Asia-Pacific Economic Cooperation

APEC Oil and Gas Security Studies

# Melting of the Arctic Sea Ice

## Significance for the APEC Economies' Energy Security

APERC
Asia Pacific Energy Research Centre

Series 6
November 2015

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**Hooman Peimani**

**November 2015**

## APERC

**Asia Pacific Energy Research Centre**

**APEC Oil and Gas Security Initiative: 2014-2015 EWG 06 2014S**

**PUBLISHED BY:**

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APEC#215-RE-01.31
ISBN 978-981-09-8060-3

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# Foreword

During the 11th APEC Energy Ministers' Meeting (EMM11) held in Beijing, China on 2nd September 2014, the Ministers issued instructions to the Energy Working Group (EWG). This includes an instruction to Asia Pacific Energy Research Centre (APERC) to continue its cooperation on emergency response so as to improve the capacity building in oil and gas emergency response in APEC region.

Following this instruction, APERC has started implementing the Oil and Gas Security Initiative (OGSI) in November 2014. One of the three overarching pillars of the OGSI is the publication of the Oil and Gas Security Studies (OGSS).

The OGSS serves as a useful publication to APEC economies by having access to developments and issues on oil and gas security, and information on individual economy's policies related to oil and gas security including responses to emergency situation. The research studies included in OGSS will help encourage the APEC economies to review and revisit their respective policies, plans, programmes and measures on oil and gas security, and may probably help them adopt appropriate approaches to handling possible supply shortage or supply emergencies in the future.

I would like to thank the contributors to the OGSS for the time they have spent doing research works. May I however highlight that the independent research project contents herein reflect only the respective authors' view and not necessarily APERC's and might change in the future depending on unexpected external events or changes in the oil and gas and policy agendas of particular economies or countries.

I do hope that the OGSS will serve its purpose especially to the policy makers in APEC in addressing the oil and gas security issues in the region.

**Takato OJIMI**
President
Asia Pacific Energy Research Centre

## Acknowledgments

I would like to thank all those who contributed to the completion of this report in various forms. It would not have been completed without their valuable contributions. I wish to express my deepest appreciation to the following Arctic scholars for reviewing this report and providing me with their constructive advices and comments, namely, in alphabetical order, Professor Lawson W. Brigham, School of Natural Resources and Extension, University of Alaska Fairbanks, Alaska/USA; Professor Lassi Heininen, Faculty of Social Sciences, University of Lapland, Lapland/Finland; Professor Valur Ingimundarson, Faculty of History and Philosophy, University of Iceland, Reykjavik/ Iceland; Dr. Arild Moe, Senior Research Fellow at the Fridtjof Nansen Institute, Lysaker/Norway; and, Professor Alexander Sergunin, Department of International Relations, St. Petersburg State University, St. Petersburg/ Russia. This report has benefited enormously from their valuable contributions.

As well, I would like to thank Professor Alexander Sergunin, Professor Lassi Heininen and Associate Professor Gleb Yarovoy, Department of International Relations, Petrozavodsk State University, Petrozavodsk/Russia, for authorizing the use of their map (*The Northwest Passage and the Northern Sea Route*) in this report.

I acknowledge with appreciation the contribution to this report of the following scholars and entities through their authorizing the use of their graphs, maps, pictures and tables, namely, in alphabetical order, Professor Charles Fletcher [*Picture 4: Honolulu Fly-Through with 3 ft of Sea Level Rise (2011)*]; Malte Humpert/The Arctic Institute [*Map1: Arctic Sea Routes*]; NASA's Earth Observatory [*Table 2: Annual Average Contraction and Expansion of Arctic Sea Ice (Summer and Winter Ice Extents*)]; NASA's Earth Policy Institute [*Graph 1: Global Carbon Dioxide Emissions*]; NASA's Global Climate Change [*Picture 1: Arctic Sea Ice 1979* and *Picture 2: Arctic Sea Ice 2013*]; National Snow and Ice Data Centre [*Picture 3: Arctic Sea Ice Extent; Graph 2:Average Monthly Arctic Sea Ice Extent January 1979-2015*]; the Perry-Castañeda Library Map Collection and National Snow and Ice Data Center [*Map 4: The Arctic Region*]; US Energy Information Administration [*Map 3: Resource Basins in the Arctic Circle Region*]; welt-atlas.de [*Map 5:Map of Strait of Malacca*]; and, Wikimedia Commons [*Map 5:Gulf of Aden map.png*].



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# List of Abbreviations

| | |
|---|---|
| APEC | Asia-Pacific Economic Cooperation |
| APERC | Asia Pacific Energy Research Centre |
| BBOE | billion barrels of oil equivalent |
| bcm | billion cubic meters |
| B/D | barrels per day |
| $CO_2$ | carbon dioxide |
| EEZ | exclusive economic zone |
| GHG | greenhouse gases |
| IEA | International Energy Agency |
| IPCC | Intergovernmental Panel on Climate Change |
| LNG | liquefied natural gas |
| NGL | natural gas liquids |
| NSIDC | National Snow and Ice Data Center |
| NASA | National Aeronautics and Space Administration (USA) |
| NSR | Northern Sea Route |
| NWP | Northwest Passage |
| tcm | trillion cubic meters |
| UNCLOS | United Nations Convention on the Law of the Sea |
| USGS | US Geological Survey |

# Executive Summary

The Arctic sea ice has been melting because of global warming caused by greenhouse gases, particularly $CO_2$, whose main source of emission has been heavy consumption of fossil energy for over two centuries. This phenomenon, if it continues, will have a wide range of devastating environmental impacts on the entire plant, including rising sea-levels to affect all the countries sharing a coastline with open seas, including all the APEC economies, and worsening global warming. However, it may make possible the extensive exploration of the Arctic region's undiscovered oil and gas resources previously inaccessible. As estimated by the 2008 US Geological Survey, they amount to 413 billion barrels of oil equivalent (BBOE) in total consisting of 90 billion barrels of oil, 48.11 trillion cubic meters of gas and 44 billion barrels of natural gas liquids (NGL), accounting for 13% of the world's undiscovered conventional oil resources and 30% of its undiscovered conventional natural gas resources. Approximately 84% of these resources are offshore and natural gas, including NGL, accounts for their bulk (78%). Sharing borders with the Arctic region, three APEC economies, namely, Canada, Russia and the USA, have a varying share of these resources, but, their combined resources account for their bulk (oil: 78%; gas:88%) leaving the rest for Norway and Greenland.

While extensive oil/gas exploration will likely worsen the Arctic's fragile environment, it could turn the Arctic region into a major oil/gas supplier, provided the feasibility of its sustainable large-scale oil and gas production and export at competitive prices. Such operation involves certain opportunities, including increasing the global supply of these fuels and, thus, their availability to the APEC economies depending on oil and gas (LNG) imports. This availability will further diversify their suppliers and supply routes and decrease their dependency on their current largest supplier, the conflict-prone Middle East, to the extent determined by the sustainable volume of the available Arctic-produced oil and gas. As a factor, it could help sustain oil and gas (LNG) prices by preventing drastic price hikes caused by shortages.

Yet, such prospect could face certain challenges to prevent a rapid development of the regional oil/gas resources, including the technical ones (inadequate required infrastructures; scarcity of ice-class equipment/vessels; long-process of drilling; harsh working condition; unachievable environmental standards; and, high cost of production compared to other energy-producing regions). "Arctic paradox" reflects the environmental challenges as extensive oil and gas operation in the Arctic region whose environment is fragile would speed up its melting with the mentioned global impacts.

The economic challenges include the necessity of a strong and sustainable growing demand for oil and gas, which cannot be fully met by other regions. This is essential to keep their prices high enough globally to make costly Arctic oil and gas competitive and secure investment in the regional energy industry. Potential disputes among the Arctic economies and countries over the energy-rich areas beyond their exclusive economic zones constitute the major political challenge.

Additionally, the lowering oil and gas prices have discouraged and will continue to discourage their respective extensive projects in the Arctic region, as evident in many cancellations and suspensions of such projects, to delay the availability of significant amounts of Arctic supplies, at least, for a decade.

Despite the interest of the mentioned APEC economies, Greenland and Norway in developing their Arctic resources, their respective operations' extent and timing are unpredictable due to the specified challenges. The conceivable scenarios for such operations include the *delayed development scenario*, which is probable in this decade due to certain factors, including the global abundance of oil and gas supplies at lowering prices to delaythe large-scale development of their resources. The *limited development scenario* foresees mainly limited development of their resources because of certain challenges such as the extreme technical difficulty of operation under the Arctic's harsh climatic conditions and/or such operation's low profitability or unprofitability, a possible scenario in the foreseeable future. Finally, the *extensive development scenario* considers extensive oil and gas activities owing to a sustainable and unmet high demand for such fuels and a lowering or termination of the Arctic economies' unconventional oil and gas production backed by high enough oil and gas prices, an unlikely scenario in the foreseeable future.

# I-Introduction

The Arctic sea ice has been melting because of global warming caused by greenhouse gases (GHG), especially $CO_2$. The latter's main source of emission has been heavy consumption of oil, gas and coal for over two centuries. Provided its continuity, the mentioned melting will have a wide range of devastating environmental impacts on the entire plant to affect all the countries and the APEC economies, in one form or another, by posing challenges of a varying extent to their normal operations and ultimately survival. They include rising sea-levels with implications for those of the latter sharing a coastline with open seas, including all the APEC economies, and worsening global warming, with various negative implications on a wide range of fields from the environment to economy.[1]

However, this environmentally-disastrous phenomenon may unlock vast oil and gas resources of the Arctic region by making their exploration in many ice-covered and, thus, previously inaccessible parts of the Arctic region now feasible, although still challenging. The challenge arises from various factors, including the harsh climatic conditions, certain technological difficulties and the resulting high cost of operation compared to other oil/gas-producing regions. According to the available estimates, these onshore and offshore resources located in the area to the north of the Arctic Circle account for substantial amount of the world's undiscovered conventional oil (13%) and gas (30%) resources (EIA, 2012; Larson, 2013). To make these resources available to the global energy markets, the required extensive exploration and large-scale production activities over a significant period of time will likely contribute to the worsening of the Arctic region's fragile environment. Nevertheless, such activities could potentially turn the region into a major supplier of oil and gas to increase the global supply of such fuels for a few decades under certain conditions, including the following: the region's recoverable oil and gas is significant in volume, its production is sustainable and its production cost is not too high to make Arctic oil and gas prices not competitive with those of other oil- and gas-supplying regions.

Having said that, it should be stressed that the region as a whole is perhaps, at least, over one decade, if not more, behind the time when all the requirements are well in place for a large-scale and uninterrupted exploration, production and transportation to the global markets of its undiscovered oil and gas resources. Adequate regional infrastructure for supporting these activities (such as port facilities, oil/gas terminals and rescue services) is one requirement. Other requirements include the availability of a large number of ice-class equipment and vessels for drilling and supporting activities, means of oil and gas transportation (mainly oil/LNG tankers) and emergency response facilities to contain emergency situations (such as undersea blowouts and oil spills) and conduct subsequent clean-up operations. As it stands today (2015), certain additional factors are further postponing the large-scale development of the Arctic undiscovered oil/gas resources. Chief among them is the global lowering oil and

[1] This report's focus is on the impact of the Arctic sea ice's melting on the development of the Arctic region's undiscovered oil and gas resources and the latter's potential effect on the APEC region's energy security. As a result, the report does not elaborate on all the environmental consequences of such melting; it therefore only covers those of relevance to the mentioned potential.

gas prices to make high-cost Arctic oil and gas production financially unattractive or infeasible. As a major factor, it has resulted in delaying or cancelling many Arctic oil and gas exploration and development projects.

Yet, provided the availability of the mentioned requirements, the Arctic region's emergence as a large-scale oil and gas supplier will surely have a significant impact on the APEC region for certain reasons, including the following. There are three APEC economies in the Arctic region, namely, Canada, Russia and USA. As will be discussed, some of them already have large-scale oil and gas extraction in their Arctic parts with known proven reserves and/or have plans to embark on large-scale explorations in the areas where the bulk of their undiscovered Arctic petroleum resources are located. Of course, the mentioned lowering oil and gas prices, in particular, has negatively affected many of these costly and technologically challenging plans.

Having said this, the APEC region is the world's single largest consumer of energy thanks to its large and growing economy and population. Many APEC economies with large oil and gas consumption rely on imports for substantial and growing amounts of their needs for such fuels to sustain their economic growth and living standards. Consequently, they could well be among the major beneficiaries of Arctic oil and gas supplies with the effect of making energy developments in the Arctic region of special importance to them.

Against the mentioned background, this report offers an account on the major implications of the Arctic sea ice's melting for, particularly, the APEC economies. Although this phenomenon has implications for various types of economic activities in the Arctic region such as mining and fishery by making gradually their vast resources accessible in the near future, the report focuses on its energy implications. It therefore concentrates on the prospect for developing the Arctic undiscovered oil and gas resources for large-scale productions and exports to justify elaborating on the directly-related issue of the new Arctic shipping routes for their potential use by oil and LNG tankers. Provided the sustainability of large-scale oil and gas production in the Arctic region housing a significant portion of the global undiscovered oil and gas resources, such production could substantially increase these fuels 'availability to the APEC economies to positively affect their energy security, as a factor. Towards this end, the feasibility of this outcome is discussed in light of the most relevant factors, namely, energy, economic, environmental and political ones, which, in one form or another, could facilitate or hinder oil and gas production in the Arctic region.

Throughout this report, unless otherwise specified, references to the Arctic oil and gas resources are made to the Arctic region's undiscovered ones located in the area to the north of the Arctic Circle. Their development could be feasible now or in the foreseeable future because of the Arctic sea ice's melting and their estimated amounts are large enough to potentially have a major impact on the APEC economies' energy security, if their large-scale production is sustainable.

There are three APEC economies and five countries in the Arctic region, namely, Canada, Greenland, Norway, Russia, the USA, Sweden, Finland and Iceland. However, the focus of this report is on the first five ones where the bulk of the Arctic undiscovered oil and gas resources are located, according to the currently-available information. The remaining three countries have no known oil and gas resources. Today (2015), there is no evidence to suggest that they will find significant volumes of these fuels in their Arctic parts and, in fact, apart from Iceland, they have no plans to that effect. Consequently, all references to the Arctic economies and countries in this report are to Canada, Greenland, Norway, Russia and the USA, unless otherwise stated.

## II-Background

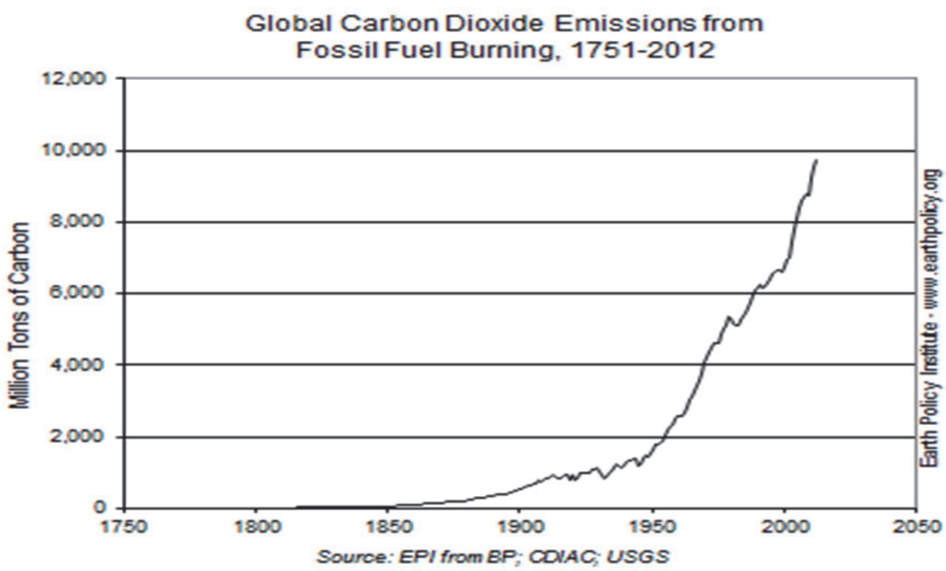
### A. Melting of the Arctic Sea Ice

Seasonal melting of the Arctic sea ice and, thus, its contraction is a natural phenomenon caused by seasonal warming in summer followed by its expansion in winter because of seasonal cooling. In general, annual contractions and expansions are not necessarily corresponding in size as fluctuations in temperatures in summers and winters may vary due to natural causes to result in larger or smaller sizes of ice losses than those of ice gains. However, such fluctuations, which could be significant are usually temporary in nature and well within the Arctic's natural course of life and, therefore, not a source of concern.

