr conventional standby boiler



DCMCCT Green Power / CO2 Reduction

- ▣ 2009 average electrical consumption equaled 947,000 KWH
- ▣ Green Choice Power equivalent to 87% of the total average electrical consumption.
- ▣ Approximate CO2 reduction from the CHP for the remaining 13% electrical consumption of the hospital was 27 tons/month.
- ▣ **Total atmospheric CO2 reduction for 2009 is over 1,000,000 lbs. per month or 6,000 tons per year**
- ▣ Equivalent to the annual greenhouse gas emissions from 1,041 passenger vehicles

Capital Infusion

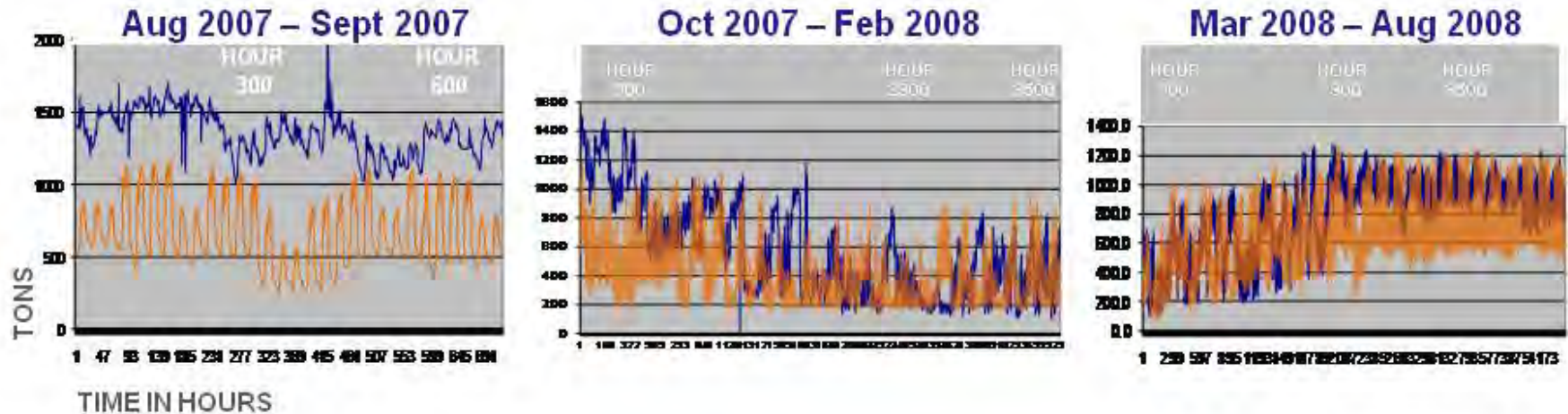
Gross Capital Savings of \$6.8M from *not* building a Central Plant: cooling towers, chillers, emergency generators & space.

Reinvested \$5.8M of these savings into building energy conservation measures and other LEED initiatives yielding intangible savings



