Energy Management: Back to Basics

TEMA Central Texas Chapter Meeting

Presented by:

Saleem Khan, P.E., CxA

email: saleem@teesi.com

TEESI Engineering

(Texas Energy Engineering Services Inc.)

www.teesi.com

(512) 328-2533

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ENERGY STAR PARTNER

Outline

- Introduction
  - Back to Basics (part 1, 2, 3…)
- Optimizing organization energy usage – Planning – Monitoring/Benchmarking – Goal setting – Scouting for tools, technologies & best practices – Audits – Resources – Execution of projects – Advocacy (Communications)
- Energy Mgmt. & Life Cycle Costs
- Key to Identifying Savings – Energy Audit
- Energy Performance Indices, Demand (KW) impact, IECC Climate Zones – 2023 changes (Eff & Refrigerants)
- Lighting, Renewables, Commissioning, Net Zero
- Resources
- Discussion

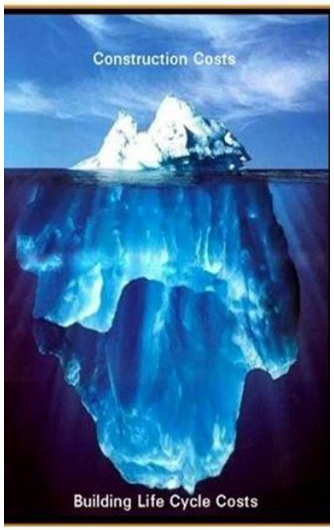
Energy Management

- *"Judicious and effective use of energy to maximize profits (minimize costs) and enhance competitive positions"* *("Handbook of Energy Management"-Wayne Turner/Fairmont Press)*
  - ***Save $ Not Btus!***
- *"An Energy Management System is a set of practices that create a culture of continual improvement in energy performance."* *- DOE https://www.energy.gov/eere/iedo/energy-management-programs*
- *"The proactive and systematic monitoring, control, and optimization of an organization's energy consumption to conserve use and decrease energy costs."* *–IBM*
- *Today: Climate Impact, Conflicts, Grid Resiliency*
  - *"Manage energy", holistic approach*

Energy Consumption in U.S. Buildings

Improving energy efficiency in U.S. buildings could save up to $145 billion annually by 2040 [1].

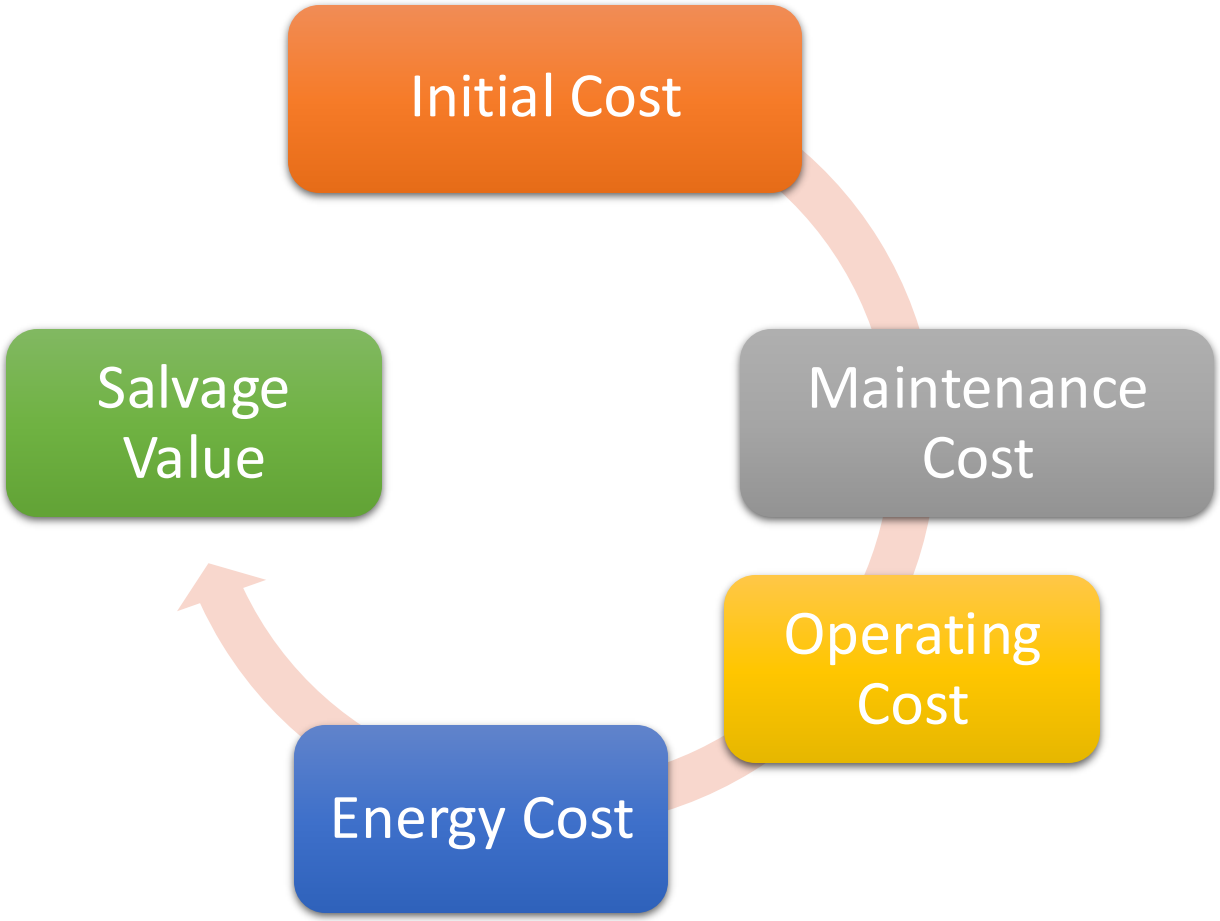
Facility Life Cycle Costs



- Ensuring energy-efficient design
- Promoting a healthy working environment
- Reducing costs through energy-efficient operations
  - Reduced carbon footprint
  - Good for the environment
  - Systems commissioning

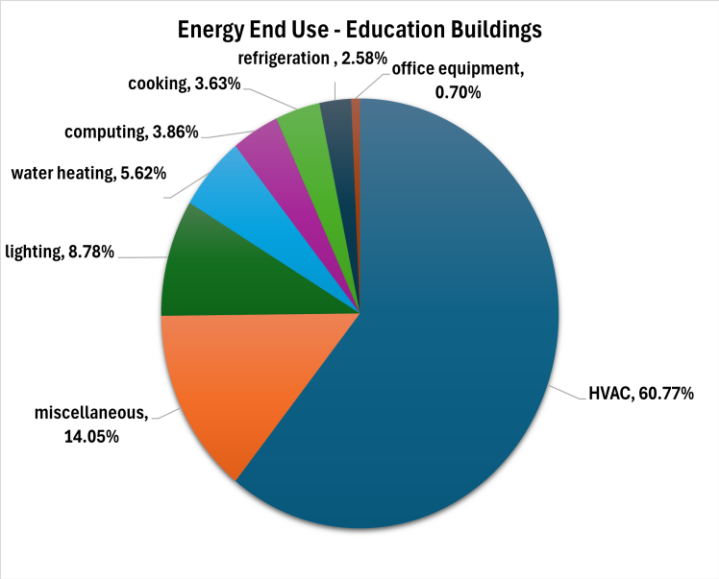
Source:
[1] Energy Efficiency Resource Standard (EERS). ACEEE. (n.d.). https://www.aceee.org/policy-brief/energy-efficiency-resource-standard-eers

