PLANNING & MODELING UNDER UNCERTAINTY – DEVELOPMENT OF THE MOZAMBIQUE NATURAL GAS MASTER PLAN

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Outline

- ICF International and Mozambique
- The Mozambique Gas Master Plan
- Analyses conducted
- Recommendations
- Lessons Learned
ICF and the Gas Master Plan for Mozambique

- ICF International ([www.icfi.com](http://www.icfi.com)) is a 4,500 person consulting firm headquartered in the Washington DC area advising governments and industry energy, environment, climate change, social programs, security, IT, communications.
  - Extensive work in energy sector clients in power planning, transmission, gas systems, market analysis, energy efficiency, renewable energy, resource assessments, gas and power market modeling
  - Offices in Beijing, Brussels, London, Rio de Janeiro, Bangkok, New Delhi, Nairobi and across the United States and Canada.

- In 2012, World Bank engaged ICF to develop a gas master plan for Mozambique – completed in 2012, with ongoing implementation support in 2013.

- Encouraged by the World Bank and other IFIs, developing countries are producing gas master plans (GMP) to guide public policy and investment to enable the widespread use of gas and promote economic development.
  - A GMP sets out a vision, objectives, strategic plans, policies, and implementation action plans. It is a roadmap for gas sector development.
ICF’s Charge was Broad

- **Scope of work combined analysis with policy development**
  - Prepare gas supply outlook
  - Develop market assessments and netback analysis
  - Review current policies and plans in context of gas development
  - Assess the financial requirements and needs
  - Evaluate pricing options for domestic sales
  - Develop a planning model and train Mozambique staff on its use
  - Assess environmental, socioeconomic, non-monetary impacts
  - Review other countries’ experiences with gas development
  - Develop consensus on the Vision for the Gas Master Plan
  - Draft a Gas Master Plan and Implementation Strategy
  - Support GoM in developing a Consensus Gas Master Plan

- Work began in April 2012 and was largely finished by December 2013
Mozambique Situation

- Anadarko and ENI gas discoveries (>100 Tcf) in far North; markets in far South
  - Pande Temane fields serving South Africa and Matola
- Little indigenous heavy industry
- Major coal development around Tete
- Limited institutional capacity to manage complex development issues
- Major poverty, educational, infrastructure, geography, governance challenges
MOZAMBIQUE RESOURCE AND SUPPLY OUTLOOK

Major Activities are Concentrated in Two Basins

Mozambique Basin – Pande Temane

Rovuma Basin

Source: INP
ICF conducted an independent resource assessment looking at 7 areas.

For Rovuma and Mozambique basins, considerable literature is available.
  - For other areas used field size distribution to estimate resource potential.

Little work has been done in the areas outside Rovuma and Pande Temane.

Legend:
- Region 1 - Rovuma Offshore North
- Region 2 - Rovuma Offshore South
- Region 3 - Rovuma Onshore
- Region 4 - Maniamba Basin Onshore
- Region 5 - Central Offshore
- Region 6 - South & West Onshore
- Region 7 - South Offshore

Note: The map shows the seven regions of interest as identified by ICF for the Mozambique resource assessment.
MOZAMBIQUE RESOURCE AND SUPPLY OUTLOOK

Substantial Resources are Low Cost

- Mozambique is well situated relative to other potential LNG developments around the world.
- LNG production from the Rovuma basin will be cost competitive with other LNG export projects.
- Nevertheless, given the quantity of LNG being developed around the world and specifically in the U.S., there may be a narrow window of opportunity, in the 2018 to 2022 timeframe to develop.
Demand Potential Driven by “Mega-Projects”

- **Two types of demand**
  - Mega-projects – anchor gas loads
  - Domestic uses primarily in small and medium enterprises (SME) – opportunistic gas loads

- **Mega-projects**: large, mostly feedstock, industries with large methane demand for export of commodities into the world markets
  - LNG, methanol, fertilizer, Gas-to-liquids
  - Power generation, steel, aluminum (w/power), cement

- For each mega-project ICF developed a product demand forecast and a “net-back” analysis
  - What is the maximum price of gas an industry would tolerate and meet investment objectives

- Each industry’s employment effects, direct and indirect were evaluated and used in the ranking of industries seeking gas from Mozambique

- Domestic uses in SMEs will arise with development of gas infrastructure anchored by the mega-projects
## Ranking the Projects

<table>
<thead>
<tr>
<th>Rank</th>
<th>Project</th>
<th>Potential Impact</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LNG</td>
<td>Without LNG, offshore development will not happen.</td>
</tr>
<tr>
<td>2</td>
<td>Power Plants</td>
<td>Reliable electricity will generate significant opportunities for industrialization and rural electrification. Small-to-medium plants, as well as large combined cycle plants, can be considered.</td>
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<tr>
<td>3</td>
<td>Fertilizer (urea) GTL (FT or Methanol)</td>
<td>Existence of domestic demand and import reduction in both sectors. Both sectors are highly dependent on market prices, especially for export.</td>
</tr>
<tr>
<td>5</td>
<td>Methanol export</td>
<td>Export markets for methanol is very much subject to market forces.</td>
</tr>
<tr>
<td>6</td>
<td>Aluminum</td>
<td>Gas-based electricity dedicated for aluminum needs to be carefully considered, with a deeper analysis of the Mozal plant.</td>
</tr>
<tr>
<td>7</td>
<td>Iron and Steel Cement</td>
<td>These sectors consume very little gas, and they are not the primary drivers of gas development in Mozambique (or elsewhere).</td>
</tr>
</tbody>
</table>
ICF Developed a Planning Model to Assess the Benefits of Alternative Development Scenarios

