SUMMARY NOTES

EEAP WEBINAR 27

Evaluating Resource Efficiency in Urban Energy Systems: Cooling Buildings and Data Centres

On June 5, 2026, the Energy Evaluation Asia Pacific (EEAP) organized its 27th webinar, focusing on the topic of "Evaluating Resource Efficiency in Urban Energy Systems: Cooling Buildings and Data Centres". The session featured presentations by:

- **Christian Allen E. Jimenez,** Research Assistant, Energy Studies Institute (ESI), National University of Singapore

- **Lalitha Ravi,** Research Associate, Energy Studies Institute (ESI), National University of Singapore

The webinar explored why cooling and data centres are becoming increasingly important for energy efficiency, carbon reduction, water security, and sustainable urban development across the Asia-Pacific region. The discussion showed that resource efficiency cannot be understood through energy savings alone. It also requires attention to thermal comfort, operational carbon, water use, governance, infrastructure design, and the wider trade-offs created by new technologies such as artificial intelligence.

The key focus of Christian's presentation was the challenge of cooling in tropical urban buildings. He explained why cooling is essential in hot and humid climates, but also why conventional cooling approaches can be inefficient and carbon intensive. He introduced practical strategies for rethinking cooling, including occupant-centreed comfort, higher temperature setpoints, decoupling sensible and latent loads, district cooling systems, intelligent controls, passive design, and the need to align cooling strategies with grid decarbonization.

Lalitha Ravi's presentation focused on the water implications of energy-efficient data centre design. She explained how the growth of AI and digital infrastructure is increasing data centre capacity, power density, heat loads, and cooling requirements. She emphasized that energy-efficient data centres are not automatically water-efficient, especially in hot and humid regions where evaporative cooling may reduce electricity use but increase water consumption. The presentation highlighted the need for better metrics, water-conscious design, reclaimed water use, cooling innovation, and governance frameworks that reflect local water stress and climate risks.

Overall, the webinar provided practical insights into how resource efficiency in urban energy systems should be evaluated as a systems challenge. It showed that credible evaluation needs to look beyond single indicators and consider multiple outcomes, including energy savings, emissions, comfort, affordability, water use, resilience, and policy relevance.

This document summarizes the key discussion points and takeaways from the webinar.

Webinar Agenda

Time (SGT)	Sessions/Speakers
11:00-11:05 AM	**Welcome Remarks & Context Setting** ***Edward Vine****, Affiliate, Lawrence Berkeley National Laboratory (LBNL) and Steering Committee Member, EEAP*
11:05-11:40 AM	**Presenters** ***1.*** **Christian Allen E. Jimenez,** Research Assistant, Energy Studies Institute (ESI), National University of Singapore Presentation Title: "*Rethinking Cooling: Reducing Operational Carbon in Urban Buildings"* ***2.*** **Lalitha Ravi,** Research Associate, Energy Studies Institute (ESI), National University of Singapore Presentation Title: "*Water Implications of Energy-Efficient Data Centre Design"*
11:40-11:55 AM	**Moderated Audience Q&A, *Edward Vine,***
12:00 PM	**Concluding Comments & Vote of thanks**

Introduction and Context Setting

Edward Vine, Affiliate, Lawrence Berkeley National Laboratory (LBNL) and Steering Committee Member, Energy Evaluation Asia Pacific (EEAP)

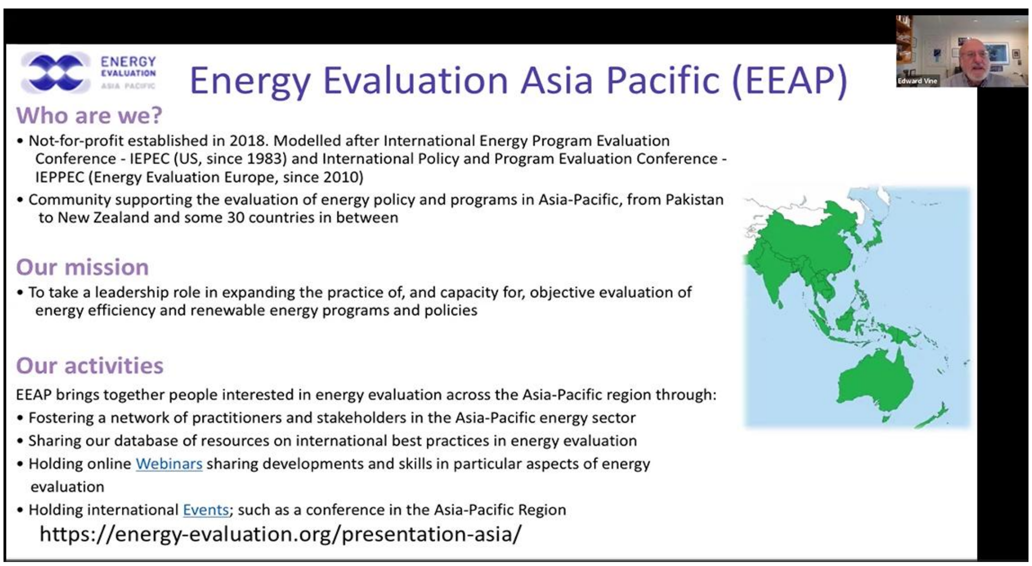
Ed greeted the participants and speakers, introduced EEAP and provided a context for the webinar.

