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Consultancy Services Related to the Feasibility Study of the Electrical Interconnection and Energy Trade between the Arab Countries

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ACRONYMS AND ABBREVIATIONS

List of Abbreviations

AC	Alternating Current
ACSR	Aluminium Conductor Steel Reinforced
AHP	Analytical Hierarchical Process
a, yr.	Annum, year
AFESD	Arab Fund for Economic and Social Development
AGP	Arab Gas Pipeline
AUE	Arab Union of Electricity
Maghreb	Area Morocco, Algeria and Tunisia
ATC	Available Transfer Capacity
BtB	Back-to-Back techniques of High Voltage AC-DC-AC technology
B\C	Benefit \ Cost ratio
BO	Build and Operate
BOO	Built-Operate-Own
BOT	Built-Operate-Transfer
BAU	Business As Usual
CA	Capacity Allocation
CF	Capacity Factor
CAPEX	Capital expenditure
CESI	Centro Elettrotecnico Sperimentale Italiano G. Motta, Italy
CCGT	Combined cycle gas turbine
CHP	Combined heat and power
ICr&NG Scenario	Combined Integrated Electric (reinforced) and NG Interconnected Scenario
COMELEC	Comité Maghrébin de l'Electricité
CAGR	Compound Annual Growth Rate
CM	Congestion Management
CP	Connection Point
CBT	Cross/Border Trading
Dii	Desertec Industrial Initiative
DIgSILENT	DIgSILENT GMbH Power Factory
DC	Direct Current
EIRR	Economic Internal Rate of Return
ENS	Energy Non Supplied
EUA	EU emission Allowance
EC	European Commission
IEM	European Internal Electricity Market
ENTSO-E	European Network of Transmission System Operators for Electricity
EU	European Union
EENS	Expected Energy Not Supplied
EHV	Extra High Voltage
GT	Gas turbine
ICC	GCC Interconnection System Operator
GENCO	Generation Company
GHI	Global Horizontal Irradiance
GDP	Gross Domestic Product
GCCIA	Gulf Cooperation Council Interconnection Project Authority
HGS	High Growth Scenario
HV	High Voltage

HHV	Higher Heating Value
HN	Horizontal Network
HPP	Hydro Power Plant
ISO	Independent System Operator
IC	Integrated Electric Interconnected Scenario
IC Scenario	Integrated Electric Interconnected Scenario
ICr	Integrated Electric Interconnected Scenario reinforced
ICr Scenario	Integrated Electric Interconnected Scenario reinforced
NG Scenario	Integrated Natural Gas Interconnected Scenario
IEA	International Energy Agency
ITC	Inter-TSO Compensation mechanism
LAS	League of Arab States
LC	Least Cost
LCOE	Levelized Cost of Electricity
LUF	Line Utilization Factor (%)
LDF	Load Factor
LRMC	Long Run Marginal Cost
LRAIC	Long-run average incremental cost
LOLE	Loss of Load Expectation
LOLP	Loss of Load Probability
MGS	Medium Growth Scenario
MTPA	Million ton per Annum
NRA	National Regulatory Authority
NPV	Net Present Value
NTC	Net Transfer Capacity
NPP	Nuclear Power Plant
OCGT	Open Cycle Gas Turbine - Thermal Power Plant
OPEX	Operating Expenses
O&M	Operations and Maintenance
OPTGEN	Optimal Generation PSR Computation tool
OAPEC	Organization of Arab Petroleum Exporting Countries
OPEC	Organization of the Petroleum Exporting Countries
OEM	Original Equipment Manufacturer
OHTL	Overhead Transmission line
PAP	Pan Arab Pipeline
PBP	Pay Back Period
pu	per unit
EIJLLSPT	Power Interconnection of Egypt, Iraq Jordan, Lebanon, Libya, Syria, Palestine and Turkey
ELTAM	Power Interconnection of Egypt, Libya, Tunisia, Algeria and Morocco
PSS/E	Power System Simulator for Engineers, Siemens
PTDF	Power Transfer Distribution Factors
PV	Present Value
PPP	Public-Private Partnership
REM	Regional Electricity Market
RTO	Regional Transmission Operator
RAB	Regulated Asset Base
ROE	Return On Equity
ROW	Right Of Way
PROMED	Software for Electricity Market Simulator, CESI
SEMC	Southern and Eastern Mediterranean Countries
SPV	Special Purpose Vehicle
SVC	Static var compensator

ST	Steam turbine
LEJS	Synchronous Area Libya, Egypt, Jordan and Syria
TOR	Terms of Reference
TPP	Thermal Power Plant
TTC	Total Transfer Capacity
TOOR	Transfer of Operating Rights
TRM	Transmission Reliability Margin
TSO	Transmission System Operator
UGS	Underground Gas Storage
UCTE	Union for the Coordination of Transmission of Electricity
VOLL	Value of Lost Load
WACC	Weighted Average Cost of Capital

Fuels

Abbreviation	Explanation
BC	Black coal
CFO	Crude Fuel Oil
DS	Diesel
LFO	Light Fuel Oil
NG	Natural Gas
GTL	Gas to Liquid
HFO	Heavy Fuel Oil
LNG	Liquid Natural Gas
LPG	Liquid Petroleum Gas
LCO	Light Crude Oil
HCO	Heavy Crude Oil
SC	Sponge Coke
N	Nuclear
Osh	Oil Shale

Currency

Abbreviation	Explanation
BUSD	Billion US dollars (currency)
MEUR	Million Euro (currency)
MUSD	Million American dollars (currency)
€	Euro
EUR	Euro
USD	US Dollars
USDc	Cent of US Dollars

Weights and Measures

Abbreviation	Explanation
bbl	barrel
BCM	billion cubic meters (thousand million cubic meters)
BTU	British Thermal Units
Btu/kWh	British thermal units per kilowatt-hour
g/kWh	grams per kilowatt-hour
Gcal	Giga Calorie 10^9 calories (energy unit).
GJ	Giga Joule - 10^9 joules (energy unit)
GWh	Gigawatt hour
kV	kilovolt
kW	kilowatt
kWh	kilowatt hour
MCM	Million Cubic Meters
MMBtu	Million British thermal units
MMTPA	Million Metric Tons per Annum
MTOE	million tons of oil equivalent
MTPA	Million Tons per Annum
MVA	Mega volt ampere
Mvar	Megavar (million volt-amperes reactive)
MW	Megawatt (million watts)
MWh	Megawatt hour
TCM	Terra cubic meters
TEP	Ton Equivalent Petroleum
TOE	Tons Oil Equivalent Unit of energy = 42 GJ = 10034 MCal
TWh	Terra Watt hour
V	Volt
W	Watt

Bilateral and Multilateral Trade Model for Electricity

Consultancy Services Related to the Feasibility Study of the Electrical Interconnection and Energy Trade between the Arab Countries

EXECUTIVE SUMMARY

Bilateral and Multilateral Trade Model for Electricity

PART 1 - DEVELOPMENT OF A CROSS BORDER ELECTRICITY TRADING MODEL

The definition of a bilateral/multilateral trading model is of paramount importance. Indeed, so far the lack of clear trading models between Arab Countries (especially in the Mediterranean Arab Countries) prevented to exchange electricity causing poor exploitation of the existing interconnections. The exploitation rate of interconnections between the Mediterranean Arab Countries in the actual situation is below 10% of their NTC (Net Transfer Capacity). Furthermore, in some cases interconnections are exploited only for mutual support with remuneration in kind.

As a matter of fact, the lack of common rules has to be considered as the major barrier for Cross Border Trading (CBT) among Arab Countries. Lengthy negotiations for power wheeling across a third country have delayed or even prevented cross border trading in several cases. Few years ago, some agreements were reached between Jordan and Egypt for power wheeling from Egypt to Syria and Lebanon. But as there is no commonly accepted regulation yet, the agreements were negotiated separately between the concerned parties for every individual case.

In addition, the weaknesses of the existing cross-border lines is another important obstacle for the development of the cross border trading among Arab Countries.

In general, to foster CBT, clear rules shall be defined for:

- the inter-TSO compensation
- Capacity allocation (CA) across interconnectors;
- Congestion Management (CM).

Considering the geographical proximity and the trend towards the full integration of the Arab regional power systems with Europe, the experience developed in Europe since the year 2000 within ENTSO-E and its predecessors can be fruitfully exploited and taken as a reference.

It is worthwhile mentioning that at the moment, in the Arab region, just the Gulf Cooperation Council (GCC) is nearing the "launch pad" of the Electricity Market integrating the power systems of Saudi Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates and Oman. To this purpose, an initial analysis of the market economics likely to exist after the countries were interconnected, was proposed in this study referring to the previous studies performed by GCC Interconnection Authority.

Concerning equal access to information and transparency, it is worth recalling that at present, not even the NTC between countries are published. Thus, some steps can be undertaken immediately, e.g.: publishing of the NTC, the hourly power flows and the procedure adopted for network access.

The final objective is the identification of a CBT model applicable to the Arab Countries for the trading of electric energy. After the examination of the possible models for bilateral/multilateral energy trading, the Consultant performed the elaboration of a model for the fair compensation of the TSO facing power transits deriving from the electric energy trade between the Arab Countries. This model takes into account the use of the network assets affected by the energy transactions as well as their annualized cost, accounting their depreciation. The mechanism for the settlement of the inter-TSO compensations was also addressed.

In general, the Consultant recommended that, considering the geographical proximity and the trend towards the full integration of the Arab regional power systems with Europe, the experience developed in Europe since the year 2000 within ENTSO-E and its predecessors can be fruitfully exploited and taken as a reference. It is worthwhile to mention that generally, when describing how the fund is financed, it could be necessary to define different types of countries for which different fees could be proposed:

- ITC Party – A country, which is party to the ITC Agreement.
- Internal ITC Parties – A ITC Party not having any electrical border to any Perimeter Country.
- Perimeter Country – A country, which is not party to the ITC Agreement, but which has an electrical border to an ITC Party.
- Edge Country – A ITC Party which has at least one electrical border to a Perimeter Country.

Perimeter flows should contribute to the fund paying an annually, ex-ante defined fee for their imports and exports of electricity into the ITC area.

In addition, to better define the framework fund for compensation, it should be noted that from a regulatory viewpoint a financial institution that provides clearing and settlement services for securing transactions, needs to be constituted. This institution, where members of each Arab Country should be represented, will assume the role of "clearing house" with the obligation of guaranteeing the transfer of compensation to the recipient TSOs.

Finally, the Consultant proposed a time schedule of the setting up of rules for the cross-border trading (CBT) of electricity based on the evolution of CBT procedures towards more market oriented solutions (explicit actions, implicit auctions, market coupling, daily auctions, etc.).

PART 2 - DEVELOPMENT OF A CROSS BORDER NG TRADING MODEL

From a natural gas perspective the most important parts of a trade model is the creation of fundamentals and institutions which facilitate a breakdown of the physical and institutional barriers which today prevent gas from being produced and traded between countries.

In the case of the Libya-Egypt pipeline the largest identified barrier at the moment is the lacking incentives to produce gas. Gas is believed to be in abundance in Libya - in order to utilize these resources, which Libya is believed to possess, is recommended to introduce a feed in price for gas export to Egypt. A price which at one hand gives an incentive for producers to engage in exploration of gas and reduce flaring and on the other hand allows the buying entity to earn a profit on transporting and reselling the gas to shippers on the Egyptian side. It is recommended that the NOC takes the role of national gas exporter, following the same practice applied in Algeria (SONATRACH) and Russia (GAZPROM).

In the case of Iraq-Kuwait allowing export from Iraqi fields to Kuwait would most likely require some treatment. Current treatment possibilities in the south are limited to the treatment facilities owned by Basrah Gas Company (BGC). It is not known whether any spare capacity exist at this facility, furthermore third party access is in most likelihood not permitted. Thus for export to take place treatment capacity must be made available.

Regarding the structure and ownership of the pipelines both pipelines are envisaged to start out with a special purpose vehicle structure and later to be divided into two coordinated national projects. However, in the startup phase it is of importance that the companies on both sides of the borders come together to take the necessary decisions and define the project structure and the feasibility study to be undertaken. Unbundling is not recommended – in order to maximize the probability of the projects being implemented a strong leading partner preferably with upstream interests is needed.

The preferred contract structure for the pipelines is take or pay contracts ensuring income for a minimum share of the capacity – this would lower risks and ensure cheaper financing. Sale of the gas in both pipeline projects should be made on commercial terms under the restrictions that the feed in price should be high enough to facilitate production of gas in both Libya and Iraq, while at the same time low enough to compete with alternative sources of gas and energy in Egypt and Kuwait.

For the LNG terminal in Bahrain, it should be noted that work already is being undertaken with regards to costing and siting of the terminal. The detailed feasibility study should build on this information. The ownership of the terminal is best placed with the State but other commercial entities such as shippers or large consumers may also have an interest in participating. International companies could have a role since the construction and the operation of the terminal is relatively complex and requires expert knowledge.

A key point to consider with regard to the ownership structure and the operational mode is the risk of not selling enough capacity to cover the cost of the terminal. In particular it should be noted that the project could be competing with pipeline import from Qatar, if the Moratorium on gas export was lifted.

In order for the project developers to alleviate this risk, it is recommended that long term capacity contracts are signed. In this respect the state could have an important role - through one of its subsidiaries it could place long term capacity bookings in the terminal and potential reserve some of the storage capacity for security of supply and strategic purposes. This could contribute both to project economics but also to the security of supply in Bahrain, in relation to this it could be considered whether a uniform security of supply tariff imposed on all consumers, instead of a commercial tariff would be a better idea. The most appropriate operational mode of the terminal was concluded to be a tolling facility. A tolling facility would be less risky than a merchant facility as the operator does not own the gas but merely sells the capacity to interested parties. Due to the lower level of risk financing would also become less expensive.

INTRODUCTION

The general purpose of this project is to determine the best electric energy and natural gas trade scenario for each Arab Country separately and for all Arab countries combined, in order to optimize the use of their gas resources. To do this, the best options for new electricity and gas interconnections were clearly identified, including the estimation of the costs for each economically feasible project. The horizon year of the analyses is 2030 and the study period is 2012-2030.

The objective of this task is to develop a bilateral/multilateral trade model based on quantified amounts of electrical energy and NG that could be exported/imported in order to determine the size and the extent of possible trading potential among Arab Countries.

The report of this task is subdivided into two main parts:

- 1st part: the development of a cross border trading model for electricity trading among the Arab Countries and recommendations for its implementation.
- 2nd part: the development of a cross border trading model for Natural Gas trading among the Arab Countries.

PART 1 - DEVELOPMENT OF A CROSS BORDER ELECTRICITY TRADING MODEL

Overview

The definition of a bilateral/multilateral trading model is of paramount importance. Indeed, so far the lack of clear trading models between Arab Countries (especially in the Mediterranean Arab Countries) prevented to exchange electricity causing a poor exploitation of the existing interconnections. The exploitation rate of interconnections between the Mediterranean Arab Countries in the actual situation is below 10% of their NTC[1]. Furthermore, in some cases interconnections are exploited only for mutual support with remuneration in kind.

As a matter of fact, the lack of common rules has to be considered as the major barrier for Cross Border Trading (CBT) among Arab Countries. Lengthy negotiations for power wheeling across a third country have delayed or even prevented cross border trading in several cases. Few years ago, some agreements were reached between Jordan and Egypt for power wheeling from Egypt to Syria and Lebanon. But as there is no commonly accepted regulation yet, the agreements were negotiated separately between the concerned parties for every individual case.

In addition, the weaknesses of the existing cross-border lines is another important obstacle for the development of the cross border trading among Arab Countries.

In general, to foster CBT, clear rules shall be defined for:

- the inter-TSO compensation
- Capacity allocation (CA) across interconnectors;
- Congestion Management (CM).

Considering the geographical proximity and the trend towards the full integration of the Arab regional power systems with Europe, the experience developed in Europe since the year 2000 within ENTSO-E and its predecessors can be fruitfully exploited and taken as a reference.

In the framework of the cooperation of Southern and Eastern Mediterranean countries (SEMC) with the EU the CBT would also promote the harmonization of legal context and regulatory issues within SEMC and between SEMC and the EU. In general, the harmonization of the CBT rules shall be progressively extended to all countries, members of the League of Arab States. In fact, “reciprocity” is one of the pillars to promote the growth of CBT within the Arab Countries and between the Arab Countries and the EU Member States.

It is worthwhile mentioning that at the moment, in the Arab region, just the Gulf Cooperation Council (GCC) is nearing the “launch pad” of the Electricity Market integrating the power systems of Saudi

[1] NTC: “Net Transfer Capacity” is the maximum total power exchange between two adjacent areas compatible with security standards and taking into account the security margin that copes with uncertainties on the computed “Total Transfer Capacity (TTC)” values.

Arabia, Kuwait, Bahrain, Qatar, the United Arab Emirates and Oman. To this purpose, an initial analysis of the market economics likely to exist after the countries were interconnected, was proposed in this report referring to the previous studies performed by GCC Interconnection Authority (see chapter 1.3.4).

In the Gulf region an important aspect to be considered deals with the presence of independent power producers (IPPs) and independent water and power projects (IWPPs), which have increased, namely in the countries belonging to the Gulf Cooperation Council (GCC). This kind of power plants replaced the prior government-financed power and cogeneration plants. The owners of IPPs and IWPPs shall be free to sell their energy also to neighbouring countries on the basis of transparent market signals on the electricity prices. To do that, rules for CA, CM and inter-TSO compensation shall also be fully clear and transparent.

Concerning equal access to information and transparency, it is worth recalling that at present, not even the NTC between countries are published. Thus, some steps can be undertaken immediately, e.g.: publishing of the NTC, the hourly power flows and the procedure adopted for network access.

Coherently with the work program, the final objective of the first part consists of the identification of a CBT model applicable to the Arab Countries for the trading of electric energy. The following activities were undertaken:

a) Examination of the possible models for bilateral/multilateral energy trading: postage stamp model, TSO liability model, zonal/nodal models. General models adopted worldwide were recalled (see chapter 1.3). Thereafter, a more specific reference was made to the European methodology, which was developed in the framework of the regulation regarding the Internal Electricity Market (IEM), especially regulation 714/2009/EC and 838/2010/EC. More than 30 European countries are participating in this mechanism. The compliance with the European regulation for electricity trading is particularly important for the Mediterranean Arab countries in view of the huge power exchanges envisioned by the Mediterranean Solar Plan and further by the Desertec Industrial Initiative (Dii);

b) Elaboration of a model for the fair compensation of the TSO facing power transits deriving from the electric energy trade between the Arab Countries. This model takes into account the use of the network assets affected by the energy transactions as well as their present value, accounting their depreciation. The mechanism for the settlement of the inter-TSO compensations was also addressed.

   The results of a dry-run implementation of the proposed Inter TSO Compensation (ITC) mechanism were presented. More precisely, the Consultant implemented a computation framework of the proposed inter-TSO compensation mechanism and performed a simulation considering the integrated model of the Arab Countries based on the results of the PROMED market simulator and the network analysis for the target year 2020.

   The evaluation of the clearing and settlement of each country to compensate for the use of national transmission assets by cross-border trades (transits) and related additional network losses caused by the these transits were described.

c) Recommendations of procedures for CM were also formulated.

1 CROSS-BORDER TRADING: DEFINITION AND MAIN IMPLICATIONS

In general, Cross-Border Trade encompasses all the energy transactions involving more than one nation; it should be noted that in general in the past the cross-border lines were originally built more for enhancing network security than for hosting international transactions. Traditionally, power exchanges across the nations were regulated on the basis of bilateral agreements. Only recently CBT has begun to become significant, giving raise to the necessity of a unified approach at a regional or even continental scale, as occurred in Europe and North America. Indeed, numerous aspects are classified under the common name of CBT, such as:

- mechanisms to define and distribute the transmission charges for CBT to the countries responsible for electricity transactions (ITC-mechanism).
- rules to allocate transport capacity (CA) on cross-border lines (interconnectors) and to manage possible congestion (CM);

Two contrasting requirements are to be considered:

- Need to create uniformity conditions: harmonizing price formation mechanisms, transmission tariffs, taxation, environmental standards in all the countries so as to create a common competitive basis and prevent any distortion of competition.
- Need to address the market towards efficient solutions: going from the centralized management of vertical integrated utilities to a market environment and from a national to an open power market perspective, requires replacing centralized with distributed decisions. Locational signals should be provided to orient these decisions towards an efficient usage of the network:
    - in the short term differentiating energy prices incentivizing the subjects to an efficient operation of the system, i.e. to avoid congestion;
    - in the long term, differentiating transmission tariffs so as to promote an efficient allocation of new generators.

As mentioned above, CBT mechanisms involve two main aspects:

- Procedures for the allocation of cross border capacity and manage the congestion in case of insufficient capacity with respect to the power transfer requests by the operators.
- Procedures for the remuneration of the use of networks in countries that host transits of power generated from third countries (i.e. the export of energy from Algeria to Spain generates flows through the Moroccan network, with the consequent need for compensation).

This first aspect is particularly critical, since the major part of current interconnection capacities between Arab countries is quite limited and, therefore, once the electricity market starts in the region, congestion will likely occur. In fact, the borders could be affected by heavy congestion and could not allow a high level of trade in electricity. This phenomenon is mainly due to the fact that in the past existing interconnections were primarily planned for mutual support in order to increase the level of reliability and safety margins. In addition, each national power system has always been developed independently of the other, i.e. without any coordination. For that reason, the ratio "*Total Energy* *exchanged / Total consumption*” for Arab region is typically equal to 0.05%, much less than the one estimated for the European interconnected systems.

This shows clearly that the reinforcement of interconnection lines will allow a substantial increase of cross-border capacity between the countries of the region and provide an opportunity for countries possessing NG resources to export electricity. To this purpose, it is worth underlining the findings obtained from the preferred scenario called ICr&NG Scenario[2], in which remarkable energy exchanges occur between the interconnected countries and consequently the Utilization Factor of each interconnectors in Arab region in export and import directions increases considerably. More in detail, the total electricity exchanges in this scenario realized by using the transfer capacities of existing and planned interconnection links were 1,828.3 TWh over the planning period (2012-2030), and in 2030, the electric energy exchanges among Arab countries were estimated around 112 TWh, which represented a ratio of 4.5% over the total yearly energy demand.

In order to increase the use of interconnections, the Arab Countries have to implement new methods and procedures relating to CBT, adopting solutions that are market-oriented.

To this scope, following the analysis of the current situation of the countries of the region, some proposals for the mechanisms of CBT were formulated and illustrated later.

Based on experience gathered by European countries during the various implementation phases of ITC compensation mechanism, the Arab Countries should initiate a series of estimation bypassing the non-efficient practices and focusing on the definition of transfer capacity already adopted in Europe, being the knowledge from "'Net Transfer Capacity" (NTC) a requirement for the allocation of cross-border transactions and resolving congestion whenever the request transaction exceeds the NTC.

About the process of congestion management as well as the remuneration of the use of networks hosting transits originated by third parties, the Arab Countries could adopt mechanisms similar to the CBT already used in Europe and encoded by ENTSO-E.

It should be noted that that during the transitional phase, in which the reforms necessary for the functioning of regional electricity markets could not be fully adopted by all the Arab Countries, congestion management could be solved by the method “own interconnector" for which the capacity can be available only to the owner and user of the interconnection lines, i.e. the System Operator of each country.

For the remuneration of transits, the method of “grid costing” for the settlement of transits could be valid even in the transitional phase. Although the “own interconnector” method is very simple and easy to be implemented, it does not provide any signal for the market; however, it can enable the Arab Countries to start adopting transfers of electricity on the basis of shared procedures.

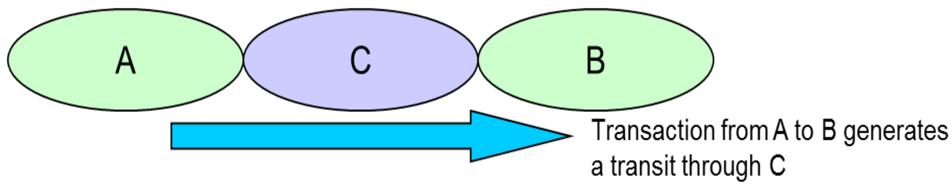
[2] See the“Pan-Arab interconnection electric power and NG Scenarios Report”

1.1 Inter-TSO compensation

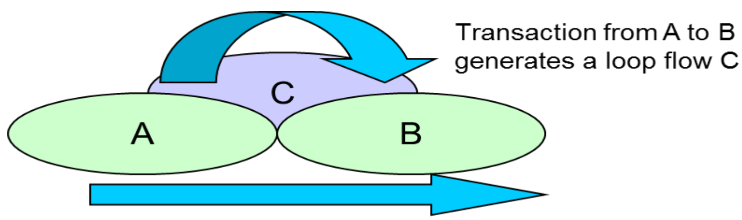
Transit is the name given to power flow crossing a national network and originated by a transaction whose injection and withdrawal points are located in other countries.

In general two cases of transits can occur:

- First case: two nations without common borders,



- Second case: loop flows



The idea is that since transited nations draw no benefits from these transactions then they should receive an economic compensation.

Flows owing to CBT can be transits, which are completely unrelated to domestic users, or exports and imports. The ITC mechanism have to be established for the purpose of compensating transmission system operators ("TSOs") for the costs incurred on national transmission systems due to hosting cross-border flows of electricity.

Ideal principles of a "fair" application of transmission tariffs in a multinational CBT context can be summarized as:

- non-interference: locational differences between access tariffs must not interfere with the incentives to operative efficiency provided by marginal prices;
- proportionality to benefits: costs should be allocated proportionally to benefits, measured by the electrical use of the lines;
- tariffs should be function of willingness to pay, inversely proportional to the elasticity to payment.

Other principles are:

- locational signals: applied to energy prices or transmission tariffs;
- avoiding transaction-based tariffs;
- avoiding tariff pancaking.

Any ITC mechanism should have three main components:

- a method to determine the extent to which cross-border electricity flows utilize the network of host countries (in addition to flows caused by national users),
- a method to determine the costs of the networks used including infrastructure and losses and thus the compensation to be paid to the TSO concerned,
- a method to define how much each TSO has to pay for the use of other TSOs' networks.

In general the main advantage for interconnected power systems to adopt a “well-built” inter-TSO mechanism is the revenue recovery of each country ensuring that TSOs recover an appropriate amount of revenue from hosting the third party power transits resulting by export from a first TSO area and import in a second area. The evaluation of the compensation to reward a TSO for hosting third party transits is on the basis of any inter-TSO mechanism: the TSOs, within whose area the net power export or import are originated, shall compensate the other TSO(s) for making infrastructure available to host cross-border flows of electricity on a fair and equitable basis.

Among the many possible mechanisms for compensating transits, one of the most popular theoretical approaches (in Europe) is a two-step hierarchical mechanism:

- Inter-TSO compensation for external use of other nations networks,
- Reflection of payments on inner G/L (Generators and Load) tariffs.

The first is characterized by the usage-based cost-reflective allocation of costs of transited countries to those who are responsible for the transits. To that purpose, two algorithms are the most accredited:

- Average participation in every node, the inflows distributed proportionally to the outflows (non-physical hypothesis). The network can be scanned from sources to sinks or vice versa.
- With and without transits WWT (ENTSO-E): The cost of losses is calculated on each TSO transmission grid in a load flow situation with transits and in a load flow situation without transits. The difference in calculated losses with and without transits is defined as transit losses. The price used to calculate the value of transit losses shall be equal to the price used to coverer losses by national tariffs.