However, the Arctic sea ice has been melting at a significant scale, especially over the last three decades, to make this phenomenon distinct from the natural one as it seems to be permanent. For this reason, the melting raises alarm about the Arctic's environmental health. According to the *Intergovernmental Panel on Climate Change* (IPCC), the Arctic sea ice has declined at an average rate of 13% per decade since the 1980s and that the Arctic Ocean is projected to be nearly ice-free in summer in this century (IPCC, 2014, p. 4).

The main culprit for such abnormality has been global warming caused by human activities, meaning phenomenal emissions of GHG of which $CO_2$'s share is the largest. The bulk of $CO_2$ is the result of extensive consumption of fossil energy (oil, gas and coal) for over two centuries, which has continued to this date at an incremental scale as illustrated in the following graph.

**Graph 1: Global Carbon Dioxide Emissions**




Source: Graph supplied courtesy of: [Adams, Emily E., Earth Policy Institute (2013), *Fossil Fuel Use Pushes Carbon Dioxide Emissions into Dangerous Territory*, 23 July 2013, http://www.earth-policy.org/indicators/C52]

The global $CO_2$ emissions will continue at an even larger scale should the global energy mix remain dominated by fossil energy, as evident in such domination in 2013 (Table 1).

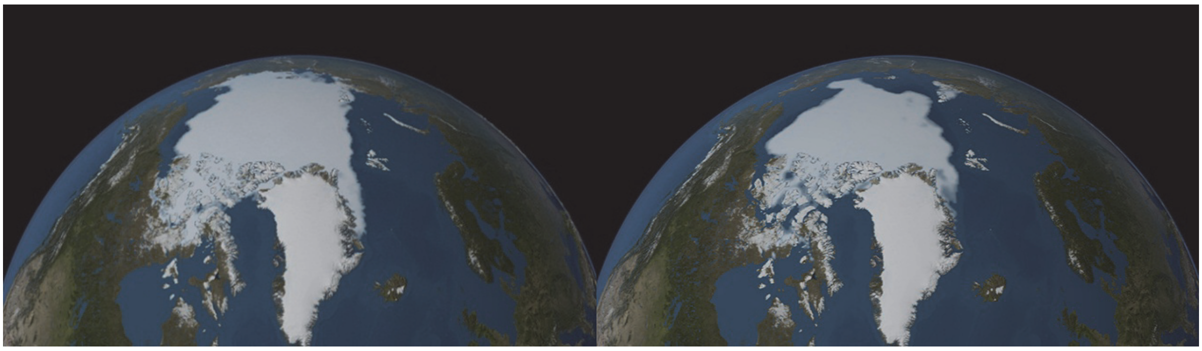
**Table 1: Global Energy Mix 2013 (Mtoe)**

| Oil | Gas | Coal | Nuclear | Hydro | Other Renewables | Total |
|---|---|---|---|---|---|---|
| 4185.1 | 3020.4 | 3826.7 | 563.2 | 855.8 | 279.3 | 12,730.5 |

Source: Author's creation based on the data provided in: [BP (2014), *BP Statistical Review of World Energy 2014*, p. 41, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf]

As a clear recent indication of the worsening situation, on 16 September 2012, the Arctic sea ice reached "its minimum extent for the year of 3.41 million square kilometers" (NSIDC, 2012). It was the "lowest seasonal minimum extent in the satellite record since 1979 [being] 760,000 square kilometers …below the previous record minimum extent in the satellite record" of 18 September 2007sea ice extent, which was 49 percent below the 1979–2000 average for that month (USEPA, 2014). This development was followed by another reduction in September 2013 when "sea ice extent was nearly 700,000 square miles [about 1.81 million square kilometers][2] less than the historical 1979–2000 average" (Ibid).The following NASA-provided satellite pictures demonstrate the phenomenal extent of this development in a comparative manner.

**Picture 1: Arctic Sea Ice 1979*** **Picture 2: Arctic Sea Ice 2013***



Source: Pictures supplied courtesy of: [NASA – Global Climate Change (2015), 1979 and 2013 Pictures, In *Time Series: 1979-2013 - Arctic Sea Ice Minimum*, http://climate.nasa.gov/vital-signs/arctic-sea-ice/]
*The original image has no title. The title is author's creation.

Table2 covering the period 1979 to 2014 reflects fluctuations in summer (September Average Extent) and winter (March Average Extent) Arctic sea ice extents, respectively, when the Arctic sea ice cover is at a minimum due to summer heat, and when the Arctic sea ice cover is at a maximum due to winter cold. The former is an indicator of Arctic sea ice health as it demonstrates the extent of the ice surviving summer heat.

[2] The author has converted the original figure in square miles to square kilometers.

**Table 2: Annual Average Contraction and Expansion of Arctic Sea Ice (Summer and Winter Ice Extents)***

| **September/March** (minimum/maximum) | **September Average Extent** (millions of square kilometers) | **March Average Extent** (millions of square kilometers) |
|---|---|---|
| 1979–2000 mean | 7.0 | 15.7 |
| 1999/2000 | 6.2 | 15.3 |
| 2000/2001 | 6.3 | 15.6 |
| 2001/2002 | 6.8 | 15.4 |
| 2002/2003 | 6.0 | 15.5 |
| 2003/2004 | 6.2 | 15.1 |
| 2004/2005 | 6.1 | 14.7 |
| 2005/2006 | 5.6 | 14.4 |
| 2006/2007 | 5.9 | 14.7 |
| 2007/2008 | 4.3 | 15.2 |
| 2008/2009 | 4.7 | 15.1 |
| 2009/2010 | 5.4 | 15.1 |
| 2010/2011 | 4.9 | 14.6 |
| 2011/2012 | 4.6 | 15.2 |
| 2012/2013 | 3.6 | 15.1 |
| 2013/2014 | 5.4 | 14.8 |

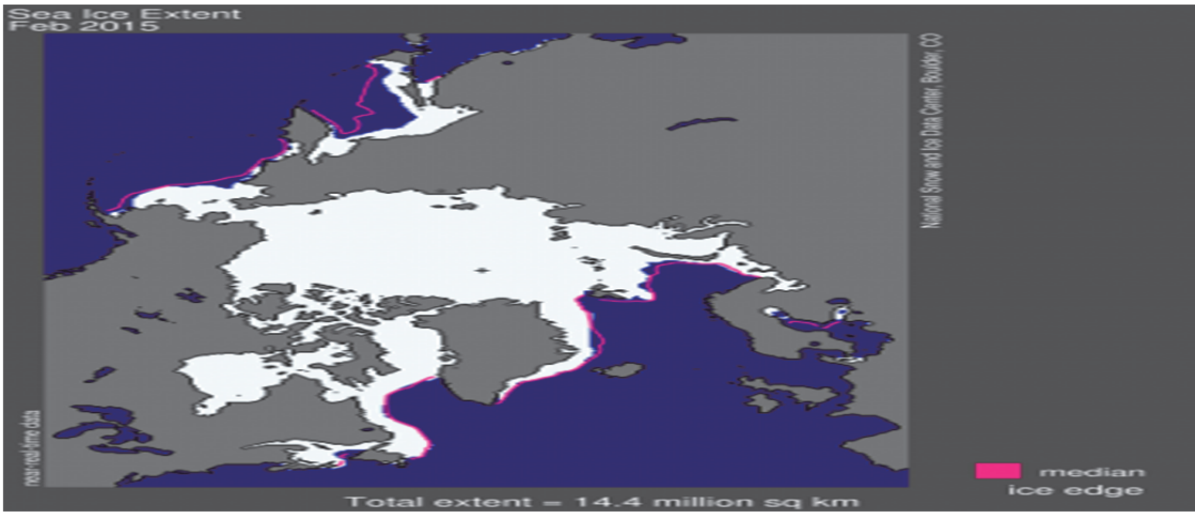
Source: Table supplied courtesy of: [Lindsey, Rebecca (2015), *NASA Earth Observatory*, "Arctic Sea Ice", http://earthobservatory.nasa.gov/Features/WorldOfChange/sea_ice.php]
*The original table has no title. The title is author's creation.

Of course, there was a significant improvement in Arctic sea ice in 2014 as its extent dropped to 5.02 million square kilometers on 17 September 2014, which was much larger than that of 16 September 2012 (3.41 million square kilometers) (NSIDC, 2014). Nevertheless, the expansion of this ice leading to the full restoration of its phenomenal loss will not likely happen in a sustainable manner so long as the global warming continues. Reporting the mentioned improvement, this point was stressed by the *National Snow and Ice Data Center* (NSIDC). Thus, "This is now the sixth lowest extent in the satellite record and reinforces the long-term downward trend in Arctic ice extent" (Ibid). NSIDC's March 2015 report on the contraction of this ice in the last winter supports this observation.

> Arctic sea ice extent in February averaged 14.41 million square kilometers (5.56 million square miles). This is the third lowest February ice extent in the satellite record. It is 940,000 square kilometers (362,900 square miles) below the 1981 to 2010 long-term average of 15.35 million square kilometers (5.93 million square miles). It is also 50,000 square kilometers (19,300 square miles) above the record low for the month observed in 2005 (NSIDC, 2015a).

Picture 3 demonstrates the status of the Arctic sea ice in February 2015.

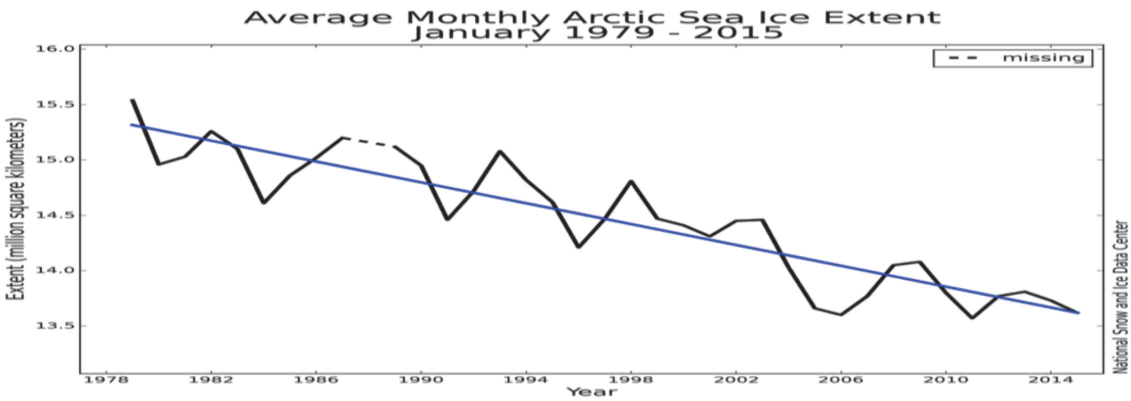
**Picture 3: Arctic Sea Ice Extent**




Source: Picture supplied courtesy of : [National Snow and Ice Data Centre (NSIDC) (2015), *Possibly Low Maximum in the North, a High Minimum in the South*, Colorado, USA, 4 March 2015, http://nsidc.org/arcticseaicenews/2015/03/possibly-low-in-the-north-definitely-high-in-the-south/]

The following NSIDC graph illustrates the process of Arctic sea ice decline during the period January 1979 to January 2015.It indicates a continued declining process despite annual fluctuations.

**Graph 2: Average Monthly Arctic Sea Ice Extent January 1979-2015**




Source: Graph supplied courtesy of: [National Snow and Ice Data Centre (NSIDC) (2015), "Average Monthly Arctic Sea Ice Extent, January 1979- 2015", *Arctic Sea News and Analysis - January 2015 Compared to Previous Years*, Boulder, Colorado, USA. http://nsidc.org/arcticseaicenews/]

As per the above graph, "monthly January ice extent for 1979 to 2015 shows a decline of 3.2% per decade relative to the 1981 to 2010 average" (NSIDC, 2015b).

## B-Implications of the Melting of the Arctic Sea Ice

The melting process has certain regional and global implications. The following is a brief account of the major ones.

### 1. Environmental Implications

The ongoing rapid melting of the Arctic sea ice will become irreversible unless a coordinated global effort is initiated to reduce significantly GHG emissions on a sustainable manner so that global warming can be contained and eventually reversed. In absence of such effort, the continuity of global warming and its worsening due to the increasing GHG emissions, particularly $CO_2$, as evident in the $CO_2$ projections for the foreseeable future (Table 3), will only speed up this environmentally devastating trend.

**Table 3: World Energy-Related $CO_2$ Emissions Current Policies (Million Tons)**

| | 1990 | 2011 | 2020 | 2030 | 2035 |
|---|---|---|---|---|---|
| **Total $CO_2$** | 20,948 | 31,162 | 36,059 | 40,825 | 43,111 |
| **Coal** | 8,323 | 13,761 | 16,374 | 18,702 | 19,621 |
| **Oil** | 8,819 | 11,079 | 12,177 | 13,205 | 13,793 |
| **Gas** | 3,806 | 6,322 | 7,508 | 8,918 | 9,697 |

Source: Author's creation based on the data provided in: [IEA (International Energy Agency), (2013), "$CO_2$ Emissions (Mt)-World: New Policies Scenario", *World Energy Outlook 2013*, p. 574; IEA (International Energy Agency), (2013), "$CO_2$ Emissions (Mt)-World: Current Policies and 450 Scenarios", *World Energy Outlook 2013*, p. 575.]

The ongoing melting process has major global environmental impacts affecting all the APEC economies. Being a result of global warming, the melting of the Arctic sea ice, in turn, aggravates this phenomenon in different ways of which the following serves as a blatant example. As part of the earth's cooling system, the Arctic sea ice reflects sunbeams and thus prevents heat absorption by the Arctic Ocean to a major extent. Its shrinkage has been decreasing the reflective ice's surface leading to an increasing absorption of heat by the Arctic Ocean. The development has worsened global warming, as a factor, to accelerate the melting of the Arctic sea ice. In turn, such melting has further aggravated global warming. This process will continue as long as the Arctic sea ice's shrinkage is not recovered.

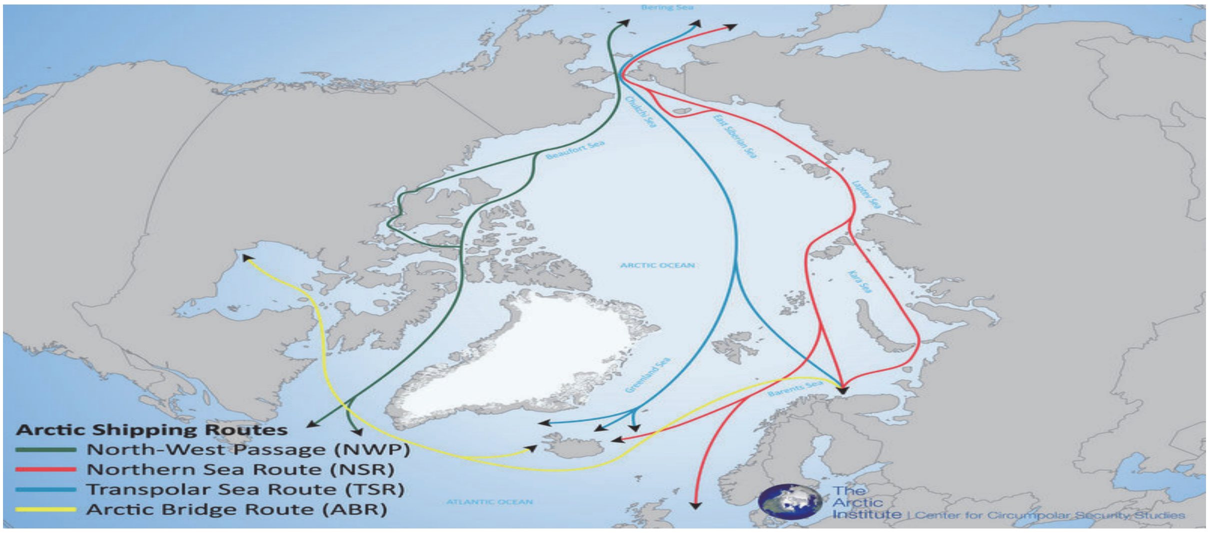
As a large piece of floating ice, the melting of the Arctic sea ice, in itself, will have no contribution to sea-level rising. However, this phenomenon will rise global and regional temperatures in different forms resulting in the melting of the world's second largest ice sheet, namely, the Greenland icesheet (1.7 million square kilometers) (NSIDC, 2015c)whose melting will directly contribute to rising sea levels globally. The latter will negatively affect all the APEC economies as all of them have a coastline with an open sea, along with those countries having such coastline. The resulting flooding will damage the affected coastal areas. Challenging the operation and survival of the APEC economies' oil and LNG terminals on their coastline is just one example of its negative implications for their energy security. The total melting of Greenland's icesheet will result in a global rise of sea levels by six meters to cover a vast part of the APEC economies and the mentioned countries (Ibid). As the worst case scenario, the total melting of the world's largest ice sheet, that of the Antarctica, because of global warming will result in rising sea levels by 60 meters (Ibid).

