ENERGY TRANSITIONS AND A GLOBALISED ARCTIC
The Role of Science, Technology and Governance

17 – 19 August 2016

Event Report
2016
Cover Photos

Second row from left to right: Solar panels in Indonesia, courtesy of Maxensius Sambodo. A group of people transporting power generation equipment to a remote island village in the Philippines, courtesy of Rene Fajilagutan, Romblon Electric Cooperative, Inc. (ROMELCO). Cantingas Mini-hydro power plant in Sibuyan Island, the Philippines, courtesy of Rene Fajilagutan, Romblon Electric Cooperative, Inc. (ROMELCO).

Inside Photos
By the Energy Studies Institute, National University of Singapore.

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![Ministry of Foreign Affairs Singapore Logo]

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![Office of Naval Research Global Logo]
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INTRODUCTION

As a result of global warming, the natural environment in the Arctic is rapidly changing. The retreat of seasonal sea-ice and advancements in science and technology are redefining this region. The resulting security, political, economic, social, and environmental changes taking place in this remote region are reshaping our thinking about the status of the Arctic within a globalised world.

The sustainable development of the Arctic is a complex issue. It requires an effective governance system that would allow for efficient implementation of appropriate strategies, policies, procedures, and rules based on the knowledge acquired through scientific research and solutions derived from technological innovation.

Globalisation is taking root in the Arctic, and multifaceted interconnections are rapidly developing. This has empowered the Arctic countries to form new partnerships around the world. Similarly, the opening up of the region has also enabled the international community to contribute to the stewardship of the Arctic. In an increasingly globalised Arctic, human activity is expected to increase in the region as it becomes more accessible.

To highlight a few key trends, maritime traffic is expected to grow; infrastructure and facilities will have to be built to monitor and mitigate the impact of human activity and climate change, and to support new economic activity. Also a broad range of mitigation and resilience solutions will have to be put in place to support the remote and islanded communities and indigenous livelihoods. With growing human and economic activity comes rising energy demand, and the development of sustainable energy options and practices is a key challenge.

At the basic level, the energy transition challenges surrounding remote and islanded communities, and operations are common across the world, including the Arctic and Southeast Asia. To give an example, many remote and islanded communities in Southeast Asia are cut off from the main grid, and researchers in both the Arctic and Southeast Asian regions are developing sustainable off-grid energy systems that can be clean, affordable, easy to manage, and resilient. Besides the technologies themselves, a proper governance framework has to be in place for the system to function effectively. Pooling relevant expertise from within and outside the Arctic to support science and technological collaboration, and sharing the best practices of energy governance is one way to tackle common challenges.

Organised by the Energy Studies Institute, National University of Singapore and held in Singapore, the event entitled “Energy Transitions and a Globalised Arctic: The Role of Science, Technology and Governance” consisted of a one-and-a-half-day workshop and a half-day conference from 17 to 19 August 2016.

The event brought together a small group of stakeholders and experts from different backgrounds and regions for focused and interactive discussions on energy matters, to enhance the stewardship of a globalised Arctic, and contribute to sustainable energy initiatives both in the Arctic and the wider world. During the workshop, the participants also discussed research gaps, complementary interests, and collaboration opportunities.

The workshop which took place on 17 and 18 August examined a range of issues related to the Arctic, which are also of relevance to the wider world – these ranged from the governance of sustainable energy transition, access to energy in remote locations, maritime infrastructure and shipping, and issues related to innovation, resilience, and capacity-building.

The half-day conference that was held on the third day welcomed Guest-of-Honour Mr
Sam Tan Ching Siong, Minister of State in the Prime Minister’s Office and the Ministry of Manpower, and the United States Ambassador to Singapore, His Excellency Kirk Wagar. The conference panellists provided a brief overview of the key findings from the four discussion topics of the workshop. Finally, the panellists and members of the audience engaged in conversation during the concluding Q&A session. The questions and comments offered insights into the energy transition challenges surrounding remote and islanded communities in the Arctic and Southeast Asia.

Elena Reshetova and Hema Nadarajah served as rapporteurs for this event.

Christopher Len, PhD
Senior Research Fellow
Energy Studies Institute
National University of Singapore
**SESSION 1: The Governance of Sustainable Energy Transition**

_Socio-Technical Energy Transitions: Governance and Institutional Factors_

**Philip ANDREWS-SPEED, Energy Studies Institute**

Philip Andrews-Speed posited that technological change is as much about people as it is about technology itself, and it is reflected in socio-technological changes. Technology changes, and society evolves as people adapt to them. This in turn changes technology, as people adapt and begin using existing technology for new applications. To illustrate this, Andrews-Speed shared two theoretical frameworks underscoring the governance of technological change. The first was built on Oliver E. Williamson’s framework published in 2000 on the various levels of institutions, and is critical in studying socio-technological changes. The second was Elinor Ostrom’s Institutional Analysis and Development (IAD) framework published in 2005.

Williamson’s analytical framework consists of three levels of institutions. The first, embedded institutions, includes norms, beliefs, and ideas. At this level, characteristics are deeply embedded in society and changes occur slowly. The second, institutional environment, includes political and economic systems, bureaucratic structures of government, judiciary, and legal systems. Change does occur at this tier, but takes place over decades. The third level focuses on institutions that govern transactions, and includes firms, markets, and hybrid networks. These are able to change relatively quickly. Changes occur at various rates across each level and, given the interconnectedness of the three levels, change can occur across all of them.

Ostrom’s framework addresses the questions of what these changes would mean at the community level. It introduces an “action arena” where actors interact in specific “action situations”. These interactions are dependent on external
variables such as biophysical conditions, community attributes, and rules-in-use.

In the move to a low-carbon society, it is critical for governments to channel their efforts towards changing energy usage habits through technologies and behaviours. The greatest challenge to change, according to Andrews-Speed, lies in the interests of powerful actors as well as consumer attitudes and expectations. Constraints are also not universal in nature; each community is inherently unique in the challenges it faces.

Andrews-Speed also provided a useful reminder that in tackling grand theories and questions, the Arctic is very much part of the world, and questions concerning the Arctic are fundamental in nature.

**Arctic Energy Landscape: The Arctic Renewable Energy Atlas (AREA)**

Matt GANLEY, Institute of the North

Matt Ganley began by providing an overview of the Anchorage-based Institute of the North, which works to develop strategies and provide best practices for the circumpolar North. He then discussed the shipping opportunities and challenges of an Arctic future arising from climate change. He pointed out that Alaska became more important over the last five years as shipping routes became more viable. With a low population density and a large geographical area, the issue of deploying energy is crucial.

Ganley then discussed Alaska’s renewable resources including fish waste, geothermal energy, hydroelectricity, as well as ocean and river kinetic plants. He also spoke about the challenges in deploying wind farms in the harsh conditions of the Bering Strait - a strait connecting the Pacific and Arctic oceans between Russia and the United States. He highlighted the upcoming biennial Arctic Energy Summit to be held in Finland in 2017, explaining that it is a multi-disciplinary event with different experts and stakeholders engaged in dialogue on Arctic energy development issues.

He then briefly discussed the key outcomes from the 2015 Arctic Energy Summit held in Fairbanks, Alaska. One of them was the recognition of a need to increase awareness of renewable energy resources and energy efficiency in the Arctic. In response, the Institute of the North has initiated the Arctic Renewable Energy Atlas (AREA). This project, endorsed by the Arctic Council’s Sustainable Development Working Group, aims to catalogue renewable energy data from all eight Arctic states. AREA aims to investigate resource supply, demand, investment and capacity, traditional and local knowledge, and available best practices. It has partnered with several actors, including the Arctic Council and Statkraft, for data collection, dissemination, and financial support.

In order to illustrate the challenges faced by the remote communities and the need for initiatives like AREA, Ganley spoke about the population within the U.S. side of the Bering Strait. The U.S. side currently has about 9,500 people. There are 16 communities that are occupied all year round and two are inhabited seasonally. This region is also home to 20 active tribal organisations. The harsh conditions and remoteness of the region make it challenging to deploy renewable technologies.

Ganley also highlighted how the larger questions of changes to climate, trade, and politics affect local communities such as those within the Bering Strait area. He spoke about the need to prepare and equip the population to deal with these changes at the community level.
Southeast Asia’s Renewable Energy Challenges: ASEAN Guidelines on Rural Electrification

Beni SURYADI, ASEAN Centre for Energy

Beni Suryadi started by providing an overview of the mission, function, and activities of the ASEAN Centre for Energy (ACE). He pointed out that the energy challenges that Southeast Asia and the 10 member states of ASEAN face differ due to geographical location, level of economic development, and government priorities. Approximately 20 per cent of ASEAN’s population (625 million) do not have access to electricity. In Indonesia alone, this number currently stands at about 50 million.

Suryadi then outlined ACE’s work on the issue of energy accessibility. A community level study conducted three years ago compared data from more than 120 rural projects within the region and found that failed projects outnumbered the successful ones. The findings were reported in the 2013 ASEAN Guideline on Off-grid Electrification Approaches, which is available on the ACE website. The report focused on addressing the following: policy framework, financing mechanisms and support policies, project setup and business models, appropriate technology, socio-economic aspects and community involvement, and capacity building and training. For each of these, an overview of what should and should not be done was provided.

Suryadi highlighted the point that each energy project is unique in character and as a result, what might be successful in one state, may not have the same outcome in another. Subsidies for example, might be successful in the case of Cambodia but it might result in a net disadvantage elsewhere. The ASEAN Guideline provides a list of anticipated impacts and Suryadi illustrated with the example of local financing. He concluded by saying that many people in ASEAN have poor access to energy, and ensuring access is what moves the big needle on the grand challenge of sustainable development.

DISCUSSION

Rasmus Gjedssø Bertelsen, the discussant for this session, began by quoting Robert Cooper, a British diplomat, who a decade ago highlighted that “It is no longer our world.” This was in reference to how a Western-centric world was giving way to one that is increasingly focused on Asia.

He highlighted the fact that not only are there more people living within Asia than outside of it today, the region’s GDP is growing significantly. He said that this will have significant implications for the Arctic region and its communities.

During discussion, questions were raised about the data used and AREA Project’s collaboration efforts, as well as the viability for a similar project to be carried out in an ASEAN context. Matt Ganley responded that it was challenging to completely and effectively achieve data harmonisation. Nevertheless, international cooperation in various activities that meshes efforts together is taking place among partners such as Canada and Russia. With respect to ASEAN, Beni Suryadi brought up the challenge of collecting data within the region. Data, available from institutions such as the Asian Development Bank and the World Bank, are limited and country
specific. Also, given the lack of coordination and harmonisation of methodologies between countries, as well as between organisations, inconsistencies often appear in regional data analysis.

The question of placing community-based frameworks into a more global one was raised as well, given the fact that more often than not, communities are affected by global issues. Philip Andrews-Speed highlighted two other frameworks that are relevant to this question. The first is a Complex Adaptive Systems framework, which has theoretical roots in biology. It posits that actors and units are as important as other actors, and no actor is important on its own. The second framework is that of Regional Public Goods. These are goods and services with public good characteristics provided beyond national borders, such as regional emergency systems. In order to move forward, it would be helpful to define what is easy to do (i.e., non-controversial, easy to reach an agreement on) and what shared interests pertaining to these public goods already exist.

In thinking ahead in terms of developing what renewable energy there is, the importance of mapping out what is available technologically, what is feasible location-wise, and socially in the Arctic and ASEAN was discussed. Matt Ganley added that this mapping process is similar for both the mining and renewable sectors.

On the issue of mapping locations and social access, Suryadi stated that within ASEAN, the issue of social accessibility is a challenge. For example, in Cambodia, areas with wind power potential may be extremely sparsely populated. Bertelsen highlighted the importance of thinking across sectors and involving local communities with regards to technology. For example, novel renewable power solutions should not have a negative effect on indigenous activities such as reindeer herding in Scandinavia. For this reason, Saami students, who are familiar with the local context, should be involved in developing solutions since they may offer insights based on traditional knowledge.

