Topics in Middle Eastern and African Economies
Proceedings of Middle East Economic Association
Vol. 20, Issue No. 2, September 2018

Decoupling Economic Growth and CO_2 Emissions in the MENA: Can It Really Happen?

Nathalie HILMI
Centre Scientifique de Monaco, Monaco

Sevil ACAR
Altınbaş University, Istanbul, Turkey

Alain SAFA
Skilpartners, France

Geoffroy BONNEMAISON
EDHEC Business School, France

Abstract:

Our aim is to study the interrelationship between CO_2 emissions and gross domestic product (GDP) trends in selected MENA countries in order to detect whether environmental pressure has decoupled from economic growth in the region.

Several MENA countries have become less carbon intensive along their growth paths due to different reasons. Some have been trying to switch their energy systems away from fossil fuels and some use less energy per unit of economic activity. Services sectors, which are less energy-intensive, are on the rise, whereas industrial sectors are shrinking. This study seeks to answer whether this is a general phenomenon observed in the MENA, and examines the impact of these factors on the possible existence or lack of such decoupling in a panel data setting.

In regards to the ways that give rise to possible decoupling, technological changes enable countries to economize on energy use, especially when the prices of energy increase in oil/gas importing economies. The role of the private sector is also crucial to drive decoupling of CO_2 emissions and economic growth. This paper intends to propose possible policy options for the region including public policies that encourage renewable energy and discourage subsidizing fossil fuels.

Keywords: decoupling, energy efficiency, fossil fuels, renewable energy, MENA

JEL Codes: Q35, F20, E60

1. Introduction: Economic Development and the Importance of Decoupling Economic Growth from Environmental Pressure

Historically it has been observed that economic growth brings higher environmental degradation and natural resource use. A wide range of literature confirms that increased output across the world has been attained at the expense of the environment (e.g. Lenzen et al., 2012). Climate change and global warming are among the most recent and notable impacts of economic activity that our generation faces.

Hence more recent research focuses on the possible channels of decoupling economic development from environmental degradation, and more specifically, from greenhouse gas emissions. We depart from a motivation that was expressed by Ward et al. (2016) as follows: "If such decoupling is possible, it means that GDP growth is a sustainable societal goal." If not, growth itself will not be sufficient to generate societal well-being. Countries will have to seek alternative ways of increasing social welfare.

On the other hand, Ward et al. (2016) also argue that decoupling might be a delusion due to three effects: substitution, financialisation, and cost-shifting. Fossil fuels are to be substituted with renewable energy; however, such a substitution will not free economies of their resource dependence. This, instead, will imply that we will need to produce increasing numbers of solar panels or wind turbines, bioenergy plantations or hydropower stations, which all require material and land (Ward et al., 2016). Besides, the authors propose that efficiency gains will not promise for endless economic growth either, as it will reach to its limits as economic activity necessitates some energy and/or materials. The authors put forward that growth-oriented policies are not panacea to environmental problems; hence, they need to be replaced by more adequate social welfare and human development indicators.

In this paper, we investigate whether economic growth in the MENA could be decoupled from environmental pressure in terms of CO_2 emissions. Besides, we would like to detect the factors that may preclude or lead to such decoupling in the region. The MENA region is comprised of a mix of various types of economies, with different endowments in fuels (coal, oil, or gas) and at different technological states. We intend to analyze how emissions behave considering the fact that these countries show variability in their energy use, renewables development, sectorial composition and population patterns. Accordingly, Section 2 outlines the major environmental changes in the region. Section 3 identifies the energy situation and related policies in relation to fossil fuels. Section 4 undertakes an econometric analysis of the region's CO_2 per capita levels as compared to GDP per capita, while considering other factors as well. Finally, Section 5 concludes and exemplifies several regional and international cooperation options that could help the region transform itself towards a low-carbon economy.

2. Environmental Patterns in the MENA along with Economic Growth

2.1. CO_2 Emissions versus Economic Growth

For the past 10 years, measures have shown a steady increase in the CO_2 emissions of the MENA countries. In addition to this increase, GDP of the entire region has been multiplied by more than 7.5, from 200 billion in 1993 to around 1,500 billion in 2014.

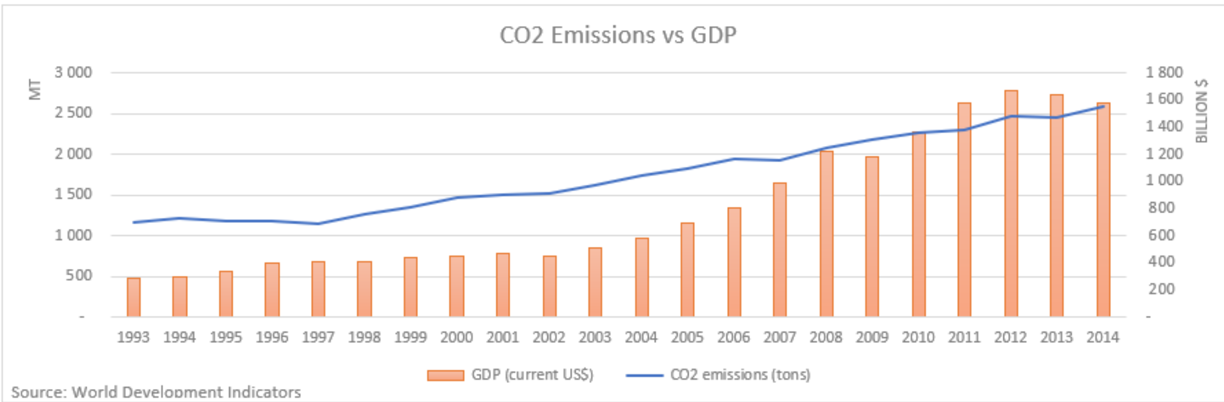


Figure 1: CO_2 and Other Greenhouse Gas Emissions versus Economic Growth

Figure 1 does not hint any signs of decoupling of GDP and emissions in the MENA as they both climb up between 1993 and 2014. Figure 2 displays the growth rates of GDP and emissions, which reveals two distinct patterns in different periods. Until the year 2000, emissions growth and GDP growth follow different directions. A similar pattern is observed in 2003-2006 and 2008-2011 respectively. These trends seem to be in line with recent decoupling expectations. However, there a few years in which emissions growth closely followed GDP growth (positively or negatively). Apparently, these figures do not provide enough evidence to conclude that decoupling is the norm in the MENA. Hence, we perform an econometric analysis to solve the puzzle in Section 4.

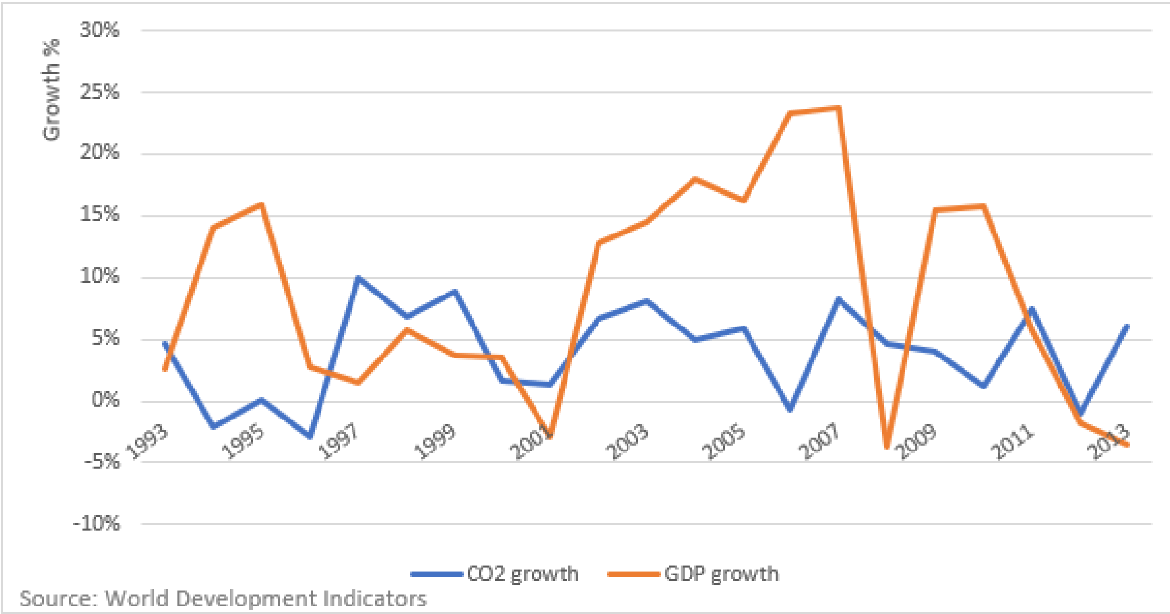


Figure 2: CO_2 Growth versus GDP Growth

2.2. Warming and Extreme Temperatures

The MENA region is a particularly vulnerable place to climate change and global warming. The region is already facing very hot temperatures, and a consequent increase in extreme weather events is a result of climate change. Over the past three decades, a general upward trend of temperatures and a downward trend in the precipitation amounts have been observed. However, due to a lack of quality in meteorological data and measurement stations, a precise evaluation of the magnitude of these moves is complicated to express (Tanarhte et al, 2012). The MENA region experienced an increase of 0.2°C per decade from 1961 to 1990 (World Bank, 2014). In some places, the impact of global warming is expected to double. For instance, on the Mediterranean coast, especially in Algeria, experts' predictions are pessimistic. They forecast in the medium term: an increase in temperature of 2°C, a decrease in rainfall of 10 to 15%, and a rise in the frequency and the intensity of droughts (Sahnoune et al, 2013) Similar places in Saudi Arabia and Iraq could suffer from the same consequences (World Bank, 2014). On average, in the MENA region, the maximum temperature today is around 43°Cbut by 2050, it could reach 46°C, and by the end of the century, 50°C according to the results of the World Climate Research Program experimental protocol RCP8.5. Of course, the elevation of the extreme temperatures will have ecological consequences as well as economic ones.

