



PREPARE TO APPROPRIATE “ASSOCIATED GAS”:

Lessons from Ecuador to Uganda

SR Rwengabo

ACODE Policy Briefing Paper Series No. 39



ELLA
Evidence and lessons
from Latin America



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List of Acronyms

ACODE	Advocates Coalition for Development and Environment
AG	Associated Gas/Associated Petroleum Gas
CO ₂	Carbon dioxide
CPF	Central Processing Facility
DGF	Democratic Governance Facility
ELLA	Evidence and Lessons from Latin America
GDP	Gross Domestic Product
GGFR	Global Gas Flaring Reduction Partnership
KW	Kilowatts
kWh	Kilowatt per hour
LEAP	Learning into Practice
LPG	Liquefied Petroleum Gas/liquid petroleum gas (aka propane or butane)
MEMD	Ministry of Energy and Mineral Development
MNCs	Multinational [Oil] Companies
MoU	Memorandum of Understanding
MW	Megawatts
NOGP	National Oil and Gas Policy [for Uganda]
OEPC	Occidental Exploration & Production Company
OGE&EE	<i>Optimización Generación Eléctrica and Eficiencia Energética</i> (Optimal Electricity Generation and Energy Efficiency)
OPEC	Organisation of Petroleum Producing Countries
PAU	Petroleum Authority of Uganda
PFMA	Public Finance Management Act
R&D	Research and Development
SOTE	Trans-Ecuadorian Oil Pipeline
VPSAG	Virtual Pipeline for Stranded Associated Gas

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While various people contributed to this work, the views expressed and sole responsibility for errors and/or omissions, unintended as they are, remain the author's. I hope this study will contribute to the policy discourse on matters of oil governance by highlighting the importance of infrastructure plans for appropriating and converting Associated Gas (AG) into energy and hence avoidance of gas flaring/venting in Uganda and other nascent oil and gas economies.

Key Issues

- ★ Routine Flaring of Associated Gas (AG) from petroleum exploitation processes is *waste of wealth*—waste of raw material for producing electric energy.

- ★ AG can be converted to energy, used to run petroleum-industry operations, and supplied to neighboring communities and the national electric energy grid

- ★ There are national and international indicatives for reducing, and eventually eliminating, gas flaring, such as World Bank initiative and the World Bank Global Gas Flaring Reduction (GGFR) Partnership.

- ★ There are companies which can design technologies for tapping and turning AG into electric energy: WARTSILA, a Finnish corporation manufactures and services power sources and other equipment in the marine and energy markets, with emphasis on sustainable innovation and total efficiency.

- ★ Ecuador has successfully experimented with the OGE&EE [*Optimización Generación Eléctrica and Eficiencia Energética* - Optimal Electricity Generation and Energy Efficiency) Project that AG can be converted into energy.

- ★ The OGE&EE Project works alongside Petroamazonas, Ecuador's national oil company, to “convert waste into wealth.” It has generated net savings of more than US\$ 600,000,000 and reduced close to 1,000,000 tons of CO2 emission.

- ★ Though Uganda has legal restrictions on petroleum flaring/venting, it is unclear how she intends to use AG, and has weak sanctions against AG flaring.

- ★ The OGE&EE experience provides important lessons for Uganda and other new entrants in the petroleum industry on converting AG to energy.
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Introduction

Although Ecuador has, since 1967, tried to maximize returns from the petroleum sector, the country only recently started to “*turn waste into wealth*”—to convert Associated Gas (AG) into electric energy for use in and beyond the oil and gas (herein interchangeable with “petroleum”) industry.¹ The energy is linked to neighboring communities and national grid. Uganda, which is in the nascent stages of the petroleum sector, has made legal restrictions on gas flaring.² According to the midstream law, only those quantities of AG needed for normal operational safety can be vented or flared, and even so with approval from the responsible Minister. While Ecuador seeks to prevent flaring by turning it into a productive resource, Uganda is not clear on what will happen to the AG if it is not flared. Uganda is also over-lenient on the penalties for violating this law.³ Both Ecuador and Uganda appreciate the need to avoid routine gas/petroleum flaring. The question, then, remains: why bother about AG flaring?



