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An Approach to Facilities Operational Improvement

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ENVIRONMENTAL IMPACT OF BUILDINGS

Buildings have a staggering impact on the natural environment. The HVAC system, the lights, the water, the elevators, the power and cooling for technology, the heating and cooling for people: Buildings are also the locus of consumption; it is in the homes, schools and workplaces, where consumers use and eventually dispose of equipment, appliances, furniture, carpeting, computers, paper, chemicals, metals, etc

all contribute to making buildings a significant source of greenhouse gas emissions and a leading energy user.

CHALLENGE WE FACE

The challenge that enhanced buildings operations movement faces is , "how to maintain the intended performance with regards to low energy use, indoor comfort and projected operating costs savings over the long term use of the building"

PURPOSE OF THIS PRESENTATION

This presentation outlines

- Various qualitative and quantitative operational measures that can be practiced to improve and sustain performance of all facilities systems and infrastructure elements.

US BUILDING STOCK

Currently the US building stock is approximately 300 billion square feet
By2035:

52 billion square feet will be demolished

150 billion square feet will be new construction

150 billion square feet will be remodeled

Almost 40% of the building stock will have been renovated

Energy use is estimated at 1.146 MBTU/SF of New Construction, half as much for remodeling and 90,000 BTU/SF/Yr for Operations

ENERGY USE INTENSITY

Commercial Buildings

Site EUI kBtu/ft²-yr (MJ/m²-yr)

100.0 (1,135)

75.0 (852)

50.0 (568)

25.0 (284)

90 (1020) Existing commercial buildings (2003 CBECS)

79.2 (900) Models of existing stock (Griffiths et al. 2007)

70.7 (803) New buildings base scenario (90.1-2004)

40.3 (458) Max Tech energy efficient scenario

12.2 (139) Max Tech energy efficient scenario w/ PV

MARKET TRANSFORMATION NECESSARY

Federal, State and City Governments need to provide the stimulus by promoting legislation for energy saving incentives, funding development of new energy and water efficiency technologies, and lead by example in improving energy and water use for their existing buildings and for all new construction.

DEVELOPING THE O&M STAFF

To have the equipment deliver projected energy savings, there needs to be a concerted program of training the Operation and Maintenance (O&M) staff who can maintain the systems and equipment functioning in the most efficient manner. It has been estimated that O&M programs targeting energy efficiency can save 5% to 20% on energy bills without a significant capital invest

FEDERAL BUILDING PERSONNEL TRAINING ACT OF 2010 - FBPTA

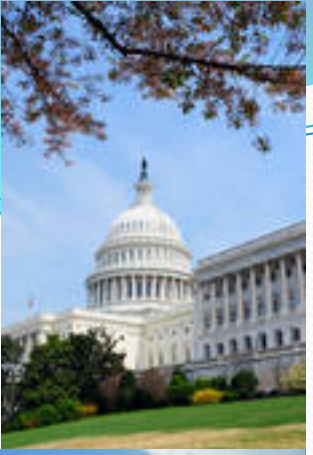
- Signed into Law on December 14, 2010
- Investment in Federal O&M Staff training to meet or exceed the facility design performance
- Identify Core competencies for High Performance Buildings- Energy, Water, Recycling, sustainability, IAQ, Safety
- Develop and implement structured core competencies with DOE & HPGB Group
- Employees must demonstrate required competencies
- Institute Continuing education Program

Strategies for Enhanced Resource Efficiency

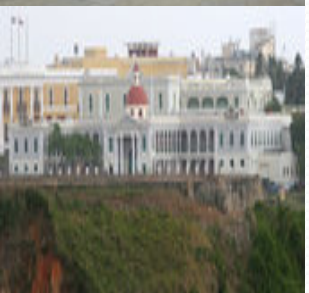
- Make Business Case
- Communicate
- Engage Leadership
- Employ Change Management Team
- Select Metrics for Tracking Performance by Resource Use Metering, Accounting, Benchmarking & Labeling
- Link Rewards to Performance

Strategies for Enhanced Operations

- Provide Relevant information to Operators
- Raise Awareness of Occupants
- Keep Score, Provide Feedback & Incorporate experience into future Operations and Improvements
- Train Operators to adopt best O&M Practices, with accountability



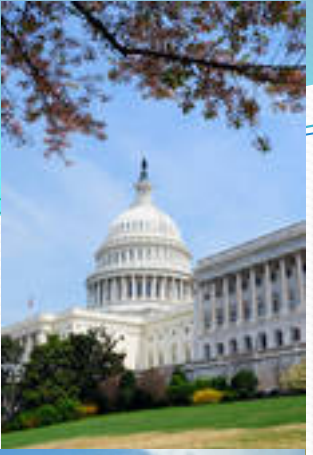




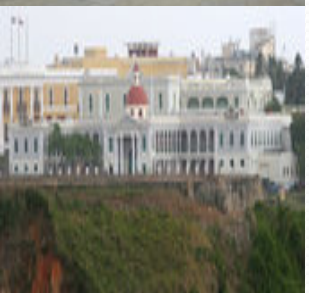
ENHANCED PERFORMANCECODES & LEGISLATIONS

US General Services Administration (GSA) and other Federal Agencies such as the EPA are working together to continue to protect America's precious resources by reducing their carbon foot prints and energy consumption.

