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East Africa Shared Gas Initiative

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About KAPSARC

The King Abdullah Petroleum Studies and Research Center (KAPSARC) is a non-profit global institution dedicated to independent research into energy economics, policy, technology and the environment, across all types of energy. KAPSARC's mandate is to advance the understanding of energy challenges and opportunities facing the world today and tomorrow, through unbiased, independent, and high-caliber research for the benefit of society. KAPSARC is located in Riyadh, Saudi Arabia.

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Key Points

Energy demand in the economies of Eastern Africa is among the lowest in the world and represents only a small outlet for the large natural gas resource that has been discovered. Despite its important potential, renewables (with the exception of hydropower) face a long road prior to making any significant penetration in the region. Consequently, if cost competitive, natural gas represents a viable energy source that has the potential to meet the growing population's needs while mitigating its carbon footprint.

- In addition to urban power generation and industrial districts, transport (compressed natural gas (CNG) buses/liquefied natural gas (LNG) vehicles) appears to be the best avenue to develop a billable demand for natural gas.

- Small-scale LNG projects, due to their scalability, may represent the path forward prior to investment in gas pipelines.

- Energy policy in East Africa will need to be flexible to cope with the cycles of the global LNG industry.

Summary for Policymakers

The current problem of low energy supplies in Eastern Africa does not stem from the availability of resources including natural gas but from the inability of governments, utilities and oil and gas companies to move forward with development plans. As countries transition their economies toward middle-income status, they need to improve energy access to create a positive entrepreneurial spiral enabling energy access, sustainable economic development, employment, billable utility demand, profitable energy market and investment (both private and public).

While natural gas demand remains low in the region, small-scale liquefied natural gas (LNG) units are seen as worthwhile solutions to nurture natural gas demand robustness prior to committing capital-intensive gas pipeline investments.

Natural gas could contribute to electrification, especially in the urban setting, and also be used in the industry and transport sectors. How such developments will fit with a significant focus on developing renewables in the region is still unclear. Rural settings with no access to the electricity grid seems to be the privileged target for decentralized power production using renewable sources, while urban settings could leverage on the flexibility and cleanliness of natural gas for industry heating purposes, power generation and transport (compressed natural gas (CNG)/LNG vehicles).

As with any commodity market that has high capital requirements, the global LNG market follows a cyclical development. Currently, overcapacity is the rule of the game. According to most analysts, LNG prices are set to rebound once the current loose market tightens. East African countries should plan accordingly and prepare for an adaptive energy and investment policy in line with the global LNG market cycles.

Background to the Workshop

With a potentially prolific Rovuma basin, Tanzania and Mozambique share 188 trillion cubic feet (tcf) of proven and probable gas reserves. About 53 million tons per annum (mtpa) of LNG capacity has been proposed for development. So far only Eni's 3.4 mtpa Coral FLNG has taken a final investment decision in June 2017. On the back of uncertain global demand outlook for LNG and over 100 mtpa of capacity under construction as of early 2017, greenfield projects such as the ones proposed in East Africa are likely to be delayed. Lower oil prices have also contributed to the drop in global LNG prices and made these projects less attractive.

Given this turn of events, it is reasonable to assume that oil and gas companies would consider domestic markets to monetize the natural gas resources in place. Although LNG exports would still be the preferred option, our study shows that some operators would consider a larger than anticipated share of the gas produced to be sold locally. In order to discuss these issues, the King Abdullah Petroleum Studies and Research Center (KAPSARC), Columbia's Center on Global Energy Policy (CGEP) and the Fondazione Eni Enrico Mattei (FEEM) organized a one-day workshop in Paris. We gathered a group of 40 high-level stakeholders from academia, industry, policy and regulatory circles, as well as think tanks, to discuss the potential of using East African natural gas in the region. More specifically, the workshop addressed the following issues:

- What is the current domestic market for energy in Eastern Africa?
- What is the role of natural gas in the region?
- Could optimal strategies to develop domestic natural gas demand emerge?
- What are the constraints to develop regional gas transport infrastructure?

