Influence of Eco-Innovation and Artificial Intelligence - Big Data Practices in the Energy Industries for the APEC Region

APEC Policy Partnership on Science, Technology and Innovation

July 2026

Asia-Pacific
Economic Cooperation

Influence of Eco-innovation and Artificial Intelligence-Big Data Practices in the Energy Industries for the APEC Region

Project Summary Report

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July 2026

APEC Project: PPSTI 111 2024A

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APEC#226-PP-01.10

EXECUTIVE SUMMARY

APEC economies collectively account for 60 percent of the world's greenhouse gas emissions (GHGs). This project thus sought to strengthen the APEC region's carbon neutrality aspiration through eco-innovation capacity of APEC economies energy sector. This project's approach included developing strategic approaches and pathways of integrating Artificial Intelligence (AI) and big data into the eco-innovation practices of APEC economies' energy sector. Beginning with background studies and insights shared by APEC economies on eco-innovation, AI and big data, this project hosted a webinar on 14 August 2025, featuring APEC experts to facilitate a deep dive session into identifying challenges faced by APEC economies in achieving carbon neutrality. The webinar enabled the crafting of strategies for using AI, big data and eco-innovation to overcome these challenges. This was then followed by a workshop hosted in Kuala Lumpur, Malaysia on 5 and 6 November 2025, which featured industry captains, academic experts, representatives of international organizations and APEC experts to facilitate in-depth discussions on pathways of lowering APEC economies' GHG emissions using AI, big data and eco-innovation. Participants benefitted from technical sessions, expert insights and roundtable interactions, allowing them to identify carbon reduction pathways using this knowledge. This project fostered closer co-ordination and collaboration between the various stakeholders (industry, academic, policy and research) that reduced barriers and offered solutions to addressing APEC economies' GHG emissions. The lessons learnt and policy recommendations developed from this project will serve as valuable inputs for future work under the APEC Policy Partnership on Science Technology and Innovation (PPSTI).

DISCLAIMER

The views expressed in this report are those of the author and do not necessarily represent those of APEC member economies. The examples discussed in this report were prepared based on the author's research and are provided for information purposes only, and do not guide the work of the Policy Partnership for Science, Technology and Innovation.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

We would like to extend our sincere gratitude to all the experts and participants for their active participation and invaluable insights, especially during the webinar and workshop session. The contributions from experts and participants brought together a diverse range of perspectives on AI-big data and eco-innovation in the APEC region's energy industries. These diverse viewpoints and perspectives were instrumental in shaping this report.

In addition, we are particularly grateful to the APEC Secretariat, especially Ms. Sam Wan Ting, for the guidance, expertise and support provided during the entirety of this project. We also acknowledge the various individuals and organizations who contributed to this project, especially Mr. Abdul Hadi Mat Som from the Ministry of Science, Technology and Innovation.

Lastly, special thanks are allocated to the diligent and dedicated Project Overseer team: Alternate Project Overseer Dr Parvez Alam Khan; Dr Bashir Mikail Usman; Mr. Majid Hussein; Ms. Noorasilah Roshidi; and Mr. Salim Umar Ibrahim for their tireless and immense contributions to the successful organization and execution of the webinar and workshop sessions. Special mentions are also given to Ts Vishantini Tangavaloo and Ms. Stacy Primus Liew for allocating time from their busy schedules to ensure the smooth running of the workshop sessions.

1. INTRODUCTION

Energy is the cornerstone of economic development. It provides a means for economies to fulfill their potential through powering industries, homes, and transportation as well through food and water production. Without energy it would be nearly impossible for economies to be functional. In fact, energy has been the driving force behind successive Industrial Revolutions, spawning innovations that have further catalyzed economic development[1]. The latest World Energy Outlook 2025 report[2] from the International Energy Agency (IEA) highlights the importance of energy to modern economic development. The report posits that the demand for energy globally has grown by 60% since the year 2000. Electricity alone, is expected to be the fastest growing energy sector, adding 40 percentage points in growth by the year 2035. However, the flagship global energy report also noted that whilst energy is indispensable to the growth trajectory and security of modern economies, there is an urgent need to gather global momentum towards reducing energy related greenhouse gas (GHG) emissions. Especially because GHGs potentially increase climate risks. Collective global action is thus needed given that emissions emanating from energy have grown by more than 50% in the same period, as illustrated by Figure 1.

In light of the increasing GHG emissions and concerns on their potentially negative effects on the biosphere, the first global 'stocktake' was undertaken by leaders and policy makers of the world's economies' at the 28th Conference of Parties (COP28)[3]. The inaugural stocktake at COP28 highlighted a deficit between nationally determined contribution (NDCs) of GHG emissions reduction and actual emissions reductions. Critical action is thus needed to address this gap if achievement of climate goals from the Paris Agreement are to be met i.e., achievement of carbon neutrality by the year 2050[4]. These action steps require the world's economies to triple renewable energy capacity and double energy efficiency by 2030; accelerate the adoption/deployment of low to zero carbon energy systems, fuels (e.g., green hydrogen), and technologies (including GHG removal technologies such as Carbon Capture, Utilization and Storage (CCUS)).

For these above stated action steps to be actualized, leaders at COP28 agreed that technology development, deployment and innovation would play a fundamental role in achievement of carbon neutrality targets within the stipulated timeframe of the Paris Agreement. This development and

[1] Stearns, P. N. (2020). *The Industrial Revolution in World History* (5th ed.). Routledge. https://doi.org/10.4324/9781003050186

[2] IEA. (2025c). *World Energy Outlook 2025*. IEA. https://www.iea.org/reports/world-energy-outlook-2025

[3] UNFCCC. (2023). *Outcome of the first global stocktake. Draft decision -/CMA.5. Proposal by the President* (First Global Stocktake, Issue. UN. https://unfccc.int/documents/636608

[4] UNFCCC. (2022). *Synthesis report by the secretariat* (Nationally determined contributions under the Paris Agreement, Issue. UN. https://unfccc.int/documents/619180

deployment of technology would be supported primarily by policy recommendations and capacity building.

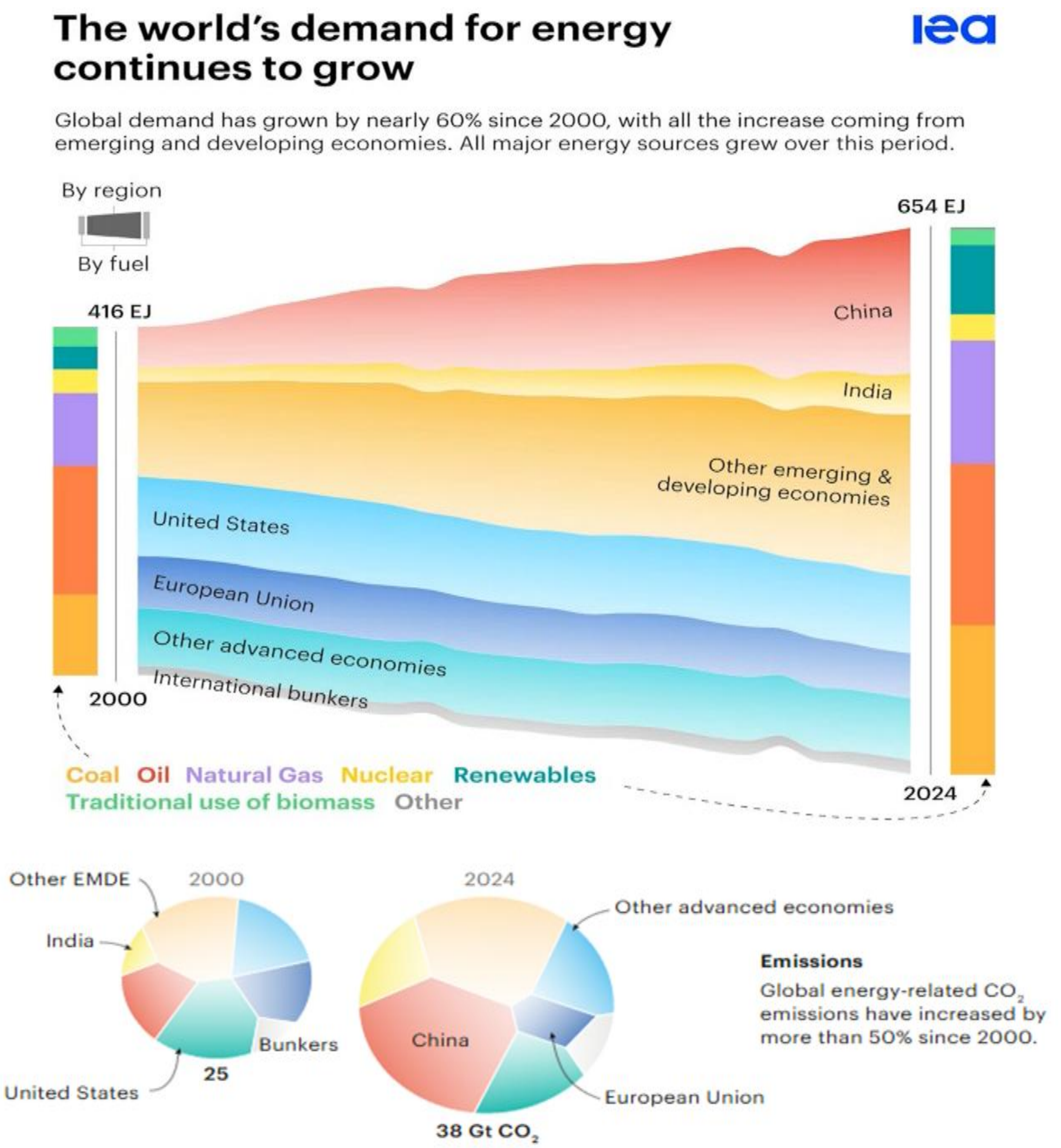

Figure 1. Global energy demand and emissions (IEA, 2025c)

This notion dovetails with the IEA's 2023 update to its flagship "Net Zero Emissions by 2050: A Roadmap for the Global Energy Sector" report[7] in which it offers recommendations that can assist the energy sector achieve carbon neutrality by the year 2050. Chief amongst its recommendations are well designed policies that foster adoption of low to zero carbon energy systems and innovation that fosters rapid development and deployment of clean energy technologies. This is important as about 34% of GHG emissions

[7] IEA. (2023b). *Net Zero Roadmap: A Global Pathway to Keep the 1.5 °C Goal in Reach*. IEA. https://www.iea.org/reports/net-zero-roadmap-a-global-pathway-to-keep-the-15-0c-goal-in-reach

reduction technologies are still at precommercial level, with more clean energy technology development and deployment needed to ensure achievement of carbon neutrality by 2050[8].