The motivation for achieving such success stems from the Energy Policy Act of 2005, Energy Independence and Security Act of 2007, and Executive Order 13514, Federal Leadership in Environmental, Energy and Economic Performance. Most Cities and States are mandating similar requirements of improved equipment design and operations and maintenance.







NEED FOR AN INTEGRATED, APPROACH TO LIFE CYCLE MAINTENANCE – GUIDING PRINCIPLES

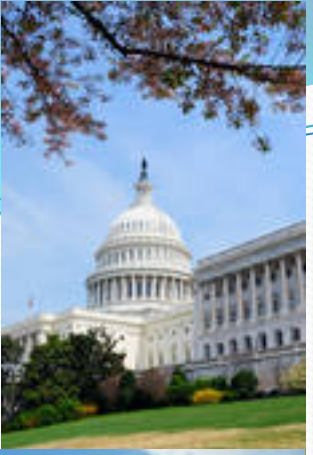
a.) an integrated team to develop and implement policy regarding sustainable design, construction, operations and maintenance-15% of each agency's Federal & Leased Spaces to meet the Guiding Principles by FY 2015.

b.) use of sustainable operations and maintenance practices to lower energy use by 3%/year & water use 2%/year

c.) assessment of existing conditions and operational procedures of the building and major building systems and identify areas for improvement,

d.) establish operational performance goals for energy, water, material use and recycling, and indoor environmental quality, e.) ensure incorporation of these goals throughout the remaining lifecycle of the building, and

f.) incorporate a building management plan to ensure that operating decisions and tenant education are carried out accordingly





MANDATORY MEASURES BY GSA GOALS

a.) Green Procurement Of Products & Services

b.) Installation of Renewable Energy Sources

c.) Procurement of power generated from renewable sources

d.)Participate in Demand Response Strategies to lower burden on electric power systems during peak loads