Asia’s role in the Arctic was also discussed. With increasing interest from Asia, the issue of their effect on Arctic governance was discussed. Bertelsen pointed out that Western states have to get used to the non-Arctic states’ emerging interest in foreign affairs and other parts of the world. A discussant highlighted the importance of Asian states in creating dynamic markets that would benefit the Arctic communities.
SESSION 2: Access to Energy in Remote Locations: Technology Assessments and Policy Considerations

Integration of Renewable Microgrids: Lessons from Alaska
Gwen HOLDMANN, Alaska Center for Energy and Power

Gwen Holdmann spoke on the experience of remote Alaskan communities accessing energy through the integration of renewable microgrids.

The Arctic has been a leader in the development of renewable energy resources. This is mainly because challenges for remote Arctic regions extend beyond the viability of renewable energy systems to displace conventional fuel sources, and address the limitations of the conventional centralised electricity grid model. Places like Alaska, Northern Canada, Russia, and Greenland are not served by continuous electric grids. As a result, there are much greater challenges associated with integrating renewables.

In Alaska, the price structure for electricity is not subsidised much, which helps in avoiding economic distortion, and also provides an opportunity for installing new renewables-based systems. Alaska is fortunate to have a diversity of resources: hydrokinetic, tidal, wind, solar, biomass, and geothermal. However, despite access to indigenous renewable resources, small remote communities rely on fly-in fuel, and are forced to pay the highest energy prices in the US, with electric power rates approaching 180c/kWh.

Alaska takes advantage of a non-traditional decentralised utility structure, with 92 utilities serving the state’s population. One example of successful integration of renewables into the energy system is Kodiak Island. It is 99 per cent dependent on renewable generation, and several projects are 100 per cent diesel free. The 10,000-person community on the island is benefitting from energy storage (battery and flywheel), hydropower, and wind.

However, Holdmann noted that a number of challenges related to maximising the displacement of imported diesel fuel through renewable-powered microgrids remain. First, there is a lack of agreement on terminology; a number of competing concepts exist, including “off-grid”, “remote”, and “islanded” communities. Second, with the increase in renewable power contribution to small, islanded microgrids, it becomes more difficult to reconcile the variability of renewable resources and demand. Third, there is a need for small capacity energy storage for grid stabilisation and reliability. Fourth, it is important to address the costs of shifting generation sources in order to account for unintended consequences such as underperformance of assets. Fifth, proper training and early community engagement are crucial to long-term project success.

In the final part of her presentation, Holdmann spoke about opportunities for international collaboration. In her opinion, they can serve as an accelerator for Alaska’s efforts in promoting renewable sources of energy by utilising its strengths and advancing opportunities, as well as minimising weaknesses and threats. Opportunities for international collaboration span both the technical and non-technical aspects of project development. Holdmann then spoke about the Alaska Center for Energy and Power’s initiative with other Arctic partners called the Arctic Remote Energy Networks Academy (ARENA) training programme. This initiative seeks to increase human capacity and promote leadership through the creation of a knowledge exchange programme emphasising the development, operation, and management of remote
energy networks (microgrids) incorporating renewable resources. She then spoke about the potential to expand this model to other similar areas of the world. ARENA helps put the right information into the hands of the right people at the right stage of project development through targeted individualised mentoring knowledge exchange and the development of peer networks.

**Integration of Hybrid Island Mini-grids: Lessons from the Philippines**

Rene FAJILAGUTAN, ROMELCO

The Romblon Electric Cooperative, Inc. (ROMELCO) is one of the 119 electric cooperatives under the supervision of the Philippine National Electrification Administration (NEA).

Rene Fajilagutan explained that it is a non-stock, non-profit organisation owned by consumers. At present, the state-owned National Power Corporation-Small Power Utilities Group (NPC-SPUG) diesel power plants provides the cooperative with power generation capacity from its four power plants (0.450 MW – 2MW each). Electricity supply is limited to eight hours per day due to high fuel, transportation, and handling costs. Thus, the cooperative ventured into the power generation business focusing on renewable energy. Its major objective is to source 90 per cent of power from renewable energy.

Between 1997 and 2009, the cooperative developed Cantingas Mini-Hydro Power Plant on Sibuyan Island. Today, the power plant is supplying more than 80 per cent of the annual energy needs of the island. Unfortunately, the remaining 233 isolated areas in the entire Philippine archipelago lack hydropower potential, and other solutions have to be sought.

In 2015, in collaboration with the Asian Development Bank (ADB), NEA, and Korean Energy Agency (KEA), ROMELCO was able to initiate the development of a state of the art PV-Diesel Energy Storage Hybrid System on Cobrador Island. The project is expected to provide a small island community of 983 inhabitants with 24/7 access to electricity as opposed to the current eight hour service from ROMELCO’s 15kW Diesel Power Plant. However, the implementation of this project was a challenging task because the area lacks good infrastructure, reliable and safe means of equipment transportation, as well as local expertise to operate and maintain the system. Nevertheless, the hybrid system has been providing the island’s households with 24/7 electricity access since March 2016. As energy consumption trends from this hybrid system demonstrate, people use more electricity when it is readily available. ROMELCO will be replicating this project in other island municipalities and on a larger scale.

**Greenland Island Infrastructures: Energy Challenges in the Fishing Industry**

Kåre HENDRIKSEN, Technical University of Denmark

According to Kåre Hendriksen, Greenland is the largest island in the world, but its population is a mere 56,000 people. In practice, Greenland operates as 75 independent islands. With a few exceptions, there are no settlements that have roads or any other overland transportation connections with other settlements. Thus, it is important to understand the specific conditions of “islanded” communities across the country. For instance, it is only possible to sail along the east coast in late summer and fall. Along the southern part of the west coast, the sea is ice-free the entire
year, but further north the sea is closed for sailing during the winter. The most northern region, Qaanaaq, can be navigated only in July and August.

Isolated settlements represent unique ecosystems with their own power and water operations. The majority of electricity production is based on diesel generators, with the exception of six settlements that are supplied by five hydropower plants. Many settlements are located on minor islands with no hydropower potential.

Fisheries are the most important export industry of Greenland. Shrimp and fish account for 90 per cent of the total export income. Shrimp contributes 42 per cent and Greenlandic halibut 29 per cent to that total. The fishing of halibut takes place mainly in Northern Greenland where there is no sea freight during the six to 10 months long winter. Thus, maintaining hygienic freezing capacity for half a year is crucial, and this requires large amounts of energy.

Hendriksen then spoke about the energy challenges that Greenland’s isolated communities are facing. The public power and water utility company Nukissiorfiit is obligated to supply all settlements in Greenland. Even though 60 per cent of the total electricity consumption today is produced by hydropower, the power supply to 69 of the 75 communities is based on diesel generators. More than half of the settlements have their own fishing factories and depend on continuous power supply. Despite the fact that the fishing industry consumes only 36GWh of all consumed electricity (344GWh) and despite considerable cross-subsidisation, there are significant differences in the power prices for the fishing industry across the country. Factories in some of the most important trading areas pay as much as five times more per kWh than some of the other settlements, which are far less dependent on the fishing industry for employment. High costs reduce employment opportunities. The settlements with the most expensive power and water are often the ones that are reachable only a few months a year, which means they need to have large freezer- and storage-capacity. At the same time, these small settlements often have no local expertise that are able to repair freezers and production machinery, thereby adding another extra cost. Every town and village has too small a population to ensure market economy mechanisms for pricing of key services and products. Thus, there are limited employment opportunities in the larger cities, while the potential employment opportunities in smaller settlements are often overlooked. Even though these smaller settlements account for the largest part of the export income, they are slowly being depopulated and their living standards are deteriorating.

Renewable Energy Integration Demonstrator – Singapore (REIDS)
Martha LOLEIT, Energy Research Institute @NTU

The Renewable Energy Integration Demonstrator – Singapore (REIDS) is one of ERI@N’s flagship projects. It is located at Semakau Landfill, eight kilometres south of Singapore. It is a RD&D platform dedicated to designing, demonstrating, and testing solutions for sustainable multi-activity off-grid communities in Southeast Asia. The project aims at expanding the understanding of how independently run microgrids can be interconnected. A hybrid microgrid could link together renewable energy generation, energy storage, loads, and other elements. The project also explores the possibilities for bridging the
gap in cooperation between government, private sector, and communities.

According to Loleit, there are approximately 1.3 billion people in the world with no access to electricity. An even higher number does not have access to proper sanitation; including drinking water. Most of this population live in Africa, Southeast Asia, and Latin America. In Southeast Asia alone, there are 119.8 million people with no access to electricity. In the near term, it is not feasible to access these populations by way of interconnected transmission systems. Hence, microgrids have potential for wide application. They can provide electricity and clean water access solutions to communities on islands, in remote villages, in emergency situations (earthquakes, tsunamis, refugee camps), in remote mining operations, and on military bases.

REIDS is a large-scale multi-energy demonstrator targeting multi-activity small territory needs. Its wide R&D scope ensures that its findings are readily transferable to many different environments and use cases. The major countries of focus are those which have a high number of people with no access to electricity including Myanmar, Indonesia, and the Philippines.

Promoting the REIDS initiative as an emblematic large-scale demonstrator is helping to position the partners of REIDS as leaders in the Southeast Asia clean energy market. The knowledge and experience developed in the context of the project will be disseminated throughout the region via presentations, seminars, market intelligence watch, marketing, and showcasing.

In order for REIDS to create a valuable contribution and bring economic development opportunities, a number of inter-related technical and non-technical factors have to be considered. First, customer needs have to be understood. Quality and reliability often overshadow the costs because people are willing to pay more for better technology. Second, new business models have to be created to fit the new context. While potential customers are willing to pay, the costs of renewable energy technologies are dropping and local entrepreneurial talent already exists. Third, innovative financing models are required to unlock investment. Access to capital remains a challenge, and flexible financing arrangements are one of the key elements. Fourth, public-private partnerships can help provide incentives and financing, and build expertise. Fifth, it is important to create local commitment. Electricity services have to be valued, and local buy-in is important. Sixth, the role of government is indispensable. Exploring new opportunities would inevitably mean working closely with the regulators to ease constraints and create incentives. Seventh, confidence in new technologies has to be built. This is why REIDS does testing and demonstrations, and also showcase equipment that is ready for broad market penetration. Finally, a holistic approach is necessary to combine environmental, social, and economic development benefits.

DISCUSSION

Participants noted that based on the respective SWOT analysis (refer to the end of this session’s write-up), the ASEAN and Arctic accounts from this session appear to be very similar. Sambodo wondered where Alaska’s culture of innovation and taking of risks originated from, and how can innovation be cultivated in ASEAN. Gwen Holdmann explained that innovation is fostered through community-based project development and
implementation. Alaska has a cooperative, privately- and community-owned utilities structure, which is different from that of Canada and Greenland. In Alaska, the incentive for developing renewables lies with the community. Competence building and capacity development are community-based too.

Hendriksen shared the experience of communities in Greenland where the majority of the population is Inuit. In many cases, it is the Danes who still run Greenland. They have access to better education; their culture is very different as they focus on doing business, whereas the Inuits focus on their livelihoods. The lack of necessary skills, especially in smaller communities, is a huge problem where even a malfunctioning car can become a big challenge. Companies do not offer side businesses, such as providing maintenance for purchased goods. The government in Greenland tends to focus on providing oil to large towns, while the places that contribute the most exports are given less attention.

Beni Suryadi mentioned that, despite some similarities, ASEAN and the Arctic face different challenges (e.g., the weather conditions are completely different). He emphasised the importance of fostering innovation in ASEAN and the issue of the willingness to pay for services such as electricity access in different contexts. Holdmann suggested that in the North, access to energy and the ability to innovate are a matter of life and death. She added that in the case of Alaska, there are high levels of poverty, and heat rather than electricity is a bigger challenge; 48 per cent of the population are below the poverty line and pay the highest price in the entire U.S. for electricity.

Another question that emerged was the co-existence of renewables with the oil and gas industry in Alaska. Renewables are advocated for electricity production while the state is one of the largest producers of oil and gas (and currently affected by the low oil prices). According to Gwen Holdmann, there is a need to transfer some of the wealth generated from the oil and gas industry into renewables.

The participants also touched on the issue of finding a way to predict how much power will be needed by communities who are new to the grid, how to determine the size of required installations, and how to provide equal access to cheap electricity, and also ensure that demand does not exceed supply.