The Arctic sea ice's melting has, of course, other negative consequences by virtue of its worsening global warming, which are not the focus of this report. They include damaging global farming and deforestation.

## 2. Economic/Trade Implications: New Sea Routes

The Arctic sea ice's melting has an economic implication with a potential significance for the regional oil and gas industry to become prominent in the future should the current melting continues. Apart from the accessibility of the regional energy, mineral and fishery resources**,** the melting ice has brought about the possibility of shipping through the Arctic Ocean by offering, potentially, up to four intercontinental shipping routes. Of these, two have limited implications in the foreseeable future as it stands today. One is the Arctic Bridge connecting Russia's Port of Murmansk or the Norwegian Port of Narvikto Canada's Port of Churchill, which is mostly suitable for trade between Canada and Russia and also some parts of Europe and Asia, mainly through Russia (HU, 2015). The other is the Transpolar Sea Route that, through the middle of the Arctic Ocean, links the Atlantic Ocean to the Pacific Ocean (Ibid). It is not a fixed shipping lane because of high seasonal variability of the Arctic Ocean's ice conditions and shipping through it will require icebreakers as the route is not ice-free during the year. According to an estimate, it may be open for shipping traffic and, thus, mainly ice-free for a while in summer "over the coming decades" as a result of the Arctic sea ice's melting (Humpert and Raspotnik, 2012).

**Map1: Arctic Sea Routes**




Source: Map supplied courtesy of: [Humpert, Malte and the Arctic Institute (2015), *Arctic Sea Routes*, http://www.thearcticinstitute.org/2012/10/the-future-of-arctic-shipping.html]

The two major Arctic routes more suitable for a varying amount of large-scale intercontinental shipping are the Northern Sea Route (NSR) through Russia's Arctic region and the Northwest Passage (NWP) via Canada's Arctic region. By shortening the distance for intercontinental trade now mainly conducted through the southern route via the Suez and Panama Canals and the Strait of Malacca, the NSR and the NWP will be important for the conduct of global trade for, potentially, all the Arctic APEC economies and countries should the current melting process continue to make these routes navigable a few months a year. Through them, some other APEC economies and countries could also potentially benefit from such routes, provided their close proximity to them. Apart from their cargo significance, the two routes could be used for oil and LNG transportation to a currently-unknown extent to make them especially important to the oil/gas-rich Arctic APEC economies and countries.

Briefly, the NSR and the NWP are currently navigable during summer for a few weeks with restrictions as discussed below and, therefore, a very limited degree of commercial navigation takes place through them at this time. However, if the current ice melting continues, they will be navigable for a differing, but longer, period of time mainly, but not totally, without icebreakers.

Although there are disagreements about when exactly they will be available for such period of time yearly, there is a consensus as to such scenario will happen in some decades and that navigation through the NSR will, at least initially, be much easier than that via the NWP. The reason lies in scientific projections on the Arctic Ocean's ice condition according to which the NSR will likely be the first route to become largely ice-free during summers while "increasing ice movement in some channels of the Northwest Passage could initially make shipping more difficult" (Arctic Council, 2014).

In fact, there are doubts about the availability of the NWP for large-scale shipping even in the case of sustained melting of summer sea ice as concluded in the Arctic Council's *Arctic Marine Shipping Assessment 2009 Report*. Accordingly, "the Northwest Passage is not expected to become a viable trans-Arctic route through 2020, but destinational shipping is anticipated to increase (Arctic Council, 2009). This assessment was corroborated by Transport Canada's following 2014 assessment:

> Even with significant warming in the Arctic, research predicts that Canada's Northwest Passage will remain difficult for large-scale commercial shipping. It also indicates that, under certain conditions, melting ice could make shipping in the Canadian Arctic more dangerous; not less. With ice melting in the Arctic Archipelago, multi-year ice in the Arctic Ocean can flow into shipping lanes. Old ice is thicker and stronger, and may present serious navigational hazards that can cause greater damage to a ship's hull as compared to first-year ice. This ice presents a hazard to most vessels. Studies are ongoing on the melting of sea ice in the Canadian Arctic, the likelihood of shipping through the Northwest Passage, and the impacts this could have on the Canadian Arctic (Transport Canada, 2014).

The difference in the availability of the Arctic sea routes is due to the regional ice situation in summer, which is summarized in the following account of the Arctic Institute's Centre for Circumpolar Security Studies. In its reference to the increasing ice-free period of the Arctic sea routes by 2025, the source adds:

> Furthermore, the distribution of the remaining summer ice will not be uniform across the Arctic Ocean. Studies suggest that sea ice will collect and persist longest along the northern flanks of the Canadian Archipelago and Greenland while the central and eastern part of the Arctic will see the most significant decline of ice, further extending the shipping season along the NSR (Humpert and Raspotnik, 2012).

Currently, neither route is open for year-round shipping and will not be so for many decades, even if the current melting process continues, as that will require the permanent melting of a large part of the Arctic, a disastrous scenario for the entire planet. In the recent time, the average duration of availability of these two routes for shipping has fluctuated depending on the climactic conditions. During the 1980-1999period, the duration of navigation through the NSR and the NWP were 45 days and 35 days, respectively (IPCC, 2014). According to a report, as of 2010, the ice free conditions of most Arctic shipping routes were only about 30 days(HU, 2015). However, another report suggests a much longer ice-free condition for the NSR in 2011, thus, “141 days, from early July until mid-November” (Humpert and Raspotnik, 2012), including the period with ice breaker escort (Moe, 2015). As reported, the NSR’s availability was down to 50 days in 2014 (Critchlow, 2015), without ice breakers’ escort (Moe, 2015).

Although limited commercial shipping, including cargo and (oil and LNG) tanker ones, has taken place through the Arctic, mainly via the NSR, it is still uncertain whether the NSR and the NWP will become reliable shipping routes, especially for large-scale fuel transportation. In terms of physical feasibility, the condition of ice in these routes will determine if sustainable large-scale commercial shipping during the summer period (3-4 months a year) could take place through them. The existing projections on such condition in the future to determine these routes’ physical availability are all estimates and thus vary from one source to another. Within the mentioned limitations, these routes are expected to become available for large-scale commercial shipping at differing dates depending on their respective assessments of the extent of the Arctic Ocean’s ice. For example, estimates for the ice-free NSR “in summer to prolong the sailing season from the current 20-30 days to about 120 days range from as early as 2013 to as late as 2080 of which most estimates fall between 2040 and 2060” (Ho, 2011).

As to the availability of the NSR and the NWP for the mentioned period of time, a March 2014 report of the *Intergovernmental Panel on Climate Change* (IPCC) suggested the availability of the NSR for navigation without icebreaker escort for up to 125 days per year by 2050 (IPCC, 2014). A reported University of California Los Angeles study supports this projection as it suggests that the NSR will be available from June to September around 2050 at which point “seasonal sea-ice coverage will have declined to such an extent that ships transiting the NSR may not need ice-breaking escorts during the months of June, July, August and September” (Cima and Sticklor, 2014). Finally, The Arctic Institute’s Centre for Circumpolar Security expands such ice-free condition to all the “Arctic’s main shipping routes,” which should include both the NSR and the NWP as it holds: “The ice-free period along the Arctic’s main shipping routes is expected to increase from around 30 days in 2010 to more than 120 days by the middle of the century” (Humpert and Raspotnik, 2012).

Yet, the physical availability for the Arctic routes for shipping is a necessary factor, but not the determining factor, for large-scale shipping through them. In assessing the potential role of the NSR and the NWP for global shipping, particularly for large-scale energy shipping, the following issues should be taken into considerations as stressed by Professor Lawson W. Brigham, Distinguished Professor of Geography and Arctic at the University of Alaska Fairbanks:

> (A) Arctic shipping is driven by Arctic natural resource development and the connections of these resources to global markets.
>
> (B) Arctic sea ice change/retreat provides greater marine access and potentially longer seasons of navigation. However, Arctic sea ice retreat is NOT the main driver of the need for marine transport. [Rather,] economics and development are driving that need.
>
> (C) The Arctic sea will be fully or partially ice-covered during winter, spring and autumn through the [21st] century and beyond. This means, in most cases, ships will have to be Polar Class (and [thus,] more expensive [than the non-polar ones]) to operate in the Arctic Ocean.
>
> (D) The changing Arctic situation WILL NOT revolutionize the global trade routes (especially for container). The new routes will potentially be *supplemental* to the routes using the Suez and Panama canals.
>
> (E) The new routes will be dominated by ships carrying natural resources out of the Arctic to [the] global markets....a good example being the tankers, bulk carriers and LNG ships using the NSR today (Brigham, 2015).[3]

The Arctic Council's *Arctic Marine Shipping Assessment 2009 Report* also specified the latter as some of the determinants of the extent of shipping through the Arctic sea routes in its reference to the main drivers for such shipping. In fact, it puts stress on "Arctic natural resource development (hydrocarbons, hard minerals and fisheries)", which includes oil and gas development, and "regional trade" as the "key drivers of future Arctic marine activity" (Arctic Council, 2009). However, according to the report, there are "many other factors and uncertainties of importance" affecting  Arctic shipping, including "governance, Arctic state cooperation, oil prices, changes in global trade, climate change variability, new resource discoveries, marine insurance industry roles, multiple use conflicts and Arctic marine technologies. ….." (Ibid).

The report also identifies limiting factors for shipping, which include "a lack of major ports, except for those in northern Norway and northwest Russia, and other critical infrastructure" (Ibid). Additionally, lack or inadequacy of certain necessities for safe navigation in the Arctic region will also limit Arctic shipping so long as they persist. They include "meteorological and oceanographic data, products and services", "comprehensive information on sea ice and icebergs", "gaps in hydrographic data for significant portions of primary shipping routes", "serious limitations to radio and satellite communications", "few systems to monitor and control the movement of ships in ice-covered waters" and "a lack of emergency response

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[3] For a detailed discussion on the mentioned issues, please consult: Brigham, Lawson W. (2010), "Think Again: The Arctic", *Foreign Policy*, September/October 2010.

capacity for saving lives and for pollution mitigation" except in "limited areas of the Arctic" (Ibid).

Other limiting factors posing challenges to Arctic shipping include jurisdictional disputes, shallow waters limiting ship size, harsh weather conditions, existence of free-floating ice making "navigation more difficult and schedules more variable," and "more expensive ship construction and operation costs [to] lessen the economic viability" of the routes (BF, 2014, p. 299). These factors also include high insurance premiums for Arctic shipping and increasing risk of accidents to pose an environmental hazard, such as oil spills (Heininen, Sergunin and Yarovoy, 2014, p. 67).

Against this background, the specifics of the NSR and the NWP, including the recent history of navigation through them and their potential significance for regional and global shipping for cargo and energy (oil and LNG) transportation, are discussed below.

### *The Northern Sea Route (NSR)*

Also known as the Russian Route as it passes through the Russian Arctic region, the NSR,[4] as an ice-free route, reduces maritime journeys between certain parts of the world significantly. For instance, it reduces a maritime journey between Russia's Port of Murmansk and Japan's Port of Kobe from 19,780 kilometers via the Suez Canal to 9672 kilometers and thus decreases the respective journey by about 19 days (*RIA Novosti*, 2014a; NWM, 2014). As well, it reduces that from the Netherlands' Port of Rotterdam to Kobe from 17652 kilometers to 12247 kilometers to shorten the journey by 10 days (Ibid).

The following Tables 4 and 5 provide additional examples for both cargo and oil/gas transportation via the NSR. It should be stressed that their provided distances are true "only if there is no ice. If there is any ice, the ships' speeds will be slow and negate any savings of time/distance" as "other factors such as shallow straits, and vagaries of weather such as long stretches of fog tend to diminish distance savings" (Brigham, 2015).

**Table 4: Distance/Time Reduction for Maritime Journeys by Cargo Ships via the Northern Sea Route**

| Journey From/To | Type of Load | From Length of Route via Suez Canal Kilometers* | To Length of Route via NSR Kilometers* | From/Days | To/Days |
|---|---|---|---|---|---|
| Murmansk-Yokohama | Cargo | 20,486 | 9253 | 39 | 18.5 |
| Murmansk-Shanghai | Cargo | 19,392 | 10,460 | 37 | 21 |
| Murmansk-Busan | Cargo | 19,955 | 9736 | 38 | 19.5 |

Source: Author's creation based on the data provided in: [New Wave Media (NWM) (2014), "The Arctic: Chart 1", *Maritime Reporter & Engineering News-Marine Propulsion Edition*, September 2014, http://magazines.marinelink.com/Magazines/MaritimeReporter/201409/page/38]
*Journey distances in miles in the source have been converted to kilometers by the author.

[4]For current information on shipping through the NSR, please consult: Ministry of Transport of Russian Federation (2015), *The Northern Sea Route Administration* website, http://asmp.morflot.ru/en/otkazu/

**Table 5: Distance/Time Reduction for Maritime Journeys by Oil/LNG Tankers via the Northern Sea Route**

| Journey From/to | Type of Load | From Length of Route via Suez Canal Kilometers* | To Length of Route via NSR Kilometers* | From/Days | To/Days |
|---|---|---|---|---|---|
| Murmansk-Kobe | Oil and Gas | 19780 | 9672 | 37.1 | 18.1 |
| Murmansk-Busan | Oil and Gas | 19740 | 9812 | 37 | 18.4 |
| Murmansk-Ningbo | Oil and Gas | 19067 | 10584 | 35.8 | 19.9 |
| Rotterdam-Kobe | Oil and Gas | 17652 | 12247 | 33.1 | 23 |
| Rotterdam-Busan | Oil and Gas | 17306 | 12387 | 32.5 | 23.2 |
| Rotterdam-Ningbo | Oil and Gas | 16634 | 13159 | 31.2 | 24.7 |

Source: Author's creation based on the data provided in: [New Wave Media (NWM) (2014), "The Arctic: Chart 1*", Maritime Reporter & Engineering News-Marine Propulsion Edition*, September 2014, http://magazines.marinelink.com/Magazines/MaritimeReporter/201409/page/38]
*Journey distances in miles in the source have been converted to kilometers by the author.

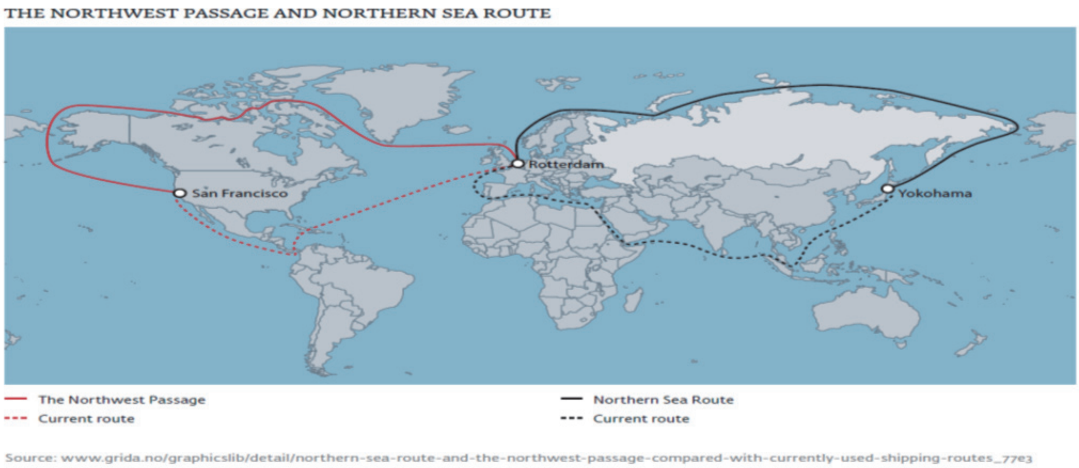
The first international commercial shipping through the NSR took place in 2009 when two German cargo ships escorted by a Russian icebreaker completed their journey across the NSR linking Busan in Korea to Rotterdam in the Netherlands with several stopovers (HU, 2015). Russia experienced four years (2010-2013) of increased use of the NSR by vessels going through it in transit between Europe and Asia to ship 1,355,897 tons of cargoes in 2013, but the volume of shipment decreased to 274,000 tons in 2014 (Pettersen, 2014b). As mentioned by Head of the Northern Sea Route Administration Alexander Olshevskiy, the reasons for this decline were related to fluctuations in the regional resources' development. Accordingly, added to a pricing issue for one using company, "Novatek is no longer shipping out gas condensate from Vitino on the Kola Peninsula but from Ust-Luga outside St. Petersburg" (Ibid). Hence, this statement corroborates the existence of a positive correlation between the Arctic natural resources' development and the usage and, thus, the volume of cargoes passing through the NSR, as identified by *Marine Shipping Assessment 2009 Report* and Professor Brigham as a major determinant for using the Arctic sea routes. In 2014, Russia was planning to increase the volume of goods passing through the NSR to 8-10 million tons a year within five years (*RIA Novosti,* 2014a).