To accelerate innovation for the rapid deployment of clean energy technologies, Artificial Intelligence (AI) is heralded as the panacea for clean energy innovation in the flagship 2025 Energy and AI report. This is because AI can potentially lower the time between innovation conception and deployment. This affirms that adoption of AI in the energy sector is integral, especially towards reducing innovation development time, costs, and time to market. For instance, AI can help in the search for resource material or in pinpointing the optimal location of a power plant location from an array of locations. However, despite the critical nature of the energy and the narrowing window for action in lowering emissions, AI adoption in the energy sector has been slow and difficult, often lagging behind other sectors[9]. Figure 2 provides an illustration of the AI situation in the energy sector.

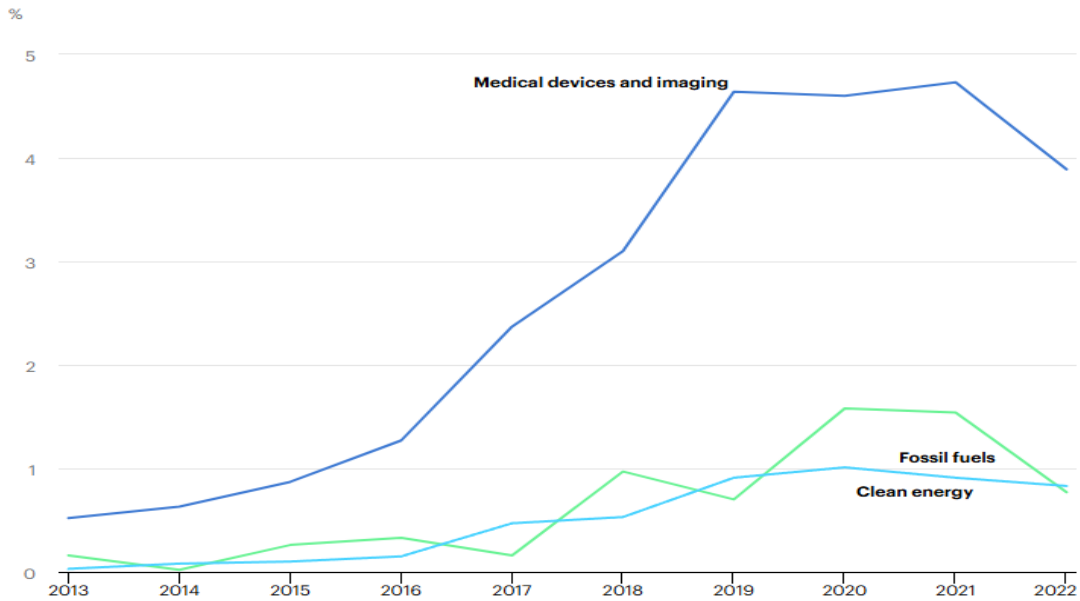

Figure 2. Adoption rates of AI (IEA, 2025a)

It is clear that lowering of GHG emissions from the global energy sector requires the development and deployment of low to zero carbon energy systems and technologies. This development and deployment of low to zero carbon systems could be catalyzed by AI. However, AI faces some challenges in its embracement in the energy sector, given the critical gap highlighted by Figure 2. Chief amongst the cited reasons for this gap in AI adoption in the energy sector is access to adequate data. Recognizing the need to foster greater adoption of AI in the energy sector for the rapid development and deployment of clean energy technologies for global and APEC economies,

[8] IEA. (2025b). *The State of Energy Innovation*. IEA. https://www.iea.org/reports/the-state-of-energy-innovation

[9] IEA. (2025a). *Energy and AI*. IEA. https://www.iea.org/reports/energy-and-ai

Malaysia proposed this project through the Asia-Pacific Economic Corporation (APEC) Policy Partnership on Science Technology and Innovation (PPSTI) with Chile; China; Chinese Taipei; and Thailand as co-sponsors.

The project featured two main avenues for exploring this state of affairs in APEC economies. Firstly, this project hosted a one-day webinar titled "Strategies for Building a nexus for Eco-innovation and AI-Big Data for the energy sector of APEC Economies". Following this webinar, a two-day workshop titled "Implementation of Eco-innovation and AI-Big Data: Fusing the two to produce Carbon Neutrality" was then hosted in Kuala Lumpur, Malaysia. This report thus details the important lessons learnt and provides recommendations generated by this important project, which is to be shared across the APEC region to promote GHG emission reduction amongst the APEC region through AI utilization for clean technology development and deployment across the region.

2. BACKGROUND

APEC member economies collectively account for 37 percent of the world's human population, contributing 61 percent to the global Gross Domestic Product (GDP). Further underscoring the importance of APEC in the global economy, almost half (46%) of the global trade in goods and commercial services emanated from APEC member economies in the year 2025[10]. In line with APEC's importance in the global economy, APEC member economies also play an important role in global energy production and consumption, with 60 percent of the world's energy production and consumption derived from the APEC region[11]. APEC economies also contribute 60 percent of the world's GHG emissions[12].

Table 1. Important APEC Energy Data*

	Amount	Unit	Share of World
Energy demand	232 425	Petajoules (PJ)	56%
Energy supply	345 518	Petajoules (PJ)	58%
Energy production	340 560	Petajoules (PJ)	54%
Electricity generation	17 244	Terawatt-hour (TWh)	68%
CO_2 emissions	21 234	Million tonnes	60%

*Source: APERC (2022)

10 APEC. (2025a). *APEC in Charts 2025*. APEC. https://www.apec.org/publications/2025/10/apec-in-charts-2025

11 APERC. (2025). *APEC Energy Demand and Supply Outlook 9th Edition - Volume 1*. APEC. https://www.apec.org/publications/2025/11/apec-energy-demand-and-supply-outlook--9th-edition--volume-1

12 APERC. (2022). *APEC Energy Demand and Supply Outlook (8th Edition) - Volume I*. APEC. https://www.apec.org/publications/2022/09/apec-energy-demand-and-supply-outlook-(8th-edition)---volume-i

Data from Table 1 also underscores the APEC region's importance in shaping the world's energy mix, as well as the impact APEC economies' energy sector can have on global GHG emissions. At present, most of the energy to meet the demand of economies globally is sourced from non-renewable sources, which collectively account for over 80 percent of the energy supplied globally. However, non-renewable energy sources are finite and non-replenishable in nature, limiting their ability to provide energy to their quantifiable availability. In addition, extracting and utilizing non-renewable sources of energy has been touted as potentially problematic for the biosphere and humanity vis-à-vis GHG emissions[13]. Therefore, this project's findings will be beneficial to APEC economies' policy makers, as both traditional non-renewable and renewable energy systems are important to APEC economies.

To combat the GHG emissions emanating from the APEC region, economic leaders aim to accelerate the region's transition towards a low carbon economy via two main avenues: reducing the region's energy intensity by 45 percent from 2005 levels, aiming to achieve this reduction by the year 2035; and doubling the share of renewables in the region's energy mix by the year 2030 (from 2010 levels). Achieving these figures within set timeframes will require innovation that bolsters economic development whilst simultaneously reducing negative environmental impacts i.e., buttressing the APEC region's attainment of carbon neutrality[14]. Thus, is it paramount for the APEC region to focus on innovation which generates both economic and environmental value i.e., eco-innovation.

Essentially, eco-innovation is innovation whose primary focus is to simultaneously produce positive economic value whilst minimizing or eliminating negative environmental impacts[15]. Accordingly, there are four main typologies of eco-innovation. The first two, product and process eco-innovations – are technological in nature and their effects economic and environmental effects are direct. Third and fourth typologies, organizational and marketing eco-innovations are non-technological in nature and their economic and environmental effects are indirect[16].