*Gas Flaring at the CPF of Petroamazonas, Block 15, Amazon Region, Ecuador.
Author's photo, November 2016*

This Policy Brief underlines the problem of gas flaring in the petroleum sector, and draws important lessons from Ecuador for Uganda in the *conversion of waste to wealth*. The oil industry is associated with greenhouse gas emissions through AG flaring and other carbon monoxide and carbon dioxide emissions, with resulting implications for global warming. The industry now faces a new challenge: the demand for alternative green energy; and the demand for zero AG flaring.⁴ Therefore, as Uganda ascends to the production phase, and hopes to implement its Green Growth Strategy, certain investments, structures and preparations are

¹ Associated Gas/Associated Petroleum Gas is a natural gas found in petroleum deposits. Apart from on-site electricity generation using engine or turbines, AG can be added to the natural gas distribution networks, where they exist, re-injected in the wells to enhance oil recovery, converted to liquids and produce synthetic fuels, or used as feedstock for petrochemical industries. All these processes enhance energy efficiency. E. Kutepova, A. Knizhnikov & K. Kochi, 2012, *Associated Gas Utilization in Russia: Issues and Prospects: Annual Report, Issue, 4*, Moscow: WWF Russia, KPMG

² Flaring is defined in Ugandan midstream law as “combustion of hydrocarbons without application of the resulting heat or gases for any useful purpose”, and venting as “release of gas to the atmosphere.”

³ Republic of Uganda, 2013, *Petroleum (Refining, Conversion, Transmission and Midstream Storage) Act, 2013*, Entebbe: UPPC [Uganda Printing and Publishing Corporation], Part IV.

⁴ Bjorn Hamso, Gas flaring: An industry practice faces increasing global attention: World Bank “Zero Routine Flaring by 2030” Initiative, Presented to 26th World Gas Conference, 1–5 June 2015, Paris.

necessary to realise the spirit of the law and global initiatives. Three aspects are addressed here: the problem of AG flaring is summarised; project lessons from Ecuador are articulated; and lessons drawn for Uganda. The concluding section makes recommendations on what Uganda needs to learn and do.

The Problem of AG Flaring

Flaring and/or venting of AG is wastage of energy. According to the World Bank, there is a puzzling relationship between the AG flared annually from the petroleum sector and the potential power generation that can be achieved from this same flared gas. This is ironical since there are, at present, techno-scientific approaches to appropriating AG for productive use in both the petroleum and energy sectors. Hence:

- About 140 billion cubic meters of AG are released annually. This can produce 750 billion kWh power.
- About 350 million tons of CO₂ emissions result from AG flaring annually, equivalent to about 77 million cars' emissions of the same gas.
- The black carbon from flares deposits on snow and ice caps, causing melting of these frozen waters.
- Under-developed, poorly functioning markets and infrastructure discourage investment in flare elimination.
- A conducive policy environment and state commitment are needed to eliminate AG flaring.
- The distance from AG to energy production underlines matters related to final users.
- Management of gas characteristics for flared gas is technically vital in making it viable investment option.⁵

The World Bank has also undertaken some initiatives to control gas flaring. The World Bank global Initiative was launched in April 2015, to end routine gas flaring by 2030. It hopes to work with governments, oil companies, and development agencies to stop the wasteful AG flaring to which some countries have committed.⁶ Presently, Russia, Nigeria, Iran, and Iraq are the highest gas-flaring countries.⁷

⁵ World Bank, 2015 (Sept. 22-23), *Global Initiative: Combining Forces to End Routine Gas Flaring*, Washington DC: World Bank. WB/IGU/SE4ALL Regional Gas Seminar, Maputo (from <http://www.igu.org/sites/default/files/7-3%20World%20Bank%20-%20Anas%20Benbarka%20-%20Gas%20Competence%20Seminar%20-%20September%202023%202015.pdf>, 21 Nov. 16)

