Initial Member Input to
ASHRAE Research Strategic Plan 2010-2018

ASHRAE Research Advisory Panel
Jeffrey D. Spitler, Chair

January 2009

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This report summarizes the findings of a survey of ASHRAE members conducted by ASHRAE's Research Advisory Panel in the summer and early fall of 2008 to gather input for development of the 2010-2018 Research Strategic Plan.[1]

Respondent Characteristics

The survey was completed by 311 people and partially completed by an additional 77 for a total of 388 respondents.

- The Technical Committees were well represented. A total of 187 respondents indicated that they were members of TCs/TGs/TRGs, and they represent 100 of the 103 TCs/TGs/TRGs (Appendix C, Tables C.1, C.2, Figure C.1).
- Eighty respondents are members of SSPCs, SGPCs, SPCs or GPCs (Table C.3). They represent 13 of the 17 SSPCs and SGPCs (Table C.4) as well as a number of SPCs and GPCs.
- Fifty-three respondents are current Chapter officers (Table C.5).
- Eighty-five respondents are members of the Board, a Council or a Society Committee (Table C.6). They include representatives of nearly all of these Society-level bodies (Table C.7).
- Thirty-five percent of those who stated their current job function are in design/application, 24% in research, 11% in management and the rest in a range of other positions or retired (Table C.8).
- The country in which the survey was completed is available for 365 respondents and includes 287 from the U.S., 26 from the U.K., 13 from Canada and 39 from 25 other countries (Table C.9).

Most Important Issues Facing the Industry in the Next Twenty Years

The first question asked was, "What do you believe are the most important issues that will face the HVAC&R industry in the next 20 years?" To facilitate understanding of overall patterns, the responses were grouped into categories.

Three quarters of respondents (268 of 353 answering this question) identified energy/ sustainability as the most important issue (categories: energy efficiency, energy conservation, energy consumption, sustainability, energy, climate change, energy cost, energy sources, alternative energy, green, carbon footprint reduction, environmental concerns, net zero energy buildings, efficiency, sustainability/efficiency, climate change/adaptation, growth and energy demand, energy and materials conservation – see Figure 1 and Table 1). No other response categories were mentioned anywhere near as often.

[1] The survey methods are described in Appendix A. The survey instrument is shown in Appendix B.

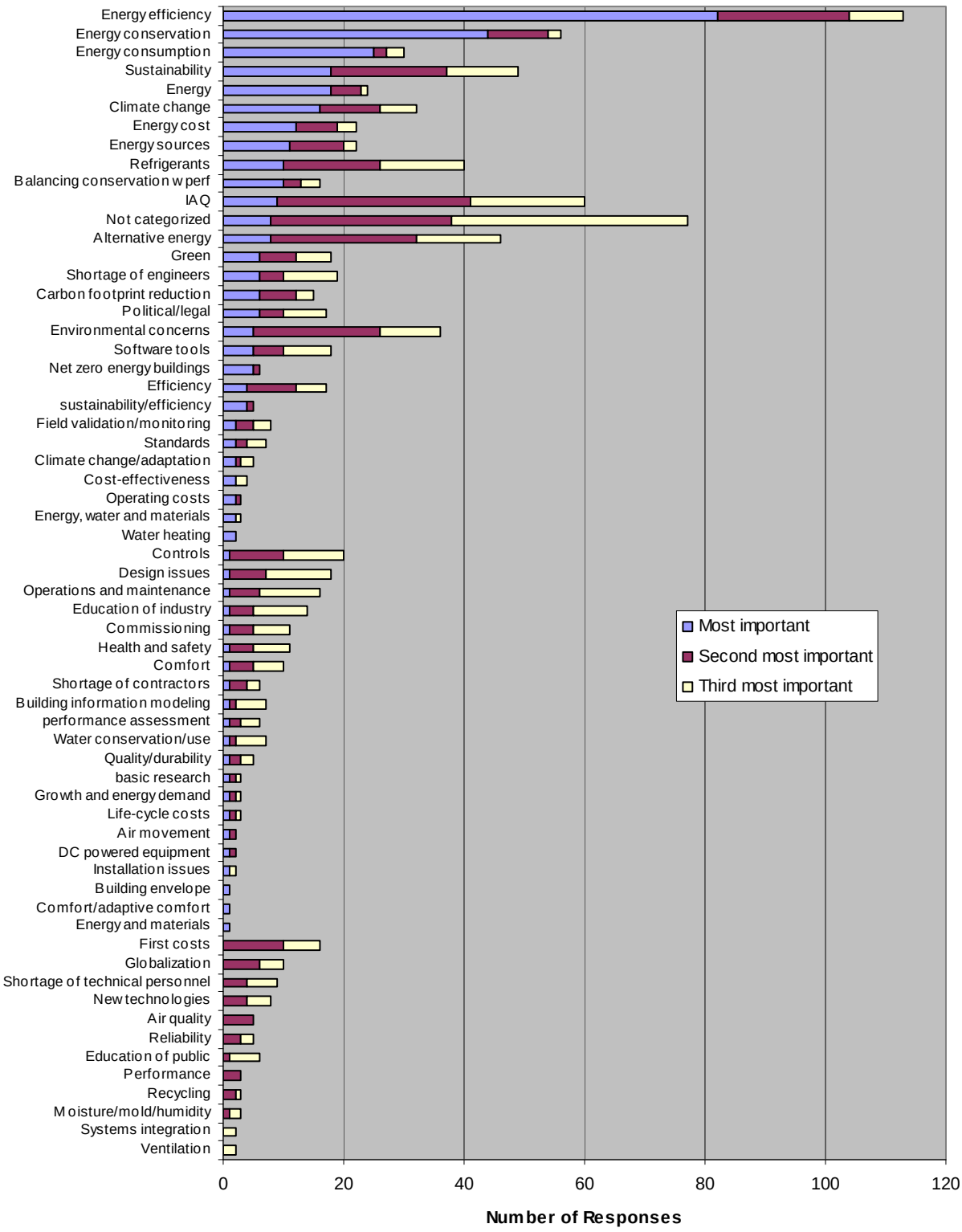

Figure 1. What do you believe are the most important issues that will face the HVAC&R industry in the next 20 years? Counts of responses by post hoc response category. Chart sorted by counts for "most important issue."

Table 1. What do you believe are the most important issues that will face the HVAC&R industry in the next 20 years? Counts of responses by post hoc response category. Left hand table is sorted by most important issue. Right hand table is sorted by Weighted Total (3*most important + 2*second most important + 1*third most important).

COUNTS BY CATEGORY Sorted by most impt	Most important	Second most important	Third most important	Weighted total
Energy efficiency	82	22	9	299
Energy conservation	44	10	2	154
Energy consumption	25	2	3	82
Sustainability	18	19	12	104
Energy	18	5	1	65
Climate change	16	10	6	74
Energy cost	12	7	3	53
Energy sources	11	9	2	53
Refrigerants	10	16	14	76
Balancing conservation with performance	10	3	3	39
IAQ	9	32	19	110
Not categorized	8	30	39	123
Alternative energy	8	24	14	86
Green	6	6	6	36
Shortage of engineers	6	4	9	35
Carbon footprint reduction	6	6	3	33
Political/legal	6	4	7	33
Environmental concerns	5	21	10	67
Software tools	5	5	8	33
Net zero energy buildings	5	1	0	17
Efficiency	4	8	5	33
sustainability/efficiency	4	1	0	14
Field validation/monitoring	2	3	3	15
Standards	2	2	3	13
Climate change/adaptation	2	1	2	10
Cost-effectiveness	2	0	2	8
Operating costs	2	1	0	8
Energy, water and materials cost	2	0	1	7
Water heating	2	0	0	6
Controls	1	9	10	31
Design issues	1	6	11	26
Operations and maintenance	1	5	10	23
Education of industry	1	4	9	20
Commissioning	1	4	6	17
Health and safety	1	4	6	17
Comfort	1	4	5	16
Shortage of contractors	1	3	2	11
Building information modeling (BIM)	1	1	5	10
performance assessment	1	2	3	10
Water conservation/use	1	1	5	10
Quality/durability	1	2	2	9
basic research	1	1	1	6
Growth and energy demand	1	1	1	6
Life-cycle costs	1	1	1	6
Air movement	1	1	0	5
DC powered equipment	1	1	0	5
Installation issues	1	0	1	4
Building envelope	1	0	0	3
Comfort/adaptive comfort	1	0	0	3
Energy and materials conservation	1	0	0	3
First costs	0	10	6	26
Globalization	0	6	4	16
Shortage of technical personnel	0	4	5	13
New technologies	0	4	4	12
Air quality	0	5	0	10
Reliability	0	3	2	8
Education of public	0	1	5	7
Performance	0	3	0	6
Recycling	0	2	1	5
Moisture/mold/humidity	0	1	2	4
Systems integration	0	0	2	2
Ventilation	0	0	2	2

COUNTS BY CATEGORY Sorted by weighted total	Most important	Second most important	Third most important	Weighted total
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Energy sources	11	9	2	53
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Carbon footprint reduction	6	6	3	33
Political/legal	6	4	7	33
Software tools	5	5	8	33
Efficiency	4	8	5	33
Controls	1	9	10	31
Design issues	1	6	11	26
First costs	0	10	6	26
Operations and maintenance	1	5	10	23
Education of industry	1	4	9	20
Net zero energy buildings	5	1	0	17
Commissioning	1	4	6	17
Health and safety	1	4	6	17
Comfort	1	4	5	16
Globalization	0	6	4	16
Field validation/monitoring	2	3	3	15
sustainability/efficiency	4	1	0	14
Standards	2	2	3	13
Shortage of technical personnel	0	4	5	13
New technologies	0	4	4	12
Shortage of contractors	1	3	2	11
Climate change/adaptation	2	1	2	10
Building information modeling (BIM)	1	1	5	10
performance assessment	1	2	3	10
Water conservation/use	1	1	5	10
Air quality	0	5	0	10
Quality/durability	1	2	2	9
Cost-effectiveness	2	0	2	8
Operating costs	2	1	0	8
Reliability	0	3	2	8
Energy, water and materials cost	2	0	1	7
Education of public	0	1	5	7
Water heating	2	0	0	6
basic research	1	1	1	6
Growth and energy demand	1	1	1	6
Life-cycle costs	1	1	1	6
Performance	0	3	0	6
Air movement	1	1	0	5
DC powered equipment	1	1	0	5
Recycling	0	2	1	5
Installation issues	1	0	1	4
Moisture/mold/humidity	0	1	2	4
Building envelope	1	0	0	3
Comfort/adaptive comfort	1	0	0	3
Energy and materials conservation	1	0	0	3
Systems integration	0	0	2	2
Ventilation	0	0	2	2

Forty-five percent of those identifying a second most important issue (152 of 341) also identified energy/sustainability. Thirteen percent identified indoor environmental quality (IEQ) (categories: indoor air quality, health and safety, comfort, air movement, comfort/adaptive comfort, air quality, ventilation). Energy and sustainability issues and IEQ issues were also most commonly identified as third most important (78/297 and 32/297 respectively).

Allocation of ASHRAE Research Funds

A total of 335 respondents completed the questions that asked what percent of 2010-2018 research funds should be allocated to various areas. On average they think that Energy and Resources should receive the largest share of funds (33%), about double the amount they believe should be allocated to Indoor Environmental Quality (16%), Tools and Applications (15%), Equipment, Components and Materials (15%), or Education and Outreach (15%) (Figure 2, Table 2).

Some people identified other categories that should receive funding, among which the most common were operations, refrigerants and environmental concerns (Table 3).

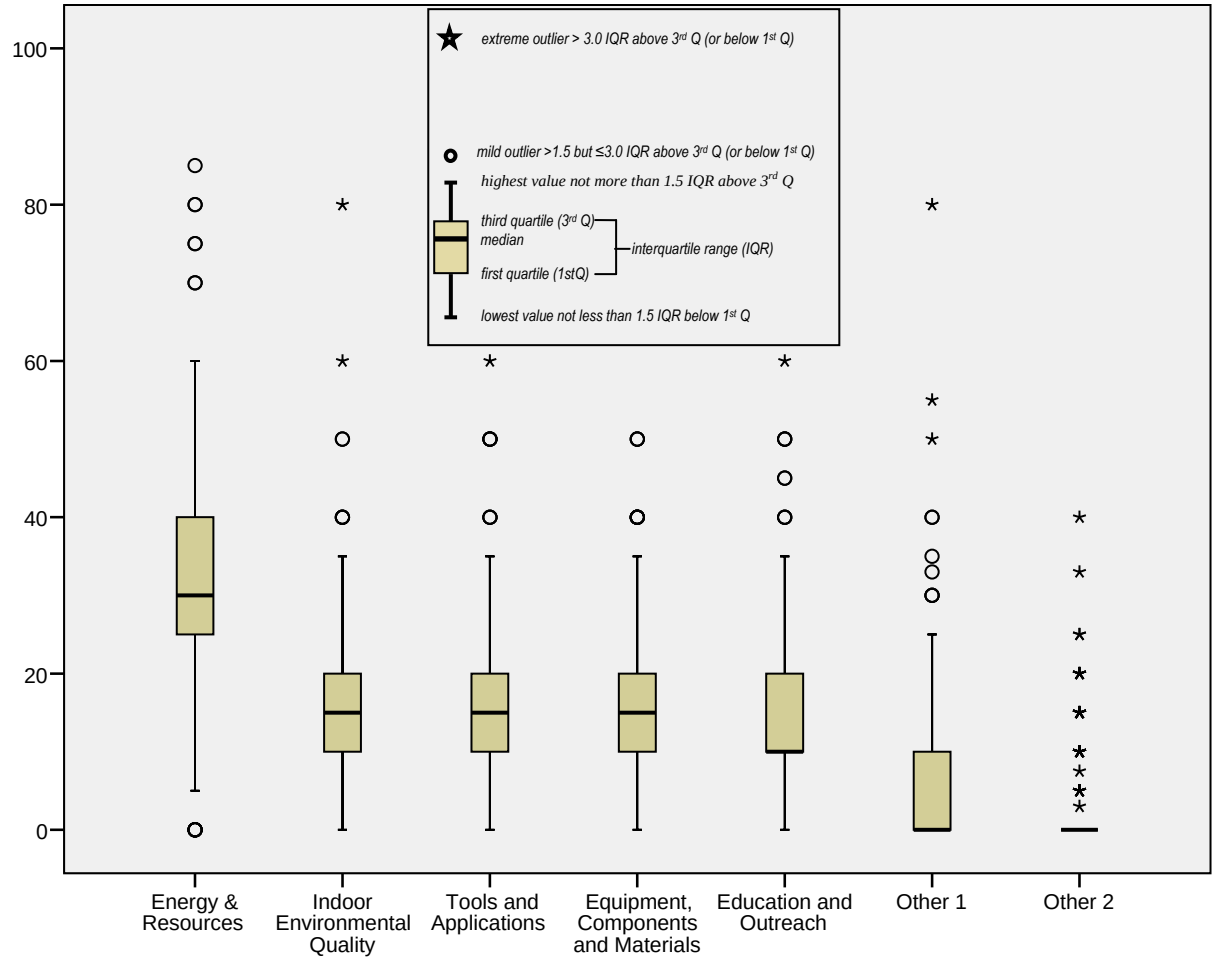


Figure 2. What percent of 2010-2018 research funds do you believe ASHRAE should allocate to…

Table 2. What percent of 2010-2018 research funds do you believe ASHRAE should allocate to…

Valid N = 335 for all columns	Energy & Resources	Indoor Environmental Quality	Tools and Applications	Equipment, Components and Materials	Education and Outreach	Other 1	Other 2
Mean	32.6	16.4	15.1	14.6	14.5	5.2	1.7
Std. Dev.	14.1	9.7	9.2	8.9	10.2	9.9	5.2
Minimum	0	0	0	0	0	0	0
10th %ile	20	5	5	5	0	0	0
20th %ile	20	10	10	10	5	0	0
30th %ile	25	10	10	10	10	0	0
40th %ile	30	10	10	10	10	0	0
50th %ile	30	15	15	15	10	0	0
60th %ile	33	20	15	15	15	0	0
70th %ile	40	20	20	20	20	5	0
80th %ile	40	20	20	20	20	10	0
90th %ile	50	30	25	25	30	20	8.5
Maximum	85	80	60	50	60	80	40

Table 3. Other priority areas – responses by post hoc categories. Sorted by total responses.

	Other 1	Other 2	**Total**
Operations	8	5	13
Refrigerants	6	2	8
Environmental concerns	5	1	6
Alternative energy	3	2	5
Climate change	4	1	5
Design issues	2	3	5
green	4	1	5
sustainabilty	5	0	5
energy sources	3	1	4
food transport, storage, distribution	4	0	4
controls	2	1	3
energy efficiency	1	2	3
security	3	0	3
Additional energy & resources*	2	0	2
Additional indoor environmental quality*	0	2	2
BIM	2	0	2
carbon footprint	2	0	2
developing countries	2	0	2
efficiency	2	0	2
first costs	0	2	2
globalization	2	0	2
health and safety	1	1	2
Industrial IAQ	2	0	2
modeling/simulations	2	0	2
new technologies	2	0	2
performance	2	0	2
productivity	2	0	2
refrigeration	0	2	2
residential buildings	2	0	2
standards	2	0	2
water conservation/use	0	2	2

*Some respondents used a letter from the pre-coded list (e.g., "A"), presumably to enable them to list more than 3 research goals for that priority area.

Specific Strategic Research Goals

The questionnaire provided an opportunity for respondents to identify specific strategic research goals. Sixty percent (234/388) did so.

More respondents (180) chose to identify specific strategic research goals in the area of Energy & Resources than in any other area (Table 4). Around 80 respondents each identified specific research strategic goals for IEQ, Education and Outreach and Tools and Applications, and about 60 for Equipment, Components and Materials. Some identified strategic research goals for the other priority areas they had listed in response to the previous question (Table 3 above).

Table 4. For which priority areas do you want to identify strategic goals?

	Frequency	Percent
Energy & Resources	180	46.4
Indoor Environmental Quality	82	21.1
Tools & Applications	76	19.6
Equipment, Components & Materials	59	15.2
Education & Outreach	81	20.9
Other 1	43	11.1
Other 2	22	5.7

The strategic goals put forward range from general ("energy") to specific ("Investigate true SEER and EER ratings for systems that have been in the field for 3, 5, 7 and 10 year time periods. Understand how airside fouling and other characteristics degrade performance and increase energy costs over time.")

Energy and Resources

In the "Energy and Resources" priority area, by far the most commonly identified goals were in the categories of:

- energy conservation/energy consumption,
- efficiency/energy efficiency,
- alternative energy,

These were followed by:

- net zero energy buildings,
- refrigerants
- energy sources
- field validation, monitoring and performance assessment, and
- energy in general (Figure 3, Table 5a).

Table 5b subcategorizes the responses within categories that received five or more responses. This more fine-grained summary shows that the single most often stated goal was the energy energy efficiency or energy consumption of HVAC systems and equipment.