Actual Loads vs. Design Projections

— ACTUAL LOAD
— PROJECTED LOAD

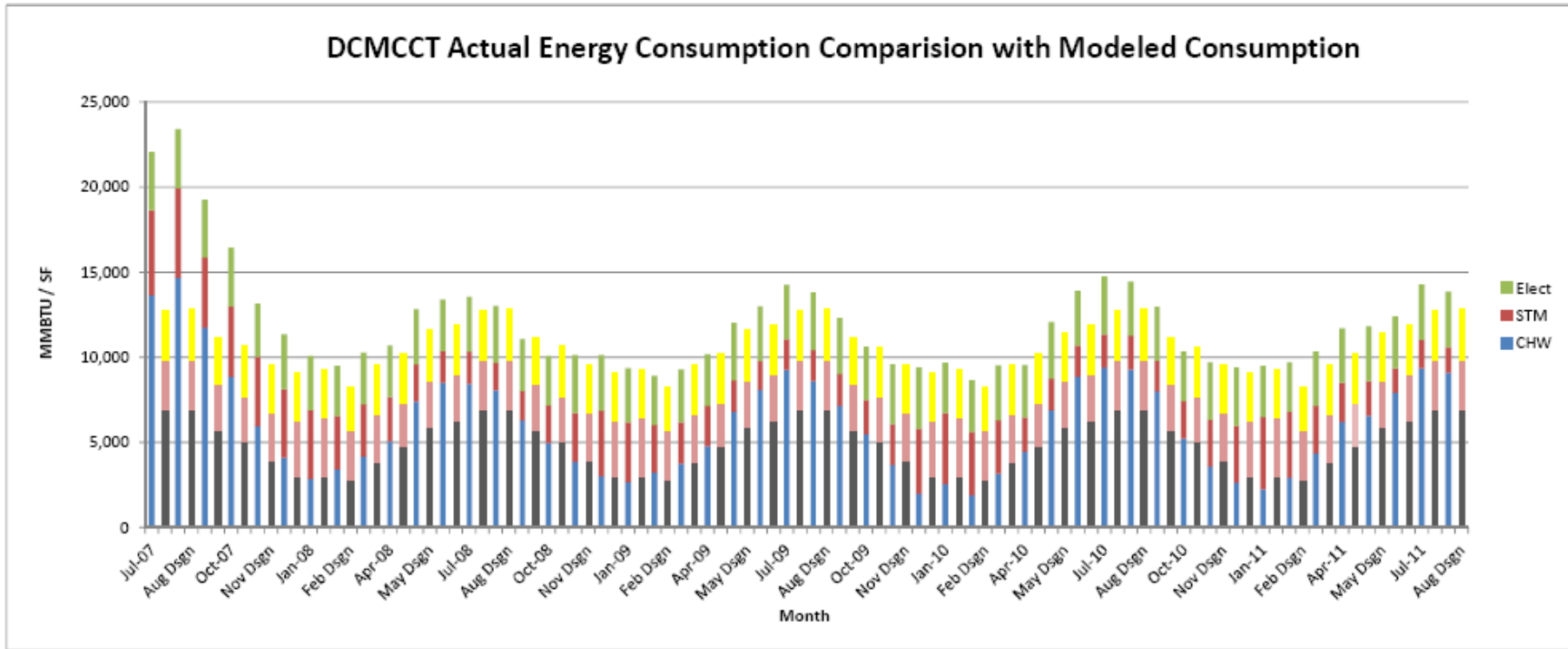


Projections based on January and February data indicated that chilled water peak tonnage would be in the 1400 – 1500 ton range – close to original "budget" projection vs over 1800 peak tons seen at opening. Actual Peak Summer Tonnage was in the 1230 to 1240 ton design range as a result of optimization.

Chilled Water and Electrical design projections during the summer months were not achieved, partly due to above average temperatures and partly due to optimistic off-peak hour modeling assumptions. Steam peak demand and consumption was significantly better than modeled projections as a result of post occupancy optimization efforts.