Equipment – Bldg Life Cycle Costs

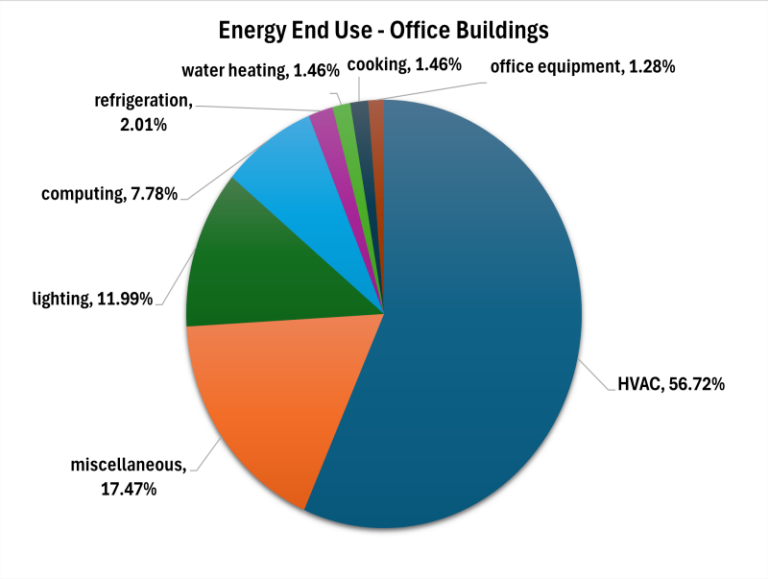


Typical Schools & Office Buildings Consumption Breakdown

Energy End Use – Education Buildings (K-12)

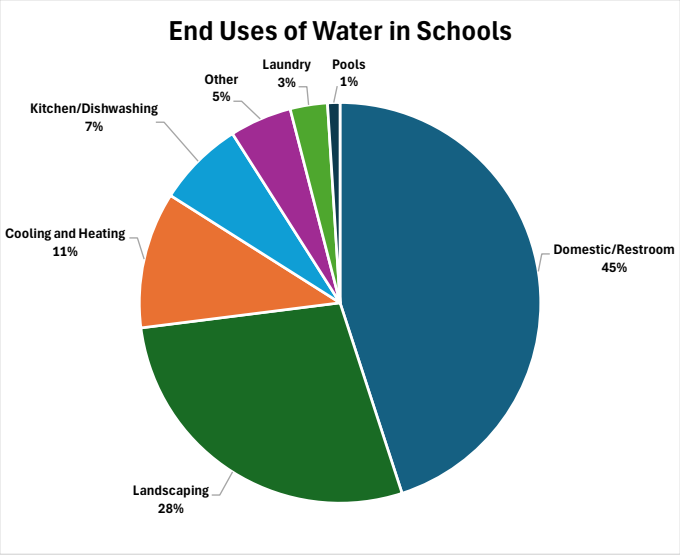


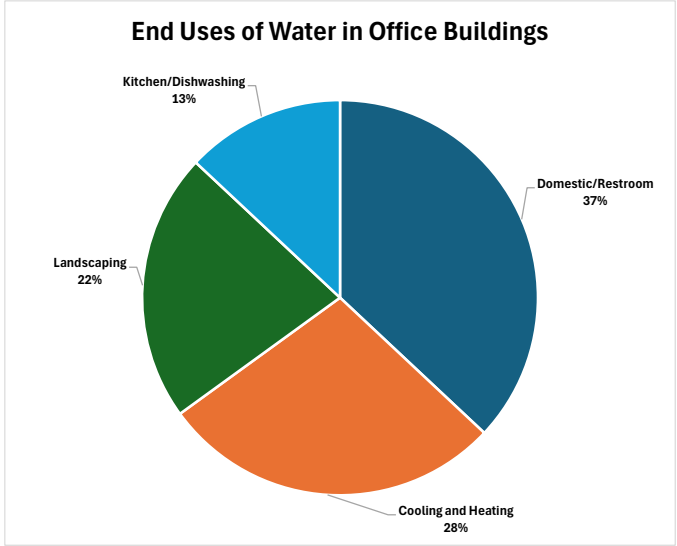
Energy End Use – Office Buildings



Note: Miscellaneous refers to energy use not falling under any given explicit categories
Data source: U.S. Energy Information Administration, Commercial Buildings Energy Consumption Survey
https://www.eia.gov/consumption/commercial/data/2018/

Typical Water Use Breakdown



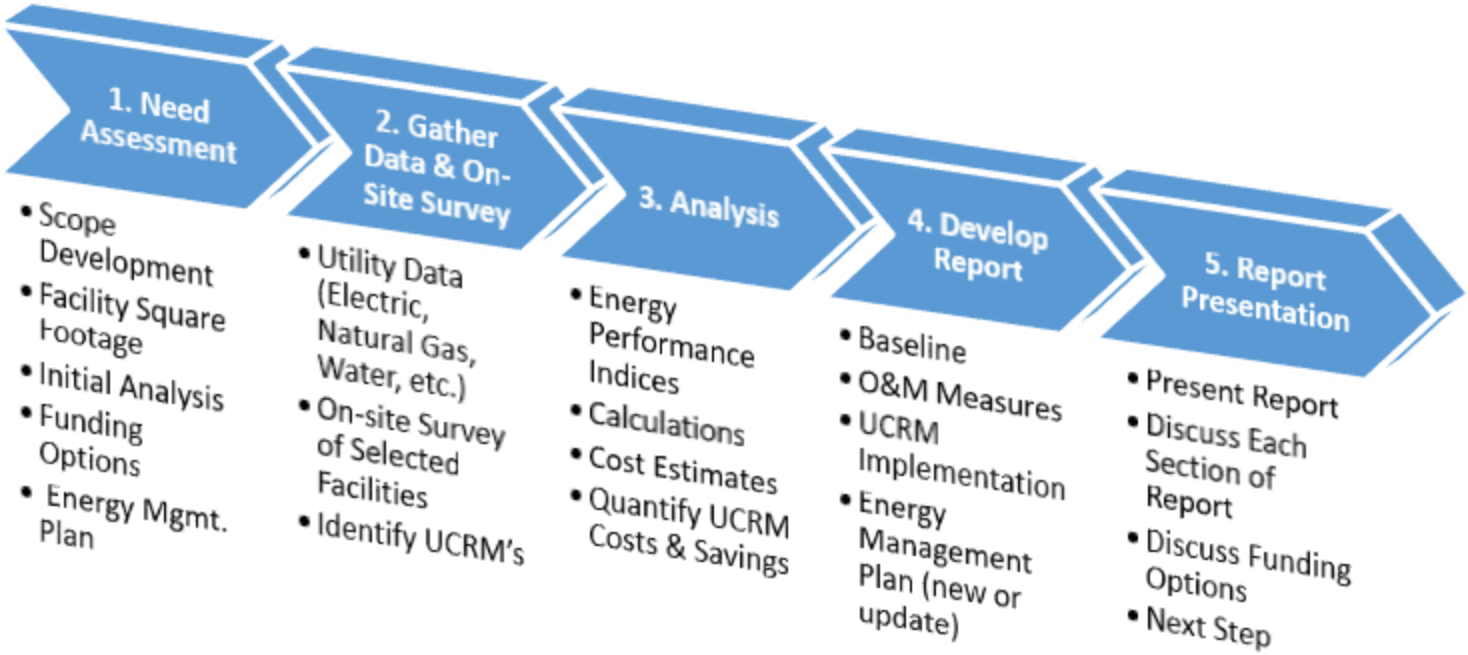


Data Source: Types of facilities (EPA 2016)
https://www.epa.gov/watersense/types-facilities#

