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## An Analysis of North Africa's Capacity to Achieve Renewable Energy Development

Wai Mun Hong<sup>\*</sup>

**Abstract:** Although blessed with abundant solar and wind energies, North Africa has yet to maximise its socioeconomic gain from tapping these resources. In view of North African demographic and middle class expansion, energy demand is set to increase. Tapping renewable energy sources will not only address these problems, but also will be an impetus to the faltering socioeconomic dynamic the region needs to boost sustainable development to benefit from globalisation. However, with bureaucratic-laden institutions and corruptions hindering the private sector from flourishing, governments are compelled to mobilise public finances to cover the lack of private investments in renewable energy projects. Increasing investments in education and R&D to meet skills demand for renewable energy projects that continues to lag behind foreign contents as the primary input. Skills mismatch between the labour force and technology intensive renewable energy industry is a result of the people's aspiration and desire to work for the government shaped by post-independence policies. The challenge for North Africa policy makers is beyond correcting institutional deficiencies to transform its business environment, but also to influence change in the perception and attitude of the public.

**Keywords:** Economic development, human development and renewable energy

**JEL classification:** O1, O15, N55

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## 1. Introduction

North Africa is one of the most well-endowed regions in the world regarding natural resources. The region does not only have one of the largest hydrocarbon reserves in the world, mainly contained within Algeria, but it is also home to an abundance of solar and wind energies that are invariantly distributed across the plain. Part of the Sahara, that is known for a high temperature desert landscape, forms a significant portion of the region. As such, North Africa enjoys approximately 3,500 potential hours of direct sunlight every year, and receives some of the world's strongest wind blowing at a speed of between six and seven miles per minute. These resources would make North Africa one of the regions most well-endowed with renewable energies in the world.

As a sought-after commodity, energy plays a strategic role in the socioeconomic and political spheres within a state and between states, regardless of form. It is an important factor of economic growth and development. The demand for energy is set to increase as demographic and middle class expansion unfolds in North Africa. Fossil fuel dependent North African economies have been facing high energy prices as they compete with the rest of the world for the commodity and push up global demand. Hydrocarbon rich Algeria is likely to benefit the most from it through exports of the natural resources to accumulate foreign reserves to fund its development programmes. The rest of the hydrocarbon scarce economies in the region have only to eat deeper into their public budgets to import energy to satisfy increasing domestic demand.

Conventional fossil-based energy resources have also raised concerns about sustainability. With the world's emerging economies fighting for the same resources to achieve growth, the depletion of conventional fossil reserves is only exacerbated. The use of traditional forms of energy has caused growing concerns over environmental problems that has given rise to a contemporary definition of growth and development that goes beyond the measurements of pure economics, to overall social wellbeing and the sustainability of the ecosystem. Renewable energy development is therefore more than addressing practical needs of energy in North Africa. These challenges have basically motivated the North African economies to develop their own energy supply with the abundance of renewable solar and wind energies they are endowed with.

The installed capacity of solar and wind energy in North Africa has not matched up to its

potential. To date, only a meager 1 percent of electricity production in North Africa<sup>1</sup> comes from renewable resources. This paper is, therefore, an attempt to address the gap between renewable energy potential and its capitalisation by assessing and analysing the capacity of North African economies to support renewable energy development projects. The purpose of this paper, rather than justifying how renewable energy constitutes a sustainable development model, is to assess and identify the qualities and constraints in human capital in the labour force and those within the policy and institutional framework, to explain their impact of the progress and development of the renewable energy sector.

This paper is divided into four sections. In the first section, I will give an analytical overview of the characteristics of renewable energy that fit the criteria of a sustainable development model based on the domestic needs and the qualities and opportunities of renewable energy development. In the final section, I will raise some questions and discuss how the opinions and aspirations of the North African people can pose challenges to policy making pertaining to renewable energy development, and their impact on the progress.

## 2. An analytical overview of renewable energy as an alternative development strategy

Socioeconomic inequality is a problem that has marred the North African economies for many decades. A region well-endowed with some of the world's most precious natural resources, North African economies with large reserves of fossil resources have benefited from growing world demand to boost economic growth and fund development projects in the past decades. Those with limited or no reserves have to resort to high public expenditure to import fossil fuels to meet growing domestic demand. North African economies may be heavily dependent on fossil fuels, but they are not the only form of energy resources North Africa is endowed with. The region also has an abundance of renewable solar and wind energies, although these industries were underdeveloped until recently when interests started to gather and ambitious projects began to emerge.

