APEC Sectoral Symposia on the Holistic Approach of Decarbonization for Energy Transition

APEC Energy Working Group

June 2024
APEC Sectoral Symposia on the Holistic Approach of Decarbonization for Energy Transition

APEC Symposium on Pursuing Decarbonization of Fossil Fuels
11-12 October 2023
Kobe City, Hyogo, Japan

APEC Symposium on Promoting Energy Efficiency and Energy Management System
23-24 January 2024
Tokyo, Japan

APEC Energy Working Group

June 2024
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1. **Background**

In energy transitions, there is no “single best solution” for achieving carbon neutrality or “net-zero”, as each APEC economy has different economic and social structures, and geographical situations. Asia Pacific Energy Research Centre (APERC) strongly believes that various, pragmatic and sustainable decarbonization pathways, that reflect the different circumstances of each economy, are essential to achieving the energy transitions.

To facilitate these transitions, it is beneficial to share knowledge and experience among member economies. For that purpose, APERC organized the symposia as an APEC project under the auspices of Japan’s Ministry of Economy, Trade and Industry (METI).

2. **Objectives**

Our objective is to provide vital information on decarbonization of fossil fuel use and energy efficiency and energy management system, and to share experience and insights on these issues so that voluntary and engaged APEC economies will be better prepared to realize various, pragmatic, and sustainable energy transitions while pursuing decarbonization towards carbon neutrality.

3. **Symposium Methodology**

The two in-person sectoral symposia were held as a follow-up to the APEC Symposium on Holistic Approaches to Decarbonization Towards Carbon Neutrality in 2021 to further discuss two issues, which are important elements of that holistic approach. One is the decarbonization of fossil fuel use including Hydrogen, Ammonia and Carbon Capture, Usage and Storage (CCUS), and the other is energy efficiency and energy management system.

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<tr>
<th>Date</th>
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<td>11 and 12 October</td>
<td>Pursuing Decarbonization of Fossil Fuels</td>
<td>Kobe City, Hyogo Prefecture, Japan</td>
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<tr>
<td>23 and 24 January</td>
<td>Promoting Energy Efficiency and Energy Management System</td>
<td>Tokyo, Japan</td>
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The symposia invited speakers from a wide range of experts, including government, private company, academia, and research institutions, to share their knowledge and experience through the theme presentations and discussions:
• Evaluation of Current Status and How to Promote Development and Deployment on Hydrogen, Fuel Ammonia, CCUS, and Direct Carbon Capture (DAC).
• Energy Efficiency in Building, Transport: Current Situation and Room for further improvement.
• Energy Efficiency in Industry: Additional Potential for Achieving Carbon Neutrality in APEC.
• Energy Management System and Smart City: Current Situation and Room for further improvement.

4. Participating Economies and Organizations
A total of 114 individuals attended the two symposia, including speakers and participants from 17 APEC economies and one non-member economy: Australia; Canada; Chile; China; Hong Kong, China; Indonesia; Japan; Korea; Malaysia; New Zealand; Papua New Guinea; the Philippines; Singapore; Chinese Taipei; Thailand; the US; Viet Nam and Portugal.

• Government officials from energy agencies involved in formulating policies, programs and measures for various, pragmatic and sustainable energy transitions and decarbonization: Department of Climate Change, Energy, the Environment and Water (Australia), Ministry of Energy (Chile), National Energy Administration (China), Electrical and Mechanical Services Department, Government of the Hong Kong, China, Ministry of Energy and Mineral Resources (Indonesia), Ministry of Economy, Trade and Industry (Japan), Ministry of Trade, Industry and Energy (Korea), Ministry of Natural Resources, Environment and Climate Change (Malaysia), Ministry of Energy Transition and Public Utilities (Malaysia), Energy Commission of Malaysia, Ministry of Business, Innovation and Employment (New Zealand), National Energy Authority (Papua New Guinea), Department of Energy (the Philippines), Ministry of Economic Affairs (Chinese Taipei), Ministry of Energy (Thailand), Department of Energy (the US), and Ministry of Industry and Trade (Viet Nam).

Symposium on Pursuing Decarbonization of Fossil Fuels in Kobe

• Representatives of clean energy solution company, integrated engineering and contractor, engineering manufacturer, power generation company, steel manufacturer implementing decarbonization technologies and measures: Carbon Engineering (Canada), Chiyoda Corporation (Japan), Kawasaki Heavy Industries,
Ltd (Japan), JERA Co, Inc (Japan), Kobe Steel, Ltd (Japan) and Gentari Hydrogen Sdn Bhd (Malaysia).

- Research institutes and academia, and others involved in R&D activities for CCUS and DAC technologies, as well as other research activities: CO2CRC Limited (Australia), Chinese Society for Environmental Sciences (China), PetroChina Planning and Engineering Institute (China), National Research and Innovation Agency (BRIN) (Indonesia), Institute of Applied Energy (Japan), Research Institute of Innovative Technology for the Earth (Japan), University of Tokyo (Japan), Institute of Energy Economics, Japan, Argonne National Laboratory (the US), European Maritime Safety Agency (Portugal), and Asia Pacific Energy Research Centre.

- Representatives of relevant organization with interest in the topic: The Global CCS Institute (Japan), and Department New Energy and Industrial Technology Development Organization (Japan).

Symposium on Promoting Energy Efficiency and Energy Management System in Tokyo

- Representative of EV provider charging infrastructure: Green EV Charge Sdn Bhd (Malaysia)

- Research institutes and academia involved in energy efficiency and energy management system, as well as other research activities: Commonwealth Scientific and Industrial Research Organisation (Australia), China National Institute of Standardization (China), Universitas Gadjah Mada (Indonesia), Japan Automobile Manufacturers Association, Inc (Japan), Energy Conservation Center, Japan, Institute of Energy Economics, Japan, Korea Energy Economics Institute (Korea), University of the Philippines, National University of Singapore, Industrial Technology Research Institute (Chinese Taipei), and Institute of Regional Sustainable Development (Viet Nam).

5. Description

APEC Symposium on Pursuing Decarbonization of Fossil Fuels was held on 11 and 12 October 2023 in Kobe City, Hyogo, Japan. The two-day symposium consisted of the following four parts:

I) **Opening Session** included opening remarks and keynote speech.

II) **Presentations and Panel Discussions** on various topics regarding carbon neutrality from experts and related Q&A.
III) **Closing Remarks**  
IV) **Site Visits**: Kawasaki Heavy Industries, Ltd, Kobe Steel, Ltd, and Mitsubishi Heavy Industries, Ltd Takasago Machinery Works

APEC Symposium on Promoting Energy Efficiency and Energy Management System was held on 23 and 24 January 2024 in Shinagawa, Tokyo. The two-day symposium consisted of the following four parts:  
I) **Opening Session** included opening remarks and keynote speech.  
II) **Presentations** on various topics regarding energy efficiency and energy management system from experts and related Q&A.  
III) **Closing Remarks**  
IV) **Site Visit (Half a day)**: Tokyo Denki University

The agenda and presentation materials are included in the Appendices.

6. **Summary of Symposium**  
6-1. Pursuing Decarbonization of Fossil Fuels (Kobe)

6-1-1. Session 1: Opening Session  
a) **Opening Remarks**  
**Dr Kazutomo Irie** (President, Asia Pacific Energy Research Centre (APERC))

**Key points**  
- Welcomed participants and explained the background & objectives of the symposium.  
- Emphasized the importance of the energy transition and decarbonization of fossil fuels and sharing knowledge and experiences among APEC economies.

**Summary**  
Dr Irie welcomed all participants and explained the background and objectives of the symposium. This symposium aims to follow up on the APEC Symposium on Holistic Approach of Decarbonization towards Carbon Neutrality held online in August of 2021 which highlighted the importance of holistic approach to decarbonization in path carbon neutrality.  

In energy transition there is no single best solution for achieving carbon neutrality or net zero as each APEC economy has different economic and social structure, and geographically situations.
Emphasized that various pragmatic and sustainable decarbonization pathways which reflect the different circumstances of each economy essential to achieving successful energy transitions to facilitate these transitions it is beneficial to share knowledge, experience among member economies. As a holistic approach inevitably covers various issues, a series of sectorial symposium is necessary to deepen our understanding in each sector. APERC intend to start the sectorial symposium series last year but extend it because of the COVID-19 pandemic ring out. As a first topic of the symposium series, picked up decarbonization fossil fuels.

b) Keynote Speech: Necessity of Decarbonization of Fossil Fuels for Carbon Neutrality
Ms Reiko Eda (Director for Natural Resources and Energy Research, International Affairs Division, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI), Japan)

Key points
・Highlighted the common goals of net zero emissions through various pathways according to circumstances of each economy and the need to utilize all kind of technologies energy sources including energy conservation, renewable energy, hydrogen, ammonia, nuclear power, CCUS, and carbon recycling.
・Described Japan’s aims to invest approximately USD1 trillion in green transformation over the next 10 years in both public and private sectors, including green transformation (GX) economic transition bonds.
・Emphasized Japan’s plan to contribute to decarbonization of Asian economies under the Asia Zero Emissions Community (AZEC) platform.

Summary
Ms Eda explained that facing the un-precedented energy crisis, we are expected to combat climate change and to promote energy security while also growing our economies, and it is important to aim common goals of net zero emissions through various pathways according to circumstances each economy. Emphasized that importance of utilizing all kind of technologies energy sources including energy conservation, renewable energy, hydrogen, ammonia, nuclear power, CCUS, and carbon recycling. Japan introduced GX economic transition bonds, which will provide bold upfront investment of JPY20 trillion, equivalent to USD140 billion in the innovations
needed to decarbonize their economy. Through this, the Japanese government will promote energy conservation, development of floating offshore wind power, Perovskite solar cells, and innovative technologies for hydrogen reduction steel making. Japan aims to invest JPY150 trillion, equivalent to USD1 trillion in the GX sector over the next 10 years in both public and private sectors including the use of economic transition bonds. Japan is working with other Asian economies to decarbonize Asia under the Asia Zero Emissions Community (AZEC) platform. The AZEC Public-Private invest forum announced the 28MOUs in a wide range of decarbonization sectors, including renewable energy, biomass, hydrogen, ammonia, and LNG. In this way, Japan hopes to take the leading role to contribute decarbonization not only domestically but for the entire APEC region.

6-1-2. Session 2: Hydrogen

a) Energy Transition and Green Hydrogen in Chile

Mr Alex Santander Guerra (Head of Division, Energy and Environmental Policy and Studies Division, Ministry of Energy, Chile)

Key points
• With its abundant renewable resources Chile positions itself as future green hydrogen exporter.
• The Chilean Government is working on the Green Hydrogen Action Plan 2023-2030 which is planned for release in November 2023

Summary
To achieve the CN (Carbon Neutrality) goal by 2050, Chile has released several mid-term (2030) policies and has set mid-term goals, such as 80% renewable electricity by 2030, 2GW energy storage by 2030, etc. Given the economy’s abundant renewable resources, solar in the north and wind in the south, Chile has positioned itself as a major green hydrogen supplier in the future. Green hydrogen will also play a significant role in local energy supply, expected to contribute 24% of Chile’s greenhouse gas emissions reduction by 2050.

To facilitate the economy's green hydrogen development, the Chilean government has developed and published the National Green Hydrogen Strategy in 2020, in which there are several goals such as 5GW electrolyzer capacity by 2025 and 25GW by 2030, green hydrogen production cost lower than USD1.5/kg by 2030, etc. The Green Hydrogen
Strategy has two action plan windows, Action Plan 2020-2023, and Action Plan 2023-2030. In Chile green hydrogen policies are overseen by an Inter-Ministerial Council, chaired by the Ministry of Energy and involves several public agencies that related to green hydrogen project development. The latest green hydrogen policy development in Chile is drafting of the Green Hydrogen Action Plan 2023-2030, which also involves consultation through citizen workshops, interaction with groups from different political backgrounds, as well as getting feedback from private companies. The preliminary version of the Green Hydrogen Action Plan 2023-2030 is supposed to be released in November 2023, and after the public consultation process the action plan will be finalized within the first quarter of 2024.

b) Gentari’s Venture into Hydrogen Production Projects in Malaysia and Overseas

Mr Awadh Asyraf Bin Supri (Head of Marketing & Sales, Far East & Australia
Gentari Hydrogen Sdn Bhd, Malaysia)

Key points
• Gentari, the clean energy solutions arm of PETRONAS, focuses on clean energy with a global target of renewable energy (30-40GW) and Hydrogen (up to 1.2 million tons) as well as Green Mobility (10% market share in select markets) by 2030.
• The company is developing mainly export-scale clean hydrogen projects (including hydrogen carriers, such as ammonia) in Canada; India; Malaysia, and is looking to grow its business in Australia; Chile; Europe; the US; and Oman while cooperating with various Japanese companies.

Summary
Gentari, though is a subsidiary of Petronas, is an independent entity focuses fully on clean energy. The company is targeting 30-40GW renewable energy portfolio and up to 1.2 tons per year clean hydrogen production by 2030. The Malaysian Government has released the Hydrogen Economy and Technology Roadmap in October 2023. Gentari is developing both blue and green hydrogen and ammonia in Malaysia utilizing existing facilities and infrastructures. The company also has clean hydrogen and ammonia project development in Canada and India. Gentari sees Australia; Chile; and the US as promising clean hydrogen suppliers in the future. Gentari has several cooperation with Japanese companies, for example, joint studies with IHI Corporation for ammonia co-firing and with ENEOS for MCH in West Malaysia, blue ammonia project development with Itochu Corporation in Canada, and e-methane
projects with Tokyo Gas and Osaka Gas separately in East Malaysia. Key learnings from the company's business activities include: importance of government support mechanisms at the early stage, strategic partnerships over the entire supply chain to improve economic factors, roadmap with practical deployment plans.

c) Development of Global Supply Chain by LOHC-MCH method

Mr Yuji Chishima (Group Leader of Business Development, Hydrogen Business Department, Chiyoda Corporation, Japan)

Key points

- The major advantage of using Methylcyclohexane (MCH) as hydrogen carrier is that existing infrastructure and logistic facilities can be utilized.
- Chiyoda has started R&D on Liquid Organic Hydrogen Carriers (LOHC)-MCH system since 2002 and has a hydrogen supply chain demonstration project of Brunei Darussalam and Japan and other projects in Rotterdam Port.

Summary

There are several carriers for long distance hydrogen transportation. Each carrier has its advantages and disadvantages. Chiyoda’s SPERA technology uses LOHC-MCH as hydrogen carrier. Chiyoda has started R&D on LOHC-MCH system since 2002. The LOHC-MCH system includes hydrogenation process at the production side, which is synthesis of MCH with hydrogen and toluene, and dehydrogenation process at the demand side, which is taking hydrogen out from MCH. The toluene from the dehydrogenation process can be transported back to the production side and be reused. Chiyoda’s key proprietary technology is the development of catalyst used in the dehydrogenation process.

MCH's property is similar to gasoline and can be shipped using existing tankers. Regulations for the handling of MCH is already in place. Chiyoda is a central member in the Advanced Hydrogen Energy Chain and Association for Technology Development (AHEAD) and the international hydrogen supply chain demonstration project, shipping hydrogen from Brunei Darussalam to Japan using MCH system. First cargo of the project has arrived in Japan. Chiyoda is also taking out R&Ds to further reduce the cost and carbon footprint of the MCH system, including direct MCH synthesis at the production end, and integration of dehydrogenation with applications that generate heat such as gas turbine, Direct Reduced Iron (DRI), or Solid Oxide Fuel Cell (SOFC) to utilize the recycled heat from the application. Besides the AHEAD demonstration project, Chiyoda is also
working on hydrogen transportation using MCH system in Singapore and Europe (Port of Rotterdam) etc.

d) Towards the Realization of International Liquefied Hydrogen Supply Chain
Mr Shintaro Onishi (Senior Staff Officer, Section 3, Business Development Department, Project Group, Hydrogen Strategy Division, Kawasaki Heavy Industries, Ltd, Japan)

Key points
・Kawasaki Heavy Industries focuses on using liquefied hydrogen as a hydrogen transportation carrier and has a liquefied hydrogen supply chain demonstration project between Australia and Japan.
・The company plans to start the first commercial liquefied hydrogen supply chain by 2030 and scaling up the supply facilities is the main challenge.

Summary
Kawasaki Heavy Industries (KHI) has developed technologies over the entire hydrogen supply chain, from hydrogen production, to transportation, storage, and utilization. For hydrogen transportation and storage, KHI focuses on liquefied hydrogen, utilizing the company’s long-time experience on LNG. KHI is a major member of the Australia-Japan liquefied hydrogen transportation pilot project (HySTRA (CO2-free Hydrogen Energy Supply-chain Technology Research Association)). Under the pilot project, a prototype of liquefied hydrogen ship has been built and has carried liquefied hydrogen from Australia to Japan. At the receiving terminal at Kobe in Japan facilities such as liquefied hydrogen loading arms and storage tank have been built.
For the next stage, scaling up the facilities is the main challenge and main task for liquefied hydrogen supply. KHI, together with its partners, is working on building commercial scale liquefied hydrogen supply chain and has been supported from the government’s Green Innovation Fund for key technology development. The company plans to start the first commercial liquefied hydrogen supply chain by 2030 and once the feasibility and economic viability is proved, building more supply chains in the future.

e) Analysis of Current and Future Hydrogen Production and Utilization in the United States
Dr Amgad Elgowainy (Senior Scientist, Distinguished Fellow, and Group Leader, Energy Systems and Infrastructure Analysis, Argonne National Laboratory, the US)
Key points
・Hydrogen (grey) production in the US is about 10 million tons per year. Most of the US’s hydrogen production and usage is in the Gulf region.
・Argonne’s hydrogen carbon footprint assessment model finds out that hydrogen produced from electrolysis using renewable electricity has the lowest carbon intensity from well-to-gate.
・Results from the economic evaluation model suggest that for the hydrogen applications to be competitive, hydrogen supply cost need to be USD1-2/kg-H2.

Summary
Hydrogen (grey) production in the US nowadays is about 10 million tons per year, most of which is used for oil refinery and ammonia production. Approximately half of hydrogen production is in the Gulf area of the US. Under the Bipartisan Infrastructure Law, several clean hydrogen hubs are to be selected and government will provide subsidies for hydrogen supply chain development at the hubs. Production of hydrogen in the hubs including not only renewable hydrogen but also fossil-fuel based hydrogen with CCS and hydrogen from nuclear power. Benchmark for clean hydrogen in the US is less than 4kg-CO2/kg-H2. In 2022, the Inflation Reduction Law gives clean hydrogen producers up to USD3/kg-H2 incentive for hydrogen carbon intensity below 0.45kg-CO2/kg-H2. Argonne’s the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET) model is used to quantify the carbon intensity and therefore the credit for clean hydrogen production.

With Department of Energy (DOE)’s support, Argonne has developed the Life Cycle Assessment (LCA) model since 1995. The model covers the whole hydrogen value chain. On the production side, electrolysis with renewable electricity has the lowest carbon intensity. For domestic hydrogen delivery, hydrogen tube trailer and liquid hydrogen trucks are considered in the model. Argonne’s technoeconomic models, including Hydrogen Delivery Scenario Analysis Model (HDSAM), also evaluated cost of hydrogen supply chain and various end use applications, including fuel cell vehicles, hydrogen refueling stations, ammonia production, e-methanol synthesis, and other e-fuels from Fischer-Tropsch (FT) process, steel production using DRI technology, etc. The modeling results suggest that for the hydrogen applications to be competitive, hydrogen supply cost need to be USD1-2/kg-H2. USD1/kg-H2, which is also consistent with the near-term and long-term price targets set by the DOE’s Hydrogen Shot program.
f) Q&A and Discussions

Key points

- The idea of a hub is basically to co-locate supply and demand in a single region at scale. At present most hub likely activities will be in ammonia sector.
- Utilization of existing infrastructure is important to bring down hydrogen supply costs.
- Government support at the early stage is necessary to scale up the market.
- Although there is no price index for hydrogen and synthetic fuels, there are some players working on price index development.
- Government support to push forward Chile’s green hydrogen projects includes bringing public land for use and coordinating territorial planning in the northern part of Chile.
- While recognizing the importance of equipment embodied emissions in hydrogen supply, most of the current assessment methodologies are well-to-gate evaluation. There are challenges to data availability and consistency of boundaries for all fuels to cover the embodied emissions for the entire global supply chain.

Summary

Q (to all): When I think of a hydrogen hub, I'm thinking that may be a location where we can start to observe the prices of hydrogen produced from different sources with different carbon contents behind it. Could you talk a little bit about if we were interested in observing the price of hydrogen and various other fuels and carriers like MCH, methanol and ammonia, and what is the best way to do that (transport hydrogen)?

A (Dr. Amgad Elgowainy): The idea of a hub is basically to co-locate supply and demand in the same region at scale. And like you mentioned, we already have a major hydrogen hub in Texas just by nature because a lot of refining capacities are located there. But as we develop a new value chain for hydrogen across other regions outside the Gulf area in the US, we need to do several things. We need clean hydrogen supply, we need market scaling up, and then we need infrastructure to connect them. That is why we have incentives for clean hydrogen production. And the market scaling up is a big question. Where are the off takers for clean hydrogen? We are now at the early stage of market scaling up and we see a lot of these are going to ammonia. It is natural because we already have infrastructure for ammonia delivery across longer distance at a bigger scale and because of potential of export to other regions. We see a lot of interest in the Sustainable Aviation Fuel (SAF), because this is really an area where there is global pressure for decarbonization. And then we see the vehicle market, which will take some
time to develop. But it is coming around. We see some applications in power sector too. Today there is no market price for hydrogen. We can google and know prices for natural gas or oil or even ammonia. There is nothing like that for hydrogen. We are looking forward to a mechanism that can tell hydrogen prices with different carbon intensities.

A (Mr Shintaro Onishi): As for the liquefied hydrogen, currently its cost is considered to be higher than that of existing fossil fuels such as LNG. However, as in the case of LNG, in the future, we have the potential to significantly reduce the price by scaling up the demand. 2030 is still the early stage of market scaling up, but for 2040 or 2050 if utilization of liquefied hydrogen scales up, we can anticipate cost-effectiveness. To scaling up the market, it is essential to collaborate with partners from various fields, as the company’s efforts alone may not be sufficient.

A (Mr Yuji Chishima): Now new infrastructure will be required basically to establish the global supply chain of hydrogen. But to bring the cost down, it will be very important to utilize existing infrastructures. In that sense, in the port area especially, there are lots of existing infrastructures which can be utilized. How we can utilize such existing infrastructures is a very important point. It should be the same for ammonia and MCH and other carriers. Instead of new infrastructure construction, utilization of existing ones can bring down the cost.

A (Mr Awadh Asyraf Bin Supri): While my colleagues (other panelists) have spoken about liquefied hydrogen and MCH, a bit of comment on ammonia. Ammonia is in a bit of a different situation as compared to the other hydrogen carriers. Ammonia has an existing market. The market size is around 200 million tons per year, and of which about 10% or 20 million tons are being traded internationally. But the question is, is this market price the right market price for the new landscape (low carbon ammonia)? Probably not, because the current ammonia market primarily serves the fertilizer market, which has its own supply and demand dynamics. But there are some learnings from the buildup of this market price that we can adopt in the future market pricing for low carbon ammonia and hydrogen. And I think on the business and publication side, we've seen some movements, some learnings that we take from also the LNG industry. In the LNG industry, we have the Japan Korea Marker, the JKM, which is published by Platts. Similar concepts are being proposed and being developed for low carbon ammonia, but we need to take away the supply-demand dynamics for the fertilizer segment rather to apply it on the new upcoming segments such as power or the bunkering segments.
Q (to Mr Alex Santander Guerra): I'm referring to the many projects that you currently have in Chile. You've got several projects already under operation in Chile and also a very ambitious target towards 2030. The question that I have is a bit of a reality check in terms of how do you see that upscaling and the actual production of hydrogen over the next seven years?

A (Mr Alex Santander Guerra): We are creating conditions for green hydrogen projects. As a government, we are creating the conditions in infrastructure, mainly ports, routes, and other ones, for example, government-owned companies develop and own the infrastructure, which is open for use by the private companies. In the case of the north of Chile, we are supporting different projects, creating conditions to bring public lands for use, and coordinating all territorial plannings and aspects related with green hydrogen projects.

Q (to Dr Amgad Elgowainy): The carbon intensity you have shown for hydrogen produced from wind or solar was zero. What I'm getting from that figure is that this is not a life cycle analysis, this is just the carbon intensity for hydrogen production. The debate that we have in Australia and globally is like, what is the actual carbon intensity if we include the life cycle analysis or the embedded carbon emissions for the production of the materials. If you have any figures, that would be nice.

A (Dr Amgad Elgowainy): What I showed was strictly conforming to the definition of well-to-gate in the US. These carbon intensity numbers are for well-to-gate, and they do not include embodied emissions. If you look at what is the embodied emission in electrolyzer, we need to track the supply chain to manufacture the electrolyzer, all of that, and then spreading it over the lifetime of the electrolyzer. It is around 70g-CO2/kg-H2. It is relatively small, but the bigger one is solar PV. Most of the solar PV panels come from China, which are more carbon intensive. So, for solar, it is about 35g-CO2/kWh and if multiplied by 60-65kWh/kg-H2 for electrolyzers, it will be about 2kg-CO2/kg-H2. For wind, it is about 0.5kg-CO2/kg-H2. To cover the embodied emissions, there are two difficulties. First, we need to track the supply chain coming to the US, which is difficult due to lack of comprehensive relevant data. And different economies have different numbers because of different supply chains. Second, can we cover the entire supply chain and can we be consistent? For example, if we do that for gas supply chain, we need to cover platforms, onshore, offshore, and processing plants, pipelines, and so on. What we do in the International Partnership for the Hydrogen Economy (IPHE) is that we excluded the
embodied emissions also though we think that something needs to be done about embodied emissions. And in the ISO LCA, we put a language there that embodied emissions is key and should be included for information purposes. Lack of data, consistent system boundary, and also regulatory framework sometimes restrict us on what we present about embodied emissions.

6-1-3. Session 3: Fuel Ammonia

a) Fuel Ammonia Production from Fossil Fuels

Mr Yoshikazu Kobayashi (Executive Analyst, New Energy System Group, Clean Energy Unit, The Institute of Energy Economics, Japan)

Key points
- Low carbon ammonia from natural gas is likely to be more cost competitive than ammonia from electrolyzed hydrogen. Lowering carbon intensity on a well-to-gate basis is the major challenge.
- Most of the planned fuel ammonia projects are at the feasibility study stage and policy supports for the demand side will be required to realize active hydrogen trade.

Summary
Mr Kobayashi made a presentation on fuel ammonia produced from fossil fuels. He emphasized that, despite the skepticism against fuel ammonia produced from fossil fuel as less clean, G7 leaders’ communique made this year confirmed that low carbon hydrogen and ammonia produced from fossil fuel as an effective means of decarbonization. He explained lowering carbon intensity on well-to-gate basis will be a major challenge for fuel ammonia based on fossil fuels and introduced several technological efforts for such intensity improvement. He also noted that most of the currently planned fuel ammonia projects are still at feasibility study stage and more policy supports toward the demand side will be required to realize active hydrogen trade.

b) Fuel Ammonia Power Generation and Building Supply Chain

Mr Najib Rahman Sabory (General Manager, Decarbonization Promotion Section, Planning Division, JERA Co, Inc, Japan)

Key points
- JERA aims to commence 20% co-firing within FY 2030, and 50% co-firing after 2030.
Plans to apply its expertise of ammonia utilization aboard and partners with foreign firms in Bangladesh; Indonesia; Malaysia; the Philippines; and Thailand.

Summary
Mr Sabory made a presentation about JERA's decarbonization strategy and the role of fuel ammonia in the strategy. He elaborated the company's investment projects in the entire value chain of fuel ammonia from production, transportation, and utilization at power plants both in Japan and abroad. He explained that JERA aims to commence 20% co-firing within FY 2030, and 50% co-firing after 2030. JERA, according to his presentation, will adopt zero-emission thermal power generation by utilizing hydrogen/ammonia single firing as of 2050. JERA also plans to apply its expertise of ammonia utilization aboard and partners with foreign firms in Bangladesh; Indonesia; Malaysia; the Philippines; and Thailand.

c) EMSA Study Potential of Ammonia as Fuel in Shipping
Mr Sergio Alda (Senior Project Officer, Sustainability, European Maritime Safety Agency (EMSA), Portugal)

Key points
・The International shipping industry would need substantially reducing its GHG emissions to achieve net zero GHG emission by or around 2050 and green ammonia has potential as a zero-carbon fuel for maritime.
・However, several challenges need addressing: safety issues, controlling NOx and N2O, and cost reduction.

Summary
Mr Alda made a presentation on the Agency's recent study on potential use of ammonia as a maritime fuel. He noted the international shipping industry will also need to substantially reduce its GHG emissions to achieve the IMO targets and contribute to achieving carbon neutrality by 2050 in the EU, and green ammonia is being explored as one of several alternatives to support decarbonizing the industry. Ammonia has several advantages such as availability of existing infrastructure and absence of CO2 emissions from its combustion onboard, yet he pointed out several challenges for its commercial use in marine engines, such as safety issues, need of controlling NOx and N2O, and need to reduce the cost gap with other alternatives.
d) Q&A and Discussions

Key points

- Ammonia co-firing has low technological risks compared to CCS at coal-fired power plants. Japan will not be able to find sufficient domestic storage capacity and utilizing storage abroad may be an option, but it may emit additional CO2 in transporting CO2. Ammonia co-firing, on the other hand, is an established technology and effectively reduce the CO2 emission in Japan.
- Potential pricing mechanism of fuel ammonia is uncertain. Ammonia already has an international market as a feedstock for fertilizer production, but clean ammonia price will reflect carbon intensity, tax benefits for production, certification by third-party organization, and energy security.
- If a hydrogen carrier is used for fuel cells, it may not be appropriate due to the low purity of cracked hydrogen from ammonia. For combustion as a fuel for boilers or turbines, ammonia is currently the most cost competitive.
- Ammonia will be used soon because it is more technologically matured with existing infrastructure. In the long run, other hydrogen carriers could enjoy the benefits of economies of scale and learning curve effect as their production will grow.

Summary

Q (to Mr Najib Rahman Sabory): Which is more economically attractive option: CCUS application at a power plant in Japan or utilizing ammonia as a co-firing or single-firing fuel?

A (Mr Najib Rahman Sabory): Ammonia co-firing has a low uncertainty compared to CCS application to coal-fired power plant. In case Japan is not able to find sufficient storage capacity within Japan, utilizing storage in overseas may be an option, but it may still emit additional CO2 in transporting CO2 abroad. Moreover, the CCS application in coal power plants might also require each power plant to be modified and retrofitted with additional infrastructure, which will result additional operation cost in coal power plants. So, there are technical and economical disadvantages to capturing and storing CO2 in coal power plants in Japan. Ammonia co-firing, on the other hand, is an established technology and effectively reduce the CO2 emission in Japan. Ammonia co-firing is a more preferred option.

Q (to Mr Sergio Alda): How will fuel ammonia be priced? What is a likely benchmark for
fuel ammonia?

A (Mr Sergio Alda): It is very difficult to tell. Ammonia already has an international market as a feedstock for fertilizer production, but clean ammonia as decarbonization fuel for shipping will reflect some other factors such as carbon intensity regulations and carbon market pricing, tax benefits for production, competition with other sectors. Consideration of energy security element may also be reflected. All of these factors will affect the final price of fuel ammonia, and it is not easy to tell based on what kind of benchmark the price will be set.

Q (to Mr Yoshikazu Kobayashi): What factors affect the end users’ choice of hydrogen carrier?

A (Mr Yoshikazu Kobayashi): It depends on the purpose of the use. If it is utilized for fuel cell, the purity of cracked hydrogen from ammonia will be relatively low and will not be appropriate. But if it is just combusted as a fuel for boiler or turbine, ammonia is currently the most cost competitive.

A (Mr Sergio Alda): It also depends on the time horizon. Ammonia may be used in the near future because it is more technologically mature and has an existing infrastructure. In the long run, other hydrogen carriers may have more benefits of economies of scale and could also become more economically attractive.

6-1-4. Session 4: Carbon Capture, Utilization and Storage (CCUS)

a) CCUS in Japan

Dr Kenta Asahina (Mineral and Natural Resources Division, Natural Resources and Fuel Department, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI), Japan)

Key points

- Japan published its annual storage capacity target of 120 to 240 million tons by 2050 and need to start its first commercial CCS operation by 2030 to find enough storage capacity and scale up the operation.
- Japan has already selected seven CCS projects as potential commercialized projects. Swift implementation of feasibility study for those projects are needed to start the
storage operation by 2030.