Finally, it was noted that Alaska is a good example whereby mechanisms exist to allow the pooling of resources and interests in order to implement small power/electricity development projects. The most important programme to date has been the Alaska Renewable Energy Fund (REF), developed in 2008. Also, the Power Cost Equalization Endowment Fund subsidises the high cost of electricity in rural areas. This subsidy forced the publication of costs and prices for each community and utility in the state. Such a system creates peer pressure because utilities must submit their numbers to receive the subsidy. The discussants noted that a difference between Greenland and Alaska is that in the case of the latter, industries and businesses are not subsidised. Thus, it is hard and expensive to start a business in a small rural community.
Table 1. SWOT Analysis: Integration of Renewable Microgrids in Alaska
Based on the presentation by Gwen Holdmann

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Significant know-how across a range of technologies based on 15 years of operational experience;</td>
<td>• No proven long-term funding mechanisms;</td>
</tr>
<tr>
<td>• Culture of innovation underpinned by the willingness to take risks;</td>
<td>• Institutional knowledge resides with a small number of individuals;</td>
</tr>
<tr>
<td>• Diverse resource base;</td>
<td>• No manufacturing base: implemented solutions are adapted from elsewhere;</td>
</tr>
<tr>
<td>• Economic motivation (no subsidies) and “keep it working” mindset.</td>
<td>• Low profile of Alaskan capability in the global market;</td>
</tr>
<tr>
<td>• Consistent terminology: off-grid, islanded, remote.</td>
<td>• Inconsistent terminology: off-grid, islanded, remote.</td>
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<table>
<thead>
<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Increasing global interest in reducing carbon emissions and developing partnerships;</td>
<td>• Subsidies for fossil fuels is a major barrier;</td>
</tr>
<tr>
<td>• Growing interest/awareness in microgrids;</td>
<td>• Regulations not designed to optimise systems;</td>
</tr>
<tr>
<td>• Potential to share experiences and lessons because Alaska is a first mover in this technology area;</td>
<td>• Different climate compared to many other remote locations;</td>
</tr>
<tr>
<td>• Opportunity for Alaska to become a “living laboratory” for many technologies.</td>
<td>• Small project size leading to under-investment;</td>
</tr>
<tr>
<td>• Lack of training increasing risk of failure.</td>
<td>• Lack of supporting infrastructure to transport expensive equipment.</td>
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</tbody>
</table>

Table 2. SWOT Analysis: Integration of Hybrid Island Mini-Grids in the Philippines
Based on the presentation by Rene Fajilagutan

<table>
<thead>
<tr>
<th><strong>Strengths</strong></th>
<th><strong>Weaknesses</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Captured market;</td>
<td>• Limited financial resources;</td>
</tr>
<tr>
<td>• “Passion to serve” mindset of the company’s leadership and employees;</td>
<td>• Lack of human resources: technical expertise to install and operate systems based on new technologies;</td>
</tr>
<tr>
<td>• Consumers’ need for 24/7 electricity service.</td>
<td>• Lack of supporting infrastructure to transport expensive equipment.</td>
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<table>
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<tr>
<th><strong>Opportunities</strong></th>
<th><strong>Threats</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>• Replication of the hybrid system project in the near future;</td>
<td>• Weather and environmental concerns;</td>
</tr>
<tr>
<td>• Partnerships with technology developers and investors;</td>
<td>• Policy and regulatory direction from the national government.</td>
</tr>
<tr>
<td>• Subsidies and economic incentives from the government.</td>
<td></td>
</tr>
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</table>
Table 3. SWOT Analysis: Greenland Island Infrastructure
Based on the presentation by Kåre Hendriksen

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Electricity production in all settlements (except one);</td>
<td>- Island operation at all locations;</td>
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<tr>
<td>- Back-up systems in all settlements;</td>
<td>- No interconnected grid;</td>
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<tr>
<td>- Maximum prices;</td>
<td>- Lack of capacity at some locations;</td>
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<tr>
<td>- Good dialogue between Nukissiorfiit and the fishing industry.</td>
<td>- Most settlements depend on diesel generators;</td>
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<td></td>
<td>- Unequal prices;</td>
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<td>- High prices in many core fishing settlements.</td>
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<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Many possibilities for hydropower;</td>
<td>- Lack of prioritisation of smaller settlements with a good fishing potential;</td>
</tr>
<tr>
<td>- Potential for tide, wave, wind, and sun energy;</td>
<td>- Total liberalisation of the energy sector limiting production in remote areas;</td>
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<tr>
<td>- Technology development;</td>
<td>- Increased electricity and water prices. undermining fishing;</td>
</tr>
<tr>
<td>- Flexible systems that can be moved according to changes in fishing stock location.</td>
<td>- Weather calamities and climate change.</td>
</tr>
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SESSION 3: Maritime Infrastructures and Shipping: Technology Assessments and Policy Considerations

Renewable Energy and Hybrid Microgrids in Southeast Asia

Timothy WALSH, Canopy Power

Timothy Walsh, the co-founder of Canopy Power, began by providing an overview of the company’s profile. A small start-up comprised of four staff members, it aims to provide “empowerment through electrification.” The rationale for this goal was explained against the context of global access to electricity: 17 per cent of the world’s population has no access, of which 85 per cent are in rural areas, and face poverty and a lack of infrastructure. One solution is off-grid power plants. About 700 million people worldwide use diesel generated electricity, and this can be costly at about US$0.30 – 0.60/kWh.

Southeast Asia accounts for a quarter of this market. Walsh argued that with solar photovoltaic panels currently being cheaper than diesel, substantial cost savings could be achieved by integrating renewable energy with diesel generators. These savings are projected to increase with time as the cost of renewables decreases. The company aspires to bring renewable microgrids to energy-poor populations. However, as a nascent company, its initial focus is on markets where people are able to pay. Examples of these markets include remote industries such as island resorts, mining industries, plantations, military bases, and isolated villages.

Walsh presented a case study of a typical island resort with a 24-hour electricity requirement that currently uses diesel generators, which are relatively expensive, dirty, smelly, and noisy when used in isolation. Integrating solar panels as well as batteries resulted in significant savings over the project’s lifetime of about 20 years. The controller can decide when to start and stop the genset as well as when to charge and discharge the batteries. Excess energy is stored in the batteries, and the generators can be turned off at night.

However, the poor accessibility of these typical island resort locations makes on-site monitoring and operation challenging. As such, remotely monitoring the health and status of the microgrids is important, and this is a something that Canopy Power is working on.

Yet there are several problems which need to be resolved: a general lack of awareness and difficulties in creating a viable business model. Furthermore, regulatory barriers in many of the Southeast Asian states make it almost impossible for private foreign companies to provide community electrification.

Sustainable Energy Solutions for Arctic Ports: Exploring Collaboration Opportunities

George ROE, Alaska Center for Energy and Power

George Roe began by introducing the various Arctic shipping route options that are being explored as the Arctic sea ice melts. He spoke about the need for greater international collaboration, which is key to finding sustainable energy solutions for Arctic ports. He listed various opportunities for collaboration, including shared challenges, needs, interests, and related markets. Roe noted potential opportunities to kick-start collaboration, such as knowledge-testing facilitation, integrated testing and demonstration, dual use, and net zero synergies exploration as well as technology commercialisation. At a systemic level, the process focuses on long-term goals, wider stakeholder engagement, and a shared roadmap with tangible products and benefits. This inherently requires actors to think big, start small, and learn fast.
Roe went on to highlight the possible applications of collaborative efforts around the Arctic, including the need for more navigational aids, enhanced cooperation in search and rescue, maritime electrification for commercial, tourist, and small vessels, as well as waste management. With loads sometimes being too far away, the energy has to be converted into a form that can be easily transported. Community relocation due to climate change provides another opportunity for collaboration.

Roe then presented a critical overview of international collaboration in the Arctic. The main threats are the constrained fiscal resources and weaknesses due to the qualitative nature of applications assessment. However, opportunities do exist in identifying, monitoring, and leveraging the ongoing initiatives, and given the stakeholder-relevant applications, common core areas are available for collaboration. He concluded by recommending some of the next steps that could be taken to move international collaboration forward, namely, identifying stakeholders and collaborators, defining case study requirements, and characterising risks and opportunities.

Offshore Wind and Hydrogen Production in the Arctic
Per Christer LUND, Innovation Norway

Per Christer Lund began by stating that insufficiency of renewable energy resources is a common misconception. The true challenge lies in harvesting, transporting, and storing the available energy. In harvesting energy, the questions encompass distributing and gathering energy as well as sharing and transporting it. There is a need to find ways to transform energy into more accessible carriers, such as hydrogen. The focus should be on small communities where there is a need to supply local communities with clean energy, such as in Indonesia and Greenland.

In the Arctic, where there are large seasonal changes, there is also a need for energy storage, such as via chemical carriers. Another key challenge is transport. He provided the example of large-scale wind power projects in Scandinavian countries. Hydrogen proved to be a viable solution during a feasibility study, with a pilot project planned during the period of 2016 to 2019, a small-scale project for export between 2020 and 2024, and a larger scale implementation initiative post-2025.

He mentioned a feasibility study which looked at the available technologies at commercial prices and possible markets. He stated that Japan is aiming to become a hydrogen society, and is working on transportation challenges to reduce vehicle emissions. Japan has pledged to have at least 10,000 fuel cell vehicles (FCVs) on the roads by 2020. However, due to the absence of local clean hydrogen sources, Japan would have to rely on imports. According to Lund, the hydrogen market is also expected to grow in Europe and California. Thus, there is clearly a market for fuel cell quality hydrogen.

Lund suggested that the Polar route would soon connect the Arctic to Asia. As Norway becomes a potential source of liquid hydrogen for Japan, and the latter is a supplier of FCVs to the Nordic states, the business case for hydrogen is strengthened. Using hydrogen as an energy carrier has two broad advantages. First, it can help overcome energy accessibility which is limited by the seasonal variations faced by the local communities. Second, it can help the Arctic states become net exporters of clean technologies.

The biggest potential for wind is offshore, and the further north in the Arctic, the better. The technology is available and the
challenge lies in integrating a floating wind farm with a floating hydrogen production factory.

**Oil Fuel to LPG: Fuel Conversion for Indonesia’s Fishing Boats**

**Maxensius SAMBODO, Indonesian Institute of Sciences**

Maxensius Sambodo shared the findings of a recent feasibility study carried out together with his Indonesian colleagues at the Indonesian Institute of Sciences. This study examined the impacts of fuel conversion in communities that used fishing boats less than or equal to five gross tonnes. Indonesia is committed to reducing its oil fuel usage and increasing its LPG usage as an alternative. This study is related to the Presidential Regulation No. 126/2015 on Supply, Distribution and Pricing of LPG for Small-Scale Fishermen’s Boats. Based on the above regulation, the Ministry of Energy planned a fuel conversion programme that is to be implemented by the end of 2016. As part of the programme, 50 conversion packages, consisting of a 9-HP engine, a converter kit and a 3kg LPG tube have been provided to fishermen.

Sambodo went on to highlight the advantages of fuel conversion, including the use of 3kg canisters of LPG, reducing gasoline consumption, local adaptation to technology, and strengthening gas infrastructure. Moreover, the fuel conversion from gasoline to LPG is likely to bring both monetary and non-monetary benefits to the small-scale fishermen. It is expected to reduce fuel costs, save time, expand fishing areas, and increase health safety due to lower emissions levels.

The motivations for the policy change are multiple: the impacts of climate change on fishermen, economic challenges, fuel and food security, technology and resilience as well as economic benefits.

This study put forward several recommendations for a sustainable fuel conversion programme. First, it brought to light the urgent need for a standardised LPG package and safety procedures tailored to small-scale fishermen. Second, there is a need for the government to select a fuel engine supplier that could easily provide spare parts to local markets. Third, a need for public and private cooperation was also highlighted as a way to solve the misuse of LPG distribution and pricing challenges.

Along with the LPG conversion programme, other complementary programmes such as the provision of environmentally friendly fishing gears were also recommended. Finally, Sambodo remarked on the highly adaptable nature of fishermen and the ability of people to quickly grasp technological changes.

**DISCUSSION**

The conversion from diesel to LPG was also discussed with respect to the payback period when the conversion kit is purchased. Maxensius Sambodo responded that the Indonesian government, during the pilot project, will replace engines at no cost.