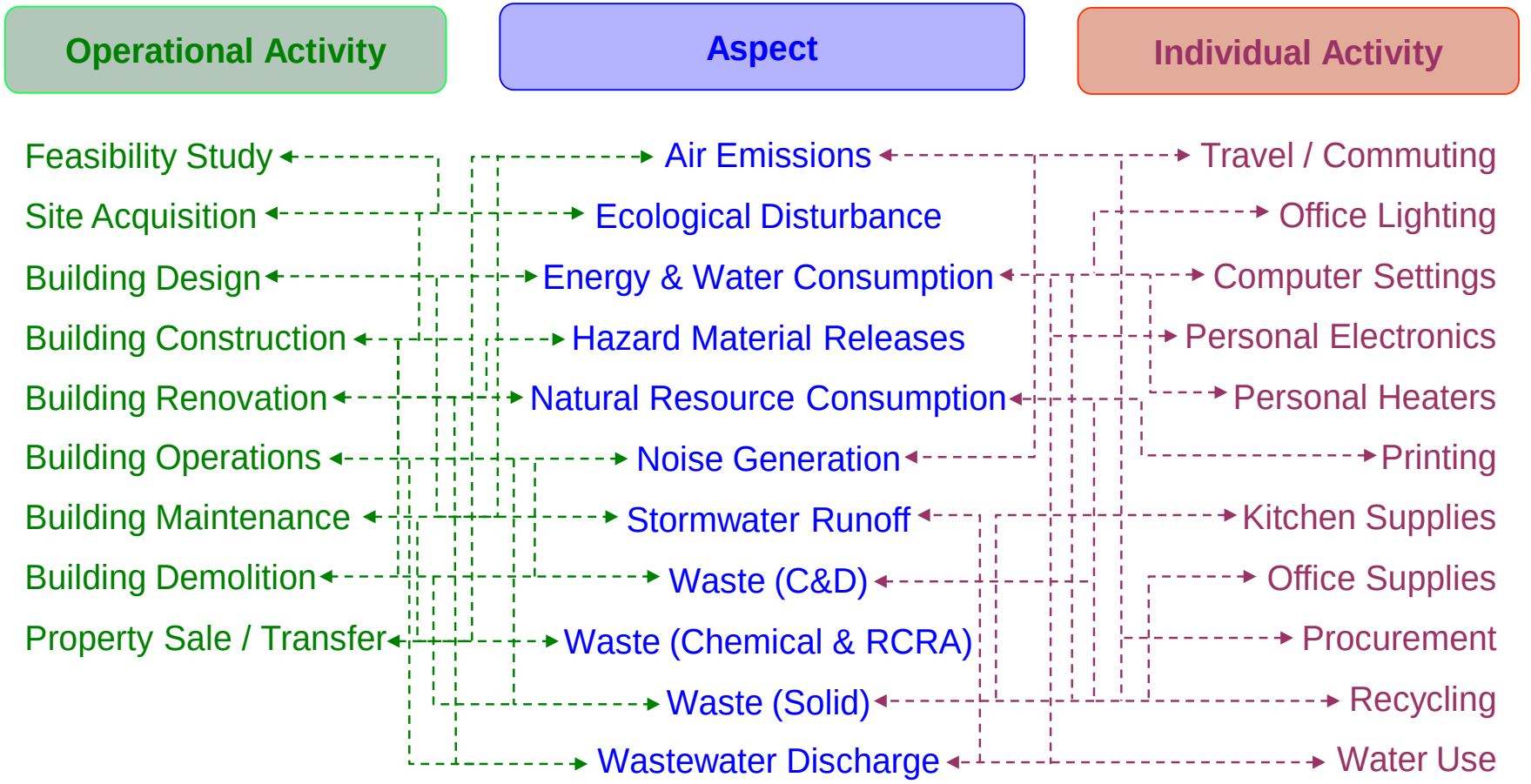
e.) Recycle Construction Debris

f.) Recycle Electronic devices, Office equipment and office papers and supplies.

g.) Procure equipment with as high energy efficiency as achievable ensure

h.)Reduce travel by use of mobile work force and work from home or off-sites

Many of our operational and individual activities are related to each other through the potential environmental aspects that they create



GSA

PBS Environment Program

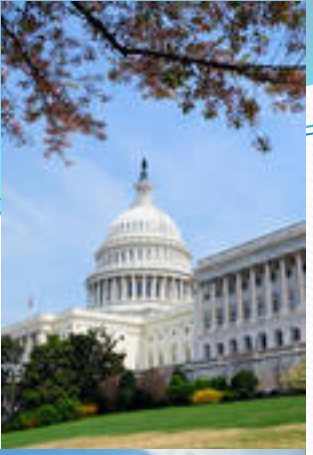
GAPS IN PERFORMANCE FROM EXPECTATIONS

- All too often a building's performance does not meet design expectations, particularly a new building's or significantly renovated Building's energy savings projection that overstates achievable performance.

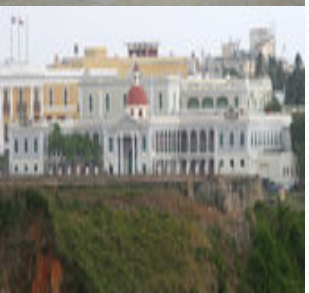
GAPS IN PERFORMANCE FROM EXPECTATIONS

Some Causes for creating such gaps are:

- inadequate modeling and benchmarking
- unreliable monitoring and equipment controls systems,
- significant changes in space usage and processes during occupancy and tenant improvements,
- failure to include operations staff in goal setting or accurately communicating the design intent to the staff, and
- lack of adequate budgets for commissioning, evaluation and ongoing benchmarking.

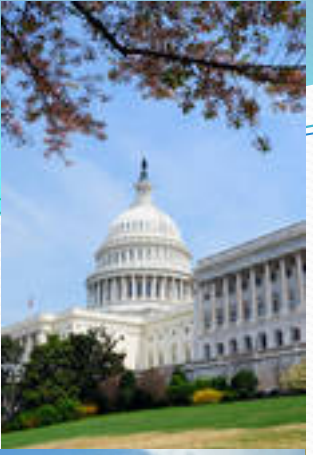




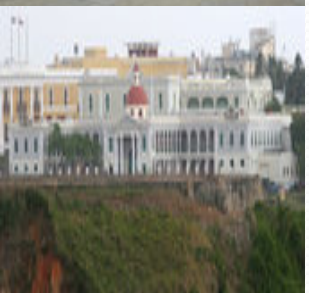


ESSENTIAL TOOLS FOR REDUCING GAPS IN PERFORMANCE FROM EXPECTATIONS

- **Energy Use Accounting of Building Systems & Plug Loads**
- **Commissioning & Retro-Commissioning**
- **Energy Audits**
- **Advanced metering & smart sub-metering**
- **Building Labeling, Benchmarking and Monitoring**
- **Use of BMS to Monitor & Control Energy Use**
- **Prescriptive and Performance Based Acts, Codes & Guidelines, such as ASHRAE Standards 99.1, 189.1 or Advanced Energy Design Guides**







ESSENTIAL TOOLS FOR REDUCING GAPS IN PERFORMANCE FROM EXPECTATIONS

- **Building Information Modeling**
- **Raising Awareness of Occupants & Neighborhood about high performance measures and their Roles and Responsibilities**
- **Keeping Score: Getting to an Appropriate Set of Metrics to measure performance**
- **Regular Assessment of Operational practices**