As APEC has set dual goals of increasing energy efficiency and doubling renewable energy in its energy mix, application of eco-innovation to the APEC region's energy sector can be an avenue for rapid fuel switching and

[13] Adu, D., Jianguo, D., Asomani, S. N., & Abbey, A. (2024). Energy generation and carbon dioxide emission—The role of renewable energy for green development. *Energy Reports, 12*, 1420-1430. https://doi.org/https://doi.org/10.1016/j.egyr.2024.07.013

[14] APEC. (2024b). *APEC Technology Empowers Low Carbon Action (TELCA): Best Practice Report*. APEC. https://www.apec.org/publications/2024/11/apec-technology-empowers-low-carbon-action-(telca)--best-practice-report

[15] Fussler, C., & James, P. (1996). *Driving eco-innovation: a breakthrough discipline for innovation and sustainability*. Financial Times/Prentice Hall.

[16] OECD. (2010). *Eco-Innovation in Industry: Enabling Green Growth*. OECD Publishing. https://doi.org/https://doi.org/10.1787/9789264077225-en

deployment of renewable energy[17]. This is ideal as it dovetails with the carbon neutrality 2050 scenario instead of the reference scenario, where improvements in energy efficiency and fuel switching occur in a gradual manner. That is, it follows the status quo where trends in technology development and deployment as well as policy frameworks continue in a similar trajectory.

As a result, this project focuses on technological eco-innovation typologies i.e., product and process eco-innovation. This is because technological eco-innovation exerts direct dual positive effects i.e., it helps actors to generate positive economic value through means like cost reduction, improvements in performance. It achieves this whilst simultaneously reducing or eliminating harm to the biosphere through means like reducing emissions, waste generation, or improvements in efficiency[18]. Thus, focusing on eco-innovation is critical for the APEC region, as it will enable development and deployment of energy efficient, low carbon or renewable energy technologies. These technologies can subsequently propel APEC economies towards the goal of attaining carbon neutrality vis-à-vis lowering the GHG emissions emanating from their energy sector[19].

In addition, eco-innovation also has the potential to bring about socio-economic benefits for APEC economies, such as jobs creation from clean technology development and deployment[20]. However, it is also important to note that despite the potential of eco-innovation, 34 percent of conceptualized clean energy technologies are still under development. Figure 3 presents an illustration of the carbon neutrality related technologies already deployed to market, as well as the remaining technologies under development.

For clean energy technologies that are under development to be deployed to market, it requires a significant timeframe. This is because innovation generally involves several stages such as conceptualization, designing, prototyping, and development before deployment to market. Besides timeframe, another important aspect that needs to be considered for innovation, especially eco-innovation, is the intrinsic risk that clean energy

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[17] Huang, Y., Ahmad, M., Ali, S., & Kirikkaleli, D. (2022). Does eco-innovation promote cleaner energy? Analyzing the role of energy price and human capital. *Energy, 239*, 122268. https://doi.org/https://doi.org/10.1016/j.energy.2021.122268

[18] Tariq, G., Ding, G., & Hussain, M. A. (2025). Pathways to Carbon Neutrality: The Impact of Hydropower, Nuclear Energy, Economic Complexity, Financial Development, and Eco-Innovation. *Environmental Quality Management, 34*(3), e70038. https://doi.org/https://doi.org/10.1002/tqem.70038

[19] APEC. (2024a). *APEC STI Strategic Foresight: Net Zero Emissions/ Carbon Neutrality Report*. APEC. https://www.apec.org/publications/2024/10/apec-sti-strategic-foresight--net-zero-emissions--carbon-neutrality-report

[20] Zhang, X., Liu, F., Wang, H., & Nazir, R. (2023). Influence of ecological innovation and green energy investment on unemployment in China: evidence from advanced quantile approach. *Economic Research-Ekonomska Istraživanja, 36*(2), 2125034. https://doi.org/10.1080/1331677X.2022.2125034

technologies bring. Especially because it involves energy systems, which are the core of APEC economies[21].

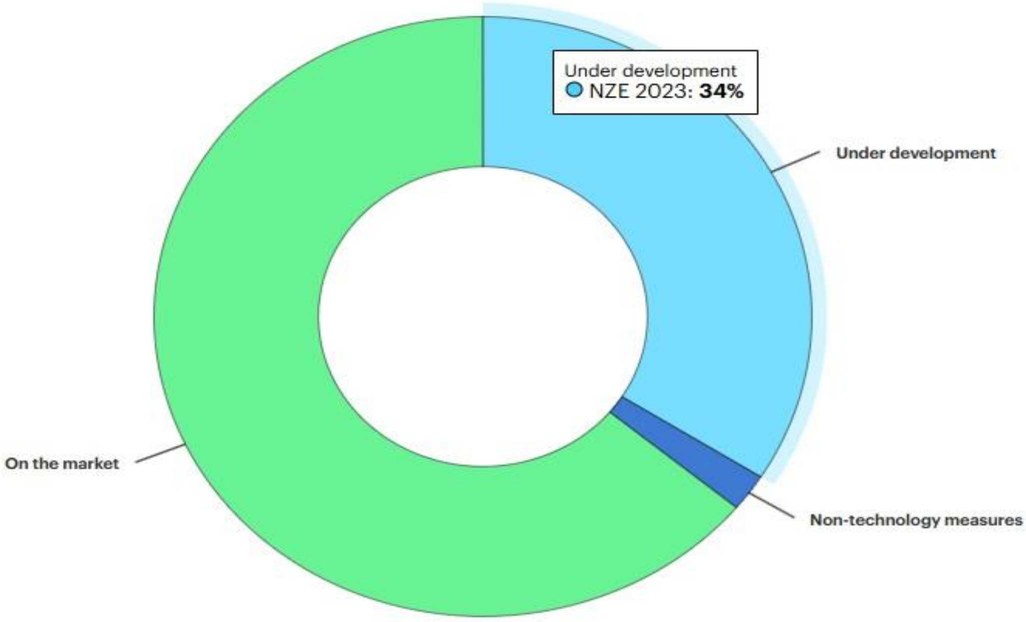

Figure 3. Clean energy technologies infographic (IEA, 2023a)

Meanwhile, Figure 4 provides further context into the current and projected state of clean technology deployment and their anticipated reduction of GHG emissions over time.

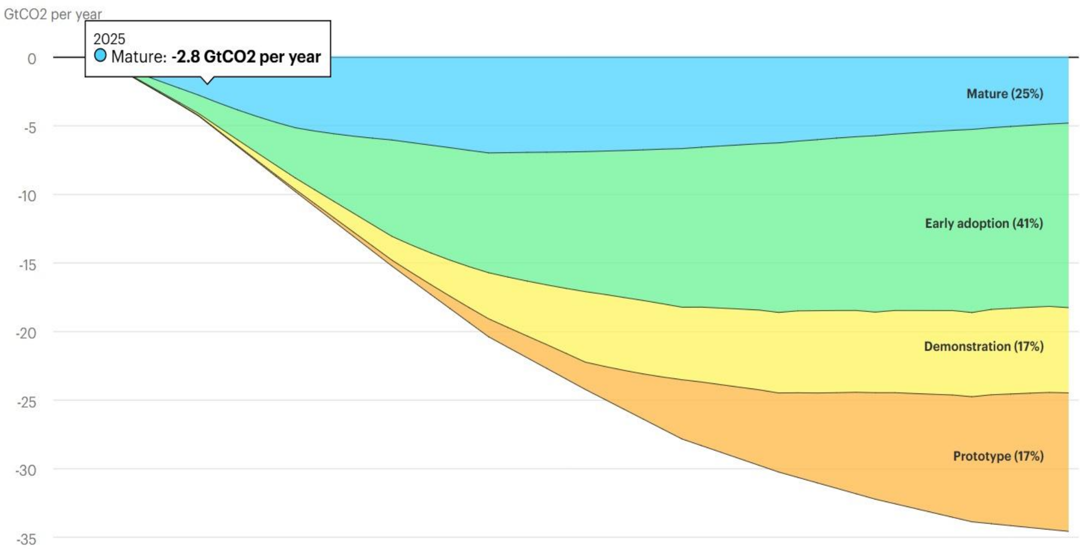

Figure 4. Illustration of Clean Technology Innovations Timeframe (IEA, 2020)

[21] Sovacool, B. K. (2025). The low-carbon risk society: Dilemmas of risk–risk tradeoffs in energy innovations, transitions, and climate policy. *Risk Analysis, 45*(1), 78-107. https://doi.org/https://doi.org/10.1111/risa.14667

For APEC economies to accelerate the development and deployment of clean energy technologies, it is imperative for the region's energy sector to embrace AI. AI is defined as "natural language processing, knowledge representation, automated reasoning, machine learning, computer vision and robotics"[23]. This definition of AI makes it multifaceted in nature as it encompasses these six major aspects. Thus, adoption and application of AI by APEC's energy sector can exert a potentially tremendous impact on clean energy technology development and deployment to market.

APEC's energy sector can potentially benefit from AI through several means. Firstly, AI can potentially shorten the time taken to conceptualize clean technology technologies through NLP i.e., Generative AI. This can shorten the time spent brainstorming and conceptualizing technologies through summarizing text and answering questions[24]. Secondly, AI can also potentially shorten the time taken during development and prototyping by allowing teams to digitally model and simulate designs as well as conduct virtual prototyping of clean energy technologies[25]. Thirdly, AI can help to optimize designs prior to deployment to market or help make subsequent improvements after deployment[26]. Hence, to accelerate development and deployment of clean energy technologies, APEC's energy sector needs to embrace AI.

However, the most fundamental ingredient of AI is big data, as data is the primary enabler of the six facets of AI[27]. For example, big data is fundamental to running simulations, training models, or automating reasoning[28]. AI and big data thus operate in tandem[29]. In fact, the value of big data within APEC is increasing, given the rising costs of training models[30]. Hence, the adoption of AI by APEC's energy industry is important for APEC economies.

