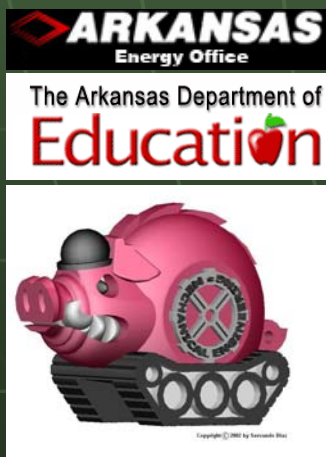


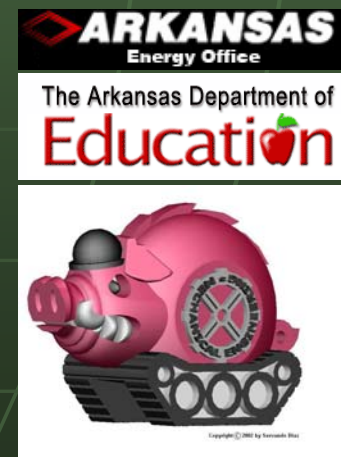


UA Engineering Research: Utility Benchmark and Survey Results for K-12 Schools in Arkansas

Supported by the Arkansas Energy Office

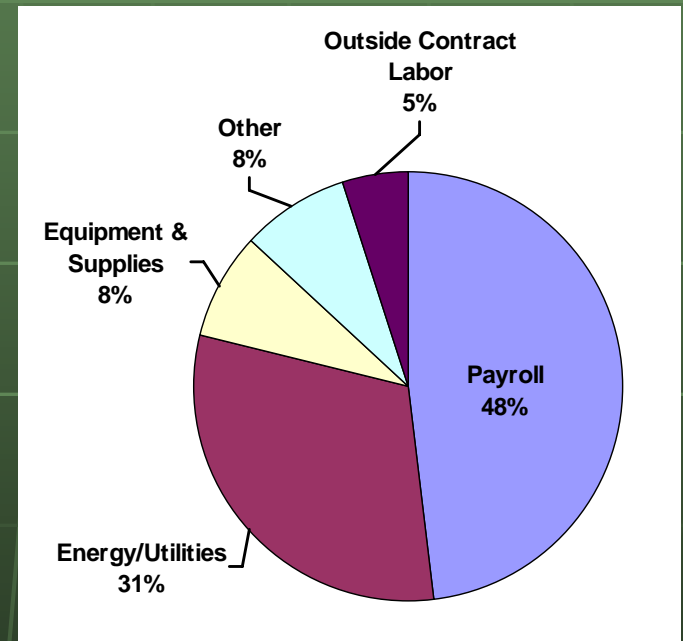


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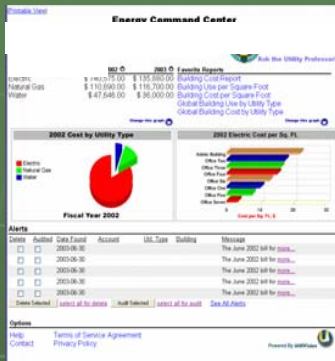
Background

- Arkansas public schools
 - 463,000 Students
 - 82 million square feet of building space
 - Annual utility expenditures exceed \$50 million
- Concerns regarding recent high utility prices and fixed O&M budgets
- Changes in state M&O budget
- AEO pilot utility tracking program



Percentage distribution of M&O budget.
American School and University, April, 2004

Pilot Utility Tracking Program



- Water
- Natural gas
- Electricity
- Trial online utility tracking efforts
- 8 participating school districts across state

UA Project Objectives

- Help schools with online data entry and utilization of service
- Perform first level evaluation of K-12 facility usage characteristics
 - Publish benchmark values for several parameters related to building performance which can be used as a point of reference
 - Evaluate the percentage of schools falling below the benchmark values and having potential for significant utility cost reductions
 - Determine the utility-related practices and concerns at the district level

2005 Summer UA Mechanical Engineering Internships



Student Benefits

- Each a different experience
- Some interacted with local utilities
- Improved people skills – facilities professionals, the business/office setting (some for the very first time), and clerical and maintenance personnel
- Represented the UA

What is Benchmarking?