Energy is an economic backbone that powers industries and quotidian activities. North Africa faces challenges at both fronts of supply and demand, where population continues to grow, its middle income class expands fast with a relatively young population, and where fossil reserves that they heavily depend on are depleting. Renewable solar and wind energies are not only able to fill the gap between

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1 North Africa in this paper refers to Algeria, Egypt, Morocco and Tunisia.

supply and demand; they also offer a cleaner alternative. From this perspective, renewable energy development is more than a strategic economic policy to uplift economic dynamism, in area in which the region has been trailing behind other developing regions, but is also a long-term plan to achieve sustainable growth and development.

Population growth in North Africa signals an impending increase in energy demand. According to U.S Census Bureau estimates, the total population in North Africa will increase by more than 25 million – from 167 million to 193 million – in this decade (between 2011 and 2022), and by another 24 million between 2020 and 2030. More strikingly is North Africa's relative young population where those aged under 15 account for approximately 30 percent of the total population, or 50 million today<sup>2</sup>. Estimations further suggest that this figure is to increase to about 55 million by 2020, but to reduce to 54 million by 2030. Overall the increase in this young age-group will directly increase the size of the working age population by almost 35 million between 2011 and 2030, and will most likely lead to the fast growth of the middle class. Homi and Gertz (2010) suggest that middle class in the MENA region will increase from 105 million in 2009 to 165 million in 2020, and to 234 million by 2030. In view of demographic changes in the North Africa, more energy supply is expected to be needed to meet increasing demand, which may exacerbate the depletion speed of the region's fossil reserves.

The electricity consumption of North Africa accounts for 1 percent of the world's total, or 220 TW<sup>3</sup>. Comparatively, its per capita electricity consumption varies between Egypt's 1,748 kW and Morocco's 826 kW. This shows that the region is not consuming energy excessively. However, lying beneath its low energy consumption is rapid growth. Between 2001 and 2011, per capita electricity consumption in North Africa grew by more than 50 percent, except in Tunisia, which is higher than the world's middle income economies' average. (See table 2.1)

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2 U.S. Census Bureau International Database.

3 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Electric power consumption (kWh), Year: 2011.

Table 2.1. Electricity consumption per capita: 2001 and 2011, kWh

	2001	2011	Growth, %
Algeria	694	1,091	57.21
Egypt	1,074	1,743	62.30
Morocco	527	826	56.87
Tunisia	1,048	1,297	23.74
North Africa*	836	1,239	48.30
Middle income economies*	1,374	1,869	44.55

Source: Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Electric power consumption (kWh per capita), Year 2001 and 2011.

Note: \* average

Rather than a reflection of improving socio-economic lives of the people, many literatures suggest that the growing and high electricity consumption in North Africa is partly induced by heavy state subsidy. According to the International Energy Agency (IEA), fossil fuel subsidies in Algeria and Egypt are approximately 50 percent and 54 percent respectively<sup>4</sup>. Pump prices are distortedly low in North Africa, where gasoline costs as little as USD 0.32 per litre and diesel USD 0.19 per litre. Apart from Morocco, the pump prices in the other North African economies are more than 10 percent lower than the world's middle income economies' average.

The catalyst between population growth, wealth and the perpetual subsidies is likely to exacerbate energy demand in North Africa in the years to come. Although growth in global demand increases revenue maximisation for net energy exporting economies like Algeria, and to a lesser extent Egypt and Tunisia, to accumulate foreign reserves. Morocco, which is already importing more than 90 percent of its energy consumption, will face a higher price for energy imports as global demand for energy outstrips supply, which will only add burden to its public budget reserves to meet the growing domestic demand.

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4 IEA's Fossil-fuel consumption subsidy rates as a proportion of the full cost of supply, 2011. Available at <http://www.iea.org/subsidy/index.html> (last assessed 01 February 2014).