Energy Audits: Key to Identifying Savings

- **Energy Assessments:** Assessments to identify energy-saving opportunities.
  - *Experience in the area*
- **Preliminary Energy Assessment & Detailed Energy Assessment**
  - **PEA:** Initial high-level energy performance review to estimate energy savings potential and feasibility.
    - **Preliminary Energy Audit/Analysis**
    - **Initial Energy Audit or Survey**
    - **Walkthrough Survey/Assessment**
  - **DEA/UAR/IGA:** In-depth, detailed review of energy systems, including HVAC, lighting, insulation, and renewable energy integration.
    - **Comprehensive Energy Analysis (CEA)**
    - **Investment Grade Audit (IGA)**
    - **Utility Assessment Report (UAR)**

Energy Assessment Process Summary



- Preliminary & Detailed (UAR, IGA, DEA…)
  - Timeline and level of detail
- **Benefits:** Identification of building upgrades to achieve the highest energy savings, with estimated costs and payback.

Typical Energy Eff. Measures and Paybacks Building Systems

➢ Low Cost/No Cost Measures	0 to 6 months
➢ Interior & Exterior Lighting Retrofit	2.5 to 10 years
➢ Motion Sensors & Day-lighting	2 to 8 years
➢ HVAC Retrofits	7 to 25 years
➢ Insulation	8 years +
➢ Commissioning	1.5 to 6 years
➢ Water Conservation	4 to 8 years
➢ Solar Thermal Pool Heating	12 to 14 years
➢ Solar PV Arrays	15 to 25 years

Typical Measures and Paybacks WTP/WWTP Systems

➢ WWTP Related O&M Measures	0 to 1 year
➢ Dissolved Oxygen Control	2 to 7 years
➢ High Efficiency Blowers	8 to 12 years
➢ Variable Speed Drives	8 to 15 years
➢ Optimize Aeration Design	5 to 10 years
➢ Power Factor Improvements	3 to 8 years
➢ Smart Meter Applications	5 to 8 years
➢ City Mains Leak Sensing Technology	1 to 6 years
➢ WWTP Demand Response	*

*Dependent on existing load profile and capital used for automation

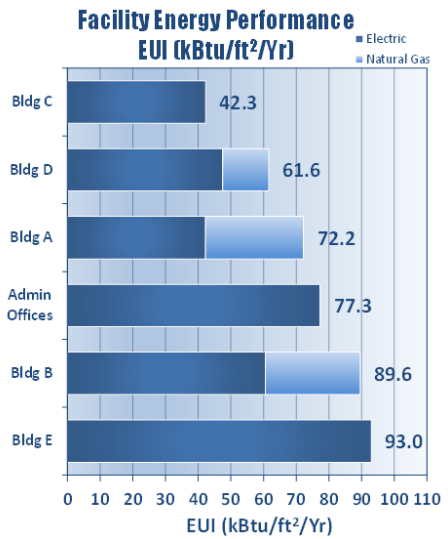
Simple Payback

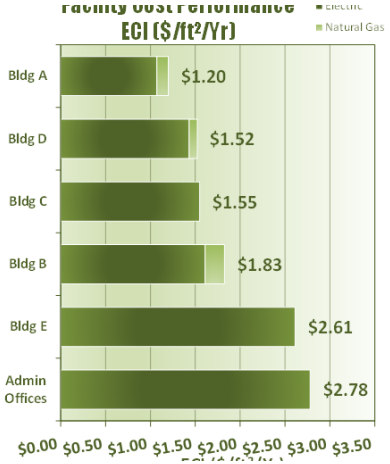
- Simple Payback = Initial Cost / Annual Savings
  - Determines the number of years required to recoup the cost of the initial investment.
  - Utilize the savings of multiple projects to improve the overall “cumulative” payback.

Project	Project Cost ($)	Project Savings ($)	Simple Payback (Years)
HVAC Replacement	$150,000	$10,000	15
Lighting Retrofit	$100,000	$25,000	4
Total:	**$250,000**	**$35,000**	**7.1**

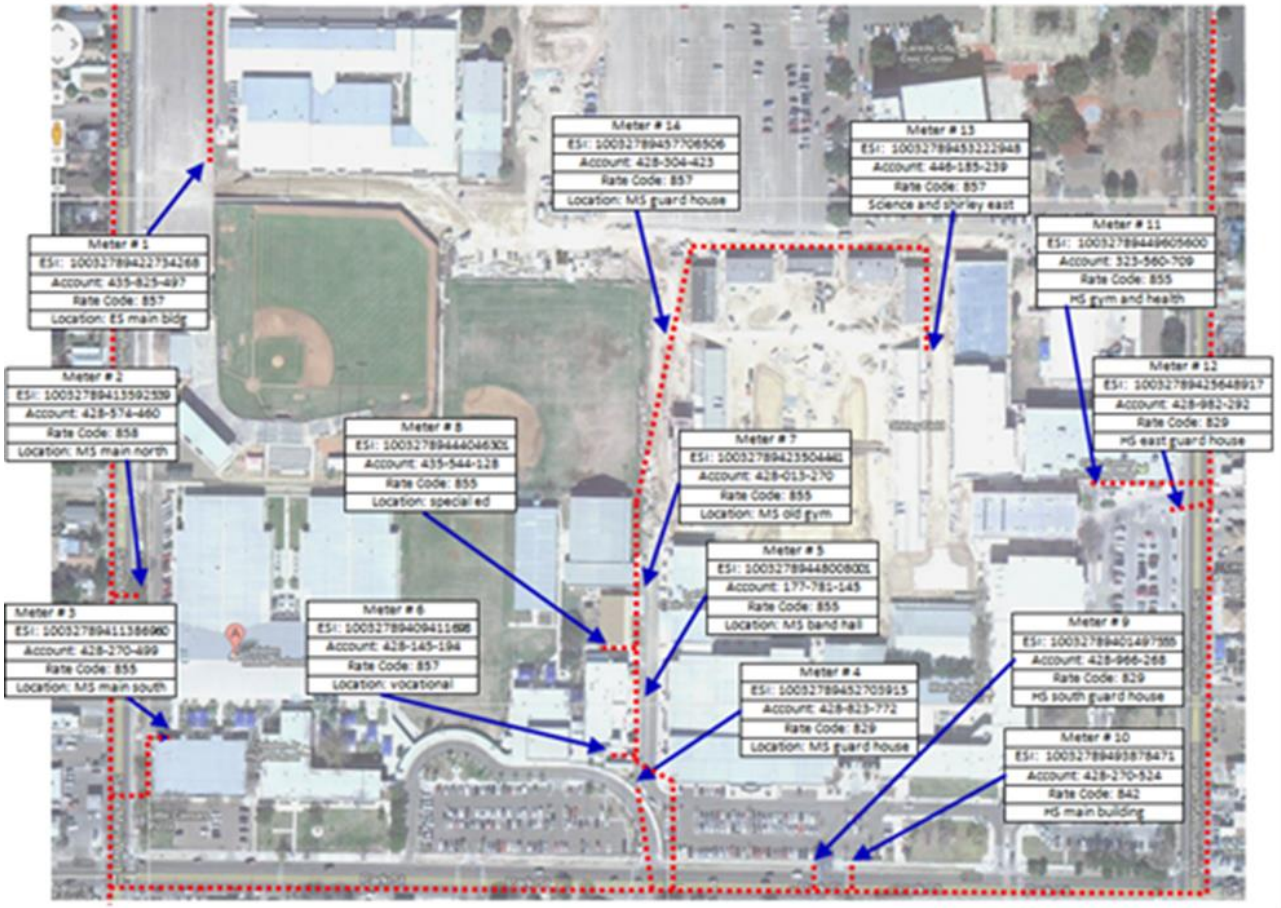
Energy Performance Indices

- Energy Use Index (EUI)
  - Total annual electric and natural gas usage
  - Btu/sf/Year
- Energy Cost Index (ECI)
  - Total annual electric and natural gas cost
  - $/sf/Year
- Other Indices
  - KWh/sf
  - Units/Student
- Used to compare building energy performance





