Cooling, Heating and Power in the Nation's Colleges & Universities

Census, Survey and Lessons Learned

Report for Oak Ridge National Laboratory/ US Department of Energy

15th Annual College & University Conference
February 28, 2002

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Purpose of Study

- Develop data on Cooling, Heating & Power in College/University sector
  - Technologies
  - Size of Systems
  - Locations
  - Plans for Growth
- Understand hurdles and challenges
- Identify “lessons learned” to assist market growth through cases and “champions”

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Why College & University Sector?

- Colleges own and operate central plants, land, facilities and campus buildings– excellent experience base
- Good ratio of thermal to electrical load
- Near term prospects for CHP investment
- Agencies need guidance to support DOE Goal of doubling CHP in US by 2010
- Industry needs insight on current market and market potential

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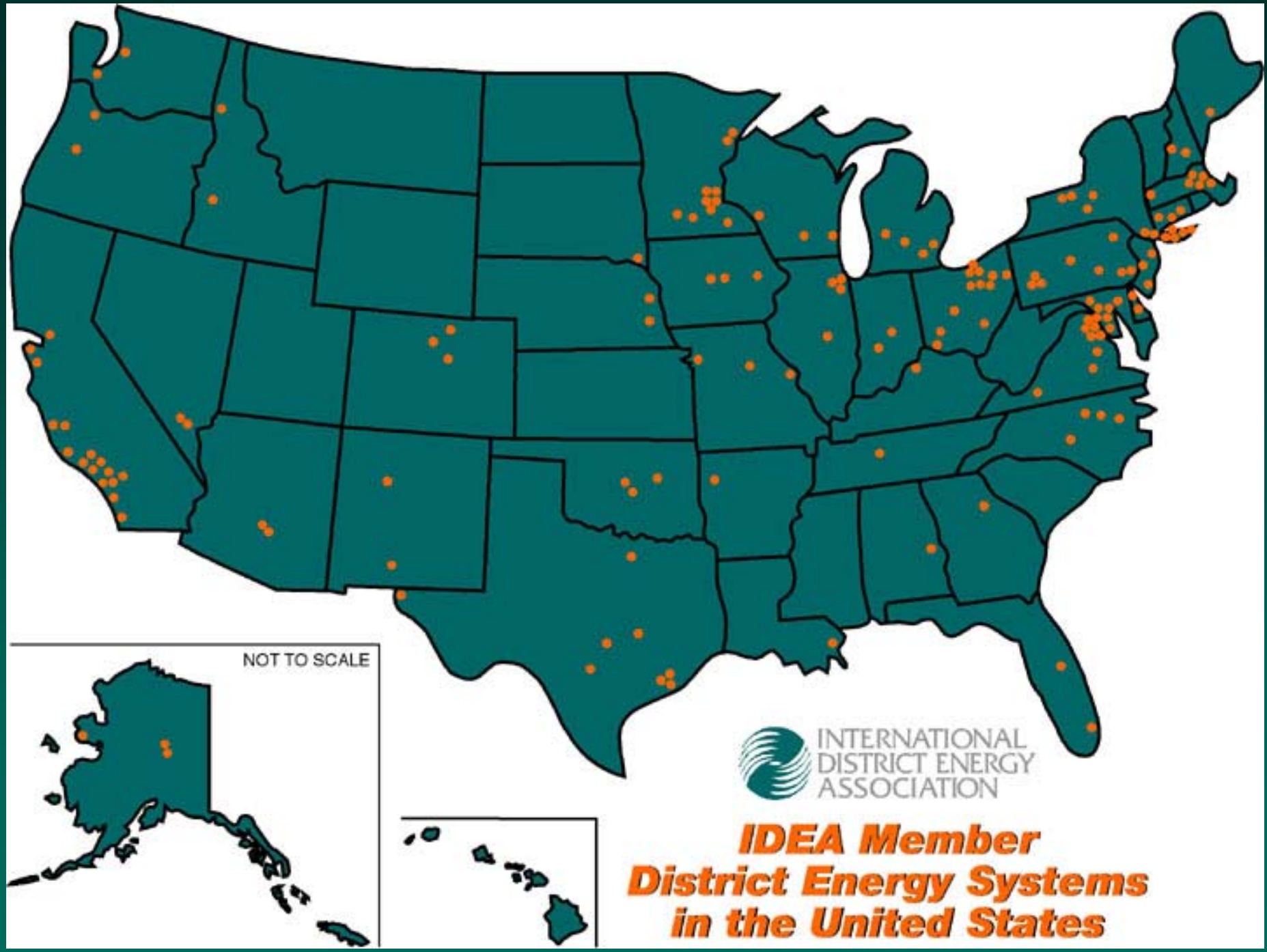
NOT TO SCALE
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IDEA Member
District Energy Systems
in the United States

Procedure

1. Compiled population for study from lists of IDEA, U Rochester, APPA
2. Web-based survey for qualitative feedback – www.zoomerang.com
3. Collect census data through email, fax and phone surveys
4. Conducted interviews for Case Studies - Lessons Learned

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Census Results

1208	Total Population (APPA, U Rochester, IDEA)
436	Contacted by IDEA
267	Contacted, not yet completed
39	Completed, no central plant
130	Completed detailed surveys

Response Rate:

10.7 % of Population

29.8 % of Contacted

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General Observations

- **Earliest central plants reported**
  - 1883 University of Northern Iowa
  - 1884 Iowa State University
- **Range of generation technologies**
- **Cooling system expansion**
- **Different drivers**
  - Campus growth
  - Power reliability
  - Replacement
  - Economics

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Findings – Heating Capacity

- Total capacity (Mlbs/Hr) 39,092,540
- Mean installed 328,509
- Median installed 206,000
- Range 6,000 to 3,300,000

Note: Capacity in Mlbs steam (150 psig) per hour.
Based on 119 institutions reporting.

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Annual Fuel Expenditure ($ US)

- **Total Fuel Expenditure $ 234,261,000**
- **Mean Annual $ 2,602,900**
- **Median Annual $ 1,500,000**
- **Range $ 30,000 to $ 18,683,000**

Note : Based on prior calendar year, not normalized for weather.

