High Efficiency Schools

HVAC Considerations

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Energy Systems Group

When is the Most Energy Efficient School not Necessarily the Best ?

School A

- $ 0.75 per square foot fuel and electric cost

School B

- $ 1.05 per square foot fuel and electric cost

Learning Environment

Energy Efficiency

- Accuracy/ consistency of temperature control
- Proper ventilation
- Acceptable system noise levels
- Perception of drafts
- Control of humidity levels
- Ability to adapt to changing conditions/ seasons

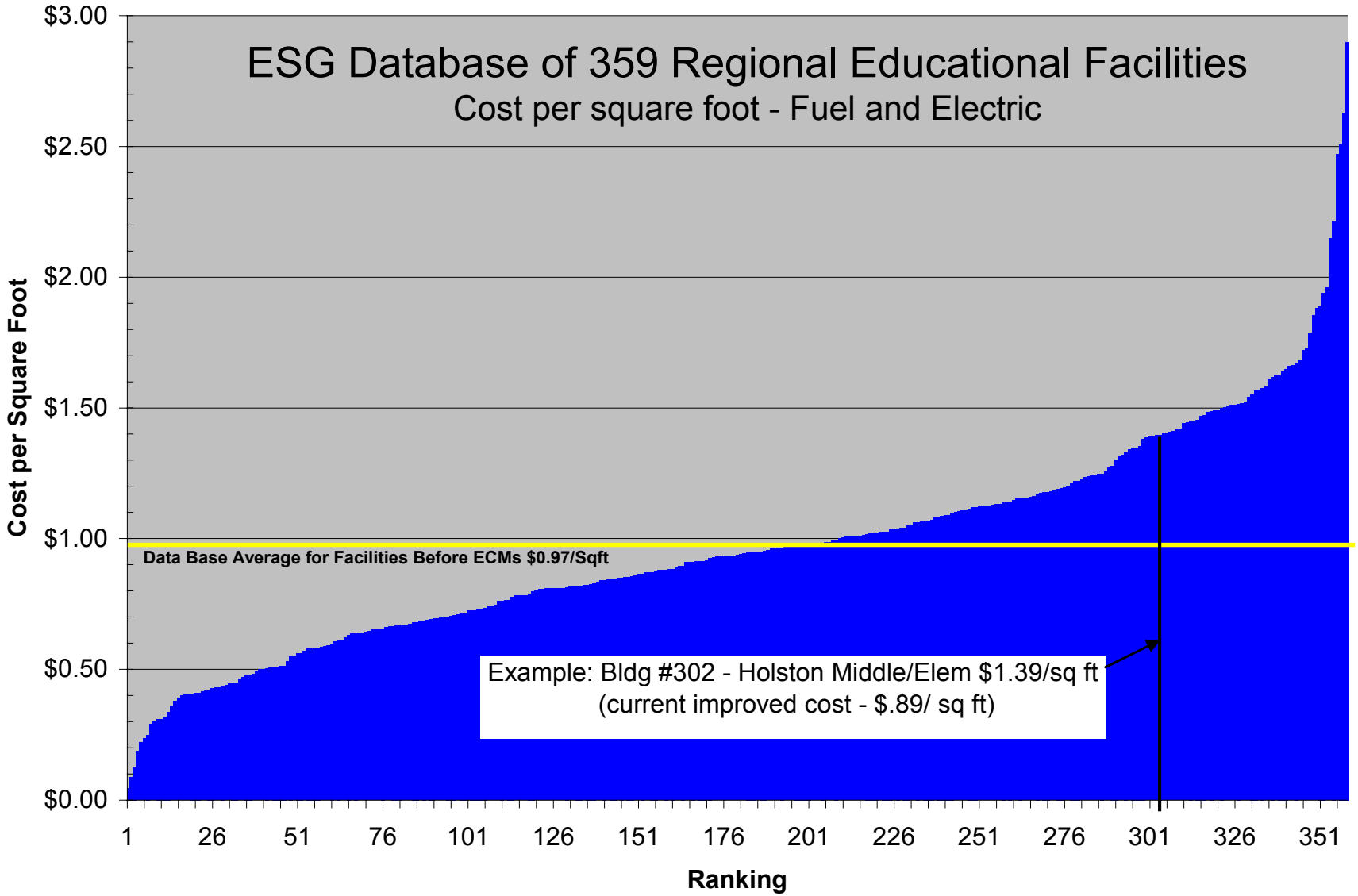
First Cost vs. Life Cycle Cost

First Cost

- Purchase/ installation cost

Long-term Costs

- Utility costs
- Maintenance costs
- Training costs
- Comfort/ Ventilation/ Humidity quality
- Replacement costs


