



COOLERCHIPS Kickoff meeting

19 October 2023

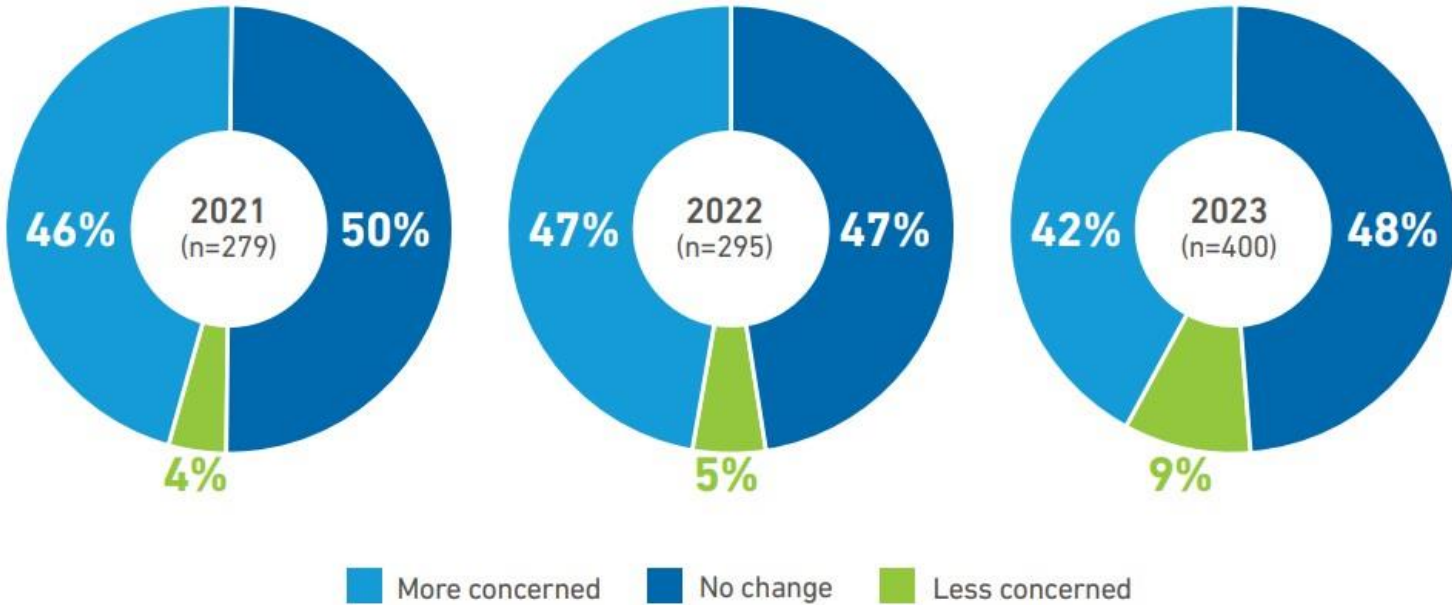
Agenda

1. Discuss the importance of reliability in data centers
2. Understand where cooling falls relative to other reliability concerns
3. Review cooling trends
4. Deep dive on direct liquid cooling market data

Outage concerns continue to rise

How concerned is senior management about IT service outages compared with 12 months ago? Would you say senior management is more concerned or less concerned about IT service outages — or is their level of concern the same as it was 12 months ago?

- Over 40% say senior managers are more concerned about outages than a year ago
- Rising costs, negative publicity and customer impact are likely drivers



(Responses for "Don't know" are not included.)

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Half of impactful outages cost more than \$100k

- Frequency of impactful outages has slowly declined in recent years
- But those that do occur are getting more expensive

Please estimate the total cost of this downtime incident (from outage to full recovery) for your organization, including direct, opportunity and reputation costs using the following options. (n=94)

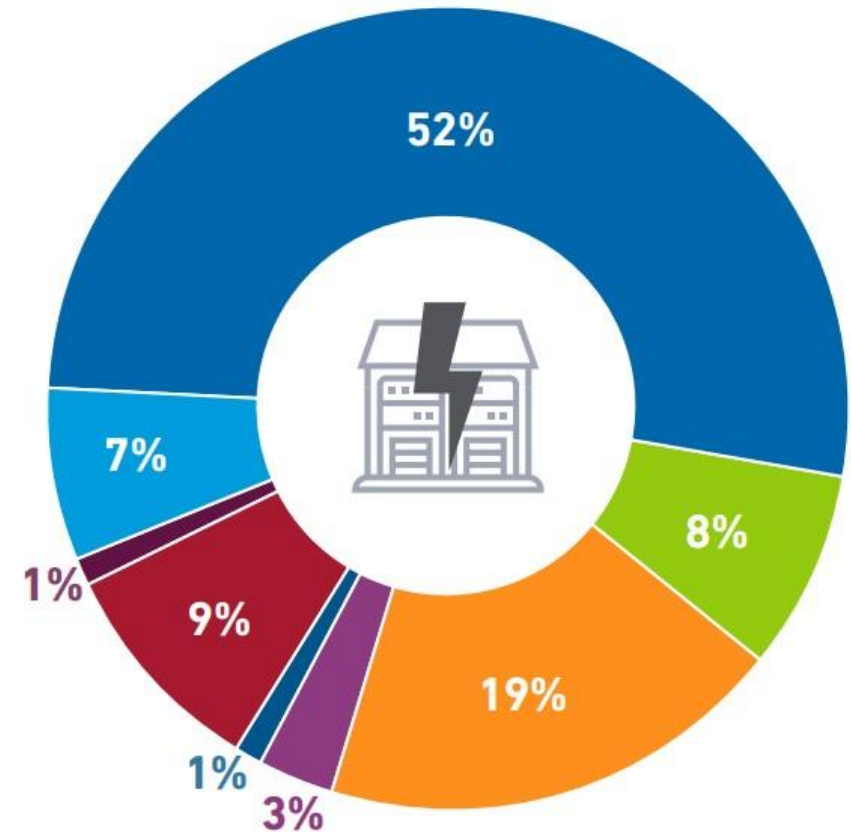
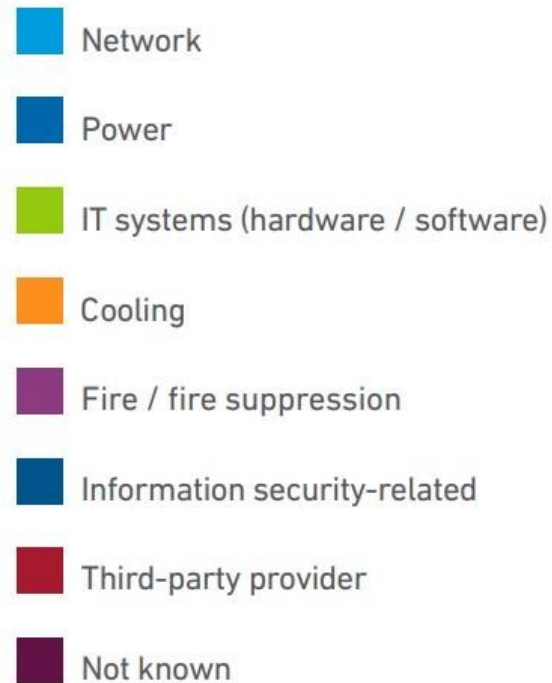