In terms of oil and gas (LNG) exports via the NSR, the amount is still modest due to a host of reasons. They include the route's annual availability only for a short period of time, the small amount of available regional oil and gas for exports because of the limited development of their respective resources and the inadequacy of the existing ice-class tankers, icebreaking tankers or icebreakers escorting oil and LNG tankers for large-scale oil/LNG movement. All these issues are discussed in the following sections.

Russia has used the NSR for limited exports of fossil energy to mainly, but not exclusively, Northeast Asia, Europe and North America (Wilson Centre, 2013, p. 22). Thus, for example, the first Russian gas condensate shipment destined to Thailand from Murmansk was carried by a Russian vessel escorted by two Russian icebreakers in August 2011 (*The Economist*, 2012). This was followed by the first LNG shipment from Norway's Hammerfest to Japan's Tobata in December 2012 by a Greek LNG tanker chartered by a Russian company, supported by two Russian icebreakers (Gazprom, 2012). Apart from Russia, certain APEC economies have tested the route. Thus, China used the NSR for the first time in 2012 when its icebreaker *Xue Long* (Snow Dragon) navigated through it (Pourzitakis, 2014). Japan's Asahi Kasei Chemicals Corp performed a test run of the NSR by importing 80,000 tons of oil products from Norway in 2013 (Cima and Sticklor, 2014).

In general, apart from ice conditions, extensive shipping for cargo and oil and gas (LNG) exports demands expanding the required infrastructure along the route and/or its proximity, including upgrading the existing ports and building new ones. Currently, according to the Arctic Logistics Information Office, "16 ports, most of them ice-covered for part of the year, are located along the NSR" (Humpert and Raspotnik, 2012). Mindful of the NSR's existing infrastructural limits, the Russian government announced taking several measures in September 2011, including improving safety and communication along the NSR by building ten new bases for search, rescue and communication (Pettersen, 2014c). Thus, to deal with the NSR's emergencies requiring their respective infrastructure, the Russian Ministry of Civil Defence, Emergencies and Disaster Relief has planned to build additional Arctic centers. Of these, three (Arkhangelsk, Naryan-Mar and Dudinka) have been completed and the remaining ones are scheduled for completion by 2015 (Pettersen, 2014a).

**Map 2: The Northwest Passage (NWP) and the Northern Sea Route (NSR)**




Source: Map supplied courtesy of: [ Original map credit: www.grida.no/graphicslib/detail/northern-sea-route-and-the-northwest-passage-compared-with-currently-used-shipping-routes_77e3; Heininen, Lassi, Alexander Sergunin and Gleb Yarovoy (2014), *Russian Strategies in the Arctic: Avoiding a New Cold War*, Moscow: Valdai Discussion Club Grantees Report, September 2014, p. 68.]

### *The Northwest Passage (NWP)*

The NWP, also known as the Canadian route as it crosses Canada's Arctic region, could shorten continental maritime shipping distances substantially. In 2007, the NWP was ice-free and, thus, open for some weeks in the summer for the first time in recorded history (Humpert and Raspotnik, 2012), but it is still unknown how stable this opening will be in the future (HU, 2015). First international commercial cargo shipping in the NWP took place in 2013 (Paquette, 2014). Managed by Nordic Bulk Carriers A/S of Denmark, the bulk carrier Nordic Orion departed Vancouver in Canada with a load of metallurgical coal on 6 September 2013 and arrived in Finland's Port of Porion 3 October 2013 (Bryant, 2013). Supported by a Canadian Coast Guard icebreaker, the use of the NWP helped the vessel reduce the distance between Vancouver and Pori by 1600 kilometers (1000 miles) (McGarrity and Gloystein, 2013). Regarding oil and gas transportation via the NWP, Canada's Coast Guard records indicated that, as of January 2014, only four tankers since 1903 had made "full transits of the Northwest Passage, including one each in 2011 and 2012" (Weber, 2014). In April 2015, there is no publically-available report of any such transportation in 2014 and 2015.

Provided the availability and sustainability of an ice-free season as mentioned earlier, the NWP could facilitate intercontinental shipping for that period for cargo and also oil and LNG tankers. Yet, apart from the mentioned climatic condition and the shortage of ice-class vessels true also for the NSR, large-scale shipping through the route requires supportive infrastructure, which it currently lacks such as "adequate nautical charts, ports, search and rescue stations and icebreakers available to commercial ships" (Ibid).

Currently, extensive data on the comparative advantage of the NWP against the southern route in terms of maritime journeys' length is not available. However, reports suggest that, for certain maritime journeys, the NWP could significantly reduce the length. Broadly speaking, the maritime journey between East Asia and Western Europe would take about 13,600 kilometers using the NWP while taking 24,000 kilometers using the Panama Canal (HU, 2015). Specifically, the NWP would trim a voyage from Seattle to Rotterdam by 3200 kilometers, "making it nearly 25 percent shorter than the current route, via the Panama Canal" (Borerson, 2008). As well, whereas a trip from Tokyo to London would be about 23,000 kilometers via the Panama Canal and 21,000 kilometers via the Mediterranean Sea and the Suez Canal, it would be 16,000 kilometers via the NWP (Evans, 2012). Yet, as discussed in the case of the NSR, any time saving by using this route due to its shorter length compared to the currently-in-use alternative routes is subject to its being ice-free.

Despite its merits, the NWP, in comparison to the NSR, is more challenging and less suitable for large-scale inter-continental shipping in the foreseeable future for various reasons. They include the following:

> The Northwest Passage is far less developed than the NSR. …. Generally the ice conditions are more complicated than along [the] NSR, even if the passage has been reported ice free for brief periods in recent years. The [NWP's] routes that have the least depth limitations have the largest ice-problems. The NWP also has far less infrastructure than [the] NSR. In its outlook to 2020 [,] the Arctic Marine Shipping Assessment sees a fairly limited potential for regional use of [the] NWP (Moe Jensen, 2010, p. 4).

In short, when they are ice-free, the NSR and the NWP offer to mainly the APEC economies and the countries near their two ends shorter sea routes than the southern route via the Suez and Panama Canals and the Malacca Straits for movement of goods, including oil and gas (LNG). However, their mentioned challenges to increase the risks and costs of shipping will limit their use for international shipping. Thus, shipping will increase through them over time at a differing extent due to their mentioned specifics. Yet, the available evidence does not support their development into the substitutes for the routes currently in use for any commercial purpose, including oil and LNG exports.

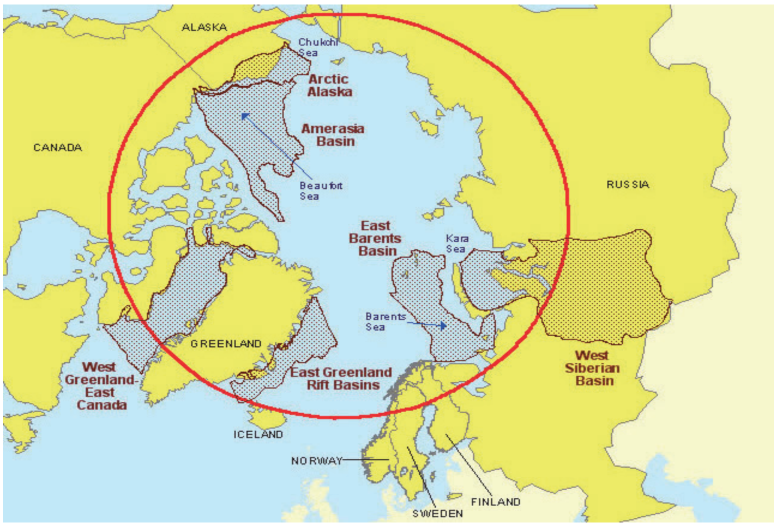
## 3. Energy Implications

### *The Arctic Oil and Gas Resources*

As supported by evidence, the ongoing melting of the Arctic sea ice, despite fluctuations, is not a short-term and therefore passing phenomenon, but a long-term trend caused by global warming. Hence, it will continue for as long as this phenomenon persists in absence of a major reduction in global GHG emissions. Provided the continuity of this situation, the mentioned melting has certain energy implications both for the global and regional energy markets, including the APEC one.

The Arctic region is rich in oil and gas of which a part has already been discovered and, to a varying extent depending on the case, developed. However, the melting of the Arctic sea ice may well unlock the vast oil and gas resources of the region known as the undiscovered ones. These partly onshore, but mainly offshore resources, are scattered unevenly among Canada, Greenland, Norway, Russia and the USA based on the current available information, including in their exclusive economic zones (EEZs), and, to a smaller extent, beyond their EEZs. While all the mentioned three APEC economies and two countries are rich in these resources to a differing extent, the "vast majority of the oil and gas is located in the West Siberian Basin, Alaska's Arctic and the East Barents Basin" (Hobson, 2013), as illustrated in the following map.

**Map 3: Resource Basins in the Arctic Circle Region**




Source: Map supplied courtesy of: [US Energy Information Administration (EIA), (2012), "Arctic Oil and Natural Gas Resources", *Today in Energy*, 20 January 2012, http://www.eia.gov/todayinenergy/detail.cfm?id=4650]

**Box 1**
**The Arctic Circle encompasses about 6 percent of the Earth's surface, an area of more than 21 million square kilometres of which almost 8 million square kilometers are onshore and more than 7 million square kilometers are on continental shelves under less than 500 meters of water. The extensive Arctic continental shelves may constitute the geographically largest unexplored prospective areas for petroleum remaining on earth (USGS, 2008).**

Oil and gas activities in the Arctic region are not a new phenomenon as onshore and offshore oil and gas exploration and/or production have been going on in the region for about a century. The status of such activities in the Arctic economies is summarized below.

### Canada

This economy conducted onshore oil exploration in the 1920s in the Northwest Territories part of which is within the Arctic Circle resulting in its oil discovery (The Wilson Centre, 2013, p. 5). It continued such exploration in the 1940s and 1950s above the Arctic Circle to include the Mackenzie Delta, the Arctic Islands and the Sverdrup Basin in the 1960s leading to its offshore oil and gas exploration in the Beaufort Sea in 1972 (Ibid). Oil and gas fields were found in these areas, for instance, in the Sverdrup Basin (15 gas fields and one oilfield) (Embry, 2012). The economy also drilled 176 wells in the oil/gas-rich Beaufort Sea, but the discovered reserves were insufficient to justify development and thus all the wells were plugged and abandoned" (Provan, 2012). Currently, there is no large-scale oil and gas production in the Canadian Arctic.

### Russia

Exploration activities in the Russian Arctic were started in the 1980s. They led to the discovery of the first offshore gas field in 1983 in the Barents Sea and the first offshore oil field in 1986 (The Wilson Centre, 2013, p. 17). Russia has since continued its exploration activities in its western Arctic waters, the Kara, Barents and Pechora Seas (Ibid). Today, it has a major operation in its Arctic region, namely on the Yamal Peninsula, which is especially significant in the case of gas. Hence, the discovered onshore and offshore oil and gas resources of the Yamal fields in Western Siberia include "11 gas and 15 oil, gas and condensate fields with approximately 16 tcm of explored and preliminary estimated gas reserves (ABC1+C2) and nearly 22 tcm of in-place and forecast gas reserves (C3+D3)" (Gazprom, 2015b).

### The USA

The economy's large-scale exploration in its Arctic began in 1968 when ARCO and Standard Oil drilled a well in the Prudhue Bay Field on Alaska' North Slope, the North America's largest oil field, and started exporting its oil through the Trans-Alaska Pipeline System to Valdez, Alaska in 1977 (The Wilson Centre, 2013, p. 4). Offshore explorations by various oil companies ending in 2012 resulted in finding oil fields, but they decided not to develop their respective fields due to their high production cost (Ibid). The ongoing oil production in the Alaska's North Slope is substantial equal to 10% of the economy's total annual oil production in 2013(Ibid, p. 7). However, there is currently no commercial-scale natural gas production in the American Arctic region, including Alaska.

### Greenland

As a self-governing region in Denmark aiming at full independence at an unspecified time in the future, Greenland started its efforts to discover oil and gas reserves in the 1970s, which has not yet led to a major discovery (The Wilson Centre, 2013, p. 9). As the most recent example, Cairn Energy Plc, a European company, found no substantial reserves in 2011 after spending about US$1 billion on its exploratory operation in Greenland's waters (Holter, 2013). Hence, today (2015), there is no oil and gas production in Greenland at all and no major related exploration activities although many licenses for oil and gas exploration in its waters have been issued (Casey, 2014).

### Norway

The Norwegians initiated geological surveys in their Arctic region in the 1970s followed by their exploration drillings in the 1980s leading to the discovery of gas reserves in their part of the Barents Sea in 1980s (The Wilson Centre, 2013, p. 17). However, the actual development of these fields, excluding one (Snøhvit), is yet to happen. The Snøhvit gas field's production started in 2007 (Statoil, 2013). Oil fields have also been found of which one will be operational in 2015, as will be discussed.

Briefly, over 400 oil and gas fields of which most are onshore have already been discovered north of the Arctic Circle, including some major ones, with gas and oil discoveries are concentrated mainly in Russia and North America, respectively (IAOGP, 2015). The discovered oil and gas reserves are quite substantial, that is 240 billion barrels of oil equivalent (BBOE) equal to 10% of the world's known conventional oil and gas reserves (USGS, 2008; IAOGP, 2015). Despite their significance, the operating oil and gas fields account for a fraction of the Arctic resources as the latter' bulk, which are mainly offshore, are yet to be discovered and subsequently developed (IAOGP, 2015). In particular, the majority of the offshore resources, especially deep sea ones, have remained untapped due to the region's hostile climatic situation.

The Arctic sea ice's melting is making the exploration of these resources, which have been inaccessible due to the ice condition now technically feasible. Of course, this feasibility is not without challenges and, therefore, such exploration is now easier, but not easy, in some parts of the region and more difficult in others. Briefly, various natural factors such as many days of total darkness (polar nights), the extreme cold temperature and continued ice coverage for most of the year of the areas containing the bulk of the Arctic undiscovered oil and gas resources (meaning, areas to the north of the Arctic circle) still challenge large-scale, commercially- viable oil and gas extraction in the Arctic region.

By and large, the exact size of these resources and their respective retrievable amounts are unknown and will remain so until actual drillings start. Yet, there are estimates on these resources based on the available evidence. Accepted widely as credible, the 2008 US Geological Survey (USGS) estimates the Arctic's undiscovered oil and gas resources to be about 413 BBOE in total consisting of 90 billion barrels of oil, 1669 trillion cubic feet of natural gas equal to 48.11 trillion cubic meters (tcm)[5] and 44 billion barrels of natural gas liquids (USGS, 2008).[6] These resources are estimated at 13% of the world's undiscovered conventional oil resources and 30% of its undiscovered conventional natural gas resources (Ibid). Being in addition to the already discovered oil and gas reserves, approximately 84% of the undiscovered resources are expected to be offshore (Ibid). Natural gas and natural gas

[5] The author has converted the mentioned figure in cubic feet to cubic meters.
[6]The source's provided figure for the total regional petroleum reserves is 412,157.09 million barrels of oil equivalent, which has been round up to 413 BBOE by the author.

liquids (NGL) account for the bulk of the total regional undiscovered oil and gas resources, as the share of oil of the latter is about 22% leaving the share of about 78% (322 BBOE) for natural gas and NGL (Lindholt and Glomsrod, 2011, p. 7).