Current Domestic Market for Energy in Eastern Africa

Energy demand is led by biomass

East Africa, in this context, is represented by nine countries: Burundi, Ethiopia, Kenya, Malawi, Mozambique, Rwanda, South Africa, Tanzania and Uganda. When looking at energy access and consumption statistics in East Africa, the numbers are alarmingly low. The region represents about 5 percent of global population, but only about 2 percent of energy demand. When South Africa is excluded, the averages are even lower: about 0.9 percent of global energy demand for more than 4 percent of the population. What is also striking is that all countries, except South Africa, are dominated by the use of traditional biomass, representing about 85 percent of primary energy demand. The majority of energy demand is dictated by the residential sector (65 percent on average) for use in heating and cooking.

Several factors could drive changes to this energy picture going forward. The first is population growth. Africa is forecast to be home to 1.7 billion people by 2030 (UN 2017). East Africa alone will see its population increase from 350 million today to 510 million by 2030. Second, when examining the social and economic development plans of each of these countries, they almost always have one goal in common – that is to achieve middle income status. Energy is the key instrument toward achieving this goal. In addition, the region is endowed with significant energy resources that could be leveraged once a positive spiral of investment and economic development is kick-started by governments.

Electricity access is very low

Total gross electricity consumption in East Africa amounted to 276 TWh as of 2014, which is very low. Electricity consumption per capita in the region amounts to 785 kWh (plummeting to 151 kWh when South Africa is excluded) compared with 12,987 kWh in the U.S. According to the International Energy Agency (IEA), as many as 233 million inhabitants, or 66 percent of the population, do not have access to electricity in these countries. Ambitious targets to increase electrification rates face tough constraints ranging from lack of finance, insufficient tariff rates and revenue collection, theft of electricity and equipment, and lack of enforcement of laws and policies.

The very low demand for electricity and low density of industrial presence present a challenge for international oil and gas companies. Traditionally, these companies look at foreign markets to insure long-term prospects and stability of gas demand. Consequently, governments have the task of dispatching oil and gas revenues adequately to spur economic development and share welfare gains among the population.

Oil and gas companies could provide assistance to governments to enable such changes. Co-development of infrastructure such as power plants and transmission lines may seem to dilute the profitability of gas development, but it could provide long-term value in terms of getting the social license to operate with governments in the region on future projects. Such an approach may be fruitful in addressing the specificities of the Eastern Africa region.

Electrification faces different constraints in urban and rural areas

The share of rural population in East Africa is very high. It ranges between 68 percent and 88 percent of the population (excluding South Africa). The

lack of electricity transmission and distribution infrastructure in these rural dwellings meant that people have historically resorted to biomass to fulfill their energy needs.

The lack of investments (public or private) make the delivery of electricity to most of these inhabitants a challenging task. In addition, some of the countries (excluding Burundi and Rwanda) are vast, with large parts being scarcely populated. The very high on-grid distribution costs associated with connecting remote households in areas of low population density mean that few of these households will be able to afford grid connection.

The different needs of the rural versus urban area impose the need to come up with different solutions. Decentralized power generation could be the solution for rural areas. In this case, renewables such as solar and wind could be an alternative. The trajectory toward affordability will then be the key issue. For urban areas, centralized natural gas-fired power generation could be an efficient and cleaner way forward.

What is the Role of Natural Gas in the Region?

Large resources might benefit the whole region

As they are within a reasonable distance from huge gas reserves, these nine East African countries may benefit from natural gas resources. Understanding the economic drivers, energy policy and regulatory environment of these countries in which the natural resources would be developed and consumed can help assess future energy needs and the optimal energy mix.

For instance, Mozambique's Area 1 in the Rovuma Basin is targeted to supply domestic markets and includes a power generation plan sized for both LNG liquefaction needs as well as domestic usages. However, this co-development is not yet sanctioned. Natural gas access to domestic market will be at best gradual.

A feedstock for petrochemical investment?

As some liquids are associated with natural gas, petrochemical initiatives could be of interest. Fertilizer is another path worth assessing since a large share of economic activity in the region takes place in the agriculture sector and using more fertilizer would greatly increase productivity. However, potential customers' billability remains questionable when targeting local markets. Additionally, the current fertilizer import market for the entire region is barely equal to the size of a standard fertilizer plant. Export is a challenging task at a time where many players in the fertilizer industry face tougher competition, especially from the U.S. Replacing import and developing export is a real but challenging opportunity.

