Webinar 13 Highlights

Cool Decarbonization Pathways in Asia and the Pacific: Integrating Cold and Cryogenic Storage, Logistics Innovation, and Clean Cooling Technologies

ADB Energy Sector Emerging Areas Knowledge Sharing Series
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Background

As developing countries in Asia and the Pacific work to meet rising demand for cooling, manage peak loads, and reduce emissions, innovative cold-energy technologies become increasingly vital for supporting reliable, efficient, and low-carbon energy systems. Clean cooling, cryogenic solutions, and long-duration cold and thermal energy storage offer new opportunities to improve grid performance, optimize industrial processes, and decarbonize logistics.

This webinar showcased three emerging technologies with strong potential for application across ADB's developing member countries (DMCs): NTU's Cold Battery/ColdBox system, CarnotFleet's mobile cold-chain decarbonization platform, and Sumitomo SHI FW's Liquid Air Energy Storage (LAES) technology. The session highlighted how these innovations support peak-load shifting, utilize waste cold, reduce diesel consumption, strengthen system reliability, and improve energy efficiency across sectors.

The webinar was moderated by Darren Yong from Baringa. Dr. Cindy Tiangco, Director, Energy Sector Office (Emerging Areas), ADB, delivered the opening remarks, underscoring the importance of accelerating clean cooling solutions to enable sustainable and resilient energy transitions across the region.

Presentation 1: Cold Thermal Energy Storage and the ColdBox

Speaker: Alessandro Romagnoli, Professor, Nanyang Technological University (NTU)

Key Highlights

1. **Utilization of Cold Energy from LNG:** presented the potential for waste cold recovery from liquefied natural gas re-gasification which brings a lot of savings in terms of

electricity and CO_2 footprint. NTU is studying options for transportable cold energy storage for end users where proximity to the terminal or co-location is not an option.

2. **Cold Energy Battery Analogy**: Best features of various existing storage technologies–chilled water storage, ice storage, lithium-ion battery, current phase change materials (PCM) storage - are merged, and cold box is developed with use of low cost sustainable materials that can store cold over long periods of time and spanning wide range of applications ranging from temperatures 5°C to -116°C.
3. **Peak-Load Management**: Conducted a peak-load shifting study with Malaysia's largest district cooling provider, which demonstrated that using waste cold from LNG regasification can reduce cooling-related energy costs by 50%–60%. The analysis shows that cold-battery systems are particularly effective where there is a significant day–night electricity price differential: the battery stores cold energy during low-tariff nighttime periods and discharges it during daytime peak hours, lowering operating costs while relieving stress on the grid.
4. **Cross-Sector Applications**: Demonstrated benefits for various end users – freezing, refrigeration applications, district cooling systems, food and pharmaceutical processing, and wafer fabrication.

Conclusion / Way Forward

The Cold Battery system offers a high-impact pathway for DMCs to utilize waste cold resources, stabilize cooling loads, and reduce energy consumption, supporting progress toward decarbonization and enhanced energy security.

Presentation 2: Leveraging LAES for Grid Stability and Flexibility

Speaker: Eric Culkin, Sumitomo SHI FW

Key Highlights

1. **LAES Technology**: Presented Liquid Air Energy Storage as a thermo-mechanical long-duration energy storage (LDES) system capable of providing hundred of megawatts capacity at 8 hours or more of firm, dispatchable power. LAES is significant in light of the multifaceted challenges in energy transition affecting both generation and transmission networks, e.g. increasing amounts of inverters, intermittent renewable generation, and power transmission issues.
2. **Grid Stability, Energy Security and Flexibility**: LAES is built around synchronous generation and synchronous charging machinery; storage provide power when it is needed thereby enhancing energy security; smaller footprint and energy density on a per sqm basis compared with lithium-ion batteries; locationally flexible and no geographical constraints.

3. **LAES Adoption in Asia:** 3 driving forces identified - increasing renewable energy generation, needed synchronous generation support for grid stability, and island grids requiring high reliability and stable cooling loads.
4. **Scalable Industrial Applications**: low cryogenic temperatures in industrial hubs, data centers, and urban grids
5. **Suitability for DMCs**: Identified strong opportunities for markets facing increasing renewable penetration, rising peak demand, and the need for long-duration storage options, e.g. Japan, Singapore and Thailand.