There was also a question for Timothy Walsh on the feasibility of expanding hybrid microgrid operations to communities, in addition to the current focus on targeting businesses. In reply, he noted that Canopy Power began working with businesses that had a means to pay, given that these projects are capital intensive and their costs must be paid upfront, which is contrary to fuel based systems. This in itself creates a barrier for potential customers. To that end, Canopy Power has been exploring various financing options in which investors might want to fund projects. It is also exploring community electrification by means of corporate social responsibility programmes within businesses.
There were some questions on Per Christen Lund’s presentation. He further explained that small communities often require only a few hundred kilowatts of capacity. Thus, batteries might be a more applicable form of energy storage. Hydrogen is beneficial for two reasons. Firstly, energy can be stored for a longer period of time, which is useful for seasonal peak uses. Secondly, it can be transported easily.

There was another technical question pertaining to the challenges in the production and transportation of hydrogen. Lund replied that a solution for offshore hydrogen production and storage, harvested from seawater using floating wind turbines has already been demonstrated by Japan’s Jidai project. He explained that using wind power, seawater is purified and distributed to electrolysers producing hydrogen. It is then compressed, stored and offloaded to a transportation vessel which will enable flexible distribution.

Rasmus Gjedssø Bertelsen highlighted the flexibility of transporting energy via shipping and also the geopolitics of moving energy. For example, with the pipeline between Russia and Western Europe, the states are locked in. There are very limited alternatives. But by moving energy in the form of hydrogen, for example via shipping, states would have increased geopolitical flexibility.

The infrastructure necessary for producing hydrogen in the Arctic was also discussed, namely, the need for infrastructure to convert energy, particularly in the colder parts of the Arctic where the best use of energy might be to generate heat instead of electricity, the need for harbour facilities, and local production of energy were some of the infrastructural development needs of the region.

The maritime legal aspects relevant to energy development projects were also raised. For example, a discussant pointed out that there are regulations specifying the depth limits of offshore wind farms. Per Christer Lund responded that the depth generally depends on the topography of the ocean floor. Statoil had built wind farms off Norway at a depth of 120 metres. Several other variables are often taken into consideration as well. These include potential conflict with fishermen, visual aspects, and transport of energy from the wind farm to the land.
Mikhail Pogodaev started by outlining the key drivers affecting the Arctic today, namely, climate change, industrial development, mining, tourism, shipping, fisheries, and governance. There is a need for more active local governments and communities to work together to develop competence and disseminate knowledge.

He then affirmed his strong belief in international cooperation despite political challenges in international affairs. The Northern Forum, established in 1991 in Anchorage, Alaska, serves as a mechanism for promoting such cooperation. Its mission is to improve the quality of life of the Northern peoples and support sustainable development by providing the Northern regional leaders with the means to share their knowledge and experience to address common challenges.

The Northern Forum is also a platform for business cooperation in the North in the areas of economic development, commerce, culture, and tourism. As a platform for cooperation between northern regions on the subnational level, the Northern Forum also works together with the Arctic Council. It has held observer status since 1998 and has provided regional and local input into the work of the Council.

Russia’s United National Electricity Network, managed by a monopoly provider Federal Grid Company of Unified Energy System (FGC UES), relies on a total of 700 power plants. At the beginning of 2016, the total installed capacity of UES’ power plants amounted to 235.3 GW. The nation-wide energy system consists of two parts: centralised and isolated energy systems. The latter include the regions of the Russian Far East and the Arctic. They span vast territories and call for the development of “island” energy systems.

Sakha (Yakutia) is one of the regions located outside the centralised energy system. It is the biggest region in Russia, and its northern districts cover the area of 2.4 million square km and have 162 communities with the population of 105,000 people. Yakutia benefits from high solar radiation and was recently chosen by the federal government as a centre for the development of renewable energy, in particular solar resources.

In June 2015, the largest solar energy station in the High North of Russia with the capacity of 1 MWh was opened. Other renewable energy projects in Yakutia include a wind power station in Tiksi (operational since 2007; 449.7 kWh) and a number of solar power stations: Uchyugey (2012; 20 kWh), Batamay (2012; 30 kWh), and Dulgalakh (2013; 20 kWh) among others.

The nomadic people of Yakutia and other Arctic regions face additional challenges of access to affordable energy. These are directly related to their mobility. There is a need to include these communities into the discussions concerning access to energy sources. Furthermore, access to modern technologies such as cell phone coverage increases energy consumption and poses new challenges for increased electricity supplies. Regional governments are interested in sharing experiences to improve local governance. There is a need to improve legislation in using and stimulating innovation and to unlock funding opportunities. Due to the financial crisis in Russia, the federal government is likely to cut funding for the renewables and
redirect it towards meeting other objectives.

Electricity Access for Remote Areas: Lessons from Indonesia
Maxensius SAMBODO, Indonesian Institute of Sciences

Indonesia’s Energy Law (2007) clearly signalled the importance of energy access, especially for the remote areas. He explained that there are however, three main issues that need to be addressed. First, an estimated 50 million out of Indonesia’s population of 257 million are still without access to electricity. Second, there is a large gap between urban and rural electrification rates in the country. Third, electricity consumption is relatively low compared to other countries in the region. These factors imply a huge potential for electricity demand.

Unfortunately, Indonesia’s state-owned electricity distribution monopoly, Perusahaan Listrik Negara (PLN), cannot progressively expand power supply due to financial constraints. Access to electricity is a problem for urban and rural population alike. In Java, 5.1 million households are not supplied with electricity from PLN’s grid. Even in Banten Province, located close to Jakarta, there are over 142,500 households lacking electricity access. In addition to limited financial resources of the PLN, the national government provides electricity subsidy to PLN’s household customers with the capacity less than or equal to 900 Voltage-Amps. The combination of these two factors puts electrified communities at a disadvantage and creates an obstacle in expanding financing of electricity access for remote areas. The government and PLN’s investment directed at rural electrification programmes amounts to 6.4 per cent of total electricity subsidies.

Recently, there has been a rapid transformation in the source of electric power in rural areas. A special allocation fund introduced by the Indonesian government in 2016 provides funding for the small-scale energy projects. Solar panels seem to be prioritised mainly because solar projects are quick to roll out. Sustainability has also become the priority in many central and local government projects on aimed at small-scale power access. But local areas where solar capacity is installed lack human resources for effective management and maintenance of the energy systems.

Table 4. SWOT Analysis: Electricity Access for Indonesia’s Remote Areas

Based on the presentation by Maxensius Sambodo

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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</thead>
<tbody>
<tr>
<td>• Shift away from kerosene consumption;</td>
<td>• No standard of services (different management, capacity, and technology practices);</td>
</tr>
<tr>
<td>• Strong government commitment:</td>
<td>• Electricity subsidy;</td>
</tr>
<tr>
<td>- Task Force on the fast track for new energy, renewable energy, and energy conservation;</td>
<td>• Competing (predatory) energy programmes;</td>
</tr>
<tr>
<td>- Unit implementation of electricity development.</td>
<td>• Lacking local parts and capacity: PV components are imported;</td>
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<td></td>
<td>• Remote communities do not share a “we are a part of Indonesia” identity due to lack of support from the national government.</td>
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<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
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<tbody>
<tr>
<td>• Saving on energy spending by changing policies and incentives;</td>
<td>• Issues of fairness: equal access to all;</td>
</tr>
<tr>
<td>• Establishment of a rural fund;</td>
<td>• Increasing electricity demand and potential inability of the existing system to meet it.</td>
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<tr>
<td>• Establishment of village business units.</td>
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Challenges on the ground often lead to project failure in the medium- to long-term. He added that the government needs, therefore gradually reduce the electricity subsidy and provide funding for infrastructure, including transmission and distribution. There is also a need for a support agency at the district (or sub-district) level that can solve technical problems, train locals, and supervise and monitor projects. This agency would also need to be well connected and coordinated with the PLN. He stressed that technology access and resilience are far more important than the cost. Finally, in order to avoid isolating some communities, the region’s standard of electrification ratio has to be properly defined.

Insurance Companies and Sustainable Energy Projects
Lára JÓHANNSDÓTTIR, University of Iceland

Insurance is one of the largest industries in the world, with the world premium volume amounting to US$2,534 billion in 2015. The industry is incentivized to focus on sustainable energy projects because the insurance sector is highly exposed to climate change. More frequent and severe weather events result in more claims. Hence, climate change is said to create additional opportunities for insurance companies. The types of energy projects that these companies can get involved in are wind, solar PV, geothermal, hydro, and bio energy.

Insurance companies can play a variety of roles. They can be insurers, risk experts, institutional investors, policy advocates, and customers of energy companies. As insurers, companies can participate in the early development of energy technology, insure individuals in property insurances, insure installation of new technologies, insure business operations, as well as provide recycling insurance for energy projects. For instance, insurance companies can provide recycling insurance for large-scale wind farms, which guarantees decommissioning and recycling of wind farms at the end of their life cycle.

As risk experts, insurance companies can help clients by aligning terms and conditions with risk-reducing behaviour, and design strategies for risk pooling/transfer through the insurance system nationally, regionally, and globally. For example, companies operating in the Arctic region encounter various types of uncertainties and risks, namely: operational (remote areas), environmental (pollution, biodiversity concerns), reputational (projects with bad publicity), insurance cost and coverage (high premiums, low insurance coverage), legal complexity and liability (many different jurisdictions and requirements), economic (conflicting interests, limited investor interests), and weather (harsh conditions). Access to insurance, along with cooperation, training, knowledge sharing, and baseline research, provide a way to manage such risks.

As institutional investors, insurance companies screen investments and actively own insurance portfolios. Screening helps identify promising investment opportunities as well as core risks. Active ownership allows for opportunities for shareholder advocacy. By playing a role of active stakeholders in green investment projects where significant capital is needed, insurance companies help identify and tackle barriers to institutional investment. These include fossil fuel subsidies which need to be reduced, carbon prices or taxes which need to emerge and reflect externalities associated with climate-related damage, transparency and disclosure reflecting different types of risks which need to be addressed, and clean technologies which need to provide more visible commercial gains.

Jóhannsdóttir said that as policy advocates, insurance companies can take an active role in the climate debate, lobbying for more effective and stringent climate policies.
They can also advise governments in relation to business and climate change issues.

As customers of energy companies, insurers can demonstrate commitment and lead by example. They can show how they handle their own energy affairs and emissions, purchase renewable energy, and install solar systems on their office roofs.

In conclusion, as one of the world’s leading insurance market, Lloyd’s claims in its 2012 report, businesses operating successfully in the Arctic region will be the ones that seriously take responsibility towards local communities and the environment by working with various stakeholders to manage their operations in a sustainable manner, being aware of and taking measures to mitigate risks.

With the Government of Canada’s commitment to renew the nation-to-nation relationship with First Nations, Metis, and Inuit peoples, an investment in the development and operation of green energy presents an opportunity to concomitantly increase the quality of life for the indigenous communities, contribute to Canada’s action on climate change and environmental protection, and assist Canada in becoming a global leader in the development and operation of green energy.

In Saskatchewan, the Crown-owned utility, SaskPower in 2015, partnered with Black Lake First Nation in a 70/30 equity ownership model for the development of the 45 MW, run-of-river, Tazi Twi hydroelectric project. SaskPower was able to provide a bankable long-term Power Purchase Agreement, as well as access to preferred interest rates available to the government, and made it possible for the First Nation to acquire the capital to participate as an equity owner. These types of projects have enormous potential for wealth generation in many indigenous communities in the Canadian North.

Successful sustainable energy development will in many cases mean developing renewable energy projects that leverage existing human capacity in complimentary industries. Many Northern communities have significant experience, for instance, in the forestry sector, whether through timber harvesting for dimensional lumber, or pulp and paper, or through vegetation management for transportation and utility corridors. Waste products from these industries can be converted into biomass for renewable power production or combined heat and power production. The most successful projects have taken into account not just energy needs, but economic development and sustainable resource utilisation to ensure long-term sustainability, local pride, and ownership of systems.

He pointed out that a major hurdle for many indigenous and Northern communities is that existing regulatory,
financial, and institutional structures inadvertently discourage renewable energy adoption. Canada heavily subsidises energy costs, and as a result, communities often have little incentive to switch to renewables-based energy systems. The government could utilise a combination of policy instruments that would incentivise transitions to renewable energy, including those tied to conservation efforts. Approaches that could be explored include a power purchase agreement with territorial/provincial utility which would encourage local resource conservation and profit sharing, which would benefit communities who reduce their dependence on imported fuel.

