Appendix I: Current Trends in the United States

Current Trends in the US Power Mix

As South and Southeast Asia navigate the coming energy transition, the United States and other international stakeholders can play an important role in helping regional countries progress toward their energy security and climate goals. With US energy exports to developing Asia growing in recent years, US energy policy has a direct bearing on the energy mix and development pathways of its trade partners in the region. Within this context, the following analysis surveys trends in US electricity demand.

Since 2008, partly spurred by the financial crisis, total US electricity demand has plateaued at around 4 trillion kilowatt-hours. The US Energy Information Administration (EIA) estimates an average increase of around 1% per annum to 5 trillion kilowatt-hours by 2050, driven by steady economic growth outpacing efficiency improvements over that time period. While some of this increase is expected to come from vehicle electrification, the EIA estimates that this will not exceed 3% of total electricity demand by midcentury.

According to the EIA, the United States will effectively double its share of renewable electricity generation from 21% in 2020 to 42% by 2050.[112] While this figure includes solar, wind, hydropower, and biofuel sources, solar and wind have primarily driven and are expected to continue driving the shift toward cleaner electricity. Nuclear and hydroelectric projects offer additional options for achieving zero or near-zero emissions, but public opposition and higher regulatory hurdles have limited the growth of these power sources. According to the EIA, 2021 will see over 5 gigawatts of nuclear generating capacity retired when three plants close in the fall.[113] Hydroelectric capacity has stayed relatively constant since the turn of the century.[114]

Though coal was historically a major source of electricity generation and is fairly abundant in the United States, coal generation has decreased over the past ten years. As the shale revolution led to low gas prices, natural gas became the predominant source of electricity in 2016.[115] This increase in natural gas production began in the middle of the first decade of the 2000s as hydraulic fracturing and other advanced extraction technologies rose to prominence. In addition to increasing domestic use of natural gas for power generation, this boom in production boosted exports of liquefied natural gas (LNG). From 2015 to

[112] US Energy Information Administration (EIA), 'EIA Projects Renewables Share of US Electricity Generation Mix Will Double by 2050,' February 8, 2021, https://www.eia.gov/todayinenergy/detail.php?id=46676#.

[113] EIA, 'Nuclear and Coal Will Account for Majority of US Generating Capacity Retirements in 2021,' January 12, 2021, https://www.eia.gov/todayinenergy/detail.php?id=46436#:~:text=According%20to%20the%20US%20Energy,Nuclear.

[114] EIA, 'Table 10.1 Renewable Energy Production and Consumption by Source,' March 2021, https://www.eia.gov/totalenergy/data/monthly/pdf/sec10_3.pdf.

[115] EIA, 'Electricity Explained: Electricity in the United States,' March 18, 2021, https://www.eia.gov/energyexplained/electricity/electricity-in-the-us.php.

2020, US exports of LNG increased by more than 80 times.[116] Although much of this trade is with more developed Asian economies such as the Republic of Korea and Japan, developing Asian nations such as Thailand and India have seen significant increases in imported US LNG.[117]

While the past decade has been a story of natural gas replacing coal generation in the United States, in coming decades renewables are expected to largely replace retiring coal and nuclear plants. By 2030, renewable sources are expected to pass natural gas as the predominant source of electricity in the United States. Natural gas, for its part, is projected to retain a relatively constant share of electricity production out to 2050.

US Energy Policy Instruments

The United States uses a mixture of policy instruments to achieve its energy goals. While legislation such as the Clean Air Act regulates air pollutants like lead and ozone more directly, greenhouse gas emissions have not been regulated directly by federal laws. Some states, such as California, have implemented carbon cap-and-trade schemes or other ways of regulating emissions. However, the federal government uses other tools such as tax credits, regulatory access, and research funding to promote renewable energy.

Tax credits, either to incentivise production or investment, are a key driver of the power mix in the United States. Wind producers received a production tax credit (PTC), which in 2020 was $0.018 per kilowatt hour, that could reduce their tax burden. In its 2021 electricity outlook, the EIA predicted that 'more than two-thirds of cumulative wind capacity additions from 2020 to 2050 occur before the PTC expires at the end of 2024.'[118] While wind has outpaced solar for the past ten years, the loss of the PTC will limit its cost-competitiveness with solar.[119]

This trend is partly driven by the rapidly decreasing cost of solar power compared to wind power, but also because current investment tax credits of at least 10% provided to solar power projects are still maintained past 2024 in the EIA's modeling predictions. The expected shift from wind to solar predominance demonstrates the utility that tax credits can play in developing a renewable energy mix.