The second step, “Reflection of payments on inner G/L tariffs” is based on the uniform offset of G and L national tariffs. Otherwise it would violate the single system paradigm (users must pay a national access tariff independent from source and destination of the transaction). The uniform reflection of inter-TSO payments proposed is:

- on G tariffs in exporting countries,
- on L tariffs in importing countries.

In fact, in an exporting country, the internal network is more profitable to generators than loads. Thus, it is equitable that the generators be charged of the transits payments. This will increase G tariff. For the same reason, transits compensations received by TSOs should decrease L tariffs. Symmetric behavior has to consider for importing countries.

1.1.1 Treatment of losses in international transactions

The losses are proportional to the square of transported current: they make power extracted lower than the one injected. Economically, the losses reppresent a cost that should be charged to the users of the line.

A few possible solutions can be generally adopted in order to deal with the losses caused by transits:

- losses included into the market clearing algorithm. This is the most rigorous solution, but in decentralized markets market operators don't dispose of a network model detailed enough;
- losses accounted for by means of marginal loss factors. Especially "zonal price" systems, that don't consider intra-zonal lines, use loss factors calculated ex-ante by TSOs in a certain number of representative working conditions;
- losses evenly distributed between agents (typically included into transmission tariffs);
- in CBT, losses can be taken into account into the average participation mechanism.

1.2 Congestion Management

The procedures of CM used in Europe give a transparency signal for transfers. It is important to emphasize that, in general, each solution for congestion management presents advantages and disadvantages and, therefore, the decision to use a specific procedure for dealing with congestion is to be selected on the basis of local circumstances and the regulatory framework of the involved countries.

Provision of adequate CB NTC, capable to accommodate electricity overflows caused by the execution of commercial contracts concluded between the parties located in different countries is a vital precondition for an integrated system. Historically, the electricity networks evolved as national and intra-national infrastructure not designed to accommodate CB electricity flows originating in different countries and crossing national borders between insufficiently linked national electricity systems. Congestions on the CB electricity lines are considered the main technological barrier on the way of further market integration and hampers finding an optimal cost–effective energy generation mix.

In principle, the participants to the inter TSO mechanism should deal with additional cross-border payments between network users if congestion management mechanisms (auctions) create revenues for TSOs. By this, there could be several issues in relation to the interaction between ITC charges and payments and revenues from congestion management arrangements. For instance, if revenue from market-based congestion management mechanism is funding a particular circuit or part of the network, it may be that it would be appropriate for this to be taken into account as part of the payments or receipts of that TSO under the ITC mechanism.

All Congestion Management methods can be divided into two broad categories:

- NTC / ATC based capacity allocation methods;
- Flow Based Capacity Allocation (FBCA) methods.

The NTC / ATC approach applied at most European borders to date sets a fixed limitation to the exchange programme (i.e. the total of all CB power transfers) between two countries, which is nominally (i.e. in the NTC / ATC capacity allocation procedure) independent from the power exchange between all other countries. Since this independence does not exist in reality, the NTC / ATC model requires TSOs to either introduce high security margins or take a risk of the network being overloaded due to neglected interdependencies with other borders. Moreover, the NTC / ATC approach forces TSOs to decide ex ante on a regional level how to share capacity between the borders. This is necessary because the amounts of simultaneously feasible NTC / ATC are interdependent.

More in detail, NTC / ATCs are used as an upper limit of the available transmission capacity; hence no further capacity can be allocated by TSOs once the limit is reached. This method requires implementation of a mechanism to define the priority for using NTC / ATCs. Auctions may be the base mechanism for this method of congestion management: the bids of the participants are stacked, highest bids first, until NTC / ATC is completely used. In order to better clarify this aspect it is worthwhile to mention that, for instance, TSOs should organize simultaneous and coordinated auctions on each pair of zones while market participants should send their bids consisting of a quality and a price for the cross border input rights they want to buy. Combined input (in one zone) and off-take (in another zone) prices indicate the maximum value they are willing to pay for obtaining capacity on the given zone pair, up to the requested quantity. Market participants aiming at bilateral trade may require, if they wish, to limit their allocated input quantity at the same level that the allocated off-take quantity, in order to get a balanced right from zone to zone.

Finally, NTC / ATC methods, although being the most widely used, do not provide:

- efficient usage of interconnections as physical realities of the network cannot be taken into consideration in an appropriate manner. As all CB exchanges between two countries in a meshed network affect the system loading in all other interconnected transmission systems also the NTC-values within a meshed network are strongly interdependent. Thus a determination of realistic international exchange scenarios based on bilateral NTC values for the meshed networks is practically impossible;
- proper network reliability at minimal cost. Under condition of meshed electricity network any transaction in addition to the countries where electricity physical flow originates and ends causes electricity overflows (loop-flows) in the other countries whose electricity systems are effected by the transaction thus being unpredictable by their natures leading to reduced security of respective energy systems and expansion of respective TSO activities aimed to provision of the power systems safe and reliable operation.

In order to overcome the drawbacks of the capacity based transfer capacity allocation methods Flow Based Capacity Allocation (FBCA) methods were developed.

There are two basic groups of FBCA methods:

- FBCA methods based on PTDF with CB capacity per border;
- FBCA methods based on PTDF with maximum flow per line.

In the FBCA mechanism, the commercial transactions are no longer limited to the interconnections where they are reported, but they are converted into physical power flows by using a simplified representation of the network so that their impacts on third interconnections can be considered thus ensuring overall security. All regional commercial transactions are converted into physical power flows at the critical branches by using the PTDF factors. The PTDF factors describe what physical flow on a given interconnection would be caused by a requested commercial exchange between two countries or two control areas (or ‘hubs’). These two hubs do not necessarily need to be directly connected. In other words, the PTDF factors translate a commercial transaction between two hubs into the expected physical flows over the entire network. The term 'critical branches' is used to indicate branches that are or can be restrictive in the CB capacity allocation.

It should be noted that flow-based allocation is a supra-national approach: all bids for energy and/or cross-border capacity are optimised by a centralized entity that takes care of the actual allocation ('auction office'). Another important aspect is that in the flow-based allocation mechanism, the commercial transactions are no longer limited to the interconnections where they are reported, but they are converted into physical power flows by using a simplified representation of the network so that their impacts on third interconnections can be considered thus ensuring overall security.

Compared to the NTC / ATC model, the principal advantages of the FBCA approach are:

- the possibility to reduce uncertainty on networks usage, thereby allowing for higher capacities at the same level of operational risk;
- the capacity competition between borders, i.e. that the amount of transmission rights between any two countries is no longer fixed by the TSOs prior to the auction, but results from the auction, based on the economic values assigned to the transmission directions by the market participants;
- the possibility to obtain direct transmission rights between any two (not necessarily neighbouring) countries.

Generally, after having agreed on the procedure to evaluate the transfer capacity (be it NTC/ATC or FBCA), one shall allocated the capacity to accommodate the commercial transactions (CA-capacity allocation phase) and, in case of insufficient transfer capacity, handle the congestion (CM-congestion management phase) in a non-discriminatory and transparent way.

At present the CA (capacity allocation) and CM (congestion management) methods based on NTC / ATC capacity allocation offer different kinds of allocation mechanisms:

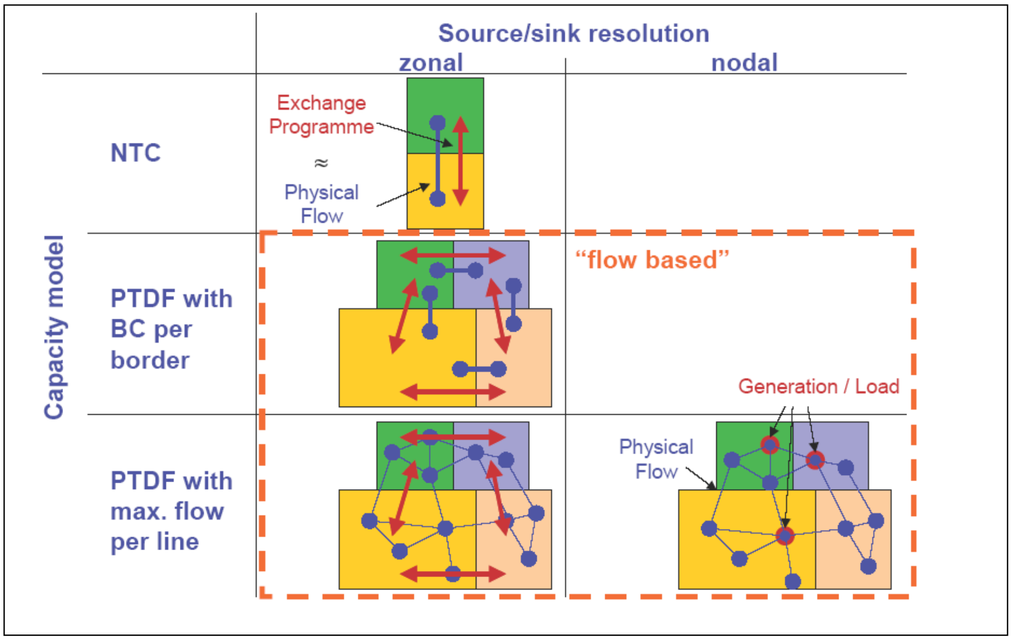
- *First come, first served*: the capacity is allocated according to the order in which the transmission requests were received by TSO. From the earliest request, all amounts of capacity are fully used until the available capacity is consumed.
- *Pro rata*: all requests are partially accepted in the way that each applicant is granted a fixed share of his requested capacity amount; the share is equal to the amount of available capacity divided by the sum of all requested capacity amounts.
- *Explicit auctions*: according with that method, the applicants have to declare how much they are willing to pay for this capacity. These bids are ordered by price and allocated starting from the highest one until the available capacity is used up.
- *Implicit auction*: with implicit auctions the transmission capacity is managed implicitly by the spot markets: Network users submit purchase or sale bids for energy in the geographic zone where they generate or consume, and the market clearing procedure determines the most efficient amount and direction of physical power exchange between the market zones. Hence, this method is integrated with the electricity market and a separate allocation of transmission capacity is not required.

There are two expanding practical approaches aimed at higher level of coordination between several markets in NTC/ATC based capacity allocation with power exchanges involvement enabling more efficient allocation of limited capacity than it is possible when applying pure coordinated or non-coordinated capacity based capacity allocation approach:

- market coupling is the development of the auction process where the interconnection capacity is allocated using implicit and sometimes explicit allocation schemes. The market coupling is a process in which either two or more power exchanges cooperate to link together separate power markets, or a separate entity handles all the necessary functions needed to maximize the utilization of the interconnections. Market coupling enables full netting of power flows (two-way transmission) in the interconnections;
- market splitting is a cross border/bidding area trading and cross border congestion management method where the available trading capacity on all interconnections between bidding areas is utilised by an implicit auction, meaning that transmission capacity cannot be directly purchased/reserved by the market participants, but it is traded together with the energy. In market splitting there is only one power exchange operating in several countries that acts as the market operator. In cases of congestion, the market is split into two or more separate price areas. This price differentiation leads to congestion income which is split between the TSOs according to a predetermined arrangement.

With reference to the FBCA method, the commercial transactions can been accommodated by means of different kinds of allocation mechanisms (explicit or implicit FBCA)

- In the explicit FBCA, the influence of all the CB commercial exchanges is summed on each critical branch and when the resulting physical flow is higher than what is available on a certain critical branch (i.e. the maximum allowed flow minus the flow that is already present prior to the allocation), the bid with the lowest offered price per MW of the flow on the congested critical branch is the first one to be reduced to prevent congestion. In essence, a set of bids is determined that gives the highest market value to the auctioned regional set of transfer capacities, under the given constraints.



Source of information: ETSO

Figure 1.1 Exchange Programs and Physical Electricity Flows under Different Cross-border Capacity Allocation Methods

- In the implicit FBCA, the influence of all price area imbalances is summed on each critical branch and when the resulting physical flow is higher than what is available on a certain critical branch (i.e. the maximum allowed flow minus the flow that is already present prior to the allocation), the energy bid/offer with the lowest offered price per MW of the flow on the congested critical branch is the first one to be reduced. In essence, a set of buying/selling bids is determined that gives the highest market value to the auctioned regional set of transfer capacities, under the given constraints. An additional criterion is needed in order to define a unique set amongst the infinity of possible sets of CB commercial exchanges translating the price area imbalances. Solution to this being by the nature the optimization problem can be solved by the application of linear programming techniques.

Even if the designation 'flow-based' might have led to some confusion in the past, it is important to note that the explicit flow-based allocation procedure does not aim at reducing the differences between physical flows and commercial exchanges on a given critical branch, 'flow-gate' or tie line between two member states under meshed network conditions. In the case of implicit flow-based allocation, the additional criterion needed in order to define a unique set of cross border commercial exchanges translating the price area imbalances could be related to the difference between the cross-border commercial exchanges and the physical flows. Therefore, using a 'flow-based' allocation might not necessarily reduce the difference between commercial exchanges and physical flows on tie lines between control areas. Instead it will provide the means to allocate capacity to those bids which value it the most in a given region while at the same time keeping the flow pattern of the given region within security limits for all participating TSOs.

Comparing the capacity allocation methods, you can recognise that many of them share similarities in some aspects but are also very different for other aspects: for instance, "First come, first served", "pro rata" and "explicit auctions" share the fact that the transmission allocation is separated from the energy market. Otherwise, explicit and implicit auctions are commonly based on the value that each applicant assigns to his request.

Additional method for CB congestions relief is the countertrading, where the TSO having detected a potential or actual violation of network security via possible congestion of particular lines, trades power such as to induce a power exchange (and thus a power flow) in the opposite direction of congestion. This method of congestion relief is predominantly used for congestion management within national borders between bottlenecks within national energy systems.

1.3 Examination of the Possible Models for Bilateral/ Multilateral Energy Trading

This section aims to provide the overview of possible ways of addressing the issues of multilateral trade model for electricity, by assessing the cross-border and inter-regional charging methodologies in the European Union, the Nordic Europe region, and the United States.

The objective is to investigate a set of options based on international experience, including the options which are adopted in Europe, putting in evidence the advantages and disadvantages of each.

In general there is a number of different ways how to establish a Multilateral Trade Model for Electricity, particularly for "meshed" networks, and the results may be sensitive to the type of model being used or how it is executed.

The on-going research on cross-bordert pricing indicates that there is no generalized agreement on the pricing methodology. An efficient regional transmission pricing mechanism should recover the transmission costs of individual countries by allocating the cost to network users in a proper way. There may be different ways to estimate the cost of loading a particular asset. For all of these reasons, in the following paragraph a summary of the pros and cons of the major examples is reported. In addition, also the challenges and opportunities of the proposed Electricity Interconnection and Market Integration in the GCC (Gulf Cooperation Council) are reported.

1.3.1 Continental European Inter-TSO Compensation model

Typically, before the liberalization of the European electricity sector, a new cross-border infrastructure was developed through bilateral contracts. In this contest, the costs due to trans-national flows of electricity were recovered using a system of transit fees. It should be noted that the main impediments for the implementation of a single EU electricity market (ERGEG, 2005) were arisen by the resulting "tariff pancaking" and the large difference in the structure and level of tariffs among Member States. To abolish these cross-border tariffs, an inter-TSO compensation mechanism (ITC) was introduced in 2002 when eight European TSOs voluntarily signed a first ITC agreement.

Since then, ETSO has continued to develop the mechanism and the regional scope quickly expanded (ETSO, 2009). With the Third Package and subsequent legislation, the ITC was formalized as an EU-wide instrument. It is based on a hierarchical system:

1. payments compensating for costs originating from cross-border flows of electricity are allocated among TSOs;
2. TSOs take into account their net payments when determining national transmission charges based on national rules regarding tariff.

Regulation 714/2009 sets the legal basis for an obligatory inter-TSO compensation mechanism according to which TSOs are compensated for all the costs incurred as a result of hosting cross-border flows of electricity on their networks by those TSOs from whose systems cross-border flows originate or where they end. The costs shall be established on the basis of the forward-looking long-run average incremental costs, taking into account losses, investment in new infrastructure, and an appropriate proportion of the cost of existing infrastructure. The concrete methodology currently applied is laid down in Regulation 838/2010. The ITC is a "zero-sum game" with the fund being calculated and distributed annually based on an ex-post analysis. Contributions into the fund are determined based on TSOs' proportion to the absolute value of net flows onto and from their national transmission system as a share of the sum of the absolute value of net flows onto and from all national transmission systems.

Presently, the Inter-Transmission System Operator Compensation (ITC) mechanism is defined by the Commission Regulation (EU) 838/2010[3]. More than 30 countries are participating in this mechanism. In continental Europe, electric transmission networks are owned and operated by one or more distinct TSOs in each country, but they are synchronised and extensively interconnected. Within the European Union both national and European Union-level legislation applies. Part of all the arrangements concerning interconnectors are common because they are set out in European legislation but some aspects are agreed bilaterally between the networks and/or governments, with energy regulators involved to varying degrees, depending on the country.

In general, European legislation[4] forbids network operators from charging fees at their borders: in other words, market participants can only be charged to deliver electricity across national borders when there is congestion, and congestion must be managed by charging "market-based" fees.

Recognising that cross-border flows can impose costs that might not in general be recovered from connected users, the Regulation also defines a system of "inter-TSO compensation[5]" for which payments between TSOs to compensate any such under-recovery of revenues are considered. In principle the Regulation addresses the issues that interest the inter-regional charging. European TSOs, through their trade association ENTSO-E, were operating an inter-TSO compensation (ITC) scheme since 2002.

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[3] COMMISSION REGULATION (EU) No 838/2010 of 23 September 2010. Guidelines relating to the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging.

[4] REGULATION (EC) No 714/2009 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 13 July 2009 on conditions for access to the network for cross-border exchanges in electricity and repealing Regulation (EC) No 1228/2003

[5] Article 13 Inter-transmission system operator compensation mechanism

The inter-TSO compensation (ITC) arrangement created a basis for the efficient operation of the European electricity transmission system and for a free electricity market. The ITC arrangement enabled the elimination of cross-border fees from cross-border electricity transmissions.

In the last version of the ITC scheme, TSOs are compensated for costs associated with transit flows only (transit flows are those which occur when a country simultaneously imports and exports on different interconnectors). The assets exploited by transit flows are identified through a defined network modelling, and the associated costs are rated using the same methodology used to set up the national regulated revenues. Thus the ITC scheme:

- generates a central fund which represents the total costs arisen by transits,
- allows each TSO to pay into the fund in proportion to net cross-border flows, measured on an hour-by-hour basis.

Furthermore, TSOs should provide a fair third-party access to the interconnectors: TSOs are not allowed to charge for access to unconstrained interconnectors, and the legislation requires that TSOs use market based mechanisms to manage congestion this means either explicit auctions of the allocation of capacity, or market coupling, or a combination of both. The revenues from congestion management on interconnectors must be used either to fund new investment or to reduce (national) network tariffs.

1.3.1.1 Investment cost for Interconnectors and network reinforcement

First of all, it should be noted that there are no general rules about allocating investment costs relevant of the assets associated with cross-border flows. Nevertheless, in some cases costs are shared equally in respect of assets that don't belong to either one network or the other, and each TSO charges its own network reinforcement costs.

Finally, loop flows are significant in parts of Europe, because the network is relatively dense and meshed. The ITC scheme takes into account loop flows because it is based on physical flows.

1.3.1.2 Tariff Methodology and Congestion Revenues

The national transmission tariffs cover the costs of each TSO's contribution to the ITC scheme. In most of countries in Europe, tariffs are not locational, and load pays most of the total cost and in many countries the generator tariff is zero.

According to ENTSO-E agreement on inter-TSO compensation system, the system compensates costs which are caused by the transmission of electricity through countries.

The ITC fund provides compensation for the costs of losses incurred national transmission systems as a result of hosting cross-border flows of electricity and the costs of making infrastructure available to host cross-border flows of electricity.

ENTSO-E[6] is responsible for establishing arrangements for the collection and disbursement of all payments relating to the ITC Fund. More in detail, according to ENTSO-E agreement on inter-TSO compensation system for 2010, the agreed sum for ITC fund was around 100 million euros. Also for transmission loss compensations the foreseen sum was of the same level of magnitude, but the compensation was determined by the actual losses.

The level of the ITC/perimeter fee was equal to the transmission compensations between parties involved in the arrangement. The new agreement was influence the pricing of the Russian cross-border transmission service. The ITC/perimeter fee for imports and exports in accordance with the new agreement was fixed at 0.7 €/MWh.

With reference to the costs of internal network congestion, generally they are covered in the first instance by the TSO, and are then moved to customers through tariffs. There are cases in which market participants reduce the availability of capacity on interconnectors, in order to help manage internal congestion costs.

The guidelines for congestion management, under which congestion must be managed using market-based mechanisms don't define uniform rules for providing access to the interconnectors between countries, although regulators have a general preference for implicit auctions.

Under both implicit and explicit auctions for capacity, the TSOs obtain congestion revenue directly, in the case of explicit auctions, and through the market coupling/splitting for implicit auctions.

There are no general rules for deciding on how the congestion revenue should be split. Congestion revenues are collected by the TSOs and shared out based on agreement between two countries involved. This income must be used either to reduce tariffs or to upgrade interconnection; in practice it is usually used to reduce tariffs.

1.3.1.3 Incentives to Increase Capacity for Inter-Regional Flows

In Europe all existing and new AC interconnectors are regulated. Investment in new interconnection therefore depends on the regulatory framework rather than merchant investors building interconnectors in order to exploit price differentials. Some vertical integration companies within European power sector hampered liberalisation with TSOs, failing to improve interconnections so as to protect domestic generator's interests. Despite legal restrictions on its use, direct income from congestion revenues disincentives reducing congestion.

1.3.2 Nordpool model

Nordpool is composed by the transmission systems of Denmark, Norway, Finland, and Sweden and operates as a pool type system: the set of generators offers a schedule of output and prices, loads bid a schedule of demands and prices, and the TSOs dispatch a least-cost generating schedule. A close

[6] COMMISSION REGULATION (EU) No 838/2010 of 23 September 2010 on laying down guidelines relating to the inter-transmission system operator compensation mechanism and a common regulatory approach to transmission charging

cooperation between the national TSOs is present, and the TSOs are owners of the Nordpool market operator.

Since the connections between countries and regions of Nordpool have not enough capacity to accommodate in every time unrestricted flows, the market is usually split into different price regions. The connections across national borders are owned by a different company.

Inter-regional transmission is particularly significant in Nordpool for two reasons:

- there is a long history of co-operation between the Nordic countries, particularly in electricity;
- generation systems of the different countries are quite diverse, so inter-regional flows are particularly efficient / beneficial, allowing hydro-based systems to import thermal power in dry years, and export in wet years.

1.3.2.1 Inter-Regional Flows Mechanism

New interconnectors and upgrades between the national systems in Nordpool are charged by the two TSOs concerned: for assets in neither TSO's area (i.e., a sub-sea cable), the costs are shared equally, and otherwise each TSO pays the costs of assets in its own country.

Nevertheless, the arrangement arrived by bilateral negotiation is possible, this way TSOs are free to agree with alternative sharing rules.

There is no mechanism in place for the TSOs to pay each other's costs. Reinforcements that benefit Nordpool as a whole through facilitating inter-regional flows are in principle identified by a planning process run by Nordel, the association of Nordic TSOs.

The TSOs cover the costs of interconnectors from transmission tariffs paid by their own customers: in other words, there is no mechanism for inter-TSO payments to share the costs of interconnection infrastructures and the ITC scheme applies only to transits. It should be noted that the Nordpool TSOs were part of the ENTSO-E "inter-TSO compensation" (ITC) scheme and thus they receive compensation for hosting transit flows. Costs associated with loop flows are dealt with under the ITC scheme as well.

In summary, the cost of building or upgrading interconnection is shared by two networks involved. Some costs relating to existing infrastructure that is deemed to be involved in transit flows is compensated as part of the Inter-TSO Compensation scheme.

As above mentioned, the connections between countries and regions of Nordpool don't have enough capacity, in addition the Nordel planning process identifies internal network constraints that are significantly limiting inter-regional flows as well. Nevertheless, internal network reinforcements are made if the selves reinforcements are needed both for grid reliability and to manage congestion. All internal network upgrades are funded by the TSO concerned, even if they have significant effects on other parts of the Nordel region.

In general, there are two distinct mechanisms for managing congestion:

- the market-splitting process operates to manage congestion between different price areas;
- within a price area, the TSO manages congestion by "counter-trade" on the wholesale market.

The difference between the two mechanisms is that in the first case the costs of congestion fall on market participants, and in the second case they fall in the first instance on the TSO.

Another important characteristic is that the capacity of the interconnectors is not fixed: the TSOs are able to declare reduced availability of interconnector capacity, thereby making market splitting more likely and reducing the degree of internal congestion. There are significant disputes within Nordpool over which the TSOs should change the capacity of interconnectors in order to manage internal congestion. This aspect is under study to date.

1.3.2.2 Tariff Methodology and Congestion Revenues

The costs of the transmission system in each country, as well as that TSO's share of interconnector assets, are recovered from network users through transmission tariffs. The tariff methodology makes no distinction between interconnector and other assets. Both costs in each country are recovered from network users through transmission tariffs. The transmission tariffs are paid by load customers and partly by producers.

Annual average transmission charges paid by producers are annual total transmission tariff charges paid by producers divided by the total measured energy injected annually by producers to the transmission system. Annual average transmission charges paid by producers are within the ranges 0 to 2,5 EUR/MWh,

Congestion revenues are collected centrally and shared out based on agreement between all participating countries. This income must be used either to reduce tariffs or to upgrade interconnection.

1.3.2.3 Incentives to Increase Capacity for Inter-Regional Flows

The cost of new assets falls on the network in which the asset is located. Even if Nordel takes some lead in assessing priority projects, timeframe is slow on these projects.

At the stage of investment planning, the Nordpool TSOs individually or through Nordel carry out a cost–benefit test of potential upgrades employing a "Nordic" perspective.

Furthermore, it is important to mention that Regulators are required, under the congestion management guidelines, to publish details of congestion revenues earned. This extra transparency should reduce the fact that the ownership of congestion revenues on interconnectors provides a disincentive to investment.

1.3.3 United States model

In the following the inter-regional model in force in the US, based on arrangements in Independent System Operator/Regional Transmission Organizations (ISO/RTO) markets is described.

An ISO/RTO[7] region includes and operates in an integrated manner a number of separately-owned transmission networks.

[7] The ISO/RTO is a non-profit organization, set up and operated under Federal Energy Regulatory Commission (FERC) rules set out by FERC in Order 2000.12

Inside this contest, the ISO/RTO is an independent body with operational authority performing the following functions:

- schedules generation,
- operates the wholesale market,
- collects tariff revenue on behalf of its member transmission owners,
- plays an important part in network planning.

1.3.3.1 Inter-Regional Flows Mechanism

During the process of ISOs/RTOs forming, the pre-ISO/RTO arrangements charging system was preferred to be maintained, i.e. within a ISO/RTO "the costs of an individual transmission owner's existing network is recovered from the transmission-owner's own customers". Nevertheless the costs are reduced by any transmission charges collected from third-party use of the transmission system for exports and power wheeling service. In a given ISO/RTO areas, new assets that facilitates flows between different networks within the ISO/RTO area are not paid for only by the customers of the network that owns the asset. At the contrary, for the new assets that are deemed to bring "regional benefits" to customers across the ISO/RTO, and thus their costs is shared among all customers in the ISO/RTO.

