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Renewable Energy and Resource Curse

on the possible consequences of solar energy in North Africa

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Abstract

The African continent possesses a vast amount of various types of natural resources. Accordingly, a large number of African countries export their natural resources. These natural resources include important energy sources such as oil and natural gas, in turn the export of these energy sources plays a crucial role in the economics and politics of many African countries. Despite its crucial role, the heavy reliance on natural resource exports by African countries is often related to the term 'resource curse'.

Unfortunately, negative terms such as 'resource curse', 'oil curse' and 'aid curse' have now become synonymous with the African continent and several studies have accentuated that such 'curses' exist in many African countries.

The world is facing a 'new energy era' as many countries, including African countries, are changing their policies to promote the use of renewable energy. Here, North Africa has been receiving attentions due to their enormous potential for solar energy production, as well as other renewable energies such as wind energy, from the Sahara desert. For example, organizations such as Desertec Industrial Initiative (DII), with the Moroccan Agency for Solar Energy (MASEN) signed a Memorandum of understanding regarding a large cooperative solar project in Morocco in May 2011.

Despite the potential benefits that North Africa can gain from the establishment of solar power in the region, it remains a matter of concern as solar energy is also a type of energy, and one cannot underestimate the possibility that this could become a new curse. As such, this thesis will deal with this crucial issue by presenting a projection of the potential for the five North African countries (Algeria, Egypt, Libya, Morocco, and Tunisia) to suffer from a solar energy curse.

As the use and study of solar energy in North Africa is still in its infancy, there is limited data and information available. As such the projection of the potential for solar energy to become a new curse is based on data and literature regarding the current and ongoing resource curse. To supplement this, data and information from other countries which have had more experience with renewable energy, such as Germany and Spain, is applied.

By looking at the current resource curse, under the assumption that a solar energy curse will be similar to the current resource curse, the combination of the poor institutional quality and the enormous size of resource rents is selected as the cause of the resource curse.

In the case of institutional quality, the institutional quality of the five North African countries in 2011 are compared to the five selected resource cursed boundary-countries and the five selected resource curse avoided/escaped boundary-countries by using the World Governance Indicator (WGI). The result is that their institutional qualities are closer to the resource cursed boundary-countries

which suggest that they have the potential to suffer from a solar energy curse if their institutional qualities are to remain poor in the future.

In the case of rent size, the solar energy rent is projected and compared to the average oil and natural gas rent size of the Middle East and North Africa (MENA) countries during the period of 1993-2009. The outcome of the comparison is that solar energy rent, or even when combined with wind energy based on a different study, is projected to be much lower than the average oil and natural gas rent size of the MENA countries.

When combining the two findings, solar energy is not projected to become a new curse for the five North African countries due to the small size of the projected solar energy rent. However, it is found that, under the assumption that the oil and natural gas will remain in the future in the three North African energy exporters (Algeria, Egypt, Libya), the successful establishment of the solar energy in these countries can prolong the time for them to rely on their fossil-fuels exports, therefore, prolonging the current resource curse.

The finding that the solar energy will not become a new curse for the five North African countries does not mean however that there is no future potential for them to suffer from this ‘curse’. It is found that what are called the resource curse effects are not solely caused by the enormous resource rents but are often problems that many countries have already been suffering from for quite some time, regardless of the resource rent. As such, resource rents can be perceived as an element which has added extra fuel in intensifying the existing problems within the region. The enormous size of resource rents accentuates the problems that are related to the resources. This, however, results in a rather deceptive perspective as one will see the problems as the resource curse effects, when they are often existing problems that they have been suffering from irresponsive of the resource and its rent. In other words, the reason why existing problems, especially in energy exporting countries, are perceived as the effect of the resource curse is because the ‘flame’ created by enormous extent of resource rents has been concealing the core and existing issues.

This is not to say that the resource curse does not exist, or the enormous resource rent size is not the cause of the resource curse and its effects. What is important is that good institutional quality, which is an important factor that aids the improvement of accountability, transparency, democracy and other factors, played a crucial role in the countries that avoided/escaped the resource curse, and also can help in dealing with the existing problems which may appear, or become, a future ‘curse’.

Unfortunately, by looking at the current chaotic events and complexities in the region, e.g the Arab Spring and its impacts, it is difficult to project whether institutional quality is to improve in the future. There are different ways in perceiving the current status of the region. For example, Tunisia’s regime change is considered as a positive outcome of the Arab Spring (Hlepas, 2013), whereas Weill

(2012) finds that the impacts of the current consequences of the Arab Spring, i.e the regime change in Tunisia, is unpredictable and remains to reveal itself. In fact, the current chaotic events and uncertainties in the region make it difficult for one to project future institutional quality, and more importantly, possibility for the five North African countries to suffer from a new curse or the prolonging of the current resource curse for the North African energy exporters. Nevertheless, these countries are entering, or have already entered, the crucial turning point which can determine their path to the future. The five North African countries should take this turning point as the opportunity in improving their institutional quality which will help them to avoid possible 'curses' and, more importantly, lead them to sustainable development.

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List of abbreviations

bbl/d	Barrels Per Day
Bcf	Billion Cubic Feet
Bcm	Billion Cubic Meters
CSP	Concentrating Solar Thermal Power
DII	Desertec Industrial Initiative
DNI	Direct Normal Irradiance
EIA	U.S Energy Information Administration
EEG	Renewable Energy Sources Act
FiT	Feed in Tariff
GDP	Gross Domestic Product
GHG	Greenhouse Gases
GPF	Government Pension Fund
GW	Gigawatt
HVDC	High Voltage Direct Current grid
IMF	International Monetary Fund
JREF	Japan Renewable Energy Foundation
kWh	Kilowatt per hour
LCOE	Levelized Cost of Electricity
LNG	Liquefied Natural Gas
m^2	Square meter
m^3	Cubic meter
MASEN	Moroccan Agency for Solar Energy
mb/d	Million Barrels per day
MENA	Middle East and North Africa
ME	Middle East
Mtoe	Million Tonnes of Oil Equivalent
MW	Megawatt
MWh	Megawatt per hour
NA	North Africa
NDPVF	Niger Delta People's Volunteer Force
NDV	Niger Delta Vigilante
NNOC	Nigerian National Oil Corporation
NNPC	Nigerian National Petroleum Corporation
OPEC	Organization of Petroleum Exporting Countries
PV	Photovoltaic
RES	Renewable Energy Sources
SBI	Sustainable Budget Index
SSA	Sub-Saharan Africa
Tcf	Trillion cubic feet
TWh	Trillionwatt per hour
UAE	United Arab Emirates
UCM	Unobserved Components Model
WDI	World Development Indicators
WGI	The Worldwide Governance Indicators
y	Year

Chapter 1. Introduction

Africa is a continent that possesses a vast amount of various types of natural resources. Consequently, many countries in Africa export their natural resources. Here, the natural resources include important energy sources such as oil and natural gas. For example, Nigeria is a large oil exporter and, as of the end of 2011, it is estimated that Nigeria possessed about 37.2billion barrels amount of proven oil reserves. Also, it is estimated that around 767,000 barrels per day (bbl/d) of crude was exported to the United States, which made Nigeria the 4th largest foreign oil supplier to the United States in 2011. Furthermore, Nigeria's oil sector is estimated to account for 95 percent of its export revenue and 40 percent of government revenue (EIA Country Analysis Nigeria). There are also other large oil producer/exporters in Africa such as Algeria and Libya. Despite the fact that oil and other natural resources play a major role in African countries' economies, their heavy reliance on natural resource export often relates them to the term 'resource curse'. In fact, the term 'curse' frequently occurs when discussing the development in African countries. For example, there are terms such as 'resource curse', 'oil curse', and 'aid curse'. Unfortunately, these terms are no longer new in Africa, and many studies, such as Alicante & Misol (2009) and Moyo (2010), accentuate that such 'curses' exist in many African countries.

In recent years, many countries have been changing their policies to promote the use of renewable energy, accordingly the number of countries promoting renewable energy policies have doubled during the period of 2005-2011 (REN21, 2012, p.49). This trend has also been in African countries. For example, Algeria aims to have 40 percent of final energy share from renewable energy by 2030 (REN21, 2012, p. 105). When it comes to the issue of renewable energy, though other African countries are also in focus, North African countries have been receiving large attention due to their great potential for solar energy, as well as for wind energy, from the Sahara desert. Organizations, such as DESERTEC and Desertec Industrial Initiative (DII), have been paying a great deal of attention to the region, and they project that electricity generated via renewable energy in Middle East and North Africa (MENA) regions can be exported to Europe, which is projected to be 15 percent of the total European electricity consumption (DESERTEC Foundation: Global Mission EU-MENA). It is currently already possible to see the development of solar energy and other renewable energies in the MENA region. For example, DII and the Moroccan Agency for Solar Energy (MASEN) signed a Memorandum of Understanding in Morocco regarding a large cooperative solar project in Morocco in May 2011. The aim of the first reference project by DII is to demonstrate the export feasibility of electricity generated by solar energy in the deserts to Europe by utilizing the existing line between Spain and Morocco (Dii newsletter, July 2011). Here, the potential for North African countries to become renewable energy exporters should be a matter of concern for them, as well as other African countries. As many of them are already suffering from the resource curse, the introduction of renewable energy may lead to a new curse of renewable. In other words, although positive effects may be obtained from the introduction of renewable energy in North Africa and other African countries, special attention should be paid to the possible negative effects, in this case renewable energy becoming a 'new curse'. Therefore, the aim of this thesis is to project the potential for the five North African countries (Algeria, Egypt, Libya, Morocco, and Tunisia) to suffer from a 'renewable energy curse' in the future.

When projecting the possibility of renewable energy in becoming a new curse, one is faced with a number of difficulties. Though the world total renewable electricity net generation[1] and renewable promoting polices have been increasing, renewable energy is still at its beginning stage. Also, projecting the potential for renewable energy to become a new curse for the entire African continent is problematic as it will make the subject too broad. Therefore, in order to narrow down this broad subject, this thesis will focus on solar energy in North Africa, as this is the region that has been in focus due to its ideal location, to project whether North Africa may suffer from a possible 'solar energy curse' in the future. Due to the fact that renewable energy is at its beginning stage, it is likely that there may be a lack of concrete data and information in projecting a solar energy curse. In this case, therefore, data and literature on the current resource curse will be employed in order to project the possibility of the solar energy curse in North Africa. Accordingly, Chapter 2 will illustrate details and case studies of the resource curse in order to provide the basic knowledge on what this curse is about. It will also briefly look at 'aid curse', as it is often argued that the impacts of the 'aid curse' are similar to that of the resource curse. The aim in analyzing the aid curse is to show that the curse is not only related to abundance of natural resources but can be formed by different sources.

Chapter 3 will look at the recent growing focus on renewable energy through an illustration of changes in policies towards renewable energy and its growing capacity in the world. As renewable energy in North Arica is gaining special focus, Chapter 3 also discusses the changes and growth of renewable energy in the region and explains why North Africa is the focus of attention especially when it comes to solar energy.

After providing a general outline of the resource curse in Africa and more specifically the current status of solar energy in North Africa, the literature on the resource curse will be reviewed in or order to identify the main cause(s) of the resource curse. The primary aim of identifying the main

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[1] See figure 2.

cause(s) of the resource curse is so that it may be utilized as the boundary-line(s) in order to project which North African countries could potentially suffer from a solar energy curse. More specifically, as will be discussed in Chapter 4, the enormous size of resource rents and poor institutional quality, and the combination of these two, will be chosen as the boundary-lines to project whether solar energy could potentially become a new curse in North Africa in the future.

Accordingly, these chosen boundary-lines will be tested in Chapter 5 to see whether they are suitable for projecting the solar energy curse. For the rent size boundary-line, or Gross Domestic Product (GDP) growth comparison method in chapter 5, Sachs & Warner's (1997) theory, which states that a country is considered to be suffering from the resource curse if it has a high share of resource exports in GDP and, during that time, experiences poor economic growth rate compared to similar countries or an average region value, is tested with a number of 'filters', such as energy exporters/importers separation, income level, and development status, among the MENA countries in order to see whether it can be used as the boundary-line. Though the GDP growth comparison method improves after adding filters such as development status, it is not entirely suitable to be used as the boundary-line. In other words, different method in rent comparison will be used.

For the institutional quality boundary-line, the Worldwide Governance Indicators (WGI), which is used in Iimi's (2006) study on Botswana, will be used to test the institutional quality comparison method. The reason for choosing WGI to compare the institutional quality is that, according to UNDP (2007, p.56), the Governance Matters V 1996-2005 (Kaufmann et al, 2006), which is based on WGI, is considered as the most quoted and used governance indicator source in media, academia and among international organizations. Furthermore, the WGI contains six aggregate governance indicators which are Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption. The fact that the WGI presents the governance quality in six dimensions is particularly advantageous because institutional quality is a broad term which is problematic when viewed as a single unit[2]. Also, the WGI uses margins of error which is necessary in comparing institutional quality. Further explanation regarding the use of margin of error will be illustrated in section 6.2.1. The institutional quality comparison method is tested with a number of filters such as energy exporter/importer separation and development status, among the MENA countries.

Here, especially regarding institutional quality, one should not ignore the recent political transformations, which have been correctively referred to as the Arab Spring Movement, when

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[2] According to Stevens & Dietsche (2008, p.59), when measuring institutional quality, governance indicators are often used as proxies. Therefore, throughout this thesis, governance and institutions will be perceived as one factor. Thus, this candidate will be referred to as 'institutional quality'.

dealing with the Northern African region and also the other Arab Worlds. The period 2010-2011 is perceived as a crucial turning point for the North African countries because they were going through various changes, for example, regime changes in Tunisia and Egypt. It is unwise to regard the current visible consequences of recent events in the region as the final consequences of the Arab Spring. For example, though there has been a regime change in Tunisia, the ruling elites and state structures created by Zine El Abidine Ben Ali have yet to be eradicated. In other words, it is uncertain how the Northern African region is to be transformed in the future.

It is crucial to be aware of the possible impacts of the Arab Spring and the role it will have in shaping the future of the North African countries' institutional quality. A projection of future institutional quality in itself without the inclusion of the Arab Spring is already a difficult task. Here, this political uncertainty in the region makes is even more difficult to project the institutional quality of the region which is considered as an important element in measuring the possible solar energy curse in the future. In this case, the best way to 'project' the institutional quality of the Northern African countries is to analyze past and most recently available changes in their institutional quality. As will be discussed later, the combination of the poor institutional quality and the enormous rent size is considered as the main cause of the resource curse. Therefore, if a country's most recent institutional quality is poor and continues to remain poor in the future, under the circumstance that solar electricity exports will create an enormous additional rent, then the country will be considered to have the potential to suffer from a solar energy curse.

Chapter 6, 7 will apply the chosen boundary-lines to project the potential for the North African countries to suffer from a solar energy curse. The institutional quality of the five North African countries will be compared to the five resource cursed boundary-countries and the five resource curse avoided/escaped boundary-countries in order to see where they stand. Institutional quality date from 2011, which is the most recent data, from WGI will be used to compare the institutional quality. The confidence level of 95 percent will be applied, and all six aggregate governance indicators will be compared.

For the rent size comparison, as the GDP growth comparison method is not found to be sufficient, it is decided to compare the oil and natural gas rent size to the projected solar energy rent size. For the oil and natural gas rent size, the average oil, natural gas, and oil and natural gas rent sizes of the MENA countries (1993-2009) are calculated based on data from the World Development Indicator (WDI). For the projected solar energy rent size, it is decided to focus on parabolic trough technology as it dominates the concentrated solar thermal power (CSP) market. However, as the solar energy is in its initial stage in North Africa, the solar energy rent size is projected based on data from other countries, such as Germany and Spain, which have more experiences with renewable energy. The rent size is based on the formula; Feed in Tariff (FiT) = Levelized Cost of Electricity (LCOE) + Rent. The projected solar rent size is in two major forms which are X US$pense/kilowatt per hour (kWh) and US$Xbillion/year(y). The comparison will be made in different forms as well because the projected solar energy rent in X US$pense/kWh form allows one to calculate individual North African countries' projected solar energy rent size by using data from Trieb et al. (2012), and the projected solar energy in US$Xbillion/y form allows one to compare the total sum of oil and natural rent size and the total average oil and natural rent size. It must be mentioned that, the projected solar energy rent size is based on studies, such as DLR (2006) and Trieb et al. (2012), which only, or mainly, focus on the electricity export via CSP form North Africa and MENA respectively, to Europe via direct connection. Therefore, the sole reliance on this data may over/underestimate the CSP and its capacity, additional projection is made based on the study from Zickfeld et al. (2012) which projects that wind power is to dominate Europe and MENA (EUMENA) renewable energy in 2050. The projection of the CSP rent size, and CSP and wind power rent size will be calculated.

Chapter 8 will discuss the solar energy curse in a different perspective. More specifically, this chapter will hypothesize a situation where solar energy is introduced successfully in North Africa, becoming the substitute energy source for natural gas in meeting the domestic electricity demand, and see the possible impact on the current resource curse in North African countries under the assumption that the poor institutional quality will remain in the future.

Finally, Chapter 9 will gather the results obtained in chapter 6, 7, and 8. The main discussion here will concern whether solar energy has the potential to become a new curse or not, and the importance of a comprehensive understanding of the resource curse.

Chapter 2. Resource Curse

2.1 Natural Resource in Africa

The definition of natural resources can vary dependent on how one perceives it. When defining the term natural resources in the context of the resource curse, great consideration should be taken. In this thesis, natural resources will be defined as “stocks of materials that exist in the natural environment that are both scarce and economically useful in production or consumption, either in their raw state or after a minimal amount of processing.” (WTO 2010, p. 46). Furthermore, goods must be scarce in the economic sense to qualify as natural resources; otherwise one can consume as much as they wanted at no cost to themselves or to others. For example, air would not be considered as natural resource because one is able to obtain it freely with no cost. Natural resources can be considered as natural capital assets distinct from physical and human capital in that they are not created by human activity.

A distinctive feature of many natural resource endowments is that they are not widely dispersed among countries but rather geographically concentrated in a few fixed locations. This helps to explain why natural resources often represent a disproportionate share of economic production and exports in certain countries. Many African countries possess various types of natural resources as can be seen from table 1. From table 1, one can see that there are many natural resource-rich countries in Africa, and the endowments of these natural resources may play a great role in their economies. Especially, when considering oil and natural gas which are considered as important energy resources, one can suspect that oil and natural gas exporters rely heavily on exporting these resources. Therefore, it is important to pay attention to what kind of effects are brought by the heavy reliance on natural resources exports in African natural resource-rich countries. Accordingly, this chapter will focus on identifying the ‘curse’ of natural resource in African countries which often appears to have similar effects as the ‘curse’ of aid.

Table 1: Natural Resources in African Countries

Country	Natural Resources
Algeria	Petroleum, natural gas, iron ore, phosphates, uranium, lead, zinc
Angola	Petroleum, diamonds, iron ore, phosphates, copper, feldspar, gold, bauxite, uranium
Benin	Small offshore oil deposits, limestone, marble, timber
Botswana	Diamonds, copper, nickel, salt, soda ash, potash, coal, iron ore, silver
Burkina Faso	Manganese, limestone, marble, small deposits of god, phosphates, pumice, salt
Burundi	Nickel, uranium, rare earth oxides, peat, cobalt, copper, platinum, vanadium, arable land, hydropower, niobium, tantalum, gold, tin, tungsten, kaolin, limestone
Cameroon	Petroleum, bauxite, iron ore, timber, hydropower
Cape Verde	Salt, basalt rock, limestone, kaolin, fish, clay, gypsum
Central African Republic	Diamonds, uranium, timber, gold, oil, hydropower
Chad	Petroleum, uranium, natron, kaolin, fish (Lake Chad), gold, limestone, sand and gravel, salt
Comoros	NEGL
Republic of the Congo (Brazzaville)	Petroleum, timber, potash, lead, zinc, uranium, copper, phosphates, gold, magnesium, natural gas, hydropower
Democratic Republic of Congo (Kinshasa)	Cobalt, copper, niobium, tantalum, petroleum, industrial and gem diamonds, gold, silver, zinc, manganese, tin, uranium, coal, hydropower, timber
Cote D'Ivoire	Petroleum, natural gas, diamonds, manganese, iron ore, cobalt, bauxite, copper, gold, nickel, tantalum, silica sand, clay, cocoa beans, coffee, palm oil, hydropower
Djibouti	Potential geothermal power, gold, clay, granite, limestone, ,marble, salt, diatomite, gypsum, pumice, petroleum
Egypt	Petroleum, natural gas, iron ore, phosphates, manganese, limestone, gypsum, talc, asbestos, lead, rare earth elements, zinc
Equatorial Guinea	Petroleum, natural gas, timber, gold, bauxite, diamonds, tantalum, sand and gravel, clay
Eritrea	Gold, potash, zinc, copper, salt, possibly oil and natural gas, fish
Ethiopia	Small reserves of gold, platinum, copper, potash, natural gas, hydropower
Gabon	Petroleum, natural gas, diamond, niobium, manganese, uranium, gold, timber, iron ore, hydropower
Gambia	Fish, clay, silica sand, titanium (rutile and ilmenite), tin, zircon
Ghana	Gold, timber, industrial diamonds, bauxite, manganese, fish, rubber, hydropower, petroleum, silver, salt, limestone

Guinea	Bauxite, iron ore, diamonds, gold, uranium, hydropower, fish, salt
Guinea-Bissau	Fish, timber, phosphates, bauxite, clay, granite, limestone, unexploited deposits of petroleum
Kenya	Limestone, soda ash, salt, gemstones, fluorspar, zinc, diatomite, gypsum, wildlife, hydropower
Lesotho	Water, agricultural and grazing land, diamonds, sand, clay, building stone
Liberia	Iron ore, timber, diamonds, gold, hydropower
Libya	Petroleum, natural gas, gypsum
Madagascar	Graphite, chromite, coal, bauxite, rare earth elements, salt, quartz, tar sands, semiprecious stones, mica, fish, hydropower
Malawi	Limestone, arable land, hydropower, unexploited deposits of uranium, coal, and bauxite
Mali	Gold, phosphates, kaolin, salt, limestone, uranium, gypsum, granite, hydropower Note: bauxite, iron ore, manganese, tin, and copper deposits are known but not exploited
Mauritania	Iron ore, gypsum, copper, phosphate, diamonds, gold, oil. Fish
Mauritius	Arable land, fish
Morocco	Phosphates, iron ore, manganese, lead, zinc, fish, salt
Mozambique	Coal, titanium, natural gas, hydropower, tantalum, graphite
Namibia	Diamonds, copper, uranium, gold, silver, lead, tin, lithium, cadmium, tungsten, zinc, salt, hydropower, fish Note: suspected deposits of oil, coal, and iron ore
Niger	Uranium, coal, iron ore, tin, phosphates, gold, molybdenum, gypsum, salt, petroleum
Nigeria	Natural gas, petroleum, tin, iron ore, coal, limestone, niobium, lead, zinc, arable land
Rwanda	Gold, cassiterite (tin ore), wolframite (tungsten ore), methane, hydropower, arable land
Sao Tome & Principe	Fish, hydropower
Senegal	Fish, phosphates, iron ore
Seychelles	Fish, copra, cinnamon trees
Sierra Leone	Diamonds, titanium ore, bauxite, iron ore, gold, chromite
Somalia	Uranium and largely unexploited reserves of iron ore, tin, gypsum, bauxite, copper, salt, natural gas, likely oil reserves
South Africa	Gold, chromium, antimony, coal, iron ore, manganese, nickel, phosphates, tin, rare earth elements, uranium, gem diamonds, platinum, copper, vanadium, salt, natural gas
Sudan	Petroleum; small reserves of iron ore, copper, chromium ore, zinc, tungsten, mica, silver, gold; hydropower
Swaziland	Asbestos, coal, clay, cassiterite, hydropower, forests, small gold

	and diamond deposits, quarry stone, and talc
Tanzania	Hydropower, tin, phosphates, iron ore, coal, diamonds, gemstones, gold, natural gas, nickel
Togo	Phosphates, limestone, marble, arable land
Tunisia	Petroleum, phosphates, iron ore, lead, zinc, salt
Uganda	Copper, cobalt, hydropower, limestone, salt, arable land, gold
Western Sahara	Phosphates, iron ore
Zambia	Copper, cobalt, zinc, lead, coal, emeralds, gold, silver, uranium, hydropower
Zimbabwe	Coal, chromium ore, asbestos, gold, nickel, copper, iron ore, vanadium, lithium, tin, platinum, group metals

Source: Central Intelligence Agency
https://www.cia.gov/library/publications/the-world-factbook/fields/2111.html (accessed: 20.02.2013)

2.2 Resource Curse

As mentioned earlier, many African countries are resource-rich and it would be logical to reason that the endowments of natural resources may play a crucial role in their economies and economic development. However, the question whether production of extractive commodities, such as oil and natural gas, promotes or harms economic development still remains. The big push theory[3] stresses that poor economies need a large expansion in demand, to expand their market size, so that entrepreneurs will find it profitable to incur the fixed costs of industrialization. The logic behind the big push theory is that anything that stimulates demand is acceptable, such as a large public spending program, foreign aid, or a rise in the world price of a natural resource which is often called the resource boom (Sachs & Warner 1999, p.43). In other words, regarding the natural resources and resource booms, the big push theory provides a mechanism by which resource rents help set industrialization in motion, and, furthermore, resource booms cause industrialization because they can raise incomes and therefore demand for domestic manufactures (Sachs & Warner 1999, p. 51).

Despite the big push theory, however, it is often claimed that such resource abundance does not always lead to sustainable economic growth and development for the countries concerned. In fact, it is possible to see that many resource-poor economies often outperform resource-rich economies in economic growth. Indeed, countries which rely on primary export sectors, such as oil and minerals, often grow slower than their peers, and this phenomenon in mainstream economics is often referred to as the “resource curse” (Harford&Klein 2005, p.1). The term resource curse was first used by Auty (1993) who describes how natural resource-rich countries are not able to use the resource wealth to

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[3] The originator of the big push theory was Rosenstein Rodan (1943) and further contributions were made by Murphy et al. (1989).

boost their economies but achieve lower economic growth than the resource-poor countries.

The ironic cases, resource-rich countries being outperformed by resource-poor countries, have been witnessed throughout economic history. For example, in the seventeenth century, Spain was outperformed by the Netherlands despite the overflow of gold and silver from its colonies. In the nineteenth and twentieth centuries, the growth of Switzerland and Japan, resource-poor countries, was higher than resource-rich countries such as Russia. Furthermore, it is possible to see that recent world's outstanding performers have been the resource-poor countries such as South Korea and Taiwan while resource-rich countries, such as Mexico, Nigeria, and Venezuela, have gone bankrupt (Sachs & Warner 1995, p. 2).

Despite these historical facts, it is still ironic to see the negative relationships between resource abundance and economic growth. After all, natural resources have high potentials to increase wealth and raise the investment and growth rates of an economy. Therefore, this chapter will carefully look into the negative impacts related to the abundance of natural resources. First, the resource curse effects will be illustrated.

Conflict

One of the most well known impacts of natural resources abundance is that it has the potential to provoke, or continue, civil conflict. There are four types of explanations of how natural resources can cause conflicts: “looting”, also called “Greed”, mechanism, the “grievance” mechanism, “state weakness” mechanism, and the “separatist” incentive mechanism.

According to the looting mechanism, primary commodities refer to as profitable opportunities for emerging rebel groups. Emerging rebel groups could profit by extracting and selling the commodities directly or by extorting money from a third party. Furthermore, natural resources have the potential to increase the chances of civil wars by enabling emerging rebel groups to fund their initial start up costs (WTO 2010, p. 94).

According to the grievance mechanism, resource extraction has the potential to cause grievances amongst local people who feel they have been unfairly compensated for the expropriation of their land, environmental degradation, insufficient amount of job opportunities and, moreover, the social disruptions caused by labour migration. These possibilities can lead to civil wars (WTO 2010, p. 94).

According to the state weakness mechanism, natural resources -especially oil- wealth has the potential to increase the chances of civil war by making a state less responsive to its citizens and by hindering the states' ability to resolve social conflicts. In other words, in this instance natural resources wealth is linked with the weakening of the state's bureaucracy (Oyefusi, 2007, p. 10).

According to the separatist incentive mechanism, natural resource wealth, if concentrated on a periphery of a country or in an area populated by an ethnic minority, has the potential to raise the chances of civil war by presenting residents to form a separate state (Ross 2004b, p. 11).

Irrespective of all different mechanisms, conflict tends to occur more when a country possesses a "point source" natural resource such as oil and minerals. These point sources tend to be accompanied by rent-seeking behavior as the revenues and rents are more easily appropriable. Furthermore, there could be struggles to retain control over the point sources wealth within the government of a country which is an obstacle for a government to function effectively (WTO 2010, p. 94).

Dutch Disease

The term Dutch disease was used for the first time in the magazine "The Economist", published in November, 26, 1977. It describes the decline of the manufacturing sector, export sector, and increased unemployment rate in the Netherlands due to the natural gas revenue after it was discovered in 1960. The Dutch disease is usually known for the combined influence of two effects which often follow resource booms. According to Ross (1999, p.306). the first effect is "the appreciation of a state's real exchange rate caused by the sharp rise in exports; the second is the tendency of a booming resource sector to draw capital and labour away from a country's manufacturing and agricultural sectors, raising their production cost." As the Dutch disease is closely related to natural resources, a more specific explanation is required, and WTO (2010) provides more specific explanation of the Dutch disease.

According to WTO (2010, p.91), "An increase in revenues from natural resources can de-industrialize a nation's economy by raising the real exchange rate thus rendering the manufacturing sector less competitive." There are two types of de-industrialization which follow the natural resources boom. One is called "direct de-industrialization", also called "factor movement effect", which refers to the shift in production towards the natural resources sector. In order to specifically explain, one can postulate that there are three sectors which are natural resources (booming sector), manufacturing (lagging sector), and a sector production non-traded goods. In the "direct de-industrialization" scenario, the booming natural resources sector would take factor inputs away from the rest of the economy. When this situation occurs, it will result in creating a high demand for non-tradable goods which eventually leads to the increase in the relative price of non-traded goods. If the economy is small, where the prices of traded goods determined on world markets, it is likely to experience an appreciation of the real exchange rate, and the manufacturing sector will become less competitive (WTO2010. p. 91).

Another type of de-industrialization is called "indirect de-industrialization" which is also called “spending effect”. It is the situation where the increase in natural resource revenues leads to additional spending which result in a further appreciation of the real exchange rate (WTO 2010, p. 91). One is likely to see the increase in domestic income and internal demand for foods due to the extra revenues from the resource exports boom. In other words, the additional spending would boost the relative price of non-tradables as the price of tradables is set on world markets. Therefore, this would result in further appreciation of the real exchange rate.

Of course, countries are supposed to specialize in industries which have the most comparative advantages and, therefore, resource-rich countries should specialize in natural resources extraction and exports. However, it becomes a serious problem if the decline in manufacturing sector is ignored due to the positive spillovers on the rest of the economy. For example, Krugman (1987 p.49) argues that the discovery of tradable natural resources such as oil may cause a permanent loss of other sectors such as manufacturing sector, which he considers as the core of economic growth, and diminish the learning-by-doing benefits. When the natural resource depleted, Krumgan (1987, p.49) argues that it is unlikely that the lost manufacturing sector is to recover. More specific explanations for Dutch disease is illustrated in section 4.2.1

Institutions

Institutions play a major role in growth and development of an economy. Therefore, it can be argued that the natural resources dominance would have direct/indirect effects on economic growth through institutions. For example, Rodrik et al. (2004) argue that institutions play a crucial role in determinants of growth and development.

It has been contended that resource abundance can be an obstacle in economic growth when accompanied by weak institutions such as “poorly defined property rights, poorly functioning legal systems, weak rule of law and autocracy.” (WTO 2010, p. 93). For example, when an economy is run under autocratic leadership, there is a possibility that policies are guided by the desire to extract bribes from firms. When this situation occurs, one can assume that there would be more support for the resource sector by government when a resource boom takes a place. In other words, the policies support may become biased towards the ‘booming sector’ and harms manufacturing sector. Consequently, a weakened manufacturing sector can harm economic growth (WTO 2010, pp.93-94).

Second, if an economy is facing natural resource booms, there is a potential for institutions to become weaker due to rent-seeking. According to WTO (2010, p.94), agents may engage in rent-seeking to appropriate the available resource income from the economy which is called “voracity effect”. Also, natural resource booms have the potential to boost corruption among bureaucrats and politicians who allocate the rents from natural resources exploitation or exportation due to the increase of the rent-seeking behavior. More Specific explanations with regards to institutions are illustrated in section 4.2.2 and 4.2.3.

Volatility

Natural resources, especially point sources such as oil, are usually subject to price volatility. The price fluctuation of natural resources in the past was mainly supply-driven, often linked to historical geopolitical events. The late 1970s' oil price shock, for example, represents such case (WTO 2010, p.97). On the other hand, according to Kilian (2009, p.3), the recent price volatility of oil has been caused by demand-driven factors such as the rapid income growth of key emerging markets in Asia. It is possible to assume that the heavy reliance on such a volatile natural resource would result in a volatile fluctuation of a country's government revenue and expenditures, which would in turn create an environment for unsustainable growth. Also, heavy reliance on a volatile resource, according to Budina & Van Wijbergen (2008), can lead to, or correlate with, the debt overhang problems. A more in-depth explanation for the problems of volatility and debt overhang will be illustrated in section 2.4.3.

Taxation

Tax collection from the citizens has a close relationship with the capability and accountability of government. The populance can demand efficient responsive government in return as they are taxpayers. In other words, this provides a political relationship between rulers and subjects. For example, according to OECD (2008, p.9), bargaining between rulers and taxpayers gave governments an incentive to promote broad economic prosperity and improve public policies in Western Europe and North America in ways that meet citizens' demand. Similarly, Ross (2004a, p. 229) suggests that the tax collection is thought to have contributed to the emergence of strong state and democratic institutions in many Western countries.

However, if the natural resources become guaranteed income, rulers do not need tax from their citizens. For example, Humphreys et al. (2007. P. 11) argue that when citizens do not pay tax, they often have less information about state activities and may demand less of states. Even if citizens are to disapprove of state action, they lack the means to withdraw their financial support from states.

This often leads to break down in the relationship between rulers and subjects. Consequently, the government becomes less accountable.

Debt

Resource-abundant countries have the potential to build up more debt despite large revenues from natural resources. As one may suspect, the debt issue can be linked with other resource curse impacts/effects such as volatility and the Dutch disease. For example, when the real exchange rate increases as a result of the Dutch disease, a resource-dependent country may borrow more money as the interest payments on debt is likely cheaper. However, if the prices of natural resources and the real exchanges rates are to fall, the government of the resource-dependent country is left with less money and more expensive debt with increased interest rate.

Diversification

Usually, it is the case that resource-dependent countries, particularly in oil and mineral, fail to diversify due to the "the attenuated economic linkages between a resource sector and the rest of the economy." (Le Billon, P., 2003, p. 13). In other words, the diversification of an economy becomes difficult in a resource-dependent country because resource extraction is more profitable, and out-competes other industry. This means that natural resources exporters are in danger of becoming even more dependent on extractive industries. In other words, the large revenues from extracting natural resources can be an obstacle in bringing about long-term investment in infrastructure which tends to encourage diversification.

Human Resources

According to Haglund (2012, p.8), resource extractive industries often fail to deliver sustainable growth in small and undiversified economies, and often diverts skilled workers away from other exporting sectors which would harm their economies. Of course, if it were to attract the best talent from government sectors, it could potentially weaken the state institutions.

As can be seen above, it is possible to see the negative impacts related to the abundance of natural resources; the resource curse effects. The existence of the resource curse and its effects is not new, and many resource-rich African countries have been suffering from it.

Unfortunately, the abundance of natural resources is not the only source which provides negative impacts on economies in Africa. As mentioned earlier, based on the big push theory, poor economies need large demand expansion and anything that stimulates demand is acceptable, such as foreign aid.

According to Abuzeid (2009, p.17), foreign aid has been regarded by traditional development economists as a tool for developing countries to overcome the saving gap. The lack of capital necessary for generating investment was regarded as the main factor that has kept Third World countries in poverty. Based on this assumption, foreign aid was viewed as a crucial element that could help developing countries close this financial gap. This idea is also referred to as the big push theory. The big push theory, regarding foreign aid, proposes that aid can form a crucial part of investment which in turn would result in higher growth and initialize an upward path to economic development. Despite the theory and the potential that foreign aid can contribute to development, however, it has been argued by a number of authors, such as Moyo (2010) and Djankov et al. (2008), that foreign aid can provide negative impacts on economic development in developing countries including many African countries. A number of suggested negative impacts of aid are illustrated below.

Conflict

An effort to seize power and get access to aid wealth may create conflict. In other words, aid can create competition for controlling the aid wealth. For example, according to Hardford & Klein (2005, p.3), the competition for control of large-scare food aid is perceived to be the cause of Somalia's civil war. They suggest that the competition over aid is less obvious compared to the competition over natural resources as aid is not usually formed as a physical resource. Therefore, one often witnesses 'rent-seeking' behavior taking place along with political infighting, fraud, and theft. Somalia's experience is one of the cases that rent-seeking activities, generated by the reception of foreign aid, led to a civil conflict.

Dutch Disease

Despite the origins of the Dutch disease and its effects mentioned earlier, there is a scenario that aid can 'replace' natural gas, or natural resources, in the Dutch disease theory. In other words, any type of large inflow of any foreign currency has the potential to bring about Dutch disease effects.

It is often the case that in many developing countries, a huge inflow of aid tends to coincide with the strengthening of local currency and damaging manufacturing exports which will, consequently, be an obstacle to long-term growth. For example, when aid flows are spent on domestic goods, it has the potential to raise the price of other resources which have a limited domestic supply. When this situation occurs, it can lead industries, mostly the export sectors, which face the international competitions and development on that resource, to become less competitive. Also, it should be mentioned that the export sector, which is considered as the essential element for developing countries to achieve sustainable growth, usually grows slower relative to capital-intensive or non-exportable sectors in countries which receive more aid (Moyo 2010, p. 63).

Institution

Foreign aid has the potential to turn politicians in power to engage in rent-seeking activities which will enable them to appropriate resources and exclude opponent or other groups from the political process. Consequently, this damages such institutions as they become less democratic and less representative (Djankov et al. 2008, p.170). However, one should carefully deal with this approach as the existing poor institutions may have created the rent-seeking behavior rather than aid flows. This matter will be more specifically dealt throughout the thesis.

Volatility

Bulíř & Hamann (2003, p.66) find that aid is often more volatile than fiscal revenues. The relative volatility tends to increase when the degree of aid dependency is higher in countries. Also, the shortfall of aid and domestic revenue tend to coincide. If a country is suffering from revenue volatility, it is likely that there is higher volatility in aid receipts as well. Bulíř & A. Hamann (2003, p.83) suggest that the domestic policy instability may be the cause of the fluctuations of revenue and aid.

Taxation

A heavy reliance on foreign aid can provide a problem related to taxation which is similar to the resource curse effect. According to Bräutigam (2000, p.25), large flows of aid have the potential to reduce incentive for governments to improve their capability and accountability as they do not need to collect tax raised from their citizens. In other words, if the revenue flow is not dependent on the taxes raised from citizens, there is high chance that the government will be more accountable to aid donors rather than to their citizens.

Debt

According to Moyo (2010, pp. 64-65), when a country is in its early stage of development, it is less likely that the country would have advanced financial and institutional structures, and sizable investment opportunities to use aid effectively. Also, countries with poor financial development are not usually capable of absorbing foreign aid. If the country is not able to spend aid money, or even leave it as it is, they still have to pay interest on what they owe. Furthermore, since aid flows are not always put to good use, aid money is usually consumed rather than invested which causes higher chances of for inflation.

Human Resource

According to Bräutigam (2000, p.39), if the rules that govern bureaucracies produce bureaucrats that are unmotivated and poorly trained, aid donors often by-pass the government when they want to achieve the goals of their projects. Large donors tend to be able to pay higher salaries which would attract more skilled workers. In other words, donors can remove skilled workers away from government resulting a greater chance of weakening the institutions.

As can be seen above, foreign aid is often regarded as a curse. The possible negative impacts and effects of aid illustrated above have come to be perceived as a curse by a number of authors, and some refer to it as 'the curse of aid' by Djankov et al. (2008), or 'aid curse' by Moyo (2010). The suggested negative impacts and effects of aid often appear similar, though not always the same, to the resource curse effects. Here, it must be noted that this thesis does not argue that aid is a curse. For example, though it is possible to find similarity between the negative impacts of resources and aid, Harford & Klein (2005, p.1) argue that it is not conclusive that foreign aid may also cause a resource curse. The purpose of illustrating what is argued to be considered as negative impacts of foreign aid was to help one realize that the abundance of natural resources may not be the only source of such curse but may also come from other sources.

2.3 Oil Curse

Many African economies rely heavily on exporting their natural resources which is directly a derivative of their export revenues, government revenues, and Gross Domestic Product (GDP). Although there are many types of natural resources, point sources can be considered more 'economically valuable' than the other resources. Oil, one of the biggest point sources, is an 'economically valuable' natural resource as it is one of the biggest energy sources in the world. Furthermore, when regarding the topic resource curse, oil is probably the most debated natural resource due to its importance as a big world energy source and its value. Also, it is often the case that one comes across the term 'oil curse' when looking into the resource curse. As a number of African countries are considered as oil exporters, and oil is one of the most debated natural resources regarding the natural resource curse, this section will focus on oil and its curse effects.

As mentioned before, there are African countries which have oil fields, and there are countries that heavily rely on oil exports. According to U.S Energy Information Administration (EIA), for example, oil plays an important role in Angola's economy, which accounts for 95 percent of export revenues and over 75 percent of government revenues (EIA Country Analysis Angola). Equatorial Guinea has become a large oil exporter since the mid- 1990s. Here, the hydrocarbon sector, including crude oil, condensate, natural gas plant liquids and dry natural gas, plays a role in their economy as it accounts for 90 percent of government revenue and around 98 percent of export earnings (EIA Country Analysis Equatorial Guinea). Nigeria's economy is also heavily dependent on the oil sector as it accounts for 95 percent of export revenues and 40 percent of government revenues (EIA Country Analysis Nigeria).

Despite the large revenues from oil exports, and its potential to help economic growth and development, many oil-producing countries have not been able to achieve their desirable outcomes. Instead, many oil-producing countries are outperformed by non-oil-producing countries. This is also evident in Africa. For example, Katz et al. (2004, p.1) compare seven oil-producing, Angola, Cameroon, the Republic of Congo, Equatorial Guinea, Gabon, Nigeria, and Chad, to other African countries. Despite the enormous revenues from oil export, they find that, in terms of per capital GDP, only Gabon and Equatorial Guinea rank above the Sub-Saharan Africa (SSA) average. Furthermore, Katz et al. (2004, p.3) find oil-producing African countries, in general, have not achieved better social indicators than other African countries. For example, in 2000, only Cameroon, the Republic of Congo, Nigeria and Gabon reduced infant mortality rates below the SSA average, and the life expectancy at birth was only higher in Cameroon, Equatorial Guinea and Gabon compared to the SSA average.

One may blame the resource curse effects for the disappointing economic performances of oil-producing countries. However, one should not forget that oil-producing countries deal with unique and more complicated difficulties compared to other natural resources-dependent countries due to the nature of oil markets and oil production. The main challenges come from the combinations of the “high volatility of oil prices, the enclave nature of the oil sector, the exhaustibility of oil reserves, and the high concentration of revenue flows from the oil sector, which invites rent-seeking behavior and may lead to governance problems.” (Katz et al., 2004, p. 1). In order to gain more knowledge on the resource/oil curse, and how it is an obstacle to economic growth and development, a specific case study will follow.

2.4 Case Study: Nigeria

When researching the topic of the oil curse in Africa, Nigeria stands out as the main example. Therefore, this case study will specifically look into Nigeria’s experience with oil and the oil curse within the country. A brief history of oil discovery and details on oil production and exports will be illustrated before looking specifically at the oil curse.

2.4.1 Short Oil History in Nigeria

In 1908, the Nigerian Bitumen Corp, a German company, began oil exploration in Nigeria. The Nigerian Bitumen Corp operated in the Araromi area of the present day Ondo State. In 1914, however, due to the beginning of World War I, the company abandoned its dry, shallow wells. In 1936, the Shell D’Arcy gained the rights to search for hydrocarbon across Nigeria and prospecting began the in 1973. However, it was interrupted again by World War II. In 1947, with the end of World

War II, Shell and British Petroleum formed the Shell-BP unit of Nigeria. Oil was finally discovered in 1956 at Oloibiri in the Niger Delta after half a century of exploration. Nigeria began to produce oil in 1958 at the rate of 5,100 barrels per day, most of which were exported (NLNG- The Magazine, 2011, p. 4).

Nigeria gained its independence in 1960, and the exploration rights in both onshore and offshore areas adjoining the Niger Delta were extended to other foreign companies. By 1961, foreign companies, such as Mobil, Agip, gulf Oil (Chevron), Safrap (Elf), Amoseas (Texaco/Chevron), Tenneco and others, had begun exploration both onshore and offshore. Most of the companies were successful in offshore area but it was the Shell group which had the best onshore fields. As oil had become increasingly important to its economy, in 1971, the state established the Nigerian National Oil Corporation (NNOC) and joined the Organization of Petroleum Exporting Countries (OPEC). NNOC ran as an upstream and downstream company and the petroleum ministry had a regulatory function. Later, in 1977, the NNOC and the ministry merged which created Nigerian National Petroleum Corp (NNPC). All the oil industry sectors, including both upstream and downstream, were controlled by NNPC and its subsidiary companies. Although the national oil companies took direct control of production operations in certain OPEC member countries, the multinational oil companies were still allowed to continue with such operations under the joint operating agreements in Nigeria. This shows the respective stakes of the companies and the Nigerian government in the venture (NLNG-The Magazine, 2011, p.4).

Despite Nigeria’s major problems, such as political instability, corruption, and poor governance, the nation is still perceived as an attractive area for upstream investment by international oil companies. In fact, as mentioned earlier, Nigeria’s oil sector accounts for 95 percent of export revenue and 40 percent of government revenues, which makes them one of the biggest oil dependent economies in Africa. By the end of 2011, it was estimated that Nigeria had 37.2 billion barrels of proven oil reserves. The majority of these reserves are found in Niger River Delta and offshore in the Bight of Benin, the Gulf of Guinea, and the Bight of Bonny. The production of crude oil averaged nearly 2.13 million bbl/d in 2011. Nigeria exported 2.2-2.3 million bbl/d of crude oil in 2011. It is estimated that around 767,000 bbl/d of crude, 33 percent, of Nigeria’s crude was exported to the United States making Nigeria the 4th largest foreign oil supplier to the United States for 2011. Europe (28 percent), India (12 percent), Brazil (8 percent), Canada (5 percent), and South Africa (3 percent) are additional importers of Nigerian crude oil (EIA Country Analysis Nigeria).

2.4.2 Conflicts: Oil Bunkering in Nigeria

In Nigeria, all minerals, oil and natural gas belong to the federal government of the country as it is stated in Constitution of the Federal Republic of Nigeria 1999, section 44 (3) which is illustrated below.

> "*Notwithstanding the foregoing provisions of this section, the entire property in and control of all mineral, mineral oils ,and natural gas in under or upon any land in Nigeria or in, under or upon the territorial waters and the Exclusive Economic Zone of Nigeria shall vest in the Government of the Federation and shall be managed in such manner as may be prescribed by the National Assembly*."
> (Constitution of the Federal Republic of Nigeria 1999)

Therefore, any forms of oil extraction outside the framework of an agreement with the federal government are considered illegal and a crime. In Nigeria, however, large amount of oil continues to be extracted illegally. This activity is called "oil bunkering", and bunkered oil in Nigeria accounts for about 10 percent of Nigeria's daily oil production (Human Rights Watch, 2003, p. 2).

According to Human Rights Watch (2003, p.18), oil bunkering is considered as the most profitable private business in Nigeria. The 'bunkerers' tap into pipelines away from oil company facilities and connect the pipelines to barges which are hidden in creeks, and the oil is then sold. Although there are police and military to prevent such activities, they are often bribed and ignore such bunkerings. It is estimated that the stolen oil is sold at around US$15-20 per barrel on the spot market. As there is no capital costs, the infrastructure belong to the government and the oil companies, the estimated profit is around US$2-3 million per day (Human Rights Watch 2003, p. 18).

Not only does illegal bunkering jeopardize Nigeria's oil production and its economy it also leads to conflict and violence. More specifically, it fuels conflicts and violence between armed groups. The conflict in the Niger Delta in 2004, between the Niger Delta People's Volunteer Force (NDPVF) led by Alhaji Dokubo Asari, and the Niger Delta Vigilante (NDV) led by Ateke Tom, represents conflicts resulting from oil and oil bunkering. What is more important to be noted here is that the violence around Port Harcourt in 2004 was mainly due to the struggles to control territory, and bunkering routs. For example, Fred Alasia, Chief of Staff to River State Government, stated that the conflict between NDPVF and NDV was due to the disagreements over business transactions and contracts for protecting barges that lift crude oil (Human Rights Watch 2005, p.8) in the interview with Human Rights Watch in 2004.

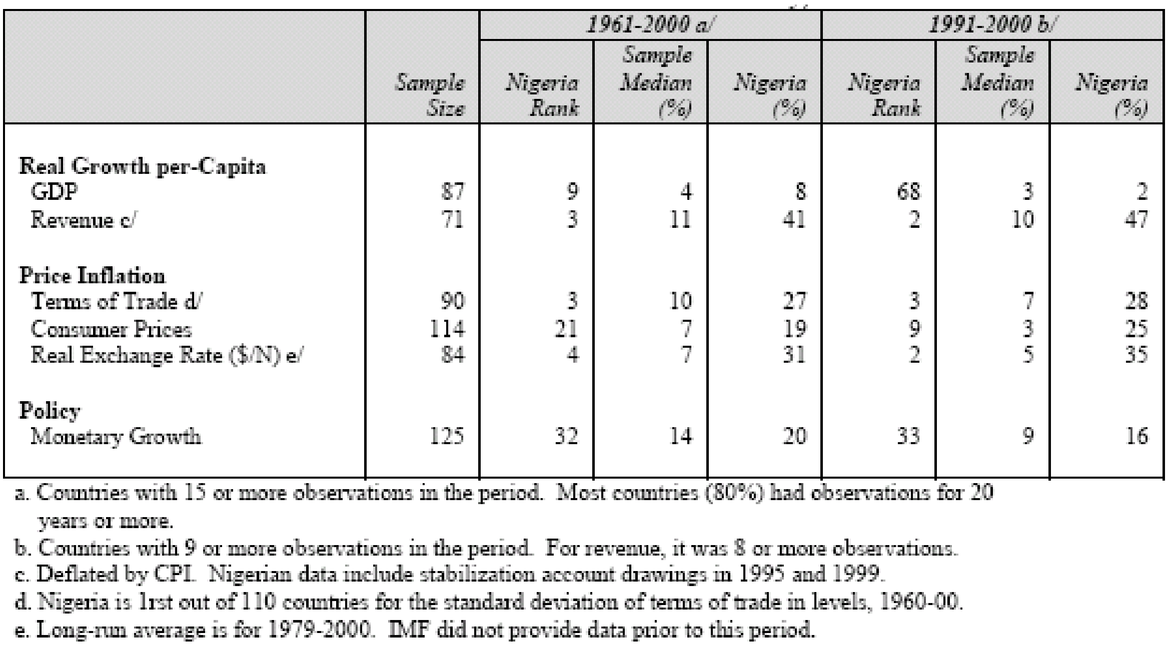
The conflict between the NDPVF and NDV can fall under the category of looting mechanism, also called greed, mechanism. As mentioned before, looting mechanism suggests that rebel groups profit by extracting and selling the commodities directly. During this process, in order to secure the bunkering routes, conflict and violence occur between rebel groups or even between with rebel group and the national force.

2.4.3 Volatility & Debt

Government revenues and expenditure of many oil-producing countries tend to experience higher volatility because of the high volatility of oil prices combined with undiversified revenue and export bases. Budina & Van Wijnbergen (2008, p. 431) argue that natural resources' commodity prices and revenues tend to be volatile, and have the potential to translate into macro-economic instability and a volatile real exchange rate. Accordingly, many oil-producing countries are exposed to oil price volatility due to the enormous wealth from oil. Budina & Pang (2007) and Budina & Van Wijnbergen (2008) perceive volatility as a tax on investment in traded production, such as in agriculture and manufacturing, and such could potentially have a negative impact on growth. Also, it can become more complicated with the heavy dependence of the budget on volatile fiscal revenue from oil.

Table 2 presents the volatility comparison between Nigeria and other countries in several key economic indicators. As seen below, Nigeria is among the top ten volatile countries during the period of 1961-2000, in most of indicators except consumer price inflation and monetary growth. When focusing more on the recent period of 1991-2000, Nigeria still remains in the top ten volatile countries in most measures except for GDP growth.

Table 2: Measures of Macroeconomic Volatility, 1960-2000



		1961-2000 a/			*1991-2000 b/*		
	Sample Size	*Nigeria Rank*	*Sample Median (%)*	*Nigeria (%)*	*Nigeria Rank*	*Sample Median (%)*	*Nigeria (%)*
Real Growth per-Capita							
GDP	87	9	4	8	68	3	2
Revenue c/	71	3	11	41	2	10	47
Price Inflation							
Terms of Trade d/	90	3	10	27	3	7	28
Consumer Prices	114	21	7	19	9	3	25
Real Exchange Rate ($/N) e/	84	4	7	31	2	5	35
Policy							
Monetary Growth	125	32	14	20	33	9	16

a. Countries with 15 or more observations in the period. Most countries (80%) had observations for 20 years or more.
b. Countries with 9 or more observations in the period. For revenue, it was 8 or more observations.
c. Deflated by CPI. Nigerian data include stabilization account drawings in 1995 and 1999.
d. Nigeria is 1rst out of 110 countries for the standard deviation of terms of trade in levels, 1960-00.
e. Long-run average is for 1979-2000. IMF did not provide data prior to this period.

Source: World Bank (2003), p. 26

Countries with high volatility, and interest groups competing for the resource rent, such as Nigeria, tend to overspend in good years and under-adjust in bad years. More specifically, in these countries, each interest group is likely to overexploit windfall gains in order to offload adjustment costs to others while capturing the gains from its lobbying effort. This behavior of expenditure is likely to lead even higher volatility (Budina & Pang 2007, p.13).

In Nigeria, public expenditure has been closely correlated with current revenues and, due to this reason, its share in non-oil GDP has been also highly volatile. This experience can be seen throughout several decades in Nigeria. For example, the public expenditure increased from 10 percent in 1971 to 60 percent in 1980 and back to 20 percent in 1984. Public expenditure increased again in 1993, reached 70 percent, and went down to 30 percent in 1997 which again increased by 80 percent in 2001 (Budina & Pang 2007, p. 12).

