



Linda Morand

Power and Energy Engineering

Emerging Concepts and
Applications

Power and Energy Engineering: Emerging Concepts and Applications

About the Book

Power engineering can be defined as the development of energy harnessing and distributing technologies that improve energy efficiency. This book on power and energy engineering discusses the design and maintenance of energy technologies. This book attempts to understand the multiple branches that fall under the discipline of power and energy engineering and how such concepts have practical applications. The various studies that are constantly contributing towards advancing technologies and evolution of this field are examined in detail. This text aims to advance the already existing knowledge on energy engineering and energy efficiency technologies. Students, researchers, experts and all associated with this field will benefit alike from this book. For all those who are interested in energy engineering, this book can prove to be an essential guide.

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Linda Morand received her MSc in energy and power engineering from the University of Warwick, United Kingdom. She is a senior professor; and has a wide range of academic and teaching interests, which include hybrid generation systems, energy storage, power systems, waste energy management and renewable energy power generation. Morand is a noted researcher in the fields of power and energy engineering; and has produced numerous articles, journal papers and books in these areas.



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Editor: Linda Morand



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Power and Energy Engineering: Emerging Concepts and Applications

Preface

Every book is a source of knowledge and this one is no exception. The idea that led to the conceptualization of this book was the fact that the world is advancing rapidly; which makes it crucial to document the progress in every field. I am aware that a lot of data is already available, yet, there is a lot more to learn. Hence, I accepted the responsibility of editing this book and contributing my knowledge to the community.

Power engineering can be defined as the development of energy harnessing and distributing technologies that improve energy efficiency. This book on power and energy engineering discusses the design and maintenance of energy technologies. This book attempts to understand the multiple branches that fall under the discipline of power and energy engineering and how such concepts have practical applications. The various studies that are constantly contributing towards advancing technologies and evolution of this field are examined in detail. This text aims to advance the already existing knowledge on energy engineering and energy efficiency technologies. Students, researchers, experts and all associated with this field will benefit alike from this book. For all those who are interested in energy engineering, this book can prove to be an essential guide.

While editing this book, I had multiple visions for it. Then I finally narrowed down to make every chapter a sole standing text explaining a particular topic, so that they can be used independently. However, the umbrella subject sinews them into a common theme. This makes the book a unique platform of knowledge.

I would like to give the major credit of this book to the experts from every corner of the world, who took the time to share their expertise with us. Also, I owe the completion of this book to the never-ending support of my family, who supported me throughout the project.

Editor

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Analysis of Nigeria-Sao Tome and Principe Joint Development and Suggestions for China

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Abstract: The Nigeria-Sao Tome and Principe Joint Development is a typical case in Africa. The two states are located in Gulf of Guinea, where delimitation disputes inside are serious and oil competitions among western developed countries outside are fierce, the Nigeria-Sao Tome and Principe Joint Development is carried out on this background. About the implement, several factors play a positive role: stable bilateral relations, adjustments of domestic policies and the establishment of Gulf of Guinea Commission; but oil steal and outside intervention are negative factors. About the content, many special provisions, such as Proportion, Management, Petroleum Development Contracts and Disputes Settlement are contained in joint development agreement. However, there are still some problems unsolved: unequal status of the two states, lack of information sharing mechanism and supervision mechanism, multinational corporations' monopoly. China should learn from it, deepen mutual understanding and mutual trust with countries nearby to promote joint development in South China Sea.

Keywords: Joint Development, Joint Development Agreement, International Law

1. Introduction

The Nigeria-Sao Tome and Principe Joint Development is a major attempt in Africa to develop offshore oil and gas resources. Nigeria and Sao Tome and Principe are located in Gulf of Guinea in West Africa, where oil and gas reserves are quite rich, attracting the world's attention. Oil carries substantial weight in these two countries. Nigeria is the world's second largest economy, oil exports, which contribute 98% of Nigeria's total export revenue and 83% of Nigeria's national income, are its most important economic source. Sao Tome and Principe also has rich offshore oil deposits, which are about 500 million barrels estimated by Exxon Mobil in 1999. At present, since China has been trying to promote joint development with countries in South China Sea, it is of great significance to analysis joint development cases, like Nigeria-Sao Tome and Principe Joint Development, to supply some useful lessons and experience.