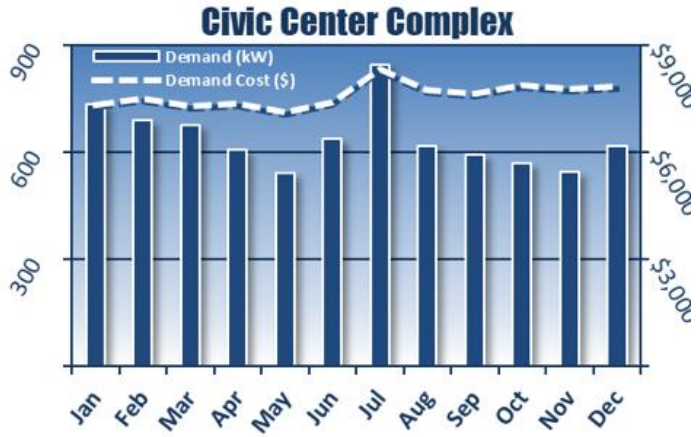
Utilities(s) Meter(s) Mapping



Electric Demand (KW)

- Demand (kW) charges stem from a facility's peak power draw during a billing period, as opposed to consumption (kWh) charges, which total the energy usage over this period.
  - Average cost vs applicable rate analysis

- Some general recommendations for reducing demand costs include:
  - *Staggering HVAC equipment start up utilizing controls.*
  - *Increasing space temperature setpoints in the summer and decreasing them in the winter to reduce unit cycle times for DX units, chiller loads, and AHU fan speeds.*
  - *During any annual equipment startup and testing, be mindful of simultaneous equipment operation.*

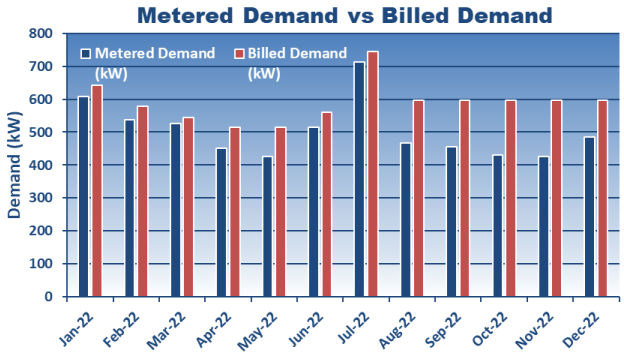


Billed-Metered Demand & Power Factor

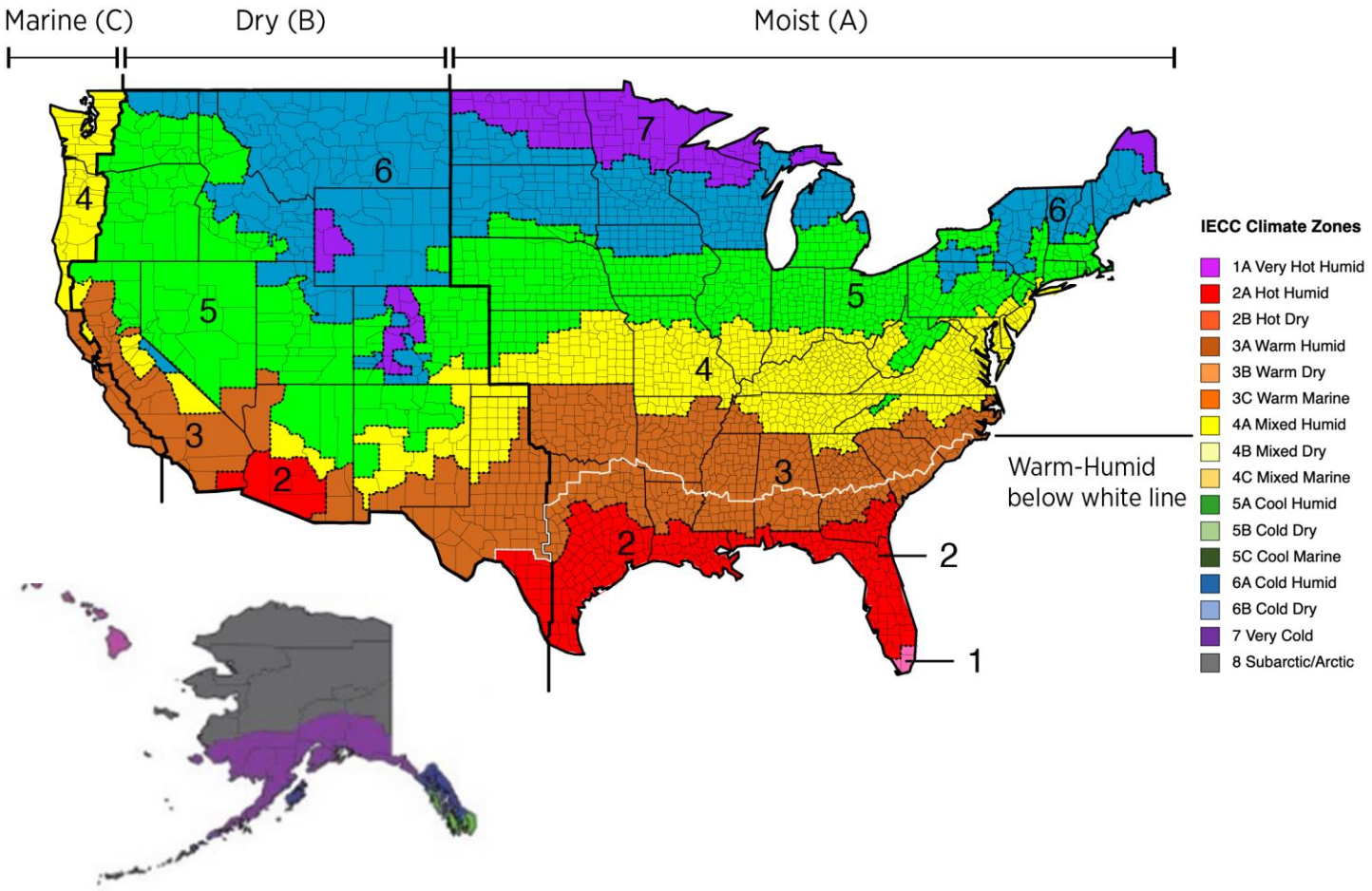
- ***Ratchet:*** The 80% (typ.) ratchet computes the larger of the metered kW in the billing period *or* 80% of the highest metered demand in the previous 11 months. This is essentially a penalty for the rest of the year when only one month experiences a surge or "spike" in demand. It is therefore prudent for the City to try to manage month-to-month demand peaks to avoid penalties in the future.