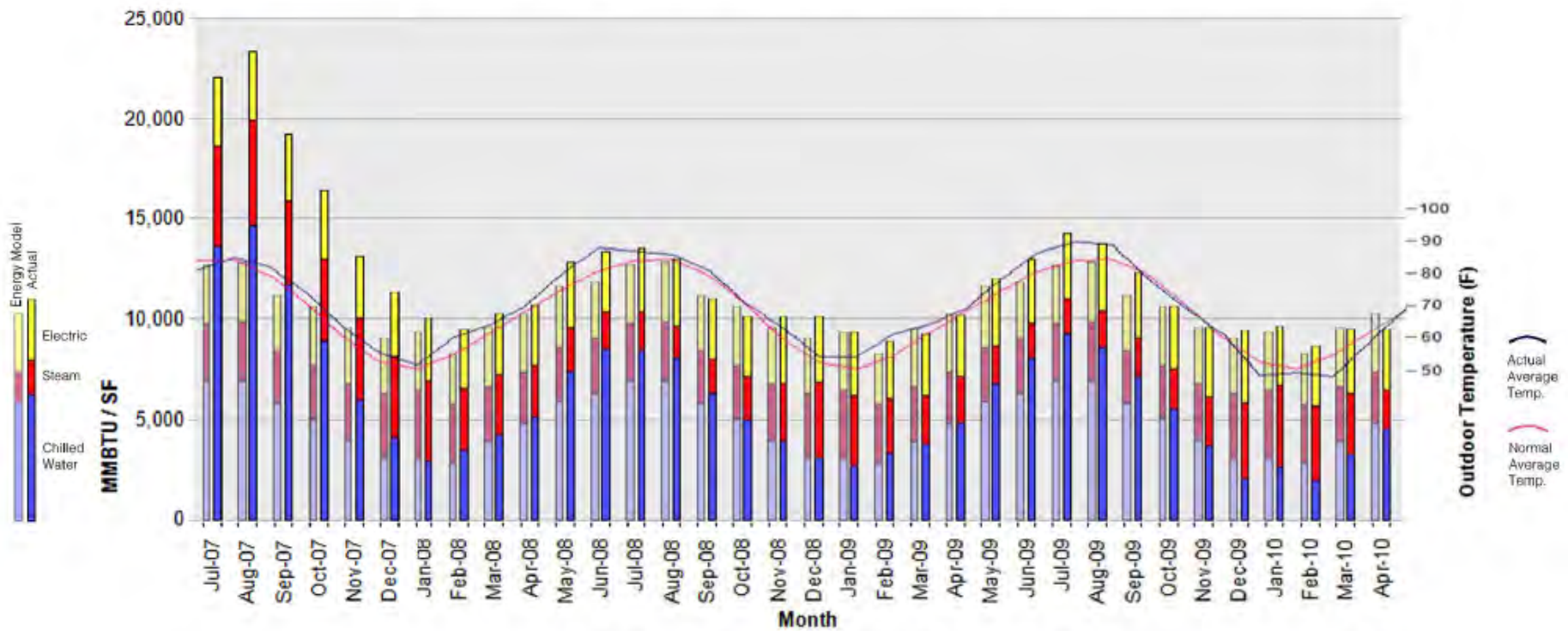
Additional night setback and discharge air temperature optimization in July 2008 resulted in noticeable reductions in August 2008. Future ECMs (to be funded by Austin Energy Rebates):
 Additional lighting occupancy sensors to reduce electrical consumption
 Isolate small 24/7 areas off large air handling systems to improve off-hour performance
 Future Goal: Achieve Energy Star Rating

Actual vs. Modeled Energy Consumption July 2007 – August 2011



Building Energy Performance – Actual v. Model

DCMCCT Actual Energy Consumption Comparison with Modeled Consumption



2008-11 Summer Cooling Degree Days

The ASHRAE 1% occurrence design temperature for Austin is 97.5F with a mean coincident wet bulb of 74.5F.

Month	Act CDDs	Avg CDDs
Jun-08	681	495
Jul-08	676	605
Aug-08	655	610
Jun-09	654	495
Jul-09	766	605
Aug-09	755	610
Jun-10	581	495
Jul-10	612	605
Aug-10	743	610
Jun-11	667	495
Jul-11	771	605
Aug-11	832	645
Total	8393	6875