Or for transportation?

One of the sectors where natural gas could find a market is as a substitute for oil in buses and eventually passenger cars and trucks. Natural gas would replace oil product imports while addressing the issue of billable customers. Diesel and gasoline prices are quite high in the region. Providing a cheaper and cleaner alternative could be an innovative way to develop a billable outlet for natural gas.

CNG vehicles such as buses, cars and eventually light trucks are being used successfully across the world. Upfront investment is meaningful in gas distribution infrastructure but is scalable. As a result, oil product imports would be reduced. As many East African cities need to develop mass public transportation while facing air quality issues in an urban setting, natural gas-fired buses represent an economically-proven solution with demonstrable upsides for the local air quality.

Anticipated gas demand once supply is available

The traditional correlations between gross domestic product (GDP) and energy consumption as well as population and energy consumption are confirmed for Tanzania, Mozambique and South Africa. Based on these relationships and a competition amongst the sources of energy, a forecasting model was built and tested to identify what the change in primary energy consumption would be if more natural gas is available. The results show that it creates a boost in GDP growth as higher revenue is generated for the State, which is then able to raise investments and promote economic activity. In Tanzania and Mozambique, by 2035 significant volumes of fuel oil

and coal will be replaced. However, the main area of additional gas demand lies in new industrial clusters based on the recovered gas itself, such as methanol and fertilizers. These are the chief potential growth markets for natural gas, especially in Tanzania and Mozambique.

The case of South Africa is more complex: its overall energy mix does not change, with coal still holding the largest share. Power generation remains coal-fired in most scenarios if there is no significant carbon pricing or drastic reduction in the costs of natural gas delivery to the country. Natural gas usage seems to increase primarily within the transport sector. The South African energy mix shows meaningful change after 2030. An important fact to take into account is the scale of the South African economy compared with the rest of Eastern Africa. A less than 10 percent penetration of natural gas in South Africa would represent more than the total gas market demand in Tanzania or Mozambique by 2030, according to the modeling exercise. Natural gas, however, still has a role to play in South Africa. The coal-fired power fleet is very old and plants will have to be retired at some point. In addition, South Africa has pledged to reduce its carbon intensity in line with the COP21 Paris Agreement. Thus, there is potential for a gas market to develop and demand centers to be unlocked, but pricing and security of supply are essential factors in order for South Africa to increase its use of natural gas.

Development of natural gas fields will lead to an economic boost, driving higher energy consumption throughout the region. Modeling such an economic boost is based on strong assumptions regarding the usage of natural gas, investment policies and the relative price of energy sources over the long term. However, the exercise highlights that the arbitrage for natural gas usage targets not only the power generation industry but also the transport sector.

Optimal Strategies for the Development of Local Natural Gas Demand

Natural gas competitiveness is challenged

The lack of gas transport infrastructure and an undercapacity of power transmission raises questions on the scale of Eastern Africa's appetite for natural gas. Environmental concerns are likely to play in favor of natural gas but demand uncertainty appears considerable for the entire region. Coal is the cheapest source of energy for base load power generation in the absence of pollution and carbon emission pricing throughout the region (with the notable exception of hydro and geothermal power generation). Existing coal infrastructure and reserves guarantee a status quo for coal until affordable natural gas resources can reach the market.

At the other end of the energy spectrum, the cost of renewable generation is becoming increasingly competitive and many resources are yet untapped. Developing decentralized renewable generation at an affordable price is the challenge. In East Africa, renewables would displace first the more expensive energy source and currently that resource is natural gas.

Hydroelectricity represents the best renewable solution for power generation in the region. Despite being dependent on fluctuations in rainfall patterns (which will probably intensify as a consequence of climate change), it is not expensive, provides a stable output and draws extensively on local materials and manpower for construction. As such, where possible, hydropower capacity is installed. In addition, in Kenya, geothermal opportunity enables the production of green power.