Table 5. SWOT Analysis: Sustainable Energy Development for Remote Communities in Canada

<table>
<thead>
<tr>
<th>Strengths</th>
<th>Weaknesses</th>
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<tbody>
<tr>
<td>§ Widespread renewable energy resources;</td>
<td>§ Remote infrastructure;</td>
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<tr>
<td>§ Three drivers changing Indigenous Canada:</td>
<td>§ Insufficient human capacity;</td>
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<tr>
<td>- Strengthening indigenous rights;</td>
<td>§ Insufficient financial capital.</td>
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<td>- Growing indigenous groups’ participation;</td>
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<td>- Shifting attitudes towards indigenous business;</td>
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<tr>
<td>§ Indigenous and remote community interest;</td>
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<tr>
<td>§ Local utility needs;</td>
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<td>§ Independent power producers.</td>
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<table>
<thead>
<tr>
<th>Opportunities</th>
<th>Threats</th>
</tr>
</thead>
<tbody>
<tr>
<td>§ To work towards national and regional climate change targets;</td>
<td>§ Narrow policy window;</td>
</tr>
<tr>
<td>§ To renew indigenous relations;</td>
<td>§ Policy inertia in the utilities sector;</td>
</tr>
<tr>
<td>§ To decrease government spending, increase government revenue;</td>
<td>§ Low capacity to develop new human resources;</td>
</tr>
<tr>
<td>§ To work towards a global export market through economies of scale.</td>
<td>§ Fiscal and financial constraints and priorities.</td>
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</table>

**DISCUSSION**

With regards to energy sources substitution in Southeast Asia, a discussant cited high upfront costs associated with replacement of diesel with cleaner fuels. He asked whether it would be possible to get an investor and a hotel (based on a 20-25 years timeline) to make projects bankable. Timothy Walsh pointed out the risk of a hotel not being around for 20 years. Investors would be looking to bundle such projects into a larger portfolio. He also stated that his company does not own and operate projects; instead, it locates a third party or signs an operating lease. On the issue of project financing and risks, Lára Jóhannsdóttir added that insurance companies are reluctant to participate because there is very little information available.

It was also mentioned that nomadic people in the Arctic and other regions worldwide would benefit from a more robust technology and equipment. Mikhail Pogodaev shared an example of the regional governments subsidising technology for reindeer herders in Russia, but also said that it is not always the case. A
discussant mentioned that in China, nomadic people have had access to portable power and satellite TV since 2010.

During the discussion, there were concerns expressed about utilities providers who are monopolies in their respective markets. In the case of Indonesia, Maxensius Sambodo remarked that the government still provides an electricity subsidy for PLN's household consumers with capacity less than or equal to 900 Voltage-Amps. But PLN is quite open to private investment, though this investment is expected to be sizable. He concluded by saying that public-private partnerships should be encouraged.

Drawing on the point about nomadic people and the challenges they encounter in the quest for energy access, Rasmus Gjedssø Bertelsen suggested that there are similarities between nomads and other hunters/fishers in other places in the Arctic. He brought up an idea of the dual use of hybrid/renewable energy. For example, the US military is interested in renewable energy because supplying fuel to Afghanistan is expensive. In Southeast Asia, people do not have electricity and air-conditioning, while in the Arctic people need heating. He also pointed out that in the Arctic, people have survived for thousands of years without access to the electricity grid. He concluded that the role of traditional knowledge and conservation is important.

Kåre Hendriksen supported the point above. He highlighted the significance of local competence and capacities. The local population is very quick to adapt to change in their own frame of reference. In Greenland, 30 years ago they were hunters; now they are fishermen, and also combine hunting and fishing where conditions allow. Technology can also create complexity which can be problematic for those in remote communities. In the past, users were able to repair their traditional equipment on their own. In contrast, modern equipment which require advance tools and knowledge are much harder to repair since the necessary skills and tools are not available to local people.

Three more points were made regarding traditional knowledge. Greg Poelzer argued that it is important to adapt technology to social frameworks. Traditional technology principles and experience can be used for greater energy efficiency. Gwen Holdmann agreed and commented on the energy efficiency of traditional homes. In Alaska, they are trying to go back to those designs and are accepting of the fact that these traditional principles are very different from the European idea of an appropriate home. Finally, Mikhail Pogodaev argued that the use of traditional knowledge can help avoid conflicts between the government and communities.

In his closing remarks, Rasmus Gjedssø Bertelsen emphasised the importance of transdisciplinary knowledge and skills, where people are working within and among various sectors, including government, academia, civil society, and businesses. Human capital is central to the development of all, including those in remote communities.
SESSION 5: Discussion on Research Gaps and Collaboration Opportunities

During this session, workshop participants identified research gaps and complementary interests, as well as potential collaboration topics and future partnerships to address these gaps. The identified research gaps are as follows.

**Identified Research Gaps**

**Knowledge and Information**
- No centralised research/information on existing infrastructure;
- Lack of data on energy production in remote/off-grid communities;
- Lack of baseline data;
- Lack of awareness that Arctic challenges are transferrable to other regions;
- Lack of understanding of common challenges;
- Insufficient sharing of knowledge between indigenous communities and governments;
- Insufficient information about the willingness to pay for energy access;
- Need for more interaction between the research and policy-making communities;
- Need for better documentation of best practices and case studies;
- Need for the mapping of global renewables to enhance knowledge of potential sites;
- The concept of “frontier societies” requires elaboration.

**Infrastructure**
- More research on thermal energy storage (as opposed to electricity);
- Existing technology gaps:
  - energy storage challenges,
  - access and adaptability of equipment in remote and harsh environments;
- The problem of equipment based on new technologies being unrepairable (a “black box”): a manufacturing-design and long-term support problem;
- Need for better remote diagnosis and support capabilities.

**Financing**
- Issues relating to the financing and insuring of isolated communities;
- Issue of micro-grid projects financing for the users who cannot afford it;
- Investment mechanisms we might not be yet aware of / familiar with;
- Insufficient government subsidies and high cost of first-world technologies: affordability, and willingness to pay;
- There is no development bank focused on to the Arctic region.

**Governance and Sustainability**
- Understanding the commitment of individual nations/communities to renewables;
- Identifying the stakeholders, their contribution and interests;
- Issues of ownership, regulation, subsidies, and tariffs;
- Issue of political capital: empowerment of indigenous communities;
- Challenge of local competence and skills-development.

**Comparative Approach and Other Issues**
- Needs vs. Wants (and how to differentiate them);
- Two approaches: complex systems vs. grand challenges;
- Other areas (e.g., Antarctica and Space) and sectors that can provide useful insights and lessons.
SESSION 6: Key Takeaways: Looking Back to Move Forward

This session highlighted and summarised the key issues raised during the four thematic sessions of the workshop. Participants were divided into four groups: (1) maritime operations and infrastructure, (2) energy access, (3) responding to change, and (4) governance of sustainable energy transition. Each group was asked to reflect on the discussions of the previous day and outline its vision for 2030, aspirations and obstacles, and propose a way forward. The summary for this session was prepared with additional inputs by Anna Simpson.

Session 6: Summary Statement

Our vision is the development of clean, affordable and accessible energy, using local resources and smart infrastructure to drive sustainable and equitable development in the region.

We recognise the need to build local capacity, drawing on local resources, developing manufacture and maintenance capabilities, and connecting to smart, remote support systems. A strong business case must be identified and communicated, both for investors and for local communities. For this, research into the potential growth in renewables and other key resources is needed, as well as the development of local enterprise and infrastructure.

To overcome key barriers, we must develop connectivity across the Arctic region, access new sources of capital, such as Asian investment, and build local capacity to deliver the vision.

Moving forward, our first steps will be to develop polycentric governance models that empower local communities while supporting long-term peace and resilience, to deepen our understanding of the opportunity space, and to engage potential investors.

Maritime Operations and Infrastructure

GROUP 1

The first group outlined a future where renewable energy resources are harnessed locally in the Arctic and shared globally with the help of robust maritime infrastructure. This vision rests on the assumption that there is a port system and other related infrastructures in place for harvesting, processing, and storing energy, as well as using clean methods to transport it. In addition to energy, access to clean water and manufacturing supplies are also important issues.

Key actors and factors in turning this vision into reality include financing institutions, native communities (e.g., Alaska native corporations) that are interested in developing and retaining the local workforce, various specialised communities working together (i.e., mining and fisheries), local manufacturers, secure shipping lanes between the Arctic and other regions, and a global market access that would provide the benefit of economies of scale.

Technology applications should be of interest to small and large companies alike, and in general, Arctic applications can be transferred to other parts of the world. For example, Singapore has one of the largest ports in the world today, but Singapore companies build and operate ports far beyond the city-state.

Some obstacles in the way of implementing the group’s vision include the lack of infrastructure in the Arctic today, challenges associated with harvesting efficiency and capabilities, and the current state of technology. Also, due to the lack of comprehensive information available, it is hard to identify opportunities for cooperation.
The core issues addressed by this group included universal access to energy, the price competitiveness of renewable resources, opportunities for co-existence of fossil fuels and renewables, and complexities associated with new technologies.

It was concluded that a 24-hour uninterrupted power supply is an important enabler of economic activity for local communities. Access to electricity would allow locals to become more entrepreneurial and help businesses stay open for longer hours. At the same time, energy access should be affordable, but not free of charge. In order to achieve universal energy access, renewables should be comparable with fossil fuels in terms of price. In other words, prices would need to go down, and energy storage systems would have to become more affordable. However, there are also opportunities for hybrid diesel-renewable technologies, which could help promote the application of renewables.

The group also argued that the terms “advanced” and “complex” should not be used synonymously when it comes to new technologies. Local communities should be able to solve problems locally, without Table 6. Group 1 Summary: Maritime Operations and Infrastructure

<table>
<thead>
<tr>
<th>Aspirations</th>
<th>Obstacles</th>
<th>Way Forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Clean energy is an enabler of local development;</td>
<td>Lack of infrastructure in the Arctic vs. fragmented infrastructure in Southeast Asia;</td>
<td>Active participation of Asian actors;</td>
</tr>
<tr>
<td>Energy harvested locally and available globally;</td>
<td>Harvesting efficiency and capabilities;</td>
<td>Local empowerment: employment, workforce development, community development;</td>
</tr>
<tr>
<td>Access to clean water;</td>
<td>Current technological constraints;</td>
<td>International research collaboration;</td>
</tr>
<tr>
<td>Locally supplied materials;</td>
<td>Different priorities: the Arctic vs. Southeast Asia.</td>
<td>Involvement of both large and small companies;</td>
</tr>
<tr>
<td>Better connectivity;</td>
<td></td>
<td>Hydrogen distribution could follow the LNG distribution model.</td>
</tr>
<tr>
<td>More business opportunities and bigger markets.</td>
<td></td>
<td></td>
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</table>

Table 7. Group 2 Summary: Energy Access

<table>
<thead>
<tr>
<th>Aspirations</th>
<th>Obstacles</th>
<th>Way Forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>Universal 24/7 energy access;</td>
<td>Project financing;</td>
<td>Advanced, not complex, systems;</td>
</tr>
<tr>
<td>Comprehensive stakeholder engagement;</td>
<td>Cost competitiveness;</td>
<td>Focused training programmes;</td>
</tr>
<tr>
<td>Competitiveness of renewables in hybrid and stand-alone projects;</td>
<td>Reducing costs via economies of scale;</td>
<td>Government investment first, followed by private project financing in developing economies;</td>
</tr>
<tr>
<td>Advanced technology does not need to be complex, but has to be adaptable.</td>
<td>Affordable, not free energy;</td>
<td>Providing incentives for proper consumption measurement.</td>
</tr>
</tbody>
</table>
obstacles persist. Project financing is problematic until initial generation capacity is set up, the service is expanded to new customers, and the local economy develops and generates revenue. Improved local economic performance signifies the enhanced ability of customers to pay for the services, which would attract new investors and funding. Participation of more businesses would eventually lower the costs. Finally, brain drain is widespread in remote areas and a common challenge is for these communities to retain those who have been trained and accumulated enough technical experience.

In the context of growing population and economies, decarbonisation relies on the flexible interconnectivity of local and global economies. This represents a two-step model where transition takes place from coal to natural gas and, finally, to renewables. Next, connectivity has to be improved in order to increase remote communities’ access to supply chains. The development of local resources and demonstration of benefits for community resilience are crucial components in order to make progress in this direction.