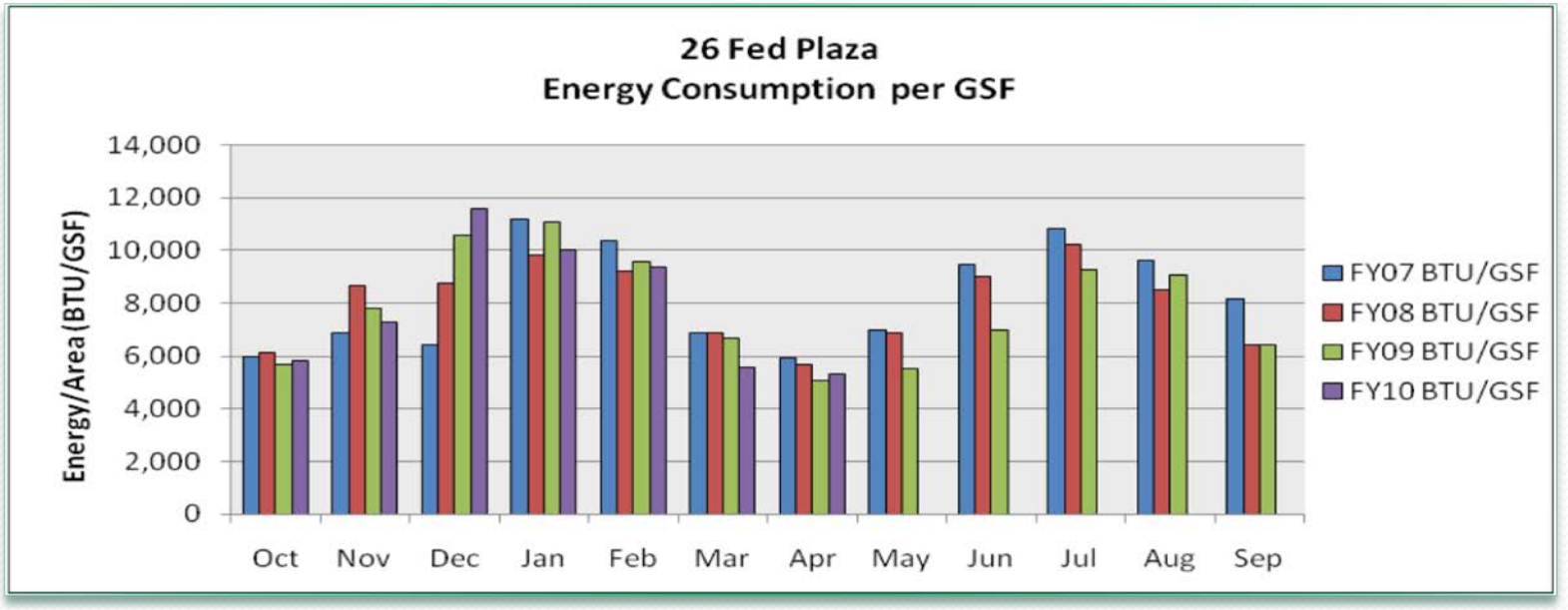
Energy Use Targets

- Establish a single objective baseline EUI for commercial buildings from which to measure relative energy use reductions
- Develop a comprehensive plan to reduce unregulated energy consumption in commercial buildings
- Identify a single objective set of commercial building types and simulation models for establishment of target EUI
- Produce one set of target EUIs for the commercial building sector for use in Federal & State building energy codes ***www.ashrae.org/energytargets***

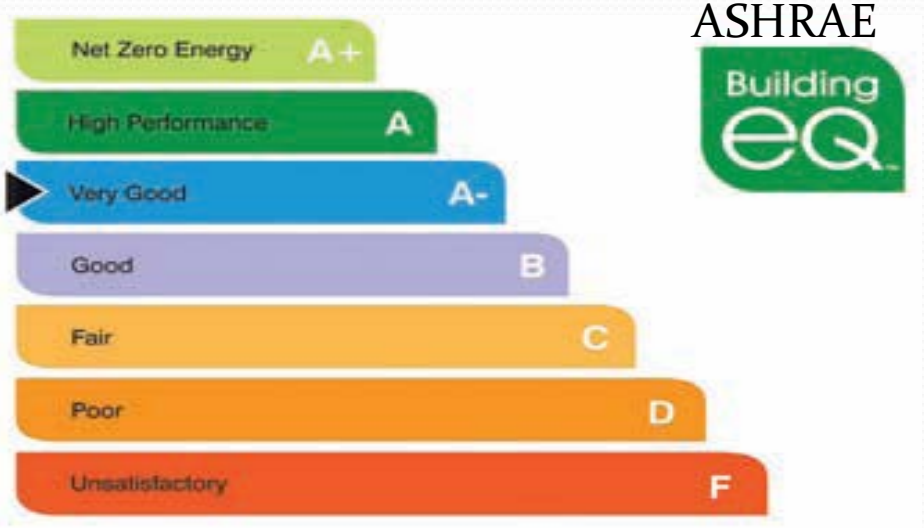
2010 Standards

- Standards 62.1, *Ventilation for Acceptable Indoor Air Quality*
- ANSI/ASHRAE /IES Standard 90.1, *Energy Standard for Buildings Except Low-Rise Residential Buildings – issued Nov 2010 – can achieve site energy use savings of 32.6 percent compared with 2004 Version. Including plug loads, the site energy savings are estimated at 25.5%.*
- *ANSI/ASHRAE/USGBC/IES Standard 189.1-2009, Energy Standard for Buildings Except Low Rise Residential Buildings-covers site sustainability, energy and water use efficiency, IAQ & impact on atmosphere, serves as jurisdictional compliance for IGCC.*
  - S-1000, Legislation introduced in the US Senate would help pave the way for higher efficiencies with goal of approaching Net Zero energy Use by FY 2030.