Growing demand for energy is a geographically invariant challenge. Fossil fuel does not only deplete reserves, but a significant portion of energy production in fossil rich economies goes to domestic use instead of exporting it to generate more revenue. Maintaining high subsidies on fuels would only further burden the public budget of North African governments

Pollution caused by fossil fuel consumption has more recently been included in the equation to promote a more sustainable development. Even though only 1.20 percent of the world's greenhouse gas emission comes from North Africa, it has grown by 50 percent between 2001 and 2010, while the world's greenhouse gas emissions have only grown by 31 percent in the same time period<sup>5</sup>. North Africa's per capita greenhouse gas emission is neither the highest nor the lowest among the middle income economies, yet it has some of the highest growth, varying from 14 percent in Tunisia to 40 percent in Egypt between 2001 and 2010<sup>6</sup>. With respect to the average growth in per capita greenhouse gas emission in the middle income economies, North Africa's average is 10 percentage points higher<sup>7</sup>. According to the finding of Martínez and Ebenhack (2008), the correlation between energy consumption and human development (cited in FEMISE, 2011: 40) suggests that energy consumption is likely to increase as North African people become more affluent.

The risks and costs of energy imports have subjected Morocco to higher vulnerability to external supply and price speculation that would further burden its public budget. These risks and costs can be strategically minimised by internalising energy supply with renewable solar and wind energies which Morocco has in abundance. This will also allow Morocco to diversify from its overreliance on imported fossil fuels. It is not only Morocco that is dependent on fossil fuel; in fact, all North African economies are, particularly in Algeria which has an abundant supply of fossil resources. Meanwhile, approximately 20 percent of Tunisia's total energy consumption is imported. Although not of the same scale, it shows Tunisia has an inclining dependence as Morocco has for imported energy, which can be addressed in similar strategies to internalise energy supply with renewable solar and wind energies. Egypt remains a net energy exporter, but is already facing the highest pressure from growing domestic demand for energy. It has much smaller fossil reserves than Algeria that will erode faster, and may soon resort to imports, facing the same problem that Morocco is already confronted with.

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5 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: CO2 emissions (kt), Year: 2001 and 2010.

6 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: CO2 emissions (metric tons per capita), Year: 2001 and 2010.

7 Ibid.

Despite the region's abundance of solar and wind energies, only a limited part of these resources has been tapped so far. The number of renewable energy development projects has been increasing over the past decade, but only 1 percent of North Africa's electricity production is generated from renewable sources, and it ranges from zero percent in Algeria to near 3 percent in Morocco<sup>8</sup>.

The development of the under-exploited renewable energy industries, on the one hand, fits into the strategy of the internalisation of energy supply, while on the other hand, creates jobs in unemployment-ridden North Africa. The spillover from renewable energy development is expected to provide the impetus to create a forward and backward linkage between different industries to develop a supply-chain network to support renewable energy production. A World Bank study (2011) projects 180,000 jobs to be created by 2025 in the local Concentrated Solar Panel (CSP) sector in the Middle East and North Africa (MENA) region. A FEMISE report (2012) estimates an accumulated 482,000 jobs to be created in the solar energy sector by 2040 in Morocco alone. Tunisia's PROSOL programme has already created 7,000 jobs since its launch in 2005 (REN21, 2013: 34).

The other dimension in which North African economies could benefit from the development of renewable energy industries is the prospect of tapping European Union (EU) markets with its renewable energy supply and the related-manufactured products, in an attempt to bridge to the gap to achieve the EU's energy targets<sup>9</sup>. Its exports to EU will not only strengthen Euro-Mediterranean economic relations, but also act as a stepping stone to greater global economic integration, and a strategy to create jobs through external demand.

North Africa has the comparative geographic advantage to extract an abundance of solar and wind energies. Tapping renewable energy sources will allow North Africa to maintain the position of an energy supplying region. The role of supply energy also doubles as a geopolitical tool for North Africa to balance negotiation power to broker better terms.

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8 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Electricity production from renewable sources, excluding hydroelectric (kWh) and Electricity production (kWh), Year: 2011.