⁶ Dominic Chavez, 2015 (May 22), 'Initiative to Reduce Global Gas Flaring', Washington DC: World Bank (from <http://www.worldbank.org/en/programs/zero-routine-flaring-by-2030/brief/initiative-to-reduce-global-gas-flaring>, 20 November 2016); World Bank, 2016a. Global Gas Flaring Reduction Partnership (GGFR), Washington DC: World Bank (from <http://www.worldbank.org/en/programs/gasflaringreduction>, 21 Nov. 16); World Bank, 2016b (August 18), 'Nigeria Endorses 2030 Flaring Initiative; Raises Own Goal to 20202'. Brief, Washington DC: World Bank (online: <http://www.worldbank.org/en/programs/zero-routine-flaring-by-2030/brief/nigeria-endorses-zero-flaring-initiative>, 20 November 2016)

⁷ Chavez, 'Initiative to Reduce Global Gas Flaring'.

Nigeria recently endorsed the World Bank initiative, headed by Bjorn Hamso, hence working with the World Bank Global Gas Flaring Reduction Partnership (GGFR).⁸ The country claims to be “strategically pursuing a National Target Date of 2020.”⁹ The GGFR is a public-private initiative comprising national and international oil companies, national and regional governments, and organised international institutions (Box 1). While not converting AG into liquid fuels¹⁰, the GGFR works by increasing the use of AG by removing technical and regulatory barriers to flaring reduction, undertaking research, disseminating best practices, and developing country-specific gas flaring reduction programs at national level.

Box 1: GGFR Membership

Members of the GGFR Partnership include: **oil companies** [(BP, Chevron, Eni, ExxonMobil, Kuwait Oil Company, Pemex (Mexico), Qatar Petroleum, Shell, SNH (Cameroon), SOCAR (Azerbaijan), Sonatrach (Algeria), Statoil, and TOTAL)]; **Governments** [(Alberta (Canada), Republic of Congo, France, Gabon, Indonesia, Iraq, Kazakhstan, Khanty-Mansiysk (Russia), Mexico (SENER), Nigeria, Norway, USA, Uzbekistan, Yamal-Nenets AO (Russia)]; and **international institutions** (The European Bank for Reconstruction and Development (EBRD); European Commission; & World Bank).

For new entrants in the oil and gas industry, such as Ghana, Uganda, Kenya, and Tanzania, projects and investment initiatives are needed that can promote a green petroleum sector. This not only resonates with global-level concerns about the nexus between AG flaring and climate change but provides benefits—monetary, skills development, energy supply, and reputation—to the country and its petroleum-sector investors. The experience of Ecuador becomes relevant here.

The OGE&EE Project in Ecuador

The *Optimización Generación Eléctrica and Eficiencia Energética* (Optimal Electricity Generation and Energy Efficiency) OGE&EE project is a social investment enterprise operating alongside Petroamazonas, Ecuador’s premier national oil company. Within the project, practices like local content (through skills development, employment), environmental conservation, community benefits, and profit generation are combined in a single model. This model deviates from the conventional winner-loser ethos in capitalist conceptions of petroleum resources

⁸ See World Bank, GGFR

⁹ World Bank, ‘Nigeria Endorses 2030 Flaring Initiative’

¹⁰ See, Theo Fleisch, 2014, *Associated Gas Monetization via miniGTL: Conversion of Flared Gas into Liquid Fuels and Chemicals*, Washington DC: World Bank (from <https://openknowledge.worldbank.org/bitstream/handle/10986/22116/AssociatedGas00fuels0and0chemicals.pdf?sequence=1&isAllowed=y>, 20 November 2016); World Bank, 2012, *Associated Gas Utilization via miniGTL*, Washington DC: World Bank (from <https://openknowledge.worldbank.org/bitstream/handle/10986/21976/Global0gas0fla0lization0via0miniGTL.pdf?sequence=1&isAllowed=y>, 21 Nov. 16).