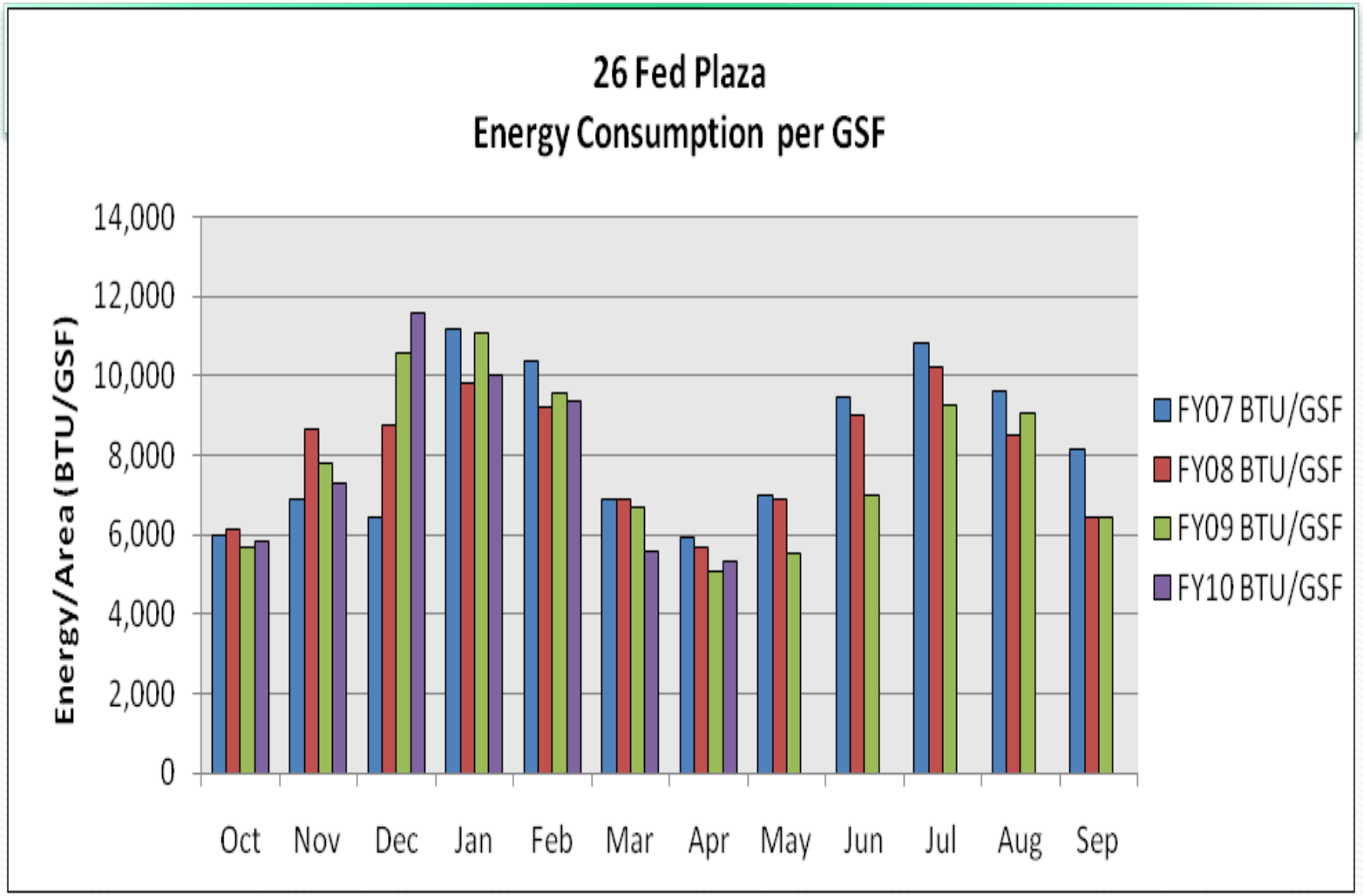
MEASUREMENTS – ENERGY USE & QUOTIENT

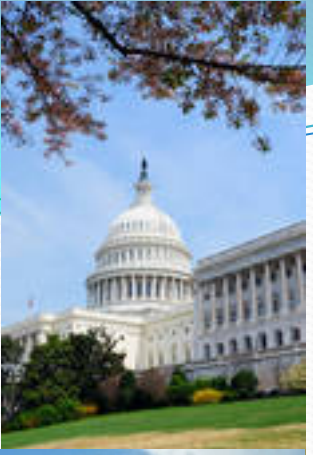


ASHRAE

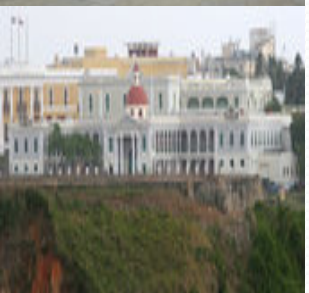


Example – EUI – Goal vs Actual









SUGGESTED ENERGY EFFICIENCY MEASURES

- A Building Designed and constructed with enhanced building technologies, infrastructure and controls, still requires enhanced measurements, verification, operations and controls to deliver enhanced performance. It is estimated that more than $10 billion a year is wasted in commercial buildings due to inefficient operations and maintenance practices.