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[23] Russell, S. J., & Norvig, P. (2020). *Artificial Intelligence: A Modern Approach* (4th ed.). Pearson Education, Inc.

[24] APEC. (2025b). *Navigating Artificial Intelligence Landscape in APEC: Balancing Development and Oversight*. APEC. https://www.apec.org/publications/2025/04/artificial-intelligence-landscape-in-apec--balancing-development-and-oversight

[25] APEC. (2025c). *Using AI to Power Up Efficient and Resilient Energy Systems*. APEC. https://www.apec.org/publications/2025/08/using-ai-to-power-up-efficient-and-resilient-energy-systems

[26] Okolie, J. A. (2024). Introduction of machine learning and artificial intelligence in biofuel technology. *Current Opinion in Green and Sustainable Chemistry, 47*, 100928. https://doi.org/https://doi.org/10.1016/j.cogsc.2024.100928

[27] McCarthy, J. (2007). What is artificial intelligence? *Stanford University Computer Science Department*, 1-15. https://www-formal.stanford.edu/jmc/whatisai.pdf

[28] Brynjolfsson, E., & McAfee, A. (2017). Artificial intelligence, for real. *Harvard Business Review*, 1-31. https://hbsp.harvard.edu/product/BG1704-PDF-ENG

[29] Verganti, R., Vendraminelli, L., & Iansiti, M. (2020). Innovation and Design in the Age of Artificial Intelligence. *Journal of Product Innovation Management, 37*(3), 212-227. https://doi.org/https://doi.org/10.1111/jpim.12523

[30] APEC. (2025a). *APEC in Charts 2025*. APEC. https://www.apec.org/publications/2025/10/apec-in-charts-2025

This project thus focuses on the role of eco-innovation and AI in fostering clean energy technology deployment in APEC's energy sector. The strategies discussed and identified from this project's expert led webinar and workshop sessions will help in identifying areas of further improvement and acceleration of the clean energy technology deployment in APEC's energy sector. Therefore, this project thus aims to improve eco-innovation capacity for APEC economies' energy sector, thereby contribute to the APEC region's energy efficiency, renewable energy and carbon neutrality targets.

3. WEBINAR & WORKSHOP SESSIONS

To accomplish the above stated objectives of this project, the first step is hosting a one-day expert-led webinar. The webinar's aim is to deep-dive into identifying, discussing and classifying the challenges and opportunities brought about by the implementation of AI-Big Data and eco-innovation in APEC region's energy sector operations. Following this webinar, the second step involves the hosting of a two-day workshop in Kuala Lumpur, Malaysia. The workshop aims to deliver a tailored, expert-led program, exploring the integration of AI and big data in building the eco-innovation capacity. Hence, the workshop includes several sessions spread over the two days featuring various dynamics such as energy sector expert-led presentations, case studies discussions, workshop sessions and deep dive forums. This was undertaken to maximize learning and retention; foster stakeholder engagement; and elucidate discussion amongst industry captains on finding pathways for the APEC region's achievement of carbon neutrality. The following subsections provide details of the sessions under each step i.e., the webinar and the workshop.

3.1 Webinar: Strategies for Building a Nexus for Eco-innovation and AI-Big Data for the Energy Sector of APEC Economies

The one-day webinar was successfully hosted on 14 August 2025 from 145pm to 330pm (Malaysian Time) on the Microsoft Teams platform. To deep-dive into identifying, discussing and classifying the challenges and opportunities to implement AI-Big Data and eco-innovation in APEC economies' energy sector, the webinar took on a forum style.

The webinar featured two renowned energy experts, Prof Dr Jinlong Ma, the Vice President & Head of Research of Asia Pacific Sustainable Energy Centre (APSEC) and Ms. Joy Esther Gai the Regional Head & Global Strategic Partnerships Lead of World Green Building Council (WGBC). The forum was moderated by Dr Manuel Antonio Heredia Munoz, Senior Researcher at the Asia Pacific Energy Research Centre (APERC).

Regarding the expertise of the speakers, Prof Ma's notable expertise includes energy system planning, renewable energy development, power sector transformation, GHG inventory and emission abatement strategies. Ms. Joy's notable expertise lies in zero-carbon energy projects, development of global partnership value propositions to accelerate the transition to a net-zero, and collaborative efforts that maximize impact. Meanwhile, Dr Manuel's expertise lies in energy modelling and policy analysis of APEC's energy sector, sustainable energy transitions and decarbonization pathways. The experts were thus selected due to their diverse but important respective expertise. Table 2 details the schedule of the webinar:

Table 2. Itinerary of the webinar

Time	Item
13:45 – 14:00	Virtual arrival of participants/logging into the Webinar
14:00 – 14:10	Welcoming of Participants, Guest Speakers & Opening Remarks by Project Overseer
14:10 – 15:10	Forum Discussion led by the Moderator Dr Manuel Antonio Heredia Munoz
15:10 – 15:20	Question and Answer Session
15:20 – 15:30	Closing Remarks, Vote of Thanks and Photo Session

The discussions undertaken by the experts during the webinar formed the inputs into the subsequent workshop. That is, the recommendations and strategies from webinar are to be central to tailor made programs that were delivered in the workshop sessions.

3.2 Workshop: Implementation of Eco-innovation and AI-Big Data: Fusing the Two to Produce Carbon Neutrality

The two-day workshop was successfully hosted from 5 November 2025 to 6 November 2025 in Kuala Lumpur, Malaysia. To deliver an impactful tailor-made program on eco-innovation capacity building through AI-Big data, the workshop featured a complement of sessions.

To ensure continuity and consistency from the webinar, the workshop retained all three of the renowned energy experts from the webinar session. Thus, Prof Dr Jinlong Ma (APSEC), Ms. Joy Esther Gai (WGBC), and Dr Manuel Antonio Heredia Munoz (APERC) were the selected experts for the workshop topics as their expertise is relevant to the workshop's aims, objectives and desired outcome. Additionally, Ms. Yasmin Fouladi, U.S Visiting Researcher at APERC, was added to the list of experts for the workshop, given her expertise in energy policy research, international relations, and sustainable energy.

Meanwhile, Mr. Jairus Wong Kwun Ping, Engineer at the Electrical and Mechanical Services Department (EMSD) of Hong Kong, China, and Ms. Fang Xiaoyu, Deputy Director at National Energy Administration (NEA) of China where the expert speakers nominated by their respective economies. Table 3 details the workshop agenda.

Table 3. Workshop agenda.

Day 1: 5 November 2025	
Time	Item
09:00 – 09:10	**Welcoming Remarks** by Mr. Imran Abdul Kadir, Vice President of Strategy, Sustainability & Transformation, Universiti Teknologi PETRONAS (UTP)
09:10 – 09:20	**Context Setting & Webinar Insights** by the PO: Assoc Prof Dr Satirenjit Kaur Johl, Chair for Department of Management, UTP
09:20 – 09:50	**Guest Speaker** – Ybhg Datuk Adzmir Abdul Rahman, Chief Executive Officer, Sabah Energy Corporation *"Resilient Leadership for a Sustainable Energy Mix: Balancing Growth, Technology & Decarbonization"*
09:50 – 10:30	**Expert Sharing Session 1** – Prof Dr Jinlong Ma, Vice President & Head of Research, APSEC *"Implementation of Eco-innovation & AI- Big Data: Fusing the two to produce Carbon Neutrality"*
10:30 – 11:00	Tea Break
11:00 – 11:40	**Guest Speaker** – Ir Dr Sanjayan Velautham, Chief Operating Officer, Energy Commission of Malaysia *"Steering Malaysia's Energy Transition Towards Carbon Neutrality for Greener Future"*
11:45 – 12:25	**Expert Sharing Session 2** – Ms. Yasmin Fouladi, U.S. Visiting Researcher, APERC *"Simultaneously building capacity for both public & private energy players: Important attributes for successful implementation of eco-innovation projects"*
12:30 – 13:45	Lunch Break
14:00 – 14:15	**Ice Breaking Session** led by the Alternate PO: Dr Parvez Alam Khan, Lecturer, Department of Management, UTP
14:20 – 15:20	**Breakout Sessions** led by Prof Dr Jinlong Ma and Ms. Yasmin Fouladi *Interactive Sessions to facilitate stakeholder discussion*
15:30 – 15:50	**Presentation** of Breakout Sessions Discussions
15:50 – 16:00	**Survey Administration** *Administration of Survey to assess impact*
16:00 – 17:00	**Tea Break** & Networking
17:00	**End of Day 1**

Day 2: 6 November 2025	
09:00 – 09:10	**Day 2 Opening remarks and Recap of Day 1** by the PO: Assoc Prof Dr Satirenjit Kaur Johl, Chair for Department of Management, Universiti Teknologi PETRONAS
09:15 – 10:10	**Deep-Dive Session 1** by Ms. Joy Esther Gai, Regional Head & Global Strategic Partnerships Lead, WGBC *“Levelling the playing field - Improving and Promoting the participation of females in the energy sector”*
10:15 – 10:30	Tea Break
10:30 – 11:10	**Case Study Presentation 1** by Mr. Jairus Wong Kwun Ping, Engineer/Energy Efficiency C4/2, EMSD *“Smart Cooling: Breakthrough Strategies and Innovations”*
11:10 – 11:50	**Deep-Dive Session 2** by Dr Manuel Antonio Heredia Munoz, Senior Researcher, APERC *“Effective pathways towards capacity building for eco-innovation implementation in APEC Energy Sector”*
11:50 – 12:45	**Case Study Presentation 2** by Ms. Fang Xiaoyu, Deputy Director of the Department of Science and Technology, NEA *“Empowering China’s Energy Transition with AI: Practices exploration & future prospects”*
13:00 – 14:00	Lunch Break
14:00 – 15:30	**Roundtable Discussion** led by Ms. Joy Esther Gai & Ms. Yasmin Fouladi *“Interactive roundtable sessions to produce strategies, best practices & policy recommendations”*
15:30 – 16:00	Tea Break
16:00 – 16:30	**Presentation** of Roundtable Discussions
16:30 – 16:45	**Survey Administration** *Administration of Survey to assess impact*
16:45 – 17:00	**Closing Ceremony** presented by Professor Ts Dr Mohd Fadzil Hassan, Dean of Postgraduate & Research, UTP
17:00	**End of Day 2 and Workshop**

The sessions were structured in such a way that they encouraged participants to learn from experts as well as interaction amongst themselves to exchange views, ideas and knowledge. Such an approach was undertaken to maximize learning, development and knowledge retention.