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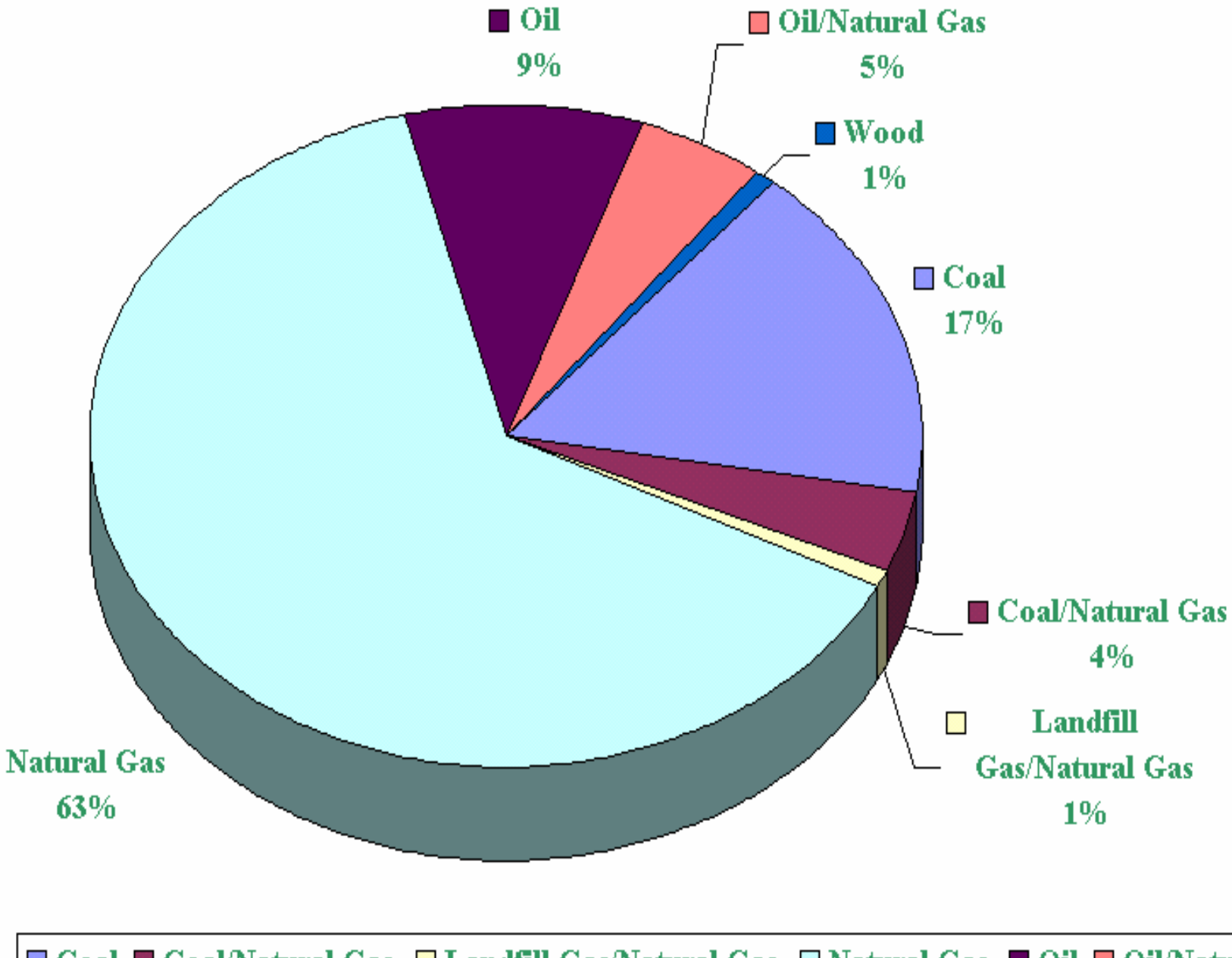
Primary Fuel Source



Heating System Piping Length - (S&R linear ft)

- Total Length (ft) 4,199,163
- Mean Length 46,145
- Median Length 21,000
- Range 2,000 to 245,000

Total equivalent to 795 miles.

Note : Based on 91 institutions reporting.
Includes supply and return mains, service laterals and customer connections.