Nonetheless, natural gas has an important role to play in power generation that can be centralized close to an urban area or an industrial district. For example, Tanzania has developed a significant gas network around Dar es Salaam to monetize local natural gas resources by producing heat and power for the industrial sector's development including many small and medium sized companies.

In rural areas, since power or gas grids are sparse, it is more economical to use decentralized solutions such as liquefied petroleum gas (LPG) for cooking or solar/wind for lighting. Moreover, the decreasing cost of renewables could make such solutions more and more competitive. However, low electricity rates in rural areas is not a favorable factor for the development of renewable power generation. Waiting for further cost reduction in renewable technologies seems to be a probable strategy in the absence of international or domestic public support.

Electric vehicle or natural gas fired?

Electric vehicles may represent a long-term opportunity once electric grids and power generation capacity are implemented. A robust process to bill customers will also need to be deployed. Solutions linking solar panels/wind turbines to electric car charging devices could present new opportunities once they become affordable in rural Africa.

The economics of CNG vehicles or LNG trucks look favorable for investment under the right mileage, distribution infrastructure cost, maintenance cost and truck incremental cost. CNG passenger cars and potentially LNG trucks for logistics seem to have some competitive advantage in countries where domestic gas resources are abundant. Furthermore, since these countries need to develop mass transportation, CNG buses are a proven way to achieve cleaner air objectives.

What are the Constraints to Developing a Regional Gas Transport Infrastructure?

Potential gas pipelines – infrastructure and politics

Assuming an unlimited access to capital, many opportunities could be drawn to connect East Africa's hydrocarbons projects. Political pragmatism is also crucial in ensuring successful completion of these projects. For example, there is a clear case for Zambia to convert the Tazama oil pipeline into natural gas as it would fuel power generation for Zambia's mining sector. Such a scheme would require the installation of a floating storage and regasification unit (FSRU) at Dar Es Salaam port in Tanzania. However, if such a project is initially fueled with Mozambique gas, will stakeholders think it may inhibit future national LNG projects? If so, how can this be developed to allow future Tanzanian gas to replace it? Other plans could be designed but they all face the political issue of a transparent dialogue between Tanzania and Mozambique on the supply side, and with South Africa on the demand side regarding the development of regional energy infrastructure (the "Renaissance" gas pipeline). Moreover, neither Tanzania nor Mozambique have the financial capacity to launch such construction projects on their own.

Building blocks for natural gas policy linking South Africa to Eastern Africa

South Africa aims to use more natural gas. It plans to secure the gas resource from LNG imports in the short term. Once the market reaches a critical size domestically, it will look to leverage the large finds in Mozambique and Tanzania. Over the long term, domestic shale natural gas resources (Karoo shale gas) are expected to be part of the mix as well.

The core principle would be to assess and sequence appropriate gas value chains (LNG-to-power, energy-intensive industrial use, transport fleet, gas to liquids (GTL), fertilizers, etc.). Developing usage of natural gas will need support from the State, such as identifying the impactful incentives for industry development. Developing collaborative regional projects underpinned by gas would leverage a relatively large and billable market in South Africa that has financial/engineering capabilities for building the infrastructure necessary for natural gas transmission. This would create a backbone for a natural gas transmission/distribution system in the region.

Such government-to-government agreements would underwrite a medium- to long-term gas delivery system for the southern region. Typically, South African access to competences and financing capabilities could be drawn upon for Mozambique's and Tanzania's onshore facilities such as power generation and fertilizers/ ammonia/petrochemicals (GTL if economical). A meaningful gas-driven regional integration based on strengthening regional transport corridors could create value for South Africa and the neighboring countries for such infrastructures.

The importance of a long-term political view on the usage of natural gas in energy economies in the region can also be an Achilles' heel to the resource and its role in the region. The lack of political confidence among the partners' commitment would be a key failure factor. The way to share the rent created by such a gas transmission pipeline is at the core of the decision-making process. Such hurdles appear quite insurmountable in the current political and economic environment.

Gas pipeline vs. small-scale LNG – FSRU

Developing a gas pipeline faces the usual challenges of pricing the gas to end customers that allows for the financing of such a long-term investment. Developing an underground pipeline appears to be the most sustainable transport mode as this would reduce the frequency of incidents expected during the lifetime of the infrastructure.