In terms of their geographical distribution, more than 70% of the undiscovered oil resources are estimated to be in Arctic Alaska, Amerasia Basin, East Greenland Rift Basins, East Barents Basins and West Greenland-East Canada (USGS, 2008). More than 70% of the undiscovered natural gas resources are estimated to be in the West Siberian Basin, the East Barents Basins and Arctic Alaska (Ibid).The regional distribution of the undiscovered oil and gas resources has been estimated by Statistics Norway as follows. The bulk of these resources are in Russia followed by the USA, Greenland, Canada and Norway, as evident in the following estimates (Tables 6 and 7).

**Table 6: Shares of the Arctic APEC Economies and Countries of the Arctic's Undiscovered Oil Resources, including NGL**

| Arctic Economies and Countries | Share of Total Undiscovered Oil Resources, Including NGL % | Share of Offshore Resources of Total Undiscovered Oil Resources % |
|---|---|---|
| Russia | 41 | 70 |
| USA (Alaska) | 28 | 50 |
| Greenland | 18 | 100 |
| Canada | 9 | >80 |
| Norway | 4 | 100 |

Source: Author's creation based on the data provided in: [Lindholt, Lars and Solveig Glomsrod (2011), *Discussion Papers No. 645*, Statistics Norway, Research Department, February 2011, pp. 6, 7, http://www.ssb.no/a/publikasjoner/pdf/DP/dp645.pdf]

**Table 7: Shares of the Arctic APEC Economies and Countries of the Arctic's Undiscovered Gas Resources**

| Arctic Economies and Countries | Share of Total Undiscovered Gas Resources % | Share of Offshore Resources of Total Undiscovered Gas Resources % |
|---|---|---|
| Russia | 70 | 90 |
| USA (Alaska) | 14 | 50 |
| Greenland | 8 | 100 |
| Canada | 4 | >80 |
| Norway | 4 | 100 |

**Source:** Author's creation based on the data provided in: [Lindholt, Lars and Solveig Glomsrod (2011), *Discussion Papers No. 645*, Statistics Norway, Research Department, February 2011, pp. 7, 8, http://www.ssb.no/a/publikasjoner/pdf/DP/dp645.pdf]

As evident in the above tables, the bulk of the Arctic's undiscovered oil and gas resources are offshore to make their extraction more technologically difficult and, consequently, more expensive than those of onshore ones.

Of course, all these figures are estimates based on the best available evidence and, thus, the recoverable amounts of the undiscovered resources may be proven to be higher or lower once the actual drilling starts. Hence, there is uncertainty about the Arctic undiscovered oil and gas resources as a substantial share of them are under seabed and that the estimates are on the total resources, but not on their recoverable portion. Consequently, extensive geological tests and, ultimately, drilling are needed to determine the actual size of these resources and their recoverable volume.

## C. The Significance of the Arctic Undiscovered Oil and Gas Resources for the Global and APEC Energy Markets

The Arctic region's undiscovered oil and gas resources are substantial. Yet, the region's global role as an oil and gas supplier depends on various factors, particularly, their recoverable volume requiring the above-mentioned exploration activities.

As will be discussed, development of some of these resources, especially, the offshore ones, may well be challenging both technologically and financially, if not impossible in cases, in the foreseeable future due to certain factors. They include short drilling season in the Arctic region; harsh working condition (such as extreme cold and movement of ice) despite the ongoing melting of the Arctic sea ice; absence of the required regional infrastructure to provide services to operating oil/gas companies and deal with emergencies; shortages and/or absence of Arctic-suitable (ice-class) equipment (such as drilling rigs) and support vessels, floating LNG liquefaction plants and means of exports (oil and LNG tankers); and absence of the adequate number oil/gas emergency response equipment/vessels to prevent environmental disasters, contain blowouts, explosions and spills and conduct clean-up operations.

**Map 4: The Arctic Region**


**Source:** Map supplied courtesy of: [The Perry-Castañeda Library Map Collection and National Snow and Ice Data Center (2015), "What is the Arctic", *All About Arctic Climatology and Meteorology*, Boulder, Colorado, USA. https://nsidc.org/cryosphere/arctic-meteorology/arctic.html]

In short, the actual amount of recoverable oil and gas, the scale of its sustainable production and the availability of the means for its exports will determine the significance of the regional undiscovered oil and gas resources for the global energy markets and, in particular, the APEC one. Consequently, the latter will determine the Arctic region's role as an oil and gas supplier. In particular, it will determine whether the Arctic region can emerge as a small- or large-scale short-term, medium-term or long-term supplier capable of meeting a part of the global needs, including that of the APEC economy, in a sustainable manner. Or, alternatively, whether it can replace other oil/gas-supplying regions for any period of time, especially the Middle East on which many global energy-importers, especially the APEC ones, are heavily dependent for a large portion of their energy requirements. This region's conflict-prone nature has prompted these energy-importers to consider alternatives for the bulk or a part of their imports to end or reduce their heavy dependency on the Middle Eastern suppliers, or at least some of them with unstable and/or unpredictable situations.

However, given the vast proven oil and gas reserves of the Middle East, which enables it to outlive all other oil/gas-producing regions, no single region can possibly be considered as a long-term replacement for it. In consequence, at best, any other region, including the Arctic, can function as a supplier to decrease dependency on Middle Eastern supplies and, therefore, reduce the vulnerability of the mentioned importers to Middle Eastern political/security fluctuations. The role of the Arctic region as a supplying region should be assessed within this framework.

Having said that, provided the bulk of the estimated Arctic region's undiscovered oil resources is extractable at a financially-and environmentally-viable commercial scale, its oil resources (90 billion barrels) are substantial, but way below all the existing oil exporting regions excluding those of the Asia Pacific region, as evident in Table 8.

**Table 8: The Energy Exporting Regions' Proven Oil Reserves (2013) and the Arctic Region's Undiscovered Oil Resources**

| Energy Exporting Regions | Proven Oil Reserves 2013 Billion Barrels | Share of Total Global Proven Oil Reserves % | Daily Production Thousand Barrels | Share of Total Global Production % |
|---|---|---|---|---|
| Middle East | 808.5 | 47.9 | 28,358 | 32.2 |
| Central and South America | 329.6 | 19.5 | 7,293 | 9.1 |
| North America | 229.6 | 13.6 | 16,826 | 18.9 |
| Europe and Eurasia | 147.8 | 8.8 | 17,226 | 20.2 |
| Africa | 130.3 | 7.7 | 8,818 | 10.1 |
| Asia Pacific | 42.1 | 2.5 | 8,232 | 9.5 |
| Arctic | Estimated Undiscovered Oil Resources 2013 | Share of Total Global Undiscovered Oil Resources | | |
| | 90 | 13 | N/A | N/A |

**Source:** Author's creation based on the data in: [BP (2014), *BP Statistical Review of World Energy 2014*, pp. 6, 8, 18, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf; US Department of Interior-US Geological Survey (2008), *Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle*, http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf; US Energy Information Administration (EIA), (2012), "Arctic Oil and Natural Gas Resources", *Today in Energy*, 20 January 2012, http://www.eia.gov/todayinenergy/detail.cfm?id=4650]

These resources are not large enough to secure the region a long-term, large-scale exporting status to replace other regions, particularly the Middle East. Nevertheless, they could enable it to play a role as a supplier of regional or global significance, depending on its sustainable oil export capability, provided its oil can be exported at competitive prices. This requires keeping its cost of production low in the range of those of other suppliers operating in less production-challenging regions.

Today, it is very difficult to project such capability in absence of statistics on the recoverable volume of the Arctic region's undiscovered oil resources and the actual amount of their future production. Yet, provided the estimate on these resources are correct and a large portion of them are recoverable, it could be a significant player in the energy markets to meet a part of needs of the oil-importers in the Arctic region's proximity, including the East Asian APEC economies (China; Hong Kong, China; Japan; Korea and Chinese Taipei). In such case, the region could help, as a factor, to ensure the availability of additional supplies in case of shortages and, thereby, possibly help prevent sharp oil prices hikes caused by supply shortages.

The region's undiscovered gas resources are much larger than all the existing gas exporting regions except the Middle East and Europe and Eurasia, as reflected in Table 9.

**Table 9: The Energy Exporting Regions' Proven Gas Reserves (2013) and the Arctic Region's Undiscovered Gas Resources**

| Energy Exporting Regions | Proven Natural Gas Reserves 2013 Trillion Cubic Meters* | Share of Total Global Proven Gas Reserves % | Production Billion Cubic Meters | Share of Total Global Production % |
|---|---|---|---|---|
| Middle East | 80.3 | 43.2 | 568.2 | 16.8 |
| Central and South America | 7.7 | 4.1 | 176.4 | 5.2 |
| North America | 11.7 | 6.3 | 899.1 | 26.9 |
| Europe and Eurasia | 56.6 | 30.5 | 1032.9 | 30.6 |
| Africa | 14.2 | 7.6 | 204.3 | 6.0 |
| Asia Pacific | 15.2 | 8.2 | 489.0 | 14.5 |
| Arctic | Estimated Undiscovered Natural Gas Resources 2013 | Share of Total Global Undiscovered Natural Gas Resources | | |
| | 48.11 | 30 | | |

Source: Author's creation based on the data in: [BP (2014), *BP Statistical Review of World Energy 2014*, pp. 20, 22, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf; US Department of Interior-US Geological Survey (2008), *Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle*, http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf; US Energy Information Administration (EIA), (2012), "Arctic Oil and Natural Gas Resources", *Today in Energy*, 20 January 2012, http://www.eia.gov/todayinenergy/detail.cfm?id=4650]
*The author has converted USGS's provided figure for gas in trillion cubic feet (1,670) into trillion cubic meters.]

Given this reality, the Arctic region could turn into a major large-scale and long-term gas-exporting region under at least two conditions. One is the feasibility of the large-scale development of the regional undiscovered gas resources. These are mainly offshore and in the frozen areas most of the year and, therefore, are more technologically and financially challenging for development than other regions' gas fields, including offshore ones, are. Another is the practicality of large-scale LNG production and export of the regional gas in that form at competitive prices as piped exports cannot be an option for, at least, the majority of the Arctic offshore gas resources because of their deep sea locations, among other factors.

Provided these conditions were realized, the Arctic region could affect the global LNG markets positively by ensuring the abundance of LNG and thereby contributing, as one factor, to its price stability, especially in its main markets. However, apart from the difficulty of securing technological and environment sustainability of large-scale gas production in the Arctic region, the Arctic region's achieving the mentioned role demands its producing its LNG at a cost, low enough to make it price-wise competitive with that of other supplying regions operating under much easier and less costly working conditions. Achieving this objective may well be proven difficult given the previously-stated challenges.

Briefly, drawing on the above-mentioned unknowns and challenges, it seems that the region will not likely be a game changer in the global energy markets for a certain reason. It cannot develop itself in the foreseeable future as a supplier on a par with the Middle East capable of affecting, at a significant scale, the global availability and pricing of oil and gas supplies.

### Major Stakeholders and Players

Provided their development is sustainable, the major stakeholders and players of the Arctic undiscovered oil and gas resources are the three Arctic APEC economies, Greenland and Norway for which these resources have a differing significance. To be discussed in the following section, this significance depends on their access to other oil and gas resources in their territories, whether they can or cannot meet their oil and gas needs with these resources and for how along and whether they can generate a significant amount of revenue through exporting their Arctic oil and gas. Furthermore, the major oil/gas-importers, APEC and non-APEC ones, alike, are all the potential beneficiaries of the Arctic undiscovered resources. Subject to the sustainable volume of the Arctic region's oil and gas exports, such resources could meet a varying degree of their energy requirements from an additional supplying region with supplying routes different from the existing ones. These factors could improve their energy security to the extent affected by the availability and accessibility of Arctic supplies. Of these oil and gas importers, those, which are close or relatively close to the region and depend for the bulk of their imports on the suppliers from far regions (namely, Africa, South America and Middle East) could further benefit by having a supplier in their close proximity. This would decrease the time of delivery of part of their imports and, possibly, its cost, if Arctic oil and gas prices were competitive for such purpose. In this regard, the East Asian APEC economies (China; Hong Kong, China; Japan; Korea and Chinese Taipei), which heavily rely on imports for a large and growing part of their oil and gas requirements, could especially benefit from the Arctic oil and gas resources. Beyond the APEC region, the Arctic region could potentially be a significant supplier provided its having a large amount of supplies beyond the needs of its own economies and those of the mentioned ones.

In conclusion, extensive production of the Arctic's oil and gas, if becomes a reality, will expand the global supply of these fuels and increase the availability of such supplies to the APEC economies depending on petroleum imports. In such case, it will decrease the APEC economies' dependency on Middle Eastern oil and gas to the extent permitted by the volumes of the Arctic-supplied oil and gas (LNG) and their sustainable availability to the APEC economies. Potentially, Arctic supplies could also help stabilize oil and gas (LNG) prices by helping prevent their drastic price hikes caused by supply shortages.

# III. Opportunities and Challenges

When it comes to oil and gas, the melting of the Arctic sea ice is bringing about certain opportunities of significance to all the economies depending on such fuels' imports, including the APEC ones. This development is also creating certain challenges. The following is a summary of the major opportunities and challenges.

## A-Opportunities

The melting of the Arctic sea ice is certainly a reason for concern for everyone as it is a blatant example of the destructive nature of global warming affecting the survival of planet earth. Yet, this development could potentially offer certain energy opportunities. To the extent falling within the framework of this study, chief among them is its potential contribution to the APEC region's energy security by availing additional oil and gas supplies from the Arctic region. Of course, this is subject to the feasibility of the extraction of the bulk of the regional undiscovered oil and gas resources. Due to their size as discussed earlier, these resources, once commercially available, could certainly avail a large amount of oil and gas to APEC's oil/gas-importing economies. However, as it will be discussed shortly, such availability is not guaranteed at this stage and also in the near future if the current trend continues, as the bulk of the undiscovered Arctic oil and gas resources are offshore, particularly deep-sea ones. Their extraction are challenging technologically, financially and environmentally while their transportation to the energy markets will not be easy because of their locations to remove pipelines as an option in, at least, most cases.

### 1-Availability

The availability of Arctic undiscovered oil and gas resources depends on the urgency of their development for the Arctic region's three APEC economies, Greenland and Norway. This is determined by the status of their oil and gas industries and, therefore, how soon they need their Arctic resources to meet their domestic energy and/or export requirements.

#### *Canada*

This economy has substantial proven conventional and unconventional oil and gas reserves in its non-Arctic territories. Based on the 2013 statistics, Canada's oil reserves are 174.3 billion barrels and its gas reserves are 2 tcm (BP, 2014, pp. 6, 20). Their development is less challenging and thus easier and cheaper than those of its undiscovered Arctic resources although the latter will substantially increase its overall petroleum resources. Canada has experienced a significant increase in its oil production from 3,003,000 barrels per day (B/D) in 2003 to 3,948,000 B/D in 2013 (Ibid, p. 8). Its oil consumption (2,385,000 B/D, 2013) is way below its production while such production will significantly increase because of the economy's oil sand development (Ibid, p. 9).

Canada has experienced a reduction in its gas production, from 184.7 billion cubic meters (bcm) in 2003 to 154.8 bcm in 2013 (Ibid, p. 22). Yet, the economy is not facing any gas shortage as evident in its 2013 consumption (103.5 bcm), which was way below its production (Ibid, p. 23). Canada is now focusing on developing its unconventional gas reserves, which will increase its gas production in the near future to make embarking on gas projects in its Arctic part not an urgent necessity.

### *Russia*

Tapping on its undiscovered Arctic oil and gas resources is not an absolute necessity for this economy in the near future. Although its oil and gas reserves in less remote and temperate areas are declining, the Russian non-Arctic oil (93 billion barrels, 2013) and gas (31.3 tcm, 2013) reserves are still large enough to secure adequate production of oil (10,788,000 B/D, 2013) and gas (604.8 bcm, 2013) to meet their respective domestic consumptions (3,313,000 B/D, 2013; 413.5 bcm, 2013) and leave significant amounts for exports (Ibid, pp. 8, 9, 20, 22). Russia still has large undeveloped proven oil and gas reserves in its non-Arctic areas such as in Eastern Siberia.