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Leading causes of significant outages

- Cooling failures can be tolerated for minutes rather than seconds
- Systems can be interdependent, resulting in cascading events that lead to outages

What was the primary cause of your organization's most recent impactful incident or outage? (n=108)

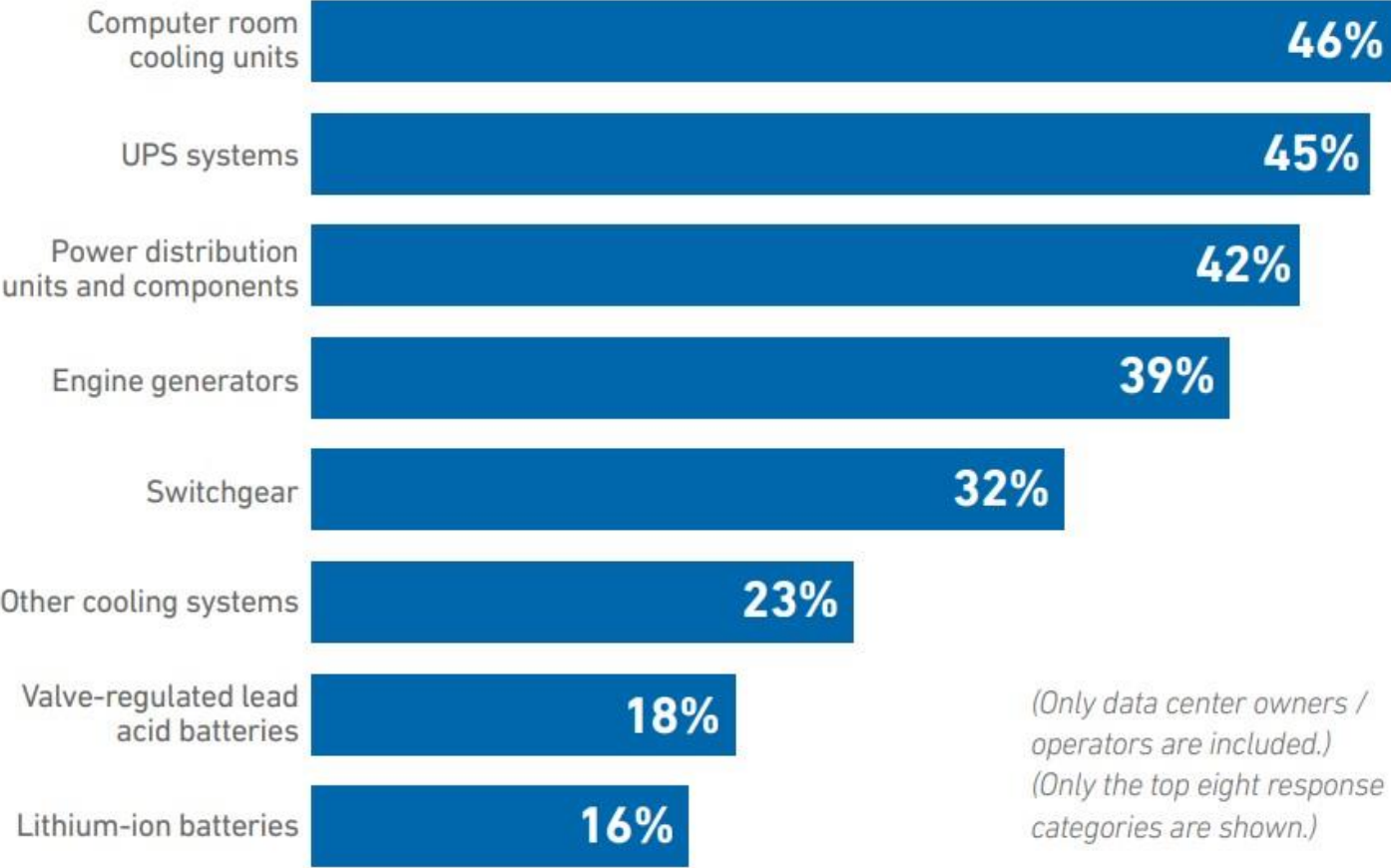


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Supply chain issues widely affect facilities hardware

In terms of data center facilities equipment, which of these have been most affected by your organization's supply chain disruptions? Choose all that apply (n=256).

- Supply chain issues complicate hardware replacements – especially for cooling units
- Failures can have prolonged effects for data center organizations and their customers