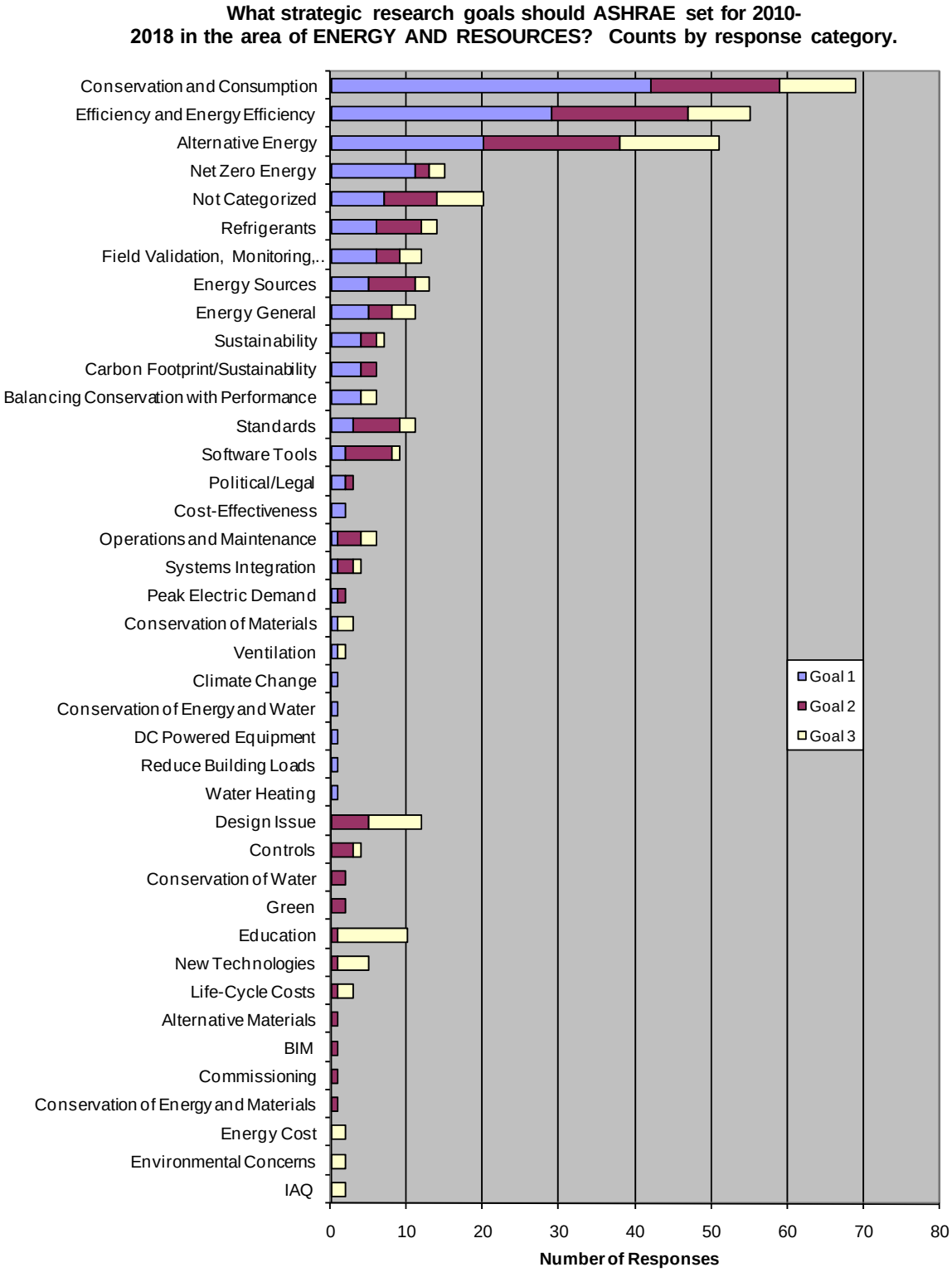


Figure 3. What strategic research goals should ASHRAE set for 2010-2018 in the area of ENERGY AND RESOURCES? Counts by post hoc response category. Chart sorted by counts for Goal 1.

Table 5a. What strategic research goals should ASHRAE set for 2010-2018 in the area of ENERGY AND RESOURCES? Counts by post hoc response category. Left table sorted by Goal 1, right table by weighted total.

ENERGY AND RESOURCES Sorted by Goal 1	Goal 1	Goal 2	Goal 3	Weighted Total
Conservation and Consumption	42	17	10	170
Efficiency and Energy Efficiency	29	18	8	131
Alternative Energy	20	18	13	109
Net Zero Energy	11	2	2	39
Not Categorized	7	7	6	41
Refrigerants	6	6	2	32
Field Validation, Monitoring, Performance Assessment	6	3	3	27
Energy Sources	5	6	2	29
Energy General	5	3	3	24
Sustainability	4	2	1	17
Carbon Footprint/Sustainability	4	2	0	16
Balancing Conservation with Performance	4	0	2	14
Standards	3	6	2	23
Software Tools	2	6	1	19
Political/Legal	2	1	0	8
Cost-Effectiveness	2	0	0	6
Operations and Maintenance	1	3	2	11
Systems Integration	1	2	1	8
Peak Electric Demand	1	1	0	5
Conservation of Materials	1	0	2	5
Ventilation	1	0	1	4
Climate Change	1	0	0	3
Conservation of Energy and Water	1	0	0	3
DC Powered Equipment	1	0	0	3
Reduce Building Loads	1	0	0	3
Water Heating	1	0	0	3
Design Issue	0	5	7	17
Controls	0	3	1	7
Conservation of Water	0	2	0	4
Green	0	2	0	4
Education	0	1	9	11
New Technologies	0	1	4	6
Life-Cycle Costs	0	1	2	4
Alternative Materials	0	1	0	2
BIM	0	1	0	2
Commissioning	0	1	0	2
Conservation of Energy and Materials	0	1	0	2
Energy Cost	0	0	2	2
Environmental Concerns	0	0	2	2
IAQ	0	0	2	2

ENERGY AND RESOURCES Sorted by Weighted Total	Goal 1	Goal 2	Goal 3	Weighted Total
Conservation and Consumption	42	17	10	170
Efficiency and Energy Efficiency	29	18	8	131
Alternative Energy	20	18	13	109
Not Categorized	7	7	6	41
Net Zero Energy	11	2	2	39
Refrigerants	6	6	2	32
Energy Sources	5	6	2	29
Field Validation, Monitoring, Performance Assessment	6	3	3	27
Energy General	5	3	3	24
Standards	3	6	2	23
Software Tools	2	6	1	19
Sustainability	4	2	1	17
Design Issue	0	5	7	17
Carbon Footprint/Sustainability	4	2	0	16
Balancing Conservation with Performance	4	0	2	14
Operations and Maintenance	1	3	2	11
Education	0	1	9	11
Political/Legal	2	1	0	8
Systems Integration	1	2	1	8
Controls	0	3	1	7
Cost-Effectiveness	2	0	0	6
New Technologies	0	1	4	6
Conservation of Materials	1	0	2	5
Peak Electric Demand	1	1	0	5
Ventilation	1	0	1	4
Life-Cycle Costs	0	1	2	4
Conservation of Water	0	2	0	4
Green	0	2	0	4
Climate Change	1	0	0	3
Conservation of Energy and Water	1	0	0	3
DC Powered Equipment	1	0	0	3
Reduce Building Loads	1	0	0	3
Water Heating	1	0	0	3
Energy Cost	0	0	2	2
Environmental Concerns	0	0	2	2
IAQ	0	0	2	2
Alternative Materials	0	1	0	2
BIM	0	1	0	2
Commissioning	0	1	0	2
Conservation of Energy and Materials	0	1	0	2

Table 5b. ENERGY & RESOURCES. Subcategorization of responses within categories receiving five or more responses.

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
Conservation and Consumption Subtotals					
general	11	5	2	18	45
of HVAC&R systems and equipment	7	2	0	9	25
Reduce energy consumption by X % by 20XX	4	3	0	7	18
develop benchmarks and guidelines for (e) bldg retrofits	3	0	0	3	9
more energy recovery	2	0	0	2	6
envelope strategies	1	1	0	2	5
equipment designs	1	1	0	2	5
benchmark energy use	1	0	0	1	3
develop global and building energy management strategies	1	0	0	1	3
Economcally feasible, extremely low energy buildings	1	0	0	1	3
HVAC design to reduce energy consumption by 50% over current state of the art	1	0	0	1	3
measurement for fuel use in power generation and heating	1	0	0	1	3
measurement of HVAC&R systems and components	1	0	0	1	3
more guidelines and standards	1	0	0	1	3
reduce building energy consumption	1	0	0	1	3
reduce use of fossil fuels in new buildings by 30% in new buildings	1	0	0	1	3
reducing the IKW/TR and to use all the incidedent surface energy on any building	1	0	0	1	3
renovate existing buildings	1	0	0	1	3
research to support 50% reduction in ASHRAE Std. 90 for 80% of commercial	1	0	0	1	3
site eui with plug an dprocess loads 50% below 90.1-2004	1	0	0	1	3
assess locations	0	1	0	1	2
climate optimized building designs	0	1	0	1	2
effective changes with 2nd law of thermodynamic	0	1	0	1	2
fix limits of embodied energy	0	1	0	1	2
reduce duct loss	0	1	0	1	2
free cooling options	0	0	1	1	1
glazing and shading devices	0	0	1	1	1
ground source energy transfer	0	0	1	1	1
healthcare environments	0	0	1	1	1
increase the attention and resources dedicated to water cooled HVAC systems--geothermal	0	0	1	1	1
insulation to optimize energy savings	0	0	1	1	1
low energy supermarkets (integrated)	0	0	1	1	1
passive heating and cooling of buildings	0	0	1	1	1
TOTALS	42	17	10	69	170
Efficiency and Energy Efficiency Subtotals					
general	9	3	0	12	33
of HVAC&R systems and equipment	5	4	3	12	26
equipment	0	3	1	4	7
improving system efficiencies	2	0	0	2	6
plant and equipment	1	1	0	2	5
20% improvement in supplying refrigeration across all temperature ranges relevant to cold chain	1	0	0	1	3
air movement	1	0	0	1	3
building operations	1	0	0	1	3
by utilizing local air movement in summer	1	0	0	1	3
cost effective	1	0	0	1	3
cost for people in the developed world	1	0	0	1	3
Higher energy efficiency, decide on a %	1	0	0	1	3
of buildings	1	0	0	1	3
of systems	1	0	0	1	3
Optimisation of Chiller Efficiencies	1	0	0	1	3
Reduce energy consumption by X % by 20XX	1	0	0	1	3
varying the output to better match the load	1	0	0	1	3
best practices guidelines industrial refrigeration systems	0	1	0	1	2
buildings	0	1	0	1	2
de-humidification	0	1	0	1	2
destratifying air in existing space without displacement supply systems	0	1	0	1	2
High efficiency motor for variable speed capable systems	0	1	0	1	2
improve fan horsepower	0	1	0	1	2
more efficient refrigeration systems	0	1	0	1	2
improve in proven technologies	0	0	1	1	1
low energy solutions into the construction process	0	0	1	1	1
system efficiency benchmarks by climate and application	0	0	1	1	1
variable speed compressors	0	0	1	1	1
TOTALS	29	18	8	55	131

Table 5b (continued)

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
Alternative Energy					
general	7	5	4	16	35
for HVAC applications	2	2	2	6	12
for HVACR applications	2	1	0	3	8
viable/practical/reliable	2	1	0	3	8
solar, on-site	1	1	1	3	6
solar	0	3	0	3	6
for buildings	1	0	0	1	3
for buildings and systems	1	0	0	1	3
for buildings, passive designs	1	0	0	1	3
for combined heat and power	1	0	0	1	3
on-site, C&I scale	1	0	0	1	3
wind	1	0	0	1	3
for equipment	0	1	1	2	3
on-site	0	1	1	2	3
general; and renewable materials	0	1	0	1	2
on-site, residential	0	1	0	1	2
solar, utility scale	0	1	0	1	2
Bio-fuels	0	0	2	2	2
low energy	0	0	1	1	1
technology	0	0	1	1	1
TOTALS	20	18	13	51	109
Net Zero Energy Subtotals					
general	4	0	0	4	12
practical paths, tools, training for achieving	3	1	0	4	11
roadmap by 2018	2	0	0	2	6
All new buildings to be net zero energy	1	0	0	1	3
technology basis for advanced guidance for Net Zero Energy Building	1	0	0	1	3
develop near- and net-zero energy housing technologies and systems	0	1	0	1	2
Collaborate with worldwide councils and alliances on energy issues	0	0	1	1	1
database of low energy buildings	0	0	1	1	1
Provide design and operation tools and training	0	0	0	0	0
TOTALS	11	2	2	15	39
Energy Sources Subtotals					
develop new sources	2	0	0	2	6
50% site generation of electricity	1	0	1	2	4
on site generation	0	2	0	2	4
New concepts of Energy Resources Instead of Oil e..g. Vegetable Oil	1	0	0	1	3
self sufficiency	1	0	0	1	3
affordable	0	1	0	1	2
distrributed	0	1	0	1	2
Movement away from "dirty" fuel sources	0	1	0	1	2
Non fossil energy source for HVACR equipment	0	1	0	1	2
new clean or renewable energy sources	0	0	1	1	1
TOTALS	5	6	2	13	29
Energy General Subtotals					
general	2	1	0	3	8
storage	1	1	1	3	6
resources	1	0	0	1	3
more guidelines	1	0	0	1	3
cooling	0	1	0	1	2
energy guide for industrial refrigeration systems	0	0	1	1	1
user friendly & easy energy access	0	0	1	1	1
TOTALS	5	3	3	11	24
Sustainability Subtotals					
most efficient sustainable HVAC designs	1	1	0	2	5
building design and operation	1	0	0	1	3
energy sustainable products or systems	1	0	0	1	3
guidance for building design/construction	1	0	0	1	3
general	0	1	0	1	2
building	0	0	1	1	1
TOTALS	4	2	1	7	17

Table 5b (continued)

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
FOLLOWING CATEGORIES WERE TOO HETEROGENEOUS TO SUBCATEGORIZE					
Refrigerants					
TOTALS	6	6	2	14	32
Field Validation, Monitoring, Performance Assessment					
TOTALS	6	3	3	12	27
Standards					
TOTALS	3	6	2	11	23
Software Tools					
TOTALS	2	6	1	9	19
Design Issue					
TOTALS	0	5	7	12	17
Carbon Footprint/Sustainability					
TOTALS	4	2	0	6	16
Balancing Conservation with Performance					
TOTALS	4	0	2	6	14
Operations and Maintenance					
TOTALS	1	3	2	6	11
Education					
TOTALS	0	1	9	10	11
New Technologies					
TOTALS	0	1	4	5	6

Examples of some of the dozens of goals put forth by individual respondents in the area of Energy and Resources are (verbatim):

- Develop standards, methods and procedures for using alternative energies for HVAC applications to reach zero carbon by 2030.
- Explore new methods to heat and cool buildings, i.e. location and direction related to the sun and wind, underground installations.
- Renewable or non-fossil fuel based integrated (combined heat and power) solutions.
- Building operational efficiency.
- High efficiency equipment.
- Optimization of chiller efficiencies.
- High quality energy storage.
- Demonstrate the importance of envelope design, construction and commissioning in reducing energy consumption.
- Developing benchmarks and technical guidelines for retrofits of existing buildings and HVAC to reduce energy, improve comfort.
- Energy use reduction through optimizing use of existing equip – conservation.
- More energy recovery.
- Capability to measure energy consumption of HVAC&R systems and components.
- Establish benchmark energy use in all areas including industrial ventilation, industrial refrigeration, commercial refrigeration, food processing and other less studied areas.
- Achieve a 20% improvement in supplying refrigeration across all temperature ranges relevant to the cold chain.
- Deliver Zero Energy Building Roadmap by 2018.
- Advanced Packaged System improvements - techniques and equipment to improve operation of equipment (Reference NBI study).
- Duct installation processes to reduce duct losses.
- Develop HVAC duct system concepts and designs that are inherently more energy efficient in terms of fan horsepower.

Indoor Environmental Quality

In the priority area of "Indoor Environmental Quality," the items most often listed by respondents as "Goal 1" fell in the areas of:

- standards;
- air cleaning & filtration;
- ventilation;
- effects of IEQ on productivity; and
- establishing the parameters of IAQ/IEQ (acceptable contaminant concentrations, temperature, humidity etc.) (Figure 4, Table 6a).

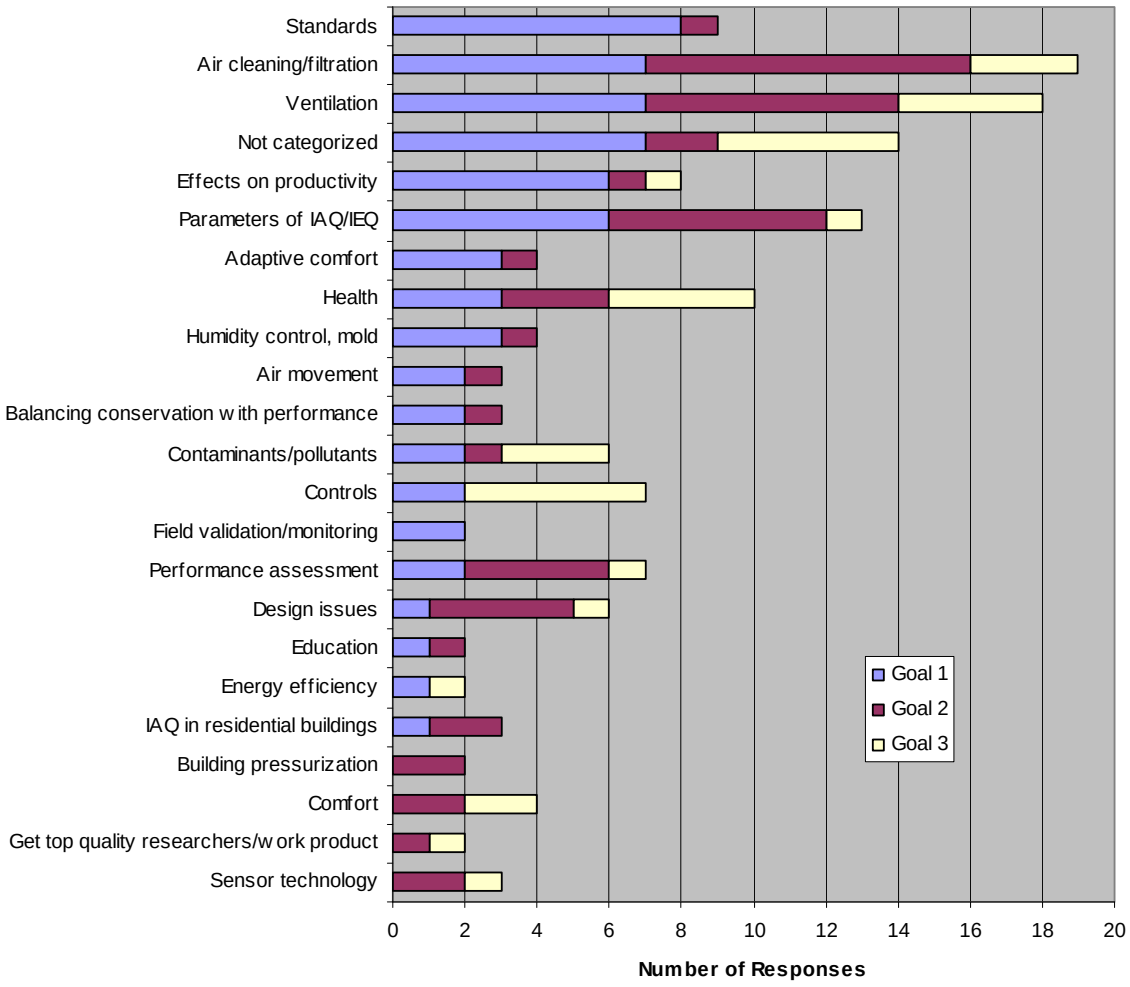


Figure 4. What strategic research goals should ASHRAE set for 2010-2018 in the area of INDOOR ENVIRONMENTAL QUALITY? Counts by post hoc response category. Chart sorted by counts for Goal 1.