9 According to a 2010 publication of an European Commission communique on energy policy "Energy 2010 - A Strategy for Competitive, Sustainable and Secure Energy" sets a target for European Union (EU) member states to reduce greenhouse gas by 20 percent, to increase renewable energies' share in the mix by 20 percent, and to improve energy efficiency by 20 percent, by 2020. These objectives can be achieved through cooperation with a third country.



In short, renewable energy can play multiple strategic roles to address the multifaceted socio-economic and political challenges North Africa faces.

### 3. Facilitating factors of renewable energy development in North Africa

North African policymakers have been quick to recognise the strategic role of renewable solar and wind energies as the notion of sustainable development gathers pace. Since the 1980s, they have been swift in establishing public institutions to provide different mechanisms to promote renewable energy development across North Africa, and creating frameworks to administer the progress. (See table 3.1) It has not only gathered national interests, but also support from the international sphere. Active support comes from the United States and European governments, and international energy agencies, the United Nations, the African Development Bank, the World Bank, and the EU financial institutions. Industrial consortiums such as the German's Desertec Industrial Initiative (DII) and French's MEDgrid are some active private actors in the renewable energy projects in North Africa.

Table 3.1. Selected (semi-)public institutions for renewable energy development

Year	Institutions	Country
1982	Centre de Développement des Energies Renouvelables	Morocco
1985	Agence Nationale des Energies Renouvelables	Tunisia
1985	National Agency for Promotion and Rationalisation of Energy Use	Algeria
1986	New and Renewable Energy Authority	Egypt
1987	L'Association Marocaine des Industries Solaires et Eoliennes	Morocco
1988	Centre de Développement des Energies Renouvelables	Algeria
1996	Centre International de Technologies de l'Environnement de Tunis	Tunisia
2000	Centre d'Information sur l'Energie Durable et l'Environnement	Morocco
2002	New Energy Algeria	Algeria
2002	The National Energy Efficiency Fund of Algeria	Algeria
2009	Moroccan Solar Energy Agency	Morocco
2010	National Agency for the Promotion of Renewable Energy and Energy Conversion	Morocco
2010	Moroccan Agency for Solar Energy	Morocco
-	Agency for the Development of Renewable Energy and Energy Efficiency	Morocco

Source: Author's compilation from various sources.

North African governments have not only set targets to increase the share of renewable energy in the energy mix, but also implemented policies to promote its development. (See table 3.2) Many of the policies facilitating renewable energy development focus on attracting investment.

Table 3.2. Renewable energy targets

Country	Electricity generation	Installed capacity
Algeria	6 percent by 2015 15 percent by 2020 40 percent by 2030	
Egypt	20 percent by 2020	
Morocco		42 percent by 2020
Tunisia	11 percent 2016 25 percent 2030	16 percent by 2016 40 percent by 2030

Source: REN21's 2013 MENA Renewables Status Report.

To date, only Algeria has a feed-in-tariff programme in place. While similar programmes are still in discussion, Egypt has implemented its net-metering programme. Instead of a feed-in-tariff programme, Tunisia took to net-metering. Morocco has neither of these programmes. Egypt and Tunisia are also more active in promoting private investments in renewable energy sector by offering capital subsidies, and tax reductions. Public financing remains the most popular form of investment in renewable energy projects in North Africa. While Algeria and Morocco favour public competitive bidding to finance their projects, Tunisia took to public investments, and Egypt took the hybrid of the two forms.

The objective to develop the renewable energy sector to promote job creation can only be meaningful if the project involves a significant share of local participation. That is, in the perspective of renewable energy development in North Africa, the region needs to have a labour force that is adequately qualified to fill the jobs. North African governments have invested heavily on facilitating technological education and training. Tunisia has constructed five technology parks. Of the five, Technopark of Borj Cedria has a focus on renewable energy<sup>10</sup>. Egypt has established three science parks including the Sinai

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10 UNESCO. Available at <http://www.unesco.org/new/en/natural-sciences/science-technology/university-industry-partnerships/science-parks-around-the-world/science-parks-in-middle-east/> (last accessed 12 December 2013)

Technology Valley where renewable energy is a faculty<sup>11</sup>. Morocco has also constructed three science parks, although, to date, none of them has focused on renewable energy<sup>12</sup>, the government has included the construction of a new knowledge campus in Oujda located near its border with Algeria as part of its US\$3.2 billion five-year renewable energy investment plan between 2009 and 2014 (Sawahel, 2008). Algeria currently has five science parks, as yet renewable energy remains outside the focus<sup>13</sup>. These investments, however, are rather an effort to counter the lack of research and development (R&D) capacity needed for production at the higher spectrum of the value-chain network, and to increase the share of local contents.