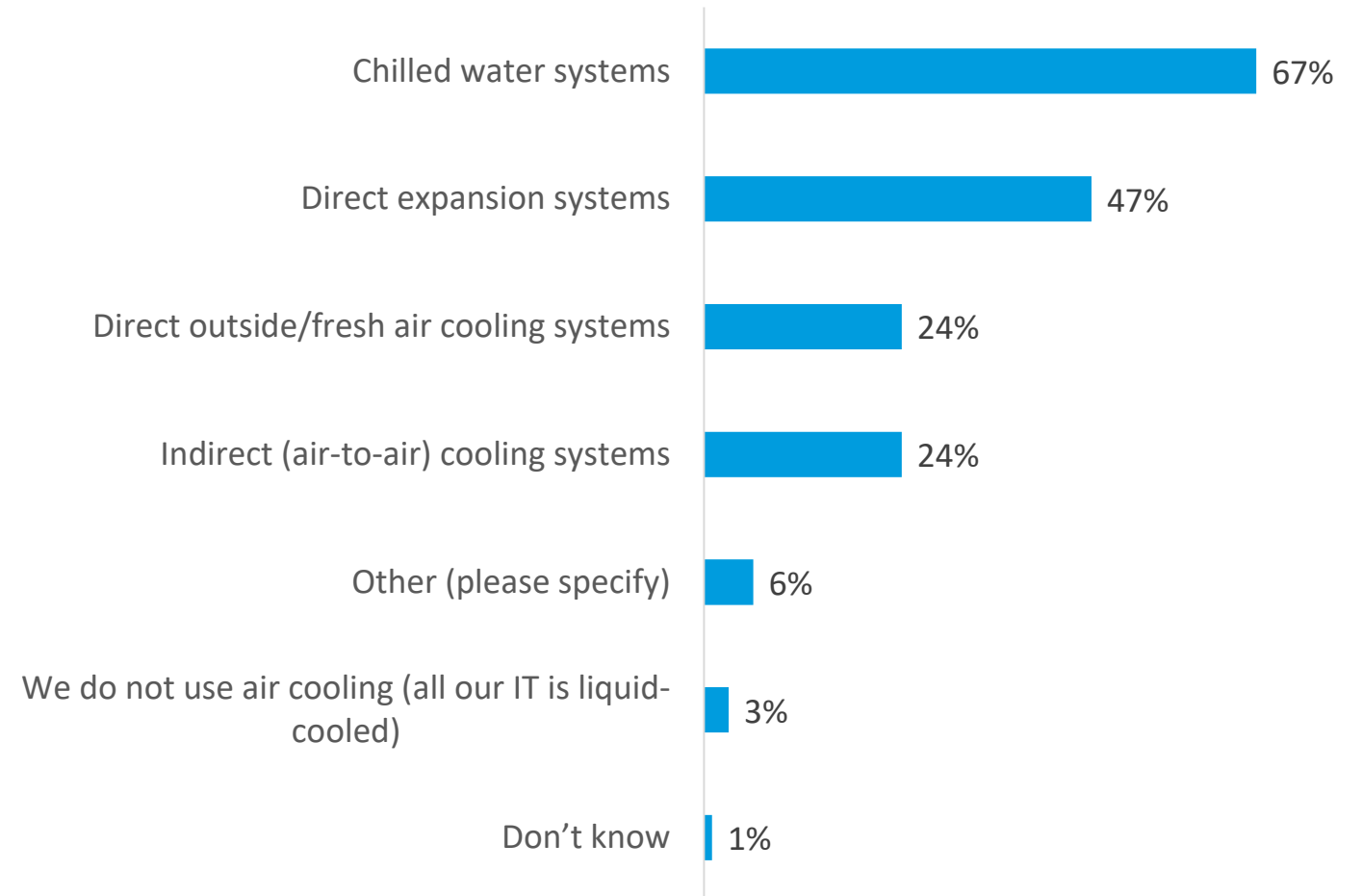


*(Only data center owners / operators are included.)
(Only the top eight response categories are shown.)*

Chilled water, DX systems lead air cooling approaches

- Air cooling approaches depend on site-specific factors
- Water-stress levels, outside air quality and local climates limit design choices

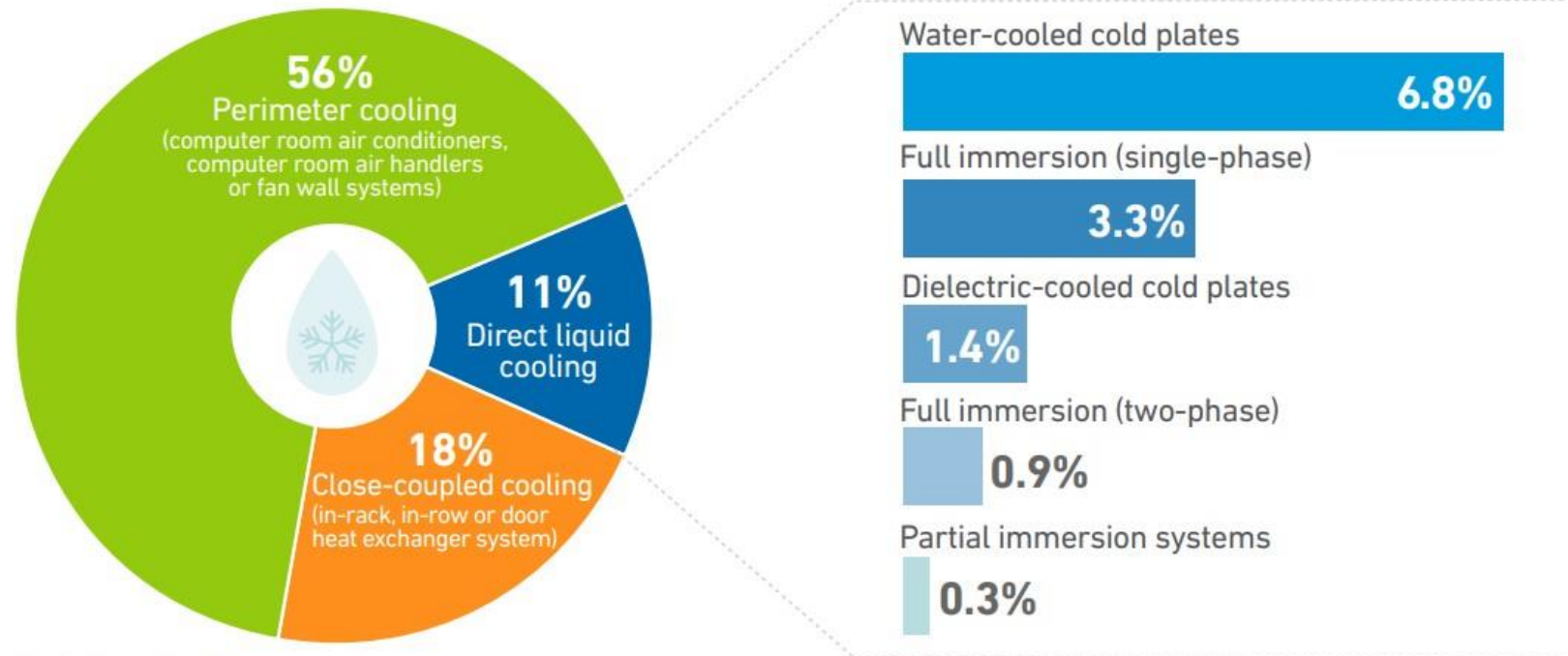
What type of air cooling approaches does your organization utilize for cooling the IT in its data center(s)? Choose all that apply. (n=488)



Even on the densest racks, perimeter cooling dominates

- DLC deployments will likely increase as the business case improves
- Higher energy prices for air cooled systems and economy-of-scale benefits will contribute to greater adoption

How do you currently cool your highest density cabinets? (n=572)