Commissioning and Warranty Phase Issues

- Electrically enhanced ionization air filters **electrical harness cable failures**
- **Replacement** of OAU steam preheat coils
- BAS control, condensate drain and **sizing issues** with OAU humidifiers
- OAU Heat Pipe Spray assemblies **drain pan additions and drain piping modifications**
- Surgery Unit HEPA **filter replacements**
- Under Floor Air Distribution Device **OEM transformers, wiring and control failures**
- **BAS intercommunication issues** with Seton IS network.
- AHU airflow monitor station **transmitters drift and calibration problems**
- Installed domestic water and steam flow meters control range **based on future loads**
- Daylight Harvesting System **programming and controller failures**
- **Placement and control setting issues** with occupancy sensors
- Communication room AC unit fan on-off **control integration**
- **Undersized** exhaust fan for the Pharmacy Chemo IV Prep clean hood
- Domestic hot-cold water **cross connection – never found**
- **Undersized** Domestic Hot Water recirculation pumps
- **Capacity issues** the RO/DI water system serving the autoclave clean steam generator

Post Commissioning Modifications

- ❑ Evaluated all rooms for air change rates and minimum VAV flow set-points and modified numerous minimum set-points to take better advantage of the AHU VAV capabilities while still maintaining Texas hospital code and ASHRAE 62 required air change rates. Approximately 10% of the total minimum volume was trimmed which equates to roughly 140 tons of chilled water demand
- ❑ Continuous outside air tracking and set-point adjustment was implemented to optimize the outside air supplied to the various areas of the hospital based on the required percentage of OA to SA. An estimated 25,000 cfm of outside air was conserved by this effort, or approximately 15% of the total outside air originally scheduled

Post Commissioning Modifications

- ❑ Control modification made to use the Surgery OAU dessicant dehumidification only when the chilled water coil cannot lower the dewpoint to 48 F.
- ❑ Datacom room temperature setpoints were raised from 68F to 75F after IS approval
- ❑ Space temp setpoints and ranges
- ❑ Implemented cold deck temperature reset based on outdoor air temperature from 48.5F to 49.5F range to 56F to 59F at outside air temperatures above 85F - OAU cooling coil leaving air temperatures set at 56F

Lessons Learned – Design Phase

- ❑ Join the building design engineer and energy modeler at the hip during schematic design and don't let them separate until after construction documents have been completed.
- ❑ Recommend a minimum of 4 iterations of the energy model (SD, DD, CD prelim and CD final) be performed.
- ❑ The HVAC/control system design must comprehensively implement the energy conservation strategies used for the energy modeling.

Lessons Learned – Commissioning-Construction Phase

- ❑ Thorough submittal review is required to ensure ECMs are met per design intent and that even obvious things do not fall through the cracks.
- ❑ The construction manager / general contractor should build the construction schedule with priority given to complete all commissioning prior to occupancy.
- ❑ Conduct post-commissioning after occupancy for greater energy savings.
- ❑ Evaluate and adjust design set-points and parameters after occupancy to optimize energy performance.
- ❑ **Energy Management requires operations staff training beyond O&M training.**

Owner involvement in commissioning offers several advantages, the most beneficial of which is the ability to stay with the project through and past the warranty period to help identify and ensure that problems are addressed.

Missed Energy Conservation Measures

- ❑ Economizers for all air handling units
- ❑ Smart lighting controls
- ❑ Individual fan coil units for 24/7 areas such as on-call rooms, security offices, etc.
- ❑ UV in air handling units in lieu of ionization filters
- ❑ Better monitoring sensors and in more locations (air and water flows and lighting)
- ❑ Lab exhaust heat recovery and VAV fume hoods

Future Improvements

- Lowering of Lighting Power Density
- De-lamping and lower wattage replacement lighting
- Parking garage occupancy sensors
- Exterior stairwell lights photocells and occupancy sensors
- Additional occupancy sensors for mechanical, electrical and other miscellaneous rooms throughout the hospital
- Fan coil units for Security, Cath. Lab Equip, and Surgery /Anesthesia On-call rooms
- BAS Static Pressure Reset
- Modifications and repair to existing Daylight Harvesting system
- **Monitoring and setback of unoccupied patient rooms**
- Solar water heating



Future Improvements



Hospital Case 2

Making Cost-Effective Decisions Early in the Hospital Design Process

Ascension Health/Seton Family of Hospitals—Dell
Children's Medical Center of Central Texas

Location: Austin, Texas

Current Size: 176 beds; 515,000 ft²

Planned Addition (early estimate): 72 beds; 75,000 ft²

Functions: Intensive care and medical/surgical patient
beds

Photo by Seton Family of Hospitals, used by permission.