Summary
Dr Asahina made a presentation about the Japanese government’s policies on CCS. He introduced the historical development of CCS in Japan from 2000 and explained the current long-term CCUS roadmap that was released in March 2023. To achieve an annual storage capacity of 120 to 240 million tons by 2050, Japan will start the CCS business by 2030. He explained that the Japanese government has selected seven advanced CCS projects to establish various business models with different combinations of CO2 sources, transportation methods, and CO2 storage areas. He also added that the Japanese government is also working to demonstrate maritime CO2 transportation by ship next year.

b) CCUS in Australia
Dr Matthias Raab (Chief Executive Officer, Executive, CO2CRC Limited, Australia)

Key points
・Australian upstream operations have reached a crossover point where the cost of emitting CO2 exceeds the cost of CCS, stimulated by several factors, including 2050 net-zero targets set by most companies. A further income stream for CCS operators would be the CO2 utilization through enhanced oil recovery for a long time in many projects.
・There are no real technical barriers to CCS operation in Australia. CCS is an essential technology and needs to be adopted on an unprecedented scale for Australia to reach its legislated 2030 and 2050 targets.

Summary
Dr Raab presented the current status of Australian CCS project development. He suggested that Australian gas reached a crossover point where, for projects onshore and offshore, the cost of emitting CO2 exceeds the cost of CCS. He noted that several factors stimulated this crossing over. The first one is that most companies have had their own 2050 net-zero targets. The second one is that CCS can be utilized for enhanced oil recovery for a long time in many projects. He claimed that there are no real technical barriers exist for CCS operations. He emphasized that CCS is an essential technology and needs to be adopted on an unprecedented scale.
c) Carbon Capture, Utilization and Storage in China

Prof Jiutian Zhang (Green Development Institute, Beijing Normal University, Secretary General, China CCUS Association of Chinese Society for Environmental Sciences, China)

Key points
- CCUS is a very important decarbonization solution for China's energy transition and achievement of its carbon neutrality goal before 2060 and will play an important role in keeping the power system at zero emission as well as for the industry sector to realize carbon dioxide removal.
- More than 100 CCS projects in different stages are developed. Major challenges are to reduce costs with innovation and develop good business models.

Summary
Professor Zhang made a presentation on the CCUS operations in China. He contended that CCUS is very important for China's energy transition and achievement of its carbon neutrality goal before 2060. To secure a robust power system, he argued, CCUS will play an important role in keeping the power system at zero emission. CCUS is also very important in decarbonizing the industry sector and realizing negative emissions potentials. Without CCUS, he claimed, China cannot reach the goal of carbon neutrality. In China, a growing number of CCUS demonstration projects are being developed, and the number has already exceeded 100. CCS will be broadly adopted in various sectors from the oil and gas, power, steel, chemical, to cement sectors. He suggested that the main task of CCS technology development is to reduce costs, and developing good business models will bring more CCS potential in the future.

d) CCUS in ASEAN: Recent Developments in Indonesia

Dr Usman Pasarai (Senior Researcher, Research Center for Process and Manufacture Technology, National Research and Innovation Agency (BRIN), Indonesia)

Key points
- CCUS will play a critical role in achieving carbon neutrality in Southeast Asia (SEA). CO2 capture in SEA will have to reach 35 million tons in 2030 and exceed 200 million tons in 2050 to achieve the Paris Agreement.
- Indonesia is an active promoter of CCS in SEA. Most of 15 CCUS initiatives in
Indonesia at varied development stages will be on stream before 2030. Indonesia has relevant laws and regulations on greenhouse gas emissions, carbon tax, carbon trading and upstream oil & gas business activities.

Summary
Dr Pasarai presented the CCUS developments in ASEAN and Indonesia. He referred to the estimate made by the International Energy Agency (IEA) that, in order to remain in line with the Paris Agreement, CO2 capture in SEA will have to reach 35Mt in 2030 and exceed 200Mt in 2050. He introduced that, currently, there are 15 CCS/CCUS initiatives in Indonesia at varied development stages, and most of the projects will be on stream before 2030. He assesses the CO2 storage potential of saline aquifers in Indonesia at around 650Gt and assesses the storage capacity of depleted oil and gas fields in Indonesia at 12Gt. He explained that Indonesia has relevant laws and regulations on greenhouse gas emissions, carbon tax, and carbon trading and performance-based payment. The Indonesian government recently issued dedicated regulations on implementing CCUS in the upstream oil and gas business activities.

e) Q&A and Discussions

Key points
- Emissions trading, or any other type of carbon pricing system, may help business actors conduct CCS operations by reducing their emissions and gaining reduction credits for sale. The carbon pricing system sometimes becomes very complicated. It should be designed as simple as possible.
- Technological development is needed to reduce costs further, particularly in the carbon-capturing process. Financing will be a major challenge because few CCS projects have been conducted in Asia. Social acceptance is another challenge. Close dialogue and transparent information sharing with the local community are necessary. A legal framework to limit the responsibility of businesses is important to reduce business risks.
- Because the success of CCS largely depends on the government’s support, whether the government is supportive of CCS or not greatly affects the progress of CCS projects. Stable policy and regulatory environments are required to smoothly realize CCS projects, which must operate for many decades to amortize costs.
- It was agreed that CCUS collaboration in APEC is essential, starting from knowledge sharing among economies. Sharing best practices in safety practices in operation, legal and regulatory framework to incentivize business, and intergovernmental
dialogue and agreement for international CCS operations will facilitate CCS projects in the APEC region.

Summary
Q (to Dr Kenta Asahina): What is the legal basis for CCS operations in Japan?

A (Dr Kenta Asahina): The Japanese government is currently preparing for the legal basis for CCS in Japan and try to legislate next fiscal year.

Q (to Prof Jiutian Zhang): China has an emissions trading system for the power sector, but not for the industrial sector. Do you think that emission trading in broad sectors may become an incentive to promote CCUS?

A (Prof Jiutian Zhang): Emissions from industrial sources such as steel and cement are not covered in the existing carbon market system in China. China may work to include CCS to the existing carbon market mechanism.

Q (to Dr Matthias Raab): Australia has a domestic carbon crediting system. What is the status of methodological development for CCS in the system?

A (Dr Matthias Raab): The clean energy regulator in Australia has developed a method for CCS. In the methodology, CCS facilities are eligible to obtain Australian carbon credit units, the price of which is set at a minimum of AUD26. However, the method is redundant to the newly introduced safeguard mechanism because, in the safeguard mechanism, an existing CCS project is no longer eligible for carbon credits.

Q (to Dr Usman Pasarai): Why will the Enhanced Gas Recovery (EGR) project be the first CCS project in Indonesia?

A (Dr Usman Pasarai): All of the relevant parties, from the Indonesian government to oil and gas operators, made commitments to the projects. A major reason is that the required costs for CCS will be covered by the revenues from the enhanced gas production.

Q (to all): What do you think of CCU projects?
A (Dr Matthias Raab): Currently, most CCU projects are enhanced oil recovery in the US. The conversion of captured carbon into useful products is not at the commercial stage, and there is an issue with how quickly the scale-up and cost reduction will be realized.

Q (to all): What is the cost of storage today and in the future?

A (Dr Matthias Raab): The pure storage cost in an Australian onshore project were stated by the operator to be below AUD30 per ton of CO2. The cost for other projects vary depending on the availability of existing infrastructure.

A (Prof Jiutian Zhang): The marginal storage cost will be competitive with other emissions mitigation technologies in the future. Renewable power could be expanded to a very large scale, but the resources such as suitable land will be increasingly scarce, and the cost of renewable energy will become higher.

A (Dr Matthias Raab): The share of capturing cost out of the whole value chain, on average, is 65 to 70%. The cost of capture varies also depending on the purity of CO2 of captured gas.

Q Will carbon-neutral energies potentially become new game changers?

A (Dr Matthias Raab): The key point is, what is the dependency on the world on fossil fuel going forward? The four material pillars of our society are fertilizer, steel, cement, and plastics. CCS is mainly looking for electricity generation. However, that is only 27% of the whole energy equation. CCS needs to be adopted to decarbonize such material sectors.

Q (to Dr Matthias Raab): What is the current situation of the Australian government regarding willingness to promote CCS?

A (Dr Matthias Raab): The government will not financially support the oil and gas industry to start their CCS project. The newly introduced safeguard mechanism will require faster actions within the next five years than the industry can achieve because the CCS projects take much longer to build.

Q (to Dr Matthias Raab): In Australia, how onshore and offshore regulations for CCS
operations are designed and implemented?

A (Dr Matthias Raab): All offshore projects are governed by the Federal Offshore Greenhouse Gas Act. In addition to the federal law, most states in Australia have onshore legislation. The Australian government is currently revising its offshore regulations to streamline the regulatory framework.

6-1-5. Session 5: Direct Carbon Capture (DAC)

a) Research and Development for DAC in Japan
Prof Kenji Yamaji, President (Research Institute of Innovative Technology for the Earth, Japan)

Key points
• The DAC projects by New Energy and Industrial Technology Development Organization, Japan are pursued under the government initiative named “Moonshot” to realize human well-being and various DAC technologies are developed to capture low-concentration CO2 in the atmosphere.
• Realizing low-cost and high-efficiency DAC system should be given a high priority in the initiative. Various new technologies are also developed such as synthetic fuel to bring additional values to DAC.

Summary
Professor Yamaji overviewed the DAC technology development projects in Japan. The projects are being pursued under a larger government initiative named “Moonshot.” He explained that there are nine Moonshot goals to realize human well-being and DAC technology development is included in the Goal No.4, realization of sustainable resource circulation to recover the global environment by 2050. In this initiative, various DAC technologies are being developed to capture low-concentration CO2 in the atmosphere to realize low-cost and high-efficiency DAC system. In addition to DAC technologies, he suggested, various new technologies are being developed to convert captured CO2 into valuables.

b) Commercial-scale Direct Air Capture
Mr Adam Baylin-Stern (Director, Policy and Engagement, Carbon Engineering, Canada)
Key points

・When a large-scale project under construction in West Texas in the US by Carbon Engineering comes online, the project is designed to capture up to half a megaton of CO2 per year, which is expected to be the largest DAC project in the world when it comes online in 2025, and helping to demonstrate DAC commercially and on climate-relevant scale.

・Direct Air Capture, especially combined with underground storage, is ultimately an environmental service, and it is necessary for governments to help create the market for such service and to support accelerators for early projects.

Summary

Mr Baylin-Stern briefed the audience on his company’s DAC projects in this presentation. He explained that, because CO2 is dilute in the atmosphere, a large quantity of air has to be mobilized to capture CO2 at commercial scale. The company uses a process based on technologies that have industrial precedents and which are widely available across the world and couples them with the company’s proprietary configurations. He noted that a large-scale project is now under construction in West Texas in the US, and once it comes online, the project is designed to capture up to half a megaton of CO2 per year. He stated that DAC technology enables important decarbonization solutions such as carbon dioxide removal (CDR) as well as sustainable aviation fuel (SAF) utilizing captured CO2 combined with hydrogen. He contended that Direct Air Capture, especially when combined with underground storage, is ultimately an environmental service, and it is necessary for governments to help create the market for such service and to provide accelerators for early projects.

c) Q&A and Discussions

Key points

・Currently DAC projects are only conducted on a small scale. But a project pursued by 1PointFive, using Carbon Engineering DAC technology, may become a game changer with a mega-ton scale DAC operation. Japan’s R&D project is currently early stage but they intend to scale up and continue collecting date for life cycle assessment.

・Life cycle CO2 emissions including capital goods (infrastructure) was discussed, however, they are found to be a minor part. Energy inputs to DACCS operation are important emissions factors in determining net removal from the process, including full
accounting of lifecycle emissions associated with the use of natural gas and electricity.

- Preferred conditions for DAC operation include availability of high quality geologic reservoirs, land availability, and low-cost, low-carbon electricity. There was interest in cryogenic CO2 capture technology as a getting high-pressure carbon dioxide.

- Importance of policy framework, e.g. incentive and credits trading, were also discussed. Credit obtained from high integrity removal pathways such as Direct Air Capture with Carbon Storage (DACCS) are increasingly recognized as having a higher climate value than avoidance/reduction credits.

- Both downstream pathways of utilization and storage were noted as highly important. In Japan’s project, main focus is DAC proses but including utilization, and it will be assisted of the utilization carbon recycling or usage of carbon recovered. On the other hand, the cost of hydrogen is a key influence on the economics to produce synthetic fuels as a utilization option.

Summary
Q: What is the current number that your existing facility can capture per day?

A (Mr Adam Baylin-Stern): The nameplate design capacity of the Carbon Engineering Innovation Center in British Columbia, Canada is about 1,000 tons of CO2 per year, or a few tons per day.

A (Prof. Kenji Yamaji): Japan just started research and development of DAC, so we are in very early stage. The Dr Kodama’s project which RITE is participating is very small plants, it’s about 5kg per day of carbon dioxide captured from the air. And we are collecting various data, we are now counting life cycle assessments it a really net reductions with that scale, it is probably input of energy greenhouse gas is more than the removal from atmosphere. But by scaling up, we are planning to several hundred kg per day other vent plant. And in case probably we can get more data, and cost is concerned. We are not in stage evaluate commercial scale.

Q (to Mr Adam Baylin-Stern): In life cycle analysis, do you have an estimate of carbon penalty?

A (Mr Adam Baylin-Stern): Penalty in terms of lifecycle analysis exists, and it’s essential to minimize it, and ensure that it is fully accounted for within net removal of a facility. The lifetime of the project extends multi-decade, and the material impact is very minor. In
mitigating the carbon penalty, energy usage in the upstream sector is the key.

Q (to Mr Adam Baylin-Stern): What are the most important economic conditions needed for Direct Air Capture?

A (Mr Adam Baylin-Stern): There is a set of factors. If DAC is combined with underground storage, quality and availability of geologic reservoirs are an important factor. Solid regulatory environments and the availability of low-carbon energy inputs, particularly low-carbon and affordable electricity, are another key factor.

Q: DAC uses a large land per unit of CO2 captured. Do you see in the future that land footprint to be more optimized?

A (Mr Adam Baylin-Stern): Because DAC can be used as an option for negative emissions, it is a relatively land-efficient carbon removal technology. It is nonetheless true that DAC needs large facilities. The best way to achieve cost-effective deployment is to prioritize development in places with large sites available.

Q (to Prof Kenji Yamaji): I would like to know details of cryogenic CO2 capture.

A (Prof Kenji Yamaji): Cryogenic CO2 capture is a technology that uses cold energy from liquefied natural gas. Although the technology can get very high-pressure carbon dioxide, there are several problems. Controlling water vapor is technologically challenging, and location of the facility is limited to near liquefied natural gas facility.

Q (to Prof Kenji Yamaji): Presentation material seems to imply the DAC cost can be reduced to around USD60 per ton of CO2. Is this a realistic estimate?

A (Prof Kenji Yamaji): The number in the slide is illustrative. The assessment is cited from the analysis made by the report of Innovation for Cool Earth Forum (ICEF). If it currently USD800 per ton, they can be reducing USD100 per ton. Reduce the cost realized carbon neutrality. In that sense, I call it backstop technology.

Q: It seems there are two DAC options: one with underground storage and another with use of captured carbon. Which should we choose?

A (Prof Kenji Yamaji): Moonshot goal No 4 is realization sustainable resource circulation
to recover global environment by 2050. Resource circulation is mentioned in Moonshot goal No 4 of objective and we add utilization parts to the DAC project. But main focus is the DAC process. There are many developments business challenge or utilization recovered carbon dioxide not only recovered from the atmosphere but recovered before emitted to the atmosphere. In addition to that, some parts of DAC project of Moonshot goal No 4, part of the utilization, may be assist of the utilization carbon recycling or usage of carbon recovered.

A (Mr Baylin-Stern): Ultimately, achieving carbon neutrality will require both options. The choice to pursue any given pathway will ultimately be influenced by the setting of policy priorities and by the emergence of strong business cases based on DAC.

6-1-6. Session 6: Closing Remarks
Dr Kazutomo Irie, President, Asia Pacific Energy Research Centre (APERC)
Dr Irie was very appreciative to all the speakers, moderators, and active participants. He concluded this symposium was rich and multifaceted contents, and informative and encouraging for those who are persuading decarbonization ultimately toward carbon neutrality. Dr Irie stated that APERC will continue move forward with the APEC sectoral symposium and APERC was planning to organize the second symposium on energy efficiency in January 2024 in Tokyo.

6-1-7. Site Visits - Day2 (12 October)
Participants were divided into three groups and visited one of the facilities on the list:
Total 51 individuals attended the site visit programs.

Kawasaki Heavy Industries  9:20-12:00
Kawasaki Heavy Industries promotes the development of its original technologies in the four-phase process of hydrogen: production, transportation, storage, and utilization.
Kobe LH2 Terminal (Hy touch Kobe) is the world's first liquefied hydrogen receiving terminal. It accommodates a 2,500m3 volume spherical liquefied hydrogen storage tank as well as other equipment including a loading arm system specially designed for transferring liquefied hydrogen between land based facilities and ships. Co - generation system (CGS) with one MW class hydrogen gas turbine has been installed in city area (Kobe Port Island). Demonstrating power and heat derived from hydrogen to community. Achieved the world's first heat and power supply in city area using gas turbine CGS fueled 100% hydrogen.
Kobe Steel, Ltd (KOBELCO) 10:00-12:30
Kobe Steel, Ltd is expanding the utilization of hydrogen at various industries including their Group companies to contribute to the transition to decarbonization. During the transition period until a large amount of economical green hydrogen becomes available, they think it is important to promote the use of liquid hydrogen in combination with the hydrogen produced by water electrolysis using small-scale renewable energy power generation. They believe that KOBELCO's hybrid-type hydrogen gas supply system will be a key to successful decarbonization.

Mitsubishi Heavy Industries (MHI) -Takasago Machinery Works 10:00-12:30
Mitsubishi Heavy industries has launched the world’s first integrated validation facility from hydrogen production to power generation (Takasago Hydrogen Park) in September 2023. Takasago Hydrogen Park is divided into sections according to three hydrogen-related functions: hydrogen production, storage, and utilization. MHI Group is pursuing the energy transitions as an engine for corporate growth based on its declaration of “MISSION NET ZERO”, targeting carbon neutrality by 2040.

6-2. Promoting Energy Efficiency and Energy Management System (Tokyo)

6-2-1. Session 1: Opening Session
a) Opening Remarks
Dr Kazutomo Irie (President, Asia Pacific Energy Research Centre (APERC))

Key points
- Welcomed participants and explained the background and objectives of the Symposium.
- Emphasized the importance of the energy transition, energy efficiency, and sharing knowledge and experiences among APEC economies.

Summary
Dr Irie welcomed all invited speakers and active participants. Dr Irie explained the objective of the symposium was follow up the APEC symposium on Holistic approach of Decarbonization towards Carbon Neutrality held online in August 2021. As a second follow up symposium, picked up energy efficiency and energy management system. Dr Irie emphasized that in energy transition there was no single best solution for
achieving carbon neutrality or net zero as each APEC economy has different economic and social structure, and geographical situations. Various pragmatic and sustainable decarbonization pathways that reflect the different the circumstances of each economy are essential to achieving successful energy transitions. Sharing knowledge and experiences among member economies is beneficial, and a sectoral symposium is necessary to enhance our understanding of each sector. This symposium topic included energy efficiency in building, energy efficiency in transport, energy efficiency in industry and energy management systems and smart city.

b) Keynote Speech: The Evolution of Energy Efficiency Policy to Support Clean Energy Transition in Japan

Mr Hideyuki Umeda (Director for International Policy on Carbon Neutrality, Agency for Natural Resources and Energy (ANRE), Ministry of Economy, Trade and Industry (METI), Japan)

Key points

・ Emphasized that Japan needs to reduce 62 million kL in final energy consumption in FY 2030, which will be achieved by improvement of energy efficiency and expansion of non-fossil energy.
・ Concluded Japan's demand-side policies support clean energy transition. Japan will keep contributing to energy efficiency and decarbonization in APEC region by sharing its experience and policies.

Summary

Mr Umeda described Japan's performance in energy efficiency during the past decades and the need to reduce 62 million kL in final energy consumption in FY 2030, which will be achieved by improvement of energy efficiency and expansion of non-fossil energy. He then gave an overview of Japan's demand-side policies, including regulations which are stated in the Act on Rationalizing Energy Use and Shifting to Non-fossil Energy, and incentives in which energy conservation subsidies package is provided. Finally, Mr. Umeda concluded that Japan's demand-side policies have moved toward supporting clean energy transition, and Japan will keep contributing to the energy efficiency and decarbonization in the APEC region through its knowledge, experience, and policies in this regard.

c) Keynote Speech: The Key to an Energy Resilient APEC: Energy Efficiency and
Energy Management

Dr Meng Liu (Chair, APEC Expert Group on Energy Efficiency and Conservation (EGEEC) and, Deputy Chief, Division of Resources and Environment, China National Institute of Standardization, China)

Key points
- Recommended an increased focus on evaluating the cost-effectiveness of energy efficiency policies.
- Emphasized the importance of collecting and reporting energy efficiency data.

Summary
Dr Meng Liu appreciated joining the symposium as a member of the APEC Expert Group on Energy Efficiency and Conservation (EGEEC). He remarked that energy efficiency has been widely accepted as a critical solution to achieve sustainable development. Global focus on energy efficiency remains steady fast. The estimated 2023 rate of progress in energy intensity was set to fall back to below longer-term trends, to 1.3% from a stronger 2% last year. The global trend of energy efficiency will continuously increase.

APEC economies represent over 38% of the global population and 56% of global economic activity. The role APEC plays in the global energy market is indispensable. It accounts for 56% of world energy demand, 58% of world energy supply, and 68% of world electricity generation. APEC accounts for 60% of global CO2 emissions. The energy goal of APEC is to improve energy intensity by at least 45% by 2035 compared to 2005 levels. As of 2020, APEC-wide final energy intensity has improved 26% leaving an additional 19% improvement needed to meet the goal.

There are four important key sectors and areas regarding energy efficiency: industry, transport, building, and regulations and standards.

Regarding industry, it is important to deploy high efficient equipment. This also requires accelerated energy system integration and optimization. Moreover, expanding engagement in energy management activities such as PDCA is needed. As we are facing the technological age, integrating industry with emerging technology such as IoT, AI, etc is significant to improve energy efficiency.

On the transport sector, green, decarbonization, and smart transport are the main keywords.

On building, global experience shows the improvement in the green building codes. Multiple energy supply and demand are required to develop an integrated district energy
system. It could be cost-effective and efficient as well. Regulations and standards are important to continue the eco-system. Standards can be divided as four categories: Minimum energy performance standards (MEPS), Energy management system standards (EnMS), Supporting energy conservation standards for MEPS and EnMS, and Standards for energy efficiency and conservation market mechanism. The ISO 50001 (EnMS) system is based on a process of monitoring, targeting, and implementing energy saving measures in a cycle of continuous improvement. As of 2023, 23 ISO standards were released. In 2022, the number of ISO 50001 certificates issued worldwide grew by almost 30% to 28,000.

The key to success in achieving energy efficiency, leadership commitment, energy efficiency target, policy framework, and coordination of stakeholders are needed. There are complicated correlations between energy efficient improvement and emission reduction. Therefore, coordinated improvement between these two indicators. Furthermore, integration among different technologies, energy, and systems, especially smart technologies is important. He also suggested the importance of cost-effective evaluation of policies and continuous improvement of the policy portfolio (regulations and standards). Last but not least, capacity building for collecting quantitative/qualitative data and international collaboration to share a good practice/experience can contribute to more sustainable economies.

6-2-2. Session 2: Energy Efficiency in Building

a) Improving Energy Efficiency in Buildings in Hong Kong, China
Mr Wallace Leung (Chief Engineer, Energy Efficiency B, Electrical and Mechanical Services Department, Government of Hong Kong, China)

Key points
・ Buildings account for about 90% of electricity consumption and 60% of carbon emissions in Hong Kong, China. The reduction targets of 30-40% and 20-30% were set for electricity consumption in commercial and residential buildings, respectively, by 2050, using the operational conditions of 2015 as the comparison basis. Hong Kong, China’s energy intensity has decreased by 33.3% from 2005 to 2021.
・ The major regulatory approach is implemented by 1) Ordinance on energy efficiency and energy audit of buildings, 2) Mandatory Energy Labelling for appliances covering 80% of residential consumption, and 3) Building Regulation for energy efficiency of
building envelope of commercial buildings and hotels.

Summary
There are around 46,000 buildings in Hong Kong, China, which account for about 90% of total electricity consumption and for around 60% of carbon emissions. Hong Kong, China set the targets of 30-40% and 20-30% reduction of electricity consumption in commercial and residential buildings, respectively, by 2050, compared to operational conditions of 2015. The major regulatory approach of energy efficiency policies in Hong Kong, China is implemented through 1) Buildings Energy Efficiency Ordinance which stipulates minimum energy efficiency and energy audit for building services installation of buildings, 2) Mandatory Energy Efficiency Labelling for appliances which covers around 80% of energy consumption in residential buildings, and 3) Building (Energy Efficiency) Regulation which governs the energy efficiency of building envelope of commercial buildings and hotels. The governmental buildings have taken the lead to carry out energy saving retrofit and retro-commissioning and share the experience with the private sector.

Hong Kong, China also implemented Energy Saving Initiatives such as helping energy saving in schools and NGO venues, and smart meters are expected to be installed for all electricity utilities’ customers by the end of 2025. Besides, finance subsidies are provided through the Scheme of Control Agreement signed between the government and the two power companies, the Integrated Building Rehabilitation Assistance Scheme by Urban Renewal Authority, and accelerated deduction under profit tax, facilitating the improvement of energy efficiency in buildings.

Hong Kong, China has improved its performance in energy intensity by 33.3% from 2005 to 2021. Hong Kong, China’s energy efficiency in buildings is on the right track and will continue to do so.

b) Modeling the US buildings energy efficiency
Ms Courtney Sourmehi (Industry Economist, Energy Information Administration, U.S. Department of Energy, the US)

Key points
- The National Energy Modeling System (NEMS) Annual Energy Outlook 2023 Reference case projects that electricity will be the fastest growing energy source in buildings in the US through 2050. The drivers of this growth include stable and declining electricity prices, the relative efficiency of electric appliances and continued
population shifts to warmer regions.

- In the residential and commercial sectors, higher equipment efficiencies and compliance with building codes extend ongoing declines in energy intensity.
- Despite growth in heat pump adoption, natural gas continues to be the leading source for space heating for single-family homes.

Summary

The National Energy Modeling System (NEMS) is used to project energy markets out to 2050. Residential and commercial energy consumption projections by fuel through 2050 show electricity is the fastest growing energy source in buildings in the US. Thanks in part to energy efficiency, floorspace and housing stocks expand at a faster rate than energy consumption over the next 30 years. Natural gas remains the dominant source of space heating in the US.

In the residential and commercial sectors, higher equipment efficiencies and compliance with building codes extend ongoing declines in energy intensity. Changes in the buildings fuel mix reduce energy-related CO2 emissions, which decline faster in buildings than any other end-use sector. The drivers of building electrification in the US include the relative efficiency of electric appliances, a continued population shift to warmer regions, which is projected to increase demand for air-conditioning.

The Inflation Reduction Act of 2022 extended and expanded investment tax credits for residential and commercial distributed generation and combined heat and power cogeneration.

Regarding residential equipment shares, despite historical growth in heat pump adoption in single-family new-construction, we project natural gas will continue to be the biggest source for space heating in the US in the context of stable gas prices, given current laws and regulations. The average stock efficiency of natural gas-fired equipment increases over time and continues to compete with electric equipment.

c) Energy Efficiency of Buildings in Australia

Dr Subbu Sethuvnenkatraman (Research Group Leader, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia)

Key points

- Sixty percent of building energy use is through electricity and buildings account for 18% of total emissions in Australia.
- Digitalization of buildings involves connecting the buildings and getting access to all
data in a cost-effective way, and then delivering benefits through analytics.

• The pathway for decarbonization is achieved by a combination of energy efficiency measures supported by policies and technology changes with digitalization, and high uptake of renewable energy resources.

Summary
Buildings make up of about 18% total emissions in Australia, and nearly 60% of building energy use is through electricity. Australia has high uptake of Distributed Energy Resources (DER), where one in every three households is likely to have rooftop solar by 2050.

Australia’s energy efficiency policies for buildings have been implemented through National Energy Performance Strategy, Trajectory for low emission buildings, Sector wide decarbonization plans, National Construction Code (NCC), and Greenhouse and Energy Minimum Standards (GEMS) for appliances. As the data presents, the policies successfully improved the emission intensity in office buildings.

Regarding decarbonization of Australian built environment sector, there are ongoing policy improvements. For the residential buildings, from 2023, requirements for thermal performance for new homes has been increased from six to seven stars; and for commercial buildings, usage-based rating system (NABERS) successfully improved efficiency.

There are emerging opportunities that drive changes in Australia. Switching from gas heating to heat pumps, gas/electric boiler to heat pumps, and self-consuming facilitate electrification and decarbonization. Some of the trends regarding digitalization are moves such as installing smart meters and the sensors for monitoring and control. Access to data is valuable for consumers to participate in the market.

Take an example of Australian buildings which are undergoing a digitalization journey. First, we need to connect the buildings (“digital ready”) and get access to all data in a cost-effective way. Second, we need to deliver benefits through analytics (both operational and energy cost). We connect different sources, such as Building Management System (BMS) and IoT sensors, to a data platform for analytics.

For decarbonization of the Australian building sector, the modeling shows we should be able to reduce emissions from buildings to reach at least 2% of 2020 level emissions by 2050. The pathway is going to be supported by a combination of energy efficiency measures supported by policies and technology changes that enable digitalization and high uptake of renewable energy resources which are going to be available to the building sector.
d) Japan’s Path for Carbon Neutrality and the Role of Energy Efficiency in Buildings

Dr Naoko Doi (Senior Research Director, Assistant Director, Climate Change and Energy Efficiency Unit, The Institute of Energy Economics, Japan (IEEJ))

Key points

- Promoting the introduction of zero energy buildings, energy efficiency renovation of stock buildings, and efforts in operational energy efficiency improvement are the keys in the building sector.
- In the second supplementary budget for households in FY2023, a total of JPY421.5 billion are being provided for the energy efficiency of residential sector.
- Japan’s evolving energy efficiency policies include promoting carbon neutrality of water heaters, demand response ready appliances, and consumers’ engagement which would requires the electric/gas retailers to set energy saving targets.

Summary

Japan amended its energy conservation law. It was made to include “non-fossil fuels” on top of fossil fuels for energy efficiency improvement in April 2022. Demand response is also included as the energy efficiency concept. Promoting the introduction of zero energy buildings, energy efficiency renovation of stock buildings, and efforts in operational energy efficiency improvement are the keys in the building sector.

The Japanese government set a comprehensive approach to mobilizing JPY150 trillion of public-private investment for green transformation (GX). In the second supplementary budget for FY2023, for households, a total of JPY421.5 billion are being provided for the energy efficiency of residential sector.

According to the estimation, if all the newly built residential houses are ZEH from 2021, its share will reach 28.7% by 2050, while around 70% are existing stock buildings. Hence, the results show the needs for additional measures such as (1) operational energy efficiency improvement, (2) strengthening of energy efficiency renovation for existing stocks, and (3) promotion of ZEH in apartment buildings.

Japan’s evolving energy efficiency policies areas includes promoting carbon neutrality of water heaters, demand response ready appliances, and consumers’ engagement which would requires the electric/gas retailers to set energy saving targets.

Tokyo Metropolitan Government set the goal of reducing CO2 emissions by half, compared to 2000 emission level, by 2030. Among the measures to achieve this goal,
the Top-level Business Entity Certification System, which has been implemented for years, is utilized to facilitate the energy efficiency of building sector.

e) Q&A and Discussions

Key points

・ In the US, EIA is looking to create an even more accessible open-source version of the National Energy Modeling System. From a building’s perspective, they will take a deep look into how they can more robustly represent nuances in policy development.

・ The government of Hong Kong, China takes the lead by showing the commitment to the private sector through implementing energy saving targets, energy audit, retro-commissioning, etc in government facilities. The government merits achievements of private buildings to the society, provides technical advice to SMEs and encourages them to apply the finance subsidy for energy saving retrofit.

・ Data is the primary basis for continuous commissioning or tuning in Australia. Starting with basic instrumentation or monitoring is going to be important.

  Data driven Measurement and Verification (M&V) provided will be a major motivator for people to participate in energy efficiency schemes and benefit from them.

・ The Energy Conversion Law in Japan has been amended to include non-fossil energy. All energy sources, including all fossil fuels and renewables need to be regulated. The regulated industry and commercial sectors must report the annual fuels consumption aside from the fossil fuels.

Summary

Q (to Ms Courtney Sourmehi): What are you most excited about modeling in buildings as EIA updates NEMS this year, and why?