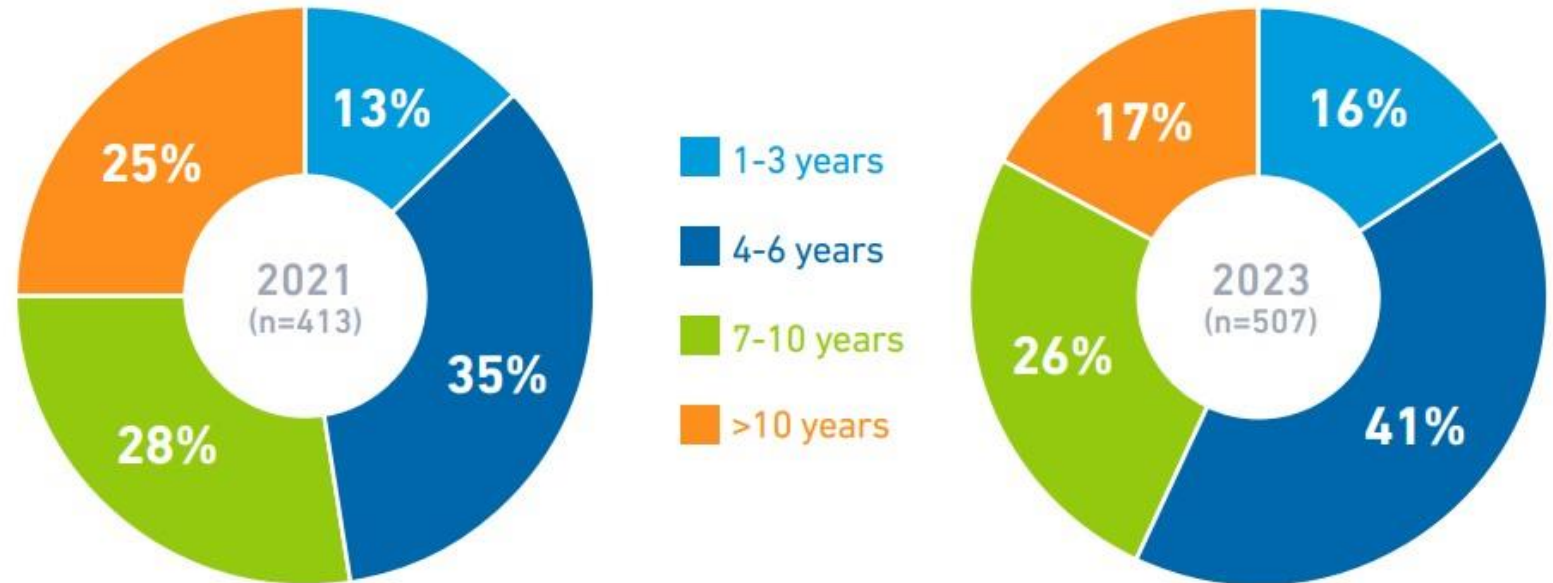
(All figures rounded.)

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Air cooling to remain the primary cooling approach for the near term

- More than 4/5 expect air cooling to remain dominant for at least 4-6 years
- This will likely shift with changing IT workload requirements and new, innovative cooling strategies

How long do you think air cooling will remain the primary approach for data centers 1 MW or greater?



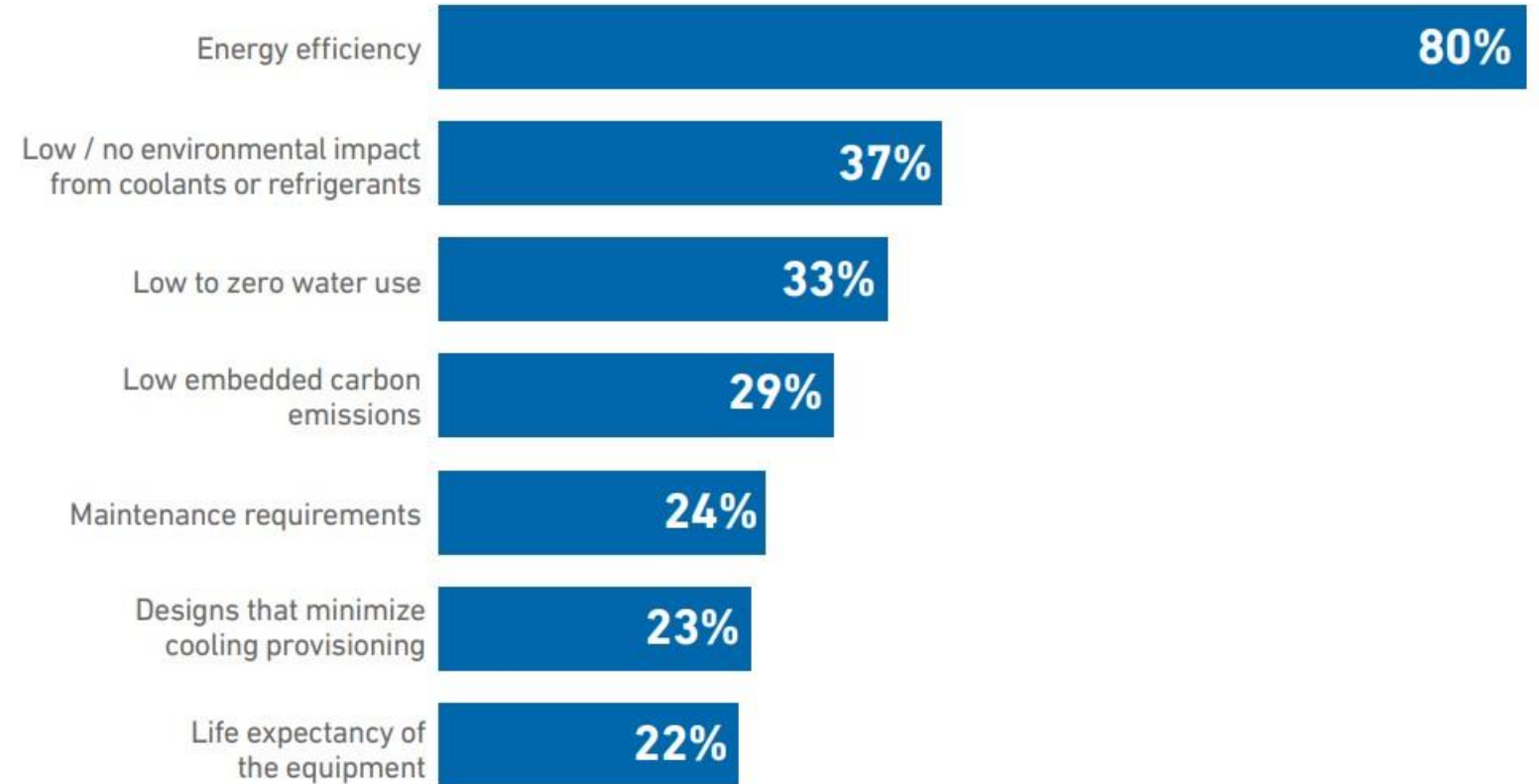
(All figures rounded.)