Background

When Dell Children's Medical Center of Central Texas was completed in 2007, it received a LEED® Platinum rating. One sign that the design has transitioned successfully to the operational phase is that the annual building energy consumption has been tracking within about 5% of design model predictions for the past two years.

In addition to these successes, hospital engineers also faced some challenges that have informed improvements to the health system's subsequent building designs. For example, Seton Family of Hospitals is applying lessons learned at the existing building to improve metering in a tower addition planned for 2013.

Example: Steam Metering and Growth

In anticipation of future growth, the steam piping was sized for more than 1 million ft² of hospital floor area, and the steam meters for high-, medium-, and low-pressure steam were sized to match the piping. Consequently, the steam meter readings will be useful in the long term, but the flows in the near term are too low for the meters to provide accurate readings. The health system investigated solution options when the problem was discovered, but the taps were meter specific, and the vendor was unable to offer a workaround solution.

To improve future projects, owners should consider both present and future loads during piping design. In continuously operational facilities, solutions that do not require future interruption of steam supply will be favorable. If anticipated expansion is significant, solutions may include adjusting the piping design or metering key branches to allow for a more complete metering approach that captures steam use in both the near and long term.

Example: Site-Specific Product Considerations

Turbine meters were installed to measure hot and cold domestic water use in the existing building, but the hard water in Austin led to calcium deposits that prevented the meters from working properly. The owner will consider alternative meter designs in future projects to meter domestic water use as was originally intended. Throughout an integrated building design process, considering site-specifics can improve the success of metering efforts.

Example: Anticipating Electrical Distribution Design Needs

When an intraoperative magnetic resonance imaging (MRI) unit was added two years after building completion, the owners intended to monitor its energy consumption by metering panel loads in the shielded operating room. They soon discovered, however, that the original design did not account for metering due to complexities of the shielding. Radio frequency shielding requires all penetrations to be isolated, and in the case of power or signal wiring penetrations, the type and location of electrical filters are determined in coordination with the shielding vendor or contractor. Without such coordination during building design, it is difficult to implement changes later. Another complication is that electronic devices, including power monitors, cannot be placed within the shielded enclosure unless they are compatible with the MRI system.

Additionally, Seton Network Facilities reports that because the MRI power is coming directly from the main switchgear room rather than a new electrical room that was built for the project, metering the MRI would be difficult and cost prohibitive after the fact. The takeaway for other facilities is that design teams should evaluate prospective metering needs and plan electrical systems accordingly early in the design process. For example, if another facility were to encounter a similar case and identify the problem early enough, one solution

Hospital Case 2

Making Cost-Effective Decisions Early in the Hospital Design Process

could be to specify a “smart” breaker for the panel in the main switchgear room.

Dell Children’s planned tower addition will not include major process or medical equipment, but a related improvement in its design process is that the owner is asking the design team to dedicate separate panels to lighting to support cost-effective submetering of the lighting load. Other target loads, such as air handler unit energy, are under consideration for panel segregation and metering.

Whether or not these loads are metered when the building opens, the key is that the discussion occurs early in the design process. By dedicating panels to a single type of load and planning electrical distribution at the outset, the owner will be able to cost-effectively install meters either during construction or as part of a future project.

Recommended Steps for Hospitals ▼

The target audience for this approach includes health systems that are :

- Considering or proposing a new construction project.
- Starting the schematic design phase of a project.

The following approach is more likely to succeed for health systems that:

- Use an integrated design process.
- Engage their building operators early in the design process.
- Clearly document and communicate owner expectations to the design team.