Table 6a. What strategic research goals should ASHRAE set for 2010-2018 in the area of INDOOR ENVIRONMENTAL QUALITY? Counts by post hoc response category. Left table sorted by Goal 1, right table by Weighted Total.

INDOOR ENVIRONMENTAL QUALITY Sorted by Goal 1	Goal 1	Goal 2	Goal 3	Weighted Total
Standards	8	1	0	26
Air cleaning/filtration	7	9	3	42
Ventilation	7	7	4	39
Not categorized	7	2	5	30
Effects on productivity	6	1	1	21
Parameters of IAQ/IEQ	6	6	1	31
Adaptive comfort	3	1	0	11
Health	3	3	4	19
Humidity control, mold	3	1	0	11
Air movement	2	1	0	8
Balancing conservation with performance	2	1	0	8
Contaminants/pollutants	2	1	3	11
Controls	2	0	5	11
Field validation/monitoring	2	0	0	6
Performance assessment	2	4	1	15
Design issues	1	4	1	12
Education	1	1	0	5
Energy efficiency	1	0	1	4
IAQ in residential buildings	1	2	0	7
Building pressurization	0	2	0	4
Comfort	0	2	2	6
Get top quality researchers/work product	0	1	1	3
Sensor technology	0	2	1	5

INDOOR ENVIRONMENTAL QUALITY Sorted by Weighted Total	Goal 1	Goal 2	Goal 3	Weighted Total
Air cleaning/filtration	7	9	3	42
Ventilation	7	7	4	39
Parameters of IAQ/IEQ	6	6	1	31
Not categorized	7	2	5	30
Standards	8	1	0	26
Effects on productivity	6	1	1	21
Health	3	3	4	19
Performance assessment	2	4	1	15
Design issues	1	4	1	12
Adaptive comfort	3	1	0	11
Humidity control, mold	3	1	0	11
Contaminants/pollutants	2	1	3	11
Controls	2	0	5	11
Air movement	2	1	0	8
Balancing conservation with performance	2	1	0	8
IAQ in residential buildings	1	2	0	7
Field validation/monitoring	2	0	0	6
Comfort	0	2	2	6
Education	1	1	0	5
Sensor technology	0	2	1	5
Energy efficiency	1	0	1	4
Building pressurization	0	2	0	4
Get top quality researchers/work product	0	1	1	3

Table 6b subcategorizes the responses within those categories that received five or more responses. This more fine-grained summary shows that the single most often stated goal was establishment of IEQ metrics/parameters/indices /contaminants of concern and accompanying minimum acceptable levels/maximum concentrations. Another frequently mentioned and intimately related goal is to assess/minimize/optimize/refine outdoor air (ventilation rate) requirements.

Table 6b. INDOOR ENVIRONMENTAL QUALITY. Subcategorization of responses within categories receiving five or more responses. Counts by post hoc response subcategory.

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
Air Cleaning/Filtration Subtotals					
filtration & air cleaning, better methods & use	1	3	1	5	10
filtration & air cleaning for PM 2.5 & ozone	2	0	0	2	6
filtration, general	0	2	0	2	4
filtration & air cleaning, reliable, repeatable standards for lab testing	1	1	0	2	5
filtration, improved media	1	0	0	1	3
UVGI, integration with mech & nat ventilated spaces	1	0	0	1	3
filtration, lower pressure drop and energy use	1	1	0	2	5
filtration, VOC	0	1	0	1	2
filtration & exhaust to allow smoking in public places	0	1	0	1	2
filtration & air cleaning, in-service performance	0	0	1	1	1
use of ozone for air purification	0	0	1	1	1
TOTAL	**7**	**9**	**3**	**19**	**42**
Ventilation Subtotals					
Assess/minimize/optimize/refine OA requirements	4	2	1	7	17
Dedicated outdoor air systems: provide details to enable easy repl of VAV systems; advance technologies that can serve as parallel sensible cooling systems; address flush & filtration issues that lead to incorrect paradigms w/DOAS	1	1	1	3	6
General	2	0	0	2	6
Increase use of IAQ Procedure, lower OA rates w/increased filtration effic	0	2	0	2	4
Better understand ventilation system efficiency	0	1	0	1	2
How to make hybrid systems that work	0	1	0	1	2
Heat recovery options	0	0	1	1	1
Ventilation system design tools	0	0	1	1	1
TOTAL	**7**	**7**	**4**	**18**	**39**
Parameters of IEQ/IAQ Subtotals					
Define IEQ metrics/parameters/indices/contaminants of concern and/or minimum IEQ/acceptable IAQ/maximum contaminant concentrations/exposure limits	6	3	1	10	25
Verify linkage between CO2 and contaminants	0	1	0	1	2
Extend mass balance eqn to evaluate exposure	0	1	0	1	2
Make available cost/efficiency data to understand what indoor parameters should be pursued in design	0	1	0	1	2
TOTAL	**6**	**6**	**1**	**13**	**31**
Health Subtotals					
Health impacts of: ventilation, HVAC, MERV level, mixtures of pollutants, humidity, new building materials, nanoparticles	2	1	3	6	11
Environmental health issues	0	1	1	2	3
Germ-free air	1	0	0	1	3
Transmission of diseases in indoor environment	0	1	0	1	2
TOTAL	**3**	**3**	**4**	**10**	**19**
Standards Subtotals					
Research for new versions of Standard 62.1, to provide sound basis, to help implement 62.1 & 62.2 into code	3	0	0	3	9
General	2	0	0	2	6
Extend standards and code enforcement into operating requirements	1	0	0	1	3
Make Standard 62.1 more practical	1	0	0	1	3
Develop uniform standard for IEQ (IAQ, thermal acoustic, light)	1	0	0	1	3
Strengthen IAQ requirements	0	1	0	1	2
TOTAL	**8**	**1**	**0**	**9**	**26**
Effects on Productivity Subtotals					
Make improvements in indoor environment, occupant health, comfort that increase productivity 10% to 20%	2	0	0	2	6
Quantify effect of IEQ (IAQ, non-IAQ) on productivity/performance/occupant satisfaction	2	1	1	4	9
Quantify effect of increased ventilation rates on productivity	1	0	0	1	3
Develop metrics and methodology for quantifying effects of IAQ/IEQ on productivity	1	0	0	1	3
TOTAL	**6**	**1**	**1**	**8**	**21**
Performance Assessment Subtotals					
All (too heterogeneous to subcategorize)	2	4	1	7	15
TOTAL	**2**	**4**	**1**	**7**	**15**
Controls Subtotals					
Microenviromental control	1	0	1	2	4
Other: OA control & delivery, humidity control, improved occupant control, economizer control, improved control measures & equip	1	0	4	5	7
TOTAL	**2**	**0**	**5**	**7**	**11**
Design Issues Subtotals					
All (too heterogeneous to subcategorize)	1	4	1	6	12
TOTAL	**1**	**4**	**1**	**6**	**12**
Contaminants/Pollutants Subtotals					
Material emissions	1	0	2	3	5
Other	1	1	1	3	6
TOTAL	**2**	**1**	**3**	**6**	**11**

Examples of the many individual goals put forward include (verbatim):

- Bring Standard 62 back to more practical guidance
- continue research to help to implement 62.1 and 62.2 in code
- develop a uniform standard for indoor environmental quality (IAQ, Thermal,Acoustic, light)
- New versions of Standard 62 and related research
- Reliable, repeatable standards for lab testing of performance of particulate and gas phase air filters
- Ventilation Standart is presently using arbitrary values and should be baesd on Research Data
- Assessment of outside air requirements, natural ventilation strategies
- Provide the details to enable dedicated outdoor air systems easily replace VAV systems for all new and renovation projects (this is well on its way without direct ASHRAE support)
- ASHRAE research will develop metrics and methodology for quantifying the effects of IAQ/IEQ on productivity.
- Connect productivity and IEQ through experimental intervention studies (not epidemiological studies which are less convincing)
- Establish links between IEQ and performance, productivity, occupant satisfaction
- Assesment of parameters influencing the indoor environmental quality (i.e. what are the indicators to be used for rate the indoor environment)
- Define absolute limits of contaminants by 2018
- Define parameters of IEQ
- Definition of acceptable IAQ in terms of temperature, RH and pollutant concentrations.
- Improved IEQ, decide on a metric and an improvement target
- Air cleaning to address priority pollutants (ozone, PM2.5, etc)
- Characterization of optimal air cleaning technologies (particulates and ozone)
- Increasing improvement of filtration media
- Provide improved filtration for environmental contaminants, especially gas phase contaminants.

Tools and Applications

Goals identified in the area of "Tools and Applications" were somewhat more heterogeneous (Figure 5, Table 7a). Goals most commonly enumerated related to:

- building information modeling, building modeling and simulation and interfaces,
- design issues; and
- energy efficiency and energy conservation.

Table 7b summarizes responses within those categories that received five or more responses. This more fine-grained summary shows that the single most often stated goal was simplified tools for calculating energy consumption/savings. Another frequently mentioned goal was improved software tools, design guides and strategies.

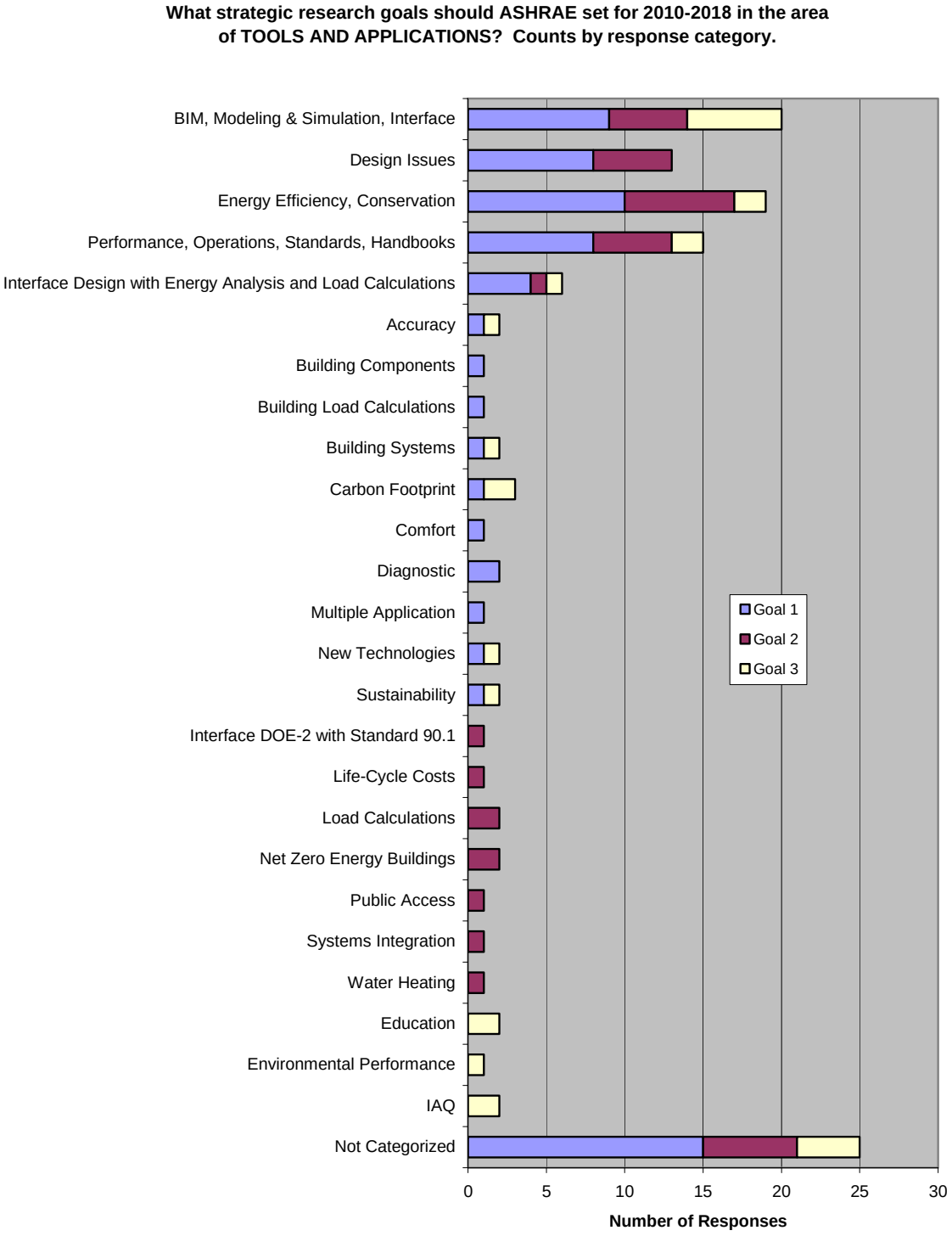


Figure 5. What strategic research goals should ASHRAE set for 2010-2018 in the area of TOOLS AND APPLICATIONS? Counts by post hoc response category. Chart sorted by counts for Goal 1.

Table 7a. What strategic research goals should ASHRAE set for 2010-2018 in the area of TOOLS AND APPLICATIONS? Counts by post hoc response category. Left table sorted by Goal 1, right table by weighted total.

TOOLS & APPLICATIONS Sorted by Goal 1	Goal 1	Goal 2	Goal 3	Weighted total
BIM, Modeling & Simulation, Interface	9	5	6	43
Design Issues	8	5	0	34
Energy Efficiency, Conservation	10	7	2	46
Performance, Operations, Standards, Handbooks	8	5	2	36
Interface Design with Energy Analysis and Load Calculations	4	1	1	15
Accuracy	1	0	1	4
Building Components	1	0	0	3
Building Load Calculations	1	0	0	3
Building Systems	1	0	1	4
Carbon Footprint	1	0	2	5
Comfort	1	0	0	3
Diagnostic	2	0	0	6
Multiple Application	1	0	0	3
New Technologies	1	0	1	4
Sustainability	1	0	1	4
Interface DOE-2 with Standard 90.1	0	1	0	2
Life-Cycle Costs	0	1	0	2
Load Calculations	0	2	0	4
Net Zero Energy Buildings	0	2	0	4
Public Access	0	1	0	2
Systems Integration	0	1	0	2
Water Heating	0	1	0	2
Education	0	0	2	2
Environmental Performance	0	0	1	1
IAQ	0	0	2	2
Not Categorized	15	6	4	61

TOOLS & APPLICATIONS Sorted by Weighted Total	Goal 1	Goal 2	Goal 3	Weighted total
BIM, Modeling & Simulation, Interface	9	5	6	43
Design Issues	8	5	0	34
Energy Efficiency, Conservation	10	7	2	46
Performance, Operations, Standards, Handbooks	8	5	2	36
Interface Design with Energy Analysis and Load Calculations	4	1	1	15
Accuracy	1	0	1	4
Building Components	1	0	0	3
Building Load Calculations	1	0	0	3
Building Systems	1	0	1	4
Carbon Footprint	1	0	2	5
Comfort	1	0	0	3
Diagnostic	2	0	0	6
Multiple Application	1	0	0	3
New Technologies	1	0	1	4
Sustainability	1	0	1	4
Interface DOE-2 with Standard 90.1	0	1	0	2
Life-Cycle Costs	0	1	0	2
Load Calculations	0	2	0	4
Net Zero Energy Buildings	0	2	0	4
Public Access	0	1	0	2
Systems Integration	0	1	0	2
Water Heating	0	1	0	2
Education	0	0	2	2
Environmental Performance	0	0	1	1
IAQ	0	0	2	2
Not Categorized	15	6	4	61

A few examples of the many individual goals put forward include (verbatim):

- Develop dedicated outside air system designs to provide precise distribution of ventilation air, dehumidification and permit more "off" time for main HVAC system and fan.
- improving and expanding design guides
- Improving the ability of the engineer to design useful and efficient systems
- total integration of architectural, mechanical and structural design tools
- Design and modeling tools for next-generation HVAC systems and eqipment that may be directly coupled to low-enthalpy alternative and waste energy resources
- develop design tools for strategies, technologies, and systems for which design tools do not currently exist (be sure to recognize the difference between analysis and design tools)
- Reducing the amount of time to arrive at a finished design
- Develop reliable ans user freinfdly simulation tools for buidings
- modeling software tools to help designers understand implicaitons of decisions
- More modeling and simulation tools to assist design needs
- Tools for simulating commercial and industrial refrigeration
- Continued development of CFD modeling
- Tools to simulate building performance based on feedback from actual operational data to inform building operators and to revise design simulation sotware
- develop and disseminate tools for measuring and labeling building energy efficiency
- Development of tools that enable enhanced building operations leading to reductions in building energy use by up to 20%.
- Enhancing/improving application of proven EE technology eg UFAD
- Exergy based analysis modules that may be easily coupled to existing-future energy modeling and analysis tools
- provide tools to help practicing engineers qucikly evaluate energy effectivenss of alternate HVAC systems
- Standardized energy efficient and functional building system control sequences

Table 7b. TOOLS & APPLICATIONS. Subcategorization of responses within categories receiving five or more responses.