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Energy efficiency leads as sustainability factor for cooling

- Perceptions on cooling sustainability are most directly tied to energy use
- However, impacts from energy use can also be easier to quantify, and those from other sources may be understated

Which of these do you consider to be the most important factors in determining whether a cooling system is sustainable? Choose no more than two. (n=825)



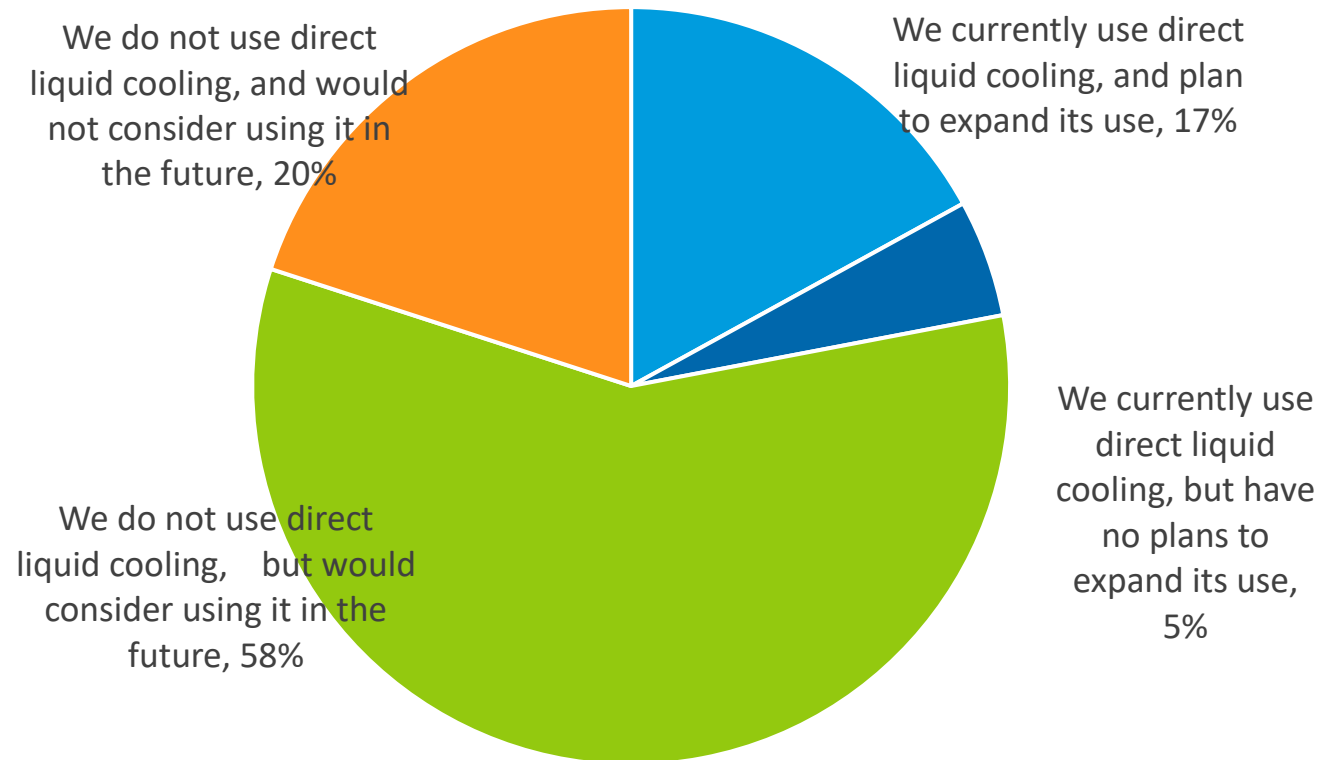
(Responses for "Don't know" are not included.)

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Most either use, or are considering DLC

- Those currently using DLC are more likely to expand its use
- 1/5 are not using or considering DLC – likely due to lower cooling requirements and higher cost concerns

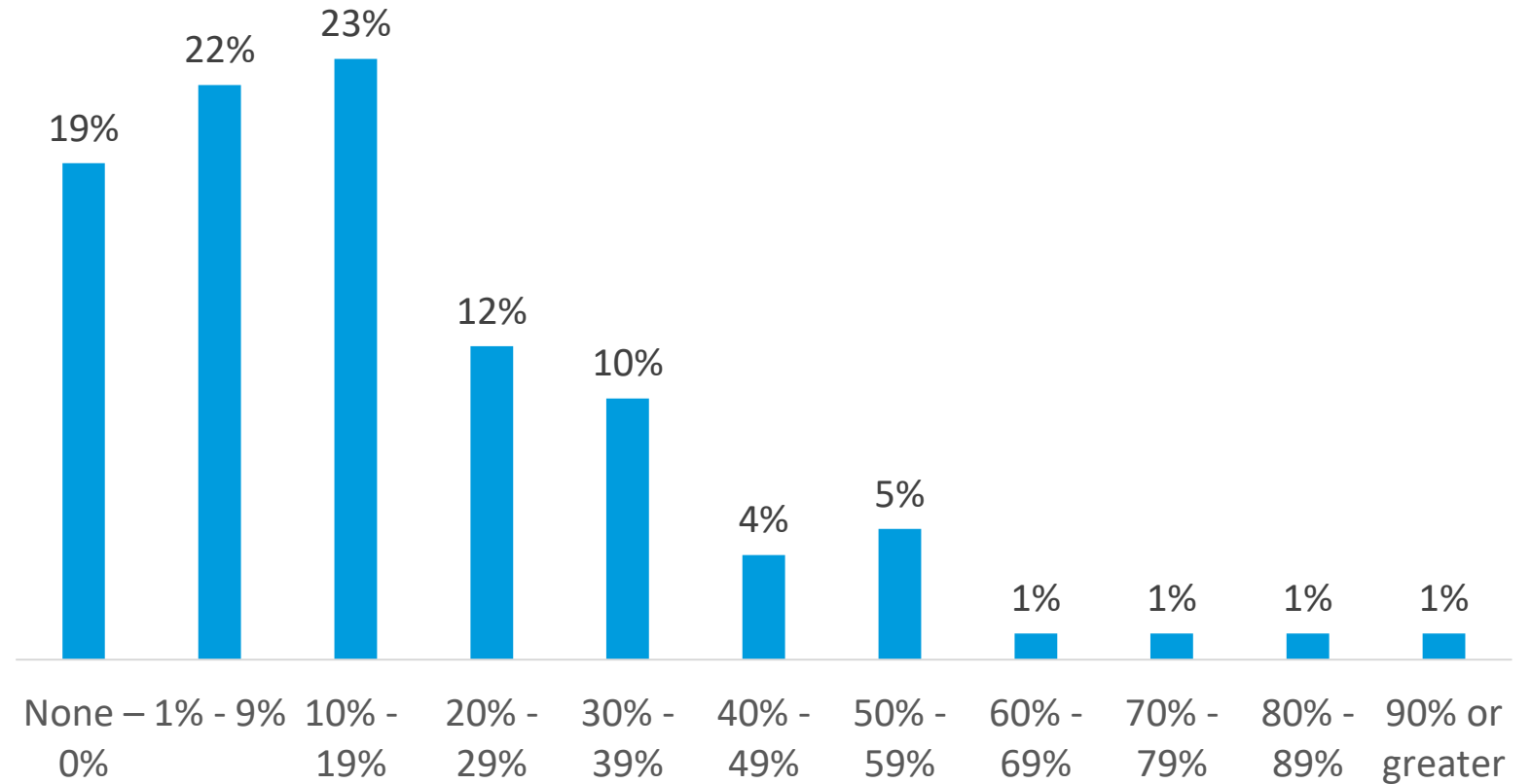
Do you currently use, or are you considering using, any direct liquid cooling technology in your owned data centers?
(n=433)