exploitation, and *ensures that the oil company, the country, and project-affected communities win together*. Eventually, the oil industry gets cheaper electricity as do neighbouring communities, while the country begins to acquire a green petroleum sector. The project's goal is to reduce the carbon footprint per extracted barrel of oil (both in terms of emissions, costs, and other parameters).¹¹

Berend van den Berg, *the initiator of the project*, revealed that the OGE&EE project was initially designed as a \$1.2 billion program. But by end of 2016, it had only been capitalised to about US\$620 million. The project consists of about 120 sub-projects in an area covering 25,000sq km, 17 oil blocks, 56 oil fields and 66 facilities. The initiative has multiple power plants which *use AG as fuel to produce more than 325MW of power*; over 900kms power distribution facilities; and approximately 100km of gas gathering and transportation facilities. The OGE&EE project turns previously deteriorated facilities to standard and implements waste heat recovery systems. It interconnects the integrated oil industry electric grid to the national electric grid, paving the way to optimising excess hydro-electric power during off-peak hours. This, Behrend describes as “transforming water into oil”, *turning waste into wealth*. Research and development (R&D) in such areas as flexible fuel solutions, which can use AG, crude oil, condensates, or a combination of each, is undertaken. The AG is converted to power, monetised by means of virtual pipelines, and made technically and economically viable to bring small volumes of remote AG to market.

The OGE&EE project uses AG “with low volumes at the source and high CO₂, heavier hydrocarbons and water content”¹² The project team did not have their own R&D centre, but relied on WARTSILA, a Finnish corporation with net sales totalling EUR 4.8 billion. The company manufactures and services power sources and other equipment in the marine and energy markets, with emphasis on sustainable innovation and total efficiency.¹³ The project has already generated net savings of more than US\$ 600,000,000 and reduced close to 1,000,000 tons of CO₂ emission. In terms of design and funding, the project designers did not have R&D capacity. However, they dictated the design criteria whereby the upfront expenses were assumed by WARTSILA under a Service Agreement in which the OGE&EE only paid subject to performance (“no cure no pay”) on a US\$/kWh basis. The project's Combined Cycle Power/Heat for Processing Facilities was also funded by the technology company based on design criteria provided by the OGE&EE team. Payment was made after a 10-day performance test. A Virtual Pipeline for Stranded Associated Gas (VPSAG) was conceptualised by the OGE&EE, then a development agency, the Inter-American Development Bank, funded it on condition that it would be validated by a third party. Presently, the OGE&EE is looking for funding for a pilot project on similar innovations. Thus, while government and the national oil

¹¹ Berend van der Berg, 2017, Email Correspondence with the Author, February 2017. Material in this paragraph is derived from this email correspondence, presentations, and personal discussions.

¹² Interactions with van den Berg during visit to Amazon region, Nov. 2016

¹³ Read about WARTSILA here: <http://www.wartsila.com/oil-gas> / <http://www.wartsila.com/energy>.

company were willing to allow the project proceed, they were hesitant to fund its investments.



Visiting Petroamazonas's Central Processing Facility, Block 15, where one of the OGE&EE facilities are operated. November 2016. Author's photo.

The OGE&EE team reveals that the public sector tends to have reservations regarding funding R&D, since the *authorities normally fear the fact that not all R&D projects become successful*. So, OGE&EE team transferred virtually all the R&D risk to technology companies (pay per view). The overall R&D budget was in the range of 3–4% of the total Project Cost: “we invested over US\$ 650,000,000 whereby the R&D funds were in the range of US\$ 30,000,000. 85% of these R&D expenses were financed by technology companies and paid over time on a performance basis.” These third-party funding modalities allowed for payments to be made based on actual performance. Internally the OGE&EE did the following R&D work:

- High pressure associated gas buffers to compensate peaks and lows in AG supply.
- Adjustment prime movers so that, with the minimum gas treatment, they could run on raw AG (thereby reducing the overall investment cost and maximizing returns from the AG-as-fuel for power generation).
- Change from overhead to underground cables even for higher voltages.