2.3. Aridity and Drought

As a result of the increase in the average temperatures, most of the countries of the region are likely to receive less rain. Countries on the Mediterranean shore and specifically Algeria, Morocco and Egypt could be affected by this (World Bank, 2014). However, this could impact very differently the southern part of the region, especially countries like Oman and Yemen, which encounter higher moisture and rain, as they remain under the influence of the inter-tropical climate. That would therefore divide the MENA region into two separate zones, one facing drier climate, and the other facing more intense and powerful precipitation conditions.

Consequently, less precipitation might impact the aridity of the region. Changes in the aridity are mainly driven by changes in precipitation. Countries on the Mediterranean shore would be impacted, and aridity might severely increase in these regions. Some research predicts that the number of drought days will expand in the next century. This increase was even quantified claiming that 50 percent of droughts (in terms of days) will be experienced around the Mediterranean shore (Prudhomme et al., 2013).

3. Energy-related Challenges in MENA

3.1. Fossil Fuel Energy and Energy Intensive Industries

With the enormous generosity of its lands, the MENA region possesses huge amounts of fossil fuel resources. Therefore, the region is one of the biggest energy producers thanks to oil and gas production. According to the International Energy Agency, the MENA region has one of the highest energy self-sufficiency ratios in the world. Energy production is 2.5 times as large as the entire demand in the region. Energy supply is mainly derived from the expansion and the development of fossil fuel extraction and production systems. Some of the countries of the region are the largest oil producers in the world, such as Saudi Arabia and UAE, which respectively produce more than 600 and 300 million tonnes of oil equivalent (mtoe) per year (Figures 3 and 3 bis).

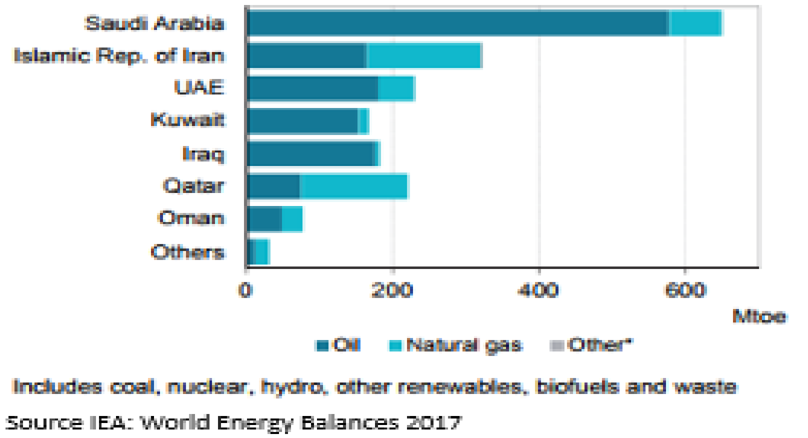


Figure 3: Energy Production from Different Resources (in *mtoe*)

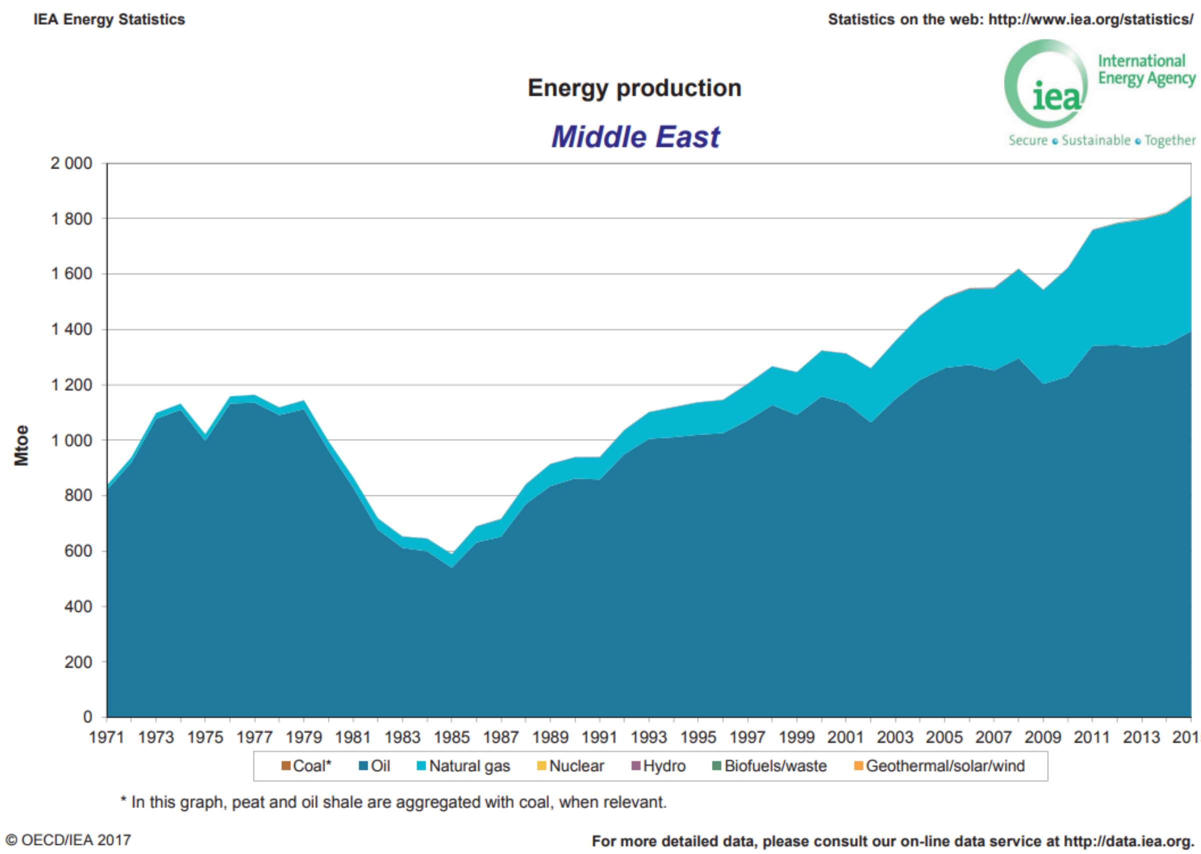


Figure 3 bis: Energy Production from Different Resources (in *mtoe*)

Therefore, as a result of this wealth, most of the investment efforts of the past decades were made towards the fossil fuel industry, at the expense of alternative sources of energy like renewable energies. That is why a huge part of the energy production of the region comes from gas and oil production. The share of renewable energy in the region's total energy production in 2015 remains extremely low, less than 1% for the entire region, while oil represents 52% and natural gas up to 47% according to International Energy Agency (IEA) statistics. Similarly, the share of fossil fuel energy consumption over total consumption reached over 97% by 2013 (Figures 4 and 4 bis).

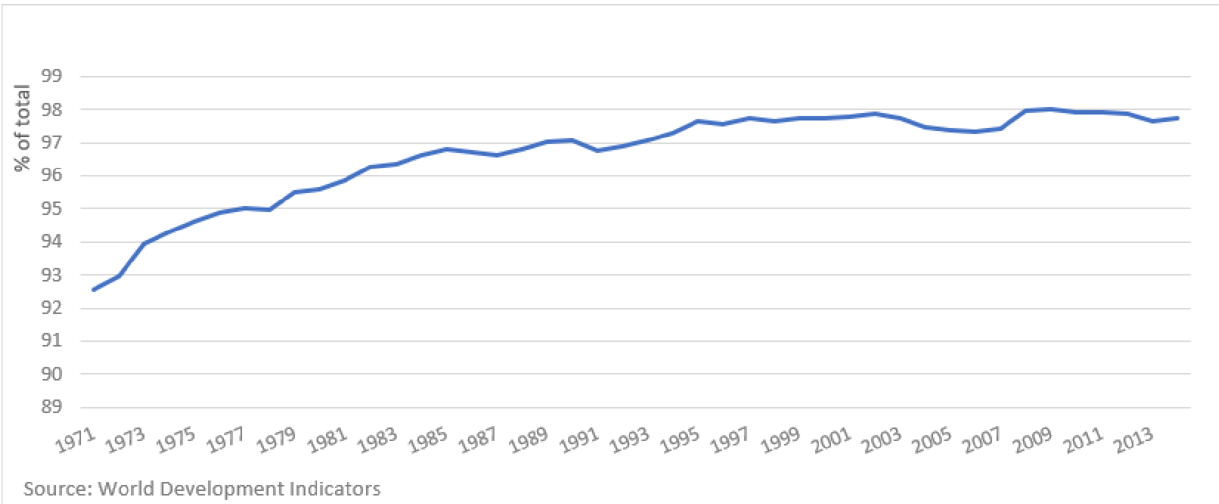


Figure 4: Fossil Fuel Energy Consumption (% of Total)