Most expect some DLC use in the next 3 – 5 years

- Less than 1/5 do not expect to use DLC in the near term
- More than 1/5 expect DLC to cover at least 30% of their IT racks within 5 years

Looking ahead three-to-five years, what percentage of your IT racks – if any – do you expect to incorporate direct liquid cooling? (n=183)

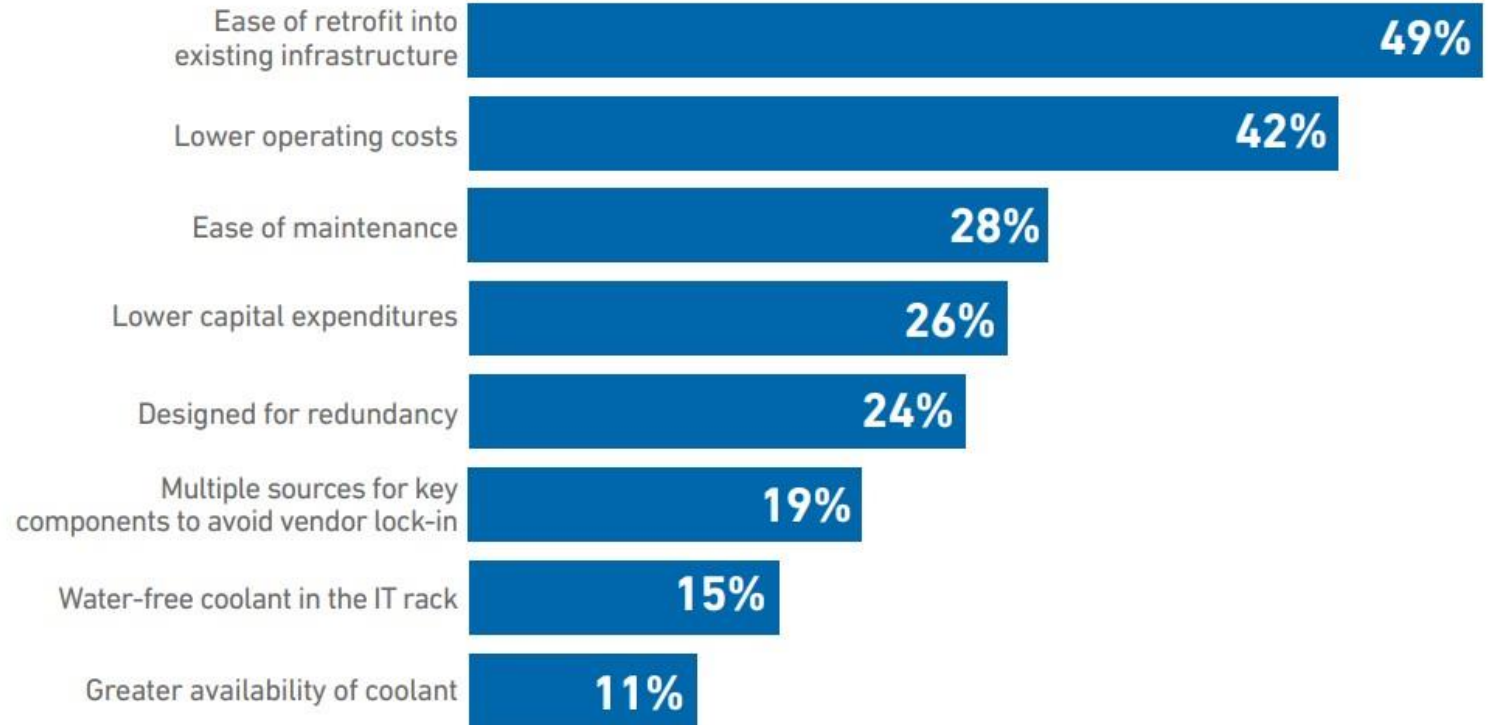


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Viability of DLC determined by ease of retrofitting

- Retrofit expenses often make DLC prohibitively expensive – especially for legacy facilities
- New sites designed with flexibility for different cooling approaches will likely deploy DLC for high-density racks

Which of these factors do you consider most important to determine whether a direct liquid cooling system is viable? Choose no more than two. (n=778)



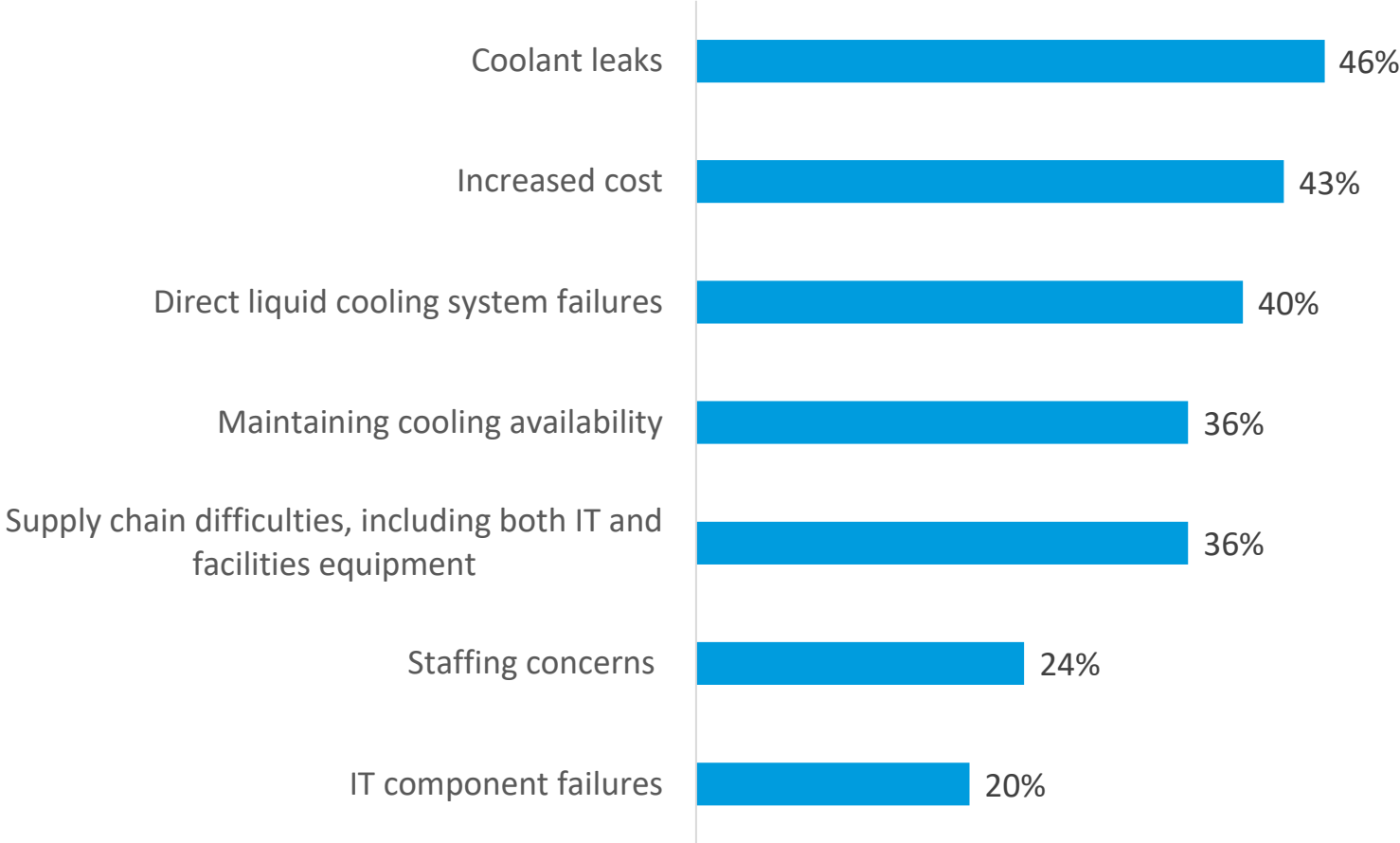
(Responses for "Don't know" and "Other" are not included.)