A (Ms Courtney Sourmehi): We are actually looking to create an open-source version of the National Energy Modeling System. Now our model is currently open and available to the public, but it can be expensive to run because you have to procure certain subscriptions that we cannot provide based on our subscription agreements with third party vendors. But we are looking to build a version of NEMS that is even more accessible. The general public could access NEMS via GitHub, to use and to do their own modeling to test our assumptions. We have also undertaken project Blue Sky, an initiative to develop the next generation energy systems model.

From a building’s perspective, I am interested in looking at how we can add an income
dimension to better model income-targeted programs that save energy. One important facet of building energy efficiency modeling is weatherization upgrades. There are new funds from the Inflation Reduction Act that are intended to support weatherization programs. Some programs specifically target low-income homes as well as tribal areas in the US. Income-targeted programs are difficult to model, at our current level of geographic granularity. It is really difficult to estimate those kinds of impacts. We are going to take a really deep look into how we can more robustly represent these latest policy developments.

Q (to Mr Wallace Leung): How do government buildings take the lead to encourage the private sector to improve energy efficiency? Are there any subsidies or incentives given and how do you measure the achievements?

A (Mr Wallace Leung): First, the government takes the lead by showing the commitment of government facilities to the private. Government buildings have a duty to save minimum 5% of energy in every five years since 2003. The current target is up to 6%. The central government allocates funding to drive the Energy Savings Initiative to achieve this target, through energy audit, retro-commissioning, energy saving retrofit, and install renewable energy system.

To promote the movement to the private buildings, the government, for example, will recognize the buildings which have done a good job, showing their achievement to the society through third parties’ building certification schemes.

For other building stocks, largely owned by small and medium enterprise, the government would encourage them especially in retro-commissioning, because normally they do not have enough resources. We provide technical advice with them or encourage them to apply for the finance subsidy for energy audit, retro-commissioning and energy saving retrofit. That’s what we do to encourage building energy efficiency.

Q (to Mr Wallace Leung): Retro-commissioning is important for the existing building stocks. Could you please explain more regarding this?

A (Mr Wallace Leung): The government normally did not allocate funding directly to the building owners to carry out energy saving works, but we have incentives and finance subsidy schemes to drive energy efficiency improvement works.

In Hong Kong, China, the power companies have set up funding schemes to subsidize the Energy Savings Initiative. Now, they provide free energy audit service, retro-
commissioning service as well as to subsidized part of the funding of the capital cost investment for some energy saving retrofitting works. We use these financial subsidies to drive the energy saving works. But for some specific groups of buildings, for example, schools and some NGOs, we set up special schemes to help them save energy. For example, we help them to replace the LED lighting and variable speed air conditioners in their venues as part of the community programs. We put this as a showcase for the society.

Q (to Dr Subbu Sethuvenkatraman): How to improve energy efficiency by adopting retro-commissioning with digitalization technology in your introduced case?

A (Dr Subbu Sethuvenkatraman): Digitalization underpins the energy efficiency upgrades that you might want to do with very low cost. Data is the primary basis for continuous commissioning or tuning. Based on our digitalization experience with commercial buildings, the primary data sources building tests start with installation of smart meters. The uptake of smart meters in building varies very widely. Perhaps at the higher end of the spectrum, premium buildings or buildings in major cities would probably have some form of digital infrastructure. The biggest challenge is medium and small sized buildings which do not have access to expensive upgrades and people who do not even have building management systems. How do they monitor and improve efficiency? That’s why we believe the data platform that we have created, and we are trying to make it as open data platform for the public good where people can actually provide all the data and the data can be used by contractors or service providers to implement energy efficiency upgrades scheme. Starting with basic instrumentation or monitoring is going to be really important. The other aspect is having reliable tools like measurement and verification. The fundamental challenge with all policy implementation is that you do not have a baseline. If you do not have a baseline, how do you make sure the improvement that has happened? It is important if you’re gathering data on a continuous basis. If you’re able to provide data driven M&V services, that is going to be a major motivator for people to actually participate in energy efficiency schemes and benefit from them.

Q (to Dr Naoko Doi): How to promote electrification and non-fossil fuels in Japan?

A (Dr Naoko Doi): The Energy Conversion Law has been amended to include non-fossil energy, so all energies including all fossil fuels, renewables and other non-fossil fuels,
need to be regulated. The industry sector and commercial sector regulated by this law have to report the annual consumption of fuels aside from the fossil fuels. Non-fossil fuels need to be utilized efficiently, including variable renewable energies.


a) Improving Energy Efficiency in Transport Sector of Singapore

Professor Qiang Meng (Department of Civil and Environmental Engineering (CEE), National University of Singapore)

Key points
- On the land transportation, the Singapore government is committed to reduce peak land transport emissions from the 2016 peak by 80% by or around 2050 mid-century through a holistic vehicle electrification plan.
- On the maritime industry, each container ship requires tugboats. Therefore, electric tugboats and optimal tugboat scheduling are needed to save energy.
- On the aviation industry, Changi Airport is upgrading its lighting and chilling systems to enhance energy efficiency of airport operations. The airport will step up its solar deployment on terminal buildings.

Summary

Singapore is a small city with a high population density. Although the airport is the second busiest in Asia and PSA Corporation is ranked number two in terms of container throughput worldwide, it is livable and sustainable city.

Singapore has an extra-developed road network which takes up 12% of the total land area. More than 60% (around one million vehicles) are private and rental cars. The car ownership rate is kept around 11% due to implementing Certificate of Entitlement (COE) management. On the other hand, two-thirds of daily individual travel trips are overtaken by buses and MRTs. About 1,000 vessels in Singapore water areas and one vessel leaves or enters every two-three minutes. 298,000 aircraft movements were recorded from January to November 2023.

Singapore works towards reducing its greenhouse gas emissions by using less carbon-intensive fuels, and by improving energy efficiency. A whole-of-government approach has been adopted to implement measures to improve energy efficiency and reduce the energy use of various sectors. Government agencies actively promote energy efficiency in five sectors through legislation, incentives, public education, etc.
Approximately 2.5 million tons of oil equivalent of primary energy were consumed in 2020 by the transport sector in Singapore (https://www.statista.com/statistics/973029/singapore-transport-related-energy-consumption/). Electricity consumption of transport was 2,899.7GWh in 2022 ranked in the third place (www.ema.gov.sg).


The Singapore government is committed to reduce peak land transport emissions from the 2016 peak by 80% by or around 2050 mid-century through a holistic vehicle electrification plan.

Although the Singapore government proposes several incentive schemes to purchase EVs, the price is high than that in other economies.

The Land Transport Master Plan 2040 envisions a land transportation system that is convenient, well-connected, and fast.

SBS Transit Ltd has already adopted strategies to reduce energy consumption. Also, SMRT Corporation Ltd is also taking the initiative that will reduce Heating, Ventilation and Air-Conditioning (HVAC) energy consumption through predictive AI to adjust setpoints, while maintaining commuter comfort.

On the maritime industry, each container ship requires tugboats. Therefore, electric tugboats and optimal tugboat scheduling in order to save energy are needed.

On aviation Changi Airport is upgrading its lighting and chilling systems to enhance energy efficiency of airport operations. Moreover, the airport will be stepping up its solar deployment on terminal buildings.

b) Improving Energy Efficiency in Transport in Malaysia

Mr Huzaimi Nor Bin Omar (Chief Operating Officer, ChargeEV, Green EV Charge Sdn Bhd, Malaysia)

Key points

- National Energy Transition Roadmap (NETR) 2023-2050 was launched, focusing on carbon emission reduction towards realizing the Net Carbon Emission 2050.
- Manufacturing incentives and voluntary energy efficient vehicle labeling schemes are implemented. Electric vehicles take center stage as the primary focus that EV penetration is expected to be 15% by 2030, 38% by 2040, and 80% by 2050.
- National EV Taskforce (NEVTF) and National EV Steering Committee (NEVSC) look
at the progress of EVs.

Summary
Regarding policy push for energy efficiency transport in Malaysia, Low Carbon Mobility Blueprint (LCMB) 2021-2030 is the first holistic policy document on land transport. The transportation sector is the highest contributor to emissions (20-29%) and final energy consumption (27%). As of last year, 33 million vehicles, 46% of which belong to passenger vehicles and motorcycles. Also, vehicle sales reached the highest (719,000s vehicles) last year. Moreover, the National Energy Transition Roadmap (NETR) 2023-2050 has been launched recently. NETR focused on carbon emission reduction towards realizing the Net Carbon Emission 2050. Various initiatives are taken. First, manufacturing incentives and voluntary energy efficient vehicle labeling schemes are implemented. Second, launched in 2022, electric vehicles take center stage as the primary focus that EV penetration is expected to be 15% by 2030, 38% by 2040, and 80% by 2050. Finally, the National EV Taskforce (NEVTFT) and the National EV Steering Committee (NEVSC) look at the progress of EVs. Due to these initiatives, EV market is growing in Malaysia. However, only 1.8% EV penetration rate in 2023.

He introduced YINSON Greentech which is aiming to accelerate the transition towards a net zero world.

c) Improving Energy Efficiency in Transport in the Philippines
Dr Noriel Christopher Tiglao (National College of Public Administration and Governance (NCPAG), University of the Philippines)

Key points
・ In 2015, the transport sector contributed to 34% of the total Philippines greenhouse gas emissions, with road transport accounting for 80% of those emissions.
・ Based on the transportation modeling, expansion of mass transit network is the single policy scenario that contributed to a higher overall reduction in petroleum and alternative fuel consumption levels.
・ The Comprehensive Roadmap for the Electric Vehicle Industry has four components: EVs and charging stations, manufacturing component, research and development, and human resource development.
Summary
Dr Noriel Christopher Tiglao made a presentation on Energy Efficiency in Transport in the Philippines.

In the Philippines, the total final energy consumption (TFEC) increased from 18.61Mtoe in 1990 to 32.224Mtoe in 2016, increasing annually by 2.8%. The TFEC of the transportation sector had increased by an average of 5.5% per year. In the 1990s, the residential sector had the largest share of TFEC whereas the transportation sector ranked second. From 2000 to 2016, the transportation sector occupied the largest share of total final energy consumption, with an average share of 34.2%. The road transportation mode consistently had the largest share, followed by the water transportation and air transportation mode. The rail transportation mode has little demand for energy, but this would change in the future. Diesel consistently had the largest share, followed by gasoline. The transportation sector is highly dependent on fossil fuels and it will remain as the highest energy consuming sector.

In the Philippines, the transportation sector is the largest source of air pollution and energy-related GHG emissions. In 2015, transport GHG emissions contributed to 34% of the total Philippines GHG emissions, with road transport accounting for 80% of those emissions. Similarly, 74% of air pollutants come from transport sources. Here, the transport sector in the Philippines is energy-intensive and contributed about 35.6MtCO2e and 27.4MtCO2e of emissions in 2019 and 2020, respectively.

In April 2021, the Philippines submitted its NDC. The Philippines commits to a projected GHG emissions reduction and avoidance of 75%, of which 2.71% is unconditional. Data from the Department of Transportation indicates that from a baseline of 24.02MtCO2e in 2010, the GHG contribution from the transport sector is projected to grow to 87.10MtCO2e in 2030 and 166.07MtCO2e in 2040. Based on initial calculations, transport projects can contribute to a GHG reduction of 10.03MtCO2e in 2030 and 14.23MtCO2e in 2040. Notably, rail has the largest contribution to GHG reduction at 6.79%.

Based on the transportation modeling, the expansion of the mass transit network is the single policy scenario that contributed to a higher overall reduction in petroleum and alternative fuel consumption levels. This is followed by the vehicle restraint (TDM) policy. The motor vehicle inspection system did not contribute to a significant reduction in fuel consumption.

The Electric Vehicle Industry Development Act (EVIDA) ensures the Philippines’s energy security and independence by reducing reliance on imported fuel for the transport sector and provides an enabling environment for the development and adoption of EVs and EV
charging stations. The Comprehensive Roadmap for the Electric Vehicle Industry (CREVI) refers to a National Development Plan for the EV industry which has four components: EVs and charging stations, manufacturing component, research and development, and human resource development.

National Energy Efficiency and Conservation Plan (NEECP) is a comprehensive framework and plan that institutionalizes energy efficiency and conservation in the domestic across key sectors. It forecasted that the Philippines’s energy mix in 2040 will appear like the energy mix to date, with a strong emphasis on oil products. This is due, in part, to the predicted continued demand for diesel and petrol from the transportation sector. While there have been programs to test electric vehicles and the use of natural gas in public transport, these have been limited.

The Philippine Energy Labelling Programs (PELP) is the development and rollout of energy performance requirements. Eco-driving has the potential to reduce fuel consumption. The observed engine fuel rate for eco-driving reduces by 41% compared to aggressive driving.

Two strategies come out: Transport Vehicles Fuel Economy Labeling Program (VFELP) needs cooperation between the private sector as well as the government agency. At the same time, research and development require co-create programs for incentivizing fuel efficiency and emission reduction. Public transport is key to keeping management and competition standards.

**d) Achievement and Potential of Multi-Pathway Approach in Road Transport Sector -Japan’s Experience**

**Mr Takao Aiba** (Vice Chairperson of Environmental Policy Subcommittee, and Chairperson of International Climate Change Policy Expert Group, Japan Automobile Manufacturers Association, Inc, (JAMA) )

**Key points**

- Japan has reduced 23% of CO2 emissions from the road transport sector, comparing with 9% in the US and 3 % in Germany and the Netherlands.
- An integrated approach is essential. There are four pillars: 1) automobile manufacturers should provide more fuel-efficient vehicles, 2) fuel suppliers should provide diversified fuel supply, 3) users/customers should select environmentally friendly cars, and 4) governments should enforce traffic flow improvement.
- Study findings of the JAMA's scenario-based analysis show that there is potential not
only for 100% BEVs, but also for a wide variety of electrified vehicles including HEVs and PHEVs and the use of Carbon-Neutral Fuel (CNF) for global CO2 emissions reduction in road transport to be in line with the IPCC's 2050 1.5-degree climate scenarios.

Summary
Mr Takao Aiba made a presentation on achievement and potential of multi-pathway approach in road transport sector.
Japan Automobile Manufacturers Association, Inc (JAMA) is a non-profit industry association comprising Japan's 14 manufacturers of passenger cars, trucks, buses, and motorcycles. JAMA member companies are making efforts towards carbon neutrality by 2050 by developing technologies to further reduce automotive CO2 emissions. Technology-neutral stance is important, which means a diversity of options is crucial to achieving carbon neutrality. Many pathways exist toward carbon neutrality.
Japan has reduced 23% of CO2 emissions from the road transport sector. This is indispensable when it comes to 9% increase in the US, 3% increase in Germany, and 3% increase in the Netherlands. It could be said that Japan is the leader in emission reduction in the transportation sector.
An integrated approach is essential. There are four pillars: automobile manufacturers should provide more fuel-efficient vehicles, fuel suppliers should provide diversified fuel supply, users/customers should select environmentally friendly cars, and governments should enforce traffic flow improvement. By implementing an integrated approach Japan is steadily reducing CO2 emissions from 2000.
Study findings of the JAMA's scenario-based analysis show that the supply of Carbon-Neutral Fuel (CNF), which comprises of biofuel and synthetic fuel, could take a crucial role. These pathways are recognized in the G7 communiqué and the Global Stocktake at COP28.
To sum up, Japan has been a leader in CO2 emission reduction in the road transportation sector among G7 members through the Integrated Approach. Particularly expanding line up of electrified vehicles suitable for regional circumstances, which is in line with the range of pathways’ concept, has improved energy efficiency. Based on the quantitative scenario analysis, JAMA believes that there is potential not only for 100% BEVs, but also for a wide variety of electrified vehicles including HEVs and PHEVs and the use of CNF for global CO2 emissions reduction in road transport to be in line with the IPCC's 2050 1.5-degree climate scenarios.
e) Q&A and Discussions

Key points

- In Singapore, the government is also concerned about the impact of EV charging demand on the capacity of grid. A smart charging strategy is also important. The highest EV charging demand at HDB could be after 6pm.
- Malaysia tries to understand the demand for generation and distribution on the grid. Currently initiatives on EVs are integrated. Malaysia understands there is huge potential for energy storage.
- In the Philippines monitoring enforcement and evaluation are key things. Moreover, there is a need to work with the private sector for reporting. Co-production and co-creation approaches are needed for stronger stakeholder cooperation and improving collaborative governance.
- In Japan the fuel economy standards using the top-runner approach set a very high target to reduce CO2 emissions. Backed by government incentives, the share of HEVs grew dramatically, which contributed to improving fuel economy in Japan.

Summary

Q: What is the impact on the electricity grid? How do different economies deal with the electricity grid?

A (Mr Huzaimi Nor Bin Omar): Currently initiatives on EVs are integrated. As mentioned, all stakeholders are involved in task forces. During the EV projection, Malaysia tries to understand the demand for generation and distribution on the grid. The number of EVs is primitive now but he forecasted that regulation would come soon. Technologies such as energy storage systems are taken into carefully. Malaysia understands there is huge potential for energy storage as well.

A (Prof Qiang Meng): The majority of people in Singapore are living in the government house. When the government designed the building, they already had electricity. However, in the future, demand will grow. Therefore, the government is concerned about the impact of EV charging demand on the capacity of the grid. A smart charging strategy is also important. The highest charging demand is after six pm. The government might need a sub-system of the grid.

A (Dr Noriel Christopher Tiglao): In the Philippines the issues are not only grid supply, but island matters. In order to ensure better energy for an island, the government tries to
set strict targets on shares of renewable energy.

A (Mr Takao Aiba): Depending on the charging situation, people want to reduce charging time. If people use quick charging systems, charging time will be reduced, but the impact on the grid increases. The city is fine with this situation, but in the rural area is not so easy.

Q (To Dr Noriel Christopher Tiglao): The Energy Conservation Law was amended so that 50,000KWh of power should be reported back to the government. How will the government implement this reporting system?

A (Dr Noriel Christopher Tiglao): Monitoring enforcement and evaluation are key things. He believes that there is a need to work with the private sector for reporting. Co-production and co-creation approaches should be widely explored for improving collaborative governance.

Q (To Mr Takao Aiba): What are the main factors according to the CO2 reduction in the Japanese case?

A (Mr Takao Aiba): The fuel economy standard using the top-runner approach, setting a very high target, has been effective. Backed up by the government’s economic incentive support, from the end of 2000s the share of HEV grew dramatically, which contributed to improving the fuel economy in Japan. Moreover, small cars/kei-cars account for 30-40% in Japan which features the Japanese market.

Q (To Professor Qiang Meng): On slide 10 why is tax on EVs higher than conventional cars? Why does the government treat EVs negatively?

A: I got the information from the website. Will double-check. But I assume that road tax will be decided by the power of cars.

Q (To Mr Takao Aiba): Do you consider the production costs of fuels?

A (Mr Takao Aiba): The production costs of synthetic fuel are important. 60% or two-thirds of its costs are green hydrogen. If green hydrogen costs are reduced, so is synthetic fuel. Brazil has a capacity for biofuel. The production costs depend on the environmental
factors of production.

6-2-4. Session 4: Energy Efficiency in Industry

a) Improving Energy Efficiency in Industry in Chinese Taipei

Dr Tze-Chin Pan (Deputy Division Director, Energy Policy and Planning Division, Green Energy and Environment Research Laboratories, Industrial Technology Research Institute, Chinese Taipei)

Key points

・ Considering that the growth rate of electricity consumption in the industrial sector dramatically exceeds that of energy demand, Chinese Taipei focuses on improving efficiency in electricity usage.
・ Designated factories in Chinese Taipei are faced with a mandatory target of saving electricity by 1%, which means that the total energy saved from 2015 to 2024 should exceed the total electricity consumption by 1%.
・ This target is currently under discussion regarding the potential strengthening of future targets to also encompass reductions in fossil fuel usage or setting more ambitious targets.

Summary

Chinese Taipei's energy and economic trends in recent decades were observed that while the GDP growth significantly outpaced the total energy demand from 2010-2022, the contribution of the industrial sector to the GDP rose markedly during this period, accounting for 40% of the total output of our economy. Despite this, the energy consumption in the industry remained relatively constant.

The rapid expansion of Chinese Taipei's electronics manufacturing industry, including semiconductors manufacturing industry, is believed to have caused this phenomenon. The energy intensity of the electronics manufacturing industry is significantly lower than that of heavy industries. For example, in Chinese Taipei, the energy intensity of the paper industry is about 16 times that of electronics manufacturing industry. Considering that the growth rate of electricity consumption in the industrial sector dramatically exceeds that of energy demand, the policy focus in Chinese Taipei is centered on improving efficiency in power usage.

A pivotal element of Chinese Taipei’s policy framework is the designation of large energy users who are subject to regulatory requirements aimed at driving continuous
performance improvements. The designation thresholds consider factors such as fossil fuel consumption volumes or electricity contract capacity. Factories that are designated are required to appoint energy management officers who must obtain certification from government to oversee compliance. These factories are also mandated to undergo energy audits conducted by energy management officers and report comprehensive consumption data to authorities annually. This reporting system enables authorities to monitor trends, identify priority sectors and technologies, and inform the development of new policies based on insights gleaned from aggregated industry data. Designated factories in Chinese Taipei are faced with a mandatory target of electricity saving by 1%, which means that the total energy saved from 2015 to 2024 should exceed the total electricity consumption by 1%. However, discussions are currently underway regarding the potential strengthening of future targets to also encompass reductions in fossil fuel usage or setting more ambitious goals for the largest energy consumers. Subsidy programs serve to complement regulatory measures by incentivizing the replacement of outdated equipment with more efficient models. Additional performance-based incentives are available for projects that can exceed energy savings thresholds of 10% or more. Looking ahead, Chinese Taipei’s new energy-saving strategy will focus on deploying emerging efficiency-boosting technologies and transitioning demonstration projects to wider adoption.

b) Improving Energy Efficiency in Industry in Korea

Mr Minkyu Kim (Associate Research Fellow, Department of Energy Demand and Policy Analysis, Korea Energy Economics Institute (KEEI), Korea)

Key points
- Under the Korea's voluntary energy efficiency targets program, the government collaborates with about 30 significant energy-intensive corporations, which account for over 60% of industrial energy usage.
- Those corporations pledge to annual improvement targets for their energy intensity with a partnership agreement with the authorities.
- The Korean LEEN initiative (Learning Energy Efficiency Networks) fosters innovation and facilitates knowledge-sharing among small and medium-sized companies, through workshops, diagnostic services, and other collaborative activities.
Summary
The manufacturing industry in Korea, which constitutes over 27% of the Gross Domestic Product (GDP), serves as the economic backbone of the economy. This sector is also responsible for over 50% of the economy’s energy consumption.
Given the industry’s critical role in both the economic and environmental spheres, enhancing efficiency is prioritized to bolster decarbonization targets and fortify energy security. The energy intensity of Korea, a metric that gauges the energy efficiency of its economy, surpasses that of numerous major economies and is improving at a relatively slower pace on average.
Under the aegis of Korea's voluntary energy efficiency targets program (KEEP 30; Korea Energy Efficiency Partnership 30), the government collaborates closely with about 30 significant energy-intensive corporations, which collectively account for over 60% of industrial energy usage. Firms participating in this program pledge to annual improvement targets for their energy intensity, facilitated through a partnership agreement with the authorities.
Incentives such as support for technology development or tax benefits are subsequently provided, contingent on regular performance evaluations. The Korean LEEN initiative (Learning Energy Efficiency Networks) augments this approach by instituting regional networks designed to foster innovation and facilitate knowledge-sharing among small and medium-sized enterprises, through mechanisms such as workshops, diagnostic services, and other collaborative activities.

c) Improving Energy Efficiency in Industry in Thailand
Mr Wisaruth Maethasith (Engineer, Professional Level, Energy Regulation and Conservation Division, Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand)

Key points
- The key policy measures targeted at the industrial sector encompass mandatory energy management standards for designated high energy usage factories and buildings.
- The designated facilities are obligated to appoint energy managers, implement management systems, and submit annual compliance reports to be verified by independent auditors.
- Thailand provides financial incentives such as equipment subsidies, which cover upper 30% of project costs for energy efficiency upgrades that meet the stipulated
Summary
Thailand's National Energy Efficiency Plan, which aspires to achieve a 36% reduction in energy intensity by the year 2037, relative to the levels recorded in 2010. Given that the manufacturing sector has emerged as the predominant energy consumer at the economy’s level, enhancements in industrial energy efficiency are deemed indispensable for the realization of this ambitious, economy-wide objective.

Under Thailand's plan, the key policy measures targeted at the industrial sector encompass mandatory energy management standards for designated high energy usage factories and buildings. The designation thresholds consider factors such as annual electricity consumption volumes. Facilities that have been designated are obligated to appoint energy managers, implement management systems, and submit annual compliance reports, which are to be verified by independent auditors.

In addition to the regulatory requirements, Thailand provides financial incentives such as equipment subsidies, which cover upper 30% of project costs for energy efficiency upgrades that meet the stipulated payback criteria. Tax incentives are also in place to encourage investments in energy efficiency.

Furthermore, Thailand is at the forefront of pioneering approaches to harness greater private sector investment in energy efficiency. This is achieved by bundling standardized factory project opportunities into investable financial products, which are certified based on projected savings and returns. The aim of this initiative is to amplify the impacts of energy efficiency by private sector.

d) Improving Energy Efficiency in Industry in Japan
Mr Akira Ishihara (Special Adviser, International Cooperation Division, the Energy Conservation Center, Japan (ECCJ))

Key points
• Considering the revisions to Japan's Energy Conservation Act, new strategies have been devised with the objective of promoting a transition in energy usage away from fossil fuels.
• Benchmark targets, which were previously applicable only to the most energy-intensive industries, have been expanded to additional sub-sectors within both the industry and commercial buildings.
• Overall, Japan's experience emphasizes the importance of integrated policy packages
that combine clear economy-wide objectives with tailored support measures, suited to the varying circumstances of industries and company sizes.

Summary
Despite an overall decrease in the industry's energy consumption in Japan, achieving further reductions would necessitate multilateral approaches, given the diverse circumstances across sectors.

The substantial gains of the past were largely attributed to the implementation of the best available technologies, such as combined heat and power systems and heat recovery. These technologies have now been widely adopted, indicating that the scope for incremental improvements solely through individual technologies might be limited.

Considering the revisions to Japan's Energy Conservation Act, new strategies have been devised with the objective of promoting a transition in energy usage away from fossil fuels. Benchmark targets, which were previously applicable only to the most energy-intensive industries, have been expanded to encompass additional sub-sectors within both the industry and commercial buildings.

Companies bear the responsibility of establishing internal efficiency and decarbonization targets and plans, adhering to the guidelines set forth by the government. Moreover, the government also delineates actual economy-wide reduction objectives that companies strive to collectively achieve.

Energy audits persist in playing a crucial role in driving performance improvements. Local platforms have been instituted to bolster information sharing and provide support for small and medium-sized enterprises that might lack in-house expertise. These audits consider optimization opportunities across various stages, ranging from minor retrofits to large-scale investments.

Looking towards the future, several technologies have high potential to improve the industries energy intensities. Heat pumps, for instance, are witnessing broader application in the industry owing to technical advancements, offering not only efficiency benefits but also a pathway for transitioning to lower-carbon electricity. The coordination of multiple efficient systems is demonstrating growing implementation, as evidenced by the integrated energy hub for an industrial park.

Digitalization also paves the way for new opportunities to visualize and optimize entire production processes. Overall, Japan's experience accentuates the importance of integrated policy packages that amalgamate clear economy-wide objectives with tailored support measures, suited to the varying circumstances of industries and company sizes.
e) Q&A and Discussions

Key points

・ The existence of a target is necessary for the progress of energy conservation. The existence of a target allows more efficient use of economic subsidies, leading to efficient energy conservation.

・ Improving awareness of the effects of energy conservation is important for promoting energy conservation. A lack of accurate information on the economy and effects of energy conservation leads to a lack of awareness, hindering energy conservation. Therefore, government intervention is necessary.

・ Differences in judgment criteria between management and operational workers can be a factor hindering energy conservation. Even if the workers feel energy efficiency deterioration of the equipment, the management may hesitate to make new investments for equipment. Third-party perspectives are needed.

・ There is a need to address cases where energy conservation investments are not made due to lack of knowledge of energy conservation for investment decision-makers. Workers should provide information to decision-makers.

Summary

Q (to Dr Tze-Chin Pan): Dr. Pan mentioned that Chinese Taipei has a policy of reducing electricity consumption by 1% every year, and currently, a review of this policy is being considered. In the discussions for the review, will renewable energy be included as a target in addition to fossil fuels?

A (Dr Tze-Chin Pan): Including renewable energy as a target could be one option. On the other hand, it could also be considered to raise the original target of reducing electricity consumption by 1% itself. Either way, the direction is still under discussion at present.

Q (to Mr Minkyu Kim): What kind of incentives are given in the voluntary energy efficiency improvement program in the industrial sector of Korea?

A (Mr Minkyu Kim): The government evaluates the progress of energy conservation, and depending on the level of evaluation, incentives including economic ones such as tax benefits are given.
Q (to Mr Wisaruth Maethasith): In the system of reporting energy consumption in Thailand, is it mandatory for companies to set energy conservation targets?

A (Mr Wisaruth Maethasith): In Thailand, companies are required to set energy conservation targets, but there is no specification of numerical targets or the types of energy to be targeted.

Q (to Mr Akira Ishihara): Since the goal of companies is to maximize profits, especially in small and medium-sized enterprises, it is likely that they would prioritize investment towards business expansion over energy-saving investment. How should this be addressed?

A (Mr Akira Ishihara): In small and medium-sized enterprises, there is a lack of knowledge and key persons regarding energy conservation. Therefore, in small and medium-sized enterprises, energy audits and analysis of energy-saving potential are important, and government support for these is necessary.

Q (to all presenter): Energy conservation brings benefits to companies and is expected to progress based on market principles. In this context, is there a significance for the government to implement energy conservation policies?

A (Dr Tze-Chin Pan): There could be cases where energy conservation investments are not made because those who make investment decisions or workers who should provide information to decision-makers do not have knowledge of energy conservation. Also, there could be cases where energy conservation is not performed due to financial constraints. Energy conservation policies are necessary to address such cases.

A (Mr Wisaruth Maethasith): Differences in judgment criteria between management and the field can also be a factor hindering energy conservation. Even if the field feels the deterioration of energy efficiency of the equipment, the management may hesitate to make new investments for equipment that is financially operational. To address such problems, the opinion of a third party would be necessary.

A (Mr Akira Ishihara): The existence of a target is also necessary for the progress of energy conservation. There are targets for the government and companies, and the existence of each target allows for more efficient use of economic subsidies and efficient
energy conservation. This is the same for not only energy conservation but also climate change.

A (Mr Minkyu Kim): Improving awareness of the effects of energy conservation is also important for promoting energy conservation. In Korea, the awareness of the importance of energy conservation is high, but there are cases where support for energy conservation is small compared to government support for renewable energy. This is due to a lack of accurate information on the economy and effects of energy conservation, leading to a lack of awareness. From this perspective, the importance of energy conservation should be appealed to society.

6-2-5. Session 5: Energy Management System and Smart City

a) APEC Low-Carbon Model Town (LCMT) Project

Mr Minh Tran (Deputy Head, Environment and Regional Sustainability Department, Institute of Regional Sustainable Development, Viet Nam)

Key points
- “Da Lat” was selected as the case studies to prevent emissions caused by incineration of solid waste and to contribute to generation of electricity for local consumption.
- Introduction of EVs leads to reduction of dependence on fossil fuel run vehicles and GHG emission. Modal shift leads to reduce road congestion and provide added attraction to tourists. Energy management systems can help reduce energy by up to 20% when installed.

Summary
The aim of the APEC Low-Carbon Model Town (LCMT) project is to conduct feasibility studies on low-carbon development and develop low-carbon visions for cities based on international best practices.
Low carbon intervention is conducted in pre-selected assessment areas, town structures and buildings, transportation, untapped energy, multi-energy and area energy system, renewable and energy management system, overall city. There are three sources of funding for interventions, multi-lateral funding agencies, government funding, private sector entrepreneurs and post-workshop consultation to be undertaken to gather data to facilitate assessment in feasibility study. Case studies of regions “Da Lat” resembling operating scenario had been selected and
they provide some learnings. Potential to prevent emissions caused by incineration of
>160MT of solid waste and contribute to generation of electricity for local consumption.
Introduction of EVs leads reduction of dependence on fossil fuel run vehicles and reduce
GHG emission. Modal shift also leads reduce road congestion and provide added
attraction to tourists. Implementation of Green Building Standards increase energy
requirement in buildings and reduce GHG emissions. Introduction of ride sharing options
and improving public transport system reduce requirement of fossil fuel vehicles and
provide business opportunities for locals. Energy consumption in buildings expected to
increase by 10% CAGR (Compound Average Growth Rate) between 2010 & 2030 under
existing conditions. Energy Management System can help reduce energy by up to 20%
when installed.

b) Energy Management System and Smart Cities: Current Situation and its Future
in the Philippines

Mr Felix William Fuenteabella (Undersecretary, Office of Undersecretary, Department of
Energy, the Philippines)

Key points
• The Philippines energy plan 2023-2050 shows Renewable Energy (RE) share in power
generation to be 35% by 2030 and 50% by 2050. The plan implements an energy
management system among designated establishments, an energy management
program by government, and efficiency guidelines for buildings design.
• The Smart and Green Grid Plan (SGGP) forms part of the Philippines Energy Transition
Program. The aggressive RE targets require the timely expansion of the transmission
system to integrate and manage the additional RE capacity to come online from 2024
to 2040.