Introduction to Energy Evaluation Asia Pacific (EEAP)

Ed greeted the participants and speakers, introduced EEAP, and provided the context for the webinar. He described EEAP as a community of practice specializing in energy evaluation across the Asia-Pacific region. Established as a non-profit organization in 2018 and modeled after similar evaluation communities in the United States and Europe, EEAP aims to expand the practice and capacity of objective evaluation in energy efficiency and renewable energy programs and policies.

He emphasized that EEAP supports learning and capacity building through webinars, conferences, workshops, resources, and engagement with diverse stakeholders, including governments, NGOs, research institutions, evaluators, and practitioners. He highlighted the role of evaluation in helping answer key questions such as which actions pay off, how programs and policies can be improved, and what approaches can be scaled up.

Ed also framed the webinar around the importance of evidence-based decision-making at a time of technological, environmental, and climate-related risks. He noted that evaluation can support the adoption and effective implementation of energy efficiency and renewable energy policies, foster behavioral change among stakeholders, and help identify wider economic and environmental benefits beyond energy savings.
He also announced EEAP's upcoming July webinar on multiple benefits and innovative evaluation methodologies, and highlighted EEAP's first virtual conference planned for October 2026. The introduction concluded with a tribute to Steve Wiel, recognizing his important contributions to energy efficiency, appliance standards, climate change mitigation, technical assistance, and international policy work.



"Rethinking Cooling: Reducing Operational Carbon in Urban Buildings"

Christian Allen E. Jimenez, Research Assistant, Energy Studies Institute (ESI), National University of Singapore

Christian Allen Jimenez began by explaining that cooling is not optional in tropical regions such as Southeast Asia. Hot and humid climates create year-round demand for cooling, both to maintain habitable indoor environments and to support productivity. He distinguished between sensible cooling, which deals with air temperature, and latent cooling, which deals with humidity. In tropical climates, the latent load is especially important and more difficult to remove than temperature alone.

He noted that cooling demand is also intensified by the urban heat island effect, where built materials and human activity increase outdoor temperatures. This creates a feedback loop: higher outdoor temperatures increase cooling demand, while cooling systems reject more heat into the surrounding environment. At the global level, space cooling is one of the fastest-growing sources of building electricity demand, driven by rising incomes, urbanization, and increasing air-conditioning ownership.

Using Singapore as an example, Christian explained that buildings account for a significant share of emissions, and cooling can represent 40 to 60 percent of building energy use. He then described a key inefficiency in conventional cooling systems: air is often overcooled to remove humidity and then reheated before being supplied to the occupied space. This approach uses extra energy and highlights the need to rethink how buildings provide both comfort and cooling.

A major theme of the presentation was that comfort should not be defined only by air temperature. Thermal comfort also depends on factors such as humidity, air movement, radiant temperature, clothing, and activity levels. Christian pointed to flexible and occupant-centreed comfort approaches, including Singapore's GO25 movement, which encourages indoor temperature setpoints of 25 degrees Celsius or higher, supported by air movement, relaxed dress codes, and better humidity control.

Christian then introduced several strategies for rethinking cooling. One approach is to decouple sensible and latent cooling so that different equipment handles temperature and humidity. A humidity control unit with a desiccant wheel can remove moisture, while condenser heat can help regenerate the desiccant without requiring additional energy. Once humidity is addressed separately, cooling systems do not need to overcool the air, reducing the need for reheat.
At the district level, he discussed district cooling systems to use economies of scale and combine cooling loads across different types of buildings. Examples from Singapore and Bangkok showed how district cooling can reduce energy consumption and carbon emissions. He also noted that district cooling is not limited to new developments; existing buildings can also be retrofitted and connected to district cooling networks.

Christian also highlighted intelligent and adaptive operations. Poor HVAC controls can waste large amounts of energy, for example when rooms are overcooled, meeting rooms are conditioned while empty, or doors are left open. Sensors, digital twins, and predictive controls can help cooling systems respond better to actual conditions and occupancy needs. Finally, he emphasized passive design and high-performance building envelopes, such as shading, insulation, orientation, natural ventilation, and reduced internal loads, as ways to reduce cooling demand before mechanical systems are even used.