### *The USA*

This economy has vast proven conventional and unconventional oil and gas reserves outside its Arctic part. Respectively, its proven oil and gas reserves are 44.2 billion barrels and 9.3 tcm, according to 2013 statistics (Ibid, pp. 6, 20) whose development is much easier and cheaper compared to that of its undiscovered Arctic resources. Needless to say, these resources will surely add significantly to the economy's total oil and gas resources. The American oil production phenomenally rose from 7,362,000 B/D in 2003 to 10,003,000 B/D in 2013 (Ibid, p. 8).

Although the American oil consumption, 18,887,000 B/D in 2013 (Ibid), is way above its production to make the economy import oil, its access to a large number of oil suppliers, including its neighbouring Canada, and the economy's developing its unconventional oil reserves (shale oil) have decreased the urgency of developing its undiscovered Arctic oil resources. The American gas production has also been increasing, from 540.8 bcm in 2003 to 687.6 bcm in 2013, even though its production is still significantly lower than its consumption (737.2 bcm, 2013) (Ibid, pp. 22, 23). Yet, its gas production has phenomenally increased thanks to its developing its unconventional gas reserves (mainly shale gas, but also coal-bed-methane). These reserves' production will soon help it reach self-sufficiency in gas to end its gas imports while it could even lead to gas production in excess of its needs to be exported as LNG. This development has removed urgency from developing its Arctic undiscovered gas resources.

### *Greenland*

For Greenland, development of its undiscovered Arctic resources is extremely important as it currently has no oil and gas production. As a self-governing region within Denmark, it receives funds from the Danish government necessary for its operation. Yet, given Greenland aims at independence from Denmark, generating sustainable income to replace the mentioned funds is one of the major necessities for achieving its objective for which the major available resources are its untapped Arctic oil and gas ones.

### *Norway*

This country has been experiencing a steady decline in its oil reserves located in the North Sea and the Norwegian Sea (from 9.6 billion barrels in 2003 to 8.7 billion barrels in 2013) (Ibid, p. 6) to lower its oil outputs from 3,264,000 B/D in 2003 to 1,837,000 B/D in 2013 (Ibid, p. 8). Despite this decline, meeting its domestic needs in the foreseeable future is not a concern as its oil production is still much larger than its consumption, being 241,000B/D in 2013 (Ibid, p. 9).However, tapping on its Arctic undiscovered oil resources is a necessity to ensure Norway's ability to remain a major oil player in the global energy markets in the next few decades by increasing its oil exports now significantly lower than it was in 2003. Export-generated oil revenue is very important for its economy as "crude oil, natural gas, and pipeline transport services accounted for 52% of Norway's exports revenues, 23% of gross domestic product (GDP), and 30% of government revenues" in 2012 (EIA, 2014). Yet, its gas production (108.7 bcm/2013), which is much larger than its consumption (4.4 bcm/2013) leaves a huge amount of gas for exports (BP, 2014, pp. 22, 23). Consequently, urgently developing its Arctic undiscovered gas resources is not a necessity, but Norway needs to increase its gas assets to secure its role in the global gas markets due to the relatively small size of its current gas reserves, that is 2 tcm in 2013 (BP, 2014, p. 20).

## 2- Plans and Projects

Despite the mentioned differences in their oil and gas situations, all the five Arctic economies and countries have plans for developing their undiscovered Arctic resources, of course, to a varying extent and at a differing pace as summarized below. Yet, it should be added that, generally speaking, the global lowering of oil and gas prices since late 2014 has negatively affected their implementation by making expensive Arctic projects unattractive to cause cancellations or postponements of many projects up to this date (April 2015). As a major contributing factor, the slowdown in the implementation of Arctic oil and gas projects will likely last for as long as the lowering prices continue.

### *Canada*

Canada has no ongoing exploration activities in its Arctic region, but that may change as it has issued licenses for offshore exploration (The Wilson Centre, 2013, p. 9) and is considering other requests in this regard. Of these, some may not become a reality as the involved energy corporations have changed their minds due to various reasons, particularly, financial ones, especially due to the lowering oil and gas prices. For instance, Chevron Canada Ltd, which had requested licensing for drilling in Canada's part of the Beaufort Sea (McCarthy, 2014), "indefinitely" suspended its drilling plan in December 2014 (Strong, 2014).

However, other oil/gas exploration projects, which may be implemented, will not likely start before the end of this decade. For example, Canada's Imperial Oil, with ExxonMobil and BP

Canada as joint-venture partners, applied for regulatory approval to explore in the Canadian sector of the Beaufort Sea in late 2013. It is a significant proposed project as it involves drilling in that sea's deep waters, "waters far deeper than those of previous drilling attempts in the region" (WWF, 2014). As stated by Imperial Oil spokesperson Pius Rolheiser, "assuming approvals are granted an investment decision could be made in 2016 and drilling could start on one or more exploration wells in summer 2020 (Platts, 2013). Even if the mentioned projects and others actually start by the end of this decade and they are successful in terms of finding oil and gas reserves, which can be developed commercially, their actual production and export will logically happen many years after it. This is due to certain barriers such as the short drilling season in the Arctic for climatic reasons (about three months a year) to require a few seasons and consequently years for drilling of wells to reach oil and gas and a shortage of ice-class equipment/vessels needed for their respective production and exports.

### *Russia*

Russia has taken steps to explore its untapped Arctic region. Towards this end, reportedly, the economy has plans for self-exploration for which it will spend nearly US$40 billion over time (The Wilson Centre, 2013, p. 19). Russia's major ongoing Arctic project is on the Yamal Peninsula, as mentioned earlier. Known as the Yamal Megaproject, the ongoing development project run by Gazprom is especially important because of the peninsula's vast gas reserves. Nevertheless, it also involves major oil development projects. In fact, in February 2015, Gazprom Neft made its first winter shipment of oil from the Yamal Peninsula's Novoportovskoye field as it shipped 16,000 tons of crude oil to its European consumers "by oil tanker, escorted by an atomic icebreaker" (*Frontier Energy*, 2015a). It has planned to export over 50,000 tons of oil during the current winter delivery period finishing in May 2015 (ibid). Currently, Russia has one operating offshore oil-producing field in the Arctic, the Prirazlomnoye, located in the Pechora Sea at the water depth of 19 to 20 meters, whose production started in December 2013 (Gazprom, 2015a). Operated by Gazprom Neft, the field reached its targeted production of 300,000 tons in 2014 (Staalesen, 2015).

The economy started exploring the deep-sea resources of its Arctic part in 2014. As part of a joint venture between Rosneft and ExxonMobil, it discovered significant hydrocarbon reserves in the Kara Sea's Universitetskaya-1 well amounting to 338 million cubic meters of gas and 100 million tons of oil, according to the preliminary assessments (*Sputnik*, 2014). Due to ExxonMobil's opting out of the project, the project is not operational now. According to a quoted Rosneft source, the company "planned to resume drilling in 2016 but that commercial production would now be pushed back to beyond 2020" (Pinchuk and Golubkova, 2015).

Based on the current evidence, Russia will likely increase its Arctic offshore operation whose extent, speed and timing will be determined by certain factors. They include the availability of markets for its oil and gas projects, their technological feasibility especially for deep sea-projects, the existence of suitable global oil and gas prices to make its projects financially feasible and profitable and the plausibility of its projects as it still has vast onshore proven reserves whose development are much easier technologically and much cheaper. Other major factors include the previously-mentioned lowering especially oil, but also gas prices to remove justifications for very costly Arctic offshore projects. In this regard, the possibility of the realization of the American and Canadian plans for LNG exports to help further lower LNG prices will also be a determining factor.

### *The USA*

The economy started exploring its Arctic undiscovered oil and gas resources in 2012 as Shell conducted drilling in the Chukchi Sea. Facing environmental opposition delaying its exploration from its planned 2010 to 2012, the undertaking faced various technical and environmental problems and did not result in any discovery; as a result, Shell ended its operation in 2013 (Fong, 2014). Shell affiliates were subsequently fined US$1.1 million by the US Environmental Protection Agency for environmental violations while drilling for their emitting too many pollutants into the air (Demer, 2013). Such violations involved the "Noble Discoverer drilling ship's work in the Chukchi Sea" and the "Shell-owned Kulluk drilling rig in the Beaufort Sea" (Ibid).

As announced by the US Department of Justice on 8 December 2014, "Shell's drilling contractor, Noble Drilling (U.S.) LLC, was charged with "environmental and maritime crimes for operating the drill ship Noble Discoverer and the drilling unit Kulluk in violation of federal law in Alaska in 2012" (Department of Justice, 2014). The drilling company subsequently agreed to plead guilty to environmental and maritime crimes on eight felony offenses as part of a plea agreement with the prosecutor requiring it to "pay $12.2 million in fines and community service payments, [and] implement a comprehensive Environmental Compliance Plan" while being placed on probation for four years (Ibid).

Yet, Shell is now planning to restart its exploratory activities in the summer of 2015 as the company submitted to the US federal regulators a broad drilling blueprint in August 2014 that laid out its plans for drilling new exploratory oil wells in the Chukchi Sea (Dlouhy, 2014a). In March 2015, Shell received the go-ahead from the US government to restart its operation there (Critchlow, 2015).

Some other drilling projects due in 2014 were cancelled such as ConocoPhillips's one in the Chukchi Sea off Alaska due to "U.S. regulatory uncertainty" (Rosen, 2013). Moreover, Statoil has postponed its plans to drill in the Arctic waters north of Alaska until 2015 at the earliest (Dlouhy, 2014b). In short, there will not be many projects to begin in this decade.

Therefore, evidence suggests that certain factors will likely delay the large-scale development of the American Arctic undiscovered oil and gas resources by creating disincentives for the interested corporations and/or limit their operations. They include the required environmental standards for drilling to make oil and gas exploration and production more difficult and costly in the Arctic region than they are in other regions. Public opposition to such activities due to environmental concerns and high cost of operation in the Arctic for the mentioned reason and others, such as the region's short drilling season and harsh operational conditions due to its climate, are other disincentives. Growing availability of locally-produced oil and gas in the US thanks to the phenomenal increase in the American non-Arctic oil and gas production (especially unconventional ones) and low oil and gas prices, especially gas ones, and their likely further lowering constitute additional disincentives. To this list, it should be added the predictable American gas self-sufficiency and the economy's possible gas production beyond that in a few years. In consequence, the interested corporations' planned or envisioned future Arctic oil and gas production will be more expensive than such production will be in other parts of the USA and thus not competitive. The ongoing global falling oil prices to make imported oil more attractive than before, if it continues, will further detract from the wisdom of developing the US undiscovered Arctic oil and gas resources at a large-scale.

### *Greenland*

Greenland has recently conducted some exploratory activities without resulting in any oil or gas discovery, including by Cairn Energy in 2011 (The Wilson Centre, 2013, p.9). Yet, it is still aiming at further exploration for which it has started a new round of licensing since 2011 resulting in issuing licenses to many foreign corporations. For instance, in October 2012 Greenland's government approved an agreement with Maersk Oil for Tullow Oil Plc to take a non-operated 40% equity position in Block 9 (Tooq Licence) located in Baffin Bay, north-western Greenland (Tullow Oil Plc, 2014a). Maersk Oil will continue to act as operator of the licence with a 47.5% interest and Nunaoil, Greenland's state oil company, will hold a 12.5% interest in "this unexplored and highly prospective province" (Ibid). Reportedly, Tullow Oil Plc and its joint venture partners will decide whether to drill an exploration well "only if Tullow is satisfied that all necessary technical, financial, environmental, safety and social standards and criteria have been reached" (Ibid). In 2013, Greenland's Bureau of Minerals and Petroleum awarded to three consortia of companies the first four oil and gas exploration and exploitation licenses for eastern Greenland located in the North and South Danmarkshavn basins, namely, Avinngaq (Statoil, ConocoPhilips and Nunaoil), Amaroq (ENI, BP, DONG and Nunaoil) and Umimmak and Nerleq (Chevron, GreenPex, Shell and Nunaoil) (Casey, 2014). It also licensed a joint venture of Chevron, Shell and JX Nippon Oil and Gas Exploration Corporation in 2013 (*World Oil News Center*, 2013).

However, there is no certainty as to these licenses will lead to actual exploration and exploitation activities. Various factors make such activities difficult and costly, including Greenland's oil and gas resources' remoteness, lack of the required support infrastructure for oil and gas operations to necessitate large investments and harsh ice condition covering its offshore licensed areas (Casey, 2014). Added to this, the mentioned lowering oil and gas prices have motivated many of the above-mentioned corporations to change their minds about operating in Greenland or delay their projects. Added to the closure of Cairn energy's office in Greenland after its investing "billions in fruitless wildcatting in these frontier waters," Statoil, GDF Suez and Dong Energy "have ended their projects there while Shell, Maersk and Cairn Energy have sought two-year extensions before committing to further expensive exploration" (*Frontier Energy*, 2015b).

In consequence, as it stands, Greenland is way behind other regional economies when it comes to its Arctic oil and gas resources and the prospect for a major change in this regard is simply unknown at this time (April 2015). This is due to Greenland's financial and technological inability to embark on oil and gas exploration and production projects on its own and the cautious approach of foreign corporations to such projects.

### *Norway*

The situation is different for Norway whose non-Arctic oil and gas reserves have been either depleting rapidly to affect their production and/or not large enough to secure its future needs as a global oil and gas exporter, as mentioned earlier. Hence, developing its Arctic resources is important for the Norwegians. Given the necessity of large-scale oil and gas production in its Arctic region in the near future, Norway's respective explorations have received momentum especially since 2010. The outstanding Norwegian discoveries have been two major oil reserves in the Barents Sea in September 2013, one by the OMV with an estimated reserve of 60-160 million barrels of oil and 10-40 bcm of gas at the Wisting Central Well and another by the Lundin, that is, its finding of a 75 meter oil column at the Gohta prospect (Staalesen, 2013). The latter's estimated reserves of hydrocarbons are 111-232 million barrels of oil equivalent (Lundin Petroleum, 2014). The major finds in 2014 include one by Tullow Oil Plc, which announced finding an oil reserves in July, namely Hanseen with the estimated reserve of up to 50 million barrels of recoverable oil (Tullow Oil Plc, 2014b). As well, in August 2014 Norway's Statoil and Russia's OAO Rosneft commenced their joint exploration in the Barents Sea's Pingvin License PL713 (*Natural Gas Europe*, 2014).

Exploratory activities aside, Norway has taken measures to develop some of its older offshore Arctic discoveries. They include one gas filed (Snøhvit) in the Barents Sea in operation since 2007 by Statoil (Statoil, 2013) and an oil field (Goliat) in the same sea, which was found in 2000 by Eni Norge in joint venture with Statoil to become operational in 2015 (NPD, 2014).

Briefly, comparatively, Norway is the only Arctic energy player with extensive exploration and significant production activities in its share of the Arctic undiscovered oil and gas resources. However, like its other Arctic neighbours, the lowering oil and gas prices are forcing Norway to delay its planned projects. Indeed, Eldar Saetre, the chief executive officer of Statoil, Norway's biggest energy corporation, indicated that Statoil would unlikely drill in the Norwegian Arctic in 2015 (Milne, Adams and Crooks, 2015). He also raised the possibility of delaying a major project in the Barents Sea, the huge Johan Castberg oil field, which he described as "a costly initiative because of the Arctic's hostile conditions and lack of infrastructure" (Adams and Aglionby, 2015).

### *Other Arctic Countries*

It should be added that the bulk of the Arctic's undiscovered oil and gas resources are expected to be found within the territories of Canada, Russia, the USA, Greenland and Norway, including their EEZs. Up to this date, the remaining three Arctic countries (Finland, Iceland and Sweden) have not been engaged in major oil/gas exploratory operation and have not found any significant oil and gas resources. Within this context, Iceland is the only country, which has started limited activities towards this end by issuing a few licenses, which are yet to be translated into actual drilling activities. Of these, one license, issued in January 2014 of relevance to the APEC region, is a joint venture in which China's CNOOC holds a 60% majority stake in partnership with Eykon Energy and Petoro Iceland AS (Yao, 2014). Up to this date, there is no report on the actual drilling by the latter.