Steps to support cost-effective metering early in the design process include:

- Identify monitoring capabilities that will be desired at project completion.
- Identify monitoring capabilities that may be considered in the long term.
 - Review planned and prospective additions to the building.
 - Review planned and prospective changes to end uses, such as major medical equipment or process loads.
- Work with the design team to identify and meet needs in electrical distribution design and component selection to enable both near and long term metering.
- Work with the design team to identify and meet needs in piping design and component selection to enable both near and long term metering.
- Evaluate meter product options for limitations and site-specific considerations.

Mueller Energy Center's Plant Modules

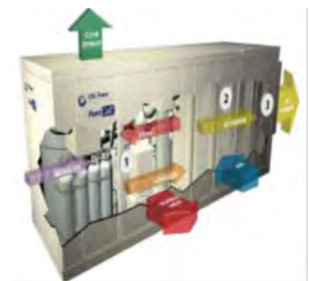
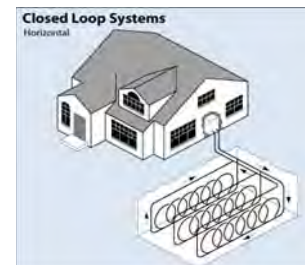
- ▣ Packaged CHP Plant
- ▣ Mercury 50 – 4.3 MW, 38% efficiency, 5 ppm
- ▣ HRSG w/burner
- ▣ Packaged Boiler – 22,000 lb/hr
- ▣ 930 ton steam absorption chiller
- ▣ Packaged Chiller Plant – 1500 ton
- ▣ Thermal Storage Tank – 8000 ton/hr
- ▣ Packaged Emergency Generator – 1500 kW

Keys to Success for CHP and Small Gas Turbines at Austin Energy

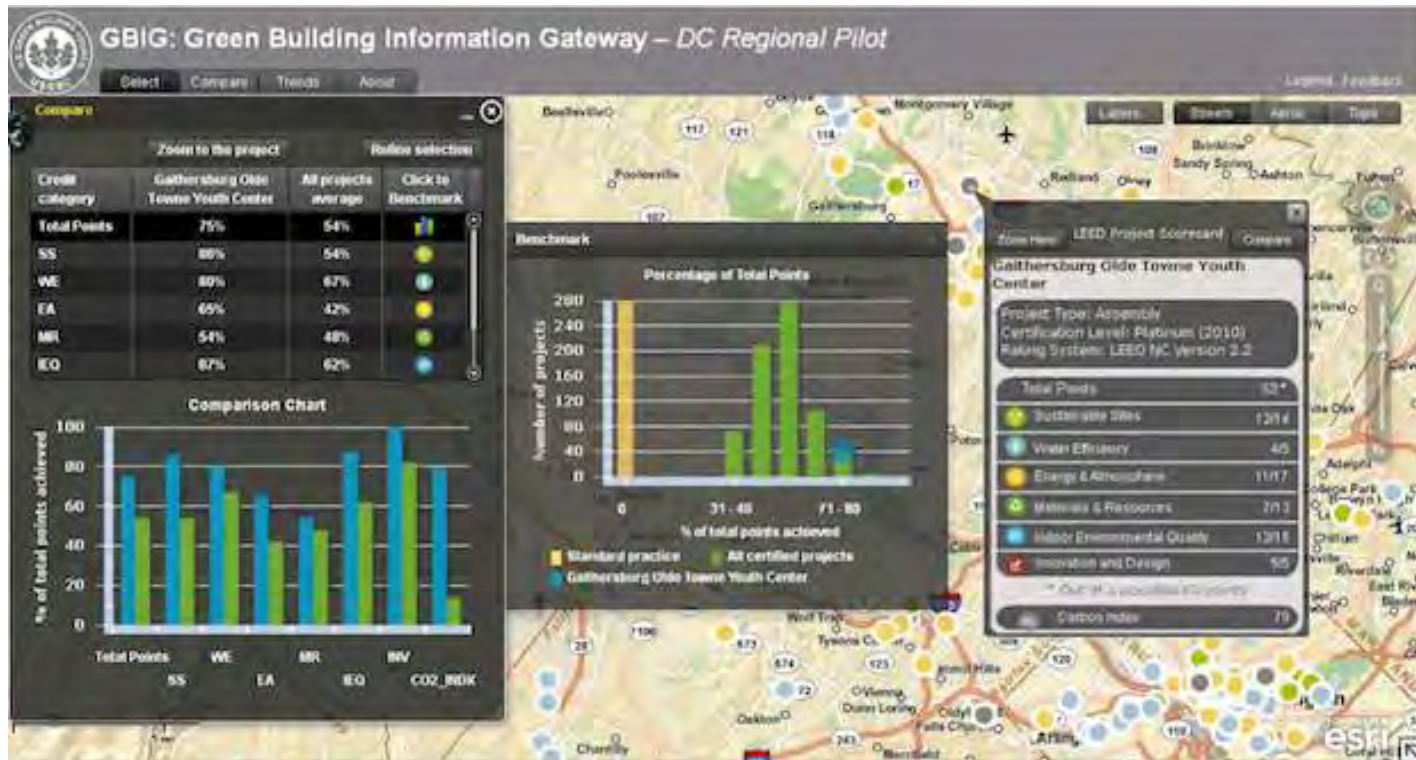
- ▣ Understand annual load profiles (8760 hrs.) and Stage Size equipment for Part Load and Full Load Efficiency
- ▣ Design to thermal base load
- ▣ Match prime mover to deliver the waste heat
- ▣ Maximize flexibility in design
- ▣ Proforma
 - Value of electricity (to customer and grid)
 - Value of thermal (chilled water, steam, hot water, etc.)