Conclusion / Way Forward

Sumitomo's LAES is currently in demonstration stage, a 20 MWh commercial storage plant in Hiroshima and synchronized to the grid in October 2025. It is jointly developed by Sumitomo Heavy Industries and Hiroshima Gas Co., Ltd. The technology is designed to deliver holistic solution, accounting for energy balancing and grid performance with 30+ years lifetime.

Presentation 3: Building Instant, Safe, and Affordable Means of Cold Chain

Speaker: Arvind Chandaka, CarnotFleet

Key Highlights

1. **Cold Chain Innovation Overview**: Introduced a plug and play cold chain solutions that decarbonizes temperature-controlled logistics through high-efficiency refrigeration in production, storage and distribution of perishable goods. Highlighted strong applications for food distribution, pharmaceuticals, and essential goods where reliable cold-chain operation remained critical.
2. **Challenges**: Perishable goods experience high loss rates—about 24% globally and up to 40% in Southeast Asia—largely due to inadequate cold-chain systems and human error. Cold-chain operations also cost 1.5–2 times more, and human-error losses can be 2–3 times higher than in non-refrigerated supply chains.
3. **Decarbonization and Emissions Reduction**: Achieved through efficient Plug&Play technologies (maximizing heat transfer, minimizing heat loss), adopting cloud-based system (combination of firmware, connectivity, apps, web services) for data & analytics and cold chain monitoring of the total lifecycle, significantly reduced diesel use in cold-chain transport.
4. **Digital Optimization**: Enabled remote management, route optimization, and temperature integrity monitoring, improving both efficiency and reliability.
5. **Regional Relevance of the Technology**: Positioned as a practical decarbonization tool for Asia's rapidly growing cold-chain networks – perfect solution to the region's context, especially in relation to heat and humidity, high traffic situation in the countries, not a

lot of investments into cold storage especially in the warehousing space, less capital as compared to the EU countries, not much land availability.

Conclusion / Way Forward

CarnotFleet's technology provided an immediate, scalable opportunity for DMCs to lower emissions in cold-chain logistics while supporting food security, health systems, and resilient supply chains.

Panel Discussion

Panelists emphasized the importance of integrating cold-energy storage, clean cooling systems, and LDES technologies to meet rising cooling needs while managing growing grid constraints. They discussed opportunities for coupling waste-cold recovery with renewable integration, improving industrial energy efficiency, and enabling low-carbon logistics.

In terms of barriers, panelists have identified the following barriers to LDS / LAES adoption:

- *No explicit market value for grid-stability services:* Traditional generators inherently provide inertia and stability, but these services are not recognized or compensated in most markets; and as grids shift to variable renewables, the lack of formal valuation limits incentives for technologies like LAES that can supply these services.
- *Limited recognition of long-duration storage (LDS) needs:* i) Many markets have not yet formally acknowledged the system-wide need for LDS. Ii) Procurement mechanisms for long-duration storage are still emerging, with only a few leaders (e.g., Australia, parts of North America).
- *Absence of targeted procurement frameworks:* ISOs/TSOs (independent / transmission system operators) and utilities often lack dedicated tenders or mandates for LDS, slowing technology uptake. Without clear procurement signals, developers face uncertainty and cannot move projects forward.
- *Long infrastructure development timelines:* LAES projects require significant planning, permitting, and capital investment. Early action is needed; waiting until grid reliability issues emerge will be too late to deploy solutions in time.
- LAES and LDS adoption is hindered by unclear market valuation for grid services, lack of targeted long-duration storage procurement, retrofit challenges in LNG terminals, and end-user hesitancy driven by unfamiliarity and demand for fast, robust financial returns.

Panelists highlighted the critical role that governments play in supporting cold-energy storage by prioritizing food security and building enabling cold-chain infrastructures. MDBs and banks also play a crucial role in financing and promoting these capital-intensive systems across the DMCs while encouraging cross-sector partnerships with academia, SMEs, utilities, and industry.

Conclusion / Way Forward

The session demonstrated that cold-energy storage, cryogenic technologies, and clean cooling systems can jointly support developing countries in improving energy efficiency, reducing fossil-fuel dependence, and enhancing energy system resilience. These innovations offer scalable pathways for ADB DMCs to address rising cooling demand, support industrial competitiveness, and achieve national climate and decarbonization goals. Opportunities for regional collaboration, financing, technology transfer, and pilot deployment will be essential to accelerate adoption across Asia and the Pacific.