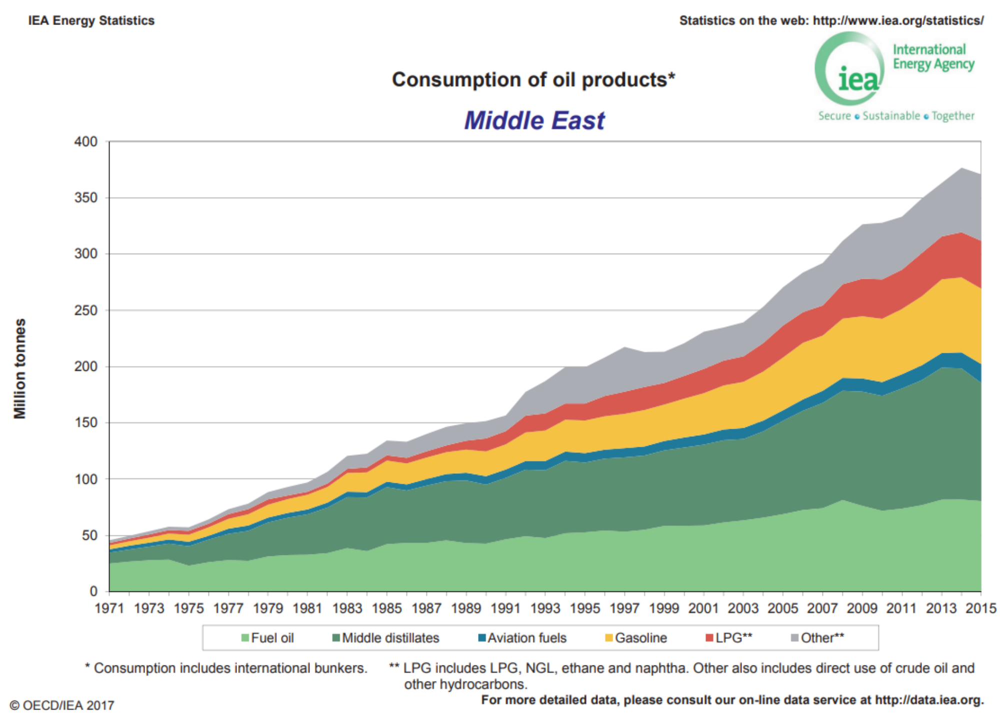


Figure 4 bis: Oil Products Consumption (Million tonnes)

In Figure 5, we can see that oil and gas shares are very important for electricity generation, compared to other sources.

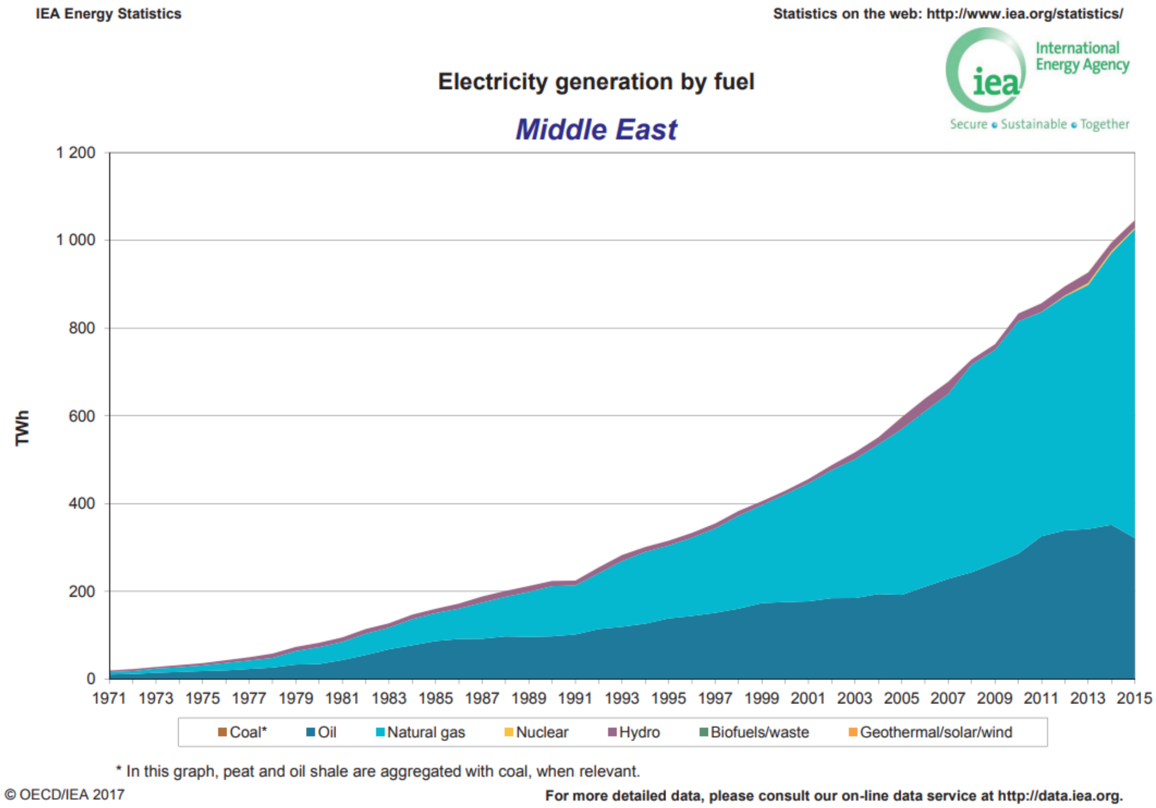


Figure 5: Electricity Generation by Fuel

Indeed, as we can see in Figure 5 bis, the MENA region remains way behind the OECD average in terms of energy production from renewable resources for the past 25 years. Only 0.4% of their total energy production comes from renewable sources (excluding hydro-power) compared to the 9.1% in the OECD members in 2014 according to the World Development Indicators. The region faces a serious delay in the development and the use of these energies, as a consequence of the super development of their fossil fuel extraction structures.