The Future: Evaluate, Design, Install and Operate Renewable Energy Components such as:

- ▣ Photovoltaic Panels and Film
- ▣ Solar hot water
- ▣ Mega Watt to Micro-turbines
- ▣ Geothermal heat pumps
- ▣ Fuel cells – small localized application v. large scale delivery
- ▣ Wind turbine
- ▣ Heat recovery electric chillers
- ▣ Green roof technology - O₂ production & O₂ reduction
- ▣ Insulating Technology
- ▣ Fenestration Technology
- ▣ Biofuel, Biowaste/methane and Bio composting Generators



LEED 2012: The USGBC Adds Teeth, Real-Time Reporting To Its Green Building Ratings



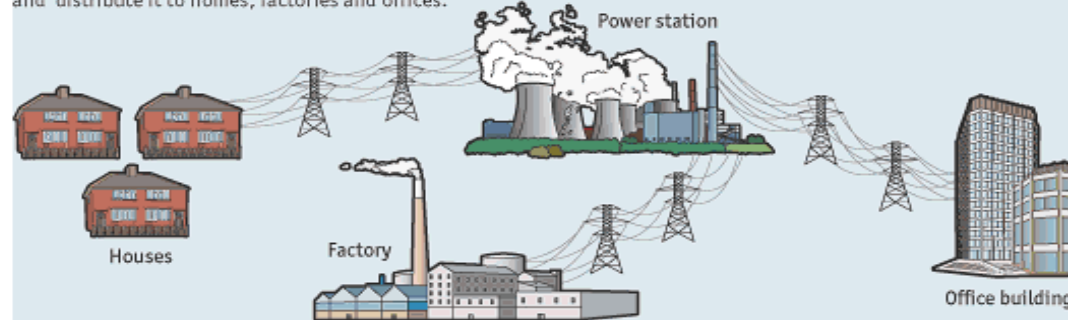
Responding to criticisms that its ratings can be meaningless and easily gamed, the USGBC is introducing new rules so buildings must continually recertify and measure their energy use against their neighbors.