What is more concerning is that the close linkage between government expenditures and current revenue has the potential to lead to wasteful spending, public investment projects' poor productivity, and corruption. For example, according to Budina & Pang (2007, p.14), "when investments are made during boom periods in line with the increase in current income, projects are likely to be beyond the country's ability to absorb, while maintenance of the new projects may suffer when prices subsequently fall." Also, it is likely that maintenance of the new projects is to suffer when prices fall. This problem occurred in Nigeria during the late 1970s and 1980s when most of the projects, which were financed by public borrowing, did not succeed in generating the rate of return that was needed to improve the repayment capacity of the country.

More specifically, during the 1970s, public expenditure was mostly financed by revenue from oil, which was possible due to the high oil price in the 1970s, domestic borrowing, and modest external borrowing. During the second oil shock in 1980, the price of oil increased to almost US$40/barrel and the stock of gross external debt was around US$4.3 billion, 6.6 percent of GDP, which was relatively modest. Also, foreign reserve still stood at US$10.6 billion. However, the problem occurred after the collapse of the oil price in the early 1980s. After the collapse, Nigeria faced a rapid increase in external debt and loss of foreign exchange reserves. The public and publicly guaranteed that external debt increased from US$4.3 billion to US$11.2 billion, and foreign exchange reserve experienced substantially decline from US$10 billion to US$1.23 billion between 1981 and 1983. Nigeria had to borrow heavily from commercial sources at high interest rate in the early 1980s (Budina & Pang, 2007, pp. 4-5).

Budina & Pang (2007, p.23) argue that the main factor behind the buildup of large debt between 1981 and 1983, during the period of oil price collapse, was due to Nigeria's pre-2000 fiscal policy. They suggest that, while the non-oil deficit was reduced due to the result of the sizeable public expenditure cuts, the drop in oil revenue as a result of the oil price collapse was much larger. This allowed the average annual non-oil deficit to exceed the average annual oil revenue by more than 50 percent of non-oil GDP for the period. This in turn led to a build up of external public debt (Budina & Pang 2007, pp. 6-7).

When oil price drops unexpectedly, it is often not an easy task to adjust expenditure downward although the need to do so is much greater than the actual decline in income which triggers the need for adjustment in the first place. This is due to the fact that oil-producing countries such as Nigeria often have problems with access to capital markets. It would logically follow that Nigeria's need to borrow is low when oil prices are high, and is high when prices are low. The problem is that their capacity to borrow is inversely related to their borrowing needs as the value of their oil wealth also peaks when prices are high and drops when prices are low. According to Budina & Van Wijbergen (2008, p.433), the linkage between shortfalls in income, collateral values decline, and reduction in resource inflows can lead to debt overhang problems. The debt overhang refers to a situation where new lenders are concerned that their money will be diverted to service old debt, reducing the value of their claims even if projects, which are financed by the new moneys, have a high rate of return to service new debts in the absence of old claims outstanding (Budina & Van Wijbergen 2008, p. 433). Consequently, the need for adjustment becomes larger than the current income fall because following debt repayment can not be refinanced as well. As a result, adjustment costs are raised even higher. This explains how the volatility of Nigerian government expenditure has exceeded the volatility of oil price. Budina & Wijbergen (2008) find the combination of the good year/bad year behavior and the debt overhang problem as one of the main explanation for Nigeria's disappointing non-oil growth record.

2.5 Existing Solutions Case Studies: Lessons from Norway and Botswana

This section will present the case studies of two countries which have experienced and avoided/escaped the resource curse, Norway and Botswana respectively. Although they have been successful, this does not then imply that their methods can be copied and utilized to form the remedy for other countries suffering from the resource curse, such as Nigeria. It is however, important to examine their experiences as countries suffering from the resource curse may adopt, and or find their own way to deal with the resource curse.

2.5.1 Norway

According to EIA, Norway is the largest oil producer in Western Europe, and the seventh largest oil exporter in the world. As of January 1, 2012, Norway had around 5.32 billion barrels of proven oil reserves, found mostly in the North Sea. Furthermore, around 50 percent of Norway's exports revenue, 21 percent of GDP, and 26 percent of government revenues were from crude oil, natural gas, and pipeline transport service in 2010 (EIA Country Analysis Norway).

Norway has frequently been mentioned when discussing the oil curse as it is considered as an oil-producing country which successfully avoided/escaped the oil cures. However, this is not to say that the Norwegian economy never suffered from the oil curse. Norwegian politicians began spending windfalls from the point in which Norway began to produce oil in the 1970s. Consequently, the Norwegian economy was faced with high inflation coupled with currency exchange rate appreciation. When the oil prices collapsed in 1986 Norway's economic growth slowed.

After this painful experience, Norwegian politicians started to pay attention to oil addiction. For this reason, Norway built "The Government Pension Fund (GPF) of Norway", originally called "The petroleum Fund of Norway", in 1990. The Norwegian politicians passed legislation which specifically required most of the government-owned oil company to be placed in an investment fund in order to ensure that the wealth generated from oil and natural gas would benefit future generations (Hundley 2007). More specifically, according to the Norwegian Ministry of Finance, the purpose of the GPF is to "facilitate government savings to finance rising public pension expenditures, and support long-term considerations in the spending of government petroleum revenues." (Ministry of Finance, Norway).

The Norwegian GPF played a crucial role in dealing with the oil curse, and this can be a great lesson for oil-producing countries that are currently dealing with the oil/resource curse.

First, together with the fiscal guideline, the Norwegian GPF functions as a fiscal policy tool which limits government spending. The capital of this fund consists of petroleum activities revenues. The expenditure of the fund is a transfer to the fiscal budget in order to finance the non-oil budget deficit. For instance, the fiscal guideline puts a limit on the non-oil structural central government deficit of 4 percent of the GPF's assets which is the estimated long-run real rate of return. Therefore, this rule amounts to saving the real capital of the fund and spending only its return (Velculescu 2008). By using a similar system, oil-producing countries in Africa could learn how to deal with the volatility of oil price and, furthermore, may reduce their debt problems.

Second, the Norwegian GPF pursues a transparent investment strategy. The Norwegian Ministry of Finance, the owner of the fund, regularly reports on governance framework, goals of the fund, investment strategies and results, and ethical guideline. The operational manager of the fund, the Central Bank, then publishes reports on the management of the fund which present its performance and annual list of all investments. Furthermore, it also publishes the information on the fund's voting in shareholders' meetings (Velculescu,2008). Oil-producing countries can benefit from such system which can reduce high corruption rate.

Lastly, the assets of the Norwegian GPF are invested exclusively abroad. This strategy ensures risk diversification and proper financial returns. More importantly, it protects the non-oil economy from shocks in the oil sector, by keeping harmful oil rents out of the economy, which puts pressure on the exchange rate. In other words, it prevents the possibility of Dutch disease which many of the oil-producing countries suffer from (Velculescu, 2008).

2.5.2 Botswana

Although Botswana is not an oil-producing country, it suffered from the resource curse due their diamond abundance which can be also considered as a point source.

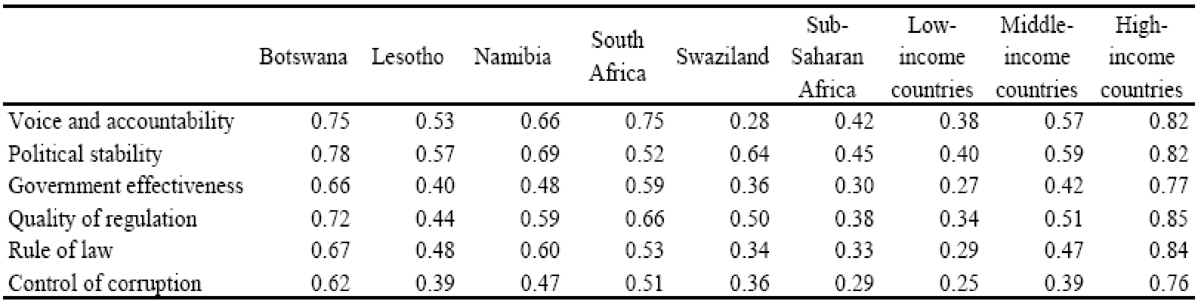
As mentioned earlier, there are many negative effects that can be provided by the heavy reliance on natural resources, and many African countries suffer from the resource curse. However, Botswana wisely dealt with the resource curse and is now considered to have escaped from it.

Botswana is one of the most resource-rich countries in the world. It exported US$2 billion worth of diamonds, nickel, copper, gold, and other resources which was over 80 percent of its total exports in 2002. Among these resources, diamonds were the main resource which contributed the most to their economic growth (Iimi, 2006, p. 6).

Diamonds were discovered in 1967 in Botswana and, since then, the nation has been experiencing strong growth. However, there have been a number of arguments that the nation’s strong growth may not be sustainable as the capital-intensive mining sector provide insufficient amount of employment opportunities. This argument can be considered convincing as the contribution of mining production to the GDP was around 40 percent, while it only absorbed 4 percent of total employment between 1998 and 2002 (Iimi 2006, p. 7). The government of Botswana has been trying to diversify its economy, but development of the non-traditional industries has been one of the nation’s biggest challenges.

Despite these obstacles, however, Botswana is considered to have escaped the resource curse. Iimi (2006) argues that Botswana’s success in escaping the resource curse stems from its sound institutions and good governance. Table 3 illustrates the Governance Research Indicator Country Snapshot of 2002. Each index is normalized between zero and one. As can be observed below, Botswana scored relatively highly compared to other countries which indicates that the nation’s governance level is in a good shape.

Table 3: Governance Research Indicator Country Snapshot (GRICS). 2002



	Botswana	Lesotho	Namibia	South Africa	Swaziland	Sub-Saharan Africa	Low-income countries	Middle-income countries	High-income countries
Voice and accountability	0.75	0.53	0.66	0.75	0.28	0.42	0.38	0.57	0.82
Political stability	0.78	0.57	0.69	0.52	0.64	0.45	0.40	0.59	0.82
Government effectiveness	0.66	0.40	0.48	0.59	0.36	0.30	0.27	0.42	0.77
Quality of regulation	0.72	0.44	0.59	0.66	0.50	0.38	0.34	0.51	0.85
Rule of law	0.67	0.48	0.60	0.53	0.34	0.33	0.29	0.47	0.84
Control of corruption	0.62	0.39	0.47	0.51	0.36	0.29	0.25	0.39	0.76

Source: Iimi (2006, p.9)

Of course, each aspect is important and has an influence on natural resource management. However, Iimi (2006) especially accentuates on four aspects, Voice and Accountability, Government Effectiveness, Quality of Regulation, and Control of Corruption, which played crucial role in Botswana’s escape from the resource curse.

The aspect of voice and accountability indicates the ability to discipline the ones in authority for resource extraction. Resource rents are often spent inappropriately when unmonitored by the citizens and when only processed by the ones in power who often are corrupted. Botswana’s free 2004 national election, which was conducted under the Southern African Development Community for democratic elections, demonstrates that Botswana’s attempts to stop such situation from occurring (Iimi 2006, pp 9-10).

The aspect of government effectiveness is important regarding the natural resource management because an effective resource management policy by the government can prevent overexploitation of the resource wealth. In order to prevent this situation and ensure sustainability, the government of Botswana uses the Sustainable budget Index (SBI). The SBI measures the ratio between consumption expenditures and non-resource revenues. The government can be certain that natural resource capital is not being consumed as long as SBI turns out less than one. By using the SBI, Botswana was able to avoid over-spending during 'good times' in the early 1980s, and drastic spending cuts in 1991 when diamond prices fell (Hamilton 2006, p. 26). This system can be effective in oil-producing countries such as Nigeria as they will be able to deal with volatility of oil price and prevent debt problems.

The aspect of quality of regulation is especially important in natural resource management, as it involves a long-term relationship with private parties. Of course, it would be problematic if price controls or excessive regulatory burdens are to occur. Regarding this matter, Botswana's diamond-mining leases term is 25 years and the nation's quality of regulation is relatively good. For example, in Botswana's mining sector, Botswana's government retains 50 percent of the shares in Debswana, and the Ministry of Minerals, Energy and Water Resources has direct responsibility for natural resource regulation and management (Iimi 2006, pp. 10-11).

The aspect of corruption control is also important as transparent distribution of resource wealth is crucial. Botswana has been able to avoid corruption in the public sector relatively well because of their transparent budgetary and procurement process. The Directorate of Corruption and Economic Crime, an independent anticorruption authority established in 1994, plays a crucial role in lowering the corruption level by reporting corruption cases to the president directly. Also the sound anticorruption framework in Botswana is an important element that helps manage resource properly. This kind of system would be particularly helpful in countries such as Nigeria where corruption is one of the biggest problems (Iimi 2006, p.11).

By looking at several theoretical effects of the resource curse and case studies, one could argue that many resource-abundant African countries may be suffering from the resource curse. However, this is not to say that all effects of the resource curse always appear in the resource-abundant countries. Also, there are different opinions on a number of resource curse effects in resource-rich countries. For example, there are different perspectives on Dutch disease in Nigeria. Budina & Pang (2007, p.11) argue that, as Nigeria started an "explicit expenditure smoothing policy" in 2004, there was no real Dutch disease problem nor will there be one in the future. On the other hand, Olusi &

Olagunji (2005) argue that Dutch disease is present in Nigeria. They argue that the impact and effect of Dutch disease are different between developed countries and less developed countries as their lagging sectors are different. In the Dutch disease theory, as presented earlier, the lagging sector is manufacturing sector. However, Olusi & Olagunji (2005, p. 161) argue that the traditional lagging sector for less developed countries, including Nigeria, is the agricultural sector. Accordingly, they argue that the agricultural sector is regarded as the lagging sector making the case of Dutch disease very much present in Nigeria.

As can be seen above, the presence of the resource curse, and its form, in resource-rich countries may be different dependent on the way one perceives it. However, what is important is to see how an individual country would deal with the resource curse. It is not an easy task to find the ultimate solution for the resource curse as countries may suffer more from one resource curse effect than another. Nevertheless, as can be seen from the case studies in Norway and Botswana, it is possible to avoid/escape from the resource curse. Their solutions appear to be similar as it was the quality of their institutions coupled with good governance that played a significant role in avoiding/escaping the resource curse. Therefore, the improvement of institutional and governance can be considered one of the solutions in avoiding/escaping the resource curse.

Chapter 3. Renewable Energy

3.1 Realization of the Importance of the Renewable Energy

The world's heavy dependence on fossil-fuels, such as coal, oil and natural gas, is a well-known fact. Today, for example, fossil-fuels still dominate energy consumption which accounts for 87 percent of market share (BP statistical Review of World Energy June 2012 Report, p.1). However, the long-term excessive reliance on fossil-fuel poses great threats such as climate change. There are many organizations and initiatives which are concerned with climate changes and aim to reduce Greenhouse gases (GHG). For example, the Kyoto Protocol to the United Nations Framework Convention on Climate Change is an international treaty that sets binding obligations on industrialized countries to reduce emissions of GHG. This was adopted at the third session of the Conference of the Parties in Kyoto in December 1997 which was open for signature from 16 March 1998 to 15 March 1999 at United Nations Headquarters, New York. By that date, the Protocol had received 84 signatures. Currently, there are 192 parties including all members of the European Union (United Nations Framework Convention on Climate Change)[4]. Many developed countries have agreed to legally binding limitations or reductions in their GHG in two commitment periods. The first commitment period applied to emissions between 2008 and 2012, and the second commitment period applies to emission between 2013-2020. For example, during the first commitment period, 37 industrialized countries and the European community committed to reduce GHG emissions to an average of 5 percent against 1990 levels. During the second commitment period, Parties committed to reduce GHG emissions by at least 18 percent below 1990 levels in the eight-year period from 2013 to 2020 (United Nations Framework Convention on Climate Change)[5]. Furthermore, the Europe 2020 strategy, what is often referred to as 20/20/20 climate/energy target, also shows Europe's concern with the emissions of GHG as it involves 20 percent reduction in greenhouse gas emissions compared to 1990 levels (or by 30 percent if the conditions are right), increase the share of renewable energy sources in final energy consumption to 20 percent, and a 20 percent increase in energy efficiency (COM/2010/2020/FINAL, p. 11).

Another threat, or the inevitable truth, is that fossil-fuels will eventually run out because they are not renewable resources. In other words, there is a limited time for the world to rely on fossil-fuels as the dominant energy sources. For example, Campbell & Laherrère (1998) published an important article named "The End of Cheap Oil" which questions the future oil supply and predicts

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[4] http://unfccc.int/kyoto_protocol/status_of_ratification/items/2613.php (accessed: 23.05.2013)

[5] http://unfccc.int/kyoto_protocol/items/2830.php (accessed: 23.05.2013)

that global oil production is to reach a peak level and start to decline. Their consideration and prediction became the foundation of a new theory called the “peak oil theory” which was later coined by Collin Campbell in 2001. He defines peak oil as “the maximum rate of the production of oil in any area under consideration, recognizing that it is a finite natural resource, subject to depletion.” (Robelius 2007, p. 58). It is not difficult to find supporters of the peak oil theory.

Schindler et al. (2008) illustrate a number of evidences for peak oil such as no large oil field (such as Ghawar field in Saudi Arabia) discoveries in recent years; decline in oil exploration expenses and increase in expenses for maintaining oil production from major oil companies; and decline in oil production in Saudi Arabia which is considered as one of the major oil producers in the world.

Chefurka (2007) argues that oil production already peaked in May 2005. He follows the approach of the Energy Watch Group to create decline model for the world’s oil production. Although, the world total oil production has been increasing (BP Statistical Review of World Energy June 2012 Report, p. 8), his model projects 1 percent per year in decline rate in 2010 to a constant rate of 5 percent per year after 2025 which will result in an average of 4 percent decline rate per year until 2050. According to Chefurka (2007), in 2050, oil production will be only 18 percent of what it is today. Furthermore, In December 2009, Mr. Gabrielli, the CEO of Petrobras, gave a presentation on oil capacity, including biofuels, and projected that oil production is to peak in 2010 because the oil capacity additions from new projects are unable to offset the declining rates of world oil (Eriksen, 2010).

Of course, peak oil is different from running out of oil. There is still a vast amount of oil and other fossil-fuels which can be extracted, and there may be new fields discoveries in the future. Furthermore, the recent improvement of fossil-fuels exploration and extraction technologies may have already begun to postpone such a peak of fossil-fuels. For example, a new technique such as Hydraulic Fracturing (often called “Fracking”) is used to free natural gas that is trapped in shale rock formations which is often referred to as “shale gas”. More specifically, a mixture of water and sand is injected into the rock at very high pressure which creates fractures within the rock that provide the natural gas a path to flow to the wellhead. The fracking fluid mix also helps in keeping the formation more porous (NaturalGas.org)[6]. This recent improvement and development in shale gas production begun in the United States and is often referred to as ‘Shale Gas Revolution’ (Stevens, 2010). According to Stevens (2010, p.14), shale provided 1 percent of US gas supply in 2000 but increased to 20 percent in 2009. Furthermore, it is projected to account for 46 percent of US gas supply by 2035 (Stevens 2012, p.2). The increase in shale production has also been observed in Canada and some

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[6] http://www.naturalgas.org/environment/technology.asp#advances (accessed: 28.05.2013)

analysts such as Krauss (2009) argue that shale gas will help in expanding the worldwide energy supply.[7]

Despite the peak oil theory or new technology development which may help in prolonging the time for 'a fossil fuel peak', it nevertheless remains an inevitable truth that oil and other fossil-fuels are non-renewable energies and will eventually run out.

Due to the mentioned threat and inevitable truth, there has been growing interest in renewable energy which can be the alternative energy source to replace the use of the fossil-fuels. Renewable energy is also derived from natural resources such as sunlight, wind, rain, tides, and geothermal heat which are renewable and, unlike fossil-fuels, can be naturally replenished easily. The focus on renewable energy is rapidly growing all over the world, and this can be seen by world's policy changes and growth of global renewable energy capacity.

3.1.1 Changes in Policies towards Renewable Energy

In the 1980s and 1990s there were not many countries supporting the idea of renewable energy and had policies to promote it. However, more countries, states, provinces, and cities have begun to change their policies to promote renewable energy, and this can be witnessed especially during the period of 2005-2011. For example, the number of countries promoting some form of renewable energy policies doubled during the period of 2005-2011 from an estimated 55 countries to 118 countries by early 2011 (REN21 2011, p. 49). There are at least 118 countries, including all 27 European Union member states, which have policy targets for renewable energy and more than half of these countries are developing countries. For example, there were 22 developing countries with targets for renewable energy and the figure expanded to 45 by early 2010 (REN 21 2010, p.35). Furthermore, most countries with renewable electricity targets aim for an average annual share increase of 0.2-1.4 percent. There are also other targets such as renewable energy shares of primary or final energy supply and the installation of the electric capacities of specific technologies (REN21 2012, p. 65).

Figure 1 and 2 present the total renewable electricity net generation by regions and the world total renewable electricity net generation during the period of 1990-2010. As can be observed from these two figures, most regions have been experiencing an increase in the total renewable electricity net generation, and consequently, there has been a steady increase in the world total renewable electricity net generation.

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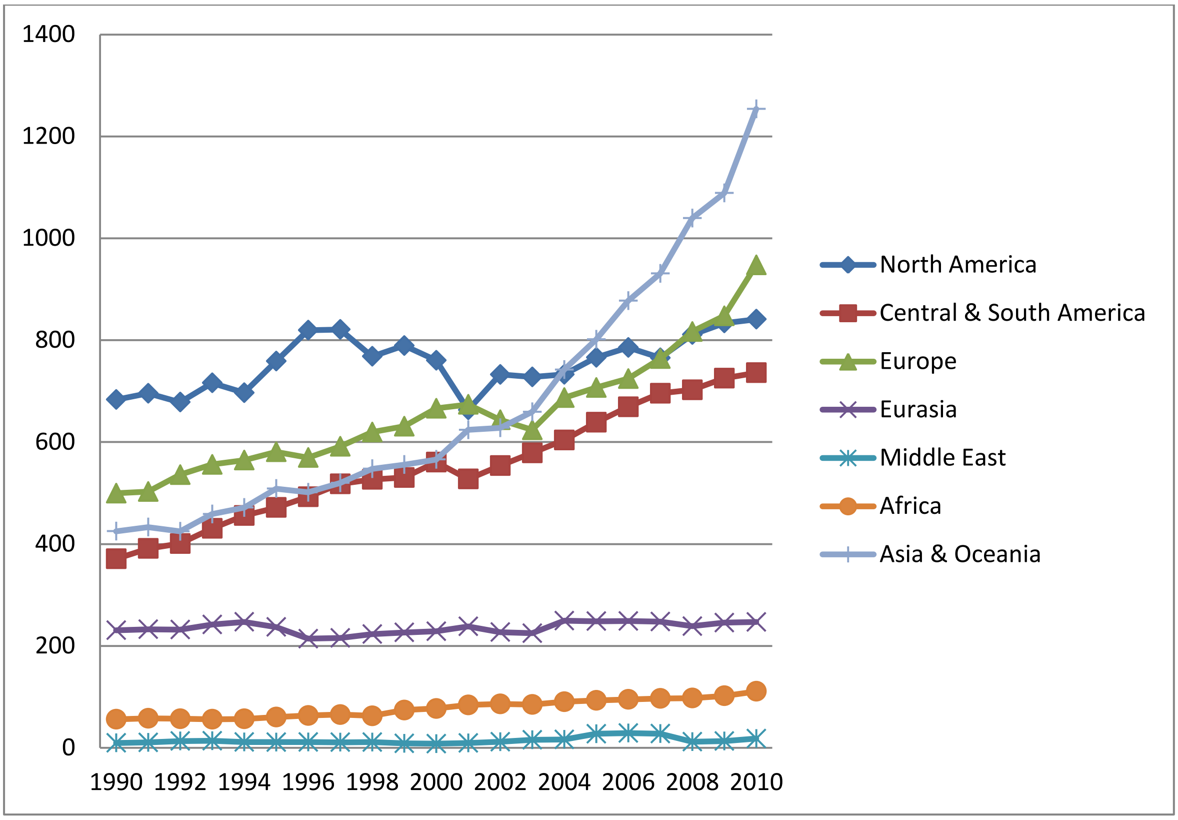
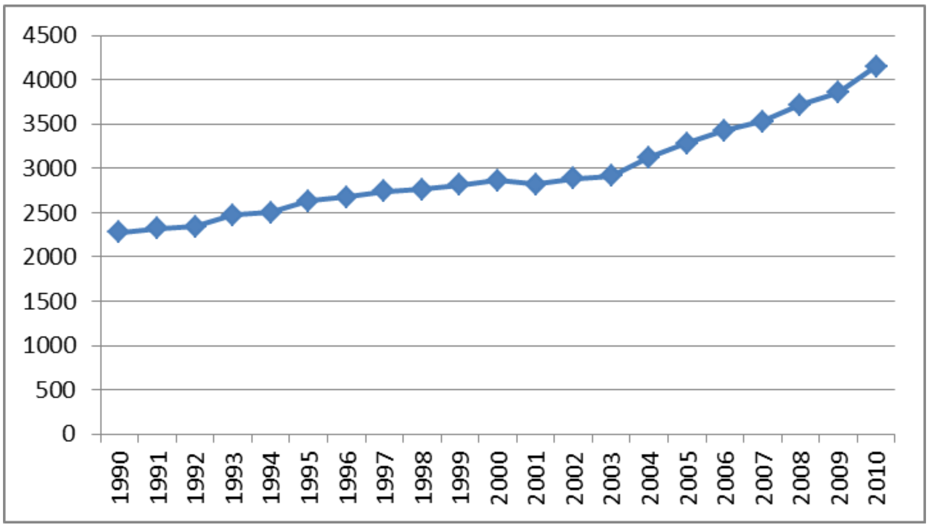
[7] It must be mentioned that there are growing opposition to shale gas driven by concerns over the environmental impact of hydraulic fracturing and the impact on greenhouse gas emissions (Stevens 2012, p. 1).

Figure 1: Total Renewable Electricity Net Generation by Regions 1990-2010 (Billion kWh)



Source: U.S. Energy Information Administration (EIA)
http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=6&pid=29&aid=12&cid=regions&syid=1990&eyid=2011&unit=BKWH
(accessed: 16.11.2012)

Figure 2: The World Total Renewable Electricity Net Generation 1990-2010 (Billion kWh)



Source: U.S. Energy Information Administration (EIA)
http://www.eia.gov/cfapps/ipdbproject/iedindex3.cfm?tid=6&pid=29&aid=12&cid=regions&syid=1990&eyid=2011&unit=BKWH
(accessed: 16.11.2012)

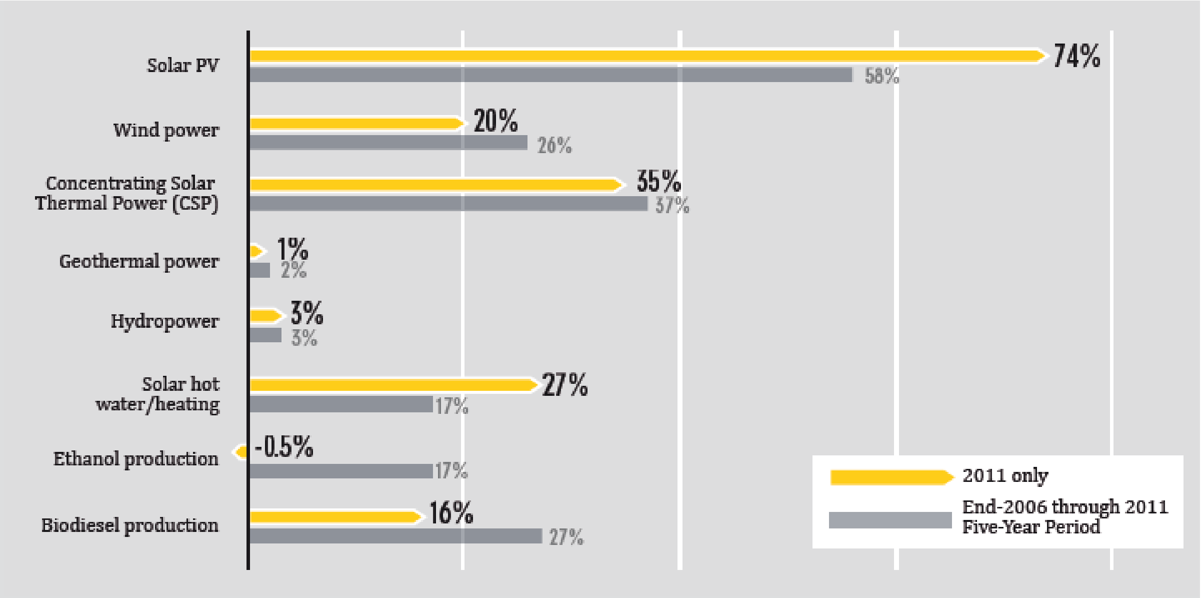
There have been many targets to promote renewable energy aimed for the 2010-2012 timeframe. However, in recent years, there has been growing number of targets aiming for 2020 or even beyond. All 27 EU countries mentioned earlier have confirmed national targets for 2020 in 2008, following a 2007 EU-wide target of 20 percent of final energy by 2020 (REN21, 2010, p. 35). The plans of developing countries also show increasing ambition in the targeted amount. For example, China, the investment leader in renewable energy capacity with Germany in 2009, aims for 15 percent of final energy consumption from renewable energy by 2020. Their recent draft development plan targets 300 Gigawatt (GW) of hydro, 150 GW of wind, 30 GW of biomass, and 20 GW of solar Photovoltaics (PVs) by 2020 (REN21, 2010, p. 35). There were new policy targets introduced in 2011 by nine countries. For example, Lebanon aims to include in its final energy production a 12 percent share from renewable sources by 2020. In order to achieve this they propose the installation of an additional 190,000 square meter (m^2) of solar thermal collectors, to be completed by 2014 (REN21, 2012, p. 65).

3.1.2 Growth of Renewable Energy Capacity

It is estimated that, in 2010, about 16.7 percent of global final energy consumption was supplied by renewable energy. Within the energy consumption supplied by renewable energy about 8.2 percent came from modern renewable energy sources including hydropower, wind, solar, geothermal, biofuels and modern biomass. Here, traditional biomass accounted for around 8.5 percent of total final energy. Hydropower supplied around 3.3 percent of global final energy consumption, and its capacity is growing steadily from a large base. Furthermore, all other modern renewable energy sources provided around 4.9 percent of final energy consumption in 2010 (REN21, 2012, p. 21). These renewable energies have been growing rapidly in both developed and developing countries as it can be seen from the policy changes towards renewable energy from section 3.1.1.

According to REN21 (2012, p.21), modern renewable energy can replace fossil-fuels in four distinct markets: power generation, heating and cooling, transport fuels, and rural/off-grid energy services. Between end-2006 and 2011, there has been a rapid growth of total global installed capacity of renewable energy technologies. As can be seen from figure 3, the fastest growing renewable technology during the period was PV with operating capacity increasing an average of 58 percent annually. It was followed by the concentrating solar thermal power (CSP) with an average of 37 percent annual growth, and wind power with 26 percent annual growth. Furthermore, there has also been an increase in demand for solar thermal heat system, geothermal ground-source heat pumps, and some biomass fuels. Hydropower and geothermal power, according to REN21 (2012, p.13), are growing at rates of 2-3 percent per year globally.

Figure 3: Average Annual Growth Rates of Renewable Energy Capacity and Biofuels Production, 2006-2011



Source: REN21 (2012, p.22)

During 2011, more mature renewable energies, such as solar PV and onshore wind power, experienced a drop in price because of declining costs due to economies of scale, technology development, and other factors, but also reductions or uncertainties in policy support contributed to price reduction.

It must be noted that, at the same time, some renewable industries, such as Solar PV manufacturing, has been challenged by declining prices and policy support, and the international financial crisis. According to REN21 (2012, p.22), due to the continuous economic challenges and changes in policy environments in many countries, there have been some uncertainties and negative outlooks in some industries. Despite some challenges, it is still certain that renewable energy industries have been growing, and there has been a growing realization of the importance of the use of renewable energy for future consumption. Though the global renewable energy capacity grew rapidly for many technologies, solar energy technologies have been achieving the most outstanding development and growth. Here, the growth of solar energy technology and its capacity have particular relations to North Africa and the Sahara desert. Due to its high potential to produce large amounts of electricity via solar energy, North Africa has received a lot of attention recently. The reason why North Africa is receiving special attention is not only because it can help in meeting their own electricity demand but also can help in meeting Europe's electricity demands in the future.

Therefore, the following section will be focusing on the solar energy and its potential in relations to North Africa in more detail.

3.2 The Potential of Solar Energy in North Africa

Due to the continuous growing demand for electricity, it has been a crucial task to find and support new sources and possibilities for electricity generation. The huge potential of solar energy is no longer a new idea, and it has been discussed by various organizations and studies. For example, according to the DESERTEC concept, with high Direct Normal Irradiance (DNI), "within six hours, deserts receive more energy from the sun than humankind consumes within a year." (DESERTEC Foundation: Concept). In other words, solar energy can play a major role in generating electricity.

Solar power can be described as the conversion of sunlight into electricity. The conversion of sunlight into electricity is usually materialized in two ways, known as PVs and CSP.

PVs are most well-known arrays of solar cells that generate electrical power by converting solar radiation into direct current electricity with the photovoltaic effects. More specifically, PVs convert solar energy into energy forms by "directly absorbing solar photons-particles of light that act as individual units of energy-and either converting part of the energy to electricity (as in a photovoltaic (PV) cell) or storing part of the energy in a chemical reaction (as in the conversion of water to hydrogen and oxygen)." (Solar Energy Development Programmatic EIS: Solar Energy).

As mentioned earlier, PV was the fastest growing technology during the period, end-2006 to 2011. The European Union currently dominates the PV market which accounts for almost three-quarter of the world's total installed solar PV capacity. Germany and Italy, for example, accounted for 57 percent of new operating capacity in 2011. Besides Europe, there are also large PV markets in China, the United States, Japan, and Australia (REN21, 2012, p. 47).

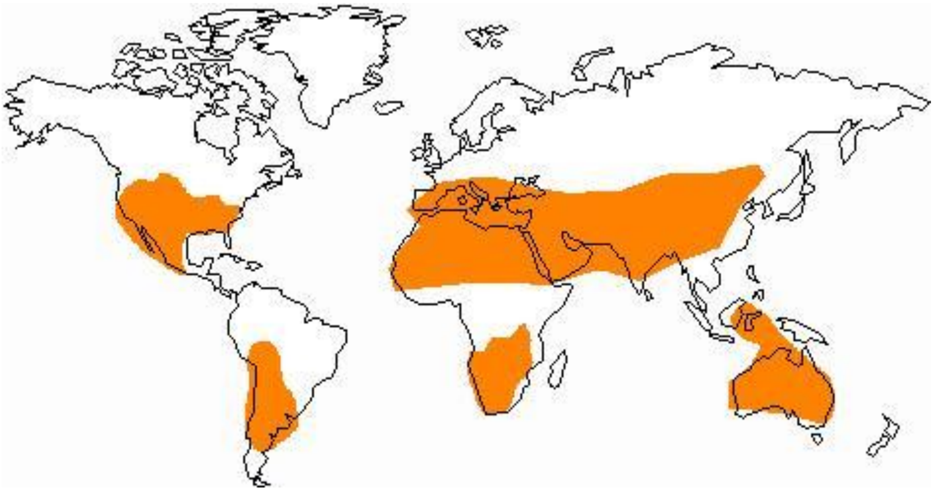
CSP power plants utilize focused sunlight. They generate electric power by using mirrors to concentrate the direct sun light and convert it into high-temperature heat. This heat is used to produce steam which drives steam turbines and electricity generators. Heat storage tanks, which are usually molten salt tanks or concrete blocks, are then used to store heat during the day which would power steam turbines during the night or when high demand occurs. Also, the turbines can be powered by oil, natural gas or biofuels, when there are overcast periods or bad weather, in order to ensure uninterrupted service. The CSP power plants have the ability to supply power on demand for 24 hours a day (GREEN ASSEMBLY ASIA ENVIRONMENT: CLIMATE CHANGE Definitions).

Commercial-scale CSP plants resumed in 2005 after the experience of a stagnant market beyond the early 1990s. Between 2005 and 2009 the global capacity of CSP plants -all located in the US and

Spain- increased to about 70 percent (REN21, 2010, p. 20). The CSP market was down in 2011, relative to 2010, but significant capacity was under construction at the end of 2011. As mentioned earlier, during the period of 2006-2011, total global capacity of CSP grew at an average annual rate of 37 percent. The CSP market is dominated by parabolic trough plants, about 90 percent of newly built plants and most of operating plants, but there is growing investment in other technologies. Furthermore, Spain is known to have most of the world's CSP capacity (REN21, 2012, p. 51).

In general, deserts have been perceived as, or regarded, "wastelands". However, this way of thinking has been changing rapidly due to the development of solar energy technology. Instead of being considered as "wastelands", they are beginning to be viewed as the basis of the future electricity provider. For example, according to Desertec-AFRICA, each square kilometer of the desert receives solar energy equivalent to 1.5 million barrels of oil per year. In other words, if one is to multiply this by the deserts in the world, deserts have the potentials to provide several hundred times more energy than the whole energy the world uses in one year.

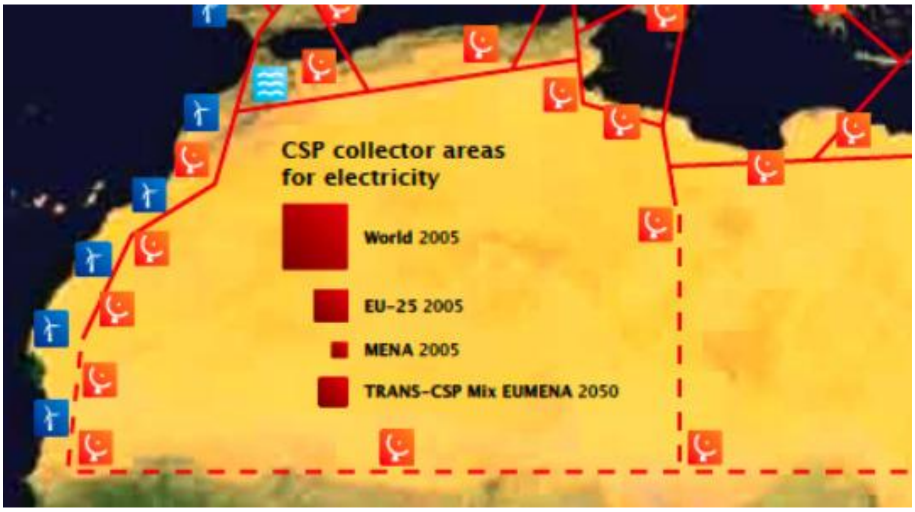
Figure 4: High Solar Insolation Regions in the World



Source: Desertec-Africa http://www.desertec-africa.org/ (accessed: 16.11.2012)

Figure 4 presents the areas in the world which receive high solar insolation. Data above indicates that, the Sahara, Kalahari and Namib deserts in Africa fall in the category of the lands which receive high solar insolation. The Sahara desert, especially, is regarded as an ideal location to develop solar energy. For example, at the Euroscience Open Forum in Barcelona in 2008, Arnulf Jaeger-Waldau, the European commission's institute for Energy, said that it only requires the capture of 0.3 percent of the light falling on the Sahara and Middle East deserts to meet the European energy demand. Furthermore, he accentuates the CSP plants by saying "compared to the size of the countries on the continent, the area needed for a CSP plant large enough to power Europe is tiny- roughly the size of Wales." (Amstell 2009). Figure 5 is provided by the DESERTEC Foundation and helps to understand and seeing how much land is needed to provide enough energy for the world. The red squares represent the sufficient land size for CSP to generate electricity for the world, Europe, and MENA in 2005. The last square, TRANS-CSP Mix EUMENA 2050, represents the land necessary for EUMENA in 2050. As can be observed, the Sahara desert has high potential to become an important energy source.

Figure 5: The Potential of the Sahara Desert to Provide Electricity for the World



Source: DESERTEC Foundation
http://www.desertec.org/fileadmin/downloads/media/pictures/DESERTEC_EU-MENA_map.jpg (accessed: 19.11.2012)

According to Desertec-AFRICA, if deserts in Africa can be utilized to their full potential, this could mean that countries, such as Algeria, Angola, Libya, and Nigeria, would have the potential to become solar-rich instead of oil-rich nations. As they are currently oil-rich nations, their oil export revenues could be directed to invest in solar energy technologies, such as CSP, to harness energy from the sunlight in the Sahara, Kalahari and Namib deserts. If solar energy technology is successfully established in the continent, for example in Nigeria, the northern part of the country can become the energy power source instead of the southern Niger delta region. This is because the electricity produced via CSP plants –located in parts of the North which lies in the arid Sahel zone- can be sold locally and exported to Europe, which may generate more revenue compared to the current revenue made from export of petroleum. DESERTEC and Desertec-AFRICA strongly believe that the CSP technology is the most suitable solar based technology that could utilize the full advantage of the high solar irradiation from deserts.

In order to understand why the CSP technology is regarded as suitable for deserts, it is necessary to see the amount of solar heat that is required. For example, when using coal, dependent on the capacity of the power plant, 400-700°C could be generated to produce enough steam to drive the coal-fired power plant. In the case of solar heat, a mega sized mirror or a large collection of mirrors (about the size of a football field) are required to concentrate sunlight to generate heat of 400-700°C (Desertec-AFRICA). As one can assume, large deserts can be places that can meet the above requirement. Also, when it comes to the CSP technology, they can be operated by only the use of DNI. For example, a region, or a site, is considered suitable if it receives more than 2,000 kWh of sunlight radiation per square meter per year, and considered best if it receives more than 2,800kWh/m^2 per year (Desertec-AFRICA). The Sahara desert is one of the few sites in the world that meet these requirements, large fields and high DNI, and it is, of course, considered as an ideal site for CSP installations. Furthermore, according to Desertec-AFRICA, apart from the deserts, Sahel Stepes and Savanna Grassland are also considered to be suitable sites for solar thermal installations. In other words, Africa is a continent with many suitable sites for the installation of the CSP system, and these factors could make the African continent an important energy provider in the future.

As can be seen above, the Sahara desert as well as other African sites have huge potentials to become future solar energy providers. In other words, the geography and the weather, which often have been perceived as obstacles for their development and growth, may be the essential elements that may lead the continent to be the leading electricity producer in the future. The potential of solar energy, especially in the MENA region, has been exemplified by many energy companies and organizations, and the idea is in the process of being materialized.

3.3 DESERTEC Foundation & Desertec Industrial Initiative (DII) and Current Development in North Africa

3.3.1 DESERTEC & Desertec Industrial Initiative (DII)

As mentioned earlier, there are many energy companies and organizations which are interested, and also work on materializing the potentials for solar energy. When it comes to solar energy in North Africa, also in the Middle East region, the DESERTEC foundation has been one of the leading organizations which have been working on utilizing the potential of solar energy. Therefore, it is worth looking at its concepts and ideas.

The DESERTEC Foundation was established on 20 January 2009 as a non-profit foundation. DESERTEC demonstrates a way to “provide climate protection, energy security and development by generating sustainable power from the sites where renewable sources of energy are at their most abundant" (DESERTEC Foundation: Concept) and implement the global DESERTEC Concept "Clean Power from Desert" all over the world (DESERTEC MILESTONES). More specifically, its concept describes the prospects of providing Europe and MENA with a sustainable supply of renewable energy, electricity, by the year 2050. Furthermore, the DESERTEC Foundation does not only work on materializing their concept in the MENA region, but also in other parts of the world. The DESERTEC Foundation now works together with Japan Renewable Energy Foundation (JREF) to boost Japan's transition to clean, affordable and reliable sources of clean power from nuclear power. Furthermore, The Japanese Softbank Corp., let by JREF founder Masayoshi Son, works on the implementation of the so-called "Asian Super Grid". The "Asian Super Grid" is to transport renewable energy, such as from the Gobi deserts, via interlinking national electricity grid from Japan, Korea, China, Mongolia and Russia (DESERTEC Foundation Press release, October 24, 2012).

The DESERTEC Foundation was developed by the Trans-Mediterranean Renewable Energy Cooperation network which is a voluntary organization founded in 2003. The driving pillars behind the formation and development of such network are Physicist Dr. Gerhard Knies and HRH Prince Hassan bin Talal of Jordan who was the president and founder of the Club of Rome. Furthermore, the research institutes for renewable sources of the governments of Algeria (NEAL), Egypt (NREA), Jordan (NERC), Libya (CSES), Morocco (CDER), Yemen (Universities of Sana'a and Aden), and German Aerospace Center (DLR) contributed in the development of the DESERTEC Concept. The DLR scientist Dr. Franz Trieb provided the basic studies related to DESERTEC which were financed by the German Ministry of the Environment (BMU) (DESERTEC MILESTONES).

On 13 July 2009, in Munich, 12 companies[8] signed a Memorandum of Understanding to establish the Desertec Industrial Initiative (DII). The objective of DII is to "analyse and develop the technical, economic, political, social and ecological framework for carbon-free power generation in the deserts of North Africa" (Munich RE Press release, July 13, 2009) and, of course, to accelerate implementation of the DESERTEC Concept in EUMENA. Furthermore, their long-term aim is to "produce sufficient power to meet around 15% of Europe's electricity requirements and a substantial portion of the power needs of the producer countries." (Munich RE Press Release, July 13, 2009). The DII has been expanding since its establishment and currently consist of more than 55 countries and institutions as shareholders or associated partners. The idea of implementing solar energy in the MENA region has been receiving vast amounts of supports. Their growing status could be seen in the 3rd DII conference in 2012, in Berlin. A number of quotes taken from the 3rd DII conference in Berlin are presented below.

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[8] ABB, ABENGOA Solar, Cevital, Deursche Bank, E.ON, HSH Nordbank, MAN Solar Millennium, Münchener Rück, M+W Zander, RWE, SCHOTT Solar, SIEMENS.

Mr. Padmanathan, the CEO of ACWA Power said;

"The only way we can survive is to deliver energy to the lowest possible price. We in Saudi Arabia have significant renewable resources both wind and solar and they are already on a good way. We are with DII to make that development faster."

Christian Ruck, member of the German Bundestag, CDU/CSU said;

"I am a big supporter of the DESERTEC vision. This idea is on the edge of becoming reality. We have to start concretely and as early as possible. We can reduce the cost of renewable, their volatile and the cost of co2 emissions."

Hans-Josef Fell, Member of the German Parliament, Spokesman on Energy for the Alliance 90/The Greens Parliamentary Group said;

"When we organize an export from North Africa to Europe, money and know-how flow back to North Africa and there would be a great need for these counties that this happens."

Accordingly, the DESERTEC Foundation and DII received a lot of supports from both European and the MENA region. In North Africa, not only due to the DESERTEC Foundation and DII, there has been substantial growth in solar energy and other renewable energy development. Therefore, the next section will illustrate the current development of solar energy in North Africa which will enable one to understand where the North African countries stand with the potential of solar energy.

3.3.2 Current Development in North Africa

There has been specific focus in Morocco as regards to DII's reference project. Morocco can be considered as a natural choice for the reference project as there is an existing power grid connection between Morocco and Spain, and it was here that the first DII project was demonstrated. In 2010, the government of Morocco announced the implementation of 2,000 megawatt (MW) solar program by 2020, for which MASEN was founded (Dii Newsletter, March 2011).

In May 2011, DII and MASEN signed a Memorandum of Understanding in Morocco regarding a large cooperative solar project in Morocco. The aim of this DII's first reference project is to demonstrate the export feasibility of electricity generated by solar energy in the deserts to Europe by using the existing line between Spain and Morocco. Here, DII acts as an enabler, which provides the expertise in developing a feasible business case for the planned solar project. MASEN, on the other hand, acts as project developer and manages the overall process in the country (Dii Newsletter, July 2011).

The location of this reference project is in Ouarzazate, it has a total capacity of 500 MW, combination of CSP (400 MW) and PV (100 MW), and its estimated cost is approximately €2 billion. The project's first phase is to be 150 MW pilot plant which is expected to be a CSP with an estimate cost of €600 million (Dii Newsletter, February 2012). The second phase, with the combination of wind and PV (100 MW), has already been defined. It is projected that the first electricity provided by the joint DII/MASEN project could be transferred into the grids between Morocco and Spain around 2014-2016 (Dii Country Focus: Morocco). This reference project has been under discussion for the past two years, and on 19 November 2012, a financial commitment of €300 million was signed in Marrakech by the European Investment Bank, the Development Agency for France, KfW Entwicklungsbank and MASEN (European Investment Bank, November 19, 2012).

Morocco is not the only country that is involved with the DESERTEC Foundation and DII. Following the development of reference project in Morocco, in April, 2011, Paul van Son, CEO of DII, met with four members, Ministers Abdelaziz Rassaa (Industry & Energy), Riffat Chaabouni (Education & Research), Abderrazak Zouari (Regional Development & Business) and Abdelhamid Triki (Planning & International Relations), of the interim Tunisian government and agreed on further steps in implementing the DESERTEC vision in Tunisia. The main focus of the meeting was creating/developing jobs and establishment of knowledge transfer for the next generation (Dii Newsletter, July 2011).

DII and STEG Energies Renouvables, shareholder in DII since October 2010, initiated a feasibility study of solar and wind energy projects in Tunisia. Currently, they are working on a pre-feasibility study, which includes reviews of technical and regulatory prerequisites and the capacity of the electricity network to integrate desert power, within the framework of cooperation agreement signed by DII and Tunisian authorities in 2011. Furthermore, the study focuses on identifying reference projects, including PV, CSP, CSP Hybrid, with a total volume of 1 GW, particularly on the transmission link between Tunisia and Italy (Dii Country Focus: Tunisia).

In December 2011, DII and Sonelgaz (the Algerian governmental National Society for Electricity and Gas) signed a Memorandum of Understanding for their future cooperation in Brussels. The aim of this cooperation was to support renewable energy strategy in Algeria and also to enable cooperation with Europe in reference project in the form of export agreements. Furthermore, the cooperation between DII and Sonelgaz focuses on identifying reference projects. The reference project consists of a total capacity of 1 GW, and, of the 1 GW, 90 percent is to be for export purposes and 10 percent for local consumption. Algeria already has an operating solar-combined cycle hybrid power plant near Hassi R'Mel which generates electricity via parabolic trough solar field (25 MW), and gas fired facility (125 MW) (Dii Country Focus: Algeria).

Another African country also moving towards renewable energy is Egypt. In December, 2010, Egypt's first solar thermal plant went into operation in Kuraymat. Flagsol GmbH, a subsidiary of Solar millennium and Ferrostaal, provided the solar technology for this reference project. It is a hybrid power plant which uses solar energy and natural gas, and it has a capacity of 150 MW. Dr. Christoph Wolff, the CEO of Solar Millennium AG, explains that the successful operation of the plant is proof that the Desertec vision can be realized, and it can create jobs in clean energy generation (Solar Millennium Press Release September 22, 2011). Similarly, Oliver Blameberger, a member of the Executive Board of Solar Millennium, finds this project as an important step towards the realization of DESERTEC vision, and there could be the successful European-African cooperation in the field of renewable energy (Solar Millennium Press Release December 23, 2010).

Libya is probably the slowest country that is promoting the renewable energy. Unlike other North African countries, in 2010, Libya did not produce any electricity via renewable energy. Also, at the 3rd DII Conference in Berlin, it was possible to see that there was little interests, in comparison to the other North African countries, from international companies and organizations as there was lack of discussion regarding renewable energy in Libya. Nevertheless, according to REN21 (2012, p.105), Libya has targets to expand the use of renewable energy in the future. Table 4 presents the share of primary and final energy from renewable energy, existing share in 2009/2010 and the future targets of North African counties.

Table 4: Share of Primary and Final Energy from Renewables, Existing in 2009/2010 and Targets

Country	Primary Energy		Final Energy	
	Share (2009/2010)	Target	Share (2009/2010)	Target
Algeria	-	-	-	40% by 2030
Egypt	-	-	-	20% by 2020
Libya	-	10% by 2020	-	-
Morocco	-	8% by 2012 10-12% by 2020 15-20% by 2030	-	10% by 2012
Tunisia	-		-	-

Source: REN21 (2012 pp. 105-106)

As can be seen from this chapter, the world has been realizing the importance of the renewable energy. Although there have been policies to promote renewable energy since the 1980s, it is only the recent period that has seen the rapid growth in policies promoting renewable energy, especially for the electricity generation. Despite the types of renewable energies, their capacities have also been growing rapidly throughout time. Here, the solar energy technologies have been experiencing substantial growth. Indeed, solar energy appears to have great potential in meeting the future electricity demand. As for North Africa, the Sahara desert has been identified as the place where once can produce enormous amount of electricity by erecting solar power plants. International companies and organizations, such as DESERTEC Foundation and DII, have already begun their process in planting reference projects in the North African countries, and the idea of renewable energy is spreading in the continent.

Chapter 4. Will Solar Energy Become a "New Curse", or Bring Development for Africa?

4.1 Solar Energy: Potential to Become a New Curse & Potential to Reduce the Resource Curse Effects

The demand for energy has been constantly growing and, therefore, the search for new energy sources has been extensively focused globally. As mentioned in chapter 3, fossil-fuels still dominates global energy consumption. However, due to a number of factors, such as peak oil and policies for reduction in GHG emissions, the world has begun to look for alternative solutions, as such renewable energy, and the use/development of renewable energy has been growing rapidly. The use of renewable energy is environmental friendly, and the growth of its use is likely inevitable. Despite the difference between fossil-fuels, or other natural resources, and renewable energy, one definite fact still remains; renewable energy is energy.

As mentioned before, the aim of this thesis is to analyze whether renewable energy has the potential to become a new curse in Africa. However, it is not an easy task to see whether renewable energy will become a new resource curse as most of renewable energy sources are still at their beginning stage and, therefore, there is limited data and literature which can be used to project its future. Moreover, identifying a renewable energy curse by generalizing all renewable energy sources as one subject is unlikely to provide an accurate result as they have different characters and capacity. In other words, in order to achieve the main target of the thesis, it is necessary to narrow down the subject, selecting a specific renewable energy source. Therefore, solar energy is selected because, as discussed in chapter 3, it is the renewable energy which has been receiving significant focus, especially, in Europe and the MENA region.

As mentioned earlier, solar energy has been perceived as one of energy sources which will contribute in meeting the future energy demand for Europe and MENA. In the case of North Africa, it has been receiving focus due to the possession of the Sahara desert, and there are already few solar power stations erected or underway. In other words, the exploration and exploitation of solar energy has been ongoing in the North African region. This is, to a certain degree, similar to the exploration and exploitation of oil in Africa in order to meet the world energy demand. Of course, one can not simply argue that the exploration/exploitation of oil in Africa to help satisfying the world's energy demand has been the main factor that brought the oil curse in the oil-producing African countries. However, the combination of the discovery of oil in the continent and demand, whether directly or indirectly, led them to a heavy reliance on oil exports, and the oil curse occurred in many of these countries. In other words, one should pay great attention to the current solar energy development in the North African region, and the possibility of solar energy becoming a new curse. Fortunately, although not yet proven, one may foresee certain possibilities in reducing the current resource curse effects due to the nature of solar energy. For example, the most obvious difference between oil and solar energy is that one is a non-renewable energy, and the other is a renewable energy. Despite the fact that the difference is rather obvious, one should not overlook this point as it may be a great factor that helps prevent some of the current resource curse effects. Furthermore, if the DESERTEC's long-term aim, meeting around 15 percent of Europe's electricity demand via renewable energy from MENA, is to be combined with the nature of solar energy, the possibility in preventing the current resource curse effects in the field of solar energy could increase even more. Accordingly, this chapter will illustrate the possible impact of the DESERTEC's long-term aim on the current resource curse effects in combination with the nature of solar energy.