Summary
The future energy scenario in the Philippines include five points, energy saving, power
generation mix, emerging technologies, ICT, energy resiliency. And there are three
energy strategic framework as access to affordable energy, reliability and resiliency and
clean and sustainable energy.

In the Philippines energy plan 2023-2050, reference is 35% Renewable Energy (RE)
share in power generation mix by 2030 and 50% RE by 2030-2050. There are some
plans for energy efficiency and conservation act such as Implementation of Energy
management system among designated establishments, government energy
management program and guidelines on energy conserving design of buildings. And fiscal incentives and energy efficiency excellence awards is valid.

The smart grid visions of smart power generation, smart utility and smart home and cities are conducted to ensure the seamless integration of additional renewable energy capacity to the grid in the coming years. The Smart and Green Grid Plan would serve as the basis for the transmission development plan.

The Smart and Green Grid Plan (SGGP) forms part of the Philippines Energy Transition Program and will complement the Philippines energy plan 2023-2050. The aggressive RE targets require the timely development of smart and green transmission system to integrate and manage the additional RE capacity expected to come online from 2024 to 2040.

c) Implementation of Energy Management System on Campus Buildings in Indonesia

Dr Sentagi Sesotya Utami (Associate Professor, Engineering Physics, Faculty of Engineering, Universitas Gadjah Mada (UGM), Indonesia)

Key points

・ In Indonesia, the Integrated Smart and Green Building (INSGREEB) in campus building is installed.
・ INSGREEB started in 2012, focusing on integrating building physics and acoustics using smart instrumentation and systems, and adapted to COVID-19 conditions. The innovation continues with a new paradigm “Healthy, but still energy efficient” from 2020.

Summary

In Indonesia the Integrated Smart and Green Building (INSGREEB) in campus building is installed. INSGREEB starts in 2012 and focus on integrating building physics and acoustics using smart instrumentation and systems and adapted to COVID-19 conditions, the innovation continues with a new paradigm “Healthy, but still energy efficient” from 2020.

Carbon emission in Indonesia, distribution of CO2 emissions by Building increase from 29% in 2011 to 36% in 2021. So, to set Green Building Goal is important. Green Building Goals have four aspects. Human development and mastery of science and technology, sustainable economic development, equitable development, strengthening Indonesia’s resilience and governance are valid and they are pillars of Indonesian development for 2045.
Smart building system includes nine principles, Automatization, Connected and Integrated, Energy Management Implemented, Cyber Security Applied, Use of Artificial Intelligence, User Satisfaction, Flexible, Ongoing Monitoring, Inclusive. About Automatization, Lighting automation, Thermal and Indoor Air Quality (IAQ), Control Algorithm is applied. About User Satisfaction, the platform adapts and prioritizes the building occupant’s needs in terms of safety, health, comfort, accessibility, security while improving life quality and increasing productivity is the key to achieve occupant satisfaction.

**d) Q&A and Discussions**

**Key points**
- Energy management systems can be implemented effectively at the institution, city, and economy-wide level.
- Artificial intelligence (AI) software has great potential but is far from being realized. Future efforts should focus on using AI to meet human needs for energy services more efficiently, which requires better measurement systems.

**Summary**

Q: If technology such as AI makes growing energy consumption much faster than other uses of energy? And also, technology makes agriculture, which is currently small, become much more important in terms of energy use?

A (Mr Minh Tran): As far as data centers are concerned, we seem on for example, in our office, if we digitalize our entire system, we save on space. So basically, it's a behavior shift of the entire world. So, no problem with that.

On the agricultural side, if we come up with a better design for energy, transit session markets, it can be captured because what we are measuring there are emissions. The energy transition market is still being developed globally.

A (Dr Sentagi Sesotya Utami): I believe that the technology of computers and data centers is very advanced now. We had to send off apple11 with the size of computer room. Now we can say that just one touch screen, something like that to send out our launcher or Apollo11. It still exists now. This is just an example that you know technology can adapt with the use of energy itself.
Q: Is there any thinking around managing energy use from air conditioning due to reducing humidity?

A: (Dr. Sentagi Sesotya Utami): In order to move out the humidity the most effective way is actually through air exchange. If we have an air exchange, we have the potential of having natural ventilation that would be very green. That is what we want to have in our green buildings to avoid using a lot of mechanical systems.

6-2-6. Session 6: Closing Remarks
Dr Kazutomo Irie, President, Asia Pacific Energy Research Centre (APERC)

Dr Irie was very appreciative to all the speakers, moderators, and active participants. He concluded this symposium was rich and multi-faceted contents, and informative and encouraging for those who are persuading decarbonization ultimately toward carbon neutrality. Dr Irie stated that APERC will continue move forward with the APEC sectoral symposium and APERC was planning to organise the third symposium on bioenergy in approximately October 2024 in Thailand in cooperation with the Thai ministry of energy. And he introduced the sixth 2024 ESCI Energy Smart Communities initiative best practices Awards Program hosted by Chinese Taipei.

6-2-7. Site Visit - Day2 (24 January)
Tokyo Denki University 10:00-12:00

Fifty-one individuals attended Tokyo Denki University site visit. Tokyo Denki University (TDU) is an integrated science and engineering university founded in 1907 (formerly Denki School). TDU Senju Campus is engaged in a variety of CO2 reduction initiatives. They adopt vertical installed huge Thermal Capsule, Air-flow window with Retro-reflective film, Breeze air conditioning system, and energy-saving operation coordination with monitoring system for calculate the number of people in the room. They also provide real-time monitoring of electricity consumption, CO2 emissions, and water usage. These initiatives are unique and have had a significant effect on reducing electricity consumption and CO2 emissions.
7. Symposium Analysis
APEC Symposium on Pursuing Decarbonization of Fossil Fuels on 11 and 12 October 2023 in Kobe City, Hyogo, Japan.

In the symposium, including speakers, participants, and organizers, more than 60 individuals participated. 26 attendees completed the evaluation survey.

Figure 1. APEC Project Evaluation Survey on Fossil Fuels
According to the survey results shown in Figure 1, most respondent thought that the objectives in the symposium were clearly defined and easily understood.

In general, the survey results support the notion that it achieved the intended objectives. Some respondent thought that the presentations were a bit compressed in time and needed more time to get more details. Some request more sessions focus on decarbonization of fossil fuels other than renewable energies.

In the symposium, including speakers, participants, and organizers, more than 60 individuals participated. 25 attendees completed the evaluation survey.

![Figure 2. APEC Project Evaluation Survey on Fossil Fuels](image)
According to the survey results shown in Figure 2, most respondent thought that the agenda items and topics covered were relevant and the content was well organized and easy to follow. The symposium included diverse viewpoints across economies and professions. The symposium was a good foundation for future international cooperation and discussion among APEC economies. Some respondent thought that this type of symposium should be a two-day event to allow more time for the Q&A. For reasons unknown, one person shows a negative reaction for applying the project’s content and knowledge gained at his/her workplace.

The participation rate of female speakers should be increased.
### 8-1. Agenda

**APEC Symposium on Pursuing Decarbonization of Fossil Fuels**  
11-12 October 2023 in Kobe City, Hyogo, Japan

Venue: Banquet hall “Kairaku” on the B1 Floor, Kobe Portopia Hotel

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<th>Time</th>
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<tr>
<td>08:30-09:00</td>
<td>Registration</td>
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<tr>
<td>09:00-09:20</td>
<td>1. Opening Session</td>
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<td>09:00-09:05</td>
<td>1-1 Opening Remarks</td>
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<td>09:05-09:20</td>
<td>1-2 Keynote Speech:</td>
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<td></td>
<td>Necessity of Decarbonization of Fossil Fuels for Carbon Neutrality</td>
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<tr>
<td>09:20-09:40</td>
<td>2-1 Production of Hydrogen I</td>
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<td>09:40-10:00</td>
<td>2-2 Production of Hydrogen II</td>
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<td>10:00-10:20</td>
<td>2-3 Transportation of Hydrogen</td>
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<td>10:20-10:40</td>
<td>2-4 Transportation of Hydrogen (Liquefied Hydrogen)</td>
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<td>10:40-11:00</td>
<td>2-5 Hydrogen Utilization</td>
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<td>11:00-11:20</td>
<td>Q&amp;A for all presenters and discussion</td>
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<td>11:20-11:35</td>
<td>Coffee Break</td>
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MC: Prof Mayumi Matsumoto, Visiting Associate Professor, Special Division of Environmental and Energy Sciences, Komaba Organization for Educational Excellence (KOMEX), the University of Tokyo, Japan

Moderator: Ms Sichao Kan, Senior Researcher, New Energy System Group, Clean Energy Unit, Institute of Energy Economics, Japan (IEEJ)
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<th>Time</th>
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<pre><code>          | Moderator: Mr Mathew Charles Horne, Senior Researcher, Asia Pacific Energy Research Centre (APERC) |
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| 11:35-11:55  | **3-1 Production of Fuel Ammonia from Fossil Fuels**
              | Mr Yoshikazu Kobayashi, Executive Analyst, New Energy System Group, Clean Energy Unit, The Institute of Energy Economics, Japan |
| 11:55-12:15  | **3-2 Fuel Ammonia for Power Generation**
              | Mr Najib Rahman Sabory, General Manager, Decarbonization Promotion Section, Planning Division, JERA Co., Inc., Japan |
| 12:15-12:35  | **3-3 Ammonia as Fuel in Shipping**
              | Mr Sergio Alda, Senior Project Officer, Sustainability, European Maritime Safety Agency (EMSA), Portugal |
| 12:35-12:55  | **Q&A for all presenters and discussion**                                 |
| 12:55-14:10  | Lunch Break - Banquet hall “Kairaku” on the B1 Floor                   |
| 14:10-16:00  | **4. Carbon Capture, Utilization and Storage (CCUS): Evaluation of Current Status and How to Promote Development and Deployment**
              | Moderator: Dr Atsushi Kurosawa, Director, Global Environment Program, Research and Development Division, Institute of Applied Energy (IAE), Japan |
| 14:10-14:30  | **4-1 CCUS in Japan**
              | Dr Kenta Asahina, Mineral and Natural Resources Division, Natural Resources and Fuel Department, Agency for Natural Resources and Energy, Ministry of Economy, Trade and Industry (METI), Japan |
| 14:30-14:50  | **4-2 CCUS in Australia**
              | Dr Matthias Raab, Chief Executive Officer, Executive, CO2CRC Limited, Australia |
| 14:50-15:10  | **4-3 CCUS in China**
              | Prof Jiutian Zhang, Green Development Institute, Beijing Normal University, Secretary General, China CCUS Association of Chinese Society for Environmental Sciences, China |
| 15:10-15:30  | **4-4 CCUS in ASEAN**
              | Dr Usman Pasarai, Senior Researcher, Research Center for Process and Manufacture Technology, National Research and Innovation Agency (BRIN), Indonesia |
| 15:30-16:00  | **Q&A for all presenters and discussion**                                 |
| 16:00-16:15  | Coffee Break                                                             |
              | Moderator: Mr Glen E. Sweetnam, Senior Vice President, Asia Pacific Energy Research Centre (APERC) |
| 16:15-16:35  | **5-1 R&D for DAC in Japan**
              | Prof Kenji Yamaji, President, Research Institute of Innovative Technology for the Earth, Japan |
| 16:35-16:55  | **5-2 R&D/commercialization for DAC in North America**
<pre><code>          | Mr Adam Baylin-Stern, Director, Policy and Engagement, Carbon Engineering, Canada |
</code></pre>
<p>| 16:55-17:15  | <strong>Q&amp;A for all presenters and discussion</strong>                                 |</p>
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<tr>
<td>17:15-17:20</td>
<td><strong>6. Closing Remarks</strong></td>
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<td>Dr Kazutomo Irie, President, Asia Pacific Energy Research Centre (APERC)</td>
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<tr>
<td>18:00-</td>
<td>Reception</td>
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<td>(JST)</td>
<td>Banquet hall “Kairaku” on the B1 Floor</td>
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<td>Thursday, 12 October</td>
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<td>Site Visit</td>
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APEC Symposium on
Promoting Energy Efficiency and Energy Management System
23-24 January 2024 in Tokyo, Japan

Venue: Banquet room “RUBY 34” on the 34th Floor, Shinagawa Prince Hotel

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<th>(JST)</th>
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<td>09:00-09:05</td>
<td>1-1 Opening Remarks&lt;br&gt;Dr Kazutomo Irie, President, Asia Pacific Energy Research Centre (APERC)</td>
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<td>09:05-09:20</td>
<td>1-2 Keynote Speech:&lt;br&gt;Mr Hideyuki Umeda, Director for International Policy on Carbon Neutrality, Agency for Natural Resources and Energy (ANRE), Ministry of Economy, Trade and Industry (METI), Japan</td>
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<td>09:20-09:35</td>
<td>1-3 Keynote Speech:&lt;br&gt;Dr Meng Liu, Chair, APEC Expert Group on Energy Efficiency and Conservation (EGEEC) and, Deputy Chief, Division of Resources and Environment, China National Institute of Standardization, China</td>
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<td>09:35-09:45</td>
<td>Group Photo</td>
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<td></td>
<td>09:45-11:05</td>
<td>2. Energy Efficiency in Building: Current Situation and Room for further improvement&lt;br&gt;Moderator: Mr Ting-Jui Sun, Senior Researcher, APERC</td>
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<td>09:45-10:00</td>
<td>2-1 Improving Energy Efficiency in Buildings in Hong Kong, China&lt;br&gt;Mr Wallace Leung, Chief Engineer, Energy Efficiency B, Electrical and Mechanical Services Department, Government of Hong Kong, China</td>
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<td></td>
<td>10:00-10:15</td>
<td>2-2 Modeling US buildings energy efficiency&lt;br&gt;Ms Courtney Sourmehi, Industry Economist, Energy Information Administration, U.S. Department of Energy, the US</td>
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<td>10:15-10:30</td>
<td>2-3 Energy Efficiency of Buildings in Australia&lt;br&gt;Dr Subbu Sethuvanakraman, Research Group Leader, Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia</td>
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<td>10:30-10:45</td>
<td>2-4 Japan’s Path for Carbon Neutrality and the Role of Energy Efficiency in Buildings&lt;br&gt;Dr Naoko Doi, Senior Research Director, Assistant Director, Climate Change and Energy Efficiency Unit, The Institute of Energy Economics, Japan (IEEJ)</td>
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<td>10:45-11:05</td>
<td>Q&amp;A for all presenters and discussion</td>
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<td>Coffee Break</td>
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<td>11:20-12:40</td>
<td>3. Energy Efficiency in Transport: Current Situation and Room for further improvement&lt;br&gt;Moderator: Mr Finbar Maunsell, Assistant Researcher, APERC</td>
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| 11:20-11:35 | 3-1 Improving Energy Efficiency in Transport Sector of Singapore  
Professor Qiang Meng, Department of Civil and Environmental Engineering (CEE), National University of Singapore |
| 11:35-11:50 | 3-2 Improving Energy Efficiency in Transport in Malaysia  
Mr Huzaimi Nor Bin Omar, Chief Operating Officer, ChargeEV, Green EV Charge Sdn Bhd, Malaysia |
| 11:50-12:05 | 3-3 Improving Energy Efficiency in Transport in the Philippines  
Dr Noriel Christopher Tiglao, National College of Public Administration and Governance (NCPAG), University of the Philippines |
| 12:05-12:20 | 3-4 Achievement and Potential of Multi-Pathway Approach in Road Transport Sector -Japan’s Experience  
Mr Takao Aiba, Vice chairperson of Environmental Policy Subcommittee, and Chairperson of International Climate Change Policy Expert Group, Japan Automobile Manufacturers Association, Inc., (JAMA), Japan |
| 12:20-12:40 | Q&A for all presenters and discussion |
| 12:40-13:55 | Lunch Break |
Moderator: Mr Mathew Horne, Senior Researcher, APERC |
| 13:55-14:10 | 4-1 Improving Energy Efficiency in Industry in Chinese Taipei  
Dr Tze-Chin Pan, Deputy Division Director, Energy Policy and Planning Division, Green Energy and Environment Research Laboratories, Industrial Technology Research Institute, Chinese Taipei |
| 14:10-14:25 | 4-2 Improving Energy Efficiency in Industry in Korea  
Mr Minkyu Kim, Associate Research Fellow, Department of Energy Demand and Policy Analysis, Korea Energy Economics Institute (KEEI), Korea |
| 14:25-14:40 | 4-3 Improving Energy Efficiency in Industry in Thailand  
Mr Wisaruth Maethasith, Engineer, Professional Level, Energy Regulation and Conservation Division, Department of Alternative Energy Development and Efficiency, Ministry of Energy, Thailand |
| 14:40-14:55 | 4-4 Improving Energy Efficiency in Industry in Japan  
Mr Akira Ishihara, Special Adviser, International Cooperation Division, the Energy Conservation Center, Japan (ECCJ) |
| 14:55-15:15 | Q&A for all presenters and discussion |
| 15:15-15:30 | Coffee Break |
| 15:30-16:35 | 5. Energy Management System and Smart City: Current Situation and Room for further improvement  
Moderator: Mr Glen Sweetnam, Senior Vice President, APERC |
| 15:30-15:45 | 5-1 APEC Low-Carbon Model Town (LCMT) Project  
Mr Minh Tran, Deputy Head, Environment and Regional Sustainability Department, Institute of Regional Sustainable Development, Viet Nam |
| 15:45-16:00 | 5-2 Energy Management System and Smart Cities: Current Situation and its Future in the Philippines  
Mr Felix William Fuenteblella, Undersecretary, Office of Undersecretary, Department of Energy, the Philippines |
| 16:00-16:15 | 5-3 Implementation of Energy Management System on Campus Buildings in Indonesia  
Dr Sentagi Sesotya Utami, Associate Professor, Engineering Physics, Faculty of Engineering, Universitas Gadjah Mada (UGM), Indonesia |
<p>| 16:15-16:35 | Q&amp;A for all presenters and discussion |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>16:35-16:40</td>
<td>6. Closing</td>
</tr>
<tr>
<td>16:35-16:40</td>
<td>6-1 Closing Remarks</td>
</tr>
<tr>
<td></td>
<td>Dr Kazutomo Irie, President, Asia Pacific Energy Research Centre (APERC)</td>
</tr>
<tr>
<td>17:30-</td>
<td>Reception:</td>
</tr>
<tr>
<td></td>
<td>Banquet room “AQUAMARINE 32” on the 32nd Floor</td>
</tr>
<tr>
<td>(JST)</td>
<td>Wednesday, 24 January 2024</td>
</tr>
<tr>
<td>10:00-12:00</td>
<td>Site Visit (half a day): Tokyo Denki University</td>
</tr>
</tbody>
</table>
8-2. Presentation Materials

1. APEC Symposium on Pursuing Decarbonization of Fossil Fuels

1-2. Energy Transition and Green Hydrogen in Chile

1-3. Development of Global Supply Chain by LOHC-MCH method

1-4. Towards the Realization of International Liquefied Hydrogen Supply Chain

1-5. Analysis of Current and Future Hydrogen Production and Utilization in the United States

1-6. Fuel Ammonia Production from Fossil Fuels

1-7. Fuel Ammonia Power Generation and Building Supply Chain

1-8. EMSA study Potential of Ammonia as Fuel in Shipping

1-9. CCUS in Japan

1-10. CCUS in Australia

1-11. CCUS in ASEAN: Recent Developments in Indonesia

1-12. Research and Development for DAC in Japan

1-13. Commercial-scale Direct Air Capture

2. APEC Symposium on Promoting Energy Efficiency and Energy Management System
2-1. Keynote Speech: The Evolution of Energy Efficiency Policy to Support Clean Energy Transition in Japan

2-3. Improving Energy Efficiency in Buildings in Hong Kong, China

2-4. Modeling the US buildings energy efficiency

2-5. Energy Efficiency of Buildings in Australia

2-6. Japan’s Path for Carbon Neutrality and the Role of Energy Efficiency in Buildings

2-7. Improving Energy Efficiency in Transport in Malaysia

2-8. Improving Energy Efficiency in Transport in the Philippines

2-9. Achievement and potential of multi-pathway approach in road transport sector - Japan’s experience

2-10. Improving Energy Efficiency in Industry in Chinese Taipei

2-11. Improving Energy Efficiency in Industry in Thailand

2-12. Improving Energy Efficiency in Industry in Japan


APEC Symposium on Pursuing Decarbonization of Fossil Fuels – October 11, 2023

Necessity of Decarbonization of Fossil Fuels for Carbon Neutrality

Reiko Eda
Agency for Natural Resources and Energy, Japan
EGCFE Chair

Energy transition through various pathways and innovation

Basic Policy for Realization of GX (Green Transformation)

To realize a stable supply of energy, measures including promoting shifts to decarbonized power sources will be taken.

- Renewable energy: To expand the introduction of renewable energy, a grid development plan has been established. Investment in the next 10 years will 3 times as much as in the past 10 years.
- Nuclear power: Replacement of reactors decided to be decommissioned with next generation innovative reactors. Review of operating period (40 years + 20 year extension = shutdown period such as inspection)

Government support will be provided for upfront investment of 20 trillion yen to achieve carbon neutrality by 2050 while strengthening industrial competitiveness and realizing economic growth, aiming for more than 150 trillion yen of public and private investment over the next 10 years.

To promote the GX investment as described above, a “Growth Oriented Carbon Pricing Concept” will be embedded and implemented in such as possible.

1. Government support for bold upfront investment by issuing “GX Economic Transition Bonds” (20 trillion yen over the next 10 years)
2. Introduction of carbon pricing to give incentives for GX investment
   - (1) Full-scale operation of emissions trading system in high emission industries (from FY2026)
   - (2) Auctioning auctioning is phased in gradually to power generation companies (from FY2033)
3. Strengthen financial support through public-private partnership

G7

G7 Climate, Energy, and Environment Ministerial, 15-16 April, Sapporo

G7 Leaders’ Summit 19-21 May, Hiroshima

Highlight of the 2023 Basic Hydrogen Strategy

- To introduce hydrogen having well regard to the 5+3E principles (Safety, Energy security, Economic efficiency, Environmental compatibility) and industry competitiveness.
- The scope of strategy includes hydrogen and its derivatives such as ammonia, synthetic methane, synthetic fuels, etc., taking into consideration of the challenges and timelines surrounding these products.

Basic Strategy

- To diversify hydrogen production technologies including electrolysis, fuel cells, biogene (including plants and manmade), and reusing waste hydrogen
- To diversify hydrogen supply chains and transportation systems

Creating Demand

- To introduce hydrogen having well regard to the 5+3E principles (Safety, Energy security, Economic efficiency, Environmental compatibility) and industry competitiveness.
- To diversify hydrogen production technologies including electrolysis, fuel cells, biogene (including plants and manmade), and reusing waste hydrogen
- To diversify hydrogen supply chains and transportation systems

Other

- Promote regional use and consumption and engage local governments
- Cross-border cooperation for standardization and other activities
- Maintain innovation R&D
- Enhance public awareness and acceptance

APEC Symposium on Pursuing Decarbonization of Fossil Fuels
AZEC Ministerial Meeting
- On 4 March 2023, METI hosted Asia Zero Emissions Community (AZEC) Ministerial Meeting.
- Minister Nishimura, Minister of Economy, Trade and Industry of Japan, who chaired the meeting, made remarks on the importance of decarbonization in Asia, AZEC concept, and Japan's specific efforts.

Participating economies (in alphabetical order)
Australia, Brunei Darussalam, Cambodia, Indonesia, Japan, Laos Malaysia, the Philippines, Singapore, Thailand, Viet Nam
Participating international organizations (in alphabetical order)
Economic Research Institute for ASEAN and East Asia (ERIA)
International Energy Agency (IEA)

Policies to promote clean fossil energy in APEC (2)

<table>
<thead>
<tr>
<th>Economies</th>
<th>Programs/Policies</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Singapore</td>
<td>National Hydrogen Strategy</td>
<td>Establishes five activities to foster the development of hydrogen technologies and the global hydrogen supply chain.</td>
</tr>
<tr>
<td>Singapore</td>
<td>Fund research into emerging low-carbon alternatives</td>
<td>Fund studies and demonstration projects to research and foster the development of low-carbon hydrogen projects.</td>
</tr>
<tr>
<td>Singapore</td>
<td>Carbon price rising from USD per tonne now to 35 to 60 USD per tonne in 2030</td>
<td>Affect business decisions and consumer behavior to investment in CCUS, biofuels, renewables and low-carbon energy carriers.</td>
</tr>
<tr>
<td>Australia</td>
<td>Australia’s National Hydrogen Strategy</td>
<td>Designed to establish Australia's hydrogen industry as a major global player by 2030.</td>
</tr>
<tr>
<td>Australia</td>
<td>Emissions Reduction Fund (ERF)</td>
<td>The government will purchase lowest cost abatement in the form of Australian carbon credit units (ACCUs).</td>
</tr>
</tbody>
</table>

Policies to promote clean fossil energy in APEC (3)

<table>
<thead>
<tr>
<th>Economies</th>
<th>Programs/Policies</th>
<th>Goal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thailand</td>
<td>The Thailand Board of Investment’s Investment Promotion Package (notification no. Sac. T/75/MA/Nov 2021)</td>
<td>Natural gas exploration plans and petrochemical projects implementing CCUS will be granted 8-year corporate income tax exemption.</td>
</tr>
<tr>
<td>Thailand</td>
<td>Biofuel blending mandate (introduced in 2007)</td>
<td>E20 as the primary gasoline by 2037.</td>
</tr>
<tr>
<td>Japan</td>
<td>2050 Carbon-Neutral and 2030 Climate Goal</td>
<td>Reduces greenhouse gas emissions to net-zero by 2050.</td>
</tr>
<tr>
<td>Japan</td>
<td>Basic Policy for Realization of Green Transformation</td>
<td>“Green Economy Transition Bonds” ($20 trillion yen over the next 10 years).</td>
</tr>
</tbody>
</table>

13th APEC Energy Ministerial Meeting
15-16 August, Seattle
- The first Energy Ministerial Meeting in eight years.
- Participants held discussions mainly on three issues:
  1. Power Sector Decarbonization
  2.Accelerating Methane Abatement
  3. Supporting a Just Energy Transition
- The Chair’s statement was compiled.
- Inclusion of the phrase “various pathways”
Energy Transition and Green Hydrogen in Chile

Building strong public policies in the energy sector

Alex Santander G.
Director of Policies and Studies
Ministry of Energy Chile

We know where we’re headed...we’re building how to get there

Mid-term consensus building is required

2050

2030

2023

Some updated goals

100% Zero emission energy in the electrical sector by 2050
Energy Transition bill

70% Zero emission fuels in non-electric energy end-uses by 2050
National GH2 Strategy and GH2 Action Plan

+80% Renewable energies in the electrical sector by 2050
Renewables promotion bill

+2 GW On storage projects by 2030
Energy Transition bill and associated regulation

Reducing GHG emissions
A legal mandate to be a carbon neutral economy

Carbon Neutrality Plan
One of the best potentials in the world

Renewable energies

Technical potential

x80 times the current installed capacity in Chile

Sustainable development requires territorial harmony

Reference scenario

Carbon neutral scenario

Carbon neutrality

Energy efficiency

Renewable energies

Electromobility

Green Hydrogen

Additional forest capture

Forest capture

COVID-19

Energy transition

35%

Renewable energies

22%

Electromobility

18%

Green Hydrogen

6%

Additional forest capture

Forest capture

Reference scenario

Carbon neutral scenario

Carbon neutrality

Energy efficiency

Renewable energies

Electromobility

Green Hydrogen

Additional forest capture

Forest capture

COVID-19

Energy transition

35%

Renewable energies

22%

Electromobility

18%

Green Hydrogen

6%

Additional forest capture

Forest capture

Reference scenario

Carbon neutral scenario

Carbon neutrality
**National GH2 Strategy and GH2 Action Plan**

<table>
<thead>
<tr>
<th>Year</th>
<th>Action Plan 2020-2023</th>
<th>Action Plan 2023-2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>2020</td>
<td>Current National GH2 Strategy</td>
<td></td>
</tr>
<tr>
<td>2025</td>
<td>Top destinations for green hydrogen investments in Latin America</td>
<td>Electrification capacity operating and under development</td>
</tr>
<tr>
<td>2030</td>
<td>Production in at least 2 hydrogen clusters in Chile</td>
<td></td>
</tr>
<tr>
<td>2035+</td>
<td>5 GW</td>
<td></td>
</tr>
</tbody>
</table>

**Our pillars**

- **Mission-oriented policy**
- **Efficient route to a zero-emission economy**
- **Balanced use of resources and territory**
- **Green Hydrogen as an engine for local development**

**A clear governance for H2**

**Interministerial roundtables**

- 5 – 6 meetings held by each group
- Raised close to 200 sectoral initiatives
- Identified 51 critical issues
- Currently working bilaterally with counterparts

**GH2 Action Plan 2023-2030**

- **Advisory Council**
  - Climate change mitigation
  - Capacity building
  - Green hydrogen

- **Strategic Committees**
  - GH2 Interministerial Committee
  - National GH2 Strategy

- **Interministerial Roundtables**
  - Citizen Workshops
  - GH2 Interministerial Committee

**Results of the GH2 Action Plan 2023-2030**

- **Investment and Institutional Framework**
- **Sustainability and Local Value**
- **Infrastructure and Technical Organization**

**Activities by action line**

<table>
<thead>
<tr>
<th>Activity</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>30%</td>
<td></td>
</tr>
<tr>
<td>39%</td>
<td></td>
</tr>
<tr>
<td>31%</td>
<td></td>
</tr>
</tbody>
</table>
**GH2 Plan Structure**

**Initiatives / Inputs associated with GH2**

**GH2 Plan Structure**

**Identification of Critical Issues**

Relevant or essential issues to be considered in the GH2 Action Plan for the achievement of the Strategy’s goals, arising from the concerns, challenges and opportunities identified.

**GH2 Plan Structure**

**General Initiatives and Actions**

**A GH2 Action Plan with a State Vision**

STRATEGIC COMMITTEE

Strategic Committee aims to provide strategic and policy orientations, with broad consensus among participants, to constitute a high-level framework for the Green Hydrogen Action Plan and build a political discourse that communicates, domestically and globally, the hydrogen guidelines.

**Sustainability Dimension**

- Industry is developing in a unique window of opportunity
- Pillar for domestic economic growth
- High international environmental standards
- Contribution to local development and quality of life improvement for local communities

**International Dimension**

- International openness
- Diversification of players
- Compliance with international trade rules
- Promotion of innovation and technology transfer
- Green corridors
- Certification with sustainability standards

**Citizen workshops**

- 2,300 registered
- Workshops in 5 regions: Antofagasta, Valparaíso, Santiago, Biobío and Magallanes
- 5 public audiences + 15 workshops
- A total of approximately 1,150 people participated
- 34% private sector
- 34% public sector
- 20% civil society
- 18% academia.

**Strategic Committee progress**

3 other dimensions are being worked on

1. Economic
2. Human capital
3. Communities
The option Chile is taking

Our economy is signed several instruments that seek promoting cooperation for the development of the hydrogen industry.

To position ourselves internationally, we require investment in critical internal infrastructure, such as transmission lines, ports, roads, pipelines, connectivity, etc.

Leverage international collaboration for the economy’s interests attract investments, promote innovation and technology transfer, training, etc.

Chile must maintain its openness and investment diversification policy to avoid the vulnerability of concentration of actors.