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Coolant leaks and costs cited as top barriers to DLC adoption

- Costs concerns are likely tied to retrofit expenses
- Existing users of DLC are less likely to have concerns around leaks (25% vs 46%)

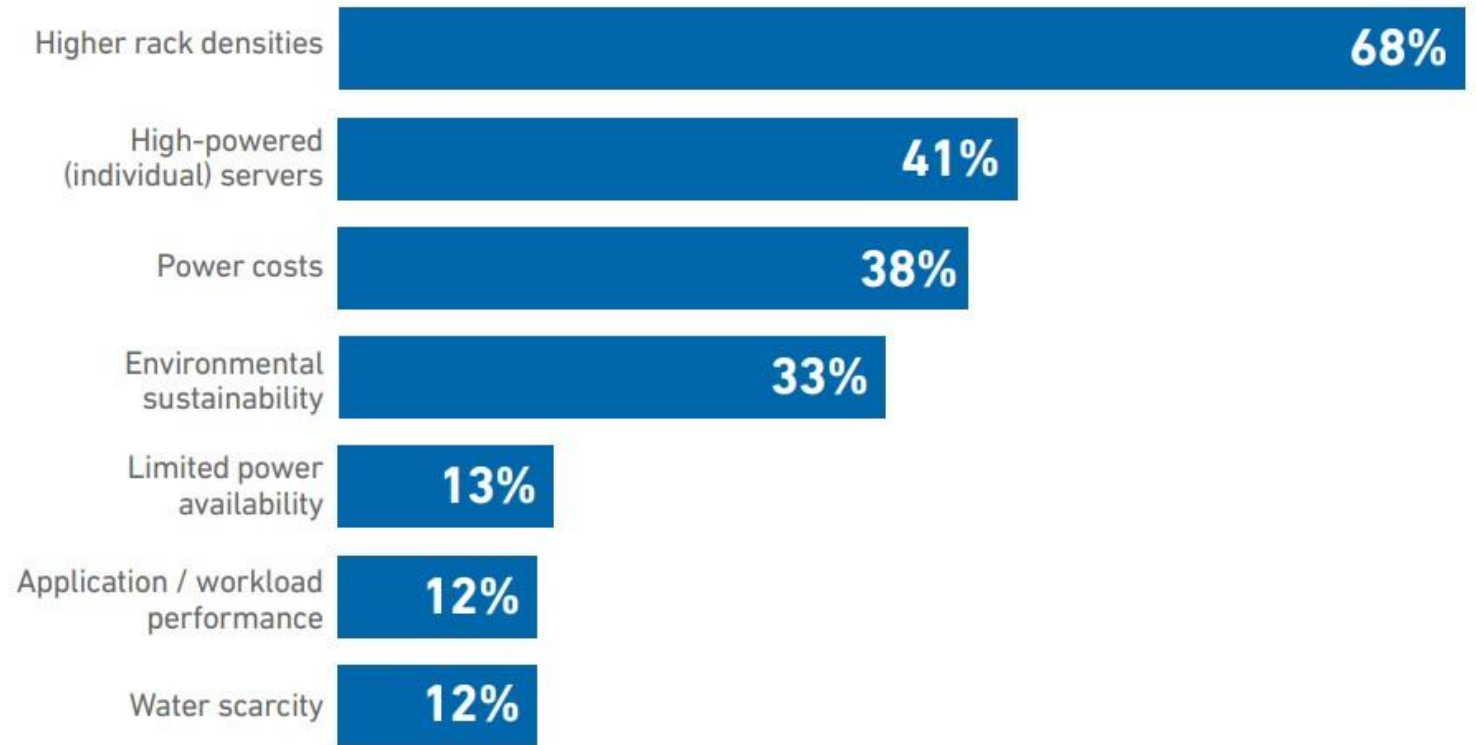
Which of the following does your organization consider major barriers in deploying direct liquid cooling for your owned data centers? Choose no more than three. (n=185)



Rising rack densities will drive DLC adoption

- Average rack densities are rising for most – but only slowly, and from a low base
- Widespread DLC adoption is less likely to occur in the near term

Which of these do you think are the primary drivers for direct liquid cooling adoption? Choose no more than two. (n=740)