In case when costs are shared on the basis of a pro-rata throughout the RTO (e.g., in proportion to each network's peak load), the charging arrangement is defined as "*postage stamp*" pricing: in other words, for these assets that are considered to be "regional" in nature, all customers within the ISO/RTO pay the same tariff. It is worthwhile to mention that "regional" assets are those above a certain voltage threshold. A further distinction is typically made between assets that are primarily required to improve system reliability (i.e., "reliability" projects) and those which primarily justified by economic benefits ("economic" projects).

The costs of new lines that interconnect two ISO/RTO regions also may be shared between the two organizations applying the cost-sharing arrangements and hence recovered from customers in both regions. Assets in either region can be partly paid for from tariffs collected from customers in the other region. The costs of the investment upgrade will be shared only by customers in networks that are expected to see reduced costs and prices. Those networks that do not benefit (in terms of reduced generation costs and prices) do not need to make a contribution to the upgrade.

It should be noted that if an ISO/RTO is adjacent to a non-ISO/RTO region, although it is not possible to share costs between network owners, the costs of new interconnection can be shared in an appropriate way on the basis of potential geographical restriction of the extent of transmission networks.

Within ISO/RTO regions, the ISO/RTO makes the collection of all of the transmission charges paid by customers of its member transmission companies and redistributes transmission tariff revenues.

In case that adjustments are necessary to cover the total costs of regional assets the ISO/RTO can adopt the necessary adjustments in order to ensure that each TO receives its regulated revenue.

The cross-border flows have an impact on rest of the network depending from the flow direction.

Cross-border flows can impose costs on the network owner of assets that are not directly related to the connection between the two networks. In US ISO/RTO markets, do not make a distinction between interconnector and other involved assets.

Part of the Inter-Regional Flows Mechanism in US, is the network congestion arrangement. In US ISO/RTO markets, it is dealt with by a centralized system of locational marginal pricing (LMP). The ISO/RTO is able to define a least-cost schedule of generation dispatch inside a given region, subject to network constraints. Constraints (as well as transmission losses) cause different prices at various nodes on the system. The costs of congestion reflect the energy prices and supported directly by the market participants. In an area where there is insufficient low-cost generation or insufficient import capability the nodal price will rise and load customers will therefore pay more. Otherwise, in an area with excess low-cost generation, nodal prices fall and generators receive less.

1.3.3.2 Tariff Methodology and Congestion Revenues

The methodology in different ISO/RTO markets is the same: Generators pay “deep” connection costs, but there is no other mechanism for allocating network costs to specific users. Transmission tariffs are paid by load customers (and exports and wheeling through customers) only, and do not vary within a given network. They pay in proportion to the user’s consumption or contribution to peak load (i.e. the total revenue requirement for that network, divided by that network’s peak load, multiplied by the user’s peak load). Thus, within an ISO/RTO the transmission tariff varies only by network. Congestion revenues within ISO/RTO markets usually benefit who paid for the congested line. Thus, a new generator that pays a deep connection charge will be able to receive a portion of the future congestion revenues on the assets it has paid to reinforce. Congestion revenue associated with assets not paid for by generators will generally go to the network owner. The rights to the congestion revenues typically must be auctioned-off periodically, so the network owner actually receives the auction revenue rather than the congestion revenue itself.

1.3.3.3 Incentives to Increase Capacity for Inter-Regional Flows

In order to eliminate the problem of disincentives by network owner to maintain the congestion revenues in US ISO/RTO markets, the ISO/RTO itself takes the lead on network expansion assessing need for new infrastructure and can appoint third party to build if necessary. On the other hand FERC has paid considerable attention to governance issues at the ISO/RTO to ensure that it operates independently and is able to perform regional transmission planning functions effectively.

1.3.4 Electricity Interconnection and Market Integration in the GCC: Challenges and Opportunities

The traditional approach in GCC was to consider the electric interconnections as a means to provide security (emergency mechanism). This could be considered as a sub-optimal way of using the GCC electric network in fact, the idea of GCC Interconnection Authority is to obtain a much higher benefit by creating a regional electricity market.

In recent years, GCC Interconnection Authority has developed the “launch pad” this Electricity Market, which aims to:

- add the power capacity,
- diversify the power capacity (nuclear, solar..),
- reform some structural sector,
- address the domestic pricing of electricity.

The importance of this development can be linked mainly to the cooperation between GCC and other Arab Countries, and consequently, to the cooperation between GCC and Europe Union: important exchange of experiences which can be mutually beneficial.

An important aspect to be considered in this section is the fact that the countries in the Gulf Cooperation Council (GCC) have increased the presence of independent power projects (IPPs) and independent water and power projects (IWPPs): this kind of power plants have substitute the prior government-financed power and cogeneration plants.

1.3.4.1 New Policies for a Growing and Evolving Electricity Market

An important aspect is the fact that the countries in the Gulf Cooperation Council (GCC) have increased the presence of independent power projects (IPPs) and independent water and power projects (IWPPs): this kind of power plants substituted the prior government-financed power and cogeneration plants.

By shifting investment in power generation and water desalination to the private sector, these countries were able to redirect public resources to other development priorities and to engage private-sector stakeholders in the challenge of supplying the region's growing power and water needs. Obviously, this strategy changing can be considered propaedeutic for the development of the electricity market and more in general for the diversification of the investment resources.

These changes also include the development of an "IPP liability indicator" to constantly measure the government's outstanding liabilities of the IPP, encouraging:

- sharing with industrial users,
- tendering IPPs to ensure a diverse range of generation assets,
- adding government buyout clauses to prevent IPPs from becoming stranded assets in a future liberalized electricity market.

1.3.4.2 Evolution of GCC Electricity Trade

The GCCIA interconnection is considering the opportunity to develop the power trading between the GCC members. Three potential market models for the GCC are investigated from a regulatory point of view taking into account several issues, such as:

- Existing legislation, laws and commercial codes of GCC power sector.
- Dissimilar Market Structure in the GCC member states.
- Transmission System Congestion.
- Existing Power Purchase Agreements with Independent Power Producers.
- Cross-Border Tariffs.

The models studied by GCC Interconnection Authority are:

- The Wheeling Model,

- The Decentralized Model,
- The Integrated Model.

The three models differ in the degree of integration of the markets and the possible role of the ICC in the GCC System Operations.

The Wheeling Model is based on the function that provides transmission access to energy traders, according to a prescribed tariff. The GCC Interconnection System Operator (ICC) should have the responsibilities of Scheduling Bilateral / Forward Contracts between sellers and buyers by allocating transmission access according to a prescribed tariff or wheeling charges.

Nevertheless, it should be noted that in this case, the sale of interconnector excess capacity would be regulated by an auctioning process, which would provide a more efficient competitive approach. Such model is what is likely to be used by GCCIA in the first years. The disadvantage of this method is that it doesn't promote competition in generation.

The evolution of the Wheeling Model is the Decentralized Model. In each GCC country, an own structure of the Vertically Integrated Utilities (VIUs) would be required. Considering such a model, the ICC assumes also responsibility of Administering Arrangements for imbalances to compensate the imbalances in ICC system by running a local Spot Market. Finally, the ICC would also assume responsibility for procuring ancillary services, and allocating costs to System users.

Typically the spot markets could cause inefficient markets bringing to fragmented and suboptimal prices: just some market players could be beneficed.

The ultimate considered development of the GCC electricity markets is when all GCC local spot markets would integrate into a single GCC electricity market. It is the natural evolution of the previous model. In this model, the GCC ICC becomes the GCC Market Operator.

In addition to Scheduling Forward Contracts, the ICC would have:

- the responsibilities of Running the GCC Spot Market
- the management of the required ancillary services,
- the responsibilities to allocate the costs to System customers on the basis of the required needs.

Since the integrated model can achieve optimal electricity pricing through the creation of single one market operation, the bi-lateral and multi-lateral transactions would be considered anti-competitive and therefore would be banned by the GCC electricity regional regulator[8].

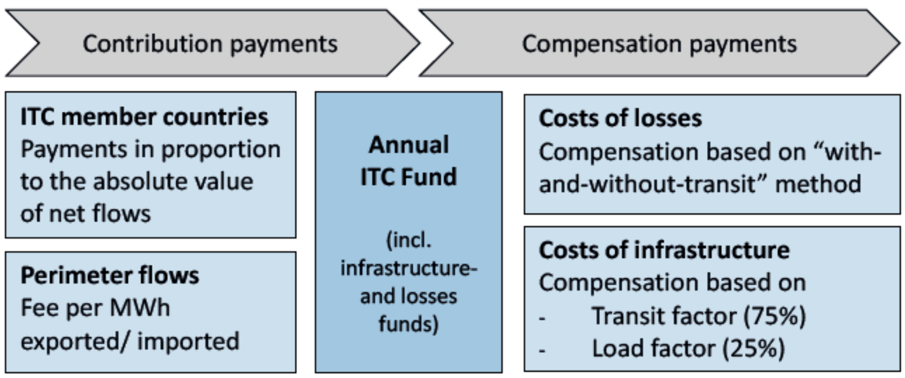
[8] Ahmed Ali Al-Ebrahim, Nasser Al-Shahrani and Richard D. Tabors " GCC Interconnection Authority: 'Launch Pad' of GCC Electricity Market"

2 ARAB COUNTRIES MULTILATERAL TRADE MODEL

This chapter aims to propose a multilateral trading model of the Arab Counties system on the basis of the methodology at present adopted in continental Europe.

For the Member States belonging to the EU and to the EEA[9], the Inter-Transmission System Operator Compensation (ITC) mechanism is defined by the European Commission Regulation (EC) 838/2010. More than 30 countries are participating to this mechanism. The compliance with the European regulation for electricity trading is particularly important for the Mediterranean Arab Countries in view of the huge power exchanges envisioned by the Mediterranean Solar Plan and further by the Desertec Industrial Initiative (Dii).

The proposed analysis reflects the European methodology (described in paragraph 1.3.1), which was developed in the framework of the regulation regarding the Internal Electricity Market (IEM).



Source: European University Institute

Figure 2.1 Current European ITC mechanism

The political and legal concepts of the IEM reflect the idea of a free trade in electricity without any barrier for the cross border flows. Since this kind of solution is not a realistic option for the time being for many the Arab Countries, additional costs[10] deriving from cross border electrical flows need to be allocated among the national TSOs adopting fair rules.

The objective of the proposed Arab Countries ITC mechanism is to remunerate the utilization of the transmission network hosting cross border flows in Pan Arab interconnected system. In general, the ITC guidelines play an important role, regarding:

- compensation rules for the provision of infrastructures affected by cross-border flows of electricity;

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[9] EEA: Economic European Area, which includes Norway, Liechtenstein and Iceland

[10] Additional losses in countries hosting power wheeling, additional operating and maintenance costs for the network assets subject to higher power flows.

- testing of the proposed ITC methodology based on the electricity transmission infrastructures available for cross-border flows of electricity over the relevant period and criteria for the ex-ante simulation of yearly operation of the Pan Arab interconnected system.

In defining the possible model for the inter-TSO compensation mechanism, one should take into account:

- the parts of the network affected by cross-border flows,
- the following aspects for a fair compensation of the cross-border power flows:
  - compensation payments should be made on a regular basis with regards to a given period of time in the past. Ex-post adjustments of compensation paid shall be made, if needed, to reflect the costs actually incurred,
  - both the magnitude of the hosted cross-border flows (transits or power wheeling) and the magnitude of cross-border flows causing transits either from net exporting or net importing countries should be evaluated on the basis of the physical electric flows measured in a given period of time,
  - benefits that a network may incur, when hosting cross-border flows, should be taken into account to reduce the compensation to be received.
- The possible treatment of perimeter countries[11].

The following paragraphs describe:

- the main issues to be addressed to set up cross-border trading of electricity,
- the model of transits compensation that could be adopted by Arab Countries,
- Presentation of the results of a dry-run implementation of the proposed ITC mechanism based on the results obtained from the simulations carried out with the PROMED market simulator and adopting the Pan Arab interconnected network model for the target year 2020. The simulation results of the inter TSO payments to compensate for the use of national transmission assets affected by cross-border trades (transits) and related losses are described.

2.1 Arab Countries Multilateral Trading Model Definition

This paragraph describes the main challenges, the computational and organisational aspects necessary for the implementation of the proposed methodology for the multilateral trading taking into consideration different transits / wheeling alternatives through the interconnected Arab transmission system.

The wheeling charges will be calculated for all Arab Countries taking into account the results arisen from the analysis of the “Preferred Scenario”.

[11] Perimeter countries are countries adjacent to the free trade area under examination; e.g.: Ukraine, the Russian Federation and Morocco are perimeter countries of the European cross-border trading of electricity.

First of all, the Arab model for wheeling charges calculation is here defined as the model that allows for evaluating the compensation to be paid and to be received by each country. The model is a two-step approach, namely:

- Identification of net import/export countries and countries hosting transits. The computation of transit/power wheeling and other cross-border flows for each TSO or national utilities is based on hourly measurement of the energy flows at the tie-lines.
- Calculation of the additional costs related to the power wheeling for loss and infrastructure compensation; definition of the settlement process to work out the total compensation of each country, its contribution and its net position.

The transit / power wheeling is defined as the hourly minimum value between the power export and power import for a country, where export and import are the sums of physical flows on all exporting lines and all importing lines respectively (we have simulated these power flows in Task 4 of this project).

In general, the main advantages for the Arab Countries to adopt a “well-built” multilateral trading mechanism can be summarized here below:

- Increasing of the economic efficiency: sending price signals to the electricity market participants and TSOs to incentivize them to act in a way which is efficient from the viewpoint of the system as a whole,
- Revenue recovery: ensuring that TSOs recover an appropriate amount of revenue.

2.1.1 Methodology Definition

The proposed methodology calculates the compensation to reward a TSO for hosting third party transits resulting by export from a first TSO area and import in a second area. The TSOs, within which area the net power export or net power import are originated, shall pay to compensate the other TSO(s) hosting the transits.

The reference period is one year: in order to consider all the foreseen interconnections of the preferred scenario available, the target year 2020 is here considered.

The process for the calculation of the compensations proposed below can be divided into:

1. Definition of the horizontal networks,
2. Costing of the horizontal network and losses,
3. Clearing and Settlement mechanism, and
4. Metering / data monitored and measured on tie-lines for “ex post” correction procedures.

1st step: Definition of the Horizontal Network (HN)

The "Horizontal Network" is that part of the transmission system, which is used to transmit electricity between countries and within the country. It contains the transmission system elements that are influenced significantly by cross-border exchanges. This approach assumes that the functions of the whole network can be split into three parts:

- access of the generation to the "Horizontal Network";

- access of the load to this "Horizontal Network";
- the "Horizontal Network (see Figure 2.2).

The two first functions constitute the "Vertical Network". For most countries, the "Horizontal Network" consists at least of the 500/400 kV and 220 kV interconnections, lines and transmission substations.

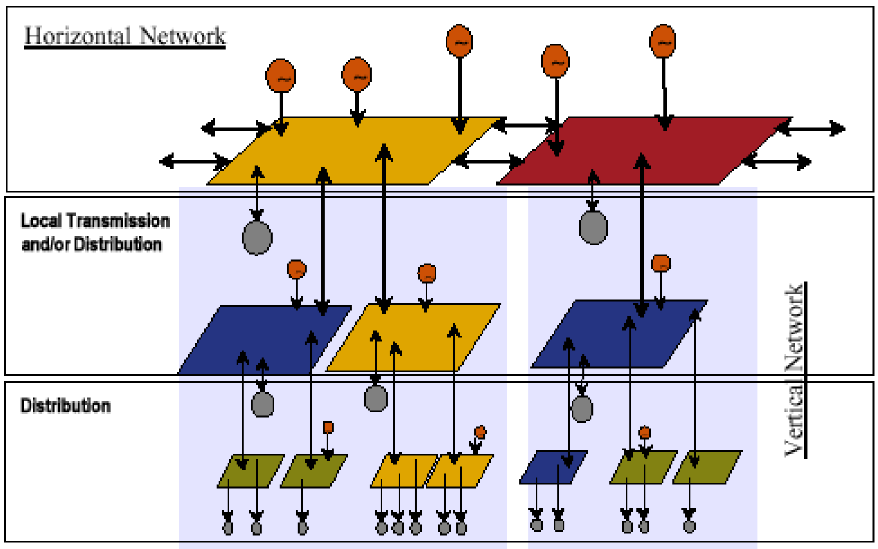

Figure 2.2 Concept of "Horizontal" and "Vertical" Networks (source ENTSO-E)

2st step: Costing of the horizontal network and losses

Network costs

The methods described above for determining how much of a host country's network is used for cross-border flows (HN) has to be combined with a method for determining the costs of the network. In fact, the next step is the estimation of costs for both assets (infrastructure) and transmission losses in the horizontal networks hosting cross-border flows.

There are different options for cost determination and the main are:

- Long-run average incremental cost (LRAIC) of transmission expansion – a forward looking measure of future costs, often used where the aim is to send price signals about the cost of new investment; and
- An appropriate proportion of the cost of existing infrastructure as the regulated costs.

Calculating the costs using LRAIC results in a much more complicated system and in our case there are no data of transmission expansion of national power systems.

Standardised costing is used in ENTSO-E that is usually based on existing evaluations approved by national regulators. The standard costs for lines are given per voltage levels ($/km/voltage) and the standard costs for transformers are given per types of transformers using their installed capacity ($/MVA). Setting revenues for TSOs, and as part of this assessing the cost of the network infrastructure, is a core competence of national regulators.

Estimation of Losses

Cross-border flows cause changes in the volume of losses within the transmission network. An ITC element shall therefore be set up in order to compensate for costs or benefits related to this variation of losses. The most appropriate method for the evaluation of transmission losses incurred as a result of transit flows is still an open question. There are different options for that purpose: marginal approach that takes into account marginal effect of transit for losses, proportional approach and With and Without methodology (WWT). The WWT methodology is currently implemented in ENTSO-E ITC mechanism.

With reference to the cost of transmission losses, the price to be used to calculate them should be equal to the price used to cover losses by national tariffs: in this case the Consultants propose to use the expected long term average costs of energy for each country calculated and presented in previous phases of this study.

3rd Step Clearing and Settlement

The driver aspect of the fair clearing and settlement procedure is the evaluation of the ex-ante fund to be collected for compensation of transits. In fact, the ITC mechanism's principal objective should be ensuring that sufficient revenue is recovered to fund the parts of the host TSO's network. To this purpose, the concept of establishing a fund is paramount for the compensation of all participating entities by the financing from the entities participating in the ITC mechanism according to the net power flow, i.e. the net import or export on each entity on an hourly basis charged by an explicit fee.

The aim of settlement process is to compute the total compensation of each country, its contribution to the fund and its net position regarding the wheeling charges for energy losses and infrastructure compensation. The activity is performed utilizing an "ad-hoc" financial computation model.

The data required to adopt such a financial model are one key element of the assessment, and according to the results of the analysis already performed during this project the input data set here considered are:

- The Interconnections flows for 8760 hours during the year: country by country, the magnitude of hosted transits, exports and imports for a given year. In our simulation of the proposed ITC mechanism we have used the data of 2020;
- the load value of each country for 8760 hours during the year;
- the magnitude of losses on each country's network caused by cross-border flows;
- Costing of the horizontal network and of relevant losses.

Hence, the economic and financial model is able:

- to give a financial value to these losses by using long term annual average specific cost of electricity generation;
- to compute the claim that each country should receive regarding the specific usage of its "infrastructure";
- to define the framework fund for compensation;

- to compute the total compensation of each country, its contribution and its net financial position regarding the wheeling charges compensation.

Finally, to better define the framework fund for compensation, it should be noted that from a regulatory viewpoint a financial institution that provides clearing and settlement services for securing transactions needs to be constituted. This institution, where members of each Arab Country are represented, will assumes the role of "clearing house" with the obligation of guaranteeing the transfer of compensation to the recipient TSOs, should one of the participating members runs into default or, in extreme cases, goes bankrupt: the purpose of the "clearing house" is to enable investors to trade without concern about the creditworthiness of the individuals with whom they are dealing. Generally, it attempts to reduce the risk that a clearing member will not be able to honour its commitments and monitors the financial strength and portfolio positions taken by member countries.

In practice, delays and breakdowns in the payments and clearing process should be managed by a dedicated legislative guideline that would allow avoiding potential confusion in the energy trade and probably contributing to the reduction of risk of lack of payments from the individual members.

The following figure shortly describes the adopted model.

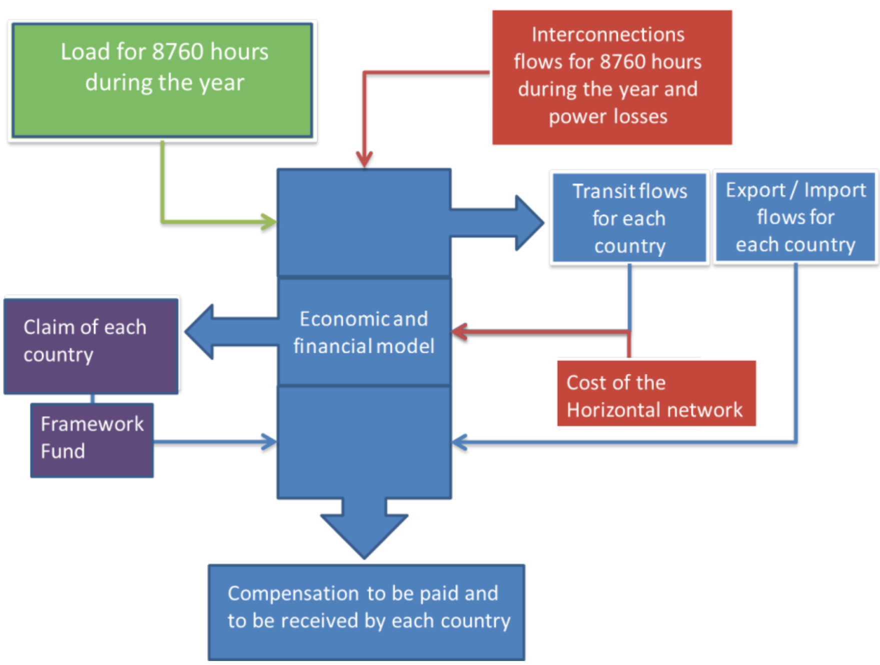

Figure 2.3 Economic and financial model flowchart

As above mentioned, the model is based on the results of power exchanges and losses computation of Task 4 ("Feasibility of electrical energy trading and interconnection reinforcements"). The main "output data" of the model is the financial compensation to receive and the contribution to pay for each country.

4th Step Metering / data monitored and measured on tie-lines

To define an ITC mechanism a set of data should be monitored and measured on tie lines and communicated among control centres. Generally, a centralized procedure to check "ex-post" on a weekly basis for each hour and each TSO the difference between measured import/export and the scheduled (contractual) import/export have to be developed. The variations can be compensated the following week. This procedure reflects the existing international practices in Europe where a centralized Data Bank supplied by all involved TSO's Data Acquisition System and Data Administrator agreed and recognized by all the parties is present. The establishment of this centralized Data Bank where all data and measurements on interconnection lines are stored and processed, is advised to be developed since it is a prerequisite for the ITC execution.

More in detail, the metering of the import/export flows allows the correction of the "ex-ante" losses estimation caused by transits.

The amount of losses on the network of every TSO could be computed "ex-post" on a monthly basis for 6 representative moments. As already stated, the basis for these "ex-post" calculations is a data bank which is uploaded every day for the 24 hours with the flows such as measured on the tie-lines and validated by the involved TSO's. These data are in particular used to determine the "Unintentional Deviations".

For calculation purposes, every TSO should establish the local situation of its grid in at least 6 snapshots that are agreed upon by all TSOs. The suggested moments could be (referring to a month):

- Every third Wednesday at 03h30, 11h30 and 19h30.
- Every last Friday before this Wednesday at 03h30, 11h30 and 19h30.

For each snapshot, the amount of losses linked with cross-border flows should be computed with the WWT methodology, i.e. by comparing losses on each line with or without transit.

Of course, the quality of calculation depends on the quality of the data measurement.

To avoid the errors of measurement, the snapshot is taken after a calculation of a State Estimator. Indeed the results of a state estimator offer the best representation of the whole network. Then, the flows on the tie lines in the snapshot are compared with the flows used for the determination of the transit flows at the same time. If the delta > x MW (x to be defined), the snapshot is adapted so that the flows on the tie lines are equal to the measured flows stored in the centralized data bank.

As these calculations are centralized, the snapshots are also stored in the centralized Data Bank.

2.2 Simulation of the Expected results of Multilateral Trade Model

The Consultant implemented a computation framework of the proposed inter-TSO compensation mechanism and performed a simulation considering the integrated model of the Arab Countries at the target year 2020.

The proposed ITC mechanism was simulated for all involved "Parties". The parties were all the Arab Countries, part to this study, and an international organization, namely GCCIA. The GCCIA does not own any generation but, being administrator of an important transmission network with exclusive function of electricity exchanges, was considered in the mechanism as a party.

The first objective of the proposed mechanism was to compensate for the use of a national network by "transit flows". For a given country the transit flows (other term is wheeling) were defined as flows resulting from energy exchanges where injections and loads were located outside of the "transited country". These transit flows were determined on the basis of hourly simulations by means of a market simulator (PROMED) in a given period of time (2020). It should be noted that the"Losses" caused by transits were also taken into account in the proposed compensation mechanism using the Pan Arab Interconnected Model of the transmission network in configuration 2020.

2.2.1 Calculation of the horizontal networks

The Consultant here proposes a procedure for defining the horizontal networks using the PSS/E computation package. The HN was defined by applying a technical auditable approach. The network simulation model is the integrated transmission model of all Arab countries prepared under the Task 4 with all available lines in operation in order to represent the interconnected transmission system in normal operation condition.

In order to evaluate the horizontal networks of each Arab Country, a single network snapshot in peak load condition was considered as being sufficiently representative to achieve a satisfactory estimation.

The HN was defined by applying the Allocation of Transit Flow (ATF) approach based on AC power flow computation. Grid elements in the overall transmission network were identified by calculating the participation of each network element due to transit by comparison with a situation without transit:

- a standard flow (100MW) was applied between interconnected countries,
- one region network each time was considered, highlighting inner lines and interconnection nodes,
- horizontal network comprised all the national lines such that at least one standard flow generates a transit flow ≥ 10 MW.

Figures Figure 2.4, Figure 2.5, Figure 2.6 and Figure 2.7 illustrate the application of ATF method in the interconnected model. The result of calculation was a complete list of the elements that constitutes the Horizontal Network and served as an input for the estimation of costs for assets (infrastructure) hosting cross-border flows.