2. Nigeria-Sao Tome and Principe Joint Development: Background and Factors

2.1. Background

The background of Nigeria-Sao Tome and Principe joint development project is mainly divided into two aspects:

External powers compete fiercely for oil in Gulf of Guinea. The Gulf of Guinea is one of the world's richest oil-producing areas,^[1] and draws the world's attention because of high oil quality and convenient transportation. European and American developed countries try all means to have a share of oil in this rich land, which can be mainly manifested in two aspects:

Competition among traditional powers. The United States is the largest investor and beneficiary in Gulf of Guinea, and the advantages are still expanding. Gulf of Guinea, compared to Middle East, is nearer to the United States and free from terrorism, and of strategic importance for the United States. Nigeria, the largest oil producer in Gulf of Guinea, is an ideal oil supply country for the United States. After a series of diplomatic pushes and massive investments, many American

oil companies like Chevron Texaco, Exxon Mobil and Esso have already established a foothold.^[2] European countries represented by the United Kingdom and France don't want to be left behind. The United Kingdom expands business further in Nigeria, and also joins hands with France to compete with the United States to attain prospecting and mining rights.^[3] France considers oil as a crucial factor when making diplomatic exchange and economic cooperation with West African countries.^[4] These developed countries and oil giants mentioned above compete vigorously to carve oil resources.

Competition between traditional powers and emerging powers. Being aware of the tremendous business opportunities and the severe situation in Gulf of Guinea, newly emerging powers, such as China, South Korea and India, start competing with those traditional powers. It can be envisaged that, it is quite difficult for newly emerging powers to break the existing interests division mode. Due to traditional powers' continuous blocking, emerging powers have paid a huge price for growing. South Korea, for example, paid a record \$310 million to win just No.323 deep-sea bloc in Nigerian oil bloc bidding, while the previous highest bid for single oil bloc was only \$200 million.^[5] In addition, competition also exists among emerging forces. South Korea and India produced dissatisfaction with each other because of claiming bidding bloc before.

Internal maritime delimitation disputes are prominent. Several countries located in Gulf of Guinea, which makes maritime delimitation very sensitive and complex. In the maximum concave, Nigeria, Cameroon, Gabon, Equatorial Guinea and Sao Tome and Principe, whose delimitation claims overlap, share a narrow sea. Any establishment or change of delimitation claims from one country will affect the others, which can be testified vividly in the case concerning Land and Maritime Boundary between Cameroon and Nigeria. Since Cameroon submitted the dispute to the International Court of Justice in March 1995, countries left began to assert their claims.

Equatorial Guinea's territorial water and exclusive economic zone boundary is delineated in accordance with international law and its domestic law. The boundary located in the northeast corner of Gulf of Guinea, overlaps with both Cameroon's and Nigeria's claims. Equatorial Guinea then sent letters to the Court respectively in June 1999 and in September 1999, requiring acting as a non-party intervener to participate in the Cameroon v. Nigeria to protect its legitimate interests. After that, Nigeria responded respectively in August 1999 and in September 1999, that Equatorial Guinea can be allowed to participate the case through Separation of the Proceedings at the premise of not affecting the trial process; Cameroon also took a stand respectively in August 1999 and in October 1999.^[6]

Sao Tome and Principe didn't chose to intervene the Cameroon v. Nigeria, but its delimitation with neighboring countries is pending. Sao Tome and Principe reiterated its archipelagic baselines in 1998, and reached maritime delimitation treaties respectively with Equatorial Guinea in 1999 and with Gabon in 2001, but the treaties are not enforced

finally. The tripartite boundaries among Sao Tome and Principe, northern Equatorial Guinea and southern Cameroon are undelineated.^[7] In addition, Sao Tome and Principe has been pursuing negotiations with Nigeria because of overlapping EEZ claims.