The United States can also exercise regulatory discretion on federal lands or in federally controlled waters, where it has more direct control to promote renewables. Federal lands require leasing agreements between the federal government and a private corporation. By approving leases only for wind or solar projects instead of oil and gas exploration, the federal government can influence some of the energy makeup. This tool is particularly

[116] EIA, 'US Natural Gas Exports and Re-exports by Country,' February 26, 2021, https://www.eia.gov/dnav/ng/ng_move_expc_s1_a.htm.

[117] As noted by workshop participants, Japan re-exports some of its imported natural gas, and as a result, US LNG products also find their way to developing Asia via more developed neighbors.

[118] EIA, 'Annual Energy Outlook 2021,' February 3, 2021, https://www.eia.gov/outlooks/aeo/electricity/sub-topic-02.php#:~:text=More%20than%20two%2Dthirds%20of,the%20current%2030%25%20phases%20out.

[119] Ibid.

useful in western US states, where much of the federally administered land is located, and in maritime projects, where oil wells or wind farms could be in federally controlled waters.

As seen with the Biden administration's revoking of the Keystone XL pipeline, the executive branch can exert control over international energy agreements as well. The Federal Energy Regulatory Commission, which oversees interstate transport of oil, gas, and electricity, can help create an electricity market that facilitates the growth of renewables and stored energy through pricing, trade, and infrastructure requirements.[120]

Finally, federal support comes from direct research funding through programs such as the Department of Energy's Energy Office of Efficiency and Renewable Energy and the Advanced Research Project Association–Energy (ARPA-E) program. The former provides hundreds of millions of dollars in funding, including for research facilities for improving energy storage and industrial energy efficiency.[121] ARPA-E received $427 million in funding in 2021, including $100 million specifically meant to meet the Biden administration's climate goals, and targets high-impact, transformative technologies, such as solid-state batteries, superconductors, and advanced software to predict spikes in demand or outages.[122] These projects can then be commercialised after receiving initial government funding. Nearly $5 billion in private investment has followed the $2.4 billion in public investment in ARPA-E projects since 2009.[123]

New Goals for the Biden Administration

Since assuming office in January, President Biden has shifted many US policy stances. The following discussion considers changes affecting renewable energy and international development.

Renewable energy. During the campaign, Biden's Plan for a Clean Energy Revolution and Environmental Justice was central to his bid for president. Styled as an economic revitalisation plan, as well as a means of addressing climate change, the proposed $1.7 trillion plan focused on domestic infrastructure and renewable energy projects instead of fossil fuel exports.[124] It also included a pledge to realise a 'carbon pollution-free power sector' by 2035 through doubling offshore wind by the end of the decade, prioritising wind and solar development on federal land, and renewing or extending tax credits to wind and solar producers, amongst other measures. Wind and solar power have experienced

[120] Federal Energy Regulatory Commission, 'What FERC Does,' https://www.ferc.gov/about/what-ferc/what-ferc-does.

[121] US Department of Energy, 'DOE Launches Design and Construction of $75 Million Grid Energy Storage Research Facility,' March 10, 2021, https://www.energy.gov/articles/doe-launches-design-construction-75-million-grid-energy-storage-research-facility.

[122] US Congress, 'House Resolution 133,' January 3, 2020, 1428-9, https://www.congress.gov/116/bills/hr133/BILLS-116hr133enr.pdf.

[123] ARPA-E, 'US Department of Energy Announces $100 Million for Transformative Clean Energy Solutions Supporting President Biden's Climate Innovation Agenda,' February 11, 2021, https://arpa-e.energy.gov/news-and-media/press-releases/us-department-energy-announces-100-million-transformative-clean.