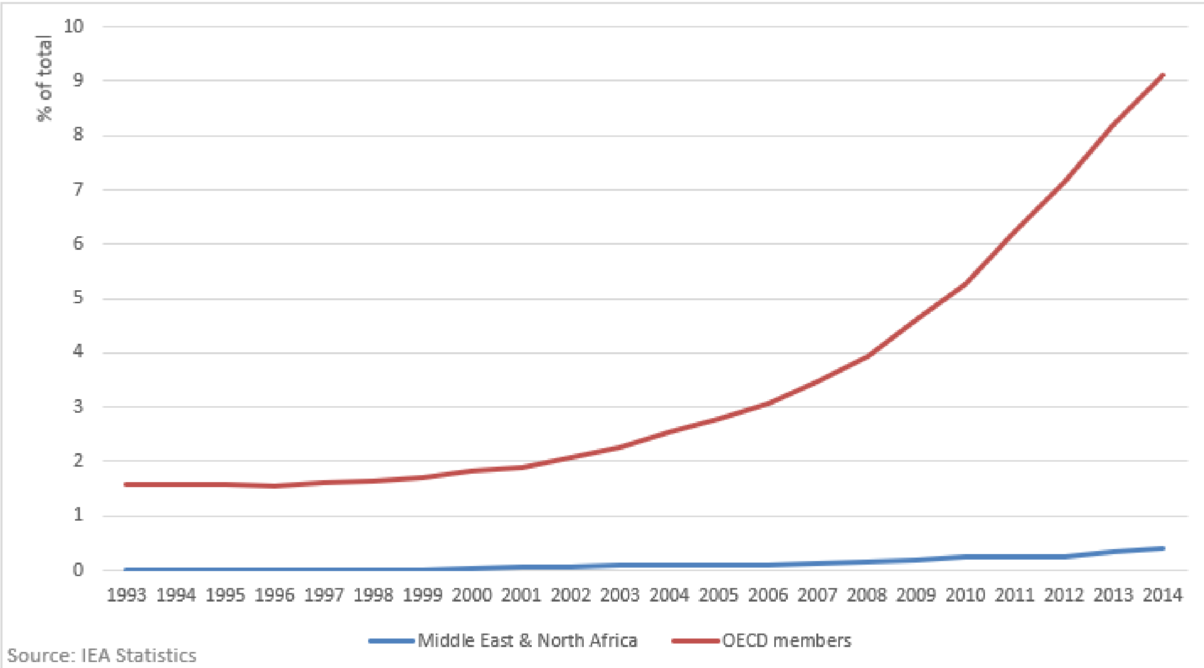


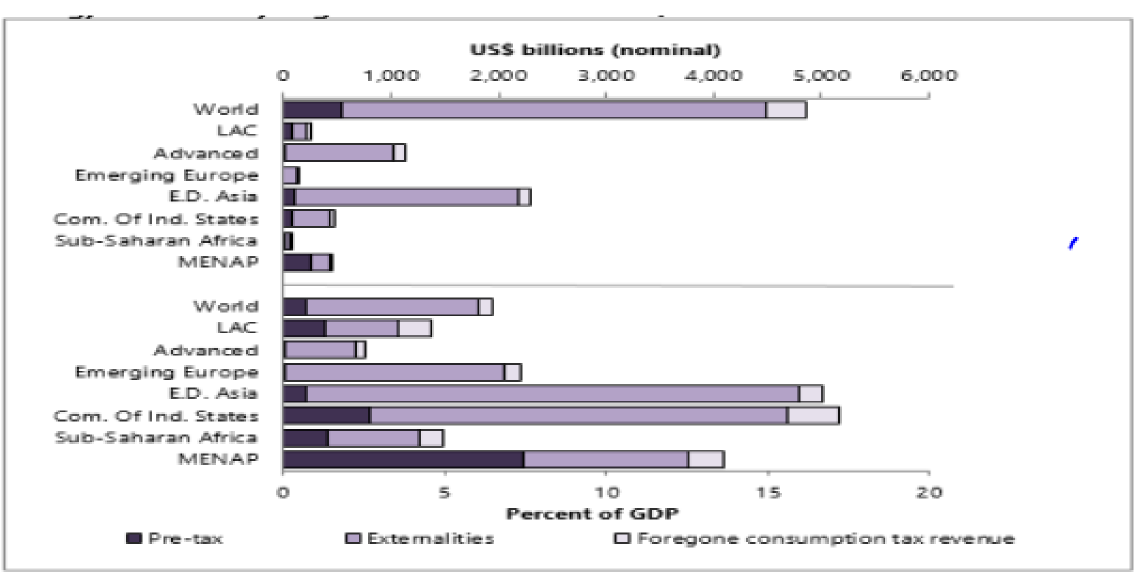
Figure 5 bis: Electricity Production from Renewable Sources (Excluding Hydro-electricity)

Most of the energy production of the MENA region is used by the industry sector according to the International Energy Agency. More than 50% of the total final consumption of energy is made by the industry sector in the region while only 17% is used by the residential sector. This fortifies the importance given to the extractive industries in the region, as this industry is energy-intensive. This phenomenon can be partially understood by the economic systems of the region, and the desired development of energy-consuming industries as the basis of the region's economy.

3.2. Low Energy Prices and Generous Fossil Fuel Subsidies

Thanks to their resources, most of the countries of the MENA region have favored a very energy generous system for their societies. Governments across the region have all supported low energy prices through lavish subsidies to keep the end-prices very low. This political decision affected not only the energy producer countries but also those that are net energy importers which use this strategy to provide social protection and stability. Having cheap access to energy resources is usually an incentive to consume and use more energy, and alters energy efficiency by sustaining comfortable lifestyles especially in the Gulf monarchies (Krane, 2014).

According to the International Monetary Fund (IMF) estimates, pre-tax energy subsidies in the region amounted up to $237 billion in 2011, which was then equivalent to 48 percent of world subsidies, 8.6 percent of regional GDP, and even 22 percent of total government revenues in the region (Figure 6). Therefore, for instance, in Abu-Dhabi, the citizens benefit from the government's generation subsidies that allow facilities to only pay $0.02 or less per kWh of electricity (which represents one fifth of the price in the United States (Kumetat, 2015). Although the electrification rate is not equal across the countries in the region, with 21.7 million people still lacking access to electricity, it still amounts to 94.3 per cent of the population in the whole region according to the IEA Electricity Access Database. The majority of the population therefore benefits from cheap and easy access to energy. Electricity is abundant and is generously provided by the government. However, a new challenge will be faced by this population and their governments when energy transition policies are to be settled. Indeed, it is feared that, on average, it will provide more expensive electricity to the population. (See: http://gulfnews.com/news/uae/government/electricity-and-water-tariff-revised-in-abu-dhabi-1.1931425).



Source: IMF How Large Are Global Energy Subsidies? (2015)

Figure 6: Energy Subsidies and Level of Forgone Taxation in 2013

As a clear example of this generous policy, the pre-tax energy subsidies represent a 7.02% of the MENA countries' total GDP, which is by far the biggest amount among the regions presented in Figure 6, while the average subsidy ratio for the world is around 1%. Recently, the IMF has emphasized the necessity of reducing these energy subsidies as they come at a higher cost than expected. Although they are expected to benefit a large majority of the entire population, including the rich and the poor, they are extremely expensive and costly for the governments and hamper the efforts to eliminate budget deficits. Providing cheap and reliable electricity in the area constitutes an important structure of government stability in the Arab states. Indeed, the generous policies of some of the Middle Eastern countries have regularly helped to litigate the impacts of the civil discontent and help gain social peace in the region. It is argued that energy subsidies are intended to keep the domestic prices below market prices and serve as a strategic tool to promote industrial development and diversification. As such, the region's governments aim to protect the citizens from poverty and to distribute the benefits from these resources to the population by utilizing fossil fuel subsidies and keeping electricity prices low (Fattouh, El-Katiri, 2012). One of the goals of the implementation of the fossil fuel subsidies is to improve energy access, especially for the poor, in order to alleviate energy poverty. However fossil fuel subsidies often benefit more affluent segments of society rather than the poor. Besides, fossil fuels generate negative externalities and are responsible for most of the global greenhouse gas emissions. They also encourage excessive energy consumption, accelerate the depletion of natural resources, and reduce any incentives for investment in energy efficiency and alternative forms of cleaner energy.

Overall, various factors evoked above tend to increase the region's energy demand above the world standards. Indeed, although forecasts vary for these estimations, the demand of the region is projected to increase by 6% per year over the period from 2010 to 2030 when the world demand is only expected to rise by 3% per year for the same period (Al Masah Capital Limited, 2010)

3.3. Rising Demand and Internal Pressure

Energy consumption in the MENA is high. Since 2000, this consumption has been steadily increasing at an average rate of 5.2% per year (BP, 2012). Few factors can explain this increased demand in energy. First, the MENA region encountered a quick and rapid development with positive economic annual GDP growth rates for the past two decades (see Table 1).

Table 2. GDP Growth Rates in the MENA

Years	1990	2000	2008	2009	2010	2011	2012	2013	2014	2015
GDP growth (annual %)	13%	6%	5%	1%	5%	4%	3%	3%	3%	3%

Source: World Data Bank Indicators

According to the World Bank statistics, real GDP growth is projected to stay around 2.9% in 2018-2019, for the 4th consecutive year. Even though such a growth rate may seem to be relatively small for a developing region, the impact of economic growth is correlated with the increase in demand for power and energy consumption. Furthermore, most of the MENA countries will experience increases in energy demand and electricity production because of their growing population. In 2016, the total population of this region was estimated to be at 431,815,000 and is projected to climb up to 647 million people by 2050 according to the World Bank population estimates (World Bank, 2014).

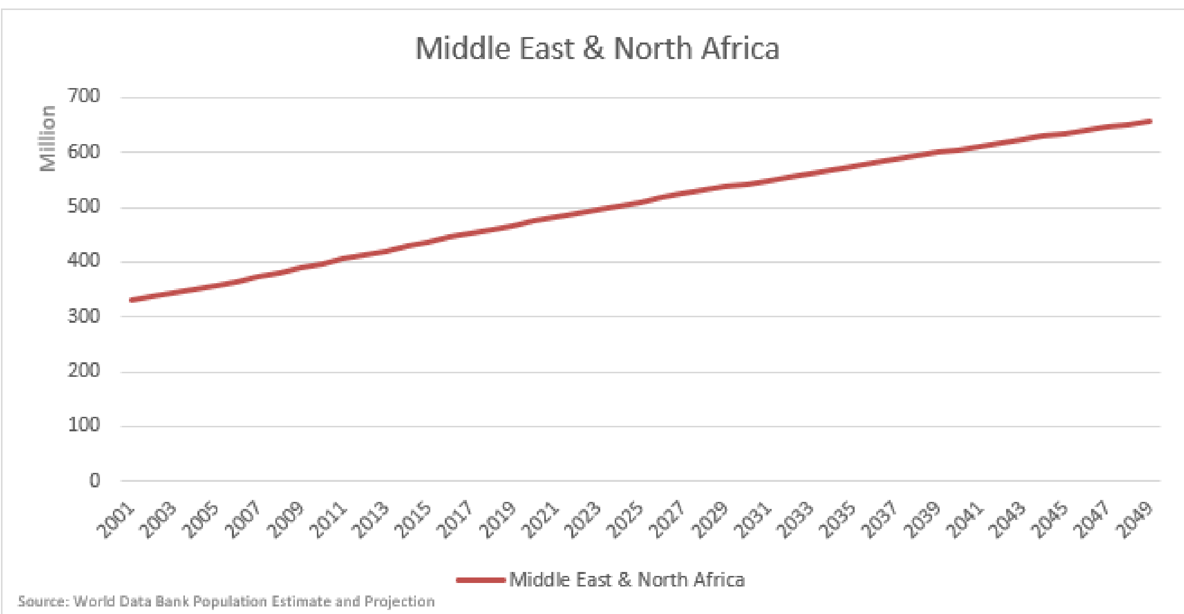


Figure 7: Population Estimates and Forecasts in the MENA Region until 2050

The population will then increase by more than 66% within 34 years as we can see in Figure 7 above. This implies a significant increase in the need for energy production and energy distribution in the region. This rising need will also be fostered by the age of the population in the MENA region. Indeed, the population of the region remains very young so the demand in energy consumption is relatively low compared to its potential. According to the OECD report on the energy policy of Turkey, the energy demand is expected to have a significant growth in the years to come because of two factors: a rising and young population and the rise of urbanisation. All the countries of the region will be faced by a similar challenge stemming from a rising demand for a growing population.