Month	Metered Demand (kW)	Billed Demand (kW)
Jan-22	608	642
Feb-22	538	579
Mar-22	527	544
Apr-22	451	514
May-22	426	514
Jun-22	515	560
Jul-22	713	745
Aug-22	467	596
Sep-22	455	596
Oct-22	431	596
Nov-22	426	596
Dec-22	484	596
Total	*6,041 Metered kW*	*7,078 Billed kW*

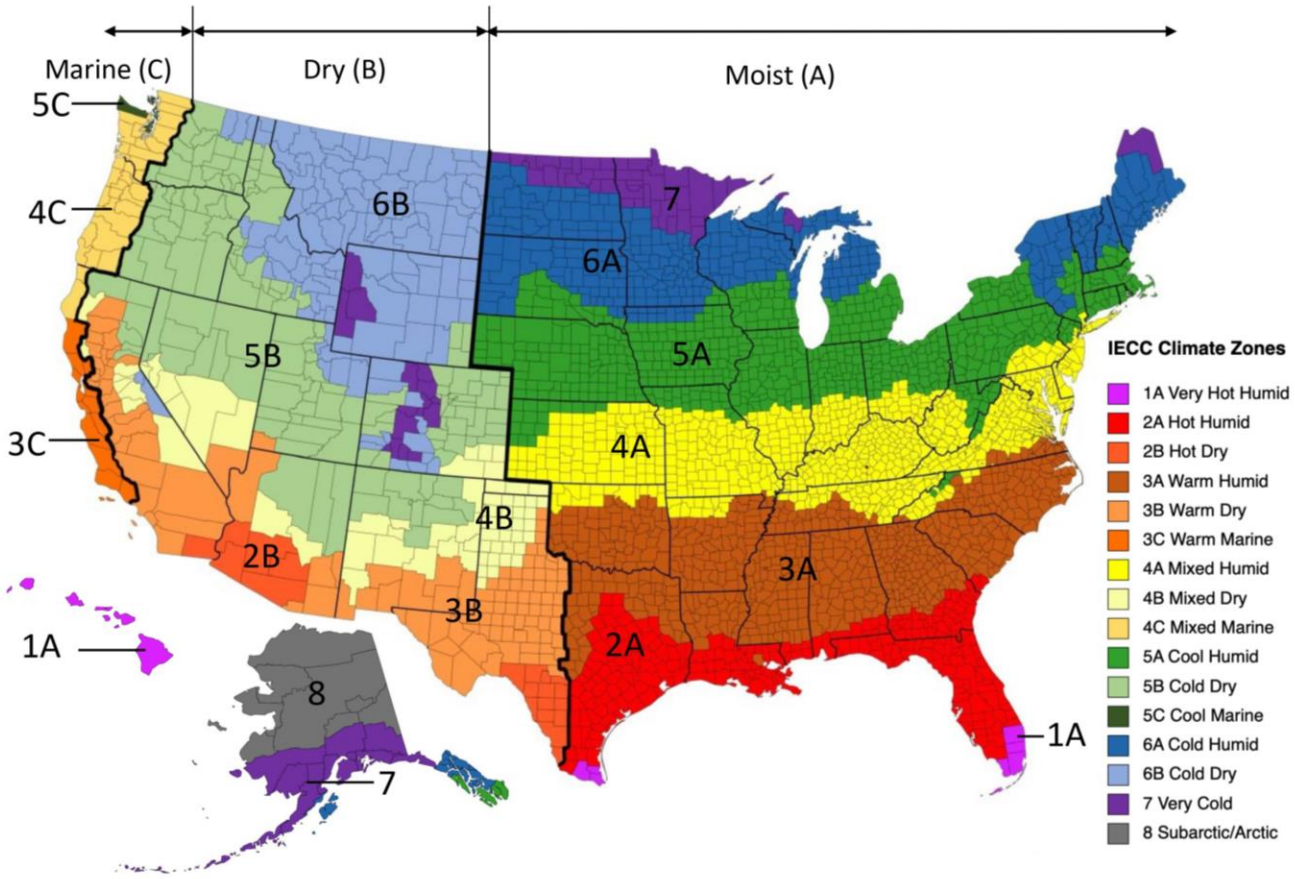
- ***Power Factor:*** The power factor is equal to the ratio of the actual power being used by a facility to the apparent power that the utility provider must make available. When the apparent power (kVA) demand from the provider is significantly greater than what is actually necessary, the power factor is considered low, and a penalty is incurred.