[124] 'The Biden Plan to Build a Modern, Sustainable Infrastructure and an Equitable Clean Energy Future,' Biden-Harris Campaign, 2020, https://joebiden.com/clean-energy.

remarkable growth in the US market over the past decade, driven by plummeting prices. However, incorporating these variable renewable sources will require upgrading US infrastructure, which is another key aspect of Biden's proposed plan. At the end of March 2021, he proposed the American Jobs Plan, which includes massive infrastructure spending alongside support for renewable energy. The plan includes a $100 billion investment from Congress and mobilisation of private capital to upgrade the electrical grid. It also would establish a Grid Deployment Authority in the Department of Energy to leverage existing access and rights of way to expand the high-voltage transmission network across the country.[125]

Alongside modernising electricity transmission infrastructure, the proposal includes a significant focus on improving battery storage. This goal will likely be buoyed by efforts to electrify the transportation sector, which is necessary to achieve carbon neutrality by 2050. Research and development to improve battery technology for electric vehicles could help the power sector improve its ability to store energy from variable renewable sources. Biden has ordered that the federal fleet of over 600,000 vehicles begin transitioning to zero-emission electric vehicles, offering a direct boost to demand. While the immediate effects will be in the transportation and auto manufacturing sectors, the electrification of a significant portion of vehicles will have implications for the entire energy sector.[126]

International energy development. Under former president Donald Trump and his export-based strategy of energy dominance, US international energy development focused on LNG and natural gas. Through executive orders, appointments of key personnel, and the decision to officially rejoin the Paris Agreement, the Biden administration is signaling a shift in focus toward combating climate change. In one of the earliest statements from a senior official, Ambassador Atul Keshap, the principal deputy assistant secretary of the Bureau of East Asian and Pacific Affairs at the Department of State, emphasised the importance of the United States' commitment to the Mekong–US Partnership for combating climate change. He also noted the administration's intention to work with India and the other Quad countries to promote investment and development efforts in the Mekong subregion.[127]

[125] 'Fact Sheet: The American Jobs Plan,' White House, March 31, 2021, https://www.whitehouse.gov/briefing-room/statements-releases/2021/03/31/fact-sheet-the-american-jobs-plan.

[126] 'Remarks by President Biden before Signing Executive Actions on Tackling Climate Change, Creating Jobs, and Restoring Scientific Integrity,' White House, January 27, 2021, https://www.whitehouse.gov/briefing-room/speeches-remarks/2021/01/27/remarks-by-president-biden-before-signing-executive-actions-on-tackling-climate-change-creating-jobs-and-restoring-scientific-integrity.

[127] Atul Keshap, 'Remarks at the Mekong-US Partnership Track 1.5 Policy Dialogue Opening Plenary,' US State Department, March 18, 2021, https://www.state.gov/remarks-at-the-mekong-u-s-partnership-track-1-5-policy-dialogue-opening-plenary.

On January 27, Biden issued an executive order under the title 'Tackling the Climate Crisis at Home and Abroad.'[128] The order developed a climate finance plan to utilise channels such as USAID, the US Trade and Development Agency, and the National Security Council to refocus international efforts on more climate-friendly policies. The order included a re-evaluation of overseas financing for carbon-intensive fossil fuel energy infrastructure across departments and the Export–Import Bank. It shifted focus instead to opportunities for international collaboration that promoted clean energy technologies. The order also put a pause on leasing new oil and gas rights to public land.

Regarding LNG and natural gas, Biden has indicated support for both as transition fuels. During the campaign, both Trump and Biden supported natural gas producers, partly driven by the importance of the issue in the key swing state of Pennsylvania. Since assuming office, Biden has stated that he has no intention of completely banning hydraulic fracturing, or 'fracking,' against the wishes of many members of his own party. The January 27 executive order pauses new oil and gas development and leases on federal land, which would include fracking, but does not halt existing projects (with the exception of a temporary moratorium on the Coastal Plain Oil and Gas Leasing Program in the Arctic National Wildlife Refuge).[129] The newly appointed secretary of energy, Jennifer Granholm, has indicated that she supports US LNG exports as well as renewable energy development. She stated during her confirmation hearing, for example, that LNG has 'an important role to play in reducing international consumption of fuels that have greater contribution to greenhouse gas emissions.'[130]

Despite having only been in office for three months, President Biden's focus on energy transitions is already clear. Through the various avenues available to the executive branch, the new administration is showing support for greener electricity, while slowing but not stopping the use of some transitional fossil fuels. As the Biden administration finalises its domestic stances on energy, the international community will await the outcome of the Leaders' Summit on Climate, scheduled for late April, to see how these national policies translate into NDCs and international climate cooperation.