- Measuring and comparing one's performance against the performance of similar organizations
- Recognizing areas for potential improvement and identifying the best practices for more efficient and effective performance

Improving Performance Through Benchmarking

Six Steps:

1. Identify key variables
2. Select good comparable sources
3. Collect and measure performance data
4. Normalize and adjust to meaningful data
5. Analyze data
6. Change and improve performance

1. Key Variables

- Annual Consumption
 - Electricity
 - Natural Gas
 - Water
- Annual Expenditures
 - Electricity
 - Natural gas
 - Water
- Peak electric demand
- Electrical Load Factor

2. Sources

- 1999 Commercial Buildings Energy Consumption Survey (CBECS)
 - K-12 schools
 - Arkansas, Oklahoma, Louisiana, Texas
 - Natural gas and electricity are only energy sources

3. Data Collection

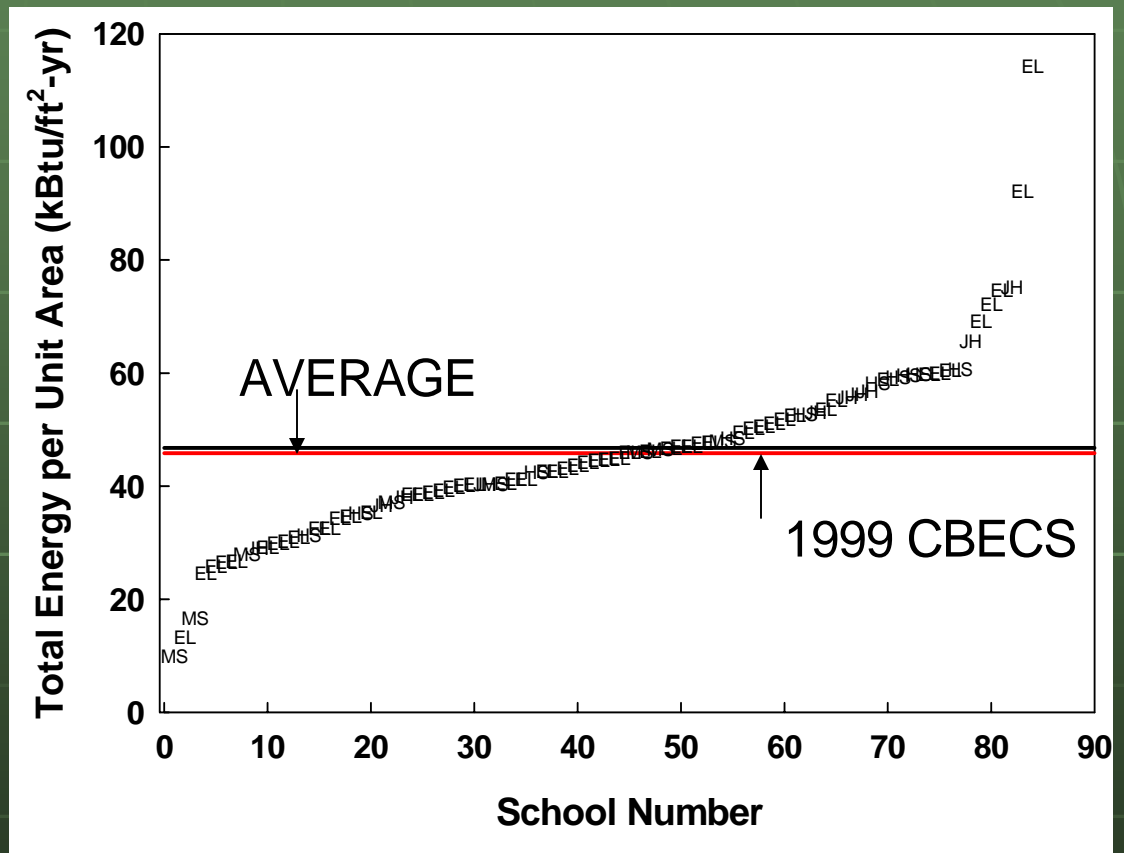
- 84 school campuses in 8 Arkansas school districts
 - 56 Elementary (EL)
 - 8 Middle School (MS)
 - 10 Junior High (JH)
 - 10 High School (HS)
 - 452 total utility meters
- Bills entered into online database
 - Assistance from interns
- Used data from May 2004 – April 2005
 - Most consistent 12 months
 - Monthly data compiled into annual values