In addition to the decarbonisation of the world economy, the major aspirations proposed by the group included ocean-based, polycentric strategy building and decision-making. They also believe that there is a need for a comprehensive definition of ‘change’ in order to clearly understand market, state and community ambitions.

The major obstacles in the way of implementing the vision for flexible interconnectivity are unpredictability driven by volatility, uncertainty, complexity and ambiguity; limited connectivity; and underdeveloped as well as underdeveloped local resources.
As climate change is opening access to the northern-most region of the world, the fourth group recognised that the Arctic is becoming more global and believed it should be seen as a model for cooperation. The most important aspirations include peace and stability, and consideration of the interests of both rightsholders- and stakeholders. The most powerful international body in charge of the region is the Arctic Council, which has an established set of players and observers, and a defined agenda. There should be greater awareness that the Arctic is not only a space for business, but also a place that local communities call home.

Key obstacles during the transition are the conflict of interest between businesses and communities, and a lack of awareness about potential opportunities. Arctic governance should be based on a sustainable inclusive cooperation model that would benefit a multitude of players. Along with the Arctic Council participants and observers, the other players include indigenous peoples, utility providers, national resource development companies, and researchers involved in R&D. Finally, renewables should be the basis for energy security, and technologies should be adapted to suit the local conditions. This requires greater international research collaboration.

<table>
<thead>
<tr>
<th>Aspirations</th>
<th>Obstacles</th>
<th>Way Forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Comprehensive definition of “change”; - market vs. state driven - Flexible interconnectivity; - Decarbonised economies.</td>
<td>- Unpredictability; - Limited connectivity; - Under-developed local resources.</td>
<td>- Decarbonisation using natural gas as a bridge fuel between coal and renewables; - Increasing connectivity between isolated areas; - Developing local resources and bringing them to the larger market.</td>
</tr>
</tbody>
</table>

### Table 9. Group 4 Summary: Governance of Sustainable Energy Transition

<table>
<thead>
<tr>
<th>Aspirations</th>
<th>Obstacles</th>
<th>Way Forward</th>
</tr>
</thead>
<tbody>
<tr>
<td>- Empowerment of: - people (not only businesses); - institutions (the Arctic Council); - Rightsholders vs. stakeholders; - Peaceful, secure, and developed Arctic; - Sustainable development as a guiding principle for all initiatives.</td>
<td>- Lack of awareness about potential opportunities; - Conflict of interest among different actors; - Insufficient ability to adapt and utilise new technologies to the Arctic conditions.</td>
<td>- Renewable energy guidelines adopted by the Arctic Council; - New technologies that empower the locals; - Cooperation: - between governments and communities; - among communities; - Bringing in external actors to help develop technological solutions.</td>
</tr>
</tbody>
</table>
DISCUSSION

In the concluding workshop discussion, participants shared their respective thoughts on what they considered were the key insights, based on what they have learnt from the preceding sessions.

Once again, commonalities between the Arctic and Southeast Asia were noted with regards to technological and organisational challenges and opportunities. At the community level, technology and organisation systems should be resilient and effective. Attempts to attract investment and align government priorities to deal with the changing environmental conditions are universal.

Both regions have many remote communities, which will be shaped by long-term worldwide trends as well as the global geopolitical context. Today it is a Western centric geopolitical system that connects different parts of the world, but it is essential to consider the role of non-Western systems and initiatives.

Along with the wider geopolitical context, endogenous factors – national and sub-national contexts – should be considered. First, indigenous rights are changing, and more consultations between government and community are required nowadays. Second, the public is becoming increasingly vocal and are demanding that environmental rights be put at the top of the development agenda.

Several Arctic participants suggested that Singapore could serve as the knowledge hub for energy development issues. The challenges faced by the Arctic are relevant to Singapore and Southeast Asia, and Singapore’s active involvement could significantly push the Arctic energy development agenda forward.

Also, some participants appeared confident that there is an opportunity to introduce 100 per cent renewable energy, back-up, and storage systems. In this context, there is a recognised capacity gap, which creates opportunities for mutual learning between remote communities in Southeast Asia and those in the Arctic.
The conference commenced with welcome remarks by Professor Chou Siaw Kiang, Executive Director of the NUS Energy Studies Institute, and addresses from Guest-of-Honour, Mr Sam Tan Chin Siong, Minister of State in the Prime Minister’s Office and Ministry of Manpower, and the Ambassador of the United States to Singapore, His Excellency Kirk Wagar.

Professor Chou explained that a few of the workshop participants would be sharing key findings from the preceding workshop which had ended the day before. He then thanked the Ministry of Foreign Affairs Singapore for its generous support for the workshop and conference, and expressed his appreciation to the US Office of Naval Research Global, for providing a grant towards the workshop.

He commended the US on its Chairmanship of the Arctic Council and the ongoing emphasis placed on the importance of international cooperation in Arctic issues. He stated that the NUS Energy Studies Institute will continue to support Singapore’s efforts to promote awareness of the Arctic Council’s work outside of the Arctic region, and also contribute constructively to the Arctic’s sustainable development through international research cooperation and collaboration.

The Guest-of Honour, Minister of State, Mr Sam Tan welcomed the overseas participants, especially those who had travelled a long way from the Arctic to attend this event. He noted that while Singapore is dependent on energy imports, the country is avidly exploring the greater use of solar energy.

He lauded the fact that energy experts and policy practitioners from the Arctic and Southeast Asia had come together to share their experiences. In this context, he stated that Singapore welcomes the ad referendum agreement on a new “Agreement on Enhancing Scientific Cooperation in the Arctic” which will be the third legally binding agreement under the auspices of the Arctic Council. He believes that this will help facilitate greater scientific cooperation among the Arctic states and also for observers such as Singapore.

Mr Tan then spoke at length about Singapore’s engagement in the Arctic. In 2014, the government established the Arctic Affairs Programme, housed at the National University of Singapore to build knowledge on the Polar Code and Arctic shipping governance. He also highlighted how Singapore has worked to contribute to the larger body of Arctic science and research through the involvement of the National Parks Board (NParks) of Singapore in the Arctic Council’s Working Group on Conservation of Arctic Flora and Fauna (CAFF).
Mr Tan then highlighted the technological research carried out through the NUS Centre for Offshore Research and Engineering (CORE) on offshore oil rigs and ice mechanics, the Keppel-NUS Corporate Lab’s work on a first “green” rig for use in the Arctic, and the upcoming Technology Centre for Offshore and Marine Singapore (TCOMS) which can be used to evaluate offshore and marine technologies. He noted that these research pursuits will contribute to the Arctic’s energy sustainability. In closing, Mr Tan indicated that he will be attending the White House Arctic Science Ministerial scheduled in late September this year in Washington DC. At this US event, he will share Singapore’s experiences in Arctic research, and the outcomes of this conference.

The Keynote Speaker, His Excellency Kirk Wagar similarly spoke about the inaugural White House Arctic Science Ministerial. This is the first-ever event that will bring together foreign government leaders, high-level government officials from different countries, senior international scientific experts, and representatives from indigenous groups to expand joint collaborations relating to Arctic science, research, observations, monitoring, and data-sharing.

Turning to the conference topic, Ambassador Wagar noted that remote communities and experts in both the Arctic and Southeast Asia can benefit from one other’s experience in facilitating energy access in remote locations and harsh environments. Thus, this event is both timely and appropriate.

He also highlighted the Memorandum of Understanding signed in November 2015 between the University of Alaska Fairbanks and the National University of Singapore which covers Arctic research and policy collaboration, as well as student and research exchanges. He believes there are many opportunities ahead for cooperation and collaboration between those within and outside the Arctic.
REMARKS BY GUEST-OF-HONOUR, MINISTER OF STATE IN THE PRIME MINISTER’S OFFICE AND MINISTRY OF MANPOWER SAM TAN CHIN SIONG

REMARKS BY MINISTER OF STATE IN THE PRIME MINISTER’S OFFICE AND MINISTRY OF MANPOWER SAM TAN CHIN SIONG AT THE NUS ENERGY STUDIES INSTITUTE “ENERGY TRANSITIONS IN A GLOBALISED ARCTIC – THE ROLE OF SCIENCE, TECHNOLOGY AND GOVERNANCE” CONFERENCE, FRIDAY, 19 AUGUST 2016 AT 9.00AM, HOTEL JEN TANGLIN

Ambassador of the United States to Singapore His Excellency Mr Kirk Wagar,

NUS Energy Studies Institute Executive Director, Professor Chou Siaw Kiang,

Distinguished speakers and guests,

Ladies and gentlemen,

A warm welcome to all of you to Singapore! An especially warm welcome to our speakers who have travelled a long way from the Arctic to be here. In May this year I travelled 32 hours from Singapore to Nuuk, Greenland, to attend the Arctic Circle Greenland Forum. It was a long journey, more than 11,000 kilometres away, so I appreciate you making this long journey to our tropical island.

I am happy to attend today’s conference organised by the NUS Energy Studies Institute on “Energy Transitions and a Globalised Arctic”. I am very happy that they have taken this initiative to organise this forum on a very important topic which is very close to the heart of the Singapore Government. As economic activity in the Arctic increases, energy will become especially important in powering these activities, whether commercial or otherwise. The remoteness of many Arctic communities makes access to energy crucial
and critical. In January this year, I visited Svalbard, the world’s northern-most archipelago. In the morning I went to the cafeteria to have breakfast and the sun was not out. I learnt that the sky was permanently dark for three months in a year, even at two o’clock in the afternoon! Svalbard is blanketed in 24-hour darkness for three months every year. Living in these remote locations without reliable access to energy can be particularly challenging.

As a small country, Singapore imports almost all of our energy needs. To ensure that Singapore remains energy secure, a new liquefied natural gas (LNG) terminal was constructed on Jurong Island, and operations began in 2013. We have limited renewable energy options, due to our resource constraints. Nuclear energy is not an option due to the risks involved, as any mishap could destroy the whole country. As such, we have been exploring the possibility of generating more power from other sources such as solar energy. For instance, the Housing and Development Board (HDB) has begun to test-bed solutions by placing solar panels on rooftops of high-rise public housing. In fact, one of the largest collections of solar panels in Singapore is housed at the Solar Park in the Marina Barrage, which I am told the workshop participants visited yesterday afternoon.

While Singapore has no oil and gas resources of our own, we nonetheless possess technologies to help develop these resources, which can in turn reduce the environmental impact of oil and gas exploration and production. These technologies can be applied in the Arctic. For example, the NUS Centre for Offshore Research and Engineering (CORE) spearheads our research in offshore oil rigs and ice mechanics, while Keppel and NUS set up a Corporate Laboratory in 2013 to identify applied solutions to areas which will benefit industry development and our researchers. So Keppel in parallel is working with a US developer on the first “green” rig. It is crucial for Keppel and like-minded people to build a green rig which can be safe in the Arctic region. We have also set up the Technology Centre for Offshore and Marine Singapore (TCOMS) to advance our national offshore and marine industry. When fully set up, TCOMS will house a state-of-the-art deepwater ocean basin that will cater to the needs of our industry partners, by enabling faster, accurate and cost effective evaluation of offshore and marine technologies.

Singapore’s experience may not be entirely relevant to Arctic communities, but there might be areas in which we can learn from each other. I am told that one similarity between Southeast Asia and the Arctic is that both our regions have communities which remain outside national energy grids. Hence, I am pleased that energy experts and policy practitioners from the Arctic and Southeast Asia have come together over the workshop’s last two days to share their experiences in energy governance and in devising solutions to meet such challenges. Science, technology and the sharing of experiences play a major role in energy solutions. In the Arctic, the Arctic Council is a good platform for such collaboration. In this regard, we welcome the ad referendum agreement of the Agreement on Enhancing Scientific Cooperation in the Arctic, which will be the third legally binding agreement under the auspices of the Arctic Council. When ratified, the Agreement will lower barriers to scientific cooperation and increase interaction amongst the Arctic states and for observers such as Singapore.