[128] 'Executive Order on Tackling the Climate Crisis at Home and Abroad,' White House, January 27, 2021, https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/27/executive-order-on-tackling-the-climate-crisis-at-home-and-abroad.

[129] 'Executive Order on Protection Public Health and the Environment and Restoring Science to Tackle the Climate Crisis,' White House, January 20, 2021, https://www.whitehouse.gov/briefing-room/presidential-actions/2021/01/20/executive-order-protecting-public-health-and-environment-and-restoring-science-to-tackle-climate-crisis.

[130] US Senate Committee on Energy and Natural Resources, 'The Nomination of the Honorable Jennifer M. Granholm to be Secretary of Energy Responses to Questions for the Record Submitted to the Honorable Jennifer M. Granholm,' January 27, 2021, https://www.energy.senate.gov/services/files/126F0A25-8274-4980-AD74-8011CAA0E5EB.

Appendix II: NBR–ERIN Workshop Agenda

STRENGTHENING EMERGING ASIA'S POWER SECTOR: NEEDS, REQUIREMENTS, AND POTENTIAL ROLES FOR

EAST ASIA SUMMIT ENGAGEMENT

Virtual Workshop

January 20, 2021 | 11:00 a.m.–1:30 p.m. Japan Standard Time

January 22, 2021 | 11:00 a.m. – 1:00 p.m. Japan Standard Time

Growth in electricity demand in South and Southeast Asia is amongst the fastest in the world. Yet questions remain about how countries across this region might be able to individually or collectively meet their demand requirements while navigating complex economic, environmental, and energy security considerations. Major market shifts, such as the shale revolution in the United States and the impacts of the Covid-19 pandemic, have had a profound impact on the availability and affordability of a range of energy supply options. However, capitalising on these opportunities is often deeply constrained by rigid, opaque, and uncompetitive energy markets (particularly for natural gas and LNG); unresponsive energy pricing arrangements; weak and inadequate transmission infrastructure; and the need to broadly strengthen energy sector policymaking, governance, and technical and local capacity. How might stakeholders from across the region come together to address these issues, and what specific facilitating roles can fora such as the EAS play in this process?

Day One | January 20, 2021

11:00–11:10 Welcome and Introduction

11:10–12:25 *Powering Emerging Asia: Supply and Demand Outlooks and Paths Forward*

This panel will outline the current outlook for rising power demand and supply prospects across this region and potential scenarios for how the next 20 years of energy development might proceed. What are the region's energy development trajectories under business as usual and pandemic-adjusted scenarios? How are stakeholders and policymakers across the region seeking to reshape power markets to balance the need to boost supplies while moving towards a cleaner energy mix? Where do initiatives like the Indo–Pacific Strategy, the Japan–US–Mekong Power Partnership, and the Belt and Road Initiative fit into this picture? How might innovative partnership strategies help to

better jumpstart any necessary sector reforms? What role does the East Asia Summit currently play in these processes, and what new roles might it be able to take on?

12:30-1:30 ***Resourcing the Toolkit: Building Technical and Human Capacities for Power Sector Transformation***

Strengthening local- and national-level capacities in power-sector management – whether via skill trainings, improved access to data or technical resources, or other people-people exchanges – is critical to how South and Southeast Asia might be able to navigate (and ultimately, take advantage of) recent market and technological breakthroughs. Meanwhile, the World Bank estimates that distortions in South Asia's power sector are already decreasing the sub–region's GDP by 4%-7%, and weak governance in generation and delivery of electricity is a key factor in these losses. This panel will discuss ongoing efforts, emerging best practices, and potential new recommendations for strengthening technical and human capacity at a national-, sub-regional, and regional-level. How have longstanding international efforts driven by Japan's METI, USAID, or sub-regional fora such as ASEAN approached these challenges? What gaps remain? Where might efforts be more effective or better amplified via the East Asia Summit? How could a range of stakeholders contribute to a truly regional framework for knowledge sharing, and what might this look like?