SUGGESTED ENERGY EFFICIENCY MEASURES

- Commission new buildings & Retro-commission existing buildings to determine direction for alterations and improvements.
- Use Building Information Modeling, Benchmarking & Building Automation Systems to monitor & control energy use.
- Install advanced meters to track energy use and make adjustments if energy use goes above targets.
- Focus first on high energy use areas such as lighting, central heating and cooling plant, ventilation systems and control systems.

SUGGESTED ENERGY EFFICIENCY MEASURES

- Manage energy needs of areas that need 24X7 cooling and humidity controls, such as data centers, technology rooms, food refrigeration areas, laboratories
- Consider use of Water-side or Air-Side Economizers to reduce the cooling load demand
- Use free cooling, as much as possible
- Consider upgrade of lighting systems

SUGGESTED ENERGY EFFICIENCY MEASURES

- Use innovative ways to avoid simultaneous heating and cooling and use of reheat coils to bring comfort to zones where excessive cooling has been provided.
- Review and focus on reducing total energy costs
- Stage Central Plant Equipment to Improve Part-Load Performance, depending upon the configuration of plant equipment and auxiliaries, constant speed or variable speed systems.

SUGGESTED ENERGY EFFICIENCY MEASURES

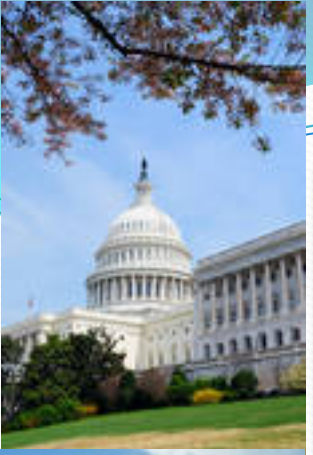
- Reset chilled water temperature higher and condenser water temperature lower when conditions permit to improve operating efficiency
- Reducing scale or fouling
- Unless waste heat or low price steam or natural gas is available, replace absorption chillers with electric drive centrifugals
- Consider Thermal storage
- Employ state-of-the-art energy management/ automation systems

O&M PROGRAMS

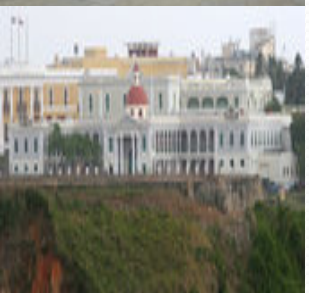
- A well-functioning O&M program increases reliability
- Proper O&M reduces costly IAQ situations
- Properly performed O&M ensures that the design life expectancy of equipment will be achieved or exceeded
- An effective O&M improves compliance with Federal laws such as the Clean Air Act and the Clean Water Act.
- A well functioning O&M program means not always answering complaints
- Many high performance buildings are designed with state of the art efficient and complex equipment, particularly controls, which often require improvements and iterative adjustments over multiple seasons to ultimately operate as designed

Example – Good HVAC Practice

1. Equipment Operations Scheduling
2. Sensor Errors
3. Dampers & Control Valves Controls
4. Avoid simultaneous heating & cooling
5. Manage Fresh Air intake & Economizers operation
6. Monitoring, Controls & Self Diagnostics
7. Use of CMMS
8. Equipment performance validation by portable PDAs

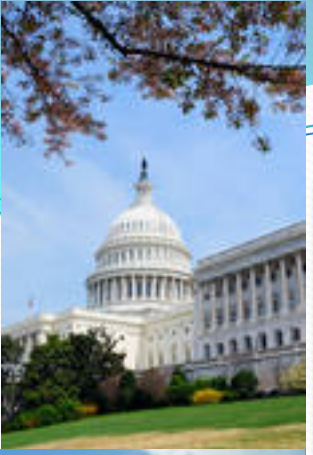




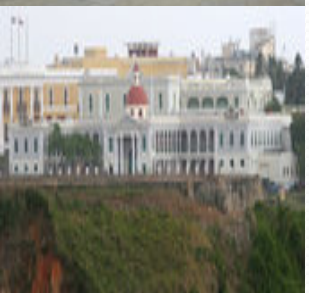


DIRECTIONS

For us to change our behavior, we must first determine what we have, how we got there and how divergent issues can be consolidated to facilitate net high performance results. That makes it important to audit, meter, monitor, track, compare and from such data, deduce directions for implementing various justified Energy Efficiency Measures, employ different prescriptive, modeling and analytical tools, periodically perform retro-commissioning and be prepared to accommodate and adapt systems to changes in use, occupancy, weather or building process or plug loads.