Conflict

As mentioned earlier, many resource-rich countries in Africa, especially oil-producing countries, suffer from conflicts/violence. If a country is to become a solar energy electricity exporter -under the circumstance that the nature of solar energy is the same as oil- conflict/violence may also occur. Fortunately, however, the nature of solar energy is different from oil and other natural resource and has the potential to reduce certain amounts of conflict/violence. The major difference between oil and solar energy which has the potential to reduce conflict/violence is that oil can be stored for long periods of time whereas solar energy can not. This simple difference can, for instance, help facilitate to a certain degree-the reduction of conflict/violence in Nigeria especially regarding oil bunkering. As mentioned earlier in chapter 2, oil bunkering harms Nigeria's oil production as oil bunkerers steal around 10 percent of nation's daily oil production. More importantly, this fuels conflict/violence between armed groups which is motivated by the struggles to control territory and oil bunkering routes. If Nigeria were to become a solar electricity exporter, however, the chance of conflict/violence occurring may decline. Oil can be bunkered due to its liquid form and the fact that it can be stored for a long time. In the case of electricity, on the other hand, the amount of time that it can be stored is extremely short. Also, electricity can not be tapped and stored in a drum. Furthermore, it is unlikely that the bunkerers will develop high level technology to steal electricity. Therefore, in the case of solar energy, bunkering is less likely to occur.

In chapter 2, four types of conflict/violence mechanisms are illustrated, and oil bunkering in Nigeria is in the category of looting mechanism. Due to the nature of solar electricity, however, it appears that solar energy may have less chance in providing such conflict/violence, under the looting mechanism, as the bunkerers have much less chance to profit, or even to extract, from selling electricity. Therefore, if Nigeria were to become a solar electricity exporter, the decline in conflict/violence between rebels could be expected.

Dutch Disease

Dutch disease is probably one of the most famous resource curse effects. Many resource curse effects often occur in economies that heavily rely on their point source and its revenue. However, if the combination of the nature of solar energy and the DESERTEC's long-term aim come in to reality, the chances that solar energy exporters are likely to suffer from the Dutch disease can be reduced as they are less likely to be as heavily dependent on electricity exports compared to other point source exports. DESERTEC Foundation's main focus is not to make the MENA countries as big electricity exporters but enable them to satisfy their own energy demand with their renewable energy. Also, although still unsure, their long-term aim, meeting 15 percent of Europe's energy demand by importing electricity via solar and other renewable energy from the MENA region, suggests that the share of the electricity export may not be as high as the export dependency created by the oil export. In this scenario, the combination of the successful establishment of solar energy with the DESERTEC Concept and much lower electricity export revenue compared to other point source may play a role in reducing the chances of suffering from the Dutch disease.

As explained in chapter 2, there are two types of Dutch disease, de-industrialization; direct de-industrialization, also called factor movement effect, and indirect de-industrialization, also called spending effect. If the given scenario is to occur, it will be especially effective in preventing the spending effect. More specifically, if electricity exports from the MENA or North African countries do not provide them with such enormous revenue, such as from oil, it is less likely that there would be huge additional spending caused by the revenues from electricity exports, or appreciation of the real exchange rate. Furthermore, under the given scenario, there is, compared to other point sources, less chance that the electricity-exporting countries will suffer from 'solar energy boom' because most of the solar electricity would be used to satisfy the MENA region's electricity demand rather than for export. In this case, unlike what Krugman (1987) argues in the case of the natural resources, one may have less chance in witnessing the worsening competitiveness of the manufacturing sector, diminishing of the learning-by-doing benefits, and decline in market share and relative wages.

Volatility

The nature of solar electricity may prevent the extreme volatility that often occurs with point sources such as oil. There are few reasons why oil suffers from volatility. Oil needs to be scouted with difficult procedures and even more difficult forms of extraction have to be researched and applied. Also, only relatively few countries in the world have large oil fields. These factors have contributed to the establishment of such institutes as the OPEC, which continue to have considerable influence on the price of oil through their member nation quota system.

Unlike oil however, due to the nature of solar electricity there may be less chance that it will suffer from extreme volatility. This is due to the fact that solar irradiation with the intensity like that found in the MENA countries is also available in a large number of other countries. Also, as mentioned before, electricity can not be stored like oil. In other words, a cartel of solar electricity suppliers is hardly possible. For the North African countries, solar irradiation is easily detected. Especially in the desert, there is very little variation of the solar radiation throughout the year. This is what makes deserts the ideal place for solar energy. Combined with the CSP plants which can deliver electricity from solar power on demand and even 24/7, the electricity output from solar energy would be stable. Therefore, the volatility is expected to be low which makes North Africa an attractive region for implementing solar energy.

Here, it must be noted that the potential improvements above concerns volatility only on the supply side. As will be mentioned in section 7.2.1, due to the population growth and economic growth, the demand for energy will continue to increase. In other words, it is uncertain exactly how the volatility on demand side will look like in the future. Therefore, it is still uncertain whether the volatility matter will be solved because one does not know the size of the solar power capacity from North Africa in the future. Nevertheless, as can be seen above, it is still likely that solar energy will have less volatility issue with supply side due to its nature and CSP technology in North Africa.

Debt

Resource-rich countries tend to build up debt even when they receive vast amounts of resource revenues since governments expect more income in the future. This situation occurs when there is an increase in the real-exchange rate which often makes interest payment on the debt cheaper. However, if the prices of natural resources, especially oil, and the real exchange rate fall, governments have less money and more expensive debt to repay. In other words, debts issue occurs due to the combination of resource curse effects such as Dutch disease, volatility and heavy dependence. In the case of solar energy, as mentioned earlier, there would be less chance for mentioned resource curse effects to occur due to the nature of solar energy and the DESERTEC Concept. Therefore, there might be less chance for the electricity exporters to suffer from debt, or debt overhang problems.

As can be seen above, one may project that North Africa may suffer less from a solar energy curse due to the nature of solar energy and the DESERTEC Concept and its long-term aim. However, this prediction is rather inaccurate as it relies on an uncertain assumption that the DESERTEC Concept will materialize. Furthermore, the projections presented above still do not show the best way to find out if solar energy will become a curse. Therefore, one needs to concentrate on finding a concrete way to predict whether solar energy will become a new curse.

Unlike the existing resource curse theories, the renewable energy curse idea is quite new. There is lack of literature or other types of data regarding the possible renewable energy curse in comparison to the current resource curse. Also, at the 2nd and 3rd DII Desert Energy Conferences, where many solar energy experts attended, the term resource curse was not familiar to many of them. Of course, the focus of these conferences was not on the resource curse.

Fortunately, however, in recent years, it has been possible to find a number of publications, whether directly or indirectly, regarding renewable energy curse. For example, Gennaioli & Tavoni (2011) argue that there is ‘curse’, the diffusion of corruption practices, in the case of wind energy sector in Italy. They find higher criminal association activity level in high-wind provinces and especially after the introduction of a more favorable public policy regime, and argue that the expansion of the wind energy sector has been driven by the level of the wind and the quality of political institutions, through their effect on criminal association (Gennaioli & Tavoni 2011, p. 1).

There is also some literature regarding solar energy. For instance, the article by Massetti & Ricci (2011), although it is not directly related to the idea of the resource curse, focuses on solar energy in the MENA countries. Massetti & Ricci (2011, p.39) argue that the MENA countries may form a cartel to sell electricity to Europe at a price higher than the marginal cost.[9] This article shows that there is a possible curse symptom that the MENA countries may suffer from as there is a possibility that they can rely heavily on exporting electricity in the future.

Furthermore, via an email interview, Paul van Son, the CEO of DII, agrees that there are, similar to any energy asset, risks related to renewable energy such as various investment risks, operational risks of the installation, security risks, integrity and compliance risks, financial risks, such as off-take volume/prices, grid failure risk, and credit risk of off-takers, social acceptance risks and political risk. In the case of solar installations one faces of course volatility of sunshine and in the case of wind, volatility in wind. Also, he considers compliance issues such as manipulation, corruption and criminality as major threat against sustainable development and suggests that, along with the

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[9] This is different from the DESERTEC’s point of view. However, at the 2nd DII DESERTEC ENERGY CONFERENCE CAIRO 2011, ironically, the best European thesis award was given to Lilliestam & Ellenbeck (2011) whose topic was whether the DESERTEC would make Europe vulnerable to the “energy weapon”, and they found that it is, though not by high chance, possible.

development of renewable energy, these subjects must be addressed and all measures must be taken to eliminate such effects. By analyzing the existing literature and the aforementioned interview it can be argued that the risks related with renewable energy may not be fundamentally different from risks related with fossil-fuels, although the latter is also exposed to fuel price risks and emission issues. Therefore, according to Van Son, the risk/return patterns may, thus, strongly determine the renewable energy in the future.

Although there is a body of literature regarding the renewable energy curse, in order to achieve the main goal of this thesis, one still faces a greater task ahead: *How does one find out whether solar energy will turn into a new curse?* Anyone can make assumptions, whether the solar energy in North Africa may turn into a new curse or not by comparing the nature of oil and solar energy or applying the current resource curse effects presented in chapter 2 on solar energy as presented above. However, as mentioned earlier, this method is unlikely to bring an accurate projection.

Unlike the resource curse, the solar energy curse in North Africa is a young topic, and there is limited literature and data available. How then would it be possible to achieve the main target of this thesis when its subject matter is still in its infancy and there are limited resources available? Obviously, although helpful, the literature relating to renewable energy curse and interview with Paul van Son is not sufficient enough to grasp the entire picture of the path that one needs to take to find how to project whether solar energy in North Africa will turn into a new curse.

So far, the question has moved from "would solar energy turn into a new curse?" to "how does one find out whether solar energy will turn into a new curse?". The latter question should be properly dealt in order to achieve the goal of this thesis. However, it has been difficult to come up with a concrete plan. It means that there should be another step to take in order to answer the "how" question and, eventually, the main question. This 'other step' is to answer the question "what will be the *cause* of a solar energy curse?" In any kind of questions, directly or indirectly, when the cause is found, it is one step closer to finding the answer. However, yet again, it is problematic to find the cause of the possible solar energy curse in North Africa as it has not been fully established in the region yet, therefore, one can not argue against/for the existence of a solar energy curse. This situation leaves only one path which is to go back to the backbone of this thesis: the resource curse. More specifically, as solar energy is, although renewable, a type of resource, one needs to build up the plan with the basis of the resource curse.

As mentioned before, the term resource curse has been studied for decades. There are numerous works and different perspectives on the resource curse. Also, during that time there have been various causes and solutions found regarding the resource curse. In chapter 2, for instance, the concept of the resource curse, resource curse effects and cases studies are illustrated. However, it is hard to find the elements or factors that lead to the resource curse by just looking at the concept of the resource curse and its effects. Of course, by looking at the case study in Nigeria, for example, it was possible to see that the resource curse exists in resource-abundant countries. However, the experiences of Botswana and Norway show that not all resource-abundant countries suffer from the resource curse. Therefore, although the resource curse does exist in many resource-abundant countries, it is proven that the abundance of resource and heavy dependence on resources can not be considered as the main reason for the existence of the resource curse. In other words, abundance of solar irradiation will not be considered as the main factor that would create a solar energy curse in North Africa. Then what is the factor that makes the resource-abundant countries to suffer from the resource curse? And what is/are the main difference between countries which suffer from the resource curse and countries which avoided/escaped from the resource curse? These questions seem rather simple, but they are very essential questions that one should focus on as it begs the question as to what elements and factors put countries into the resource curse or not, furthermore, in other words, ask what causes the resource curse. If these questions are dealt properly, it would be possible to find the main factor(s) that 'determines' whether a country is under the danger of being resource cursed or not. In other words, the boundary-line(s) can be obtained. When the boundary-line(s) is obtained, one can find which countries are in the resource curse and, furthermore, may be used to project which countries have the potential to suffer from a solar energy curse. Therefore, the next section will search for the most convincing and concrete boundary-line(s) for filtering which countries are suffering from the resource curse, and also which countries have the potential to suffer from a solar energy curse.

4.2 Search for the Boundary-line(s) via Literature

Although this thesis is focusing on the resource curse and the possible solar energy curse, it must be noted that the abundance of natural resource and dependence on natural resource have not always been perceived as the negative factors or as the curse. Until the end of the 1980s, many economic theories took a similar path which considered the abundance of resources, or dependence on natural resources such as oil and natural gas, as an advantage in achieving economic growth and development.

For instance, Ginsburg (1957, p.211), a geographer, argues that having a sizable and diversified natural resource endowment is an advantage to any country embarking upon a period of rapid economic growth. Similarly, Walter Rostow, a development theorist, argues that natural resource abundance can help developing countries to move forward from underdevelopment to industrial take-off as the United States and Britain have experienced (Rosser 2006, p.5). Similar views continued to occur until the late 1980s. For example, Bela Balassa, a neoliberal economist, argues that the abundance of natural resources is able to facilitate a nation's industrial development as it can provide domestic markets and investible funds (Rosser 2006, p.5). However, since the late 1980s, the view towards the abundance of natural resources and dependence on natural resources have started to be perceived differently as it has often been observed that many resource-rich countries have not achieved expected sustainable growth and development and, as mentioned in chapter 2, are often outperformed by resource-poor countries. Rather than being considered as a blessing, resource abundance had begun to be viewed as a factor that causes countries to experience negative economic, political and social outcomes which include decline in economic performance, low level of democracy, and civil war (Rosser, 2006, p. 7). This phenomenon of natural resources and negative economic development, as mentioned in chapter 2, was coined the resource curse by Auty (1993), Sachs & Warner (1995), and later by other scholars. Sachs & Warner (1995) examined the experiences of natural resource economies during the period of 1970-1989, and discovered that the natural resource abundance had been negatively correlated with economic growth.

Although it was Auty (1993) that is known to have created the term resource curse, it was the work of Sachs & Warner (1995) that inspired many economists and scholars to consider the cause of the resource curse (Brunnschweiler & Bulte, 2008, p.248). Of course, there have been different explanations for the resource curse. The main, or most popular, explanations for the resource curse are based on Dutch disease, rent-seeking and, more recently, institutional quality. The following section will examine the other main explanations for the resource curse from literature in order to test whether they can be the boundary-line(s) for identifying the resource curse and a solar energy curse.

4.2.1 Dutch Disease

Dutch disease is one of the more famous explanations for the resource curse. Since the early 1980s, several publications supporting the idea of the Dutch disease have been written by scholars and commentators such as Bruno & Sachs (1982), Corden & Neary (1982) and Matsuyama (1992).

Matsuyama's (1992) model, for example, includes an agriculture sector and a manufacturing sector. He argues that any forces that push the economy away from manufacturing and towards agriculture can lower the growth rate by reducing the learning-induced growth of manufacturing. Also, he shows that in a land-intensive economy, trade liberalization can slow economic growth by inducing the economy to pull resources away from manufacturing and towards agriculture. In his model, the adverse effects of agricultural production occurs when the factors of production, that would otherwise be directed towards manufacturing, are diverted towards the agricultural sector (Sachs & Warner 1997, pp.5-6). It is, however, important to note that such a theory may be useful when it comes to studying labour intensive production of natural resources, such as in agriculture, but it is not so relevant for a natural resource sector which uses very little labour such as oil, and therefore does not directly draw employment from manufacturing.

Perhaps, it is Sachs & Warner (1995, 1997) whose work is more closely linked to the Dutch disease and the resource curse. Their Dutch disease model is similar to the de-industrialization model which is presented in chapter 2. In their model, there are also three sectors which are tradeable natural resource sector a tradeable (non-resource) manufacturing sector, and a non-traded sector. Capital and labour are only used in the manufacturing sector and non-trade sectors. They argue that there is higher demand for non-tradeable goods when the natural resource endowment is greater. When natural resources are abundant, capital and labour which are supposed to be employed in manufacturing sector will often shift into the non-trade goods sector. Consequently, when there is a resource boom, the manufacturing sector is likely to shrink and the non-traded goods sector is to be expanded. The shrinking in manufacturing sector is dubbed the “disease” in their work (Sachs & Warner 1997, p.6)

In Sachs & Warner’s (1995,1997) work, they measure the impact of mineral and other resource exports on GDP growth, 97 countries over a 19 year period, by using regression analysis. They find that economies with a high ratio of natural resource exports to GDP in 1971 grew slowly between 1971 and 1989. Based on their research, they argue that, when compared to resource-poor economies, resource-rich economies tend to have larger service sectors and smaller manufacturing sector. Also, they show that resource-rich economies tend to have slower growth in exports of manufactures than resource-poor economies. Furthermore, they argue that the correlation remains even after they controlled for growth-related variables such as trade policy, bureaucratic efficiency, initial per capita income, region, and terms of trade volatility.

It must be mentioned that, though the Dutch disease theory appears as a promising explanation for the poor economic development of resource exporters in the early 1980s, there are a number of studies which argue against it, or are less convinced by, the Dutch disease theory. Ross (1999, p.305) argues that the Dutch disease model does not fit many developing economies. This is due to the fact that the Dutch disease model assumes that an economy’s capital and labour supplies are fixed and is fully employed before a boom occurs. It might be the case that a booming sector draws capital and labour away from agriculture and manufacturing under the mentioned circumstances. However, according to Ross (1999, p.306), this is often not true as many developing countries have labour surpluses, and their resource booms draw in foreign capital and labour, offsetting any scarcities. There are other scholars who argue against the Dutch disease theory such as Sala-i-Martin & Subramanian (2004). They present the experience of Nigeria and argue that it is rather the corruption and waste from oil that has been responsible for its poor long-run economic performance than the Dutch disease and, furthermore, argue that the assumption of superior learning effects in manufacturing are unproven (Sala-i-Martin & Subramanian 2004, p.3 , 5). Also, Kostad and Wiig (2009, p.5318) argue that the Dutch disease does not fully explain the negative growth effect of resources once other mechanisms are controlled for. These argument will be tested in Chapter 7 where the resource curse is measured based on Sachs & Warner's (1995, 1997) studies.

4.2.2 Centralized (Patronage Politics) & Decentralized (Rent-Seeking) Political Models

As regards to the negative effects of resources on growth, there are two popular political economy models regarding the resource curse which are known as the Centralized Political model and the Decentralized Political models.

The centralized political model is often referred to as Patronage politics[10]. This model accentuates the decision making of the politicians in controlling/governing resource-abundant countries. It is argued that an increase of natural resource rents can increase the value of staying in power as it would mean control over greater rent and, consequently, increases the chances for other to challenge the government for power (Kolstad & Wiig, 2009, p. 5318).

When the value of staying in power increases, those with the power can spend more resources in order to secure their position in government; increasing their chances of being re-elected. This can be done in various ways. For example, Isham et al. (2005, p.147) argue that politicians can buy off critics, provide the population with benefits, infrastructure projects, patronage, or outright graft. Similarly, Kolstad & Wiig (2009, p. 5318) further argue that it can be done through patronage, political supporters to supporters to get government jobs, or investing public funds in politically important but economically unproductive projects which are often referred to as 'white elephants projects'. When there is a chance for others to challenge the government for power, as Kolstad & Wiig (2009, p. 5318) argue, it can further lead governments to spend resources unproductively such as repression or bribing/buying off potential opponents. Accordingly, it can be argued that the bias allocation of labour and investment can potentially damage economic growth.

The decentralized political model emphasizes the decisions/actions of individuals outside the

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[10] According to Weingrod (1968, p.379), "patronage refers to the way in which party politicians distribute public jobs or special favours in exchange for electoral support.".

power elite. This model is often referred to as the rent-seeking model, where individuals choose between using their effort on rent extracting activities, or on productive activities. Though increases in resource rents leads to increase of income, this model sees that there can be a displacement effect in productive sectors as more entrepreneurs may choose to become rent-seekers (Kolstad & Wiig, 2009, 5319-5320). More details on the decentralized political model can be found in the following section, Institutional Quality, which accentuates the importance of the institutional quality base on the rent-seeking behavior.

4.2.3 Institutional Quality

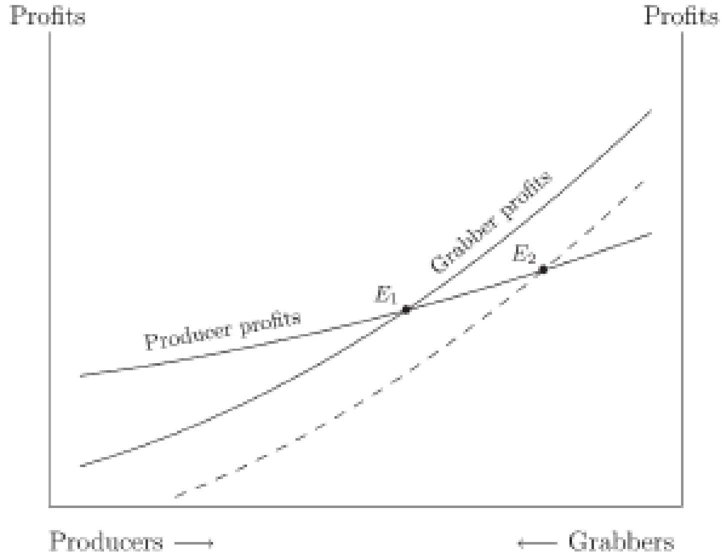
Sachs & Warner (1995) do not believe that institutional quality plays an important role in explaining the resource curse. However, this argument has been challenged by many scholars such as Robinson et al. (2006), Kolstad & Wiig (2009), and Mehlum et al. (2006a,b).

Robinson et al. (2006, p. 5317) argue that countries with institutions which promote accountability and state competence will likely benefit from resource booms because these institutions can help prevent rent-seeking or patronage behavior that may occur as a result of a resource boom. If countries do not have such institutions, they are likely to suffer from a resource curse. Similarly, Kolstad & Wiig (2009, p.5324), though they find resource rents as the main source of the resource curse, argue that resource rents induce dysfunctional and costly behavior in terms of patronage and rent-seeking when countries have weak institutions of democratic accountability and rule of law.

Mehlum et al. (2006a,b) present a more specific study on the relationship/correlation between the resource curse and the institutional quality. They reject the idea that the resource abundance is the cause of the resource curse as there are countries that still achieved growth despite the abundance of resources.

More specifically, they make a distinction between producer-friendly institutions, where rent-seeking and production are complementary activities, and grabber-friendly institutions, where rent-seeking and production are competing activities. According to Mehlum et al. (2006a, p.1121), rich resources attract entrepreneurs into production, implying higher growth with the producer-friendly institutions, whereas the entrepreneurs are diverted away from production and go into unproductive rent activities with grabber-friendly institutions.

Figure 6: The Allocation of Entrepreneurs

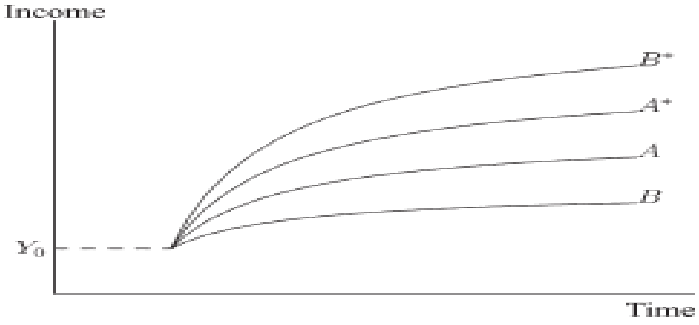


Source: Mehlum et al. (2006a, 1123)

Figure 6 helps in explaining Mehlum et al.'s (2006a) idea of the producer-friendly institution and grabber-friendly institutions. The Horizontal axis represents the total number of entrepreneurs. The number of entrepreneurs that enter into production is measured from left to right, and the number of entrepreneurs that enter in to grabbing is measured from right to left. The equilibrium E1 represents the situation where there is individual entrepreneur has no incentives to move from grabbing to production, and vice versa.

As can be seen from figure 6, the profit curve for producers increases when the number of producers increases. One the other hand, the profit curve for grabbers decreases when there is an increase in the number of grabbers, and decrease in the number of producers. This is because when there are more grabbers, there would be fewer producers to extort and, consequently, grabbers have to compete relative to targets. When there are less grabbers, they do not have to compete as much because there are more targets to extort, thus, more profit for the remaining grabbers. The dashed line in figure 6 represents a move towards the producer-friendly institutions. In the new equilibrium E2, there are more producers and less grabbers. One can see that the production in grabbing has also increased. The reason for this is that the good institutions induce entrepreneurs to shift from grabbing to production. According to Mehlum et al. (2006a, p.1123), it leads to the increase in production and income in society and the profit to be higher for both producers and the remaining grabbers.

Figure 7: Growth Paths of Four Hypothetical Countries



Source: Mehlum et al. (2006a, p. 1126)

Mehlum et al. (2006a) accentuate the importance of the institutional quality by comparing four hypothetical countries (resource poor with grabber-friendly institution (A), resource poor with producer-friendly institution (A*), resource-abundant with grabber-friendly institution (B), and resource-abundant with producer-friendly institution (B*)) which are presented in figure 7. As expected, economies with producer-friendly institutions outperformed economies with grabber-friendly institutions. However, what one should also focus on is the comparison between economies with grabber-friendly institutions where the resource poor economies outperform the resource-abundant economies. Mehlum et al. (2006a, p.1126) argue that economies with bad institutions with more resources are considered to be suffering from the resource curse, more natural resources push income down. Thus, when assuming that they start out at the same income level, resource-poor economy with grabber-friendly institutions outperforms resource-rich economy with grabber-friendly institutions.

Mehlum et al. (2006a, b) contradict to the arguments that resource abundance is the cause of the resource curse, but rather, it could be a blessing to an economy if it has a producer-friendly institution. Thus, the institutional quality is the key that can bring economies in/out of the resource curse.

4.2.4 Saving of Resource Income

Despite being a resource cursed country or not, resource-abundant countries have the resource income which they spend. It means that there must be a difference in the way the resource-abundant countries spend and save their resource revenue which may contribute in making them resource cursed or not. In other words, spending behavior may play an important role, or can act as the boundary-line, in finding whether an economy is affected by the resource curse or not. According to Torvik (2009, p.245), however, the comparison of the saving behavior between the 'resource-abundant winner economy' and the 'resource-abundant loser economy' is problematic as the income from non-renewable resource in the national account is misleadingly classified as income. For instance, based on Torvik's (2009, pp.245-246) explanation, if an economy has US$1000 worth of oil and they export all that oil and receive US$1000, this would mean that the economy exchanges the US$1000 worth of oil with US$1000 in cash, thus the US$1000 the economy received from the oil export must be considered as zero profit. When put differently, if a county exports its oil and puts the proceeds in the financial market, the country's natural capital is reduced while it increases the financial capital. Thus, there is no change in wealth of the country. Furthermore, if this economy consumes all the proceeds from the oil export, this can not be considered as saving but rather its saving rate should be perceived as negative. This is where the problem occurs, because the savings rate in the national accounts would be calculated as zero. In other words, the fundamental problem with sales of non-renewable resource such as oil in national account is that it is considered as income which actually overestimates the true saving rate (Torvik, 2009, p. 246). Torvik (2009), therefore, argues that if one is to study the saving rates and its behaviour, it is necessary to see the savings rates that take changes in countries' resource wealth into account. Torvik (2009) selects the traditional savings rates from national accounts as a starting point, and then subtracts net extraction of resources, such as oil, gas, mineral, and timber. Torvik (2009, p. 246) terms these saving rates as 'resource-adjusted savings rates'. In his finding, one can see that the countries which are considered to have avoided/escaped the resource curse tend to have higher resource-adjusted savings rates than the resource cursed countries.

In the case of solar energy, one may not even have to take Torvik's (2009) resource-adjusted savings rates to see the difference of the saving/spending behavior between the resource cursed countries and resource curse avoided/escaped countries. For instance, as solar energy is a renewable energy, if a country exports electricity via solar energy and puts the proceeds in the financial market, there would be an increase in the financial capital while the country's natural capital does not decline. This would mean that if an economy is to consume all the proceeds from electricity export, this can be still considered as saving because the exports of electricity will be still possible due to its solar energy's nature; renewable. Unfortunately, the establishment of solar energy in North Africa is still a long way off, thus, one can not use this saving rate as the boundary-line. Also, though Torvik 's(2009) 'resource-adjusted saving rates' may appear a convincing tool to see the difference between the resource cursed countries and resource curse avoided/escaped countries, but it does not prove that overspending of resource income leads to bad economic development, or vise-versa. Therefore, the spending behavior/saving rate may not be suitable to be the boundary-line that decides whether a country is affected by the resource curse or not.

4.3 The Need of Simplicity in Searching for the Boundary-line(s)

There are various resource curse effects, and what are claimed to be the causes of the resource curse as seen in section 4.2. Therefore, it can be argued that it is not an easy task to select the ‘perfect boundary-line’ as the resource curse is a broad subject which can be viewed from various angles. In other words, one may arrive at different outcomes as regards to the decision as to which countries are suffering from the resource curse, as this may be heavily dependent on the selected cause, or boundary-line. Also, the fact that the purpose of this thesis is to analyze whether solar energy has the potential to become a new curse makes it harder to find the boundary-line(s). Perhaps, the question is not to find the ‘perfect boundary-line’, but it is to find the ‘most suitable boundary-line’. Nevertheless, this task remains difficult. The chosen boundary-line(s) should be the backbone of both the resource curse and the solar energy curse. In other words, one should specify what kind of elements that the boundary-line should require in order to obtain the most suitable boundary-line. The requirements that the boundary-line should contain are illustrated below.

First, the most obvious necessity is that, the boundary-line should be applicable for both the resource cursed countries and the resource curse avoided/escaped countries. It means the boundary-line should be a factor that both the resource cursed countries and the resource curse avoided/escaped possess, and it also should be the factor that can ‘determine’ whether a country is/will be in the resource curse or not.

Second, the boundary-line should be applicable for both the resource curse and the solar energy curse. As mentioned earlier, the purpose of this thesis is to project whether solar energy will become a curse or not. If the boundary-line is only applicable for the resource curse, it will not be possible to tackle the purpose of this thesis.

Third, the chosen boundary-line should have influence on, whether directly or indirectly, all the resource curse effects. Of course, the resource curse may not be caused by just one factor. However, finding the most influential factor which is related to the resource curse effects, and what are considered as the causes of the resource curse, may be the best boundary-line as the difference of this factor can influence on many resource curse effects.

These necessities, or requirements, will act as the three filters to select the most suitable boundary-line. Figure 8 presents the resource curse effects and causes of the resource curse mentioned throughout this thesis which will go through the three filters mentioned above.

Figure 8: The Resource Curse Effects and Causes

The first filter requires that the boundary-line should be applicable for both the resource cursed countries and resource curse avoided/escaped countries. Therefore, after the first filter, one will have government/governance, institutions, resource rent, saving/spending behavior, taxation, and volatility remained. Some of the eliminated ones are rather the resource curse effects, such as the Dutch disease, and others can be considered as parts of the chosen candidates. For example, the centralized political model and decentralized political model can go under the government/governance and institutions. Of course, some of the chosen candidates are also parts of the resource curse effects. The reason why they are chosen is that, as the purpose of the first filter, they are elements that, whether resource cursed or not and whether resource-abundant or not, they are the elements that all countries have in general.

When one applies the second filer to the remained candidates, the outcome may vary. As mentioned earlier, the boundary-line should be applicable for both the resource curse and the solar energy curse, and the remained candidates may appear as they are all applicable. What are definitely applicable are government/governance, institutions and resource rent. The saving/spending behavior should be eliminated as explained earlier in section 4.2.4. When it comes to the volatility, it is true that it will also occur for solar energy. However, as mentioned in section 4.1, solar energy is a renewable energy which means that its volatility is expected to be much lower than other resources such as oil. Therefore, volatility will be eliminated. In the case of taxation, when perceived as the resource curse effect, one can not be sure whether it will become a problem for the solar energy as it is uncertain whether solar energy will provide enough revenues for the government not to rely on taxes from their citizens. It is true that taxation is connected to accountability, however, taxation itself is not an element that can cause the resource curse as it becomes a problem due to other factors such as resource rents and government/governance. Therefore, taxation is eliminated.

The remaining candidates are government/governance, institutions, and resource rents. If these candidates have direct/indirect influences on all the resource curse effects, satisfying the third requirement, they can be considered as the boundary-line(s). Here, it must be mentioned that the term governance and institutions are often used interchangeably. According to Stevens & Dietsche (2008, p.59), for example, when measuring institutional quality, governance indicators are often used as proxies. Therefore, throughout this thesis, governance and institutions will be viewed as one factor. Thus, this candidate will be referred to as 'institutional quality'.

In the case of the resource rents, whether in the current resource curse or in the solar energy curse, it has to be qualified as being the boundary-line as the resource curse itself would not have become an issue if there has been no rents from resources. However, it is questionable whether resource rents alone can create all the resource curse effects as it is also highly dependent on how the resource rent is being utilized. This is where the institutions, or institutional quality, come in. Institutional quality is probably even more of a suitable boundary-line as institutions exists in every country whether resource cursed or not, or even resource-rich or not. In other words, all the resource curse effects are connected to the resource rent and institutions. Therefore, resource rent and institutional quality will be chosen as the final candidates which will be used as the boundary-lines to find the resource curse.

Chapter 5. Checking the Boundary-lines and Finding Limitations

In Chapter 4, resource rents and institutions are qualified as the boundary-lines to distinguish between the resource cursed countries and the resource curse avoided/escaped countries. The purpose of this chapter is to test the chosen boundary-lines to verify that they can be utilized to project the possibility of the solar energy curse in the future. Both qualified boundary-lines will be individually tested in this chapter.

5.1 Resource Rent and its Contribution to GDP & GDP Growth as the Boundary-line

When employing resource rents as a boundary-line to identify resource curse affected countries, one is faced with a great difficulty. Although it may be true that many resource-rich countries are suffering from the resource curse, it is however not sufficient to say that the resource rent itself is the cause of the resource curse as it is rather the way the resource rent is being used or utilized. Nevertheless, as resource rents is considered as the boundary-line, It is necessary to analyze whether it could potentially function as the boundary-line.

Economic growth plays a relatively large role in examining whether a county is affected by the resource curse or not. This is because, as mentioned in chapter 2, the poor economic growth of a resource-rich economy is often regarded as a consequence of the resource curse. Sachs & Warner (1997) consider a country to be suffering from the resource curse if it has a high share of resource exports in GDP and, during that period, experiences a poor economic growth rate compared to similar countries or an average region value. For instance, as mentioned in section 4.2.1, they look at 97 countries, between 1971 and 1989, using regression analysis to measure the impact of mineral and other resource exports share on GDP. Their finding is that an economy with a high share of resource exports to GDP in 1971 had a very slow growth rate. Here, the resource exports share of GDP will be perceived as the impact of the resource rents in this section. In other words, the resource exports share of GDP can represent the resource rent’s impact, and it would be worth trying to use this as the boundary-line to find which countries are affected by the resource curse. Therefore, based on Sachs & Warner’s (1995,1997) approach, this section will attempt to find whether the five North African countries are affected by the resource curse by looking at the resource export share in GDP and comparing the GDP growth during the same period.

When identifying which North African countries have been affected by the resource curse, Algeria and Libya (and possibly Egypt) stand out. However, as mentioned before, the energy importers, Morocco and Tunisia (also Egypt) will be included in the process in this section as it will help one to see their current position compared to the countries affected by the resource curse. For example, if the rent size of solar energy can be projected, one can see how much its share will be of their GDP. If this 'share of the resource rent in GDP boundary-line' were to work, one can project if the energy importers have the potential to suffer from a solar energy curse.

As Sachs & Warner (1997) argue, the comparison should be made within countries with similar development statuses or an average region value. Therefore, taking the five North African countries in the GDP growth comparison is appropriate as they are in the same region and are all developing countries. However, the comparison only among the five countries will not provide accurate results as there are only three countries, Algeria, Libya and Egypt, which have the potential to be affected by the resource curse. Furthermore, Egypt occupies a unique position as it is both an exporter and importer of energy. Accordingly, one should broaden the range for the comparison in order to achieve more accurate results. Here, the MENA countries are considered suitable to be in the comparison as most of the MENA countries are developing countries, and they are in the same/close region. Therefore, the whole MENA region will be included in the process of comparing the GDP growth. One should note that the MENA region/countries are defined differently dependent on how one views them. For example, the World Bank considers 19 countries[11] as the MENA countries whereas the International Monetary Fund (IMF) considers 20 countries[12] as the MENA countries. Therefore, in this section, there will be three MENA country groups in accordance to the World Bank, the IMF, and the mutual countries selected from the World Bank and the IMF.

First, the average GDP growth during the period of 1993-2011 in the five North African countries and the average of the MENA countries will be compared in order to see where these five North African countries stand within the region. The reason for choosing the period 1993-2011, instead of a longer period, is due to the purpose of this thesis. If one is to just focus on the current resource curse, it should, indeed, choose to consist of a longer period of time. However, this thesis is dealing with solar energy, and its potential curse. As the use of solar energy in this region is still in its infancy, GDP growth in earlier period prior to the introduction of solar energy is not as relevant as the chosen period of focus. Therefore, for continuous future studies, it makes more sense to see recent GDP growth. Also, some may argue that, if this thesis were to only focus on the future, one should just use the GDP growth of the most recent year rather than the average GDP growth over a longer time frame. However, only looking at the GDP growth of a single year would not produce an accurate

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[11] Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Libya, Morocco, Oman, Qatar, Syria, Tunisia, UAE, West Bank and GAZA, Yemen

[12] Algeria, Bahrain, Djibouti, Egypt, Iran, Iraq, Jordan, Kuwait, Lebanon, Libya, Mauritania, Morocco, Oman, Qatar, Saudi Arabia, Sudan, Syria, Tunisia, UAE, Yemen

result as the GDP growth of a single year in a country may be greatly different from the previous or following year due to various reasons such as political changes or volatility of the resource they export. Furthermore, this section is based on Sachs & Warner's (1995,1997) idea which compares the economic growth of countries with a high share of resource exports in GDP in the same period of time to find which countries are in the resource curse.

Table 5: Average GDP Growth between 1993 and 2011 in the Five North African Countries, the NA and the MENA Countries[13]

<table>
<tr><th colspan="2">Algeria</th><th colspan="2">Egypt</th><th colspan="2">Libya</th><th colspan="2">Morocco</th><th colspan="2">Tunisia</th><th colspan="2">The Five GDP Average (IMF)</th></tr>
<tr><td colspan="2">2.98</td><td colspan="2">4.84</td><td colspan="2">1.74</td><td colspan="2">4.04</td><td colspan="2">4.22</td><td colspan="2">3.56</td></tr>
<tr><th colspan="4">MENA GDP Average (World Bank)</th><th colspan="4">MENA GDP Average (IMF)</th><th colspan="4">MENA GDP Average (World Bank & IMF)</th></tr>
<tr><td>All</td><td colspan="2">Exclude the five</td><td>ME/NA</td><td>All</td><td colspan="2">Exclude the five</td><td>ME/NA</td><td>All</td><td colspan="2">Exclude the five</td><td>ME/NA</td></tr>
<tr><td>4.54</td><td colspan="2">4.89</td><td>5.14/3.24</td><td>4.57</td><td colspan="2">4.90</td><td>5.21/3.61</td><td>4.47</td><td colspan="2">4.74</td><td>4.97/3.61</td></tr>
</table>

Source: World Economic Outlook Database September 2011, World Development Indicators (WDI)

As can be seen from the comparison in table 5, the average GDP growth for the energy exporters, Algeria and Libya, is lower than the average GDP growth of the MENA, ME, and NA countries and also within the five North African countries. However, if Egypt is considered as an energy exporter, it can be argued that energy exporters experience higher economic growth than other countries in the region as well as achieving higher economic growth than the average MENA and NA countries. However, its GDP growth is below the average GDP growth of the ME countries.

Table 5 also presents the comparisons among the average GDP growth of the MENA, the average GDP growth of the MENA excluding the five North African countries and the average GDP growth in the ME and NA regions. Despite which countries are considered to be in the MENA region, it can be perceived that the average GDP growth of the MENA region increases when excluding the five North African countries. Another finding is that the ME region, in general achieved higher economic growth compared to the NA region.

Overall, table 5 shows that the two energy exporters, Algeria and Libya, have been performing poorly in their economic growth when compared to the other MENA countries in general. However,

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[13] The World Economic Outlook Database September 2011 does not provide the full annual GDP growth for all the countries. For Iraq, it there was missing years, 1993 to 2004. Therefore, the World Bank Development Indicator was used to present the period 1998-2004, but still missing 1993 to 1997. The GDP growth for West Bank and GAZA was also provided from the World Bank Development Indicator which covered 1995-2005. Also, the GDP growth in 2011 for Libya is missing.

the comparisons that are made in table 8 provide insufficient results to consider that the two energy exporters and other MENA countries are affected by the resource curse. In order to specifically identify which countries are affected by the resource curse, one should make the comparison among energy exporters. This comparison was made in table 5, but only among the five North African countries, technically only between Algeria and Libya, thus producing inaccurate results. Therefore, in order to achieve more accurate results, the MENA region should be divided into energy exporters and importers. Also, in the bigger picture, when the comparison is made between energy exporters and importers, it will enable one to see whether energy importers really outperform energy exporter in general, at least within the region. This process may not show which countries are affected by the resource curse individually, but it may show that if the resource-rich countries are outperformed by the resource-poor countries as mentioned in section 2.2, thus proving the existence of the resource curse itself.

When dividing the five countries into the energy exporters and importers, the placing of Egypt becomes problematic. Egypt can not be excluded from the category of energy exporters, nor energy importers. When compared to Algeria and Libya, Egypt may not be considered as an energy exporter as its oil and natural gas rents share of the GDP is substantially lower than the other two countries. For example, the average oil and natural gas rents share of the GDP in the period of 1993-2009 for Algeria, Egypt and Libya were 26.65 percent, 12 percent, and 42 percent, accordingly.[14] However, the share of oil and natural gas rents to take 12 percent of the GDP is not a small amount. For example, Mehlum et al. (2006b, p.1) considers that 10 percent resource export share in the GDP as a high rate. In other words, Egypt can be considered as both energy exporter and importer. Therefore, when comparing energy exporters and importers in the MENA and NA regions, all the comparison that are made will present the results including/excluding the average GDP growth of Egypt in both of the exporters and importers categories. Also, it would mean that countries which are considered as energy exporters in this section should have more than 10 percent share of oil, natural gas and other mineral resources exports in their GDP during the period of 1993-2009[15] which are presented in table 6 below. As can be perceived from table 6, Algeria, Bahrain, Egypt, Iran, Iraq, Kuwait, Libya, Oman, Qatar, Saudi Arabia, Syria, United Arab Emirates (UAE), and Yemen will be considered as energy exporters.

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[14] See table 6.

[15] The year 2010 and 2011 are not provided by the World Development indicators.

Table 6: Resource Rents (% of GDP) of the MENA Countries during the Period of 1993-2009

Country	Mineral Rents (% GDP)	Natural gas rents (% GDP)	Oil rent (% of GDP)	Total rents (% of GDP)
Algeria	0	13	13.65	26.65
Bahrain	0	8.06	18.47	26.43
Djibouti	0	0	0	0
Egypt	0.06	4.65	7.29	12
Iran	0.12	6.35	25.88	32.35
Iraq[16]	0	1.33	86.75	88.08
Israel	0	0	0	0
Jordan	0	0	0	0
Kuwait[17]	0	2.5	45.38	47.88
Lebanon	0	0	0	0
Libya	0	3	39	42
Mauritania				
Morocco	0.82	0	0	0.82
Oman	0	7.35	34.18	41.53
Qatar	0	14.41	24.82	39.23
Saudi Arabia	0	3.06	39.82	42.88
Syria	0.12	2.76	21.71	24.59
Tunisia	0	3.04	3.94	6.98
UAE	0	5.53	24.59	30.12
West Bank and Gaza	0	0	0	0
Yemen	0	0	31.82	31.82

Source: World Development Indicators (WDI)

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[16] The average is made between 1997 and 2009 as the year between 1993 and1996 is not provided.

[17] The average is made between 1993 and 2008 as the year 2009 is missing.

Table 7: Average GDP Growth Comparison between Energy Exporters of the NA and the MENA Countries 1993-2011[18] (%)

(Numbers in brackets present the GDP growth excluding Egypt)

Algeria, Egypt, Libya		3.19%
Algeria, Libya		2.36%
World Bank	MENA	4.79% (4.93%)
	Exclude Algeria, Libya	5.43%
	Exclude Algeria, Egypt, Libya	5.5%
	ME	5.5%
	NA	3.19% (2.36%)
IMF	MENA	4.65% (4.74%)
	Exclude Algeria, Libya	5.12%
	Exclude Algeria, Egypt, Libya	5.14%
	ME	5.23%
	NA	3.8% (3.54%)
World Bank + IMF	MENA	4.65%
	Exclude Algeria, Libya	5.12%
	Exclude Algeria, Egypt, Libya	5.14%
	ME	5.23%
	NA	3.8% (3.54%)

Source: World Economic Outlook Database September 2011, World Development Indicators (WDI)

Table 7 presents the GDP growth comparisons among the energy exporters in the five North African countries, the MENA energy exporters, the MENA energy exporters excluding the energy exporters of the five North African countries, and the ME and NA energy exporters. One can see that the average GDP growth of the energy exporters of the five North African countries, whether including/excluding Egypt, is lower than the average GDP growth of the energy exporters of the MENA, ME and NA countries, except for the result from the World Bank for the NA region.[19] This may mean that the North African energy exporters may be closer to the resource curse than the other countries in the region.

Despite which countries are considered in the MENA region or not, according to table 7, it

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[18] The World Economic Outlook Database (September 2011) does not provide the full annual GDP growth for all the countries. For Iraq, it there was missing years, 1993 to 2004. Therefore, the World Bank Development Indicator was used to present the period 1998-2004, but still missing 1993 to 1997. The GDP growth for West Bank and GAZA was also provided from the World Bank Development Indicator which covered 1995-2005. Also, the GDP growth in 2011 for Libya is missing.

[19] The average GDP growth of the energy exporters of the five North African countries is the same as the average GDP growth of the NA countries from the World Bank's result. It is due to the fact that the energy exporters from the five North African countries are the only countries that are considered as energy exporters in the World Bank's result.

appears the ME energy exporters, in general, perform better in their economies compared to the NA energy exporters. However, it would be incorrect to assume that all NA energy exporters perform worse economically, or closer to the resource curse, than the ME energy exporters because, for instance, Sudan achieved higher average GDP growth (5.68 percent) than many ME energy exporters which achieved the third highest average GDP growth in the MENA region during the period of 1993-2011 (world Economic outlook Database, September 2011). This may also be the reason why the average GDP growth of the NA countries excluding the three North African energy exporters is higher than the average GDP growth of the energy exporters of the five North African countries whether including/excluding Egypt.

Nevertheless, what can be concluded from table 7 is that, though it may provide uncertain information about which region, ME or NA, is closer to the resource curse, one could argue that the North African energy exporters are closer to the resource curse than the other countries in the region in general when comparing the average GDP growth.

Table 8: Average GDP Growth: Comparison among the Energy Importers of the MENA, ME, NA, and the North African Energy Importers 1993-2011

Egypt, Morocco, Tunisia	4.37	
Morocco, Tunisia	4.13	
World Bank	MENA	3.98
	Exclude Morocco, Tunisia	3.93
	Exclude Egypt, Morocco, Tunisia	3.74
	ME	4.28
	NA	3.49 (3.15)[20]
IMF	MENA	4.12
	Exclude Morocco, Tunisia	4.12
	Exclude Egypt, Morocco, Tunisia	3.88
	ME	5.02
	NA	3.68 (3.29)[21]
World Bank + IMF	MENA	3.98
	Exclude Morocco, Tunisia	3.93
	Exclude Egypt, Morocco, Tunisia	3.74
	ME	4.28
	NA	3.49 (3.15)[22]

Source: World Economic Outlook Database September 2011, World Development Indicators (WDI)

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[20] Excluding Egypt.

[21] Excluding Egypt.

[22] Excluding Egypt.

Table 8 presents comparisons among the average GDP growth of the North African energy importers, the MENA energy importers, the MENA energy Importers excluding the three North African countries and the ME and NA energy importers. As can be seen from table 8, the average GDP growth of the energy importers of the North African countries, whether including/excluding Egypt, was higher than the average GDP growth of the energy importers of the MENA countries and the NA countries. However, the result varies when it is compared to the ME region.

From the result based on World Bank and World Bank + IMF, the average GDP growth of the three North African countries is higher than the ME countries. However, when Egypt is excluded, the two North African countries' average GDP growth is lower than the ME countries. This is because, in the three North African countries, Egypt (4.84 percent) has comparably higher average GDP growth than Morocco (4.04 percent) and Tunisia (4.22 percent). Also, in the ME energy importers, though other countries achieved relatively high average GDP growth, West Bank and GAZA (2.73 percent) performed exceptionally poor compared to the other ME countries which appears as the reason why the average GDP growth of ME countries is substantially low.

For the result from the IMF, the average GDP growth of the three North African importers, whether including/excluding Egypt, was lower than the ME countries. It is due to the fact that energy importers, according to the IMF result, from the ME region are only Jordan (5.45 percent) and Lebanon (4.58 percent) which have relatively higher average GDP growth compared to the NA energy importers. For example, Jordan's average GDP growth is higher than all the individual NA countries, and Lebanon also has a higher average GDP growth than the NA countries except for Egypt. The comparison between the energy importers in the MENA region seems more complex than for the energy exporters. This may be due to the fact that out of 23 MENA countries, combining the countries from the World Bank and IMF, only seven countries are energy importers, and it makes the difference in their individual average GDP growth steeper. In other words, the average GDP growth substantially changes accordance of which countries to be included/excluded. Despite which countries to be considered in the MENA region, table 8 suggests that the ME energy importers, in general, performed better in their economies than the NA energy importers.

When one compares table 7 and table 8, a number of interesting results can be obtained. If one compares the average GDP growth between the North African energy exporters and importers, whether including/excluding Egypt, the energy importers achieved higher average GDP growth. In other words, the idea that resource-poor countries outperform resource-rich countries works. However, when looking at the comparison made outside of the five North African countries, which shows broader sites, most of the results are opposite except for the World Bank's result between the NA energy exporters and energy importers.

As can be concluded from the comparisons made above, the average GDP growth comparison alone does not seem to be the method that one can fully rely on in finding the resource curse as some energy export dependent countries achieve higher average GDP growth than energy importers, vice versa, and there is also a huge difference in the GDP growth among individual energy importers/exporters in the MENA, ME and NA region. However, this is not to say that the comparison of the GDP growth is a useless method in finding the resource curse. It definitely has the potential to function as a tool in identifying the resource curse but, as mentioned earlier, the average GDP growth comparison alone does not seem to have the ability to provide a clear distinction between the resource cursed and the non-resource cursed countries, or even the existence of the resource curse, thus inaccurate. In other words, more precise method should be implemented and used in order to achieve a better result in finding the resource curse.

5.2 Applying other 'Filters' on the GDP Growth Comparison Methods

One of the major problems in the average GDP growth comparison made in section 5.1 may be that it focused on classifying, and separating, the MENA countries and the five North African countries based on only their statuses of being energy exporter/importer. One could also argue that there are other factors that can put the MENA countries into different categories. Therefore, this section will apply some other 'filter's on the GDP growth comparison method for its improvement, and see whether it could provide more efficient results.

5.2.1 Income Level

The World Bank classifies economies into five groups based on their income level, low income economies, lower-middle income economies, upper-middle income economies, high income economies, and high income OECD members (World Bank Data Countries and Economies). The Gross National Income per capita is the main criterion for classifying economies.

Here, economies with low income levels and middle income levels are sometimes referred to as developing economies by the World Bank (World Bank Data How we Classify Countries). Many MENA countries are considered as developing countries as well. When the MENA countries are separated into energy exporters and importers, these countries can be separated again via different income-level given by the World Bank. Therefore, this section will test the World Bank's 'income level' filter on the GDP growth comparison method in order to see if the GDP growth comparison method can improve.

Table 9: Breaking the MENA Countries into Different Income Level Categories[23]

World Bank + IMF	Energy Exporters	Energy Importers
High income	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia**, United Arab Emirates	Israel*
Upper middle income	Algeria, Iran, , Libya, Tunisia	Jordan, Lebanon
Lower middle income	Egypt***, Iraq, Mauritania**, Morocco, Sudan**, Syria, *, Yemen	Djibouti, Egypt***, West Bank GAZA

Source: The World Bank Data Countries and Economies
http://data.worldbank.org/country (accessed: 21.02.2012)

Table 9 divides the MENA countries into three categories according to their income levels. What one can notice from table 9 is that there are no NA countries with the high income level, and there are six ME energy exporters with the high income level. Though it is not certain, this fact may have played a significant role for the results provided from the GDP growth comparisons made in 5.1 where the MENA and ME energy exporters have higher average GDP growth compared to the energy importers which is opposite of what Sachs & Warner (1997) argue.

Table 10: Dividing the MENA Countries according to the Income Level

Upper Middle Income MENA countries Average GDP Growth (1993-2011)

Algeria	Libya	Tunisia	The Three Average	Upper middle (World Bank)	Upper middle (IMF)	Upper middle (World Bank & IMF)
2.98	1.74	4.22	2.98	3.83	3.83	3.83

Lower Middle Income MENA Countries Average GDP Growth (1993-2011)

Egypt	Morocco	The Two Average	Lower middle (World Bank)	Lower middle income (IMF)	Lower middle (World Bank & IMF)
4.84	4.04	4.44	3.82	4.18	4.02

Source: World Economic Outlook Database, September 2011, World Development Indicators (WDI), World Bank Data GDP growth (Annual%)

Table 10 presents the average GDP growth comparison between the five North African countries and the other upper and the middle income MENA countries. High income countries are excluded in this comparison because none of the five North African countries have high income level.

For the upper-middle income countries, Algeria and Libya have lower average GDP growth than

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[23] * only from the World Bank, **only from the IMF ***Both energy exporter/importer

the average GDP growth of the MENA countries. It is only Tunisia that has a higher average GDP growth compared to the other upper-middle income MENA countries. Here, it should be noted that Tunisia and the rest of the upper-middle income MENA countries, Jordan (5.45 percent) and Lebanon (4.58 percent), are energy importers, and Algeria and Libya are energy exporters. In other words, within the upper-middle income MENA countries, the energy importers outperform the energy exporters.

In the case of lower-middle income MENA countries, however, the result is different from the upper-income MENA countries. The average GDP growth of Egypt and Morocco is higher than the average GDP growth of the lower-middle income countries. However, when the average GDP growth of Egypt and Morocco are separately compared to the lower-middle income MENA countries, it is only Egypt that has a higher average GDP growth. Morocco also achieves the higher average GDP growth compare to the lower-middle income MENA countries, however, not from the IMF result. It is due to the fact that the IMF includes Sudan (5.68 percent) and Iraq (5.59 percent) as the lower-middle income countries which have higher average GDP growth than Morocco. Also, regarding the lower-middle income MENA countries, the case that the energy importers outperform the energy exporters does not apply. When using the result from the World Bank + IMF, there are nine lower-middle-income MENA countries[24], and already four countries, Sudan Iraq, Egypt (if considered as an energy exporter), and Yemen, have the better average GDP growth than the energy importers.