North Africa's public spending on education has also expanded. The average public spending on education in North African economies is approximately 20 percent of total government expenditure, or equivalent to about 5 percent of GDP<sup>14</sup>. The government's emphasis on education is the strongest in Morocco where 25 percent of its public expenditure went to education and is the weakest in Egypt where education spending is only 12 percent. Based on the latest available data, North African governments spent approximately USD 19.5 billion on education<sup>15</sup>. The highest expansion in public expenditure on education has grown at an annualised rate of between 5 percent for Algeria and Morocco and 10 percent for Tunisia in the last decade<sup>16</sup>. Total investment in R&D in the region has also expanded, from USD 684 million at the beginning of 2000s to USD 2.23 billion by the end of the decade<sup>17</sup>. All except Algeria's expenditure on R&D has grown, at an annualised rate between 47 percent in Egypt and 18 percent in Morocco<sup>18</sup>. With this, the number of researchers in North Africa has also grown by approximately 35

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11 Ibid.

12 Ibid.

13 Ibid.

14 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Public spending on education, total (% of government expenditure) and Public spending on education, total (% of GDP), Year: 2008.

15 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: GDP (current US\$) and Public spending on education, total (% of GDP), Year: 2008 (Algeria and Egypt), 2009 (Morocco) and 2010 (Tunisia).

16 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: GDP (current US\$) and Public spending on education, total (% of GDP), Year: various years on availability. Annualised growth in public expenditure on education in Algeria is based on data of year 1980 and 2008, Egypt's 2003 and 2008, Morocco's 2001 and 2009, and Tunisia's 2001 and 2010.

17 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: GDP (current US\$) and Research and development expenditure (% of GDP), Year: 2001, 2004, 2005, 2009, 2010 and 2011.

18 Ibid. Annualised growth in R&D expenditure in Algeria is based on data of year 2001 and 2005, Egypt's 2004 and 2011, Morocco's 2001 and 2010, and Tunisia's 2001 and 2009.

percent in the same period<sup>19</sup>.

North African economies each have sizable manufacturing industries that are enough to support the scale of petty components production at the lower spectrum of the value-chain network. Approximately 30 percent of North African industrial sector is manufacturing based, with shares varying between 7 percent in Algeria and 56 percent in Tunisia. The World Bank (2011) had also identified Egypt and Algeria to possess the capacity to produce petty components related to renewable energy production.

North Africa's labour force size is approximately 53 million,<sup>20</sup> with between 20 to 40 percent of them equipped with a minimum secondary school education<sup>21</sup>, and with the proportion increasing, is probably big enough be able to fill the gap between the supply and demand for labour in the manufacturing sector.

Many facilitating factors of renewable energy development in North Africa come from the input of the governments to promote the projects. Although the manufacturing sector in North Africa is mostly made up of the labour intensive production of low value added goods, it provides the base for developing renewable energy projects to produce petty components.

#### 4. Constraining factors of renewable energy development in North Africa

Many constraining factors of renewable energy development in North Africa are associated with institutional deficiencies that often have a direct impact on investment in renewable energy projects. In 2012, approximately 5 percent of the world's new investment in renewable energy projects went to the MENA region, or USD 11.5 billion (REN21, 2013a: 58-59). Compared with the 1.5 percent share the region received in 2004, it is a 3 percentage point increase that is equivalent to USD 11 billion growth. However, in recent years, Morocco was the only North African economy that has been receiving new investments in renewable energy between 2009 and 2012 (REN21, 2013b: 27). By 2012, Morocco's

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19 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Researchers in R&D (per million people), Year: 2005 (Algeria), 2007 and 2009 (Egypt), 2006 and 2008 (Morocco), 2001 and 2008 (Tunisia).

20 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Labor force, total, Year: 2010.