2.2. Factors

There are some beneficial factors promoting Nigeria-Sao Tome and Principe joint development:

Nigeria and Sao Tome and Principe both adjust their domestic policies. How to attract foreign investment, especially international oil companies, becomes a key problem for Nigeria and Sao Tome and Principe. Therefore, Nigeria and Sao Tome and Principe have introduced various preferential policies to improve domestic investment environment to ensure smooth conduct of joint development.

For example, Nigeria polices, including foreign investors can obtain crude oil for refining from Nigerian National Petroleum Corporation, can enjoy the same price of crude oil with domestic refineries, can withdraw investments freely and so on, play an important role in attracting foreign investors.^[8]

Sao Tome and Principe also enacted a new bill in 2004 to regulate petroleum fund management, aiming at establishing a national oil fund and ensuring transparency of national management of oil revenues. Oil contracts signed by government must be open, and at least 65% of oil revenues will be used for medical care, education and infrastructure construction annually. When the oil fund is converted into money, the President, the Prime Minister, the Central Bank President and other major financial officers have to sign; the oil sector, has to be audited twice a year by Accounting Council and International Accounting Firms.^[9] The bill creates favorable investment environment in Sao Tome and Principe.

Nigeria and Sao Tome and Principe have stable bilateral relations. Although these two countries have disputes of offshore oil revenues, the bilateral relationship overall is stable, which with no doubt can promote the joint development.

On the one hand, relatively speaking, Nigeria and Sao Tome and Principe conduct joint development smoothly. From the formal signing of the Treaty in 2001, to the establishment of Joint Ministerial Council (JMC) in 2002, and to the first licensing round in 2003, the whole process is relatively short and the conduction goes successfully.

On the other hand, Nigeria and Sao Tome and Principe carry out some more mutually beneficial cooperation. For example, Nigeria intended to provide an interest-free loan of sixty-year repayment period to Sao Tome and Principe in July 2010. Before that, Nigerian government had already decided to provide a \$30 million loan to Sao Tome and Principe.^[10] In addition, a military coup happened in Sao Tome and Principe in July 2003, Nigeria strongly condemned the coup, and sent an envoy to Sao Tome and Principe to help Sao Tome and Principe to resolve the crisis.

The Gulf of Guinea Commission was established in 2006. Gulf of Guinea Commission was established in the summit meeting of Gulf of Guinea countries held in Libreville, capital

of Gabon. The headquarter is based in Angola. The committee is responsible for consulting and mediating oil exploration and other aquatic resources disputes among Gulf of Guinea countries. Until now, the committee consists of eight member states: Angola, Cameroon, Congo (Brazzaville), Gabon, Equatorial Guinea, Nigeria, Congo (DRC) and Sao Tome and Principe.

Treaty establishing the Gulf of Guinea Commission builds a legal framework for the Gulf of Guinea Commission and provides guidance for oil exploration activities and disputes resolution in Gulf of Guinea. The treaty includes a preamble and 31 terms, the preamble emphasizes that member states should strengthen multilateral cooperation, enhance mutual trust, consolidate good-neighbor relations, and make full use of resources obtained to promote economic development and improve people's living standards. Member States express their willingness to develop social economy and obeying the treaty.^[11]

The establishment of the Gulf of Guinea Commission provides a stable environment to carry on joint development activities for Nigeria-Sao Tome and Principe, and provides guarantee for African countries to manage and utilize energy with international organizations to develop social economy.

Nigeria-Sao Tome and Principe joint development is also influenced by some negative factors:

Oil losses are serious. Oil theft is rampant in Nigeria, causing huge losses to national oil industry. One Nigerian government report shows that, Nigeria loses nearly \$35million daily due to oil theft, and explosions caused by excavations are common. In March 2014, Shell, working in Nigeria, said that Shell lost over \$1billion caused by oil theft and infrastructure destruction in 2013. Therefore, when Shell found oil leakage in November 2014, the company shut down an important pipeline immediately^[12] to minimize losses.