Furthermore, the lower-middle income countries from the five North African countries (Egypt and Morocco) achieve better average GDP growth than the upper-middle income countries (Algeria, Libya and Tunisia). A more extreme case can be also witnessed where Egypt (4.84 percent) has a higher average GDP growth than some of the high income MENA countries such as Oman (4.25 percent) and Saudi Arabia (2.79 percent). These facts show the income level does not always correlate with the average GDP growth which suggests that the pure combination of the income level and the average growth may not be a suitable method in finding the resource curse. However, one should take careful consideration when deciding to eliminate such a method as adding few critical filters may improve the method such as 1) the separation between the energy importers and the exporters in the region; 2) separation between the ME and NA countries as the ME countries perform better than the NA countries in terms of the GDP growth which is found in 5.1.

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[24] Sudan, Iraq, Egypt, Morocco, Mauritania, Syria, West Bank GAZA, Djibouti.

Table 11: Dividing the MENA Countries according to the Income Level after adding the Two Filters 1993-2011

Upper Middle Income MENA Countries			Upper Middle Income MENA Exporters			Upper Middle Income MENA Importers		
WB	IMF	WB+IMF	WB	IMF	WB+IMF	WB	IMF	WB+IMF
3.83	3.83	3.83	2.9	2.9	2.9	5.02	5.02	5.02
Lower Middle Income MENA Countries			**Lower Middle Income MENA Exporters**			**Lower Middle Income MENA Importers**		
WB	IMF	WB+IMF	WB	IMF	WB+IMF	WB	IMF	WB+IMF
3.82	4.18	4.36	4.59 (4.51)	4.63 (4.59)	4.63 (4.59)	3.31 (2.79)	3.50 (2.83)	3.31 (2.79)
Upper Middle Income ME Countries			**Upper Middle Income ME Exporters**			**Upper Middle Income ME Importers**		
WB	IMF	WB+IMF	WB	IMF	WB+IMF	WB	IMF	WB+IMF
4.67	4.67	4.67	3.98	3.98	3.98	5.02	5.02	5.02
Lower Middle Income ME Countries			**Lower Middle Income ME Exporters**			**Lower Middle Income ME Importers**		
WB	IMF	WB+IMF	WB	IMF	WB+IMF	WB	IMF	WB+IMF
4.07	4.51	4.36	4.51	4.51	4.51	2.73	-	2.73
Upper Middle Income NA Countries			**Upper Middle Income NA Exporters**			**Upper Middle Income NA Importers**		
WB	IMF	WB+IMF	WB	IMF	WB+IMF	WB	IMF	WB+IMF
2.98	2.98	2.98	2.36	2.36	2.36	4.22	4.22	4.22
Lower Middle Income NA Countries			**Lower Middle Income NA Exporters**			**Lower Middle Income NA Importers**		
WB	IMF	WB+IMF	WB	IMF	WB+IMF	WB	IMF	WB+IMF
3.50	3.98 (3.77)	3.98 (3.77)	4.84	4.75 (4.71)	4.75 (4.71)	3.50 (2.83)	3.50 (2.83)	3.50 (2.83)

Source: World Economic Outlook Database September 2011, World Development Indicators (WDI), The World Bank Data GDP growth(annual%)

Table 11 presents the results after applying the two filters offered earlier. In the case of the energy exporters for all the MENA, ME, and NA regions, all the lower-middle income exporters outperformed the upper-middle income exporters. However, in the case of the energy importers for all the MENA, ME, and NA regions, exactly the opposite results have been achieved. Therefore, this disproves the assumption that a high-income economy has a higher level of GDP growth.

For the comparison among the upper-middle income MENA, ME and NA countries, as seen earlier, the energy importers outperform the energy exporters. However, in the lower-middle income countries comparisons, complete opposite results are obtained. In all separate comparisons among the MENA, ME and NA regions, all the lower-middle income energy exporters outperform the energy importers.

Above finding shows that the use of this method, which is based on the correlation between the income level and status of being energy exporter/importer, is problematic in identifying the resource curse. Furthermore, it is found that there is no clear correlation between income level and GDP growth. Also, the use of the second filter, the separation between the ME and NA countries, produced another complication rather than improving the method. For example, West Bank and Gaza is the only lower-middle income ME importer, result from the World Bank and the World Bank + IMF, and, there is not even a single lower-middle income ME importer from the IMF result. Similar case can be found in the upper-middle income ME exporters (only Iran), the upper-middle income NA importers (only Tunisia), and the lower-middle income NA exporters from the World Bank result (only Egypt). The GDP growth comparison between a single country and the average of few countries, of course, produces an inaccurate result.

The results from table 11 proves that the method combining the income level, the average GDP growth, and the country's status (regarding being an exporter/importer) is problematic when attempting to identify the resource curse. The failure of this method may be due to the combination of these three factors which complicates the process. However, perhaps, the main problem of this method is the indirect use of the income level as the development statuses of the countries. As seen earlier, a country with a higher income level does not mean that its average GDP growth is higher. Therefore, one needs to adapt a better filter to separate the countries which may bring more successful results.

5.2.2 Development Status

Although the method in 5.2.1 appears to have failed in identifying the resource curse, it has provided a useful point. As mentioned earlier, the World Bank refers low income and middle income economies as developing countries. Also, when considering the MENA countries, all the upper and lower middle income MENA countries are regarded as developing countries (World Bank Data Countries and Economies). However, classification of the countries by income level does not necessarily mean that it reflect development status (World Bank Data How we Classify Countries). Therefore, instead of using the income level, this section will apply the development status on the GDP growth comparison method.

One of the major problems in the method presented in 5.2.1 is that it concentrates too much in narrowing down and separating the countries into certain groups to achieve desired results. Therefore, this section will use a simpler method; the combination of the development status and the division of the countries between energy exporters and importers groups. Here, it must be mentioned that, though all the upper and lower middle income MENA countries are considered as developing countries according to the World Bank, four countries, Djibouti, Mauritania, Sudan, and Yemen, are considered as the ‘least developed countries’ according to the UN classification (UNCTAD, 2011, p. xi). As the development status is a major filter in this method, if a group is to contain the least developed countries, their average GDP growth will be calculated both with/without the least developed countries in this method. As none of the five North African countries are classified as a developed country, this ranking can be excluded from this analysis.

Table 12: Seeing the GDP Growth in the MENA Region: Dividing the MENA Countries according to the Development Status and Exporters/Importers 1993-2011[25]

The average GDP growth of the MENA developing countries (%)	World Bank	3.82 <3.98> (3.74) [3.89]
	IMF	4.03 <4.1> (3.97) [4.02]
	World Bank + IMF	3.94 <3.98> (3.88) [3.89]
The average GDP growth of the MENA developing energy exporters (%)	World Bank	3.87 <3.79> (3.71) [3.57]
	IMF	4.05 <3.79> (3.96) [3.57]
	World Bank + IMF	4.05 <3.79> (3.96) [3.57]
The average GDP growth of the MENA developing energy importers (%)	World Bank	3.92 <4.31> (3.77) [4.20]
	IMF	4.12 <4.63> (3.98) [4.57]
	World Bank + IMF	3.92 <4.31> (3.77) [4.20]
The average GDP growth of the ME developing energy exporters (%)	World Bank	4.38 <4.38>
	IMF	4.38 <4.38>
	World Bank + IMF	4.38 <4.38>
The average GDP growth of the ME developing energy importers (%)	World Bank	4.25
	IMF	5.02
	World Bank + IMF	4.25
The average GDP growth of the NA developing energy exporters (%)	World Bank	3.19 (2.36)
	IMF	3.8 <3.19> (3.54) [2.36]
	World Bank + IMF	3.8 <3.19> (3.54) [2.36]
The average GDP growth of the NA developing energy exporters (%)	World Bank	3.68 <4.37> (3.29) [4.13]
	IMF	3.68 <4.37> (3.29) [4.13]
	World Bank + IMF	3.68 <4.37> (3.29) [4.13]
The average GDP growth of the Five countries (%)	Exporters	3.19 (2.36)
	Importers	4.37 (4.13)

Source: World Economic Outlook Database, September 2011, World Development Indicators (WDI), World Bank Data GDP growth (Annual%)

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[25] ( ): exclude Egypt, < >: exclude the least developed countries, [ ]: exclude the least developed countries and Egypt.

Table 12 presents the average GDP growth comparison between the MENA, ME and NA developing energy exporters and importers.[26] When the average GDP growth between the MENA developing exporters and importers are compared, it is possible to find that in almost all cases, the energy importers have a higher average GDP growth than the exporters. A different result is obtained from the World Bank + IMF. This may be due to the fact that Iraq (5.59 percent) and Sudan (5.68 percent) achieved much higher average GDP growth compared to the other developing MENA exporters which brings up the entire developing MENA exporters' average GDP growth. For example, if Iraq and Sudan are excluded, the average GDP growth of the developing MENA exporters would be 3.60 percent (3.40 percent)[27], which is much lower than the initial result of the World Bank + IMF, 4.05 percent (3.96 percent)[28]. What is more important is the results which excluded all the least developed countries. The results show that, when excluding the least developed countries, the MENA developing energy importers have a higher average GDP growth. This suggests that development status may correlate with the exporters/importers difference and the GDP growth which can be used to identify the resource curse.

In the case of the ME developing energy exporters and importers, the idea that energy exporters are outperformed by energy importers does not work. All the results share the same countries for the developing ME exporters, and the average GDP growth of the energy exporters is higher than the energy importers except for the IMF result. When looking at an individual country, however, one can not conclude that all the energy exporters have a higher average GDP growth as it is only Iraq (5.59 percent) that has a higher average GDP growth than Jordan (5.45 percent) and Lebanon (4.58 percent). It is the average GDP growth of West Bank & Gaza (2.73 percent) which brings down the average GDP growth for the developing ME energy exporters. For example, if one excludes the West Bank & Gaza, the average GDP growth of the ME energy importers would be 5.02 percent which is much higher than the average GDP growth of the ME exporters' average GDP growth. Also, it must be mentioned that the reason why there is no change between the average GDP growth of the ME developing energy exporters before/after excluding the least developed countries (only Yemen) is that, though changed from 4.3775 to 4.38333, the numbers are rounded at the third decimal. And for the ME developing energy importers, there are no least developed countries.

When the average GDP growth of the NA developing exporters and importers are compared, the results attained are mixed. Except for the result from the World Bank, it shows that the NA developing exporters achieve higher average GDP growth than the energy importers. However, one

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[26] Developing countries include Algeria, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia, West Bank and Gaza.

[27] Excluding Egypt.

[28] Excluding Egypt.

can not conclude that all the NA exporters achieve a higher average GDP growth than the energy importers as it is only Sudan (5.68 percent) that achieved a higher average GDP growth than the energy importers. Also, Djibouti's average GDP growth (1.61 percent) brings down the average GDP growth substantially for the energy importers. For example, if one excludes Sudan and Djibouti when measuring the average GDP growth from the IMF and IMF + World Bank results, the average GDP growth for the importers becomes 4.37 percent (4.13 percent)[29], and 3.33 percent (2.82 percent)[30] for the energy exporters which shows the reversed results. When looking at the results excluding the least developed countries from the NA exporters and importers, it is possible to see that the average GDP growth of the energy importers are all higher than the energy exporters. This, again, shows that the development level may correlate with the exporters/importers difference and the GDP growth which can be used to identify the resource cursed countries in the region.

When one compares the average GDP growth between the energy exporters and the importers from the five North African countries, it shows that, whether Egypt is included in either sides or not, the energy importers achieve a better average GDP growth. Within the five North African countries, at least, it can be said that the energy importers outperform the energy exporters. Furthermore, one can see that, whether being an energy exporters or importers, ME countries, in general, achieved the better GDP growth than the NA countries.

By looking at the comparison made above, one can say that the idea that energy exporters being outperformed by energy importers does not always work. However, when excluding the countries that have substantially much higher or lower average GDP growth, the idea that energy importers have higher average GDP growth works better. Unfortunately, there are a number of findings, for example, Sudan (a least developed country and an energy exporter) has higher average GDP growth than many other developing countries, which brings uncertainty in using Sachs & Warner's (1997) method. The finding from this section does not present one with sufficient enough evidence that the idea of Sachs & Warner, economies with a high share of resource exports in GDP, during the same period, experience a slow economic growth when compared to similar countries or average region value, as the method in finding the resource curse.

In other words, the use of the average GDP growth between energy exporters and importers can not be a suitable boundary-line. Though, their method does improve when the development status is applied, one can not be sure that if the improved method alone can be used to identify the resource curse. In other words, the use of this method might be more suitable to 'check' the result from other, more accurate, boundary-line. This will be discussed later in this thesis.

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[29] Excluding Egypt.

[30] Excluding Egypt.

5.3 The Institutional Level as the Boundary-line

5.3.1 Identifying Suitable Sources to Measure Institutional Quality

In recent studies regarding the resource curse, institutional quality is perceived as a decisive factor that can place a country under the resource curse. For example, as presented earlier, Mehlum et al. (2006a, b) present convincing studies which emphasizes the importance of the institutional quality regarding the resource curse. Also, in section 4.3, institutional quality is chosen as a candidate for the boundary-line for checking which countries are affected by the resource curse and have the potential to be affected by a solar energy curse. Therefore, the aim of this section is to test whether the comparison of institutional quality among the MENA countries can be qualified as the boundary-line. This test is especially important for energy importers such as Morocco and Tunisia. For example, if this test is to work, the current institutional quality statuses may show which countries have already been affected by the resource curse but also may help in projecting which countries, especially the energy importers which are not currently affected, have the potential to suffer from a solar energy curse. Furthermore, in projecting which countries may suffer from a solar energy curse, the institutional quality comparison may be more relevant as the size of the rents provided by exporting solar electricity and the extent in which the North African countries will rely on this export is undeterminable.

When considering institutional quality as the boundary-line in identifying the resource curse, one faces great difficulty in measuring institutional quality itself, as this is a broad term which is linked to many socio political and economic aspects. Iimi (2006) emphasizes the importance of the institutional quality regarding the resource curse.[31] As can be seen in section 2.5.2, Iimi (2006) finds that Botswana's good institutional quality played a crucial role in protecting them from the effects of the resource curse. Here, when measuring institutional quality, he uses data from Kaufmann et al. (2003), which is based on the Worldwide Governance Indicators (WGI). As the GDP growth comparison method (Sachs & Warner 1997) is tested in section 5.1 and 5.2 in order to find whether the resource rent causes the resource curse, this section will also use the institutional quality comparison method (Iimi 2006) and the importance of the institutional quality notion (Mehlum et al., 2006a, b) to analyze whether it can be used as the boundary-line for identifying the resource curse.

Following Iimi's (2006) method, the WGI will be used in order to make the comparison of the institutional quality among the five North African countries and the MENA countries. Here, the reason for including the MENA countries is because the institutional quality comparison among only

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[31] See section 2.5.2 or table 3.

the five North African countries is too narrow of a range and may therefore not produce an accurate outcome. In other words, by using a broader range, one is more likely to achieve a general pattern of the institutional quality difference among the energy exporters and energy importers. Also, it must be noted that the reason for choosing the WGI is not only based on Iimi's (2006) work but also after conducting a comparison with other indicators sources. For example, UNDP (2007) presents information and data on 35 governance indicator sources including the Governance Matters V (1996-2005) (Kaufmann et al., 2006). According to UNDP (2007, p.56), the Governance Matters V (1996-2005), which is based on WGI data, is known as the most quoted and used governance indicator source in media, academia and among international organizations, which report aggregate and individual governance indicator for 213[32] economies over the period of 1996-2005.

As this thesis will use the WGI to measure institutional quality, it is necessary to see how it is constructed in order to have a clear understanding of its uses.

The WGI defines governance as "the traditions and institutions by which authority in a country is exercised. This includes (a) the process by which governments are selected, monitored and replaced; (b) the capacity of the government to effectively formulate and implement sound policies; and (c) the respect of citizens and the state for the institutions that govern economic and social interactions among them."(Kaufmann et al. 2010, p. 4).

The WGI are based on 30 different data sources[33] which report the views and experiences of citizens, entrepreneurs, and experts in the public, private and NGO sectors from around the world, on the quality of various aspects of governance. The WGI draws on four different types of source data including surveys of households and firm, commercial business information providers, non-governmental organizations, and public sector organizations.[34]

The WGI contains six aggregate governance indicators which are **Voice and Accountability, Political Stability and Absence of Violence, Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.[35]** According to the UNDP (2007, p.57), the WGI is the most comprehensive governance index and provides insight into how countries compare in the six areas of governance quality. The fact that the WGI presents the governance quality in six dimensions is particularly advantageous because the institutional quality[36] is a broad term which is problematic if

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[32] It is now over 200 countries over the period 1996-2011. http://info.worldbank.org/governance/wgi/resources.htm (accessed: 15.050.2013)

[33] See http://info.worldbank.org/governance/wgi/sources.htm (accessed: 15.05.2013)

[34] See http://info.worldbank.org/governance/wgi/resources.htm#sources (accessed: 15.05.2013) for more details.

[35] See table 13 for more specific description of each dimension.

[36] As mentioned in section 4.3, governance and institutions will be seen as one factor, therefore, refer to as institutional quality.

viewed as a single unit.[37] Also, the WGI's chosen period, 1996-2011, is rather recent which makes the WGI more suitable for the purpose of this thesis as the earlier institutional quality would be less relevant in identifying which countries are more in the danger of suffering from a solar energy curse.

Each of six aggregate WGI measures are constructed by averaging together that corresponds to the concept of governance being measured. Three main steps are taken in the process.

The first step is to assign data from individual sources to the six aggregate indicators. Individual questions from the data sources are assigned to each of the six aggregate indicators. For example, a firm survey question on the regulatory environment would be assigned to Regulatory Quality aggregate indicator.

The second step is to rescale the individual source data to run from 0 to 1. Here, a higher value corresponds to better outcomes. If an individual data source provides more than one question relating to a particular dimension of governance, they average together the rescaled sources.

The third step is to construct a weighted average of the individual indicators for each source by using an Unobserved Components Model (UCM)[38]. UCM is used to make the 0 to 1 rescaled data comparable across sources first, and construct a weighted average of the data from each source for each country. The UCM perceives that the observed data from each source are a linear function of the unobserved governance level, plus an error term. This linear function is different for each data sources, and therefore corrects for the remaining non-comparability of units of the rescaled data. The outcome of governance estimates are a weighted average of the data from each source. Here, weights reflect the pattern of correlation among data sources.

It must be noted that UCM assigns greater weight to data sources which are more strongly correlated with each other. According to Kaufmaan (2010, p.16), UCM's data-driven precision-weighting approach has the advantage of improving the precision of the overall aggregate indicators but does not affect much the ranking of countries on the aggregate indicators. This is one of the main reasons for WGI to choose this statistical tool. The composite measures of governance are in units of a standard normal distribution, with mean zero, standard deviation of one, and running from -2.5 to 2.5. Here, higher values indicate the higher quality of governance. It should be mentioned that the most important reason for choosing UCM is that this methodology generates margins of error for each governance estimates. WGI argues that these margins of error should be taken into account when making comparisons across countries and over time. More detailed explanation of margins of error will be illustrated in section 6.2.1.

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[37] Other studies also perceive institutional quality with different dimension. For example, Hlepas's (2013) index of national institutional quality has four pillars which contain Government Effectiveness, Regulatory Quality, Rule of Law, and Control of Corruption.

[38] Goldberger (1972) is known to be the pioneer of UCM.

Table 13: WGI's Six Aspects of Governances and Descriptions

Aspects	Description
Voice and Accountability (V·A)	Captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.[39]
Political stability and absence of violence (P·S & A·V)	Measures perceptions of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including politically-motivated violence and terrorism.[40]
Government effectiveness (G·E)	Captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formation and implementation, and the credibility of the government's commitment such policies.[41]
Regulatory quality (R·Q)	Captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development.[42]
Rule of law (R·L)	Captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular the quality of contract enforcement, property rights, the police, and the counts, as well as the likelihood of crime and violence.[43]
Control of corruption (C·C)	Captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests.[44]

Source: The Worldwide Governance Indicators (WGI)

Table 13 presents WGI's six aspects of governance and their description. Here, as mentioned in section 2.5.2, Iimi (2006) argues that four aspects, Voice and Accountability, Government Effectiveness, Regulatory Quality, and Control of Corruption, played a crucial role for Botswana to escape from the resource curse. However, it is not to say that other aspects, Political Stability and Absence of Violence and Rule of Law, are not important. For example, Mehlum et al. (2006a, b) accentuate the importance of rule of law and apply it as an indicator in measuring institutional quality. Also, Mehlum et al. (2006a, p.1121), considers a weak rule of law as one of the elements that leads to grabber-friendly institution which results in rent-seeking behavior.

In the case of the Political Stability and Absence of Violence aspect, it is hard to find evidence that, especially in the resource-rich countries, better political stability is capable of reducing the violence. However, when looking at recent events in North Africa and more specifically at the murder

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[39] http://info.worldbank.org/governance/wgi/pdf/va.pdf (accessed: 30.11.2012)
[40] http://info.worldbank.org/governance/wgi/pdf/pv.pdf (accessed: 30.11.2012)
[41] http://info.worldbank.org/governance/wgi/pdf/ge.pdf (accessed: 30.11.2012)
[42] http://info.worldbank.org/governance/wgi/pdf/rq.pdf (accessed: 30.11.2012)
[43] http://info.worldbank.org/governance/wgi/pdf/rl.pdf (accessed: 30.11.2012)
[44] http://info.worldbank.org/governance/wgi/pdf/cc.pdf (accessed: 30.11.2012)

of Libya’s Colonel Gaddafi and the fall of his notorious regime, political stability within the region remains a major issue. This one example may not be convincing enough to say that the Political Stability and Absence of Violence aspect is relevant regarding the resource-rich countries or the resource curse itself. Nevertheless, it is worth including this aspect as one can test the correlation between the aspect and the resource curse. Therefore, all six aspects will be used to test the ability of the institutional quality comparison to be capable of being the boundary-line to measure the resource curse.

It must be noted that, though the enormous resource rent size is considered as one of the causes of the resource curse, it is more the poor management over the resources that is the determining factor which can bring about the resource curse. Here, institutional quality is closely related to the ‘resource rent management quality’. For example, Voice and Accountability can prevent the inappropriate spending of the resource rent (Iimi 2006); government effectiveness can prevent overexploitation of the resource wealth (Iimi 2006); Rule of Law prevents rent-seeking; Control of Corruption can improve genuine saving (Dietz et al. 2007). In other words, institutional quality is, therefore, related to the accountability, democracy, transparency, and other factors which are important elements, not only regarding the escaping or preventing the resource curse, for countries’ development. Furthermore, as it will be mentioned later, the improvement of institutional quality is necessary in preventing the already existing problems that are often fueled by the resource rent which, consequently, is perceived as the resource curse. Therefore, it makes it even more important to test and measure the all six institutional quality aspects in order to project the solar energy curse.

5.3.2 The Institutional Quality Comparison between Energy Exporters and Importers

The aim of this section is to test the correlation between institutional quality and the MENA countries’ statuses of being energy exporters or importers. More specifically, the purpose of this test is to see whether there is a general difference in the institutional quality between the MENA energy exporters and importers. Although there is no concrete proof that all the energy exporters generally have the worse institutional quality than the energy importers, if the MENA energy exporters turn out to have worse institutional quality compared to the MENA energy importers in general, it can indirectly support the assumption that the MENA energy exporters, more importantly the North African energy exporters, may be affected by the resource curse and more likely to suffer from a solar energy curse. Furthermore, if it were to be the case, when the general difference is found, it could also confirm that the institutional quality comparison can be used as the boundary-line to identify the resource curse and a solar energy curse in the future.

As mentioned earlier, the WGI presents the institutional quality of countries during the period of 1996-2011. In this test, the standard errors will not be included, and the average institutional quality during the period of 1996-2011 will be applied. Here, it must be mentioned that the average institutional quality during certain periods by using WGI may not be the appropriate way. However, the aim of this section is not specifically to find out whether the five North African countries are affected by the resource curse, but testing the correlations between the MENA countries' statuses of being energy exporters or importers and the institutional quality. It means that if a specific year is chosen to test the correlation between them, this could provide an inaccurate result as there might be a large difference in the institutional quality score from the chosen year and the previous/subsequent years depending on certain event taken in each year. However, this test will include the average institutional quality during the period of 1996-2011, recent period of 2007-2011, and a single year 2011. If there is no substantial difference among three chosen period, one could argue that the use of the average institutional quality during certain period to test the correlation between the MENA countries' statuses of being energy exporters or importers and the institutional quality can be considered relevant. Furthermore, it must be mentioned that the 95 percent confidence level will be applied throughout this thesis when using the WGI.

Table 14: The Institutional Quality Comparison between the MENA Energy Exporters and the Importers 1996-2011, 2007-2011, 2011[45]

	V&A	P·S & A·V	G·E	R·Q	R·L	C·C
MENA	-0.95 (-1.03) *-1.03	-0.56 (-0.68) -0.84	-0.28 (-0.28) *-0.30	-0.33 (-0.27) *-0.29	-0.25 (-0.27) *-0.32	-0.25 (-0.30) *-0.38
MENA Exporters	-1.14/-1.15 (-1.24/-1.24) *-1.26/-1.27	-0.50/-0.50 (-0.60/-0.58) *-0.83/-0.79	-0.38/-0.36 (-0.32/-0.31) *-0.35/-0.33	-0.45/-0.46 (-0.39/-0.40) *0.48/-0.49	-0.31/-0.33 (-0.31/-0.32) *-0.37/-0.37	-0.30/-0.28 (-0.33/-0.31) *-0.42/-0.40
MENA Importers	-0.65/-0.60 (-0.73/-0.68) *-0.68/-0.62	-0.66/-0.66 (-0.81/-0.82) *0.91/-0.86	-0.16/-0.14 (-0.23/-0.21) *-0.26/-0.22	-0.14/-0.12 (-0.08/-0.06) *-0.001/0.04	-0.12/-0.13 (-0.20/-0.20) *-0.25/-0.23	-0.21/-0.17 (-0.29/-0.25) *-0.34/-0.30
ME	-0.86 (-0.93) *-0.99	-0.52 (-0.68) *-0.76	-0.12 (-0.06) *-0.04	-0.16 (-0.06) *-0.04	-0.05 (-0.08) *-0.10	-0.09 (-0.12) *-0.22
ME Exporters	-1.07 (-1.17) *-1.23	-0.28 (-0.40) *-0.54	-0.17 (-0.09) *-0.08	-0.25 (-0.18) *-0.24	-0.12 (-0.12) *-0.15	-0.09 (-0.10) *-0.21
ME Importers	-0.33 (-0.35) *-0.41	-1.14 (-1.37) *-1.31	0 (-0.02) *0.07	0.09 (0.23) *0.48	0.12 (0.01) *0.03	-0.09 (-0.16) *-0.26
NA	-1.10 (-1.21) *-1.1	-0.63 (-0.68) *-0.99	-0.56 (-0.68) *-0.77	-0.64 (-0.63) *-0.74	-0.59 (-0.60) *-0.70	-0.54 (-0.62) *-0.65
NA Exporters	-1.33/-1.42 (-1.42/-1.51) *-1.36/-1.44	-1.08/-1.23 (-1.09/-1.19) *-1.57/-1.66	-0.84/-0.99 (-0.91/-1.07) *-1.03/-1.17	-0.96/-1.17 (-0.91/-1.15) *-1.08/-1.33	-0.80/-1.05 (-0.79/-1.00) *-0.92/-1.08	-0.82/-0.94 (-0.90/-1.00) *-0.96/-1.06
NA Importers	-0.90/-0.87 (-1.04/-1.00) *-0.90/-0.84	-0.27/-0.19 (-0.37/-0.26) -0.58/-0.41	-0.30/-0.28 (-0.44/-0.44) *-0.53/-0.52	-0.33/-0.33 (-0.32/-0.35) *-0.38/-0.40	-0.31/-0.37 (-0.36/-0.41) *-0.47/-0.49	-0.30/-0.26 (-0.39/-0.34) *-0.40/-0.34
The Five	-1.04 (-1.18) *-0.96	-0.45 (-0.44) *-0.87	-0.36 (-0.45) *-0.59	-0.54 (-0.49) *-0.66	-0.36 (-0.39) *-0.54	-0.44 (-0.54) *-0.60
The Five Exporters	-1.20/-1.28 (-1.34/-1.42) *-1.24/-1.30	-0.68/-0.71 (-0.58/-0.49) *-1.22/-1.18	-0.70/-0.87 (-0.77/-0.94) *-0.91/-1.07	-0.83/-1.09 (-0.77/-1.05) *-1.00/-1.34	-0.59/-0.86 (-0.61/-0.83) *-0.80/-1.00	-0.69/-0.80 (-0.75/-0.83) *-0.85/-0.94
The Five Importers	-0.87/-0.79 (-1.02/-0.94) *-0.74/-0.54	-0.28/-0.12 (-0.41/-0.22) *-0.66/-0.35	-0.02/0.15 (-0.12/-0.05) *-0.27/-0.10	-0.17/-0.09 (-0.11/-0.06) *-0.20/-0.14	-0.04/0.02 (-0.10/-0.06) *-0.24/-0.16	-0.21/-0.07 (-0.35/-0.22) *-0.38/-0.24

Source: The Worldwide Governance indicators (WGI)

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[45] Numbers without brackets represent the average institutional quality during the period of 1996-2011, numbers in brackets represent the average institutional quality during the period of 2007-2011, numbers after * represent the average institutional quality in 2011. Also, the number presented before the / is including Egypt, and the number presented after the / is excluding Egypt.

Table 14 presents the comparison of the institutional quality between the energy exporters and importers of the MENA, ME, NA and the five North African countries. The comparison between the MENA energy exporters and energy importers shows that, except for the Political Stability and Absence of Violence dimension, MENA energy importers have better institutional quality in all dimensions in all three periods. Also, except for the Political Stability and Absence of Violence dimension, the average institutional quality of MENA energy exporters is worse than the average institutional quality of the whole MENA countries, whereas the energy importers' average institutional quality is better than the average institutional quality of the whole MENA countries.

In the case of the comparison between the ME energy exporters and energy importers, except for the Political Stability and Absence of Violence and Control of Corruption dimensions, the ME energy importers have a better average institutional quality compared to the ME energy exporters. When looking at the Political Stability and Absence of Violence dimension, one can see that the ME energy importers have substantially worse score in institutional quality compared to ME energy exporters. In the case of the Control over Corruption dimension, though still the energy exporters score slightly better, the difference between the ME energy exporters and energy importers is not so wide. Furthermore, except for the two dimensions, the average institutional quality of the ME energy exporters is worse than the average institutional quality of the whole ME countries, whereas the ME energy importers' average institutional quality is better than the average institutional quality of the whole ME countries.

In the case of the comparison between the NA energy exporters and energy importers, the average institutional quality of the NA energy importers, in all dimensions, is better than the NA energy exporters whether including or excluding Egypt. Also, the average institutional quality of the NA energy exporters is worse than the average institutional quality of the whole NA countries, whereas the energy importers have a better average institutional quality than the average NA countries. Similarly, in the comparison between the five North African countries, one can obtain the same result as the NA case. Whether including/excluding Egypt, the energy importers have a better average institutional quality in all dimensions. Also, the average institutional quality for the energy exporters is worse than the average institutional quality of the five North African countries, whereas the energy importers have better institutional quality than the average of the five North African countries' institutional quality.

By looking at the result of the above test, in general, it appears that the MENA energy importers have better institutional quality compared to the energy exporters. Also, as mention earlier, this is more of the case within the NA countries and the five North African countries. Though it is not always the case, the finding that the MENA energy importers generally have better institutional quality than the MENA energy exporters confirms the potential of the institutional quality comparison method to be a suitable boundary-line to identify the resource curse. Therefore, one needs to find a way to improve this method.

5.3.3 Testing the Correlation between the Development Status and the Institutional Quality

In section 5.2.2, unlike the income level, it was found that development status plays a crucial role in improving the GDP comparison method in identifying the resource curse in the five North African countries and the MENA countries. Section 5.3.2 shows that the institutional quality comparison method has the potential to be the boundary-line. However, one needs to find a way to improve the method in order to achieve a more accurate result. Therefore, the aim of this section will be to test whether the application of the development status filter can improve the institutional quality comparison methods in identifying the resource curse. In order to tackle the aim of this section, it is necessary to test whether there is a sufficient correlation between development status and institutional quality. Therefore, the development status will be directly applied to the institutional quality method, without making any separation between the MENA energy exporters and energy importers. If a strong correlation is found, one can argue that the applying development status may improve the institutional quality comparison method in identifying the resource curse. In this test, again, both the five North African countries and the MENA countries will be included in the process in order to have wider range and to get a better result.

Table 15: Separating the Countries according to the Development Status[46]

Developed Countries	Developing Countries	Least Developed Countries (UN classification)[47]
Bahrain, Israel, Kuwait, Oman, Qatar, Saudi Arabia, UAE	Algeria, Egypt, Iran, Iraq, Jordan, Lebanon, Libya, Morocco, Syria, Tunisia, West Bank & GAZA	Djibouti, Mauritania, Sudan, Yemen

Source: The World Bank Data Countries and Economies http://data.worldbank.org/country (accessed: 08.05.2012)
UNCTAD (2011, Contents xi)

The MENA countries, including the five North African countries, are divided into three categories according to their development status in table 15. It must be noted that the list of developed

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[46] The selected MENA countries are both from the World Bank and the IMF lists.

[47] It must be mentioned that these four countries have been considered as the least developed countries by all the UNCTAD's the least developed countries report from 1996 until 2011.

countries can vary dependent on which sources one uses. For example, the IMF considers 35 countries as developed countries, or advanced economies in their term (IMF 2013, p.140). It must be noted that the developed countries listed in table 15 are considered as high income economies by the World Bank. Of course, as mentioned before, the income level does not necessarily reflect development status. However, there is a clear distinction between developing countries and high income countries according to the World Bank, as the listed developed countries are considered as either OECD high income countries or non-OECD high income countries whereas the listed developing countries in table 15 are clearly labeled as developing countries (The World Bank Data Countries and Economies). Therefore, the countries that are considered either OECD high income countries or non-OECD high income countries by the World Bank are seen as developed countries in this section.

In this test, again, the standard errors will not be included, and the average institutional quality during the periods of 1996-2011, 2007-2011, and the single year 2011 will be applied. If there is no substantial difference among three chosen period, as in section 5.3.2, one can assume that the use of the average institutional quality during certain period to test the correlation between the development status and institutional quality can be considered relevant.

Table 16: The Institutional Quality Comparison among the Three Development Statuses Groups of the MENA Region, and the Five North African Countries[48]

	V·A	P·S& A·V	G·E	R·Q	R·L	C·C
Developed Countries	-0.66 (-0.77) *-0.83	0.18 (0.15) *0.13	0.48 (0.55) *0.51	0.48 (0.55) *0.49	0.55 (0.56) *0.54	0.55 (0.55) *0.41
Developing Countries	-1.05 (-1.12) *-1.05	-0.83 (-0.97) *-1.23	-0.54 (-0.53) *-0.54	-0.69 (-0.59) *-0.59	-0.47 (-0.54) *-0.61	-0.58 (-0.66) *-0.71
Least Developed Countries	-1.16 (-1.26) *-1.34	-1.11 (-1.31) *-1.46	-0.89 (-1.03) *-1.10	-0.79 (-0.98) *-0.85	-1.02 (-0.98) *-1.04	-0.74 (-0.80) *-0.84
The Five	-1.03 (-1.18) *-0.96	-0.45 (-0.44) *-0.87	-0.36 (-0.45) *-0.59	-0.54 (-0.49) *-0.66	-0.36 (-0.39) *-0.54	-0.44 (-0.54) *-0.60

Source: The Worldwide Governance indicators (WGI)

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[48] Numbers without any brackets represent the average institutional quality during the period of 1996-2011, numbers in brackets represent the average institutional quality during the period of 2007-2011, numbers after * represent the average institutional quality in 2011.

Table 16 presents the institutional quality comparison among the three development status groups of the MENA countries and the five North African countries, in three different periods. As can be observed, in all six dimensions, during all three chosen periods, the average institutional quality is the highest in the developed countries and the lowest in the least development countries. Also, when the average institutional quality of the five North African countries, which are considered as developing countries, is compared to the three different development statuses groups, it is possible to see that their average institutional quality is between the average institutional quality of the developed countries and the average institutional quality of the least developed countries. This order occurs in all three given periods. Therefore, one can see that there is a strong correlation between development status and institutional quality. Furthermore, one can see that most of the average institutional quality scores of the five North African countries are higher than the average institutional quality of the MENA developing countries. In other words, if one is to use this method as the boundary-line, it may appear as the five North African countries are less likely to be in the resource curse, or less chances to suffer from a solar energy curse. However, it is dangerous to make such an assumption as this analysis is based on the average institutional quality, and, more importantly, the separation between the energy exports and the importers is not included in this test which is crucial when searching for the resource curse.

The fact that all more developed countries have higher institutional quality compared to the less developed countries in this test does not mean that one can assume that it is always the case because this analysis relies on the average institutional quality. The main point that should be derived from this analysis is that, though one can not conclude that the development status and the institutional quality are always parallel to each other, a strong correlation between the development status and the institutional quality is detected. In other words, the development status can be a crucial element which can improve the institutional quality comparison method in identifying the resource curse, or a solar energy curse.

5.3.4 Applying the Development Status on the Institutional Quality of the Energy Exporters and Importers

In section 5.3.2, it was argued that the institutional quality comparison has the potential to become the boundary-line to identify the resource curse in the five North African countries and the MENA countries. Though it has the potential, it appears that it needs certain improvements to obtain more accurate results. In section 5.3.3, fortunately, it is found that the application of the development status on the institutional quality comparison method can improve its process in identifying the resource curse. Thus, the aim of this section is to find out whether the application of the development status improves the institutional quality comparison method in identifying the resource curse when the separation of the energy exporters and importers is added.

Table 17: Dividing the Energy Exporters and the Importers based on the Development Status[49]

Developed MENA Exporters	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE
Developed MENA Importers	Israel
Developing MENA Exporters	Algeria, Egypt, Iran, Iraq, Libya, Syria
Developing MENA Importers	Egypt, Jordan, Lebanon, Morocco, Tunisia, West Bank & Gaza
Least Developed MENA Exporters	Mauritania, Sudan, Yemen
Least Developed MENA Importers	Djibouti
Developed ME Exporters	Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, UAE
Developed ME Importers	Israel
Developing ME Exporters	Iran, Iraq, Syria
Developing ME Importers	Jordan, Lebanon, West Bank & Gaza
Least Developed ME Exporters	Yemen
Least Developed ME Importers	None
Developed NA Exporters	None
Developed NA Importers	None
Developing NA Exporters	Algeria, Egypt, Libya
Developing NA Importers	Egypt, Morocco, Tunisia
Least Developed NA Exporters	Mauritania, Sudan
Least Developed NA Importers	Djibouti

Source: The World Bank Data Countries and Economies
http://data.worldbank.org/country (accessed: 08.05.2012)
UNCTAD (2011, Contexts xi)

Table 17 presents the division of the energy exporters/importers of the MENA, ME, NA, and the five North African countries based on the development status. By looking at table 17, one can foresee some of the obstacles in making fair comparisons. Based on the same development status, there are cases with only one energy importer and few energy exporters. For example, these cases can be seen in the MENA developed energy importer (Israel), the least developed MENA energy importer (Djibouti), the ME developed energy importer (Israel), and the NA least developed energy importer (Djibouti). Also, Yemen is the only country that is in the category of the ME least developed exporter. Furthermore, there are some cases that the comparisons are just impossible to be made as there are no countries in certain categories such as the ME least developed energy importers, NA

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[49] The Selected MENA countries combine the consideration of the World Bank and the IMF. The Least developed countries are from the UN classification.

developed energy exporters, and NA developed energy importers. It appears as, within the whole MENA countries, besides the comparisons between the developing exporters and importers, other comparisons are likely to produce inaccurate result due to the lack of candidates. Despite these obstacles, one can find that it is possible to make comparisons between the developing energy exporters/importers of the MENA, ME, and NA countries. The fact that these comparisons can be made is crucial because the five North African countries all fall in the category of developing countries. Therefore, the comparison between the developing energy exporters and energy importers of the MENA, ME, and NA will be made to test whether applying the development status on the institutional quality of the energy exporters/importers can improve the institutional quality comparison method. The standard errors will be excluded, and the average institutional quality during the periods of 1996-2011, 2007-2011, and the single year 2011 will be applied as before.

Table 18: The Institutional Quality Comparison between the Developing Energy Exporters and the Importers of the MENA, ME and NA Regions based on the Development Status[50]

	V&A	P·S&A·V	G·E	R·Q	R·L	C·C
MENA	-1.05 (-1.12) *-1.05	-0.83 (-0.92) *-1.23	-0.54 (-0.53) *-0.54	-0.69 (-0.59) *-0.59	-0.47 (-0.54) *-0.61	-0.58 (-0.66) *-0.71
MENA Exporters	-1.33/-1.39 (-1.40/-1.44) *-1.36/-1.40	-0.96/-1.03 (-1.03/-1.08) *-1.48/-1.52	-0.84/-0.94 (-0.79/-0.86) *-0.80/-0.84	-1.12/-1.27 (-1.02/-1.18) *-1.13/-1.29	-0.78/-0.92 (-0.84/-0.07) *-0.91/-1.01	-0.82/-0.89 (-0.91/-0.97) *-0.94/-0.99
MENA Importers	-0.76/-0.71 (-0.85/-0.78) *-0.75/-0.67	-0.67/-0.69 (-0.88/-0.90) *-0.99/-0.93	-0.21/-0.18 (-0.25/-0.21) *-0.29/-0.22	-0.20/-0.18 (-0.09/-0.07) *-0.08/0.06	-0.10/-0.10 (-0.19/-0.19) *-0.27/-0.24	-0.33/-0.29 (-0.40/-0.36) *-0.48/-0.44
ME	-1.06 (-1.07) *-1.12	-1.15 (-1.42) *-1.53	-0.69 (-0.59) *-0.50	-0.82 (-0.67) *-0.53	-0.56 (-0.67) *-0.66	-0.70 (-0.76) *-0.81
ME Exporters	-1.47 (-1.46) *-1.47	-1.24 (-1.48) *-1.75	-0.98 (-0.81) *-0.68	-1.40 (-1.27) *-1.25	-0.97 (-1.06) *-1.02	-0.95 (-1.06) *-1.03
ME Importers	-0.65 (-0.68) *-0.76	-1.06 (-1.35) *-1.32	-0.40 (-0.38) *-0.31	-0.24 (-0.08) *0.18	-0.15 (-0.28) *-0.29	-0.44 (-0.45) *-0.58
NA	-1.04 (-1.18) *-0.96	-0.45 (-0.44) *-0.87	-0.36 (-0.45) *-0.59	-0.54 (-0.49) *-0.66	-0.36 (-0.39) *-0.54	-0.44 (-0.15) *-0.60
NA Exporters	-1.2/-1.28 (-1.34/-1.42) *-1.24/-1.30	-0.68/-0.71 (-0.58/-0.49) *-1.22/-1.18	-0.7/-0.87 (-0.78/-0.94) *-0.91/-1.07	-0.83/-1.09 (-0.77/-1.05) -1.00/-1.34	-0.59/-0.86 (-0.61/-0.83) -0.80/-1.00	-0.69/-0.80 (-0.75/-0.83) -0.85/-0.94
NA Importers	-0.87/-0.79 (-1.02/-0.94) *-0.74/-0.54	-0.28/-0.12 (-0.41/-0.22) *-0.66/-0.35	-0.02/-0.15 (-0.12/0.05) *-0.27/-0.10	-0.17/-0.09 (-0.11/-0.06) *-0.2/-0.14	-0.04/-0.02 (-0.10/-0.06) *-0.24/-0.16	-0.21/-0.07 (-0.35/-0.22) *-0.38/-0.24

Source: The Worldwide Governance indicators (WGI)

Table 18 presents the institutional quality comparison between the developing energy exporters and energy importers of the MENA, ME and NA regions based on the Development status during three different periods. As can be observed in table 18, in all the average institutional quality comparisons made between the MENA, ME, and NA developing energy exporters and energy importers, the energy importers appear to have higher institutional quality than energy exporters in

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[50] Numbers without any brackets represent the average institutional quality during the period of 1996-2011, numbers in brackets represent the average institutional quality during the period of 2007-2011, numbers after * represent the average institutional quality in 2011. Also, the number presented before the / is including Egypt, and the number presented after the / is excluding Egypt, as Egypt can be consider both energy exporter/importer.

all dimensions. One should notice that the NA countries in table 18 only involve the five North African countries. Even within this comparison, the energy importers have higher institutional quality than the energy exporters. Also, in all institutional quality dimensions in all regions, one can see that the average institutional quality is highest for the energy importers, middle for the regional average, and then the lowest for the energy exporters. As table 18 shows a very steady order and un-fluctuated data, one can argue that the application of development status improves the institutional quality comparison methods, and one is able to use the institutional quality comparison method in identifying the resource curse. Also, in the case of the Political Stability and Absence of Violence aspect, where it is hard to find evidences that better political stability is capable of reducing the violence, it also shows a steady order and un-fluctuated data. Therefore, this aspect will be added in this thesis to identify the resource curse in the five North African countries.

Chapter 6. Measuring the Resource curse and a Solar Energy Curse via the Institutional Quality Comparison Method

In chapter 5, two methods, the GDP growth comparison and the institutional comparison, are tested in order to see whether they are suitable to be the boundary-lines to identify the resource curse. Unfortunately, the GDP growth comparison method was found to be problematic in identifying the resource curse. As mentioned in section 4.3, resource rents should be considered as one of the boundary-lines to identify the resource curse. Perhaps, the problem with the GDP growth comparison method is that it does not directly deal with the actual resource rents. This issue will be dealt later in Chapter 7. On the other hand, the institutional quality comparison method, especially after adding the 'development status filter', appears to function sufficiently in measuring the resource curse. Therefore, this chapter will first use the institutional quality comparison method to identify the resource curse in the five North African countries, and their potentials to suffer from a solar energy curse.

Before proceeding the comparison, one should be aware of the recent events in the region and its possible impact on the institutional quality of the five North African countries.

The Northern African region and other Arab Worlds have been going through a significant revolutionary wave, or reform, in recent years which is called the Arab Spring. The Arab Spring began in Tunisia, December 18, 2010, which eventually led to the ousting of President Zine El Abidine Ben Ali in January, 2011. Among the other North African countries, the rulers of Egypt (Hosni Mubarak) and Libya (Colonel Muammar Gaddafi) also have been forced from power. Furthermore, major protests have broken out in Algeria and Morocco. Consequently, the period 2010-2011 is perceived as a crucial turning point for the five North African countries and many other MENA countries. Accordingly, it can be argued that the recent events in these countries have impacted greatly on their institutional qualities. Hlepas (2013) presents the index of institutional quality and its changes in the recent years in the five North African countries, Israel, Jordan, Lebanon, Syria, and EU 15[51], this can be seen in figure 9.[52] As can be seen from figure 9, the institutional quality of the five North African countries, except for Morocco, have fallen since 2010. Hlepas (2013, p.12) suggests that this is probably because of their involvement in the Arab Spring.

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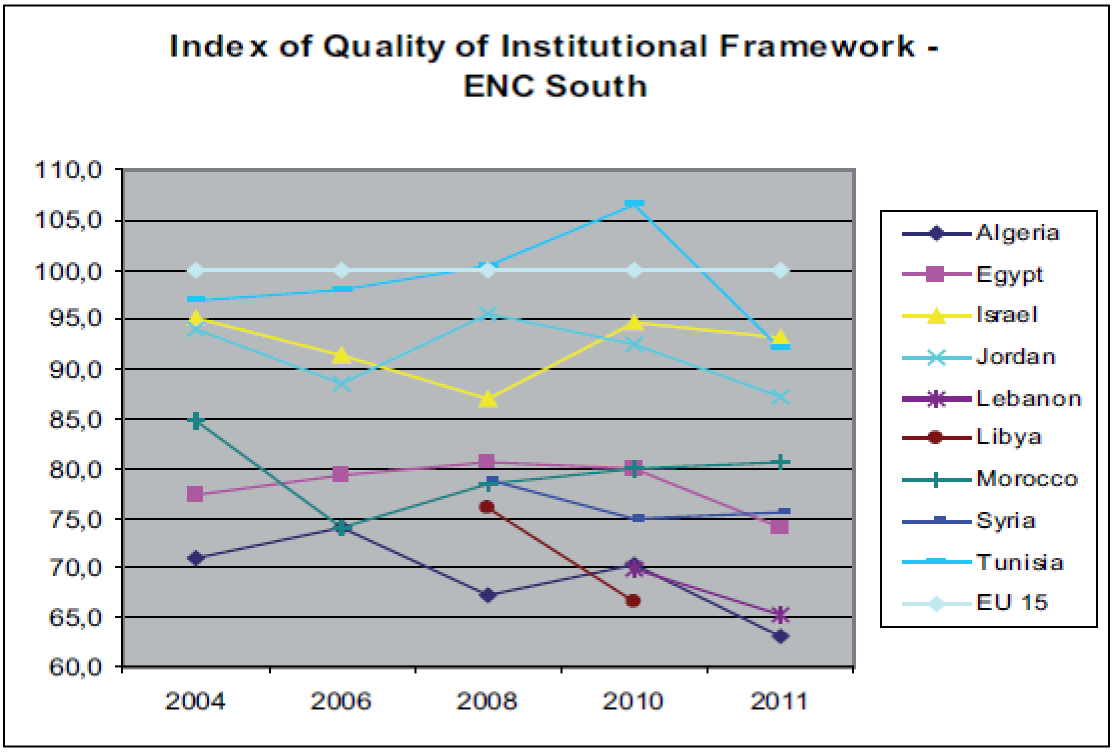
[51] Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, United Kingdom.

[52] It must be mentioned Hlepas's (2013) institutional quality index is based on the concept that the Index of national institutional quality is dependent on "Government Effectiveness", "Regulatory Quality", "Rule of Law" and "Control of Corruption"(Hlepas 2013, p. 6).

Figure 9: Index of Institutional Quality Changes in Recent Years in the of the Southern European Neighborhood Countries



Source: Hlepas (2013, p.13)

Despite the decline in the institutional quality since 2010 as presented in figure 9, there are studies that project positive outcome, perceiving the Arab Spring as the positive indication, from the Arab Spring. For example, Weill (2012, p. 4) argues that the Arab Spring, or the recent political changes, can contribute to the enhancement of weak institutional quality in the MENA countries. According to Weill (2012, p.4), these changes have been motivated by the willingness to obtain greater transparency and lower corruption. Furthermore, he views Tunisia's recent free elections in October 2011 as the portrait of these positive changes.

It is true that the Arab Spring brought political changes and regime changes in Egypt and Tunisia. However, one should not overlook the current visible consequences of the recent events, such as regime changes, in the five North African countries because it is uncertain what kind of role they will play in the future within this region. Also, according to Dodge (2012, p. 64), it is hard to say that, though there has been regime changes in countries such as Egypt and Tunisia, the ruling elites, state structures, the powerful secret services and crony capitalist that Mubarak, Gaddafi and Ben Ali created have not been completely eradicated. Furthermore, though there is no doubt that the Arab Spring is a historic moment in the politics of the Arab Worlds, Dodge (2012, p. 64) finds that its long-term impact is still to reveal itself and is unpredictable. In other words, changes in the five North

African countries' institutional qualities are also unpredictable.

It is important to be aware of the Arab Spring and its possible impact because it plays, or is to play, a great role in shaping the future institutional quality of the five North African countries. The projection of the institutional quality in the future itself, despite the Arab Spring, is already a difficult task. Here, the ongoing political changes and the Arab Spring in the region add more uncertainty in their future, and it makes it even more difficult to project the institutional quality of the region in the future. Perhaps, institutional quality is a subject that is not possible to be projected especially in countries or regions that are going through significant transformation. In this case, therefore, the best way to 'project' the changes in the institutional quality is to look at the changes in their institutional quality in the past or the most recent institutional quality available. As it will be discussed later, the combination of the poor institutional quality and the enormous rent size is the main driving factor that leads countries into the resource curse. Therefore, if a country's institutional quality is poor and continues to remain poor in the future, this can be the cause of a solar energy curse in North Africa in the future.

6.1 Choosing the "Boundary-Countries" for the Institutional Quality Comparison Method

When using the institutional quality comparison method to identify the resource curse in the five North African countries, one should compare their institutional quality to some other countries' intuitional quality. However, the five North African countries' institutional quality can not be compared to just a number of randomly selected countries as this thesis has a specific purpose which is to identify the resource curse and project a solar energy curse. In other words, their institutional quality must be compared to the institutional quality of the resource cursed countries and resource curse avoided/escaped countries. In this way, it is possible to identify where the five North African countries stand; closer to the resource curse or closer to avoiding/escaping the resource curse. Of course, the current resource curse can be only found in energy exporting countries. However, the North African energy importers will be included in the process in identifying the current resource curse because, as mentioned earlier, their institutional quality can show where they stand from a possible solar energy curse in the future.

The first step in this analysis is to select countries which have been affected by the resource curse and the countries that have avoided/escaped the resource curse. The final chosen countries will be referred to as the 'boundary-countries'. The candidates for the boundary-countries will be selected from various articles and literature regarding the resource curse.

Table 19: Candidates for being the Boundary-Countries for the Resource Cursed and Resource Curse Avoided/Escaped Countries

Resource cursed	Algeria, Angola, Ecuador, Equatorial Guinea, Liberia, Democratic Republic of the Congo, Mexico, Nigeria, Saudi Arabia, Sierra Leone, Sudan, Trinidad & Tobago Venezuela, Zambia,
Escaped/avoided	Australia, Botswana, Brazil, Canada, Chile, Indonesia, Malaysia, The Netherlands, Norway, Oman, Peru, Thailand

Source: Abidin (2001), Alicante & Misol (2009), Humphreys et al (2007), Ilim (2006), Mieksell (1997), Mehlum et al. (2006 a,b), Sarraf & Jiwanji (2001)

Table 19 presents countries from various studies on the resource curse, which are considered to be either affected by the resource curse or have avoided/escaped the resource curse. What one can notice from table 19 is that many candidates from African region are affected by the resource curse including Algeria. It must be mentioned that some countries are considered to be suffering from the resource curse but also considered to have avoided/escaped the resource curse. For example, Peru is considered to be affected by the resource curse by Mikesell (1997), whereas Mehlum et al. (2006b) considers Peru as a country which avoided the resource curse. Different findings from these authors may be due to the different ways in approaching the resource curse and also the different period of time the literature was written. For example, Mikesell's (1997) approach identifies more with the Dutch disease explanation whereas Mehlum et al. (2006a) identifies with the institutional quality explanation regarding the resource curse in Peru.