The presentation concluded that sustainable cooling is a systems challenge. There is no single technology that can solve the problem. Instead, progress requires passive-first design, hybrid and efficient cooling systems, better controls, district-level solutions where appropriate, changes in comfort expectations, and grid decarbonization to move toward near-zero cooling pathways.

Key takeaways from the presentation:

- Thermal comfort should be evaluated through multiple factors, including humidity and air movement, not temperature alone.
- Occupant-centreed comfort, higher temperature setpoints, fans, and humidity control can reduce energy demand while maintaining comfort.
- Decoupling sensible and latent cooling, district cooling systems, digital controls, and passive design can significantly improve cooling efficiency.
- Sustainable cooling requires systems thinking and must be aligned with wider decarbonization of the electricity grid.

“Water Implications of Energy-Efficient Data Centre Design”

Lalitha Ravi, Research Associate, Energy Studies Institute (ESI), National University of Singapore

Lalitha Ravi began by explaining that digital tools, including AI systems such as ChatGPT, Gemini, and Claude, may feel intangible, but they depend on large physical infrastructure. Data centres operate continuously to provide computing power, and the servers inside them consume electricity, generate heat, and require thermal management systems to remove that heat.

She noted that AI adoption is expected to substantially increase global data centre capacity demand. AI workloads are becoming more power dense, with individual racks projected to require far more power than conventional CPU-based racks used only a few years ago. Since almost all the electricity consumed by IT equipment becomes heat, rising rack density creates major challenges for heat rejection and cooling.

Lalitha explained that data centre cooling can be understood at two levels: server-level cooling and building-level heat rejection. At the server level, fans or liquid cooling systems remove heat from equipment. At the building level, heat is rejected using air-cooled systems or evaporative cooling systems. Water becomes especially important when data centres use evaporative cooling, because water transfers heat more effectively than air and can help reduce cooling electricity demand.

However, this creates a critical trade-off for hot and humid regions. In colder climates, data centres may use naturally available cooling sources such as cold outdoor air or deep lake water. In much of Southeast Asia, there is limited opportunity for free cooling, so evaporative cooling may be used to manage energy demand. This can reduce power use but increase water consumption, meaning that energy efficiency does not automatically translate into water efficiency.

The presentation highlighted the scale of the issue. Cooling towers in data centres can account for a very large share of facility water use, and water usage effectiveness in the Asia-Pacific region can be much higher than global averages. Lalitha also explained that the data centre water footprint extends beyond on-site water use. It includes embedded water associated with electricity generation and semiconductor manufacturing. On-site water consumption is projected to become an increasingly important part of the overall data centre water footprint as power density and cooling loads rise.

Lalitha then discussed key metrics. Power Usage Effectiveness (PUE) measures how efficiently a data centre uses power, while Water Usage Effectiveness (WUE) measures how much water is used per unit of IT energy. She emphasized two important points: a data centre with low PUE can still have high water use, and WUE alone is incomplete because it does not show what type of water is being used, whether the water comes from potable, reclaimed, recycled, or rainwater sources, or whether the facility is located in a water-stressed area.

The presentation also reviewed evolving cooling strategies. Liquid cooling can remove heat more efficiently at the server level and includes approaches such as direct-to-chip liquid cooling and immersion cooling. However, Lalitha stressed that liquid cooling does not automatically eliminate water consumption because the building-level heat rejection system still determines whether water is used. Reducing water use therefore requires attention to the whole system, including reclaimed or recycled water supplies, heat export to third-party networks, alternative cooling sources, and site selection based on water risk and climate vulnerability.

Lalitha also discussed the governance of importance of data centre water use in the Asia-Pacific region. A large share of projected data centre water consumption by 2030 is expected to be in Asia-Pacific countries. She used the example of Johor, Malaysia, where rapid planned data centre growth has raised concerns about water stress and competition with domestic and agricultural water needs. She also highlighted Singapore's approach, including tropical data centre standards, a green data centre roadmap, tighter approvals, annual water-use tracking for larger facilities, and funding support for efficiency upgrades and water recycling.

The presentation concluded that smart data centre design is not a single technical fix. It depends on engineering choices, governance, local climate, grid mix, water availability, and the wider resource context. Data centres must therefore be evaluated not only on energy efficiency, but also on water efficiency, resilience, local resource impacts, and responsible digital growth.