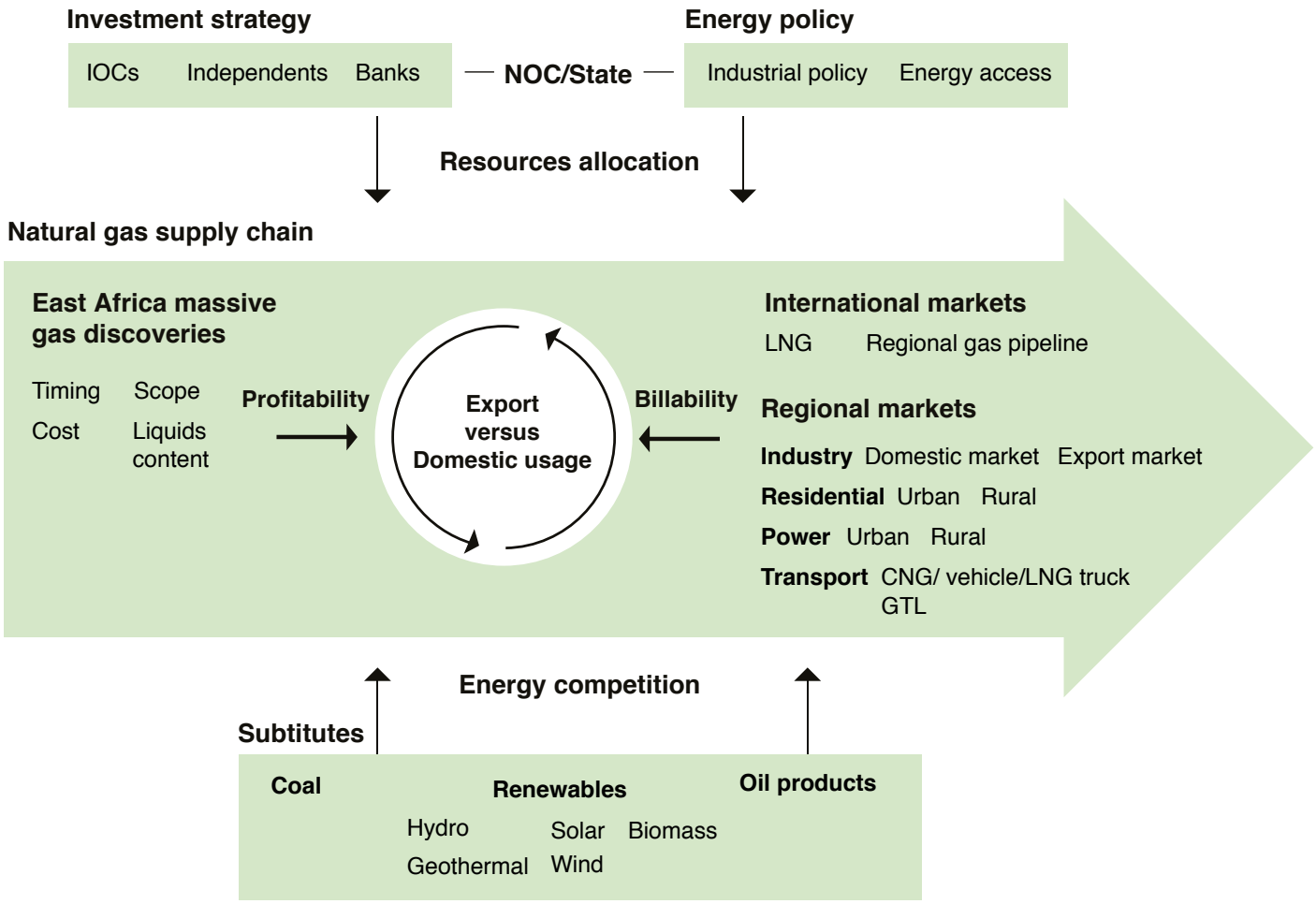
Small-scale LNG could be an alternative for the coastal region of Eastern Africa. The scalability issue, if solved in a cost-efficient way, could represent an interesting solution for long and short distance transport. With such flexibility, the financial risk is limited and FSRU implementation does not impair the investment in a gas pipeline once a critical volume of gas sales is reached. Small LNG storage and regasification installation would fuel a small autonomous distribution grid, a specific industrial customer, a small power plant (possible backup of a renewable scheme) and LNG truck/CNG buses/cars.