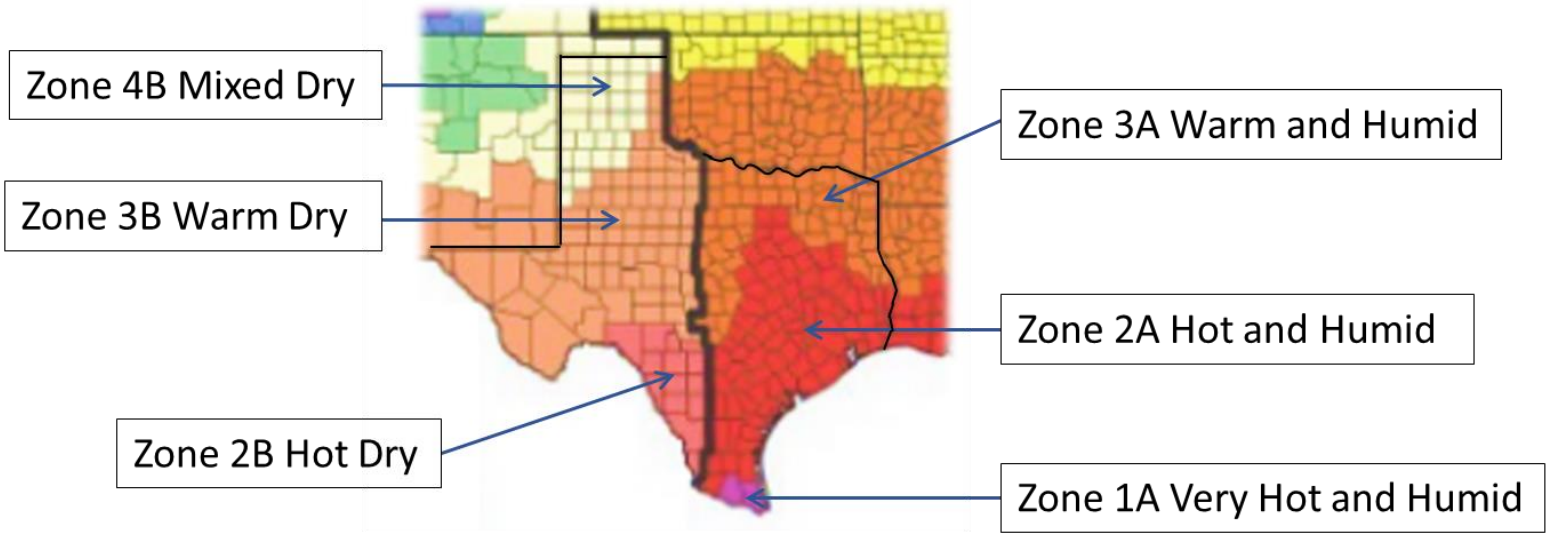
2018 IECC Climate Zone Map



2021-24 IECC Climate Zone Map

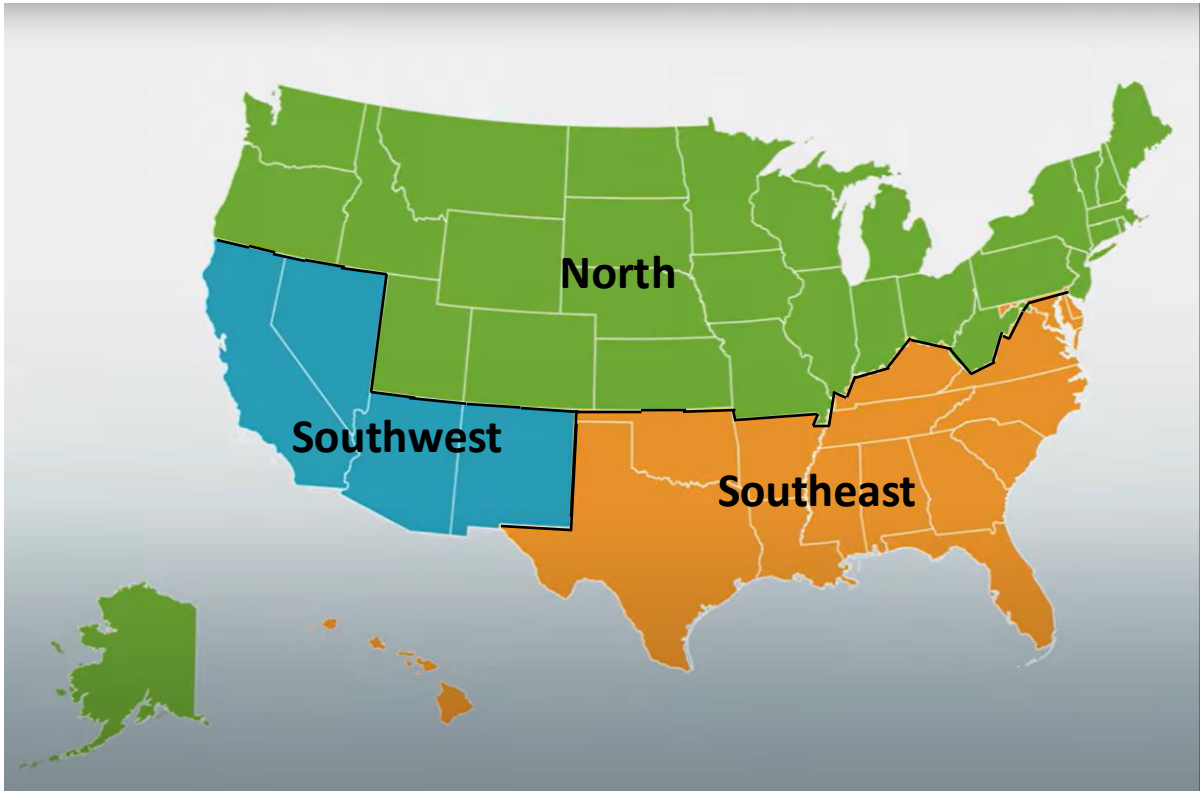


2021 IECC Climate Zone Impact (Texas)



- *The DFW area counties (Dallas, Tarrant, Johnson, Ellis, Navarro) changed from Warm and Humid (3A) to Hot and Humid (2A)*
- *The Brownsville/South Padre Island area counties (Hidalgo, Willacy, Cameron) changed from Hot and Humid (2A) to Very Hot and Humid (1A)*

Regions for Central Air Conditioner Energy Efficiency Standards (2023)



Minimum efficiency increases not only by product type but by geographic region (N, SE & SW)

2023 Efficiency (3-5 tons)

- **Residential & Light Commercial HVAC units (approx. 3 - 5 tons)**
  - Units to meet more stringent testing requirements for single phase products manufactured on or after January 1, 2023.
    - *Test condition: External Static Pressure (ESP) change from 0.1" to 0.5"wc to more accurately reflect field conditions*
    - *ESP: All pressure outside the unit that fan/blower has to overcome to deliver air to space (supply & return duct plus grills & diffusers).*
    - *3 phase units year 2025*
  - SEER, EER, HSPF to SEER2,EER2 & HSPF2
    - *Example: Packaged HP (<65KBtus) Before 2023 14.0 SEER after 2023 13.4 SEER2*
  - Minimum efficiency increases not only by product type but by geographic region

Emissions Terms Related to Refrigerants

➢GWP (Global Warming Potential)

Ratio of the ability of a substance to trap heat in the atmosphere to that of carbon dioxide. Used for upcoming refrigerant transitions.

➢ODP (Ozone Depletion Potential)

Ratio of the ability of a substance to degrade ozone to that of CFC-11 (chlorofluorocarbon-11). Used for previous refrigerant transitions.

Legacy HVAC Refrigerants

Refrigerant	Type	GWP*	ODP	Safety	Typical HVAC Application	Status
R-12	CFC	10,900	1.0	A1	Legacy chillers, auto A/C	**Banned (1996)**
R-22	HCFC	1,810	0.055	A1	A/C, heat pumps	**Phased out (2020)**
R-410A	HFC	2,088	0	A1	A/C, heat pumps	**Phasing down**
R-134a	HFC	1,430	0	A1	Chillers, auto A/C	**Phasing down**
R-404A	HFC	3,922	0	A1	Commercial refrigeration	**Phasing down**

**GWP = 100-yr Global Warming Potential; ODP = Ozone Depletion Potential; Safety = ASHRAE 34 class. Sources: U.S. EPA Technology Transitions / AIM Act (40 CFR 84.64); ASHRAE Standard 34.*

Newer Low-GWP Refrigerants

Refrigerant	Type	GWP*	ODP	Safety	Typical HVAC Application	Status
R-32	HFC	675	0	A2L	A/C, heat pumps	**Current**
R-454B	HFO blend	465	0	A2L	A/C, heat pumps (R-410A repl.)	**Current (2025+)**
R-513A	HFO blend	630	0	A1	Chillers (R-134a repl.)	**Current**
R-1234ze	HFO	1	0	A2L	Chillers	**Current**
R-290	Natural (HC)	3	0	A3	Packaged / small units	**Current**
R-744	Natural (CO_2)	1	0	A1	Heat pumps, refrigeration	**Current**
R-717	Natural (NH_3)	0	0	B2L	Industrial refrigeration	**Current**