ESG Database of 359 Regional Educational Facilities
Cost per square foot - Fuel and Electric
$3.00
$2.50
$2.00
$1.50
$1.00
$0.50
$0.00
Cost per Square Foot
Data Base Average for Facilities Before ECMs $0.97/Sqft
Example: Bldg #302 - Holston Middle/Elem $1.39/sq ft
(current improved cost - $.89/ sq ft)
1
26
51
76
101
126
151
176
201
226
251
276
301
326
351
Ranking

Efficient Production of Heating

- Condensing boilers
- Staged boilers
- Burner retrofits
- Reset of hot water temperature
- Smaller boiler(s) for low load periods
- Regular combustion analysis/ tuning

Condensing Boilers

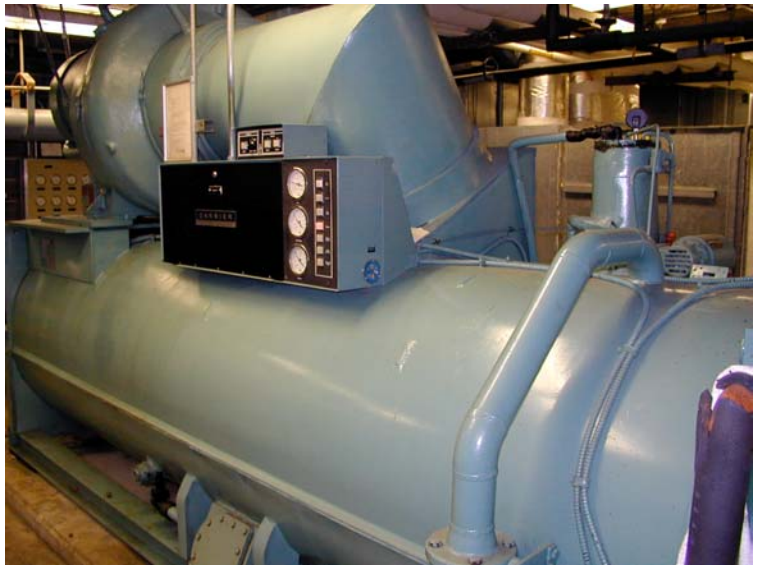
90 % + Efficiency

DOMESTIC HOT WATER HEATER SYSTEMS

New systems are more efficient and can reduce maintenance expenses.