<table>
<thead>
<tr>
<th>FTA-network of trade agreements</th>
<th>Joint statements and cooperation agreements</th>
<th>MoU</th>
<th>MoC</th>
</tr>
</thead>
</table>

2023 - 2026
Investment signals, standards, ammonia and off-takers
First movers and shared risks

2026 - 2030
Productive chaining and decarbonization
Towards green markets and industry consolidation

Time windows for action this decade

1st time window
Investment signals, standards, ammonia and off-takers

2nd time window
Productive chaining and decarbonization

Key actions

National GH2 Strategy
Updating considering Industrial Policy

Ministry of Energy
Ministry of Transport
Ministry of Public Works
Oil Company CoC: ENAP

Supporting infrastructure:
Ports, roads, transmission lines, pipelines, etc.
**Projects under development**

- **General**
  - H2 Transport
  - Industrial
  - Power-to-Mobility
  - H2 in Ports
  - H2 in Airports

- **Transport**
  - Road
  - Off-Road

- **Electrical System**
  - Power-to-Gas
  - Power-to-Mobility

**Next steps**

- **December 2023**
  - Public Consultancy Period of Preliminary version of GH2 Action Plan 2023-2030
  - Closing Audiences of GH2 Action Plan 2023-2030

- **November 2023**
  - Preliminary Version of GH2 Action Plan 2023-2030 (for Public Consultancy)

- **October 2023**
  - First version of GH2 Action Plan 2023-2030 (for internal reviewing)

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- First version of GH2 Action Plan 2023-2030 (for internal reviewing)

**https://www.planhidrogenoverde.cl/**

**Regulation to develop**

- **Regulation to develop**
  - Modification to existing regulation
  - Development of new regulation

- **Regulatory Seguimiento**
  - Implementation of regulations
  - Monitoring of regulations

- **Regulatory Seguimiento**
  - Implementation of regulations
  - Monitoring of regulations

- **Minera**
  - Antofagasta
  - 671 MW (PV)
  - NH3 for local use and export

- **Other**
  - PEM technology
  - Fuel Cells
  - H2 production and storage

**Power-to-Mobility**

- Pilot: 1 mining truck
- R+D project to design a H2 powertrain

**Power-to-Gas**

- Pilot: 1-3 FC buses
- Air Liquide, Atamostec, CEA Liten

**Power to Power**

- Hydrogene de France
- HDF Project
- 36 MW (wind)

**GH2 Action Plan 2023-2030**

- First version of GH2 Action Plan
- Preliminary version of GH2
- Final Version of GH2
- Preliminary version of GH2 and start of continuous follow-up process of GH2 Action Plan 2023-2030

**November 2023**

- Preliminary Version of GH2 Action Plan 2023-2030 (for Public Consultancy)
1-3. Development of Global Supply Chain by LOHC-MCH method

I. Who are Chiyoda?

Chiyoda has provided pioneering engineering solutions for each generation since 1948, and under the current philosophy ‘Energy and Environment in Harmony’, continues our vision of ‘serving society through technology’.

From Coal to Oil, Oil to Gas, Gas to Renewables and New Energy
Chiyoda’s Vision for the Future
Engineering that shapes the future of energy and the global environment

II. Hydrogen Carriers

Landscape of Hydrogen Carriers

For large scale global H2 supply chain, methylcyclohexane (MCH) as H2 carrier and direct use of ammonia (NH3) are proven, realistic solution now, while LH2 and NH3 with dehydrogenation would co-exist after 2030s.

Landscape of Hydrogen Carriers (Key Characteristics)

<table>
<thead>
<tr>
<th>Hydrogen Carrier</th>
<th>LOHC</th>
<th>LH2 (UHT/HT)</th>
<th>NH3</th>
<th>LH2</th>
</tr>
</thead>
<tbody>
<tr>
<td>H2 Concentration</td>
<td>1/500</td>
<td>1/600</td>
<td>1/1000</td>
<td>1/800</td>
</tr>
<tr>
<td>Liquid Phase</td>
<td>Ambient</td>
<td>Ambient</td>
<td>Low</td>
<td>Low</td>
</tr>
<tr>
<td>Leakage Risk</td>
<td>Moderate</td>
<td>Low</td>
<td>Moderate</td>
<td>High</td>
</tr>
<tr>
<td>Transportation Readiness</td>
<td>Ready (large-scale)</td>
<td>Ready (medium-scale)</td>
<td>Ready (direct use)</td>
<td>2030 - 2035 (large-scale)</td>
</tr>
<tr>
<td>Infrastructure Ownership</td>
<td>Existing Chemical Tanker (large size, Modular)</td>
<td>Existing Chemical Tanker (medium size, Modular)</td>
<td>Building Chemical Tanker F-type (UHT/HT, Modular)</td>
<td>New dedicated ship (UHT/HT)</td>
</tr>
<tr>
<td>Infrastructure Ownership</td>
<td>Existing petrochemical infra.</td>
<td>Existing petrochemical infra.</td>
<td>Limited existing LH2/NH3 infrastructure</td>
<td>New dedicated LH2 infra.</td>
</tr>
<tr>
<td>H2 Purity</td>
<td>&gt;90% (for grade after dehydrogenation)</td>
<td>&gt;90% (for grade after dehydrogenation)</td>
<td>75%</td>
<td>&lt;25%</td>
</tr>
<tr>
<td>(for grade after dehydrogenation)</td>
<td>(for grade after dehydrogenation)</td>
<td>(for grade after dehydrogenation)</td>
<td>(for grade after dehydrogenation)</td>
<td>(for grade after dehydrogenation)</td>
</tr>
</tbody>
</table>

* LH2 unit converted
III. What is the SPERA Hydrogen™ Technology

History of Technology Development

Chiyoda commenced R&D of the MCH system in 2002 and developed its proprietary dehydrogenation catalyst on a laboratory scale in 2010 – a significant step forward towards a hydrogen economy and a low carbon society.

MCH Technology (SPERA Hydrogen™) at a Glance

Chiyoda’s SPERA Hydrogen technology uses MCH as the hydrogen carrier in a LOHC system, enabling the safe, efficient and commercially viable storage and transportation of hydrogen on a global scale.

1st Global Hydrogen Supply Chain Demonstration

In December 2020, AHEAD successfully completed the world’s first ‘Global Hydrogen Supply Chain Demonstration Project’, an important milestone for the construction of an international hydrogen supply chain.
Further MCH Technology Development
Chiyoda is further developing technologies and system integration from upstream to downstream to optimize and reduce total H2 value chain cost.

Further MCH Technology Development: MCH Direct Fuel Cell
* New Fuel Cell System (MCH Direct Fuel Cell) * that use MCH as a fuel is under R&D phase.
  * Develop new medium-temperature fuel cell that is operated under temperature range for dehydrogenation (below 400 deg-C)
  * Realize high-efficiency energy conversion system with excellent heat balance and cost balance.

Further MCH Technology Development: Direct MCH® Synthesis
Direct MCH® Synthesis technology has been developed at laboratory scale in 2019, successfully fill the green hydrogen by Direct MCH to FCEV in 2021, and is under scaling up stage toward commercialization around 2030.

- Existing Technology (Electrolysis + MCH)
  * Hydrogen is produced by water electrolyzer, and hydrogen is converted to MCH by hydrogenation process (MCH Reactor).
  * Hydrogen gas tanks and MCH reactor are required for this technology.

- New Technology (Direct MCH® synthesis)
  * MCH is directly produced from renewable electricity, water and toluene, not through hydrogen production.
  * Hydrogen gas tanks and MCH reactor are NOT required for this technology.

Further MCH Technology Development: SPERA Hydrogen Refueling Station
Smaller size dehydrogenation package for H2 distributed demand, such as refueling station, has been demonstrated in 2018, and is under optimization stage to realize downsizing and automation.
MCH Hydrogen Value Chain Collaboration

Chiyoda and Axens have concluded Joint Commercial Cooperation Agreement on Nov. 2022, that bring strong synergies allowing fast track approach for MCH supply chain implementation with single point of contract.

SPERA Hydrogen Use Case

There are 3 major use cases (Global Supply Chain / H2 Port & Delivery Hub / Large Scale Storage) by using MCH Technology, to seamlessly link between global hydrogen supply chain, storage and domestic distribution.

1. Global H2 Supply Chain Projects : Singapore Hydrogen Project

To achieve net zero in Singapore by 2050, Singapore and Japanese companies strongly collaborate with government support, to develop global H2 supply chain by MCH, toward the operation start in 2026.

1. Global H2 Supply Chain Projects : European Hydrogen Project (Rotterdam)

The Port of Rotterdam (POR) released its Hydrogen Master Plan in May 2020, aiming to become the H2 import hub of NW-EU by importing 20 MTPA of H2 by 2050. PoR, Koole Terminals, Mitsubishi and Chiyoda signed an MOU in July 2021 to jointly study importing H2 on an international scale using SPERA Hydrogen.

The LHyTS project (10 organizations) seeks to demonstrate that LOHC in the form of MCH can be successfully transported at scale, providing an export route to the Port of Rotterdam and other European destinations.

Thank you!
1-4. Towards the Realization of International Liquefied Hydrogen Supply Chain

KHI Group Hydrogen Products
Kawasaki Heavy Industries contributes to decarbonization as the only company in the world that has the technology for the entire hydrogen supply chain to produce, transport, store, and utilize hydrogen.

Concept of a CO₂-Free Liquefied Hydrogen Supply Chain

Hydrogen Carriers and their Characteristics

Hydrogen Carriers Energy Efficiency

Japan–Australia Pilot Project (HESC Project)
Status of the Pilot (HESC) Project

- Hydrogen Production (Australia)
- Land Transportation and Liquefaction (Australia)
- Maritime Transportation
- Liquefied Hydrogen Carrier
- Hydrogen Liquefier

World’s First International Shipping of Liquefied Hydrogen

- World’s first demonstration of hydrogen transport and cargo handling by liquefied hydrogen carrier

Commercialization Demonstration Project

- Adopted as a Green Innovation Fund project for commercial supply chain construction in 2030.
- Began a commercialization demonstration project which implements technology for enlargement.

Progress and Scale of Commercial Demonstration of Liquefied Hydrogen Supply Chain

- Reduce hydrogen costs by increasing the size of equipment
- Kawasaki aim to realize commercial scale of liquefied hydrogen carriers and various equipment through commercial demonstration planning in the mid-2020.

Summary

- Kawasaki does not limit hydrogen sources to ‘fossil fuels,’ to support the hydrogen introduction described in the "Green Growth Strategy through Achieving Carbon Neutrality in 2050" decided by Japanese government.
- In establishing an international supply chain for liquefied hydrogen, Kawasaki will contribute to the realization of hydrogen costs and installed volumes that are competitive with fossil fuels in 2050 by cooperating with the demand side of hydrogen power generation, which is expected to generate large-scale demand.
Today, more than 10M metric tons of hydrogen are produced in the U.S. annually, mainly from steam methane reforming of natural gas.

H2@Scale: a DOE initiative for a hydrogen economy

Current status and trends of hydrogen deployment in the USA

The GREET® (Greenhouse gases, Regulated Emissions, and Energy use in Technologies) model

GREET sustainability metrics include energy use, criteria air pollutants, GHG, and water consumption

With DOE support, Argonne has been developing the GREET life-cycle analysis (LCA) model since 1995 with annual updates and expansions.

It is available for free download and use at greet.es.anl.gov.

>55,000 registered users globally including automotive/energy industries and government agencies.

Will be used for tax credits evaluation of clean H2 production.

Energy use

- Total energy: fossil energy and renewable energy
- Fossil energy: petroleum, natural gas, and coal
- Renewable energy: biomass, nuclear energy, hydro-power, wind, and solar energy

Air pollutants

- VOC, CO, NOx, PM2.5, and SOx

Greenhouse gases

- CO2, CH4, N2O, trace carbon, and aldehydes
- CO2 of the five (with their global warming potentials)

Resource availability and energy security

- Human health and environmental justice
- Global warming impacts
- Regional/seasonal water stress impacts

Water consumption

- Addressing water supply and demand (energy-water nexus)
**Hydrogen production via CH₄ reforming, w/ and w/o CCS**

![Diagram of CH₄ reforming process](image)

**Hydrogen production via water electrolysis**

![Diagram of water electrolysis process](image)

**Well-to-gate (WTG) GHG emissions of hydrogen production pathways**

<table>
<thead>
<tr>
<th>Pathway</th>
<th>Illustrative Emissions (kg CO₂e/kg H₂)</th>
<th>Actual Emissions (kg CO₂e/kg H₂)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SMR</td>
<td>3% CH₄ leakage</td>
<td>0.7% CH₄ leakage</td>
</tr>
</tbody>
</table>

https://greet.es.anl.gov/files/hydrogenreport2022

**Infrastructure options for gaseous hydrogen (GH2) delivery**

**Infrastructure of liquid hydrogen (LH2) delivery**

**H₂ fuel cell electric vehicles are attractive zero-emission options when daily energy use is high: vehicle cost perspective**

- Life of energy storage and fuel cell needs to be factored in
- Fueling/charging cost is additional
- May shift to right or left

![Diagram of fuel cell vehicle cost](image)
Ammonia as fertilizer, fuel and H₂ carrier
• Ammonia production process modeling
• Techno-economic analysis
• Well-to-gate emissions

E-fuels via Fischer-Tropsch (FT) process using H₂ + CO₂
• FT fuels can be synthesized by using CO₂ and H₂ via RWGS and FT reaction
• CO₂ + H₂ → syngas → FT fuels

SNG Production Cost – w/ and w/o IRA Tax Credits
• Ethanol-CO₂ supply

H₂ supply form and onboard storage technology strongly impact H₂ refueling station (HRS) cost
• Cost of H₂ delivered to the station is additional

E-methanol as chemical, fuel, H₂ carrier
• Methanol can be synthesized by using CO₂ and H₂ via RWGS and methanol reaction
• CO₂ + H₂ → syngas → methanol
• Conversion process modeling
• Well-to-gate GHG emissions
Steel production using hydrogen in DRI technology

- NG=$3.7/GJ, Elec =$0.07/kWh, H$_2$=$1.3$/kg
- The production cost with DRI-NG-EAF is similar with that of BF-BOF
- DRI-H$_2$ is more costly, and sensitive to H$_2$ price
- For DRH$_2$ steel to reach price parity with market price, H$_2$ cost needs to be $1-2$/kg
- IRA 45V incentivize DRI with H$_2$

Acknowledgment

Hydrogen TEA and LCA at Argonne have been supported by DOE’s Office of Energy Efficiency and Renewable Energy’s Hydrogen and Fuel Cell Technologies Office (HFTO) for over two decades

Thank You!

aelgowainy@anl.gov

Our models, tutorials and publications are available at:
https://greet.es.anl.gov/
https://hdsam.es.anl.gov/
Fuel Ammonia Production from Fossil Fuels

APEC Symposium on Pursuing Decarbonization of Fossil Fuels
October 11, 2023

Yoshikazu (Yoshi) Kobayashi
The Institute of Energy Economics, Japan (IEEJ)

Fuel ammonia supply chain

- Ammonia is produced from hydrogen, which can be produced from various sources.
- In most cases, hydrogen and ammonia are produced in an integrated manner.

Importance of low-carbon ammonia

- Low-carbon ammonia (=ammonia produced from fossil fuels) is clearly recognized as an effective means for decarbonization by G7 leaders this year.

We recognize that low-carbon and renewable hydrogen and its derivatives such as ammonia should be developed and used, if this can be aligned with a 1.5 °C pathway, where they are impactful as effective emission reduction tools to advance decarbonization across sectors and industries, notably in hard-to-abate sectors in industry and transportation, while avoiding N₂O as a GHG and NOₓ as air pollutant.

--- G7 Hiroshima Leaders’ Communiqué, Paragraph 25

Different sources, different uses

- **Green hydrogen**
  - Fossil fuel-based hydrogen (SMR, ATR)
  - Natural gas with pyrolysis
- **Blue hydrogen**
  - Fossil fuel-based hydrogen with CCUS
- **Turquoise hydrogen**
  - Natural gas with pyrolysis
- **Green hydrogen**
  - Renewable energy-based hydrogen (Electrolysis, High-temperature reactor)
- **Pink (or purple) hydrogen**
  - Nuclear-based hydrogen (Electrolysis, High-temperature reactor)

- **Hydrogen**
  - Industrial gas
    - Oil refining, Semiconductor, etc.
  - Zero-emission energy
    - Transportation (FCV for land transportation; Hydrogen derivatives for maritime shipping; Synthetic fuel for aviation fuel)
    - Industry (Fuel for high temperature; Reduction agent for steel making)
    - Building (Hydrogen or synthetic fuel for heating and cooking)
    - Power generation (Co-firing/Single-firing of ammonia and hydrogen)

Energy Storage
- Storage of surplus electricity generated from variable (intermittent) renewable energy

What is CCUS?

- **CCUS = Capture, Utilization and Storage.**
- Key technology to make the existing fossil fuel-based hydrogen technology clean enough.

Ammonia’s role for hydrogen trade

- 80% of hydrogen export project currently planned will utilize ammonia as its carrier.
- Some of the exported ammonia will be directly utilized without cracking.

Source: Ministry of Foreign Affairs of Japan

IBA, Global Hydrogen Review 2023, p102
Not color but carbon intensity

- Different feedstocks of hydrogen/ammonia have different levels of carbon intensity.
- Carbon footprint per unit of production (= carbon intensity) needs to be lowered to zero in the long run.

Carbon intensity of different types of hydrogen

<table>
<thead>
<tr>
<th>Standard</th>
<th>Carbon Intensity (kg-CO2e/kg-H2)</th>
<th>Boundary</th>
</tr>
</thead>
<tbody>
<tr>
<td>RED/RFNB0 (EU)</td>
<td>3.4</td>
<td>Life cycle</td>
</tr>
<tr>
<td>EU taxonomy</td>
<td>3.0</td>
<td>Life cycle</td>
</tr>
<tr>
<td>Low Carbon Hydrogen</td>
<td>2.4</td>
<td>Well to gate</td>
</tr>
<tr>
<td>Standard (UK)</td>
<td>4.0</td>
<td>Well to gate</td>
</tr>
<tr>
<td>Clean Hydrogen Production</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Standard</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation Reduction Act</td>
<td>0-4</td>
<td>Life cycle (well to gate)</td>
</tr>
<tr>
<td>Japan Hydrogen Strategy</td>
<td>3.4</td>
<td>Well to gate</td>
</tr>
<tr>
<td>Certify Low Carbon</td>
<td>60% reduction</td>
<td>Well to gate</td>
</tr>
<tr>
<td>(Industry)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*Life-cycle carbon intensity including the manufacturing process of hydrogen production facilities may go up to 0.9-2.5 kg-CO2e/kg-H2 in case of solar and 0-1.0 kg-CO2e/kg-H2 in case of wind.
Source: IEA (2022), Towards Hydrogen Definitions based on Their Emissions Intensity, pp.30-43

Blue hydrogen/ammonia: SMR route

- Most of the existing ammonia production plants adopt steam-methane reforming (SMR) process to produce hydrogen as a feedstock of ammonia.
- Natural technologies with very low technological risks.
- Production costs can be lowered by scale up.

Simplified flow of SMR process

1. Natural gas (fuel)
2. Steam
3. Reactor
4. Water gas shift (WGS)
5. Furnace
6. Pressure swining absorber (PSA)
7. Carbon capture
8. CO2
9. Air
10. H2/NH3
11. Tail gas

Source: Author

Turquoise hydrogen/ammonia

- Turquoise hydrogen is produced from natural gas with pyrolysis process.
- The process does not emit carbon dioxide but carbon; how to monetize the produced carbon is a big challenge for the process.
- Turquoise hydrogen can be of course utilized to produce ammonia.

How clean is clean enough?

- Several governments / organizations published threshold of carbon intensity for low carbon or clean hydrogen.
- The amount of subsidy or tax benefit may change subject to the level of carbon intensity.

Blue hydrogen/ammonia: ATR route

- Auto thermal reforming process (ATR) uses oxygen and steam or carbon dioxide to partially oxidize the feedstock natural gas. Because of the oxidation, the reaction is exothermic.
- Larger volume of CO2 can be captured easily compared to SMR because ATR needs less energy inputs for the process.

Simplified flow of ATR process

1. Natural gas
2. Gas heated reformer (GHR)
3. Autothermal reforming (ATR)
4. Water gas shift (WGS)
5. Air
6. Air separation unit (ASU)
7. Pressure swining absorber (PSA)
8. Carbon capture
9. CO2
10. H2/NH3
11. Tail gas

Source: IEA

Production cost of hydrogen

- Low carbon hydrogen produced from fossil fuel is likely to maintain cost competitiveness against hydrogen produced by electrolysis by renewable electricity.
- The effects of the recent hike of natural gas and renewable electricity generation cost on the hydrogen / ammonia production cost remain to be seen.
Projects for fossil fuel-based ammonia

- According to IEA’s database, currently 12 million tons of ammonia production projects are currently planned.
- More than half of the planned projects are in North America (mostly in the US).
- 90% of the planned capacities are still at either conceptual or feasibility study phase. Policy supports may be needed to accelerate the development.

![Fossil fuel-based ammonia projects by region](image)

Summary

- While hydrogen and ammonia can be produced from various feedstock and inputs, low carbon hydrogen produced from fossil fuel was confirmed as an effective means for decarbonization by the G7 summit leaders.
- Carbon intensity of fossil fuel-based ammonia will be lowered in the long run to realize carbon neutrality.
- Low carbon hydrogen produced from fossil fuel is likely to be more cost competitive than hydrogen produced by electrolysis by renewable electricity.
- Most of the projects for low carbon hydrogen produced from fossil fuels are still at feasibility study stage. Policy supports may be needed to accelerate the development.

![Fossil fuel-based ammonia projects by status](image)

Source: IEA, Hydrogen Projects Database
First initiative: Renewable Energy
- We are developing renewable energy widely, such as wind/solar/battery around the world.
- Development target is 5.0GW by FY2025.

Second initiative: Zero CO2 Emission Thermal Power Generation
- Renewable power alone is not enough to cover the entire electricity demand Japan, due to limited potential, power grid unconnected to other regions, etc.
- By introducing “clean fuel (Hydrogen/Ammonia)” into thermal power generation, we can realize CO2 reduction while securing stable electricity supply.

IEA - The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector (October 2021)

The Role of Low-Carbon Fuels in the Clean Energy Transitions of the Power Sector

Contents of the report:
- Executive summary
- The role of thermal generation in clean energy transition
- Technical options for decarbonizing thermal power plants
- Production and transport of low-carbon hydrogen and ammonia
- Case studies
- System value aspects of low-carbon thermal plants
- Resource requirements and other uses of low-carbon fuels
- Conclusions

IEA’s BE Development
- Sunlight: 1.0GW
- Wind & Solar: 2.0GW
- Battery: 0.5GW

IEA Zero CO2 Emissions 2050 Roadmap for its Business in Japan
- Achieve net zero emissions in Japan through low-efficiency coal elimination, ammonia and hydrogen substitution, and renewable energy.
- The path to zero emissions varies depending on the situation of the economy or region. Develop optimal roadmap over time.

The challenge of achieving zero CO2 emissions by 2050:
- IEA will take on the challenge of achieving, by 2050, zero CO2 emissions in Japan and overseas.

The Three Approaches of JERA Zero CO2 Emissions 2050
1. Complementary between Renewable and Zero CO2 Emission Thermal Power Generation
2. Establishment of Roadmap Suitable for Each Economy and Region
3. Adoption of “Smart Transition”

Renewable Power
- Advantage:
  - No CO2 emission during power generation
- Disadvantage:
  - Unstable output due to weather conditions

Thermal Power Generation
- Advantage:
  - Sufficient and Stable supply
  - Flexibility and adaptability on demand
- Disadvantage:
  - CO2 emission from fossil fuels combustion

Hydrogen/Ammonia Supply Chain Development
- Production
- Conversion, Transportation, Storage
- Utilization
- Utilization services
- Zero-emission fuel technologies
- Hydrogen production technologies: reforming, water electrolysis, etc.
- Ammonia synthesis technologies
- Hydrogen/ammonia supply chain development

IEA © 2021. All Rights Reserved.
Initiatives to Establish Hydrogen and Ammonia Supply Chain

- JERA is collaborating with many players to develop a low-carbon fuel supply chain.

![Map of Initiatives](image)

**Initiatives to Establish Hydrogen and Ammonia Supply Chain cont...**

- Small-scale ammonia substitution test has been completed. (2022.7)
- Preparations are underway to conduct a large-scale 20% substitution demonstration in FY2023.

![Diagram of Initiatives](image)

**Outline of required modification for Ammonia**

- JERA makes modification works for Ammonia in Hekinan Unit 4.
- Small modification is required, but the most of existing facility and DeNOx(SCR) unit for treatment of exhaust gas can be used.

![Diagram of Outline](image)

**JERA’s Zero Emissions Technologies’ Development Timeline**

- 20% ammonia generation Demonstration test will start by FY2023. Demonstration test of ammonia generation over 50% will conduct by FY2028 at Hekinan and other Power Plants.
- After the demo tests, commercial operation will start at the power plants.

![Timeline Diagram](image)

**Development of Ammonia Substitution technology**

- A challenge of using ammonia in a blended fuel is controlling NOx emissions
- JERA's demonstration test program will use modified burners that inject ammonia at the center of a stream of pulverized coal and air.
EMSA study
Potential of Ammonia as Fuel in Shipping

Sergio Alda
Senior Project Officer Unit 1.1 - Sustainability

APEC Symposium Pursuing Decarbonization of Fossil Fuels
Kobe, 11 October 2023

EU ETS extension to maritime

Cap-and-trade system: puts a price on GHG emissions to harness economic forces.

Covering around 2/3 of CO2 emissions related to EU maritime transport.

Applicable to large ships (above 5000 gross tonnage) regardless of the flag they fly.

ETS-funded Innovation Fund for ships and ports.

FuelEU Maritime - overview

• Limits the GHG intensity of the energy used on-board
• Obligation to use OPS or zero-emission technology from 2030
• Targets established in 5-year intervals from 2025 until 2050

60% CO2 reductions
30% NOx reductions
>250 EUR/MWh savings
223 days on-time
67% equipment life

EMSA Studies on Alternative Fuels and Power Solutions

• Part of EMSA’s work in the area of sustainability and in support of the European Green Deal
• Framework contract signed in 2021 and for a period of 4 years and up to a total of 6 studies
• Consortium integrated by:

EMSA Studies Project Organisation

Key Numbers

1-8. EMSA study Potential of Ammonia as Fuel in Shipping
Update on potential of Biofuels in shipping

Potential of Ammonia as fuel in shipping

Guidance on Shore-Side Electricity

Studies released

Availability and Scalability

HB is the most mature process

Grey NH3

Production

235

Mtons/year

2020

Green NH3

Announced

>133

Mtons/year

What are the challenges?

• Many sectors will have demand for green or blue ammonia.
• Green electricity will also be in high demand.
• Demand depends on policy, many of which are not yet confirmed.
• Green production needs to be efficient, utilized at maximum capacity.
  • Location, pipelines, access to ports.
  • Connection to grid (sustainable?).
• Potentially oversized.

Sustainability

The challenge is green electricity:
• Certification mechanisms.
• If connected to the grid, need to ensure the source of that energy.
• Transportation, if not decarbonized, may lead to increased footprint.

Engine still under development
• NOx & N2O slip uncertain.
• Pilot fuel usage.

Other Environmental Impacts (production):
• Production of hydrogen requires pure, deionized water. The amount of (fresh) water can increase water scarcity. Desalination and rejection of brines can be detrimental to ocean biodiversity and marine life.
• Generating green electricity will require land (solar or offshore wind).
• Production of solar should avoid using land used for crops.
• Inland transportation has been ongoing for many decades. Accidents happened and handling of ammonia is known.
• Ammonia spills can be harmful for marine life, need for further evaluation.

Sustainability (2)

Where Solar?
• Western Australia
• Northern Chile
• Parts of China and US
• Northeast Brazil
• Northern Africa
• Avoid land used for crops (Australia, Chile, etc)
• Offshore may be an option in Western Europe and USA.

Where Wind?
• Avoid land used for crops (Australia, Chile, etc)
• Offshore may be an option in Western Europe and USA.

Sustainability (3)

Other Environmental Impacts (bunkering/onboard):
• Ammonia spills may cause more severe harm.
  • Ammonia dissolves partly into water (towards an equilibrium of NH3, NH4+ and NH3 (g)).
  • At pH of 8, NH3(aq) ranges from 0.8% to 7.4% (higher pH, higher percentage).
  • Toxicity depends on bio-sphere, from 17 mg/L to 510 mg/L in toxicity limit for Ammonia exposure.
• Ammonia spills may be a threat to the marine life, also quality of the water, nutrients on the water, stimulate noxious blooms of algae.
• Stricter safety for bunkering or when vessel enter and leave ports (similar to LNG, but for different reasons)

Total Cost Ownership (TCO) - Ammonia fuelled vessel

Containership 14,500-20,000 TEU - TCO difference to VLSFO vessel

100
Suitability

What is needed?
1. Tanks, either Type A or Type C
2. Ammonia supply pumps
   - High pressure ~ 80 bar
   - Low pressure ~ 5-15 bar
3. Temperature control
4. Filters
5. Double block and bleed
6. Vent system incl. a collection & treatment system for ammonia vapor
7. Double wall pipe system

Conclusions

Ammonia as a fuel is likely to take place. It presents a series of advantages and is a promising fuel:
- Known and well-established production process
- Naturally carbon-free, although attention is to be given to NOx, N2O and Pilot fuel and truly green production pathways
- It is known to shipping as a cargo (IGC covers it), and poses many challenges to be used as a fuel
- There are challenges to overcome to handle its corrosivity and toxicity: bunkering, engine, fuel supply systems.
- However, it has been used for many decades and there is substantial knowledge available

Main challenges:
- Ensure availability of green energy and competition with other sectors
- High costs associated with green ammonia production
- Safety and Regulations concerns: need to accelerate awareness and regulatory framework developments
- Need more knowledge on spillage and other environmental aspects
- IMO Guidelines to be ready by 2025

Thank you for your attention
Follow our activities on social media:
emsu.europa.eu/newsroom/connect
CCUS in Japan

Kenta Asahina
CCS policy office, METI, Japan

Mechanism of CO2 Underground Storage

CO2 is stored in the spaces between the particles in the rock.

G7 Climate, Energy and Environment Ministers’ Communiqué

Key sentence
St. Carbon Management:

- We recognize the need for monitoring and analyzing the potential for and expanding geologic storage infrastructure and planning for CO2 transport, including the potential for regional Carbon dioxide Capture and Storage (CCS) hubs in line with social acceptance.

- We will cooperate to promote development of export/import mechanisms for CO2.

- Considering the evolving nature of these technologies, we recognize that CCU/carbon recycling and CCS can be an important part of a broad portfolio of decarbonization solutions to achieve net-zero emissions by 2050, and Carbon dioxide Capture, Utilization (CCU)/carbon recycling technologies.

History of Japanese CCS Projects

Japan’s Long-Term Roadmap
Japan’s Long-Term Roadmap

(Foundational Principles)

To implement CCS systematically and rationally to promote the sound development of CCS business in Japan with minimal social costs, thereby contributing to the development of Japan’s economy and industry, securing a stable energy supply, and the achievement of carbon neutrality.

(Objectives)

A business environment for commencement shall be prepared by 2030, involving cost reduction, public understanding, overseas CCS promotion, and CCS Business Act legislation, based on the rough estimation of enabling CO₂ storage of about 120 to 240 million tons as of 2050, and full-scale CCS business shall deploy after 2030.

Business model construction

-2010 Full-scale deployment

-2020

-2030

120 to 240 million tons

[Specific actions]

(1) Government support for CCS business
(2) Efforts for reducing CCS costs
(3) Promotion of public understanding of CCS business
(4) Promotion of overseas CCS business
(5) Examination for the development of the CCS Business Act (tentative name)
(6) Formulation and review of the CCS Action Plan

Advanced CCS Program

Possible types of CO₂ source, transport methods, and CO₂ storage areas

<table>
<thead>
<tr>
<th>CO₂ sources</th>
<th>Transport methods</th>
<th>CO₂ storage areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal power plant</td>
<td>Pipeline</td>
<td>Offshore</td>
</tr>
<tr>
<td>Chemical plant</td>
<td>Ship</td>
<td>Near shore</td>
</tr>
<tr>
<td>Paper plant</td>
<td>Ship</td>
<td>Near shore</td>
</tr>
<tr>
<td>Hydrogen plant etc.</td>
<td>Ship</td>
<td>Offshore</td>
</tr>
</tbody>
</table>

Overview of Selected Advanced CCS Projects

On June 6, Seven CCS projects was selected as Advanced CCS project (including two overseas export projects) which was considered CO₂ source, transportation methods, storage areas.

Selected project target a wide range of industries such as electric power, oil refineries, steel, chemical, pulp/paper, and cement, and capture CO₂ emitted from various regions in Japan.

The total estimated annual storage of CO₂ in 2030 is about 12 million tons (including 30% exported overseas).

