Next-Generation Energy Technologies – The Role of Battery Energy Storage Systems (BESS) for Net Zero Carbon Concept

By
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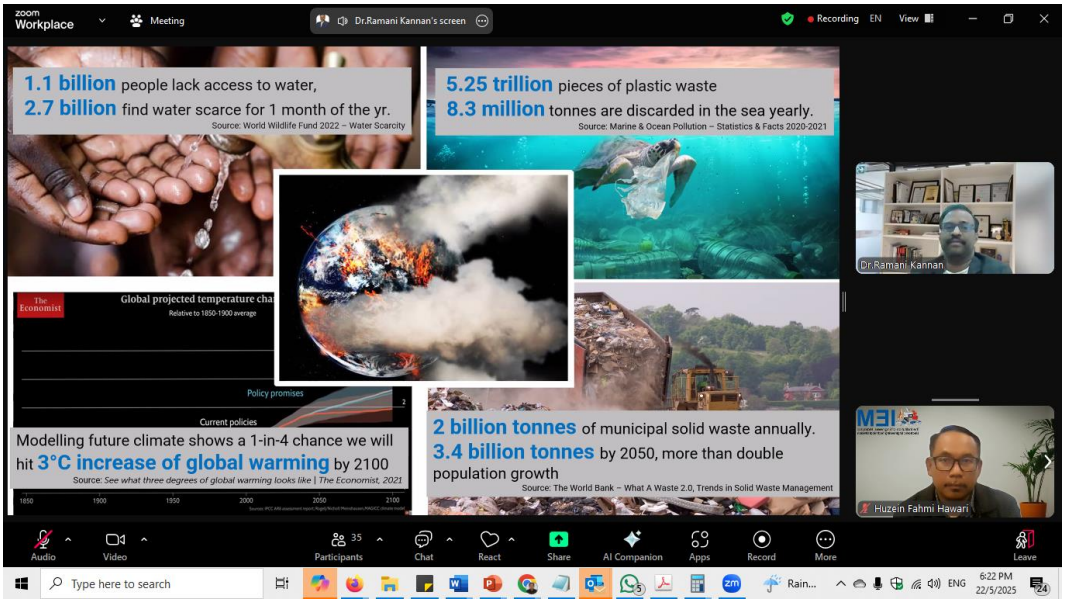
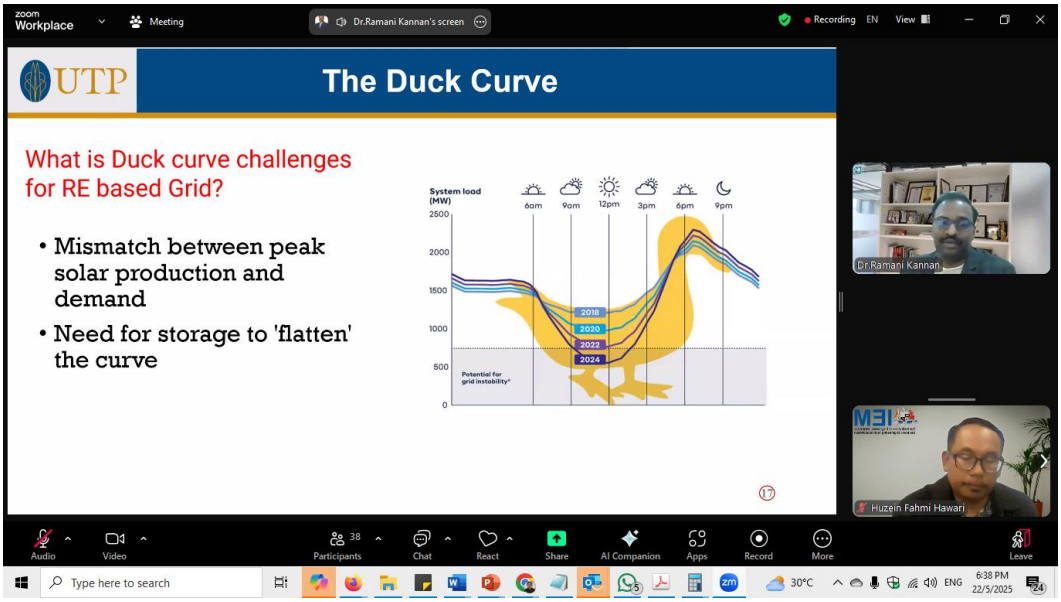
He is the eETD chairman for 2024/2025.