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
Energy Efficiency, Conservation Subtotals					
simplified tools for calculating energy consumption/savings	4	2	1	7	17
Low energy building design tools	1	1	0	2	5
demonstrate IEQ / energy maintained	1	0	0	1	3
energy based analysis modules	1	0	0	1	3
Enhancing/improving application of proven EE technology eg UFAD	1	0	0	1	3
measuring and labeling building energy efficiency	1	0	0	1	3
Standardized building system control sequences	1	0	0	1	3
Benchmark energy data	0	1	0	1	2
embodied energy	0	1	0	1	2
energy databases	0	1	0	1	2
free online software	0	1	0	1	2
General	0	0	1	1	1
Exergy based analysis modules	0	0	0	0	0
TOTALS	10	7	2	19	46
BIM, Modeling & Simulation, Interface Subtotals					
help to understand implications of decisions	3	0	0	3	9
accuracy, reliable, user friendly	1	1	1	3	6
ASHRAE needs to stay involved in BIM	1	0	2	3	5
general	1	0	1	2	4
reliable, user friendly	1	0	0	1	3
Improve software	1	0	0	1	3
simulating commercial and industrial refrigeration	1	0	0	1	3
dimensional design enviroments within reach of all ASHRAE members by 2018	0	1	0	1	2
expand CFD modeling	0	1	0	1	2
feedback from operational data	0	1	0	1	2
Low energy building design tools	0	1	0	1	2
50% of ASHRAE members use simulation	0	0	1	1	1
partner with AIA and others	0	0	1	1	1
TOTALS	9	5	6	20	43
Performance, Operations, Standards, Handbooks Subtotals					
general	2	1	0	3	8
understand system operation	1	1	0	2	5
new handbooks	0	2	0	2	4
energy performance by use and occupancy	1	0	0	1	3
equipment sizing	1	0	0	1	3
general support for handbooks and updates	1	0	0	1	3
performance criteria	1	0	0	1	3
provide real time performance feedbak	1	0	0	1	3
database equipment performance	0	1	0	1	2
coursework and education on building performance	0	0	1	1	1
develop tools	0	0	1	1	1
TOTALS	8	5	2	15	36
Design Issues Subtotals					
improve software tools, design guides, strategies	3	3	0	6	15
general	3	0	0	3	9
assist engineer in design process, life cycle	1	0	0	1	3
Integrate design/energy modeling software	1	0	0	1	3
Adaptive control strategy design tools	0	1	0	1	2
reduce time to finished product	0	1	0	1	2
TOTALS	8	5	0	13	34
FOLLOWING CATEGORY WAS TOO HETEROGENEOUS TO SUBCATEGORIZE					
Interface Design with Energy Analysis and Load Calculations					
TOTALS	4	1	1	6	15

Equipment, Components and Materials

Goals identified for Equipment, Components and Materials fell mainly in the areas of:

- efficiency, conservation, sustainability and environment
- alternative materials and
- refrigerants (Figure 6, Table 8a).

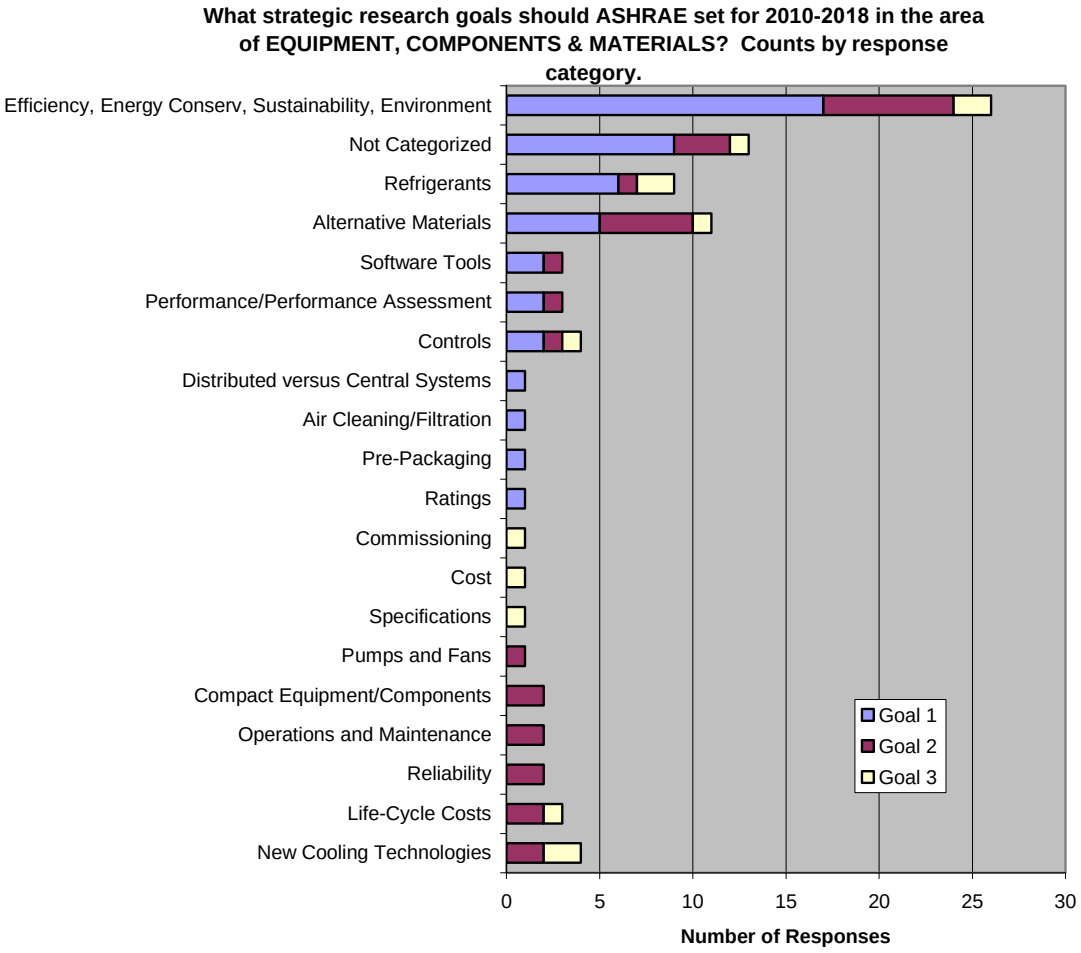


Figure 6. What strategic research goals should ASHRAE set for 2010-2018 in the area of EQUIPMENT, COMPONENTS AND MATERIALS? Counts by post hoc response category. Chart sorted by counts for Goal 1.

Table 8b subcategorizes responses within those categories that received five or more responses. This more fine-grained summary shows that the single most often stated goal was alternative and/or environmentally safe/natural refrigerants. A close second was efficiency improvements to equipment.

Table 8a. What strategic research goals should ASHRAE set for 2010-2018 in the area of EQUIPMENT, COMPONENTS AND MATERIALS? Counts by post hoc response category. Left table sorted by Goal 1, right table by weighted total.

EQUIPMENT, COMPONENTS & MATERIALS Sorted by Goal 1	Goal 1	Goal 2	Goal 3	Weighted Total
Efficiency, Energy Conserv., Sustainability, Environ.	17	7	2	35
Not Categorized	9	3	1	34
Refrigerants	6	1	2	22
Alternative Materials	5	5	1	26
Software Tools	2	1	0	8
Performance/Performance Assessment	2	1	0	8
Controls	2	1	1	9
Distributed versus Central Systems	1	0	0	3
Air Cleaning/Filtration	1	0	0	3
Pre-Packaging	1	0	0	3
Ratings	1	0	0	3
Commissioning	0	0	1	1
Cost	0	0	1	1
Specifications	0	0	1	1
Pumps and Fans	0	1	0	2
Compact Equipment/Components	0	2	0	4
Operations and Maintenance	0	2	0	4
Reliability	0	2	0	4
Life-Cycle Costs	0	2	1	5
New Cooling Technologies	0	2	2	6

EQUIPMENT, COMPONENTS & MATERIALS Sorted by Weighted Total	Goal 1	Goal 2	Goal 3	Weighted Total
Efficiency, Energy Conserv., Sustainability, Environ.	17	7	2	35
Not categorized	9	3	1	34
Alternative Materials	5	5	1	26
Refrigerants	6	1	2	22
Controls	2	1	1	9
Software Tools	2	1	0	8
Performance/Performance Assessment	2	1	0	8
New Cooling Technologies	0	2	2	6
Life-Cycle Costs	0	2	1	5
Compact Equipment/Components	0	2	0	4
Operations and Maintenance	0	2	0	4
Reliability	0	2	0	4
Distributed versus Central Systems	1	0	0	3
Air Cleaning/Filtration	1	0	0	3
Pre-Packaging	1	0	0	3
Ratings	1	0	0	3
Pumps and Fans	0	1	0	2
Commissioning	0	0	1	1
Cost	0	0	1	1
Specifications	0	0	1	1

Table 8b. EQUIPMENT, COMPONENTS & MATERIALS. Summary of responses for categories receiving five or more responses.

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
Efficiency/Energy Conservation/Sustainability/Environmental Subtotals					
efficiency improvements - equipment	4	1	0	5	14
energy conservation	2	1	0	3	8
environmental impact of materials	0	4	0	4	8
efficiency improvements - general	2	0	0	2	6
efficiency improvements - HVAC	2	0	0	2	6
energy use - general	1	0	1	2	4
efficiency improvements - components	1	0	0	1	3
efficiency improvements - air control	1	0	0	1	3
efficiency improvements - secondary systems	1	0	0	1	3
net zero buildings	1	0	0	1	3
sustainability	1	0	0	1	3
alternative energy	1	0	0	1	3
improve application of existing high efficient technologies	0	1	0	1	2
efficiency improvement - refrigeration equip	0	0	1	1	1
TOTALS	17	7	2	26	35
Alternative Materials Subtotals					
low cost options	2	0	0	2	6
renewable options	1	1	0	2	5
light and durable options	1	0	0	1	3
non-metal options	1	0	0	1	3
low temp absorption chillers	0	1	0	1	2
heat exchangers	0	1	0	1	2
new lubricants	0	1	0	1	2
secondary coolants	0	1	0	1	2
building envelope options	0	0	1	1	1
TOTALS	5	5	1	11	26
Refrigerants Subtotals					
alternative refrigerants - environmentally safe or natural	4	1	1	6	15
alternative refrigerants - general	1	0	1	2	4
low leak technology	1	0	0	1	3
TOTALS	6	1	2	9	22

Examples of specific goals identified include (verbatim):

- conduct pre-competitive research to enable equipment efficiency increases
- Efficiency and control of air.
- improve efficiency of HVAC components and systems
- Improved efficiency of HVAC equipment and heat recovery equipment.
- Increase the operating efficiency of unitary equipment by X%
- Increased efficiency of secondary systems
- Equipment advances which may facilitate the use of alternative energy sources
- Alt materials to metals
- Combat rising material costs with new alternative materials and reduce the amount of material used
- Fund investigations into low cost materials, such as composites and plastics.
- Light and durable material
- Develop low leak technology and processes to reduce accidental loss of refrigerant by 90% over current levels
- development of refrigerants with favorable thermodynamic, thermophysical, and efficiency characteristics (natural substances preferred)
- Energy efficient and environmentally safe refrigerents
- natural refrigerants

Education and Outreach

Goals recommended for Education and Outreach focused primarily on:

- education for continuing and new engineers and technicians,
- internet, basic and public education,
- building owners/operators certification,
- design issues, competency,
- reference materials, software tools (Figure 7, Table 9a).[2]

Table 9a. What strategic research goals should ASHRAE set for 2010-2018 in the area of EDUCATION AND OUTREACH? Counts by post hoc response category. Left table sorted by Goal 1, right table by weighted total.

EDUCATION & OUTREACH Sorted by Goal 1	Goal 1	Goal 2	Goal 3	Weighted Total
Education for Continuing and New Engineers, Technicians	24	10	9	101
Internet, Basic, Public Education	9	5	6	43
Not Categorized	8	11	3	49
Building Owners/Operators, Certification	7	4	1	30
Design Issues, Competency	7	2	1	26
Reference Materials, Software Tools, Research	4	11	3	37
Energy Efficiency and Energy Conservation	4	0	1	13
Sustainability	4	0	0	12
ASHRAE Chapters	2	3	0	12
Climate Change	1	1	0	5
Standards	1	0	0	3
Code officials and Inspectors	0	1	0	2
Commissioning	0	1	0	2
Life-Cycle Costs	0	1	0	2
Net Zero Building	0	1	0	2
Recycling	0	1	0	2
Comfort	0	0	1	1
Carbon Footprint	0	0	1	1
IAQ	0	0	1	1
Operations and Maintenance	0	0	1	1

EDUCATION & OUTREACH Sorted by Weighted Total	Goal 1	Goal 2	Goal 3	Weighted Total
Education for Continuing and New Engineers, Technicians	24	10	9	101
Not Categorized	8	11	3	49
Internet, Basic, Public Education	9	5	6	43
Reference Materials, Software Tools, Research	4	11	3	37
Building Owners/Operators, Certification	7	4	1	30
Design Issues, Competency	7	2	1	26
Energy Efficiency and Energy Conservation	4	0	1	13
Sustainability	4	0	0	12
ASHRAE Chapters Subtotals	2	3	0	12
Climate Change	1	1	0	5
Standards	1	0	0	3
Code officials and Inspectors	0	1	0	2
Commissioning	0	1	0	2
Life-Cycle Costs	0	1	0	2
Net Zero Building	0	1	0	2
Recycling	0	1	0	2
Comfort	0	0	1	1
Carbon Footprint	0	0	1	1
IAQ	0	0	1	1
Operations and Maintenance	0	0	1	1

[2] Some of the suggested goals probably fall outside the scope of ASHRAE Research and provide useful guidance for other bodies within ASHRAE.

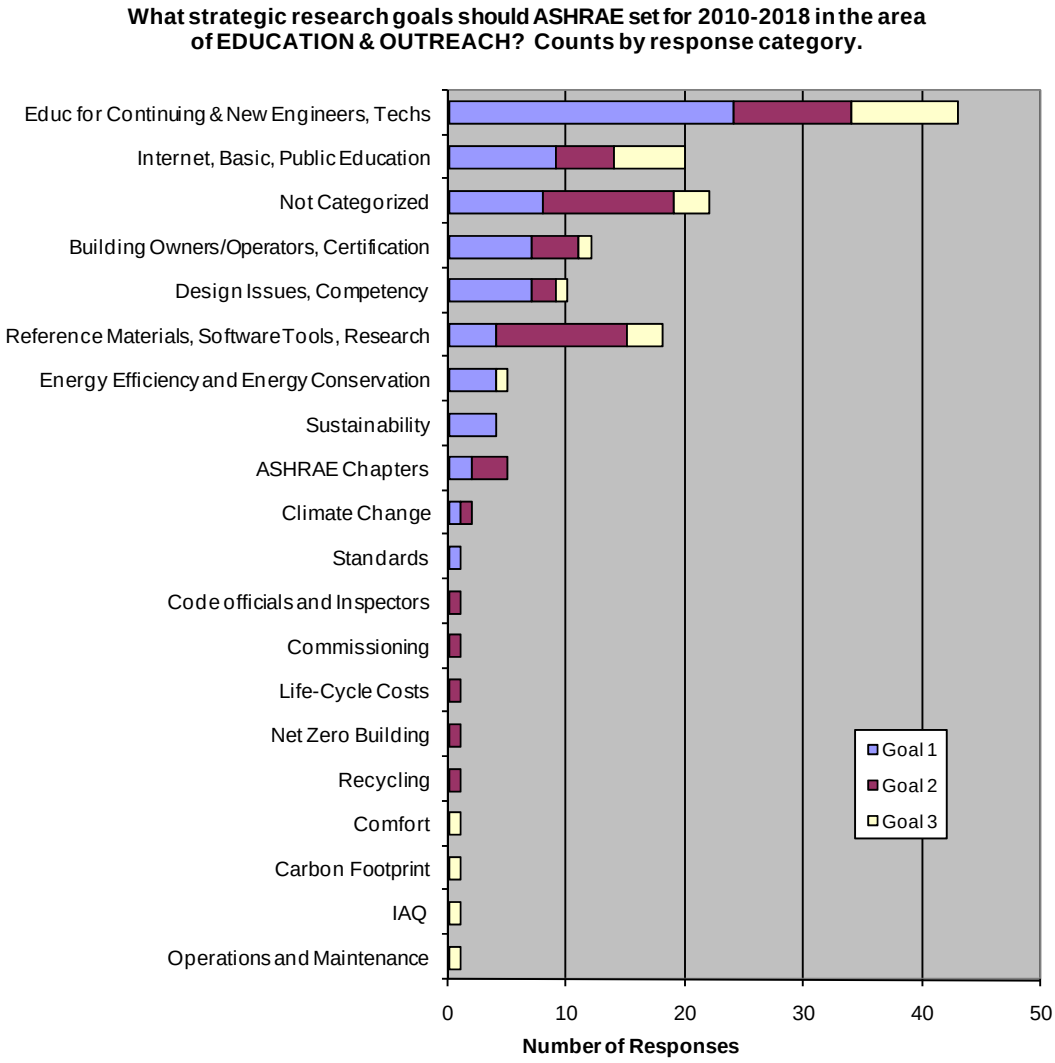


Figure 7. What strategic research goals should ASHRAE set for 2010-2018 in the area of EDUCATION AND OUTREACH? Counts by post hoc response category. Chart sorted by counts for Goal 1.

Table 9b subcategorizes responses within those categories that received five or more responses. This more fine-grained summary shows that the single most often stated goal was online courses. Two goals tied for second most stated: short courses by ASHRAE; and principles of design and engineering.

Table 9b. EDUCATION & OUTREACH. Summary of responses for categories receiving five or more responses.