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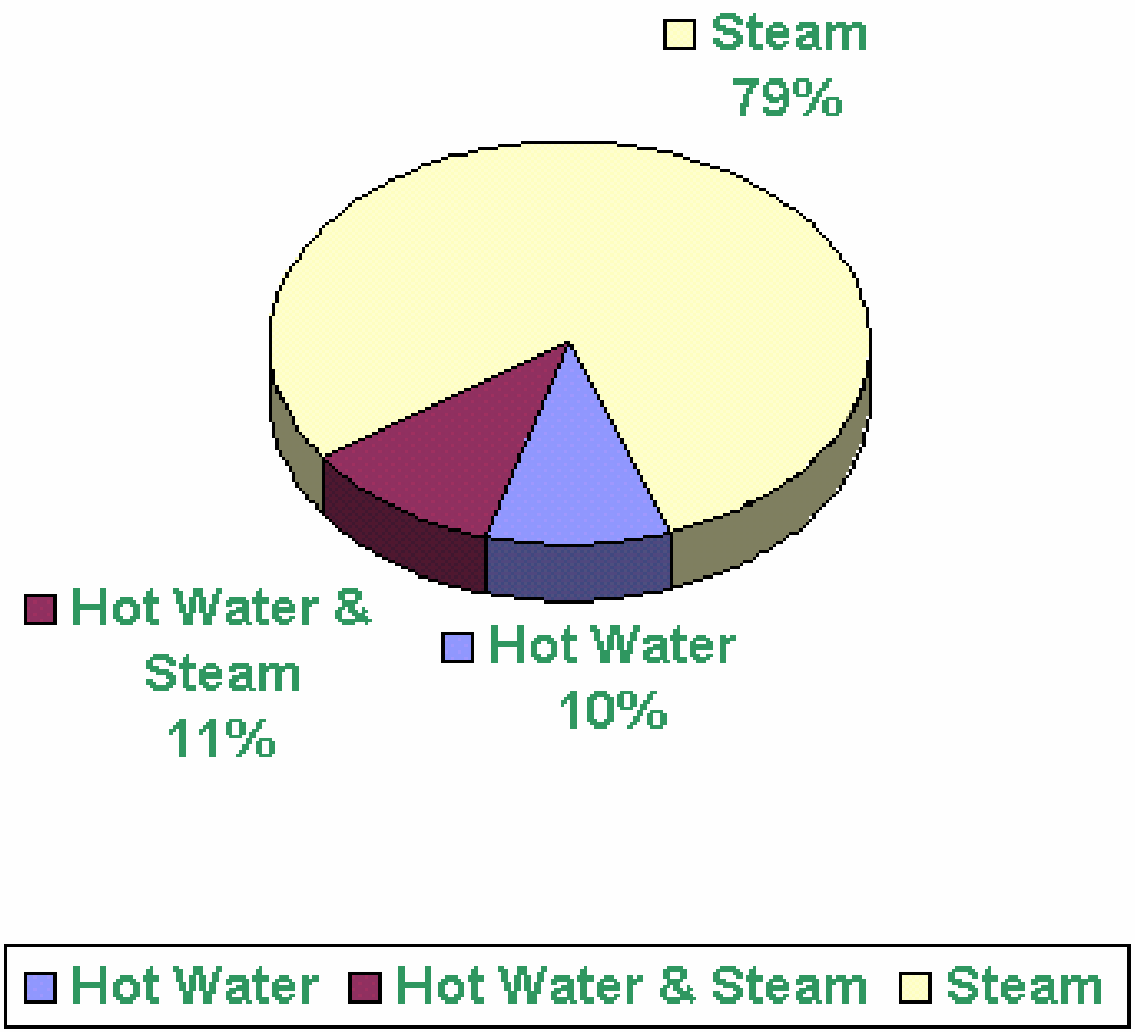
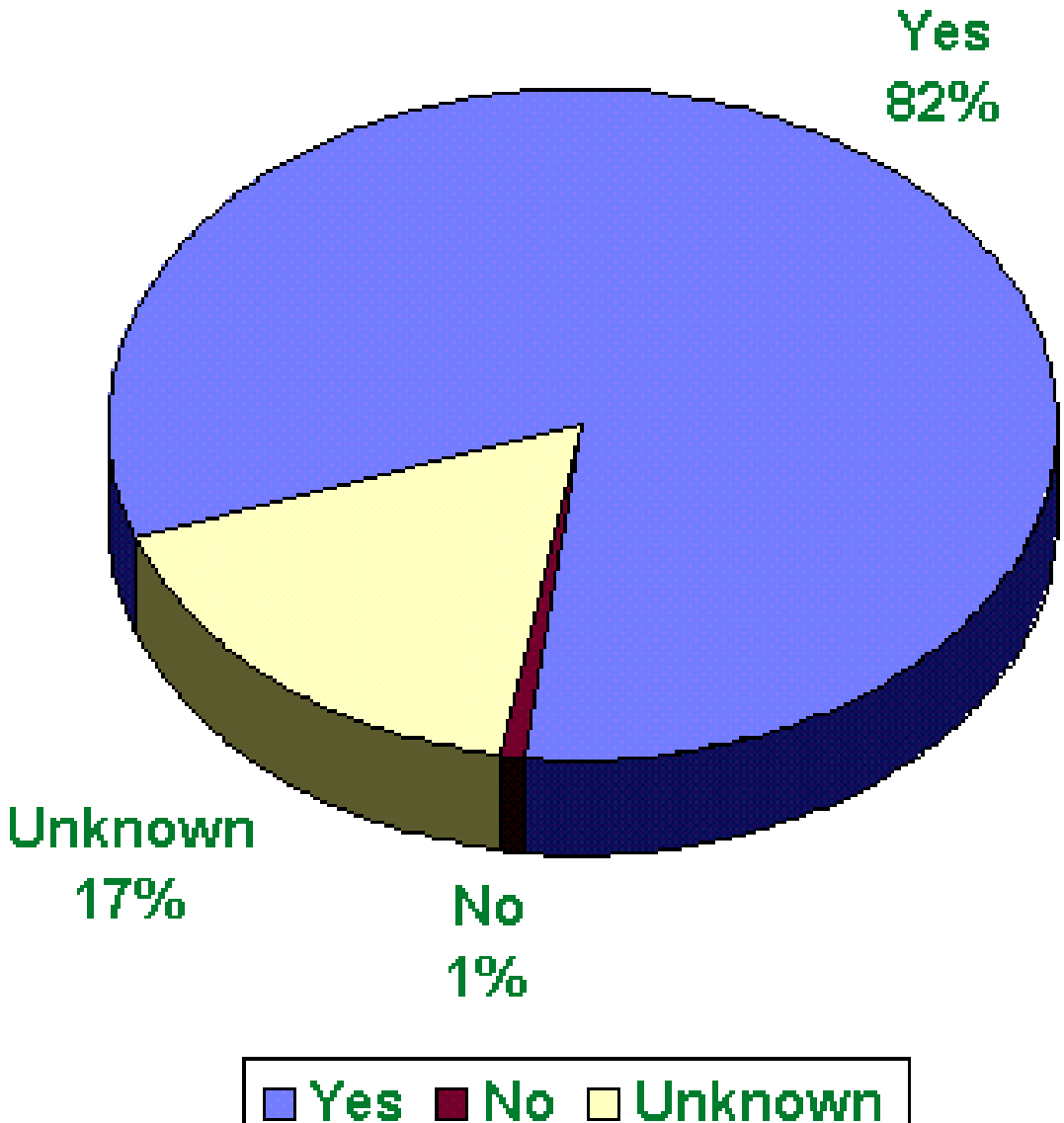
Heat Distribution Method



Presence of Condensate Return Piping in Institutions with Steam Distribution Networks



Campus Cooling Capacity (Tons)

- Sum Total Cooling Capacity 829,910
- Mean Cooling Capacity 9,764
- Median Cooling Capacity 5,400
- Range 580 to 44,000

Note : Based on 85 institutions providing data.