On 22nd May 2025, the Electronic Engineering Technical Division (eETD) of The Institution of Engineers, Malaysia (IEM), Penang Branch successfully organised an online technical talk titled *"Next-Generation Energy Technologies: The Role of Battery Energy Storage Systems (BESS) for Net Zero Carbon Concept."* The session was held via Zoom from 6:00 PM to 8:00 PM and was moderated by Ir. Dr. Huzein Fahmi. The speaker, Ts. Assoc. Prof. Dr. Ramani Kannan, an expert in power electronics, renewable energy, and battery management systems from Universiti Teknologi PETRONAS (UTP), delivered a comprehensive and insightful presentation to a group of 37 registered participants.

Dr. Ramani began the session by addressing the global urgency of achieving net zero carbon emissions. He highlighted that while renewable energy sources like solar and wind are essential to this transition, their intermittency presents significant challenges. He introduced the concept of the "duck curve" to illustrate the mismatch between peak renewable energy production and electricity demand, emphasizing how Battery Energy Storage Systems (BESS) play a critical role in addressing this issue by storing excess energy for use during peak demand periods.

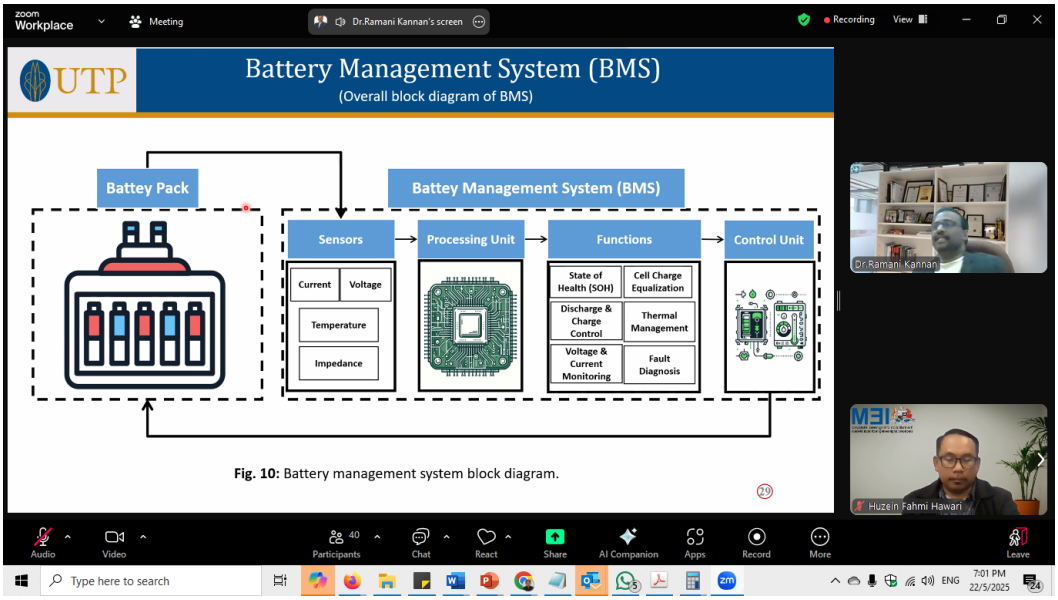


Background of global environmental crisis



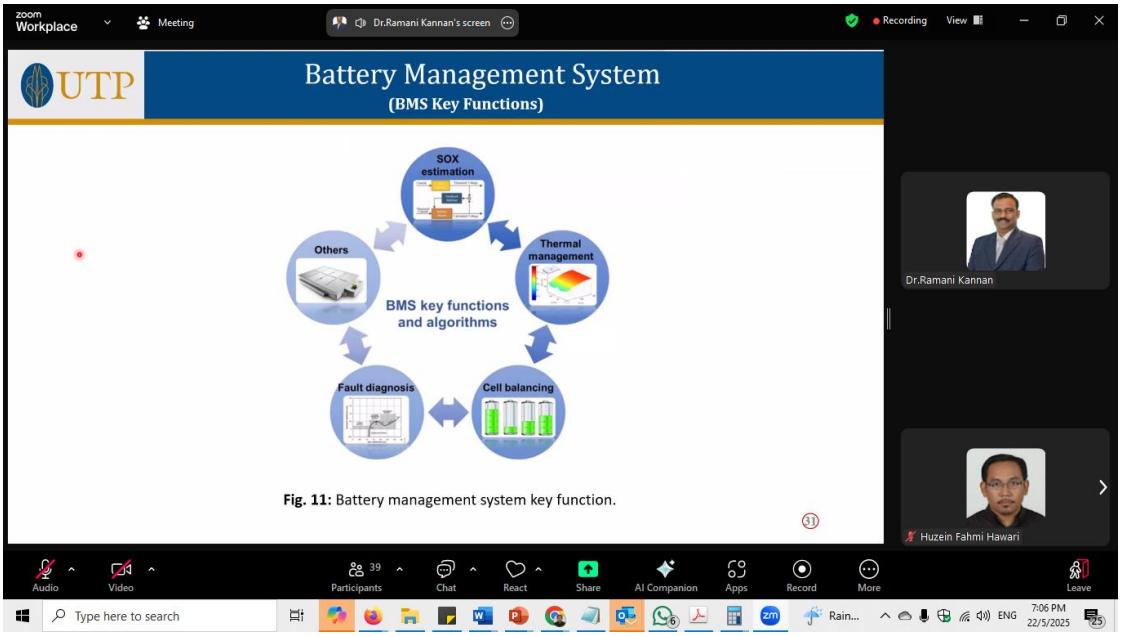
The speaker sharing on 'Duck Curve'