4. Normalization

- Consumption, power, and cost parameters normalized per student and per ft² of building area
- Mean, 25th percentile and 75th percentile values calculated for all benchmarking parameters and school types

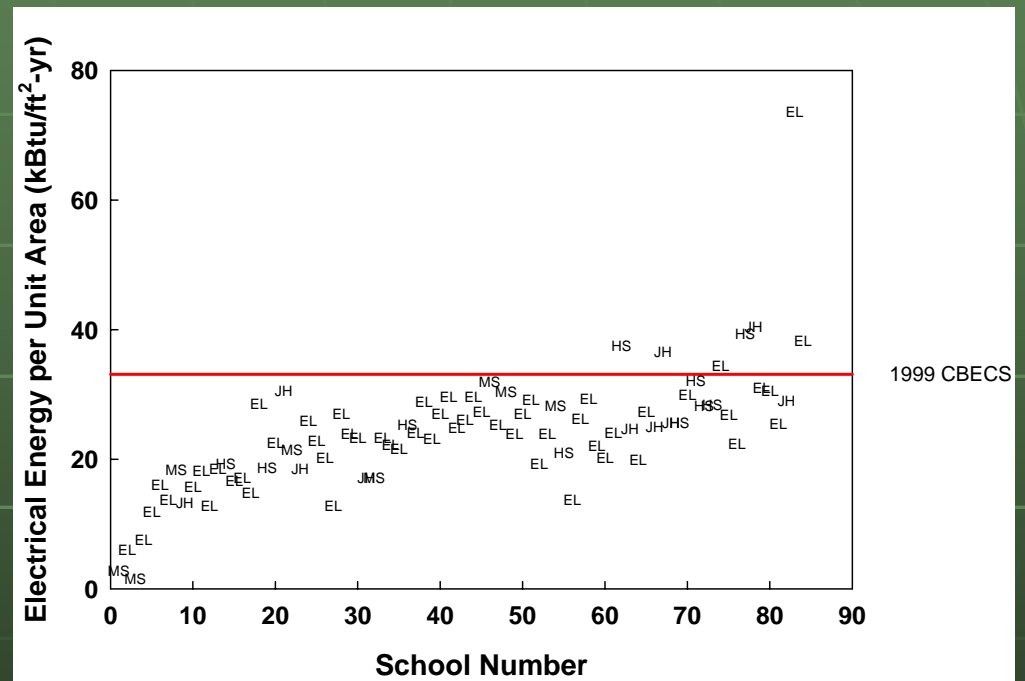
Total Energy Consumption

- Includes Electricity and Natural Gas
- Study Average
 - 46.8 kBtu/ft²-yr
- CBECS Average
 - 45.8 kBtu/ft²-yr