<table>
<thead>
<tr>
<th>Storage area</th>
<th>CO₂ Source</th>
<th>Transportation methods</th>
<th>Types of storage site</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thermal power plant</td>
<td>Oil refinery, electric power plant</td>
<td>Pipeline</td>
<td>Onshore depleted gas fields + Near shore</td>
</tr>
<tr>
<td>Chemical plant</td>
<td>Chemical plant, Paper plant, electric power plant</td>
<td>Pipeline</td>
<td>Onshore depleted gas fields + Near shore</td>
</tr>
<tr>
<td>Paper plant</td>
<td>Oil refinery, electric power plant</td>
<td>Ship, Pipeliner</td>
<td>Near shore</td>
</tr>
<tr>
<td>Hydrogen plant etc.</td>
<td>Oil refinery, Chemical plant, others</td>
<td>Ship, Pipeliner</td>
<td>Offshore</td>
</tr>
<tr>
<td>6) Oil &amp; others</td>
<td>Oil refinery, Chemical plant, others</td>
<td>Ship, Pipeliner</td>
<td>Overseas project (Jakarta)</td>
</tr>
<tr>
<td>7) Other</td>
<td>Oil refinery, Chemical plant, others</td>
<td>Ship, Pipeliner</td>
<td>Overseas project (Cape Town)</td>
</tr>
</tbody>
</table>

Locations of the selected projects and companies

The necessity of developing business environment toward the start of CCS business by 2030

- Based on IEA trial calculation, estimated annual storage capacity of Japan’s CCS can be roughly estimated at 120 to 240 million tons in 2050 (about 10-20% of current emissions). Supposing CCS is introduced in 2030, the annual storage capacity needs to increase by 6–12 million tons every year during the 20 years until 2050.

- There are concerns that postponing the introduction of CCS in 2030 will make it difficult to secure the annual storage capacity necessary to achieve 2050 Carbon Neutrality.

Purpose of advanced CCS program

- To secure annual storage of 120–340 million tons of CO₂ by 2050. A business model for CCS that can cross-sectoral should be established at an early stage. Thus, Japanese government selected “Advanced CCS projects” led by operators and will actively support them.

- This supporting program will establish various CCS business models by supporting projects with different combinations of CO₂ source, transportation methods and CO₂ storage areas. Furthermore, it aims to secure 6–12 million tons of CO₂ storage per year by 2030.

- This year, this program will provide support for the analysis of this geologic data and feasibility study.

0 to 10 thousand ton CO₂ Storage capacity

10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280 290 300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480 490 500 510 520 530 540 550 560 570 580 590 600 610 620 630 640 650 660 670 680 690 700 710 720 730 740 750 760 770 780 790 800 810 820 830 840 850 860 870 880 890 900 910 920 930 940 950 960 970 980 990 1000

Expected annual storage capacity (rough estimate)

240 million tons

Transport storage

103
Lessons from Advanced CCS Program

- T & S companies requires several hundreds million dollars and high technologies to install. The number of potential entrants would be limited.
- In order to install Carbon Capture process and transportation, “Aggregator” for emitters is necessary to foster by promoting outsourcing. Some public utilities companies to think to enter.
- In CCS, quantities of CO₂ to transport would be more than 100 times. Primary transport would be pipelines and shipping would fill the regional gap.

CCS System and its challenges
- In Japan there are around 7,500 factories to consume more than energy equivalent to 3,000kl annually
  - Large class facilities : couples of 100k – million ton
  - Middle class facilities : couples of 10k – 100k ton
  - Small class facilities : ~ couples of 10 K ton
- “Aggregation business” to covers Carbon Capture needs
  - Covering potential users and accept outsourcing of capture
- Smooth installation of pipelines and liquefied shipping
  Pipelines are required to cover the general requirement
- Expansion of its capacity and sustainable discovery of potential

Liquefied CO₂ Shipping Demonstration Project

In the hub and cluster plan for CCS, liquefied CO₂ ship transportation is an important technology for transporting CO₂ which is captured at distant emission sources.

Route examples

- Osaka Coal/Steam (IGCC)
- Capture - Carbon Recycling R&D base
- Maizuru Power Station (Coal fired power plant)
- Tomakomai CCS/CR hub
- Storage and monitoring

Demonstration transportation of CO₂ will start in 2024

Building Asian-wide CCUS Network

In June 2021, the Asia CCUS Network (ACN), an international industry-academia-government platform, was established as part of AETI. It aims to share knowledge and develop a business environment for CCUS utilization throughout Asia where large-scale CO₂ storage potential is expected.

Japan’s contribution toward CCS value chain

- Japan is the only economy that has various technology related to the CCS value chain, such as CO₂ capture, transport and storage.
Enabling industrial-scale emission abatement in the Asia Pacific

Dr Matthias Raab
Chief Executive Officer

APEC conference, Kobe, Japan
11 October 2023

Economic relationship between Australia & Japan

• Japan is Australia’s third-largest trading partner, with 2-way goods and services trade valued at A$66.3 billion.
• Australia’s major exports to Japan are natural resources, including gas, coal, iron ore, copper and aluminium.
• In 2022, Australia supplied:
  – 43 per cent of Japan’s LNG and
  – 66 per cent of coal
• Australia and Japan have a deeply connected energy relationship and joint responsibility to decarbonise the energy sectors. CCS plays a vital role in this.

CO2CRC is a world leader in applied CCUS research

We do research and commercially relevant demonstrations in CCUS applications.
We build and operate first of a kind plant and equipment.
We develop industry led technology options to accelerate commercial deployment.
We own and operate the Otway International Test Centre in South-West Victoria, Australia.

CO2CRC has

• Trained over 60 PhDs
• Published more than 450 peer-reviewed journal papers
• Between 40 – 180 researchers participating in our research program at any one time

Recognising economic value of CCS

Cost of emitting CO₂ vs cost of CCS

- Equivalent costs
  - Cost of emitting CO₂
  - Cost of CCS

Modified after Rystad Energy analysis

Global collaboration between industry and academia

We collaborate between industry and academia to improve the application of CCUS in the world.

Trained over 60 PhDs
Published more than 450 peer-reviewed journal papers
Between 40 – 180 researchers participating in our research program at any one time
Carbon Capture & Storage is Necessary

- Carbon capture and storage (CCS) is necessary for the global emissions reduction targets to be met according to the IPCC, IEA and DOE.
- CCS is safe, reliable and permanent; CCS has been in operation for decades, with multiple case studies of success.
- There are no technical barriers that exist to prevent the required rollout of CCS.
- CCS is a key enabler for a future hydrogen economy.
- So… CCS is necessary, but not everywhere is suitable for CCS.
- Offshore Australia has vast potential for geological carbon storage, something that our major trading partners lack (London Protocol).

How Do We Get to Net Zero and What are the Challenges?

- We need to rollout multiple CCS projects with large-scale storage (multi-Mt/a) around and across Australia.
- This roll-out needs to be done quickly to meet Net Zero.
- However, the current project cycle takes ~9 years due to cumbersome regulatory processes, which only allows for three full project cycles between now and 2050.
- How many large (>4Mt/a) CCS projects are in place or being planned?
  - How many are needed to meet Net Zero?

Existing and Planned Large Australian CCS Projects/Hubs

- By 2032, if all of the projects below are online, we could potentially have up to 31 to 35 Mt/a stored in these projects:
  - SEA CCS (2 Mt/a)
  - CarbonNet (5 Mt/a; soon to store)
  - Moomba (5.7 Mt/a; storage now)
  - Bonaparte (5.7-4 Mt/a (12 Mt/a))
  - Bayu Undan (30 Mt/a)
- This is quite optimistic, and most of these projects will not store CO₂ before 2030.

Number of Major Projects (>4Mtpa) to get to Net Zero

- The longer the delay, the more complex and difficult is the Net Zero challenge.
- Blue line: most optimistic, red line is realistic.
- The average required number of projects is between ~20 and 40 from 2045, with 40 being more realistic; majority of the projects will be required from 2032 after existing project cycle.
- Regulatory delay results directly in emissions that are higher than otherwise possible – it really does matter.

Global Total Primary Energy Supply in the Net Zero (NZE) Scenario

The role of CCS will be significantly larger if the decline of fossil fuels is slower

Carbon capture, utilisation and storage (CCUS) plays an increasingly important role: CO₂ capture grows from around 0.04 Gt in 2021 to 1.2 Gt in 2030 and 6.2 Gt in 2050, with industry and fuel transformation sectors accounting for more than 40%, direct air capture (DAC) for around 5%, and power and heat generation for the rest by then.

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Summary

• To get to Net Zero, CCS is essential and will require a major project roll-out, which will have to accelerate dramatically after the current project cycle ends in ~2032
• To deliver on Net Zero, CCS projects will require a greatly accelerated regulatory process so that the project cycle can be shortened from the existing 9 years
• CO2CRC leads the CCS Regulatory Affairs Task Force and is working with industry and government to provide the required improvements in government regulation and allow companies to deliver on their Net Zero commitments

The Barossa / Darwin LNG / Bayu-Undan Project

• The Barossa Gas Field has high (16-18%) concentrations of naturally occurring CO₂
• Gas produced from the Barossa Gas Field will be transported via pipeline to Darwin LNG
• The Darwin LNG facility will separate the Methane (CH₄) from the CO₂
• The CO₂ will be transported via Pipeline from Darwin LNG to the Bayu-Undan depleted gas field and injected into the reservoir for permanent geological storage

The Barossa / Darwin LNG / Bayu-Undan Project

• This project will involve repurposing the Bayu-Undan offshore facilities reservoir (located in Timor-Leste waters) into a geological CO₂ storage hub (BU CCS) with a maximum capacity of 10 MTPA+
• New CO₂ transport and import facilities will be required
• Because Bayu-Undan is located in Timor-Leste, moving CO₂ from Australia to Timor-Leste will trigger the London Protocol

In Summary

• CCS is a proven suite of technologies
• Elements of a robust storage site:
  ─ Trapping, compression, seal and storage formation, no adverse impacts
• CCS is mandatory for future LNG

Collaboration to accelerate CCUS technology advancements

• Australia, Japan and Korea have ambitious 2030 emission reduction targets, CCUS is a key technology
• Development of offshore CO₂ monitoring techniques
• Execution of field trials at CO2CRC’s Otway International Test Centre for improving CO₂ injection
• Progress transboundary CCS projects between Korea, Japan and Australia
• Development of carbon credit methodology for transboundary CCS
• Review of domestic and international legal challenges for transboundary CCS projects
Breakthrough technologies

Otway International Test Centre

Key Success Factors
- At scale investment: Long term Government and Industry funding
- Focused on accelerating Australia’s transition to a low emissions future
- Industry-led Research
- Well-established collaboration between universities and industry, domestically and globally
- Globally unique test centre to accelerate development and commercial deployment of technologies

A paradigm shift in subsurface monitoring

In order to see, the industry needed:

- The system was configured to provide a new image of the plume every 2 days.
- It first detected the gas plume on the 2nd day of injection with ~300 tonnes.

Risk based monitoring through downhole seismic and SOV/DAS

Summary
- Australia has a golden opportunity for global CCS leadership
- The CCS industry can move faster than government can approve projects
- Legislated targets are at odds with the industry’s ability to get project approvals
- To achieve 43% of emission reduction by 2030, we will need 50% reduction in permitting time
- Permitting will determine the pace to net-zero
- Delays are deadly – a lack of urgency will force the status quo in emissions and deter investment
- Australia can create many win-win situations with Japan.
International Educational Opportunities in CCS

• CO2CRC Education: Essentials to detailed technical specialist level; bespoke courses can be tailored to individual needs

• CO2CRC Symposium: Shaping the Next Decade of CCS
  – 20-23rd November
  – Learn more about Australian CCS projects, CCS technology and the regulatory and policy landscape locally and globally

• CO2Tech: proposal reviews through to detailed technical evaluations

CO2CRC acknowledges and appreciates the strong relationships it has with industry, community, government, research organisations, and agencies in Australia and around the world
Economic and energy trends
Southeast Asia is a major engine of global economic growth and energy demand.

As the economy and population have grown, total energy supply expanded by around 80% between 2000 and 2020. Power generation has almost tripled over the past two decades, driven by a significant increase in coal-fired generation, which accounted for more than 40% of total generation in 2020. As a result of the fossil-driven energy demand growth, CO2 emissions increased from 0.7 Gt in 2000 to over 1.6 Gt in 2020.

Southeast Asia’s economy grew by around 6.7% on average each year between 2010 and 2019. SEA’s energy demand have exhibited a fast-growing region, was second only to that of China.

CO2 emissions trends
Southeast Asia is still a long way off the pathway consistent with its clean energy ambitions.

In 2050, Southeast Asia comprises around 8% of the world’s population and global GDP. Achieving net-zero emissions will rely on support to ensure the deployment of key technologies and infrastructure for the SDS and NZE Scenarios.

Role of CCUS in NZE pathways
CCUS technologies will play in putting the world on a path to NZE, contributing more than 10% of cumulative emission reduction globally by 2050.

Average annual CO2 reduction from 2030 in the NZE

The role for CCUS spans virtually all parts of the global energy system: including heavy industry, low-carbon hydrogen production, power generation, carbon removal, and as a source of CO2 for synthetic fuels.

CCUS/CCS projects in Indonesia @August 2022
15 CCS/CCUS activities in Indonesia are still in the study/preparation stage, but most are targeted for onstream before 2030.
**On going CCUS projects in the Indonesia’s upstream oil & gas business**

![Image](source: IOG 4.0 SKKMIGAS (2023))

**Strategic priorities for CCUS in Indonesia/SEA**

**Identify and develop onshore and offshore CO2 storage resources**

![Image](source: The Indonesia CCS Center (2023))

**CO2 storage potential**

One of the first steps to evaluate regional CCUS options is to identify and estimate the storage potential of suitable geological formations

<table>
<thead>
<tr>
<th>No.</th>
<th>EVALUATION</th>
<th>YEAR</th>
<th>BASINS</th>
<th>FORMATIONS</th>
<th>CO2 STORAGE (Giga Tones)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LEMIGAS – ADB</td>
<td>2013</td>
<td>South Sumatra</td>
<td>Talang Akar</td>
<td>7.4</td>
</tr>
<tr>
<td>2</td>
<td>LEMIGAS – World Bank</td>
<td>2015</td>
<td>South Sumatra</td>
<td>Talang Akar</td>
<td>3.7 (P50)</td>
</tr>
<tr>
<td>3</td>
<td>LEMIGAS – ADB</td>
<td>2022</td>
<td>South Sumatra</td>
<td>Batu Raja</td>
<td>4.9 (P50)</td>
</tr>
<tr>
<td>4</td>
<td>Yunyue Elita Li et al. (Exxon Mobil, Univ. of Singapore, Australia)</td>
<td>2023</td>
<td>North Sumatra</td>
<td>&gt; 650 Gt in Saline Aquifers; &gt; 12 Gt in O&amp;G fields</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Ryoko Setoguchi (JOCMEC)</td>
<td>2023</td>
<td>East Java</td>
<td>56 (Best Case)</td>
<td></td>
</tr>
</tbody>
</table>

**Policies and regulations**

Recent government policies will provide a boost to the CCUS development in Indonesia

- Law Number 16 of 2001 concerning Ratification of the Paris Agreement to the UNFCCC. Ratification of this agreement is expected to increase international cooperation to implement climate change mitigation and adaptation actions with the support of funding, technology transfer as well as transparency mechanisms and sustainable governance.  
- Law Number 7 of 2021 concerning Harmonized Taxation. This law regulates carbon tax.  
- Implementation of Carbon Economic Value. This regulation stipulates the implementation of carbon trading, levies on carbon emission, and performance-based payment for reducing carbon emission.
- Minister of Environment and Forestry Regulation Number 21 of 2022 on the Guidelines of carbon Economic Value Implementation.  
- Minister of Energy and Mineral Resources Regulation Number 1 of 2023 on the Implementation of Carbon Capture and Storage, as well as Carbon Capture, Utilization and Storage in Upstream Oil and Gas Business Activities.  
- Financial Services Authority (OJK) Regulation no. 4 of 2023 concerning Carbon Trading through the Carbon Exchange.

**Policies and regulations**

Regulations have been established

![Image](source: IOG 4.0 SKKMIGAS (2023))
Research and Development for DAC in Japan

Kenji Yamaji
Program Director for Moonshot Goal No. 4
President, Research Institute of Innovative Technology for the Earth (RITE)

APEC Symposium on Pursuing Decarbonation of Fossil Fuels
Session 5. Direct (Air) Carbon Capture (DAC)

October 11, 2023
KOBE PORTPIA HOTEL @Kobe City, Hyogo, Japan

Recent Development for Carbon Neutrality in Japan

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015/12</td>
<td>Paris Agreement adopted at COP21</td>
</tr>
<tr>
<td>2016/10</td>
<td>Special Report of IPCC for 1.5°C (Carbon Neutrality by 2050)</td>
</tr>
<tr>
<td>2020/10</td>
<td>Japan announced 2050 Carbon Neutrality</td>
</tr>
<tr>
<td>2020/12</td>
<td>Japan decided Green Growth Strategy (updated June, 2021)</td>
</tr>
<tr>
<td>2021/04</td>
<td>Climate Summit by US President Biden</td>
</tr>
<tr>
<td></td>
<td>Japan announced a new 2030 Target (46% reduction)</td>
</tr>
<tr>
<td>2021/10</td>
<td>Japan decided 6th Strategic Energy Plan</td>
</tr>
<tr>
<td>2021/11</td>
<td>COP26 in UK</td>
</tr>
<tr>
<td>2022/02</td>
<td>Russian invasion of Ukraine started</td>
</tr>
<tr>
<td>2022/11</td>
<td>COP27 in Egypt</td>
</tr>
<tr>
<td>2023/02</td>
<td>Japan decided Basic Policy for G (Green Transformation)</td>
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</tbody>
</table>

Various measures such as Energy Conservation, Renewables, Nuclear, CCUS, Hydrogen/Ammonia, NETs (Negative Emission Technologies) are mobilized to realize Carbon Neutrality. Nuclear is used to the level of the upper constraint in the optimal solution.

Electrification and decarbonization of electricity are commonly required in all scenarios for Carbon Neutrality while costs of electricity increase. Electricity of 100% renewables further increases the cost, thus suppress the electrification of final demands in the optimal solution.

Hydrogen and zero-emission synfuels are used in non-electric demand sectors. NETs are used to offset the emissions from the hard-to-abate sectors for realizing Carbon Neutrality.

DAC (Direct Capture of CO₂ in Air) is commonly used in all scenarios to realize Carbon Neutrality. Scale of the utilization of recovered CO₂ is limited. CO₂ storage capacities abroad are used as well as the domestic storage capacities for Carbon Neutrality in Japan.

Super smart society (Society 5.0) promotes circular/sharing economies leading substantial energy/material reductions, thus to explore a new perspective to realize a huge energy conservation with low costs.

Image of Primary Energy in Japan for Net Zero Emissions (by Keigo Akimoto, RITE)

Moonshot Goals

1. To realize “Human Well-being”.
9 Moonshot goals were decided in the area of society, environment, and economics.

Goal 4: Realization of sustainable resource circulation to recover the global environment by 2050.
Started in 2020 as the first group of MS Goals

The concept of Moonshot Goal No. 4

Implications of RITE 2050CN Scenario Analysis Results

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Development of highly efficient Direct Air Capture (DAC) and carbon recycling technologies

Dr. KODAMA Akio
Professor, Kanazawa University

Development of innovative dry CO2 capture and recycling technologies

Dr. SUGIYAMA Masakazu
Professor, Nagoya University

Research and development toward saving energy for Direct Air Capture with available cold energy

Dr. KONIZUGA Kiyofumi
Professor, Tohoku University

Development of Technologies to Recover CO2 and Convert Them into Valuable Materials

In this program, various technologies to realize direct air capture (DAC) are being developed to capture low-concentration (around 0.04%) CO2 that diffuses into the atmosphere, with the aim of commercializing low-cost, high-efficiency DAC technologies. In addition to DAC technologies, various new technologies are being developed to convert captured CO2 into valuable materials.

Moonshot & R&D Program

Moonshot Goal 4
Realization of sustainable resource circulation to recover the global environment by 2050

Outline of DAC-U projects

Development of technologies to recover greenhouse gases (“GHGs”) and convert them into valuable materials

Chemical engineering

Mineralization

Biomass

Target of Moonshot Goal 4
Realization of sustainable resource circulation to recover the global environment. Commercial plants or products utilizing circulation technology will be deployed globally.

Output target (2030): cool Earth
Development of circulation technology on a pilot scale for reducing greenhouse gases, that is also effective in terms of life cycle assessment (LCA).

Timeline for realization of the MS Goal

2020 2030 2040 2050

Program Director:
Dr. YAMAJI Kenji
Program Director, JST CREST

Innovative Technology for the Earth (RITE)
President, Director-General of the Research Institute of Innovative Technology for the Earth (RITE)

Dr. KODAMA Akio
Professor, Kanazawa University

Dr. NORINAGA Koyo
Professor, Kyushu University

Dr. YANO Masahiro
Dr. MORIMOTO Shinichirou
Dr. MITSUDA Nobutaka

Kyushu University, Kumamoto University, Hokkaido University, and Nagoya University

Dr. SUGIYAMA Masakazu, Dr. HAYASHI Hideaki, Dr. FUKUSHIMA Yasuhiro

Development of Combined Carbon Capture and Conversion (quad-C) modules targeting low carbon emissions towards "Beyond-Zero" Emission

Dr. FUJIKAWA Shigenori
Professor, Waseda University

Dr. FUKUSHIMA Yasuhiro
Professor, University of Tokyo

Dr. NOGUCHI Takafumi
Professor, Ren-Watt University

Development of Global CO2 Recycling Technology towards "Beyond-Zero" Emission

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Capturing atmospheric CO2 efficiently with repeated dry & wet cycles of crushed concrete waste

The University of Tokyo, Hokkaido University

Implementing organizations:
Dr. NOGUCHI Takafumi
Professor, The University of Tokyo

Various mafic rocks utilizing the geological characteristics of Japan
Site-specific weathering, CO2 mineralization, and co-benefits

Waseda University, Hokkaido University, Kyoto Prefectural University, Mitsubishi Heavy Industries, Ltd.

Implementing organizations:
Dr. NAKAGAKI Takao
Professor, Waseda University

Accurate accounting of CO2 reductions
Clarify the optimal soil application method of mafic rocks for plant growth

AIST, RIKEN

Implementing organizations:
Dr. MORIMOTO Shinichirou
Environmental and Social Impact Assessment Team Leader, National Institute of Advanced Industrial Science and Technology (AIST)

Selection and breeding of macroalgae with higher CO2 fixing capacity than land plants
Genome editing of CO2 fixation enzyme gene and production of edited strains for accelerating CO2 fixation capacity

Kyoto University, Kyoto Institute of Technology, Mie University, Green Earth Institute Co., Kansai Chemical Engineering Co.

Implementing organizations:
Dr. UEDA Mitsuyoshi
Special Appointed Professor, Kyoto University

Redesign of macroalgae for highly efficient CO2 fixation by functional modifications and their product generation
Gene optimization for reinforced biomass production
New hybrid plant creation by super-distant cross

AIST, Tokyo Metropolitan University, Sumitomo Forestry Co., Ltd.

Implementing organizations:
Dr. MITSUDA Nobutaka
Deputy director of BPRI and the group leader, National Institute of Advanced Industrial Science and Technology (AIST)

Development of next-generation CO2-fixing plant through the gene optimization, distant hybrid, and microbial symbiosis
New hybrid plant creation by super-distant cross

Dr. YANO Masahiro
Senior Executive Researcher, National Agriculture and Food Research Organization (NARO)

Development of Super-DAC crops (rice, maize, and sorghum)
Elucidation of soil carbon dynamics derived from crop residues

NARO, Tokyo University of Agriculture and Technology, Nagoya University

Implementing organizations:

Cost for CO2 Removal

(DAC as a Backstop Technology)

Cost for CO2 Removal

Thanks for your attention
Commercial-scale Direct Air Capture Technology, projects and policy to support cost-effective net zero

Remainder carbon budget

We have fewer than 7 years left on the carbon clock before an expected average of 1.5 degrees of warming.

Historical emissions

- 2 degrees
- 450 ppm
- 1.5 degrees
- 430 ppm

Remaining carbon budget

- Remove ~1 Trillion tonnes to return to safe levels.

Atmospheric CO2 concentration

- Safe level: 350 ppm
- Pre-industrial: 280 ppm
- 2 degrees: 450 ppm
- 1.5 degrees: 430 ppm

Remaining carbon budget

- Today: ~419 ppm

The carbon clock is ticking. The climate problem is urgent.

CO2 removal differs from offsets that provide a credit for avoided emissions.

Permanent carbon removal & avoided carbon offsets

1. Remove CO2 from the atmosphere
1. Remove CO2 from the atmosphere

= 1. Remove CO2 from the atmosphere

1. Remove CO2 from the atmosphere

= NET ZERO CO2

Our Vision

Our vision is to lead the world in the large-scale removal of carbon dioxide from the air and advance our shift to a sustainable, net zero society.

CE DAC enables complementary solutions for carbon dioxide reduction and removal from the atmosphere.

CO2 (ATMOSPHERIC CO2)
**STRATOS, THE FIRST COMMERCIAL SCALE DAC PLANT TO USE CE TECH, IS UNDER CONSTRUCTION BY 1POINTFIVE**

- Permian Basin, Texas, US
- Expected to capture 500kt/year once fully complete
- Site prep and early construction started Q4 2022
- Operations targeting mid-2025

**CE Innovation Centre**

- Squamish, BC, Canada
- Built 2021
- Validation plant for pre-commercial testing of equipment (run-replace-run), ~1,000 t/y capacity
- Extensive facilities for lab and bench scale testing

**Sources:**
Carbon abatement costs based on currently available solutions; data from Goldman Sachs, Carbonomics, November 2022

DACS can offer an economic solution to c. 10+ Gt of hard to abate emissions

**A solution for hard to abate transportation sectors**

DAC enables complementary solutions for reduction and removal

**IATA 2050 Net Zero Roadmap (Published June 4, 2023)**

The International Air Transport Association (IATA) is the trade association for the world’s airlines, representing some 290 airlines or 83% of total air traffic. We support many areas of aviation activity and help formulate industry policy on critical aviation issues.

IATA’s targeted scenario is shown in the colored bars, while the black lines illustrate the potential range of outcomes, depending notably on the extent and pacing of financing and policy support. In all the scenarios modeled, even that where SAF fully replaces traditional jet fuel, there will be residual emissions which will need to be removed using carbon capture.
Over the last 18 months, aviation partners have joined CE/1P5 to accelerate DAC.

**March 2022**
Airbus purchased 400,000 tonnes of CDR from 1PointFive.

**July 2022**
Airbus announced a CDR collaboration with seven other airlines at the Farnborough airshow.

**November 2022**
Airbus announced a pre-purchase of 30,000 tonnes of CDR from 1PointFive, becoming the first airline to directly purchase CDR.

**August 2023**
All Nippon Airways announced the pre-purchase of 30,000 tonnes of CDR from 1PointFive, becoming the first airline to directly purchase CDR.

---

**Economic Benefits of DAC Deployment**

Government support is necessary to build at scale through market creation and facilitation, plus accelerators for early projects.

**Supportive policies for DAC are needed to:**
- Value the measurable, immediate, and long duration carbon removal that DAC provides
- Create climate investment and viable long-term markets
- Create jobs and transition opportunities

**Examples include:**
- Market creation policies (e.g., low carbon fuel standards, direct procurement, CORSIA)
- Financial support policies (e.g., output-based subsidies; tax credits; project-based support)
- Market facilitation policies (e.g., CO₂ storage protocols; capacity objectives; market linkages)

Jurisdictions with supportive policy environments are catalyzing project investment.

---

**Rhodium Group research shows promising job creation and business opportunities accompanying DAC.**

Major sectors receive an economic boost, including:
- Chemical manufacturing
- Natural gas
- Cement manufacturing
- Steel manufacturing
- Construction
- Engineering
- Industrial equipment

**Business Opportunities Across Sectors**

- Based on a net zero by 2050 scenario, DAC-related sectors realize at minimum 11% market growth, with potential for 40% to 189%.

**Direct Job Creation**
- Potential to create significant job growth across a variety of sectors with wide-scale deployment.

---

**More Information Can Be Found At:**
- www.carbonengineering.com
- @carbonengineer
- CarbonEngineering

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The Evolution of Energy Efficiency Policy to Support Clean Energy Transition in Japan

January 2024
Ministry of Economy, Trade and Industry (METI), Japan

Trends in final energy consumption

- Real GDP is up 2.6 times since the oil crisis in 1970s, while final energy consumption is up 1.2 times.

<table>
<thead>
<tr>
<th>Sector</th>
<th>1973</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Household</td>
<td>52 million kJ</td>
<td>82 million kJ</td>
</tr>
<tr>
<td>Transport</td>
<td>74 million kJ</td>
<td>124 million kJ</td>
</tr>
<tr>
<td>Office</td>
<td>55 million kJ</td>
<td>85 million kJ</td>
</tr>
<tr>
<td>Industry</td>
<td>155 million kJ</td>
<td>220 million kJ</td>
</tr>
</tbody>
</table>

Industrial sector
Office sector
Transport sector
Household sector

Industrial Energy Consumption 2030

<table>
<thead>
<tr>
<th>Sector</th>
<th>FY2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>160 million kJ</td>
</tr>
<tr>
<td>Office</td>
<td>65 million kJ</td>
</tr>
<tr>
<td>Transport</td>
<td>84 million kJ</td>
</tr>
<tr>
<td>Household</td>
<td>52 million kJ</td>
</tr>
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</table>

The policy target of energy conservation

<table>
<thead>
<tr>
<th>Fiscal Year</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>FY2013</td>
<td>363 million kJ</td>
</tr>
<tr>
<td>FY2019</td>
<td>334 million kJ</td>
</tr>
</tbody>
</table>

Energy Conservation Act (the Act on Rationalizing Energy Use and Shifting to Non-fossil Energy)
- Reporting obligation for large-scale enterprises
- Requirement to achieve energy efficiency criteria for manufacturers (called "Top Runner Program")

Energy Conservation Subsidies Package (2022/2023)
- Replacing inefficient facilities
- Experts' advice for SMEs
- Insulation retrofitting and residential water heater (heat pumps)

The Overview of Demand-side Policies: Regulation and Incentives

- Regulation
- Incentives

Energy Conservation Act: (1) Reporting obligation for large-scale enterprises
- The amount of fossil energy consumption
- The amount of non-fossil energy consumption
- The plan of energy conservation and shift to non-fossil energy

Evaluation
- Non-binding target
- Reduction of specific energy consumption by 1% or more on an annual average basis, etc.
- Benchmark index/Target levels (only for applicable sectors)

Minister’s order to submit improvement plan
- In case the enterprise does not follow the order
- Announcement and additional order with penalty
Energy Conservation Act: (1) Reporting obligation for large-scale enterprises

1979. The Act on Rationalizing Energy Use

2022. The Act on Rationalizing Energy Use and Shifting to Non-fossil Energy

Energy Conservation Act: (2) Requirement for Manufacturers

How Top Runner Program Works

- Setting up Top Runner Criteria
- (3-10 years)
- Target year
- Time

The Outcome Example: Air-conditioners

- Trends in simple averages for air-conditioners (Cooling capacity 2.8kW (14.6 - 21.9m²))
- Period consumption of electric power is based on JIS C 9612:2005
- Source: Energy efficiency performance catalogs of each FY (summer, winter)

The Outcome Example: Air-conditioners

- Approx. 37% improvement
- Source: Energy efficiency performance catalogs of each FY

Incentives: Energy Conservation Subsidies Package

<table>
<thead>
<tr>
<th>Businesses</th>
<th>Dec. 2022</th>
<th>Dec. 2023</th>
</tr>
</thead>
<tbody>
<tr>
<td>Replacing inefficient facilities</td>
<td>500 billion JPY</td>
<td>700 billion JPY</td>
</tr>
<tr>
<td>(the amount of next 3 years)</td>
<td>(the amount of next 3 years)</td>
<td></td>
</tr>
<tr>
<td>Experts’ advice for SMEs</td>
<td>2 billion JPY</td>
<td>2.1 billion JPY</td>
</tr>
<tr>
<td>(14 million USD)</td>
<td>(14 million USD)</td>
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</tr>
</tbody>
</table>

Households

- Insulation Retrofitting
- Residential Water Heater

- 280 billion JPY | 420 billion JPY |
| (1.9 billion USD) | (2.9 billion USD) |

Incentives: (1) Replacing inefficient facilities

- Type 1: Energy efficiency improvement throughout the plant or building
  - Improvement Rate: 10% or Reduction of Energy Consumption 700kloe

- Type 2: Select facilities from the list
  - Specialized for Electrification and Fuel Switching
    - Coal Furnace
    - Electric Furnace

- Type 3: Select facilities from the list
  - Air Conditioner
  - Heat Pumps
  - Motors

Incentives: (2) Residential Water Heater

- Heat Pump Water Heater
- Hybrid Water Heater
- Residential Fuel Cell

Household Energy Consumption

- Space Heating
- Space Cooling
- Ventilation
- Water Heater

- Others
- Light

While central-heating system (with water heater) is the main system of space heating in Europe, individual-heating system (with air conditioner) is the main system of space heating in Japan; people habitually take a bath, so water heater occupies 33% of the household energy consumption.