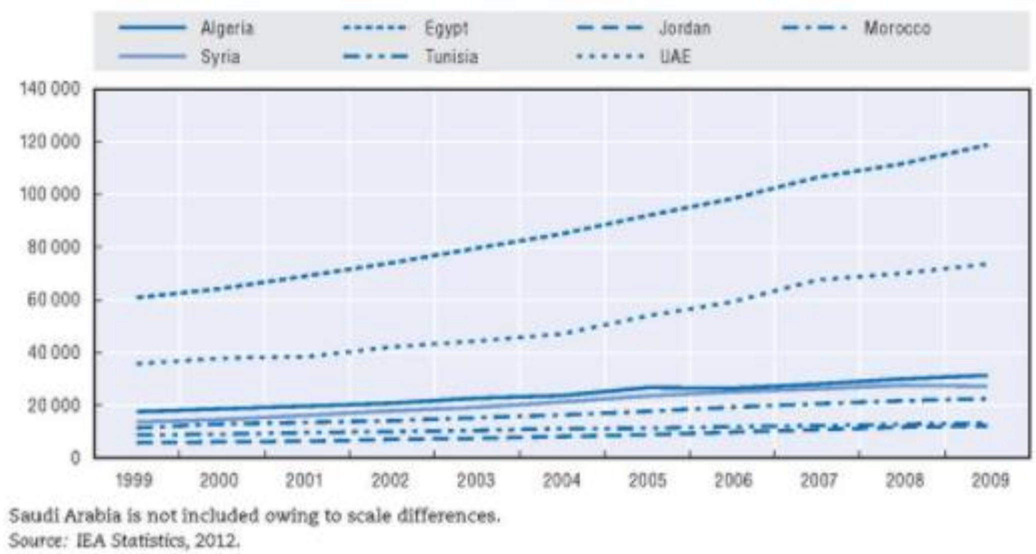


Figure 8: Electricity Demand in Selected Countries of the MENA (GWh)

These challenges concern every country in the MENA region, no matter if the country produces a lot of oil or not, or if it has a very generous energy subsidy policy or not. All of them are now facing the problem of a growing population as well as a societal demand for means and possibilities to have access to information, and therefore, all of them are united in a similar trouble. Figure 8 exemplifies the increased energy demand patterns of selected countries in the MENA. Accordingly, UAE and Egypt appear to be in the lead in increased energy demand among other countries between 1999 and 2009.

4. The Way towards Low-carbon Transition: An Econometric Analysis for the MENA

In this section, we undertake a panel data analysis of the MENA countries to study the relationship between CO_2 emissions and gross domestic product (GDP) per capita and to detect whether environmental pressure has decoupled from economic growth in the region during the period 1960-2013 controlling for several factors.

There are two main approaches in panel data models. The fixed effects approach depicts differences by unit through fixed coefficients. But if the units in a regression analysis are randomly selected, differences across units will also be random. This randomness results from the presence of factors that, in fact, affect the explained variable, but are not included in the model as explanatory variables. This approach is called random effects modelling.

When choosing between fixed effects models and random effects models in a panel data analysis, we need to take into consideration the correlation of unit effects to independent variables. If unit effects are correlated to independent variables, then the fixed effects model is selected; if not, the random effects model is used. The appropriate model may also be selected by the help of the Hausman (1978) test. This test determines whether there is a correlation between error term and independent variables due to cross-section effect, that is to say, whether or not the random effects model is appropriate. As can be seen in Appendix I, the Hausman tests reveal that the fixed effects model is the appropriate one for our purposes.

A standard panel fixed effects regression model can be written as follows for a *k* number of explanatory variables. $i=1,2,....,N$ represents the cross-section unit, and $t=1,2,......,T$ represents time.

$$y_{it} = \alpha_i + \beta_1 x_{it} + \beta_2 Z_{it} + \varepsilon_{it} \quad (1)$$

Where, in our model, y_{it} stands for *CO_2 emissions in metric tons per capita (lnCO2pc)*, x_{it} corresponds to log of GDP per capita (constant 2010 US$) (*lnGDPpc*), and Z_{it} is composed of the following set of variables:

lnCO2pc_1: *1st lag of the dependent variable*
lnEnergyuse: *Natural log of Energy use (kg of oil equivalent per capita)*
Popden: *Population density (people per sq. km of land area)*
Renewables: *Combustible renewables and waste (% of total energy)*
IndVA: *Industry, value added (% of GDP)*

The data is taken from the World Bank's World Development Indicators and the explanation of each variable is provided in Appendix II. The α_is are treated as fixed parameters (in effect, unit-specific *y*-intercepts), which are to be estimated. This can be done by including a dummy variable for each cross-sectional unit (and suppressing the global constant). This is sometimes called the Least Squares Dummy Variables (LSDV) method.

As shown above, we also include the first lag of the dependent variable as a regressor. In the fixed effects model, the fixed effects are permitted to be correlated with the regressors, which allows a limited form of endogeneity (Cameron and Trivedi 2009). But the underlying assumption is that the regressors are uncorrelated with the error term. In our models, Arellano-type robust standard errors are used in order to take into account both heteroskedasticity and autocorrelation (HAC).

The estimation of Equation (1) gives us the estimated value of *Y* for a given *X* value, the estimates of the real/true parameters β_1, β_2, … β_k, and the estimated real/true value of the error term ε. It is assumed that the mean of the error term ε equals zero and its variance is constant; that is, $E(\varepsilon_{it}) = 0$ and $Var(\varepsilon_{it}) = \sigma_\varepsilon^2$. The direction of beta coefficients indicates the direction of variation. In order to see how compatible the estimation of the equation is with reality, we interpret the R^2 coefficient. R^2 indicates the percentage of the total variation in *Y* explained by the regression plane, that is by changes in X_1, X_2, …, X_k. R^2 takes a value between 0 and 1; as its value increases, so does the percentage of variation in *Y* explained by the regression plane. This, in turn, means increased "goodness of fit" between the estimated regression and the sample observations. Conversely, goodness of fit diminishes as R^2 decreases (Koutsoyiannis, 1992: 125).

The constant term in the fixed effects model is cross-section (here, country) specific; that is; it allows individual constants for each country. A dummy variable representing each country is used. In this way, it becomes possible to control for missing, unpredicted or unobserved factors. In this model, the slope parameters, namely the betas, are the same for all cross-section units, whereas the fixed parameter α_i changes across cross-sections since it embodies a unit effect.

The results of the analysis are displayed in Table 2. Departing from available data, Model 1 undertakes an analysis of the following MENA countries: Algeria, Bahrain, Egypt, Iran, Iraq, Israel, Jordan, Kuwait, Lebanon, Malta, Morocco, Oman, Qatar, Saudi Arabia, Tunisia, Turkey, United Arab Emirates, and Yemen. Model 2 excludes Iraq, Israel, and United Arab Emirates from analysis due to lack of data on industry value added of these countries. The period of analysis covers 1960-2013; however, the sample is an unbalanced dataset as there are many missing data points in several years for most of the selected countries.

Table 2. Panel Fixed Effects Estimation with Robust (HAC) Standard Errors

	Model 1	*Model 2*
	Coefficient (Std. Error)	*Coefficient (Std. Error)*
lnCO2pc_1	0.56 ***	0.32 ***
	(0.07)	(0.11)
lnGDPpc	0.21 ***	0.33 ***
	(0.06)	(0.07)
lnEnergyuse	0.096 ***	0.242 ***
	(0.03)	(0.04)
Popden	−6.33307e-05 **	−5.23293e-05 *
	(2.82243e-05)	(2.57149e-05)
Renewables	−0.009 ***	−0.0099 ***
	(0.002)	(0.002)
IndVA		0.002 ***
		(0.0003)
No. of observations	677	472
No. of countries	18	15
Within R-squared	0.87	0.91

Note: Iraq, Israel, and UAE are excluded in Model 2 due to lack of data on industry value added.

The results provide no evidence for decoupling of CO_2 emissions from economic output growth in the MENA region for the investigated period. On the contrary, CO_2 emissions per capita are found to increase as GDP per capita increases. Moreover, there is even no sign of convergence of emissions towards previous emission levels.