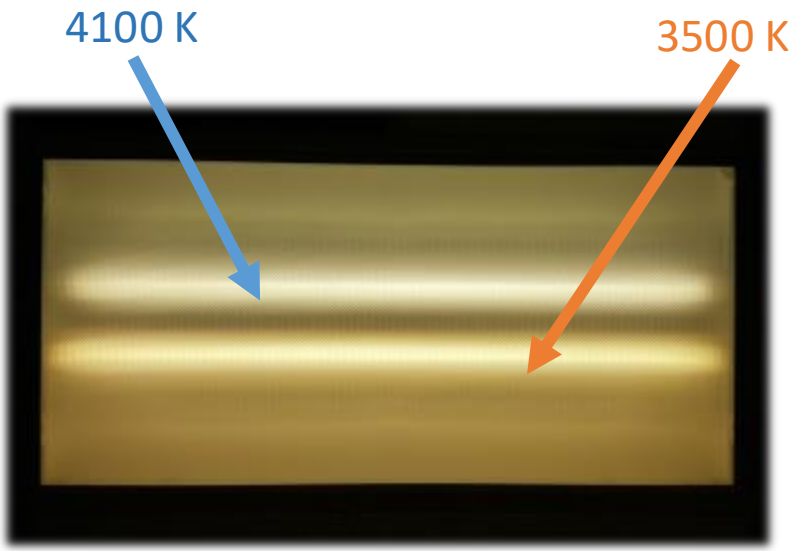
**GWP = 100-yr Global Warming Potential; ODP = Ozone Depletion Potential; Safety = ASHRAE 34 class. Sources: U.S. EPA Technology Transitions / AIM Act (40 CFR 84.64); ASHRAE Standard 34.*

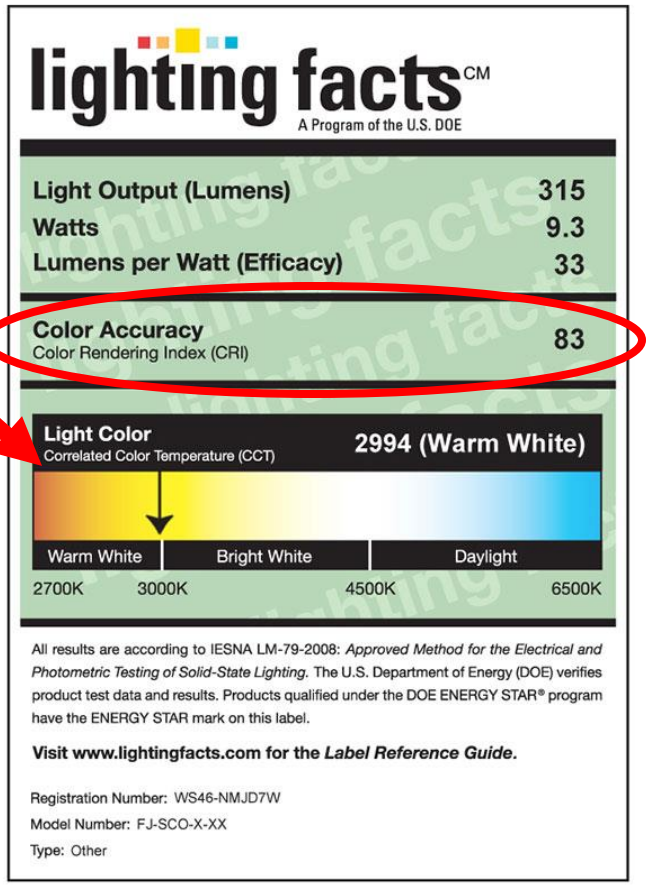
Refrigerant Safety Classes (ASHRAE 34)

Safety Group	1 No Flame Propagation	2L Lower Flammability	2 Flammable	3 Higher Flammability
A — Lower Toxicity *(OEL ≥ 400 ppm)*	**A1** R-134a, R-410A, R-513A, R-514A, CO_2	**A2L** R-32, R-454B, R-1234ze, R-1234yf	**A2** R-152a	**A3** R-290 (propane), R-600a, R-1270
B — Higher Toxicity *(OEL < 400 ppm)*	**B1** R-123	**B2L** R-717 (ammonia)	**B2** —	**B3** —

Letter = toxicity (A = lower, B = higher); **Number = flammability** (1 = none, 2L = lower with burning velocity ≤ 10 cm/s, 2 = flammable, 3 = higher). *Source: ASHRAE Standard 34 — Designation and Safety Classification of Refrigerants.*

Color Temperature & Color Rendering Index



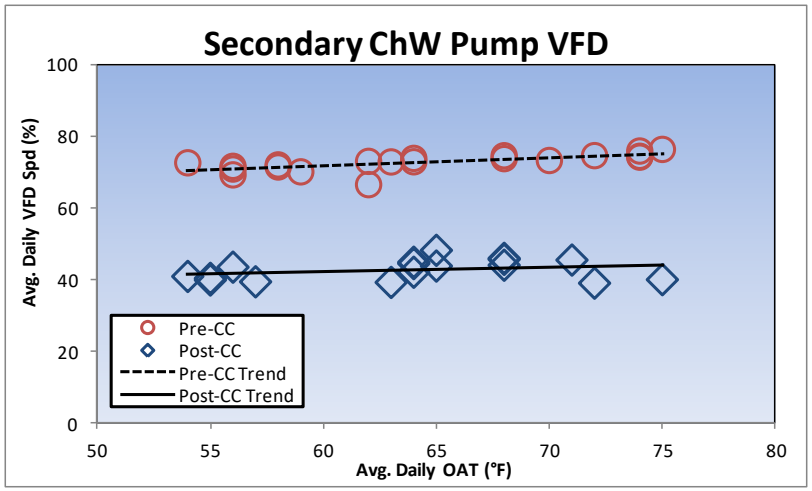


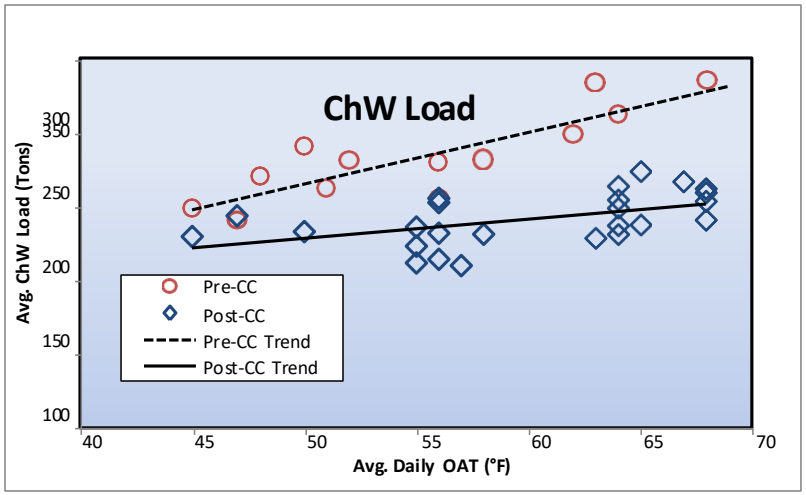
- Color Rendering Index -The ability to reveal the colors of various objects “faithfully” in comparison with a standard light source. Measured 0 to 100

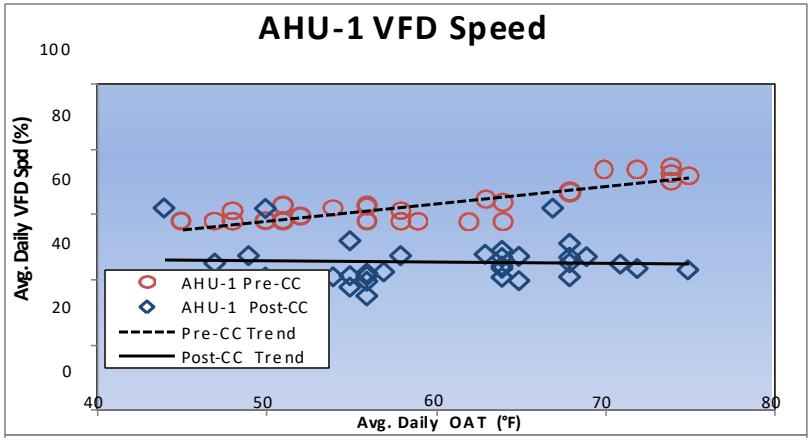
Commissioning (Cx)