Incentives: (2) Residential Water Heater

Subsidy for Owners (2022) | Subsidy for Owners (2023)
--- | ---
1. Heat Pump Water Heater | 50,000 Yen/unit | 100,000 Yen/unit
2. Hybrid Water Heater | 50,000 Yen/unit | 130,000 Yen/unit
3. Residential Fuel Cell | 150,000 Yen/unit | 200,000 Yen/unit

Subsidy amount depends on the additional function (e.g. DR-Ready). Described is the main example of amount.
G7 Hiroshima Leaders’ Communiqué

<table>
<thead>
<tr>
<th>Energy - 25.</th>
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</thead>
<tbody>
<tr>
<td>“Through our experience in coping with past and current energy crises, we highlight the importance of enhanced energy efficiency and savings as the “first fuel”, and of developing demand side energy policies.”</td>
</tr>
</tbody>
</table>

G7 Climate, Energy and Environment Ministers’ Communiqué

<table>
<thead>
<tr>
<th>63. Energy efficiency</th>
</tr>
</thead>
<tbody>
<tr>
<td>……We underline the need for ‘energy efficiency first’ to be recognized as a driving principle for our actions to ensure that energy efficiency and energy savings are duly taken into consideration in policy, planning and investment decisions. We also note that energy efficiency regulations, such as vehicle fuel efficiency regulations, building codes, minimum energy performance standards, energy performance certificates, and energy reporting systems for large scale consumers continue to gain momentum. These measures will leverage further efforts to decarbonize energy demand, with strategic approaches including electrification, fuel switching, grid flexibility, digitalization of energy demand information and disclosure of energy and climate related information. ……”</td>
</tr>
</tbody>
</table>
The APEC Symposium on Promoting Energy Efficiency and Energy Management System

The Key to an Energy Resilient APEC: Energy Efficiency and Energy Management

Dr. LIU Meng
Chair, APEC EGEEC
China National Institute of Standardization
23 January 2024, Tokyo Japan

Global overview

- **Steadfast**: Global focus on energy efficiency remains steadfast.
- **Slowdown**: The estimated 2023 rate of progress in energy intensity is set to fall back to below longer-term trends, to 1.3% from a 2% in 2022, which largely reflects an increase in energy demand of 1.7% in 2023, compared with 1.3% in 2022.
- **Trend**: The global trend of continuously increasing in EE will not be changed.

(Source: International Energy Agency)

Importance of energy cooperation in APEC region

- APEC economies represent over 38 percent of the global population and 56 percent of global economic activity, with strong economic trade ties throughout the world.
- The role APEC plays in the global energy market is indispensable. It accounts for 56 percent of world energy demand, 58 percent of world energy supply, and 68 percent of world electricity generation. APEC accounts for 60 percent of global CO2 emissions.

(Source: APEC Energy Demand and Supply Outlook (8th Edition), by APERC)

Importance of energy cooperation in APEC region

- APEC energy goals,
  - to improve energy intensity by at least 45 percent by 2035 compared to 2005 levels;
  - to double the share of modern renewables in the energy mix by 2030, relative to the numbers from 2010.
- As of 2020, APEC-wide final energy intensity has improved 26% leaving an additional 19% improvement needed to meet the goal.

(Source: APEC Energy Efficiency and Conservation (ECEC))

EE (energy efficiency) in key sectors and areas

- Industry
- Transport
- Buildings
- Regulations and standards
- …

(Source: APEC Energy Efficiency and Conservation (ECEC))
### EE activities in key sectors and areas

#### Industry
- Using high efficient equipment.
  - Widely deployment=efficient operation
- Accelerating system integration and optimization
  - $1+1>2$
- Expanding engagement in energy management activities.
  - PDCA
- Integrating with the emerging tech such as IoT, AI, etc
- Data and information empower the efficiency

#### Transport
- Green transportation system
  - Vehicles – Deploying more green vehicles and developing electrified railways.
  - Infrastructure – Building up the charging and swap battery networks, hydrogen refilling stations.
- Decarbonization and efficiency of the existing transport system
  - Improving the EE standards for fossil-fuel vehicle
- Smart transportation system
  - Integrating with the emerging tech such as IoT, AI, etc

#### Buildings
- Improving the green building codes.
- Optimize the energy supply in building.
  - Distributed energy resources (Renewable energy such as solar energy, biomass, heat pump, geothermal energy, etc.)
  - Integrated District Energy System, IDES (power, heating and cooling, etc.)
- Accelerating construction of low energy consumption buildings.
- Promoting energy-saving retrofitting for the existing buildings.

#### Regulations and standards
- Laws and supporting policies.
  - Laws for EE&C
  - Supporting policies for EE&C related finance, tax and pricing
- Standards.
  - Minimum energy performance standards (MEPS)
  - Energy management system standards (EnMS)
  - Supporting energy conservation standards for MEPS and EnMS
  - Standards for EE&C market mechanism

### International standards for EnMS and energy savings

#### ISO/TC301 (Energy management and energy savings)
- The ISO 50001 (EnMS) system is based on a process of monitoring, targeting and implementing energy saving measures in a cycle of continuous improvement.
- As of 2023, 23 ISO standards released, 6 ISO standards under development.
- In 2022, the number of ISO 50001 certificates issued worldwide grew by almost 30% to 28000.

Source: www.iso.org
International standards for EnMS and energy savings

- ISO/TC301 (Energy management and energy savings) [Source: www.iso.org]

<table>
<thead>
<tr>
<th>Standard</th>
<th>Title</th>
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</thead>
<tbody>
<tr>
<td>ISO 17743:2016</td>
<td>Energy savings — Definition of a methodological framework applicable to calculation and reporting on energy savings</td>
</tr>
<tr>
<td>ISO 50046:2019</td>
<td>General methods for predicting energy savings</td>
</tr>
<tr>
<td>ISO 17742:2015</td>
<td>Energy efficiency and savings calculation for countries, regions and cities</td>
</tr>
<tr>
<td>ISO 50049:2020</td>
<td>Calculation methods for energy efficiency and energy consumption variations at country, region and city levels</td>
</tr>
<tr>
<td>ISO 50047:2016</td>
<td>Energy savings — Determination of energy savings in organizations</td>
</tr>
<tr>
<td>ISO 17741:2016</td>
<td>General technical rules for measurement, calculation and verification of energy savings of projects</td>
</tr>
<tr>
<td>ISO 50015:2014</td>
<td>Energy management systems — Measurement and verification of energy performance of organizations — General principles and guidance</td>
</tr>
<tr>
<td>ISO 50021:2019</td>
<td>Energy management and energy savings — General guidelines for selecting energy savings evaluators</td>
</tr>
<tr>
<td>ISO 50045:2019</td>
<td>Technical guidelines for the evaluation of energy savings of thermal power plants</td>
</tr>
<tr>
<td>ISO/TS 50044:2019</td>
<td>Energy saving projects (EnSPs) — Guidelines for economic and financial evaluation</td>
</tr>
<tr>
<td>ISO 50007:2017</td>
<td>Energy services — Guidelines for the assessment and improvement of the energy service to users</td>
</tr>
</tbody>
</table>

Suggestions

- Efficiency
  - Energy efficiency → coordinated improvement in EE and emission reduction
  - Individual equipment efficiency → System efficiency improvement
  - Rated/designed efficiency → Operational efficiency improvement

- Integration
  - Technology integration: energy technologies, energy tech + non energy tech
  - Energy integration: clean and renewables energy mix
  - System integration: energy systems, energy sys + non energy sys

Key to success

- Commitment of leadership
- Energy efficiency target
- Comprehensive policy framework
- Coordination of stakeholders

Suggestions

- Policy
  - Cost-effective evaluation of policies
  - Continuous improvement of the policy portfolio (regulations and standards)

- Capacity building
  - Basic data and database
  - International collaboration

THANK YOU

Dr. LIU Meng
liumeng@cnis.ac.cn
Improving Energy Efficiency in Buildings in Hong Kong, China

Mr. Wallace Leung
Chief Engineer/Energy Efficiency, Electrical and Mechanical Services Department
Hong Kong, China
23 January 2024

Buildings in Hong Kong, China
- Around 46,000 buildings
- Around 80% are residential buildings
- Account for 90% of total electricity consumption
- Account for around 60% carbon emission

Policies
- LEAD (Leadership)
- PUSH (Push)
- PULL (Pull)

Policy:
- Regulatory Approach
- Mandatory Energy Efficiency Labelling
- Building (Energy Efficiency) Regulation

Regulatory Approach
- Buildings Energy Efficiency Ordinance
- The building services installations of New, Constructed Building or Existing Building undergoing major remodeling works shall comply with the Building Energy Code
- Existing Building shall conduct regular energy audit

Mandatory Energy Efficiency Labelling
- Products: +50% energy consumption in resident/buildings
- Further development: +50% energy consumption in resident/buildings

Building (Energy Efficiency) Regulation
- Green the energy efficiency of building envelope of commercial buildings and buildings
- Tower: ≤ 21 W/m²
- Podium: ≤ 50 W/m²

Zero-Carbon-Ready Building Certification Scheme
- Recognize buildings that have achieved high energy performance standards and/or set reduction targets towards zero-carbon-ready
- Align the performance indicators for building sector and set common standard to facilitate green finance

Promote Energy Saving Retrofit and Retro-commissioning
- Energy saving retrofit
  - Retrofit shall comply with the latest Building Energy Code
  - Guidebook for promotion
- Retro-commissioning
  - Fine-tuning of buildings mechanical, electrical and plumbing (MEP) systems to optimize their operational efficiency without substantial capital investment
  - Technical guidelines and online resource centre for promotion

Green Building Certification
- Building Environmental Assessment Method (BEAM) Plus is a leading initiative to offer independent assessments of building sustainability performance

Building Environmental Assessment Method (BEAM) Plus
- New building
- Existing building
- New data centre
- Existing data centre

Over 1,200 buildings, first certification

Government take lead
- New government buildings with floor area <5,000 m² with central air-conditioning need to achieve the Gold rating of BEAM Plus

Concessionary measure for private building
- New private building development is eligible to grant pass four with condition by participating BEAM Plus. Around 60% of private buildings starting from Jan 2024, buildings need to obtain Gold rating of BEAM Plus in order to get the concession

Green Building Certification
- Reduce energy consumption by about 10-20% subsequently
- Reduce by 30-40% subsequently

Energy Saving Retrofit and Retro-commissioning
- Take lead to carry out energy retrofit and retro-commissioning for over 200 government buildings since 2019 and share the cases online
- 5% building energy saving in average achieved

Capacity building for the Trade
- Training and registration scheme: >1,900 participants
Examples of Energy Saving Initiatives

**Existing Schools**
- Replace LED lighting and variable-speed AC.
- Smart Power Meters
- District Cooling Systems

**Existing NGO Venues**
- Government building and energy audit
- Energy saving advice for various NGOs

**Smart Power Meters**
- The two power companies started installing smart meters for all customers for target completion in 2025.
- Detailed data for past 14 months and hourly data for past 24 hours.

**District Cooling Systems**
- Energy optimization controls by artificial intelligence.

Finance Subsidy
Promoting energy efficiency and conservation through the Scheme of Control Agreements signed between the Government and the two power companies.
- Subsidy energy-saving retrofitting works, retro-commissioning and smart technology projects to enhance energy efficiency in communal areas of private buildings.
- Target to save 60 million kWh per year.

Building Rehabilitation Assistance Scheme by Urban Renewal Authority
- Subsidy energy-saving equipment replacement during building repair works in communal areas of private buildings.

Accelerated deduction under profit tax
- For new or existing buildings that have achieved BEAM Plus certification, capital expenditure incurred in the installation of energy efficient building installations registered under an Energy Efficiency Registration Scheme for Buildings is eligible for accelerated deduction under profit tax.

Energy Data Monitoring
- Hong Kong China’s Energy Intensity Target
  - The government has set targets to reduce the energy intensity by 40% by 2020.

Feed-in-Tariff for renewable energy systems
- Application increased for 300 times (i.e. from 40 to 1200) since the launch in 2008.
- 120 million kWh/year

Online Building EUI Benchmarking Tool
- Based on real consumption data of 100 sample commercial buildings.
- 15% reduction from 2015 to 2021
Modeling the US buildings energy efficiency

How technological change affects the US energy use through 2050

APERC Energy Efficiency Workshop
Courtney Sourmehi, Industry Economist
January 23, 2024 | Tokyo, Japan

About EIA

The U.S. Energy Information Administration (EIA) is the statistical and analytical agency within the U.S. Department of Energy. EIA collects, analyzes, and disseminates independent and impartial energy information to promote sound policymaking, efficient markets, and public understanding of energy and its interaction with the economy and the environment.

Energy efficiency

- Energy services provided per unit of energy consumption (e.g., COP), improvement driven by technological change
- In the National Energy Modeling System (NEMS): Measured at the end-use technology level, enabling projections of economy-wide changes through 2050

EIA.gov: Buildings energy data and modeling resources

National Energy Modeling System (NEMS) structure

Energy-related CO2 emissions fall across all AEO2023 cases because of increased electrification and higher equipment efficiencies

- In the residential and commercial sectors, higher equipment efficiencies and compliance with building codes extend ongoing declines in energy intensity
- Changes in the buildings fuel mix reduce energy-related CO2 emissions, which decline faster in buildings than any other end-use sector

Energy consumption does not keep pace with increases in housing and floorspace due to the role of energy efficiency

Drivers of building electrification in the United States

- Relative efficiency of electric appliances
- Declining cost of onsite electricity generation (for example, solar photovoltaics)
- Utility energy efficiency rebates
- Stable to declining electricity prices
- Continued population shifts to warmer regions

Data source: U.S. Energy Information Administration, Annual Energy Outlook 2023 Reference case (AEO2023)

Note: Intensities reflect both purchased electricity and electricity produced onsite for own use.
Legislation and policy assumptions: Inflation Reduction Act

- **Extend and modify energy credit** (IRS 48)
  - renewables and combined heat and power investment tax credits

- **Extend, modify new energy efficient home credit** (IRS 45L)
  - newly constructed, high efficiency residential housing packages

- **Extend modified accelerated cost recovery system** (IRS 167)
  - commercial qualified facilities, qualified property, grid improvement property cost recovery

Inflation Reduction Act: Ongoing work

- **Home Owner Managing Energy Savings (HOMES) rebates**
- **High-Efficiency Electric Home Rebate Program**
- **Assistance for Latest and Zero Building Energy Code Adoption**
- **Energy efficient commercial buildings deduction** (IRS 179D)

Residential single-family new-construction equipment shares

- Despite historical growth in heat pump adoption, we project natural gas-fired heating equipment, including furnaces and boilers, will account for the largest share of energy consumption for space heating through 2050
- The average stock efficiency of natural gas-fired equipment increases over time

Buildings technological improvement in NEMS

1. Building technology reports represent the average cost and performance of installed equipment in buildings
2. Model uses technology menus to select optimal equipment based on energy service requirements, consumer behavior rules, cost and performance considerations
3. Technologies compete to meet service demand in each US Census division and building type
4. NEMS projects average stock and purchased stock efficiency, by end use and region, over time

The US distributed generation capacity in commercial and residential buildings

- Additional data
For more information

U.S. Energy Information Administration homepage | www.eia.gov
Buildings Working Group materials | www.eia.gov/outlooks/aeo/workinggroup/buildings
Today in Energy | www.eia.gov/dailyenergy
Annual Energy Outlook | www.eia.gov/aeo
Short-Term Energy Outlook | www.eia.gov/steo
State Energy Data System | www.eia.gov/state/seds
Monthly Energy Review | www.eia.gov/mer
Residential Energy Consumption Survey | www.eia.gov/recs
Commercial Building Energy Consumption Survey | www.eia.gov/cbecs
International Energy Portal | www.eia.gov/international

View our data online

• Interactive graphs available as part of our online data table browser
  www.eia.gov/outlooks/aeo/data/browse

• Excel spreadsheets for Reference and side cases
  www.eia.gov/outlooks/aeo/tables_ref.php
  www.eia.gov/outlooks/aeo/tables_side_xls.php
Energy Efficiency of Buildings in Australia

Dr. Subbu Sethuvenkatraman
Jan 24

Energy use in buildings: Australia

- 86% Australian population live in cities
- Buildings make up about 18% total emissions
- Nearly 60% of building energy use is through electricity
- High uptake of Distributed Energy Resources (DER). One in every three households likely to have rooftop solar by 2050

Decarbonisation of Australian built environment sector

- Trajectory for low emission buildings (2019, 2024)
- Sector wide decarbonisation plans (2023)
- National Construction Code (NCC), Greenhouse and Energy minimum Standards (GEMS) for appliances

Drivers for energy efficiency

- As a consumer
  - Reduce energy bills
  - Climate resilient
  - Health and comfort
- Technology/policy
  - Net zero
  - Electrification
  - Distributed generation + storage
  - Consumers becoming prosumers

Emerging Opportunities

- Electrification & Decarbonisation
  - Switch from gas heating to heat pumps
  - Gas/electric boiler to heat pumps
  - Self consume: use onsite generation and storage
- Digitalisation
  - Smart meters, sensors for monitoring and control
  - Optimal control, management, preventive maintenance
  - Participate in the electricity market
Digitalisation journey: Australian experience

Two step process:

- Connecting the buildings ("digital ready") and getting access to all data in a cost effective way
- Delivering benefits through analytics (both operational and energy cost)

Pathway for decarbonisation of building sector

~20% 2020 level

Thank you

Dr. Subbu Sethuvenkatraman,
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+61 416 528 314

Australia’s National Science Agency
Japan’s Path for Carbon Neutrality and the Role of Energy Efficiency in Buildings

The Institute of Energy Economics, Japan
Climate Change and Energy Efficiency Unit
Naoko DOI

Japan’s Progress of Policy Formulation at the Demand Side: Toward Carbon Neutrality

- In 2021, Japan announced the target to achieve carbon neutrality by 2050.
- April 2022, amendment of energy conservation law was made to include “non-fossil fuels” on top of fossil fuels for energy efficiency improvement. Demand Response is also included as the energy efficiency concept.
- Headed by Prime Minister Kishida, and participated by Ministers and representatives from industry, series of discussions are being held to plan for Green Transformation (GX).
- Roadmap for GX by technology/sector was announced in December 2022.
- For achieving the carbon neutrality, comprehensive approach covering the building sector is formulated.
- Promotion of introducing zero energy buildings, stock buildings energy efficiency renovation, and incessant efforts in operational energy efficiency improvement are the key in the building sector.

Roadmap for Japan’s Green Transformation

<table>
<thead>
<tr>
<th>2023</th>
<th>2024</th>
<th>2025</th>
<th>2026</th>
<th>2027</th>
<th>2028</th>
<th>2029</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Economic Initiatives</td>
<td>Provision of incentives for green transformation</td>
<td></td>
<td>Support for existing technologies</td>
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<td></td>
<td>Support for group activities</td>
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<td></td>
<td>Strengthening regulation for decarbonization and new industry innovation</td>
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<tr>
<td></td>
<td>Energy conservation law, building energy conservation law, tax on energy supply structure</td>
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<td></td>
<td>Comprehensive approach to mobilize 150 trillion Yen of public/private investment for GX</td>
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<td>Security response to energy supply disruption</td>
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<tr>
<td></td>
<td>Global infrastructure</td>
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<td></td>
<td>International cooperation</td>
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<td></td>
<td>Finance</td>
<td>Green Transition Bond</td>
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<td></td>
<td>provisions of bond issuance</td>
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<td></td>
<td>Issuance of Green Transition Bond</td>
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<td></td>
<td>Trial (2023)</td>
<td>Companies responsible for 45% of Japan’s CO2 emissions are joining the trial.</td>
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<td></td>
<td>Start operation of emissions trading</td>
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<td></td>
<td>Carbon surcharge</td>
<td>U000AUXCARUHUR</td>
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<td>Project on low-carbon hydrogen</td>
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<tr>
<td></td>
<td>Support for Asian Economies for their “Realistic” energy transition through AZEC (Asia Zero Emission Community)</td>
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<td></td>
<td>Cooperation on green innovation</td>
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<td></td>
<td>Accelerating 2050 on clean products evaluation; corporate (GHG reduction assessment)</td>
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Energy efficiency and demand-side actions are the key for Japan to achieve carbon neutrality by 2050.

- Strengthening Energy Efficiency and Demand Side Actions
  - Industry: Direct mixing system, demand-side system, technology innovation and financial support
  - Residential/Commercial: GHG reduction targets, 100% new renewables
  - Roadmap for GX - 10% in 2030, 20% in 2050

Roadmap for Japan’s Green Transformation: Buildings

Comprehensive Approach to Strengthen Energy Efficiency

- Comprehensive approach to mobilize 150 trillion Yen of public/private investment for GX

Directions for Further Deepening Japan’s Energy Efficiency by 2030

Energy savings in each sector - to be accumulated to save energy consumption by 0.2 billion kl in 2030

<table>
<thead>
<tr>
<th>Sector</th>
<th>2019</th>
<th>2020</th>
<th>2021</th>
<th>2022</th>
<th>2023</th>
<th>2024</th>
<th>2025</th>
</tr>
</thead>
<tbody>
<tr>
<td>Residential</td>
<td>New energy-saving houses</td>
<td>3.5 mil kL, 3%</td>
<td></td>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Remodelling of existing house</td>
<td>3.0 mil kL, 4%</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Efficient water heaters</td>
<td>1.5 mil kL, 3%</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td></td>
<td>Efficient refrigerators</td>
<td>2.0 mil kL, 7%</td>
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<tr>
<td></td>
<td>Home energy management system</td>
<td>2.0 mil kL, 3%</td>
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<td></td>
<td>Heat pump water heater (e.g., double glazing window): 135 billion yen</td>
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<td></td>
<td>Heat pump water heater: 210 billion yen</td>
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<tr>
<td>Commercial</td>
<td>Commercial energy management</td>
<td>2.0 mil kL, 6%</td>
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<tr>
<td></td>
<td>Renewable energy heating systems</td>
<td>2.0 mil kL, 3%</td>
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<td></td>
<td>Efficient lighting</td>
<td>2.0 mil kL, 0%</td>
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<td></td>
<td>Efficient ventilation</td>
<td>2.0 mil kL, 0%</td>
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<td></td>
<td>Commercial energy management systems</td>
<td>2.0 mil kL, 1%</td>
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<tr>
<td></td>
<td>Efficient water heaters</td>
<td>2.0 mil kL, 3%</td>
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<tr>
<td>Transport</td>
<td>High-speed train</td>
<td>4.0 mil kL, 25%</td>
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<tr>
<td></td>
<td>Electric bus, electric vehicle</td>
<td>2.0 mil kL, 25%</td>
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<td></td>
<td>High-speed train</td>
<td>2.0 mil kL, 3%</td>
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<tr>
<td>Industry</td>
<td>Condensing boiler for rented housing</td>
<td>0.2 mil kL, 0%</td>
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<tr>
<td></td>
<td>Condensing boiler for large buildings</td>
<td>0.2 mil kL, 0%</td>
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</table>
Government Support and the Private Sector Business Expansion

In the second supplementary budget for FY2023, for households, a total of 421.5 billion yen are being provided for the energy efficiency of residential sector.

<table>
<thead>
<tr>
<th>Heat Pump Water Heater</th>
<th>50,000 Yen/unit</th>
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</thead>
<tbody>
<tr>
<td>Heat Pump Water Heater</td>
<td>50,000 Yen/unit</td>
</tr>
<tr>
<td>Residential Fuel Cell</td>
<td>200,000 Yen/unit</td>
</tr>
</tbody>
</table>

Overseas HP Production and Investment for Plant Expansion

- Japanese market entry Year 2006, and Trials 2009 started
- Started a factory in China in 2014, and decided to install a new plant for pump-type heaters in Poland.
- Started production of Residential heat pumps for Europe in the Czech Republic from 2016.

Panasonic

- Started a production line in Europe and Turkey, establishment of a factory in West Turkey.

Nissan Electric

- Planned to introduce DR ready requirements for appliances. Careful consideration are being made to determine the appliances for DR ready, consider cost.

Japan’s evolving energy efficiency policies areas

- Non-fossil Fuel Target for Industry Sub-Sectors and Transport
- Residential, paper and steel, transportation, food and steel, and automobiles manufacturing, and non-fossil fuel target for each industry, such matters subject to public opinion has not set.
- Demand Response Implementation by Large-scale Energy Users
- To increase consumers’ engagement on energy efficiency, electric/gas retailers would be required to set energy usage target at the demand side, which will be reviewed by government.
- Carbon Neutrality of Water Heaters
- Adoption of carbon pricing system.
- Demand Response Ready Appliances
- To increase consumers’ engagement on energy efficiency, electric/gas retailers would be required to set energy usage target at the demand side, which will be reviewed by government.
- Electric/Gas Retailers’ Energy Efficiency Pledge and Review
- To increase consumers’ engagement on energy efficiency, electric/gas retailers would be required to set energy usage target at the demand side, which will be reviewed by government.

Tokyo Midtown

- Tokyo Cap-and-Trade Program : Top Level Certification System
- The Top-level Business Entity Certification System:
  - Mechanism that reduces the reduction obligation rate of a business entity with excellent specified global warming countermeasure business entity.
  - The emissions reduction obligation rate:
    - Large-scale businesses in Tokyo is imposed GHG emissions reduction rate of 27% or 25% (fiscal years 2020-2024).

Estimated Distribution of Stock: Residential Buildings in Japan

- An estimation is being made to consider the potential share of Zero Energy House In 2050.
- If all the newly built residential houses are ZEH from 2021, its share will reach 28.7% by 2050.
- This results show the needs for additional measures such as (1) operational energy efficiency improvement, (2) strengthening of energy efficiency renovation for existing stocks, and (3) promotion of ZEH in apartment buildings.

Example of Top Level Certified Buildings

- Skytree: In 1992 Standard
- 1999 Standard
- 2012 Standard

Tokyo Cap-and-Trade Program : Buildings’ Energy Savings Score Card

- Score cards – current status
- Score cards – current status
- Score cards – current status

Distribution of Residential Building Stock by Energy Efficiency Standard

- ZEH : 28.7%
- 1999 Standard
- 1992 Standard

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SESSION 3-2 “IMPROVING ENERGY EFFICIENCY IN TRANSPORT IN MALAYSIA”
BY HUZAIMI NOR OMAR

POLICY PUSH FOR ENERGY EFFICIENCY (TRANSPORT) IN MALAYSIA

1. Low Carbon Mobility Blueprint 2021-30 is the 1st holistic policy document on Land Transport of Malaysia.
2. Focus is on energy savings which also resulting on carbon emission reduction and cost savings.

STOCK TAKE – VARIOUS INITIATIVES (GOVERNMENT)

STOCK TAKE – VARIOUS INITIATIVES ON EV (GOVERNMENT)

STOCK TAKE – VARIOUS INITIATIVES ON EV (GOVERNMENT)

$\text{1. National Energy Transition Roadmap latest policy document launched.}$
$\text{2. NETR focus is on carbon emission reduction towards realizing the Net Carbon Emission 2050 target.}$

$\text{3. Electric Vehicles taking center stage as the primary incentives focus.}$
$\text{Continuous and evolving target for EV penetration.}$
$\text{LCMB 2030 National Energy Policy 2022-2040}$
$\text{38% of EV penetration at 2040}$
$\text{NETR 2025-50}$
$\text{80% xEV penetration at 2050}$

$\text{STOCK TAKE – VARIOUS INITIATIVES (GOVERNMENT)}$

$\text{Implementation of Energy Efficient Vehicles Manufacturing incentives}$
$\text{Voluntary Energy Efficient Vehicle (EEV) Labelling Scheme}$

$\text{STOCK TAKE – VARIOUS INITIATIVES ON EV (GOVERNMENT)}$

$\text{Incentives on EV}$
$\text{Regulatory reinforcement}$
$\text{Requirement of EVCS Distribution License by Energy Commission started April 2023}$
$\text{Requirement to comply to Planning Guideline of EV Charging Bay inclusive of fire hazard guidelines in enforcement from October 2023}$
$\text{Full exemption of import duty, excise duty and sales tax on locally assembled EV or CKD until 2027}$
$\text{Full exemption of import duty and excise duty on CBU EV until 2025}$
$\text{100% Road tax exemption until 2025}$
$\text{Individual income tax relief for EV Charging from 2024 to 2027}$
$\text{RM2,400 cash rebates for e-motorcycle}$
$\text{Company tax deduction up to RM300k for non-commercial EV leasing (2023 – 2027)}$

$\text{Key ministries only}$
$\text{Ministries, Government Agencies, Association and Corporate}$
$\text{NEVSC}$
$\text{NEVTF}$

$\text{Both chaired by Ministry of Investment & Trade. To accelerate EV charging infrastructure and EV adoption in Malaysia}$

$\text{Electro Vehicles taking center stage as the primary incentives focus}$
$\text{Continuous and evolving target for EV penetration}$

$\text{Various models are available, and more are being introduced}$
$\text{Various models are available, and more are being introduced}$
$\text{EV Charger stations are on trial in Sarawak}$
$\text{Hydrogen (FCEV) are on trial, mostly in Sarawak}$
$\text{Automated Rapid Transit (ART) on trial at Kuching since 2023}$
$\text{3 Free H2 bus and 3 Hyundai Nexo as corporate fleet in operation in Kuching since 2020}$
$\text{Premier of Sarawak driving Toyota Mirai as part of trial}$
$\text{Sarawak to produce larger scale green hydrogen in 2027.}$

$\text{EV MARKET ARE GROWING IN MALAYSIA}$

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Thank you

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Transport Sector Energy Consumption

- The road transportation mode consistently had the largest share ranging from 77.0% to 88.2%, followed by the water transportation mode (~7.2% to 19.7%), followed by the domestic air transportation mode (~1.9% to 5.9%), and the lastly followed by the rail transportation mode (~0.03% to 0.23%)
- Diesel consistently had the largest share ranging from 53.0% to 60.8% followed by gasoline (~29.6% to 36.3%), followed by biodiesel (0.7%), Auto-LPG (0.4%) and electricity (0.08%)
- The transportation sector is highly dependent on fossil fuels and it will remain as the highest energy consuming sector with a 35.6% average share across the entire planning horizon, and accounting for the bulk of the increase (38.1%) in total final energy consumption levels between 2015 and 2030

Air Quality and Climate Impacts

- In the Philippines, the transportation sector is the largest source of air pollution and energy-related greenhouse gas (GHG) emissions.
- In 2015, transport GHG emissions contributed to 34% of the total Philippines GHG emissions, with road transport accounting for 80% of those emissions
- The DENR reports that 74% of air pollutants come from transport sources (e.g., cars, motorcycles, trucks, and buses). Transport sources account for 83.09% of NOx (1.40 Mt) and 37.73% of PM (0.29 Mt) of pollutants in Metro Manila
- The transport sector in the Philippines is energy-intensive and contributed about 3.6 metric tons of carbon dioxide equivalent (MtCO2e) and 27.4 MtCO2e of emissions in 2019 and 2020, respectively. Moreover, the price volatility of oil products and fears of fuel shortages, in addition to continued fuel dependence, pose a burden on our energy security, the economy, and the public

Low Carbon Transport Development

- In April 2021, the Philippines submitted its Nationally Determined Contribution (NDC) in accordance to the Paris Agreement
- The Philippines commits to a projected GHG emissions reduction and avoidance of 76%, of which 27.1% is unconditional and 48.9% is conditional, representing the country’s ambition for GHG mitigation for the period 2020 to 2030 for the sectors of agriculture, waste, industry, transport, and energy
- This commitment is referenced against a projected business as usual (BAU) cumulative economy-wide emission of 3,430 MtCO2e for the same period
- Data from the Department of Transportation indicates that from a baseline of 24.02 MtCO2e in 2010, the GHG contribution from the transport sector (combinedroad, rail, air, water) is projected to grow to 87.10 MtCO2e (in 2030) and 166.07 MtCO2e (in 2040) under the BAU scenario
- Based on initial calculations, transport projects can contribute to a GHG reduction of 10.03 MtCO2e in 2030 and 14.34 MtCO2e in 2040, which are equivalent, respectively, to 11.51% and 8.63% GHG reduction from the BAU
- Disaggregating the total by projects, rail has the largest contribution to GHG reduction at 6.79% (2030) and 4.23% (2040), followed by Public Utility Vehicle (PUV) Modernization Program at 2.91% (2030) and 2.75% (2040)
Assessing Sustainable Transport Measures

Vergel & Tigao (2013) estimated fuel consumption and air pollutant emissions for baseline and transportation policy scenarios in 2010 and 2015 using fuel consumption factors from local studies. The expansion of the mass transit network is the single policy scenario that contributed to a higher overall reduction in petroleum and alternative fuel consumption levels. This is followed by the vehicle restrict (VD) policy. The implementation of all-CNG bus policy contributed to the significant reduction of diesel fuel consumption. The public utility buses consumed the largest share (28%) of diesel fuel consumed in Metro Manila in 2010. The MVIS policy did not contribute to a significant reduction in fuel consumption.