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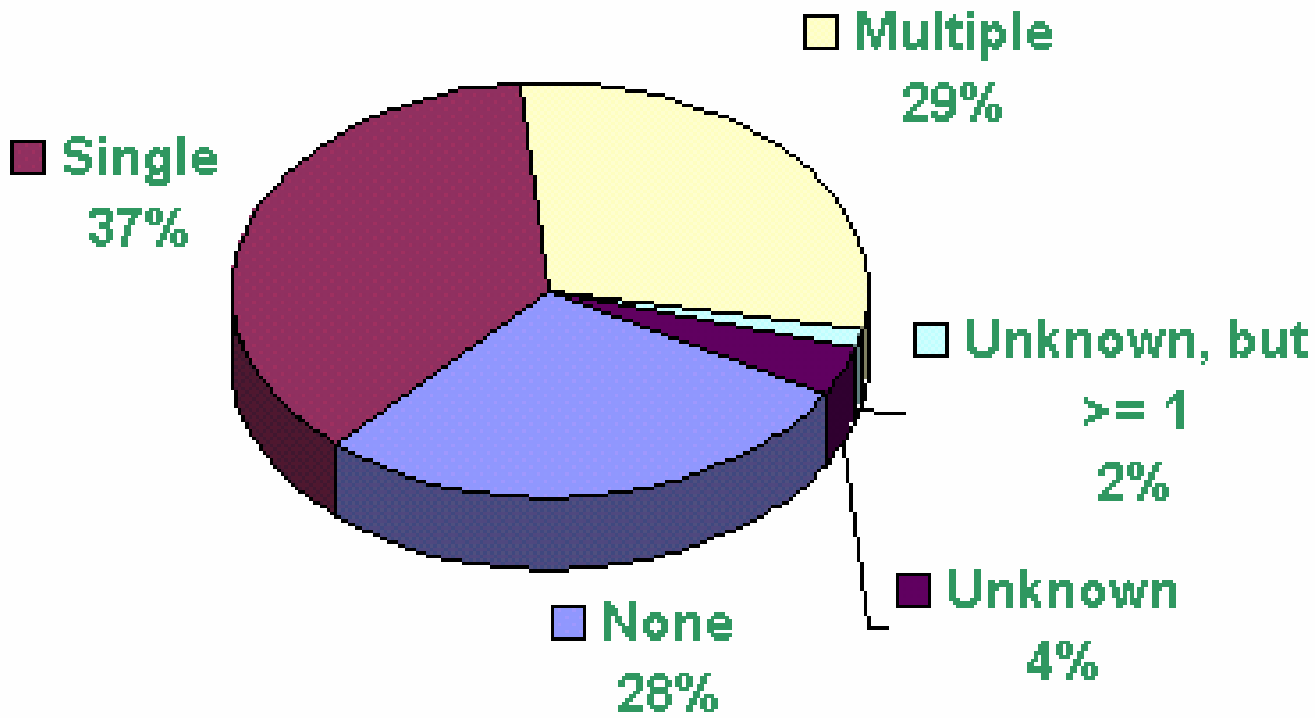
Number of Central Cooling Plants on Campus



Thermal Storage - Cooling

- Chilled Water Storage
  - Total Capacity 16,840,000 gallons
  - Eleven (11) institutions reporting

- Ice Storage
  - Total Capacity 139,000 ton hours
  - Seven (7) institutions reporting

Note : Based on 88 institutions with district cooling systems.

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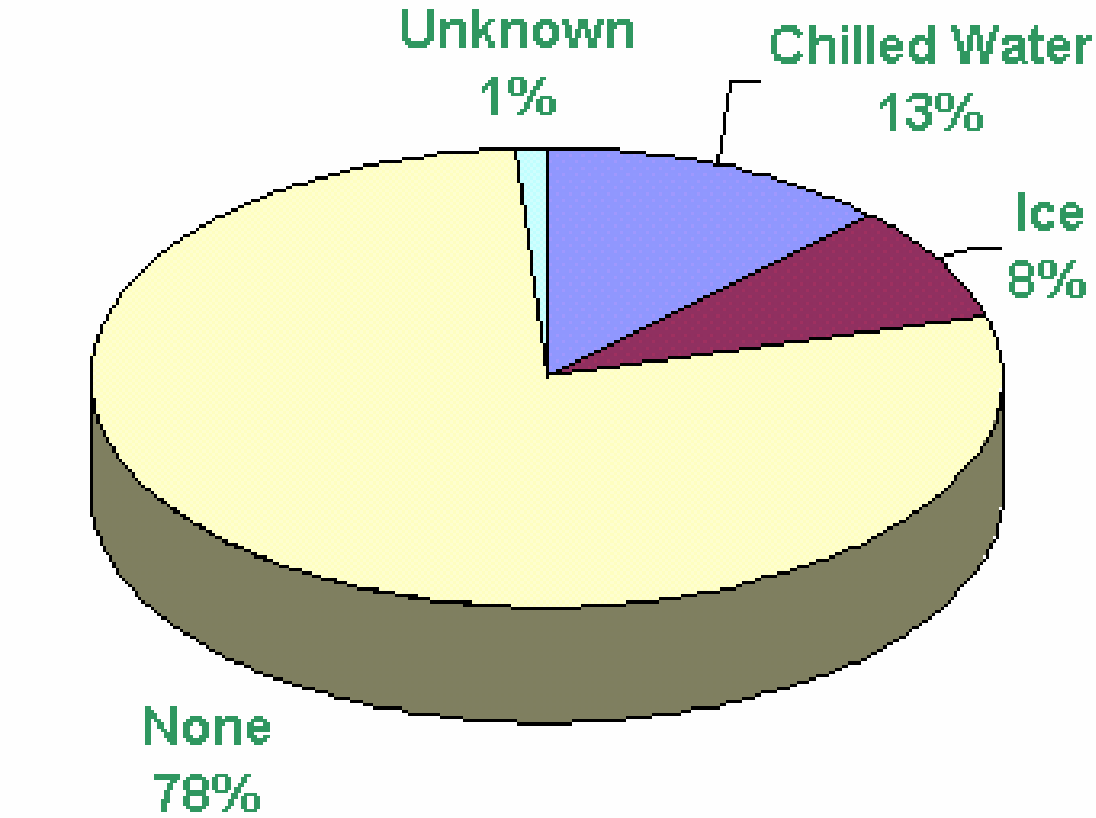
Thermal Storage Methods Employed at Institutions with Central Cooling Plants



Cooling System Piping Length - (S&R linear ft)

- Sum Total Length (ft) 1,436,618
- Mean Length 22,447
- Median Length 16,000
- Range 2,000 to 89,228

Total equivalent to 272 miles.

Note : Based on 64 institutions reporting. Includes supply and return mains, service laterals and customer connections.