Such techniques would be especially worthwhile by bundling them as part of large LNG projects with domestic and billable usage of natural gas in road and marine transportation. Once billable usages establish a large profitable volume of gas demand then a pipeline construction would be a cost-saving solution. Even South Africa's industrial roadmap envisaged some LNG import through FSRU as a first step to boost natural gas usage before domestic shale gas could be extracted or a regional gas transmission grid is operational. FSRUs may allow countries to test a market and to scale up if successful (or to stop the investment, thereby avoiding too much stranded cost if unsuccessful).

How to find the financial capacity to invest?

Despite the final investment decision (FID) for ENI's Coral FLNG project and Exxon Mobil's farm-in, cancellation of some of the envisaged projects remains a real possibility. The Mozambique government faces a debt crisis. In addition, the development of other planned projects could be postponed further. The region's other main gas resource holder, Tanzania, is facing a lack of political convergence regarding natural gas strategy as well as some governance issues, which suggest that delays in the development of natural gas linked projects are to be expected.

LNG export with an associated monetization of liquids in different petrochemical export-led projects remain the privileged road for Eastern Africa gas development. A scenario with less LNG export coupled with larger domestic usage of natural gas in transport, petrochemical and industrial power generation could be envisaged even as a second best solution by the finance community if some flexibility is introduced in the investment framework. Currently, a committed government with stable institutions is required but that may not exist yet in the region. In fact, East African national oil companies have huge financial constraints that are exasperated by the poor overall sovereign ratings. At the same time, any financial project structure would also need support from the World Bank.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About the Workshop

KAPSARC in collaboration with Columbia's Center on Global Energy Policy (CGEP) and Fondazione Eni Enrico Mattei (FEEM) convened a workshop focusing on East Africa's demand potential for natural gas. More than 35 international experts gathered to engage in discussion and presentations on East Africa's gas utilization. The workshop was held under a modified version of the Chatham House Rule under which participants consented to be listed below. However, none of the content in this briefing can be attributed to any individual attendee.

List of Participants

Benjamin Augé – Fellow, Ifri

David Basiima – Engineer, Petroleum Authority of Uganda (PAU)

Henri Beaussant – Independent Consultant

Tim Boersma – Director of Global Natural Gas Markets, Columbia University – SIPA Center on Global Energy Policy

Philippe Copinschi – Professor, Sciences Po, Paris

Anne-Sophie Corbeau – Research Fellow, KAPSARC

Thierry Deschuyteneer – Strategic and Prospective Studies Manager, Fluxys

Valérie Ducrot – Executive Director, WEC – Global Gas Centre

Paul Eardley-Taylor – Head of Oil and Gas, Southern Africa, Standard Bank

Jean-Pierre Favennec – President, IFP/Energy for Africa

Daniel Fobelets – Group Strategy and Portfolio Manager – Integrated Gas, Shell

Luca Franza – Researcher, Clingendael International Energy Program (CIEP)

Tim Gould – Head of Division, International Energy Agency

Manfred Hafner – Energy Scenarios and Policy Program Coordinator, FEEM

Alexander Huurdeman – Senior Oil and Gas Expert, World Bank

James Jewell – International Energy Analyst, Department of Energy, International Affairs, Middle East and Africa

Christophe Le Blan – Business Developer, Total

Dezlyn Makhetha – East African Developments, Standard Bank

Tatiana Mitrova – Director of the SKOLKOVO Energy Centre, Skolkovo Moscow School of Management

Fernando Nhantumbo – Visiting Researcher, KAPSARC

Giovanni Occhiali – Researcher, FEEM

Kishan Pillay – Director of Oil and Gas: Industrial Development Division, South African Department of Trade and Industry

Michel Prud'homme – Senior Director, International Fertilizer Association

Mesgina Risat – SSA Downstream Sales Director, BH GE

Ernest Rubondo – Executive Director, Petroleum Authority of Uganda (PAU)