Day Two | January 22, 2021

11:00–11:05 Welcome and Opening Remarks

11:05–12:30 ***Mobilising Energy Sector Investments***

As recently noted by the IEA, slowing global economic growth, the collapse in oil and gas prices, combined with disruptions brought on by Covid-19 have resulted in a historic drop in energy investment. At the same time, the Asian Development Bank estimates that Asia and the Pacific will require $1.7 trillion per year in infrastructure investments through 2030, with more than half of the total need in the power sector. Moreover, energy industries and markets in emerging Asia were already straining to meet demand and mobilise investment before the pandemic. Nevertheless, global financial markets are awash with cheap capital looking for investment opportunities in a near-zero interest rate world. Pension funds, insurance companies, large investment funds, sovereign wealth funds, and global energy companies are looking for 'bankable' energy infrastructure investment opportunities. What might it take to seize on the opportunity to 'reset' approaches? This session will examine the potential to mobilise capital and investment partnerships to help fully unlock the potential of public and private financing for power sector and infrastructure investments. What does it look like to 'leverage development finance and export credit to catalyse private investment' under Asia's new normal? What are the necessary financial, contractual, and policy preconditions to ensure that energy projects currently proposed or under construction are financially viable?

12:35–1:00 ***Crafting the Call to Action***

This session will kick-off with the sharing of a draft 'call to action' that aims to synthesise preliminary workshop findings and identify opportunities for greater EAS engagement to play a positive role in strengthening Emerging Asia's power sector. All participants will then be invited to join in a facilitated discussion designed to further refine, test, and strengthen recommendations.

Appendix III: The 1st ERIN Statement on the East Asia Energy Forum[131]

1. Background

Energy is indispensable for people's life and for the prosperity of any national economy. Nevertheless, East Asia Summit (EAS) countries face serious energy challenges in terms of Energy Security, Economy, Environment, and Safety (3E+S).

In terms of energy security, rapid economic growth in the region has resulted in many energy importing countries increasing their energy import dependency and some energy exporting countries reducing their energy export capacity. Consequently, energy importing countries have become more exposed to supply fluctuations and greater market risks than in the past. To illustrate the trends, the crude oil import rate in the EAS region (except for Japan) increased from 44% in 2000 to 63% in 2012. Energy exporting countries have also suffered from reduced income as export volumes have declined. Further energy security risks in the region include: uncertainty of energy supplies from the Middle East and volatile energy prices.

Combined with the overall rise in energy imports over time, higher energy costs have the capacity to undermine EAS economies, the living standard of people and the competitiveness of the industries in the region. In particular, highly variable and uncertain international energy prices are a contributing factor holding back investment required for energy resource development and infrastructure improvement.

From an environmental perspective, growing energy consumption has led to an increase in carbon dioxide (CO2) and other emissions that have negative long-term and short-term effects on people. As a ratio of global CO2 emissions, the EAS region increased its contribution from around 28% in 2000 to 43% in 2012, and in 2014 it totaled some 1.36 billion tons.

The Fukushima nuclear accident in Japan in 2011 caused many people in the region to become much more sensitive to the issues of energy safety, and in particular nuclear safety. While there are risks with all forms of energy, without nuclear power it will be difficult for countries in the EAS region to respond to future demands of energy security, economy and environment.

Currently, the nuclear power generation capacity in Asia is expected to more or less triple from the present 89 GW to 274 GW over the next 25 years. To realise this growth people's trust in nuclear safety must return. This requires dissemination throughout the EAS region of nuclear safety technologies, planning and culture. In Japan, following a highly detailed safety review, its nuclear power plants are expected to resume operation gradually from

[131] The original statement may be found at https://www.eria.org/uploads/media/ERIN/The_1st_ERIN_Statement.pdf.

2015 onwards, with an expectation its share of nuclear power in electricity generation by 2030 will be between 20 to 22%.

2. Achieving resilient energy systems

In response to changing circumstances inside and outside of the EAS region, each country needs to strengthen its own energy system and capacity which is resilient to future change of social structure, economical condition, and environmental circumstances such as climate change. This can be accomplished by setting balanced policy goals and through deploying comprehensive policy approaches.

Four key elements of setting balanced policy goal for a resilient energy system include:

- Enhanced energy efficiency;
- Lower cost renewable energy;
- Reduced carbon emissions and particulates from fossil fuel use; and
- Safer nuclear power.