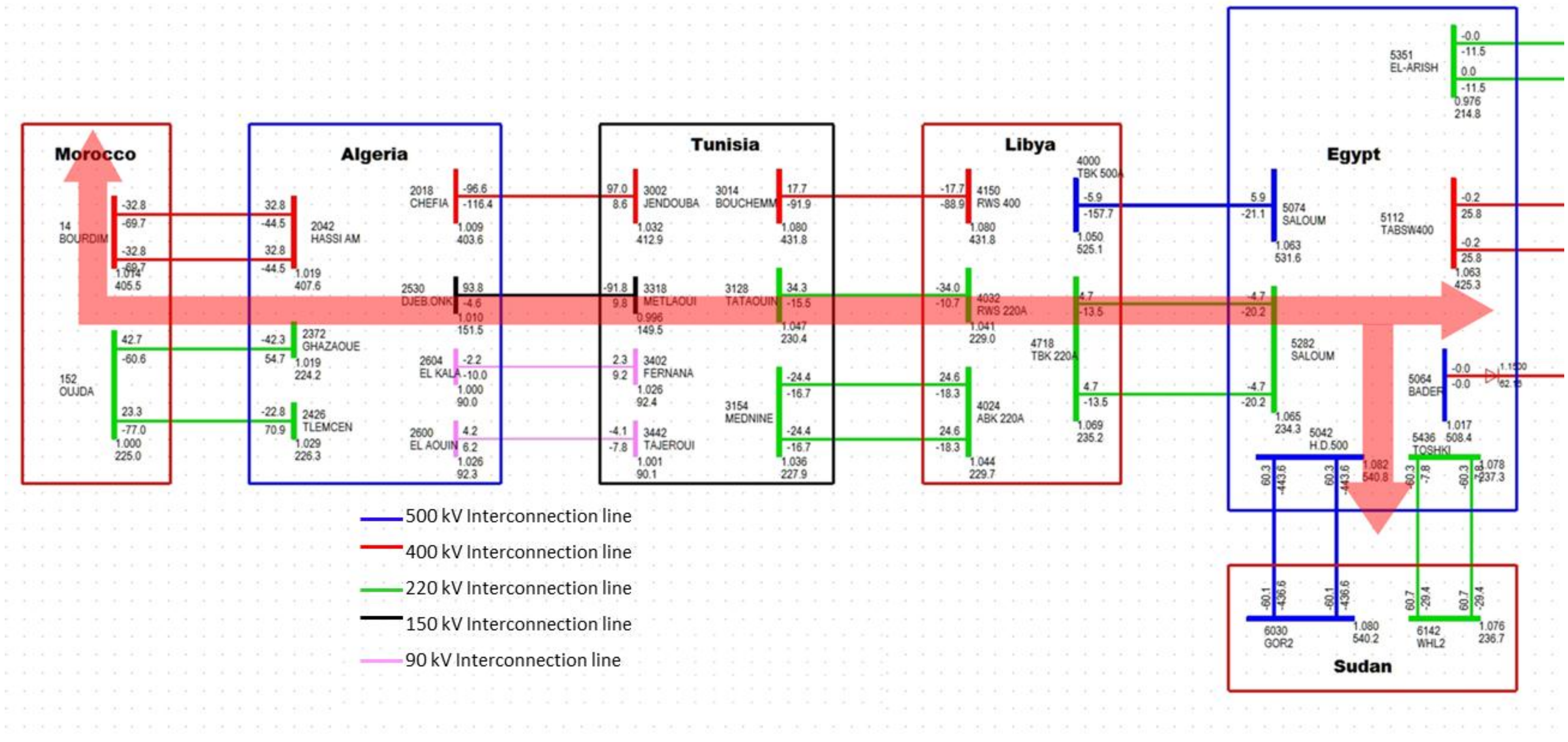

Figure 2.4 Definition of Horizontal Network of Maghreb countries and Sudan

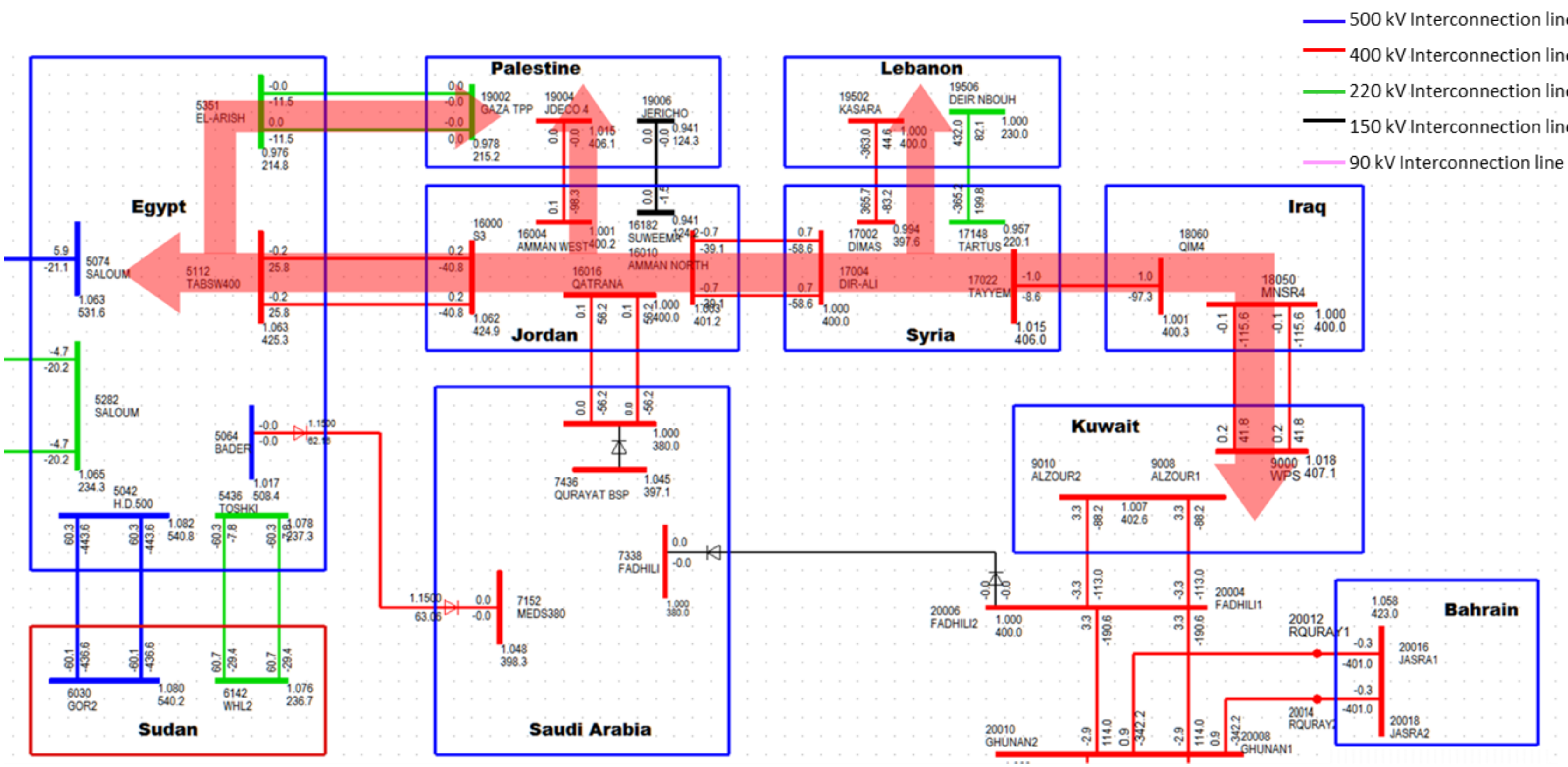

Figure 2.5 Definition of Horizontal Network of Mashreq countries

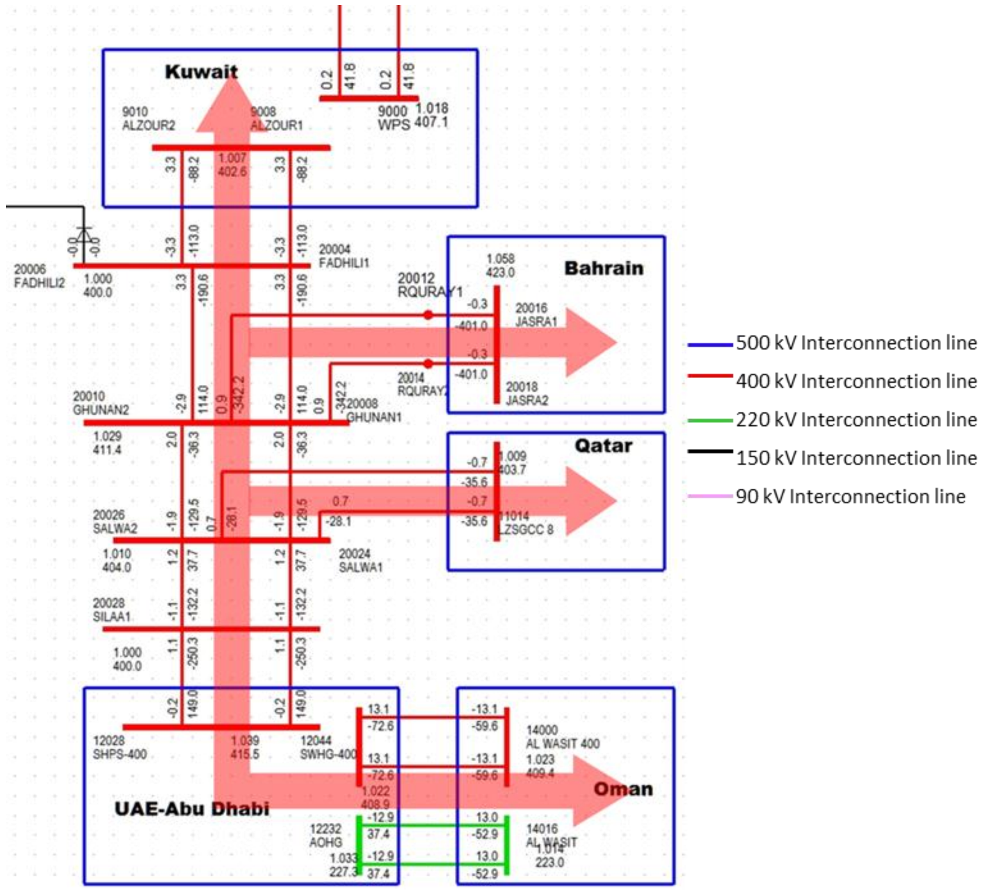

Figure 2.6 Definition of Horizontal Network of GCCIA countries

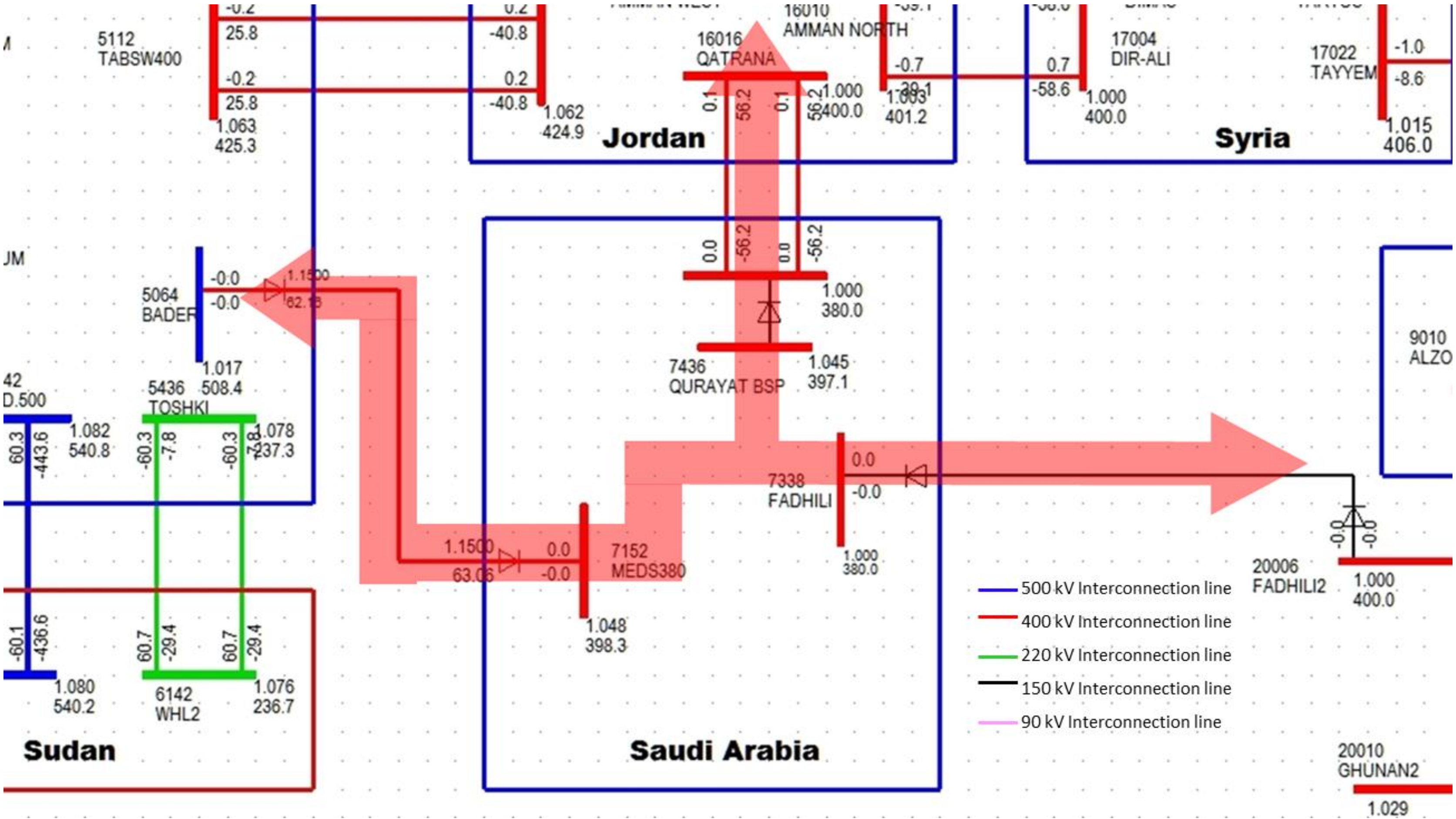

Figure 2.7 Definition of Horizontal Network of Saudi Arabia

It should be noted that the above figures illustrate the application of ATF method in the interconnected model pointing out just the interconnection lines between Arab countries. Thus, the figures don't represent the real horizontal network but, putting in evidence the interconnection lines, they represent just the scheme of interconnected countries considered to evaluate the complete list of the elements that constitutes the Horizontal Network.

2.2.2 Costing of the annualized horizontal network

The total cost for the horizontal network represents a part of the cost for the entire network of one TSO, and it is a sum of all network elements infrastructure costs which belong to the horizontal network of one TSO.

Table 2.1 shows the standard cost used for costing evaluation of the horizontal network.

Table 2.1 Infrastructure standard cost

Asset type	Specific Cost	Asset type	Specific Cost
	kUSD/km		kUSD/MW
Double circuit 500 kV Line	650	Transformers 500/400kV	15
Single circuit 500 kV Line	580	Transformers 500/220 kV	11
Double circuit 400 kV Line	450	Transformers 400/275 kV	10
Single circuit 400 kV Line	380	Transformers 400/225 kV	9
Double circuit 380 kV Line	450	Transformers 400/220 kV	9
Single circuit 380 kV Line	380	Transformers 400/132 kV	12
Double circuit 275 kV Line	450	Transformers 275/132 kV	12.8
Single circuit 275 kV Line	380	Transformers 220/150 kV	12
Double circuit 230 kV Line	290	Transformers 220/90 kV	13
Single circuit 230 kV Line	210		
Double circuit 225 kV Line	290		
Single circuit 225 kV Line	210		
Double circuit 220 kV Line	290		
Single circuit 220 kV Line	210		
Double circuit 150 kV Line	220		
Single circuit 150 kV Line	190		
Double circuit 132 kV Line	200		
Single circuit 132 kV Line	100		

We propose to use the Standardised costing approach, using a narrower range of standard costs that would be applied to all countries. It should be noted that the adopted standard costs were estimated on the basis of Consultants experience and no detailed investigations were followed. In the Consultant's view, references to standard costs of network components agreed among the Arab countries shall be considered. The precise definition of standard network types would be a matter for consultation but should be outlined that all the counties must use uniform standardized cost parameters.

The asset costs include costs for depreciation, yield and operation and maintenance, but exclude costs for ancillary services: it harmonizes the costing scheme for the relevant horizontal network.

Each element category of the horizontal network of each country was classified and associated with a standard cost; in this way starting from the cost of the transmission infrastructure the total cost of each horizontal network was evaluated.

We did not consider any depreciation of the asset values or residual value referring to the target year 2020. To estimate the annuity that each TSO pays for transmission network we applied the discount rate equal to 10% with a life time of the assets pair to 40 years. In this way the equivalent annualized cost of the horizontal network of each country was evaluated.

Table 2.2 shows the annualized cost of the lines of horizontal network for each country. The "Lines Annualized cost" was evaluated as a sum of:

- the "Annuity of used Lines",
- the "OPEX of used branches",
- the "Annuity of new Interconnections".

These three values were estimated by means of the "Expected transit factor" that represents the ratio of a TSO's transit relative to the aggregated transit of all participating TSOs. The Expected transit factor was evaluated on the basis of PROMED simulations.

More in detail, the Expected transit factor of each country was multiplied by respectively:

- annuity cost of the lines (CAPEX Annuity) of Horizontal Network (HN) to obtain the "Annuity of used Lines",
- ongoing operation and maintenance costs of the lines of the HN to obtain the "OPEX of used branches". The operation and maintenance costs were assigned a value based on Consultant experience (a percentage of the total capital cost for each kind of asset).

It should be noted that the "annuity of a used line" is the annuity cost of the lines of Horizontal Network of a given country multiplied by the "Expected transit factor" of the same country (note that the "Expected transit factor" represents the ratio of a TSO's transit relative to the aggregated transit of all participating TSOs). Otherwise, the "Annuity of new interconnection" is the equivalent annualized cost of the disbursement of each country for the new interconnection considering a discount rate equal to 10% with a life time of the assets pair to 40 years.

Table 2.2 Annualized cost of Horizontal Network Lines

Country	Voltage level	Lines CAPEX Annuity	Annuity of used Lines	OPEX of used Branches	Annuity of new Interconnections	Expected Transit factor (TF)	Lines Annualized cost
	kV	kUSD/a.	kUSD/a.	kUSD/a.	kUSD	%	kUSD/a.
Morocco	400	58,090	0	0	0	0.0%	**0**
	225	7,748	0	0	0	0.0%	**0**
Algeria	400	110,054	1,578	54	0	1.4%	**1,632**
	220	8,742	125	4	0	1.4%	**129**
	150	1,146	16	0	0	1.4%	**17**
Tunisia	400	25,013	770	26	6	3.1%	**802**
	220	43,432	1,337	37	0	3.1%	**1,374**
	150	729	22	1	0	3.1%	**23**
Libya	500	9,786	25	1	122	0.3%	**148**
	400	14,288	37	1	0	0.3%	**38**
	220	4,893	13	0	0	0.3%	**13**
Egypt	500	238,302	31,589	1,272	200	13.3%	**33,061**
	400	759	101	3	0	13.3%	**104**
	220	0	0	0	0	13.3%	**0**
Sudan	500	22,835	0	0	1	0.0%	**1**
	220	0	0	0	0	0.0%	**0**
Saudi Arabia	380	282,347	33,238	1,138	87	11.8%	**34,463**
	230	0	0	0	0	11.8%	**0**
Kuwait	400	29,805	33	1	17	0.1%	**51**
	275	7,183	8	0	0	0.1%	**8**
Bahrain	-	-	-	-	-	0.0%	-
Qatar	-	-	-	-	-	0.0%	-
UAE Abu Dhabi	400	69,792	2,088	71	0	3.0%	**2,159**
	220	0	0	0	0	3.0%	**0**
Oman	-	-	-	-	-	0.0%	-
Jordan	400	43,111	4,316	148	20	10.0%	**4,483**
	132	0	0	0	0	10.0%	**0**
Syria	400	36,585	3,403	116	3	9.3%	**3,523**
	230	6,880	640	19	0	9.3%	**659**
Iraq	400	43,563	2	0	17	0.0%	**19**
Lebanon	-	-	-	-	-	0.0%	-
Palestine	-	-	-	-	-	0.0%	-
GCCIA	400	26,571	12,696	435	0	47.8%	**13,131**

Table 2.3 shows the annualized cost of the transformers of horizontal network for each country. The “Transformers Annualized cost” was evaluated as a sum of:

- the “Annuity of used Transformers”,
- the “OPEX of used Transformers”.

Also in this case, these two values were estimated by means of the “Expected transit factor”. The Expected transit factor of each country was multiplied by respectively:

- annuity cost of transformers (CAPEX Annuity) of Horizontal Network (HN) to obtain the "Annuity of used Transformers",
- ongoing operation and maintenance costs of the transformers of the HN to obtain the "OPEX of used Transformers".

Table 2.3 Annualized cost of Horizontal Network Transformers

Country	Type of transformer	Transformer CAPEX Annuity	Annuity of used Transformers	OPEX of used Transformers	Expected Transit factor (TF)	Transformers Annualized cost
		kUSD/a.	kUSD/a.	kUSD/a.	%	kUSD/a.
Morocco	400/225kV	1,035	0	0	0.0%	**0**
Algeria	400/220kV	2,301	33	1	1.4%	**34**
	220/150kV	-	-	-	1.4%	-
	220/90kV	-	-	-	1.4%	-
Tunisia	400/220kV	2,209	68	2	3.1%	**70**
	220/150kV	-	-	-	3.1%	-
	220/90kV	-	-	-	3.1%	-
Libya	500/400kV	1,227	3	0	0.3%	**3**
Egypt	500/220kV	17,042	2,259	66	13.3%	**2,325**
	400/220kV	-	-	-	13.3%	-
Sudan	-	-	-	-	0.0%	-
Saudi Arabia	-	-	-	-	0.0%	-
Kuwait	400/275kV	20,401	23	1	0.1%	**23**
	275/132kV	0	0	0	0.1%	**0**
Bahrain	-	-	-	-	0.0%	-
Qatar	-	-	-	-	0.0%	-
UAE Abu Dhabi	-	-	-	-	3.0%	-
Oman	400/220kV	1,381	0	0	0.0%	-
Jordan	-	-	-	-	10.0%	-
Syria	-	-	-	-	9.3%	-
Iraq	-	-	-	-	0.0%	-
Lebanon	-	-	-	-	0.0%	-
Palestine	-	-	-	-	0.0%	-
GCCIA	-	-	-	-	47.8%	-

The total network annualized cost, defined as sum of "Lines Annualized cost" and "Transformers Annualized cost" of the entire interconnected Arab system, was equal to **98.29 MUSD/a.**

This value gives a good estimation of the appropriate and reasonable size of the ITC compensation fund to be established.

2.2.3 Estimation of Transit Losses and Loss Costing

An additional important parameter for the evaluation of the clearing and settlement of each country was the estimation of transmission energy losses caused by power transits. Since the aim of this task is the definition of one possible model for the inter-TSO compensation mechanism and its exemplificative simulation, a simplified estimation of the transmission energy losses starting from the transmission model prepared in the Task 4 is here proposed. Loss compensations as a result of transit were calculated using the WWT methodology. The methodology is a simplified version of the WWT applied in ENTSO-E ITC mechanism.

The compensation for losses incurred on national transmission systems as a result of hosting cross-border flows of electricity was calculated separately from compensation for costs incurred associated with making infrastructure available to host cross-border flows of electricity. The amount of losses incurred on a national transmission system was established by calculating the difference between the amount of losses actually incurred on the transmission system during the relevant period and the estimated amount of losses on the transmission system which would were incurred on the system during the relevant period if no transits of electricity had occurred.

More in detail, starting from a power flow analysis of the system peak load condition with zero exchange, and considering several different levels of power transits, it was estimated the energy losses affected by the energy trading. The adopted procedure consists on:

- evaluation of the power losses of each country considering different levels of power transit by means of power flow analysis; several situations characterized by different power transit step levels were considered starting from zero power transit up to the maximum level of power transit in both directions. The situations were defined by adding 50 MW power transit each time.
- determination of the power losses caused by transit as the difference of losses observed in the previous several situations and the situation with no transit;
- estimation of a polynomial interpolation of the relation between power losses and transit level of a given country; the polynomial interpolation allowed to obtain the function that links the power losses with the power transit (for each power transit that occurs during the year, the relevant network losses could be estimated). It should be noted that the polynomial depends on transit level across a country: since the transit values for each country was evaluate hour by hour for the given year, the polynomial interpolation allows to calculate the qualitative estimation of the power losses of each country due to the transit, for each hour of the target year.
- qualitative estimation of the power losses of each country due to the transit, for each hour of the target year, just applying the polynomial interpolation to the transits evaluated on each hour of the year by PROMED simulation,
- estimation of the energy losses of each country due to the electric energy trading during the year summing the hourly power losses of each country.

An additional important parameter for the evaluation of the clearing and settlement of each country is the cost of losses. In this study, the estimation of the cost of losses is not an output of the simulation and its evaluation could require an unacceptable effort in term of computational process time. The more common approach is to consider the costs of transmission losses in horizontal network based on the estimated national prices for electricity (USD/MWh).

Once the energy losses from wheeling was assessed, the relevant cost of losses can be assessed multiplying “Energy Losses from wheeling” by the long term average cost of energy (USD/MWh) of each Arab county relevant to year 2020. It is worthwhile to outline that, based on the results of previous phase of the study, the estimation of the average cost of generation for each Arab country was calculated in form of a weighted average specific costs of electricity generation taking into consideration the yearly average specific cost of generation and the additional cost related to the investment cost due to the disbursements of invested capital.

Table 2.4 shows the annual cost of losses for each Arab country that represents the Net financial position for losses of each Party of the Inter TSO compensation mechanism. In other words, the annual cost of losses due to the electric energy trade is the amount of money that a given Party should receive in order to compensate the additional cost of energy losses caused by the hosting energy wheeling (transit loss compensation).

Table 2.4 Annul cost of losses as Net financial position for losses

Country	Long Term Average Cost	Energy Losses from Wheeling	Net position for Losses
	USD/MWh	MWh	MUSD
Morocco	99.97	0	0.000
Algeria	104.14	26,760	2.787
Tunisia	103.85	336,460	34.941
Libya	108.79	790	0.086
Egypt	97.61	409,904	40.011
Sudan	54.00	0	0.000
Saudi Arabia	106.32	1,249,356	132.832
Kuwait	107.67	600	0.065
Bahrain	101.30	0	0.000
Qatar	68.17	0	0.000
UAE Abu Dhabi	84.21	378,951	31.911
Oman	94.18	0	0.000
Jordan	105.63	213,821	22.586
Syria	92.87	-99,587	-9.249
Iraq	102.47	5	0.000
Lebanon	120.72	0	0.000
Palestine	0.00	0	0.000
TOTAL	**-**	**-**	**255.97**

2.2.4 Simulation Results: Clearing and Settlement

In this paragraph a quantitative evaluation of the proposed preferred mechanism was performed. A first estimation of the quantitative impact of the inter-TSO payment mechanism was also obtained.