Besides, the waterways and forests in Niger Delta area are criss-cross, local folk armed groups, such as Delta People's Volunteer Army, taking advantage of this complex geographical condition, steal oil from underwater pipeline for a long time. They sell oil to buy weapons to fight against the government.^[13] What is very worried is that the joint development zone is exactly located in the Niger Delta, thus huge oil losses and anti-government forces presence are with no doubt harmful to joint development.

Western penetration brings negative effect to joint development. Except giant oil companies, European countries and the United States also strengthen their military presence and economic penetration from a national strategic level. The United States is the most typical representative.

For example, in Nigeria, the United States sent former military officials to provide military training and assistance to improve Nigeria's combat capability,^[14] to ensure safety oil transportation; in Sao Tome and Principe, in addition to huge investments, the United States has built a large-scale radar network to strengthen surveillance of Gulf of Guinea. Although those initiatives contribute to eliminating theft and ensuring maritime oil transportation, negative effects exist too:

Economically, the fate "oil curse" of Nigeria and Sao Tome and Principe is still inevitable. The US investments in Nigeria and Sao Tome and Principe are basically carried around oil, which although creates a lot of jobs for local people, these two countries are still very poor and the rich-poor division is still serious from a long-term point of view because of the absence of a stable economic system and an equal distribution. In addition, Sao Tome and Principe are excessively dependent on US investments,^[15] lacking economic independence and creativity, and the government doesn't spend money on domestic infrastructure construction. Thus Nigeria and Sao Tome and Principe are impossible to get rid of "oil curse" in a short time.

Militarily, the strengthening of outside military exacerbates the two countries' instability. The United States provide military assistance in Nigeria to protect its own oil security. The intervene of the United States turns the former bilateral mode of Nigeria government-folk armed groups into a tripartite mode of the United states-Nigeria government-folk armed groups. What's more, local folk armed groups always kill American oil company's officials in order to revenge.

Politically, the decision-makers' personal role has been strengthened and corruption is rampant. The United States does not help Nigeria and Sao Tome and Principe governments to improve national management, but highlights the decision-makers' individual influence unprecedentedly, leading to frequent corruptions and scandals. To cooperate with Nigeria, the American officials inevitably have to transfer benefits to decision-makers, whose political principle is "cooperation with money givers" and who do not put long term development and political democracy as principal factors.

3. The Nigeria-Sao Tome and Principe Joint Development: Contents and Disadvantages

3.1. Contents

In February 2001, Nigeria and Sao Tome and Principe signed "Treaty between the Federal Republic of Nigeria and the Democratic Republic of Sao Tome and Principe on the Joint Development of Petroleum and other Resources, in respect of Areas of the Exclusive Economic Zone of the Two States", which contains mainly following aspects:

Proportion: Article 3(1) regulates that "Within the Zone, there shall be joint control by the States Parties of the exploration for and exploitation of resources, aimed at achieving optimum commercial utilization. The States Parties shall share, in the proportions Nigeria 60 percent, Sao Tome and Principe 40 percent, all benefits and obligations arising from development activities carried out in the Zone in accordance with this Treaty."

Management: Nigeria-Sao Tome and Principe joint development is a "two-tier" management structure: the Joint Ministerial Council and the Joint Authority. The first tier, the

Joint Ministerial Council, shall have overall responsibility for all matters relating to the exploration for and exploitation of the resources in the Zone, and such other functions as the States Parties may entrust to it. The Council shall comprise not less than two nor more than four Ministers or persons of equivalent rank appointed by the respective Heads of State of each State Party. The Council shall meet at least twice a year and as often as may be required, alternately in Nigeria and in Sao Tome and Principe. Meetings shall be chaired by a member nominated by the host State Party. All decisions of the Council shall be adopted by consensus. The second tier, the Joint Authority, shall have juridical personality in international law and under the law of each of the States Parties and such legal capacities under the law of both States Parties as are necessary for the exercise of its powers and the performance of its functions. In particular, the Authority shall have the capacity to contract, to acquire and dispose of movable and immovable property and to institute and be party to legal proceedings. The Authority shall be responsible to the Council. The Authority, subject to directions from the Council, shall be responsible for the management of activities relating to exploration for and exploitation of the resources in the Zone, in accordance with this Treaty.