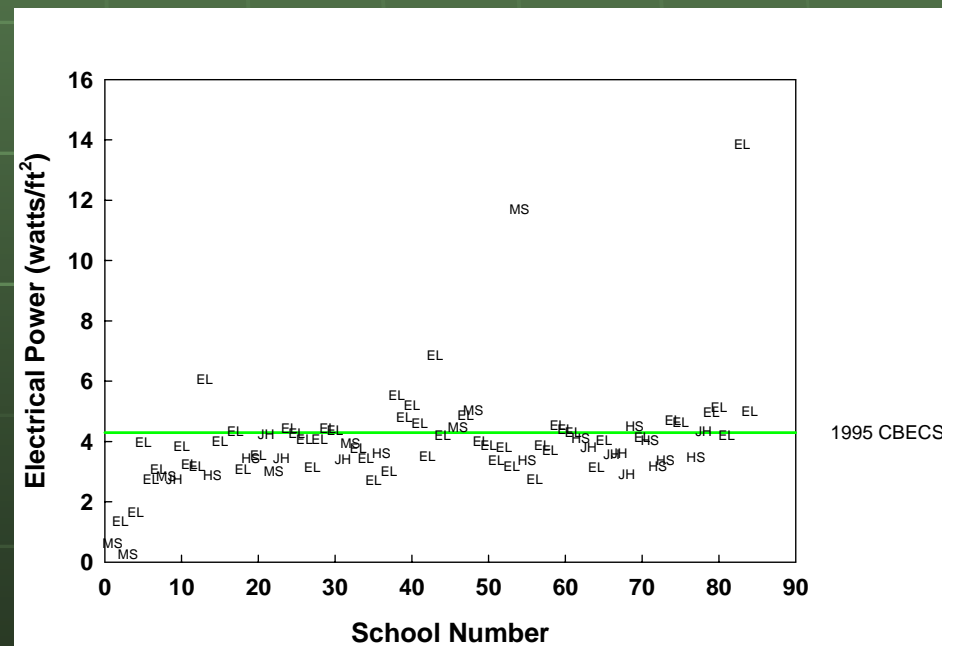
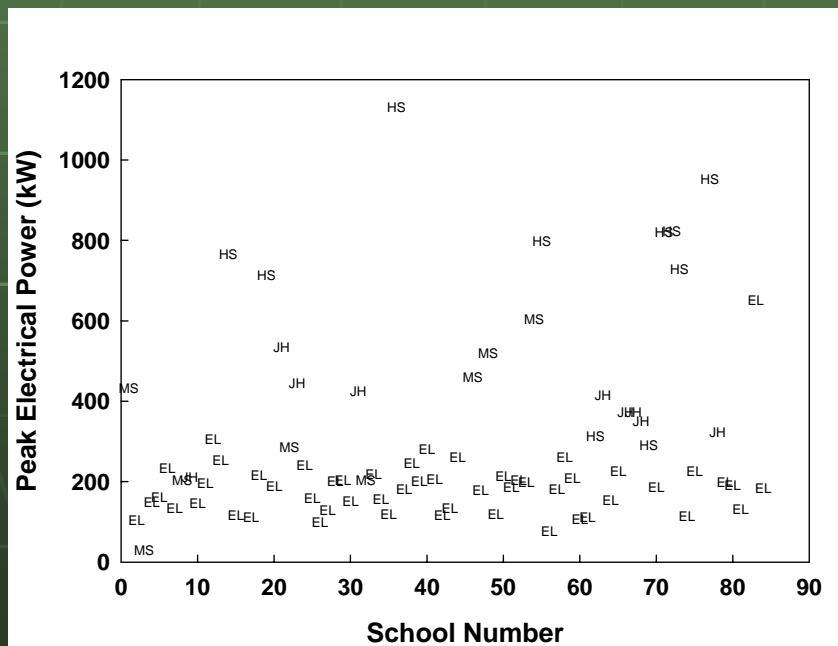
Electricity Consumption

- Study Average
 - 24.3 kBtu/ft²-yr
 - 7.11 kwh/ft²-yr
 - 993 kwh/student-yr
 - \$0.47/ft²-yr
- CBECS Average
 - 33.1 kBtu/ft²-yr
 - likely influenced by increased cooling requirements of Louisiana and Texas