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Table 2.5 Cost claim, Contribution to Fund, Transit Loss Compensation, Financial Position of each Party

Country	Year 2020						
	Demand (L)	Transit (T)	Net Flow	Expected Cost claim (a)	Contribution to Fund (b)	Transit Loss Compens. (c)	Net Financ. Position (a+c-b)
	MWh	MWh	MWh	kUSD	kUSD	kUSD	kUSD
Morocco	45,388,789	0	5,610,324	0	15,116	0	-15,116
Algeria	78,663,277	653,954	6,471,211	1,063	17,436	2,787	-13,586
Tunisia	24,674,913	1,403,994	3,240,836	2,351	8,732	34,941	28,560
Libya	75,174,988	118,219	8,297,041	191	22,355	86	-22,078
Egypt	253,869,605	6,044,002	16,509,316	9,923	44,483	40,011	5,451
Sudan	28,522,069	0	1,699,079	0	4,578	0	-4,578
Jordan	30,177,821	4,564,476	4,977,076	8,023	13,410	22,586	17,199
Syria	80,400,002	4,241,264	2,814,246	7,085	7,583	-9,249	-9,746
Iraq	95,086,125	1,297	7,473,323	2	20,136	0	-20,134
Lebanon	17,851,138	0	8,245,891	0	22,218	0	-22,218
Palestine	2,711,670	0	2,711,666	0	7,306	0	-7,306
Saudi Arabia	479,852,476	5,367,561	20,094,579	8,742	54,143	132,832	87,431
Kuwait	112,931,338	50,518	12,234,365	82	32,964	65	-32,818
Bahrain	24,369,856	0	2,289,338	0	6,168	0	-6,168
Qatar	45,303,813	0	10,505,349	0	28,306	0	-28,306
UAE Abu Dhabi	146,705,637	1,363,878	14,084,083	2,219	37,948	31,911	-3,818
Oman	34,588,943	0	4,222,829	0	11,378	0	-11,378
GCCIA	0	21,786,512	0	58,609	0	0	58,609
TOTAL Pan Arab system	**1,576,272,460**	**45,595,675**	**131,480,552**	**98,290**	**354,260**	**255,970**	**0**

The previous table shows all the drivers that should be considered for the implementation of a fair ITC compensation model. It should be noted that the aim of the procedure is to obtain the same value for the contribution to be paid by all countries (Parties) and the compensation to be received by all countries (Parties).

First of all, the model establishes the "Expected Cost claim" of a party "k" on the basis of the following relation (ENTSO-E source[12]). It represents the compensation of the usage of the network due to transits that each country expects.

The Transit Loss Compensation represents the expected compensation that the Party should be received for the increase of transmission losses due to transits.

[12] ETSO Response to EC Consultation Paper on the Inter-TSO Compensation Mechanism, 17 March 2009

The contribution to the fund represents the amount of money to be paid by each Party that causes net flows. All the contributions of the Arab Countries are collected to create an appropriate fund.

The Net Financial Position of each country is the balance between what a country has to pay (contribution) and what it has to receive (cost of claim and transit loss compensation).

The proposed Expected Cost claim formula is based on the aggregation of two factors that contribute to define the expected fair compensation cost. These factors are:

- Transit factor that represents the ratio of a TSO's transit with respect to the overall transits of the entire interconnected system,
- Load Factor that considers the size of transit relative to a TSOs load. This factor corrects the transit factor introducing the size of the load of each country. Load Factor refers to the square of transits of electricity, in proportion to load plus transits on that national transmission system relative to the square of transits of electricity in proportion to load plus transit for all national transmission systems.

In the formula of Expected Cost claim, the transit factor was weighted 75 % and the load factor 25 %:

$$Cost\ claim\ (k) = (0.75 \cdot TF + 0.25 \cdot LF) * FF$$

Where :

$$TF(k) = \frac{T_k}{\sum_{i \in ITC} T_i}$$

is the transit factor, the ratio of a party's transit (T_k) relative to the aggregated transit of all participating parties that constitute the ITC mechanism ($\sum_{i \in ITC} T_i$).

$$LF(k) = \frac{\frac{T_k}{(T_k + L_k)} * \frac{T_k}{\sum T_i}}{\sum_{i \in ITC} \left(\frac{T_i}{(T_i + L_i)}\right) * \left(\frac{T_i}{\sum T_i}\right)}$$

is the load factor that weighs the size of a party's transit (T_k) with respect to its load (L_k).

FF is the framework fund that in this case was established by the costing of the annualized horizontal network to be 98.29 MUSD/a.

Once defined the compensation of each country, the net financial position of each Arab Country for the Financial Fund is defined.

In compliance with the Inter-TSO compensation mechanism guideline of ENTSO-E, the contribution calculations are based on the evaluation of the Net Flows in Import ($Net\ Import\ Flow\ (k)$) and Export ($Net\ Export\ Flow\ (k)$) direction for a Party "k" that are defined for any ITC Party k as:

$$Net\ Export\ Flow\ (k) = \sum_{h \in hour\ of\ the\ year} max \left[0; \sum_{j \in ITC(k)} EF(k,j,h) - \sum_{j \in ITC(k)} IF(j,k,h) \right]$$

$$Net\ Import\ Flow\ (k) = \sum_{h \in hour\ of\ the\ year} max\left[0; \sum_{j \in ITC(k)} IF(j,k,h) - \sum_{j \in ITC(k)} EF(k,j,h)\right]$$

$$Net\ Flow\ (k) = Net\ Export\ Flow\ (k) + Net\ Import\ Flow(k)$$

Where:

$EF(k,j,h)$ is the Flows in Export from the country "k" to another country "j" during the hour "h".

$IF(j,k,h)$ is the Flows in Import from a country "j" to the country "k" during the hour "h".

Thus, the contribution for Party "k" is proportional to the *Net Flow* of Party *"k"* by means of a fee (*Fee*):

$$Contribution\ (k) = Fee \times [Net\ Flow\ (k)]$$

The net financial position of each Party for the Financial Fund is defined as:

$$NFPF\ (k) = \ Cost\ Claim(k) + \ Transit\ Loss\ Compensation\ (k) - \ Contribution\ (k)$$

It should be noted that to obtain the balance between the contribution to be paid and the compensation to be received by each country, the value of the Fee has to be estimated. This Fee, to be applied to each Party that causes net flows, needs to collect an adequate fund for the compensation of each Party that holds transit.

To this purpose, the fee to apply is equal to 2.694 USD/MWh. In other words, adopting a fee equal to 2.694 USD/MWh to be paid by each Party "k" that causes net flow (import/export net flow), the so collected fund results sufficient to compensate each Party "k".

In this simplified case the perimeter[13] countries are not taken into consideration as contributor to the Fund.

In general, thanks to the proposed ITC method, the larger the imbalance between import and export flows of a country, the larger will be its payment into the fund.

Analyzing the results the proposed case of study it should be noted that the country with the major amount of financial compensation to receive is Saudi Arabia (87,431 kUSD/y) while that with the major amount of financial contribution to pay is Kuwait (32,818 kUSD/y).

[13] Perimeter countries are all countries that are interconnected with Arab countries but not part of the ITC mechanism. Edge countries are all the Arab countries bordering on both other Arab countries and perimeter countries. Whenever edge countries have an import (or export) from both ITC countries and perimeter countries, the flow from the perimeter countries (on which an injection fee is already paid) must not contribute to their net flow.

It is worthwhile to mention that this kind of analysis needs a much more detailed and rigorous study and here just a simplified but in any case significant approach is proposed; in fact, in general, when describing how the fund is financed, it could be necessary to define different types of countries for which different fees could be proposed:

- ITC Party – A country, which is party to the ITC Agreement.
- Internal ITC Parties – A ITC Party not having any electrical border to any Perimeter Country.
- Perimeter Country – A country, which is not party to the ITC Agreement, but which has an electrical border to an ITC Party.
- Edge Country – A ITC Party which has at least one electrical border to a Perimeter Country.

Perimeter flows should contribute to the fund paying an annually, ex-ante defined fee for their imports and exports of electricity into the ITC area.

3 CONGESTION MANAGEMENT FOR ARAB COUNTRIES

3.1 Organization structure of Arab Countries Auction Office

This paragraph gives a brief overview of a possible structure of Arab Countries organizational form that establishes the management of the cross border trading in an efficient and co-ordinated way.

A more efficient and secure use of available capacities, addressing in a more accurate way the needs of cross border investment and improving firmness of transmission rights need a co-ordinated approach manifested through a joint Auction Office.

It is worthwhile to mention that, besides the co-ordination of the ITC mechanism, the organization of a Arab Countries office using coordinated flow-based auctions (Auction Office) can guarantee the following additional expected advantages:

- better utilisation of existing interconnections;
- higher level of transmission system security;
- facilitating regional trading activities due to the efficient use of network capacities and the increase of firmness of transactions;
- increasing transparency among all parties involved;
- encouraging infrastructure investments.

The Arab Countries Auction Office structure can be founded under different legal forms from which the most suitable has to be chosen. The general decision for its founding is to choose either a supranational form company or a national form company.

Under the category “Supranational Forms” the most suitable type of supranational forms is the founding of Arab Company. Note that it is not defined as a mere business partnership between several country, but more in general it can be described on the basis of several different possibilities reported here below:

- Merger of two public companies from different countries;
- Foundation of a holding from either public companies or limited companies which have their seat in different countries and
- Foundation of a subsidiary of different companies which have their seat in different countries.

It should be noted that first of the phase of selection and valuation of the an Arab form Company, a common regulation in which the above mentioned possibilities are defined and possible issue are touched, has to be agreed.

With reference to national form company, two types of national forms will be analysed:

- Companies with limited liability for the shareholders,
    - Limited Liability Company (Ltd.). It is a legal entity with a limitation of liability for the shareholders founded according to national law. The shareholders have the opportunity to instruct the management in questions of daily business. Founding procedure is less extensive and costly than founding a public company.
- Companies with full liability for the shareholders,

  - Joint Venture. It is only an agreement between the involved TSOs. It is not a legal entity and there is no limitation of liability. The advantage of such a construction is that the founding procedure is easy and an on-going distribution of profit is possible.

Once defined all possible forms for founding an Auction Office, here under the best suitable one is selected analysing pros and cons of each of the above mentioned alternatives.

The founding of a Arab Company is very complicated and also there is no enough experience due to the fact that this is a quite new legal form. Therefore the best suitable solution seems to establish the national form.

The major differences between Limited Liability Company and the Joint Venture Agreement are related to the legal personality and the limitation of liability. The Limited Liability Company (Ltd.), owned and operated by the Arab Country foresees the legal personality and the limitation of liability so it seems to be the preferred solution, in fact, with such a ownership structure a balance of interest is guaranteed and the best possible form of coordinated cooperation is given.

Since the geographical extension of the overall Arab countries is very considerable, the most accurate way to coordinate the needs of cross border investment and improving firmness of transmission rights is to develop three joint Auction Offices dislocated in the three main regions of Arab world.

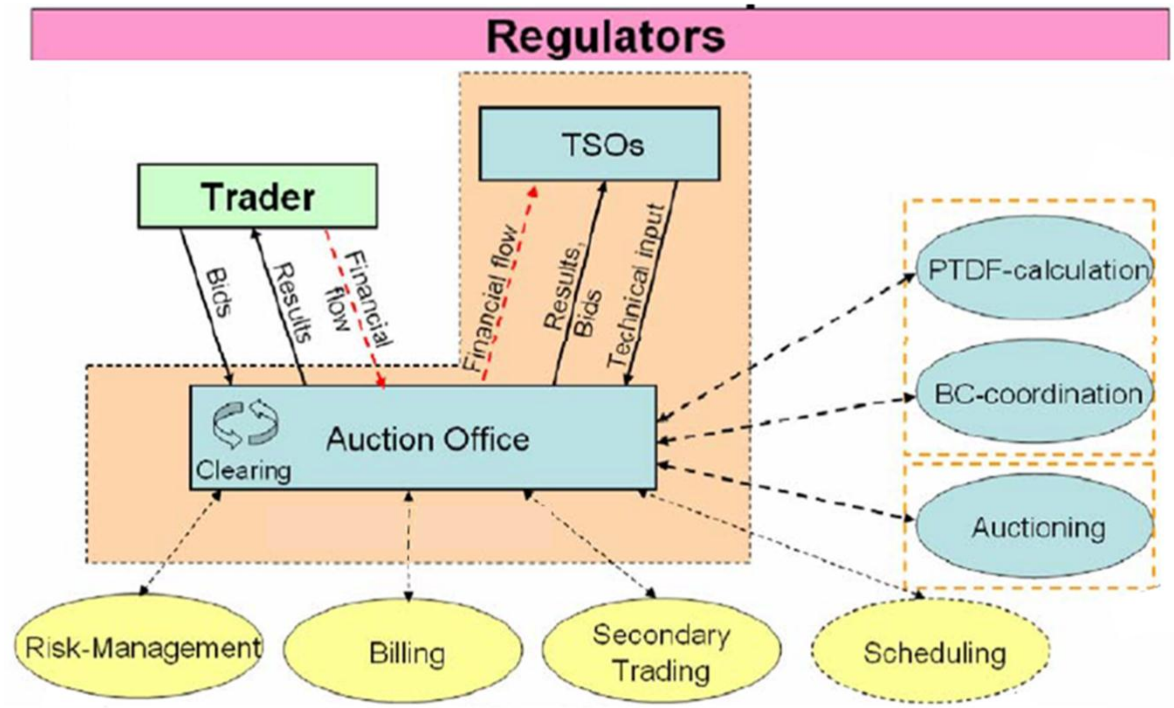
For that reason, the three Auction Offices should be foreseen in:

- North Africa,
- EIJLSP Region,
- GCC Region.

For establishing the Auction Offices there are different contracts necessary:

- Articles of Association
  - Rules of Procedure/ Terms and Conditions for the supervisory board.
  - Rules of Procedure/ Terms and Conditions for the management.
  - Contract for a syndication Multilateral Agreement between TSOs and Auction Offices (if applicable).

Here below, a possible processes of real operations is reported. As it can be noted also other stakeholders, such as Traders and Regulators, can take part in order to raise the transparency of this new allocation method. Furthermore, risk management, billing, secondary trading and scheduling are integrated into the concept. This dry-run is taking into account further functions such as billing, risk-management, secondary trading and scheduling support.



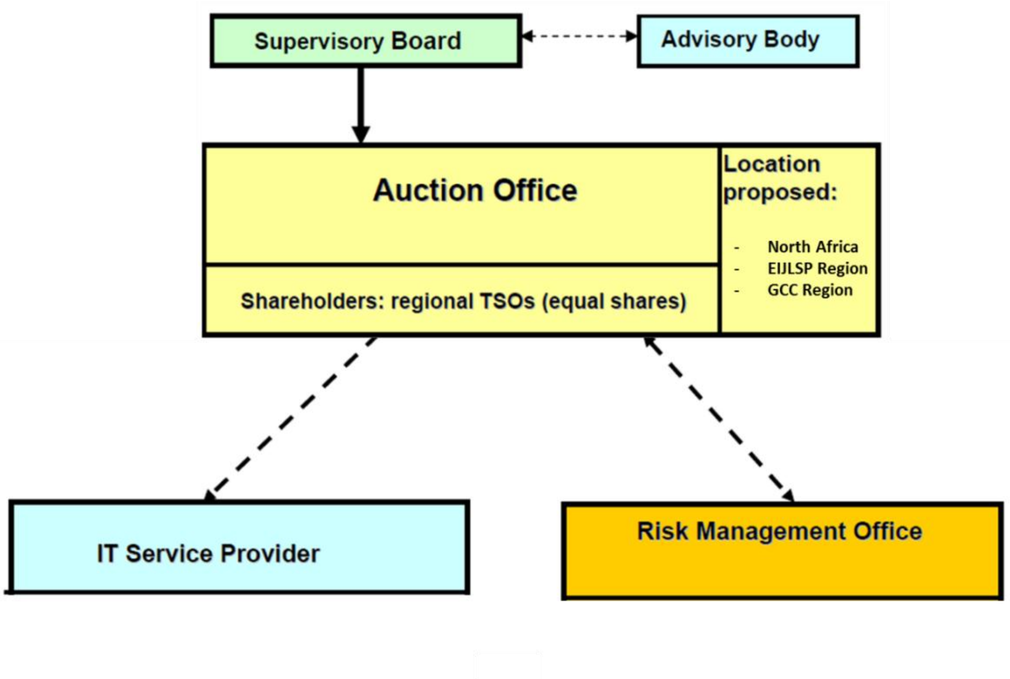
Source of information: TERNA

Figure 3.1 Proposed structure of the Auction Office operation

The management of the Auction Offices reports to Supervisory Board and is bound to its decisions. Furthermore, an Advisory Board should be established in order to increase the reliability and transparency of the Auction Offices for other stakeholders (e.g. Regulators).

The Supervisory Board will consist of shareholders. The shareholding is composed of Arab TSOs participating in the Auction Offices. In line with the company laws, the Supervisory Board represents the economic interests of shareholders, taking into consideration the recommendations made by the Advisory Body.

The Advisory Body could be composed of Members from TSOs, Regulators, Traders.



Source of information: TERNA

Figure 3.2 Structure of Arab Countries Auction Office

The success of each coordinated Auction Office depends highly on a comprehensive risk management. The Risk Management Office that could be foreseen for each different Auction Office (North Africa, EIJLSP Region, GCC Region) will require guarantees for payment of trades from their participants.

On the other hand, the IT Service Provider makes available all relevant functions, such as clearing, billing scheduling support, online monitoring and performing of risk management. In addition it guarantees the maintenance, support and further development of these functions.

3.2 Possible CBCM methods

The detailed analysis of different CBCM methods proves is reported in Table 3.1.

Table 3.1 Assessment of CB/CM Methods

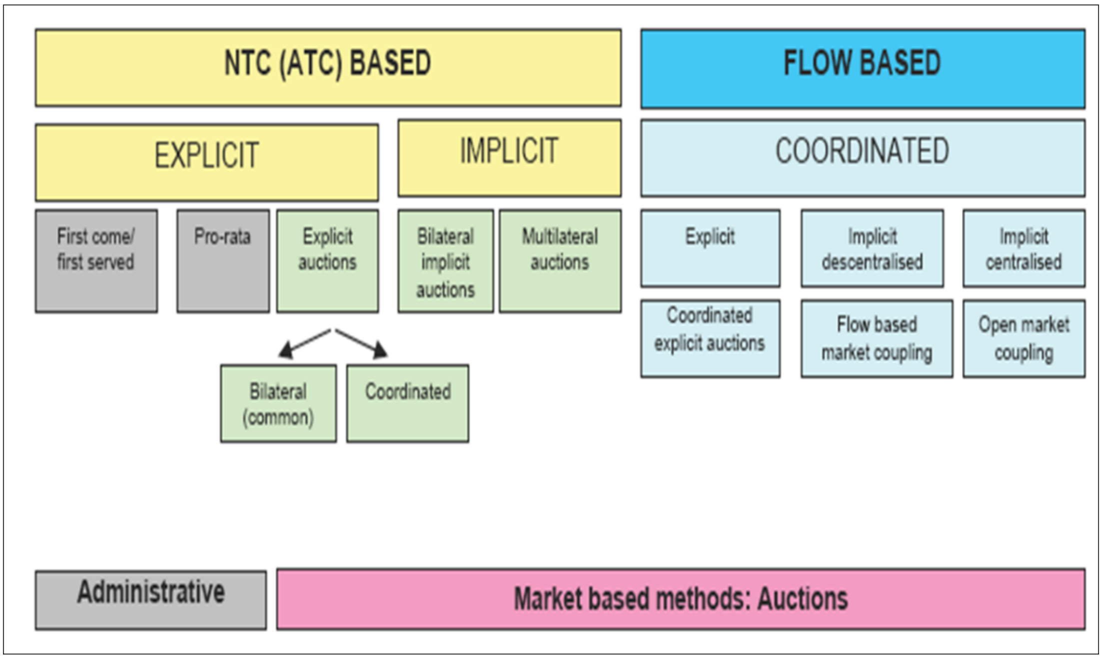
Method	Description	Analysis, Observations & Financial Implications
Access limitation	Access rationed. The instances still present in the list, consist of DC links with ownership different from linked networks (the last example of such an exemption is Estlink undersea DC cable connecting BALTSO (Estonia) and NORDEL (Finland)).	■ no economic signals; ■ not market based; ■ absence of efficient CB economic signals for generation/transmission investment; ■ no pan-European incentive for *social welfare* maximization and least-cost operation; ■ a few users may retain benefits from CB trade
Priority List (First-Come First-Served)	The market members gets capacity in a priority order until the whole ATC is allocated. Examples of priority criteria are: chronological order, past use of capacity, etc. Transparency limited by confidentiality of trade.	■ selection based on capacity used ratio and not on economic efficiency; ■ not market based; ■ new entrants less favored (discriminated) although it can also help to mitigate market power exercise if limitations (maximum purchase) are imposed; ■ absence of efficient CB economic signals for generation/transmission investment; ■ no pan-European incentive for *social welfare* maximization and least-cost operation; ■ marketer members capture *congestion rent* and pay capacity price (usually null or low); ■ favours exporters (or importers) with a large portfolio of customers (suppliers); ■ selection based on capacity used ratio and not on economic efficiency
Pro-rata Rationing	Capacity is allocated in proportion to requests if they exceed the announced ATC	■ non-discriminatory; ■ not market based; ■ no economic signal; ■ transparent; ■ simple implementation when compared to other mechanisms; ■ the capacity is arbitrarily priced by the regulatory authorities at a level not equal to the efficient economic value (which is the ‘opportunity cost’ of trading between the countries); ■ no efficient CB economic signals for generation/transmission investment;

Method	Description	Analysis, Observations & Financial Implications
		■ no pan-European incentive for social welfare maximization and least-cost operation; ■ market participants capture congestion rent and pay capacity price (usually low); ■ individual size of transmission right delivered inconsistent with standard trading products; ■ open to abuse by submission of excessive requests; ■ selection based in proportion to requests (if they exceed the announced ATC) and not on economic efficiency
Explicit Auctions (ATC based)	The seller (TSO) determines ex ante ATC considering security analysis, accepts bids from potential buyers and allocates the capacity to the ones that value it the most.	■ economic signal; ■ non-discriminatory; ■ transparent; ■ often a joint coordinated mechanism between the concerned TSOs; ■ several significant implementation features: uniform clearing price vs. pay as bid; ■ different allocation products and frequencies (yearly, monthly, daily); ■ with perfect market assumption: ○ price reflects cost of using capacity to the social welfare; ○ internal and CB trade present the same profit opportunity for participants; ○ efficient signals to market players for the operation and the value of the network

Implicit Auctions (ATC based)	The TSO/Power Exchange (typically in import area) determines ex ante ATC considering security analysis, accepts energy bids from potential buyers outside the area and accepts offers with lowest price for the electricity. Capacity is implicitly allocated to successful bidders.	■ economic signal; ■ non-discriminatory; ■ transparent; ■ usually requires a Power Exchange in import area; ■ applicable for day-ahead and intra-day time horizons; ■ internal and CB trade present the same profit opportunity for participants; ■ efficient signals to market players for the operation; ■ no separate trade with capacity and then with electricity
Implicit Auctions (Market Splitting; Market Coupling)	The energy markets provide initially a common clearing. If ATC reached, markets "split" into pre-determined *price areas* cleared individually at area prices.	■ economic signal; ■ non-discriminatory; ■ transparent; ■ if multilateral, a joint coordinated mechanism between the concerned TSOs; ■ if multilateral, requires homogenized energy markets; ■ requires centralized Power Exchange; ■ requires financial instruments for long term price-hedging and bilateral trade between price areas; ■ internal and CB trade present the same profit opportunity for participants; ■ efficient signals to market players for the operation and the value of the network

Source of information: ERGEG

The Figure 3.3 shows the development path from NTC or ATC-based day ahead CB TC allocation towards the flow-based CBCM methods.



Source of information: ETSO

Figure 3.3 Development of CB/CM Methods from NTC (ATC) Based Towards the Flow Based Ones

3.3 Recommendations of procedures for Congestion Management

To speed-up the co-operation and facilitate the decision making for a first step of the integrated Arab system implementation, the Pro-rata Rationing method is recommended at the very beginning since it represents the simplest approach between possible economic benefits and the need of transforming the integrated power sector into a major energy trading market. It is worthwhile mentioning that in accordance with the proposed method, the capacity is allocated in proportion to requests if they exceed the announced. Nevertheless, this method should be replaced by the explicit auction mechanism, as soon as an adequate auction platform and the procedure for settlement of the purchased capacity are put in place: a step forward towards a more market based approach could be determined introducing the procedure that allows the applicants to declare how much they are willing to pay for this capacity by means of an explicit auction. These bids should be ordered by price and allocated starting from the highest one until the available capacity is used up. In the Explicit Auctions, the seller (TSO) determines ex ante ATC considering security analysis accepts bids from potential buyers and allocates the capacity to the ones that value it the most.

A more detailed analysis on the proposed congestion management procedures is recommended since just a dedicated investigation can validate the goodness of the mechanism. To this purpose, particular attention should be paid for the case of Jordan, Syria and Lebanon where both Syria than Lebanon, competing each other, need to import power from Egypt through Jordan but Jordan likewise competes with Syria and Lebanon for the same energy. In this case, a market based approach as Explicit Auctions could give very interesting economic signals and reflect the cost of using cross-border capacity. The method of Explicit Auction guarantees the same profit opportunity for participants and gives efficient signals to market players for the operation and the value of the network.

4 SPECIFIC RECOMMENDATIONS

In general, the Consultant recommends that, considering the geographical proximity and the trend towards the full integration of the Arab regional power systems with Europe, the experience developed in Europe since the year 2000 within ENTSO-E and its predecessors can be fruitfully exploited and taken as a reference.

It is worthwhile to mention that the analysis reported above needs a much more detailed and rigorous study and here just a simplified but in any case significant approach is proposed; in fact, in general, when describing how the fund is financed, it could be necessary to define different types of countries for which different fees could be proposed:

- ITC Party – A country, which is party to the ITC Agreement.
- Internal ITC Parties – A ITC Party not having any electrical border to any Perimeter Country.
- Perimeter Country – A country, which is not party to the ITC Agreement, but which has an electrical border to an ITC Party.
- Edge Country – A ITC Party which has at least one electrical border to a Perimeter Country.

Perimeter flows should contribute to the fund paying an annually, ex-ante defined fee for their imports and exports of electricity into the ITC area.

In addition, to better define the framework fund for compensation, it should be noted that from a regulatory viewpoint a financial institution that provides clearing and settlement services for securing transactions needs to be constituted. This institution, where members of each Arab Country are represented, will assumes the role of “clearing house” with the obligation of guaranteeing the transfer of compensation to the recipient TSOs , should one of the participating members runs into default or, in extreme cases, goes bankrupt: the purpose of the “clearing house” is to enable investors to trade without concern about the creditworthiness of the individuals with whom they are dealing. Generally, it attempts to reduce the risk that a clearing member will not be able to honour its commitments and monitors the financial strength and portfolio positions taken by member countries.

In this section, the recommendations on the setting up of rules for the cross-border trading (CBT) of electricity are also formulated by the Consultant. More specifically, the Consultant proposed a time schedule of the setting up of rules for the cross-border trading (CBT) of electricity (see Table 4.1).