The speaker then elaborated on the architecture and components of BESS, which include battery modules, power conversion systems (PCS), energy management systems (EMS), and integrated cooling and safety mechanisms. He discussed various types of battery technologies, such as lithium-ion, lithium iron phosphate, sodium-ion, and flow batteries, and their roles in stabilising grid operations, supporting voltage and frequency control, and enhancing power quality. These technologies are increasingly essential for grid reliability and the large-scale integration of renewable energy.



Block diagram of Battery Management System (BMS)

A significant portion of the presentation was dedicated to Battery Management Systems (BMS), where Dr. Ramani explained key functions including State of Charge (SoC), State of Health (SoH), charge/discharge control, thermal management, fault detection, and cell balancing. He emphasised that intelligent BMS platforms are crucial to extending battery lifespan, ensuring operational safety, and maintaining system efficiency.

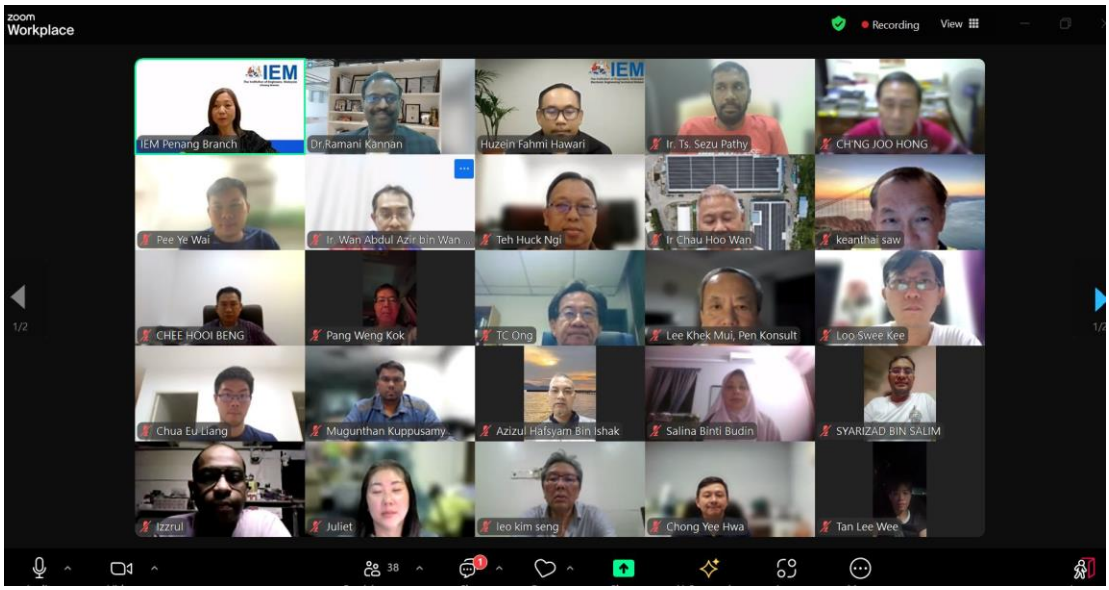


Key function of Battery Management System

In addition, Dr. Ramani shared insights into emerging trends and future directions in energy storage. He introduced his ongoing research at UTP's RAISE Lab, which includes the application of artificial intelligence (AI) and machine learning for predictive health diagnostics of battery systems, cloud-based fault diagnosis, and the integration of BESS into smart grid and electric vehicle ecosystems. Real-world examples of large-scale BESS deployments from across

the globe, such as those in China, India, and Australia, were presented to underscore the scalability and growing impact of energy storage technologies.

The session concluded with an interactive Q&A session, where participants posed thoughtful questions related to technical, economic, and implementation challenges of BESS. The event wrapped up with a virtual group photo, marking the successful conclusion of an enlightening and technically rich session. Overall, the talk provided valuable knowledge on the evolving role of BESS in achieving a carbon-neutral future and inspired engineers to play an active role in the energy transition.



Group photo of the speaker and some of the participants