With such projects as the OGE&EE, there is always a tremendous pressure to increase local content. Such may be the right way to go. Nevertheless, there are risks when trying to increase local content without matching local competence. As van den Berg warns, “any work in the hands of the wrong people will generate unsatisfactory results. It is for this reason that I strongly believe that the push for local content has to go hand in hand with capacity building through either joint ventures, ‘inplants’ (I was hired for 8 years to work together with Ecuadorians working for the national oil company), etc.”¹⁴ These initiatives were allowed because of government’s interest in expanding energy production

¹⁴ Van den Berg, email correspondences, February 2017.

Lessons for Uganda

- ❖ Uganda will reap benefits from investing in OGE&EE-like projects as it establishes CPFs: the energy generated supplements endeavors to expand energy production.
- ❖ Even if the Joint Venture Partners (JVPs) may be hesitant to invest in AG conversion, there are global and specific initiatives and companies that can invest in the initiative
- ❖ Avoiding AG flaring, as provided for in the midstream law, but especially *if the waste is turned to wealth*, has positive augments Uganda's Green Growth Strategy.
- ❖ Uganda's commitments under the Paris Agreement require that OGE&EE-like projects and initiatives be encouraged and facilitated, where necessary through public-private partnerships.
- ❖ Funding for AG-energy conversion it not as problematic as many people may think.

Conclusion and Policy Recommendations

AG flaring/venting remains a significant challenge in the petroleum sector especially when one considers the considerations an oil company needs to make before investing in additional technology and infrastructure needed to prevent flaring and commercialize AG-energy outcomes. Uganda, like other new entrants in the petroleum industry, has one advantage: it can integrate relevant structures and technologies in infrastructure developments for the petroleum-sector. Ecuador may have suffered this delay due to the relative lateness of anti-flaring initiatives and technologies. Operationalization of Uganda's legal restrictions on AG flaring requires deliberate efforts to design, develop, and utilize structures and technologies for AG appropriation – whether by the JVPs or new investors. From this observation, and the lessons from the OGE&EE project in Ecuador, the following recommendations can be made:

Uganda’s state, government, and JVPs should benchmark the OGE&EE Project: Benchmarking the OGE&EE project reveals practical experiences on avoidance of AG flaring, generation of valuable electric energy, and contribution to reductions in carbon emissions.

State and government agencies, particularly the Petroleum Authority of Uganda, Directorate of Petroleum, and National Oil Company, should realize that the issue transcends laws, regulations, guidelines: Avoiding AG flaring requires going beyond legal provisions on paper. Systems of implementation, practices, and provision of incentives for investment in AG appropriation are needed to realise the objective of any legal provision.

The Petroleum Authority and Directorate of Petroleum should create synergy of interests: Bureaucratic commitment, political will, and investor interests need to converge on the modalities for preventing AG flaring and seeing AG not as waste but as wealth to tap.

The Ministry of Energy and Mineral Development (MEMD), working with research agencies and institutions, should promote and encourage R&D to identify and exploit other Energy Mixes: alongside AG-energy process and energy-sector diversification, Uganda should invest in R&D on potentialities for other energy mixes, such that the AG-energy conversion process is seen as part of the broader move to hydro-energy, wind energy, and other forms of green energy.

Government and JVPs should invest in, and conduct more, Research: if AG was previously seen as waste but is now seen as wealth, what other petroleum-sector wastes can be converted to wealth? Identifying these resources is vital for expanding benefits from the oil and gas sector.



Berend van den Berg, explaining the OGE&EE project processes, at Petroamazonas’s CPF, Block 15, Ecuador, November 2016. Photo by Author

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