Table 4.1 Assessment of CB/CM Methods

Consultant Recommendations	**Expected timing from “T_{zero}”**
Calculation and publishing of NTC across the borders, starting from the existing interconnections	3 months
Agreement on rules for Capacity Allocation (CA) and Congestion Management (CM): clear, transparent and non-discriminatory rules	6 months
Starting of CA & CM procedures and publication of the ATC	18 months

Setting up of mechanisms for inter-TSO compensation due to transits: - Evaluation of the "horizontal network" - Agreement on the transmission asset values - Installation of efficient metering and recording systems - Starting of a dry-run period for evaluation of transits and incurred costs - Set up of contractual rules to be signed by TSO / VIU joining the inter-TSO compensation mechanism - Evaluation of the *ex-ante* fund to be collected for compensation of transits - Starting the recording of transits - Evaluation of the *ex-post* fund to be collected for compensation of transit Settlement of the compensations to the TSO / VIU who were affected by transits	Progressive development in two years
Extension of the inter-TSO compensation mechanism to "perimeter countries" defining an appropriate import/export fee	---
Further tuning of the inter-TSO compensation mechanisms on the basis of the acquired experience	---
Evolution of CA & CM procedures towards more market oriented solutions (explicit actions, implicit auctions, market coupling, daily auctions, etc.).	---
Enhancing of transparency. Info publicly available on the Internet, ex-post reporting on outcomes of CA & CM, on transits and incurred costs, Grid Codes, Network Access Codes, etc.	Continuous action from "T_{zero}"

PART 2 - DEVELOPMENT OF A CROSS BORDER NG TRADING MODEL

Overview and Background

As a result of the data collection activities and following analysis of synergies between the identified natural gas projects and the Electricity interconnection scenario, three natural gas projects were identified for further studies:

- An interconnection between Libya and Egypt;
- An interconnection between Iraq and Kuwait
- A LNG import terminal in Bahrain.

On a general level before any pipeline can be created agreements have to be signed between countries that will detail the relationships and cooperation that exists between the importing and exporting countries and if relevant any transit countries. Such a move is important especially when there is assurance needed for potential political and security risks that could jeopardize the pipelines creation. Such assurances are particularly important in the case where private investors are involved in order to ensure their cooperation.

In order to create a pipeline there are three principal aspects that need to be ascertained initially;

- The ownership of the pipeline
- The financial structure of the pipeline
- Trade model

The ownership structure of the pipeline refers to the operation of the pipeline from a shareholder perspective. This is the agreed structure of the pipeline whether it is a private enterprise a public enterprise or a hybrid enterprise containing elements of both. This is dependent upon the underlying starting point of the countries that are involved and the state of their present gas industry. This principally refers to the relationship that may exist between the National Oil Companies (NOCs) on one side and the International Oil companies (IOCs) on the other. In the following chapter 2 the possible relationships for such an agreement are analyzed. Without an agreed ownership structure of the project it may never reach past the initial developmental stage.

The financial structure relates to the proportion of the project that is gotten from equity and the proportion that is generated from debt. The higher the rate of equity the higher the commitment that is envisaged by the project owners, which are usually the NOCs. The final level of equity in the project will depend on the considerations of the project and agreed intergovernmental negotiations. The financial model is developed in task 5 and is not analyzed in this document.

The physical construction of a pipeline alone is not enough to make gas flow from one country to the other, in order for this the organization of both the gas markets must be able to accommodate trade of gas. In Chapter 5 several examples of trade models applied by other large exporters of gas, such as Norway and Russia, are examined. The lessons learned in this chapter are used to develop and discuss the possible setup for the two pipelines. The LNG terminal in Bahrain is not included in this section as only interconnections between countries are considered.

Chapter 6 also outlines some of the requirements to the network code and describes the practice in the US and Europe. The specific content of the network code is premature and without the scope of this project. Chapter 7 focuses recommendations for the basic setup regarding ownership, organization, pricing, and the basic requirements for the network codes.

5 EXAMINATION OF OWNERSHIP OPTIONS

5.1 State involvement and international arbitration

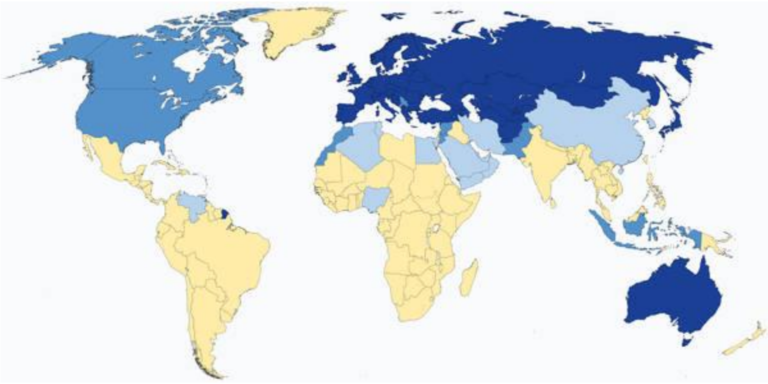
At present there remain boundaries from financial, institutional and technical perspectives to trade of natural gas in the region. Additionally, there are presently large differences in the state of gas infrastructures of different countries. In order to enhance trade and development it will be necessary to establish initial dialogue between national regulators with the purpose to detail an initial framework to instigate. There will need to be an evaluation of the type of regulatory mechanism that would be most suited to promote and develop transportation infrastructure in Libya and Iraq. The definition and suggestion for how a relationship between national oil companies (NOCs) and international oil companies (IOCs) will be highly important in this respect.

The involvement of the state in some form is usually necessary for a transnational gas pipeline project, and is generally needed to give security for investors on the project. As a general rule the state will play two important roles in a project as both a facilitator and a supporter in the implementation and operation of a project. Host governments of oil and gas reserves should look for direct participation as an equity investor in transnational gas pipeline projects if they have the available capital. This should be:

- to lend support to the implementation
- ensure that they have control over the resource base
- minimize project risks, such as approvals
- and take off of the project with a view to earning dividend later on

As such State cooperation would be recommended for infrastructure that is pursued in Iraq or Libya. Participation from the state is also particularly important in terms of the financing of the project. Providers of major capital for pipeline infrastructure will usually require considerable legal assurance from the state in order to mitigate risk and secure investment. The threat of sudden change in law such as taxation law, accounting standards, foreign exchange controls and labor laws must be taken into consideration.

Country to country intergovernmental agreements is seen as vital to any regional gas project. Governments should aim to set up a regulatory environment that creates stability for investments. A way of doing this may be to sign up to the Energy Treaty. The Energy Treaty contains clauses that are related to the transit of gas, as such these treaty clauses could come into effect should there be any issues in the transit of the gas. The figure below summarizes the members and the status of their membership.



Dark blue designates signatories to the 1994 Energy Charter Treaty, and members of the Energy Charter Conference
Blue designates signatories to the 1991 Energy Charter, and observers to the Energy Charter Conference
Light blue designates observers to the Energy Charter Conference by invitation of the Conference (without signing the 1991 Charter)
Source: http://www.encharter.org/

Figure 5.1 Members of Energy Charter Treaty

Importing countries should also ensure that they assist in supporting the financial status of the buying institution and encourage this entity to pay promptly and efficiently for its imported gas. On a more physical level they should ensure that the pipeline is secure and that proper security is in place in the event of an attack by individuals determined to disrupt supply.

5.2 Division between IOCs and NOCs

Both Libya and Iraq are in need of outside investment to develop their new oil and natural gas exploration, and to restore or update some of the domestic natural gas industry's infrastructure. Often countries enter into collaboration with International Oil Companies (IOCs) in order to get access to technology and knowledge; in return the IOCs receive rights to export parts of the reserves. On the other hand there is, in many countries, a drive for utilizing the gas resources domestically in order to supply a growing need for gas in the power sector. The various options for involvement of IOCs are presented and discussed in this chapter.

In order to evaluate the possible models for export in Libya and Iraq it is firstly necessary to evaluate how different countries have operated their gas markets and developed their gas infrastructure networks. Some countries have decided upon a model where the national oil company (NOC) acts as vertically integrated company with control over all aspects of gas production, transmission and sales. Other countries operate a hybrid model where NOCs and international oil & gas companies (IOCs) act together with each receiving benefits from the cooperation with access to technology and reserves respectively. Finally, other countries have chosen not to operate with the concept of NOCs with the industry left to international oil companies. The figure below summarizes main features of these institutional setups.

NOC/IOC	NOC	IOCs
• Principally joint venture or production sharing • Usually reliant upon development from IOC • Access to reserves main benefit for IOC • Productive relationships depend on equitable balance • Exxon Mobil/Qatar • Typically relationship required at initial development stage	• The national oil company acts alone as vertically integrated company • Ususally involved in all aspects of the natural gas supply chain • Access to majority of global reserves • Usually closely intergrated with the government • Ability to self finance major projects • Petrochina	• Usually the case in markets that were deregulated • A number of different firms operating in natural gas supply chain • Usually a number of IOCs operating in the market • Government is usually not involved in decisions

Figure 5.2 Main features of various institutional set ups in natural gas

In the following a brief presentation of the potential contractual arrangements between parties is given.

5.3 Potential contractual agreements between parties

5.3.1 Potential agreements

There are a number of potential agreements that can be established between players in development of countries infrastructure and reserves. When evaluating what is the most preferred type of agreement there are two main issues that need to be established. The first is in the identification of who should have the right to explore and produce the gas. The second is who will own the oil and gas in the event that any is found. Once the answer was established for these two questions then the type of contract can be agreed upon. Some of the principal methods of contractual agreements are detailed in the section below.

5.3.2 Concession Agreements

Concession agreements rely on relationships between equity structures and are widely utilized in the US, Norway, Thailand, Australia. In such an agreement the concession holder receives all of the gas production and will have to pay taxes on the production. The State will in general not receive more gas than what it has purchased for its domestic supply requirement. In addition the right to export what is produced is often allowed which generally swings the favor of the agreement in the way of the IOC. This type of agreement is uncommon in the MENA region and additionally would not be recommended for Iraq and Libya who are aiming to have greater control over their resource base and establish initial equitable conditions.

5.3.3 Joint Venture Agreements (JV)

This type of agreement is very common in producing countries and is usually a co-ownership in structure and partnership between the two entities. The nature of this partnership will depend upon the terms in the individual contract. If this type of agreement is used two or more parties would enter into a contract and would usually form a new legal entity. Under this agreement NOCs are usually also involved in paying their share of capital development, but they might also pay in contractual provisions. As the venture is a joint undertaking the NOCs and IOCs both agree on a proportion of the equity of the project according to their contribution to the project. Usually the IOC will also be subject to an income tax. All of these individuals in such an agreement may be party to an investment protection agreement with international dispute resolution provisions.

5.3.4 Production Sharing Agreement (PSA)

In a production sharing agreement the NOC usually will give development rights to an authority of its choosing, which in the MENA region is usually an IOC. The government of the country with reserves may then establish a production sharing agreement with the IOC that is developing them. If the initial exploration activities are deemed a success and gas is found the IOC will be able to at least recover the costs and, where terms allow to generate a profit by getting a share of the fixed production which it usually then exports. In the event that there is not any production used for cost recovery this is called profit production. The profit production will be shared between both the State and IOC under a fixed agreement or on a varying scale based on the volumes produced. Royalties may or may not apply depending on the individual agreement. Such agreements are commonly found in countries including Indonesia, Malaysia, Libya, Egypt and China.

5.3.5 Service Contract Agreements

Under the terms of any service contract agreement the IOC will pay for any research in exploration and the development costs for the field. The payback terms usually vary but it is usually in the form of either a discounted crude or gas purchase price, potential cash payments, or sometimes in the take of the overall recoverable reserves. The domestic producer generally maintains the production upside, however there is also normally a sliding scale of the oil or gas to make the project attractive to IOCs to ensure their cooperation. There are usually performance incentives to any IOC that are involved; these may be linked to encouraging higher production levels or in the reduction of operating costs. IOCs are in all likelihood also liable for income tax in such agreements as standard. IOCs generally dislike being only a service contractor to the State, and would be unlikely to agree to such a contract in the cases evaluated where Iraq and Libya are concerned.

5.3.6 Hybrid Contracts

Usually the domestic government contracts will be a mixture of the four types of contract taking from them the elements that may appeal depending on the fields and the existing status of the domestic country's energy industry. Governments are increasingly introducing hybrids of these various structures. Such contracts usually involve combinations of royalty, reserve amounts, taxation clauses and stipulations in the degree of state participation and the allowable cost oil/profit oil shares and applicable fees. As should be expected from such agreements domestic producers will seek to establish structures that will match their concerns on a particular project. IOCs are in the situation where they will usually accept the terms that were established in particular countries historically.

5.3.7 IOC and NOC in public private partnerships (PPP)

A potential pipeline project structure could be between two (the exporting and importing) countries' governments and an IOC. With this type of structure the two partners can engage in a mutually cooperative situation where each benefits from each other's respective advantages. The technical know-how, management competence and finance sources of the IOCs may be needed to develop the pipelines and it would be expected that such companies would be willing to accept the risk of the aspects of the project that are under their control such as over budgeting and scheduling. If they chose to engage the NOCs the IOCs will in the majority of cases be able to effectively manage their cooperation with the host governments. This is especially the case where the two (NOCs and host governments) are intertwined. Such cooperation will also allow developers of pipeline projects to mitigate against other risks such as security of the pipeline. Obviously it correct to suggest that the cooperation of the importing country is essential to the success of the pipeline as the security of demand for the pipeline and necessary agreed off take will be needed before the pipeline contract can be decided.

5.3.8 Contractual and ownership structure agreements in the region

The region has a long standing tradition of IOCs cooperation in the gas industry. Countries such as Qatar and Egypt have relied extensively on joint venture agreements between the government represented by the NOCs and private companies as represented by IOCs.

There are a number of existing pipelines that operate in the region that have joint venture ownership terms. There is the Greenstream pipeline that operates between Libya and Italy and also there are additional pipelines running from Algeria through transit countries of Morocco and Tunisia.

Various ownership structures are possible for international pipeline construction. It could be that the cross border pipeline could be owned by a joint NOC and IOC partnership when the pipeline is constructed by the IOC, this is the case in Libya for example where there is joint ownership of the pipeline but the initial investment of some 9 billion Euros was covered by Italian company ENI. In order to develop and maintain the pipeline it may be necessary to set up a separate entity, **a special purpose vehicle**, that has the control of the whole pipeline project, Greenstream adopted a similar set up with Greenstream BV being formed to manage the pipeline and assets and being a joint venture between ENI and NOC. Such an arrangement could be of particular relevance to the pipelines envisaged in this study.

IOCs are often keen to be involved in the creation of such export infrastructure. Often it was the case that IOCs have to sell to the domestic market at preferential and often discounted rates in order to secure access to the country's reserves. This was for instance the case in Egypt where developers were given access to fields under the condition that they agreed on a sell back cost to the Egyptian domestic market at unfavorable rates compared to the export option.

The countries that have best managed to develop their reserves and export markets have as a general rule used IOCs initially to expand their operations and enhance infrastructure for export. The countries that have done this the most successfully have the optimal level between continuing control of their own resources and the benefits of technology and project management transfer from IOCs. Qatar as an example was very successful in the use of IOCs in particular Exxon Mobil and has benefited from a technical perspective from such cooperation. Qatar has also been adaptable in changing its project structures to make them more attractive to foreign investors, and in altering its fiscal regimes to enhance economic aspects of the projects for investors[14].

If Libya and Iraq are to develop their export infrastructure then attracting such companies will be important.

Complex new projects are also segments where strategic alliances between IOCs and NOCs can potentially be successful. Algeria's Sonatrach for example, needs IOCs to help it get reserves from remote parts of Algeria.

The success of partnerships between IOCs and NOCs is not always positive however, and there are numerate examples of failed relationships. For example the situation that exists between BP and TNK-BP in Russia there were differing interests between the BP and the Russian partners which subsequently progressed to issues in corporate governance. The same has to a certain degree been the case in Kazakhstan with the development of the Kashagan field.

5.3.9 Conclusion ownership Libya-Egypt pipeline

The ownership of the pipeline should optimally be a mix of the national oil and gas companies of Libya and Egypt, regional gas suppliers/companies, and potentially IOCs, below in Figure 5.3 an outline of the possible setup is illustrated. As equity holders several options exist, hereunder but not limited to, NOCs of Libya and Egypt, potential capacity holders, the future pipeline operator, and finally gas suppliers in Egypt looking to move upstream to secure supplies to their customers.

The NOC of Libya will be a necessary equity holder; the importance of exerting some control over the flow of gas from the country would be seen as being of strategic importance to the country. EGAS of Egypt would in all likelihood also be a valuable equity partner. While the motivation for the NOC of Libya would be a need for gas evacuation, the motivation for EGAS would be a need to diversify a new source of supply to Egypt. However, participation with equity share does require availability of “free funds”, with the current situation (Autumn 2013) it is deemed unlikely that free funds are to be found on the Egyptian state side. Regarding Libya the prospects for finding free funds are not likely to be better. In any case it will at the end of the day be a question of priority of the governments of the two countries.

Other equity stakeholders may be potential capacity holders, hereunder IOCs with an interest in transport of gas from Libya to Egypt. Currently the majority of international oil and gas majors are present in both Egypt and Libya. Potential IOCs could be BP, Shell, or Dana Gas as examples.

The choice of pipeline operator often coincides with the major equity stakeholders. For example in the South Caucasus Pipeline (Azerbaijan-Turkey) the operational responsibility is divided between the two major shareholders, Statoil (commercial operator), and BP (technical operator).

Local gas suppliers in Egypt would also be potential equity holders, such suppliers could for example be GASCO, however due to a high degree of vertical integration many of the companies operating on the wholesale and retail market in Egypt are in one way or the other affiliated with EGAS. Thus the funding would ultimately come from the same source, the Egyptian state. An outline of the possible ownership structure is illustrated below in Figure 5.3.

[14] See also appendix 1 for a description of developments in the Arabic countries.

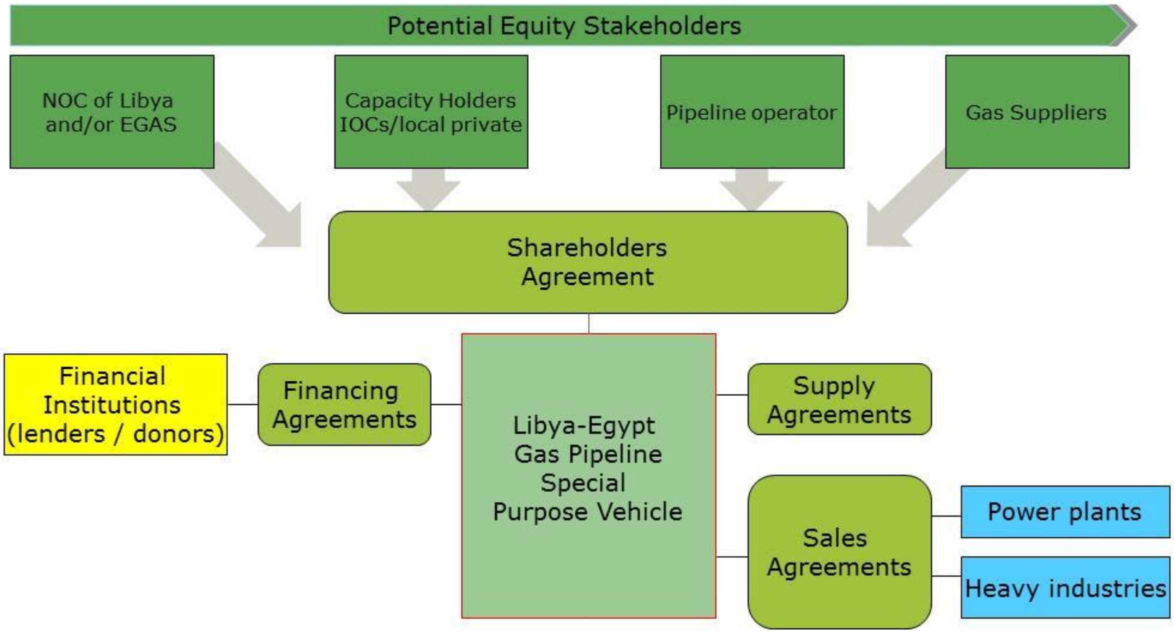


Figure 5.3 Outline of possible ownership setup, Libya-Egypt

5.3.10 Conclusion ownership Iraq-Kuwait pipeline

The responsible body for any oil or gas export development project in Iraq is the Ministry of Oil. Thus the MOO will naturally be the main driver with respect to project ownership, in the gas sector the MOO is represented by the South and North Gas Company (SGC & NGC).

The central role of the MOO doesn't mean that private companies should be excluded from participating in the development. Private companies have traditionally been invited for participation in upgrading and developing Iraq's oil and gas infrastructure. One example is the establishment of the Basrah Gas Company (BGC) which is a joint venture between the SGC, Shell, and Mitsubishi, with SGC as a majority partner. The BGC purpose is to develop the gas processing infrastructure in the southern part of Iraq in order to reduce flaring and make the gas marketable. The BGC sells gas and LPG at fixed prices to SGC who is responsible for the marketing of the gas primarily internally in Iraq, although some export of LPG is expected to take place soon.

It is expected that whenever the local market is fully supplied with gas, considerations regarding export of LNG to the world market will begin, which would be in the interest of Shell and Mitsubishi. Hence, in this case, striking a balance between selling gas internally at unprofitable rates against allowance for gas export at a later stage was achieved.

It should thus be noted that the BGC is not likely to be the best driver for development of the pipeline between Iraq and Kuwait. However a joint venture of a similar kind between SGC and a regional company with an interest to sell gas to Kuwait could be a possible solution. This regional company could for example be Kuwait Energy, which hold licensees in some of the few non associated gas fields in southern and central Iraq. Although being involved in exploration and production in various countries across the world, it could make sense for Kuwait Energy to increase the value of the assets in Iraq by diversifying the possibilities for marketing of the gas.

Expectations are that the local market should be satisfied before any export agreements can be carried out, however the overall allocation of the resources are, according to the public domain, allocated 50/50 on domestic and export respectively. An outline of the possible ownership structure is illustrated below in Figure 5.4.

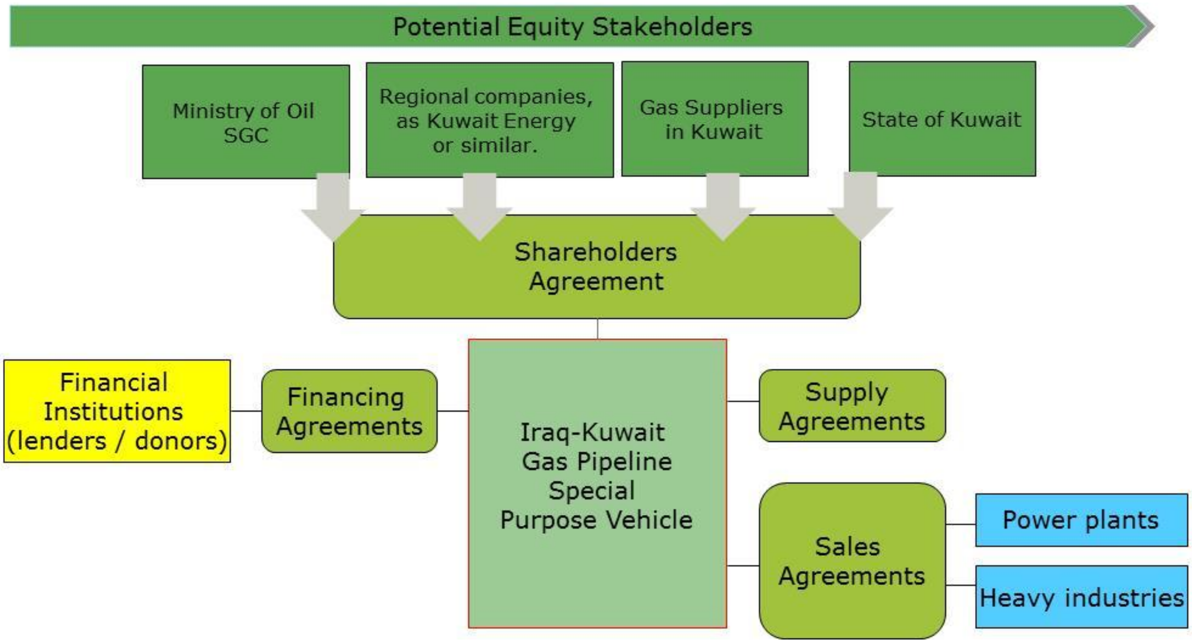


Figure 5.4 Outline of possible ownership setup, Iraq-Kuwait

5.3.11 Conclusion ownership LNG import terminal in Bahrain

The oil and gas sector in Bahrain is dominated by the state company Nogaholding which has majority shares in most of the upstream, middle stream, and downstream companies in Bahrain. Nogaholding has thus also been the main focal point with respect to development of the LNG import terminal project. Specifically it is understood Nogaholding has ventured with Norwegian Skaugen Gulf Petchem Carriers (SGPC), and Capital Management, to develop the terminal. However, majors such as Shell have also shown interest in the project. The role of BAPCO was throughout the process to act as technical advisor to Nogaholding.

Status of the project is as far as can be ascertained through the public domain, that the LNG terminal is in the planning phase and that no final investment decision was taken. Key considerations such as state participation vs. private involvement, technical solutions, and finance are still yet to be finally resolved. Structuring the ownership is to a large degree dependent on the type of facility needed. Generally LNG terminals are structured in two types, merchant and tolling facilities[15]. Tolling facilities are LNG regasification terminals that only provide a service to the seller and the purchaser. Thus the project company does not at any point own any gas. Users of the facility may be either the seller (often the producer) or the buyer (often utilities or gas intensive industries). The special vehicle company

[15] For a more detailed overview see: ”Project Financing of a LNG import facility as a tolling facility”, Noonan & Martín.

charges a fee for the services provided, covering the opex, debt, tax, and equity return. Due to the nature of the setup (no ownership of gas), the main risk is that capacity is not being used. What normally is done is that long term agreements are being signed in order to cover the minimum required capacity booking of the terminal.

Merchant facilities are LNG regasification terminals where the project company buys/import the gas from the liquefaction and sells it with a markup to the market, thus the achieved margin should cover the costs of providing the service. With this type of facility the project company takes on more risk than with a traditional tolling facility, these risks can be:

- Upstream disruptions
- Credit risk on the sales side, default of the offtakers
- Currency risks if LNG is purchased in dollars and regasified volumes are sold in the local currency.

Hence the risk of a merchant facility are everything else being equal higher than for a tolling facility implying that the financing costs, will typically be higher for a merchant facility. Usage of the facility must also be addressed in connection with the financing, it is assumed that a fixed capacity booking will be made in the terminal. The fixed capacity booking is assumed to be 75% of the capacity of the terminal, the remaining capacity would serve as a buffer in the summer periods where demand for electricity is peaking. The experience with LNG import terminals is that capacity is very rarely sold out. Thus the sale of the baseline capacity should be able to retrieve the costs of financing, maintenance, and operational costs. An outline of the possible ownership structure is illustrated below in Figure 5.5.