4. RESULTS AND DISCUSSION

4.1 Webinar Session

The webinar was attended by 60 participants. The participants came from a wide array of backgrounds: energy industry, academia, research bodies, and policy experts. Figure 5 illustrates the proceedings of the webinar.

Figure 5. Webinar Proceedings

The forum session, moderated by Dr Manuel, sought to unearth the challenges regarding the integration of AI and big data towards implementation of eco-innovation in APEC's energy sector. The two focal experts, Prof Dr Jinlong and Ms. Joy, presented three major challenges in APEC economies. The first major challenge is the existence of information gaps pertaining to eco-innovation and its benefits, especially amongst the stakeholders. The second challenge is the lack of a comprehensive linkage and flow between industry and academia/research. The third challenge is the discrepancy in timeframes between the established goals and targets and actual achievement of these goals and targets. The experts also delved into the potential solutions for integrating AI and Big data towards addressing these challenges for APEC economies' energy sector. Table 4 summarizes these key points.

Following identification of the challenges, Dr Manuel then engaged the experts deep dive into these challenges and identify solutions and mechanisms to address these challenges within APEC's energy sector. The purpose of this deep dive was to identify possible solutions and strategies for fostering eco-innovations in line with the APEC region's two main energy goals.

The first solution suggested is for the actors in APEC's energy sector actors to utilize quantitative data for reducing the prevalent information gaps. Given that data is the language that industries use to communicate between stakeholders, the actors in APEC's energy sector ought to increase their utilization of the large volumes of quantitative data that they generate.

Table 4. Summary of key points from webinar

Challenge	Expert	
	Prof Dr Jinlong Ma	Ms. Joy Esther Gai
Addressing Information Gaps	Using AI to improve short term, medium term, and long-term forecasts	Readiness Frameworks e.g., zero carbon and climate resilience readiness; circularity readiness.
Linkage between academic research and industry	Applying AI technology in research: Produces results at a much faster rate, reducing innovation to market deployment lag.	Improving Data Transparency Between Disciplines: Use of data to communicate and make decisions.
Mismatch in timeframes	Utilizing AI to identify the carbon neutral pathway i.e., through optimization of energy systems	Bridging the gap between two important sectors: the technical sector and the financial sector through synergy of data.

This is because most discussions on environmental sustainability tends to be qualitative. Harnessing quantitative data will be helpful in providing more quantitative information, which will help to provide a clearer picture to stakeholders.

This second solution is also complemented by the first solution i.e., quantifiable data and information will lead to effect of improvement of the communication between academic, research, and industry. Quantitative data and information are objective and will provide a clear and important guide for both academic and industry to focus on. It is important for these stakeholders to have a close collaboration as this can yield groundbreaking innovations that solve real world, quantifiable problems. This will allow both sides to focus on their respective capabilities. For instance, the industry can focus on their core capability such as production, engineering, or manufacturing, whilst the academia focuses on fundamental research. Thus, closer collaboration will improve the synchronization between academic research and industry.

Thirdly, it is important for stakeholders to continue talking about the key issues impacting environmental sustainability. This will help to shift environmental sustainability from being a conversational topic to tangible goals. This will be achieved through integrating AI and big data, with specific emphasis on sustainable energy and how it can help the APEC region to achieve carbon neutrality. This means that industry should focus on increasing adoption of AI.

Therefore, it is important for APEC's energy sector stakeholders to walk the talk instead of talking the talk.

To implement these suggested solutions, the experts suggested main three strategies. Firstly, it's important to note that AI is still evolving and developing. The energy industry can adopt AI as a user and utilize it to foster eco-innovation. This can be achieved by mobilizing funds to increase adoption of AI in APEC's energy sector. Figure 6 provides an illustration of the strategies to implement the solutions that address the challenges, as suggested by the experts.

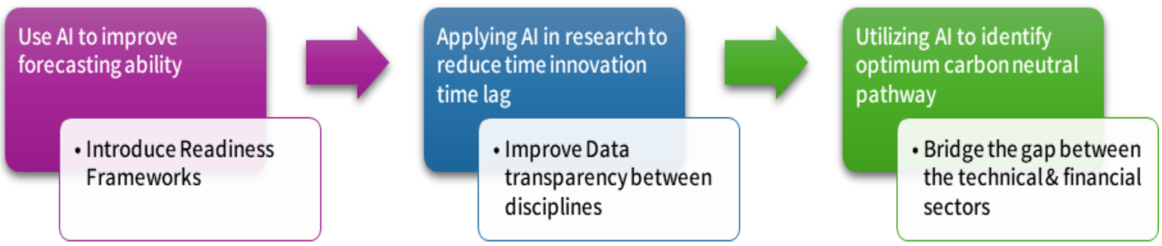

Figure 6. Summary of suggested solutions and strategies

Secondly, strategic investments can be directed towards boosting sustainable energy technology deployment i.e., modernizing energy infrastructure with AI enabled sustainable energy production systems. For instance, AI infrastructure such as data centers, computational technology, servers can be embraced alongside establishing smart grid infrastructure, effectively increasing the deployment of AI and sustainable energy technologies. This can also potentially lessen the gap between technical and financial sectors due to increased accessibility of data. This reduction of the gap between finance and technical can increase mobilization of funds and strategic investments. This is more pronounced when supportive policies and regulations that increase the embracement of AI and sustainable energy technologies are in place. Therefore, adoption of AI will lead to innovative AI driven solutions in a shorter time frame and cost base for producing the eco-innovations for deployment in the energy sector

4.2 Workshop Sessions

The workshop was attended by 58 participants from across 10 APEC member economies and four non-APEC member economies. The host economy, Malaysia, provided a significant number of participants from the energy sector. The workshop's sessions produced holistic findings given the numerous APEC energy sector stakeholders present during the workshop. The Day 1 and Day 2 of the workshop sessions are summarized below.

Day 1 Opening Session. Welcoming Remarks, Context Setting & Webinar Insights

The workshop's welcoming remarks were given by Mr. Imran Abdul Kadir, Vice President of Strategy, Sustainability & Transformation, Universiti

Teknologi PETRONAS. In his welcoming remarks, Mr. Imran welcomed all APEC and non-APEC participants to the workshop. He began by recollecting the monumental 2011 decision by APEC leaders to collectively curb the mounting environmental challenges whilst simultaneously safeguarding energy security. This decision was premised on the urgent need to reduce GHG emissions, which have only intensified over the course of time. Hence, to reduce GHG emissions, Mr. Imran stressed on the importance of innovation in renewable energy and energy efficiency technologies. Mr. Imran then highlighted the importance of this workshop, noting that the project was one of only two projects from Malaysia to receive APEC funding. The project received APEC funding having worked through the APEC PPSTI through close collaboration with Malaysia's Ministry of Science, Technology and Innovation (MoSTI). He concluded by stressing that prior to AI and big data, the view towards GHG emissions was fuzzy and unclear. However, with the advent of AI and big data, emissions from refineries, pipelines and powerplants can be tracked in real time. Thus, Mr. Imran closed by expressing the goal of the workshop to allow for discourse and insights from experts in attendance, leading discussions on optimizing these technologies to allow for more innovations.

Following these welcoming remarks, the Project Overseer, Assoc Prof Dr Satirenjit Kaur Johl, set the context of the workshop. She began by highlighting the six leading contributors towards climate change globally i.e., GHG emissions, deforestation, industrial processes, land use changes and natural factors. Amongst these contributors, she chronicled that GHG is the leading contributor, and to ensure a better tomorrow for the next generation, it's important to focus on eco-innovation as it focuses on both environmental and economic outcomes. After presenting important data that highlights the need for the APEC region to transition towards a low-carbon economy without compromising energy security, AP Dr Satirenjit presented the two APEC goals i.e., energy intensity reduction and doubling of renewable energy and the two scenarios underpinning this transition i.e., reference scenario and carbon neutrality scenario as illustrated in Figure 7.