As expected, higher energy use triggers more emissions in the MENA since most of the countries in the region are oil or gas dependent no matter if they are importers or exporters of such fossil fuels. According to the IEA (2012), CO_2 emissions from the energy sector have more than doubled since 1990 and are expected to continue to rise significantly in the medium and long term, following the growth in global energy demand. This phenomenon is in line with our findings in relation to the MENA region. For example, Turkey's economic and social development led to a massive increase in its energy demand over the last decades. Electricity supply has already been augmented by 50% since 2000. Besides, the Turkish Electricity Transmission Company (TEIAS) estimates that demand will continue increasing between an annual 6% and 7% growth rate until 2023 (TEIAS, 2013). Since the country has no major oil or gas reserves, it is highly dependent on energy imports which account for approximately 80% of the total supply (Yuksel, 2013). The majority of the energy supply is derived from fossil fuels leading to higher per capita CO_2 emissions in Turkey. Yet, the share of the energy sector emissions in total greenhouse gas emissions of the country reached 72% in 2015.

A similar trend can be observed in Algeria, where the rapid expansion of the population is driving an important increase in energy consumption. In 2000, the population of the country amounted to 31.7 million people, and, in 2015 to 40.7 million, implying an increase of more than 30% within 15 years according to the World Bank statistics (World Bank, 2017). In addition to the growing demand for energy use coming from increasing population, energy consumption in Algeria is higher than other developing countries as it reaches 1.3 toe per capita according to World Bank data in comparison to e.g. 0.8 toe per capita of Egypt. Therefore, total energy consumption of the country has been increasing at a rate of 4% per year since 2000, and more specially, electricity demanded increases at a pace of 11.5% per year since 2009 according to the Global Energy Market Research on Algeria conducted by Enerdata. This had consequences on the exportation of oil. The amount of oil exported has been declining for the past 10 years from 1,253,000 b/d in 2007 to 668,300 b/d in 2016 (OPEC Annual Statistic Bulletin). Also, almost the entire final energy consumption of the country originates from gas (53%) and oil (38%). Since most of the energy supply is from fossil fuels, this has led to an increase in the CO_2 emissions in Algeria. Thus, CO_2 emissions from energy use have increased by 5% per year since 2000 and has reached 125 Mt in 2015 (Enerdata, 2016).

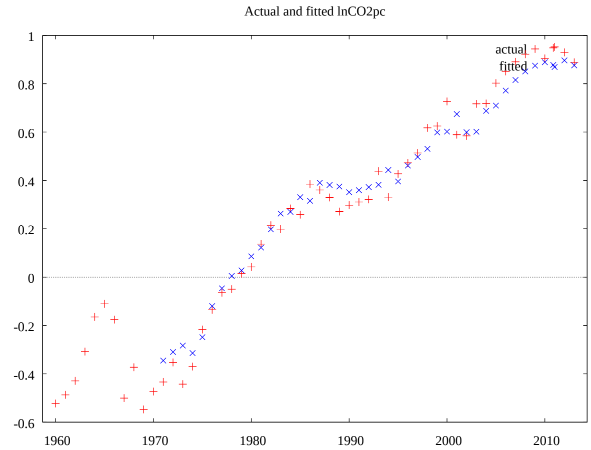
As electricity generation from renewable sources in the MENA remains quite limited as exemplified in Section 3, and because there is limited data for the renewable energy sector for most of the countries of interest, we use the share of combustible renewables and waste in total energy as a proxy for *Renewables* in our models. The findings reveal that the utilization of renewable energy alternatives definitely decreases emissions. Given this result, one would expect that the region would more easily set out on a less carbon-intensive development path if it could exploit its potential in renewable alternatives such as solar and wind. For instance, Turkey has a huge potential for the exploitation of renewable energy, which remains, with the exceptions of small hydropower plants and the construction of wind power plants over the last years, relatively untapped.

In Model 2, we also find that higher industrial share in total value-added gives rise to more CO_2 emissions per capita possibly due to industry's carbon-intensive structure throughout the region. For instance, as of 2015, 13% of the total greenhouse gas emissions in Turkey originated from industrial processes and product use according to the Turkish Statistical Institute (TurkStat, 2017).

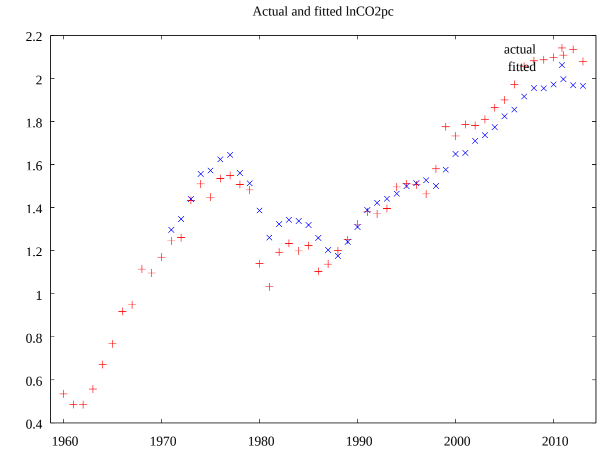
Finally, population density could be expected to affect carbon emissions via two channels: scale and efficiency. On the one hand, denser population requires establishing more infrastructures, which then increases carbon emissions. But on the other hand, it should be relatively easy to use resources more efficiently in densely populated areas (i.e. thanks to the availability of central heating and relatively broad transportation networks) as compared to less populated zones. Our results indicate that the efficiency channel dominates the scale channel. As population density increases in the MENA countries, carbon emissions per capita decrease.

Figure 9 plots actual versus fitted values of *lnCO2pc* in Egypt, Iran, Morocco, Tunisia, Turkey, and Algeria. Apparently, the model fit seems to be successful in catching the original values of emissions in these countries. Focusing on their emissions trends, Turkey and Morocco monotonically increase CO_2 per capita in time, while Algeria has almost stabilized it. Egypt, Iran, and Tunisia experienced a decline in their emissions per capita towards the end of 1980s and the beginning of 1990s.

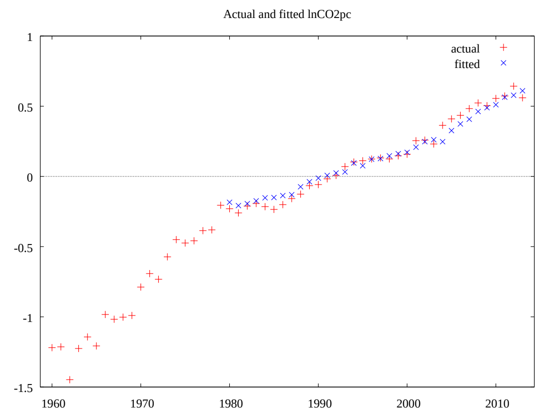
Egypt



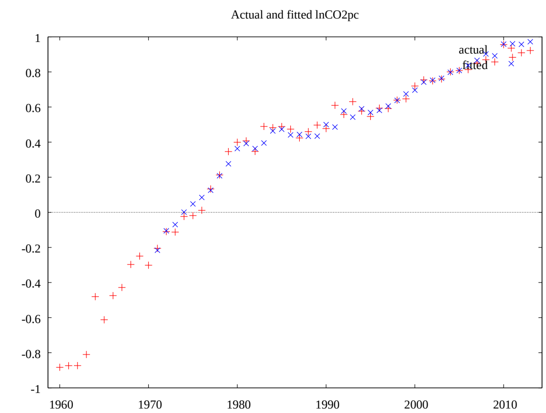
Iran



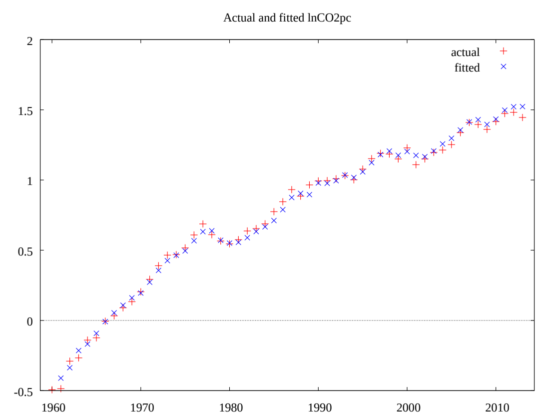
Morocco



Tunisia



Turkey



Algeria

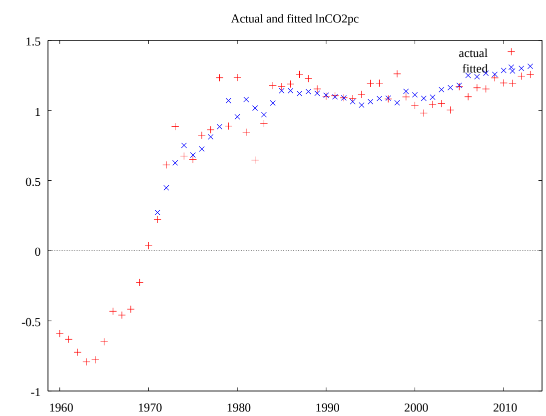


Figure 9: Actual versus Fitted *lnCO2pc* Values for Selected Countries
Source: Authors' own calculations and graphs

5. Conclusion and Suggestions: Towards a Brighter Future?

The lack of decoupling between growth and emissions is mostly driven by the carbon-intensive patterns of growth and industrialization in the region. Most sectors such as manufacturing and construction are highly dependent on fossil fuel inputs and are significant contributors to emissions in the region. What is more, the energy sector remains to be highly carbon-intensive as oil and gas consumption is the norm across the region. In countries like Turkey, an emphasis on domestic coal continues too.