21 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Labor force with secondary education (% of total) and Labor force with tertiary education (% of total), Year: 1997 (Tunisia), 2004 (Algeria) and 2011 (Morocco). Data for Egypt not available.

accumulated new investment in renewable energy projects amounted to approximately USD 2.2 billion, and Morocco remains the most attractive destination for renewable energy projects in the region. Tunisia last saw investment in renewable energy projects in 2009 of USD 57 million, Egypt's was in 2010 of USD 923 million, and Algeria's in 2011 of USD 33 million.

The meagre investment in renewable energy projects in North Africa is in many ways directly influenced by how the region is perceived as an investment destination. In The World Bank's Doing Business Ranking 2012, North African economies' rankings range between 51 for Tunisia to 153 for Algeria out of 189 economies. Using the bench of the 95th position in the rankings to differentiate favourable and unfavourable, 9 out of 10 areas are ranked unfavourable in Algeria, 8 in Egypt, 4 in Morocco and 3 in Tunisia. The most common unfavourable areas found in North African economies are registering property, dealing with construction permits, getting credits, protecting investors and getting electricity, respectively.

Within region comparison shows that, despite having a less favourable business environment, Morocco received the largest investment in renewable energy projects per capita at USD 68, which is more than 6 times higher than Egypt's USD 11, 12 times higher than Tunisia's USD 5, and is comparable to China's USD 73<sup>22</sup>. Despite having more policies implemented than Morocco, Tunisia receives less investment in renewable energy projects. This gap suggests that the Doing Business Ranking may have failed to capture the impact of social unrest on the Tunisian business environment since it does not measure factors associated directly with the political dimension. Likewise for Egypt, the fluidity of the current socio-political situation is likely to heighten the risk of further investment in the country. The bloated natural resource rents that the Algerian government continues to receive could have left them less enthusiastic and forthcoming with renewable energy projects. The attack on the oil field in In Amenas in January 2013 is also a likely factor of the worsening investment climate in Algeria.

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22 Author's own calculations, The World Bank's Global Development and Financial Indicators, Series: Population, total, Year: 2012, REN21 (2013a), Figure 22. Global New Investment in Renewable Energy by Region, 2004-2012, and REN21 (2013b), Table 12. New Investment in Renewable Energy by Country, 2009-2012 (Million USD).

Table 4.1. Doing Business Ranking, 2013

Areas ↓ / Economy →	Algeria	Egypt	Morocco	Tunisia	Average
<b>Ease of Doing Business</b>	<b>153</b>	<b>128</b>	<b>87</b>	<b>51</b>	<b>105</b>
Starting a business	164	50	39	70	81
Dealing with construction permits	157	149	83	122	125
Getting electricity	148	105	97	55	101
Registering property	176	105	156	72	127
Getting credit	138	86	109	109	109
Protecting investors	98	147	115	52	103
Paying taxes	174	148	78	60	115
Trading across borders	133	83	37	31	71
Enforcing contracts	129	156	83	78	112
Resolving insolvency	60	146	69	39	79
N° of areas rank > 95th	9	7	4	3	7

Source: Author's own elaboration, The World Bank.

Komendantova et. al. (2012) reveal in a survey conducted in 2008 that CSP investors in North Africa ranked the complexity and corruption of bureaucratic procedures as the greatest concern among the five areas. Regulation instability was second, then absence of guarantees, political instability and lack of government support, respectively. However, it is worth highlighting that the perception of low risk of political instability among investors is probably because the survey was conducted during a relatively peaceful period before social uprising broke out across the region, and during a time corruption was the main focus of institutional deficiency in the region.

Private consulting firm Ernst & Young has published a quarterly Renewable Energy Country Attractiveness Index since 2003, and evaluates and ranks the 40 most attractive countries for investment in renewable energy. In the May 2013 edition, it cites that because of the ensuing socio-political

instability in Egypt and Tunisia, they were dropped from the ranking, highlighting unclear policy as the main cause, and left Morocco the only North African economy on the list<sup>23</sup>. Morocco is ranked 32 with its greatest strength in the solar and wind energy sector, and also scored well in giving priority to renewable energy development. Its shortcomings are basically related to the poor financial market to support the renewable energy projects, while economic and political stability and business environment are less problematic but still remain a concern with respect to other countries' economies in the ranking. Institutional deficiency has long plagued North Africa even during the period of high economic growth, but this is not the only problem the region continue to battle to improve investments.