Many candidates of the boundary-countries regarding the resource curse can be found from several articles and literature, as can be seen from table 19. However, though a number of candidates exist, it is unwise to compare the institutional quality of the five North African countries to all of the candidates found above because the process will be unnecessarily complicated. Accordingly, the result may not be tangible and sufficient. Instead, one should choose the most suitable candidates to be used as the boundary-countries. As can be seen in Chapter 5, when testing the average GDP growth comparison method and the institutional quality comparison method, the application of the development status contributed to the improvement of both methods. Here, the development status can be used to divide the candidates into separate groups. This process may help provide a clearer distinction among the candidates which may be useful in selecting the most suitable boundary-countries.

Table 20: The Division of the Candidates by the Development Status

	Least Developed	Developing	Developed/emerging
Resource cursed	Angola, Equatorial Guinea, Liberia, Sierra Leone, Sudan, Zambia	Algeria, Brazil, Ecuador, Mexico, Nigeria, Venezuela,	Saudi Arabia, Trinidad and Tobago
Escaped/avoided		Botswana, Chile, Indonesia, Malaysia, Peru, Thailand	Australia, The Netherlands, Norway, Oman

Source: The World Bank Data Countries and Economies
http://data.worldbank.org/country (accessed: 08.03.2012)
UNCTAD (2011, Contents xi),

Table 20 presents the separation of the candidates from table 19 according to their development statuses. As mentioned earlier, the five North African countries are considered as developing countries. Therefore, as this thesis has been emphasizing the importance of the development status in measuring the resource curse, the boundary-countries shall be selected from the developing countries group in table 20. Here, it should be noted that above candidates' experiences with the resource curse have not, or are not, taken at the same period of time. This means that the priority requirement for becoming a boundary-country is that the country is still heavily reliant on its resource rents. In other words, countries will be selected if their resource rents is more than 10 percent of their GDP during the period of 1993-2009 as seen in table 6.[53] Furthermore, if a country's resource rents is not more than 10 percent of its GDP but still can be perceived as an important country regarding the resource curse, it may be considered as an additional boundary-country. More explanation will be followed later in this section.

When choosing developing resource cursed boundary-countries, one can see that Algeria is in the developing resource cursed countries group. As the purpose of this thesis is to find the resource curse and the possible solar curse in the five North Africa countries, Algeria can not be selected as a boundary-country. From the remaining candidates, Nigeria is the only country from Africa. Nigeria is a good candidate as a boundary-country because it is frequently mentioned in the literature on the resource curse, as seen in chapter 2, and is in Africa. Also, as mentioned in section 3.2, Nigeria is also considered to have a great potential in becoming a solar electricity exporter. Also, Nigeria's oil rents alone takes average of 32.5 percent during the period of 1993-2009 (World Development Indicators) making it suitable to be one of the boundary-counties.

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[53] Of course, Mehlum et al. (2006b, p.1) considers that '10 percent of resource export share in the GDP' as a high rate. Here, it must be noted that resource rents are mostly obtained from exporting resources. This is the reason why countries will be selected as boundary-countries i.e their resource rents is more than 10 percent of their GDP.

Venezuela is an OPEC member which is frequently mentioned in the literature regarding the resource curse. It is known to have suffered from the Dutch disease and considered to be a rent-seeking society (Rossi 2011, p.14), which in turn has led their slow economic growth. More importantly, Venezuela is seen as a resource cursed country because of its poor institutional quality (Mehlum et al., 2006 a, b). Furthermore, its oil rent size takes 32.5 percent of its GDP during the period of 1993-2009 (WDI) making it also a suitable candidate for the boundary-country.

For the developing resource curse avoided/escaped boundary-countries, one can see Botswana is the only candidate from Africa. Though the main focus of this thesis 'energy', it does not mean Botswana is not a good candidate for being a boundary-country. Though Botswana is not an energy exporter like Nigeria and Venezuela, it exports diamonds which is considered as a point source. As seen in chapter 2, Botswana is a country that is considered to have avoided/escaped the resource curse due to its good institutional quality. Unfortunately, the WDI does not provide Botswana's diamond rent size as the percentage of GDP during the period of 1993-2009. However, diamond sector still plays an important role in Botswana's economy as it is estimated to account for more than one-third of GDP, 70-80 percent of export earnings, and about one-third of the government's revenues (Central Intelligence Agency[54]). Therefore, Botswana will be chosen as one of the resource curse avoided/escaped boundary-country.

In the case of Chile, a large exporter of copper, presents a classic case of a country which is avoiding/escaping the resource curse. Chile experienced its first export boom between 1973 and 1974 during the period of severe economic and political instability, which also led to the overthrow of the Allende government in 1973 (Mikesell 1997, p. 197). During the Allende's regime, though there was increase in copper prices, Chile's GDP declined and it experienced high inflation and disruption in copper production because of the nationalization of the banks and industries. The military government started an anti-inflation program and devaluated the real exchange rate which had appreciated due to the 100 percent inflation rate during the Allende regime. During the 1970s, the periodic real exchange rate appreciation occurred as a result of the nominal exchange rate depreciation lagging behind inflation. Despite this, trade liberalization and reduced domestic demand led to an increase in non-copper exports during the period of 1976-1978. It was followed by the country's second export boom during the period of 1979-1980, which was coupled with a rise in copper prices and rapid growth in real GDP. Although Chile experienced an increase in its current account deficit financed by foreign debt following a decline in copper exports in 1981, Chile still managed to maintain a 5 percent annual GDP growth during the 1980s. The Chilean government

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[54] https://www.cia.gov/library/publications/the-world-factbook/geos/bc.html (accessed: 17.05.2013)

dealt with the windfalls from copper export by retaining it in a stabilization fund and prevented the non-mining tradable sector to be damaged by the Dutch disease (Mikesell 1997,p. 197). As can be seen from Chile's experience, Chile appears to have prevented the Dutch disease and escaped from the resource curse. Chile's mineral rent size accounted for 9.8 percent of GDP during the period of 1993-2009 (WDI). Although mineral rent alone did not account for 10 percent of GDP during the period of 1993-2009, it increased more than 10 percent when adding oil and natural gas rents (0.05 percent and 0.2 percent accordingly) during the period of 1993-2009. Therefore, Chile will be selected as one of the boundary-countries that avoided/escaped the resource curse.

The chosen developing resource curse boundary-countries represent rather famous cases which are often mentioned in articles and literature regarding the resource curse. However, in order to provide broader range, additional developing boundary-countries shall be added.

For the additional resource cursed developing boundary-country, Ecuador appears to be a suitable candidate. Ecuador is also an OPEC member with vast amounts of oil. It is one of the largest oil exporters in Latin America and its oil sector accounts for about 50 percent of export earnings and about one-third of all tax revenues (EIA Country Analysis Ecuador). It is often considered as the 'Growth Loser" in articles and literature regarding the resource curse. For example, Mehlum et al. (2006 a,b) and Robinson et al. (2006) argue that Ecuador's poor institutional quality is the main reason why they are affected by the resource curse. Also, it might be worth mentioning that Ecuador is an interesting country to be selected as a boundary-country because its experience with oil can be compared to Norway's experience. More specifically, their oil discoveries occurred in the similar period but their experiences are quite the opposite. Furthermore, Ecuador's oil rent size accounts for 16.1 percent of GDP during the period of 1993-2009 (WDI). Therefore, Ecuador will be added as a developing resource cursed boundary-country.

For the additional resource curse avoided/escaped developing boundary-country, Malaysia can be considered as a suitable candidate. Malaysia is an oil-producing country which is frequently considered to have avoided/escaped the resource curse. For example, Malaysia is the only country, along with Mauritius, which sustained 2 percent per annum growth during the period of 1970-80 whereas economies with high share of resource exports in GDP tended to grow slowly during the period of 1970-90 (Sachs & Warner 1997, p. 27).

The explanation of how Malaysia avoided/escaped the resource curse is often related to the institutional quality which makes it even more suitable to be a boundary-country for the institutional quality comparison analysis. For example, Ross (2001, p.18) emphasizes the importance of the democracy (transparency) in oil and mineral export dependent countries, and that a democratic government is essential in avoiding certain resource curse effects such as corruption. He argues that countries which use their resource revenues effectively, thus avoiding/escaping the resource curse, such as Malaysia are at least partly democratic. Similarly, Auty (2000, p. 349) mentions that resource-abundant countries which experience sustainable and rapid economic growth are consensual democracies such as Malaysia. Furthermore, Mehlum et al. (2006a,b) point out that the main reason that Malaysia, resource-abundant growth winner, has been able to avoid/escape the resource curse, when compared to the growth loser, is their good institutional quality.

In recent years, the Malaysian government has been putting effort into enhancing output from existing oil and natural gas fields and to advance exploration in deepwater areas. Malaysia's new tax and investment incentives which were introduced in 2010 aim to promote both oil and natural gas exploration and development. Furthermore, they aim to increase aggregate production capacity by 5 percent per year up to 2020 in order to meet domestic demand and to sustain both crude oil and Liquefied Natural Gas (LNG) exports to overseas markets (EIA Country Analysis Malaysia). Though Malaysia's oil rent size is not more than 10 percent, its oil rent size (5.7 percent) and natural gas rent size (4.9 percent) together is 10.6 percent of GDP during the period of 1993-2009 (WDI). As good institutional quality and governance are pointed out as the main reason that Malaysia was able to avoid/escape the resource curse, and its oil and natural gas rent in recent years is still relatively high, Botswana will be chosen as an additional boundary-country.

So far, three resourced cursed boundary-countries and three resource curse avoided/escaped boundary-countries, which are all developing countries, have been identified. As the five North African countries are considered as developing countries, the selection of the boundary-countries from the developing countries has been perceived necessary in obtaining a fair and accurate outcome. However, though the comparison among the countries with similar development status is important, the institutional quality comparison among only developing countries may provide a complication because their institutional quality scores may often overlap, thus unable to make comparisons. Therefore, additional boundary-countries will also be selected from the countries with different development status which enables one to have a broader range in making the institutional quality comparison. Also, including boundary-countries with different development statuses in the institutional quality comparison gives an opportunity for one to reassess whether the development status plays a crucial role in finding the resource curse as it has been argued throughout this thesis. The additional boundary-countries will be selected from the developed resource curse avoided/escaped countries and the least developed resource cursed countries.

From the developed resource curse avoided/escaped countries, Norway will be selected as an additional boundary-country because their experiences present classic case regarding avoiding/escaping the resource curse. Norway's successful escape from the resource curse is already presented in section 2.5.1. Its oil rent size accounts for 11 percent of GDP during the period of 1993-2009 (WDI). Furthermore, as mentioned earlier, its experience with oil can be compared to Ecuador which has the opposite experience. As choosing just one country from developed countries may provide inaccurate results, in case of Norway being just an exceptional case among the developed resource curse avoided/escaped country, it is necessary to select another additional country. The Netherlands' natural gas rent size is not near 10 percent of GDP. However, their experience, with the Dutch disease, is considered as one of the most important explanations of the resource curse as can be seen throughout this thesis. Therefore, the Netherlands will be selected as an additional developed resource curse avoided/escaped boundary-country.

Angola is an OPEC member and one of the largest oil-producing countries in Africa. For a short period of 2009 it became the largest oil producer in Africa. Angola's oil sector accounts for over 95 percent of export revenues and over 75 percent of government revenues (EIA Country Analysis Angola). Furthermore, Angola's oil rent size takes 81.7 percent of GDP during the period of 1993-2009 (WDI).

Oil production in Angola is known to have been the driver of economic growth. For example, the cumulative economic growth reached 67.5 percent between 2003 and 2006 mainly due to oil production. However, though oil wealth drove per capita GDP up to US$2,335, at purchasing power parity, in 2005, most of the population did not receive any benefits. The recent poverty rate is estimated at 68 percent (Hammond 2011, p.358). Furthermore, Angola appears to suffer from massive corruption and poor accountability. For instance, in 2006, the Transparency International gave Angola a rank of 142 out of 163 (Hammond 2011, p. 360). Overall, Angola's possession of oil, and other resources such as diamonds, has not helped its economy but rather formed corruption, rent-seeking behavior, debt and conflict. Therefore, Angola will be selected as one of the additional least developed resource cursed boundary-country.

The comparison between Sierra Leone and Botswana is often made when discussing the resource curse because their experiences with diamond wealth are quite the opposite. In Sierra Leone, diamonds were discovered in the 1930s and its exports played a crucial role in their economy between the 1930s and the 1970s, accounting for two-thirds of the country's export earnings and one quarter of its GDP (Maconachie & Binns 2007, p. 104).

In 1968, president Siaka Stevens and the All People's Congress party came to power. The diamond wealth was often used to rewards Stevens' supporters and, moreover, its industry became a parastatal which was closely related to corruption. During the period that Stevens was retaining the power, Sierra Leone's official diamond exports fell from 1.7 million carats in the 1960s to 50,000 carats by 1985. The Stevens' regime was closely linked to corruption and rent-seeking and created a socially excluded underclass which provided the basis for the pre-conditions for war in the 1990s (Macronachie & Binns 2007, p. 105).

The famous 'blood diamonds' is an extensively highlighted topic which is often linked to the conflict in Sierra Leone. More importantly, Sierra Leone's conflicts are often linked to the resource curse especially regarding the greed and grievance mechanisms which are mentioned in section 2.2. The history of Sierra Leone with their diamond wealth demonstrates that it has suffered massively from the resource curse and makes it suitable as a boundary-country. Unfortunately, Sierra Leone's diamond rent size as percentage of GDP is not available from the WDI, and it appears that the mining industry, which include the diamond sector, only accounted for 4.5 percent in the nation's GDP in 2007 (African Development Bank 2009, p. 563). However, as Sierra Leone is a suitable candidate in presenting the opposite experience to Botswana with diamond wealth, it will still be selected as the least developed resource cursed boundary-country.

6.2 Identifying the Resource Curse & Solar Energy Curse Potential in the Five North African Countries by the Institutional Quality Comparison Method

6.2.1 Methodology

The specific aim of this section is to find out whether the North African energy exporters are affected by the resource curse, and if the five North African countries have the potentials to suffer from a solar energy curse, by using the institutional quality comparison method. Here, the institutional quality of ten boundary-countries will be compared to the five North African countries, and all of WGI's six institutional quality aspects will be compared separately. However, in this section, the average institutional quality during the period of 1996-2011 and 2007-2011 will not be applied. As mentioned earlier, the purpose of applying the average institutional quality of these two periods was not to identify the resource curse but to test the correlation between institutional quality and development status. Therefore, in order to obtain the most accurate result, the most recent institutional quality scores (2011), provided by WGI will be applied in this section. This analysis will also include the standard error with the 95 percent confidence level.

Here, a specific explanation of the use of standard error and its relations to confidence level should be examined. Standard errors, which are known as standard deviation, are considered essential features in the WGI because they capture the inherent uncertainty in measuring governance. The standard error is smaller when more data sources are available for a country. This can be seen in table 21. In other words, lower values indicate more precision.

Table 21: Governance Scores, Number of Data Sources, and Standard Errors based on Government Effectiveness Dimension

	Sources	Governance Score	Standard Errors
Botswana	11	+0.53	0.18
Morocco	9	-0.22	0.19
Sierra Leone	8	-1.16	0.20

Standard errors are closely related to confidence intervals which are also referred to as confidence level. The confidence level displays statistically-likely range of values for each indicator. For instance, when the 95 percent confidence level is chosen, it is likely that governance falls within the indicated range. On the other hand, if one chooses a lower confidence level, such as 50 percent, 75 percent, or 90 percent, the confidence interval is more likely to result in narrower ranges but governance is less likely to fall in the indicated range (WGI).

According to Kaufmann et al. (2010, p. 11), WGI always report the 90 percent confidence interval associated with both estimates of governance, i.e the estimate of governance +/-1.64 times its standard deviation (Kaufmann et al. 2010, p. 11). For example, Angola's institutional quality score based on Voice and Accountability in 2011 is -1.17 and the standard error is 0.11 (see table 23). If the confidence level of 90 percent is applied, the standard error then becomes +/-0.1804. WGI refers this range as the "margin of error", which was mentioned in the previous chapter, for the governance score. In other words, this range means that, based on the observed data, WGI is 90 percent confident that the true, but unobserved, level of governance for the countries lies in this range. More specific example is illustrated below.

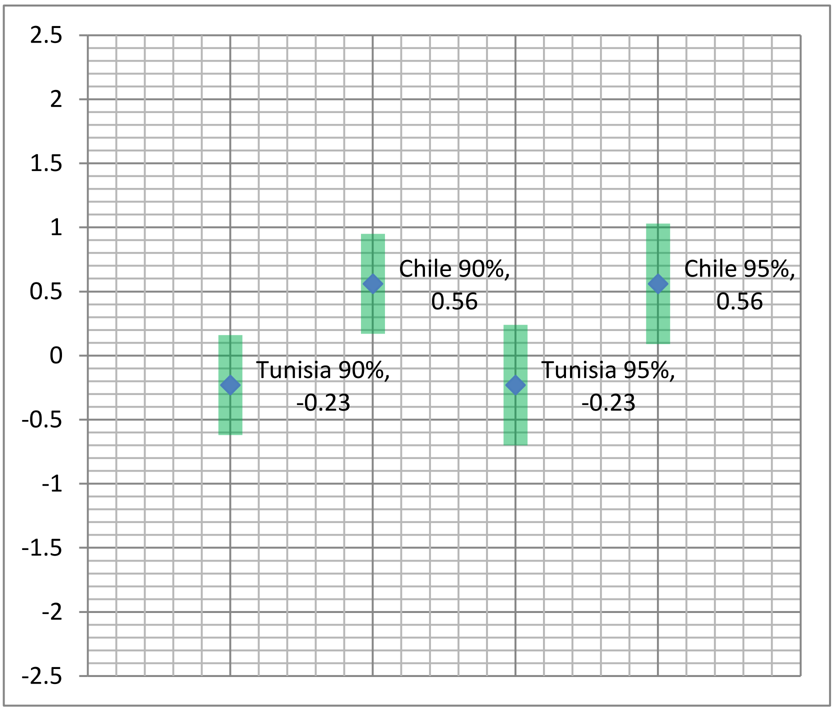
Table 22: Governance Score of Tunisia and Chile based on Political Stability & Absence of Violence and Standard Error based on Different Confidence Levels

	Governance Score	Standard Error	Standard Error (90% Confidence Level)	Standard Error (95% Confidence Level)
Tunisia	-0.23	0.24	+/-0.39[55]	+/-0.47[56]
Chile	0.56	0.24	+/-0.39	+/-0.47

Source: Worldwide Governance Indicators (WGI)

Table 22 presents the governance score based on Political Stability & Absence of Violence and their standard error based on different confidence levels. Each confidence level applies different standard deviation. For example, applying the 95 percent confidence level means +/-1.96 times the given standard deviation (Wolfram MathWorld: Confidence Interval).

Figure 10: Figure form of Table 22[57]



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[55] Exact value is 0.3936 but rounded up to 0.39.

[56] Exact value is 0.4704 but rounded up to 0.47.

[57] Vertical-Axis present the governance score range from -2.5 to + 2.5. This vertical-Axis form will be applied to all figures in section 6.2.2.

As can be seen from figure 10, which presents the figure form of table 22, it is possible to see overlaps of two confidence intervals between Tunisia and Chile when 95 percent confidence level is taken whereas there are no overlaps of two confidence intervals when 95 percent confidence level is taken.[58] As mentioned earlier, when comparing two countries or one country at two points in time, the application of the margins of error should be taken into account. An overlap of two confidence intervals means the difference between them in time is not statistically significant. In other words, when the aggregate governance scores' changes are small relative to the reported margins of error, they should not be over-interpreted (WGI).[59] In this thesis, as the institutional quality (governance score) will be presented in figure form, the standard error with the 95 percent confidence level will be applied to make sure that statistically significant interpretations will be made. Furthermore, it must be noted that when the 95 percent confidence level is applied, +/-1.96 times the standard deviation, the outcome will be rounded to 2 decimal places as shown in table 22.

Before proceeding with the institutional quality comparisons, there are a number of aspects that should be explained. In this section, Egypt will be considered as an energy exporter. This is because this analysis does not only search for the possibilities of the five North African countries to suffer from a solar energy curse, but also identify the resource curse in the North African energy exporters. When dealing with the current resource curse in this section, there is no reason to consider Egypt as an energy importer. Also, when identifying the solar energy curse, one does not have to test Egypt as both exporter and importer because all five North African countries are projected to become solar electricity exporters in the future.

As mentioned earlier, it is not possible to project the future institutional quality of the five North African countries. Therefore, when projecting which countries would suffer from a solar energy curse in the future, it will be based on the assumption the most recent institutional quality will remain at similar levels in the future.

The institutional quality comparisons will be separated into six sections as these comparisons will be based on six dimensions. Firstly, the institutional quality comparison in six dimensions will be made separately, then all results will be gathered at the end of this section. The reason behind this is that, a low score in one institutional quality dimension does not mean that country is affected by the curse.

Lastly, graphs will present the institutional quality of the five North Africans countries and the boundary-countries with the confidence intervals. Tables will be followed to illustrate details of each

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[58] It must be mentioned that the horizontal width of each bar does not represent any meaning. The horizontal width is purely used to make it easier to view the figure forms which will be applied in all figures in the next section.

[59] http://info.worldbank.org/governance/wgi/faq.htm#10 (accessed: 07.12.2012)

graph. Tables will demonstrate the overlaps of confidence intervals in 6 dimensions. Description of each dimension is illustrated below.

Affected by Curse: Confidence intervals do not overlap and institutional quality score is lower than the resource cursed boundary-countries

Overlap Curse: Confidence intervals overlap with the resource cursed boundary-countries

Over Cursed: Confidence intervals do not overlap and institutional quality score is higher than the resource cursed boundary-countries

Both: Confidence intervals overlap with both the resource cursed boundary-countries and the resource curse avoided/escaped boundary-countries

Overlap Avoided/Escaped: Confidence intervals overlap with the resource curse avoided/escaped boundary-countries

Under Avoided/Escaped: Confidence intervals do not overlap and institutional quality score is lower than the resource curse avoided/escaped boundary-countries

The graphs and tables will be based on governance scores and margin of errors provided by WGI for the year 2011 which is illustrated in table 23.

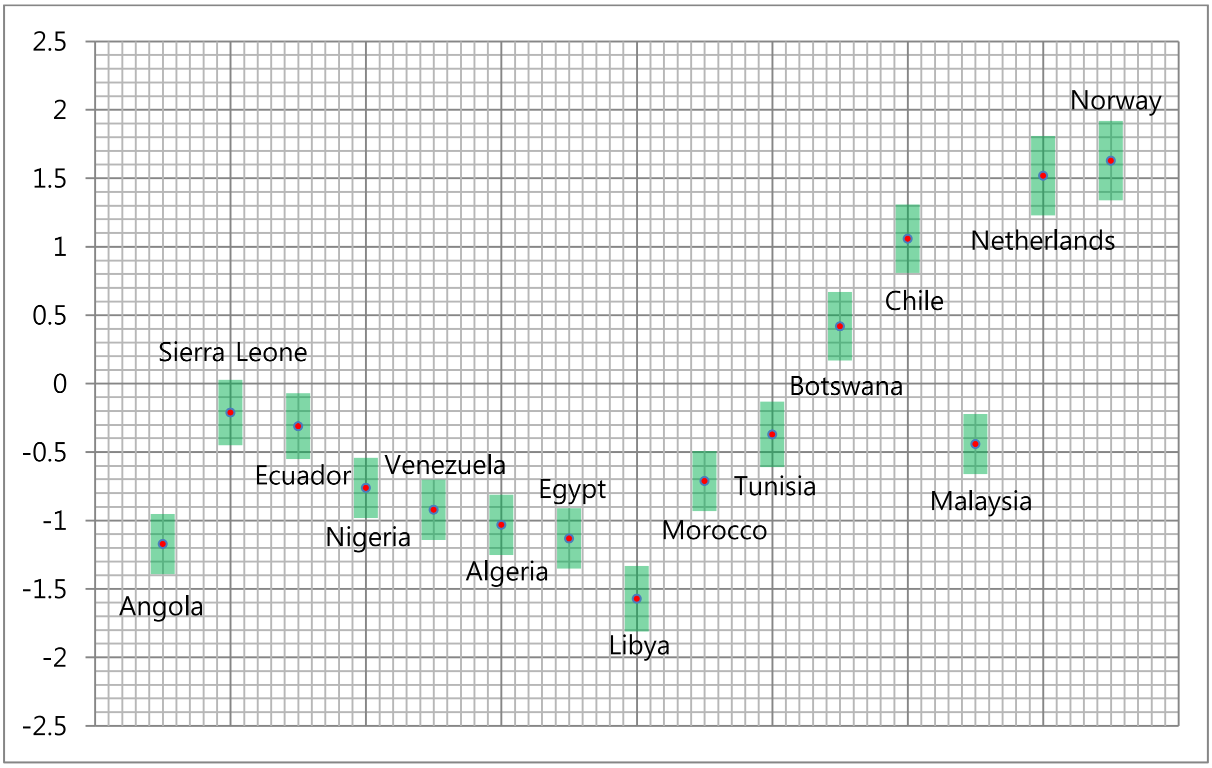
Table 23: Governance Scores and Margin of Errors of the Five North African Countries and Boundary-Countries in 2011

	V·A		P·S & A·V		G·E		R·Q		R·L		C·C	
	G.S	S.E	G.S	S.E	G.S	S.E	G.S	S.E	G.S	S.E	G.S	S.E
Angola	-1.17	0.11	-0.33	0.24	-1.15	0.18	-1.10	0.16	-1.23	0.13	-1.36	0.16
Sierra Leone	-0.21	0.12	-0.19	0.27	-1.16	0.20	-0.70	0.17	-0.86	0.14	-0.69	0.18
Ecuador	-0.31	0.12	-0.73	0.24	-0.55	0.19	-1.02	0.17	-1.14	0.13	-0.82	0.17
Nigeria	-0.76	0.11	-1.94	0.24	-1.12	0.18	-0.69	0.16	-1.25	0.13	-1.14	0.15
Venezuela	-0.92	0.11	-1.30	0.24	-1.10	0.18	-1.49	0.17	-1.63	0.13	-1.22	0.16
Algeria	-1.03	0.11	-1.35	0.24	-0.66	0.18	-1.16	0.17	-0.82	0.13	-0.57	0.17
Egypt	-1.13	0.11	-1.29	0.24	-0.60	0.18	-0.33	0.16	-0.42	0.13	-0.68	0.16
Libya	-1.57	0.12	-1.01	0.25	-1.47	0.21	-1.52	0.19	-1.16	0.15	-1.31	0.19
Morocco	-0.71	0.11	-0.47	0.25	-0.22	0.19	-0.09	0.16	-0.21	0.13	-0.26	0.17
Tunisia	-0.37	0.12	-0.23	0.24	+0.02	0.18	-0.18	0.16	-0.10	0.13	-0.21	0.17
Botswana	+0.42	0.13	+1.04	0.24	+0.53	0.18	+0.50	0.16	+0.66	0.13	+0.97	0.16
Chile	+1.06	0.13	+0.56	0.24	+1.17	0.19	+1.54	0.17	+1.37	0.13	+1.57	0.16
Malaysia	-0.44	0.11	+0.16	0.24	+1.00	0.19	+0.66	0.17	+0.52	0.13	+0.00	0.15
Netherlands	+1.52	0.15	+1.12	0.24	+1.79	0.21	+1.84	0.23	+1.82	0.15	+2.17	0.18
Norway	+1.63	0.15	+1.35	0.24	+1.76	0.21	+1.41	0.23	+1.89	0.15	+2.17	0.18

Source: The Worldwide Governance indicators (WGI) (accessed: 13.05.2013)

6.2.2 The Institutional Quality Comparisons with Six Different Dimensions

Figure 11: Institutional Quality based on Voice and Accountability 2011 (-2.5 to +2.5)



Source: Worldwide Governance Indicator (WGI)

Table 24: Details of Figure 11

V & A	Algeria	Egypt	Libya	Morocco	Tunisia
Under curse	Sierra Leone, Ecuador	Sierra Leone, Ecuador	Sierra Leone, Ecuador, Nigeria, Venezuela	Sierra Leone	-
Overlap curse	Angola, Nigeria, Venezuela	Angola, Nigeria, Venezuela	Angola	Ecuador, Nigeria, Venezuela	Sierra Leone, Ecuador, Nigeria
Over curse				Angola	Angola, Venezuela
Both	No	No	No	Yes	Yes
Overlap avoided/escaped				Malaysia	Malaysia
Under avoided/escaped	All	All	All	Botswana, Chile, the Netherlands, Norway	Botswana, Chile, the Netherlands, Norway

Figure 11 presents the institutional quality comparison based on Voice and Accountability dimension of the five North African countries and the boundary-countries, and table 24 presents the details of figure 11.

When one compares the institutional quality among the five North African countries, Tunisia appears to have the highest institutional quality. Though Tunisia's confidence interval overlaps with Morocco, Tunisia's institutional quality is better than the North African energy exporters. On the other hand, Libya, though their confidence interval overlaps with Egypt, appears to have the lowest institutional quality within the five North African countries.

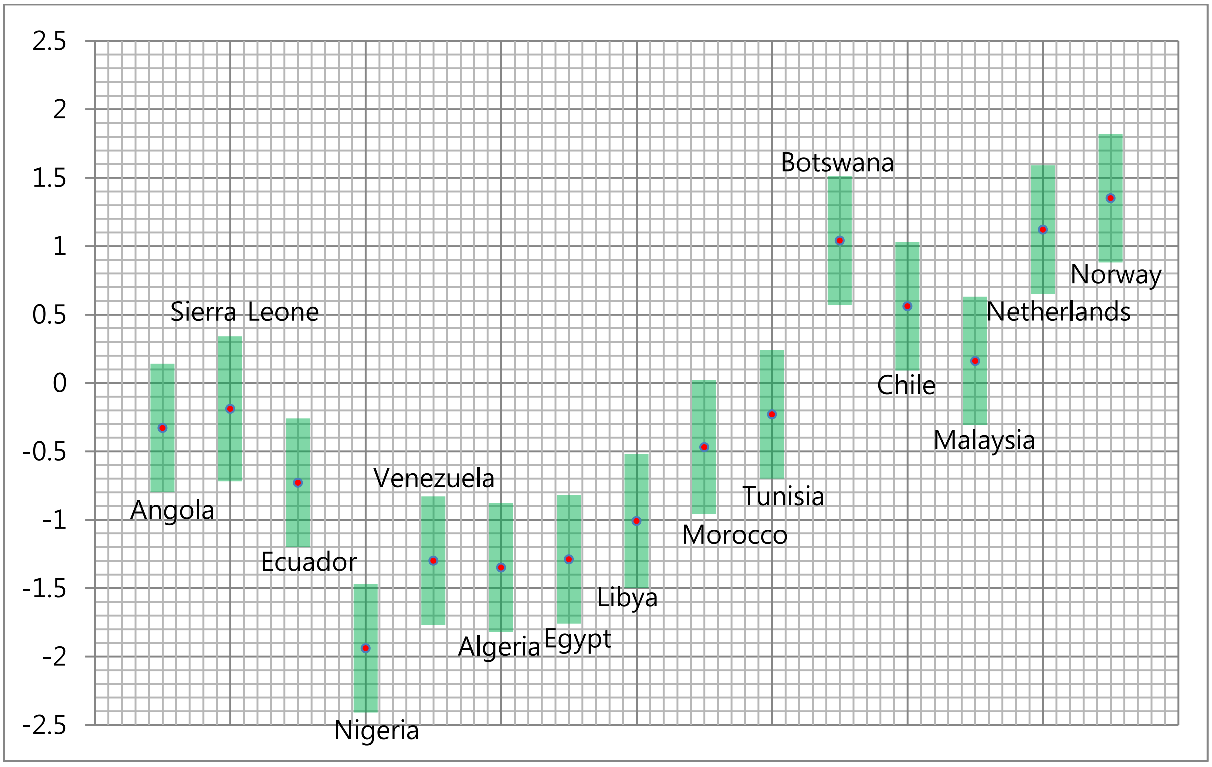
When one compares the institutional quality of the five North African countries to the resource curse avoided/escaped boundary-countries, the resource curse avoided/escaped boundary-countries, especially the developed countries, have significantly higher institutional quality except for Malaysia. Malaysia's confidence interval overlaps with Morocco and Tunisia which means these three countries do not have significant difference in their institutional quality. Nevertheless, in general, the institutional quality of the five North African countries is relatively lower than the resource curse avoided/escaped boundary-countries.

The institutional quality of the five North African countries appears to be closer to the resource cursed boundary-countries rather than the avoided/escaped boundary-countries in figure 11. The institutional quality of the five North African countries are either lower than some of the resource cursed boundary-countries, or their confidence intervals overlap with the resource cursed boundary-countries.

When one compares the institutional qualities of the three North African energy exporters to the resource cursed boundary-countries, they appear to have low institutional quality as their institutional qualities are lower than the resource cursed boundary-countries or their confidence intervals overlap with the resource cursed boundary-countries. Libya appears to have the lowest institutional quality among the North African energy exporters because Libya's institutional quality is lower than most of the resource cursed boundary-countries except for Angola. Nevertheless, it is possible to see that the North African energy exporters seem to be affected by the resource curse, or at least closer to suffering from the resource curse than avoiding/escaping it. Thus, they have the potentials to suffer from a solar energy curse.

When one compares the institutional quality of the North African energy importers to the resource cursed boundary-countries, they appear to have the potentials to suffer from a solar energy curse as their institutional qualities are either worse than the resource cursed boundary-countries, or their confidence intervals overlap with the other cursed boundary-countries. However, when looking at table 24, it is possible to see that their institutional quality is higher than some of the resource cursed boundary-countries such as Angola and Venezuela. In other words, the North African energy importers may have less chance to suffer from a solar energy curse than the North African energy exporters.

Figure 12: Institutional Quality based on Political Stability and Absence of Violence 2011 (-0.25 to +2.5)



Source: Worldwide Governance Indicator (WGI)

Table 25: Details of Figure 12

P·S & A·V	Algeria	Egypt	Libya	Morocco	Tunisia
Under curse	Angola, Sierra Leone	Angola, Sierra Leone			
Overlap curse	Ecuador, Nigeria, Venezuela	Ecuador, Venezuela, Nigeria	All	Angola, Sierra Leone, Ecuador, Venezuela	Angola, Sierra Leone, Ecuador
Over curse				Nigeria	Venezuela, Nigeria
Both				Yes	Yes
Overlap avoided/escaped				Malaysia	Chile, Malaysia,
Under avoided/escaped	All	All	All	Chile, the Netherlands, Norway	Botswana, The Netherlands, Norway

Figure 12 presents the institutional quality comparison based on Political Stability and Absence of Violence dimension of the five North African countries and the boundary-countries, and table 25 presents the details of figure 12.

When one compares the institutional quality among the five North African countries, it is difficult see which countries have better institutional quality because their confidence intervals often overlap.

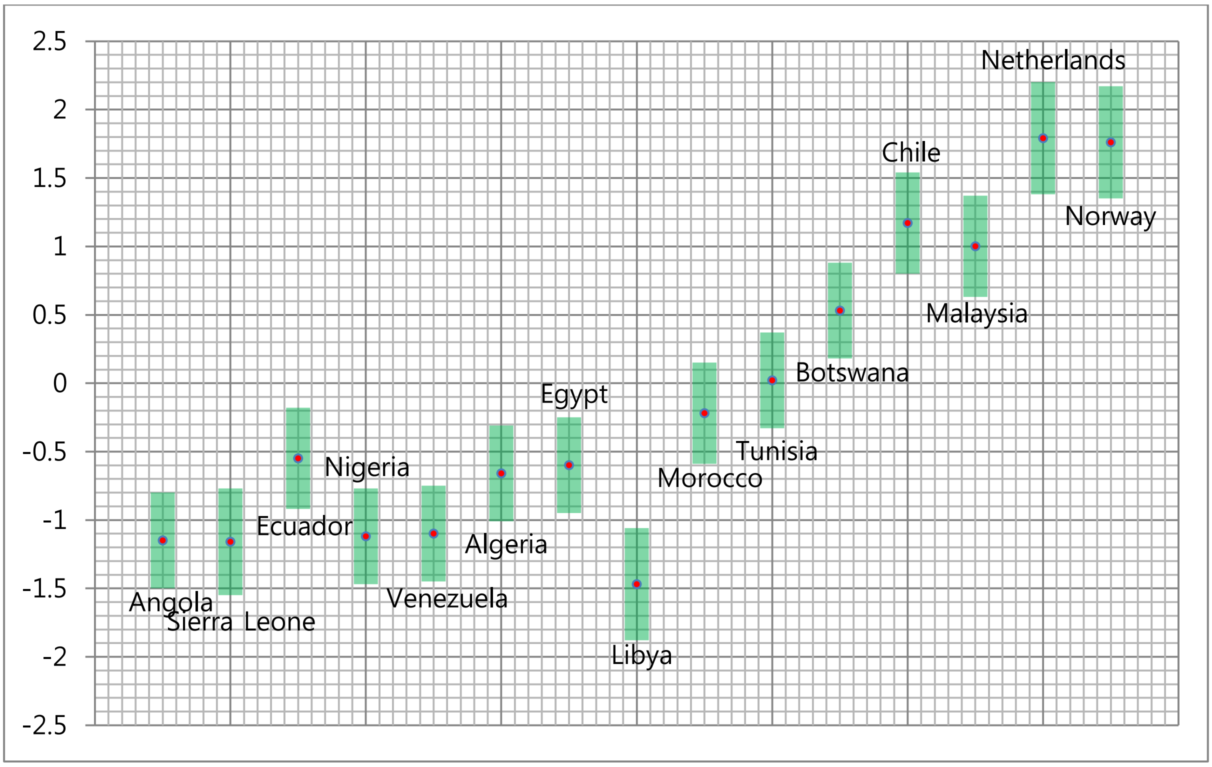
However, when carefully observed, it is possible to see that Tunisia has better institutional quality than Algeria and Egypt. Apart from Tunisia, it is not possible to make comparisons among the five North African countries because their confidence intervals overlap.

When the institutional quality of the five North African countries is compared to the resource curse avoided/escaped boundary-countries, few confidence intervals overlaps between two groups are detected. For example, the confidence interval of Morocco overlaps with Malaysia, and Tunisia overlaps with Chile and Malaysia. However, as can be seen in figure 12 and table 25, the rest of the North African countries have relatively worse institutional quality compared to the resource curse avoided/escaped boundary-countries. The institutional quality of the five North African countries appears closer to the resource cursed boundary-countries rather than the resource curse avoided/escaped boundary-countries in figure 12. The institutional quality of the five North African countries are either lower than some of the resource cursed boundary-countries, or at least their confidence intervals overlap with the resource cursed boundary-countries.

When one compares the institutional quality of the North African energy exporters to the resource cursed boundary-countries, they all appear to have low institutional quality because their institutional qualities are lower than the resource cursed boundary-countries or their confidence intervals overlap with the resource cursed boundary-countries. However, Algeria and Egypt, though their confidence intervals overlap with Libya, may be in a deeper resource curse than Libya because their institutional qualities are worse than some of the resource cursed boundary-countries such as Angola and Sierra Leone, whereas Libya’s confidence interval only overlaps with the resource cursed boundary-countries’ confidence intervals. Nevertheless, one can see that the North African energy exporters may be already suffering from the resource curse, or at least closer to the resource curse than avoiding/escaping it. Thus, their potentials to suffer from a solar energy curse is high.

When one compares the institutional quality of the energy importers to the resource cursed boundary-countries, despite their confidence intervals overlapping with the resource curse avoided/escaped boundary-countries, one can see that their confidence intervals often overlap with the resource cursed boundary-countries. In other words, they have the potential to suffer from a solar energy curse rather than avoiding it because their institutional qualities are closer to the resource cursed-boundary countries. However, when looking at table 25, their institutional qualities are never lower than the resource cursed boundary-countries. In other words, the North African energy importers may have less chance to suffer from a solar energy curse than the North African energy exporters.

Figure 13: Institutional Quality based on Government Effectiveness 2011 (-2.5 to +2.5)



Source: Worldwide Governance Indicator (WGI)

Table 26: Details of Figure 13

G · E	Algeria	Egypt	Libya	Morocco	Tunisia
Under curse			Ecuador		
Overlap curse	All	All	Angola, Sierra Leone, Nigeria, Venezuela	Ecuador	Ecuador
Over curse				Angola, Sierra Leone, Nigeria, Venezuela	Angola, Sierra Leone, Nigeria, Venezuela
Both				No	Yes
Overlap escaped/avoided					Botswana
Under avoided/escaped	All	All	All	Chile, the Netherlands, Norway	Chile, The Netherlands, Norway

Figure 13 presents the institutional quality comparison based on Government Effectiveness dimension of the five North African countries and the boundary-countries, and table 26 presents the details of figure 13.

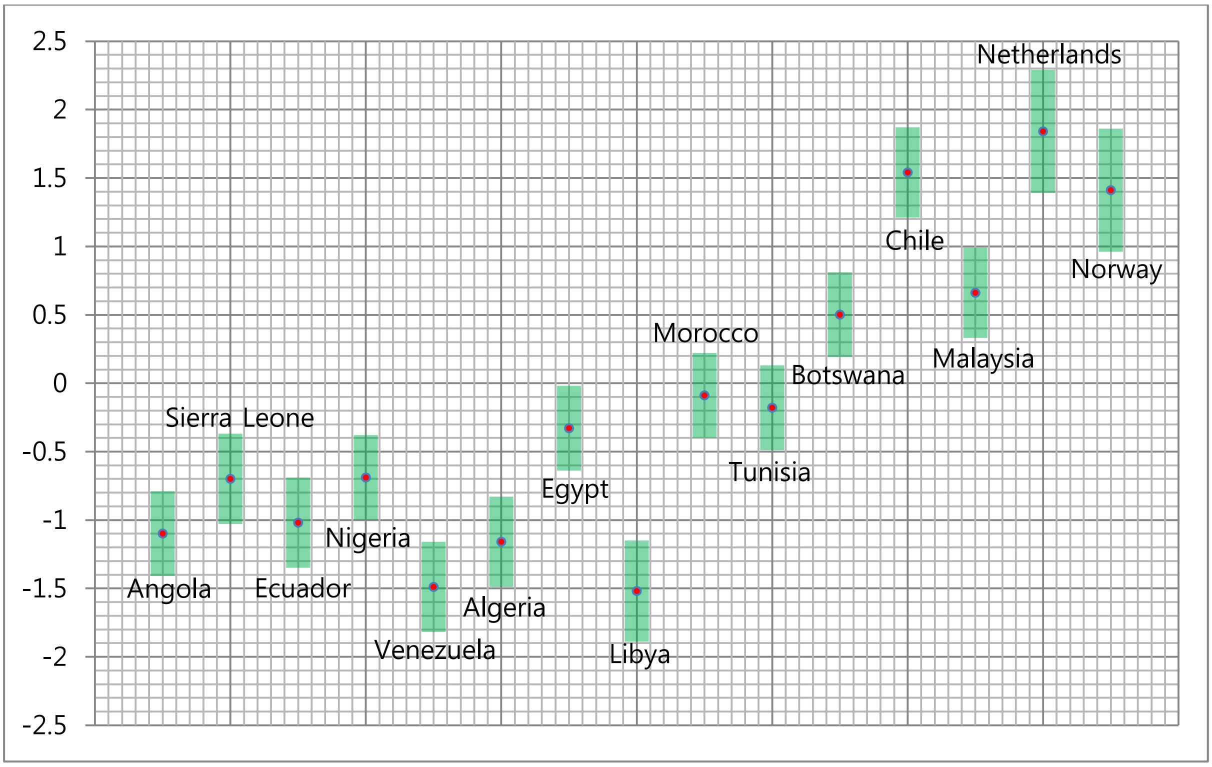
When one compares the institutional quality within the five North African countries, Libya has the lowest institutional quality because their institutional quality is clearly lower than the rest of the North African countries. The distinction among the rest is not possible as their confidence intervals all overlap.

When the institutional quality of the five North African countries are compared to the resource curse avoided/escaped boundary-countries, it is possible to see that only Tunisia's confidence interval overlaps with Botswana's confidence interval. The rest of the North African countries have worse institutional qualities compared to all the resource curse avoided/escaped boundary-countries. The institutional quality of the five North African countries appears to be closer to the resource cursed boundary-countries rather than the resource curse avoided/escaped boundary-countries as can be seen in figure 13. All of the North African countries' confidence intervals overlap with at least one resource cursed boundary-country. Libya, however, is the only country whose institutional quality is lower than one of the resource cursed boundary-countries (Ecuador).

When one compares the institutional quality of the North African energy exporters to the resource cursed boundary-countries, they all appear to have low institutional quality because their institutional qualities are lower than the resource cursed boundary-countries or their confidence intervals overlap with the resource cursed boundary-countries. Libya, however, has the lowest institutional quality among the North African exporters and, as mentioned earlier, is the only country that whose institutional quality is worse than Ecuador whereas the confidence intervals of Algeria and Egypt only overlap with the resource cursed boundary-countries. Nevertheless, though Libya may be considered to suffer more seriously from the resource curse, the North African energy exporters can be considered to be suffering from the resource curse and have the potentials to suffer from a solar energy curse.

When one compares the institutional quality of the North African energy importers to the resource cursed boundary-countries, one can see that their confidence intervals more often overlap with the resource cursed boundary-countries than with the resource curse avoided/escaped boundary-countries. In other words, they are more likely to suffer from a solar energy curse rather than avoiding it. However, when looking at figure 13, Morocco and Tunisia have significantly higher institutional qualities compared to Libya. Also, unlike the North African energy exporters, their institutional qualities are often higher than the resource cursed boundary-countries as can be seen from table 26. Therefore, in other words, the North African energy importers may have less chance to suffer from a solar energy curse than the North African energy exporters in the future.

Figure 14: Institutional Quality based on Regulatory Quality 2011 (-2.5 to +2.5)



Source: Worldwide Governance Indicator (WGI)

Table 27: Details of Figure 14

R · Q	Algeria	Egypt	Libya	Morocco	Tunisia
Under curse			Sierra Leone, Nigeria		
Overlap curse	All	Sierra Leone, Nigeria	Angola, Ecuador, Venezuela	Sierra Leone, Nigeria	Sierra Leone, Nigeria
Over curse		Angola, Ecuador, Venezuela		Angola, Ecuador, Venezuela	Angola, Ecuador, Venezuela
Both	No	No	No	Yes	No
Overlap escaped/avoided				Botswana	
Under avoided/escaped	All	All	All	Chile, Malaysia, the Netherlands, Norway	All

Figure 14 presents the institutional quality comparison based on Regulatory Quality dimension of the five North African countries and the boundary countries, and table 27 presents the details of figure 14.

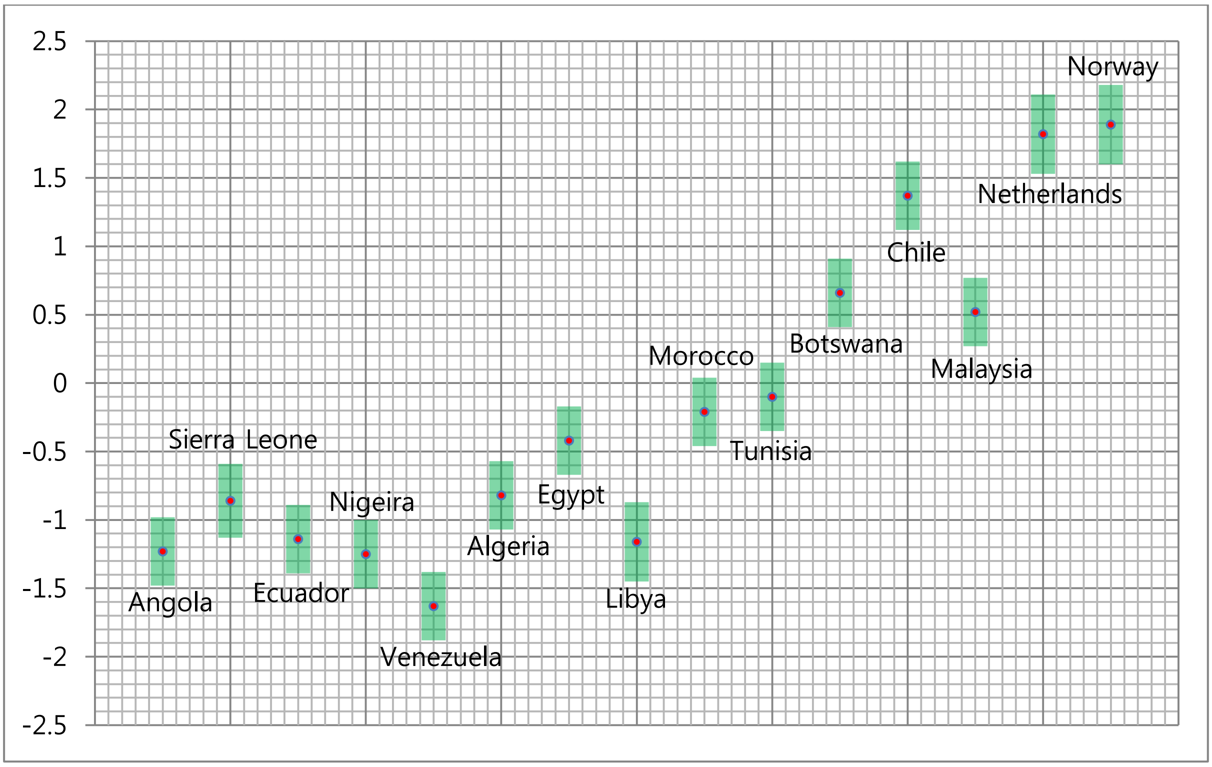
When one compares the institutional quality within the five North African countries, Algeria and Libya appear to have the lowest institutional qualities. As the confidence intervals of Egypt, Morocco and Tunisia overlap, it is not possible to see which countries have better or worse institutional quality.

When the institutional quality of the five North African countries is compared to the resource curse avoided/escaped boundary-countries, it is possible to see that the resource curse avoided/escaped boundary-countries generally have higher institutional quality. Only Morocco has confidence interval which overlaps with a resource curse avoided/escaped boundary-country (Botswana). Again, the institutional quality of the five North African countries appears to be closer to the resource cursed boundary-countries rather than the resource curse avoided/escaped boundary-countries in figure 14. All of the North African countries' confidence intervals overlap with a number of resource cursed boundary-countries. Libya, however, is the only country that has institutional quality lower than some of the resource cursed boundary-countries (Sierra Leone and Nigeria), whereas the rest have either better institutional quality or their confidence intervals only overlap with the resource cursed boundary-countries.

When one compares the institutional qualities of the North African energy exporters to the resource cursed boundary-countries, they all appear to have low institutional quality because their institutional qualities are lower than the resource cursed boundary-countries or confidence intervals overlap with the resource cursed boundary-countries. Libya appears to have the lowest institutional quality among the North African exporters because Libya's institutional quality is worse than some of the resource cursed boundary-countries. Algeria's institutional quality is also very low. On the other hand, Egypt appears to have a much higher institutional quality, at least compared to Algeria and Libya, which might mean that it is suffering less from the current resource curse. Nevertheless, the North African energy exporters, in general, seem affected by the resource curse and have the potentials to suffer from a solar energy curse.

When one compares the institutional quality of the North African energy importers to the resource cursed boundary-countries, one can see that their confidence intervals overlap with the resource cursed boundary-countries more often than with the resource curse avoided/escaped boundary-countries. In other words, it is more likely that they will suffer from a solar energy curse rather than avoiding it. Unlike the North African energy exporters, their institutional qualities are often higher than the resource cursed boundary-countries, such as Angola, Ecuador, and Venezuela, as can be seen from figure 14 and table 27. Therefore, the North African energy importers may have less chance of suffering from a solar energy curse than the North African energy exporters.

Figure 15: Institutional Quality based on Rule of Law 2011 (-2.5 to +2.5)



Source: Worldwide Governance Indicator (WGI)

Table 28: Details of Figure 15

R · L	Algeria	Egypt	Libya	Morocco	Tunisia
Under curse					
Overlap curse	Angola, Sierra Leone, Ecuador, Nigeria	Sierra Leone	All		
Over Curse	Venezuela	Angola, Ecuador, Nigeria, Venezuela		All	All
Both	No	No	No	No	No
Overlap escaped/avoided	No	No	No	No	No
Under avoided/escaped	All	All	All	All	All

Figure 15 presents the institutional quality comparison based on Rule of Law dimension of the five North African countries and the boundary countries, and table 28 presents the details of figure 15.

When one compares the institutional quality within the five North African countries, one can not clearly see which countries have higher or lower institutional quality because their confidence intervals often overlap. However, what is clear is that Morocco and Tunisia have better institutional qualities compared to Algeria and Libya.

When the institutional quality of the five North African countries is compared to the resource curse avoided/escaped boundary-countries, it is possible to see that the resource curse avoided/escaped boundary-countries have higher institutional qualities compared to all the five North African countries. This might suggest that the North African energy exporters are not close to escaping the current resource curse, and all North African countries have the potentials to suffer from a solar energy curse.

When the five North African countries' institutional qualities are compared to the resource cursed boundary-countries, mixed results are attained. In the case of the North African energy exporters, they are likely to be affected by the resource curse because their confidence intervals all overlap with the resource cursed boundary-countries' confidence intervals. Egypt may be in a slightly better position as their institutional quality is higher than many resource cursed boundary-countries. Nevertheless, all the North African energy exporters have the potential to suffer from a solar energy curse because their institutional qualities are closer to the resource cursed boundary-countries.

In the case of the North African energy importers, they are in a peculiar position as their confidence intervals do not overlap with either side of the boundary-countries. Of course, this does not mean they are not in danger of suffering from a solar energy curse. For example, as can be seen in figure 15, their institutional quality scores are below 0[60], and their confidence intervals overlap with Egypt's confidence intervals which overlaps with many resource cursed boundary-countries. Therefore, the fact that their institutional quality score is rather low, and are closer to the resource cursed boundary-countries, suggests that they have the potentials to suffer from a solar energy curse rather than avoiding it. However, as mentioned before, their chances of suffering from a solar energy curse are likely to be less than Algeria and Libya because their institutional qualities are relatively higher than Algeria and Libya.