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
Education for Continuing and New Engineers, Technicians Subtotals					
short courses by ASHRAE	3	0	0	3	9
continuing education	2	0	0	2	6
refrigeration courses	2	0	0	2	6
training engineers and building operators	2	0	0	2	6
education in high school	1	1	0	2	5
technician training	1	1	0	2	5
improve education and career routes	1	0	1	2	4
50% increase in students chosing engineering	1	0	0	1	3
ASHRAE professional courses	1	0	0	1	3
developing countries	1	0	0	1	3
E-learning courses	1	0	0	1	3
HVAC in undergraduate curriculum	1	0	0	1	3
information dissemination	1	0	0	1	3
initiatives for students and young professionals in and outside of US	1	0	0	1	3
involvement in tertiary institutions	1	0	0	1	3
methods	1	0	0	1	3
minorities and women about HVAC	1	0	0	1	3
understand energy targets, CO2, sustainability and indoor environment	1	0	0	1	3
useful and up-to-date textbooks	1	0	0	1	3
career outreach	0	1	0	1	2
education programn on refrigerator desin	0	1	0	1	2
exam	0	1	0	1	2
general	0	1	0	1	2
good graduate books	0	1	0	1	2
offer a degree certificate	0	1	0	1	2
training of practitioner	0	1	0	1	2
tudent exchange organization	0	1	0	1	2
educational efforts for ASHRAE-specific products and services	0	0	1	1	1
increase international relationships	0	0	1	1	1
K-12 involvement	0	0	1	1	1
mentoring for young engineers	0	0	1	1	1
outreach to high schools	0	0	1	1	1
special training, short courses	0	0	1	1	1
Support School Programs	0	0	1	1	1
tighten continuing ed requirements	0	0	1	1	1
TOTAL	24	10	9	43	101
Internet, Basic, Public Education Subtotals					
online courses	3	2	0	5	13
Educate the public	2	0	0	2	6
educational programs	1	0	0	1	3
HVAC performance	1	0	0	1	3
outreach to people in the world	1	0	0	1	3
outreach to residential consumers	1	0	0	1	3
HVAC systems awareness	0	1	0	1	2
interactive learning environment	0	1	0	1	2
provide CPD modules	0	1	0	1	2
communications with local community colleges and trade schools	0	0	1	1	1
education through professional organization	0	0	1	1	1
e-learning for architects, buildings and facilities team	0	0	1	1	1
include housing and construction	0	0	1	1	1
increase ASHRAE awareness	0	0	1	1	1
tools to make overal application by 2020 possibly	0	0	1	1	1
TOTAL	9	5	6	20	43

Table 9b (continued)

	Goal 1	Goal 2	Goal 3	Unweighted Total	Weighted Total
Reference Materials, Software Tools, Research Subtotals					
education material and tools	0	2	0	2	4
funding for research projects	1	0	0	1	3
international impast	1	0	0	1	3
results should apply to ASHRAE standars	1	0	0	1	3
simulation of buildings	1	0	0	1	3
general	0	0	3	3	3
dissemination of ASHRAE research	0	1	0	1	2
find greatest offenders to energy wastage	0	1	0	1	2
fund research to directly benefit HVAC&R personel, field managers	0	1	0	1	2
funding for research, papers, seminars about low GWP refrigerants	0	1	0	1	2
how-to' guide for simulation	0	1	0	1	2
improve handbooks	0	1	0	1	2
improve Live Handbook Webserve for sttudents	0	1	0	1	2
Live Handbook Webservice for students/users	0	1	0	1	2
reference books	0	1	0	1	2
TOTALS	4	11	3	18	37
Building Owners/Operators, Certification Subtotals					
general	2	1	0	3	8
operations education for facility managers	1	1	0	2	5
control systems	1	0	0	1	3
designers and builders	1	0	0	1	3
operations education for owners	1	0	0	1	3
Outreach to building operator groups such as BOMA	1	0	0	1	3
seminars on optimum design	0	1	0	1	2
how to recognize opportunites on operating their facilites more efficiently	0	1	0	1	2
clearer guidance to operators (RTFM+)	0	0	1	1	1
TOTAL	7	4	1	12	30
Design Issues, Competency Subtotals					
principles of design and engineering	3	0	0	3	9
Definition and Determinaition of Staff Compentancy	1	0	0	1	3
Minimal levels of education should be set for membership	1	0	0	1	3
integrated design	1	0	0	1	3
information for systems designers	1	0	0	1	3
envelope	0	1	0	1	2
smart design	0	1	0	1	2
specialized design guides	0	0	1	1	1
TOTAL	7	2	1	10	26
ASHRAE Chapters Subtotals					
more outreach to the chapters	2	0	0	2	6
15% increase at chapter meetings	0	1	0	1	2
funding for student chapters	0	1	0	1	2
training sessions on 2007 application chapter	0	1	0	1	2
TOTAL	2	3	0	5	12
FOLLOWING CATEGORY WAS TOO HETEROGENEOUS TO SUBCATEGORIZE					
Energy Efficiency and Energy Conservation					
TOTALS	4	0	1	5	13

Examples of specific goals include (verbatim):

- Develop short courses of 1-3 hours in length for ASHRAE chapters to conduct. A resonable goal would be for 100 short courses in a standard formats for chapters to use.
- Find a way to reach and train the majority of practicing engineers that are not trained for current technology.
- Get useful information to members (too heavily weighted to ultra advanced systems vs more practical information lately)

- 50% increase in students chosing engineering
- Make more short courses and prof Dev. courses available, while greatly enhancing the teaching environment for the on line courses. Requiring a phone and the internet is a huge negative.
- make our industry aware that we are going to educate professionals to make realise the targets on Energy, CO2, sustainability and indoor environment before 2018
- E learning courses to focus for fresh Engineers
- More useful and uptodate undergrad textbooks
- Prepare documnets for better instruction of fundamentals for refigeration and psychrometrics to students and engineers - less emphasis on modeling and more emphasis on fundamentals that are adapted to models
- refrigeration related courses in universities/colleges
- Emphacis on understanding and utilizing the principles of design and engineering
- Integrated design approach and training
- understanding the first principles of design
- Develop educational programs for building owners to learn about control systems.
- Outreach to building operator groups such as BOMA.
- We need to educate facility managers on how to efficiently operate their facilities
- On-line multi-media courses
- on-line practitioner courses on systems

Other Priority Areas Identified by Respondents

No consistent additional themes were apparent in the goals respondents identified in additional priority areas (Figures 8 and 9, Tables 10 and 11).

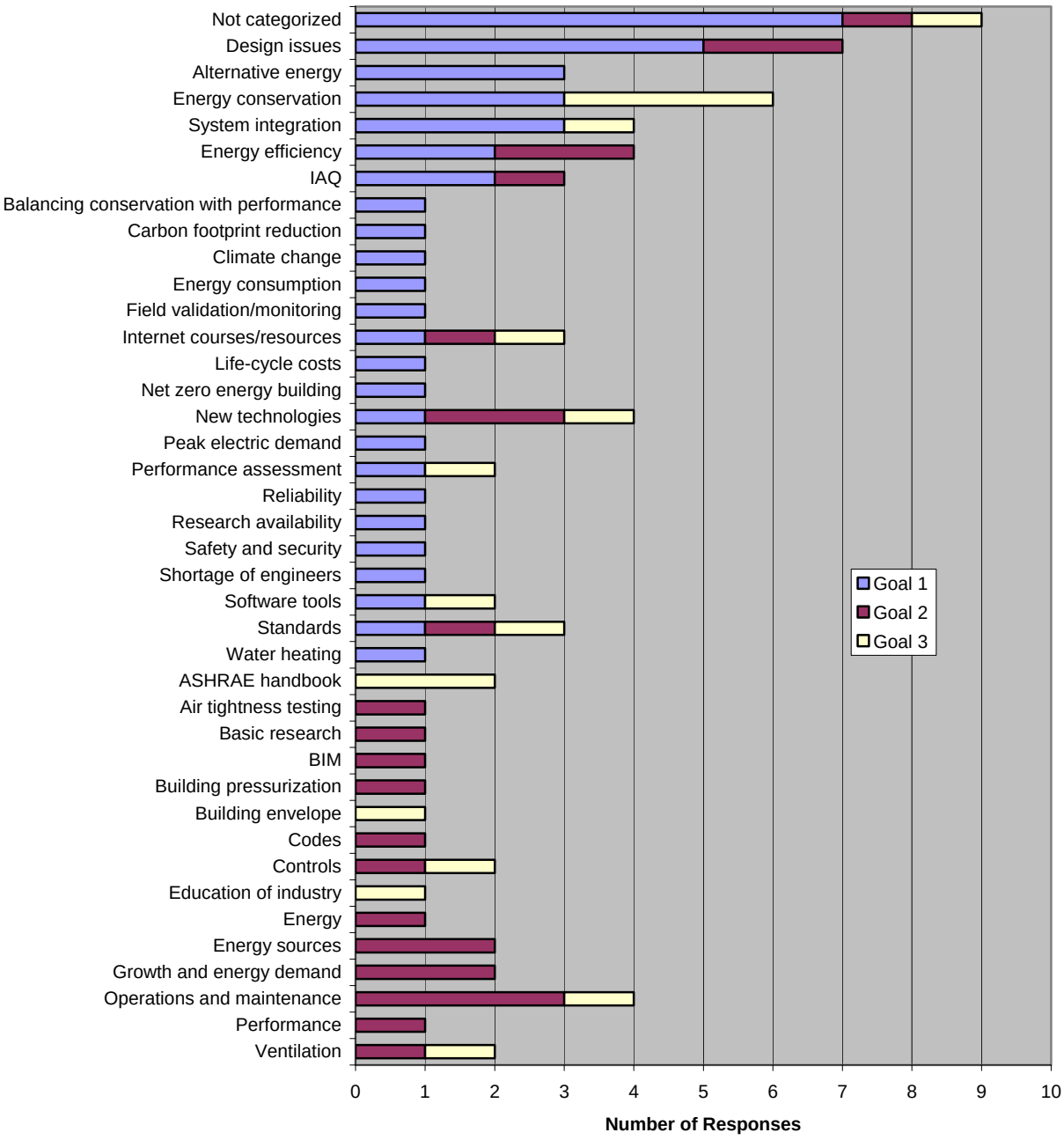


Figure 8. What strategic research goals should ASHRAE set for 2010-2018 in the area of FIRST ADDITIONAL PRIORITY AREA YOU IDENTIFIED? Counts by post hoc response category. Chart sorted by counts for Goal 1.

Table 10. What strategic research goals should ASHRAE set for 2010-2018 in the FIRST ADDITIONAL PRIORITY AREA YOU IDENTIFIED? Counts by post hoc response category. Left table sorted by Goal 1, right table by weighted total.

FIRST ADDITIONAL PRIORITY AREA Sorted by Goal 1	Goal 1	Goal 2	Goal 3	Weighted Total
Not categorized	7	1	1	24
Design issues	5	2	0	19
Alternative energy	3	0	0	9
Energy conservation	3	0	3	12
System integration	3	0	1	10
Energy efficiency	2	2	0	10
IAQ	2	1	0	8
Balancing conservation with performance	1	0	0	3
Carbon footprint reduction	1	0	0	3
Climate change	1	0	0	3
Energy consumption	1	0	0	3
Field validation/monitoring	1	0	0	3
Internet courses/resources	1	1	1	6
Life-cycle costs	1	0	0	3
Net zero energy building	1	0	0	3
New technologies	1	2	1	8
Peak electric demand	1	0	0	3
Performance assessment	1	0	1	4
Reliability	1	0	0	3
Research availability	1	0	0	3
Safety and security	1	0	0	3
Shortage of engineers	1	0	0	3
Software tools	1	0	1	4
Standards	1	1	1	6
Water heating	1	0	0	3
ASHRAE handbook	0	0	2	2
Air tightness testing	0	1	0	2
Basic research	0	1	0	2
BIM	0	1	0	2
Building pressurization	0	1	0	2
Building envelope	0	0	1	1
Codes	0	1	0	2
Controls	0	1	1	3
Education of industry	0	0	1	1
Energy	0	1	0	2
Energy sources	0	2	0	4
Growth and energy demand	0	2	0	4
Operations and maintenance	0	3	1	7
Performance	0	1	0	2
Ventilation	0	1	1	3

FIRST ADDITIONAL PRIORITY AREA Sorted by Weighted Total	Goal 1	Goal 2	Goal 3	Weighted Total
Not categorized	7	1	1	24
Design issues	5	2	0	19
Energy conservation	3	0	3	12
Energy efficiency	2	2	0	10
System integration	3	0	1	10
Alternative energy	3	0	0	9
IAQ	2	1	0	8
New technologies	1	2	1	8
Operations and maintenance	0	3	1	7
Internet courses/resources	1	1	1	6
Standards	1	1	1	6
Energy sources	0	2	0	4
Growth and energy demand	0	2	0	4
Performance assessment	1	0	1	4
Software tools	1	0	1	4
Balancing conservation with performance	1	0	0	3
Carbon footprint reduction	1	0	0	3
Climate change	1	0	0	3
Controls	0	1	1	3
Energy consumption	1	0	0	3
Field validation/monitoring	1	0	0	3
Life-cycle costs	1	0	0	3
Net zero energy building	1	0	0	3
Peak electric demand	1	0	0	3
Reliability	1	0	0	3
Research availability	1	0	0	3
Safety and security	1	0	0	3
Shortage of engineers	1	0	0	3
Ventilation	0	1	1	3
Water heating	1	0	0	3
ASHRAE handbook	0	0	2	2
Air tightness testing	0	1	0	2
Basic research	0	1	0	2
BIM	0	1	0	2
Building pressurization	0	1	0	2
Codes	0	1	0	2
Energy	0	1	0	2
Performance	0	1	0	2
Building envelope	0	0	1	1
Education of industry	0	0	1	1

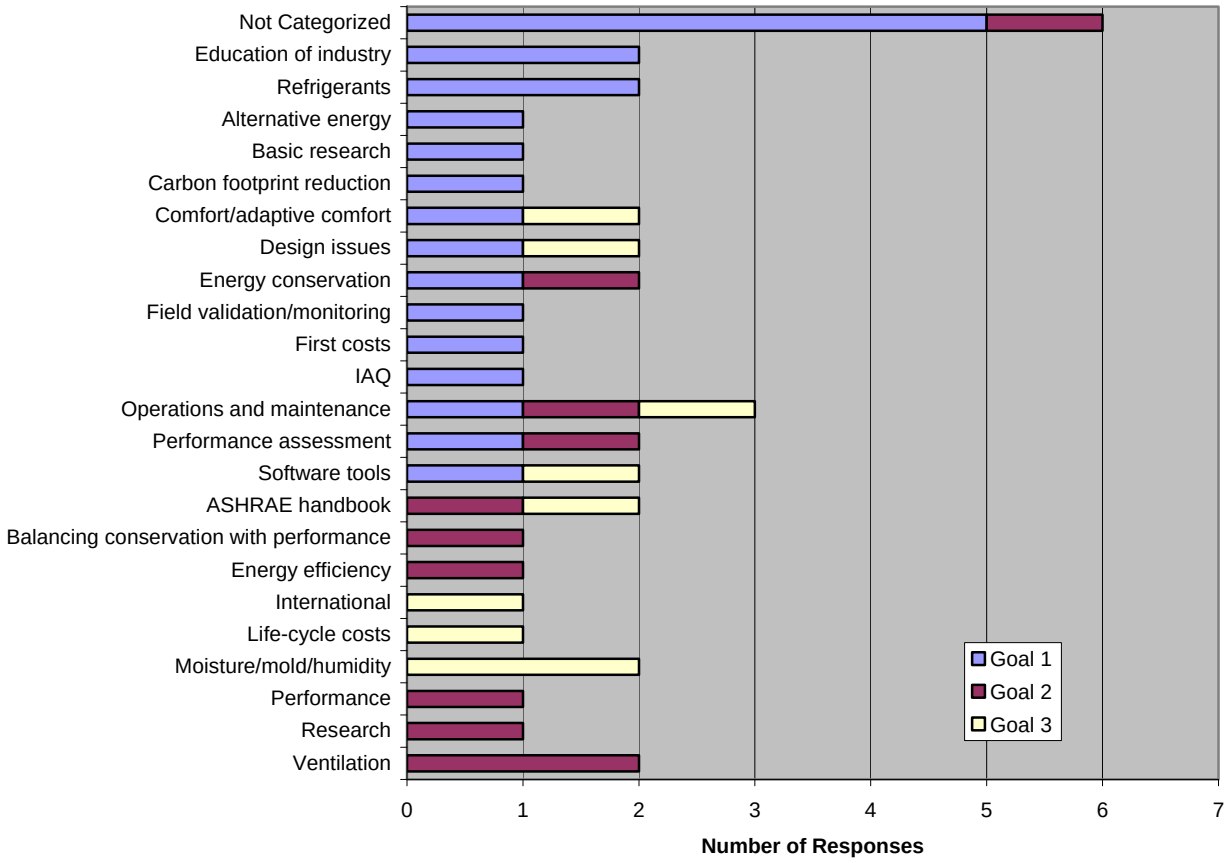


Figure 9. What strategic research goals should ASHRAE set for 2010-2018 in the area of SECOND ADDITIONAL PRIORITY AREA YOU IDENTIFIED? Counts by post hoc response category. Chart sorted by counts for Goal 1.

Table 11. What strategic research goals should ASHRAE set for 2010-2018 in the SECOND ADDITIONAL PRIORITY AREA YOU IDENTIFIED? Counts by post hoc response category. Left table sorted by Goal 1, right table by weighted total.

SECOND ADDITIONAL PRIORITY AREA Sorted by Goal 1	Goal 1	Goal 2	Goal 3	Weighted Total
Not Categorized	5	1	0	17
Education of industry	2	0	0	6
Refrigerants	2	0	0	6
Alternative energy	1	0	0	3
Basic research	1	0	0	3
Carbon footprint reduction	1	0	0	3
Comfort/adaptive comfort	1	0	1	4
Design issues	1	0	1	4
Energy conservation	1	1	0	5
Field validation/monitoring	1	0	0	3
First costs	1	0	0	3
IAQ	1	0	0	3
Operations and maintenance	1	1	1	6
Performance assessment	1	1	0	5
Software tools	1	0	1	4
ASHRAE handbook	0	1	1	3
Balancing conservation with performance	0	1	0	2
Energy efficiency	0	1	0	2
International	0	0	1	1
Life-cycle costs	0	0	1	1
Moisture/mold/humidity	0	0	2	2
Performance	0	1	0	2
Research	0	1	0	2
Ventilation	0	2	0	4

SECOND ADDITIONAL PRIORITY AREA Sorted by Weighted Total	Goal 1	Goal 2	Goal 3	Weighted Total
Not Categorized	5	1	0	17
Education of industry	2	0	0	6
Operations and maintenance	1	1	1	6
Refrigerants	2	0	0	6
Energy conservation	1	1	0	5
Performance assessment	1	1	0	5
Comfort/adaptive comfort	1	0	1	4
Design issues	1	0	1	4
Software tools	1	0	1	4
Ventilation	0	2	0	4
Alternative energy	1	0	0	3
ASHRAE handbook	0	1	1	3
Basic research	1	0	0	3
Carbon footprint reduction	1	0	0	3
Field validation/monitoring	1	0	0	3
First costs	1	0	0	3
IAQ	1	0	0	3
Balancing conservation with performance	0	1	0	2
Energy efficiency	0	1	0	2
Moisture/mold/humidity	0	0	2	2
Performance	0	1	0	2
Research	0	1	0	2
International	0	0	1	1
Life-cycle costs	0	0	1	1

Approaches to Strategic Planning for Research

Forty-seven percent of those who expressed an opinion think that the mix of research ASHRAE conducts is balanced about right between Research Strategic Plan priorities and Technical Committee priorities (Figure 10, Table 12). This is not necessarily a strong endorsement of strategic planning for research, though. Several years ago when research work statements submitted exceeded available funds, support of the Research Strategic Plan was used to prioritize projects put out for bid. More recently, however, sufficient funds have been available to complete all projects for which the TCs have completed an acceptable work statement. Analysis by RAP of all projects completed since the 2005-2010 Research Strategic Plan was developed suggests that the Plan has not markedly influenced the development of work statements to address the research goals. Rather, it appears that the TCs have developed research projects based on their internal objectives and identified the research goals they supported, in many cases tangentially, after the fact. As a result, in many cases a number of projects have been done that were indicated to address a particular goal, but the heart of the goal remains largely unfulfilled.