National Energy Efficiency and Conservation Plan (NEECP)

• "A comprehensive framework and plan that institutionalizes energy efficiency and conservation in the country across key sectors of the economy in accordance with the EEC Act.

• Section 4(d) of the EEC Act stipulates that the NEECP shall outline the governance structure, and programs for energy efficiency and conservation with defined national targets, baseline strategies, and regular monitoring and evaluation. The plan is also required to be regularly reviewed and revised by DOE.

• The DOE has forecasted that the country’s energy mix in 2040 will appear like the energy mix to date, except that the share of diesel consumption will be lower than the gasoline consumption. The limited infrastructure and regulatory barriers in place mean that it may be several years before the use of electric vehicles can be effectively scaled up.

• Under the Clean Energy Scenario (CES) of the Philippine Energy Plan 2018-2040, there will be a 10% penetration rate for EVs for road transport by 2040.

Comprehensive Roadmap for the Electric Vehicle Industry (CREVI)

• The Electric Vehicle Industry Development Act (EVIDA) became law on April 15, 2022, as Republic Act 11697, which mandates the creation of CREVI.

• A law that "ensures the country’s energy security and independence by reducing reliance on imported fuel for the transport sector and provides an enabling environment for the development and adoption of EVs and EV charging stations".

• Includes fiscal and non-fiscal incentives.

• "The CREVI refers to a national development plan for the EV industry with an annual work plan to accelerate the development, commercialization, and utilization of EVs in the country comprised of the following four (4) components":

• EVs and charging stations component;
• Manufacturing component that gives emphasis on EV for public transport in addition to EV for individual use;
• Research and Development component that generates Science and Technology (S&T) based policies and local technologies for commercialization;
• Human resource development component which includes skills and capacity building of needed personnel to support the development of the EV industry.

Improving Fuel Efficiency in Transport

• The Philippines Energy Labelling Programs (PELP) is a large program that has been undergoing phase-by-phase implementation since 2020.

• The development and rollout of energy performance requirements beyond the appliances sector remains a high priority for the DOE. These include technologies and industrial devices such as motors, and possibly transformers, which is widespread in use and energy consuming.

• Minimum fuel efficiency ratings and labeling for vehicles also fall under the PELP.

• The updated Roadmap highlights the necessary actions to expand the PELP product/technology coverage, through the conduct of market assessment studies, establishing and harmonizing standards in coordination with experts and ASEAN economies respectively.

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• DOE will develop the minimum energy performance requirements, maximum energy consumption limits, and minimum energy performance for transport vehicles.

Philippine Transport Vehicles Fuel Economy Labeling Program (VFELP)

• With the expansion and amendment of the PELP coverage as indicated in DC2023-11-0035 and the requirement for fuel economy performance labeling under Section 17 of the EEC Act, the government’s initiative on energy efficiency and conservation policies for the Transport Sector entails the development of the Philippine Transport Vehicles Fuel Economy Labeling Program.

• The program covers the fuel economy performance rating for the transport sector which will initially cover road transport vehicles.

• Requires that transport vehicle manufacturers, importers, distributors, dealers, and rebuilders shall comply with the vehicle fuel economy labeling requirements set by the DOE with the assistance of the DOTr, DENR, and other concerned agencies (EEC under Section 17, Section 2 of DC2020-12-0023, Sections 58 and 60 of DC2018-11-0014).

• DOE will develop the necessary technical requirements, including but not limited to: implementing guidelines, vehicle fuel economy performance testing guidelines, and minimum energy performance for transport vehicles.

Key Strategies

• Transport Vehicles Fuel Economy Labeling Program (VFELP)

• The Short-Term (2023-2025) strategic action includes the development of a Monitoring, Verification and Evaluation (MV&E) framework.

• Development and rollout of energy performance requirements beyond the appliances sector remains a high priority for the DOE. These include technologies and industrial devices such as motors, and possibly transformers, which is widespread in use and energy consuming.

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• Research and Development

• Co-create programs for incentivizing fuel efficiency and emission reduction.

• Public transport monitoring and evaluation tools for government use.

• Professionalizing fuel management through training programs and development of tools for asset management.

• Upgrade Competency Standards to include eco-driving as core competency, and improve knowledge of drivers and operators on transport sector’s environmental footprint.

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Maraming Salamat Po!
APEC Symposium on Promoting Energy Efficiency and Energy Management System

Achievement and potential of multi-pathway approach in road transport sector - Japan's experience -

23rd January, 2024
Takao Aiba
Japan Automobile Manufacturers Association (JAMA)
Chair, the International Climate Change Policy Expert Group

Who We Are?

- JAMA (Japan Automobile Manufacturers Association, Inc.) is a non-profit industry association comprising Japan’s 14 manufacturers of passenger cars, trucks, buses and motorcycles.

Established: April 3, 1967

Our Objectives:
- To promote the sound development of the automobile industry and contribute to social and economic welfare.

Our Activities:
- Conducts studies and surveys related to automobile production, distribution, trade and use.
- Assists in the rationalization of automobile production, and helps establish policy for the development, improvement and promotion of production technology.
- Establishes and promotes policies related to automobile trade and worldwide exchange.
- Carries out other activities involved in meeting its organizational objectives.

Member Companies:
- Honda Motor Co., Ltd.
- Toyota Motor Co., Ltd.
- Nissan Motor Corporation
- Mazda Motor Corporation
- Subaru Corporation
- Mitsubishi Motors Corporation
- Suzuki Motor Corporation
- Daihatsu Motor Co., Ltd.

Our Objective

- The goal is carbon neutrality (CN).
- Approaches to achieving CN should be technology-neutral.
- A diversity of options is crucial to achieving our goals.
- There are optimal pathways to CN for individual economies.

JAMA stance on Carbon Neutrality

JAMA member companies are making maximum efforts towards Carbon Neutrality by 2050.

JAMA stance

JAMA member companies, together with their global stakeholders, are making maximum efforts towards carbon neutrality by 2050 by developing technologies to further reduce automotive CO2 emissions so that they can provide optimal choices for consumers in economies/regions worldwide.

- The goal is carbon neutrality (CN).
- Approaches to achieving CN should be technology-neutral.
- A diversity of options is crucial to achieving our goals.
- There are optimal pathways to CN for individual economies.
**CO2 emissions from road transport sector in Japan**

Japanese auto makers has been contributing in reducing CO2 emissions from road transport sector mainly through its effort to improve fuel efficiency by expanding lineup of electrified vehicles.

**Concept of an “Integrated Approach”**

1. Increasing Fuel-Efficient vehicles by Automobile Manufacturers
2. Diversified Fuel Supply by Fuel Suppliers
3. Efficient Vehicle Use by Vehicle Users
4. Traffic Flow Improvement by Governments

**CO2 emissions reduction by “Integrated Approach”**

Japan is steadily reducing CO2 emissions by implementing an "Integrated Approach".

**Transitioning to Carbon Neutrality by 2050**

1. Purpose of using scenarios
2. Data applied
3. Scenario parameters

**Summary of Study Findings**

- Findings show that the study’s three scenarios (excluding the BAU scenario) demonstrate the potential for global CO2 emissions reduction in automotive transport to be in line with the IPCC’s 2015 1.5°C climate scenarios.

**CO2 Emissions Worldwide 2020-2050, by Scenario**

In all three scenarios, CO2 emissions worldwide are in line with the IPCC’s 1.5°C@2050 scenarios.
CO₂ Emissions ASEAN 2020-2050, by Scenario

- 1.25 increase in carbon-neutral fuel supply compared to the CNF scenario will make it possible for CO₂ emissions in ASEAN economies to be in line with the IPCC’s 1.5 scenarios for 2050.

CO₂ Emissions Japan 2020-2050, by Scenario

- In all the scenarios, CO₂ emission levels are close to carbon neutrality.

Initiative in G7 members

- G7 Leaders recognized the importance of reducing GHG emissions from the global fleet and “the range of pathways” for keeping a limit of 1.5°C within reach.

The Global Stocktake at COP28, Dubai

- The first “Global Stocktake” on how economies can accelerate action to meet the goals of the Paris Agreement was conducted.

Summary of our presentation

- Japan has been a leader of CO₂ emission reduction in road transport sector among G7 members through
  - “Integrated Approach” consist of 4 pillars.
  - Expanding lineup of electrified vehicles suitable for regional circumstances, which is in line with “the range of pathways,” key concept of G7 and COP28 agreement.

- Based on the quantitative scenario analysis, JAMA believe that there is potential not only for 100% BEVs, but also for a wide variety of electrified vehicles including HEVs and PHEVs and the use of carbon-neutral fuel (CNF) for global CO₂ emissions reduction in road transport to be in line with the IPCC’s 2050 1.5°C climate scenarios.
1. Energy Demand in Chinese Taipei

2. Energy Efficiency Policies for Industrial Sector


4. Conclusion

1-1. Domestic Trend in Economy and Energy

- Chinese Taipei’s GDP is growing rapidly, leading to increased electricity demand, while total energy consumption remains stable.
- The industrial sector’s share of GDP, energy usage, and electricity consumption has significantly increased.

1-2. Industrial Trend in Economy and Energy

- Industrial GDP growth surpasses electricity and energy use.
- Electronic Industry shows marked increases in GDP contribution, energy consumption, and electricity usage ratios.

2-1. Energy Efficiency for Equipment and Appliances

- Minimum Energy Performance Standard (MEPS)

<table>
<thead>
<tr>
<th>Equipment and Appliances</th>
<th>Issued Date</th>
<th>Energy Efficiency (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fan</td>
<td>2024/7/1</td>
<td>7~10</td>
</tr>
<tr>
<td>Rotodynamic pump</td>
<td>2023/1/1</td>
<td>5~8</td>
</tr>
<tr>
<td>Air compressor</td>
<td>2023/1/1</td>
<td>5~7</td>
</tr>
<tr>
<td>Water chilling packages using the vapor compression cycle</td>
<td>2020/7/1</td>
<td>2</td>
</tr>
<tr>
<td>Low-voltage three-phase squirrel-cage high-efficiency induction motors</td>
<td>2016/7/1</td>
<td>2~3 (IE3)</td>
</tr>
</tbody>
</table>

- Energy Efficiency Ranking Labeling

<table>
<thead>
<tr>
<th>Water Chilling Packages</th>
<th>3rd</th>
<th>2nd</th>
<th>1st</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water-Cooled Displacement</td>
<td>-0.94</td>
<td>-0.90</td>
<td>-0.05</td>
</tr>
<tr>
<td>Centrifugal</td>
<td>5.10</td>
<td>4.50</td>
<td>3.40</td>
</tr>
<tr>
<td>Air Compressors</td>
<td>2.00</td>
<td>1.50</td>
<td>1.00</td>
</tr>
<tr>
<td>Refrigeration System</td>
<td>3.00</td>
<td>2.50</td>
<td>2.00</td>
</tr>
</tbody>
</table>

2-10. Improving Energy Efficiency in Industry in Chinese Taipei

Dr. PAN, Tze-Chin
Deputy Division Director, Energy Policy and Planning Division, Green Energy and Environment Research Laboratories (GEL), Industrial Technology Research Institute (ITRI).

2024/01/23
2-2. Energy Audit Reporting Scheme

- **Large Energy User (LEUs):** The energy user whose energy consumption meets the level stipulated by the Ministry of Economic Affairs, shall establish its own energy audit system and set objectives for energy conservation and execution.
- There are 3,500 industrial LEUs, and they consumed about 75% of industrial energy consumption.

<table>
<thead>
<tr>
<th>Energy Form</th>
<th>Basis for energy use</th>
<th>Mandatory Obligation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>Contract capacity &gt; 800kW</td>
<td>1. Set energy management officer.</td>
</tr>
<tr>
<td>Fuel oil</td>
<td>&gt; 6,000 KJ/Ly</td>
<td>2. Report the energy audit and energy conservation plan annually.</td>
</tr>
<tr>
<td>Natural gas</td>
<td>&gt; 10,000,000 m³/y</td>
<td></td>
</tr>
<tr>
<td>Coal</td>
<td>&gt; 6,000 Ton/y</td>
<td></td>
</tr>
</tbody>
</table>

2-3. Electricity Saving by 1%

- **The government mandated a target of 1% electricity saving for LEUs:**
- Annual average electricity saving (Si) from 2015 to 2024 must exceed 1% of the annual average total electricity consumption (Ci).

\[
\text{Annual average electricity saving rate} = \frac{\sum_{2015}^{2024} S_i}{\sum_{2015}^{2024} C_i} \geq 1\%
\]

- Electricity saving from one energy efficiency measure will be counted only in one year.
- If the LEUs’ annual average saving rate less than 1% in 2024, the LEUs will be penalized by the government.

2-4. Regulations for Six Energy Intensive Industries

2-5 Energy Efficiency Subsidies for Industrial Sector

**Type** | **Name** | **Applicant Eligibility** | **Subsidy Item** | **Grant Amount**
---|---|---|---|---
Equipment-Based | Motor-Driven Equipment Subsidy | All companies | Energy-saving project with more than 10% improvement in energy efficiency | IPA Motor: 700 NT$/kW (dependent on different capacity and model)  Air Compressor: 500~5,000 NT$/kW  Fan: 200~2,400 NT$/kW  Pump: 2,000~4,500 NT$/kW (dependent on different capacity and model) |
Project-Based | Energy Saving Performance Subsidy | Companies (Contract Capacity > 100 kW) | Energy-saving project with more than a 10% improvement in energy efficiency | Subsidy 20% of project total expenditure** |
| Waste Heat Recovery Subsidy | Companies (Contract Capacity > 100 kW) | Energy saving project with waste heat recycle equipment | Subsidy 30% of expenditure of waste heat recycle equipment |

**Subsidy ceiling is NT$5 million (160,000 USD).**

*The subsidy program has a fixed total budget, and each application competes with others. The review committee determines the priority order of applications.*

2-6. Regulations for Six Energy Intensive Industries

1. Set energy management officer.
2. Report the energy audit and energy conservation plan annually.

2. Energy Efficiency Policies for Industrial Sector


4. Conclusion

---

3-1. Phases of Strategic Plan

Chinese Taipei’s “Energy Saving Strategic Plan” consists of two phases:
3-2. Plan Targets and Path (Phase 1)

- **Target:** Maximizing Energy Efficiency through the efforts of public and private sectors.
- **Path:** "Energy Saving Strategic Plan" involves energy saving programs in industrial, commercial, residential, transportation sectors, and advanced technology research.

### 2023
- Increase renewable energy proportion
- Reduce energy intensity by 2% per year
- Improve energy efficiency in all sectors
- Landfill gas utilization increased by 15%
- Enhance energy efficiency by 3% in large energy users

### 2026
- Implement high efficiency technology improvement
- 15% of the nation’s electricity generation is from low emission
- 80% of industry buildings are energy efficient
- 70% of buildings meet energy standard
- 50% of all office buildings reach level 3
- Energy efficiency of new residential buildings increased by 15%

### 2030
- Implement high efficiency technology improvement
- 25% of industry buildings are energy efficient
- 90% of buildings meet energy standard
- 60% of all office buildings reach level 3
- Energy efficiency of new residential buildings increased by 30%

### 2050 Net-Zero Strategy: "Strategic Plan of Energy Saving"

### Equipment Large Energy Users Incentives

<table>
<thead>
<tr>
<th><strong>Equipment</strong></th>
<th><strong>Large Energy Users</strong></th>
<th><strong>Incentives</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>MEPS</td>
<td>Energy Audit Reporting Scheme</td>
<td>Mine-Chinese Equipment Subsidy</td>
</tr>
<tr>
<td>Energy Efficiency Ranking Labeling</td>
<td>Energy Efficiency Ranking Labeling</td>
<td>Energy Saving Performance Subsidy</td>
</tr>
</tbody>
</table>

### Conclusion

- The industrial sector in Chinese Taipei consumes 33% of the total energy, a significantly higher share than other sectors.

- To enhance industrial energy efficiency, Chinese Taipei is implementing the following measures:

- To achieve the 2050 Net-Zero, Chinese Taipei has devised the "Strategic Plan of Energy Saving".
2-11. Improving Energy Efficiency in Industry in Thailand

Mr. Wisaruth Maethasith
Department of Alternative Energy Development and Efficiency

APEC Sectoral Symposia on the Holistic Approach of Decarbonization for Energy Transition
23 January 2024

Outline

- Thailand’s Energy Situation and Industries
- Energy Efficiency Plan (Draft)
- Key Measures

Thailand’s Energy Situation

Final Energy Consumption 2022 by Fuel:

- Coal
- Natural Gas
- Petroleum Products
- Electricity (non-RE)
- Renewable Energy

Key Consideration:
- GDP and Population
- Consider Carbon Neutrality target in energy sector (95.5 MtCO2eq)
- Electric Vehicle projection from EPPO
- Sector-specific measures and supply-side measures

Energy Efficiency Plan (Draft)

Target energy intensity (EI) reduction of 36% within 2037 compared to 2010 level

WORK IN PROGRESS – SUBJECT TO CHANGE!!!
### New Energy Efficiency Plan (Draft) – cont.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Compulsory</th>
<th>Voluntary</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electr.</td>
<td>3,822</td>
<td>5,051</td>
<td>8,874</td>
<td>25</td>
</tr>
<tr>
<td>Thermal</td>
<td>7,056</td>
<td>19,565</td>
<td>26,623</td>
<td>75</td>
</tr>
<tr>
<td>Total</td>
<td>10,880</td>
<td>24,617</td>
<td>35,497</td>
<td>100</td>
</tr>
</tbody>
</table>

### Energy efficiency measures target by economic sectors: 2022 - 2037

<table>
<thead>
<tr>
<th>Sector</th>
<th>Unit</th>
<th>Compulsory</th>
<th>Voluntary</th>
<th>Total</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturing</td>
<td>ktoe</td>
<td>1,700</td>
<td>5,127</td>
<td>6,827</td>
<td>35</td>
</tr>
<tr>
<td>Residential</td>
<td>ktoe</td>
<td>3,530</td>
<td>6,827</td>
<td>10,357</td>
<td>50</td>
</tr>
<tr>
<td>Agriculture</td>
<td>kVA</td>
<td>15</td>
<td>492</td>
<td>507</td>
<td>2</td>
</tr>
<tr>
<td>Transportation</td>
<td>kVA</td>
<td>13,495</td>
<td>13,495</td>
<td>26,990</td>
<td>100</td>
</tr>
</tbody>
</table>

### Key measures – Industrial and Commercial Sector

- Energy management standard in designated factories and buildings
- Achievement of factory and building energy codes
- Energy efficiency standards and labeling
- Energy efficient equipment replacement
- Human Resource Development
- Public awareness
- Financial Incentive - Subsidy Program

### 1. Energy Management System

- Installed electric meter (total)
- Installed transformers (total)
- Total annual energy consumption

#### Classification of designated factories/buildings

<table>
<thead>
<tr>
<th>Classification</th>
<th>Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group 1</td>
<td>3,324</td>
</tr>
<tr>
<td>Group 2</td>
<td>3,324</td>
</tr>
<tr>
<td>Total</td>
<td>6,873</td>
</tr>
</tbody>
</table>

#### Legal responsibilities of designated factories/buildings

1. Appoint Person Responsible for Energy (PRE)
   - At least 1 PRE for Group 1
   - At least 1 PRE for Group 2, in which one must be senior PRE

2. Conduct energy management system as described in regulation and submit an annual report to DEDE every March.

### 2. Financial Incentive - Subsidy Program 20 – 80

- Subsidize equipment and machinery replacement (with approved high-efficiency ones) or innovative energy-efficient equipment
- Subsidize for equipment and installation cost
- Subsidize for non-designated buildings and factories when replacing with efficient equipment and machinery
- Subsidies to up to 3 million baht per applicant
- Payback period no longer than 7 years

#### Examples measures

- Installing variable speed motors used with the machine.
- Replacing air compressors, high efficiency
- Replacing high-performance electric motor
- Insulation
- The use of heat pumps

#### Smart and Sustainable Industry

- Energy-efficient equipment replacement
- Equipment replacement to utilize renewable energy
- GHG Reduction project (must be certified by TGO**)

#### Energy Service Companies (ESCO)

- Provide turnkey solutions for energy efficiency project
- Project implementation can be in the form of guaranteed saving, shared saving, or chauffrage

#### Benefits

- Exemption on import duty on machinery
- 5-year corporate income tax (CIT) exemption – 30% of the investment cost
- Benefits on exemption on import duty on machinery
- 8-year corporate income tax (CIT) exemption – no CIT exemption cap

**Thai Greenhouse Gas Organization

### For further Information


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**Source:** DEDE

---

**Total % Elec.**
Leveraging Private Sector Investment via Energy Efficiency Platform

1. Database
2. Private-sector fundraising
3. EE Reward Programs
4. Promotion of Green Projects

- Reward programs for further incentivizing investment in energy efficiency projects
- Trading of Energy Saving Certificates to offset energy efficiency target or other related environmental target
- Innovative capital-raising methods approved by SEC e.g. ICO (EPC securitization), crowd funding, Hedge funds, etc)

Incentive Ecosystem: Analyze and synthesize data for investment platform OR reward programs in energy efficiency or environment-related program

Facilitating Financing: Analyze and synthesize data for investment platform

Digitalized MRV System

3. Promote equipment utilizing RE

- In 2020, thermal energy of 22,427 ktoe is consumed
- Use of thermal energy in 2020 by Industry

Industry with the highest renewable energy utilization is Food Beverages and Tobacco such as sugar factory and palm oil factory
Industry with the highest Thermal Energy Consumption is non-metal industry such as cement industry
Industry with the highest potential to replace thermal energy consumption with renewable energy is non-metal and paper industry, replacing consumption of coal

Use of thermal energy in 2020 by Industry

Financial Support

- Partial subsidy such as for equipment replacement for manufacturing and utilization of biomass, utilization of equipment for utilization of RDF
- Suitable carbon tax policy must be implemented

Carbon Tax

Promote plantation of energy crops

Promote additional plantation of energy crops as the feedstock for industry and power plants, which require collaboration between different stakeholders

Promotion of Technologies and Innovation

Promote the development and deployment of various innovative technologies such as CCUS and hydrogen in industries

Thank You

For further information, please contact email: wisaruth_m@dede.go.th

Source: Thailand Energy Balance 2021, DEDE
Energy efficiency trend and the situations in industry

Measures in industry, as in other sectors, continue to be important to achieve low carbon. While electrification and the expansion of renewable electricity are important directions for transport, household and business sectors, industry further needs multilateral approaches such as process efficiency, efficient use of heat and electricity, and non-fossil energy sources.

Energy consumption trend (Japan, respective fields)

- GDP 2.5-fold
- Household
- Business
- Industry
- Transport

Energy efficiency is improving in a long trend. It should be enhanced further. The horizontal trend seen in 1990s might be influenced by the addition of equipment and process for environment and quality.

CO₂ reduction potential reference (iron and steel)
Best available technologies are adopted in a high level in Japan, implicating low reduction potential. (A view from IEA data in the past.)

Worldwide Trends in Energy Use and Efficiency (IEA, 2008) p32
CO₂ reduction potential in iron and steel in 2005 based on best available technology.
Trends of energy efficiency (industry)

The trend in industry is similar as the whole field trend, but recent progress ratio is not so large, which seem to be under the influence of low reduction potential. Multilateral measures are needed.

Methodologies to promote energy efficiency in industry

Total EM System as a fundamental methodology

Energy-intensive Factory & Building

Transition to non-fossil energy in EC Act

Expansion of target of policies in EC Act toward carbon neutrality (amendment in 2022) red letters: newly introduced concept in EC Act

Approaches for higher energy efficiency and low carbon (in industry)

Subsector approach (benchmark in EC Act)

The benchmark system in EC Act has been established for energy intensive and material subsectors in industry and focused subsectors in buildings and non-industry business.
Advantages of the benchmark target:
- raising motivation to pursue a realizable target
- useful in the evaluation process which is a kind of top runner.

Examples of industry benchmark indices and value

<table>
<thead>
<tr>
<th>Source: EC Guideline (METI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Indicators</strong></td>
</tr>
<tr>
<td>Energy consumption index</td>
</tr>
<tr>
<td>Emission index</td>
</tr>
<tr>
<td>Energy efficiency</td>
</tr>
<tr>
<td>CO2 emission index</td>
</tr>
<tr>
<td>Water consumption index</td>
</tr>
<tr>
<td>Energy efficiency index</td>
</tr>
</tbody>
</table>

**Non-fossil target system**

Indices
- Non-fossil electricity ratio (non fossil electricity account to total electricity account)
- Non-fossil energy index (indices separately defined for several subsectors with expected value levels)
- Indices related to non-fossil energy adopted by business operators (not mandatory)

**recommendation of actions**

**Energy audit in Japan**

Energy Audit by METI project
ECCJ has conducted more than 15,000 free energy audits since 1978. Recently, the main target is small & medium factory/building.

Further support by local platforms

**site-oriented improvement promotion scheme**

**Technical trends and development**

**The case of iron and steel industry**

**A case study**

**Management in a large business**

**Corresponding SDGs**

- SDG 9: Industry, innovation, and infrastructure
- SDG 13: Climate action
- SDG 17: Partnership for the goals

**Basic Philosophy**
Reducing environmental footprint
- as a high priority environmental strategy together with developing sustainable products, and sustainable and responsible procurement

**Current activity (problems and measures)**
Promotion of sites based energy conservation
- Measurement and visualization
- To review efficiency of the production method and line
- Power consumption prediction system
- Input: production plan, actual power consumptions, meteorological data
- Output: prediction of power consumption and solar generation
- To establish standard production plan based on the weather conditions

Enhancement of motivation
- Reporting on EE actions directly to higher managements
- System to allow energy data to any member anytime (results) 10% reduction of energy consumption/CO2 emission
Review on Technologies

Cogeneration
Source: "Energy Conservation" (ECCJ) Mar 2022 and Dec 2022

Accumulated implementation volume of cogeneration in Japan (industry and business)

Generation capacity

Electrification ratio

Heat pump coverage

Heat pump capacity (hot water/heat pump)

Boiler CHP multiple small boiler

Hot water

Heat pump COP

COP

Temperature (°C)

Coefficient of performance (COP)= output energy (heat transfer) / input energy

Industrial furnace

Application of recent technologies for higher efficiency including regenerative burner systems

Regenerative burner combustion

Exhaust gas suction

Technological study for future possibility of use of non-fossil energy resource

FEMS and optimization

FEMS: management and visualization

Optimization of production energy

- Measurement and energy visualization
- Flexible fabrication by compact equipment and arrangement
- Minimum consumption control according to production demand
- Renkei (cooperative) control

Source of figure: Hitachi, Omika Works
"EMWG leadership awards document in public"

Source: "Energy Conservation" (ECCJ) Dec. 2023

Conclusion

(1) The energy efficiency of Japan’s Industry has been improved by technologies such as heat recovery. Currently, it is also improving but not rapidly. It is necessary to promote multilateral measures of policy and technology.

(2) EC Act (amendment) will promote energy conservation, conversion to non-fossil energy, and optimal use of electricity.

(3) Measures appropriate to respective fields or businesses, should be taken; such as energy audits for small and medium-sized businesses, carbon emission reduction targets for large businesses, energy efficiency benchmark target values for subsectors, etc.

(4) The efficiency of thermal systems should be raised by expanding heat pumps, cogenersations, high-efficiency boilers and combustion systems. Also, technologies for the use of non-fossil energy is important.

(5) It is expected that FEMS including visualization, effective production planning, and control for the entire production process, will be useful.
ENERGY MANAGEMENT SYSTEM AND SMART CITIES: Current Situation and its Future in the Philippines

UNDERSECRETARY FELIX WILLIAM B. FUENTEBELLA
Department of Energy, The Philippines

FUTURE ENERGY SCENARIO IN THE PHILIPPINES

PHILIPPINE ENERGY PLAN 2023-2050

ENERGY EFFICIENCY AND CONSERVATION ACT

INCENTIVES

- Fiscal Incentives
  - Simple Energy Efficiency Projects
  - Complex Energy Efficiency Projects
  - New Energy Efficiency Projects
  - Expansion of Energy Efficiency Projects
  - Energy Efficiency Excellence Awards
- Energy Management for Public Infrastructure
- Outstanding Individual/Group
- EEE Awards for Government

SMART SUSTAINABLE COMMUNITIES AND CITIES

The aggressive RE targets require the timely development of a smart and green transmission system to integrate and manage the additional RE capacity expected to come online from 2024 to 2040.

Objectives of the SGGP

- Establish a policy and mechanism to address the timely implementation of Transmission Projects and efficient operation of the Transmission System.
- Create a framework to determine the level of completion of TDP projects and the overall performance of electric power industry stakeholders toward a holistic and comprehensive development of the country’s power system.

The SGGP forms part of the Philippine Energy Transition Program (PETP) and will complement the PEP 2023-2050.
Thank you!

DOE Information
Campaign Activities

CONSERVE, PROTECT, DESERVE!
Implementation of Energy Management System on Campus Buildings in Indonesia

23 January 2024, Shingawa, Tokyo
By: Sentagi Sesotya Utami, Ph.D.
Associate Professor in Engineering Physics UGM

Education
• Ph.D., Architectural Acoustics, University Of Michigan, USA
• M.Sc., Acoustics, Brigham Young University, USA
• S.T., Architectural Engineering, Universitas Gadjah Mada

Area of Research
• Building Physics and Green Building

Research Focus
• Developing methods to achieve nZEB model in Yogyakarta and Bandung
• Implementation of Soft Sensor Technology in Building Management System for IEQ and Energy Efficiency Performances of Tropical Buildings
• Development of commercialization of Fit To Work Monitoring System for Workers in high-risk industries

InSGreeB Profile
Adapted to Covid-19 conditions, the innovation continues with a new paradigm: ‘Healthy, but still energy efficient’

Publication
Integrated Smart and Green Building Research Group
http://insgreeb.ft.ugm.ac.id/

1.5°C Challenge!
UN climate change report on 4 April 2022: Carbon emissions from 2010-2019 have never been higher in human history, proof that the world is on a “fast track” to disaster.

It’s “now or never” to limit global warming to 1.5 degrees.

Carbon Emission in Indonesia from energy usage

Green Building Goals in Indonesia

Human Development and Mastery of Science and Technology

Sustainable Economic Development

Equitable development

Strengthening Indonesia's Resilience and Governance

Pillars of Indonesian Development 2045

Green and Smart Building Standards in Indonesia


Minister of Public Works and Public Housing Regulation Number 10 Year 2023 concerning Smart Buildings

Minister of Public Works and Public Housing Regulation Number 02/PRT/M/2015 Year 2015 concerning Green Buildings

Parameters

- Cybersecurity
- Communication protocols and networks
- Data and system integration
- System capabilities

Standard for Smart Building in Indonesia

Capability of continuous development

Integrated Building Management System

Energy Monitoring System

Sensors and Control System - Building Management System

Others:
- Accelerometer
- Water meters
Automatization

Purpose of automatization:
To monitor, arrange, and control all the building systems intended for an optimal and efficient operation that is responsive to the occupant’s needs.

Method and Tools for measurement:
- The sensor’s reading must be valid in characterizing the phenomenon of the occupant’s activity areas.
- The sensor’s readings should comply with occupants’ thermal comfort perception. Measurements should be around head heights and for sitting position at 1.1 m height.

Thermal and IAQ

Purpose of automatization:
To monitor, arrange, and control all the building systems intended for an optimal and efficient operation that is responsive to the occupant’s needs.

Thermal Sensors Placement Requirements:
- The sensor’s reading must be valid in characterizing the phenomenon of the occupant’s activity areas.
- The sensor’s readings should comply with occupants’ thermal comfort perception. Measurements should be around head heights and for sitting position at 1.1 m height.

Control Algorithm requirements:
- Complies with the occupants’ thermal comfort needs.
- Includes environmental variables (climate, occupants’ behavior, and activity patterns) to accommodate dynamic response.
- The responsive system is only possible if the control algorithm integrates with the sensors.

Cyber-security Applied

Key for a secured system:
Regulation, technology, and culture readiness

Use of AI

Purpose for implementation:
To collect, analyse, and utilise the data to create a system that is well-connected and integrated.
Questions:
• How would the ‘business model’ be?
• Who would be involved?
• What kind of information will be delivered?
• What kind of technology should be applied?

Features:
• A user-friendly HMI (for operators, engineers, building managers)
• System security
• Data Logging
• Control Algorithm
• Remote connectivity

Key to achieve occupant satisfaction:
The Platform adapts and prioritizes the building occupant’s needs in terms of safety, health, comfort, accessibility, security while improving life quality and increasing productivity.

ISO 9241-11:2018: Ergonomics of human-system interaction