Shelley Ruszkowski – Project Manager, ExxonMobil

Maxime Schenckery – Visiting Researcher, KAPSARC

Rami Shabaneh – Research Associate, KAPSARC

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Andrew Ssenabulya – Engineer, Petroleum Authority of Uganda (PAU)

Michael Stoppard – Chief Strategist, Global Gas, IHS Markit

Simone Tagliapietra – Senior Researcher, FEEM

Alan Townsend – Senior Industry Specialist, IFC

Ibrahima Wane – Analyst Africa and Middle East, Total

Kang Wu – Program Director, KAPSARC

Akil Zaimi – Senior Research Fellow, KAPSARC

About the Team

Maxime Schenckery

Maxime is a visiting researcher at KAPSARC. He has over 20 years of experience in the oil and gas industry as a corporate chief energy economist, senior policy adviser and professor. His areas of work encompass oil and gas markets forecasting, energy transition policies and innovation penetration in energy systems. He holds a Ph.D. in Economics from the University of Paris-North.

Rami Shabaneh

Rami is a research associate at KAPSARC focusing on global gas and liquids markets. He has more than 10 years of professional research and industry experience in energy market analysis. He holds a M.S. in Sustainable Energy Development from the University of Calgary.

Kang Wu

Kang is the program director of the Markets and Industrial Development research program and a senior research fellow at KAPSARC. His areas of work include oil and gas markets, energy security and China energy studies.

Anne-Sophie Corbeau

Anne-Sophie was formerly a research fellow at KAPSARC specializing in global gas markets. Before joining KAPSARC, she worked for the International Energy Agency and IHS CERA (now IHS Markit).

Tim Boersma

Tim is a senior research scholar at the Center on Global Energy Policy (CGEP). Prior to joining CGEP, he was a fellow and acting director of the Energy Security and Climate Initiative at the Brookings Institution. Tim's research focuses on energy policy coordination, unconventional natural gas extraction, gas market integration, liquefied natural gas and energy diplomacy. He holds a Ph.D. in International Relations from the University of Groningen.

Tatiana Mitrova

Tatiana is a fellow at the Center on Global Energy Policy. She has 20 years of experience in dealing with Russian and global energy markets, including production, transportation, demand, energy policy, pricing and market restructuring. She is also serving as a director of the SKOLKOVO Energy Centre in Moscow. Tatiana is a graduate of economics from Lomonosov Moscow State University.

Manfred Hafner

Manfred heads the Fondazione Eni Enrico Mattei (FEEM) research programme on energy scenarios and policy. He has more than 30 years of international experience consulting governments, international organizations and industry on energy issues. Manfred is also a professor in international energy studies teaching at several prestigious universities. He holds a Ph.D. (summa cum laude) from Mines Paris-Tech (Ecole des Mines de Paris).

Simone Tagliapietra

Simone is a senior researcher at FEEM and a rearch fellow at Bruegel. He is an expert in international energy and climate issues, with a record of numerous publications covering European energy markets, EU energy and climate policy and Euro-Mediterranean energy relations. He holds a Ph.D. in Institutions and Policies from the Università Cattolica del Sacro Cuore in Milan.

Giovanni Occhiali

Giovanni is a researcher at FEEM, working on the energy transition in Africa. His wider research interests are development economics and political economy, with particular focus on Sub-Saharan Africa. He holds a Ph.D. in Economics from the University of Birmingham.

About the Project

This collaboration between King Abdullah Petroleum Studies and Research Center (KAPSARC), Columbia's Center on Global Energy Policy (CGEP) and the Fondazione Eni Enrico Mattei (FEEM), investigates the potential demand for natural gas in the Eastern African region based on the development of resources in Mozambique and Tanzania and, potentially, Kenya. The countries analyzed include Mozambique, Tanzania, Kenya, Uganda, Malawi, Rwanda, Burundi, Ethiopia and South Africa. The project looks at the best ways to effectively develop gas use in these countries. It also looks at how the regulatory frameworks in the different regions could be improved to promote the development of regional natural gas demand. It will also examine how regional cooperation initiatives and the pace of development of LNG exports can influence such a development.

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