Thirty five percent of respondents think that the mix of research ASHRAE conducts is somewhat or much too strongly driven by the Research Strategic Plan, and 18% think that it is somewhat or much too strongly driven by the Technical Committees' research priorities. TC/TG/TRG members are more likely to think that the mix is too strongly driven by the

Research Strategic Plan, while members of Society level committees, councils and boards are more likely to think that the mix is balanced about right (Figure 11).[3]

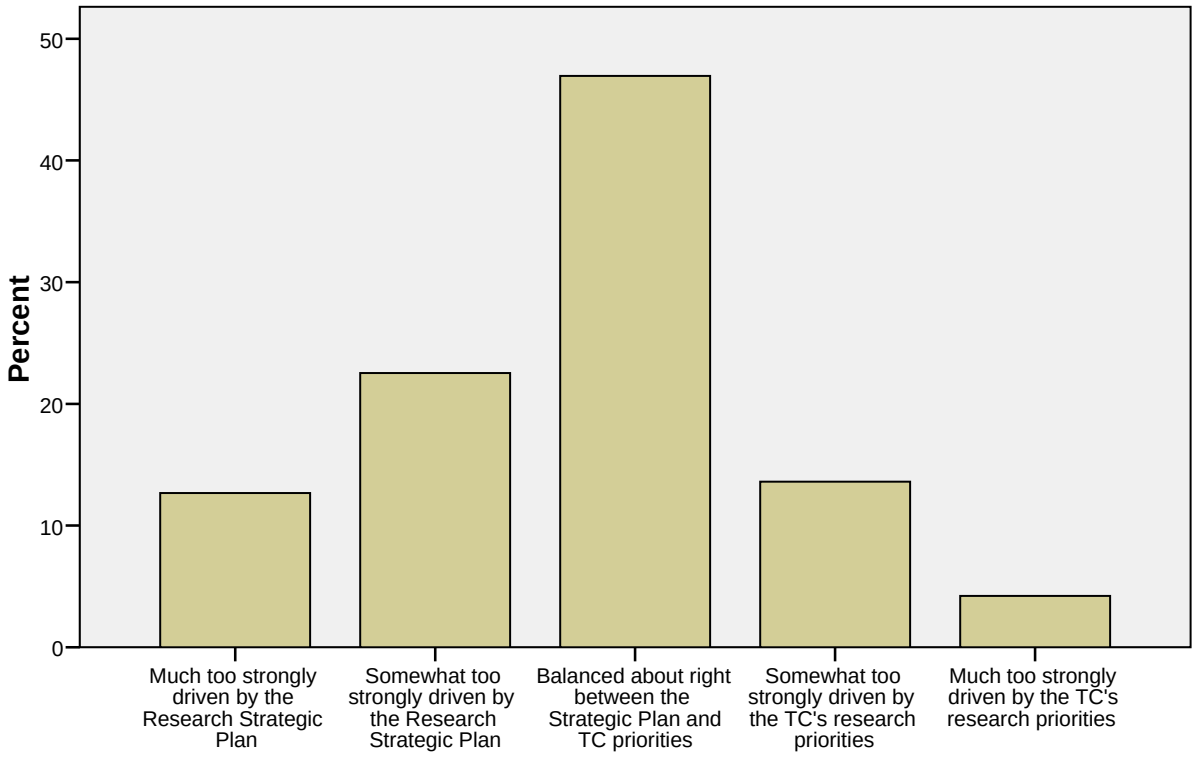
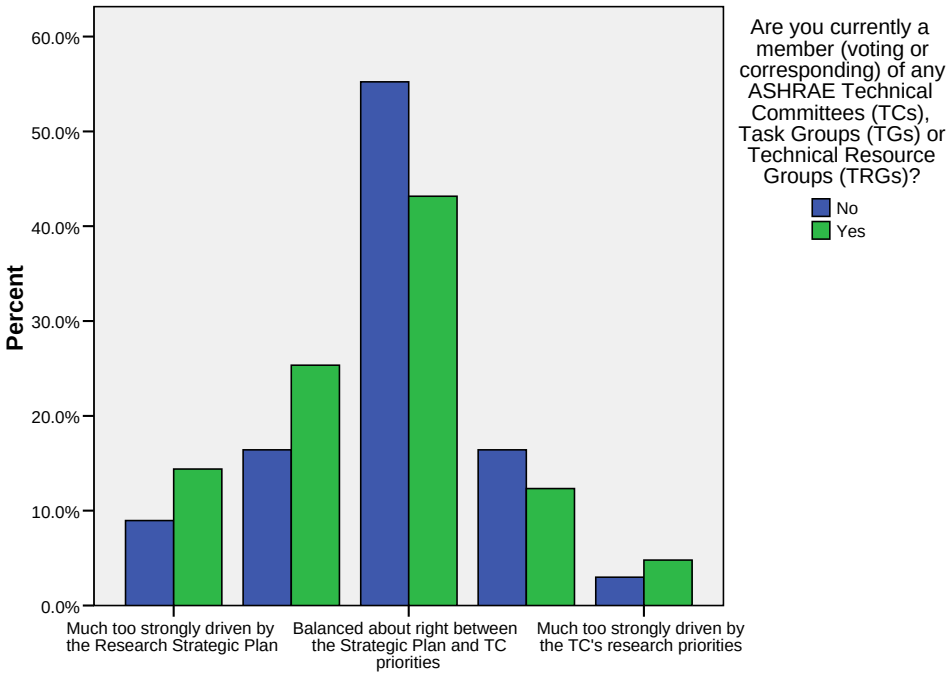


Figure 10. In your opinion, is the mix of research ASHRAE conducts...

Table 12. In your opinion, is the mix of research ASHRAE conducts...

	Frequency	Percent	Valid Percent
Much too strongly driven by the Research Strategic Plan	27	7.0	12.7
Somewhat too strongly driven by the Research Strategic Plan	48	12.4	22.5
Balanced about right between the Strategic Plan and TC priorities	100	25.8	46.9
Somewhat too strongly driven by the TC's research priorities	29	7.5	13.6
Much too strongly driven by the TC's research priorities	9	2.3	4.2
Valid total	213	54.9	100.0
Don't know	98	25.3	
Missing	77	19.8	
Total	175	45.1	

[3] Note that these groups of respondents are not mutually exclusive since respondents may both be TC members and members of Society-level bodies.



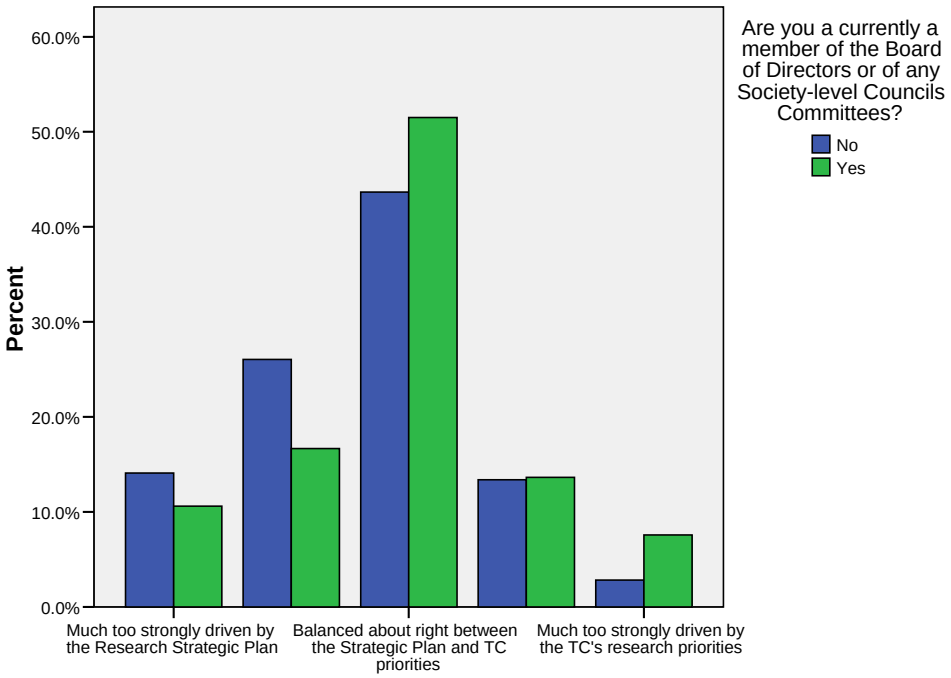


Figure 11. Opinions regarding the mix of ASHRAE research by membership on TCs/TGs/TRGs and Society-level Committees, Councils and Boards

Fifty-one percent of those offering an opinion think that the approach to research that would best serve ASHRAE's mission is to have a Research Strategic Plan that identifies numerous

goals and require the TCs to indicate how their projects support it (Figure 12, Table 13). This is the system that has been in use since development of the 2005-2010 Research Strategic Plan.

Only half as many (24%) think that the best approach would be to have a Research Strategic Plan that identifies a few key research goals to be pursued by TCs working with leadership, and have the rest of the research be driven by the TCs.

Thirteen percent think the best approach would be to have a target allocation of funds by major research area with the agenda within those areas driven by the TCs. That is the system that was in place before development of the 2005-2010 Research Strategic Plan. Some recommended another approach (8%) (detailed in Appendix C) or think the best approach would be to have no Research Strategic Plan at all (4%).

TC members were marginally more likely to favor having a Plan that identifies a few key research goals to be pursued by TCs/leadership and lets the rest of the research be driven by the TCs, and marginally less likely to favor the current system, than were non-TC members (Figure 13) ($\chi^2 = 8.4$, p = 0.08m).

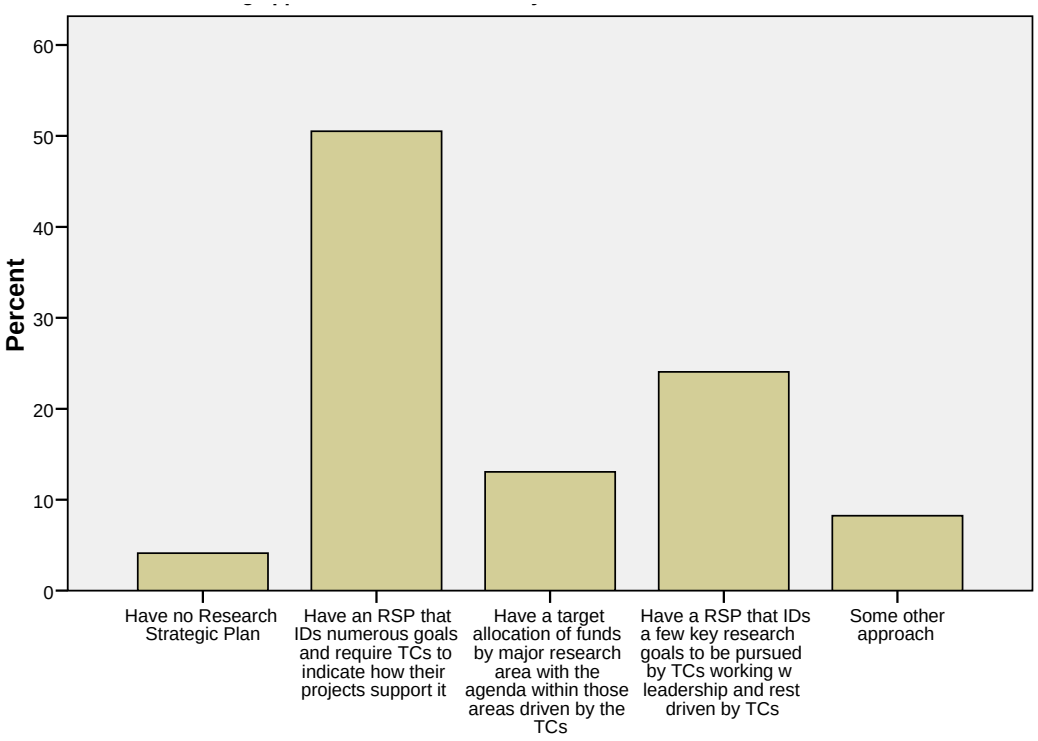


Figure 12. Which of the following approaches to research do you think would best serve ASHRAE's mission?

Table 13. Which of the following approaches to research do you think would best serve ASHRAE's mission?

	Frequency	Percent	Valid Percent
Have no Research Strategic Plan	12	3.1	4.1
Have an RSP that identifies numerous goals and require TCs to indicate how their projects support it	147	37.9	50.5
Have a target allocation of funds by major research area with the agenda within those areas driven by the TCs	38	9.8	13.1
Have a RSP that identifies a few key research goals to be pursued by TCs working w leadership and rest driven by TCs	70	18.0	24.1
Some other approach	24	6.2	8.2
Total valid	291	75.0	100.0
Don't know/no opinion	20	5.2	
Missing	77	19.8	
Overall total	388	100.0	

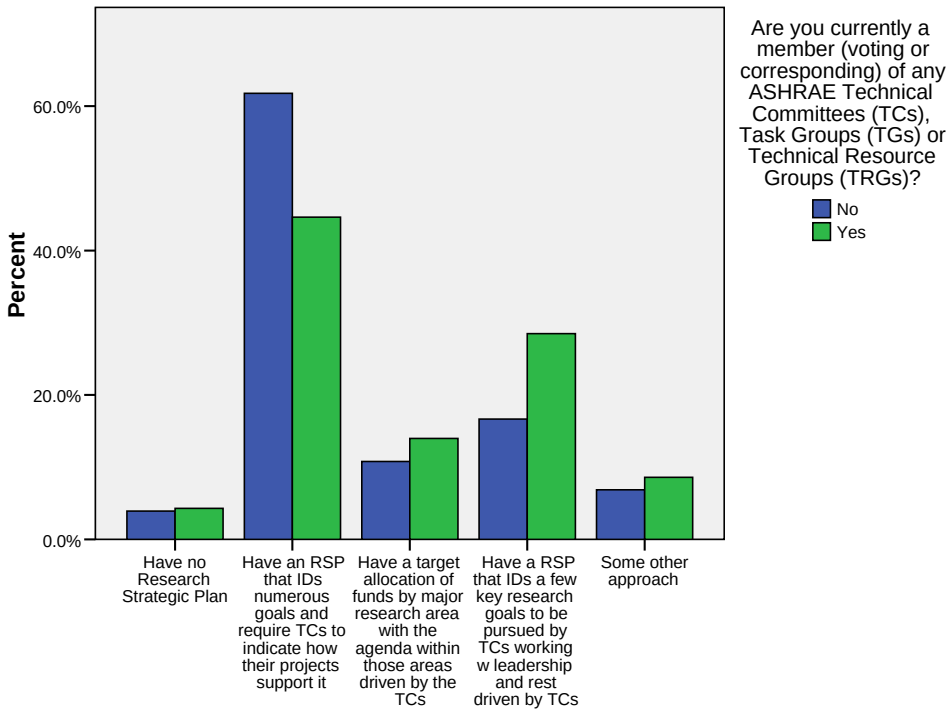


Figure 13a. Which of the following approaches to research do you think would best serve ASHRAE's mission, by TC membership.

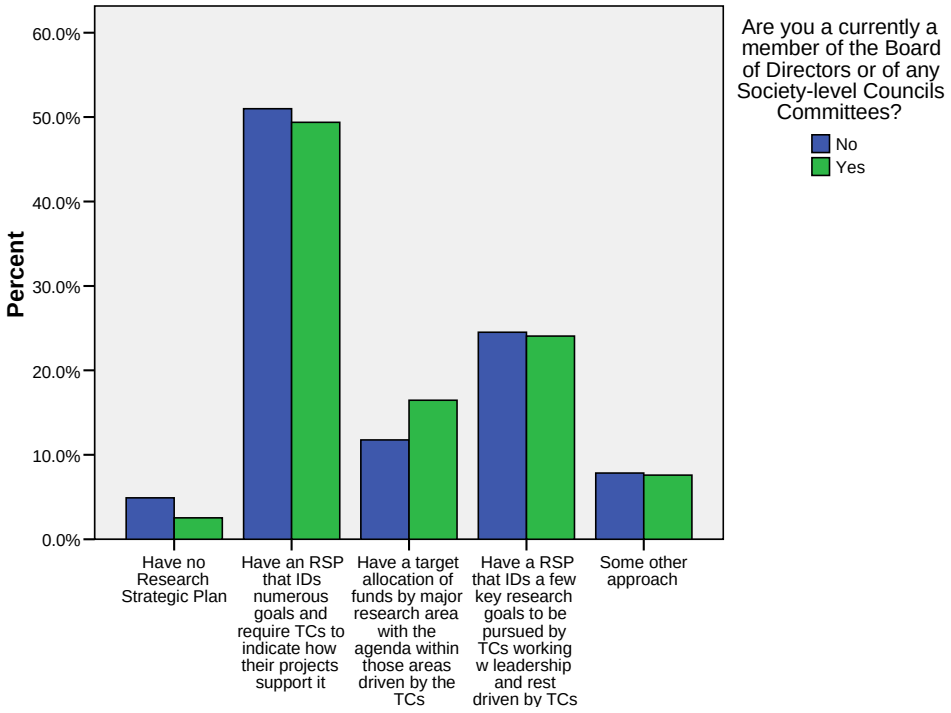


Figure 13b. Which of the following approaches to research do you think would best serve ASHRAE's mission, by membership on a Society-level Committee, Council or Board.

The questionnaire asked how ASHRAE could better structure its research program to achieve its strategic research priorities. The most commonly mentioned responses were obtaining more input, increasing coordination/collaboration within ASHRAE, streamlining the process, having the TCs take the lead and evaluating and communicating past/current research (Table 14).

The suggestions for more input included such approaches as:

- having the TCs more involved in the strategic planning process,
- obtaining more input from members,
- obtaining more input from end users rather than manufacturers on the TCs,
- bringing together more teams like the Retailers' Energy Alliance, AHR, and government, and
- using some research funds to replace the unsolicited research proposal (URP) process with open solicitations (without work statements) for proposals addressing the strategic plan.

Suggestions for coordination/collaboration focused mainly on coordination between TCs and coordination between TCs and RAC or other "ASHRAE management."

At the end of the survey, respondents were asked, "What other comments do you have for the Research Advisory Panel about the 2010-2018 Research Strategic Plan?" The responses largely reinforced important research priorities or approaches covered earlier in the survey (Table 15). One theme not clearly elicited elsewhere that was brought forward by several people here was the importance of practical research that can be used by practicing engineers.

Table 14. How could ASHRAE better structure its research program to achieve strategic research priorities?

Not categorized	34
Don't know	25
More input	14
Coordination/collaboration within ASHRAE	13
Streamline process	12
Evaluation/communication of past/current research	11
Current structure OK	9
TCs should take lead	9
Meet strategic goals	6
Oversight	6
Focus - limit	5
Funding	5
Joint ventures	5
Clarity/transparency	4
Flexibility	4
Focus - practical	4
Continuity	3
Focus - broaden	3
Unbiased appraisal of merit	3
Bidding/competition	2
Compensation	2
Joint ventures, deadlines, clearly defined tasks	1

Table 15. What other comments do you have for the Research Advisory Panel about the 2010-2018 Research Strategic Plan?