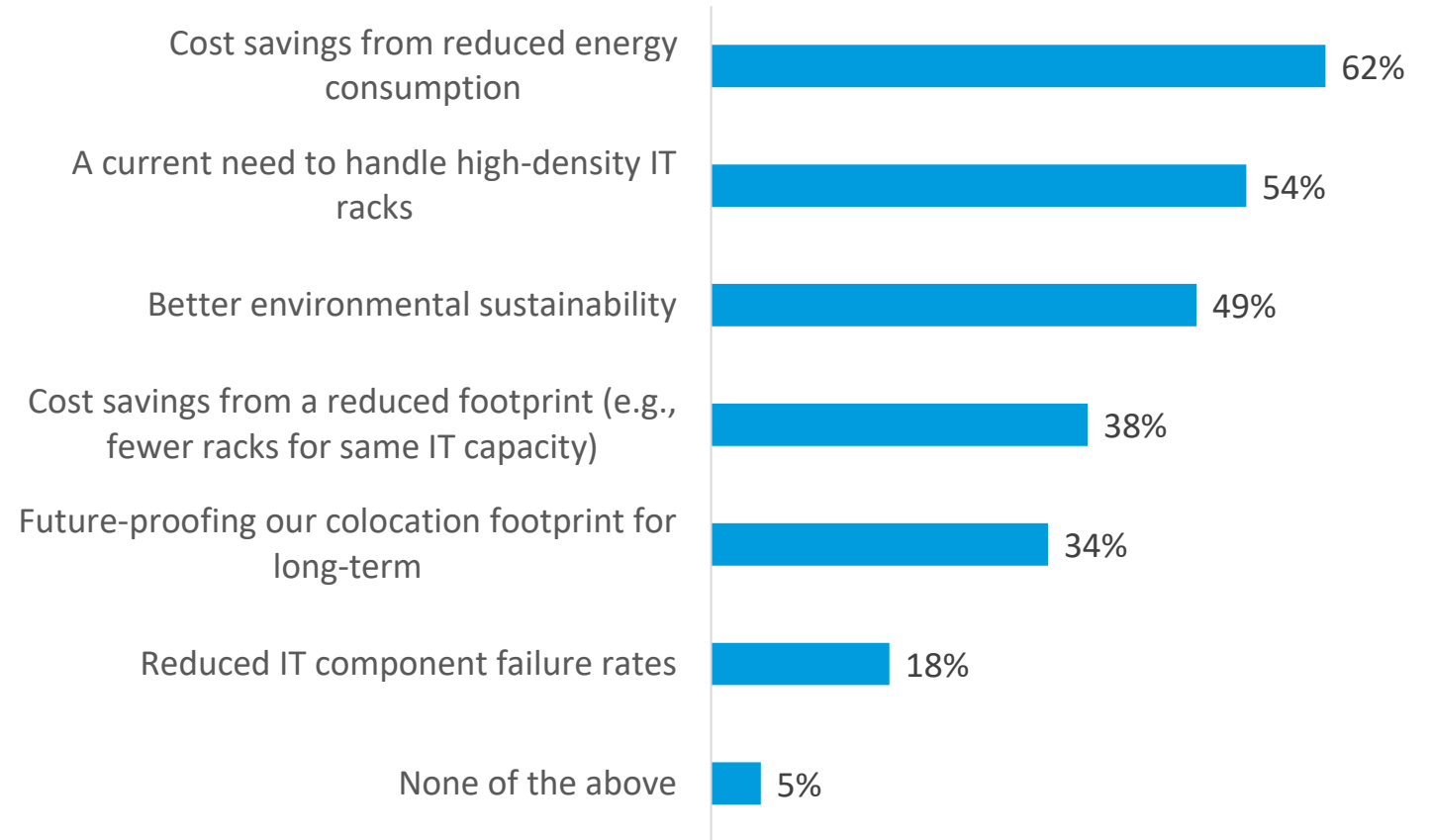
(Responses for "Other" are not included.)

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Cost savings and high-density IT requirements encourage DLC adoption

- Operating cost savings depend on energy markets
- The business case for DLC is stronger in regions with volatile energy prices and stressed power grids

Which of the following benefits would most likely convince your organization to increase the use of direct liquid cooling for your owned data center(s)? Choose all that apply. (n=188)

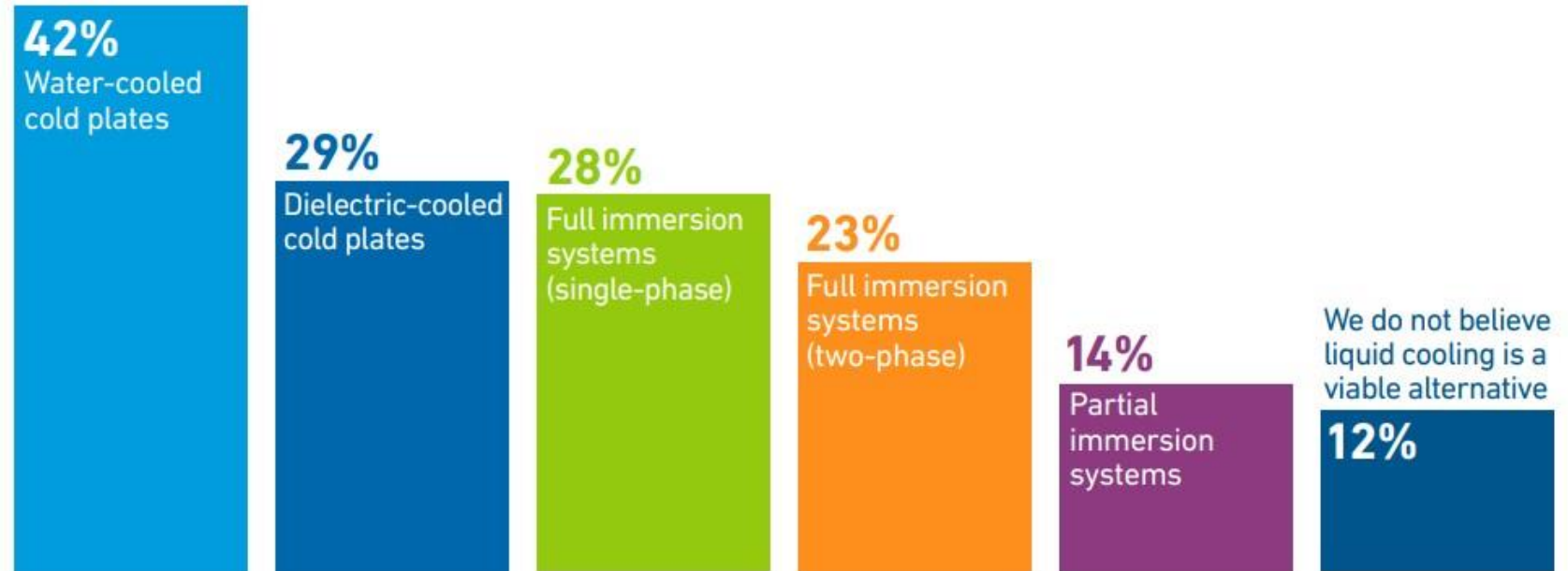


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Water-cooled cold plates viewed as most viable DLC approach

- Water-cooled cold plates are easier to adopt and require the less retrofitting
- This likely serves as a starting point for many organizations' greater adoption of DLC

Which of these direct liquid cooling techniques — if any — do you think are currently viable cooling approaches in data centers? Choose all that apply. (n=778)



(Responses for "Don't know" and "Other" are not included.)

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