Figure 7. Project Overseer (PO) AP Dr Satirenjit setting the context

She went on to explain how to achieve carbon neutrality, it is important for APEC economies to adopt eco-innovation, as it may allow for faster fuel switching and deployment of renewable energy in the industry and power sectors of APEC. AP Dr Satirenjit then delved into the importance of implementing AI, big data, and eco-innovation in searching for solutions to address the growing APEC region's GHG emissions. She then gave an overview of how this project assists this quest for APEC, by improving eco-innovation capacity through encapsulating AI and Big Data in their practices. After presenting on the first output of the project, the webinar, and the strategies that feed into this workshop, AP Dr Satirenjit then concluded by summarizing the goal of the workshop i.e., increasing the capacity of APEC's energy sector to eco-innovate through harnessing AI and Big data.

Guest of Honour Session 1. Resilient Leadership for a Sustainable Energy Mix: Balancing Growth, Technology & Decarbonization

The first guest of honor session was presented by the Chief Executive Officer of Sabah Energy Corporation, Ybhg. Datuk Adzmir Abdul Rahman. In his presentation, Datuk Adzmir began by explaining Sabah Energy Corporation (SEC)'s story as a state energy supplier, providing reliable, affordable and sustainable energy to over 500,000 households in the Malaysian state of Sabah. He then expounded on SEC's balanced approach of balancing energy growth, affordability and environmental sustainability by viewing natural gas as a transition fuel for the next 20-30 years as renewable energy is integrated into energy systems, as some sources of renewable energy pose intermittency challenges. He announced that SEC aims to transition from predominantly gas to diversified renewables by having almost half (46%) of its total generation capacity to be derived from renewable energy sources by 2030. He explained that they aim to achieve this by integrating 2 Large Scale Solar (LSS) generation plants which will offset up to 19,700 Metric tons (Mt) of CO_2 annually, the 318MW Upper Padas & Segama Hydropower which will offset almost 1.1 Million Mt of CO_2 annually, and the flagship 100MW Kudat Bayu 1 wind powerplant, which will offset about 130,000Mt of CO_2 annually.

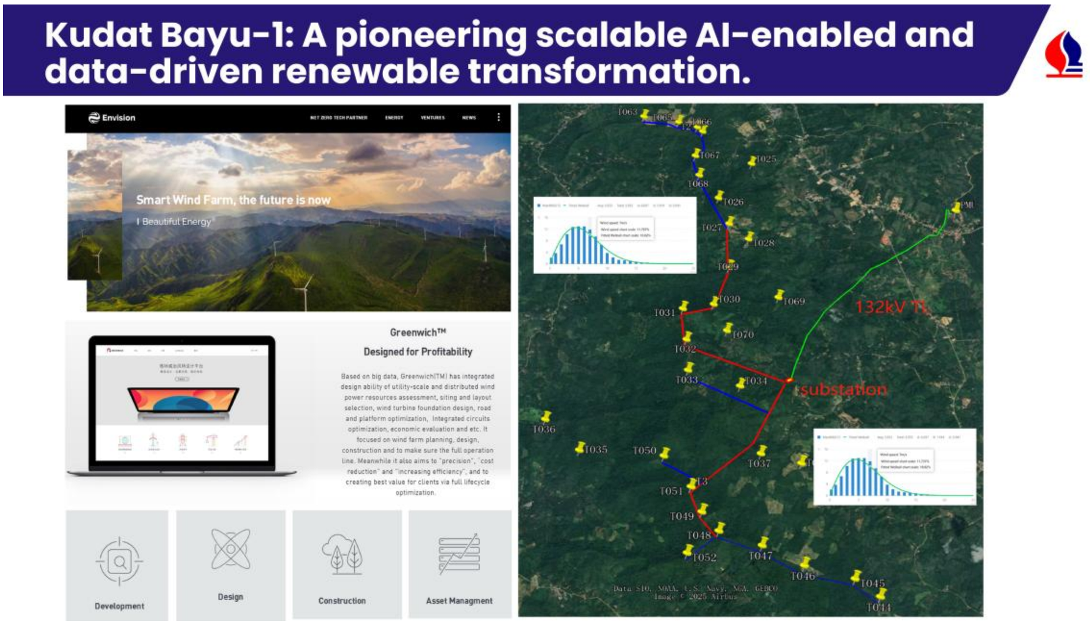

Figure 8. SEC's use of big data and AI (SEC Presentation)

Delving further into these renewable energy projects, he explained that SEC used big data and AI to conduct feasibility studies for its flagship Kudat Bayu 1 wind powerplant project. Big data and AI also played a pivotal role in helping SEC pinpoint ideal locations for other flagship renewable energy powerplants, transmission lines and substations as illustrated by Figure 8. He further elaborated that AI, and big data helps SEC to predict operations to optimum level. But it's important to have the correct data to make accurate predictions and make better, faster and fairer decisions. He concluded by mentioning that the transition to renewables requires resilient energy leadership that stays rounded in purpose and leads with data, courage and cross-border collaboration to navigate the uncertainty from the energy transition.

Expert Sharing Session 1. Implementation of Eco-innovation & AI- Big Data: Fusing the Two to Produce Carbon Neutrality

The second presentation of the day was presented by the Vice President & Head of Research of APSEC, Prof Dr Jinlong Ma. Prof Ma began his presentation by emphasizing the importance of AI and big data for the APEC region, having been the focal point at the 2025 APEC Leader's declaration in the Republic of Korea. He also emphasized the importance of carbon neutrality, having noted that the topic was also of major importance at the Group of 7 (G7) meeting in the preceding 3 days. He then delved into his presentation by explaining the role, importance and reciprocity of eco-innovation and energy, especially in the quest to achieve carbon neutrality. Prof Ma then explained the role of AI in the achievement of the APEC region's quest for carbon neutrality, stating that AI can act as a trigger and enabler for reshaping energy systems i.e., from the supply side to the end-user side. Specifically, AI can be utilized for energy systems' assessment, characterization and extraction of resources; design, planning, development and construction, operational optimization and lastly; automation and autonomy as illustrated by Figure 9.

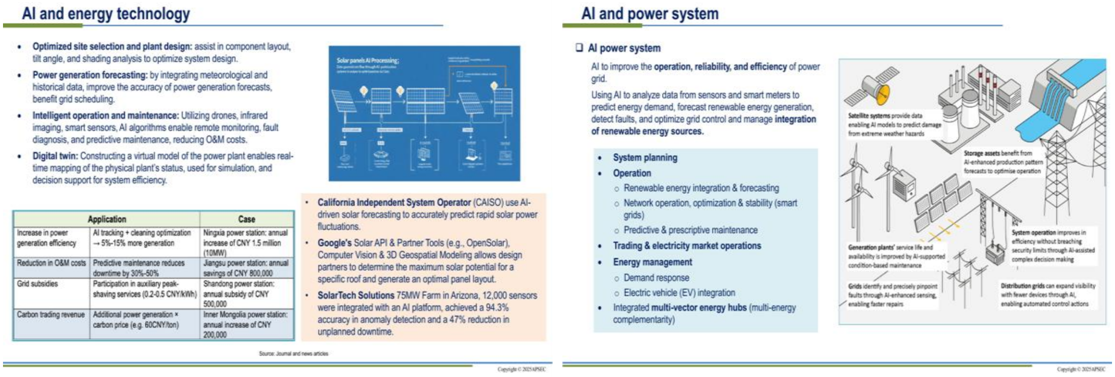

Figure 9. AI Applications in energy (Prof Ma's presentation)

To elaborate on AI's uses for energy, Prof Ma gave an application example from a solar perspective that AI can be used for panel material design and optimization, given that AI algorithms can improve problem solving accuracy and efficiency. The benefits of integrating AI as Prof Ma explained include increased power generation efficiency, reduced operations and maintenance (O & M) costs, carbon trading revenue and grid subsidies. Prof Ma highlights that however, there is a challenge on how to make the data for AI more transparent, flexible and also to make the AI itself and its data centers more sustainable. Prof Ma then gave several suggestions for this, beginning with his recommendation of using AI to solve local issues, using local resources and local people to develop and deploy AI. Prof Ma also recommended that existing laws and regulations governing AI systems be updated, so that they may for instance require companies to disclose information of their AI systems. This will promote data transparency and cross checking if AI has made a good decision. Prof Ma concluded by emphasizing strategic investments into AI and capacity building. That is, reskilling workers to perhaps have dual expertise in AI and energy systems.

Guest of Honour Session 2. Steering Malaysia's Energy Transition Towards Carbon Neutrality for Greener Future

The second guest speaker session was presented by Ir Dr Sanjayan Velautham, the Chief Operations Officer of the Energy Commission of Malaysia. Ir Dr Sanjayan started his presentation by explaining the role of the Energy Commission of Malaysia, i.e., its role in regulating the economic, technical and safety aspects of Malaysia's energy sector specifically electricity and gas supply in Peninsular Malaysia. From this backdrop, Ir Dr Sanjayan mentioned his presentation will be skewed towards policy and regulatory aspects. Ir Dr Sanjayan posits that for the transition from fossil fuels to renewables to be effective and just, there is a need for structured policy for new technologies to compete with mature technologies. He shared Malaysia's own approach towards decoupling economic growth from GHG emissions with the introduction of a raft of policy tools – the 11th Malaysia Plan for introducing LSS and the 12th Malaysia Plan specifying a renewable energy roadmap.

Ir Dr Sanjayan further elaborated on the levers Malaysia is utilizing towards achieving carbon neutrality, including the potential revival of nuclear power and interconnecting the Peninsular and Sarawak power grids for expanding green electricity exports. He also suggested that apart from supply side, it's important to target the low hanging fruit of demand side management, energy conservation and efficiency. Behavioral changes from the consumption side as a mitigation measure will enable for passive and active reduction of energy intensity. He concluded by positing that this is where AI and big data can be of significant benefit by using it to automate and optimize the low hanging fruits of energy efficiency and conservation.