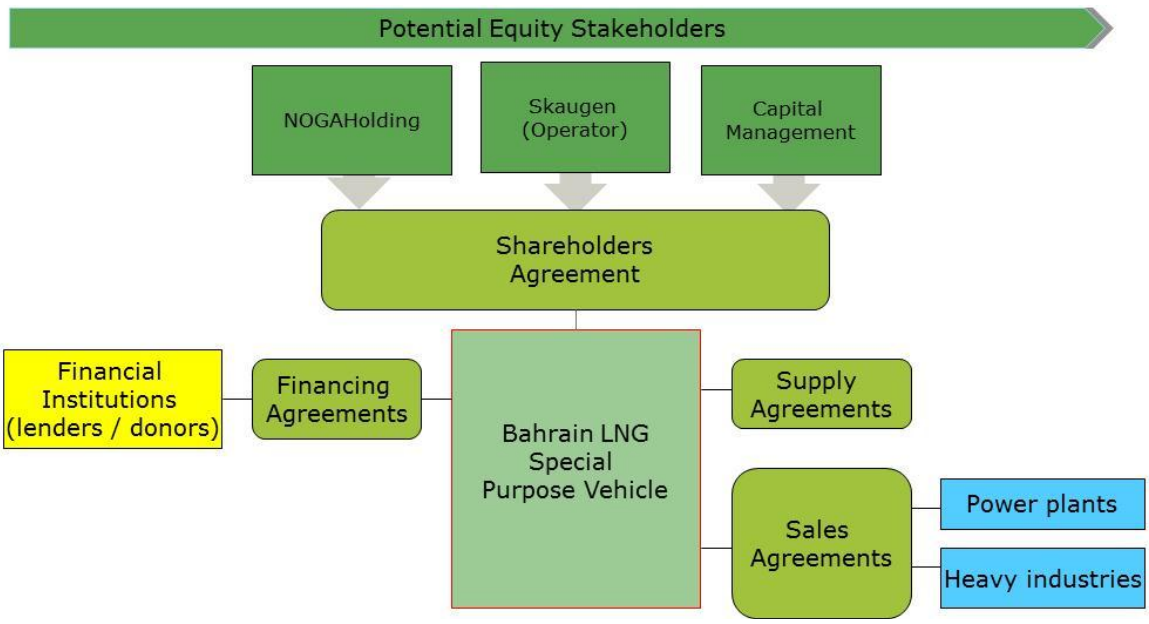


Figure 5.5 Outline of current ownership setup, LNG Import terminal Bahrain.

6 EXAMINATION OF POSSIBLE TRADE MODELS

6.1 Division between IOCs and NOCs

Having defined the ownership of the project the next step is ensuring that gas can actually be supplied to the pipeline. The trade model must facilitate the movement of gas from one region to the other. Here two elements are of crucial importance, the technical capabilities and potential upgrades needed in order to supply the gas and the institutional framework including the model for trade and supply of the gas and the network codes. In order to understand the possibilities it is useful to present a few cases applied by other gas exporting countries. In this section we thus first present the case of Norway and Russia, both two large exporting countries but with very different approaches to export of gas. Secondly moving to the operations of the pipeline the specific rules and measures needed are investigated and presented.

6.2 Norway

The Norwegian upstream system is owned by the producers in the association called Gasled. The day to day operations and the expansion plans are carried out by GASSCO which is a state owned independent system operator. A rough overview of the system is presented in Figure 6.1 below.

The producers operate and produce from the platforms, the pipelines, treatment, compression, and receiving terminals, are all primarily owned by GASSCO and illustrated with blue in figure. Contracts with the wholesale markets are held on bilateral terms between producers and shippers.

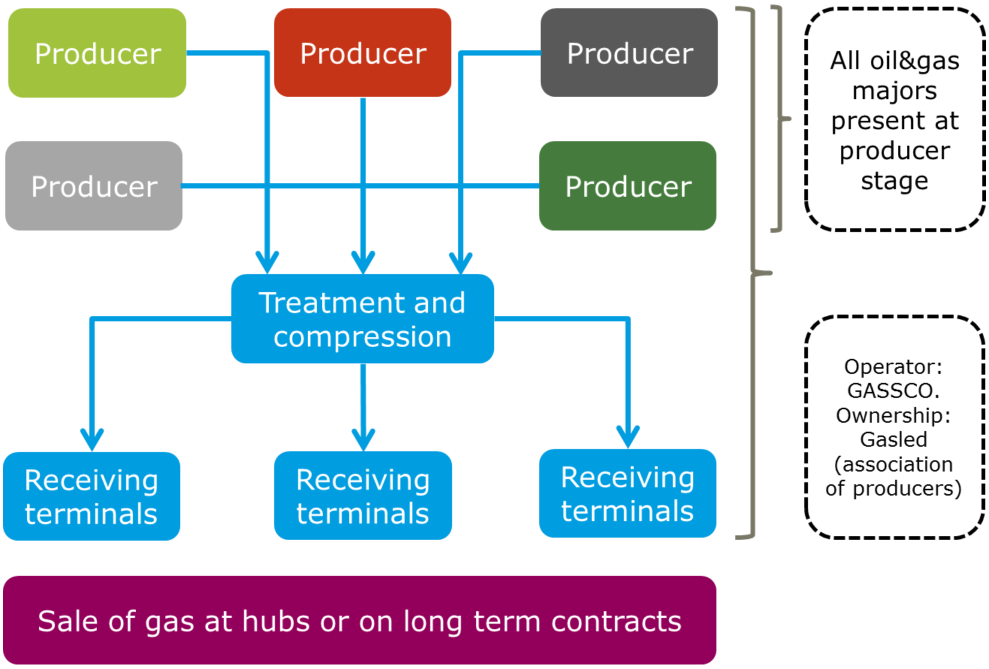


Figure 6.1 Trade Model Norway

The producers have the right and possibility to recommend certain expansions to GASSCO which will undertake the preliminary investigations hereunder demand for capacity surveys such as open seasons.

Gas is delivered at the border entry to continental Europe historically the main contract type was oil indexed contracts, however during the past 2-3 years there was a gradual move towards introducing a larger degree of hub pricing in the contracts.

Thus without going into further details regarding the Norwegian setup it can be concluded that:

- A high degree of diversity exists on the producer side
- Expansion planning is taking place outside the producers direct control
- Oil indexed contracts still the most used, however the share of gas hub indexed contracts is increasing fast.

This type of trade model works well with many producers and a developed system. For a new or emerging system it would be hard to establish this type of system due to the fat that a great deal of coordination is required among the owners of the system. This is also underlined by the fact that this system did not emerge until 2002. Before that the main incumbent Statoil owned and operated the system.

6.3 Russia

Russia is as the biggest exporter to Europe another example which should be paid attention to. Russian gas is primarily produced by Gazprom, Rosneft, Novatek. With the two latter being active primarily on the domestic market while Gazprom although also very present in the domestic market has export of gas as its main income. The gas trade model governing the sale of gas to the export markets is dominated by the fact that Gazprom has a monopoly on exporting gas, the gas is either exported to Europe or the CIS countries typically at a discount to the European price. Gazprom is at the same time also responsible for the expansion planning inside Russia and towards Europe. An outline of the structure is illustrated in Figure 6.2 below.

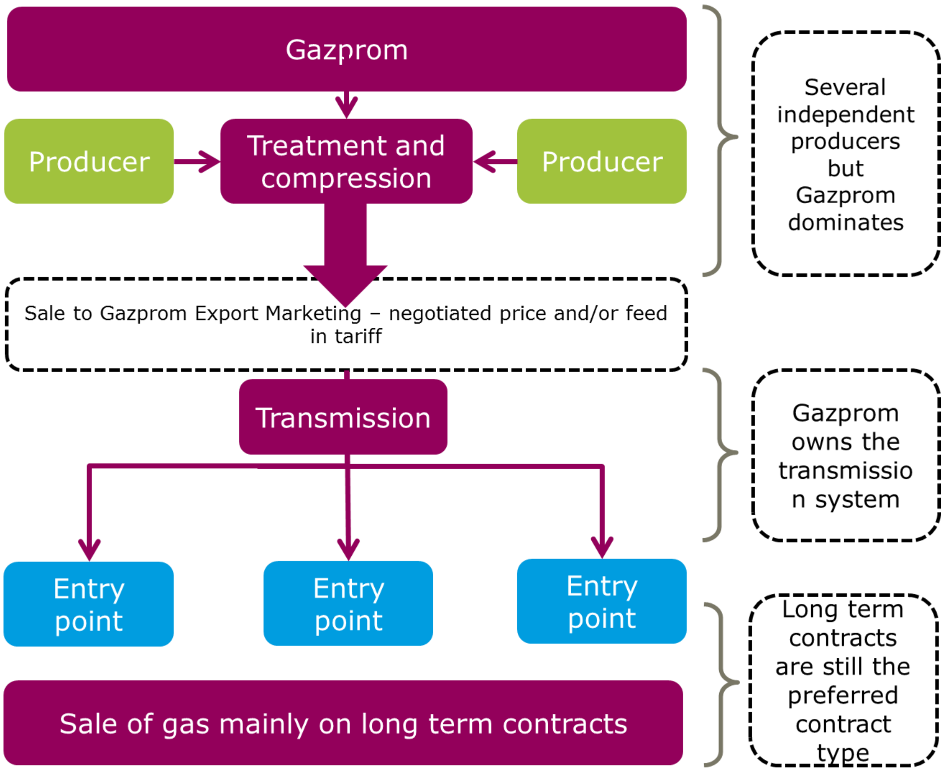


Figure 6.2 Trade Model Russia

The main lesson learnt here is that:

- Large scale export while serving a large domestic market is achievable.
- One central entity for export while more diversification on the domestic market
- Export at market prices while maintaining low/subsidized prices for the domestic population can be combined.

6.4 Organisation & pricing Libya-Egypt pipeline

6.4.1 Organisation

Libya is characterized by hosting many different IOCs, from the smaller independent to the larger majors. The agreements are usually in the form of joint ventures or EPSA (Exploration and production sharing agreement). The latest EPSA conditions have however proven to be unattractive to many IOC. Combined with the continued unrest in parts of the country and uncertainties and the political scene this has resulted in very low participation in the latest bidding round. In order to minimize some of the uncertainty for the producers and promote a higher E&P activity the EPSA conditions must be improved in the next bidding round (fifth round), December 2013. In connection with the proposed pipeline other supplementing initiatives increasing the incentives to engage in E&P activities in the area, could be created. For example a feed in tariff for producers delivering gas to the trading organisation on the Libyan side could alleviate some of the commercial uncertainties.

It is often the case that pipeline developers prefer connecting to liquid markets with a transparent price formation to reduce the risk of the take or pay contracts. The feed in tariff will send the “missing” price signal to the producers. The producers engaged directly in the pipeline project would not need to rely on a feed in tariffs as this would merely be internal price. However the feed in tariff could be relevant for other local producers who are seeking a low risk outlet for their gas production or an alternative to flaring associated gas. Such schemes were implemented elsewhere for example in the Netherlands where a feed in tariff is offered developers of marginal fields. Obviously the feed in tariff would rely on the available price which the trading organisation would be able to obtain in Egypt. Figure 6.3 illustrates a rough outline of the relationship between the various stakeholders.

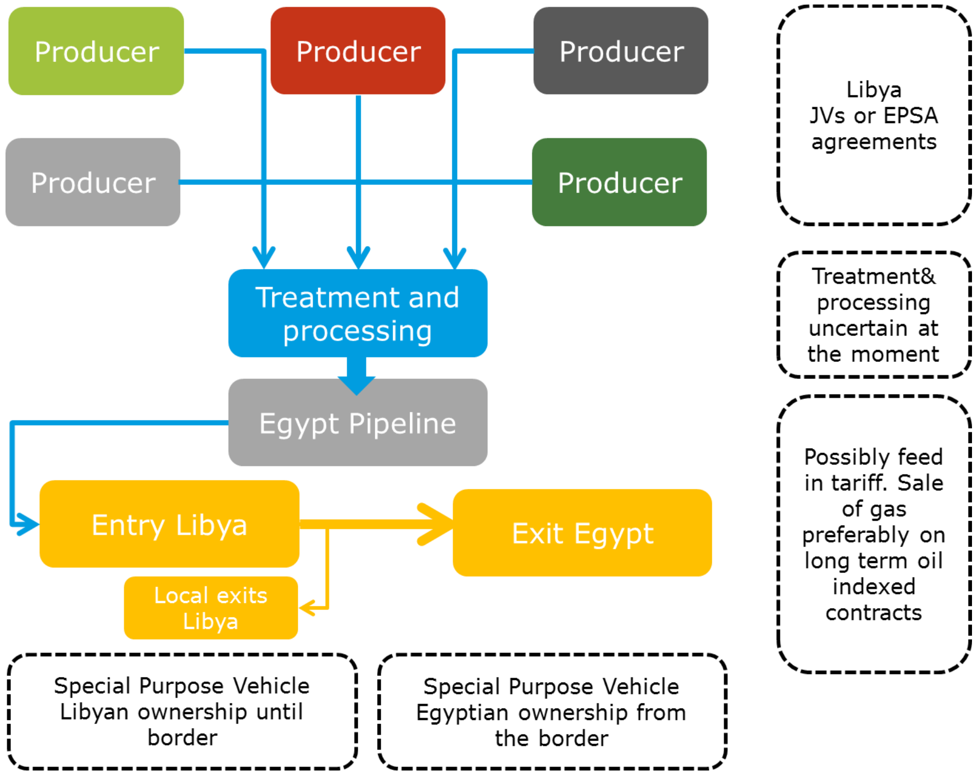


Figure 6.3 Potential organization Libya-Egypt

The possibilities for treatment and processing is at the moment unknown most likely dedicated facilities will have to be constructed to accommodate the export requirements. Treatment of the gas and the distribution of the costs could be an area of concern and should be studied further in order to determine the viability and the bottlenecks in increasing the production.

6.4.2 Pricing approach

As the pipelines envisaged only involve Libya to Egypt and Iraq to Kuwait the contracts would be advised to be on a traditional bilateral level. Such contracts are concluded between producers and shippers and the provisions entailed in the contracts can vary widely, dependent on the characteristics of the parties demand and supply. Parties typically specify the total volume of gas covered by the contract, the unit price of the gas and whether or not it will be fixed to the price of other fuels including oil in the pricing.
In general 3 models could be considered: hub pricing, oil indexation, or a hybrid between the two. At this early stage it is recommended to introduce long term oil indexed contracts with an option to introduce hub indexation should it become relevant.
The formation of a hub in Egypt in the medium to long term is not unlikely; Egypt has many of the prerequisites required for a hub to emerge.

- First of all it has a large own production with a diversity of producers.
- Secondly, it has a large own consumption both these factors could contribute to a high liquidity on the hub.
- Thirdly interconnections with the neighbouring states are good, with the Libya-Egypt pipeline and the Arab Gas Pipeline fully functional gas could in principle be transported from Libya to Syria.

- Fourthly, when gas production declines one (or several) of the liquefaction facilities could be converted to LNG import facilities, all which is needed is establishment of regasification facilities and decommissioning of the liquefaction trains, the port and stoirage facilities hould already be in place. Regasification facilities would connect Egypt more directly to the world markets and add to the liquidity of the hub.

However, it takes time for these factors to evolve and a hub to emerge, the recommendation is thus to start out with oil indexed pricing formulas.

6.5 Organisation & pricing Iraq-Kuwait

6.5.1 Organisation

It is assumed that the ownership will involve the Ministry of Oil (MOO), the Kuwaiti State, and possibly an IOC. The development in the region is already on going with initiatives to reduce flaring and utilize the gas for internal consumption and eventually export. It is suggested to build on this development, as previously described treatment facilities were constructed by the BGC with SGC and Shell as major shareholders with the intention to supply associated gas to the local market and eventually export any additional volumes to the world market in the form of LNG. The access conditions for the treatment facilities are unknown, but it is assumed that no third party access exists, and that the capacity is fully booked. If third party access is possible the pipeline could be connected to the treatment facilities. Another approach which would be more likely would be to construct additional treatment facilities at the same place as the BGC serving the exporters of gas to Kuwait. This approach was taken in the Netherlands were the main receiving receiving terminal Den Helder actually consists of 3 separate terminals with different ownership.

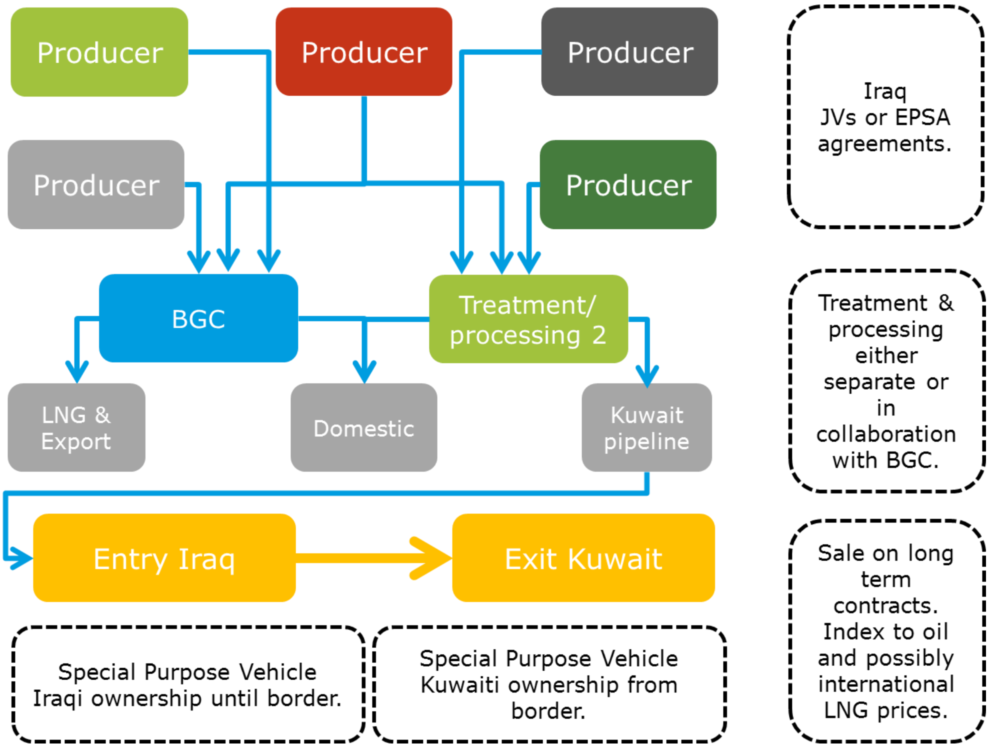


Figure 6.4 Potential organization Iraq-Kuwait

Although the BGC facility is primarily earmarked for domestic use and later on export of LNG it should be investigated if (or under which conditions) the capacity could be utilized for export to Kuwait. If netback prices in Kuwait could compete with the benchmark on the Asian market there would be reason to consider how pipeline export could complement/supplement the proposed LNG export.

6.5.2 Pricing approach

Pricing of the gas should be able to compete with both imported LNG and fuel oil for oil fired power plants. Thus a hybrid type of contract structure could be envisaged wherein discounts to LNG are built in. This would ensure that the baseload needed in the pipeline is secured and that LNG is only utilized during the peak periods in the summer.

Gas in exchange for electricity could become a possibility due to the fact that connection between Iraq-Kuwait is among the preferred electricity projects. Similar schemes exist elsewhere, for example between Iran and Armenia, where Iran supplies Armenia with gas in exchange of electricity. The specific terms of trade are not disclosed, however it is known that approximately 1m3 is exchanged for 3 kWh[16]. Similar dynamics are found in Western Europe where the Netherlands receives Norwegian gas and exports electricity the other way. However the specific dynamics would have to be verified in a separate study and cannot be concluded on here.

6.6 Investment methods and capacity planning

There will need to be the establishment of a capacity market that will enable any gas industry participants to purchase pipeline capacity and transportation services that they may need to transport gas from the point of purchase to the point of consumption. In most markets a primary capacity market may be supplied by the acting pipeline operator which may be a joint venture between an IOC and an NOC, which may sell their capacity and their transportation rights to shippers. Revenues from primary capacity should recover the operator's cost of construction of the pipeline and transport with a regulated profit on top.

In a non-liberalized market where ownership of all or several parts of the value chain are bundled, this is fairly easy, as the balance in the network is maintained by one organization that has access to all instruments and information necessary to deliver natural gas to consumers.

An important consideration in any pipeline construction initially is the identification of the market for the pipeline. To identify the market and thus eventually the capacity of the pipeline an Open Season is often carried out. An Open Season is basically used for identification of firm transport demand by letting interested parties submit binding capacity reservations in terminals/pipelines. If the capacity reservations exceed some predefined minimum economic and technical capacity the project can go ahead. Open seasons are presently applied in both the North Sea, continental Europe, and in the US interstate gas pipelines. The reason for open seasons is both to enhance economies of scale and to promote efficient pipeline investment.

[16] http://arka.am/en/news/economy/armenian_energy_ministry_finds_iran_s_offer_to_increase_gas_export_to_armenia_interesting/

Open Seasons are however mostly applied in unbundled trade models, the trade models which are applied for the two proposed pipelines does not involve unbundling, thus the producers, transporteres and eventually the seller of the gas can be the same organization/company. Thus the capacity will be determined through bilateral agreements.

In order to provide users with tariffs a tariff scheme and a network code must be in place. The tariff scheme will often depend on existing methodologies, if any, used in the countries. It is in this matter also important to ascertain whether the pipeline is an upstream pipeline feeding into a transmission system or whether it is an interconnector between two transmission systems. Generally two schemes are being applied internationally, point to point models and entry exit systems. Point to point models are most prevalent in the US and in some upstream pipelines of the North Sea, while entry exit models are mostly applied in European transmission systems. In the following a short run down of each of these models and their application in the different countries/regions is given.

6.6.1 Experience from the US

In the US the shippers bear the demand risk that is associated with the development of pipelines and will only fund the investments when they are convinced that the capacity that they create is required. The Federal Regulatory Energy Commission (FERC) role is to provide an approval for new capacity projects and clear any environmental hurdles, where the pipeline developer has sold capacity contracts in advance of construction.

The process for approving new pipeline investments in the US may contain useful elements as a potential tool for capacity development. The process for developing a new interstate pipeline regulated by FERC breaks down into four steps.

- Determining demand/market interest (Open Season)
- Publicly announcing the project
- Obtaining regulatory approval
- Constructing and testing

The first step contains a requirement for prospective pipeline developers to hold open seasons in order to gauge the level of demand capacity along the proposed route. During the open season's process a developer has to make it possible for anyone to apply openly and participate in the project. Open seasons act as a regulatory assurance that private investors will coordinate and provide an efficient level of capacity through new investment, and that no pipeline developer will exclude any another potential investor.

The second part of the open season is to get the gas shippers to enter into agreements to purchase capacity from the investment. If it is deemed that there is enough potential interest in the project then there is a next stage of evaluating different options to make additional capacity or to build a new pipeline.

The subsequent stage is that the pipeline developers have to start and obtain financial commitments from the gas shippers and file the proposals with FERC to publicize the project and gain regulatory approval. Even though this stage may appear relatively advanced others may still join the project.

At the final stage once FERC has approved the project terms and proposed the method of charging the developer will proceed with the project and awards long term contracts for capacity to each participating shipper.

Regarding the allocation of costs and capacities between the shippers this is unregulated and the pipeline developer generally allocates capacity contracts between shippers which express an interest is also an unregulated process. The pipeline developer allocates the capacity in order to maximize the commercial terms of the project.

The FERC design of the open season means that shippers will have a chance to express their demand for capacity at the same time as developers suggest a pipeline. This in actual effect means that the shipper that purchases capacity by contract in a development project will pay the average cost of making the capacity and not the incremental cost of providing the capacity. The result is that where each of the shippers has the ability to pay the same average cost based tariff there is no disadvantage to be the first mover for a pipeline project. This in effect removes the incentive to delay developments that may arise from the rules governing pipeline system.

The tariffing method applied in the US is of the type **point to point**. In the point to point access model shippers have to identify the points where they want to inject and withdraw their gas and also identify the selected transportation path. This is also known as the contract-path model. In the point to point logic tariffs are distance related and the price for capacity increases between entry and exit. In certain cases the contracted path will not necessarily reflect the actual physical flow of the gas meaning that point-to-point models do not necessarily reflect the actual costs. The point to point model is also transaction based meaning that the entry exit capacities cannot be separated from each other or from the gas supply which prevents a liquid market. Resultantly the market is not so flexible, shippers are obliged to use the predefined entry and exit points and the transportation path cannot be changed.

6.6.2 Experience from the EU

Europe has since the opening of the gas market been divided into a variety of different entry exit systems.

There are a number of general features that would need to be considered as key for the entry exit system to function efficiently, facilitate network access, wholesale trading, and competition. In pure entry exit models the capacities can be flexibly combined with one another within the entry-exit zone, as long as it is the case that the entry and exit nominations don't exceed the capacities that the shipper has booked at the respective points. In comparison to the point-to-point system the entry exit model is transaction independent. In contrast to the distance dependent point-to-point tariffs entry and exit tariffs are set individually for each of the entry and exit points. One the shipper makes an entry and exit point then it is then allowed to transport gas through a number of network levels and zones without incurring extra costs. Due to this fact, network operators have to cooperate with one another to allocate costs and ensure that tariffs are cost reflective. Tariffs should reflect the technical and economic conditions at each specific point and signal the costs of capacity extension that would be required to eliminate congestion. Having concluded independent contracts for the entry and exit capacity the shipper is able to use booked capacity independently from commodity or capacity transactions.

The entry-exit network access model is the generally accepted standard for Europe's gas networks. In contrast to the previous distance or path dependent point-to-point methods, the model allows an improvement toward greater flexibility for shippers, transparency in the system and cost reflective tariffs.

Under the entry-exit model capacity contracts for input and withdrawal are separated and independent of one another- there is no linked contract path. The aim is either to bring gas into the system (entry capacity) or to remove gas from the system (exit capacity) and as such services can be obtained by the same or different users of the network. Such a system may be contrasted with the point to point system where transportation charges depend on the actual or theoretical distance travelled by each consignment of gas. Entry exit is favored by the EU as a means of promoting gas liberalization.

Due to the differences between national gas markets in the EU each national network code determining the characteristics of the entry exit model had its own approach to handling congestions, balancing, tariffs, and third party access. However, the gas markets in the EU are currently undergoing changes with regard to the preferred trade model / network code for gas. The vision of a future European trade model is laid out in the third package, particularly regulation 715/2009. The regulation recognizes the entry exit model as the preferred model for the future. It does however require that the rules and regulations laid out in each national entry exit model are harmonized towards one single approach for the EU. The regulation, which is binding for EU member states, thus provides the framework for a harmonization of network codes and entry exit systems in the EU. A key principle is the creation of a European network of transmission system operators of gas (ENTSO-G). One of the main tasks of ENTSO-G is to initiate and assist the European Commission in improving network codes, with particular focus on the following areas:

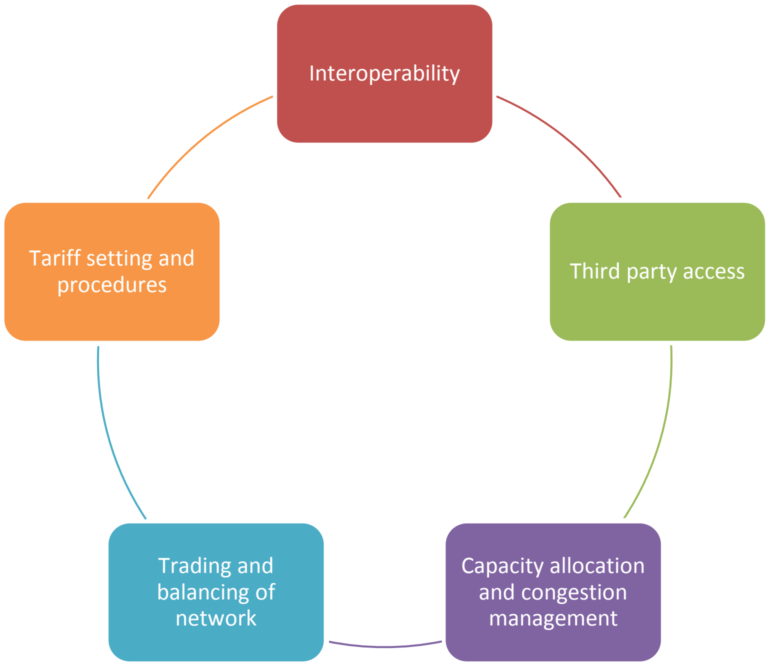


Figure 6.5 Main targets for harmonization

6.6.3 Relevant planned trade model developments

European regulators were mandated to initiate a target model for gas trade within the European market in 2010. The CEER Gas Target Model (GTM) provides an indication of how a single liberalised market could function in Europe. It states that the end of the liberalization process will be with a market that establishes functioning wholesale markets, and connects them with one another as well as ensuring that there is security of supply and economic investment in the markets.