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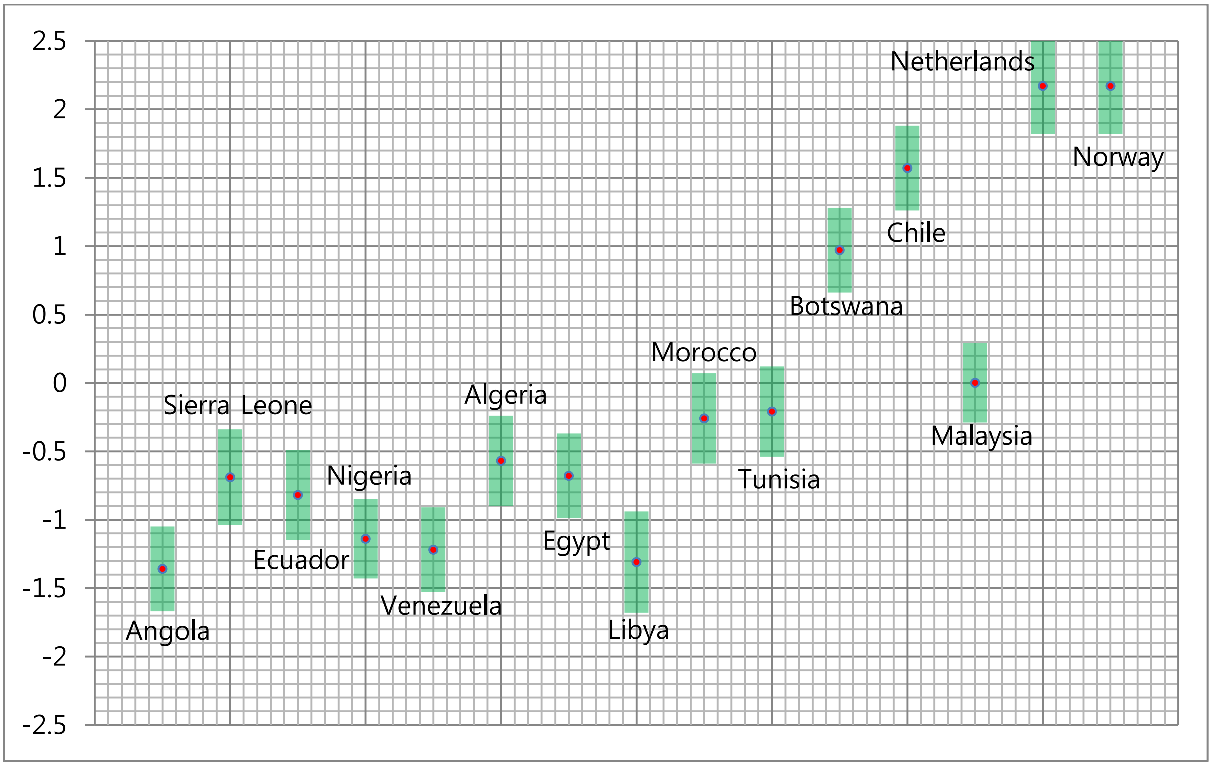
[60] The average score for the world as a whole is zero in every period in WGI.

Figure 16: Institutional Quality based on Control of Corruption 2011 (-2.5 to +2.5)



Source: Worldwide Governance Indicator (WGI)

Table 29: Details of Figure 16

C · C	Algeria	Egypt	Libya	Morocco	Tunisia
Under curse					
Overlap curse	Sierra Leone, Ecuador, Nigeria	Sierra Leone, Ecuador, Nigeria, Venezuela	All	Sierra Leone, Ecuador	Sierra Leone, Ecuador
Over curse	Angola, Venezuela	Angola		Angola, Nigeria, Venezuela	Angola, Nigeria, Venezuela
Both	Yes	No	No	Yes	Yes
Overlap escaped/avoided	Malaysia			Malaysia	Malaysia
Under avoided/escaped	Botswana, Chile, the Netherlands, Norway	All	All	Botswana, Chile, the Netherlands, Norway	Botswana, Chile, the Netherlands, Norway

Figure 16 presents the institutional quality comparison based on Control of Corruption dimension of the five North African countries and the boundary countries, and table 29 presents the details of figure 16.

When one compares the institutional quality among the five North African countries, though

Libya’s confidence interval overlaps with Egypt, Libya appears to have the lowest institutional quality as their institutional quality is lower than Algeria, Morocco and Tunisia. As the rest of the North African countries’ confidence intervals all overlap, it is hard to make the institutional quality comparisons.

When one compares the institutional quality of the five North African countries to the resource curse avoided/escaped boundary-countries, it can be observed that the institutional quality of the resource curse avoided/escaped boundary-countries, especially the developed countries, is significantly higher except for Malaysia. Malaysia’s confidence interval overlaps with Algeria, Morocco and Tunisia. Here, one should not argue that their institutional qualities are high just because their confidence intervals overlap with Malaysia. As can be seen from figure 16, Malaysia’s institutional quality is exceptionally low compared to the other resource curse avoided/escaped boundary-countries. Nevertheless, the institutional quality of the five North African countries appears to be closer to the resource cursed boundary-countries rather than the resource curse avoided/escaped boundary-countries. For example, the confidence intervals of the five North African countries all overlap with some of the resource cursed boundary-countries.

When one compares the institutional qualities of the North African energy exporters to the resource cursed boundary-countries, they all appear to have low institutional quality as their confidence intervals all overlap with a number of resource cursed boundary-countries. Libya, however, may be considered to have the lowest institutional quality among the North African energy exporters because it is the only country that its institutional quality is not higher than any resource cursed boundary-countries. Nevertheless, the fact that the North African energy exporters’ institutional qualities are quite close to the resource cursed boundary-countries shows that they are more likely to be suffering from the resource curse than avoiding/escaping from it. In other words, they have the potentials to suffer from a solar energy curse.

When one compares the institutional quality of the North African energy importers to the resource cursed boundary-countries, they appear to have the potentials to suffer from a solar energy curse because their confidence intervals overlap with a number of resource cursed boundary-countries. It is hard to say that their institutional quality is better than the North African energy exporters, or have less chance to suffer from a solar energy curse, because their confidence intervals often overlap except for Libya.

6.3 Results

6.3.1 Gathering the obtained Results from the Institutional Quality Comparisons based on Six Dimensions

The previous section illustrated the institutional quality comparisons between the five North African countries and ten boundary-countries in six different dimensions. The aim of this section is to gather the results from the comparisons made in section 6.2.2, and present which North African energy exporters are already suffering from the resource curse, and which of the five North African countries have the potentials to suffer from a solar energy curse.

The likelihood of the North African energy exporters to be affected by the current resource curse and the five North African countries to suffer from a solar energy curse will be measured in four categories which are illustrated below.

- Completely avoided/escaped the resource curse and will not suffer from a solar energy curse: Institutional quality is as high as the resource curse avoided/escaped boundary-countries with the highest institutional quality (O)

- Not suffering from the resource curse and have less chance to suffer from a solar energy curse: Better institutional quality than all the cursed boundary-countries and the confidence interval overlaps with the resource curse avoided/escaped boundary-countries (O)

- Suffering from the current resource curse and have the potential to suffer from a solar energy curse: Confidence intervals overlap with the resource cursed boundary-countries (O)

- Suffering seriously from the current resource curse and have the high potential to suffer from a solar energy curse: Have lower institutional quality than the resource cursed boundary- countries. (O)

Accordingly, there are few issues that should be addressed and clarified. Firstly, if a country is considered to be suffering from the resource curse, it will be considered to have the potential to suffer from a solar energy curse because it proves that they have poor institutional quality.

Secondly, there are some cases that the confidence intervals of the five North African countries overlap both with the resource cursed boundary-countries and the resource curse avoided/escaped boundary-countries. For instance, the confidence interval of Tunisia, regarding the Voice and

Accountability dimension, overlaps with both the resource cursed boundary-countries (Angola and Venezuela) and the resource curse avoided/escaped boundary-country (Malaysia). If a country's confidence interval overlaps with both sides of boundary-countries, it will still be considered to be affected by the resource curse or has the potentials to suffer from a solar energy curse. The reason behind this is because, when a country's confidence interval overlaps with both sides, it is often the case that the overlapped resource curse avoided/escaped boundary-countries, such as Malaysia, have relatively low institutional quality compared to the other resource curse avoided/escaped boundary-countries. Therefore, a country's confidence interval overlaps with relatively low institutional quality of the resource curse avoided/escaped boundary-countries should not guarantee that they are not to suffer from a solar energy curse. Another reason is that if a country's confidence interval overlaps with the resource cursed boundary-countries, whether it also overlaps with the resource curse avoided/escaped boundary-countries, it still means that the country has the potential to suffer from the solar energy curse whether their chance is high or not. In other words, when overlaps with both sides, it is better to perceive their position closer to the resource curse and a solar energy curse because a careful consideration of the slight possibility in advance will help in preventing a solar energy curse.

Table 30 below presents where the five North African countries stand regarding the current resource curse and a solar energy curse in the future.

Table 30: Results of the Institutional Quality Comparison in Six Dimensions

	Voice and Accountability	Political Stability & Absence of Violence	Government Effectiveness	Regulatory Quality	Rule of Law	Control of Corruption
Algeria	O	O*	O	O	O	O
Egypt	O	O*	O	O	O	O
Libya	O*	O	O*	O*	O*	O*
Morocco	O	O	O	O	O	O
Tunisia	O	O	O	O	O	O

*: indicates the countries that are in the more serious resource curse, or the highest potential to suffer from the solar energy curse

Regarding the Voice and Accountability dimension, the result shows that the North African energy exporters are already suffering seriously from the current resource curse, and the five North African countries have the potentials to suffer from a solar energy curse because their institutional qualities are lower than a number of the resource cursed boundary-countries except for Tunisia. As mentioned in the previous section, Libya appears to be affected most seriously by the resource curse and has the highest potential to suffer from the solar energy curse because their institutional quality is one of the lowest among the five North African countries and often lower than the resource cursed boundary-countries. Tunisia appears to have less chance of suffering from a solar energy curse compared to the rest of the North African countries. However, it is still in the danger of suffering from a solar energy curse as its institutional quality, based on the Voice and Accountability, is still low as it is similar to many of the resource cursed boundary-countries.

Regarding the Political Stability and Absence of Violence dimension, the result shows that the North African energy exporters are already suffering from the current resource curse, and the five North African countries are likely to suffer from a solar energy curse because their institutional qualities are either similar to the resource cursed boundary-countries or lower than them. In particular, Algeria and Egypt seem to be more seriously affected by the resource curse than Libya, and have a higher potential to suffer from a solar energy curse, as their institutional qualities are lower than a number of resource cursed boundary-countries. Though the institutional qualities of Morocco and Tunisia appear higher than a number of the resource cursed boundary-countries, their institutional qualities are still far from reaching high levels. Overall, the confidence intervals of the five North African countries often overlap with the resource cursed boundary-countries, and they all have the potentials to suffer from a solar energy curse.

Regarding the Government Effectiveness dimension, the result shows that the North African energy exporters, especially Libya, are suffering from the current resource curse, and five North African countries have the potentials to suffer from a solar energy curse because their institutional qualities are as low as the resource cursed boundary-countries. Here, as mentioned earlier, Libya appears to be in a more serious situation as its institutional quality is lower than Ecuador’s institutional quality which is considered to be affected by the resource curse. Although the institutional quality of Morocco and Tunisia are higher than many resource cursed boundary-countries, and may appear higher than Libya’s institutional quality, their institutional quality can not be considered high enough and are considered to have the potentials to suffer from a solar energy curse regarding the Government Effectiveness dimension.

Regarding the Regulatory Quality dimension, the result shows that the North African energy exporters, especially Libya, are already suffering from the resource curse, and the five North African countries have the potentials to suffer from a solar energy curse because their institution qualities are similar to the resource cursed boundary-countries. Again, Libya appears to be affected by a deeper resource curse because its institutional quality is worse than a number of the resource cursed boundary-countries. Though the energy North African importers and Egypt have higher institutional qualities compared to the North African energy exporters in figure 14, their institutional qualities are still closer to the resource cursed boundary-countries which indicate that they are in the danger of suffering from a solar energy curse in the future.

Regarding the rule of Law dimension, the result shows that the North African energy exporters are already suffering from the resource curse. Regarding the solar energy curse, however, the institutional qualities of Morocco and Tunisia are higher than all the resource cursed boundary-countries which suggests that they have less chance to suffer from a solar energy curse because their institutional qualities are 'relatively' high. However, as mentioned earlier, one should not conclude that the energy importers will not suffer from a solar energy curse because their institutional qualities can not be considered high as their institutional qualities are below the average (0), and their institutional qualities are still closer to the resource cursed boundary-countries rather than to the resource curse avoided/escaped boundary-countries. In other words, they still need to improve their institutional quality, regarding the Rule of Law dimension, in order to properly avoid a solar energy curse.

Regarding the Control of Corruption dimension, the result shows that the North African energy exporters are already suffering from the resource curse, and the five North African countries have the potentials to suffer from a solar energy curse. Though it appears that the five North African countries' chances of suffering from a solar energy curse may be the same according to table 30, Libya clearly has a higher chance of suffering from a solar energy curse as seen in figure 16. Nevertheless, the need for institutional quality improvement, regarding the Regulatory Quality dimension, is applicable to all five North African countries.

Overall, it could be argued that there is not a single country, among the five North African countries, which has a comparable institutional quality, in all dimension, to the resource curse avoided/escaped boundary countries with higher institutional quality. In other words, the North African energy exporters have not avoided/escaped from the resource curse, and the five North African countries are all projected to suffer from a solar energy curse if their current poor institutional qualities are to remain in the future.

As can be seen from the institutional quality comparison in all dimensions, the North African energy exporters are all suffering from the resource curse in certain degrees, thus having a greater potential to suffer from a solar energy curse. Here, especially, Libya appears to be suffering from the resource curse the most and also has the highest possibility to suffer from a solar energy curse in the future. On the other hand, according to table 30, Tunisia appears to have the least chances of suffering from a solar energy curse among the five North African countries. However, Tunisia's institutional quality is only slightly higher than the rest of the North African countries but their institutional quality still remains quite low. As seen in section 6.2.2, Tunisia's institutional quality is closer to the resource cursed boundary-countries than the resource curse avoided/escaped boundary-countries.

What one can see in general from the above institutional quality comparison is that the North African energy importers often have higher institutional quality compared to the North Africa energy exporters. For example, the institutional qualities of Morocco and Tunisia are better than Libya in all dimensions except for the Political Stability and Absence of Violence dimensions, and their institutional qualities are higher than Algeria regarding the Regulatory Quality and Rule of Law. Nevertheless, their institutional qualities are still closer to the resource cursed boundary-countries than the resource curse avoided/escaped boundary-countries.

Overall, though some countries have higher institutional quality than other within the five North African countries, their institutional qualities are quite poor. In other words, the North African energy exporters may already be suffering from the resource curse, and, more importantly, the five North African countries have the potentials to suffer from a solar energy curse if their institutional qualities remain poor in the future.

6.3.2. Limitations and Additional Findings

By looking at all the institutional quality comparisons made in section 6.2.2, it is possible see that the institutional quality is not always paralleled with the development status. Throughout the analysis, one can see that, such as in the case of the Voice and Accountability dimension, there are cases that the institutional quality of the least developed resource cursed boundary-countries is higher than the developing resource cursed boundary-countries or even similar to the resource curse avoided/escaped boundary-countries. Similarly, there are cases that the institutional quality of the resource curse avoided/escaped developing boundary-country, such as Malaysia, appears to be similar to the resource cursed least developed boundary-countries. Of course, a part of this outcome may be from the use of the 95 percent confidence level (double standard error). However, the application of the 95 percent confidence level, overlaps of the confidence intervals of the resource cursed least developed boundary-countries and the resource curse avoided/escaped developing boundary-countries, can not be the entire explanation as there are cases that their institutional qualities are quite similar such as Sierra Leone and Malaysia regarding the Voice and Accountability dimension. Therefore, it would be incorrect to argue that institutional quality is always paralleled to the development status. Despite this outcome, what is still proven is that the resource curse avoided/escaped boundary-countries do tend to have better institutional quality than the resource cursed boundary-countries, and they tend to have higher development statuses. Particularly, the developed resource curse avoided/escaped boundary-countries, the Netherlands and Norway, always have better institutional quality than the resource cursed boundary-countries. Therefore, institutional quality still plays a crucial role in determining whether a country is to suffer from the resource curse or to avoid/escape from the resource curse. In other words, the improvement of the institutional quality can play a crucial role for the five North African countries to avoid a potential solar energy curse in the future.

Lastly, as illustrated earlier, selecting Sierra Leone and the Netherlands as additional boundary-countries did not fulfill the main requirement for being boundary-countries where resource rent size is to consist of more than 10 percent of their GDP. One may argue that this may have affected the outcome of this section. However, as seen throughout this section, the Netherlands (resource curse avoided/escaped boundary-country) has higher institutional quality than Sierra Leone (resource cursed boundary-country) in all dimensions. Also, the development status of the Netherlands is higher than Sierra Leone. In other words, though the resource rent size to be 10 percent of GDP was not applied for these two countries, it is possible to see that selecting these countries did not hinder the purpose of this section and results.

Chapter 7. Measuring the Rent Size from Solar Energy Exports for the Five North African Countries

7.1 Rent size and its Combination with Poor Institutional Quality

In Section 4.3, resource rents is qualified as a boundary-line to measure the resource curse because the resource curse itself would not have become an issue if it were not for resource rents. In section 5.1 and 5.2, the rent size is tested to see whether it can be the boundary-line to identify the resource curse by comparing the average GDP growth. Unfortunately, though certain improvements are achieved after adding the 'development status' filter, the average GDP growth comparison method does not appear sufficient enough to be used as the boundary-line. On the other hand, the institutional quality comparison method is qualified as the boundary-line, and it was possible to project which North African countries have the potentials to suffer from a solar energy curse. However, if there is no rent from solar energy exports, the institutional quality comparison method becomes irrelevant as there is no reason for the five North African countries to be affected by a solar energy curse.

As mentioned earlier, it is often argued that one of the main reasons for the existence of the resource curse is the enormous size of resource rents, unearned revenue, from the natural resources export. For example, Mehlum et al. (2006a, p.1119), who accentuate on the importance of institutional quality, also suggest that the combination of a vast amount of resource rents and the poor institutional quality can lead a country to suffer from rent-seeking which is one of the resource curse effects. In chapter 6, it is witnessed that the North African energy exporters have poor institutional qualities, and it appears that they are already suffering from the resource curse. Of course, these North African energy exporters receive a vast amount of rent from exporting oil and natural gas. A solar energy curse, therefore, may occur if there is a combination of poor institutional quality and a sizable rent from solar electricity exports. It means that one should project the rent size from the solar electricity exports and see whether it is comparable to the current rent size of the natural resource, or energy, exports. Therefore, the aim of this chapter is to compare the rent size from the natural resources export and solar electricity exports in order to see whether solar energy can produce enormous amount of rent for the five North African countries.

7.2 Rent from Solar Energy Exports for the Five North African Countries

The five North African countries and the MENA countries have high potential to become solar energy exporters in the future. As illustrated in Section 3.2, there are different types of solar energy such as PV and CSP technologies. Of course, both technologies are valuable sources that will help in meeting the future energy demand. However, when considering the five North African countries and the other MENA countries, the CSP technology has been receiving more attention due a number of factors such as its fast development, energy storage, and high irradiation in the region.

As mentioned earlier, organizations such as DESERTEC and DII pay high attention to the MENA region due to its high electricity production potential to satisfy the future domestic electricity demand and also for Europe in the future. Therefore, the projection of the solar energy rent for the five North African countries will be based on the CSP technology.

7.2.1 Causes for the Increase in the Electricity Demand

There are two important factors which are considered to be the key drivers of the energy demand. One is the population growth. It is considered important because its size affects the size and composition of energy demand, directly and through its impact on economic growth and development (Green Peace 2012, p.5). The world population is expected to reach 9.3 billion by 2050, and most of the population growth is expected to occur in developing countries. For example, it is projected that, between 2011 and 2050, the population of the less developed regions is to rise from 5.7 billion to 8 billion, and the population of the least developed countries is to grow from 851 million to 1.7 billion. Conversely, the population of the more developed regions is to remain around 1.3 billion (UNCTAD 2011, p. 1).

Another factor that is considered to be the key driver for energy demand is economic growth. According to International Energy Agency (IEA 2009, p.58), energy projections are sensitive to underlying assumptions of the GDP growth which is considered as the principal driver of demand for energy service. Also, they find that the economic development pattern has impacts on overall energy demand and the fuel mix. The correlation between the GDP growth and the energy demand has been identified, between 1971 and 2007, as the global GDP rose each year with 1 percent increase rate which was accompanied by a 0.7 percent increase rate in primary energy consumption (IEA 2009, p. 58). Similarly, Green Peace (2012, p.54) also finds that, since 1971, each 1 percent increase in GDP has been accompanied by a 0.6 percent increase in primary energy consumption until recent years. Furthermore, the world GDP growth is expected to grow in the future, over the period 2007-2030, by an average of 3.1 percent per year (IEA 2009, p.62) which indicates the growth in energy demand. As the projections for the key drivers of the energy demand, population growth and economic growth, are expected to grow in the future, it can be argued that the demand for energy, therefore, is also expected to grow.

7.2.2 Electricity Export from the Five North African Countries to Europe

When considering electricity exports from the five North African countries, they are closely related with Europe because they are expected to be the biggest electricity importers from the five North African countries and the rest of the MENA countries. Also, as mentioned earlier, organizations, such as DESERTEC and DII, consider solar energy from the five North African countries and the rest of the MENA countries as an important future energy source for Europe. In other words, one can expect that the electricity transfer between the five North African countries and Europe will play an important role in projecting the solar energy rent size. Of course, the CSP technology is in the centre of this matter.

As the electricity transfer between the five North African countries and Europe is to play an important role in projecting the solar energy rent size, it is important to be aware of the electricity demand of the both regions. According to Schellekens et al. (2010, p.15), the current power systems and power consumption between Europe and North Africa differ greatly due to the differences in their economic development, and the abundance of oil and natural gas in North Africa. The current European power consumption is much higher, 3300 trillion watt per hour (TWh)/y, compared to the five North African countries, 180 TWh/y.

Regarding the growth in electricity demand, the five North African countries’ electricity demand has increased rapidly which is about double the size in the last 20 years. The demand growth continues to increase by up to 8 percent year. By contrast, the electricity demand in Europe has increased 1-2 percent per year, which has grown about 30 percent between 1990 and 2006. However, when calculated in absolute number, it is found that the growth of the electricity demand is increasing faster in Europe because the growth rate of 1.5 percent in 2005 is equivalent to increase of 50 TWh/y, whereas the electricity demand growth rate of 8 percent per year is equivalent to 15 TWh/y in North Africa (Schellekens et al., 2010, p. 15).

According to Schellekens et al.’s (2010, p.15) projection, the total consumption of electricity in Europe and North Africa together will reach at least 5000 TWh/y in 2050. Although they project that 25 percent (1250 TWh/y) of the demand will be from North Africa, only 60 percent (3000 TWh/y) of the system-wide electricity supply is produced in Europe, and 40 percent (2000 TWh/y) is produced in North Africa. In other words, one can speculate that about 20 percent of electricity demand in Europe is expected to be met by electricity imports from North Africa. The main reason for the increase in the electricity demand in Europe is expected to be from the fuel switch to electricity such as introduction of electric cars, whereas population growth, and the economic growth are the main reasons for the electricity demand growth in North Africa as can be seen from table 31.

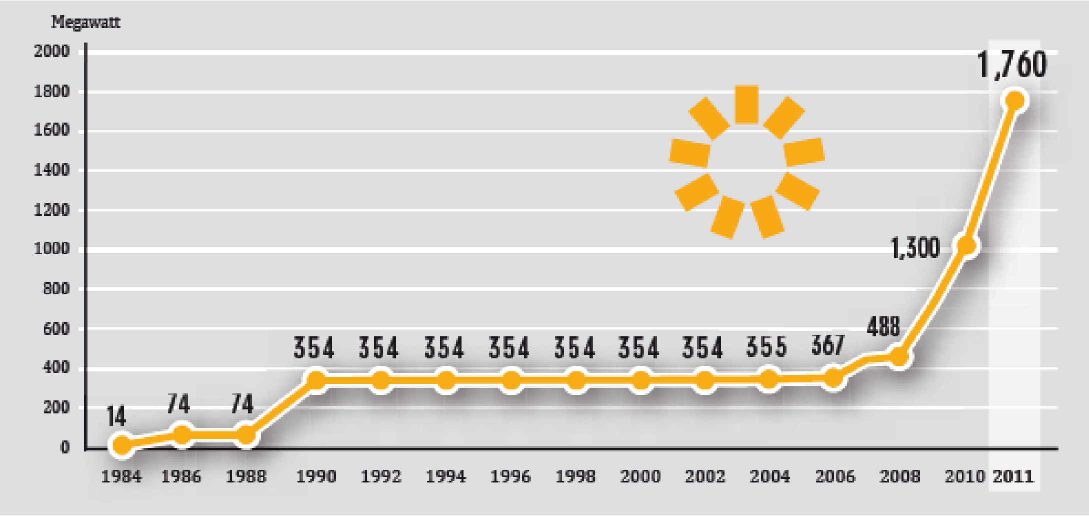
Table 31: UNPD's Prediction of the Population Growth in the Five North African Countries with Medium Variant (Thousand)

	2010	**2020**	**2030**	**2040**	**2050**
Algeria	35468	40180	43475	45490	46522
Egypt	81121	94810	106498	116232	123452
Libya	6355	7083	7783	8360	8773
Morocco	31951	35078	37502	38806	39200
Tunisia	10481	11518	12212	12533	12649
Total	165375	188669	207470	221421	230596

Source: United Nations, Department of Economic and Social Affairs Population Division, Population Estimates and Projections Section

Despite the predicted electricity demand growth in both regions, one is still faced with certain difficulties in projecting the solar energy rent size. As can be seen from figure 17, the capacity of the CSP has been increasing in recent years. For example, according to Zickfeld et al. (2012, p. 47), approximately 1 GW of CSP was installed worldwide at the end of 2010, and 1.6 GW was installed worldwide by the end of 2011, or 1758 MW according to REN21 (2012, p.102). However, despite the recent rapid growth, the capacity of the CSP is still small, and its use does not have a long history or data such as oil, natural gas, or other renewable energies. In other words, one lacks concrete data in order to calculate the rent size from the electricity export via CSP for the five North African countries.

Figure 17: Concentrating Solar Thermal power, Total World Capacity (1984-2011)



Source: REN21 (2012, p.51)

Despite these obstacles, in order to project the solar energy rent size, it is important to know the amount of electricity that could be exported, or transferred, from the five North African countries to Europe. DLR (2006), the TRANS-CSP scenario, provides the estimates of the projected amount of electricity that will be transferred from the MENA region to Europe. Here, it must be mentioned that MENA countries in DLR (2006) are not clearly defined.

Table 32: TRANS-CSP SCENARIO Projected Amount of Electricity Transfer between Europe and MENA from 2020 to 2050

Year		2020	2030	2040	2050
Transfer Capacity GW		2 x 5	8 x 5	14 x 5	20 x 5
Electricity Transfer TWh/y		60	230	470	700
Capacity Factor		0.60	0.67	0.75	0.80
Turnover Billion €/y		3.8	12.5	24	35
Land Area	CSP	15 x 15	30 x 30	40 x 40	50 x 50
km x km	HVDC	3100 x 0.1	3600 x 0.4	3600 x 0.7	3600 x 1.0
Investment	CSP	42	143	245	350
Billion €	HVDC	5	20	31	45
Elec. Cost	CSP	0.050	0.045	0.040	0.040
€/kWh	HVDC	0.014	0.010	0.010	0.010

Source: DLR (2006, p. 4)

As can be observed from table 32, DLR (2006, p.78) projects that the amount of electricity transfer from the MENA region to Europe will gradually increase and reach 700 TWh/y with a total transfer capacity of 100GW in 2050. As mentioned earlier, the electricity consumption in Europe and North Africa will reach 5000TWh/y by 2050 (Schellenkens et al. 2010, p. 15). Here, about 25 percent (1250 TWh/y) of this demand is from North Africa and the remainder (3750 TWh/y) is from Europe. However, Schellekens et al. (2010, p.15) project that, out of 5000TWh/y electricity, 60 percent (3000 TWh/y) of the electricity is to be produced in Europe, whereas 40 percent (2000 TWh/y) is to be produced in North Africa. In other words, about 750 TWh/y amount of electricity is projected to be exported from North Africa to Europe. The North African power system in 2050 is projected to be based mainly on wind power and solar, including CSP plants with storage and PV, with differences dependent on 'resource availability' (Schellekens et al., 2010, p. 21). The majority of power generation via CSP is expected to be from the central desert regions. Also, due to the high overall share of CSP, they expect that electricity for local consumption and for export will be dispatchable throughout the year, using CSP plants with storage, in conjunction with other renewable as appropriate (Schellenkens et al., 2010, p. 21). In more recent study, Trieb et al. (2012, p. 349), the five North African countries are projected to export 632 TWh/y by 2050. By looking at various studies, one can expect that quite a large amount of electricity will be exported, or transferred, from the five North African countries, and MENA countries, to Europe by 2050. In this section, the projected amount of electricity which will be exported from the five North African countries is 694 TWh/y, which is the average value of the three studies mentioned above. It must be noted that, in the actual calculation, 700 TWh/y will be applied instead of 694 TWh/y in order to avoid unnecessary digits. Furthermore, as it is a projected value, and is also partially based on DLR's (2006)s study which include other MENA countries, the projected amount of electricity exports from the five North African countries to Europe will be within the range of ±100 TWh/y from 700 TWh/y in this section rather than a fixed value.

When looking at table 32, one is able to see that DLR (2006) projects that the electricity cost will gradually decrease in the future. In 2050, for example, the average electricity cost is expected to reach as low as 5 €cents/kWh. The projected cost of electricity in 2050 by DLR (2006) composes of 4 €cents/kWh for solar electricity production by CSP plants in MENA and 1 €cent/kWh for the transmission to Europe which include electricity losses, capital cost and cost of operation, and assumes a discount rate of 5 percent/y as for the other technologies (DLR 2006, p. 78). Here, it should be noted that, regarding the transmission technology, the High Voltage Direct Current (HVDC) grid is chosen. THE HVDC grid is perceived as the most essential technology regarding electricity transfer between the two regions. The distance that the electricity has to transfer between Europe and MENA is over 3000 km. According to DLR (2005, 2006) and Schellekens et al. (2010), HVDC's biggest advantage, that it would only have about 10-15 percent of transmission losses, makes this technology the most crucial element for the electricity transfer plan between Europe and North Africa (DLR 2006, p. 2).

The 5 €cents/kWh electricity cost projection by DLR (2006) is often mentioned and used as the base of many recent calculations regarding the electricity transfer from North Africa to Europe such as in Lilliestam Johan & Saskia Ellenbeck (2011). If one is to calculate the value of the amount of the electricity transferred from MENA to Europe (600-800 TWh/y) based on 5 €cents/kWh electricity cost, it would be between €30-40billion/y.

Although, it is possible to project the value of the amount of the electricity transferred, this does not present one with the actual rent size that this thesis is looking for. Of course, 5 €cents/kWh does include the rent size. However, the included rent size is for the investors. For example, the decision for investors whether to build a power plant is dependent on the returns to investment which is often referred to as discount rate. As mentioned earlier, within 1 €cent/kWh for the transmission to Europe includes a discount rate of 5 percent/y.[61] In this thesis, one is not looking for the projected rent size for investors. One of the reasons for the resource curse is due to the enormous resource rent size or excess earning above normal profits (Rosser 2006, p. 11). Kolstad & Wiig (2009, p.5317) also mention that the return in excess of costs often occurs in many natural resource industries. Therefore, the priority task here is to find a way to project the rent size, 'the excess earning', on top of the production cost.[62]

One possible way to project the rent size for the North African countries is to learn the rent size and its proportion from the total cost of electricity in other countries with more experiences with solar energy and apply them on the five North African countries or MENA countries.

Spain and Germany are considered as the leading countries in promoting renewable energies such as solar energy and wind energy. Regarding solar energy, especially the CSP technology, Spain has been one of the leading countries with the United States. Spain has the largest CSP capacity in the world. A significant amount of capacity has started to come online in Spain between 2009 and 2010. During 2011, nearly 420 MW of capacity was added, and ended the year with the capacity of almost 1150 MW in operation, in response to an adequate "Feed-in-tariff" (FiT), and legal framework (REN 2012, p.51). However, on January 27, 2012, as part of Royal Decree-Law (RDL1/2012), the Spanish government temporarily put a halt to awarding new FiT contract starting in January 2013. The main reason for this action was due to the country's over €24 billion electricity system deficit

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[61] A discount rate of 5 percent/y means a return of 5 percent on the invested capital.

[62] The rent size in this thesis, thus, refer to the 'excess earning'.

(Couture Toby D 2012, p.1).

A FiT is a policy mechanism that is designed to accelerate investment in renewable energy projects. The principle of FiT policies is to offer guaranteed prices for fixed periods of time, usually 10-25 years, for electricity produced from Renewable Energy Sources (RES). These fixed prices are usually offered in a non-discriminatory matter for each kWh of electricity produced and can be differentiated dependent on the technology type, the installation size, the resource quality, the project location and also a number of project-specific variables. FiTs are implemented in 63 jurisdictions worldwide (Couture & Ganon 2010, p.955). In Germany and Spain, countries that are considered 'more successful' with FiTs, the payment levels of FiT offered to particular projects are determined as closely as possible in relation to the specific generation cost. More specifically, FiTs are designed to make it possible for efficiently operated RE installations to cost effectively developed (Couture & Ganon 2010, p. 955). The FiT will be a crucial element which will help in projecting the solar energy rent size for the North African Countries in chapter.

If a country has implemented FiT, the task of calculating the rent size becomes simpler. As mentioned earlier, FiT offers guaranteed prices for fixed periods of time. If one is to subtract the cost of electricity production from FiT, it is possible to obtain the additional rent size, and calculate the proportion of the rent size from the FiT. However, as one may suspect, the cost of electricity production can vary dependent on many factors such as investment cost. This is the reason why LCOE is often used to represent the cost of electricity production. LCOE is considered as a useful tool for comparing the unit costs of different technologies over their economic life. More specifically, according to NREL (2011, p. 51), LCOE is defined as the ratio of an electricity generation system's amortized lifetime costs to the life time of the system's electricity generation. LCOE, therefore, includes all costs through the lifetime of a system such as initial investment cost, operations and maintenance cost (O&M), fuel cost, and cost of capital. Furthermore, LCOE is considered as the most transparent consensus measure of the cost of electricity generation and widely used to compare the costs of different power, or electricity, generation technologies in modeling and policy decisions as well (IEA 2010, p.33).

As can be seen above, one can see that it is possible to calculate the rent size, and its proportion, of the CSP technology. A simple formula is presented below.

Formula I:

Feed in Tariff (FiT) = Levelized Cost of Electricity (LCOE) + Rent
Rent = FiT - LCOE
Rent rate = (Rent/FiT) × 100

Here, one may question how reliable it is to use the FiT and Formula I in projecting the rent size. For example, Zickfeld et al. (2012, p. 58) consider that the RES production in the MENA countries, due to the expected cost reduction, to be competitive with traditional power production in Europe. They see that public support and incentives will only be necessary in the initial phase of the system integration. As this thesis is projecting the rent size for the 2050, therefore, it is uncertain that there will be the continuous use of the FiT in the future for both Europe and MENA. However, it is also not possible to guarantee that the RES will be as competitive as many 'optimistic studies' claim. Also, for example, considering the fact that FiT is still used for onshore wind power in Germany, which is considered as one of the most advanced renewable energy technologies, indirectly suggests that, if FiT is to be introduced in North Africa and other MENA countries, one may still see the use of FiT for CSP in 2050 in the North African countries and other MENA countries. Nevertheless, as the purpose of this thesis is to investigate whether the rent size from solar energy will be comparable to the oil and natural gas rent size, the existence of FiT in the future is not so relevant.

As mentioned earlier, Spain has been one of the leading countries regarding the CSP technology. As Spain has the most experiences with the CSP technology, their solar energy rent size and its proportion from FiT will be calculated first. It must be mentioned that the global CSP market has been dominated by parabolic trough plants, account for 90 percent of CSP plants, for nearly all existing capacity operation (REN21 2011, p. 25). The parabolic trough technology also dominates the market in Spain because of the Royal Decree conditions set up in 2009. It boosted the development CSP in the country, and also gave a strong position to parabolic trough which was then the most mature solar energy technology (REN21 2012, p. 51). Therefore, when calculating the rent size of the CSP in Spain, and the five North African countries as well, the parabolic trough technology will be chosen as the base technology.

In order to calculate the rent size from the electricity exports via CSP technology in Spain, one should first identify the FiT and LCOE for the CSP technology in Spain. The most recent FiT for CSP in Spain can be seen in the Royal Decree (RD) 661 in 2007 which is 26.9375 €cents/kWh for the first 25 years (Ministerio ITC, 2007).[63] The Spanish FiT law stipulates a maximum electrical output of 50 MW for eligibility (IRENA 2012a, p.22). When regarding the LCOE for the CSP parabolic trough technology in Spain, there are few data which one can use. According to Schellekens et al. (2010, p. 115), the LCOE for CSP parabolic through technology in Spain is 17.3 €cents/kWh. As Schellenkens et al.'s (2010) study and their estimation are based on data from the DLR and the American National Renewable Energy Laboratory (NREL), which are the most widely used sources when projecting the LCOE for the

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[63] In the actual calculation, 27 €cents/kWh will be used in order to avoid too many digits. 27 €cents/kWh or €0.27/kWh as the FiT for Spain often can be seen in articles such as from Williges et al. (2010, p.3090).

CSP technology, one can speculate that the given number is rather accurate. The model power plants considered in their study are 50 MW with 3 hour storage for parabolic trough with DNI of 2000 kWh/m²/y (Schellekens et al., 2010, p.114). CSP Today (2008, p. 13) estimates that the LCOE of the 50 MW CSP units around 17-18 €cents/kWh. In a more recent study, according to IRENA (2012a, p.32), the estimated LCOE of the 50 MW CSP units in Spain are between US$0.30 kWh to US$0.35 kWh. As the parabolic trough technology dominates the market in Spain, this given range of 17-18 €cents/kWh (CSP Today 2008, p.13) and US$0.30-0.35 kWh (IRENA 2012a, p.32) will be considered as the LCOE of the parabolic trough in Spain. Here, one can notice that various studies use different currencies. Therefore, it is necessary to choose one currency in order to obtain accurate result regarding the comparison between the oil and Natural gas rent size and the projected rent size from solar energy. The US dollar will be selected as the standard currency in this thesis. The reason for choosing the US dollar is because the majority of resource rents are calculated in US dollar, notably the price of oil and natural gas.

Regarding the comparison among rent sizes, as Euro was introduced as an official accounting currency on 1 January 1999 to world financial markets, the average exchange rates between Euro and the US dollar (1999-2009) will be applied. Table 33 presents the yearly average exchange rate from Euros to the US dollar and the US dollars to Euros between 1999 and 2009. As can be seen from table 33, the average exchange rate from Euros to the US dollars and from the US dollar to Euro during the period of 1999-2009 are 1.1768[64] and 0.8752[65], respectively. Each exchange rate will be applied when appropriate.

Table 33: Yearly Average Exchange Rate between Euro and US Dollar 1999-2009

Yearly Average Exchange Rate from Euro to US Dollar											
1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Average**
1.0658	0.9236	0.8956	0.9456	1.1312	1.2439	1.2441	1.2556	1.3705	1.4708	1.3948	***1.1768***
Yearly Average Exchange Rate from US Dollar to Euro											
1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**Average**
0.9396	1.0959	1.1175	1.0609	0.8858	0.8049	0.8051	0.7972	0.7308	0.6835	0.7190	***0.8752***

Source: European Central Bank
http://www.ecb.int/stats/exchange/eurofxref/html/eurofxref-graph-usd.en.html (accessed: 09.10.2012)

When calculating the solar energy rent size of Spain -as most of data presented above are in Euros- the estimated LCOE, US$0.30 kWh to US$0.35 kWh, from IRENA (2012a, p.32) will be calculated into Euro first and the final result will be recalculated into the US dollar in order to avoid

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[64] In the actual calculation, the exchange rate will be rounded up to 1.18 in order to avoid too many digits.

[65] In the actual calculation, the exchange rate will be rounded up to 0.88 in order to avoid too many digits.

frequent changes in currency during the calculation. The FiT and LCOE range of CSP parabolic trough in Spain after applying the exchange rate is presented in table 34 below.

Table 34: FiT and LCOE Range of CSP Parabolic Trough in Spain

Spain CSP FiT	27 €cents/kWh
LCOE from difference Sources (€cents/kWh)	17.3 €cents/kWh from Schellenkens et al. (2010, p.115)
	17-18 €cents/kWh from CSP Today (2008, p. 13)
	26.4-30.8 €cents/kWh from IRENA (2012a, p.32)

As can be observed from table 34, the LCOE provided by IRENA (2012a) is much higher compared to the LCOE provided by other sources. Even within the data given from IRENA (2012a), the range of the LCOE is rather wide. More importantly, when looking at IRENA's (2012a) highest value of the LCOE range, 30.8 €cents/kWh, one can notice that it is higher than the FiT in Spain. This may be due to the fact that the Spain's FiT is from 2007 and the LCOE range provided by IRENA (2012a) is from a very recent year. Also, furthermore, this may be one of the explanations for Spain to temporarily put a halt to awarding new FiT contract from 2013 which is perceived to be due to the over €24 billion electricity system deficit. One is faced with a peculiar task of deciding whether to include or exclude the LCOE provided by IRENA (2012a) because the range is much higher than the LCOE from other sources, and its highest point of the LCOE range is higher than the FiT in Spain. Here, it is decided to use the data from IRENA (2012a) as it is the most recent data, and the use of it seems appropriate especially when the purpose of this thesis is to project the future electricity export rent size. Here, the highest point (30.8 €cents/kWh) in the range given by IRENA (2012a) can not be used because it is higher than Spain's FiT. Also, the average of the given range, 28.6 €cents/kWh, is still higher than Spain's FiT. Therefore, only the lowest value of the given range of the LCOE (26.4 €cents/kWh) will be included in the calculation which is slightly lower than Spain's FiT. Consequently, one is given with the LCOE range of 17-26.4 €cents/kWh from all the sources presented in table 34. In the calculation, the average value of the given LCOE range (21.95 €cents/kWh)[66] above will be used. The process of the calculation in obtaining the rent size and its proportion is illustrated below.

27 €cents/kWh = 22 €cents/kWh + Rent
Rent = 27 €cents/kWh – 22 €cents/kWh = 5 €cents/kWh
Rent rate= (5 €cent/kWh / 27 €cents/kWh) × 100 = 18.5%

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[66] In the actual calculation, 22 €cents/kWh will be used in order to avoid too many digits.

As presented above, the solar energy rent size via parabolic trough technology in Spain is 5 €cents/kWh, and its proportion from FiT is around 18.5 percent. By using this rent rate, one is able to project the rent size from the electricity export via parabolic trough in the five North African countries. One obstacle is that the five North African countries, except for Algeria (CSP Today 2008, p.34), do not have specific FiT for the CSP. However, fortunately, there are few projected LCOE of the parabolic trough for the five North African countries and other MENA countries provided by a number of studies, which enables one to still project the rent size.

As mentioned earlier, DLR (2006, p.78) projects the average electricity cost to reach as low as 5 €cents/kWh. Schellekens et al. (2010, p.115) project that the LCOE for the parabolic trough for the five North African countries to be 13.7 €cents/kWh. In a more recent study by Zickfeld et al. (2012, p.44), they project that the LCOE of the EUMENA CSP to reach approximately €50/MWh (5 €cents/kWh) in 2050. Of course, these sources provide different size of the LCOE because they apply, for example, different capacities, storage hours and other factors.[67] However, what one should note from the given LCOE sizes above is that data from DLR (2006) and Zickfeld et al. (2012) consider the EUMENA LCOE. On the other hand, the LCOE size provided by Schellekens et al. (2010, p.115) is referring to the LCOE size of the parabolic trough technology only in North Africa. Therefore, the LCOE from Schellekens et al. (2010) will be used to project the rent size for the five North African countries. Table 35 presents the available data for one to calculate the projected solar energy rent size for the five North African countries.

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[67] There are many determining factors that can change the LCOE of CSP, and the most important parameters that determine the LCOE of CSP, according to IRENA (2012a, p. 30), are the initial investment cost, (including site development, components and system costs, assembly, grid connection and financing costs), the plant's capacity factor and efficiency, the O&M costs (including insurance) costs, and the cost of capital, economic lifetime, etc. Also, the LCOE of CSP is closely correlated with the DNI and the amount of thermal energy storage and the size of the solar multiple. For an accurate projection to be achieved, these factors should all be considered. However, this thesis is projecting the CSP rent size in 2050. It would be, for example, hard to say that all energy storages for CSP will remain the same in North Africa. The projection made in this thesis will be mostly based on the average size of LCOE from various sources as one can not project the exact LCOE of CSP in the future.

Table 35: FiT, LCOE, and Rent for Spain and the Five North African Countries

	FiT	**LCOE**	**Rent**
Spain	27 €cents/kWh	22 €cents/kWh	5 €cents/kWh (18.5%)
The 5 Countries	**Y** €cents/kWh	13.7 €cents/kWh	**X** €cents/kWh

Source: Ministerio ITC (2007), Schellekens et al. (2010, p.115)

If one is to speculate that the rent rate for the five North African countries is the same as in Spain (18.5 percent), then the rate of the LCOE for the five North African countries is 81.5 percent. The LCOE of the parabolic trough is 13.7 €cents/kWh as illustrated in table 35. By using the available data, one is able to calculate the FiT for the five North African countries which will be used to project the solar energy rent size. Here, it must be mentioned that the calculated FiT for the five North African countries does not have any real value, and it is just calculated to project the rent size.

FiT for the five North African countries = Y €cents/kWh
LCOE for the five North African countries and its proportion = 13.7 €cents/kWh (81.5%)
Rent size for the five North African countries and its proportion = Y €cents/kWh (18.5%)

13.7 €cents/kWh = Y €cents/kWh × (81.5/100)
Y €cents/kWh = 13.7 €cents/kWh / (81.5/100)
Y €cents/kWh = 16.8098 €cents/kWh

As the FiT for the five North African countries is projected to be 16.8098 €cents/kWh, the projection of the rent size can be proceeded. In the calculation, FiT will be set as 16.8 €cents/kWh.

CSP rent for the five North African countries = 16.8 €cents/kWh – 13.7 €cent/kWh
= 3.1 €cent/kWh

As can be seen above, the projection for the solar energy rent for the five North African countries is 3.1 €cent/kWh under the assumption that proportion of the rent size from the FiT is considered the same as in Spain (15 percent). As mentioned earlier, the projected total amount of electricity that is to be exported from the five North African countries to Europe is between 600 TWh/y and 800 TWh/y in 2050. This means that solar energy exports can incur the rent size of €18.6-24.8billion/y.

Here, one should note that the calculation has been made with the projected amount of electricity transferred in 2050 (±700 kWh/y) and the recent year's LCOE. As can be seen from table 32, DLR's (2006) projection shows that the electricity production cost is projected to decline in the future due to a number of factors such as the improved efficiency and technology development. This is also the case for both FiT and LCOE. Therefore, one can argue that this will have great impact on the rent size. In other words, applying the current FiT and LCOE of Spain to project the future electricity export rent size appears problematic. Therefore, one is required to apply more suitable FiT, LCOE, and rent size proportion from FiT, in order to project the rent size from electricity export via parabolic trough, or any other renewable energy sources, in the future.

The design of FiTs and the levels of support provided under FiTs vary widely due to technology cost, resource availability, and installation size and type. According to REN21 (2012. 74), FiTs usually decline over time, and tend to be lower for the more mature technologies such as geothermal, hydropower, and wind power which can be seen from figure 18.

Figure 18: FiT Payments for a Range of Renewable Energy Technologies, Selected Countries, 2011/2012

Source: REN21 (2012, p. 74)

The CSP technology is considered to be an immature renewable technology compared to other technologies such as wind power. This can be observed by comparing the total capacity of the renewable technologies which is shown in table 36 below.

Table 36: Renewable Electric Power Capacity, World and Top Regions/Countries, Total year-End 2011

Technology	Capacity (GW)
Biomass Power	72
Geothermal Power	11.2
Ocean (tidal) power	0.5
Solar PV	70
Concentrating Solar Thermal Power (CSP)	1.8
Wind Power	238

Source: REN21 (2012, p.98)

Although it would be more ideal for one to project the rent size from CSP by applying other CSP experiences, as mentioned earlier, the CSP technology is still immature compared to other renewable energies. Therefore, in order to project the rent size from CSP in 2050 with current data, the best way is to obtain the proportion of the LCOE and rent size from FiT from the currently most advanced and matured renewable technologies. By applying the obtained proportion rates, one is more likely to obtain accurate solar energy rent size for the five North African countries.

As mentioned before, wind power is considered to be one of the most matured renewable energy sources. Germany is the European leader in wind energy with 29,060 MW of installed capacity in 2011 (GWEC 2012, p.39). Table 37 presents the wind power capacity development from 2001 to 2011 in Germany.

Table 37: Total Installed Wind Power Capacity in Germany From 2001 to 2011

Year	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Capacity	8.754	11,994	14,609	16,629	18,415	20,622	22,247	23,903	25,777	27,191	29,060

Source: GWEC (2012, p.39)

Although FiT for wind power existed in Germany since 1991, it was the year 2000 that the Renewable Energy Sources Act (EEG) provided the main stimulus to the German wind market. The EEG is amended regularly in order to adapt tariffs to the current market condition and new technological development. The latest amendment was made in recent years. The German Bundestag adopted the “Act on the amendment of the legal framework for the promotion of electricity generation from renewable energies” (Gesetz zur Neuregelung des Rechtsrahmens für die Förderung der Stromerzeugung aus erneuerbaren Energien) on 30 June 2011 which revised the EEG. The revised version entered into force on 1 January 2012 (BMU 2012b, p.1). Table 38 presents the changes of FiT for wind power (onshore) in Germany between 2001 and 2012 and the projected FiT changes in the future. The duration of tariff payment is 20 years with the degression rate of 1.5 percent. Each year shows the higher initial tariff for five years and normal tariff in brackets. The years 2004, 2009, and 2012 are the years the EEG amended FiT.

Table 38: The FiT changes from 2001 to 2012, and the Projected FiT until 2020 for Onshore Wind Energy in Germany

Year	Initial tariff (€cents/kWh)	Basic tariff (€cents/kWh)	Regression rate
2001	9.1	6.19	1.5%
2002	8.96	6.10	1.5%
2003	8.83	6.0	1.5%
2004	8.70	5.50	2%
2005	8.53	5.39	2%
2006	8.36	5.28	2%
2007	8.19	5.17	2%
2008	8.03	5.07	2%
2009	9.2	5.02	1%
2010	9.11	4.97	1%
2011	9.02	4.92	1%
2012	8.93	4.87	1%
2013	8.80	4.80	1.5%
2014	8.66	4.72	1.5%
2015	8.53	4.65	1.5%
2016	8.41	4.58	1.5%
2017	8.28	4.52	1.5%
2018	8.16	4.45	1.5%
2019	8.03	4.38	1.5%
2020	7.91	4.32	1.5%

Source: BMU 2008a, b, BMU 2012a, b, German Energy Blog, Grotz (2008), and GWEC (2010)

Table 39: PV FiT Changes in Germany 2009-2012 (€cents/kWh)

Type		2009[68]	2010[69]	2011[70]	2012[71]
Rooftop mounted	Up to 30 kW	43.01	30.14	28.74	24.43
	Over 30 kW	40.91	37.23	27.33	23.23
	Over 100 kW	38.58	36.23	25.86	21.98
	Over 1 MW	33.00	29.37	21.56	18.33

Source: Germany Energy Blog

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[68] http://www.germanenergyblog.de/?page_id=834 (accessed: 11.01.2013)
[69] http://www.germanenergyblog.de/?page_id=965 (accessed: 11.01.2013)
[70] http://www.germanenergyblog.de/?page_id=4984 (accessed: 11.01.2013)
[71] http://www.germanenergyblog.de/?page_id=8617 (accessed: 11.01.2013)

As can be observed from table 38, Germany's FiT for onshore wind energy has been declining since 2001 to 2012, and it is also projected to decline further in the future. In other words, it shows that FiTs decline over time while technologies mature. This is also the case in other renewable energies such as PV in Germany which can be seen in table 39. With data presented above, one is also able to compute the rent size changes. One difficulty is that it is hard to find the LCOE for the onshore wind power in Germany. It can be argued that the exact cost of wind energy in general would be difficult because of the fluctuation of wind speed, different size of the turbine and other factors. For example, if compared to the DNI in Sahara desert, the measurement of the LCOE of the wind power should be more difficult than the LCOE of the solar energy because wind speed can not be as stable as the DNI. Nevertheless, there are a few studies which present the LCOE of the onshore wind power in Germany. According to Schwabe et al. (2008, p. 48), the LCOE[72] of onshore wind power in 2007 and 2008 were €79/MWh (7.9 €cents/kWh) and €85/MWh (8.5 €cents/kWh), respectively. Here, one can notice that, according to Schwabe et al.'s (2008) study, the LCOE of the onshore wind power in German between 2007 and 2008 increased. When one compares Germany's FiT and LCOE of the onshore wind power in 2008, it is possible to see that LCOE is higher than the FiT which does not make sense. Perhaps, this is the reason why FiT was amended in 2009 as can be seen from table 38. In Krohn et al.'s (2009, p.56) study, the costs of onshore wind generated power ranges between approximately 5-6.5 €cents/kWh at sites with high average wind speed and approximately 7-10 €cents/kWh at sites with low average wind speed. The cost of the onshore wind generated power at sites with normal average wind is approximately 7 €cents/kWh. Germany is considered to be in the medium wind areas of Europe. Therefore, one can estimate that the cost of the onshore wind generated power in Germany is approximately 7 €cents/kWh. Here, the cost of onshore wind generated power from Krohn et al. (2009) will be considered as LCOE. The LCOE of the onshore wind power in Germany given above are from similar periods. Therefore, the average size of the give LCOE (7.8 €cents/kWh) will be used in calculating the rent size rate in Germany.

Here, one may question why the LCOE in 2008 provided from Schwade et al. (2008, p.48) -though it is higher than the FiT in 2008- is included in the calculation, whereas IRENA's (2012a, p.32) highest LCOE range for CSP is excluded. The reason for the exclusion for the CSP LCOE in Spain was that the given range is too wide, and its highest value in the given range exceeds Spain's FiT. In the case of the onshore wind power LCOE in 2008 for Germany from Schawade et al. (2008. p.48), it is not so much higher than the FiT in 2008. Of course, this is not the only reason. As mentioned earlier, Germany is

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[72] In Schwabe et al.'s (2008) study, the LCOE refers to the sum of all costs over the lifetime of a given wind project, discounted to present time, and levelized based on annual energy production. It does not include residual costs nor benefits incurred beyond the project's assumed operation life.

considered as one of the leading countries in terms of promoting and managing renewable energy which has been amending its FiT when necessary accordance of the purpose of FiT. As can be seen from table 38, also mentioned earlier, the FiT of onshore wind power was amended in 2009. This shows the immediate reaction to, though it may not be the entire reason, the fluctuation of the LCOE which makes it possible for one to rely on the LCOE provided by Schawade et al. (2008) for 2008. Furthermore, the fact that wind energy is one of the most mature renewable technologies support in using the LCOE given by Schawade et al. (2008) as well.

In order to calculate the rent size and its proportion, the period of 2009-2012 will be chosen. The reason for choosing this period is because the FiT in 2009 and 2012 are the most recent official amended FiT by EEG (BMU 2008a,b, 2012a,b). Though it may not be the most suitable value for the period of 2009-2012 as it is the average value of the earlier years, 7.8 €cents/kWh will be used as LCOE value. As wind energy is one of the most matured renewable technologies, it will be assumed that the LCOE of onshore wind power in Germany does not change as much. Also, one can not always assume that the LCOE only declines throughout the time, though also influenced by other factors, as wind speed is not as stable as, for example, the DNI in the Sahara desert. As the formula for the calculation of the rent size and its rate is illustrated earlier, only the result is illustrated in table 40 below.