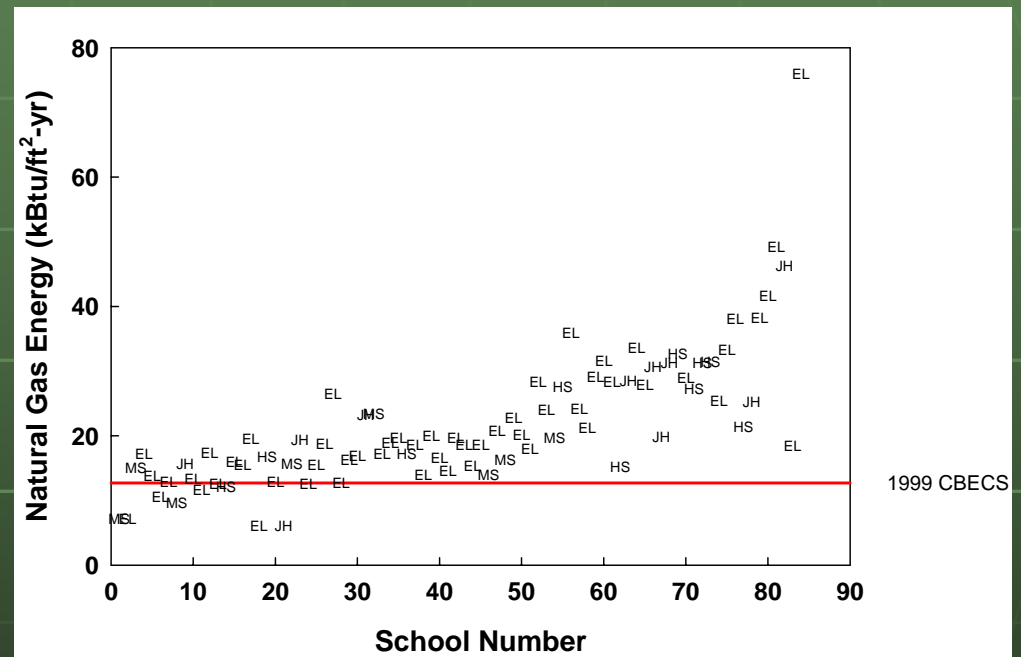
Peak Electric Demand

- Study Median – 3.9 W/ft²
- CBECS Median – 4.3 W/ft²



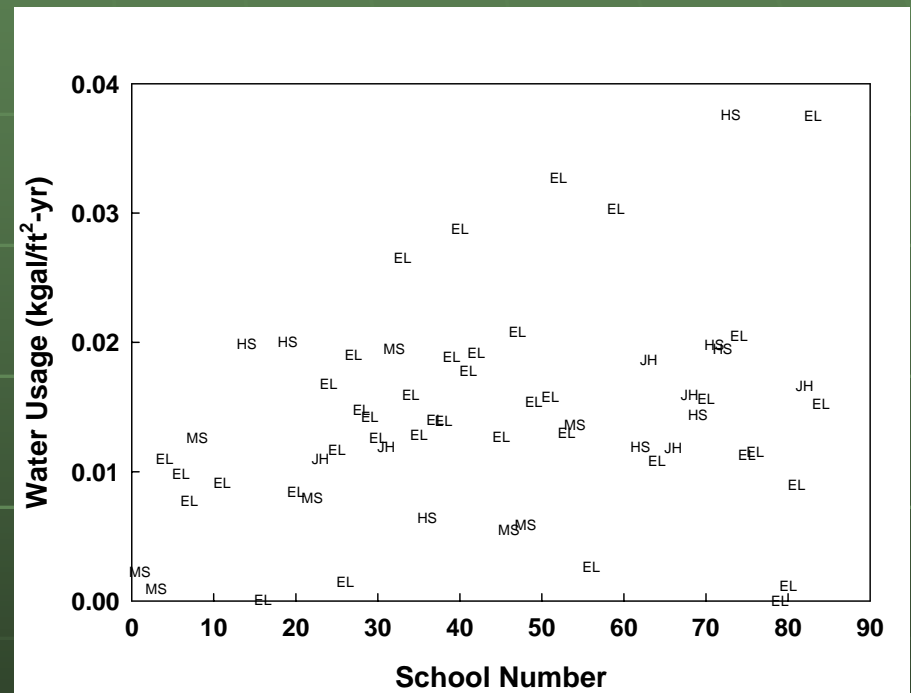
Natural Gas Consumption

- Study Average
 - 22.5 kBtu/ft²-yr
 - 32.3 CCF/student-yr
 - \$0.24/ft²-yr
- CBECS Average
 - 12.7 kBtu/ft²-yr
 - Likely influenced by lower heating needs of Texas and Louisiana