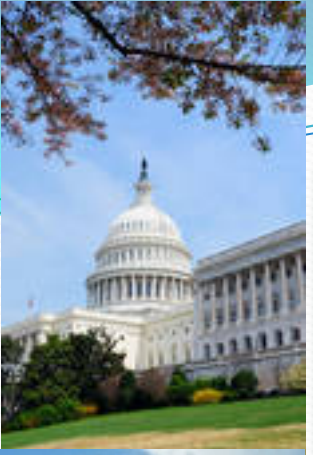


DIRECTIONS

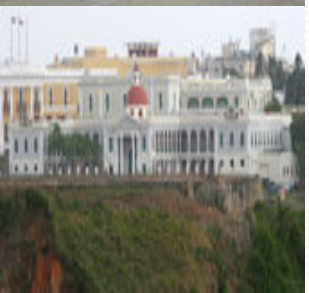
❖Federal, State and City Governments all across the United States are slowly, but steadily, promoting policies, local laws and standards to require Green Buildings Design, renovations and construction.

❖The Private Sector increasingly finds merit in building Green

❖Public policies coupled with private interests are starting to show green investments and favorable results.

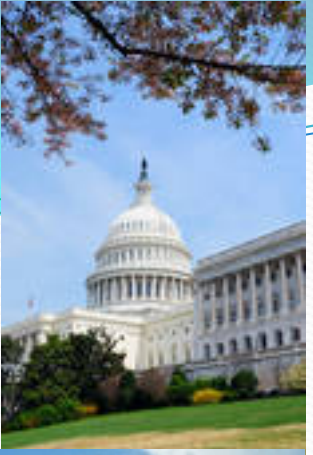




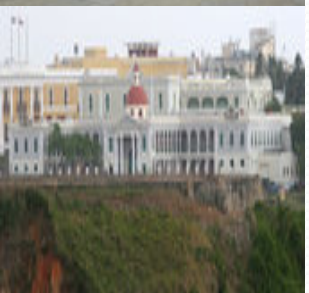


DIRECTIONS

US Government is the largest user of energy. It's Executive Branch, General Services Administration (GSA) owns and operates some 1,500 buildings. GSA has set its strategic direction to transform the marketplace by turning its building portfolio into a proving ground for green building technology, materials and operating regimes by facilitating development, acquisition and implementation of numerous smart metering, artificial lighting, green roof and HVAC components and systems upgrades; there are products that exploit solar, wind and geo-thermal energy sources.

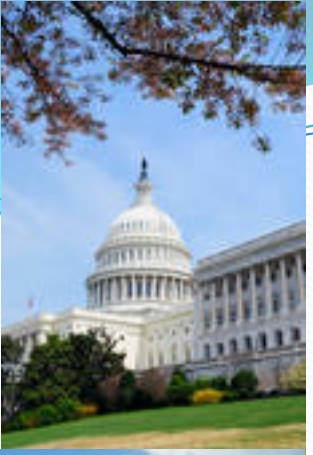




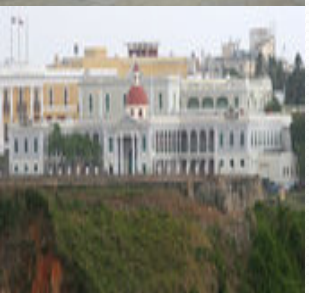


DIRECTIONS

Its Projects are required to use “Building Information Modeling”, “monitoring of energy use and benchmarking and use of life cycle costs in its budget requests, and an aggressive recycling and hazardous materials management program . It is training operations staff to reassess its operations to wring out waste, eliminate pollution, and align all of its activities to deliver a Zero Environmental Footprint. GSA is seeking out green technologies, practices, and ideas, test them, and weave them into the agency’s processes, relationships, and culture, and thereby become a proving ground to propel the industry towards high performance across all buildings’ systems.

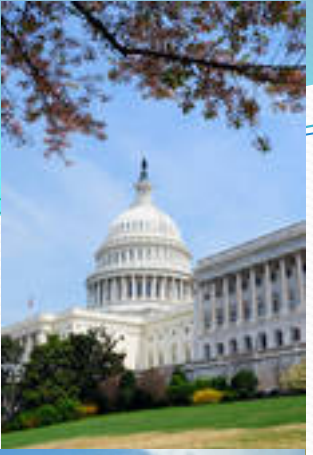




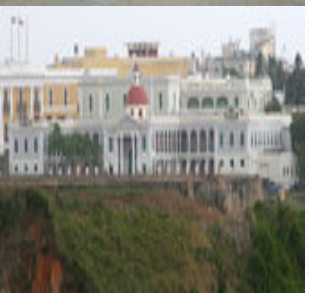


DIRECTIONS

- GSA has the largest square feet of Green Roofs in USA and is investing in innovative new green roofs technologies.
- GSA is installing advanced meters for all buildings in a phased manner to track performance and to enable O&M staff to adjust things based on metered data.