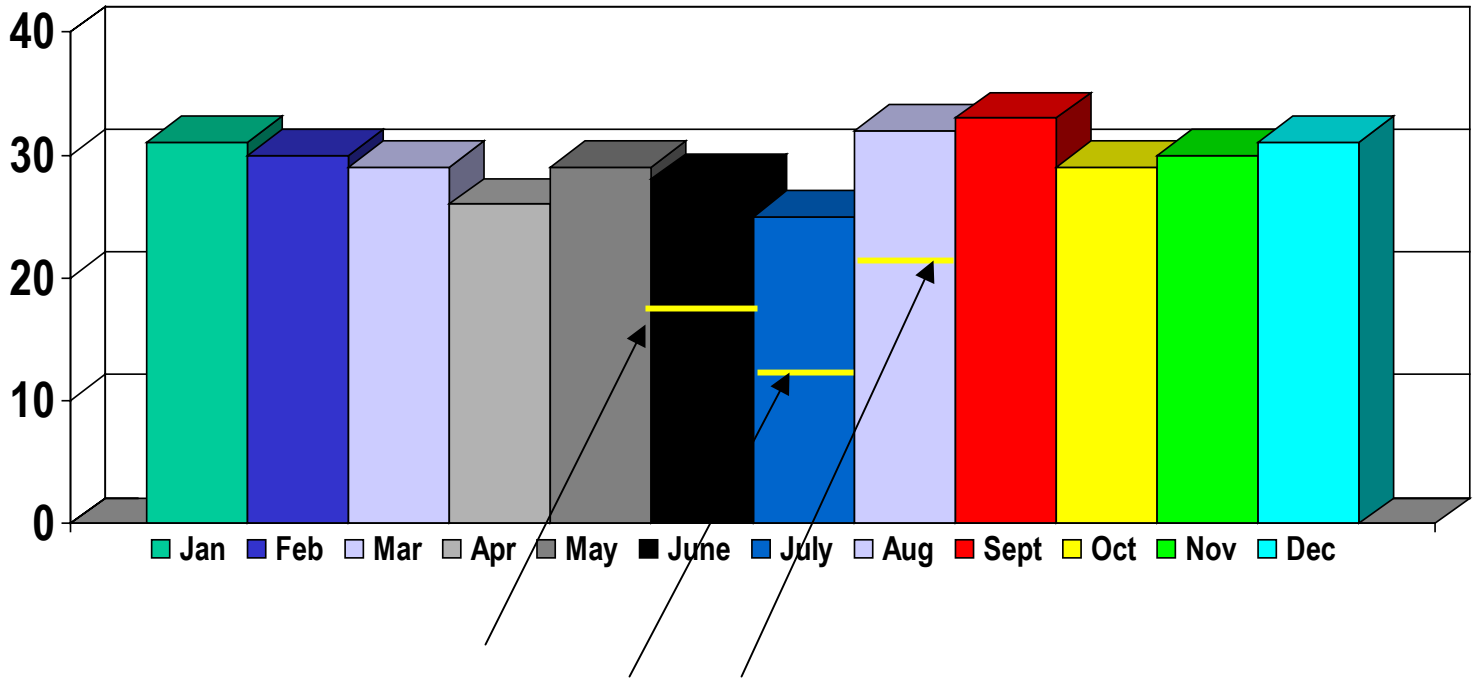
Efficient Production of Cooling

- Individual or zoned cooling vs. central plants
  - % of school needing cooling at various times (summer)
- Higher efficiency central plant chillers
  - Typical older unit – 1.2 kw/ ton
  - Typical new unit - .8 kw/ ton or <
- Retrofits to add variable speed control
- Air cooled vs. water cooled equipment
  - Water costs? Maintenance costs?
- Higher efficiency RTU's and individual units
  - Are the current units past useful life now?



Typical School Electrical Usage Pattern

Q. Why is there not a larger summer reduction in use?



Summer Unoccupied Air Conditioning Waste?

High Efficiency Distribution of HW/ CH

- Variable flow control
- Zoned control
- Reset of HW/ CW temperature

Goal:

Consistently adjust the supply to the demand

High Efficiency Distribution of Air

- Variable Volume control
- Zoned control
- Reset of discharge air
- Avoid simultaneous heating and cooling

Goal:

Consistently adjust the supply to the demand

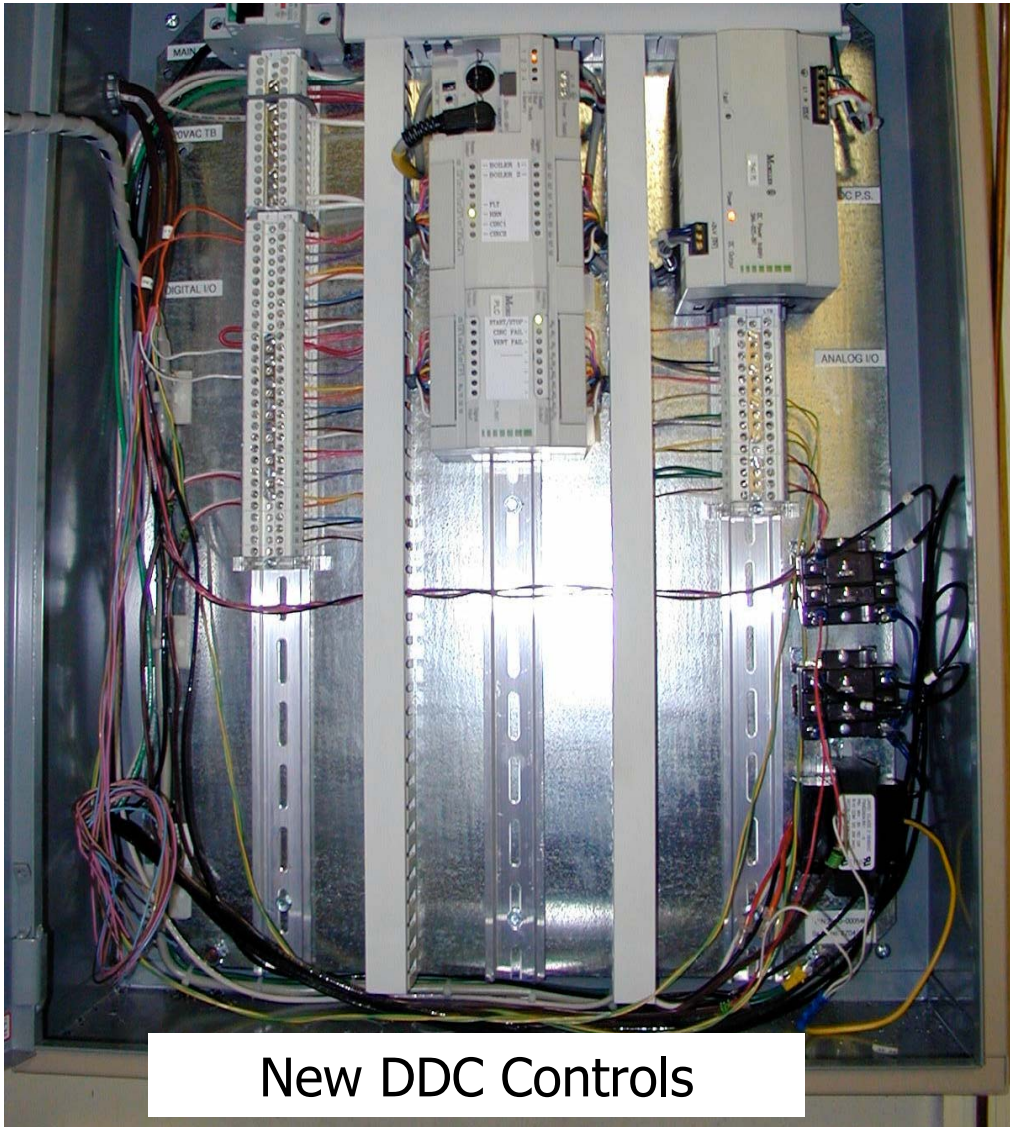
Equipment sizing

- Bigger is not always better! Avoid oversizing for:
  - AC/heat pump compressors
  - Furnaces
  - Boilers
  - Chiller
- Sometimes bigger is better!
  - Ducts
  - Fans (if they have speed control)
  - Cooling towers
  - Pipes

Control is Critical!

Great HVAC equipment is marginalized without capable and properly maintained controls

Original Pneumatic Controls



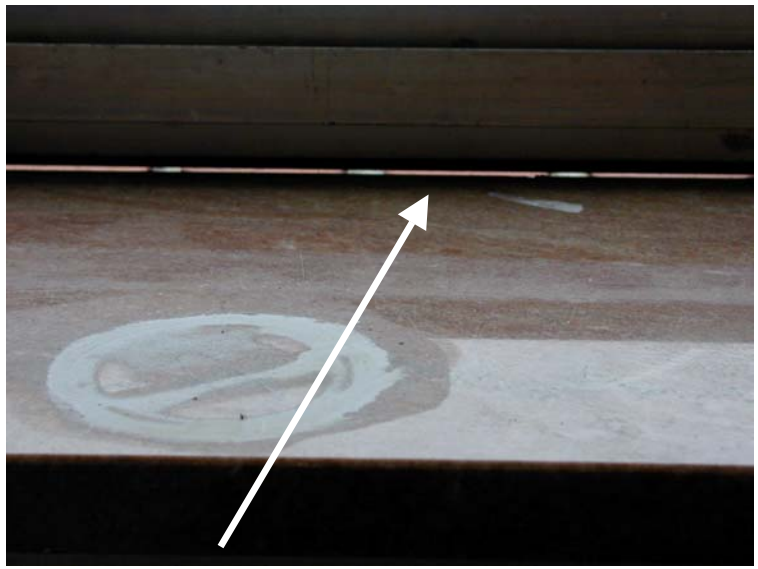
New DDC Controls

Building Envelope Impacts on the HVAC System Performance

- Difficulty controlling comfort
- Challenges utilizing scheduling and night set-back

Examples:

- Limited insulation
- Old single pane window systems
- Poorly sealed doors/ windows
- Lack of vestibules



Infiltration through old windows

Importance of Preventive Maintenance

Examples

- Boilers
  - Water treatment
  - Tube cleaning
  - Combustion analysis
- Air handling systems
  - Outside air control - Dampers
  - Valve control
  - Coil cleaning

Just because it's comfortable doesn't mean systems are working properly!

All planned and reactive maintenance activities and associated costs should be tracked to maximize organization and individual efficiency

Indoor Air Quality Issues

Real or Imagined – When people blame illness on the building… you have a big problem!