An area that has caused concerns among investors in North Africa is the difficulty of finding adequately qualified labour. In an Executive Opinion Survey conducted by the World Economic Forum in the compilation of the Global Competitiveness Index 2009-2010, between 7.6 percent of the respondents in Algeria and 10 percent in Egypt expressed an inadequately educated workforce as one of the five most problematic areas in doing business in North Africa. The gap between pay and productivity in North African economies are unfavourable with rates between the lowest of 2.95 in Algeria to the highest of 4.02 in Tunisia, given the rating scale of 1 the worst and 7 the best<sup>24</sup>. These problems continue to plague North African economies despite efforts to increase investments in education and R&D, and the constructions of science and technology parks.

The inadequate qualification of the North African labour force is beyond the level of education. It is undermined by the quality of education and the faculty preference. With respect to overall quality of education, Tunisia is the only North African economy that has a favourable quality<sup>25</sup>. Specifically on quality of mathematics and science education, a focus closely related to technology intensive industries,

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23 The Ernst & Young's Renewable Energy Country Attractiveness Index is a composite of three drivers: macro drivers, energy market, and technology-specific. Macro drivers is measured by macro stability (economic and political stability) and the ease of doing business (investment climate). Energy drivers is measured by the degree of prioritization of renewables (energy supply and demand, level of political support, competitiveness of renewables, and the importance of decarbonization) and bankability of renewables (cost and availability of finance, power infrastructure and ability to connect renewable energy, energy market accessibility, and liquidity of transactions market=). Technology-specific drivers is measured by projects attractiveness for each technology i.e. solar and wind ( strength of natural resources, power offtake attractiveness, technology maturity, technology growth profile, and strength of local supply chain).

24 Using the benchmark of 4.5 of the rating scale between 1 the worst and 7 the best to differentiate unfavourable and favourable.

25 World Economic Forum's Global Competitive Index 2009-2010, Series: 5.B. Quality of education.

Tunisia scored 5.53, while Algeria and Morocco scored under 4 and Egypt under 3<sup>26</sup>.

Promoting engineering and natural science in tertiary education is elementary to producing a labour force of matching qualification to increase the share of local content to support renewable energy projects. North African education institutions may be producing more tertiary graduates, the proportion of them specialised in science, engineering, and technical studies (SET) is still inferior to that of other faculties. Around 25 percent of tertiary graduates in Algeria, 35 percent in Morocco, and 42 percent in Tunisia are trained in SET. Humanities, arts and social sciences (HAS) is still far more popular among tertiary students, particularly those in Algeria where it produced 30 percent more graduates than SET, 13 percent in Morocco, but only 1 percent more in Tunisia<sup>27</sup>. In Egypt, the gap is more 50 percent (The World Bank, 2011: 21)<sup>28</sup>. Approximately 10 percent of tertiary students enrolled in SET and 76 percent in HAS.

North African graduates' preference for HAS suggests their desire to join the public sector because of the above-market wage rate, job security and benefits that come along with it (Hong et al., 2010: 59). Although the public sector has systematically shrunk since North African economies began to adopt neoliberal economic reforms in the 1970s and 1980s, the aspiration and desire to work for the government has not dampened significantly among job seekers. A survey conducted by Silatech, in collaboration with Gallup Inc. (2010) revealed that between 30 percent and 60 percent of youth respondents aged between 15 and 29 expressed a preference to work for the government<sup>29</sup>. The magnitude of these problems will only be reinforced by the poor business environment that is preventing the private sector from flourishing, and the highly bureaucratic-oriented public sector in North Africa only encourages more students to enroll in HAS rather than SET.

The lack of SET expertise in the labour force to support technology intensive renewable energy projects means that North African economies need to depend on foreign technology and components. The focus on and promotion of SET is therefore important for the economies to absorb foreign expertise and

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26 World Economic Forum's Global Competitive Index 2009-2010, Series: 5.04 Quality of math and science education.