Not categorized	25
Energy and resources	9
Practical research and technology transfer	7
Communication on strategic goals/funding/research results	7
TC involvement	7
Thanks	7
Coordination within ASHRAE	4
Good luck	4
Collaboration with other organizations	3
Core business of ASHRAE	3
Equipment, components and materials	3
Flexibility	2
Keep up good work	2
Offer for help	2
Software tools	2
Refrigeration	1
Indoor air quality	1

Acknowledgements

Data analysis and reporting by Martha Hewett, Alison Kwok and Mary Sue Lobenstein.

Appendix A – Methods

Survey Methods

The survey was designed by members of RAP. It included an exceptionally large number of open-ended questions because RAP did not wish to pre-define participants' response options. This design imposed a higher burden on participants and greater effort in data analysis and reporting, but RAP believed this trade-off to be worthwhile in the interest of obtaining unbiased input. It did, however, result in a high number of abandoned surveys, presumably reflecting people who started the survey and did not feel they had time to complete it.

The survey was pre-tested by members of RAP, RAC and TAC and refined based on pre-test input. Data were collected through a web-based survey hosted by SurveyGizmo. Data were collected from late May through late September, 2008. Invitations and reminders were sent to:

- Chairs, vice chairs and research subcommittee chairs of Technical Committees, Task Groups and Technical Resource Groups. Chairs were encouraged to forward the information to TC/TG/TRG members.
- Chairs of all standard and guideline project committees
- Members of the Research Administration Committee, Technical Activities Committee, Standards Committee, Environmental Health Committee, Refrigeration Committee and Research Promotion
- Members of the Technology Council, the College of Fellows and the Board of Directors
- All Chapter presidents

In addition, the link was e-mailed to the CIBSE ASHRAE Group by CIBSE. Finally, a link to the survey was posted on ASHRAE's website and could be used by anyone to reach and complete the survey.

When more than one survey was obtained with the same respondent key, the less complete of the two cases was eliminated (n=13). When more than one survey was obtained from the same IP address, and the responses were the same as far as the respondent had gone in the survey, the less complete case was eliminated (n=15). Sixty-one cases with the same IP address but clearly different responses (e.g., different TC memberships) were retained (n=61). Such duplicates were expected because many companies with ASHRAE members have a limited number of IP addresses shared by all WAN users.

Data were analyzed using SPSS for Windows Version 15.0 and Excel 2003.

Appendix B – Survey Instrument

Welcome! Thank you for providing input to ASHRAE's 2010-2015 Research Strategic Plan.

Please read these instructions before starting.

Since its inception, ASHRAE has conducted research to advance the arts and sciences of HVAC&R and allied disciplines for the benefit of the general public. Today, ASHRAE funds over $2 million in research annually.

Research priorities are guided by ASHRAE's Research Strategic Plan, developed every 5 years by the Research Advisory Panel (RAP) with broad input from the membership. This survey is one of the early mechanisms RAP is using to gather that input. The Plan currently being developed looks forward to research priorities for 2010 through 2015. This survey asks for your thoughtful input on strategic research needs for that period.

The survey includes 22 questions and will take about 10 to 20 minutes to complete, depending on whether you choose to identify specific strategic research goals. Your responses will be kept confidential. At no time will any information you provide be identified with you.

A summary report of the survey results will be available later on the ASHRAE website.

We look forward to your input and thank you for your time.

Jeffrey D. Spitler, Ph.D.
RAP Chair

1. What do you believe are the most important issues that will face the HVAC&R industry in the next 20 years? [Please list up to three issues in order of importance.]

Most Important

Second

Third

2. What percent of 2010-2015 research funds do you believe ASHRAE should allocate to each of the following areas, based on their relative strategic importance in that timeframe?

[Items A through E are the priority areas from the current Research Strategic Plan (for 2005-2010), and items F and G give you the opportunity to identify additional or different areas you think are important. Enter a number between 0 and 100 for each area. The total must add to 100.]

A. Energy and Resources

B. Indoor Environmental Quality

C. Tools and Applications

D. Equipment, Components and Materials

E. Education and Outreach

F. First additional priority area (What? -->)

G. Second additional priority area (What? -->)

0% of 100% total

3. The next few questions give you an opportunity to identify strategic research goals that you think ASHRAE should set for 2010-2015 within each of the priority areas above. You can list goals for each priority area or for just some of the priority areas, or if you prefer you can skip over these questions.

[Notes:

- *Ideally, strategic goals should be stated in quantitative terms so that progress toward the goals can be periodically assessed.*
- *If you would like to look at the current Research Strategic Plan, please open a new window in your browser and copy the following URL into it: http://www.ashrae.org/docLib/200641713376_347.pdf. The file at this address is about 2.6 MB].*

For which priority areas do you want to identify strategic goals? (show/hide trigger question)

- ☐ A. Energy and Resources
- ☐ B. Indoor Environmental Quality
- ☐ C. Tools and Applications
- ☐ D. Equipment, Components and Materials
- ☐ E. Education and Outreach
- ☐ F. First additional priority area from Question 2
- ☐ G. Second additional priority area from Question 2
- ☐ None of the above - skip over these questions

4. What strategic research goals should ASHRAE set for 2010-2015 in the area of ENERGY AND RESOURCES? [Please list up to three goals in order of importance.] (hidden)

Most Important	
Second	
Third	

5. What strategic research goals should ASHRAE set for 2010-2015 in the area of INDOOR ENVIRONMENTAL QUALITY? [Please list up to three goals in order of importance.] (hidden)

Most Important	
Second	
Third	

6. What strategic research goals should ASHRAE set for 2010-2015 in the area of TOOLS AND APPLICATIONS? [Please list up to three goals in order of importance.] (hidden)

Most Important	

Second

Third

7. What strategic research goals should ASHRAE set for 2010-2015 in the area of EQUIPMENT, COMPONENTS AND MATERIALS? [Please list up to three goals in order of importance.] (hidden)

Most Important

Second

Third

8. What strategic research goals should ASHRAE set for 2010-2015 in the area of EDUCATION AND OUTREACH? [Please list up to three goals in order of importance.] (hidden)

Most Important

Second

Third

9. What strategic research goals should ASHRAE set for 2010-2015 relative to the first additional priority area you identified in Question 2? [Please list up to three goals in order of importance.] (hidden)

Most Important

Second

Third

10. What strategic research goals should ASHRAE set for 2010-2015 relative to the second additional priority area you identified in Question 2? [Please list up to three goals in order of importance.] (hidden)

Most Important

Second

Third

11. In your opinion, is the mix of research ASHRAE conducts...

- ○ much too strongly driven by the Research Strategic Plan
- ○ somewhat too strongly driven by the Research Strategic Plan
- ○ balanced about right between Strategic Plan and Technical Committee priorities
- ○ somewhat too strongly driven by the Technical Committees' research priorities
- ○ much too strongly driven by the Technical Committees' research priorities
- ○ don't know

12. Which of the following approaches to research do you think would best serve ASHRAE's mission?

- ○ Have no Research Strategic Plan and let the research agenda be driven by the Technical Committe
- ○ Have a Research Strategic Plan that identifies numerous research goals, and require the TCs to inc Plan (similar to 2005-2010 process currently in use).
- ○ Have a target allocation of funds by major research area with the research agenda within those are process).
- ○ Have a Research Strategic Plan that identifies a few key research goals to be pursued by one or mo the rest of the research agenda driven by the TCs.
- ○ Don't know/no opinion
- ○ Some other approach. (What?) -- >

13. How could ASHRAE better structure its research program to achieve strategic research priorities?

14. Which best describes your current job function?

- ○ Design/Application
- ○ Manufacturing
- ○ Maintenance/Operations
- ○ Management
- ○ Sales
- ○ Research
- ○ Teaching
- ○ Retired
- ○ Other (Please Specify)-->

15. Are you currently a member (voting or corresponding) of any ASHRAE Technical Committees (TCs), Task Groups (TGs) or Technical Resource Groups (TRGs)? (show/hide trigger question)

- ○ Yes
- ○ No

16. Which TCs, TGs and/or TRGs are you a member of? (hidden)

- ☐ 1.1 Thermodynamics and Psychrometrics
- ☐ 1.2 Instruments and Measurement
- ☐ 1.3 Heat Transfer and Fluid Flow
- ☐ 1.4 Control Theory and Application
- ☐ 1.5 Computer Applications
- ☐ 1.6 Terminology
- ☐ 1.7 Business, Management & General Legal Education
- ☐ 1.8 Mechanical Systems Insulation
- ☐ 1.9 Electrical Systems
- ☐ 1.10 Cogeneration Systems
- ☐ 1.11 Electric Motors and Motor Control
- ☐ 1.12 Moisture Management in Buildings
- ☐ TG1 Exergy Analysis for Sustainable Buildings (EXER)
- ☐ 2.1 Physiology and Human Environment
- ☐ 2.2 Plant and Animal Environment
- ☐ 2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment
- ☐ 2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment
- ☐ 2.5 Global Climate Change
- ☐ 2.6 Sound and Vibration Control
- ☐ 2.7 Seismic and Wind Restraint Design
- ☐ 2.8 Building Environmental Impacts and Sustainability
- ☐ 2.9 Ultraviolet Air and Surface Treatment
- ☐ TG2 Blast, Chemical and Biological Remediation (BCBR)
- ☐ 3.1 Refrigerants and Secondary Coolants
- ☐ 3.2 Refrigerant System Chemistry
- ☐ 3.3 Refrigerant Contaminant Control
- ☐ 3.4 Lubrication
- ☐ 3.6 Water Treatment

- [ ] 3.8 Refrigerant Containment
- [ ] TG3 HVAC&R Contractors and Design Build Firms (CDBF)
- [ ] 4.1 Load Calculation Data and Procedures
- [ ] 4.2 Climatic Information
- [ ] 4.3 Ventilation Requirements and Infiltration
- [ ] 4.4 Building Materials and Building Envelope Performance
- [ ] 4.5 Fenestration
- [ ] 4.7 Energy Calculations
- [ ] 4.10 Indoor Environmental Modeling
- [ ] TRG4 Sustainable Building Guidance and Metrics (SBGM)
- [ ] 5.1 Fans
- [ ] 5.2 Duct Design
- [ ] 5.3 Room Air Distribution
- [ ] 5.4 Industrial Process Air Cleaning (Air Pollution Control)
- [ ] 5.5 Air-to-Air Energy Recovery
- [ ] 5.6 Control of Fire and Smoke
- [ ] 5.7 Evaporative Cooling
- [ ] 5.8 Industrial Ventilation Systems
- [ ] 5.9 Enclosed Vehicular Facilities
- [ ] 5.10 Kitchen Ventilation
- [ ] 5.11 Humidifying Equipment
- [ ] 6.1 Hydronic and Steam Equipment and Systems
- [ ] 6.2 District Energy
- [ ] 6.3 Central Forced Air Heating and Cooling Systems
- [ ] 6.5 Radiant and In-Space Convective Heating and Cooling
- [ ] 6.6 Service Water Heating
- [ ] 6.7 Solar Energy Utilization
- [ ] 6.8 Geothermal Energy Utilization
- [ ] 6.9 Thermal Storage
- [ ] 6.10 Fuels and Combustion
- [ ] 7.1 Integrated Building Design
- [ ] 7.3 Operation and Maintenance Management
- [ ] 7.4 Building Operation Dynamics
- [ ] 7.5 Smart Building Systems
- [ ] 7.6 Systems Energy Utilization
- [ ] 7.7 Testing and Balancing
- [ ] 7.8 Owning and Operating Costs
- [ ] 7.9 Building Commissioning
- [ ] TRG7 Tools for Sustainable Building Operations, Maintenance and Cost Analysis (SBOMC)
- [ ] TRG7 Underfloor Air Distribution (UFAD)
- [ ] 8.1 Positive Displacement Compressors

- [ ] 8.2 Centrifugal Machines
- [ ] 8.3 Absorption and Heat Operated Machines
- [ ] 8.4 Air-to-Refrigerant Heat Transfer Equipment
- [ ] 8.5 Liquid-to-Refrigerant Heat Exchangers
- [ ] 8.6 Cooling Towers and Evaporative Condensers
- [ ] 8.8 Refrigerant System Controls and Accessories
- [ ] 8.9 Residential Refrigerators and Food Freezers
- [ ] 8.10 Mechanical Dehumidification Equipment and Heat Pipes
- [ ] 8.11 Unitary and Room Air Conditioners and Heat Pumps
- [ ] 8.12 Desiccant Dehumidification Equipment and Components
- [ ] TG8 Variable Refrigerant Flow (VRF)
- [ ] 9.1 Large Building Air-Conditioning Systems
- [ ] 9.2 Industrial Air Conditioning
- [ ] 9.3 Transportation Air Conditioning
- [ ] 9.4 Applied Heat Pump/Heat Recovery Systems
- [ ] 9.5 Residential and Small Building Applications
- [ ] 9.6 Healthcare Facilities
- [ ] 9.7 Educational Facilities
- [ ] 9.8 Large Building Air-Conditioning Applications
- [ ] 9.9 Mission Critical Facilities, Technology Spaces and Electronic Equipment
- [ ] 9.10 Laboratory Systems
- [ ] 9.11 Clean Space
- [ ] 9.12 Tall Buildings
- [ ] TG9 Justice Facilities (JF)
- [ ] 10.1 Custom Engineered Refrigeration Systems
- [ ] 10.2 Automatic Icemaking Plants and Skating Rinks
- [ ] 10.3 Refrigerant Piping
- [ ] 10.4 Ultra-Low Temperature Systems and Cryogenics
- [ ] 10.5 Refrigerated Distribution and Storage Facilities
- [ ] 10.6 Transport Refrigeration
- [ ] 10.7 Commercial Food and Beverage Cooling Display and Storage
- [ ] 10.8 Refrigeration Load Calculations
- [ ] 10.9 Refrigeration Application for Foods and Beverages
- [ ] 10.10 Management of Lubricant in Circulation
- [ ] Other not listed

17. Are you currently a member (voting or non-voting) of any ASHRAE SGPCs, SSPCs, GPCs or SPCs? (show/hide trigger question)

- ○ Yes
- ○ No

18. Which SGPCs, SSPCs, GPCs and/or SPCs are you a member of? (hidden)

- ☐ SGPC 0
- ☐ SGPC 13
- ☐ SSPC 15
- ☐ SSPC 34
- ☐ SSPC 35
- ☐ SSPC 41
- ☐ SSPC 52.2
- ☐ SSPC 55
- ☐ SSPC 62.1
- ☐ SSPC 62.2
- ☐ SSPC 90.1
- ☐ SSPC 90.2
- ☐ SSPC 126
- ☐ SSPC 135
- ☐ SSPC 136
- ☐ SSPC 140
- ☐ SSPC 169
- ☐ Other GPC(s) (Please list -->)
- ☐ Other SPC(s) (Please list -->)

19. Are you currently an ASHRAE Chapter officer?

- ○ Yes
- ○ No

20. Are you a currently a member of the Board of Directors or of any Society-level Councils or Committees? (show/hide trigger question)

- ○ Yes
- ○ No

21. Which Society-level bodies are you a member of? (hidden)

- ☐ Advocacy
- ☐ ASHRAE Foundation
- ☐ ASHRAE Journal International Focus Group
- ☐ ASHRAE Research Canada
- ☐ Associate Society Alliance
- ☐ Board of Directors
- ☐ Certification
- ☐ Chapter Technology Transfer
- ☐ CLIMA
- ☐ College of Fellows Board/Advisory
- ☐ College of Fellows
- ☐ Conference and Exposition
- ☐ Electronic Communications
- ☐ Environmental Health
- ☐ Finance
- ☐ Handbook
- ☐ Historical
- ☐ Honors & Awards
- ☐ Life Members
- ☐ Meetings Arrangements
- ☐ Members Council
- ☐ Membership Promotion
- ☐ Natural Refrigerants Position Document Ad Hoc
- ☐ Nominating
- ☐ Ozone Depleting Substances Ad Hoc
- ☐ President-Elect Advisory Committee (PEAC)
- ☐ Planning
- ☐ Professional Development
- ☐ Publications

- [ ] Publishing and Education Council
- [ ] REA Codes and Standards Exchange
- [ ] Refrigeration
- [ ] Region-at-Large Planning
- [ ] Research Administration (RAC)
- [ ] Research Advisory Panel (RAP)
- [ ] Research Promotion
- [ ] Scholarship Trustees
- [ ] Society Rules Committee
- [ ] Solar Decathalon Ad Hoc
- [ ] Standards
- [ ] Standards Advisory
- [ ] Student Activities
- [ ] Technical Activities (TAC)
- [ ] Technology Council
- [ ] Young Engineers in ASHRAE
- [ ] Other (Please Specify -->)

22. What other comments do you have for the Research Advisory Panel about the 2010-2015 Research Strategic Plan?

Appendix C – Detailed Tables & Figures

Table C.1. Are you currently a member (voting or corresponding) of any ASHRAE Technical Committees (TCs), Task Groups (TGs) or Technical Resource Groups (TRGs)?