- Main reasons for problems
  - Not enough fresh air being brought in (15 cfm/ person)
  - Lack of humidity control (mold)
  - Lack of filter maintenance
  - HVAC design deficiencies

- Key Liability
  - **Negligence**

  (You knew you had an issue and didn't take corrective action)

Mold

Primary Causes

- Long term water leaks:
  - Improperly insulated chilled water lines
  - Condensate pans/ drains malfunctioning
  - Roof leaks
- Lack of humidity control
  - No sensing or control of humidity, no dehumidification outside air
- Oversized individual classroom AC units
- Chilled water set-point too high

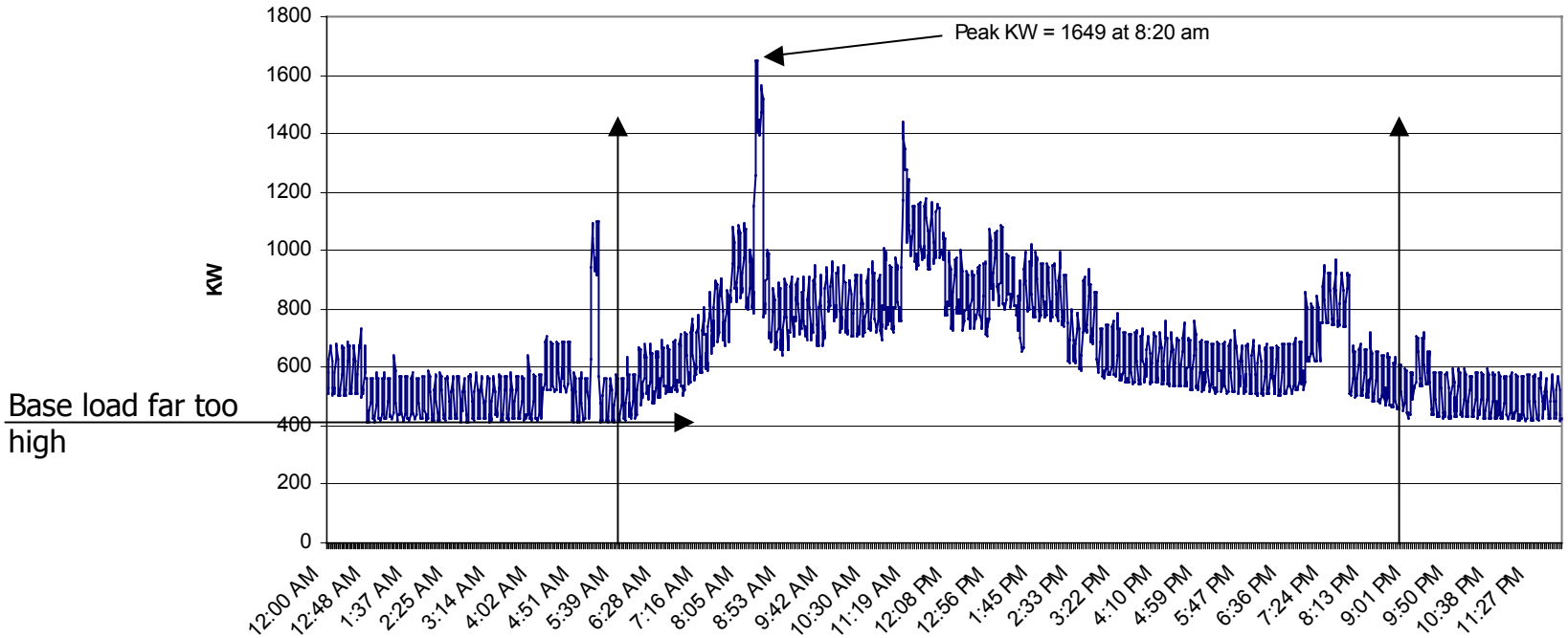
IAQ/ Mold Prevention Strategies

- Provide proper ventilation
- Humidity controls/ dedicated dehumidification
- Immediate/ proper response to water leaks
- UV lamp systems for air handling units
- Consistent preventive maintenance on HVAC systems

Energy Management Basics

- You can't manage what you can't measure
  - Who is scrutinizing your energy costs?
  - What tools are available to them?
- Many "best practices" have a higher first cost
  - Has any significant level of capital been provided?
  - Has an performance contract been considered?
- It takes a team effort
  - One or more people to take ownership
  - Obvious support from "upper management"

Electric Usage Graph – 1 day



HVAC Cost Savings Expectations

- Existing Building Retrofit Opportunity
  - It is highly dependent on what systems exist
  - It is highly dependent on how systems currently operate
    (15% to 25% is a common range to achieve)
- New Building Maximized Design Opportunity
  - Largely dependent on first cost vs. lifecycle cost analysis
  - Consult LEEDs resources for excellent information

CONCLUSION

The U.S. Department of Energy (DOE) estimates that schools in the U.S. spend more than $7.6 billion each year on energy. And, according to DOE,
25 percent of that money—$1.9 billion nationally—could easily be saved through "better building design, widely available energy-efficient and renewable energy technologies and improvements to operations and maintenance."

THANK YOU!

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