Singapore has participated in the Arctic Council as an observer for the last three years. Being geographically distant, we have sought to increase our knowledge of the Arctic
through workshops and conferences such as this, and through our own research capabilities. Our Maritime and Ports Authority (MPA) and National Parks Board (NParks) participate in the Arctic Council’s Emergency Prevention, Preparedness and Response (EPPR) and Conservation of Arctic Flora and Fauna (CAFF) Working Groups respectively. We established an Arctic Affairs Programme in 2014, housed at NUS. Under this Programme, the Ministry of Foreign Affairs co-funded several visits and seminars, aimed at building up our knowledge of the Polar Code, and Arctic shipping governance. The NUS Centre for Maritime Studies has been conducting a research study on the viability of trans-Arctic shipping routes, and their results are expected at the end of this year. NUS has also signed an MOU with the University of Alaska Fairbanks (UAF) which will promote further collaboration and research in the Arctic. The Arctic is also one of the focus areas of the new $1.56 million Maritime and Port Authority (MPA) and CIL Oceans Governance Research Programme.

We have also sought to contribute to the larger body of Arctic science and research. NParks contributes data on Arctic migratory birds that stopover at our Sungei Buloh Wetland Reserve. These birds stopover in Singapore, fly off to Australia and go back to the Arctic. We have more than 40 species of migratory birds. I visited Sungei Buloh Wetland Reserve last year, and was happy to know that 2,300 migratory birds stopover in Singapore annually, and the data is provided to the CAFF Working Group. I am pleased that NParks will be hosting an Arctic Migratory Birds Initiative (AMBI) workshop in Singapore in January 2017. I look forward to attending the White House Arctic Science Ministerial in Washington D.C. next month, to share Singapore’s experiences in Arctic research, as well as the outcomes of this Conference.

In conclusion, I would like to thank ESI once again for organising this meaningful conference, the US Embassy for sponsoring this event, and our distinguished speakers from the Arctic and Southeast Asia for sharing your fruitful and constructive knowledge with us at this platform. Thank you.
SESSION 1: Energy Transitions in a Globalised Arctic: Key Findings

In the first session, the panellists provided the key findings from the workshop and set the framework for the discussion.

Rasmus Gjedssø Bertelsen was the first to speak and summarised Session 1 of the workshop which took place on August 17th. He explained how the Arctic has historically been a part of the global international political economy. However, recent changes have been driven by Asia. As a result, we are returning to a world where most of the world’s population and economic activity is in Asia. There have been plenty of discussions about Asian interests in the Arctic. He noted that it was also suggested during the workshop that Singapore become a knowledge hub.

Bertelsen believes they serve as a reminder that the Arctic is very much part of the wider world, not just academically, but also economically.

He also mentioned the two theoretical frameworks by Oliver E. Williamson and Elinor Ostrom for studying questions of governance pertaining to energy transition. Bertelsen believes they serve as a reminder that the Arctic is a crucible where there is a need to push for new technologies and techniques for clean and locally available sources. In Russia, for example, it can take approximately two years to deliver fuel to remote communities. She believes that what is just as critical is how people interact with technology. It can be challenging to find people to manage or maintain complicated energy systems, while at the same time they are also learning from projects carried out elsewhere. Where there are high levels of poverty, finding ways to finance projects that lack economies of scale is critical and there is a need to lower barriers for smaller scale projects. There is also a need to transition from intermittent to uninterrupted 24-hour energy access. Ideally, as the demand for power increases tremendously, economic development is propelled, narrowing income inequality.

Gwen Holdmann was the second speaker and gave an overview of Session 2 of the workshop. She discussed energy access in remote locations. With more than half a billion people globally with interrupted access to electricity, there are huge similarities between the Arctic and Southeast Asia. In the Arctic, as it is in Asia, a significant portion of the population is served by remote grids that use diesel generation for power. As a result, the challenge to become connected to a central grid is yet another similarity. The Arctic is a crucible where there is a need to push for new technologies and techniques for clean and locally available sources. In Russia, for example, it can take approximately two years to deliver fuel to remote communities. She believes that what is just as critical is how people interact with technology. It can be challenging to find people to manage or maintain complicated energy systems, while at the same time they are also learning from projects carried out elsewhere. Where there are high levels of poverty, finding ways to finance projects that lack economies of scale is critical and there is a need to lower barriers for smaller scale projects. There is also a need to transition from intermittent to uninterrupted 24-hour energy access. Ideally, as the demand for power increases tremendously, economic development is propelled, narrowing income inequality.

Holdmann also indicated that remote communities can learn from the African experience on technological leaps. By skipping landlines and instead moving directly to the use of mobile phones, accessibility there improved dramatically. Moving to the issue of human capital, she believes that the local population needs to be further empowered through training in order for remote energy systems to operate effectively in remote communities, since
the locals are the ones who will need to oversee and maintain these systems.

The third speaker, Matt Ganley, summarised the workshop discussion on maritime infrastructures and shipping. He emphasised on the need for infrastructure in “island communities” in the Arctic and in Asia, and how it can be financed. He believed there are immense opportunities for applying microgrids in Asia, Africa, and the Arctic. The challenges depend on the type of renewable resources available locally and the technological maintenance; and these differ in different communities. He also talked about energy created through ubiquitous resources in the Arctic, in particular, hydrogen which has the potential to become an exportable commodity.

Finally, Philip Andrews-Speed provided an overview of Session 4 on responding to changes. Modifications to the Western-centric world and the rise of Asia as an economic engine led to the question of states, who are located far from the Arctic, getting involved in this remote region. Initiatives like One Belt, One Road and the Trans-Pacific Partnership, driven by competing actors, namely China and the United States respectively, could yield greater benefits for remote communities.

Two other important themes from the workshop were traditional knowledge and the role of insurance companies. Traditional knowledge and the need to have communities work with designers on technology solutions that are usable, repairable, and resilient need to be addressed. With regards to insurance companies, as they get greener and more focused on climate change, the need for risk management increases as well, and they become crucial actors in energy projects.

SESSION 2: Panel Discussion and Q&A

This session introduced two more panellists, Maxensius Sambodo and Mikhail Pogodaev. Members of the audience also participated in the session by asking questions and sharing their comments.

Sambodo talked about the energy revolution taking place in Southeast Asia. Its biggest evidence is the switch by poor families from kerosene lamps to solar panels for meeting their electricity needs in Indonesia. While technology is advancing, there is also a need for governance in broad terms. This includes more active leadership in communities, capacity- and knowledge-building to be able to handle sophisticated technology, and development of risk taking culture. The moderator, Philip Andrews-Speed, added that social capital and trust need to be built as well because often societies do not trust their respective governments.
Pogodaev briefly discussed the issues faced by the Russian Arctic communities due to globalisation and climate change. New external conditions bring change to the Arctic, and these impact on the traditional livelihoods of the indigenous peoples. For instance, mineral resources are an important issue. There are a lot of energy resources on these peoples’ lands, but they are sent to the other parts of the world, while the benefit to the local communities are minimal. Importantly, some of these resources could provide access to energy, which these communities currently lack. For nomadic people, though, access to energy is even more complicated because they are always on the move and cover huge areas. They need robust, portable solutions. Despite prevailing energy poverty, the Arctic residents can offer useful experiences in energy efficiency through the use of traditional knowledge. It has always been a part of their lives as they strive to use resources sustainably.

**Capacity, Resources, Rights, and Risks**

The first question from the audience was concerning the transferability of energy solutions in terms of capacity. One answer from the panel addressed the capacity question from the perspective of population density in the Arctic in comparison with Southeast Asia. In the case of Southeast Asia, land use competition is widespread and there are booming urban population centres. In contrast, the Arctic is challenged by its small population being spread thin across vast lands. This creates an additional challenge for the integration of renewables into the energy systems.

Bertelsen provided an answer focusing on human capacity. It is not the resources that are limited; it is the ability to educate young people who would develop new ideas and solutions. After all, lucrative resources are not tied to the location. Where these resources are developed depends on the institutions, human resources, and education. For example, Norway developed a good system for oil and gas resources management based on its experience with nitrogen a hundred years ago. Iceland can offer its experience in managing geothermal resources, and China’s SINOPEC is tapping into Iceland’s experience in the development of geothermal applications for large cities in China. Similarly, Singapore can play a major role in bringing Southeast Asian countries together and helping them develop various skills and capabilities.

The next question from the audience focused on the debate of prioritising resource development versus the environment. Ganley argued that for the residents of the Arctic regions, mining is important because they need an economy to drive the development. In Alaska, there is a long history of resource development, and the indigenous population has benefited greatly from it. Communities understand the risks, and there are disagreements between members of these communities. Oil and gas development was economically feasible in Alaska until recently, but mining is not very sustainable from the energy point of view. Fortunately, there is no big drive for extractive industries in the state today. In Alaska, resource rights were settled in the 1970s and the indigenous people have since guided the development of resources on their land.

Another question raised by the audience was the effect of risks such as terrorism on the Arctic and remote communities in general. In Bertelsen’s opinion, non-technical risks like armed conflict or terrorism are harder to grasp than technical risks. But social sciences show that there is a way to analyse and predict them. For example, explanations do exist for why
Nigeria suffers from the resource curse, while Norway has managed to govern its oil and gas resources very well.

Waste-to-Energy

Waste-to-energy solutions were the next point of discussion. A member of the audience suggested that instead of depending on the sources of energy from elsewhere, remote communities could make their own energy from their own waste. However, according to Holdmann, small remote communities like those of Alaska suffer from the absence of economies of scale. The volume of produced waste is so small that it makes it difficult to sustain the system of waste management. There are opportunities for changing that; for instance, it could be possible to turn fish oil and other products from fish processing into a viable energy source, thus, integrating waste management and energy generation.

Globalisation, Geopolitics and International Cooperation

A member of the audience highlighted the role of identifying the scale of projects and the size of capital expenditures in response to the question about facilitating cooperation between the Arctic and Southeast Asia. He argued that in order for cooperation to take place, stakeholders should have something to share with the other parties. For example, electricity cooperatives, which bring together communities and utility providers, could be natural places for bringing other stakeholders together. On this point, Ganley introduced to the audience the Arctic Portal created by the Institute of North and its partners as a one-stop portal for accessing data, and for sharing information and investment opportunities between interested parties.

Several panellists repeated that the Arctic is becoming globalised and that the centre of the world economic activity is moving to Asia. Thus the audience wondered what impact new emerging players with different perceptions and levels of development have on the Arctic, and whether geopolitical problems around the world affect the Arctic. Bertelsen noted that the Arctic is a part of the International System, but alarming reports about possible disputes in the North is exaggerated. Historically, the Arctic was a theatre of warfare during WWI, WWII, and the Cold War. It was militarised for reasons that have nothing to do with the Arctic. He noted that the US and Russia have many areas of contact, involving both conflict and cooperation in different areas. It is important to keep in mind the interaction between these contact areas and the fact that other areas of collaboration exists. These include the Arctic, nuclear non-proliferation, the Middle East, and Space among others. The challenge is to manage interaction between these areas and not allow conflict to spill into areas of cooperation. Bertelsen believes that Russia has shown complete willingness to isolate the Arctic from conflict.

Pogodaev added that politicians always talk about the Arctic being a place for peaceful cooperation. This has been the case despite tensions between Russia and the West. In the 1990s, there were very productive cooperation efforts between Russia, Canada, and the US. There is tremendous potential to work together and share the best practices. He stated that people-to-people cooperation is an essential component because even when there are disagreements between national governments, education and research exchange does not stop. For example, the Northern Forum was created for the purpose of sub-national level cooperation. Finally, Andrews-Speed highlighted that there are precedents of successful cooperation such as Antarctica and Space.
Role of Local Governments

Some of the panellists shared their opinions on the role of local government support in implementing renewable energy investment. Sambodo discussed Indonesia’s experience where the government allocates a lot of money for this purpose. But there is a real challenge of combining these funds with private sector participation. Also, the programme for electrifying more than one million households in Eastern Indonesia was successful only because local governments participated. Land acquisition is essential for installing generation capacity, and the national government would not be able to resolve land conflicts on the ground. Hence, the scheme is such that local governments receive funding when they ensure the land for the projects is available.

According to Pogodaev, in Russia, local governments are interested in developing energy systems and finding solutions for remote isolated areas. This creates opportunities for international cooperation. Sakha Republic has positive experience of cooperation with Alaska. Based on this, best practices are now being scaled up and transferred to other regions. Holdmann, who is familiar with the Sakha Republic – Alaska cooperation efforts added that it was beneficial for Alaskan developers too. They are now getting in touch with the experts from the Sakha Republic with respect to developing projects in permafrost. So an important lesson from this example is that knowledge transfer among practitioners is key. Nobody has all the solutions, and people are striving to improve their lives and experience. Also, in the context of Alaska, local government is important for the following reason. When utilities agree to invest, the government allows them to keep tariffs at the same rate until the projects are paid for.