Key takeaways from the presentation:

- Energy-efficient data centres are not always water-efficient, especially in hot and humid regions that rely on evaporative cooling.
- PUE and WUE are useful but incomplete metrics unless they are interpreted alongside water source, local water stress, climate risk, and facility design.
- Liquid cooling can improve server-level heat removal, but it does not eliminate water consumption if the building-level heat rejection system still uses water.
- Data centre governance in Asia-Pacific needs to integrate energy efficiency, water security, siting decisions, reclaimed water use, and climate vulnerability.

Moderated Audience Q&A

The Q&A session was moderated by Edward Vine and focused on evaluation, governance, incentives, cooling controls, district cooling, desalination, data centre water use, and responsible AI use.

- **Evaluation of the GO25 movement:** In response to a question from Ed, Christian noted that GO25 is a voluntary national movement and that there is not yet a dedicated body evaluating its effectiveness. He observed that growing company participation may nonetheless increase visibility and interest in accountability over time.

- **District cooling governance and applicability:** Christian explained that district cooling systems in Singapore involve studies and simulations before implementation because they require significant investment. He noted that district cooling is most appropriate in dense mixed-use areas with varied cooling demand, and that Singapore is promoting adoption where the conditions are suitable. He also mentioned the role of the Urban Redevelopment Authority (URA), Housing Development Board (HDB), and the Energy Market Authority (EMA) in supporting district cooling implementation.

- **HVAC controls and split incentives:** The discussion highlighted that building owners may own HVAC equipment while occupants pay utility bills, creating a potential split incentive. Christian explained that Singapore's Green Mark certification gives building owners a commercial motivation to improve energy performance, as certified buildings tend to be more attractive to tenants and investors, and government procurement favours higher-rated buildings. However, Green Mark addresses owner motivation rather than the split incentive itself; the more targeted mechanism for that is the green lease, which creates shared obligations and benefits between owners and tenants.

- **Desalination, reclaimed water, and data centres:** Lalitha explained that Singapore data centres generally rely on NEWater, Singapore's reclaimed water, for cooling wherever possible, rather than depending mainly on potable water. She noted that desalination is also part of Singapore's national water supply strategy, but it is energy-intensive and must be carefully treated before use in cooling systems to avoid scaling, corrosion, fouling, and other operational risks. Her main point was that the water source matters using reclaimed or alternative water can reduce pressure on potable water supplies, but the water quality, treatment needs, energy impact, and cooling-system reliability must be considered together.

- **Policy oversight and institutional responsibilities:** The speakers explained that water-related matters in Singapore are mainly overseen by PUB, Singapore's National Water Agency, including water supply, discharge, and water-efficiency requirements. For data centres, she highlighted that water use is also connected to broader sustainability governance. IMDA and EDB manage data-centre capacity allocation through the Data Centre Call for Application process, while BCA and IMDA assess facilities through the Green Mark for Data Centres scheme. Lalitha also mentioned that large water users, including relevant data centres, are required to track water consumption, submit annual water-use details, business activity indicators, and water-efficiency plans under water-efficiency management requirements. Support mechanisms such as the Water Efficiency Fund, benchmarking, and the Green Data Centre Roadmap help push operators toward better water and energy performance.

- **Responsible AI use:** In response to a question, Lalitha explained that AI is not "weightless" because every AI query relies on physical infrastructure such as servers, power systems, and cooling systems. Since data-centre growth increases both electricity and cooling demand, she encouraged users to be more conscious about how they use AI. Her point was not to avoid AI completely, but to use it responsibly and meaningfully, especially by reducing unnecessary or purely recreational use where possible. Responsible AI use should consider not only digital convenience, but also the real energy, heat, and water footprint behind the technology.

Presenters' Bio

Christian Allen E. Jimenez,
Research Assistant, Energy Studies Institute (ESI), National University of Singapore

Christian joined the Energy Studies Institute in July 2023 as a research assistant, where he supports carbon accounting efforts in the construction sector and contributes to the District Cooling System project. He has also worked on developing emission factors for building systems and cloud infrastructure. He holds a bachelor's degree in mechanical engineering from De La Salle University in Manila, Philippines. Prior to this, he worked as an HVAC designer, focusing on hotels and other recreational developments.

Lalitha Ravi,

Research Associate, Energy Studies Institute (ESI), National University of Singapore

Lalitha Ravi is a Research Associate at the Energy Studies Institute (ESI), National University of Singapore. Her work focuses on the application of Artificial Intelligence and Machine Learning to energy research, including the efficiency and sustainability of data centres. She recently co-developed a cloud emission factor calculator, featured in the Singapore Energy Future Report (SEFR). She holds a Master of Computing in Artificial Intelligence from NUS and previously worked as an Engineer at Oracle.