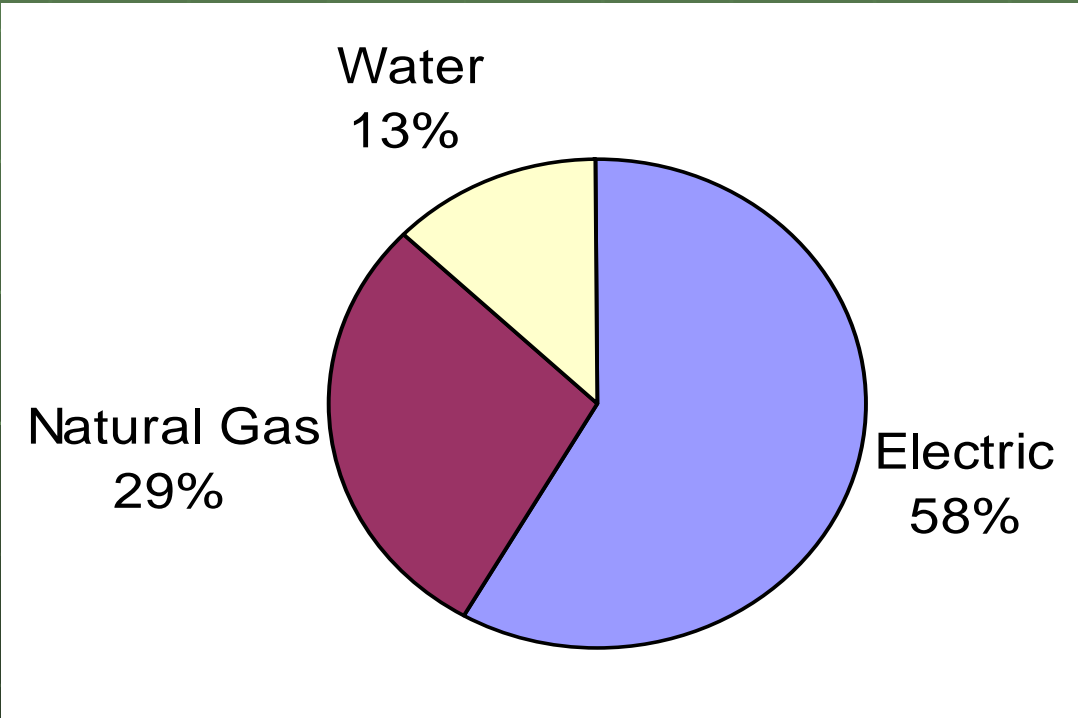


Water Consumption

- Study Average
 - 15 gal/ft²-yr
 - 2.12 kgal/student-yr
 - \$0.11 /ft²-yr
- Little data for comparison
- Significant variation



School District Utility Expenditures



Computed Benchmark Values

Table 1 Average, 25th percentile, and 75th percentile values for benchmarking parameters by school type

School Type	ELECTRICITY			NATURAL GAS			WATER		
	kWh/ft ² -yr			CCF/ft ² -yr			kgal/ft ² -yr		
	25th Percentile	Average	75th Percentile	25th Percentile	Average	75th Percentile	25th Percentile	Average	75th Percentile
Elementary	8.76	6.94	5.13	0.296	0.220	0.144	0.022	0.016	0.010
Middle School	8.27	6.44	4.62	0.353	0.230	0.107	0.015	0.011	0.006
Junior High	9.22	7.64	6.06	0.314	0.246	0.177	0.016	0.014	0.012
High School	9.39	8.06	6.73	0.281	0.232	0.184	0.024	0.019	0.013
Overall	8.88	7.11	5.34	0.304	0.225	0.147	0.021	0.015	0.010

Also tabulated cost and per student benchmarks

Table 2 Additional Electrical Benchmarks

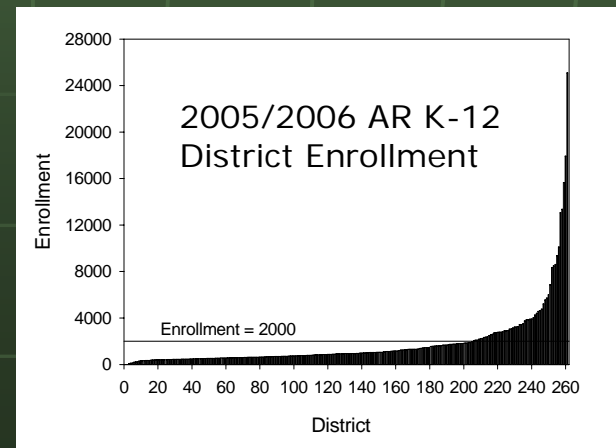
School Type	Annual Peak Watts/ft ²			Annual Load Factor		
	25th Percentile	Average	75th Percentile	25th Percentile	Average	75th Percentile
Elementary	5.27	4.17	3.06	0.304	0.268	0.231
Middle School	6.76	4.67	2.58	0.319	0.271	0.223
Junior High	3.90	3.57	3.23	0.381	0.331	0.280
High School	3.90	3.60	3.29	0.402	0.357	0.312
Overall	5.22	4.08	2.93	0.332	0.286	0.240