Why Do We Need a Smart Grid?

Conventional electrical grid

Centralised power stations generate electricity and distribute it to homes, factories and offices.

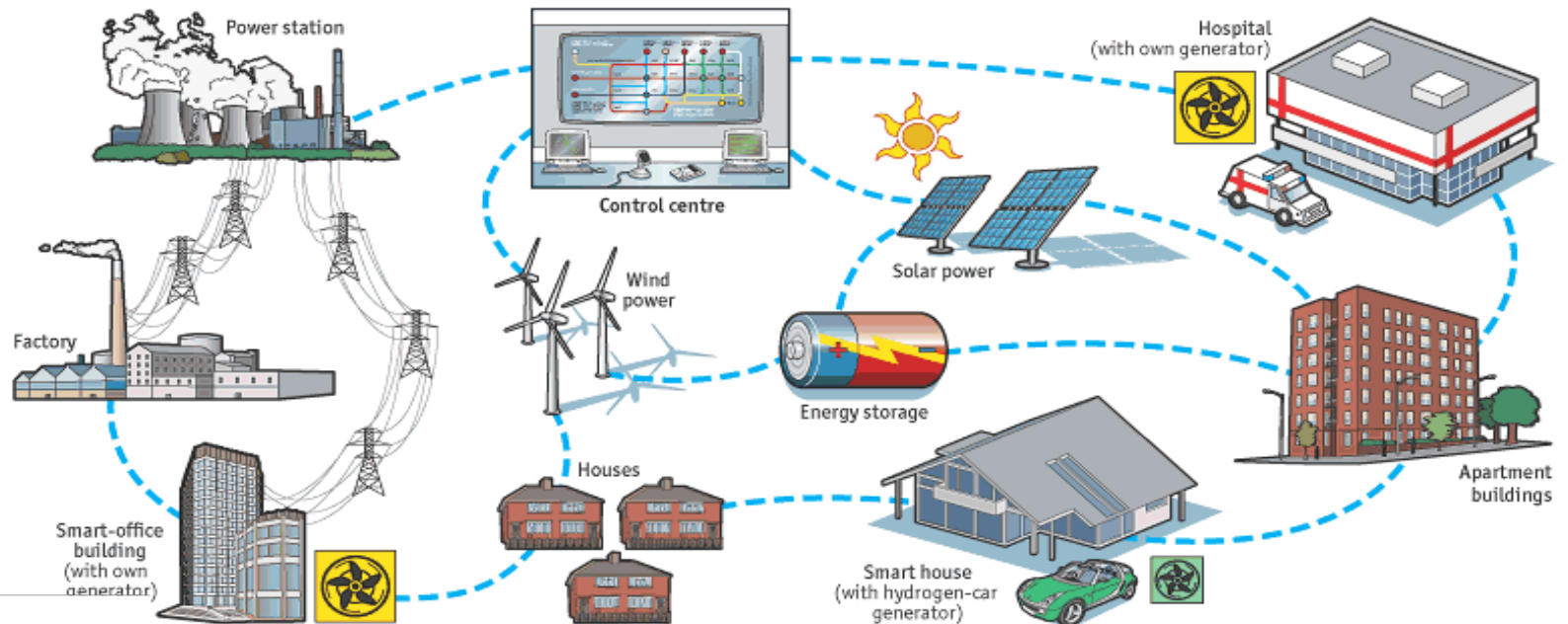


Energy internet

Many small generating facilities, including those based on alternative energy sources such as wind and solar power, are orchestrated using real-time monitoring and control systems.

Offices or hospitals generate their own power and sell the excess back to the grid. Hydrogen-powered cars can act as generators when not in use. Energy-storage technologies smooth out fluctuations in supply from wind and solar power.

Distributing power generation in this way reduces transmission losses, operating costs and the environmental impact of overhead power lines.



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