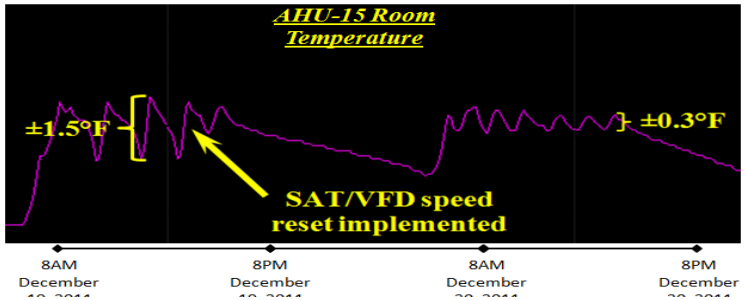
- The commissioning process is a quality-oriented process for achieving, verifying, and documenting that the performance of facilities, systems, and assemblies meets defined objectives and criteria. *(ASHRAE Guideline 0)*
- *New Construction & Renovations- Commissioning*
  - In general, commissioning is the process of ensuring that a building performs according to its design intent and the needs of its owners and occupants. *(Anderson 1997)*
- *Existing Building - Commissioning*
  - A quality-focused process for attaining the current facility requirements of an existing building and/or its systems and assemblies *(ASHRAE Guide 0.2-2015)*
- Commissioning is a process

Implementation, Monitoring & Tuning









Incorporating Renewable Energy Systems

- **Solar PV Systems:** Evaluate space and solar exposure for the installation of photovoltaic (PV) panels to offset building energy consumption.
- **Wind and Geothermal:** Consider small-scale wind turbines or geothermal systems for additional renewable energy generation.
- **Battery Storage:** Incorporate energy storage solutions to store excess energy for peak demand times.
- **Outcome:** Achieve energy independence, improve EUI, and meet net-zero goals.

Net-Zero Energy & Net-Zero Carbon

- **Net-Zero Energy (NZE) :** A Building that balances their low energy consumption with onsite or other sources renewable energy production to meet their entire energy loads.
  - *The focus is on energy balance—not necessarily on how clean the energy is, and that total production matches or exceeds usage*.

- **Net-Zero Carbon (NZC) :** "Net zero (carbon) refers to a state in which the greenhouse gases going into the atmosphere are balanced by removal out of the atmosphere. To 'go net zero' is to reduce greenhouse gas emissions and/or to ensure that any ongoing emissions are balanced by removals." [1]
  - The focus is on reducing carbon emissions, not just energy use.

Source: [1] Oxford Net Zero (n.d.). What is net zero? Netzeroclimate. https://netzeroclimate.org/what-is-net-zero-2/

Role of Energy Eff. in Achieving Net Zero

- **Energy Efficiency First**: Reduce energy consumption before incorporating renewable energy.
  - *And continue even after incorporating renewable*
- **Key Areas:** Lighting, HVAC, Controls, Insulation/envelope, Smart technologies/Storage etc.
  - *Opportunities in Retrofitting: Retrofit & renovation projects can make significant strides toward net zero.*
- **Why It's Critical**: Lower energy demand makes integrating renewables (like solar) easier for net zero.
- **Challenges** for Older Buildings: Existing buildings face challenges from retaining aspects of the original construction (outdated infrastructure, poor insulation, and incompatible layouts) that hinder it from achieving net zero.
- New Buildings…

RESOURCES!
State Energy Conservation Office (SECO)

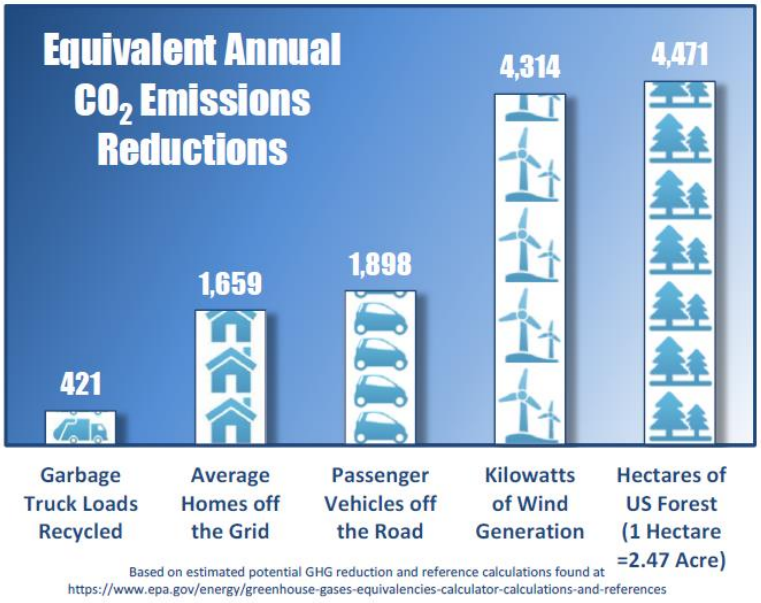
- Division of the Texas Comptroller of Public Accounts Office
- Administers Energy Programs
  - LoanSTAR Program (revolving loan)
  - Schools & Local Government Technical Assistance Program
  - Community Centers Energy Eff. Retrofits
  - Other Programs
- SECO (LoanSTAR & Schools-Local Govt TA)– **Adam Mueller**
  - Email: Adam.Mueller@cpa.texas.gov
  - Office: (512) 463-1770
- SECO (Community Center)– **Kacy Wycoff**
  - Email: Kacy.Wycoff@cpa.texas.gov
  - Office: (512) 936-2179
- http://www.seco.cpa.state.tx.us/

SECO Schools & Local Governments Technical Assistance Programs

- Preliminary Energy Assessment (PEA) Reports
- Technical Assistance
- Utility analysis for accurate base year energy use profile development
- Low cost/no cost measures
- Developing Energy Management Policy & Plan
- Assist in analysis of energy consuming systems for code and standard compliance
- Preventative maintenance schedules & equipment replacement prioritization
- Recommending quality-oriented process for facilities Commissioning
- Analysis of Renewable Energy resources

Example – Large Texas School District

- Texas School District: Facilities ranged from low, moderate to high energy usage
- Proposed Measures (included Solar PV):
  - **34%** Base Year Cost Reduction
  - **$1,294,500** annual utility cost savings
  - **14,477,400 kWh** annual electric savings
  - **15.0** simple payback period
  - CO_2 Emissions: **8,270** metric tons of CO_2 saved per year



SECO LoanSTAR Program Overview

- The Texas LoanSTAR (Saving Taxes And Resources) revolving loan program
  - The program was initiated by Texas Energy Office in 1988 & approved by DOE as statewide energy-efficiency demonstration program. Program funds were provided from petroleum violation escrow funds.
  - Provides low-interest rate loans (2-2.5% , 1-1.5%)to assist Texas public institutions by financing their energy-related cost-reduction retrofit projects.
  - Loan mechanism that enables it to continue indefinitely.
  - Project must meet weighed average (composite) simple payback (PB) criteria among other things.
    - PB criteria changed over time: 4, 8, 10 and currently 15 years

THANK YOU!

Saleem Khan, P.E., CxA
TEESI Engineering
(512) 328-2533 ext:208
saleem@teesi.com
www.teesi.com