MENA countries possess common resources such as solar, wind, and biomass resources, which are highly abundant and could be exploited in the region. The environment for investment and financing renewables in the region has improved in recent years. However, current levels of renewable energy-related investment in the region fall far short of those required to achieve a low-carbon energy revolution. In addition to that, these countries face similar challenges and backlog in the development of energy transition policy. They have a growing population, substantial economic growth, and similar energy subsidy policies.

A wide range of measures exist to help eliminate the barriers of implementing renewable energy, but most require co-ordination among all major stakeholders. To unlock sufficient and well targeted investment in renewables, it is essential to implement effective and coherent renewable energy policies with a long-term strategic perspective (Obama, 2017). Although renewable energy is becoming cheaper due to the decrease in production costs and learning-by-doing, they are still struggling to compete against fossil fuels. This is exacerbated by fossil fuel subsidies that distort market signals making renewables relatively more costly than they are, thus reducing incentives for investment in renewables and hindering their development. In addition, fossil fuel subsidies crowd out public support for the development of clean energy. Reforming such wasteful subsidies will encourage investment in renewables and improve their competitiveness.

The similarity of advantages and challenges gives room for increasing programs of collaboration and development. Below we focus on different regional and international collaboration programs for renewable energy development across the region and try to understand their consequences and outcomes for the relations between the region's governments and communities.

5.1. Regional Cooperation Options

As an example of regional collaboration attempts, the Mediterranean Solar Plan (MSP) was launched in Paris in 2008 in order to increase and reinforce the Euro-Mediterranean cooperation. It is one of the six initiatives of the Union for the Mediterranean that aims to face, in a common course of action, the challenges and the threats of climate change for the countries bordering the Mediterranean Sea. The primary goal of the MSP is to help and foster the creation of a regulatory framework to enhance the development of concrete environmental projects. In addition to this goal, the MSP has two complementary targets: developing 20 GW of new renewable energy production capacities and achieving sufficient energy savings and efficiency by 2020, tackling both the supply and the demand sides. The four main domains concerned by this plan are production, transport infrastructures, energy efficiency, and capacity building. The production sector is focusing on the creation of additional renewable electricity production system based on photovoltaic, concentrated solar power, and wind power. This production plan also aims to foster the convergence of national energy policies and the emergence of new regulatory environments that would benefit and increase the presence of renewables in the region. The transport infrastructures, energy efficiency and capacity building completed the panel of domains concerned by this plan. One of the most import outcomes of the MSP project is to create a bridge that will help reduce the financial gap for the countries in the region. As renewable technology costs are approaching cost-effectiveness, the MSP gives a favourable environment and access to concessional loans, carbon funds, and provides a sustainable and favourable environment for investors.

One emblematic project of the MSP is the Southern and Eastern Mediterranean (SEMed) Private Renewable Energy Framework (SPREF), whose objective is to stimulate the development of private renewable energy markets in Morocco, Tunisia, Egypt, and Jordan. The purpose of this project is to foster the development and the implementation of renewable energy projects in the region by providing a framework and a structure for financing mechanisms and technical cooperation according to the Union for Mediterranean Secretary. The expected beneficiaries across the four countries quoted above will be private international and local energy companies, customers, and policymakers. After analysing the opportunities for private investment in renewable energy, the project aims to enhance cooperation and information sharing, provide technical assistance for project preparation, and give access to equity and debt financing. The MSP plan aims now to increase solar power generation from 50 to 100 GW by 2030 in MENA.

Another emblematic and successful cooperation project that followed and was developed by the MSP was the Paving the Way for the Mediterranean Solar Plan (PWMSP). This regional project was launched by the European Commission in 2010 with the purpose of giving technical assistance to the energy companies of the countries by providing technical support and transfer of the framework needed for the successful implementation of the renewable energy policies. This project's aim is to coordinate the interconnection project on the regional level and develop the international electricity exchange in the Mediterranean, a process coordinated by the supervisory team of Med-TSO under the

European Investment Bank (EIB) initiative. It provides a list of renewable energy projects in the region, and proposes national development plans for the Mediterranean countries. Not only were the projects for renewable energies developed by public institutions, but they now appear under the impulsion of private actors. Another establishment is DESERTEC, which is a global civil society initiative that aims to "be the engine and drive for this world-wide development and change" for the realization of the energy potential of the deserts (see http://www.desertec.org/). It aims to support a world-wide energy transition as it could be the support for peace and wealth in humanity. To achieve its purpose, the foundation focuses on the exploitation of the potential of deserts. According to the organisation, the possibilities are endless as "in only six hours deserts receive as much energy from the sun as humankind consumes in a whole year" (see http://www.desertec.org/). It focuses its course of action on two renewable energies that are abundantly present in the desert: solar and wind power, but it also includes the development of other energies such as hydropower, biomass, and geothermal energy.

The DESERTEC Foundation believes that the MENA deserts could provide sufficient energy for seawater desalination and that two-thirds of the region's energy demand could be met through the development of both infrastructures. It asserts that developing reliable access to energy is an essential element of economic development and could be crucial in a region like the MENA, where desertification and poor electrification rates make development difficult. In addition to the reduction of poverty, the Foundation emphasizes the positive impact of their strategy on the social conditions of the population. In their DESERTEC Atlas, the Foundation puts forward the potential impacts of this global project on the educational system, the administrative system, the improvement of health conditions, and even the role of women. It asserts that this will also positively influence the relations between countries by reducing wars for water access and by eliminating poverty and scarcity of resources. It is interesting to underline that this increased cooperation in the MENA region is usually triggered by the European Union (EU). This is also because the EU helped to overcome the challenges and make joint projects more operational. It provided clarity on the legal and institutional frameworks for joint projects, which then gave pace to a favourable environment for investors.

5.2. International Help

International collaboration is also necessary in the adoption of an energy transition policy by the MENA countries and it is largely supported by developed countries. As we have seen so far, the two main initiatives taking place at the moment in the region are largely supported by the EU. The MSP was initially created by the Union for Mediterranean and has been settled to foster the development of renewable energies. The PWMSP project provides not only a strong platform to develop the energy dialogue in the region but also the tools to enforce the sustainable policies. It helps to realise all the analytical work on legal, institutional, and policy research that was required to implement a favourable structure for the development of renewable energies in that region. One of its concrete outputs was the realisation of Regional Road Maps for Legal and Regulatory Reforms with a strong focus on renewable energy and energy efficiency. The EIB is also very active in that matter. In 2010, it developed the Facilité Européenne d'Investissement et de Partenariat (FEMIP), a list of all potential investment projects in the region. More recently, the EIB developed a climate action plan that aims to help the Mediterranean partner countries to fight climate change and promote energy transition. The Climate Action in the Middle East and North Africa (CAMENA) project is used to identify, analyse, and prepare climate change projects, fund actions to improve climate investments and finance equity operations. It clearly stated priorities such as "tackling the causes of instability and supporting longer term development objectives", "minimising risks to energy, food and water security", "strengthening resilience", "promoting public-private partnerships", and "economic growth with lower greenhouse gas emissions" (EIB, 2016). The presence of the EIB in the region is old (30 years) and makes it a leading financial institution in the region. The competencies of this organism, especially regarding the Bank's due diligence and safeguard procedures, have permitted the successful implementation of many projects in the MENA region. The EU-MENA cooperation on the renewable energy projects was defined by the Energy Roadmap of 2050 as a key aspect of the region's capacity to reach the CO_2 emission targets. The Article 9 of the EU Directive on the Promotion of the Use of Energy from Renewable Sources encourages the cooperation and the development of projects between the EU members and non-EU states on renewable energy as they represent an important opportunity for Europe. This underlines well the policy of the EU towards the development of renewable energies in the MENA region.

The EU-MENA cooperation is undoubtedly a long-term strategy. The purpose of this strategy is double-folded: First, the Northern countries of the Mediterranean usually benefit from technological advances, technological knowledge and infrastructures to implement energy transition policies. Second, the South of the Mediterranean advantages from very favourable conditions for the development of these resources. However, they lack the capacity to utilize these resources. Europe represents a formidable market for these energies. According to the IEA statistics, 14% of the world's energy consumption is in Europe, and even though its energy demand is announced to rise less than the global demand, the need for renewable and clean sources of energies is increasing. The geographic position of the MENA region with respect to the European continent makes the MENA a very plausible region for the procurement of Europe's energy needs. That explains the active involvement and integration of the EU in MENA's renewable energy projects.

References

Al Masah (2010), Unlocking the Potential of Alternative Energy in MENA, Al Masah Capital Limited, Dubai.

BP, *BP Statistical Review of World Energy 2012,* June 2012.

Cameron, A.C. and Trivedi, P.K. (2009). *Microeconometrics Using Stata*. Texas: Stata Press.

Coady, D., Parry, I. W., Sears, L., & Shang, B. (2015). *How large are global energy subsidies?* (No. 15-105). International Monetary Fund.

Enerdata Information and Consulting Portal. Available from: http:// www.yearbook.enerdata.ru.