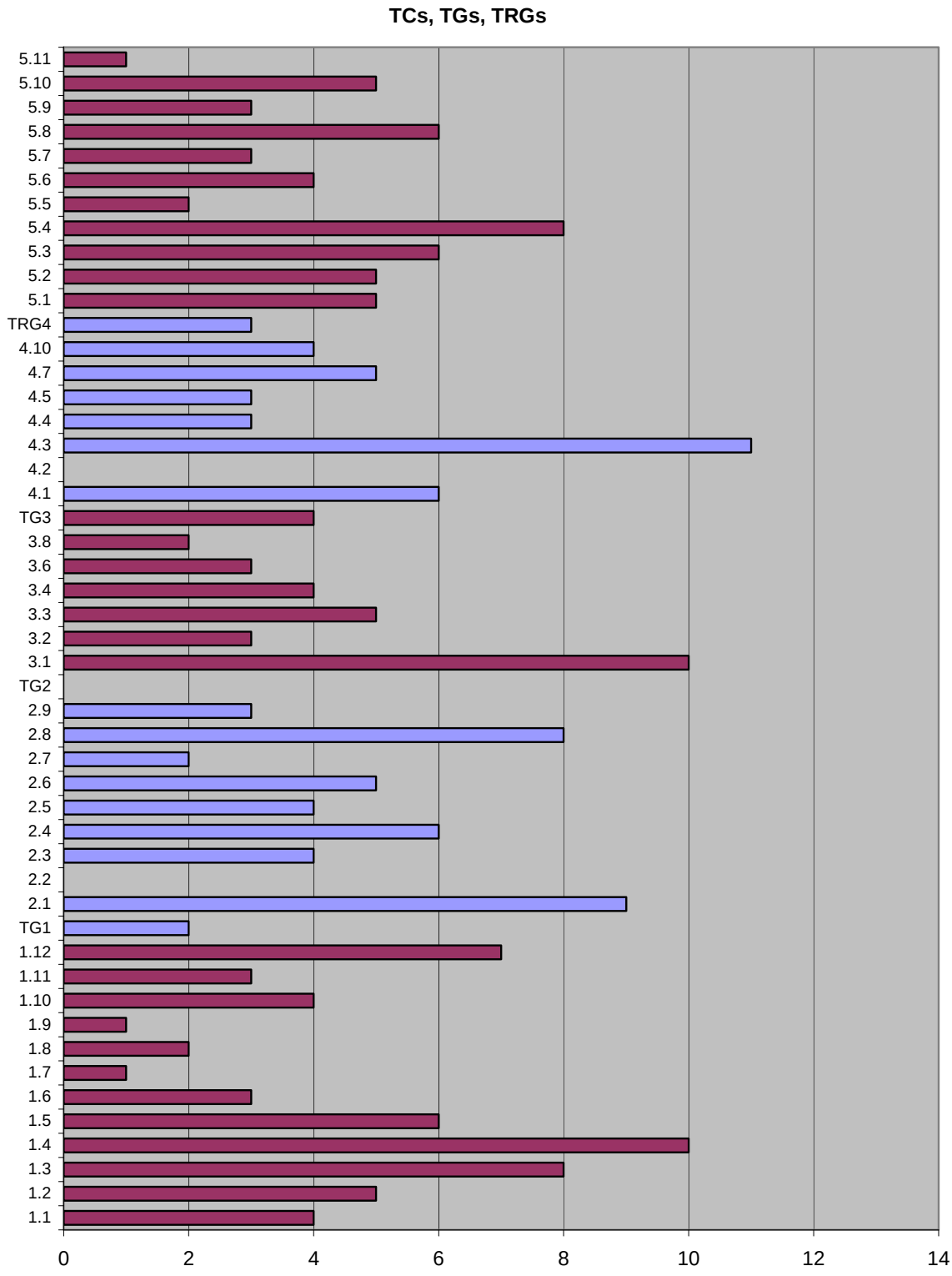
	Frequency	Percent	Valid Percent
No	123	31.7	39.7
Yes	187	48.2	60.3
Total	310	79.9	100.0
Missing	78	20.1	
Total	388	100	

Table C.2. Membership in Technical Committees, Task Groups and Technical Resource Groups

TC, TG, TRG	Respondents
1.1 Thermodynamics and Psychrometrics	4
1.2 Instruments and Measurement	5
1.3 Heat Transfer and Fluid Flow	8
1.4 Control Theory and Application	10
1.5 Computer Applications	6
1.6 Terminology	3
1.7 Business, Management & General Legal Education	1
1.8 Mechanical Systems Insulation	2
1.9 Electrical Systems	1
1.10 Cogeneration Systems	4
1.11 Electric Motors and Motor Control	3
1.12 Moisture Management in Buildings	7
TG1 Exergy Analysis for Sustainable Buildings (EXER)	2
2.1 Physiology and Human Environment	9
2.2 Plant and Animal Environment	0
2.3 Gaseous Air Contaminants and Gas Contaminant Removal Equipment	4
2.4 Particulate Air Contaminants and Particulate Contaminant Removal Equipment	6
2.5 Global Climate Change	4
2.6 Sound and Vibration Control	5
2.7 Seismic and Wind Restraint Design	2
2.8 Building Environmental Impacts and Sustainability	8
2.9 Ultraviolet Air and Surface Treatment	3
TG2 Blast, Chemical and Biological Remediation (BCBR)	0
3.1 Refrigerants and Secondary Coolants	10
3.2 Refrigerant System Chemistry	3
3.3 Refrigerant Contaminant Control	5
3.4 Lubrication	4
3.6 Water Treatment	3
3.8 Refrigerant Containment	2
TG3 HVAC&R Contractors and Design Build Firms (CDBF)	4
4.1 Load Calculation Data and Procedures	6
4.2 Climatic Information	0
4.3 Ventilation Requirements and Infiltration	11
4.4 Building Materials and Building Envelope Performance	3

TC, TG, TRG	Respondents
4.5 Fenestration	3
4.7 Energy Calculations	5
4.10 Indoor Environmental Modeling	4
TRG4 Sustainable Building Guidance and Metrics (SBGM)	3
5.1 Fans	5
5.2 Duct Design	5
5.3 Room Air Distribution	6
5.4 Industrial Process Air Cleaning (Air Pollution Control)	8
5.5 Air-to-Air Energy Recovery	2
5.6 Control of Fire and Smoke	4
5.7 Evaporative Cooling	3
5.8 Industrial Ventilation Systems	6
5.9 Enclosed Vehicular Facilities	3
5.10 Kitchen Ventilation	5
5.11 Humidifying Equipment	1
6.1 Hydronic and Steam Equipment and Systems	4
6.2 District Energy	6
6.3 Central Forced Air Heating and Cooling Systems	5
6.5 Radiant and In-Space Convective Heating and Cooling	4
6.6 Service Water Heating	6
6.7 Solar Energy Utilization	7
6.8 Geothermal Energy Utilization	4
6.9 Thermal Storage	8
6.10 Fuels and Combustion	1
7.1 Integrated Building Design	5
7.3 Operation and Maintenance Management	4
7.4 Building Operation Dynamics	1
7.5 Smart Building Systems	6
7.6 Systems Energy Utilization	3
7.7 Testing and Balancing	8
7.8 Owning and Operating Costs	1
7.9 Building Commissioning	6
TRG7 Tools for Sustainable Building Operations, Maintenance and Cost Analysis (SBOMC)	1
TRG7 Underfloor Air Distribution (UFAD)	4
8.1 Positive Displacement Compressors	4
8.2 Centrifugal Machines	7
8.3 Absorption and Heat Operated Machines	5
8.4 Air-to-Refrigerant Heat Transfer Equipment	5
8.5 Liquid-to-Refrigerant Heat Exchangers	6
8.6 Cooling Towers and Evaporative Condensers	3
8.8 Refrigerant System Controls and Accessories	2
8.9 Residential Refrigerators and Food Freezers	4
8.10 Mechanical Dehumidification Equipment and Heat Pipes	6
8.11 Unitary and Room Air Conditioners and Heat Pumps	11
8.12 Desiccant Dehumidification Equipment and Components	2

TC, TG, TRG	Respondents
TG8 Variable Refrigerant Flow (VRF)	3
9.1 Large Building Air-Conditioning Systems	4
9.2 Industrial Air Conditioning	4
9.3 Transportation Air Conditioning	3
9.4 Applied Heat Pump/Heat Recovery Systems	2
9.5 Residential and Small Building Applications	7
9.6 Healthcare Facilities	13
9.7 Educational Facilities	3
9.8 Large Building Air-Conditioning Applications	8
9.9 Mission Critical Facilities, Technology Spaces and Electronic Equipment	5
9.10 Laboratory Systems	7
9.11 Clean Space	5
9.12 Tall Buildings	1
TG9 Justice Facilities (JF)	1
10.1 Custom Engineered Refrigeration Systems	8
10.2 Automatic Icemaking Plants and Skating Rinks	5
10.3 Refrigerant Piping	2
10.4 Ultra-Low Temperature Systems and Cryogenics	3
10.5 Refrigerated Distribution and Storage Facilities	6
10.6 Transport Refrigeration	5
10.7 Commercial Food and Beverage Cooling Display and Storage	7
10.8 Refrigeration Load Calculations	6
10.9 Refrigeration Application for Foods and Beverages	5
10.10 Management of Lubricant in Circulation	4


TCs, TGs, TRGs
5.11
5.10
5.9
5.8
5.7
5.6
5.5
5.4
5.3
5.2
5.1
TRG4
4.10
4.7
4.5
4.4
4.3
4.2
4.1
TG3
3.8
3.6
3.4
3.3
3.2
3.1
TG2
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
TG1
1.12
1.11
1.10
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2
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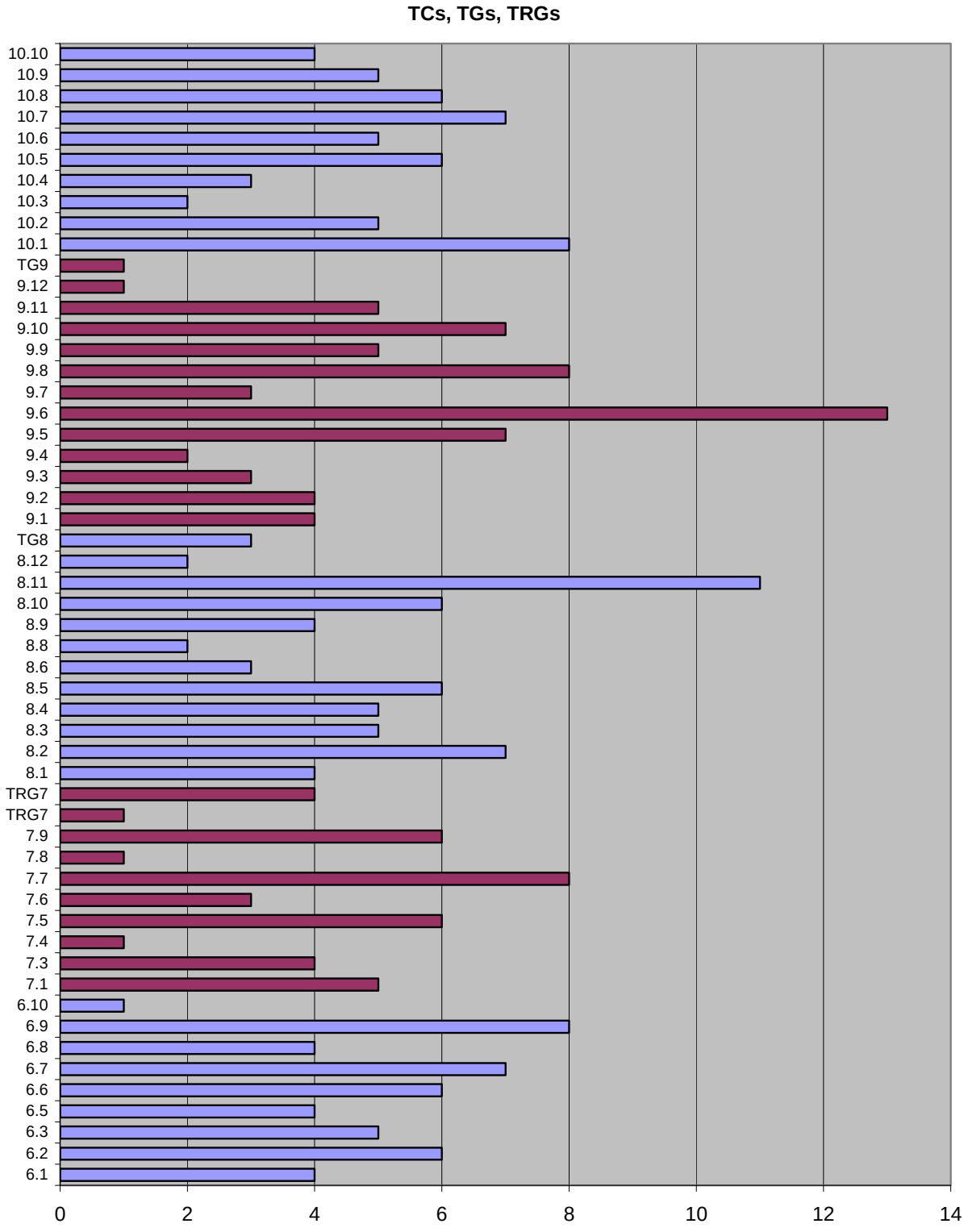
Figure C.1.a.


TCs, TGs, TRGs
10.10
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10.1
TG9
9.12
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TG8
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Figure C.1.b.

Table C.3. Are you currently a member (voting or non-voting) of any ASHRAE SGPCs, SSPCs, GPCs or SPCs?

	Frequency	Percent	Valid Percent
No	227	58.5	73.9
Yes	80	20.6	26.1
Total	307	79.1	100.0
Missing	81	20.9	
Total	388	100	

Table C.4. Membership in SSPCs and SGPCs

SSPCs, SGPCs	Respondents
SGPC 0	2
SGPC 13	1
SSPC 15	3
SSPC 34	1
SSPC 35	0
SSPC 41	5
SSPC 52.2	3
SSPC 55	6
SSPC 62.1	8
SSPC 62.2	4
SSPC 90.1	5
SSPC 90.2	2
SSPC 126	0
SSPC 135	0
SSPC 136	0
SSPC 140	1
SSPC 169	1

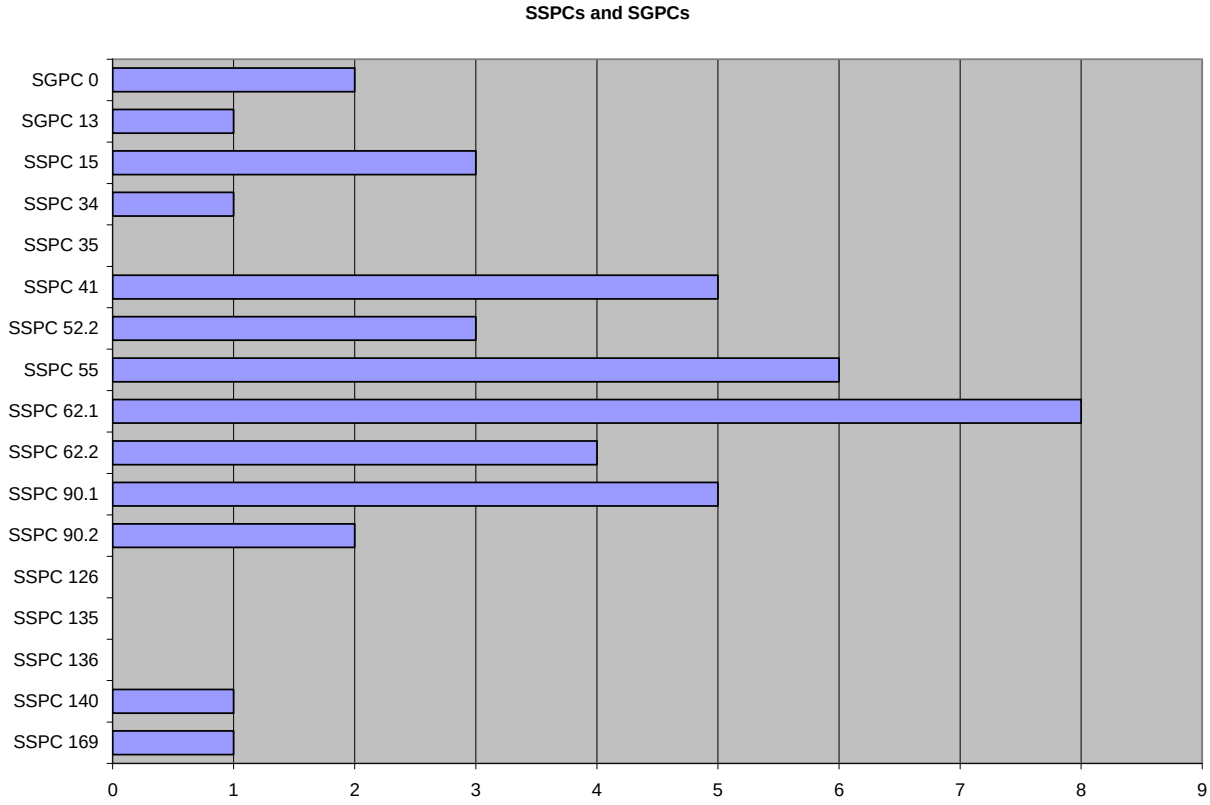

Table C.5. Are you currently an ASHRAE Chapter officer?

	Frequency	Percent	Valid Percent	Cumulative Percent
No	256	66.0	82.8	82.8
Yes	53	13.7	17.2	100.0
Total	309	79.6	100.0	
Missing	79	20.4		
Total	388	100		

Table C.6. Are you a currently a member of the Board of Directors or of any Society-level Councils Committees?

	Frequency	Percent	Valid Percent	Cumulative Percent
No	221	57.0	72.2	72.2
Yes	85	21.9	27.8	100.0
Total	306	78.9	100.0	
Missing	82	21.1		
Total	388	100.0		

Table C.7. Membership on the Board, Councils and Society Committees

Board, Councils, Committees	Respondents
Advocacy	1
ASHRAE Foundation	0
ASHRAE Journal International Focus Group	1
ASHRAE Research Canada	1
Associate Society Alliance	1
Board of Directors	10
Certification	1
Chapter Technology Transfer	2
CLIMA	1
College of Fellows	16
College of Fellows Board/Advisory	2
Conference and Exposition	2
Electronic Communications	2
Environmental Health	8
Finance	2
Handbook	5
Historical	2
Honors & Awards	3
Life Members	6
Meetings Arrangements	0
Members Council	4
Membership Promotion	2
Natural Refrigerants Position Document Ad Hoc	0
Nominating	3
Ozone Depleting Substances Ad Hoc	1
Planning	4
President-Elect Advisory Committee (PEAC)	3
Professional Development	4
Publications	3
Publishing and Education Council	4
REA Codes and Standards Exchange	0
Refrigeration	4
Region-at-Large Planning	1
Research Administration (RAC)	7
Research Advisory Panel (RAP)	3
Research Promotion	5
Scholarship Trustees	0
Society Rules Committee	1
Solar Decathalon Ad Hoc	2
Standards	6
Standards Advisory	1
Student Activities	4
Technical Activities (TAC)	7
Technology Council	11
Young Engineers in ASHRAE	2

Table C.8. Which best describes your current job function?

	Frequency	Percent	Valid Percent
Design/Application	109	28.1	35.2
Manufacturing	10	2.6	3.2
Maintenance/Operations	7	1.8	2.3
Management	33	8.5	10.6
Sales	13	3.4	4.2
Research	73	18.8	23.5
Teaching	16	4.1	5.2
Retired	13	3.4	4.2
Other	36	9.3	11.6
Total Valid	310	79.9	100.0
Missing	78	20.1	
Overall Total	388	100.0	

Table C.9. Country

	Frequency	Percent	Valid Percent
Australia	3	0.8	0.8
Belgium	1	0.3	0.3
Canada	13	3.4	3.6
China	2	0.5	0.5
Denmark	1	0.3	0.3
Germany	2	0.5	0.5
Greece	1	0.3	0.3
Hong Kong	4	1.0	1.1
India	3	0.8	0.8
Iran, Islamic Republic of	1	0.3	0.3
Ireland	2	0.5	0.5
Israel	2	0.5	0.5
Italy	3	0.8	0.8
Korea, Republic of	1	0.3	0.3
Lebanon	1	0.3	0.3
Malaysia	2	0.5	0.5
Netherlands	1	0.3	0.3
New Zealand	1	0.3	0.3
Philippines	1	0.3	0.3
Qatar	1	0.3	0.3
Serbia	1	0.3	0.3
Singapore	1	0.3	0.3
South Africa	1	0.3	0.3
Spain	1	0.3	0.3
Turkey	1	0.3	0.3
United Arab Emirates	1	0.3	0.3
United Kingdom	26	6.7	7.1
United States	287	74.0	78.6
Valid Total	365	94.1	100.0
Missing	23	5.9	
Overall Total	388	100.0	