In conclusion, based on the ongoing activities and known future ones, at the commercial-scale, the bulk of the undiscovered oil and gas resources of the Arctic region will not be available in the near future. Perhaps, some of them (in the case of Canada and the USA) will be available after 2025 based on some projections (The Wilson Centre, 2013, p. 6). However, such prospect is subject to the availability of the following to the interested corporations. Added to high enough global oil and gas prices to justify expensive Arctic oil and gas exploration and production operations, they include adequate funds, supportive regulatory framework, ice-class rigs and support vessels and suitable means of oil and gas transportation. To these, it should be added the mentioned corporation's ability to meet the environmental standards of the Arctic APEC economies as well those of Greenland and Norway. In itself, inability to meet these standards (for their further increasing the already-high operational cost in the Arctic region) and concerns about extensive environmental damages in case of accidents and the subsequent phenomenal cost of the required clean up could form a major disincentive for many interested corporations.

## 3-Potential Impact of the Arctic Oil and Gas Supplies on the APEC Economies' Energy Security

Large-scale production of the Arctic region's currently-undiscovered oil and gas resources could improve the APEC economies' energy security in the following manners provided the long-term sustainability of such production.

### *Supply Availability*

Arctic oil and gas supplies would be an addition to such supplies already available to the APEC economies. As a factor, the additional supplies would help ensure their supply security especially in the case of supply interruptions from their other suppliers.

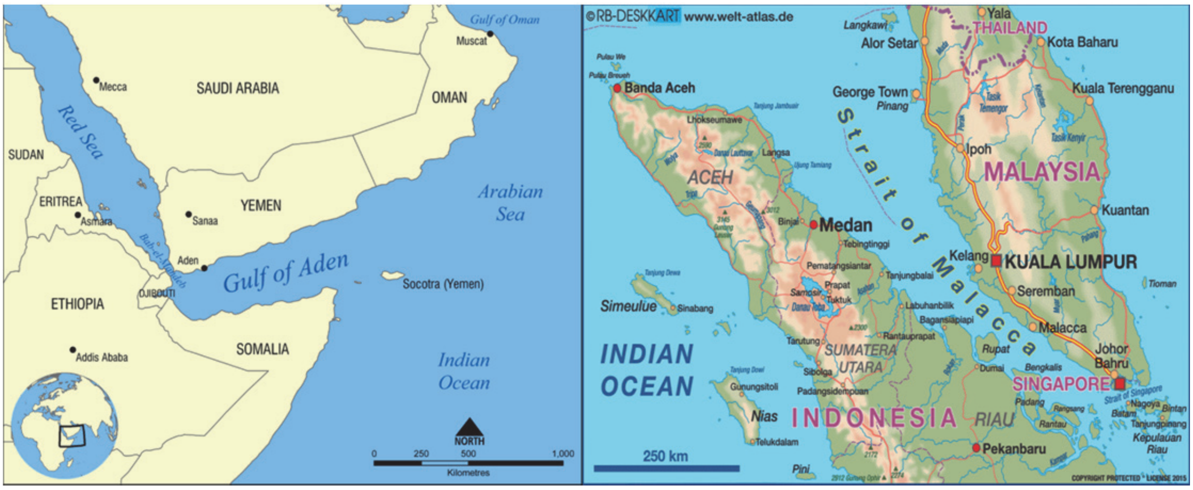
### *Supplier Diversification*

Directly related to the former, the Arctic region would raise the number of oil and gas suppliers to the APEC economies to widen their options. That would help them avoid over-reliance on a supplier or a small number of suppliers and put them in a better bargaining position with their current suppliers to secure supply contracts on more favourable terms, including price-wise.

### *Supply Route Diversification*

Given the geographical location of the Arctic region, some of its future supplying routes to the oil/gas-importing APEC economies are different from those of these economies' existing ones. This is especially true for the largest oil/gas-importing APEC economies in East Asia (China, Chinese Taipei, Japan and Korea). To a varying degree of ease, Canada, Russia and the USA, for instance, will not have to export their Arctic oil and gas (LNG) to these economies through the existing shipping routes (via the Suez Canal or the Panama Canal) for the entire part of their tankers' journeys or a large part of them because of their geographical locations as Arctic suppliers. In the second case, the rest of their journeys will not have to pass through the potentially dangerous waters due to a varying degree of piracy (high: Gulf of Eden and low: Strait of Malacca) and potential expansion of civil war to the sea routes (Yemen's civil war affecting Gulf of Eden and Bab-al-Mandeb).

**Map 5: Chokepoints on the Southern Shipping Route**




Source: Maps supplied courtesy of: [Einstein, Norman (2009), *Wikimedia Commons*, "File: Gulf of Aden map.png", 29 January 2009, http://commons.wikimedia.org/wiki/File:Gulf_of_Aden_map.png]; and [Welt-atlas.de (2015), Map *of Strait of Malacca*, https://www.welt-atlas.de/map_of_strait_of_malacca_6-847]

Provided the availability of both or one of the two mentioned Arctic routes (NSR and NWP) at least a few months a year, the other two regional suppliers (Norway and Greenland) could also bypass the Southern route by conducting a portion of their exports through those routes. While some of the Arctic suppliers' routes could be shorter than those in use currently for global oil/gas exports, the equally, if not more important, attraction of them is their security as they do not need to pass through the above-mentioned dangerous parts of the Southern Route.

### *Decreasing Dependencies on the Middle Eastern Supplies*

The undiscovered Arctic's oil and gas resources cannot be a long-term substitute for the APEC region's current suppliers' proven reserves, as evident in Table 9.

**Table 10: Comparison of the Arctic Region's Estimated Undiscovered Oil and Gas Resources and the Proven Oil and Gas Reserves of APEC's Suppling Regions (2013)**

| Arctic Region's Estimated Undiscovered Oil Resources Billion Barrels | Total Proven Oil Reserves of the APEC Region's Oil Suppliers* Billion Barrels | Arctic Region's Estimated Undiscovered Gas Resources Trillion Cubic Meters** | Total Proven Gas Reserves of the APEC Region's Gas Suppliers* Trillion Cubic Meters |
|---|---|---|---|
| 90 | 1,687.9 | 48.11 | 185.7 |

**Source:** Author's creation based on the data in: [BP (2014), *BP Statistical Review of World Energy 2014*, pp. 6, 20, http://www.bp.com/content/dam/bp/pdf/Energy-economics/statistical-review-2014/BP-statistical-review-of-world-energy-2014-full-report.pdf; US Department of Interior-US Geological Survey (2008), *Circum-Arctic Resource Appraisal: Estimates of Undiscovered Oil and Gas North of the Arctic Circle*, http://pubs.usgs.gov/fs/2008/3049/fs2008-3049.pdf]
*The APEC region's oil and gas-supplying regions are: Africa, Asia Pacific, the Middle East, Central and South America, North America and Europe and Eurasia.
**The author has converted the US Geological Survey's provided figure for gas in cubic feet (1,670 t cubic feet) into tcm.

Furthermore, the actual recoverable and thus exportable Arctic oil and gas, which can be produced at commercially viable and competitive prices and their availability throughout the year, are all currently unknown. So is the timeframe of their availability as various factors have delayed the required large-scale activities in the Arctic region to create ambiguity as to when significant amounts of the regional oil and gas will be available to the APEC economies. Hence, one cannot project with any degree of certainty as to when, to what extent and for how long the APEC region could reduce its dependency on its existing oil and gas suppliers, particularly its single largest one, the conflict-prone Middle East. This feature creates an element of uncertainty about the availability of the Middle Eastern supplies, in general, although it is not true for all the Middle Eastern suppliers. However, large-scale oil and gas exports from the Arctic region will certainly reduce at a currently-unknown point of time in the future the APEC region's dependency on the Middle East to some extent to decrease supply uncertainty for the APEC importers to a corresponding extent.

#### *Price Sustainability*

The Arctic region could possibly help, as a factor, sustain oil and gas (LNG) prices by preventing drastic price hikes due to shortages. However, this possibility is subject to the sustainability of its large-scale exports at competitive prices, which requires reducing sustainably the predictable high prices of the large-scale regional oil/gas production and transportation. In such case, additional Arctic supplies could fill the gap in the global energy markets caused by lower supplies from other regions to prevent price hikes.

## B-Challenges

Efforts to produce oil and gas at a large-scale in the Arctic region for exports could face certain challenges to affect such objective and thus prevent a rapid development of the regional undiscovered oil and gas resources of which the following are the major ones.

### 1-Technical Challenges

Certain technical challenges could potentially dissuade the Arctic economies and countries from conducting such operation in cases or limit it in others while delaying the availability of large-scale regional oil/gas in the global markets. A differing number of these factors detailed below may be applicable to each of them, of course, to a varying extent depending on their specific circumstances.

#### *Infrastructural Challenge*

The Arctic region lacks adequate infrastructure (such as ports, emergency services, communication installations and oil/gas-export facilities) to support and ease the exploration, production and export of oil and gas. Of course, the situation varies from one regional economy or country to another and efforts are being made to address this deficiency by Russia, for instance, to improve safety and communication along the NSR (Pettersen, 2014c). Nevertheless, the region is still challenged in terms of infrastructure and will remain so for a predictably long period of time as the regional efforts are still limited. Additionally, it will take a long time to address the infrastructural challenges even with more extensive and coordinated regional efforts, given the sheer size and heavy cost of the required undertaking as well as the Arctic's harsh climatic situation.

#### *Scarcity of Ice-class Equipment and Vessels*

There is a limited number of ice-class vessels/equipment suitable for operating in the Arctic region such as drilling rigs, icebreakers and supply and oil spill-response vessels (The Wilson Centre, 2013, p.10). For example, the region has a limited number of icebreakers of which the majority are Russian (37 as of 2013) leaving a small number of such vessels for the rest of the region with plans for developing their undiscovered oil/gas resources, that is, Canada (6), the USA (5), and Norway (1) (US Coast Guard, 2013). The remaining regional countries also have small numbers of icebreakers, namely Denmark (5), Finland (7) and Sweden (8) used for their own purposes (Ibid). Yet, these icebreakers' availability for oil/gas exploration to Canada, Russia, the USA, Greenland and Norway are questionable as, in the case of Finland, for example, they are available only in summers (Heininen, 2015).

Russia is so far the only regional energy player, which has taken major steps to expand its icebreaker fleet. For example, three of its "next-generation nuclear-powered" icebreakers named "Arctic", "Siberia" and "Ural" built locally by Baltiysky Zavodare are scheduled to become operational in the period 2017 to 2021 (*RIA Novosti*, 2014b). Once operational, these icebreakers will be used to escort tankers "transporting hydrocarbons from the Yamal and Gydan Peninsulas and the Kara Sea shelf to various Asia-Pacific countries" (*RIA Novosti*, 2014c). Russia also has a contract with a Norwegian company (Havyard) for an icebreaker to be delivered in 2015 (*Offshore Shipping Online*, 2013) and another one with a Finland-based company (Arctic Helsinki Shipyard Oy) to deliver an icebreaker in June 2016; the latter delivered two other icebreakers (Vitus Bering and Aleksey Chirikov) to Russia in 2012 and 2013 (*Shipping and Maritime*, 2014). Norway has so far concluded a contract with Italian firm Fincantieri for the construction of an icebreaker to become fully operational by 2017 (*Subsea World News*, 2013). Canada has planned the construction of an icebreaker (John G. Diefenbaker) whose contract is yet to be concluded (Fisheries and Oceans Canada, 2014), as is the case for the USA (US Coast Guard, 2013). Other regional countries do not have any firm plan for such purpose. Apart from icebreakers, the regional energy players are yet to address other shortages as a prerequisite for their large-scale oil/gas exploration such as building a significant number of ice-class drilling rigs.

### *Long Process of Drilling*

Exploration and extraction of oil and gas in the Arctic require much longer period of time than they do in other offshore cases. Among other factors such as environmental requirements and harsh working condition to be discussed below, this is due to a short period of time available for such activities every year. Hence, the Arctic drilling season is about 105 days for offshore drillings and 150 days for onshore drilling with the effect of requiring years to drill a well, which may or may not even have commercially viable reserves at all (The Wilson Centre, 2013, p. 12).

### *Harsh Working Condition*

Exploratory and production operations are difficult in the Arctic region, even during its drilling season and especially for offshore ones, because of its climatic situation. Added to cold weather and polar nights, large/thick floating ice, which could damage vessels and drilling rigs in that season, makes the mentioned operations difficult. For example, Shell had to stop its exploratory operations in the Chukchi Sea in 2012 for two weeks to dodge a large ice floe (Fong, 2014).

### *Environmental Requirements*

Given the environmental fragility of the Arctic region, high environmental standards have to be followed by those regional and non-regional energy corporations with plans to operate in the region. The objective should be to minimize the damage to the environment and prevent possible environmental disasters such as oil spills. Nevertheless, there should be plans, equipment and trained personnel to contain such disasters, conduct a thorough clean up afterwards and restore the environment should they happen.

Being already in place in some form, such requirements make oil and gas exploration, production and transportation in the Arctic region more difficult than they are in other regions to dissuade some of the energy corporations from operating in this region. For example, in early September 2014 drilling of an offshore well on Statoil-operated Pingvin Prospect was stopped because of a complaint filed by Greenpeace with the Norwegian Environment Agency claiming the field was “too close to vulnerable resources such as Bear Island and the ice edge” (Holter, 2014).

In the case of an APEC Arctic economy, the operation plans of two corporations (Imperial Oil Ltd and Chevron Corp) seeking separately operation licenses in the Canadian sector of the Beaufort Sea were challenged by an environmentalist NGO in July 2014 (McCarthy, 2014). Hence, World Wildlife Fund Canada contested the companies’ claims of “using the best offshore technology” to prevent blowout and oil spills as it released a commissioned oil-spill model for the Beaufort Sea. The model suggested “a major blowout as possible scenario” for those corporations’ offshore oil production plans “with no possibility of cleanup because of the region’s specific situation [and therefore the resulting oil spills] would contaminate ecologically sensitive shorelines in Canada and Alaska” (Ibid). Given Chevron Corp withdrew its application to Canada’s National Energy Board (NEB) as mentioned earlier, the challenge will certainly prolong the review process of the remaining company’s license request by the NEB and Inuit-led environmental panels for which Imperial Oil Ltd was preparing submissions (Ibid).

### *High Cost of Production*

In general, the production cost of oil and gas in the Arctic region will be very high as argued by many, including the International Energy Agency (IEA) (Østhagen, 2013). In fact, it will be much higher than that in other regions for certain reasons. These are the high cost of operation, including drilling, due to the remoteness of the Arctic resources and their being mostly offshore, extreme climatic conditions (cold weather and ice conditions even despite the Arctic sea ice’s melting), short drilling season, containment and emergency response requirements to prevent environmental disasters in case of accidents and insufficient infrastructure in the region (The Wilson Centre, 2013, pp. 6, 13). Such high production cost resulting in high-priced exportable oil and gas would make it difficult for the region’s exports to compete with those of other supplying regions especially when oil and gas prices are low. Unless these prices are high and expected to remain high for a significant period of time, such reality could dissuade energy corporations from embarking on exploration and production activities in the Arctic region if they have other options. In fact, high cost of production has over time dissuaded major energy companies from operating in the Arctic offshore fields despite finding oil/gas reserves such as Shell in the 1980s and BP in 2012 (Ibid, p. 4). This factor could delay the development of the Arctic undiscovered oil and gas resources. All or some of the mentioned reasons have so far resulted in the cancellation of planned exploratory operations in the case of the USA such as by ConocoPhillips and Statoil, as discussed earlier.

## 2-Environemntal Challenges

Extensive oil/gas extraction in the Arctic whose environment is fragile would worsen its fragility and speed up its melting with the mentioned global and regional (APEC) challenges, including sea level rising. As well, the availability of additional supplies of oil and gas from the Arctic region would help, as a factor, grow consumption of fossil fuels and thus increase $CO_2$ emissions to further worsen global warming. Named as "Arctic paradox", this dynamics can be summarized as follows:

> Large-scale efforts to discover and develop the Arctic oil/gas resources now seems to be feasible because of its melting ice caused by large-scale fossil energy consumption for over a century will lead to the "'Arctic paradox' in which increased utilization of [its] off-shore hydrocarbons as a result of climate change leads to more rapid climate and other change" (Heininen, Sergunin and Yarovoy, 2014, p. 78).

Of course, today no one can make credible projections on the extent of damage on the Arctic environment of the regional oil/gas extraction in absence of any data on the scale of such extraction in the future. By the same token, the extent of the additional pollution caused by the consumption of the regional oil and gas cannot be credibly projected.

Nonetheless, there are some estimates, which could offer an idea as to their scale. *Alaska Wilderness League*, an NGO concerned with the Arctic's environment, made the following estimation regarding offshore drilling in the Arctic in 2014. Accordingly, "[t]his not only threatens Arctic wildlife but could unleash an estimated 15.8 billion tons of $CO_2$ into our atmosphere – more than all US cars and light trucks will emit for the next 13 years!" (Alaska Wilderness League, 2014).