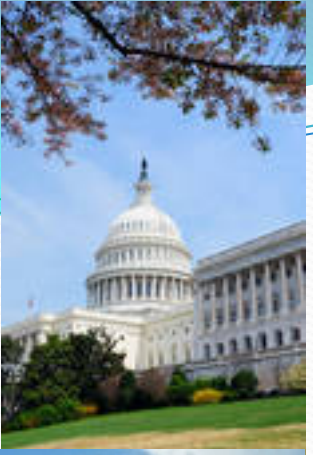




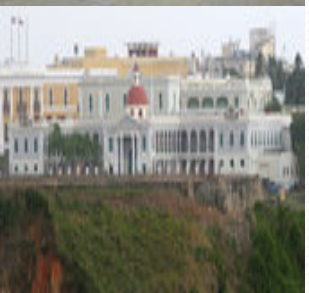


DIRECTIONS

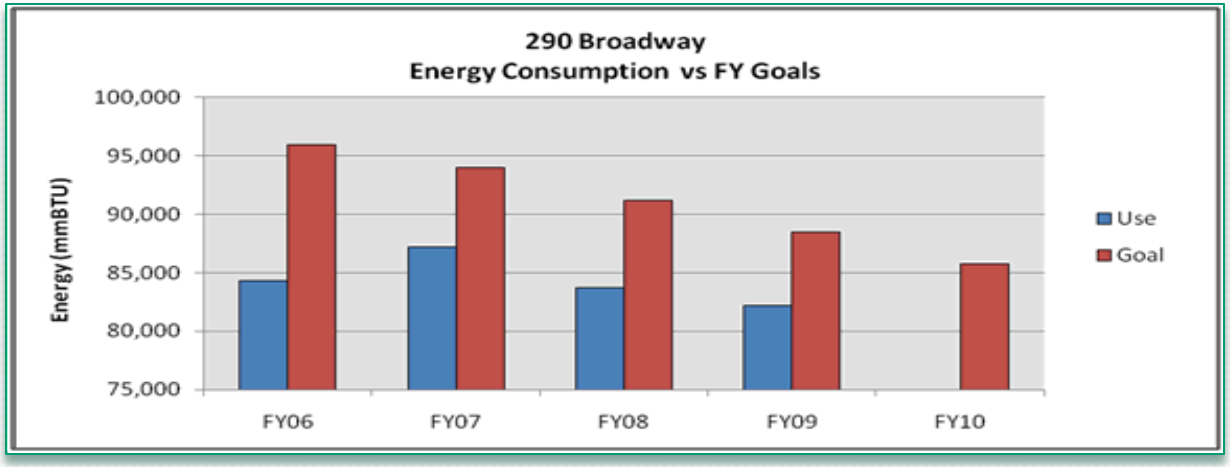
- To obtain customers' feedback, GSA performs regular Tenant satisfaction surveys, holds energy fairs and distributes flyers to guide its tenant agencies towards saving energy by shutting of lights, turning off computers, office equipment and reducing use of personal appliances.
- is developing the structured training program for O&M staff in Energy Use Analysis and using measured data to operate in a more efficient manner.

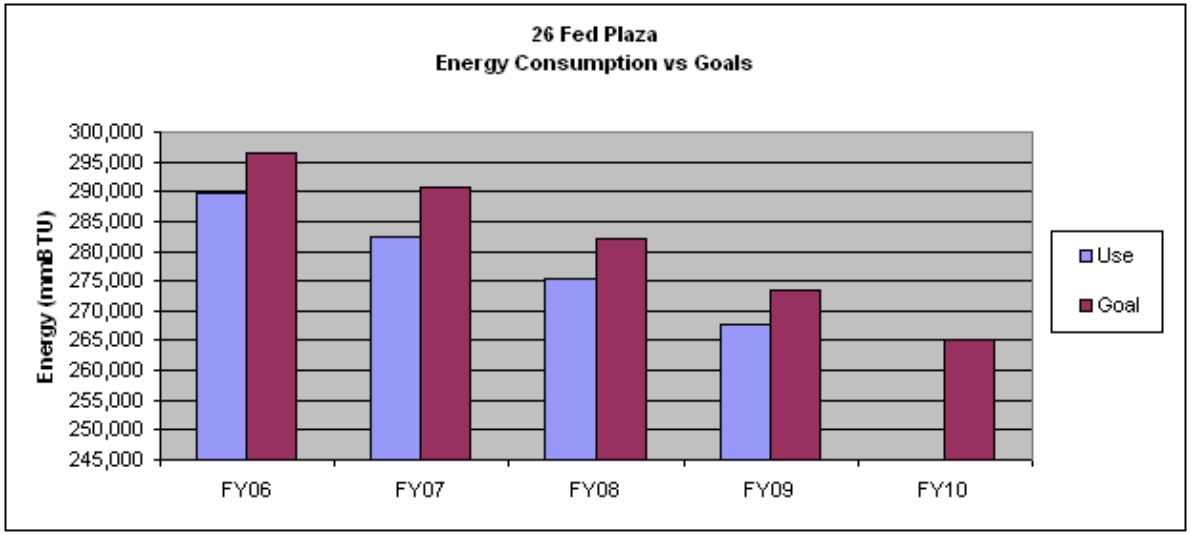






SOME RESULTS OF GSA's ENERGY EFFICIENCY INITIATIVES





Energy Use goals versus actual

DIRECTIONS

We need to pursue an integrated holistic approach that considers the impacts on environment, costs and quality over all phases in the life of a building rather than as a snapshot. For this to occur, we must first determine what we have, how we got there and how divergent issues can be consolidated to facilitate a net high performance results. That makes it important to audit, meter, monitor, track, compare and from such data, deduce directions for implementing various justified Energy Efficiency Measures.

Any Questions or Comments?