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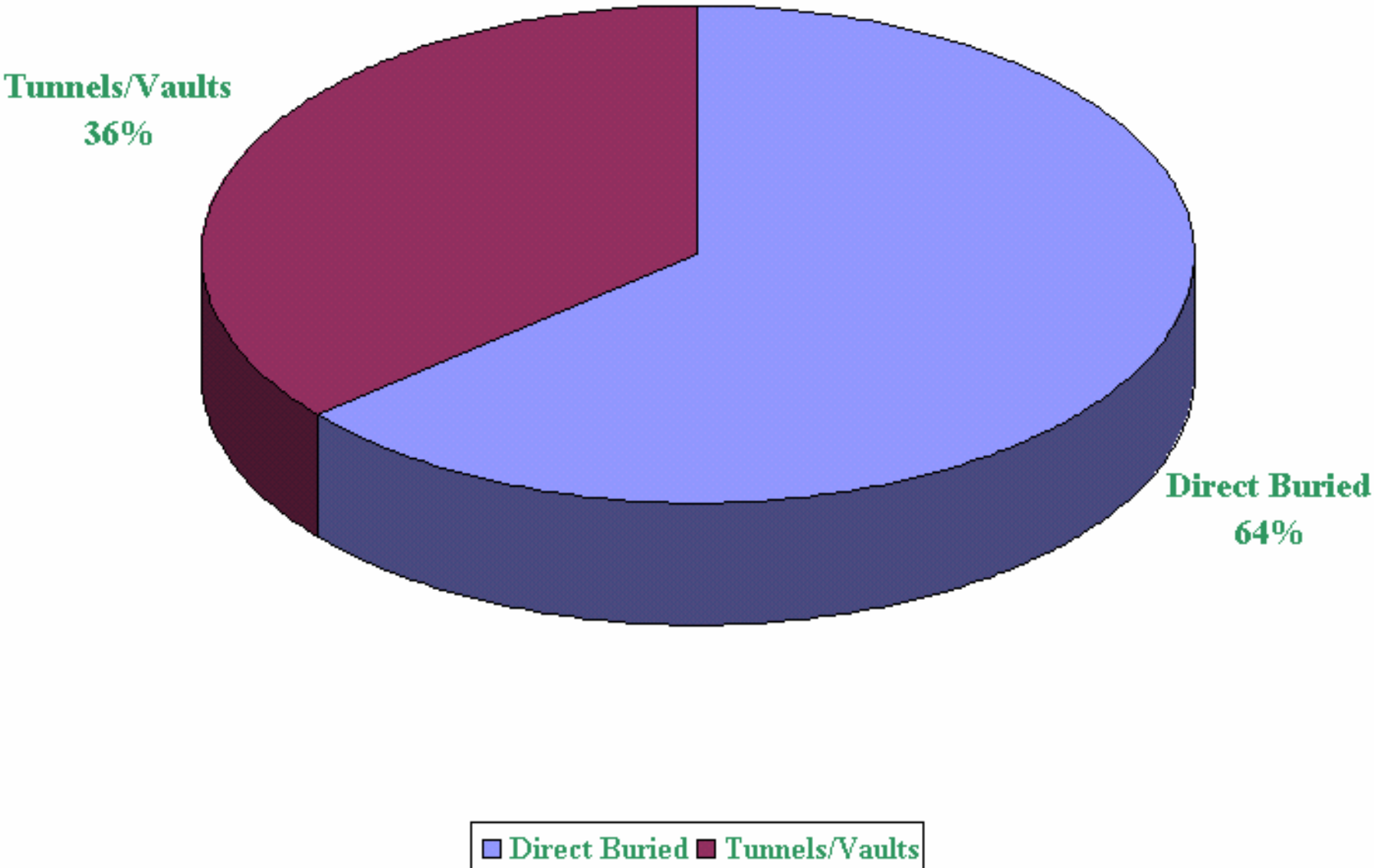
Proportion of Total Linear Feet of Cooling Pipe That Is Direct Buried vs. in Tunnels or Vaults



Campus Electrical Capacity

Installed Generation Capacity

- **Sum Total** 947.75 MW
- **Average per Institution** 16.34 MW
- **Median per Institution** 7.45 MW
- **Range** 0.18 MW to 85 MW

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Campus Electricity Production

- Of 128 reporting, 58 (45%) co-generate on campus
- Two (2) schools "generate only"
  - One has emergency backup power only
  - One generates to meet campus demand
- Equipment Range –