Missing Elements

When asked about the top issues for kick-starting large-scale energy development, the panellists mentioned the following:

- storage capacity;
- governance at the local level;
- scaling up existing energy systems;
- reconsidering demand which is often misperceived as insufficient;
- community buy-in;
- business models that get projects going;
- decreasing fossil fuel subsidies to push for adopting renewable energy solutions;
- remembering that human capital and institutions matter much more than geographical conditions;
- converting electricity to easily transportable forms;
- a resource map for the Arctic and Southeast Asia alike that would help build a business case for investors;
- a common understanding that a large market exists, or has the potential to exist.

Defining “Best Practice”

A member of the audience asked the panellists to define “best practice” since this term was repeatedly used during the session. In reply, the panellists noted that no single overarching definition of best practice exists, and noted that the concept is dynamic. Nonetheless, the panellists agreed that this concept has several features. First, it is a social contract that has to offer benefits to the companies involved. Second, projects that are considered best practice pass the test of time. This is relevant for technology, community engagement, and utility management. Third, what is best practice for one stakeholder is not necessarily the same for the other. Fourth, best practice reconciles different interests and appropriately solves problems. Finally, in the harsh conditions like the ones in the Arctic regions, best practice is often understood as the one that works well.
## Workshop Programme

**August 17th, 2016**

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<tr>
<th>Time</th>
<th>Session</th>
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<tbody>
<tr>
<td>8.30-9.00 am</td>
<td>Registration</td>
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| 9.00-9.20 am  | **Opening Remarks**  
Christopher LEN, Melissa LOW and Philip ANDREWS-SPEED (Convenors)  
Anna SIMPSON (Briefing for Session 6)                                             |
| 9.20–10.35am  | **Session 1: The Governance of Sustainable Energy Transition**  
Moderator: Christopher LEN  
Panellists:  
 § Philip ANDREWS-SPEED, Socio-Technical Energy Transitions: Governance and Institutional Factors  
 § Matt GANLEY, Arctic Energy Landscape: The Arctic Renewable Energy Atlas (AREA)  
 § Beni SURYADI, Southeast Asia’s Renewable Energy Challenges: ASEAN Guidelines on Rural Electrification  
 § Rasmus Gjedssø BERTELSEN, Discussant |
| 10.35-11.00 am| **Coffee Break**                                                          |
| 11.00 am-12.30 pm | **Session 2: Access to Energy in Remote Locations: Technology Assessments and Policy Considerations**  
Moderator: Gwen HOLDMANN  
Panellists:  
 § Gwen HOLDMANN, Integration of Renewable Microgrids: Lessons from Alaska  
 § Rene M. FAJILAGUTAN, Integration of Hybrid Island Mini-Grids: Lessons from the Philippines  
 § Kåre HENDRIKSEN, Greenland Island Infrastructures: Energy Challenges in the Fishing Industry  
 § Martha LOLEIT, Renewable Energy Integration Demonstrator – Singapore (REIDS) |
| 12.30-12.40 pm| Photoshoot                                                               |
| 12.40-2.00 pm | Lunch                                                                    |
| 2.00-3.30 pm | **Session 3: Maritime Infrastructures and Shipping: Technology Assessments and Policy Considerations**  
Moderator: Matt GANLEY  
Panellists:  
 § Timothy WALSH, Renewable Energy and Hybrid Microgrids in Southeast Asia  
 § George ROE, Sustainable Energy Solutions for Arctic Ports: Exploring Collaboration Opportunities  
 § Per Christer LUND, Offshore Wind and Hydrogen Production in the Arctic  
 § Maxensius SAMBODO, Oil Fuel to Liquefied Petroleum Gas (LPG): Fuel Conversion for Indonesian Fishing Boats |
| 3.30-3.55 pm | **Coffee Break**                                                          |
3.55-5.25 pm  
**Session 4: Responding to Change: Sustainable Development, Risk, Resilience and Innovation**  
Moderator: Philip ANDREWS-SPEED  
Panellists:  
- Mikhail POGODAEV, Regional Government Perspectives on Sustainable Development  
- Maxensius SAMBODO, Electricity Access for Remote Areas: Lessons from Indonesia  
- Lára JÓHANNSDÓTTIR, Insurance Companies and Sustainable Energy Projects  
- Greg POELZER, Sustainable Energy Development for Remote and Indigenous Communities in the Arctic and Sub-Arctic: The Steps Forward

5.25-5.40 pm  
**Observations for Day 1**  
Moderator: Melissa LOW  
Panellist:  
- Rasmus Gjedssø BERTELSEN, Brief Observations

5.40-5.45 pm  
**Announcements**

6.45-8.30 pm  
**Welcome Dinner hosted by Ministry of Foreign Affairs**

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**August 18th, 2016**

9.00–10.15am  
**Session 5: Discussion on Collaboration Opportunities**  
Moderators: Christopher LEN, Philip ANDREWS-SPEED  
- Identify research gaps and complementary interests;  
- Identify potential collaboration topics (in general);  
- Identify potential partnerships.

10.15-10.45 am  
**Coffee Break**

10.45 am-12.15 pm  
**Session 6: Key Takeaways: Looking Back to Move Forward**  
Moderators: Anna SIMPSON, Philip ANDREWS-SPEED  
This session is to highlight and summarise the key issues raised during the workshop. Participants will be divided into four groups for visioning, presenting, and reflecting.

**Closing Remarks**

12.15-2.00 pm  
**Closing Lunch**

3.10-6.00 pm  
**Field Visit**  
Marina Barrage Guided Tour

6.30-8.30 pm  
**Dinner hosted by Energy Studies Institute**
Conference Programme

August 19th, 2016

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| 9.00-9.30 am | Welcome Remarks  
Professor CHOU Siaw Kiang  
Executive Director, Energy Studies Institute  
Guest-of-Honour Address  
Mr Sam TAN Chin Siong  
Minister of State in the Prime Minister’s Office and Ministry of Manpower  
Keynote Address  
His Excellency Kirk WAGAR  
United States Ambassador to Singapore |
| 9.30–10.15 am | Session 1: Energy Transitions in a Globalised Arctic: Key Findings  
At the basic level, the energy transition challenges surrounding remote and islanded communities and operations are common across the world, including the Arctic and Southeast Asia. In this session, the panellists will provide the key findings from the one-and-a-half day workshop scheduled earlier in the same week on this issue. They will talk about the following:  
- Comparing the Arctic and Southeast Asian Energy Transition Landscapes;  
- Energy Access in Remote Locations;  
- Renewable Energy for Maritime Infrastructures and Shipping;  
- Sustainable Development of Remote Communities and Operations.  
Q&A will take place in Session 2 after the coffee break.  
Moderator: Christopher LEN  
Panellists:  
Rasmus Gjedssø BERTELSEN  
Gwen HOLDMANN  
Matt GANLEY  
Philip ANDREWS-SPEED |
| 10.15-10.45 am | Coffee Break                                                        |
| 10.45 am-12.25 pm | Session 2: Panel Discussion and Q&A  
In this panel, participants will engage in further discussions on the issues raised in the previous session. Additionally, they will share their thoughts on the role of science and technology in energy transitions, the importance of research and development, lessons to be drawn from both Arctic and Southeast Asia experiences, issues related to risk, resilience and innovation, as well as discuss research gaps, complementary interests and collaboration opportunities. They will also take questions from the audience.  
Moderator: Philip ANDREWS-SPEED  
Panellists:  
Rasmus Gjedssø BERTELSEN  
Gwen HOLDMANN  
Maxensius SAMBODO  
Matt GANLEY  
Mikhail POGODAEV |
| 12.25-12.30 pm | Closing Remarks by Professor CHOU Siaw Kiang                       |
| 12.30 pm   | Closing Lunch                                                        |
# Workshop and Conference Participants

<table>
<thead>
<tr>
<th>WORKSHOP/CONFERENCE (CO-)CONVENERS AND MODERATORS</th>
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<tbody>
<tr>
<td>Christopher LEN, PhD</td>
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<tr>
<td><em>Energy Studies Institute, National University of Singapore</em></td>
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<tr>
<td>Philip ANDREWS - SPEED, PhD</td>
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<td><em>Head of Energy Security Division; Energy Studies Institute, National University of Singapore</em></td>
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<tr>
<td>Melissa LOW</td>
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<td><em>Energy Studies Institute, National University of Singapore</em></td>
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<tr>
<td>Rasmus Gjedssø BERTELSEN, PhD</td>
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<tr>
<td><em>Barents Chair in Politics, Department of Sociology, Political Science and Community Planning, University of Tromsø-The Arctic University of Norway</em></td>
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<td>Rene M. FAJILAGUTAN</td>
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<tr>
<td><em>Romblon Electric Cooperative, Inc (ROMELCO), the Philippines</em></td>
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<td>Matt GANLEY</td>
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<td><em>Institute of the North, United States</em></td>
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<td>Kåre HENDRIKSEN, PhD</td>
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<tr>
<td><em>Arctic Technology Centre, Technical University of Denmark</em></td>
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<tr>
<td>Gwen HOLDMANN</td>
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<tr>
<td><em>Alaska Center for Energy and Power (ACEP), University of Alaska Fairbanks, United States; Fulbright Arctic Initiative Scholar (2015-2016)</em></td>
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<tr>
<td>Lára JÓHANNSDÓTTIR, PhD</td>
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<tr>
<td><em>School of Engineering and Natural Sciences, University of Iceland</em></td>
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<tr>
<td>Martha LOLEIT</td>
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<tr>
<td><em>Renewable Energy Integration Demonstrator – Singapore (REIDS), Energy Research Institute @NTU (ERI@N), Nanyang Technological University</em></td>
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<td>Per Christer LUND, PhD</td>
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<td><em>Innovation Norway</em></td>
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<td>Greg POELZER, PhD</td>
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<tr>
<td><em>International Centre for Northern Governance and Development (ICNGD); Professor, School of Environment and Sustainability, University of Saskatchewan, Canada; Fulbright Arctic Initiative Scholar (2015-2016)</em></td>
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<tr>
<td>Mikhail POGODAEV, PhD</td>
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<td><em>The Northern Forum;</em></td>
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<tr>
<td>George ROE</td>
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<td>Timothy WALSH, PhD</td>
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**WORKSHOP DISCUSSANTS**

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<thead>
<tr>
<th>Name</th>
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<tbody>
<tr>
<td>Muhammad ARDHI</td>
<td>Visiting Student, University of Tromsø-The Arctic University of Norway</td>
</tr>
<tr>
<td>Anton FINENKO</td>
<td>Research Associate, Energy Studies Institute, National University of Singapore</td>
</tr>
<tr>
<td>Chris GOUGH</td>
<td>Intern – RSO, Embassy of the United States of America – Singapore</td>
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<tr>
<td>Andrew HIGIER, PhD</td>
<td>Associate Director, Office of Naval Research – Global Singapore</td>
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<tr>
<td>HO Juay Choy, PhD</td>
<td>Adjunct Research Associate Professor, Energy Studies Institute, National University of Singapore</td>
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<tr>
<td>Blake MCBRIDE, Commander</td>
<td>Associate Director to Iceland, New Zealand and Polar S&amp;T, Office of Naval Research – Global Singapore</td>
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<tr>
<td>Hema NADARAJAH</td>
<td>PhD Student, Department of Political Science, University of British Columbia</td>
</tr>
<tr>
<td>Elena RESHETOVA</td>
<td>PhD Student, Lee Kuan Yew School of Public Policy, National University of Singapore</td>
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<tr>
<td>SHI Xunpeng, PhD</td>
<td>Senior Research Fellow, Energy Studies Institute, National University of Singapore</td>
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<tr>
<td>Anna SIMPSON (Moderator)</td>
<td>Curator, Futures Centre; Editor, The Long View Forum for the Future</td>
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<tr>
<td>SUN Zhen, PhD</td>
<td>Research Fellow, Centre for International Law, National University of Singapore</td>
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EVENT PHOTOS

WORKSHOP