Expert Sharing Session 2. Simultaneously Building Capacity for both Public & Private Energy Players: Important Attributes for Successful Implementation of Eco-innovation Projects

The fourth presentation of the day was presented by U.S Visiting Researcher at the APERC, Ms. Yasmin Fouladi. She began her presentation by articulating eco-innovation, specifically in the energy sector, with examples. She went on to explain eco-innovation's role in the energy trilemma through lowering emissions, promoting renewable energy and supporting long term environmental and economic sustainability. She then provided an overview of the energy situation in the APEC region, specifically the two APEC scenarios underpinning its outlook. Ms. Yasmin also elaborated on the importance of data, noting the prominent role that the APEC Expert Group on Energy Data and Analysis plays in gathering data for APEC economies individual projections to 2060 in the upcoming 9th outlook edition (Figure 10).

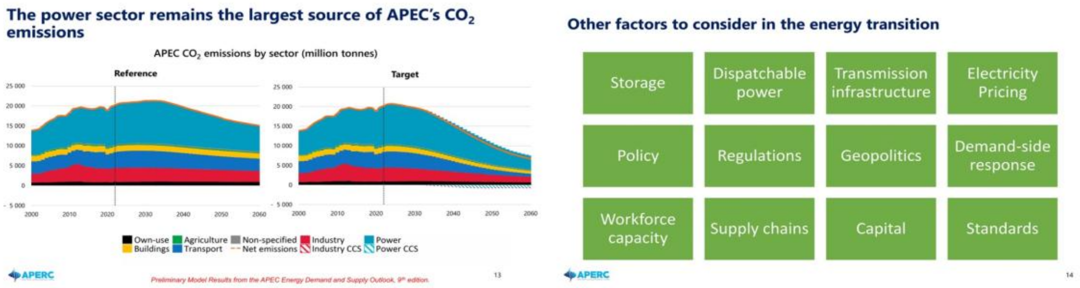

Figure 10. APEC Energy Situation Projections (Ms. Yasmin's Presentation)

Ms. Yasmin also noted that whilst electrification is essential in APEC economies' achievement of carbon neutrality, some industrial processes are hard to electrify. Thus, it is important to consider other aspects of the energy transition enablers. This can be achieved through leveraging the public sector and private sectors' sectoral competitive advantages. Ms. Yasmin mentioned, for example, that the public sector often has public and domestic interests to focus on, has regulatory authority and requires large-scale infrastructure investment. Meanwhile, the private sector focuses on market-driven innovation, is driven by a competitive drive, and has access to investment capital. However, the public sector typically lacks regulatory agility and certain technical expertise. Whereas the private sector has knowledge of the market but may lack alignment with public policy goals. To bridge the capacity gaps, Ms. Yasmin recommends that there be more multi-stakeholder dialogues, for the public sector to offer incentives for companies aligning with green public policy and eco-innovation concepts, and to increase data collection skills to improve policymaking and business plans, especially as some private sector entities lack knowledge on government programs. This can in turn help to develop and strengthen the skills, instincts, abilities, processes, and resources of the public and private organizations. This would allow for simultaneous capacity building as public capacity without market-ready private actors (or vice versa) produces stalled projects, stranded grants, or inefficient subsidies. She concluded by highlighting the role APERC has been playing in increasing the capacity of APEC economies towards energy data, statistics and modelling.

Breakout Sessions

The afternoon breakout session was an interactive session to facilitate stakeholder discussion. It was designed to foster stakeholder discussion based on real world cases/examples of challenges/problems presented by the morning session's experts. Participants were divided into 2 groups, discussing the major renewable energy sources plausible for APEC economies. Group 1 focused on Solar Energy & Geothermal whilst Group 2 focused on Green Hydrogen & Biofuels. With the assistance of the experts, the groups essentially discussed the working principle(s), the respective technology's stage/maturity, its technical and non-technical limitations. After identifying these, the groups then discussed how AI can be used to overcome these limitations. Thereafter, the groups then discussed the real-world application potential of these respective energies and how they can be integrated into APEC's energy system to achieve carbon neutrality as shown by Figure 11.

Figure 11. Breakout sessions for the 2 groups

The two groups produced meaningful insights into their discussions. The group discussing solar and geothermal energy posit that solar is at a technology enjoying growth in adoption with more room for adoption especially the area at the rooftops of buildings and additional land. Meanwhile, geothermal has tremendous potential but initially held back due to the high initial costs of exploration and drilling, with a site needing to be in a somewhat remote area. Solar's technical limitations include intermittency (limited by sun's ability to shine). Its non-technical limitations include the supply chain, i.e., whether the manufacture of the solar PV manufacturing is localized. Also, the panel becoming e-waste at the end of life. AI can be used to locate the optimum site for both solar and geothermal plants, for net metering, and assist in grid integration.

The group discussing green hydrogen and biofuels posits that both sets of technologies have a good potential. Biofuels have a broader base as they include all three states of matter i.e., biomass, bio-liquids, and biogas. They also have the advantage of being derived from waste, by-products, crops, and landfills. Meanwhile, green hydrogen is derived from electrolysis and is renewable in nature. However, both technologies have not matured. They are at an early stage, especially green hydrogen. Both also have good real-world applications. But they will need significant changes to energy infrastructure and the supporting eco-systems. This may make their costs initially high as it will require a large amount of capital and operational expenditure. AI can be used to overcome some of these limitations through real-time energy price monitoring and prediction to match supply & demand. It can also assist in improving the efficiency of large-scale production processes. AI predictions can also be used to influence policy formulation that favors growth of these technologies.

Day 2 Opening Session. Day 2 Opening Remarks and Recap of Day 1

The second and final day of the workshop began with opening remarks from the PO, AP Dr Satirenjit Kaur Johl. In her opening remarks, she welcomed respected dignitaries and gave an overview of the previous day's proceedings, emphasizing on various ways AI and Big data can be used to solve or address some of the limitations of renewable energy. She however, stressed that achieving this will require much effort from the companies adopting and developing AI, as AI on its own it cannot solve the problems.

Deep-Dive Session 1. Levelling the Playing Field – Improving and Promoting the Participation of Females in the Energy Sector

Ms. Joy Esther Gai, Regional Head & Global Strategic Partnerships Lead at the WGBC, presented the first deep dive session of day 2. Her presentation delved into the actual work conducted by WGBC, which has an incredible team of female engineers, technical personnel, and managerial personnel. She explained that the WGBC is a leading example of female participation in the built sector, mentioning that from the 33 official full-time staff in her office, only 7 are males and the rest are female. She then continued to explain the important functions of the WGBC and how it helps in decarbonization of the built environment. She highlighted that buildings account for about 25 percent of global energy-related CO_2 emissions. This makes the built environment an important aspect to consider in carbon neutrality. She mentioned that one of the first important steps is to work closely with the government. This will help the businesses to commercialize zero-carbon energy. She also mentioned it is also important to consider risk as the finance sector, an important stakeholder in the energy transition as they provide the finance to retrofit/upgrade systems. This is where AI and big data come in, to help in analysis and prediction of risk. Also, AI and data infrastructure also contribute to growth in electricity, which calls for more clean energy innovations and technologies.

She then concluded by refocusing on the role of females in decarbonization. She encourages females to actively participate in the decarbonization of buildings and built sector as females can change the entire behavioral aspect. She closed her session by giving an example of dressing. For instance, when women wear cooler clothing in buildings in tropical economies, it can have tremendous savings as 1 degree lower of the air conditioning temperature can save about 5-10% of energy.

Case Study Presentation 1. Smart Cooling: Breakthrough Strategies and Innovations

The first case study presentation of day 2 was conducted by Mr. Jairus Wong Kwun Ping, Engineer/Energy Efficiency C4/2 at the EMSD of Hong Kong, China. In his presentation, Mr. Wong first illustrated Hong Kong, China's phased climate action plan and targets i.e., reduction of electricity consumption by 2035 and a further subsequent reduction by 2050. As explained by Mr. Wong, such an approach allows Hong Kong, China to reduce emissions through reduced consumption. This reduction in consumption, as explained by Mr. Wong, is to be achieved through innovations in various sub-elements of electricity such as HVAC, lighting and transportation amongst others.

Mr. Wong then deep dove into the focus of his presentation, District Cooling System (DCS). He began by elaboration on the purpose and functioning of DCS and its benefits in terms of energy conservation. He then specified its real-world application – located at Kai Tak, Hong Kong, China with a total capacity of 462MW – serving numerous user buildings as evidenced by Figure 12.