- Model has network of supply and demand nodes linked by transportation options
  - Pipeline
  - LNG

- Supply scenario is specified

- Development scenario is specified by users
  - Identifies types of gas uses, size
  - Location
  - Delivery linkages

- Model “chooses” optimal configuration and reports flows, prices at the nodes, employment in Mozambique, addition to GDP

- Post processing generates fiscal impacts, environmental and socioeconomic implications
ICF Evaluated Six Scenarios

- **Scenario 1:** Enclave LNG Development in Palma
  - 2 trains (5 million tonnes each) in 2016, with 5 million tonnes train every two years until total of 6 trains in Palma
  - 150 MW power plant in Palma in 2018, as part of LNG development
  - 150 MW power plant in Ressano Garcia in 2015
  - Gas processing and export to Secunda with ROMPCO pipeline
  - Gas supply to Matola same as current supply

- **Scenario 2:** LNG and Palma Centered Development
  - Palma LNG and power development same as in Scenario 1
  - Fertilizer (2021) and GTL (2022) plants in Palma
  - Southern development is same as in Scenario 1

- **Scenario 3a:** Development Centered in Pemba
  - Palma LNG and power development same as in Scenario 1
  - Fertilizer (2021) and GTL (2022) plants in Pemba
  - 150 MW power plant in Pemba in 2020
  - Pipeline or LNG shipping between Palma and Pemba by 2020
  - Southern development is same as in Scenario 1
ICF Evaluated Six Scenarios

- **Scenario 3b:** Development Centered in Nacala
- **Scenario 3c:** Development Centered in Beira
- **Scenario 4:** Pemba-based LNG Development

**Scenario 3b:**
- Palma LNG and power development same as in Scenario 1
- Fertilizer (2021) and GTL (2022) plants in Nacala
- 150 MW power plants in Pemba and Nacala in 2020
- Pipeline or LNG shipping between Palma and Nacala by 2020
- Southern development is same as in Scenario 1

**Scenario 3c:**
- Palma LNG and power development same as in Scenario 1
- Fertilizer (2021) and GTL (2022) plants in Beira
- 150 MW power plants in Pemba, Nacala, Quelimane, and Beira in 2020.
- Pipeline or LNG shipping between Palma and Beira.
- Southern development is same as in Scenario 1

**Scenario 4:**
- Palma LNG and power development same as in Scenario 1
- Offshore development in Rovuma south
- Gas processing and LNG in Pemba
- One 5 million tonnes train in 2022 and second train in 2024 in Pemba
- Southern development is same as in Scenario 1
Direct and Indirect Employment and Government Revenues

- Total government revenue including taxes, royalties, and profit gas is about $6-$8 billion per year.

- Local expenditures and use of local labor for LNG related activities and in small and medium enterprises is important for increasing employment in Mozambique.

- Pipeline transport can induce gas-based industries along the way, and can be a good option for promoting development across Mozambique.

- Location of mega projects near urban centers can promote greater employment and economic activity.
Vision for the Mozambican GMP

Develop natural gas resources in a manner that maximizes benefits to Mozambique society by supporting --

- growth in domestic public and private sector institutional competencies;
- growth in domestic industry and businesses, especially small and medium scale industries;
- increased employment across the country, especially in the less-developed provinces;
- infrastructure to support expanded economic activities, especially in less-developed provinces; and
- expanded access to training and education in order to improve the quality of life for the people of Mozambique, while minimizing adverse social and environmental impacts.

- Vision developed with guidance from Government Steering Committee with senior officers from various Ministries

- Significant stakeholder involvement and meetings
Key to the GMP: A Hierarchy of Decisions

- Take only those decisions now that are critical to develop the gas sector.
  - In parallel, begin studies to develop additional information, so that less urgent decisions can be made later on a more informed basis.

- To deal with uncertainty, initiate a number of new studies, and follow through on getting more information.

- Expedite development of Palma LNG project & exports.

- Implement a public communication strategy.

- Mega projects are strategic anchors and need to be selected using a market based approach.

- Gas prices should not be priced below production cost.
LESSONS LEARNED

Lessons for Future GMPs (1)

- GMP needs to focus on strategic analysis of policies, institutions, and regulations in the gas sector, rather than just technical details and specific build-out plans.
  - The technical and economic analyses are not an end in itself, but must be done to inform the recommendations for policy changes and plans.

- Recommendations must contain an hierarchy of decisions, whereby the government can take specific decisions now and then conduct additional analysis over time that will inform future decisions.
  - The GMP is not meant to define all decisions about the sector, and the master plan should evolve over time based on actual circumstances.

- Government needs to actively plan for implementation of GMP decisions, early in the GMP process.

- Inclusion and active participation of key government ministries in GMP development, for example, through a Steering Committee or Working Group process, is important for developing a viable and actionable GMP. Broader stakeholder involvement is also critical for success.
Lessons for Future GMPs (2)

- Economic impacts analysis (e.g., contribution to GDP, employment, etc.) is contingent on the availability of economic data and models. It is also important to recognize the limitations of such economic analysis.

- Government agencies should actively participate in the development of modelling (e.g. by providing data and learning to use the models) and use planning tools to enhance their internal understanding of the challenges and the required policy decisions.
  - Such active participation will build internal capabilities and will allow the government to consider new scenarios and options based on future information.

- Power generation is an anchor load for natural gas, and GMP and power sector planning processes need to build on each other.

- Gas development will also interact with other sectors (e.g., power, transportation, and industry) and therefore an assessment of the broader institutional and regulatory/policy framework will be necessary.

- Learn from experiences of other countries.