5. Analysis

- Overall 36% of schools in the study score below the 25th percentile in either electricity, natural gas, or water consumption per square foot of building area
- Schools and districts should use the benchmark values to evaluate their own performance
- Note: further inspection would be needed to determine whether an individual building has opportunities for cost savings (Step #6)

School District Survey

- 16 statement requiring Likert scale responses
- 1 open-ended question
- Over 30% of districts responded
- Statistically analyzed all data for:
 - smaller districts (enrollment < 2000, 79%)
 - larger districts (enrollment \geq 2000, 21%)



Survey Findings – All Districts

- **86%** use buildings for community activities
- **93%** feel tracking utilities would be beneficial
- **51%** agree their district has significant potential to reduce utility costs
- **51%** disagree that their local utilities have helped conserve energy and reduce utility costs

Survey Findings – CONTRAST

- District utilizes automated building controls in most of its buildings – Larger (65% agree), Smaller (67% disagree)

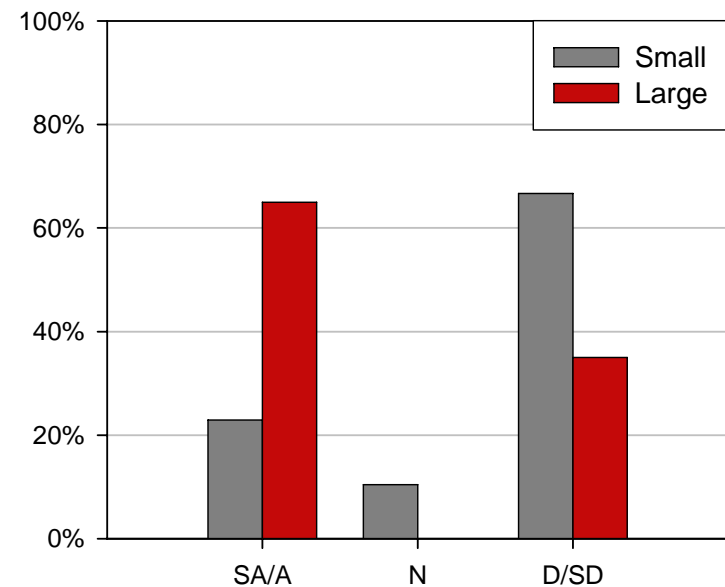
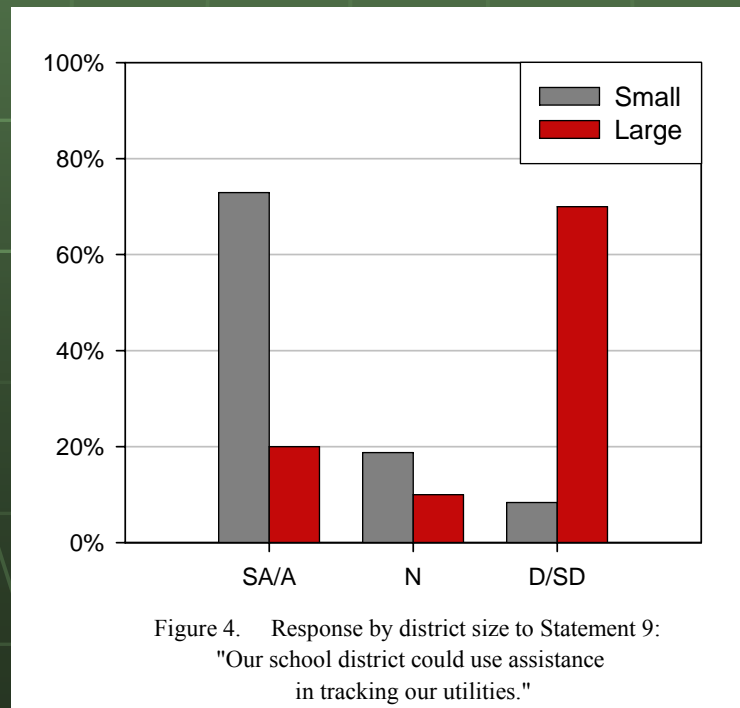


Figure 3. Response by district size to Statement 2:
"Our school district utilizes automated
building controls in most of our buildings."