Five key elements of deploying comprehensive policy approach for a resilient energy system include:

- Mutual policy support;
- Financial support;
- Technological development and transfer
- Human resource development; and
- Innovative thinking responding to future needs

2.1 Setting balanced policy goal

To achieve a resilient energy system all energies including fossil fuels, renewable energy and nuclear power need to be integrated to maximise benefits to energy users, to the economy and the environment.

Enhanced energy efficiency

Energy consumption, typically, increases with economic growth. The experiences of developed countries, such as Japan, show how to decouple these linkages and, thus, mitigate exhaustion of energy resources, reduce dependence on energy imports, and minimise environmental deterioration. Emerging economies also need to, where possible and appropriate, disconnect future economic growth from higher energy consumption. Where 'energy-growth' decoupling occurs, appropriate technologies will be required to increase energy efficiency. Where appropriate, developed countries with the technologies and successful energy efficiency experiences can assist emerging economies improve energy efficiency over time in the EAS region.

Lower cost renewable energy

Renewable energy can assist with energy security and its use is projected to increase in most EAS countries. Unfortunately, many renewable energies have a higher levelised cost

of energy than existing baseload generation sourced from fossil energy and nuclear power. To make maximum use of the advantages of renewable energy, generation costs needs to decline. To reduce these costs, lower-cost renewable technology needs to be developed along with market opportunities that permit economies of scale associated with larger volumes of renewable energy production.

An obstacle to further expansion of renewable energy is that solar power generation and wind power generation are intermittent power sources. Thus, to maintain the stability of a power supply system with increased renewables there needs to be an improvement of a power supply-demand adjustment system. This can be promoted by backup power sources, power storage facilities, and demand response, plus an appropriate electric power industry's structure. These developments take time and should be done in a phased manner, paying attention to possible spillover costs of rapid changes in energy structures.

Cleaner use of fossil fuel

A key advantage of fossil fuels is that they have higher energy density, are of relatively low cost, and are convenient to use. Their principal disadvantage is that they emit pollutants, including CO2, in their combustion. In the EAS region, where energy demand is expected to increase substantially over coming years, large increases in fossil fuels use pose environmental challenges. Thus, cleaner utilisation of fossil fuels is important to respond to this problem. Specifically, what is required is reduced emissions of pollutants by using existing and to-be-developed technologies to respond to energy-related emissions. The challenge is that clean utilisation technologies are currently costly, and they require a certain capacity in terms of human resources for their deployment.

Safer nuclear

Nuclear power promotes national energy security because it requires very small amounts of fuel. Further, it has benefits for the environment (CO2 emission free) and has low operational costs for existing plants. Its adoption is underway, or is being considered, in EAS countries which are highly dependent on energy imports, or have a large population and a high energy demand.

Nuclear accidents at the Chernobyl Nuclear Power Plant and Fukushima Daiichi Nuclear Power Plant, have affected the social licence to use nuclear power. Thus, improving safety is the highest priority if nuclear power use is to grow. As with any other technology, there are always risks. To mitigate nuclear risks, continuous efforts to enhance nuclear safety should be a top priority and, in particular, reducing the risks to health at both a national and international level.

2.2 Deploying comprehensive policy approach

To achieve a resilient energy system, all type of policies are important and should be supported in an integrated way to promote energy resilience in the EAS region.

Mutual policy support approach

Mutual policy support requires integrated decision-making and consideration of the unintended consequences. For instance, some policies that support growth in renewables, such as Feed in Tariffs are costly, and alternatives exist to achieve the same outcome at lower cost. Better and more cost effective policies require consideration of negative and positive spillovers and cross-sectoral considerations.

Financial support approach

Energy structure reform requires both adequate investment and financial support. Ideally the private sector should make the necessary energy investments, but many projects will be left unsupported if based solely on private returns, even if the public benefits are large. As a result, for high-risk investment, some public funding may be required. Possible areas for public support include the development of a strategic oil stockpile and research and development costs for immature energy technologies.

Technological development and transfer approach

Energy supply and technologies are interconnected. This is because technologies influence energy supply stability, safety and cost, and development while the use of better technologies is essential to realise a cleaner, more reliable and cost effective energy supply system.