European Investment Bank (2016). *Climate Action in the Middle East and North Africa (CAMENA).* Available at http://www.eib.org/attachments/country/camena_climate_action_en.pdf

Fattouh, B., & El-Katiri, L. (2013), Energy subsidies in the Middle East and North Africa. *Energy Strategy Reviews*, *2*(1), 108-115.

Global Energy Market Research: Algeria. Jul2016, p1-34. 46p

Hausman, J.A. (1978). Specification tests in econometrics. *Econometrica* 46 (6), 1251-1271.

IEA (2017), *World Energy Outlook 2017*, IEA, Paris.

IEA (2012), World energy data base: Turkey.

IEA Statistics (2014), OECD/IEA
Available at http://www.iea.org/stats/index.asp

IEA (2011), *World Energy Outlook 2011*, OECD Publishing, Paris.

IEA (2010), *World Energy Outlook 2010*. IEA, *World Energy Outlook 2010*.

Koutsoyiannis, A. (1992). *Theory of Econometrics: An Introductory Exposition of Econometric Methods*. Macmillan, London.

Krane, J. (2014), *Stability versus Sustainability: Energy Policy in the Gulf Monarchies* (Doctoral dissertation, Judge Business School, University of Cambridge).

Kumetat, D. (2015). *Managing the transition: Renewable energy and innovation policies in the UAE and Algeria*. London: Taylor & Francis.

Lenzen M., D. Moran1, K. Kanemoto, B. Foran, L. Lobefaro & A. Geschke (07 June 2012), *International trade drives biodiversity threats in developing nations*, Nature 486, 109–112 doi:10.1038/nature11145

Obama B. (2017), *The irreversible momentum of clean energy*, Science 10.1126/science.aam6284

OECD (2013), *Renewable Energies in the Middle East and North Africa: Policies to Support Private Investment*, OECD Publishing.

OECD (2015) *Regional Outlook Survey Results: Turkey*, unpublished.

Prudhomme C, Giuntoli I, Robinson EL, Clark DB, Arnell NW, Dankers R, Fekete BM, Franssen W, Gerten D, Gosling SN, Hagemann S (2014), Hydrological droughts in the twenty-first century, hotspots and uncertainties from a global multimodel ensemble experiment. *Proc Natl Acad Sci* 111(9):3262–3267.

Sahnoune, F., Belhamel, M., Zelmat, M., & Kerbachi, R. (2013). Climate change in Algeria: vulnerability and strategy of mitigation and adaptation. *Energy Procedia*, *36*, 1286-1294.

Tanarhte, M., P. Hadjinicolaou, and J. Lelieveld. "Intercomparison of temperature and precipitation data sets based on observations in the Mediterranean and the Middle East." *Journal of Geophysical Research: Atmospheres*117.D12 (2012).

Turkish Electricity Transmission Company (TEIAS), 2013: Turkish Electricity Production Planning Study (2005-2020). Available at: http://www.teias.gov.tr/Eng/apkuretimplani/veriler.htm#_Toc86219420

TurkStat, 2017. Greenhouse Gas Emissions Statistics, 1990–2015. Available at: www.tuik.gov.tr

Waha, K., Krummenauer, L., Adams, S., Aich, V., Baarsch, F., Coumou, D., ... & Mengel, M. (2017), Climate change impacts in the Middle East and Northern Africa (MENA) region and their implications for vulnerable population groups. *Regional Environmental Change*, 1-16.

Ward, J.D., P.C. Sutton, A.D. Werner, R. Costanza, S.H. Mohr, and C.T. Simmons (2016). Is Decoupling GDP Growth from Environmental Impact Possible? *PLOS ONE.* https://doi.org/10.1371/journal.pone.0164733

World Bank (2014). "*Turn Down the Heat: Confronting the New Climate Normal*", IBRD/WB publications.

World Bank (2016), *The World Bank Group Middle East and North Africa Climate Action Plan 2016-2020.* Available at http://pubdocs.worldbank.org/en/136861479174892204/MENA-CAP-Nov-14-Long-FINAL-8-countries.pdf

World Bank (2017). World Development Indicators Database. Available at : http://databank.worldbank.org/data/

World Bank (2017). Population estimates and projections. Available at : http://databank.worldbank.org/data/

World Bank (2017). Health Nutrition and Population Statistics Database. Available at : http://databank.worldbank.org/data/

Yuksel, I. (2013), Renewable energy status of electricity generation and future prospect hydropower for Turkey. *Renewable Energy*, 50: 1037-1043.

APPENDICES

Appendix I – Hausman test results

Hausman test for Model 1
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(5) = 156.066
with p-value = 6.81924e-032

Hausman test for Model 2
Null hypothesis: GLS estimates are consistent
Asymptotic test statistic: Chi-square(6) = 257.675
with p-value = 9.3834e-053

Appendix II – Definitions of the variables (Source: World Development Indicators)

Dependent variable:

lnCO2pc: CO_2 emissions (metric tons per capita)

Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

Independent variables:

lnCO2pc_1 : 1st lag of the dependent variable

lnGDPpc: GDP per capita (constant 2010 US$)

GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in constant 2010 U.S. dollars.

lnEnergyuse: Energy use (kg of oil equivalent per capita)

Energy use refers to use of primary energy before transformation to other end-use fuels, which is equal to indigenous production plus imports and stock changes, minus exports and fuels supplied to ships and aircraft engaged in international transport.

Popden: Population density (people per sq. km of land area)

Population density is midyear population divided by land area in square kilometers. Population is based on the de facto definition of population, which counts all residents regardless of legal status or citizenship--except for refugees not permanently settled in the country of asylum, who are generally considered part of the population of their country of origin. Land area is a country's total area, excluding area under inland water bodies, national claims to continental shelf, and exclusive economic zones. In most cases the definition of inland water bodies includes major rivers and lakes.

Renewables: Combustible renewables and waste (% of total energy)

Combustible renewables and waste comprise solid biomass, liquid biomass, biogas, industrial waste, and municipal waste, measured as a percentage of total energy use.

IndVA: Industry, value added (% of GDP)

Industry corresponds to ISIC divisions 10-45 and includes manufacturing (ISIC divisions 15-37). It comprises value added in mining, manufacturing (also reported as a separate subgroup), construction, electricity, water, and gas. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3. Note: For VAB countries, gross value added at factor cost is used as the denominator.

Appendix III – Econometric results

Model 1: Fixed-effects, using 677 observations
Included 18 cross-sectional units
Time-series length: minimum 14, maximum 53
Dependent variable: lnCO2pc
Robust (HAC) standard errors

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−1.83635	0.453958	−4.045	0.0008	***
lnGDPpc	0.210385	0.0624134	3.371	0.0036	***
lnEnergyuse	0.0956899	0.0273636	3.497	0.0028	***
Popden	−6.33307e-05	2.82243e-05	−2.244	0.0384	**
Renewables	−0.00878810	0.00228450	−3.847	0.0013	***
lnCO2pc_1	0.563090	0.0748486	7.523	<0.0001	***

Mean dependent var	1.519117	S.D. dependent var	1.113705
Sum squared resid	9.027812	S.E. of regression	0.117490
LSDV R-squared	0.989233	Within R-squared	0.867729
Log-likelihood	500.8054	Akaike criterion	−955.6108
Schwarz criterion	−851.7043	Hannan-Quinn	−915.3830

rho	0.144615	Durbin-Watson	1.548581

Joint test on named regressors -
Test statistic: F(5, 17) = 645.074
with p-value = P(F(5, 17) > 645.074) = 9.3958e-019

Robust test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: Welch F(17, 212.3) = 10.2494
with p-value = P(F(17, 212.3) > 10.2494) = 9.84078e-020

Model 2: Fixed-effects, using 472 observations
Included 15 cross-sectional units
Time-series length: minimum 4, maximum 53
Dependent variable: lnCO2pc
Robust (HAC) standard errors

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−3.70564	0.596680	−6.210	<0.0001	***
lnGDPpc	0.332563	0.0698055	4.764	0.0003	***
lnEnergyuse	0.242262	0.0408889	5.925	<0.0001	***
Popden	−5.23293e-05	2.57149e-05	−2.035	0.0612	*
Renewables	−0.00985693	0.00223724	−4.406	0.0006	***
IndVA	0.00213451	0.000329655	6.475	<0.0001	***
lnCO2pc_1	0.323715	0.106268	3.046	0.0087	***

Mean dependent var	1.274166	S.D. dependent var	1.023269
Sum squared resid	4.417819	S.E. of regression	0.098973
LSDV R-squared	0.991042	Within R-squared	0.913867
Log-likelihood	432.6955	Akaike criterion	−823.3911
Schwarz criterion	−736.0945	Hannan-Quinn	−789.0525
rho	0.245211	Durbin-Watson	1.404931

Joint test on named regressors -
Test statistic: F(6, 14) = 2466.3
with p-value = P(F(6, 14) > 2466.3) = 2.42227e-020

Robust test for differing group intercepts -
Null hypothesis: The groups have a common intercept
Test statistic: Welch F(14, 92.3) = 12.0295
with p-value = P(F(14, 92.3) > 12.0295) = 2.51174e-015

Note: Iraq, Israel, and UAE are excluded due to lack of data on industry value added.