  From 0.18 MW Capstone microturbine

  To 45 MW GE LM 6000 Gas turbine

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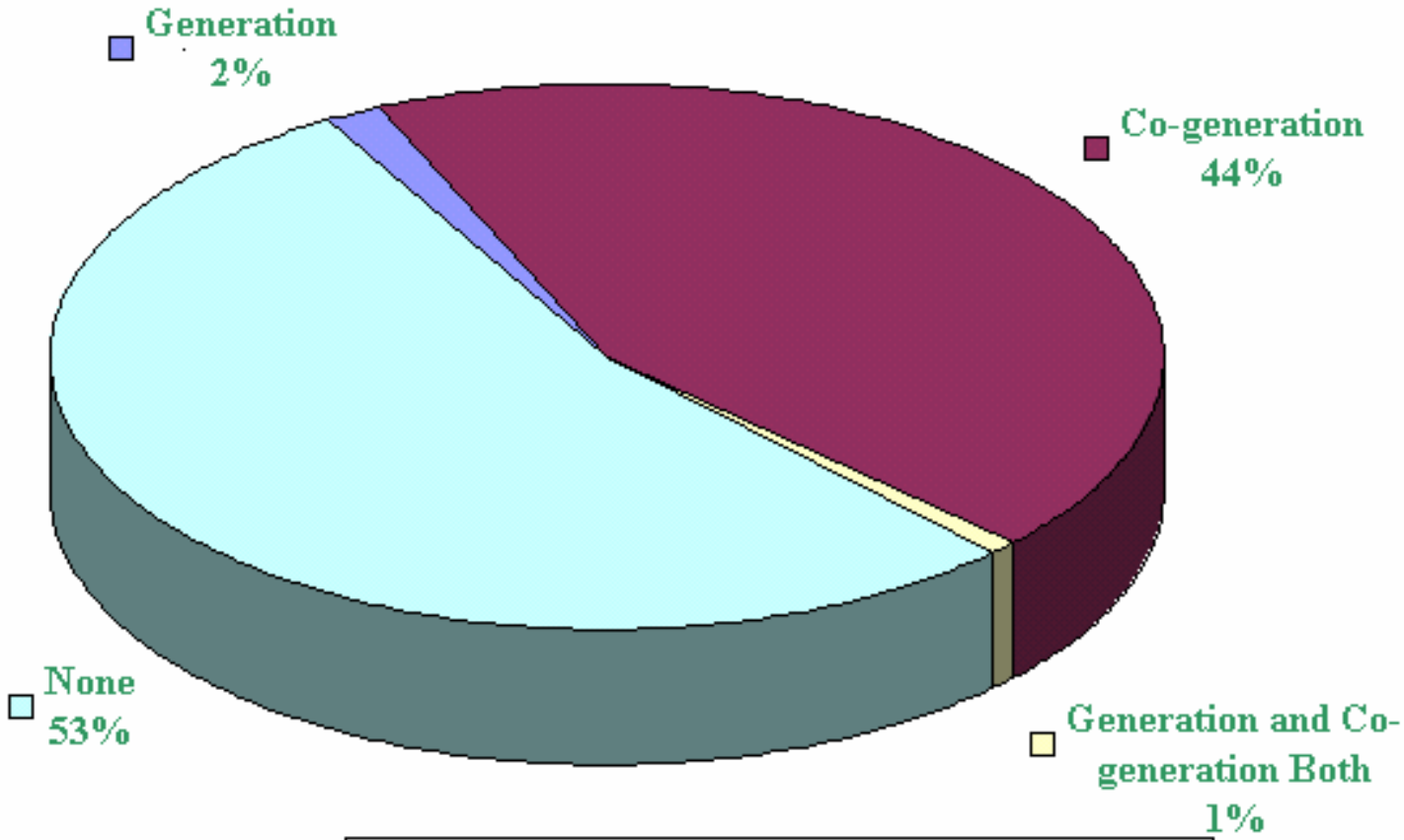
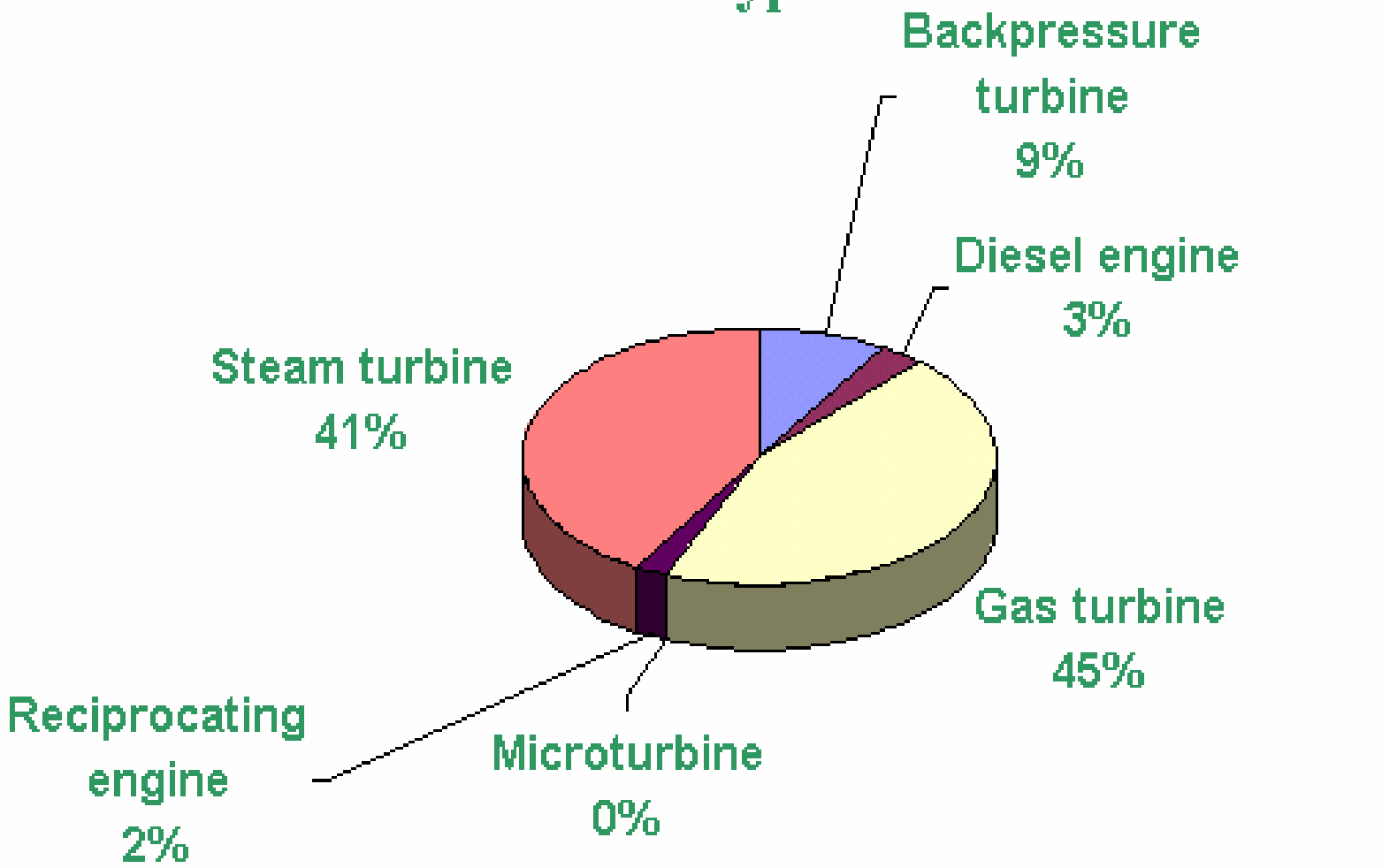
Campus Electricity Production



Percentage MW Installed Capacity by Generator Type



% Energy Requirements Met

Average Percentage Campus Needs Met

Heating	Cooling	Power
84%	67%	49%

Range of Responses (% needs met)

Heating	Cooling	Power
19 – 100%	8 – 100%	0 – 100%

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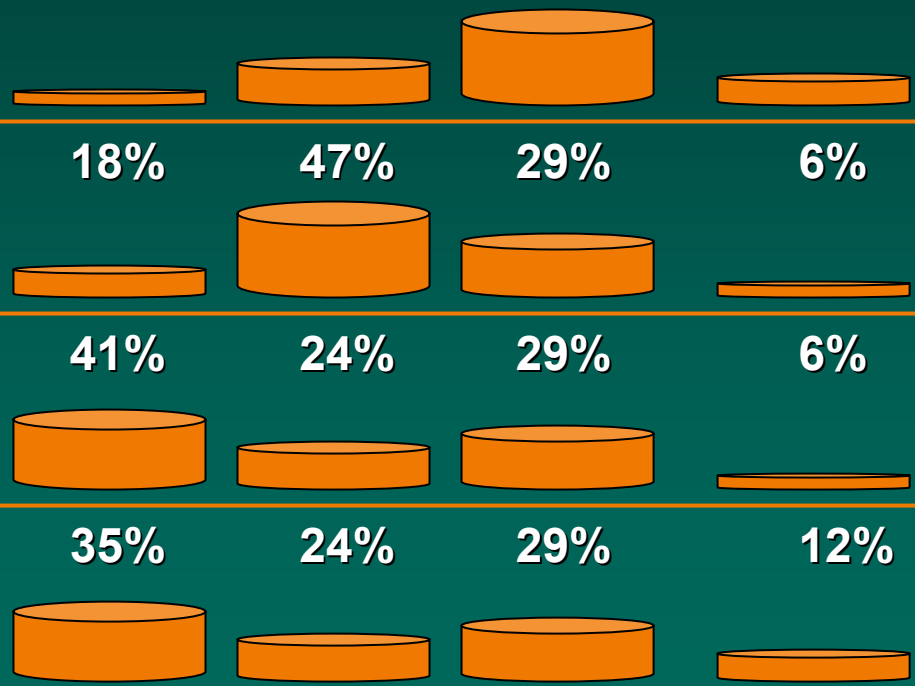
Survey Results – Challenges