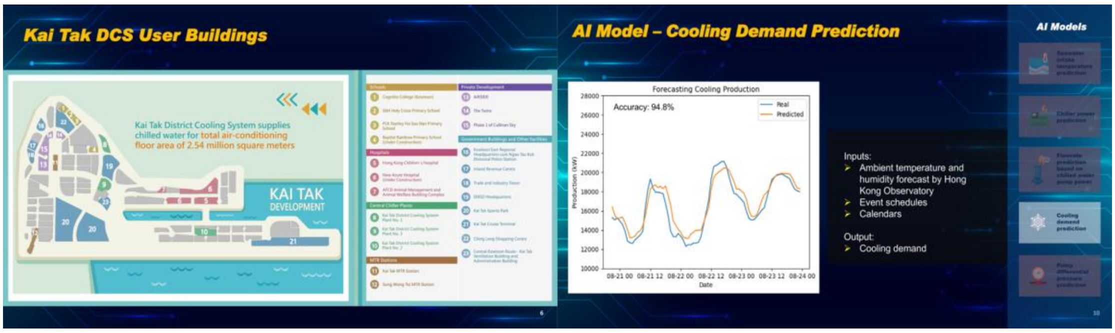

Figure 12. AI application in DCS – 95% accuracy (Mr. Wong's Presentation)

Following the illustration of how DCS functions despite the complexity of the technical challenges, Mr. Wong then gave an illustration of how AI is integrated into DCS' functionality. He illustrated the workflow that the AI was taken through to train it to forecast, optimize and display the results accurately. He delved into the technical aspects involved in training AI, sharing with participants the workflow involved, the data types used. Mr. Wong emphasized how carefully curated data is vital for model performance and prediction accuracy. He illustrated that to train their model they had about 76 million data from a 2-year record of collecting data from various sensors. As a result, he announced how their AI could achieve an accuracy result of 95 percent. He then concluded his case study presentation by sharing the real-world achievement that AI was able to achieve at the DCS, i.e., annual energy savings of about 1.7 million kWh.

Deep-Dive Session 2. Effective Pathways towards Capacity Building for Eco-innovation Implementation in APEC Energy Sector

Dr Manuel Heredia Munoz, Senior Researcher at the APERC, presented the second deep dive session of the day. He joined via remote link as he had travelled to Peru. He began by providing an overview of the energy context in APEC and the need for effective and well-designed eco-innovations in the attainment of the carbon neutrality goals set by APEC. He then highlighted the eco-innovation challenges in the APEC energy sector, i.e., uneven technological capacities, differing policy frameworks, co-ordination and harmonization issues, knowledge gaps, investment and financial misalignment.

To address these challenges, Dr Manuel then delved into the various dimensions of eco-innovation capacity building – individual, institutional and systematic level. From these levels, Dr Manuel suggested several effective pathways. Firstly, policy and governance pathways can create responsible authorities to lead eco-innovation implementation. Secondly, financial and market mechanisms can support innovation incubators for clean technology pilot projects. Thirdly, knowledge and skills development that create regional training programs and fellowships of eco-innovation. Fourthly, cross-sector collaboration and partnerships. This can foster vertical, horizontal, and cross-sectoral collaboration. Lastly, the adoption of digital and collaborative platforms. That is, the use of AI, big data and digital twins for energy innovation. Dr Manuel then elaborated on 2 specific examples of these including the Tobalaba Urban Market in Chile and the Kai Tak Sports Park in Hong Kong, China. He then concluded by positing that eco-innovation goes beyond merely adoption of technology. Instead, it is a systemic and transformative process across all levels of society. Thus, it is critical to think beyond just eco-innovation training.

Case Study Presentation 2. Empowering China's Energy Transition with AI: Practices, Exploration & Future Prospects

The last case study of the morning session was presented by Ms. Fang Xiaoyu, the Deputy Director of the Department of Science and Technology at the NEA of China. Ms. Fang's case study presentation focused on successful application of AI in China's energy sector. She began by giving an overview of China's ambition of taking an active approach to carbon neutrality by growing share of renewable energy in its energy mix to over 30 percent by 2035. Ms. Fang shared that China's installed solar and wind capacity in 2024 reached 43 percent of the entire planet's installed capacity. She elaborated that China intends to continue growing the consumption of green electricity with 1 in every 3 kWh of total consumption being supplied from green electricity. Ms. Fang further elaborated that to keep or improve this ratio, China's energy companies are increasingly adopting AI i.e., large data driven models for use in a raft of energy related functions such as exploration, operations, and safety management.

Ms. Fang also provided specific applications alongside illustrations of AI in China's energy sector. She mentioned that energy companies are now utilizing large AI models and intelligent equipment in frontline energy operations such as electricity transmission line inspection, power dispatching and control, substation operations and for predictive maintenance. Ms. Fang explained that this has led to lightning-fast fault detection and identification, reduced response time to faults, improved load forecasting and enhanced power grid dispatching. She further elaborated that for wind and solar power; AI's forecast ability exceeded 86 percent and 88 percent respectively. It also led to a significant drop in operational costs and a 20-30 percent reduction in accident rates.

Ms. Fang also then specified AI's role in China's hydropower has significantly improved water ecological quality. She stressed that AI is also steering China's oil and gas industry into more efficient operations with identification accuracy of over 90 percent for new reservoirs. China can achieve these impressive figures, as it boasts a lot of high-quality data. She explained that this allows Chinese enterprises to build end-to-end data processing capabilities that allow Chinese energy companies to form high quality datasets for higher accuracy. Ms. Fang concluded by mentioning that utilizing AI to foster innovation will bolster the economic foundations of APEC and allow the economies to progress towards carbon neutrality and ensure a sustainable future for all.

Roundtable Discussion

The afternoon's roundtable discussion sought to bring together participants and experts to discuss pathways towards infusing AI and big data into eco-innovation, to effectively boost the carbon neutrality capacity for APEC economies' energy sector. The roundtable discussion, designed to be interactive, saw participants being highly active, sharing experiences and insights from their field/organization/industries.

In addition, the spirited and highly interactive discussion also culminated in the production of APEC economies' carbon neutrality pathways. The divergent views expressed by the participants converged to an agreed upon pathways to inform policy formulation. The pathways are fully illustrated in Annex. 1. Furthermore, the results of the survey administered to the participants during the workshop are fully illustrated in Annex. 2.

5. CONCLUSION & RECOMMENDATION

The Project PPSTI_111_2024A Influence of Eco-innovation and Artificial Intelligence-Big Data Practices in the Energy Industries for the APEC Region successfully convened industry captains, academic experts, policy makers and representatives of international organizations to find solutions for integrating AI, big data and eco-innovation to address the GHG emissions emanating from APEC's energy sector. This project's first output convened APEC experts, members of academia and industry representatives to a one-day webinar that discussed and identified strategies for charting the APEC region towards carbon neutrality through integrating AI, big data and eco-innovation.

The project's second output convened industry captains, academic experts, policy makers and representatives of international organizations to a two-day workshop featuring expert led presentations, technical sharing, and group discussions on AI, big data, and eco-innovation capacity building and implementation pathways to help steer APEC economies towards carbon neutrality. These sessions provided a platform for stakeholder discussions which deepened participants' understanding of industry best practices, regional frameworks and the shared experiences opened avenues for collaboration and technical cooperation. The workshop also generated several recommendations that can inform APEC policy formulation.

This project recommends APEC economies to introduce supportive legislative instruments to foster AI development. This legislative instrument should seek to accelerate AI development, adoption and utilization, especially in renewable energy projects. The legislation must also consider the unique challenges that AI systems pose. Whilst the legislation must foster AI development, it should also allow for development freedom whilst ensuring data security and protection of Intellectual Property (IP). This means that a Law or Act governing AI could be cross-cutting as it may touch on other existing laws and acts. APEC economies could start by making updates to existing laws that govern cybersecurity and IP. Thus, it is critical for APEC economies to analyze the existing laws and acts governing data protection, cybersecurity, and IP to see the areas not covered that can be covered by an AI Act. This will help reduce conflicting laws which may stifle the development of AI or discourage investment in AI systems due to over restrictive laws. The law could for example require companies to disclose information about their AI systems, architecture, and data usage to ensure accountability, fairness and transparency.

Closely linked to legislative instruments, APEC economies should also create enabling environment for AI development through policies that promote or reward adoption of AI and eco-innovation in APEC. Specifically, to promote greater transparency of AI, APEC economies can incentivize data transparency to encourage companies to be transparent about their AI systems. For example, APEC economies can offer financial or non-financial incentives to energy companies that are transparent on their use of AI and data, particularly towards renewable energy projects. Another policy example that APEC economies can implement is to encourage the hosting of AI ecosystems such as data centers, within APEC economies. This can increase confidence in data privacy, data security and data sovereignty.

Furthermore, it's important to note that whilst AI is a very promising technology for solving numerous problems, technology alone cannot solve the problem. There is a strong need for APEC economies to focus on the human capital in their respective economies and invest into reskilling that human capital. This has the benefit of building the capacity of the next energy frontiers, whilst also reducing human fears of being replaced by AI. APEC economies need to act proactively reskill human capital before AI and renewable energy systems deployment. For example, before energy companies introduce digital smart meters (rendering meter reader jobs obsolete) they should first retrain that human capital to perform tasks such as data analysis as they will no longer need to go door to door to collect data on electricity meters. Perhaps APEC economies can create a specific AI human capital development fund to cater for this.

It is also important to introduce policies that promote greater collaboration between industry, academia and research. Tertiary education institutions must be able to produce the human capital and research required in industry. APEC economies could find ways of incentivizing APEC energy companies to collaborate more closely with academia and research. This can foster co-development of AI and renewable energy technologies. APEC economies could increase funding to research, especially for eco-innovation. Universities can focus on fundamental (TRL1-4); research organizations take over from TRL5-8; and industry finishing at TRL 9, with all three bodies co-developing this technology collaboratively using AI and big data. By building on the discussion points and momentum gathered in this project's webinar and workshop, APEC economies can strengthen their eco-innovation capacity through harnessing AI and big data.

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