Table 40: Projected Onshore Wind Energy Rent Size and its Proportion Change in Germany 2009-2012

Year	**2009**	**2010**	**2011**	**2012**
Rent size /Proportion	1.4 €cents/kWh (15.2%)	1.31 €cents/kWh (14.4%)	1.22 €cents/kWh (13.5%)	1.13 €cents/kWh (12.7%)

As can be seen from table 40, the onshore wind energy’s rent size and its proportion rate have been, or are still, declining over time. Also, when compared to the rent size and its proportion of the parabolic trough presented earlier, this matured technology has much smaller rent size. Therefore, as the purpose of this section is to project the rent size from solar energy exports for the five North African countries in the future, it proves that the use of current, or recent, Spain’s rent size and its proportion does not provide an accurate projected solar energy rent size for the five North African countries.

Although it appears that the use of the rent size proportion from the onshore wind power in Germany is more accurate in projecting the solar energy rent size for the five North African countries in the future, it may not be wise to project the rent size just by relying on the onshore wind power rent proportions due to the ‘matureness’ gap between the CSP and onshore wind power.

The operating capacity of CSP, during the period from the end of 2006 through 2011, increased around 37 percent annually. During the same period, the Solar PV appears as the fastest growing renewable technology with operating capacity increasing by an annual average of 58 percent. On the other hand, the operating capacity of wind power increased by an annual average of 26 percent which is after CSP (REN 2012, p. 13). By looking at the growth rate, it is possible to see that CSP is one of the fastest growing renewable technologies. Therefore, in order to achieve a more accurate result, rather than assuming that the FiT, LCOE, rent size, and rent size proportion are to decline throughout the time just by relying on data regarding the onshore wind power in Germany, this section will also include the fast growing renewable technology data in projecting the rent size for the five North African countries.

As mentioned in section 3.1.2, solar PV appears to be the fastest growing renewable technology. In 2011, it is estimated that almost 30 GW of new solar PV capacity came into operation worldwide, increasing the global total by 74 percent to almost 70 GW. The European Union dominated the global PV market (REN21 2012, p. 47). Again, Germany is considered the leading country in the PV market. In late 2011, Germany connected its one-millionth PV system, and continued to lead in total installed and operating PV capacity. It is estimated that nearly 7.5 GW was newly installed by the end of 2011 (REN 2012, p.47). Therefore, the rent size and its proportion of PV in Germany will be also calculated and will be used in projecting the solar energy rent size for the five North African countries.

As presented in Table 39 earlier, the PV FiTs, during the period of 2009-2012 have declined in all categories. As for LCOE, IRENA (2013, p.57) suggests that, by the second quarter of 2012, the LCOE of typical small-scale system, which are considered the residential PV system[73], in Germany had fallen to US$0.19-0.27/kWh (14.8-20.3 €cents/kWh)[74]. Here, an obstacle occurs in choosing the suitable FiT and LCOE of PV.

The FiT provided in table 39 and the LCOE range provided by IRENA (2013, p.57) are not in the same categories because the LCOE range provided by IRENA (2013, p.57) is for the residential PV system which do not usually exceed 20 kW, whereas the FIT presented in table 39 are for the PV up to 30 kW capacity. Here, as can be observed in table 39, the FiTs of PV with more capacity are lower. Then, if a new category of PV FiT is made for ‘up to 20 kW’ in Germany, it can be argued that, though not always, the FiT would be higher than the current PV FiT for up to 30 kW. This means that, when

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[73] Typically do not exceed 20kW and are usually roof-mounted (IRENA 2012b, p. 22).

[74] As IRENA(2013, p.57) presents the LCOE in the second quarter of 2012, the exchange rate of the average of 02.04.2012 – 29.06.2012 is applied in calculating into Euro.

applying the LCOE for PV up to 20 kW for the PV FiT up to 20 kW, it would make more sense to use the higher LCOE in the given range because the LCOE tends to decline throughout the time due to the capacity and technology development. Therefore, from the given range of the PV LCOE for Germany, the highest point (20.3 €cents/kWh) will be used as the LCOE value in the calculation. As for the PV FiT, due to the rapid decline in PV FiT in Germany, and also the fact that LCOE provided by IRENA (2013, p.57) specifically for the second quarter of 2012, only the FiT of 2012 will be used in the calculation. As a result, the rent size from PV is 4.13 €cents/kWh, and its proportion is about 16.9 percent.

The last task before proceeding with the calculation for the projected rent size is to obtain a suitable LCOE because the use of current, or recent, LCOE is likely to result in providing an inaccurate rent size for 2050, as seen earlier from the first projection.

The FiT and LCOE tend to decline throughout time which has been observed in other renewable technologies. IRENA (2012a) projects significant reduction for the LCOE of CSP plants, though projection is for 2020, due to several GW of CSP power plants are under construction and announced. If aggressive deployment policies are to be applied, one can expect the reduction of learning effects. IRENA (2012a, p.32) suggests that greater research and development investment, greater operational experience and the scaling up of plants will add additional elements for reductions in the LCOE of CSP plants.

There are a number of studies which also project the reduction in the LCOE of parabolic trough. Table 41 presents the projected LCOE for parabolic trough from various sources.

Table 41: Projected LCOE for Parabolic Trough from Various Sources

Sources	**2011**		**2020**		**Projected Reduction (%)**
	Low Estimate	High Estimate	Low Estimate	High Estimate	
A.T. Keanrney. 2010[75]	0.23	0.32	013	0.16	43.5-50%
Based on Kutscher et al., 2010	0.22		0.10	0.11	50-54.5%
Fichtner, 2010	0.22	0.24			
	0.33	0.36			
	0.22	0.23			
Hinkley et al., 2011	0.21		0.13		38.1%
IEA, 2010	0.20	0.295	0.10	0.14	50-52.5%

Source: IRENA (2012a, p.33)

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[75] Include both Parabolic trough and solar towers.

According to the studies presented in table 41, the LCOE of parabolic trough technology is expected to decline by 38.1-65 percent[76] in the future.[77] By applying the projected reduction rate in LCOE for parabolic trough, one is able to project a more accurate rent size. As the range of the reduction rate is wide, 38.1-65 percent, different reduction rate will be applied.

Table 42: Reduced LCOE for Parabolic Trough and the Rent Size and its Proportion for Spain

Reduction rate	**35%**	**45%**	**55%**	**65%**
North Africa's CSP LCOE after applying reduction rate	**11.2**	**9.5**	**7.8**	**6.1**
Rent size/proportion from CSP in Spain (18.5%)	2.54	2.16	1.77	1.38
Rent size proportion from PV in Germany (16.9%)	2.28	1.93	1.59	1.24
Rent size proportion from onshore wind power in Germany (14%)[78]	1.82	1.55	1.27	1
The average rent size proportion of the three technologies (16.4%)	2.21	1.88	1.54	1.21

Table 42 presents the LCOE of the parabolic trough for the five North African countries after different reduction rates have been applied.[79] Each LCOE and different rent proportion from CSP in Spain (18.5 percent), PV in Germany (16.9 percent), onshore wind power in Germany (14 percent), and the average rent size proportion of the three technologies (16.4 percent) are then applied to the formula I which is presented earlier. The range of the parabolic trough LCOE for the five North African countries is 1-2.54 €cents/kWh. As it has been decided to use the US dollar as the currency in comparing the rent sizes, the given rent size range will be then 1.18-3 US$pense/kWh. This means that the five North African countries' projected range for the total rent size from electricity export via solar energy is around US$7.1-24billion. The projected rent sizes, 1.18-3 US$pense/kWh and US$7.1-24billion in total, provide one with two ways to make rent size comparison between the solar energy rent size and the natural resource rent size. With the 1.18-3 US$pense/kWh rent size, one can directly calculate the projected amount of rent size for individual North African countries. This is possible because of recent studies, such as by Trieb et al. (2012), which provide projected amount of electricity that will be exported from individual North African countries. However, the limitation of this method is that the comparison can be only made between the projected rent size and natural

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[76] 65 percent reduction rate is provided by Schellekens et al. (2010, p.65) which is for the year 2050.

[77] The projected LCOE reduction rate is mostly made between 2011 and 2020. As there is limited data regarding the LCOE reduction rate by 2050, except for the date provided by Schellekens et al. (2010), this data will be applied in obtaining the LCOE reduction rate.

[78] Average value of the calculated rent proportion in table 40.

[79] The reduction rates have been applied on the LCOE used earlier, 13.7 €cents/kWh, for the five North African countries from Schellekens et al. (2010, p. 155).

resources rent size of the energy exporters. In other words, by using this method, one is not able to project whether the North African energy importers will have the potentials to suffer from a solar energy curse. Therefore, in order to also project whether the North African energy importers are to suffer from a solar energy curse or not, it is necessary to use the total projected rent size of US$7.1-24billion. This projected rent size can be compared to the average rent size of the natural resource in the MENA region.[80] By using this method, one is able to see whether the projected solar energy rent size will be as high as the average natural resource rents. If the projected rent size is as high as the average natural resource rent size under the circumstances that the poor institutional quality is to be remained in the future, one could argue that the five North African countries, including both the energy exporters and importers, have the potentials to suffer from a solar energy curse. In this thesis, though the latter method covers both the energy exporters and importers, both methods will be applied. In order to make the comparisons, the next section will present the average natural resource rent size of the North African energy exporters and the MENA energy exporting countries.

7.3 The Rent Size from the Natural Resources in the Five North African Countries and the MENA Countries

The aim of this section is to measure the rent size from the natural resource export in the five North African countries and the MENA countries in order to compare with the projected solar energy rent size which is made in section 7.2 As this thesis is focusing on 'energy sources', the rent size from the natural resource will be referred to as the rent size from exporting energy sources. Here, oil and natural gas will represent the energy sources because they are considered to be important and crucial energy sources in electricity production.

Oil and natural gas rents will be calculated from data obtained from the WDI. WDI provides the nations' GDP, and oil rent and natural gas rent percentages from the GDP which one can use to calculate the amount of rents. The average GDP, oil rent, natural gas rent, and sum of the oil and natural rents during 1993-2009[81] will be calculated. First, as the focus of this thesis is in North Africa, the resource rent for the North African energy exporters will be calculated in order to have general idea of how much rent they receive from exporting oil and natural gas.

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[80] The reason for making the comparison between the solar energy rent from the five North African countries and the natural resource rent from the MENA region will be explained in the next section.

[81] The reason for choosing this period, instead of 1993-2011 in section 5.1, is that it was the most recent data available.

Table 43: The average GDP, Oil rent, Natural Gas Rent, and the Sum of Oil and Natural Gas Rents in Algeria, Egypt and Libya 1993-2009 (US$ Billion)

	GDP	Oil Rent	Natural Gas Rent	Rents Combined
Algeria	77.1	12.4	10.8	23.2
Egypt	94.5	6.93	5.18	12.11
Libya	39.3	16.9	1.42	18.32

Source: World Development indicator (WDI)

Table 43 presents the average GDP, oil rent size, and natural gas rent size of the North African energy exporters during the period 1993-2009. As can be observed, the oil and natural gas rents take quite high proportions of their GDP. Algeria and Libya received much higher rents from oil and natural gas than Egypt. As mentioned in section 7.2, due to recent studies made such as Trieb et al. (2012), an individual country's rent size from oil and natural exports can be compared to their projected solar energy rent size. Though it is only possible to make comparisons among the energy exporters, the outcome of this comparison may be more accurately as it is for individual countries. The comparison will be made later in this thesis.

As mentioned earlier, the solar rent size can be projected for individual countries. However, the limitation of this method is that it is only able to make the comparison among energy exporters. Therefore, one has to compare the projected solar energy rent size to the average oil and natural gas rent size in order to see whether the projected solar rent size will be comparable to the oil and natural gas size. As this thesis is focusing on the five North African countries, the average oil and natural gas rent size can be calculated amongst them. However, there are only three energy exporters in North Africa. In other words, the average oil and natural gas rent size from only three North African countries may not provide a fair and accurate average rent size to be compared to the projected solar energy rent size due to factors such as difference in the reserves, export amount, and production rate. For instance, solar energy reserves, DNI which fairly strong in the MENA region in general, will not be so different among the countries unlike oil reserves. In other words, one needs to obtain the average oil and natural gas rent from broader range in order to make a 'fairer' comparison. Therefore, in this section, the average oil and natural gas rent size will be calculated from the MENA countries which are in the same region with similar development statuses.

Table 44: The Average GDP, Oil Rent, Natural Gas Rent, and the Sum of Oil and Natural Gas Rents in MENA Countries 1993-2009 (US$ Billion)

	GDP	Oil Rent	Natural Gas Rent	Rents Combined
Bahrain	10.4	2.06	0.951	3.011
Iran	155	47	12.5	59.5
Iraq[82]	34.3	29.5	0.295	29.795
Kuwait	56.6	27.8	1.51	29.31
Oman	24.9	8.96	2.35	11.31
Qatar	33.6	7.8	6.27	14.07
Saudi Arabia	234	103	8.46	111.46
Sudan	22.4	4.17		4.17
Syria	24.3	5.11	0.723	5.833
UAE	137	25.7	5.83	31.53
Yemen	12.1	3.8	-[83]	3.8

Source: World Development indicator (WDI)

Table 44, therefore, presents the average GDP, oil rent, and natural gas rents in other MENA energy exporters during the period of 1993-2009. In table 44, one can see that Saudi Arabia, considered to be affected by the resource curse[84], received an average rent size of US$111.46 billion from oil and natural gas export which is higher than the total average oil and natural gas rent size of other MENA countries during the same period.

What one can see from table 43 and table 44 is that the rent size from oil and natural gas vary in all countries. Some MENA countries, despite the size of the rent, are already considered to be affected by the resource curse due to their poor institutional quality. Here, one can make a small test whether the resource curse can be detected only by comparing the rent size. Therefore, table 45 illustrates the rent from oil and natural gas for the countries which are considered as the resource cursed countries.[85]

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[82] 1993-1996 and 2003 are missing.

[83] Data is only available for the year 2009, and it was 0.33 percent which is very low.

[84] See table 19, 20.

[85] See table 19, 20.

Table 45: The Average GDP, Oil Rent, Natural Gas rent, and the Sum of Oil and Natural Gas rents in Resource Cursed Countries 1993-2009 (US$ Billion)

	GDP	Oil Rent	Natural Gas Rent	Rents Combined
Angola	23.6	12.9	0.0681	12.9681
Ecuador	28.9	5.33	0.0613	5.3913
Equatorial Guinea	4.52	2.92		2.92
Nigeria	77.6	24.2	2.61	26.81
Sudan	22.4	4.17		4.17
Venezuela	133	36	3.96	39.96

Source: World Development indicator (WDI)

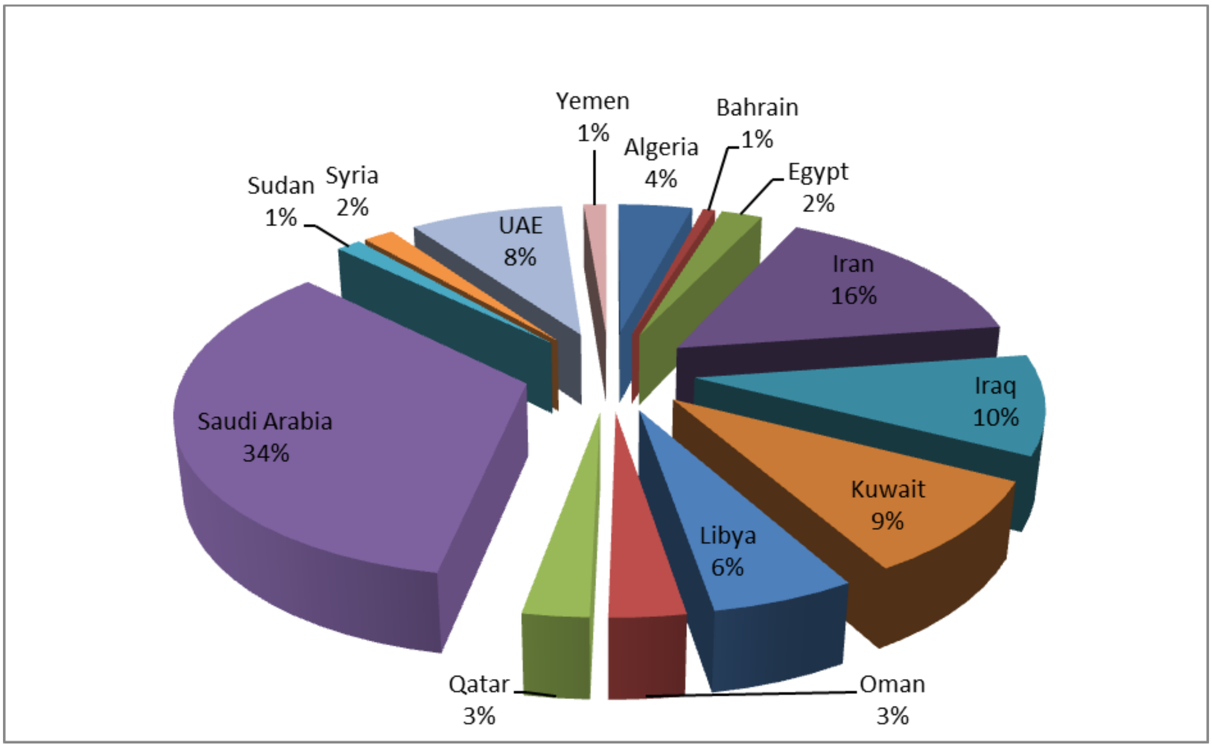
As can be seen from table 45, among the resource cursed countries, Venezuela received the largest amount of rent from oil and natural gas exports which is higher than Algeria, Egypt, and Libya. However, it may not be sufficient to conclude that the North African energy exporters are not affected by the resource curse just because they received less rents from the exports of oil and natural gas. Unlike the institutional quality comparison, the rent size comparison between the resource cursed countries and the other MENA countries does not provide any sort of pattern which enables one to identify the resource curse. This is due to the fact that individual countries have different production capacity, proven reserves, price, and other factors. Therefore, the rent size alone can not be used as the boundary-line to find whether a country is affected by the resource curse or not. In other words, one can suspect that the sizable rent can only determine a country to be affected by the resource curse when accompanied by poor institutional quality.

As for the average oil and natural gas rent size in the MENA countries, it is possible to use the data illustrated in table 43 and 44. However, before calculating the average rent size, one should carefully look at the rent size for individual MENA country.

Figure 19, 20, and 21 present individual country’s average oil, natural gas, and oil and natural gas rent size in percentage form during the period of 1993 and 2009. The MENA countries’ total oil rent, natural gas rent, and both rents combined during the period of 1993-2009 are US$301 billion, US$56.3 billion, and US$357 billion, respectively. As can be seen from figures below, Saudi Arabia has substantially higher rent proportion in oil rent (34 percent) and oil & natural gas rent (31 percent). In the case of natural gas, it is Iran which has the highest proportion (22 percent) among the MENA countries. These findings should be carefully observed when comparing the average rent size of oil, natural gas, and solar energy. This is because the difference in the rent size of the solar energy among individual country will not be as wide as for oil or natural gas. The differences in the proven reserves and production of oil and natural gas are quite high among the energy exporting countries.

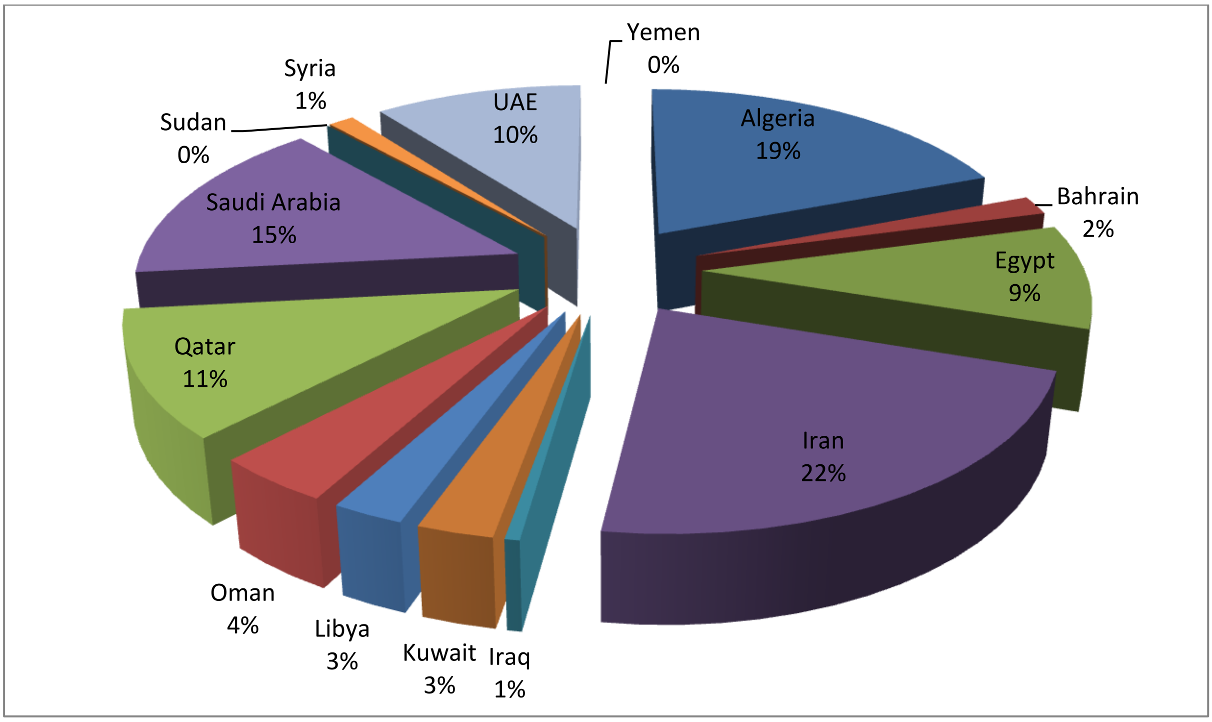
As mentioned earlier, however, as the DNI is fairly strong in the entire MENA region, the difference in the solar energy 'reserves' and electricity production are expected to be smaller. Thus, in other words, the difference in rent size from the solar energy is also expected to be smaller among the MENA countries. Therefore, countries that receive substantially higher rent from oil and natural gas, such as Saudi Arabia, may have to be excluded in order to make 'fairer' comparison among oil, natural gas, and solar energy rent.

Figure 19: The Average MENA Oil Rents Proportions 1993-2009



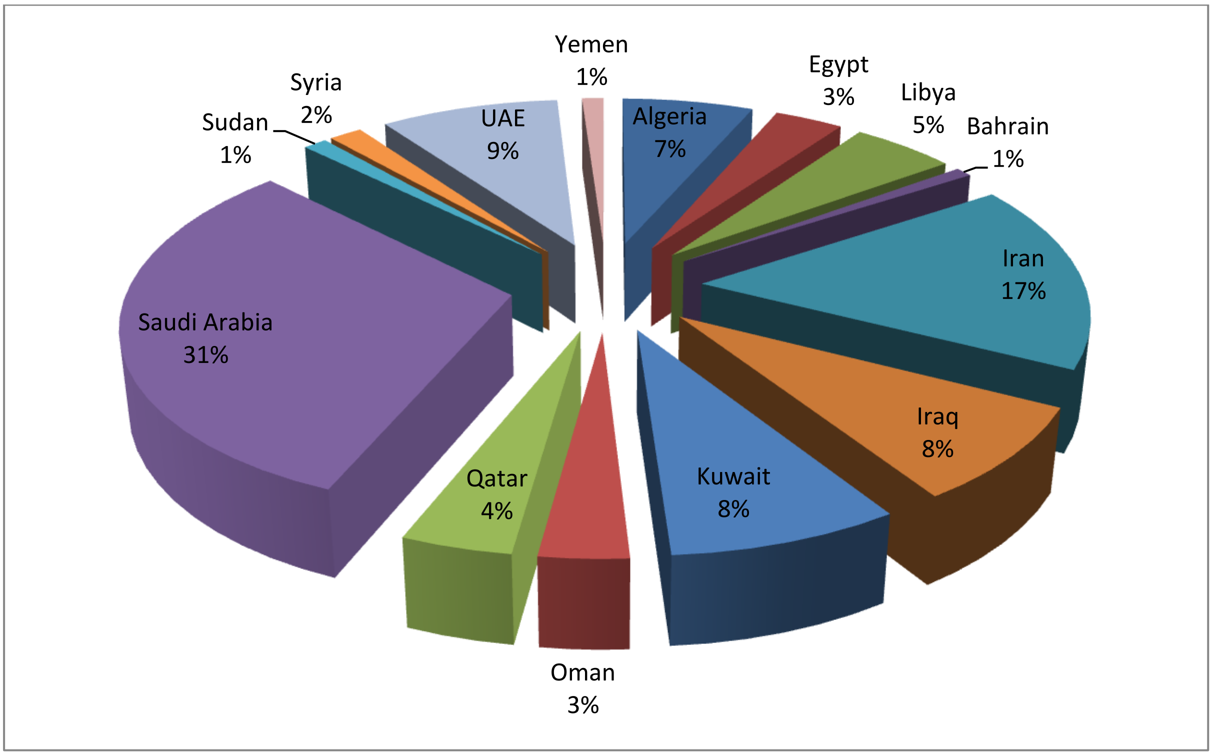
Source: World Development Indicator (WDI)

Figure 20: The Average MENA Natural Gas Rents Proportions 1993-2009



Source: World Development Indicator (WDI)

Figure 21: The Average MENA Oil & Natural Gas Rent Proportions 1993-2009



Source: World Development indicator (WDI)

As mentioned earlier, Saudi Arabia and Iran have relatively higher rents from oil and natural gas compared to the other MENA countries. If one is to exclude Saudi Arabia’s oil rent from the total average oil rent and oil & natural gas rents during the period of 1993-2009, the rents are US$198 billion and US$254 billion, respectively, which shows substantial reduction in the total rent in both cases. Therefore, Saudi Arabia’s oil rent will be excluded when making the comparison among the rent size of oil, oil & natural gas, and solar energy. In the case of natural gas, as Iran received relatively higher rent compared to the other MENA countries, one may consider to exclude Iran when calculating the total average rent size of natural gas. However, as the rent size from natural gas itself is much lower than the oil rent size in general, one should question whether it is necessary to exclude Iran from the total natural gas rent. For example, it makes sense to exclude Saudi Arabia’s oil rent because the difference between the oil rent from Saudi Arabia and Iran (which received the second highest rent from oil) is US$56 billion. This means Saudi Arabia’s oil rent size is about 219 percent higher compared to Iran. On the other hand, the difference between the natural gas rent size between Iran and Saudi Arabia (received the second highest rent from natural gas) is US$4.04 billion. This means Iran’s natural gas rent was about 148 percent higher compared to natural gas rent from Saudi Arabia. Though there are differences in the rent size, the natural gas rent size difference can be considered small when compared to the oil rent size. In other words, there is no need in excluding Iran’s natural rent.

Table 46: The Sum of Average Oil, Natural Gas, and Oil & Natural Gas Rent of MENA 1993-2009 (US$ Billion)

	Total Average Oil Rent	**Total Average Natural Gas Rent**	**Total Average Combined Rent**
MENA	301	56.3	357.3
MENA Excluding Saudi Arabia’s Oil Rent	198		254.3

Source: World Development Indicator (WDI)

Table 46 present the sum of average oil, natural gas, and oil & natural gas rent sizes from the MENA countries, both including and excluding Saudi Arabia’s oil rent, during the period of 1993-2009. The purpose of presenting the rent size for the MENA both including and excluding Saudi Arabia’s oil rent size is to show how dominant Saudi Arabia is in regarding the rent size proportion of the total MENA countries’ energy rent sizes. As a substantial difference in the total rent size can be observed by comparing the rent sizes from the MENA region, when including and excluding Saudi Arabia, the decision that was made to exclude Saudi Arabia appears sufficient. Accordingly, the projected solar energy rent size will be compared to the sum of MENA countries oil and natural gas rent sizes excluding the oil rent size from Saudi Arabia.

7.4 Comparison

The aim of this section is to compare the projected solar energy rent size and the average oil and natural gas rent size in order to see whether the projected solar energy rent size will be as high as the rent size from oil and natural gas. As mentioned earlier, two methods in comparing the rent sizes will be applied in this section.

7.4.1 Comparison with the Projected Solar Energy Rent Size of 1.18-3 US$pense/kWh for Individual North African Energy Exporters

One of the projected rent sizes made in section 9.2 is 1.18-3 US$pense/kWh for the North African countries. As mentioned earlier, due to the recent study made by Trieb et al. (2012), it is possible to project the solar energy rent size for individual North African countries. Trieb et al. (2012, p.349) present the average projected amount of electricity which will be exported from the five North African countries and also Jordan and Saudi Arabia to Europe. Table 47 presents their projection for individual North African countries.

Table 47: Projected Amount of Electricity Exported from the MENA Countries in 2050

Countries	Algeria	Egypt	Libya	Morocco	Tunisia
Projected amount of Exported electricity in 2050 (TWh)	230	74	71	213	71

Source: Trieb et al. (2012, p. 349)

By using the data given in table 47, one is able to project the solar energy rent size for individual North African countries. Table 48 presents the projected solar energy rent size and the average oil, natural gas, and oil & natural gas rent size during the period of 1993-2009 for the five North African Countries.

Table 48: Projected Rent Size from Solar Electricity Exports for the Five North African Countries in 2050, and the Average Oil, Natural Gas, and Oil & Natural Gas Rent Size 1993-2009 (US$ Billion)

Countries	Algeria	Egypt	Libya	Morocco	Tunisia
Average GDP (1993-2009)	**77.1**	**94.5**	**39.3**	**49.5**	**26.6**
Projected rent size from Electricity export via solar energy in 2050 (US$ billion)	2.7-6.9	0.87-2.2	0.84-2.1	2.5-6.4	0.84-2.1
Oil Rent size	12.4	6.93	16.9	-	-
Natural Gas	10.8	5.18	1.42	-	-
Oil & Natural Gas	23.2	12.1	18.32	-	-

As can be observed from table 48, the projected rent sizes from solar energy exports for the North African energy exporters are not at all close to the rent size from the fossil-fuel exports. Their oil and oil & natural gas rent sizes are substantially higher than the projected solar energy rent size. In the case of natural gas rent size, the projected solar energy rent size can be comparable to Libya's natural gas rents. However, as can be seen from table 48, Libya's main fossil-fuel rent is from oil and its rent size is substantially higher than the natural gas rent size. Therefore, even under the circumstance that their institutional quality is to remain poor in future, by looking at the rent size comparison, it is hard to see the possibility of solar energy becoming a new curse for the energy exporters because their projected solar energy rent sizes are substantially lower than the average oil and natural gas rent sizes. As for the energy importers, as it is pointed out as the limitation of this method, it is not possible to project their potential to suffer from a solar energy curse because the comparisons between the projected solar energy rent and oil and natural gas rents can not be made. Therefore, in order to project the potential for energy importers to suffer from a solar energy curse, the second method will be applied in the next section.

7.4.2 Comparison between the Projected Solar Energy Rent of $7.1-24billion and the Sum of Average & the Average Oil and Natural Gas Rent Size

In this section, the total projected solar energy rent for the five North African countries will be compared to the sum of MENA countries' rent size of oil, natural gas, and oil & natural gas. Table 49 presents the projected rent size from the solar energy and the sum of average oil, natural gas, and oil & natural gas rent sizes from the MENA countries during the period of 1993-2009.

Table 49: The Sum of Average Rent from Oil, Natural Gas, and Oil & Natural Gas of MENA Energy Exporters, and the Projected Solar Energy Rent Size for North Africa 1993-2010 (US$ Billion)

Oil Rent	Natural Gas Rent	Oil & Natural Gas Rent	Projected Solar Energy Rent
198	56.3	254.3	7.1-24

As can be seen from table 49, there is a substantial difference between the projected solar energy rent size and the rest of the summed rent sizes. Even if one is to take natural gas rent separately, which is much lower than the sum of oil rent, the projected solar energy rent size is substantially lower. Therefore, based on the result in table 49, and also based on the assumption that the institutional quality is to remain poor, the five North African countries do not appear to have the potentials to suffer from a solar energy curse. Here, however, one should note that there is a limitation in this method in identifying a solar energy curse for the five North African countries.

As mentioned earlier, the projected amount of electricity that will be exported from the five North African countries is based on studies from DLR (2006), Shcellekens et al. (2010), and Trieb et al. (2012). Here, one should remember that the DLR's (2006) projected amount of exported, or transferred, electricity is not only from the five North African countries, but from the MENA countries. In other words, this section has been indirectly relying on the assumption that the amount of electricity that will be exported from the five North African countries and the entire MENA countries will be similar. This is why the comparison between the projected solar rent size and, for example, the sum of the average oil rent size of the MENA countries has been possible. The problem is that, as mentioned earlier, DRL (2006) does not specify exactly which countries are involved in their MENA countries. Therefore, comparing the projected solar energy rent to the sum of the average fossil-fuel rent size from the MENA countries may be inaccurate as one is unsure which countries' fossil-fuel rent should be included or not. For example, it may be that only few MENA countries are involved in DRL's (2006) study like in Trieb et al.'s (2012, p.349) study which projects that 831 TWh/y amount of electricity to be exported from the MENA countries, Algeria, Egypt, Jordan, Morocco, Saudi Arabia, and Tunisia, which is more than DRL's (2006) projection. If the six countries in Trieb et al.'s (2012) study are the only countries included in MENA countries from the DLR's (2006) study, then the specific countries' sum of oil rent from the MENA countries can be compared to the projected solar energy rent size. Unfortunately, this is not the case. One may argue that this section could just rely on Trieb et al.'s (2012) study to compare the rent sizes. However, though specific countries are given, their study involves Saudi Arabia which is decided to be excluded in section 7.3. Due to a number of mentioned obstacles, therefore, one can not be so certain that the result found in Table 49 is accurate.

Despite the unsatisfying result in this section, one can find a more reliable way of finding whether the five North African countries will have the potentials to suffer from a solar energy curse in the future. Instead of using the sum of average oil, natural gas, and oil & natural gas rents of the MENA countries, one can use the average of all the MENA countries' rent sizes during the period of 1993-2009 which is presented in table 50. Each average rent size presented in table 50 can be compared to the individual North African country's projected solar energy rent size which is presented in table 48. In other words, the average rent sizes that are presented in table 50 will be used as the boundary-line. This is likely to bring fairer outcome because the average rent sizes presented in table 50 are based on the MENA countries which are considered to rely heavily on their energy exports.[86] Therefore, if the five North African countries' solar energy rent is as high as the results in table 50, one can suspect that they may suffer from a solar energy curse.

Table 50: The Average Oil, Natural Gas, and Oil & Natural Gas Rent Sizes of the MENA Countries 1993-2009 (US$ Billion)

Oil Rent	Natural Gas Rent	Oil & Natural Gas Rent
15.2	4.02	19.22

When one compares individual country's projected solar energy rent to the 'boundary-line' rent size presented in table 50, it is possible to see that the projected solar energy are far from reaching the average rent size of oil, and oil & natural gas. In the case of natural gas, only the projected solar energy rent from Algeria and Morocco may be as high the average natural gas rent size. However, when compared to the oil rent size, the natural gas rent size is still substantially low.

7.4.3 Perceiving All Rent Sizes as the Proportion of GDP

So far, by looking at the results from section 7.4.1 and 7.4.2, it appears that the projected solar energy rent size is not likely to be comparable to, except for few cases of natural gas rent size, the average fossil-fuels rent sizes. Therefore, based on the assumption that the institutional quality is to remain poor in the future, the five North African countries, and MENA countries, are less likely to suffer from a solar energy curse as much as they suffer from the current resource curse. However, it could be argued that the results from section 7.4.1 and 7.4.2 are not specific enough as they only show that the projected solar energy rent size is smaller than the average fossil-fuel rent sizes. Therefore, this section will transform all the obtained rent sizes from section 7.4.1 and section 7.4.2

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[86] See table 6.

into the proportion of GDP form in order to make more precise and specific comparisons. Here, as mentioned earlier in section 5.1, if the projected solar energy rent in a country is higher than, or as high as, 10 percent of GDP, which is considered high rate according to Mehlum et al. (2006b, p.1), it will be considered to have the potential to suffer from a solar energy curse.

Table 51: Rent Sizes from Table 48 in the GDP Proportion Form[87]

Countries	Algeria	Egypt	Libya	Morocco	Tunisia
Average GDP (1993-2009) US$ billion	**77.1**	**94.5**	**39.3**	**49.5**	**26.6**
Projected solar rent size proportion (% of GDP)	2.7-6.9	0.87-2.2	0.84-2.1	2.5-6.4	0.84-2.1
Oil Rent size proportion(% of GDP)	16.1	7.3	43	-	-
Natural Gas (% of GDP)	14	5.5	3.6	-	-
Oil & Natural Gas (% of GDP)	30.1	12.8	46.6	-	-

Table 51 presents the results from table 48 in the form of GDP proportion. When looking at table 51, it is possible to see that the projected solar energy rent size for all five North African countries does not exceed 10 percent of their average GDP. Especially, when looking at the energy exporters, their projected solar energy rent size is substantially lower than their fossil-fuel rent sizes.

Table 52: Rent Sizes from Table 49 in the GDP Proportion Form

Sum of Average GDP of MENA Countries (1993-2009)	Oil Rent (% of GDP)	Natural Gas Rent (% of GDP)	Oil & Natural Gas Rent (% of GDP)	Projected Solar Energy Rent (% of GDP)
$956billion	20.7%	5.9%	26.6%	0.7-2.5%

Table 52 presents the results from table 49 in the GDP proportion form. Although the result from table 49 is not considered fully reliable, it is still possible to see that the projected solar energy rent does not exceed 10 percent of the GDP and are also not close to any other fossil-fuel rent sizes.

Table 53: Rent Sizes from Table 50 in the GDP Proportion Form

Average GDP of MENA Countries (1993-2009)	Oil Rent (% of GDP)	Natural Gas Rent (% of GDP)	Oil & Natural Gas Rent (% of GDP)
$68.3billion	22.3%	5.9%	28.1%

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[87] The oil, natural gas, and oil & natural gas as % of GDP are different from table 6 because the calculation is made based on table 43 and 44 which are rounded values.

Table 53 presents the results from table 50 in the GDP proportion form. When the rent sizes in GDP proportion form from table 53 is compared to the projected solar energy rent size in the GDP proportion form from table 51 for individual countries, their projected solar energy rent size is not as high as the fossil-fuels rent sizes in the GDP proportion form. However, as observed earlier in the comparison between the results from table 51 and 53, the projected solar energy rent size in GDP proportion form for Algeria and Morocco can exceed the natural gas rent size in the GDP proportion. Nevertheless, their projected solar rent sizes in the GDP proportion still do not exceed 10 percent of the total GDP.

As can be seen from the rent size comparisons in the GDP proportion form, it is possible to see that the projected solar energy rent size is not likely to be as enormous as the fossil-fuel rent sizes. Also, considering that the five North African countries' GDP is expected to grow in the future, see table 54, the proportion of the projected solar energy rent in GDP will likely be smaller compared to the results above as the GDP values in this thesis have been based on the average GDP during the period of 1993-2009.

Table 54: Projected GDP for the Five North African Countries in the Future (US$ Billion)

	2010	2011	2012	2013	2014	2015	2016	2017
Algeria	160.779	190.709	206.502	213.067	218.180	224.959	234.128	245.422
Egypt	218.465	234.719	252.458	253.380	269.033	291.631	318.625	348.724
Libya	80.442	36.874	79.691	96.036	96.700	99.996	104.419	107.709
Morocco	90.803	99.241	100.354	107.341	115.027	123.669	133.349	144.946
Tunisia	44.278	46.360	46.146	47.701	50.239	53.615	57.186	61.017

Source: World Economic Outlook Database April 2012
http://www.imf.org/external/pubs/ft/weo/2012/01/weodata/weorept.aspx?sy=2009&ey=2017&scsm=1&ssd=1&sort=country&ds=.&br=1&c=612%2C686%2C469%2C744%2C672&s=NGDP_RPCH%2CNGDPD&grp=0&a=&pr.x=44&pr.y=5 (accessed: 15.01.2013)

So far, by looking at the outcome of the rent size comparison, the projected solar energy rent size is less likely to become as high as the fossil-fuel rent sizes. Under the assumption that the poor institutional quality of the five North African countries is to remain poor, the five North African countries are less likely to suffer from the solar energy curse because the projected rent size is small. Here, it must be noted that the projected solar energy rent size achieved in this section is based on studies, such as DLR (2006) and Trieb et al. (2012), which only, or mainly, focus on the electricity export via CSP from North Africa and MENA to Europe via direct connection. This means that the CSP technology is assumed to be the dominant renewable technology in North Africa in the future. In other words, the estimated amount of exported electricity of ±700 TWh/y via CSP in the future may be rather an 'optimistic' projection. In a recent study by Zickfeld et al. (2012), for example, it is projected that the annual power exchange between MENA[88] and Europe will be total of 1110 TWh by 2050 in their Connected Scenario.[89] Within the total amount, 1087 TWh/y amount of electricity is projected to be exported from MENA to Europe and 23 TWh/y from Europe to MENA. Thus, the net trade balance amounts 1064 TWh/y from MENA to Europe (Zickfeld et al., 2012, p. 54).

Figure 22 presents the projected EUMENA electricity production shares in Connected Scenario and Reference Scenario[90] in Zickfeld et al.'s (2012, p.62) study. As can be observed from figure 22, Zickfeld et al. (2012) project that the EUMENA electricity mix in 2050 is projected to be made up of 91 percent from renewable energies and 9 percent from natural gas. Here, their projection is that the wind energy[91] will contribute to 53 percent of the EUMENA electricity production share which is projected to be installed everywhere in EUMENA, and 16 percent is contributed from CSP which is almost entirely located in MENA (Zickfeld et al., 2012, p.12).

If one is to take the Connected Scenario from figure 22, and make a rough calculation, the electricity production share of the CSP technology would be approximately 1344 TWh/y which is 16 percent of the total projected amount of electricity production of 8842 TWh/y. Of course, this is a rough projected amount of electricity production via CSP of EUMENA. However, as Zickfeld et al. (2012, p.12) project, most CSP capacity is projected to be allocated in MENA. Therefore, if one is to estimate that, again a very rough projection, 16 percent of the electricity export from MENA to Europe is via CSP technology, it would be approximately 170 TWh/y which is much lower than ±700TWh/y. Despite the rough projection made above, by looking at figure 23 which presents the projected electricity generation and interconnector capacity in Zickfeld et al.'s (2012) connected Scenario, though exact amount is not presented, it is possible to see that the Middle East is projected to have more CSP capacity, in terms of ratio, than North Africa. In other words, it is possible that the electricity exports via CSP from North Africa to Europe may be even smaller.

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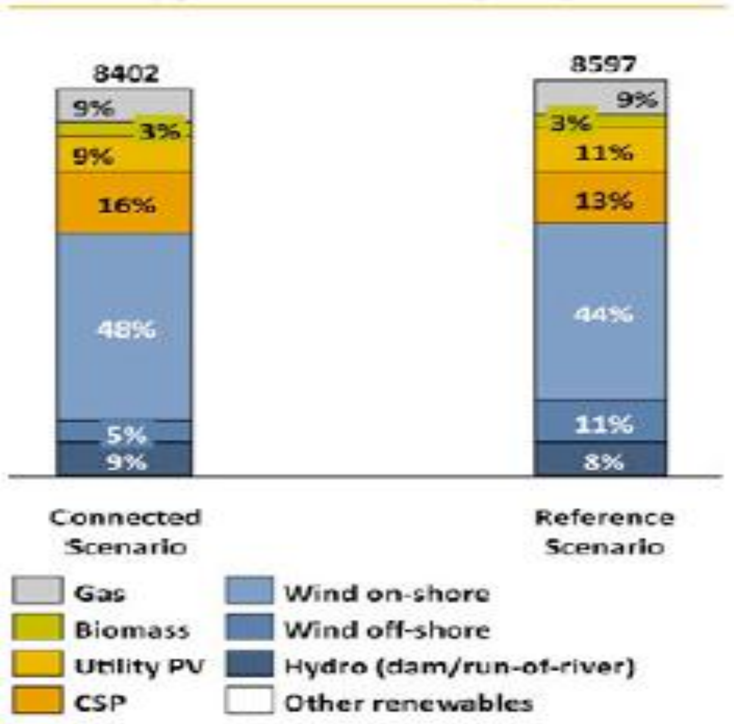
[88] Zickfeld et al. (2012) refers to MENA Countries as Algeria, Egypt, Libya, Morocco, Tunisia from North Africa, and Jordan Saudi Arabia and Syria from Middle East.

[89] Connected Scenario examines a power system with full, EUMENA-wide integration (Zickfeld et al., 2012, p. 9).

[90] Reference Scenario depicts a situation where each region, Europe and MENA, is fully optimized in itself but without cooperation between the two systems (Zickfeld et al., 2012, pp. 9-10).

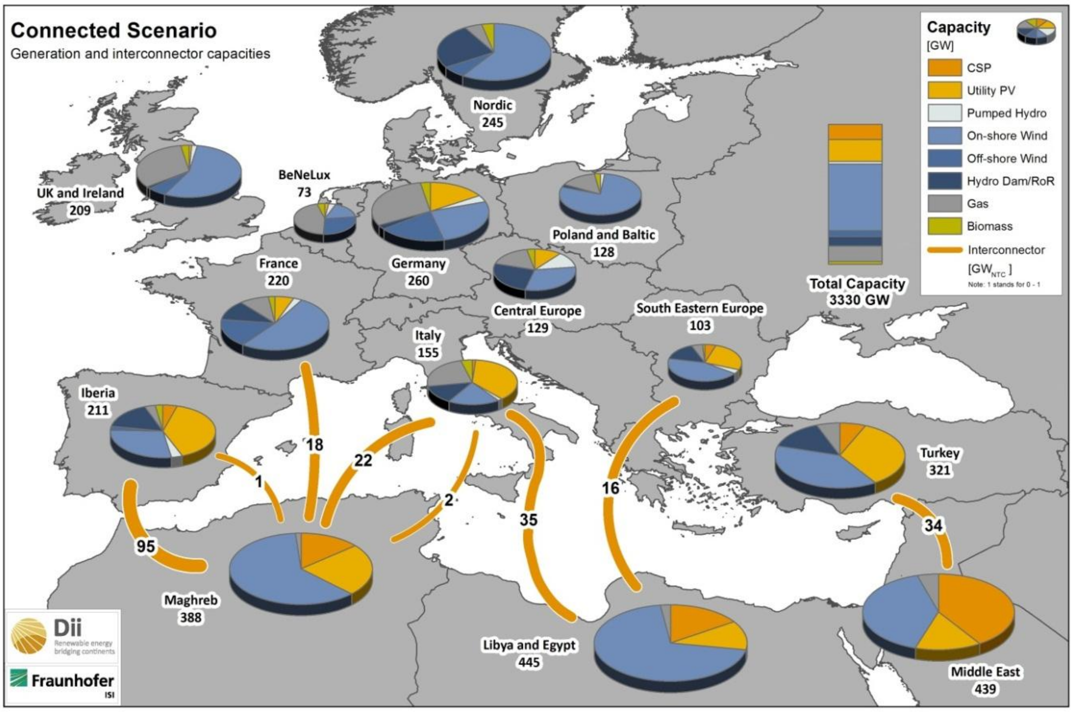
[91] Wind on-shore and off-shore.

Figure 22: The Projected EUMENA Electricity Production Shares in Connected Scenario and Reference Scenario (TWh)



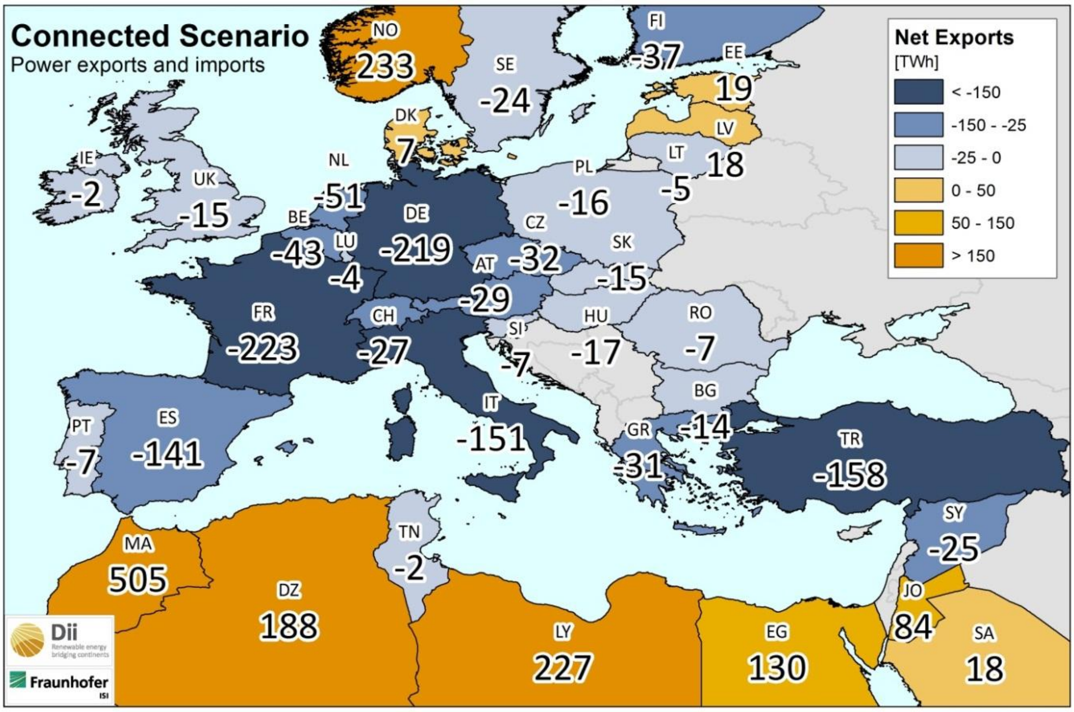
Source: Zickfeld et al. (2012, p.62)

Figure 23: Generation and Interconnector Capacity, Connected Scenario



Source: Zickfeld et al. (2012, p. 12)

Figure 24: Net Exporters and Net Importers in EUMENA, Connected Scenario



Source: Zickfeld et al. (2012, p.76)

It is possible to make a further, more detailed, projection based on Zickfeld et al.'s (2012, p.76) study as they present projected amount of electricity export and import from individual North African country as can be seen in figure 24. The most noticeable finding from figure 24 is that, unlike the other studies such as Trieb et al. (2012), Tunisia is projected to become an electricity 'Importer'.[92] Zickfeld et al. (2012, p.84) consider Algeria, Libya, and Morocco to become 'Super Producers'[93] which are projected to export electricity amount of 188 TWh/y, 227 TWh/y, and 505 TWh/y, respectively. Furthermore, Egypt, which is consider as 'Balancers'[94], is projected to export 130 TWh/y amount of electricity. Of course, the amount of electricity they are projected to export is not only expected to come from the CSP technology. Table 55 presents the projected total amount of exported electricity, and via CSP from the five North African countries based on Zickfeld et al.'s (2012) study.

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[92] Zickfeld et al. (2012, p.16) refers to importers as countries with a high demand and limited potential of good renewable resources in comparison to demand.

[93] Countries with excellent renewables resources and relatively low demand, which have enough excess in cheap renewable potentials for significant exports (Zickfeld et al., 2012, p.16).

[94] Countries with levels of demand and renewable resources that are largely proportionate to each other (Zickfeld et al., 2012, p. 17).

Table 55: Projected Total Amount of Exported Electricity, and via CSP from the Five North African Countries based on Zickfeld et al.'s (2012) Study[95]

Countries	Algeria	Egypt	Libya	Morocco	Tunisia
Projected amount of Exported electricity in 2050 (TWh)	188	130	227	505	-2
Projected amount of Exported electricity Via CSP 2050* (TWh)	19	21	36	81	-

As can be seen from table 55, the projected amount of exported electricity via CSP is much smaller compared to the projected amount presented in table 47. The total projected amount of exported electricity via CSP based on table 55 is 157 TWh/y which is far smaller compared to ±700 TWh/y. Of course, difference occurs as, unlike the other studies such as Trieb et al. (2012), Zickfeld et al.'s (2012) work does not solely focus on solar energy and rather projects that the wind power will have a much larger capacity than solar energy. Also, the projection made above, based on Zickfeld et al.'s (2012) study, may not be considered so accurate as it is not possible to predict exactly how much electricity is exported via CSP in the future. More specifically, once electricity is produced, it is impossible to tell which share of electricity in specific part of the grid comes from which technology. Nevertheless, this rough calculation is not worthless as it shows the possibility that the rent size from solar energy may be even smaller than the projected solar energy rent size made earlier as the projected amount of electricity exports from North Africa to Europe may be even smaller.

Here, though it is mentioned that it may not be accurate to project the possible rent size for each technology, it may be worthwhile to make another rough projection of the rent size from the electricity export via other renewable energies whether the rent size can be comparable to the fossil-fuel rent size. As the capacity of the wind power and CSP are projected to be high in energy mix from Zickfeld et al.'s (2012) study, their rent size will be projected.

Zickfeld el al. (2012, p.44) project that the LCOE of CSP will be approximately €50/MWh (5 €cents/kWh), and LCOE of wind power will be around €35-45/MWh(3.5-4.5 €cents/kWh) in 2050 for EUMENA. When the exchange rate from table 33 is applied, the LCOE for CSP and wind Power will be 5.9 US$pense/kWh and 4.13-5.31 US$pense/kWh, respectively. The total projected amount of exported electricity from the five North African countries to Europe will be obtained from figure 24 which will be total of 1048 TWh. Here, the obstacle is projecting the amount of electricity that will be produced from each technology. As used in the projection made earlier, when looking at figure 22,

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[95] This projection is made under the assumption that 16 percent of the total electricity export from individual North African countries, except for Tunisia, to Europe is via CSP.

the electricity production shares in EUMENA for CSP is 16 percent and 53 percent for the wind power including both wind on-shore and off-shore. As the capacity of CSP is projected to be mainly allocated in MENA, the proportion of the exported electricity via CSP will be assumed to be 16 percent of the total electricity export. As for wind power, it is mentioned earlier that the wind power will be installed everywhere in EUMENA. When looking at figure 23, one can see that the wind power share is projected to be high in North Africa. Though it does not present the exact proportion, as it appears that wind power capacity is to be more than 50 percent of the total capacity in North African in figure 23, the 53 percent proportion will be used as the wind power proportion in the projected amount of electricity export from MENA to Europe. This means the electricity amount of 555 TWh via wind power and 173 TWh from CSP are projected to be exported from North Africa to Europe. As the purpose of this projection is to project the rough rent size from two technologies, the total electricity amount of 728 TWh will be used. In section 7.2.2, the rent size proportion for wind energy, though only for onshore, is 14 percent and 18.5 percent for CSP. As this projection is for the rent size from both technologies, the average rent size proportion of the two technologies (16.25%) will be used. Since the average rent size proportion of the two technologies will be used, the average LCOE of the two technologies will be applied as well. However, as the wind power LCOE has quite a range (4.13-5.31 US$pense/kWh), and it is projected to have the highest capacity, the average LCOE of CSP and the lowest LCOE of wind power and highest LCOE wind power will be separately calculated and used as the range of the LCOE. Therefore, the range of the average LCOE of two technologies is 5-5.31 US$penses/kWh. When above values are applied in the formula I, the projected rent size is around 0.93-1.03 US$penses/kWh. Therefore, the total projected rent size is around US$6.8-7.5billion. Although it is a very rough calculation, this range of the projected rent size is even lower than the projected rent size achieved earlier. Thus, solar energy, or renewable energy, rent size is not projected to be as enormous as the average fossil-fuel rent size from the MENA countries during the period of 1993-2009.