	Not an issue	Small concern	Major concern	Barrier to progress
Capital constraints	6%	24%	53%	18%
Convincing decision makers of economic benefits	18%	47%	29%	6%
Complexity of implementation	41%	24%	29%	6%
Air emissions restrictions	35%	24%	29%	12%



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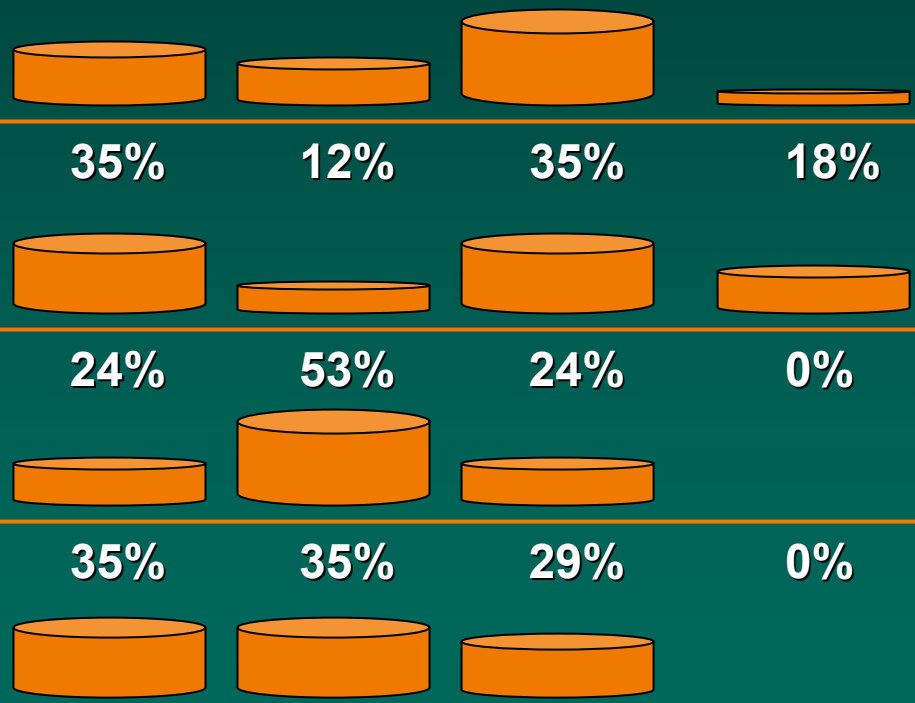
Survey Results – Challenges
(continued)

	Not an issue	Small concern	Major concern	Barrier to progress
Space constraints	29%	18%	47%	6%
Fuel price uncertainty	35%	12%	35%	18%
Current life remaining in existing equipment	24%	53%	24%	0%
Regulatory uncertainty	35%	35%	29%	0%



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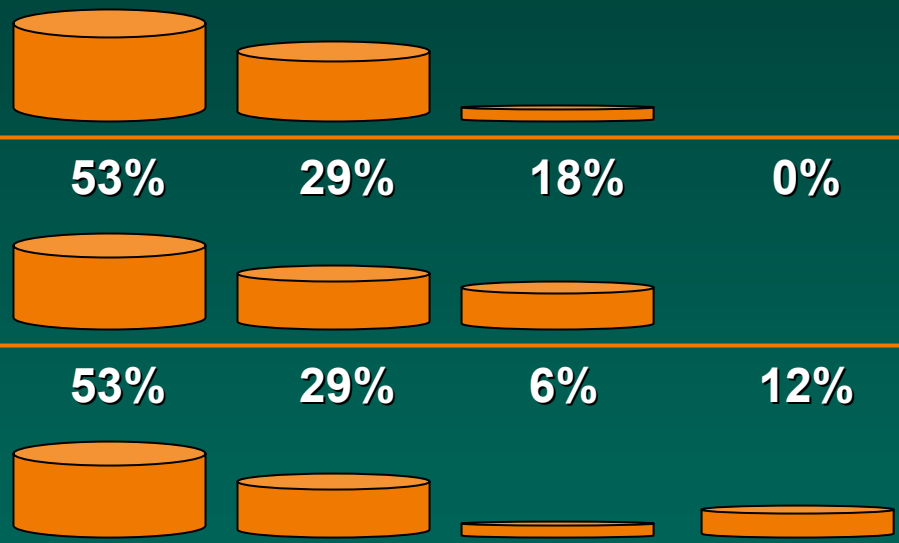
Survey Results – Challenges
(continued)

	Not an issue	Small concern	Major concern	Barrier to progress
Lack of clear technology choices	59%	35%	6%	0%
Lack of clear utility interconnection standards	53%	29%	18%	0%
Utility counteroffers	53%	29%	6%	12%