Technology levels and development capabilities differ greatly, depending on the country and energy company. Given technologies are indispensable in the reform of energy systems, technology transfers from one country to another are highly desirable. In addition to helping the recipient country, technology transfer provides indirect benefits to a technology possessing country through enhanced regional energy security, in addition to direct export benefits.

Desirable short and medium-term technology developments include cleaner utilisation of fossil fuel, reduction in renewable energy costs, and enhanced safety for existing nuclear power, amongst other benefits. Over time, zero-carbon technology, and artificial photosynthesis, and fourth-generation nuclear power technology capable of cooling nuclear plants without power should be developed, and be part of future technology transfer.

Human resource development approach

Energy systems need capable human resources to make full use of them. Thus, simultaneous with technology transfers and mutual policy support, energy progress should include the development of human resources. Fortunately for the EAS region, the human resources exist to support the development of improved energy systems and capacity building.

In some cases, knowledge is already available about energy efficiency and conservation technologies and cleaner utilisation technologies for fossil fuels to build capacity in the region. For other technologies, such as, nuclear power safety technologies, human resource must be developed over time.

Innovative thinking approach responding to future needs

Necessity for seeking appropriate energy system is continuously changing. For instance, emergence of decentralised electricity supply system based on renewable energy is being observed. This is a different type of energy system that requires new type of policy and innovative technology from existing centralised electricity planning. Innovative approaches are sought to foresee and respond to changing future needs.

3. East Asia Energy Forum and Role of ERIN

Energy cooperation in the EAS region is a key to achieving the '3E +S'. It requires a comprehensive approach with the four policy measures to accelerate robust economic development in the EAS region, and to support co-prosperity. In addition, such cooperation needs to account for characteristic and uniqueness of the region which may call as the East Asia Energy Forum.

The East Asia Energy Forum must represent the diversity of the region and account for:

- size of economies;
- stages of economic development;
- energy resources;
- technological capability;
- financial accessibility;
- human resources; and
- social systems.

These considerations avoid 'off-the-shelf' cooperation that may ignore the realities of the region or a country, and fail to deliver the full benefits of energy transformation. For instance, energy deregulation, as practiced in the US and Europe, may not work in an EAS country where its energy infrastructure is growing rapidly or with fewer human resource capacities. Thus, the full benefits of deregulation or other possible approaches need to be tailored to the particular energy circumstances of each EAS nation.

The EAS region needs the East Asia Energy Forum that accounts for the diversity of member countries and to respond to their joint and particular energy challenges. Four features that characterise the cooperation include:

- Respect for differences;
- Learning from each other;
- Common challenges addressed in an attentive and inclusive manner; and a
- Balance between market mechanisms and government leadership.

ERIN is expected to play an important role by assisting ERIA to make policy recommendations. ERIN needs to function as a network center for high level knowledge and experiences in energy policy. To this end, it will draw from the think-tanks and/or universities in the EAS region. Each member organisation of ERIN has expertise not only for their country, but also for the region and global market. ERIN, together with ERIA, will contribute to the robust development of energy markets, co-development of the region and co-prosperity under the concept of East Asia Energy Forum.

4. Mid-term roadmap of ERIN

ERIN is expected to deliver valuable policy messages to ERIA, and eventually to Energy Ministers in EAS countries. These deliverables include:

- Three year time frame:
    - 1st year: conceptual vision making;
    - 2nd year: detailed design making; and
    - 3rd year: start of implementation.
- This will be around four key policy areas:
    - More efficient use of energy;
    - Lower cost renewable energy;
    - Cleaner use of fossil fuel; and
    - Safer nuclear energy.
- In turn this will be developed around four major approaches:
    - Mutual policy support approach;
    - Financial assistance approach;
    - Technological development and transfer approach; and
    - Human resource development approach.

A roadmap of ERIN activity which built on above mentioned elements can naturally share fundamental philosophy with a roadmap which will be formed by ERIA under the jurisdiction of 9th EAS Energy Ministers Meeting, 'EAS Mid- and Long- Term Energy Policy Research Roadmap'. ERIN will support ERIA to form the roadmap and take affirmative action according to the roadmap together with ERIA.

Through a phased step-by-step approach, ERIN and the East Asia Energy Forum will make practical and valuable policy advances within the region for the benefits of its citizens.