Chapter 8. Solar Energy Prolonging the Resource Curse?

8.1 The Possible Impact of the Projected Solar Energy Rent

The aim of this thesis has been to project the chances of the five North African countries to suffer from a solar energy curse in the future. In chapter 6, the current resource curse and possibility of a solar energy curse is projected by comparing the institutional quality of the five North African countries and ten boundary-countries. As seen in table 30, in general, the five North African countries have poor institutional qualities which suggest that the North African energy exporters may already be suffering from the resource curse, and all five North African countries have the potentials to suffer from a solar energy curse if their institutional qualities are to remain poor in the future. In chapter 7, on the other hand, the solar energy rent is projected in various ways and compared to the average oil and natural gas rent sizes of the MENA countries during the period of 1993-2009 in order to see whether the solar energy rent will be as high as the current fossil-fuel rent sizes. Although different approaches in comparing the projected solar rent size and fossil-fuel rent size are made in chapter 7, the projected solar rent size is not likely to exceed, or even be close to, the average fossil-fuel rent sizes (1993-2009) that the North African energy exporters, or the MENA energy exporters receive in recent years. Also, when the individual country's projected solar rent size is compared to the average fossil-fuel rent sizes, both the energy exporters and importers are not likely to receive enormous amount of rent from solar electricity exports.

When one combines the results from chapter 6 and 7, a simple conclusion may be that the five North African countries are less likely to suffer from a solar energy curse, even if the poor institutional quality remains, as the projected solar energy rent size is not as much as the fossil-fuel rent sizes. However, one should not underestimate the chances of the projected solar rent sizes to increase in the future. As mentioned in chapter 3, there are ideas that oil production is at its peak. Of course, if one is to face the declining amount of world oil, based on an assumption that oil demand remains high, the value of the oil could increase and the oil rent size will also likely to increase. However, the world is realizing the importance of the renewable energy, and there are many strategies, such as Europe's 20/20/20 climate/energy target mentioned in section 3.1, created to expand the use of renewable energy. Of course, the five North African countries are also targeting to increase the share of renewable energy as presented in table 4. Furthermore, a number of studies which this thesis' projection is based on, especially focusing on EUMENA, predict that 90-100 percent of electricity can be provided from renewable energy in 2050. If this projection is to materialize, it means that the need for electricity via renewable energy has to increase. In this case, as the need for fossil-fuels declines, or may no longer be abundant, the price of renewable energy may rise as they will be the main sources for electricity generation. Consequently, solar energy and other renewable energy rent sizes can increase. When excluding these possibilities, however, if one is to perceive the cause of the resource curse as the combination of the poor institutional quality and enormous rent size from the natural resources, the results from chapter 6 and 7 suggest that there is little chance that the North African countries will suffer from a solar energy curse..

Despite above scenarios, one should not forget about the current resource curse. Of course, it is an important task to see whether solar energy, or other renewable energies, can become a curse. However, as the solar energy market in North Africa is still in its initial stage, and there can be various changes in the future, it may take a while for one to see whether solar energy will become a curse or not. Of course, if it is to become a curse, one should find a way to avoid/prevent it.

As measured in chapter 6, it is found that the North African energy exporters may be suffering from the resource curse. Also, it is found that the projected solar energy rent size may be similar or exceed the natural gas rent size in chapter 7. As the resource curse is present, and is a current issue, one should also pay attention to what kind of impact the successful solar energy establishment in the North African countries can have on the current resource curse. Accordingly, this section will project what kind of impact the projected solar energy rent size, which may be similar or exceed the natural gas rent, can have on the current resource curse.

8.2 North African Countries and their Heavy Reliance on Fossil-Fuels in Generating Electricity

The projected solar energy rent size obtained in chapter 7 shows that there is a possibility that it can exceed the natural gas rent size such as in Algeria. The projected solar energy rent size does not appear high enough to be considered as a great threat for solar energy to become a new curse. However, one can also ask what kind of impact this solar energy strategy will have on the North African energy exporters. In other words, the finding that the projected solar energy rent will be similar, or only slightly exceeding, to the recent average natural gas rent in the region, and the possibility that the energy exporters still have, though unsure of how much and how long, remaining fossil-fuels to export in the future can open up new perspectives on the current resource curse itself.

By looking at the projected solar rent size, one can predict that the successful establishment of the solar energy strategy does not mean that the North African energy exporters will switch their heavy reliance on exporting fossil-fuels to exporting solar electricity. In other words, the current resource curse will not simply vanish as a result of the establishment of solar energy.

For example, though based on an assumption that the fossil-fuel will remain in the future, the rent-seeking behavior could continue to remain in the resource cursed countries that are heavily relying on exporting fossil-fuels for their economies because the rent from fossil-fuels is much higher than the projected solar energy rent. Therefore, this section will hypothesize a situation under the assumption that there will be a successful establishment of solar energy in the North African countries, and project the possible impact it can have on the current resource curse.

As mentioned earlier, the five North African countries have enormous potentials to produce/export electricity, and meet its demand, via solar energy. However, as the solar energy plan is not fully established in the five North African countries, solar energy is not yet the main source that satisfies their electricity demand.

The five North African countries, and also many MENA countries, have been meeting their electricity demand via, whether their own or imported, fossil-fuels such as coal, natural gas, and oil. The heavy reliance on the fossil-fuels to generate electricity in the five North African countries can be perceived from table 56, which shows their total electricity production via coal, natural gas, and oil during the period of 2004-2009, presented below.

Table 56: Electricity Production via Coal, Natural Gas, and Oil in the Five North Countries 2004-2009

	2004	**2005**	**2006**	**2007**	**2008**	**2009**
Algeria	99%	98%	99%	99%	99%	99%
Egypt	87%	88%	88%	87%	88%	90%
Libya	100%	100%	100%	100%	100%	100%
Morocco	90%	94%	94%	95%	94%	85%
Tunisia	98%	99%	99%	99%	100%	99%

Source: World Development Indicators (WDI)

As mentioned earlier in section 7.2.2, according to Schellekens et al. (2010, p.15), the electricity demand for North Africa in 2050 is projected to be 1250 TWh/y, and the projected amount of electricity produced in North Africa is 2000 TWh/y via renewable energy. In other words, if the solar energy plan, and other renewable energy, is settled in the region with its full potentials, solar energy can be the substitution for all the fossil-fuels that are used to meet their electricity demand. Accordingly, an assumption can be made that the five North African countries could save their fossil-fuels, or save the money which is used to import fossil-fuels, which is used to produce electricity. In other words, the energy exporters could export more energy as they would have additional resources under the circumstance that a vast amount of fossil-fuels would remain in the future, thus more revenues, and the energy importers could import less energy to produce electricity, thus, saving the money that would have been spent on importing energy.

Here, one should question whether solar energy as the substitution for the entire use of fossil-fuels in meeting their electricity demand is the most optimistic outcome for the North African countries with their current institutional quality. Especially for the North African energy exporters, if they are already considered to be affected by the resource curse, would the possibility that the North African energy exporters to export more energy, prolonging the period of time that they can rely on energy exports, bring a positive and beneficial outcome if their institutional quality remains poor in the future?

Of course, as seen earlier, a country does not have to be affected by the resource curse when heavily dependent on their energies/resources exports. However, coupled with poor institutional quality, the combination of more energy to export and prolonging the period of time for them to rely on the energy export may be harmful as this can mean prolonging the time that the energy exporters will suffer from the current resource curse. This possibility, again, highlights the importance of paying attention to the possible impacts of the successful solar energy plans establishment on the current resource curse in the five North African countries, especially for the energy exporters, instead of just focusing on projecting whether the solar energy itself will turn into a new curse. As this section is focusing on the potentially prolonged length of period that the countries to suffer from the current resource curse, the North African energy exporters will be more focused.

8.3 The Sources for the Electricity Production in the Five North African Countries

As mentioned earlier, the five North African countries can be divided into two groups as energy exporters and energy importers. If one is to divide the five North African countries more strictly, it can be also divided into three groups, the energy exporters (Algeria and Libya), the energy exporter/importer (Egypt), and the energy importers (Morocco and Tunisia). In order to find the impact of the solar energy establishment on the current resource curse, each country's energy status and sources for the electricity generation will be illustrated which can provide the base in calculating the extra revenues that the energy exporters can receive. The sources for electricity production of Morocco and Tunisia, though not the main purpose of this section, will also be illustrated in order to show how much the North African countries rely on fossil-fuels in meeting their domestic electricity demand in general.

Energy Exporters: Algeria and Libya

Algeria

Algeria is a member of OPEC and is an exporter both oil and natural gas. In 2010, the hydrocarbons sector of Algeria accounted for 60 percent of its budget revenues, 36 percent of its GDP, and about 97 percent of its export earnings. Algeria's estimated proven oil reserves, as of January 2012, was 12.2billion barrels which is the third largest reserves in Africa after Libya and Nigeria. It is estimated that 750,000 bbl/d of Algeria's crude oil was exported in 2011. As for natural gas, as of January 2012, Algeria has the tenth largest natural gas reserves in the world with 159 trillion cubic feet (Tcf). In 2010, it is estimated that the total of 1.97 Tcf natural gas was exported. Within the total exported gas, 65 percent of it was exported through the natural gas pipelines which connect Algeria with Italy and Spain, and 35 percent was exported by tanker in the form of LNG (EIA Country Analysis Algeria).

As can be seen from table 57, Algeria's power generation is dominated by natural gas. Natural gas produces 96-97 percent of Algeria's electricity. The electricity production of Algeria's national power sector was estimated 40 TWh, and consumption was around 33 TWh in 2008. The electricity generation increased about 8 percent compared to 2007 (Supersperger & Führer, 2011, p.4460).

Table 57: Electricity Sources for Algeria 2004-2009

Electricity Sources	2004	2005	2006	2007	2008	2009
Coal	0%	0%	0%	0%	0%	0%
Hydroelectric	1%	2%	1%	1%	1%	1%
Natural Gas	97%	96%	97%	97%	97%	97%
Nuclear	0%	0%	0%	0%	0%	0%
Oil	2%	2%	2%	2%	2%	2%

Source: World Development Indicators (WDI)

Libya

Libya is also a member of OPEC and is an exporter of both oil and natural gas. In 2011, it is estimated that oil accounted for about 95 percent of nation's export earnings and 75 percent its government receipts. As of January 2012, Libya's total proven oil reserves was of 47.1 billion barrels which is the largest endowment in Africa. It is estimated that around 300,000 bbl/d was domestically consumed, and net exports were estimated to be around 1.5 million bbl/d in 2010. In the case of natural gas, as of January 1, 2012, the estimated proven natural gas reserves were 52.8 Tcf. Furthermore, in 2010, it is estimated that around 242 billion cubic feet (Bcf) of dry natural gas was consumed within the country, and Libya exported 352 BcF of natural gas (EIA Country Analysis Libya).

Libya's electricity production is heavily dependent on oil and natural gas. As can be seen from table 58, the nation's whole electricity is produced by oil and natural gas. Furthermore, from table 58, it is possible to see that the use of natural gas to produce electricity has been increasing, while the use of oil has been decreasing. This is due to the fact that the Libyan government plans to increase the nation's natural gas production in order to expand the use of natural gas in the power sector because this allows more oil export while maintaining and expanding existing pipe and LNG exports (EIA Country Analysis Libya).

Table 58: Electricity Sources for Libya 2004-2009

Electricity Sources	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Coal	0%	0%	0%	0%	0%	0%
Hydroelectric	0%	0%	0%	0%	0%	0%
Natural Gas	19%	28%	41%	45%	41%	41%
Nuclear	0%	0%	0%	0%	0%	0%
Oil	81%	72%	59%	55%	59%	59%

Source: World Development Indicators (WDI)

Energy Exporter/Importer: Egypt

Egypt

The oil and natural gas sectors play a substantial role in Egypt's economy. Egypt used to be a net energy exporter until the late 1990s. However, their total oil production declined since its peak in 1996. Egypt's estimated proven oil reserves, as of January 2011, was 4.4 billion barrels. Nevertheless, Egypt's oil consumption is slightly higher than production, and Egypt imports small volume of oil in order to meet the domestic demand. Despite the decline in oil production, the export of crude oil increased from 95,000 bbl/d to 114,000 bbl/d between 2010 and 2011. On the other hand, in the case of natural gas sector, it is expanding fast with production tripling between 2000 and 2010. It is estimated that Egypt's proven gas reserves stand at 77 Tcf which is the third largest in Africa after Nigeria and Algeria. Egypt produced around 2.2 Tcf and domestically consumed 1.6 Tcf in 2010. Furthermore, Egypt exported around 535 Bcf of natural gas (EIA Country Analysis Egypt).

As can be seen from table 59, a substantial amount of natural gas is used to produce electricity. Electricity consumption has been steadily growing at an average rate of 7 percent annually over the last decade (Supersperger & Führer, 2011, p.4460).

Table 59: Electricity Sources for Egypt 2004-2009

Electricity Sources	2004	2005	2006	2007	2008	2009
Coal	0%	0%	0%	0%	0%	0%
Hydroelectric	12%	12%	11%	12%	11%	9%
Natural Gas	71%	74%	72%	68%	68%	69%
Nuclear	0%	0%	0%	0%	0%	0%
Oil	16%	14%	16%	19%	20%	21%

Source: World Development Indicators (WDI)

Energy Importers: Morocco and Tunisia

Morocco

Morocco is an energy importer which has almost no conventional oil or natural gas reserves. Morocco imported around 98 percent of their primary energy supply in order to satisfy the total energy consumption of 14.7 Million Tonnes of Oil Equivalent (Mtoe) in 2008. In 2008, the nation's GDP was US$86.5 billion, and the estimated amount of the cost for energy import was around US$9.2 billion which was 11 percent of the total GDP. Morocco relies heavily on coal imports, as can be seen from table 60, in order to meet the nation's electricity demand, and coal is expected to remain as the primary fossil-fuel used in power generation for the next decades (Supersberger & Führer 2011, p.4459).

Table 60: Electricity Sources for Morocco 2004-2009

Electricity Sources	2004	2005	2006	2007	2008	2009
Coal	70%	66%	66%	63%	56%	52%
Hydroelectric	9%	5%	5%	4%	4%	12%
Natural Gas	0%	10%	12%	14%	14%	13%
Nuclear	0%	0%	0%	0%	0%	0%
Oil	20%	18%	16%	18%	24%	20%

Source: World Development Indicators (WDI)

Tunisia

In 2007, Tunisia's total primary energy consumption amounted to 7.7 Mtoe where 14 percent of this was imported. Tunisia has some oil and gas reserves and used to be a net energy exporter until 2000. For example, the estimated national output of crude oil and condensates was 34.6 million barrels in 2007. In the case of the natural gas, Tunisia developed new domestic gas reserves in the

1990s. However, the country still remains as a net natural gas importer. The total domestic natural gas produced was estimated as 2.2 billion cubic meter (m^3), another 1.2billion m^3 received as royalties from the trans-Mediterranean gas pipeline, and the total consumption stood at 4.3 billion m^3 (Supersberger & Führer 2011, p.4459).

The nation's two main primary energy sources in consumption are petroleum products and natural gas. Especially in the electricity production, which can be observed in table 61, Tunisia relies heavily on natural gas. Furthermore, a steady increase in the energy and electricity demand has been seen between 2003 and 2008 on average by 5-6 percent per year (Supersberger & Führer 2011. p. 4459).

Table 61: Electricity Sources for Tunisia 2004-2009

Electricity Sources	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**
Coal	0%	0%	0%	0%	0%	0%
Hydroelectric	1%	1%	1%	0%	0%	1%
Natural Gas	90%	91%	85%	83%	89%	90%
Nuclear	0%	0%	0%	0%	0%	0%
Oil	8%	8%	14%	16%	11%	9%

Source: World Development Indicators (WDI)

As can be seen above, the five North African countries rely heavily on fossil-fuels, whether their own or imported, in order to produce electricity. Most countries, except for Morocco, rely on the use of natural gas to meet their domestic electricity demands. Based on the date illustrated above, a hypothetical case study will be made in order to project how much of the possible additional resources that the energy exporters can export if the solar energy is to be successfully established in these countries.

8.4 Hypothetical Situation

As this section is trying to investigate the possibility of solar energy extending the current resource curse, it makes more sense to focus on the energy exporters; Algeria, Libya and Egypt. As mentioned earlier, Egypt is considered as both energy exporter and importer. In this section, Egypt will be considered as an energy exporter because this section is focusing on the extra revenues that the North African energy exports can get from their fossil-fuel exports due to the possible establishment of solar energy, and also the fact that natural gas is the main electricity source for

Egypt which they export. Furthermore, it must be mentioned that, though oil is still the main electricity source for Libya, natural gas consumption will be focused as the production of the electricity via natural gas has been growing in the country. Table 62 shows how the three North African energy exporters exploit their natural gas. As can be observed, they export a vast amount of natural gas.

Table 62: Natural Gas Production, Consumption, Export/Import, and Proved Reserves in the Three Energy Exporters (m^3)

	Production	Consumption	Exports	Imports	Proved reserves
Algeria	84.61billion (2010)	28.82billion (2010)	55.79billion (2010)	0 (2010)	4.502trillion (1 January 2012)
Libya	16.81billion (2010)	6.844billion (2010)	9.97billion (2010)	0 (2011)	1.495trillion (1 January 2012)
Egypt	61.33billion (2010)	46.16billion (2010)	15.17billion (2010)	0 (2009)	2.186trillion (1 January 2012)

Source: Central Intelligence Agency[96]

Although the purpose of this section is to find additional natural gas that can be exported or saved rather than consumed to meet the three North African energy exporters' domestic electricity demand, one needs to take a careful look at the details of the domestic consumption of natural gas. This is due to the fact that one can not say that the amount of domestically consumed natural gas, presented in table 62, was all used for one purpose. More specifically, for example, the domestically consumed natural gas is used in different sectors such as electricity sector, industry sector, transport sector, residential sector, and commercial and public services. Among different sectors mentioned above, only the amount of natural gas used for the electricity sector will be qualified as the possible additional natural gas which can be exported and bring extra revenues under the circumstances that the solar energy is to substitute the use of natural gas.

One may expect that the amount of natural gas that is domestically used to produce electricity may not be so much when considered as the proportion of the total natural gas production in a country. However, though it may be a small amount, the possible additional natural gas can be exported, or it can be used for different purposes which can, if properly used, help their economies. However, if not properly used, under the assumption that the poor institutional quality is to remain, this can also mean the prolonging of the resource curse.

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[96] https://www.cia.gov/library/publications/the-world-factbook/geos/ag.html (accessed: 17.01.2013)
https://www.cia.gov/library/publications/the-world-factbook/geos/ly.html (accessed: 17.01.2013)
https://www.cia.gov/library/publications/the-world-factbook/geos/eg.html (accessed: 17.01.2013)

Table 63: Oil and Natural Gas Consumption (Algeria)

	2010[a]	2011[a]	2012[b]	2013[b]	2014[b]	2015[b]	2016[b]	2020[b]
Oil								
Petroleum products: domestic consumption (ktoe)	16,345	16,699	17,007	17,333	17,723	19,019	20,609	25,646
Petroleum products: transport (ktoe)	9,550	10,307	10,555	10,852	11,192	12,084	13,180	15,490
Gasoline: demand ('000 b/d)	56.4	57.6	59.7	61.3	63.1	67.9	73.6	93.4
Distillates: demand ('000 b/d)	173.5	176.8	181.2	186.1	191.6	197.4	203.6	225.0
Natural gas								
Energy consumption (ktoe)	23,657	25,123	26,023	27,116	28,349	29,597	30,919	36,031
Electricity sector (ktoe)	10,261	11,426	11,552	11,679	11,807	11,937	12,091	12,557
Industry sector (ktoe)	3,611	3,777	3,947	4,114	4,353	4,587	4,875	6,164
Transport sector (ktoe)	925	937	994	1,070	1,152	1,235	1,318	1,635
Residential sector (ktoe)	4,310	4,369	4,635	4,987	5,368	5,758	6,146	7,624
Other (ktoe)	4,551	4,614	4,895	5,266	5,669	6,080	6,489	8,051

Source: Economist Intelligence Unit
http://www.eiu.com/index.asp?layout=ib3Article&article_id=658843650&country_id=210000021&pubtypeid=1142462499&industry_id=&category_id (accessed: 05.06.2012)

Table 64: Oil and Natural Gas Supply (Algeria)

	2010[a]	2011[a]	2012[b]	2013[b]	2014[b]	2015[b]	2016[b]	2020[b]
Crude oil: production ('000 b/d)	1,741	1,751	1,763	1,913	1,965	2,018	2,073	2,305
Refineries (no.)	4[c]	–	–	–	–	–	–	–
Natural gas: production (ktoe)	72,569	71,844	74,719	76,969	77,119	77,369	78,369	80,519

Source: Economist Intelligence Unit
http://www.eiu.com/index.asp?layout=ib3Article&article_id=658843650&country_id=210000021&pubtypeid=1142462499&industry_id=&category_id (accessed: 05.06.2012)

Table 65: Oil and Natural Gas Consumption (Egypt)

	2010[a]	2011[a]	2012[b]	2013[b]	2014[b]	2015[b]	2016[b]	2020[b]
Oil								
Petroleum products: domestic consumption (ktoe)	33,700	34,283	35,436	37,011	38,676	40,536	41,821	50,326
Petroleum products: transport (ktoe)	13,879	14,089	14,324	14,845	15,456	16,084	16,809	20,028
Gasoline: demand ('000 b/d)	119.3	120.5	123.1	126.9	131.2	135.4	139.3	156.5
Distillates: demand ('000 b/d)	281.9	290.3	300.4	309.9	320.6	332.2	344.5	403.4
Natural gas								
Energy consumption (ktoe)	38,212	39,927	42,272	44,384	46,497	48,809	51,712	62,568
Electricity sector (ktoe)	21,644	23,039	24,931	26,061	27,003	28,133	29,801	34,144
Industry sector (ktoe)	11,524	11,985	12,557	13,365	14,312	15,283	16,148	21,497
Transport sector (ktoe)	362	352	343	355	372	387	413	497
Residential sector (ktoe)	807	784	765	892	933	971	1,037	1,524
Commercial and public services (ktoe)	0	0	0	0	0	0	0	0
Other (ktoe)	3,875	3,767	3,675	3,710	3,878	4,035	4,312	4,907

Source: Economist Intelligence Unit
http://www.eiu.com/index.asp?layout=ib3Article&article_id=388827823&country_id=1640000164&pubtypeid=1142462499&industry_id=&category_id (accessed: 05.06.2012)

Table 66: Oil and Natural Gas Supply(Egypt)

	2010[a]	2011[a]	2012[b]	2013[b]	2014[b]	2015[b]	2016[b]	2020[b]
Crude oil: production ('000 b/d)	698	688	678	673	668	668	663	643
Refineries (no.)	9[c]	–	–	–	–	–	–	–
Natural gas: production (ktoe)	50,347	51,518	53,376	56,129	58,211	60,031	60,570	66,064

Source: Economist Intelligence Unit
http://www.eiu.com/index.asp?layout=ib3Article&article_id=388827823&country_id=1640000164&pubtypeid=1142462499&industry_id=&category_id (accessed: 05.06.2012)

Table 67: Oil and Natural Gas Consumption (Libya)

	2009[a]	2010[a]	2011[b]	2012[b]	2013[b]	2014[b]	2015[b]	2020[b]
Oil								
Petroleum products: domestic consumption (ktoe)	14,746	15,021	12,997	13,260	13,616	14,090	14,317	15,462
Petroleum products: transport (ktoe)	4,013	4,083	3,925	4,013	4,127	4,232	4,334	4,677
Gasoline: demand ('000 b/d)	30.0	30.2	25.1	28.9	32.2	34.0	35.6	39.4
Distillates: demand ('000 b/d)	133.0	136.1	120.7	131.1	140.0	148.0	152.7	174.0
Natural gas								
Energy consumption (ktoe)	5,496	5,959	4,142	5,073	5,838	6,552	7,230	9,781
Electricity sector (ktoe)	2,997	3,390	2,373	2,922	3,378	3,882	4,319	6,317
Industry sector (ktoe)	2,346	2,426	1,684	2,033	2,329	2,528	2,756	3,256
Transport sector (ktoe)	0	0	0	0	0	0	0	0
Residential sector (ktoe)	0	0	0	0	0	0	0	0
Commercial and public services (ktoe)	0	0	0	0	0	0	0	0
Other (ktoe)	152	142	85	118	131	143	155	207

Source: Economist Intelligence Unit

http://www.eiu.com/index.asp?layout=ib3Article&article_id=1868551171&country_id=1200000320&pubtypeid=1142462499&industry_id=&category_id (accessed:05.06.2012)

Table 68: Oil and Natural Gas Supply (Libya)

	2009[a]	2010[a]	2011[b]	2012[b]	2013[b]	2014[b]	2015[b]	2020[b]
Crude oil: production ('000 b/d)	1,506	1,638	443	830	1,260	1,474	1,561	1,710
Refineries (no.)	5	5	–	–	–	–	–	–
Natural gas: production (ktoe)	12,984	12,903	5,403	7,453	9,553	11,538	12,581	15,179

Source: Economist Intelligence Unit

http://www.eiu.com/index.asp?layout=ib3Article&article_id=1868551171&country_id=1200000320&pubtypeid=1142462499&industry_id=&category_id (accessed:05.06.2012)

Table 63-68 present natural gas production and consumption in different sectors in North African energy exporters. If one is to take the year 2010, it is possible to see that a vast amount of natural gas (about 43.4 percent for Algeria, 56.6 percent for Egypt, and 56.9 percent for Libya) was used for the electricity sector in the three North African energy exporters. This also means, that if electricity can be produced by the solar energy instead of natural gas, Algeria, Egypt, and Libya could have saved 43.4 percent, 56.6 percent and 56.9 percent, accordingly, of natural gas consumed in electricity sector, and these are equivalent of 14.1 percent, 43 percent and 26.3 percent, accordingly, of the total natural gas production. If one assumes that the rest of natural gas was exported, subtracting the total amount of consumed natural gas from the total production without any transmission loss, the total amount of natural gas that was exported would be 48912 Ktoe for Algeria, 12135 ktoe for Egypt, and 6944 Ktoe for Libya. However, with the additional natural gas, when one considers the situation where the solar energy was substituted for the natural gas to produce electricity, Algeria, Egypt and Libya could have exported 59173 Ktoe (21.0 percent more), 33779 Ktoe (178.4 percent more) and 10334 Ktoe (4.8 percent more), accordingly, amount of natural gas.

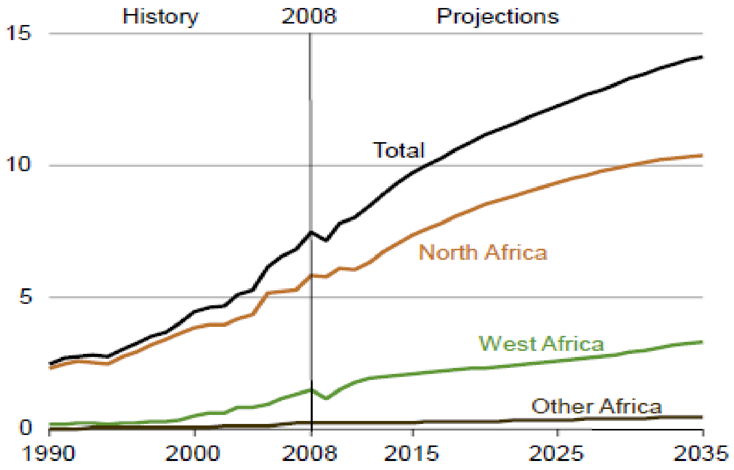
Of course, though a hypothetical analysis, the possible impact of the solar energy in the three North African energy exporters show additional natural gas they could have saved or exported. However, this hypothetical analysis is made with the statistical information regarding the year 2010.

In other words as solar energy is yet to become a substitute for natural gas in these three North African energy exporting countries, the outcome of the analysis made above can not guarantee that there will be any additional natural gas that can be exported or saved because one does not know how much these countries will be producing natural gas in the future. Therefore, one needs to make a hypothetical analysis with the projected future natural gas production rate and its use in the three North African energy exporters first, and then see whether there will be any additional natural gas for the three North African energy exporters in the future.

8.5 Projections of the Natural Gas Production and Consumption in the Three Energy Exporters

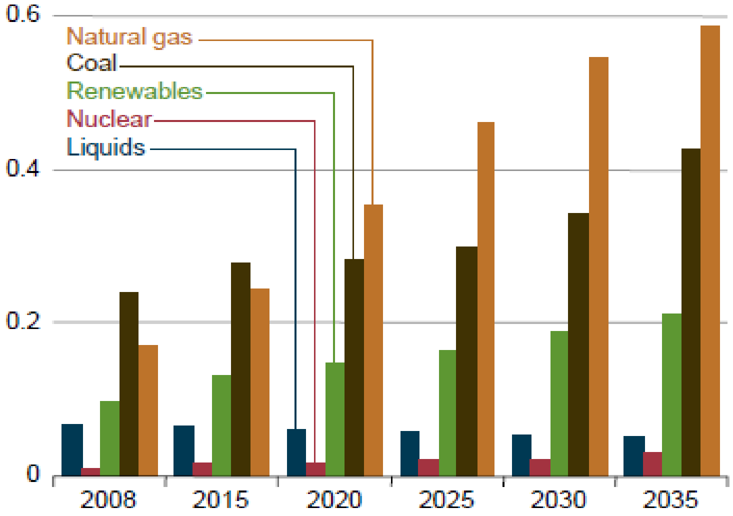
When looking at table 63-68, one is able to see that the three North African energy exporters' natural gas production and consumption are projected to increase. Similar projections are also made by other sources. For example, according to the EIA (2011, p.55), the natural gas production in Africa is projected to grow substantially, from a total of 7.5 Tcf in 2009 to 14.1 Tcf in 2035. Similarly, International Energy Agency (IEA 2011, p.27), in their Golden Age of Gas Scenario, also projects the growth in the natural gas production in Africa in the future, from 207 bcm in 2008 to 438 bcm in 2035. It is estimated that North Africa, mainly from Algeria, Egypt, and Libya, accounted for 78 percent of Africa's natural gas production in 2008. Although the annual natural gas production growth is projected to be higher in West Africa, by 3.1 percent, than North Africa, by 2.2 percent, the natural gas production in North Africa and the rest of the region is projected to grow as can be seen from figure 25 (EIA 2011, p.55).

Figure 25: Africa Natural Gas Production, 1990-2035 (Tcf)



Source: EIA (2011, p.55)

Figure 26: Net Electricity Generation in Africa by Fuel, 2008-2035 (TWh)



Source: EIA (2011, p.100)

Figure 26 presents the fuel sources for the electricity generation in Africa. As can be observed from figure 26, the reliance on fossil-fuels in generating the electricity is projected to continue.[97] The coal-fired power plants were Africa's largest source of electricity in 2008 which are expected to decline throughout the period. However, as can be seen from figure 26, it is projected that natural gas-fired generation is to expand from 29 percent of the total in 2008 to 45 percent in 2035 (EIA 2011, p.100). Although above figures do not present the predicted amount of natural gas which will be used to produce electricity for the individual three North African energy exporters, it certainly shows that natural gas will still play a crucial role in meeting the future electricity demand in the region.

When observing table 63-68, although the natural gas production and consumption in the three North African energy exporters are projected to increase, the projection of natural gas used for the electricity sector varies among the three North African energy exporters. More specifically, the projected amount of natural gas used to produce electricity will increase for all the three North African energy exporters. However, the proportion in the use of natural gas to produce electricity does not increase in all three countries when compared to the other sectors. For example, it is only Libya that is projected to be using more natural gas in electricity sector in the future (59.7 percent in 2015 and 64.6 percent in 2020) whereas Algeria's use of natural gas in electricity sector is projected to decline (40.3 percent in 2015 and 34.9 percent in 2020). Egypt's use of natural gas in

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[97] Of course, the projection by EIA (2011) is different from other studies focusing on renewable energy such as Schellenkens et al. (2010) or Zickfeld et al. (2012) because it is not based on the assumption that 90-100 percent of electricity can be produced by renewable energies. Nevertheless, it still projects the growth in renewable energies production in the future.

electricity sector is projected to increase, compared to the year 2010 (56.6 percent), in 2015 (57.6 percent), but it is projected to decline in 2020 (54.6 percent) compared to 2015. As can be seen from table 63, 65, the decline in the use of natural gas, in terms of proportion compared to other sectors, to produce electricity in Algeria and Egypt may be due to the more use of natural gas in their industry sectors as the proportion of the natural gas used for the industry sectors for both countries are projected to increase (Algeria: 15.5 percent in 2015 and 17.7 percent in 2020, Egypt: 31.3 percent in 2015 and 34.4 percent in 2020).

Nevertheless, what is more important is the proportion of natural gas used to produce electricity in the total natural gas production. As mentioned earlier, if the solar energy plan is to be successfully established and substitute natural gas, Algeria, Egypt and Libya would have saved 14.1 percent, 43.0 percent and 26.3 percent in 2010, accordingly, out of the total natural gas production. Though the proportion of the natural gas used to produce electricity, when calculated within the consumed natural gas, is projected to decline except for Libya, the proportion of the natural gas used to produce electricity is projected to increase when calculated as the proportion of the total natural gas production.

Table 69: % of the Consumed Natural Gas from the Total Natural Gas Production and Projected % of 'Additional Natural Gas' in the Total Projected Amount of Exported Natural Gas in the three Energy Exporters in 2010, 2015, and 2020

	Algeria			**Egypt**			**Libya**		
	2010	2015	2020	2010	2015	2020	2010	2015	2020
% of the total Production	14.1%	15.4%	15.6%	43%	46.9%	51.7%	26.3%	34.3%	41.6%
Additional Natural Gas %	21.0%	25.0%	28.2%	178.4%	250.7%	976.6%	48.8%	80.7%	117.0%

Table 69 presents the percentage of the consumed natural gas out of the total natural gas production, and the projected 'additional natural gas' percentage out of the total projected exported natural gas in the three North African energy exporters. Here, again, it must be mentioned that the projected amount of exported natural gas is the subtraction of the total consumed natural gas from the total natural gas production under the circumstance that there is no transmission loss.

Despite the proportion of the natural gas used to produce electricity which is calculated within the total consumed natural gas, table 69 shows that the use of natural gas to produce electricity is projected to gradually take a higher proportion when calculated out of the total natural gas production in all three North African energy exporters. When the amount of the possible additional natural gas (amount of natural gas used for the electricity production) is compared to the projected exported natural gas, it shows that the three North African energy exporters could export much more natural gas than they are projected to export. Algeria and Libya could export more natural gas gradually throughout the periods if solar energy is to substitute the use of natural gas. Egypt, on the other hand, already could have exported 178.4 percent more amount of natural gas in 2010 if solar energy substituted the use of natural gas. The amount of projected additional natural gas increase dramatically for Egypt as it could export 250.7 percent and 976.6 percent more natural gas in 2015 and 2020, accordingly, if solar energy can substitute the natural gas in meeting the domestic electricity demand in the country.

Table 70: Increase in the Domestic Consumption of Natural Gas in the Three Energy Exporters

	2010 to 2015	2015 to 2020	2010 to 2020
Algeria	25.1%	21.7%	52.3%
Egypt	27.7%	28.2%	63.7%
Libya	21.3%	35.3%	64.1%

Another finding is that the domestic consumption of natural gas is projected to increase. Table 70 presents the prediction of the increase in the domestic natural gas consumption in the three North African energy exporters. The consumption of natural gas in all three countries is projected to gradually increase. If one compares natural gas consumption of 2010 and 2020, its consumption increases by 52.3 percent, 63.7 percent and 64.1 percent for Algeria, Egypt and Libya, respectively. In other words, the solar energy substitution for natural gas can save them a vast amount of natural gas.

By looking at the hypothetical analysis made above based on the projection of the production and consumption of natural gas in the three North African energy exporters, it is possible to project that the three energy exporters are likely to produce and consume more natural gas in the future. Furthermore, more importantly, it is projected that there can be more additional natural gas exported if solar energy is to replace the consumption of natural gas to produce electricity. The projected additional amount of natural gas which can be exported or used in different sectors can be a great factor which can attract the solar energy plans for the three North African energy exporters. However, the additional natural gas also can mean that solar energy can prolong the period of time for these countries to rely on their energy exports, thus prolonging the current resource curse. Of course, the outcome of this section is based on the assumption that these countries will continue to have poor institutional quality, and they will still be abundant with fossil-fuels in the future. If the above assumptions are to occur in the future, it can mean that the earlier success in solar energy, or renewable energy, establishment in the region, the higher chance that the current resource curse is to be prolonged. This is not to say that solar energy will be harmful to the resource-abundant countries. As seen earlier, when used correctly resource abundance does not necessary lead a country to suffer from the resource curse. However, one should always take into a consideration that, whether solar energy becomes a curse or not in the five North African countries, solar energy to substitute other resources still has the potential to keep them in the current resource curse. In other words, though this situation may not be regarded as the so called ‘solar energy curse’ or a ‘renewable energy curse’ the above hypothesized situation i.e prolonging the reliance on exporting natural gas may be considered as a new curse effect.

Chapter 9. Conclusion

This thesis has focused on the current resource curse and the future potential for solar energy to become a new curse in the five North African countries. After reviewing the 'curse' and its effects in chapter 2, it was decided that the main cause(s) of the resource curse should be determined in order to measure and project whether there is the potential for the five North African countries to suffer from a solar energy curse. The selected causes, as presented in chapter 4, are poor institutional quality and the enormous rent size from the export of fossil-fuels. However, throughout this thesis, it is found that these causes could not individually function as the ultimate cause of the resource curse alone, rather, it is through the combination of poor institutional quality and the enormous rent size that results in the resource curse. Based on this assumption, the potential for the five North African countries to suffer from a solar energy curse has been projected. In chapter 6, based on the year 2011, the five North African countries appear to have poor institutional quality. Their institutional qualities tend to be lower than the resource curse avoided/escaped boundary-countries but closer to the resource cursed boundary-countries. Under the assumption that their institutional qualities are to remain poor in future, and if solar energy rent size is to be as high as the oil and natural gas rent size, the five North African countries can be considered to have the potentials to suffer from a solar energy curse. However, as seen in chapter 7, the projected solar energy rent size, or even the combination of the CSP and wind onshore rent size, is not likely to be as high as the average oil and natural rent size during the period of 1993-2009 except for few cases regarding the natural gas rent size. In other words, solar energy alone is not likely to become a new curse, and, therefore, the five North African countries are less likely to suffer from a solar energy curse. However, though it is projected that solar energy is not likely to become a new curse in the five North African countries, this is not to say that North Africa does not have to be concerned with important issues relating to the 'curse'. As seen in chapter 8, the hypothesized case study regarding the successful establishment of solar energy in the region opens up a new perspective. If solar energy, or renewable energy, is to become the substitution energy source for the use of natural gas or other fossil-fuels in meeting the domestic electricity demand, under the assumption that the poor institutional quality will remain in the future, it may play a role in prolonging the current resource curse that the North African energy exporters are suffering from. Especially the major energy exporters such as Algeria and Libya, despite the peak oil theory presented in chapter 3, there are projections that their oil production will increase in the future. For example, according to IEA (2009, p.84), Algeria's crude oil production is projected to increase from 1.4 million barrels per day (mb/d) in 2008 to 1.6 mb/d in 2030, and Libya's crude oil production is projected to increase from 1.7 mb/d in 2008 to 2.7 mb/d in 2030. Also, as can be seen from table 64, 66, 68, which presents the projection of oil and natural gas production in the North African energy exporters, their oil and natural gas production, except for oil production in Egypt, is also projected to increase until 2020.

Of course, above projections do not show the projected oil and natural gas production rates in the North African energy exporters in 2050. However, one can suspect that, under the assumption that the oil and natural gas production is to continue to grow or remain similar to the projected production growth rate, solar energy or renewable energies as the substitution source for oil or natural gas in producing domestic electricity may contribute in prolonging the time for these countries to rely on exporting their fossil-fuels. In other words, prolonging the time that the energy exporters to suffer from the current resource curse.

Here, as mentioned in Chapter 8, if 90-100 percent of EUMENA electricity is to be produced via renewable energy, the need for electricity production via renewable energy is to increase. In this case, as the need for fossil-fuels declines, or may no longer be available in abundance, the price of renewable energy may rise. However, one should realize that this projection is made among EUMENA countries. The projection that the electricity generated by renewable energy will be exported from North Africa or MENA to Europe does not mean the need for fossil-fuels from North Africa or MENA will diminish. In other words, though the world total renewable electricity net generation and the number of countries promoting renewable energy policies have been increasing as mentioned in Chapter 3, one can not argue that there will not be any countries that are in need for fossil-fuels from the North African energy exporters in the future. Furthermore, 90-100 percent electricity produced via renewable energy is also a projection, or proposed plan, and it is uncertain whether this will materialize or not. Perhaps, the more urgent matter that should be focused upon is the possible impact of the establishment of solar energy, or other renewable energies, in the energy exporting countries that are already suffering from the resource curse.

Despite the above possibility, as mentioned earlier, the results from chapter 6 and 7 suggest that the five North African countries are not likely to suffer from a solar energy curse due to the small projected solar energy rent size. However, it is still not certain that the five North African countries will definitely avoid a solar energy curse.

When the combination of the poor institutional quality and the enormous rent size is established as the main cause that determines the resource curse, one may view the resource curse and the solar energy curse as the results of rent-seeking behavior. Furthermore, as the result of this thesis is that the five North African countries are not likely to suffer from a solar energy curse due to the small projected rent size from solar electricity exports, the enormous rent size may appear as more of the core cause of the resource curse. Here, it is misleading for one to regard rent-seeking behavior and enormous resource rents size as the entire explanation for the resource curse and the cause of the resource curse because resource curse is a very broad term. As seen in chapter 2, the resource curse has various negative effects. In other words, one should not identify the resource curse as a single unit, but it should be regarded as a term that describes, and possesses, all the negative effects that are presented in chapter 2.

It is important to have a clear understanding of the term resource curse. When looking at the resource curse effects presented in chapter 2 or even the aid curse effects, though regarded as one of the causes of the resource curse in this thesis, the enormous rent size is not always the cause for the resource curse effects. For example, conflicts can occur due to other reasons such as religion. Also, debt problems in many African countries, or any other countries, are not always caused by the enormous rent from exporting recourses, the combination of volatility and Dutch disease, because there are many countries suffering from debt when they do not have enormous amount of natural resources to export.

In fact, what are considered as the resource curse effects are often already existing problems that many countries have been suffering from. Here, one can say that the resource rent is an element that can be perceived as extra fuel which exacerbates existing problems. The enormous size of the resource rent highlights the problems that are related to the resources. This creates a rather deceptive perspective because one will see the problems as the resource curse effects, when they are often the existing problems that they have been suffering from regardless of the resource and its rent. In other words, the reason why existing problems, especially in energy exporting countries, are perceived as the effect of the resource curse is because the ‘flame’ created by enormous extent of resource rents has been concealing the core and existing issues. This is not to say that the resource curse does not exist, and the enormous resource rent size, or the combination of the rent size and the poor institutional quality, is not the cause of the resource curse and its effects. For example, the enormous oil rent caused problems in Norway as mentioned in chapter 2. However, in a logical way of thinking, it is difficult to think that the enormous rent from resource exports would harm an economy rather than contribute in economy’s development. As presented in chapter 2, there are countries, such as Botswana and Norway, which avoided/escaped the resource curse. Their experiences suggest that knowing how to control, planning a long-term plan, fair distribution and good spending of the rent for development, and of course materializing them, are the key factors in avoiding/escaping such curses. Whether these are entirely all related to the institutional quality or not, one can not deny the fact that the good institutional quality should be the backbone in materializing the above mentioned factors. Especially when looking at the result of chapter 6, the importance of the institutional quality is already seen as the institutional quality of the resource curse avoided/escaped boundary-countries often have much better institutional quality than the resource cursed boundary-countries. Furthermore, as mentioned throughout this thesis, institutional quality is related to accountability, transparency, democracy and other factors which are crucial elements in eradicating the resource curse, and/or the already existing problems, which many African counties suffer from.

This thesis analyzed the possibility for the five North African countries to suffer from a solar energy curse under the assumption that this form of the solar energy curse and its effects will be similar to the current resource curse. However, it is inconclusive whether solar energy will become a new curse or, what form it will take, and how different it will be from the current resource curse. In an extreme case, one can not ignore the possibility that a solar energy curse may be completely different from the current resource curse, and the projection of the possibility of solar energy to become a new curse based on the current resource curse may not even be the correct method. In fact, it is hard to say whether a solar energy will become a new curse, or will it have similar appearance and outcome as the resource curse. Nevertheless, good institutional quality, or its improvement, appears as a necessary factor that can help in avoiding/escaping the resource curse, and, importantly, the North African countries, or any other countries, need it to solve the 'already existing problems' which can become more serious due to the resource and its rent, or what are deceivingly perceived as the resource curse effects.

If the five North African countries' institutional qualities are to remain poor, they have less chance of solving the existing problems which may turn into a new curse. Of course, the five North African countries are not likely to suffer from a solar energy curse as the projected solar energy rent is low. However, if they are to find a new source, which does not have to be natural resources or energy, that is to provide enormous rent, under the assumption that their institutional qualities are to be remained poor, it is possible that they may be facing a new type of curse. In other words, if their current poor institutional qualities remain in the future, they may be in an unfortunate position to suffer from a new type of curse.

Of course, one does not know how much their institutional qualities are to improve in the future especially when the region is experiencing chaotic events and complexities such as assassination of Gaddafi in Libya and Islamic militant's invasion of an Algerian gas field and the killing of hostages, and more importantly, the Arab Spring. As mentioned earlier, there are different ways of viewing the impacts of the Arab Spring in the region. For example, Tunisia's regime change is considered as a positive outcome by Hlepas (2013), whereas, Weill (2012) still finds that the impacts of the current consequences of the Arab Spring is still to reveal itself and is unpredictable. In fact, the current chaotic events and uncertainties in the region make it difficult for one to project future institutional quality[98], and, more importantly, the possibility for them to suffer from a new curse or a prolonged resource curse. Nevertheless, many of these countries are entering, or have already entered, a crucial turning point which can determine their path to the future. The five North African countries should take this turning point as an opportunity to improve their institutional quality which will help them to avoid possible 'curses' and, more importantly, lead them to sustainable development.

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[98] Hence the reason why the most recent institutional quality is used to identify the solar energy curse.

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[99] This page is unavailable as of March 31, 2013. The new web page is as follows; http://databank.worldbank.org/data/views/variableSelection/selectvariables.aspx?source=world-development-indicators

Samenvatting

Het Afrikaanse continent bezit een grote variëteit aan natuurlijke hulpbronnen. Deze natuurlijke hulpbronnen worden dan ook door een groot aantal Afrikaanse landen geëxporteerd. Hiertoe behoren belangrijke energiebronnen als aardolie en gas, en de export van deze energiebronnen spelen een cruciale rol in the economie en politiek van veel Afrikaanse landen. Ondanks deze cruciale rol wordt de grote afhankelijkheid van deze export vaak in verband gebracht met de term ‘resource curse’. Zeer simplistisch omschreven is een ‘resource curse’ een verzamelnaam voor een breed scala aan negatieve effecten van de van grote hoeveelheid hulpbronnen.

Helaas zijn termen als ‘resource curse’, ‘oil curse’ en ‘aid curse’ synoniem geworden met het Afrikaanse continent en verschillende studies hebben aangetoond dat deze ‘curses’ bestaan in veel Afrikaanse landen.

De wereld staat aan de vooravond van een ‘new energy era’ doordat veel landen hun beleid veranderen om het gebruik van duurzame energiebronnen aan te moedigen. Vooral Noord-Afrika krijgt veel aandacht vanwege hun enorme potentieel voor zonne-energie en andere duurzame energiebronnen als windenergie in de Sahara. Een voorbeeld hiervan is de organisatie *Desertec Industrial initiative* (DII) die in 2011 een samenwerkingsovereenkomst is aangegaan met de *Moroccan Agency for Solar Energy* (MESEN) gericht op een groot zonne-energie project in Marokko.

Ondanks het potentiële gewin voor Noord-Afrika, dat gepaard gaat met de ontwikkeling van zonne-energie in de regio, blijft het een precaire situatie. Zonne-energie is immers een nieuwe energiebron, waardoor de kans niet kan worden uitgesloten dat dit een nieuwe ‘curse’ zal worden. Derhalve richt dit onderzoek zich op de vraag of er een kans bestaat dat er een ‘zonne-energie vloek’ zal ontstaan in de vijf Noord-Afrikaanse staten. .

Omdat het gebruik van zonne-energie in Noord-Afrika nog in zijn kinderschoenen staat, alsmede het onderzoek naar deze nieuwe energiebron, zijn er weinig data en informatie beschikbaar. Daarom is deze studie naar het mogelijke onstaan van een ‘resource curse’ bij zonne-energie gebaseerd op data en literatuur aangaande de huidige ‘resource curses’. Dit is aangevuld met data en informatie uit landen die meer ervaring hebben met duurzame energie zoals Duitsland en Spanje.

Uitgaande van de aanname dat een eventuele ‘solar energy curse’ vergelijkbaar zal zijn met de huidige ‘resource curse’, zijn zwakke instituties en de enorme opbrengsten uit natuurlijke hulpbronnen als de oorzaken van de ‘resource curse’ aan te wijzen.

De oorzaak van zwakke instituties wordt onderzocht met gebruik van de *World Governance Indicator* (WGI). De vijf geselecteerde staten in 2011 worden vergeleken met vijf staten waar zich een ‘resource curse’ heeft voorgedaan en vijf staten waar een ‘resource curse’ is uitgebleven. De uitkomst van het onderzoek toont dat de kwaliteit van de instituties in de onderzochte staten vergelijkbaar is met de waarden van de staten die te maken hebben met een ‘resource curse’. Dit suggereert dat er een kans bestaat dat zich een ‘solar energy curse’ zal voordoen als de kwaliteit van de instituties laag blijft.

Wat betreft de enorme inkomsten wordt er een andere vergelijking gemaakt. De te verwachten inkomsten van zonne-energie in de onderzochte staten, zijn afgezet tegen de inkomsten uit aardolie en gas van het Midden-Oosten en Noord-Afrika (MENA) in de periode 1993-2009. De uitkomst van de vergelijking is dat de inkomsten uit zonne-energie totaal niet in dezelfde orde van grootte vallen als de inkomsten uit aardolie- en gaswinning, zelfs niet wanneer de inkomsten uit zonne-energie gecombineerd worden met de inkomsten uit windenergie.

Beide bevindingen in ogenschouw nemend, is het niet te verwachten dat zonne-energie een ‘resource curse’ zal worden in de vijf Noord-Afrikaanse landen, voornamelijk door de lage te verwachten inkomsten. Ervan uitgaande dat aardolie en aardgas in de toekomst de belangrijkste energiebronnen zullen blijven voor de drie grote Noord-Afrikaanse energie exporteurs (Algerije, Egypte en Libie), is het mogelijk dat de huidige ‘resource curse’ verlengd wordt door de succesvolle ontwikkeling van zonne-energie, zo blijkt uit dit onderzoek. Door de ontwikkeling van zonne-energie kunnen de landen langer teren op de inkomsten uit fossiele brandstoffen.

De bevinding dat zonne-energie geen ‘resource curse’ zal worden voor de vijf Noord-Afrikaanse landen betekent echter niet dat er geen ‘resource curse’ zal zijn in de toekomst. Uit het onderzoek komt naar voren dat veel effecten van een ‘resource curse’ niet alleen veroorzaakt worden door de hoge inkomsten maar dat deze problemen al langer voorkomen, los van de inkomsten uit fossiele brandstoffen. De inkomsten kunnen derhalve gezien worden als olie op het vuur waardoor bestaande problemen in de regio versterkt worden. De enorme omvang van de inkomsten uit fossiele brandstoffen intensiveert de problemen die verbonden zijn aan deze hulpbronnen. Dit geeft echter een vertekend beeld omdat men de problemen gaat zien als effecten van de ‘resource curse’ terwijl deze problemen zich voordoen ongeacht de inkomsten uit de hulpbronnen. Met andere woorden, de reden waarom bestaande problemen, vooral in energie-exporterende landen, worden gezien als effect van de ‘resource curse’ is dat de enorme inkomsten de kern van de bestaande problemen verhullen.

Dit betekent echter niet dat de ‘resource curse’ niet bestaat en dat de grote inkomsten niet de oorzaak zijn van de ‘resource curse’ en de bijbehorende gevolgen.

Kwalitatief goede instituties zijn een belangrijke factor bij het verbeteren van de toerekenbaarheid, transparantie, democratie en andere factoren. Daarnaast hebben kwalitatief goede instituties ertoe geleid dat een ‘resource curse’ in bepaalde landen is vermeden. Ook kunnen kwalitatief goede instituties helpen om bestaande problemen aan te pakken die op termijn tot een toekomstige 'curse' zouden kunnen leiden.

Door de huidige instabiele situatie die het gevolg is van de Arabische Lente, en de complexiteit van de regio, is het helaas erg moeilijk om een inschatting te maken of de kwaliteit van instituties zal verbeteren. Er zijn verschillende manieren om de status-quo van de regio te beschouwen. Zo wordt de machtswisseling in Tunesië als een positieve uitkomst gezien (Hlepas, 2013), terwijl Weill (2012) van mening is dat de gevolgen van de Arabische Lente in Tunesië vooralsnog onvoorspelbaar blijven.

De huidige turbulente gebeurtenissen en onzekerheden in de regio maken het moeilijk om de kwaliteit van instituties te voorspellen. Hierdoor is het problematisch om de kansen op een nieuwe of verlengde ‘resource curse’ te voorspellen.

Het staat buiten kijf dat deze landen zich op een cruciaal keerpunt bevinden. De vijf Noord-Afrikaanse landen moeten dit moment als een kans zien voor het verbeteren van de kwaliteit van hun instituties. Dit zal hen helpen om toekomstige ‘resource curses’ te vermijden en deze landen naar duurzame ontwikkeling te leiden.

Curriculum Vitae

Yuh Jin Bae, a natural of South Korea, was born on 15th March 1984, in Dortmund, Germany. He attended Berlin Brandenburg International secondary School. He went on to obtain a BA Development Studies and African Studies [2004-2007] at the School of Oriental and African Studies in London, in England and a MA in Languages and Cultures of Africa [2008-2009] at Universiteit Leiden, the Netherlands.