The model stipulates that wholesale markets will be structured as 'entry exit zones' where entry capacity will be allocated separately from exit capacity meaning that gas that enters the zone can be delivered to an exit point in the zone. Each zone is to have its own hub or virtual trading point.

The purpose of the model was to ensure that there could be a clarification on how the different network codes related to one another and also how the market could signal the need for incremental capacity and for the capacity to be allocated. In the approach that was adopted by the regulators in Europe they see the European gas market as a combination of entry and exit zones that maintain virtual hubs. The European regulators see the development of competition would be related to the development of hubs in Europe where gas volumes would be traded. Market integration would be served by the effective use of gas infrastructure which would allow gas to flow to where it was needed most.

The CEER model maintains several overall goals that were identified to meet the target of enhancing gas trade in Europe. These are listed below;

- Effective implementation of entry and exit systems
- Facilitation of cross market integration
- Efficient capacity allocation procedures
- Efficient use of pipeline capacity especially at cross border flows
- Improving the integration of trading points
- Improving security of supply

Although the GTM is not a legally binding one the importance of the model cannot be underestimated due to the fact that it sets out a common EU vision on what the future gas market should look like While the concepts of the model were written down the actual practical implications of the adoption of the model are still evolving. So far only four out of 12 new EU network codes will be finalized by 2014.

6.7 Comparison of trade models

While the US and the EU both utilize the principles of the open season model for investments in gas infrastructure the approach to tariff setting differs. The difference between the tariff models for investment is that in the US the pipeline investment is made separately and on an individual basis. In the US the shipper of pipeline one should not pay for the investment in pipeline two unless there is an incentive to gain from it. However in the EU the current regulation views pipelines as a network with distinct entry and exit points. In such a case the shipper will not contract to use specifically pipelines one or two, but instead the transmission between point a and the exit point b. In this way the investment cost in the network is shared among all shippers irrespective of their investment on their particular route. As a rule of thumb the entry / exit model is advantageous whenever pipeline infrastructure between two complex and possibly integrated networks is considered. The advantage of the point to point model is, as the name suggests, the simplicity. Here only the costs of the specific pipeline are transferred to the users.

7 RECOMMENDATIONS TRADE MODEL

For the Libya-Egypt pipeline it is recommended:

Ownership

1. That the state of Libya, through the NOC of Libya, takes a majority equity share in the project for example 51%.
2. That the state of Egypt through EGAS and/or GASCO, takes a significant share in the project, the share would depend on the financial capabilities and priorities of the state.
3. Eventually in the actual implementation it is foreseen that the project may be split into two national projects meeting up at the border. This would of course be reflected in the ownership solution and the financing. However, the current choice of financing regards the project as one single project.

Organisation

1. To create a special purpose vehicle to drive the initial phases of the project
2. To investigate the supply possibilities from Libya, hereunder the lack of infrastructure such as treatment facilities connected to the potential pipeline.
3. That a feed in tariff system is considered in order to create incentives for supply to the pipeline.
4. That a comprehensive gas masterplan for Libya is developed, focusing on both the demand side and the supply side.

Pricing

1. That long term oil indexed contracts are considered as the primary contract model.

For the Iraq-Kuwait pipeline it is recommended:

Ownership

1. That the state of Iraq, through the SGC, takes a majority equity share in the project for example 51%.
2. That the state of Kuwait takes a significant share in the project, the share would depend on the priorities of the state.
3. That regional companies and IOCs are invited to participate, providing equity to the project. For example Kuwait Energy, or the like, could be an option.

Organisation

1. To create a special purpose vehicle to drive the initial phases of the project. Potentially the same model as the BGC.
2. Study whether gas export could be a possibility using the BGC facilities – hereunder whether third party access to the facilities can be obtained, and if not outline possible other solutions.
3. Synergies with the electricity market hereunder whether a gas for electricity model is beneficial for both Iraq and Kuwait.

Pricing

1. Introduce hybrid contracts wherein the delivered gas is indexed to both oil and gas. The optimal share of gas vs. oil will be determined through bilateral negotiations.

7.1.1 General recommendations

In this section the recommended model is discussed. It is important to be aware that the trade model relates to the interconnection and not the entire network in Egypt-Libya or Iraq-Kuwait.

Due to the lack of interconnection between the countries there is very little precedence in trade models between countries in this region. In order to make gas flow between the countries it is important to avoid an “over” design of the trade model. Thus the main and overruling criterion for the preferred trade model is thus simplicity.

It should also be noted that until the project has progressed further a detailed specification of the network code does not make much sense. Ramboll proposes to highlight the most important aspects to be clarified for the future pipeline owners. The identified aspects of interest at this stage are:

1. Access conditions
2. Capacity allocation management
3. Congestion management procedures
4. Balancing rules
5. Tariffs

In the following these issues are briefly discussed.

7.1.2 Access conditions

A bundled model where the producers are present throughout the value chain is considered the most realistic model for establishing trade. A bundled model is most often associated with limitations to third party access. This applies to both pipelines. Bundled models is the standard for most large scale export projects.

7.1.3 Capacity determination

It may be the case that the project promoter has an interest in keeping all - or parts of the capacity to himself to avoid competition in the end market, Egypt and Kuwait respectively. In this case there will be no third party access and thus no need for carrying out an open season.

If - on the other hand the project promoter sees an advantage or is forced to allow third party access - an open season would be a relevant tool for determination of the capacity, as it ensures that all interested participants have the possibility to obtain capacity in the pipelines.

At this stage it is not recommended to carry out an Open Season.

7.1.4 Capacity allocation and congestion management

The capacity should primarily be sold on long term contracts in this case meaning minimum 10 years and maximum 30 years. While regulators are keen on short term contracts financing institution and banks prefer longer terms contracts as they give a higher certainty of revenue. Thus the optimal length of the capacity contracts is a balance between the two. Given that the pipelines are primarily intended to serve newly constructed or converted power plants it is recommended that contracts to some degree follow the expected lifetime of the power plants.

Yearly capacity should be defined as "the capacity, which may be applied for, in a given amount, by a registered network user for all gas days in a particular gas year". It may be considered by the regulator to demand that a certain percentage, in Europe usually min 10 %, of the total technical capacity is withheld to increase competition and to allow new shippers to enter the market. Typically this will be done by multiplying the total long term open season booking with factor 1.1.

While the bulk of the capacity would be contracted on long term contract the 10 % reserved for other users or shorter term capacity could be allocated according to two principles: either first come first served or ascending auctions. First come first served allocates capacity to users according to the timing of their request; the tariff is usually the regulated tariff also applicable for the longer term capacity holders. Ascending auctions can also be applied with the regulated price as a starting price combined with a predefined price ladder.

7.1.5 Balancing

The shippers are responsible for their portfolio being in balance. Whenever imbalances occur imbalance charges should be applied. The imbalance allowance should be agreed upon between the operator and the shippers. Generally since both pipelines are relatively simple point to point models the issue of balancing may be relatively straight forward. However, variability in production may be higher in the first years of operation implying an extra need for flexibility in the balancing regime. If the ownership constellation is in the type of a vertically integrated company without third party access balancing rules may not be a big issue since this is just a transfer within the company. In a future possible liberalized market the responsibility and the tools for balancing may be given to the shippers – however at present there is no access to hubs and other flexibility tools which are necessary for shifting the all responsibility towards the shippers.

7.1.6 Tariffs

At this stage a point to point network model is recommended for both pipelines, the costs of using the pipeline system can be directly transferred back to the users via a regulated tariff. In the future, ownership of the pipelines maybe split into national sections implying that an entry/exit system would be more relevant.

Tariffs for using the pipelines can either be collected via capacity sales or via volume sales. There is a tendency for application of capacity tariffs in large capital intensive upstream pipelines as this ensures certainty of revenues. However, as production becomes more unstable combined with a request for more flexibility of end users some upstream pipeline owners, in the last phase of a pipelines lifetime, chose to introduce volume tariffs for coverage of parts of the cost base.

Differentiation of tariffs may be necessary if multiple exit points are established along the pipelines. This goes for particular Iraq-Kuwait and the coastal version of the Libya-Egypt pipeline.

In the case of Libya-Egypt, should the route along the coast end out as the preferred route differentiated tariffs could be applied depending on the distance from the starting point.

Thus while the direct route would not be complicated in terms of tariffs, specific methodologies regarding the tariff setting for the northern route should be developed. With gas systems it is often difficult to attribute specific costs to specific parts of the pipeline. Compression for example benefits the entire system and cannot be attributed to one specific point. Thus it is advised to consider a common cost base with some differentiation accruing from the costs of extra pipes and installation of M/R stations.

In the case of Iraq-Kuwait the additional route from Kuwait city to the industrial site south of the city could be subject to an additional tariff element due to the added distance and possibly extra need for compression. On the other hand the users of this pipeline would offer a more stable baseload flow in the pipeline benefitting other users as well. Due to the small distances it is recommended to not differentiate the tariffs for this pipeline.

8 APPENDIX

8.1 Country experiences

8.1.1 Algeria

Algeria has managed to successfully develop its resources and maintained early ambitions to develop its position as an exporter to Europe. Algeria, upon the discovery of significant hydrocarbon reserves made an early push to develop gas export infrastructure with French assistance. With ambitions to export and an eager local import market in the form of Europe Algeria made both TransMed and Magreb pipelines to Italy and Spain respectively and the two countries were Algeria's first major export partners. Later on direct export was established between Algeria and Spain through the MEDGAS pipeline. Algeria continues to export volumes to Europe and is presently the third largest exporter to Europe behind Russia and Qatar.

Algeria is a mature exporter and will continue to play an important role in the European gas sector. Decisions in the Algerian energy sector are made by the state (which also owns Sonatrach the state's gas company) and the Algerian Ministry of Energy and Mines which is the principal government entity that has contact with Sonatrach. The Algerian gas sector is governed by a group of individuals with a General Assembly being the main government body behind decisions. The body is made up of government and national bank members and acts as the supreme petroleum council.

Sonatrach's responsibilities are in production and distribution and has subsidiaries in the virtually all aspects of the gas supply chain including transportation, upstream production, marketing and sales. Algeria has now established independent regulatory bodies for oil and gas but in the early 2000s Sonatrach also controlled regulatory aspects of the energy sector. The creation of a regulatory body disrupted Sonatrach's monopoly over pipelines, and the downstream business, and removed its regulatory responsibilities and its ability to award exploration contracts. This was partly as a response to increased investment in exploration and to make the Algerian gas sector more transparent for investors.

In terms of legislation the oil and gas industry in Algeria is regulated by the Hydrocarbon Act. The initial legislation of 2005 set out the terms and involvement of IOCs in upstream exploration, production and transportation in the gas sector. However aspects of the regulation were changed in 2006 to make it less favorable to IOCs, for instance in the 2006 amendments Algeria's national oil company Sonatrach was given the right to have a minimum 51% equity of any hydrocarbon project and additional windfall profit taxes were introduced for IOCs.

The resulting withdrawal of development from IOCs in 2012 and a disappointing return in the bidding rounds for oil and gas permits meant that there was a reversal in the Hydrocarbon law in order to win back the IOCs. This meant that the taxation terms were altered to be more favorable but the equity share clauses remained the same.[17] The Algerian government has stated that it needs IOCs help to develop new areas including more complex offshore fields and provide more gas for its rapidly increasing domestic demand.

[17] http://www.gasandoil.com/news/africa/e2e0d31edba733496f70e057c555cc37

As mentioned above Algeria has struggled in recent years to attract significant foreign investment. In the country's seventh licensing round in 2008 there were only four of a total of sixteen blocks awarded, in 2009 this was reduced to three out of nine and in 2011 only two out of ten. The lack of clear fiscal incentives and a poor equity share could be the reason why foreign investors are staying clear from the recent bidding rounds. There are also added security and instability concerns in the investment of Algeria. Despite the sweetening of the terms, Algeria may face problems attracting the only the future will tell whether it makes the country more attractive to foreign companies wishing to invest in exploration projects. The frequent delays in Algerian projects, stringent financial terms and a windfall tax on foreign oil producers whenever the price of oil exceeds 30 dollars as barrel have dampened international companies' interest in bidding rounds.

Despite of the recent troubles attracting IOCs in the bidding rounds some lessons might be drawn from the Algerian case:

- Completion of two export pipelines due to a successful corporation with ENI.
- A trend towards direct connections between countries, transit countries add to uncertainty and costs.

8.1.2 Qatar

Qatar is an example in terms of a good model for cooperation and mutually beneficial relationships between IOCs and NOCs, and in the development of the hydrocarbon sector in general. In order to enhance its gas operations across the whole value chain and improve its technological capacities and build up security of demand Qatar turned to ExxonMobil as a 'in-house' partner to develop its natural gas production and export capabilities. Qatari projects are structured as joint venture projects with primarily ExxonMobil but also additional IOCs operating in the development of the country. Through these mutually beneficial arrangements Qatar was allowed access to ExxonMobil's marketing and technological knowledge whilst ExxonMobil was allowed access to the Qatari reserves.

ExxonMobil remains the preferential partner for Qatar as it has deep levels of expertise across a vertically integrated chain and also the fact that ExxonMobil enjoys the benefits of being a big US player in the hydrocarbon and the benefits that this entails which include good relations with the US government and important relationships with equity providers.

A development and production will be the more usual set where there is a mid/downstream component integrated into the project's development. This will typically be the case for gas projects and will be less usual for oil projects. It is usual for the government typically acting through Qatargas or RasGas, to take a majority interest in a gas project. Qatar typically owns about 70% of the shares in each of the RasGas and Qatargas train companies. In certain cases however it can own up to 90%.

In addition to their fruitful partnership with IOCs Qatar has decided upon a decision structure that is quick and efficient. Additionally the country is not hindered by an unstable political climate which gives it favorable investment conditions for IOCs. Qatar gas has a highly centralised decision making structure. The main actors of Qatar's gas sector are the royal family, the Ministry of energy and industry, Qatar petroleum and Qatar petroleum's main subsidiaries. In the case of Qatar the Deputy Prime Minister who is also the minister of energy and industry chairs the board of directors and is also the general manager. Qatar Petroleum's general operations are therefore linked in with planning agencies, regulatory authorities and policy making bodies but ultimately all decisions are approved by the Emir. Such a situation gives ExxonMobil financial flexibility which was utilized by Qatar to attract capital to projects at lower costs than competitors. ExxonMobil also brings significant managerial skills on an overall level to projects and efficiency gains that are realized throughout the supply chain.

8.1.3 Norway

Norway's institutional set up may provide an indication of a different type of model for development of export infrastructure than the Qatari and Algerian methods above.

In 2001 as an aim to enhance development in the Norwegian gas sector the government asked companies operating in Norwegian operators to establish a unified ownership structure for gas export. Subsequently the Gassled ownership agreement was signed on the 20th of December 2002 and came into effect in 2003. The Gassled agreement represents a merger of the nine gas transport facilities into a single partnership. The partnership serves as the formal owner of the gas transport infrastructure in Norwegian waters.

Gassco is the operating company for Gassled and in its role as an operator acts to provide the full service of operation and development for Gassled under the transportation agreement as stipulated by Norwegian legislation. As in the terms of this arrangement Gassco takes a specific responsibility for the operatorship of the transport system in the Norwegian Sea.

Gassco's role is necessarily quite broad and encompasses asset management, capacity management, system operations, infrastructure development and maintenance. Analysis of infrastructure development in relation to Gassled's collective needs is one of the main tasks of Gassco. In its role Gassco investigates the future investments in pipelines and transport infrastructure. Transportation tariffs are identified by the Ministry in a separate series of regulations. The access regime and Gassco's various roles under the system are further regulated in the petroleum regulations.

As a substantial part of European demand is delivered from Norway through its pipelines, the infrastructure is continuously improved by Gassco in its role as system evaluator. To do this Gassco undertakes an annual transport plan analysis to try to identify the future transport needs and requirements for the system. This annual transport plan forms the basis of Gassco's recommendations for the enhancement or creation of new sections of pipeline.

In its role in Norway Gassco undertakes both general and special system operator responsibility. The special operating aspects are the ones that are given to Gassco by its powers from the Norwegian Petroleum Activities Act and the regulations this is associated with such as the system's operation, the management of the system and investments and development of infrastructure.

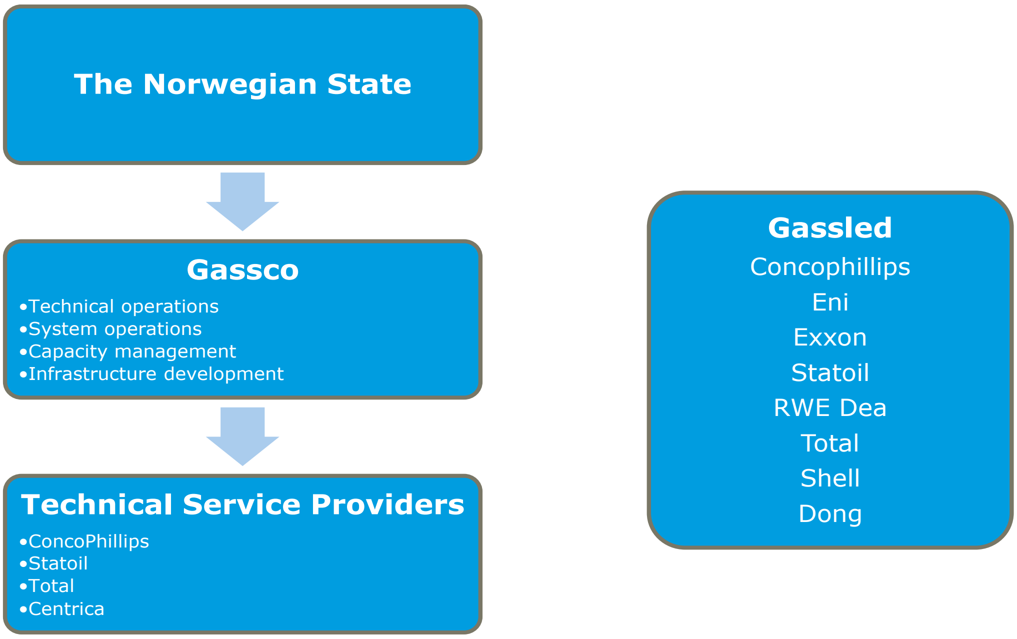


Figure 8.1 Organisational structure of Gassco

Gassco develops fields and transport infrastructure based on approval from its sponsoring companies. When Gassco considers an investment it considers the impact on all Norwegian gas and not only the resources under development. With such an oversight it may ensure the efficient exploitation of the existing gas transport system and it may advises on the correct time to make investments.

If a potential developer decides to develop a gas field the developer shall submit to the Ministry a plan that will identify how it plans to develop the field. Gassco is able to suggest and influence the owners of the field to alter their activities if it would be detrimental to the efficient functioning of the system.

In general the above scheme of transportation development can be described as a bottom up approach for development. The government is a participant of infrastructure development and an initiator is an interested company. Gassco recommends potential solutions and generates assessments but does not actually invest in infrastructure.

The Gassco example is a potential model for the development of the transport network in an effective and transparent way. The Norwegian set up may also allow the effective long term planning of the infrastructure and optimisation of infrastructure development in general.

8.1.4 Egypt

Egypt has enjoyed a degree of success in setting up its gas system and enhancing its exports. Plans to expand natural gas were made in the 1990s on the basis of significant reserve discoveries. Egypt made a significant achievement in developing its gas export industry over a relatively short period of time. It has successfully developed two stages of the Arab gas pipeline and three LNG trains with capacity of 12.7 mtpa.

Egypt's initial export success was based on the fact that the marketing strategy initially adopted in the process was aggressive with pricing decision concluded with initial partners including Jordan, Israel and the Spanish company Union Fenosa. Being central to this with a particularly low price for the company in which they were compensated at this initial stage by advantages including delayed payment of their equity share in the LNG plant and the right to use up to 50% of the LNG terminals capacity for their own exports.

In addition to its development in LNG export capabilities Egyptian, Jordanian, Syrian and Lebanese prime ministers signed the agreement of the second phase of the Arab Gas Pipeline in 2004. The second phase extends over 390 km from the city of Aqaba to the Rehab in Jordan with a capacity of 10 billion cubic meters per year to face the increasing Arab markets demand of natural gas.

This phase was awarded in August 2002 to the Egyptian consortium which was composed of EGAS, Enppi, Petrojet and GASCO) on a Build, Own, Operate and Transfer basis. The Egyptian Company EGAS will manage, operate, develop and maintain the pipeline for a period of 30 years with optional extension period of 10 years after this period the ownership of the project will be transferred to Jordan.

Egypt's present fiscal regime is based on the setting up of production sharing contracts. The framework provides stable conditions albeit in a heavily bureaucratic environment, and the licensing process remains cumbersome.

The early licensing agreements seemed to deny foreign companies the right to own the gas that was discovered in the course of drilling, which was to be automatically transferred to the Egyptian government. However, under international pressure this was reassessed and in the 1980s a 'gas clause' was introduced giving gas contractors sharing rights in associated and non-associated gas. Later in the 1990s improved fiscal terms were offered leading to an increase in exploration in Egypt. Regulation stated that only a third of proven reserves could be exported whilst another third was preserved for the domestic market and another for future generation though this has not been implemented.

In the event of a discovery, a joint venture operating company between Egypt's gas company EGAS and the contractor would be established with 50:50 rights. This institutional set up allows Egypt's gas company to exert control over field developments without requiring the state to fund development including exploration, and capital costs as in common with these agreements are done by the investors. Foreign investors are also required to sell up to two thirds of their share of gas to EGAS for the domestic market this is done between a gas sales agreements between Egyptian NOCs and contractors committing the former to a take or pay basis of 75 per cent of a given daily contract quality. This process has not always been entirely successful due to rising rig costs in the mid 2000s the price cap that was applied by EGPC became untenable and as a result exploration and development was reduced and a number of IOCs were discourage from participating in a 2008 bidding round. Egypt was forced to readjust such price caps in the face of demand increases and IOC objections.

Egypt has now introduced a new pricing agreement in order to enhance natural gas production. In a deal between the government and RWE in the joint North Alexandria and West Mediterranian Deep Water concessions for which Egypt offered to pay a higher price more in line with the international market. This agreement also stipulated that Egypt would buy all the gas produced whilst the contractors would assume the investment costs.

Lessons

- Imbalance between export and gas own consumption, leads to underinvestment in import infrastructure.
- Domestic pricing regimes need adjustment in order to attract foreign investments.
- Ownership of pipelines placed within the exporting country.

8.2 Case Studies Regional Pipelines

8.2.1 Arab gas pipeline

As there was no develop sector structure or regulatory set up for its creation the Arab Gas Pipeline was organized by the process of regulation by contract under a memorandum of understanding signed by the governments involved. In this agreement an Arab gas organisation was created to coordinate work that was done by the four countries respective gas companies. As part of the agreement the organization evaluated common standards such as the quality of gas, technical capacities and potential expansions of the pipelines. Issues such as price formulation and the various settlement options for disputes were also in the contract, however the segments of the pipeline that were in each country were governed by the respective ministries. Using the example of Jordan a domestic company was licensed by the ministry to construct and operate the section of the pipeline, and to engage Egypt in the process of purchase at prices that were agreed between Jordan and Egypt. The company was also able to sell the gas to larger customers at a price that was agreed with the regulator. The license for Jordan was over thirty years however it was given exclusivity for 18 years following which the company is required to unbundle its technical control of the pipeline and its sales function and other companies will have access to the pipeline.[18]

8.2.2 Dolphin gas pipeline

The dolphin gas pipeline is one of the largest pipelines in the region. The pipeline brings natural gas from Qatar via pipeline to meet the United Arab Emirates (UAE) demand. The project was created through the cooperation of three GCC nations the UAE, Qatar and Oman into a regional network for the first time. Dolphin energy is the constructor and operator of the project and Dolphin energy is owned by the Mubadala Development Company on behalf of the government of Abu Dhabi and 24.5% by Total of France and Occidental Petroleum of the US. Dolphin energy was an initative of the UAE in 1999 and invited the investment from France's Total and Occidental in 2002. The project involves a development and production sharing agreement (DUSA) and an export pipeline agreement (EPA) with Qatar Petroleum Company.

The UAE has expanded its development and import options through the use of hybrid companies (i.e split between state-ownership and public shares) like Dolphin Energy and the Abu Dhabi National Energy Company PJSC and through state owned investment companies such as the Mubadala Development Company and the International Petroleum Investment Company (IPIC). The Mubadala Development is a public joint company joint stock company created as an initiative of the UAE Offset Group in 2002. Interactions between the UAE and the major IOCs are when the expertise of techniques such as Enhanced Oil recovery and the development of fringe fields is needed. In the next 5-10 years it is likely that the UAE will seek further cooperation with companies such as ExxonMobil for EOR projects and Concophillips for field development.

As such the UAE may provide an example of how Libya and Iraq could approach the issue of investment and cooperation with IOCs. The UAE has traditionally used its national oil company the Abu Dhabi National Oil Company (ADNOC) to create joint venture investment arrangements with IOCs for the development and control of reserves. There has also been a further move from the UAE to

[18] Euro Arab Mashreq Gas Cooperation Centre, 2007)

alter investment laws and regulations to have the ability to invest outside its borders and be open to investment outside of the UAE and be open to foreign investment in the UAE. The Abu Dhabi National Oil Company is the NOC of the UAE. When the company develops projects it typically operates through subsidiaries formed by the joint venture production sharing agreements with IOCs. The arrangements are controlled by ADNOC which acts as the operator and retains at least 60% of the investment. Two ADNOC subsidiaries the Abu Dhabi Company for offshore operations (ADCO) and Abu dhabi Gas Industries (GASCO) are examples of this type of agreement. ADCO is a joint venture with Total (9.5%) Exxonmobil (9.5%) BP (9.5%) and Partex (2%) GASCO is a JV with shell (15%) TotalFinaElf (15%)..

With reference to the two existing pipelines the motivation governing the two differ, whilst the Arab Gas Pipeline, although serving a market in need of gas, was mainly built for gas evacuation purposes, the Dolphin pipeline was mainly motivated and driven by the end suppliers.

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