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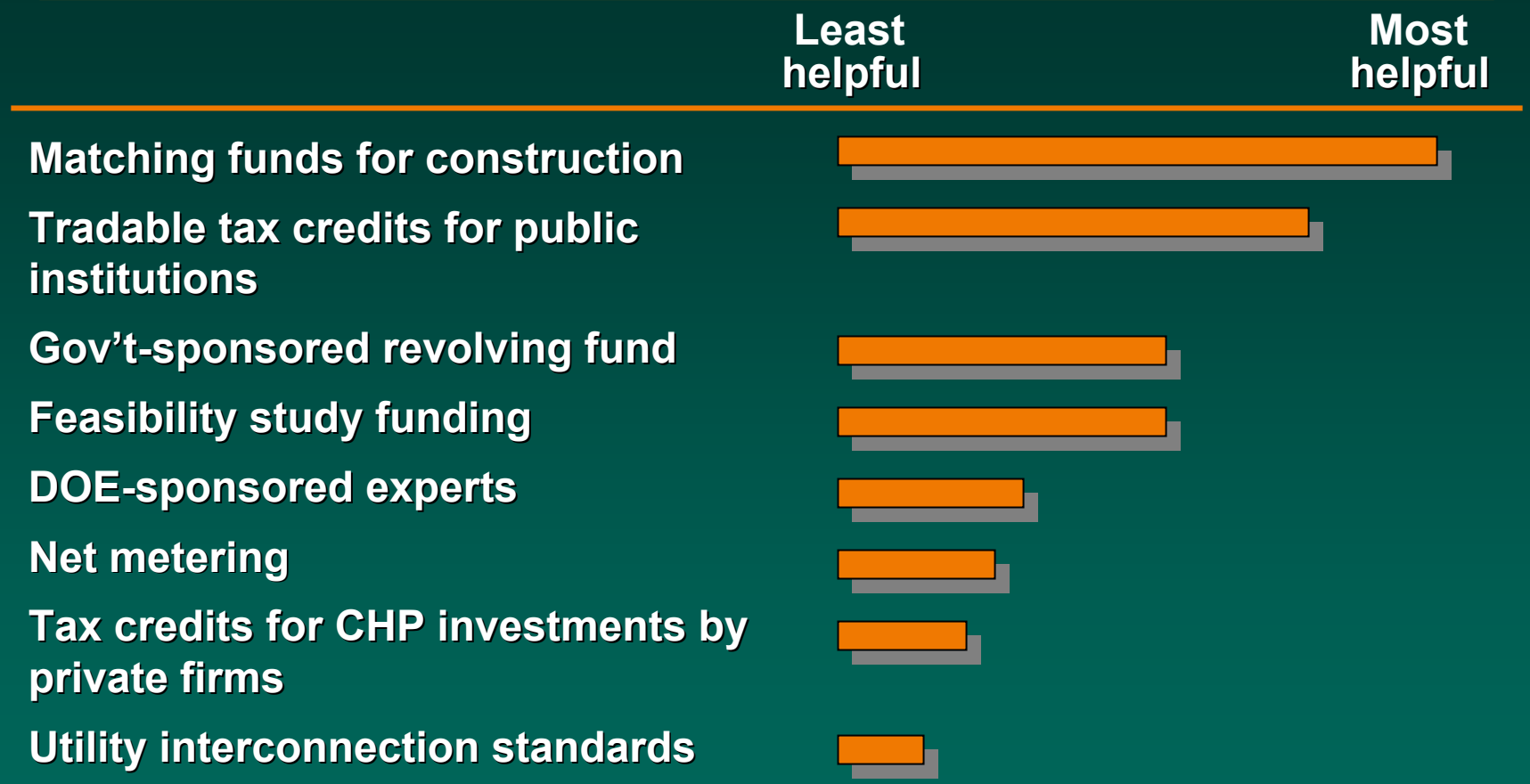
Results – Ranking of Services



(Some respondents gave a *rating*, instead of a ranking. Each item on average rated in the top half of the scale, which tells us that these are all helpful services.)

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Lessons Learned –UNC Chapel Hill

- Clean coal technology.
- Maintain fuel flexibility with coal fluidized bed boiler for CHP.
- Central plant located near residential neighborhood.
- Community interaction to gain siting approval.

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Lessons Learned - Princeton

- Using project scheduling to manage lead times between plant design and Univ. approvals.
- Dealing with multiple ownership changes at turbine supplier.
- Plant commissioning and contractual provisions to protect owner.

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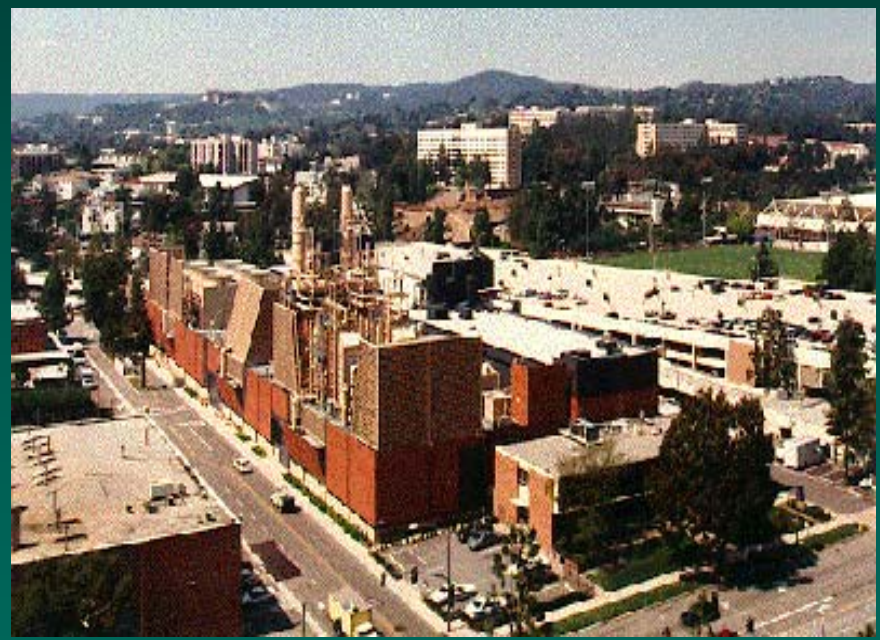
Lessons Learned – UCLA

- 43 MW Combined Cycle Cogen Facility
- 21,900 ton Cooling Facility
- Landfill gas for 30% of annual plant fuel
- Reduction of campus emissions by 34% and water use 70 million gal/year
- Eliminated 4,000,000 ft3 flareoff of LFG/day
- Benchmark BACT for Nox in LA Basin from 9ppm to 6ppm



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Lessons Learned – M.I.T

- Changing regulatory issues during phase-in of deregulation.
- Utility interface and system interconnections.
- “Exit fees” and “stranded cost” negotiations.

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Lessons Learned – Slippery Rock

- Evaluating emission-reduction options.
- Co-firing natural gas and coal reduces particulates and opacity.
- Testing % of gas-firing as design alternative to baghouse.

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Lessons Learned – Stanford

- 49.9 MW Cogen facility with 20,000 ton central cooling facility.
- Load shift and reliable cooling supply to hospitals.
- Ice storage in 1999 reduced peak by 10MW.
- Ammonia-based refrigeration.
- Construction coordination.

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Reported Expansion – in planning stage

- **Heating systems - 22**
  - 11 distribution system increase
  - 5 adding CHP to plant
  - 8 increasing plant capacity
- **Cooling systems – 42**
  - Adding capacity, distribution, storage, steam chillers, new chiller capacity
- **Electric generation – 22**

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Reported Expansion – currently in construction

- Heating systems – 7
- Cooling systems – 16
- Electric generation – 4

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Paths Forward for IDEA

- **Increase study participation**
  - www.districtenergy.org
  - www.zoomerang.com/survey
- **Partner with DOE and EPA**
  - to increase program participation
  - to expand CHP Partner Program
- **Publicize and promote CHP/District Energy – your success is valuable!**

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