Hence, large-scale oil and gas extraction in the Arctic could speed up its melting with negative implications for all regions, including the APEC region. In particular, such implications could affect oil and gas security of the APEC economies depending on these fuels' imports. As a blatant example, rising sea levels, if it continues, will likely have an impact on their coastal oil and gas (LNG) import/export terminals to interrupt or disrupt their operation and/or increase their operational cost by requiring major modifications to make them immune to rising sea-levels. Rising sea levels are a serious ongoing challenge as reflected in the following picture of Hawaii.

**Picture 4: Honolulu Fly-Through with 3 ft of Sea Level Rise (2011)**


Source: Picture supplied courtesy of: [Fletcher, C. (2014), *Sea Level Rise Hawaii*, Sea Level Rise Website, University of Hawaii at Manoa, Honolulu, Hawaii, USA, http://www.soest.hawaii.edu/coasts/sealevel/]

### 3-Economic Challenges

Given the high cost of oil and gas production in the Arctic region, strong and sustainable growing demand for these fuels that cannot be fully met by other regions is essential to keep their prices high enough globally in order to make Arctic oil and gas competitive. Such demand is also needed to secure investment in the regional oil and gas industry to guarantee its operation. Today, all projections suggest the continued growth of the global oil and gas demand in the foreseeable future. However, there is no evidence as to such demand's sustainable strength over a long period of time to the extent that it surpasses the existing supplying regions' export capacities. Today's low oil, gas and LNG prices and their further lowering, especially in the case of oil (from over US$100 in late 2013 to about US$56 in April 2015), question, as a factor, the possibility of sustained high oil and gas prices in the predictable future.

### 4-Political Challenges

Various political factors could pose challenges to the regional oil and gas production. Chief among them is potential disputes among the Arctic economies and countries over oil and gas-rich areas beyond their Arctic EEZs. These areas could contain a significant portion of the regional undiscovered oil and gas resources. Although there is currently no proof for such resources and no active dispute of this nature, such disputes would prevent or delay the development of their affected resources if they emerged. To avoid this scenario, a legal regime for the division of the mentioned areas could be useful, but it may not be feasible only as a regional effort, given the crucial role the Arctic region plays in this planet's environmental health. Therefore, perhaps, a global process may be necessary for this purpose. In the meantime, the United Nations Convention on the Law of the Sea (UNCLOS) could be a useful tool to help settle any future dispute.

## IV. Major Trends

Added to the other mentioned factors, lowering oil and gas prices have created serious doubts about a number of issues pertaining to the development of the Arctic undiscovered oil and gas resources in the foreseeable future. These are not only the implementation of the licensed and potentially soon-to-be licensed projects, but also filing a significant number of permit applications for future projects and/or pursuing the existing ones by the regional and non-regional energy corporations, as evident in the following examples.

In a letter to Canada's National Energy Board on 17 December 2014, Chevron Corp announced putting on hold indefinitely its plan to drill for oil in the Canadian section of the Beaufort Sea because of "'economic uncertainty in the industry' as oil prices fall" (Haggett, Williams and Scheyder, 2014). It therefore withdrew from a hearing on Arctic drilling rules (Ibid). Leading a joint venture with ExxonMobil Corp and BP Plc, Imperial Oil Ltd, reacted to the development by saying that it had not changed "early-stage plans to drill in the Beaufort Sea and that a final decision on the project [had] yet to be made" (Ibid). It is not clear if such decision could still be positive.

In the case of the USA, it is unclear whether, Shell, which filed a request in August 2014 to extend its lease permit for its mentioned unsuccessful 2012-2013 operations in the Alaskan waters, will actually resume its operation there. Its Chief Financial Officer, Simon Henry, stated on 31 October 2014: "'We are planning and hoping to drill next year but we have not taken a decision to do so because it will depend on ongoing litigation' and permits" (Ward, 2014). He added: "We do not yet have clarity, and we retain the ability and the right to not drill next year" (Ibid). The permit issue was practically resolved in March 2015 as the US government approved its request, but, Shell is yet to decide as to when it will restart its operation.

In the case of Canada and the USA, a small number of applications have been filed for obtaining operation permits in their Arctic waters. Up to this date (April 2015), these permits, excluding the above-mentioned one, are yet to be granted pending the mentioned applications' full compliance with their respective economies' offshore drilling regulations, including the environmental ones. It is not certain whether all or most of the requested permits will be issued at all or, at least, in time to enable their applicants initiate their operations in this decade staring from 2015 or in the subsequent years. In their absence, there will not be any such operation in the American and Canadian Arctic waters. The mentioned US Department of Justice's charging of Shell's drilling contractor, Noble Drilling (U.S.) LLC, with "environmental and maritime crimes" will likely further strengthen the environmental requirements for new offshore operations in the Arctic waters to prolong the licensing period not just in the USA, but also in Canada.

In the case of Norway, its Ministry of Oil delayed on 19 December 2014 the launch of its new round of Arctic-focused oil and gas licensing until 2015 (Koranyi and Dagengorg, 2014) for which both political disagreements and environmental opposition were suspected (*PHYSORG*, 2015). On 20 January 2015, the ministry announced launching a new licensing round as it "would offer 57 blocks in the previously unexplored eastern part of the Barents Sea, which had been free of ice since 2004" (*Reuters*, 2015). Yet, major bidding for the blocs and large-scale new exploratory operations will not likely start this year for the following reasons. The Norwegian government requires Norway's parliament approval where there is opposition to further expansion of oil/gas activities in the Arctic (*PHYSORG*, 2015). The lowering fuel prices has resulted in a global slowdown in new oil and gas exploratory activities, including in Norway, whose oil directorate's announced the Norwegian oil industry's shrinkage in 2015 (*Reuters*, 2015). Consequently, new oil and gas activities will not seemingly start in the Norwegian Arctic waters before 2017 at the earliest. This is because of the fact that, even before the mentioned December 2014 delay, the new round of licensing process was expected to last "between 24 and 30 months, longer than the 15-18 months in the previous three rounds between 2008 and 2013" (Ibid).

Greenland's offshore exploratory activities are subject to its licensed foreign energy corporations' decisions. Given the mentioned such corporations' ending operations or delaying projects, it is uncertain whether the remaining interested ones will decide to implement their licensed projects in the near future.

Finally, Russia and Norway have cancelled or delayed many Arctic projects, but still have certain ongoing exploration activities, which will likely continue provided their justifications remain valid. Today (April 2015), it is not known whether Russia and Norway will implement their previously-licensed projects in 2015 or in the following years.

## V. Scenarios

Although the Arctic region's APEC economies (Canada, Russia and the USA) as well as Greenland and Norway have plans towards developing their share of the regional undiscovered oil and gas resources, the actual extent of their respective operations and their timing are not predictable. The reason lies in their differing needs for these resources and the mentioned challenges. Given this reality, one could only consider conceivable scenarios for such operations under certain circumstances.

### A-Delayed Development Scenario

Under this scenario, various internal and external factors will delay for a significant period of time any major development of the Arctic undiscovered oil and gas resources, which are mainly offshore, to leave their bulk intact. The main contributing internal factors include environmental concerns to justify excluding certain energy-rich parts of the Arctic from energy development projects. This is already true in the case of Norway, for instance, with respect to parts of its share of the Barents Sea. Along the same line, the Arctic economies' and countries' required environmental standards for oil and gas exploration and production could well dissuade many energy corporations from embarking on such operations for at least three reasons. They could not be achieved due to the existing technological limitations, their high cost or their realization would significantly prolong the licensing and production periods. The latter would increase those corporations' operational cost with the effect of making their Arctic operation not profitable or profitable enough and thus not financially viable and attractive.

Another internal factor is the absence of adequate number of the required equipment capable of operating in the Arctic region for offshore operations such as ice-class rigs and vessels. This would create a "natural" technical barrier to the realization of many projects to postpone them to a time when such requirements are readily available at affordable prices. Yet, this barrier may not be the major one should the current situation continue for the following reason. Currently, there is a small number of envisioned and planned projects with no certainty about their realization as evident in the mentioned cancelled or delayed projects. Hence, there may not be a high demand for the required equipment leading to their shortage.

Finally, absence of funds could well be yet another internal factor. Offshore Arctic operations are quite expensive for the previously-mentioned reasons. For example, one of the contributing factors is that the period of time for determining the volume of a potential oil or gas field's extractable reserves and making decisions as to its subsequent development is much longer than it is in other regions. The resulting high cost of exploration with no guarantee for finding commercially-viable reserves could well make funding of Arctic projects difficult and thus keep many of them on paper. As a recent example, Shell is reportedly spent about US$6 billion on its 2012-2013 unsuccessful exploration operation in the American Arctic waters off the coast of Alaska (Crooks, 2014).

The main external factors include the availability of other regions' oil and gas in abundance and at low prices. In fact, the latter mirrors the current trend as, today (April 2015), there is no shortage of these supplies globally despite instability in many Middle Eastern, African and South American oil/gas-exporting countries (such as Egypt, Libya, Nigeria, South Sudan, Syria, Yemen and Venezuela) and restrictions on Iranian oil exports due to various sanctions.

The abundance of supplies from a large and growing number of suppliers and the realistic prospect for their continuity in the foreseeable future have resulted in a significant decline in oil prices, in particular, over a very short period of time, as stated before. The coming winter (2015) will likely help increase oil demand to some extent to help push oil prices up to an unpredictable extent and even these prices could possibly continue their recovery. However, the current abundance of oil, which could significantly increase if the April 2015 framework agreement on Iran's nuclear energy program leads to lifting restrictions on its oil exports, will likely help, as a factor, keep oil prices low.

Briefly, the growing global oil and gas production, both in conventional and unconventional forms, suggests that these fuels' scarcity and sustainable high prices will not be the case in the predictable future. Therefore, decisions for the timing of large-scale engagement in the Arctic region by energy corporations will be made with this point in mind. In consequence, exploratory operations could not logically be very extensive and the actual development of the Arctic undiscovered oil and gas resources could well be postponed until a sustainable strong demand for these fuels could be seen in the horizon. Provided such demand could not be fully met by the existing supplying-regions, sustainable high oil and gas prices should be a necessity to justify their development and make their products exportable at a profitable level for their developers.

The delayed development scenario is seemingly very likely and, probably, the case in this decade as per the discussed factors unless the existing situation suddenly changes for which there is no strong evidence at this time. However, given the declining oil and gas prices for a long time is damaging to all suppliers, it is conceivable that, in the case of oil whose prices could increase through coordinated efforts by the large global suppliers, efforts will be made by them to decrease their supplies. These efforts will likely be followed by others to prevent a continued freefall of prices and, eventually, reverse the trend. Consequently, in such case, oil prices, will likely be bounced back to higher ones, but not necessarily to those of early 2014 at a sustainable manner and for a long period of time.

## B-Limited Development Scenario

Under this scenario, development of the regional undiscovered oil and gas resources will mainly be limited both geographically and in scale. Their related activities (exploratory and production) will take place in a small part of the Arctic region within the regional economies' EEZs for certain reasons. These are the technical difficulty and, in cases, infeasibility of conducting such activities at a large-scale, particularly the offshore ones accounting for the bulk of the undiscovered resources, under the Arctic's harsh climatic situation and their high cost.

As well, other reasons will discourage embarking on large-scale Arctic projects without any certainty of significant positive yields, but with guaranteed high cost. They include the availability of proven oil and gas reserves in conventional form and/or unconventional form in other parts of Canada, Russia and the USA under comparatively much easier operating conditions and at much lower cost. A low global demand for oil and gas for a predictably significant period of time (due to factors such as economic slowdowns in major consuming and importing regions) and the availability of adequate amount of supplies to meet such demand and its growth constitute other reasons.

Under these circumstances, small-scale development of the Arctic undiscovered oil and gas resources could be justified to fill the gap caused by the Arctic energy players' depleting non-Arctic reserves. This is mainly applicable to Norway, which is currently facing such situation. Having no alternative oil and gas reserves, Greenland will likely be excluded from this scenario although it will still require foreign financing and technology for developing its undiscovered oil and gas resources. Yet, Greenland might find it difficult to attract committed developers for such objective, a realistic possibility given its current difficulties in this regard.

The APEC's three Arctic economies might chiefly conduct limited exploratory activities to secure enough commercially-viable proven reserves for their future needs as well as future exports under better market situations when their non-Arctic reserves are inadequate. In such case, limited and slow-paced oil/gas development projects will take place, given their mentioned objectives will require a long time for realization because of the stated Arctic challenges.

This scenario could also be possible in the ongoing decade and the first half of the following one. The required conditions to undermine this scenario include major technological breakthroughs to make feasible deep-sea operations in the Arctic region at affordable prices and in environmentally sustainable manner as well as a major sustainable long-term surge in oil and gas demand. As it stands today, there is no evidence to suggest such developments during the mentioned timeframe.

## C-Extensive Development Scenario

Under this scenario, extensive oil and gas exploration and production activities will take place in the Arctic region due to certain global and regional developments. Hence, significant increases in the global oil and gas demand in absence of viable non-fossil energy alternatives will require more oil and gas supplies while ensuring their high prices. This development will make high-priced Arctic oil and gas competitive. Additionally, the three regional APEC economies' growth in domestic demand and/or their additional export needs will incentivize them to increase their oil and gas production when their non-Arctic reserves are inadequate for these purposes and other suppliers cannot fully meet the additional global demand. Finally, factors such as high cost of production and water shortages as well as environmental concerns will reduce and/or stop their unconventional oil and gas production to make a case for tapping on their undiscovered Arctic resources.

Under these circumstances, extensive explorations and production will be justified in their Arctic undiscovered oil and gas resources as well as those of Greenland and Norway. At least in the predictable future, this scenario will not be very likely, given the global existence of large non-Arctic oil and gas reserves to sustain the existing global demand and its predictable growth in the next few decades even in the case of a total halt of the mentioned unconventional oil and gas production. Moreover, environmental concerns will likely create a barrier to the realization of such scenario for its potential extensive environmental damages to the Arctic region.

## VI. Conclusions

The melting of the Arctic sea ice has been a by-product of global warming caused by over two centuries of heavy consumption of fossil energy. This environmentally disastrous phenomenon has made technically possible exploration and production of still an unknown amount of the Arctic region's undiscovered oil and gas resources, which are mainly off-shore. In absence of significant exploratory activities, the extent of the accessible areas for such purpose and the actual size of their recoverable resources at a commercial scale are still unknown. Today (April 2015), it is unclear when such activities and their subsequent production projects will become a reality, but evidence does not suggest their realization in the predictable future. Nevertheless, the recent Arctic energy experiences, including the small number of licensed projects, suggest that, realistically, a limited degree of oil and/or gas production could take place in the second half of the next decade, at the earliest. This is of course pending the implementation of the existing known projects and the potential ones.

Of course, this is a region-wide assessment as to the overall Arctic region's conceivable production potential. As a result, the specific situation could vary from one regional energy-rich player to another, as discussed earlier. Despite such differences, the overall licensed and, perhaps, soon to be licensed new projects are small in number and mainly exploratory in nature. Therefore, they may not lead to discoverers of significant oil and gas reserves, even if they are implemented in this decade. Yet, there are doubts as to their implementation as planned reflected in the mentioned cancellations and suspensions.

A host of climatic, environmental, financial, market and technical factors have so far prevented a significant development of the Arctic undiscovered oil and gas resources. They will remain mainly undiscovered so long as these factors persist. Yet, should this situation change, the development of these resources will enable the Arctic region to play a positive role in the global energy markets. The significance of such role depends on the amount of its oil and gas productions and the volume of the available oil and gas for exports after meeting the regional producers' domestic energy requirements. Provided this share is significant, the Arctic region could contribute to the APEC region's energy security in the future to an unknown extent at this time while meeting a portion of the other energy markets' requirements.

## VII. Recommendations

Given the importance of the Arctic for the global environmental health and, thus, that of the APEC region, the APEC economies with stakes in the Arctic undiscovered oil and gas resources should consider the following three recommendations:

1- Paying special attention to the impact of oil/gas explorations and productions on the fragile Arctic environment while processing their respective permit applications;
2- Using the best practices to minimize the negative impact of such activities;
3- Making efforts to set high environmental standards for oil and gas activities in the Arctic region supported by an enforcement mechanism.

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