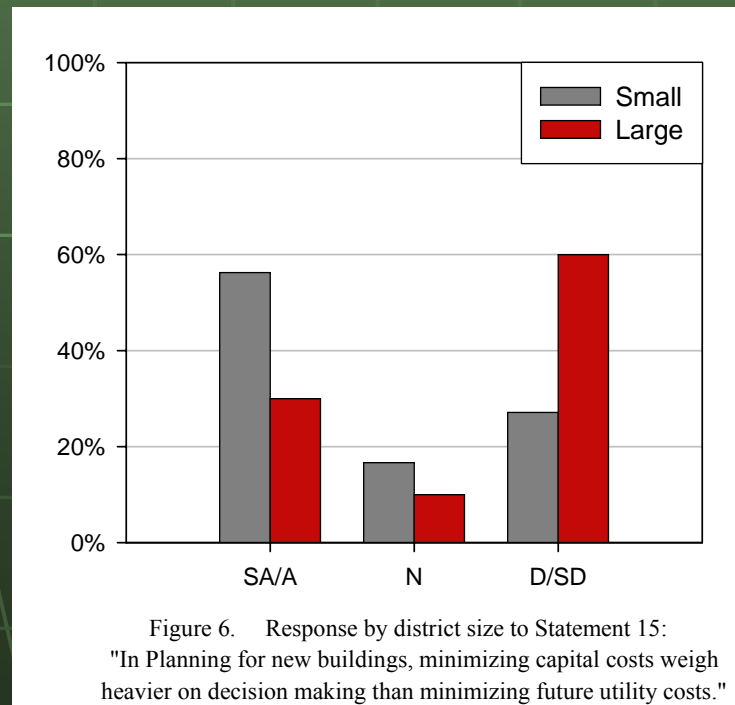
Survey Findings – CONTRAST

- Could the district use help tracking utilities? – Larger (70% disagree), Smaller (73% agree)



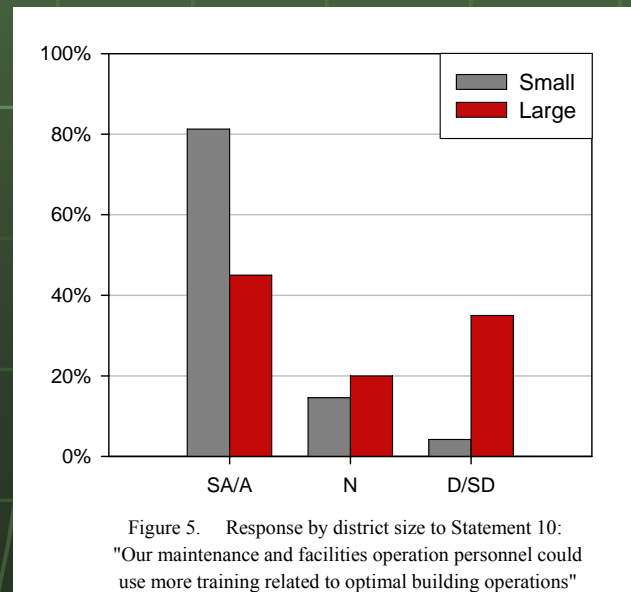
Survey Findings – CONTRAST

- In planning for new buildings, capital costs are more important than future costs – Larger (60% disagree), Smaller (56% agree)



Survey Findings – CONTRAST

- District could use additional or specialized evaluation assistance to help conserve utilities and reduce costs – Larger (40% agree), Smaller (77% agree)
- Maintenance and facilities operation personnel could use more training related to optimal building operation – Larger (45% agree), Smaller (81% agree)



Future Recommendations

- Use and further refine benchmarking parameters as a guide for other school districts across the state.
- Make a strong effort through education and assistance to understand the unique needs of smaller school districts.
- Continue to utilize engineering interns to assist the state with energy/environmental issues.

Questions?

Thanks to the Arkansas Energy Office
for support of this project.