27 Author's own calculations, UNESCO Institute for Statistics, Data Centre, Series: Distribution of tertiary graduates by programmes, Year: 2009 (Morocco), 2011 (Algeria) and 2012 (Tunisia).

28 Table 1.8 Distribution of University Students by Field of Study. Year: 1995 (Egypt).

29 42 percent of youths interviewed in Algeria said they prefer working for the government, 59 percent in Egypt, 39 percent in Morocco and 56 percent in Tunisia.



to catch up to support and increase the local content in renewable energy development in the long-run.

## 5. Discussion

North African economies' strengths to develop renewable energy industry mainly lie in natural resource endowment and state financial and strategic support, but institutional deficiencies have thwarted the progress of renewable energy. Heavy bureaucracy and corruption have marred the investment environment and prevented the private sector from flourishing. Institutional inefficiency, has in part been a result of nationalistic and inward-looking post-independence policies with the objective of consolidating power and capacity building, with which North Africa has been grappling to counter for decades.

Despite economic liberalisation since the 1970s, reforms to shrink the public sector have not discouraged the North African people from wanting to work as civil servants because of the job security, high wage and generous social benefits that come with it. The contraction of public sector was not matched by the magnitude at which private sector was expanding. As a result the private sector lacked the capacity to absorb the fallout from the shrinking public sector. Inefficiency has been one of the reasons that the privatisation of public companies in North Africa has achieved limited success. On the other hand, policymakers in North Africa have failed in institutional reforms to provide a comprehensive framework within which private enterprises could operate and compete fairly. For some of these reasons, most renewable energy projects in North Africa are funded by the state.

Likely because of the gap created by economic liberalisation and the view of most job seekers that the public sector still provides better job prospects than the private sector, many of them are willing to wait over a prolonged period until a vacancy becomes available, even in times of public sector contraction. The longer the gap persists, the preference to work for the government among the people will only manifest if the private sector does not progress, and all the more resources are needed to provide incentives to change the public perception and attitude to embrace reforms.

Increasing investment in education and constructing science parks is not enough to create wider interests in SET at tertiary institutions because preference is often shaped by perception and attitude. The renewable energy sector can still flourish with foreign expertise, but it will defeat the purpose of the effort to develop the renewable energy sector to create socioeconomic dynamism to counter the inequality that

the people have been suffering for decades. Renewable energy development can only maximise socioeconomic gains if it has wider reach on the local level. SET expertise is not only required for renewable energy development, but rather a skill that is associated with high productivity and of economic value necessary for industrialisation programmes.

Although the preference to work for the government in North Africa remains strong, the majority of North African youths, who are likely to be the main beneficiary group, would participate in regular training to increase the chance of getting a job or a better one, and to be retrained in a different career field<sup>30</sup>. That is, putting renewable energy development in perspective, subscribing to continuously learning is an important attitude in catching-up North African economies to absorb foreign technologies and know-how. The survey also reveals their flexibility to switch career fields and that the favourable perception of the progression of the renewable energy sector would encourage people formerly trained in non-SET fields to join the sector. Career switching in fields, on the other hand, if viewed in economic terms which disregards to social choice and well-being, creates a situation of unproductive investment in time and education. Yet, such cost is necessary in economies under restructuring.

The unfavourable opinion of the public of the government's effort to create quality jobs among the young is that it is counterproductive because it acts as a discouragement for them to pursue higher education qualification or skill upgrading, which in view of technology intensive renewable energy industry is an obstruction to the progress of the sector<sup>31</sup>.

The other challenge North Africa policy makers face is the conciliation between meeting long-term goals and short-term demands from the people. A socio-political situation that is particularly fluid in North Africa is that even short-term adverse effects of institutional and policy change are likely to create more social chaos and hinder any renewable energy projects, and delays will dampen the private investors' interest in financing these projects. Without private investment, the state will have to spend more on renewable energy projects, and less will be left for other development projects that are needed to address the short-term needs of the people.

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30 Silatech and Gallup Inc. (2010), Series: Taking part in regular job training increases chances of getting a job or a better one, and Willing to re-train in a different career field.

31 Silatech and Gallup Inc. (2010), Series: Satisfaction with efforts to increase the number quality jobs.



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