Petroleum Development Contracts: No petroleum activities may be undertaken in the Zone other than pursuant to a petroleum development contract between the Authority and one or more contractors. Unless the Council otherwise decides, and in accordance with procedures laid down by the Council for tendering, the principle of holding licensing rounds must be followed prior to the signature of any petroleum development contract.

Settlement of Disputes: the Treaty concludes three kinds of disputes: disputes between the Authority and private interests, disputes arising in the work of the Authority or the Council, unresolved disputes between the States Parties. Disputes between the Authority and private interests, for example, concerning the interpretation or application of a development contract or operating agreement shall unless otherwise agreed between the parties thereto be subject to binding commercial arbitration pursuant to the terms of the relevant development contract or operating agreement.

3.2. Disadvantages

The Nigeria-Sao Tome and Principe joint development exists mainly the following disadvantages:

Sao Tome and Principe is of unequal status. Although Nigeria and Sao Tome and Principe both belong to the third world, there are still significant gaps between them, which decides the dominant position of Nigeria.

Sao Tome and Principe, being independent in 1975, was announced the world's least developed countries by the United Nations. In recent years, currency devalues, living standards decline, and people living under poverty line increase continuously, the government has to save the fragile economy and pay for high foreign debts through oil. Paradoxically, Sao Tome and Principe is a novice oil industry, it can only rely on Nigeria for guidance and experience.

In contrast, Nigeria is much stronger, which is the second largest economy and also the most populous country in Africa. Since 1970s, oil exports gradually become the country's main source of income. Nigeria, classified as a emerging entity, rapidly meets middle-income standard. As always, the Nigerian government has been working to promote and protect national oil industry and related infrastructures, oil exploration experience and technology are relatively well developed.

The treaty doesn't establish a specialized information sharing mechanism. The joint development agreement aims at promoting mutual cooperation and equal exchange, nevertheless, the lack of a specialized information sharing mechanism makes the two countries embarrassed to respond questionings to international community.

The joint development zone was conducted two bids since establishment. The first bid was conducted in April 2003 to develop 9 deep-sea blocs, which lasted for 6 months. Only Chevron-Texaco won the bid for only one bloc and other bidders for other 8 blocs withdrew because of substandard qualification. What is in stark contrast is the second bid in November 2004, which lasted for just 1 month to develop 5 deep-sea blocs. The second bid attracted many small, unknown, and relatively weak oil companies, who could actively participate in the bidding after only one month's preparation although they didn't meet technology, capital and experience standards before.^[17] In this regard, the international community criticized and questioned seriously, but the two countries didn't explain and the reason is still far unknown.

The supervision mechanism is ineffective. According to the joint development agreement, the Joint Ministerial Council must have 2-4 members with the same level designated by each country's president, therefore the two presidents have been accorded enormous powers. Article 15.2 says that: "Unless otherwise expressly approved by the Council, no Executive Director, officer or other staff member of the Authority may have any direct or indirect financial interest in development activities in the Zone." It can be envisaged that the Council has great powers and it may be reduced to seek private interests, which can be proved by Fadrique de Menezes's remarks in 2004. Fadrique de Menezes condemned proposals of the Joint Authority, and declared that Nigeria national oil company ERHC, closely related to Nigerian President Olusegun Obasanjo, enjoyed 60% in bloc 4 and Filtim Huzod, belonging to former Nigerian politicians, enjoyed 85% in bloc 6, while these two companies did not have any deep-sea exploration experience before. Although Fadrique de Menezes dissatisfied with the phenomenon, he can do nothing about this. Therefore, power restriction and supervision are quite important.

Oil resources are monopolized by multinationals. Nigerian oil industry, for example, due to lacking self-exploration capabilities, mainly depends on cooperation with multinational oil companies. Therefore Nigerian oil industry is controlled by western oil companies especially multinational oil companies, 92% of oil production and 84%