



# The Water-Energy-Food Nexus in the Arab Region

## Nexus Challenges and Opportunities

### Summary

The interdependency among water, food, and energy in the Arab region is strongly and closely interlinked, probably more than any region in the world. To make enough food to support a growing population, more water and energy are needed; to make water accessible and clean for human consumption demands energy; and producing energy will require water. These interlinkages are intensifying in the region as demand for resources increases with population growth, changing consumption patterns, and low management efficiencies in both supply and demand in these three sectors, and are expected to be further compounded by the impacts of climate change; attempting to achieve the security in one of these sectors independently without addressing trade-offs with the other two sectors will endanger their sustainability and security. The Water Energy Food Nexus approach is an integrated, holistic and pragmatic approach to address the supply risks of water, energy and food simultaneously and keep the resource base sustainable. Each security of supply shall not be achieved on the cost of the other. This can be achieved by creating intelligent synergies and fair trade-offs between them. Adopting a water-energy-food nexus approach in the Arab countries would provide an opportunity for innovation and learning to minimizing security risks and maximizing opportunities and enhancing resource efficiency and equity. It will serve the Arab region in moving towards the achievement of the global sustainable development goals (SDGs) and meeting the mandate of a low carbon economy as stipulated in the 2015 Paris Climate Summit.

### Recommendations

To achieve sustainable development goals and beyond, it is imperative that the Arab world develop a coordinated sectoral approach to policy formulation, implementation and evaluation across the WEF nexus, by taking the following measures:

- Adopt the water-energy-food nexus approach in the planning and management of these three sectors to reduce the risk of supply in all three sectors and enable the region to move toward higher levels of resource efficiency, equity, and sustainability.
- Improve organizational learning, identification of the interlinkages and quantification of the inter-dependencies of the WEF Nexus to create synergies, develop fair trade-offs and maximize opportunities.
- Make a major policy shift from supply management towards resource use efficiency, demand management and more equitable and sustainable consumption patterns.
- Apply appropriate policy, legislative and economic tools to ensure that basic human needs for the three resources are met at a low, subsidized price, while excessive use is priced at a tariff that reflects cost.
- Establish a low-carbon and “resource-efficient” Arab societies that value water, energy and food resources, participates in the decision making processes, and manage these resources wisely and efficiently.

### Introduction

The Arab region is energy intensive, water scarce, food deficient, and highly vulnerable to the potential impacts of climate change and climate variability. The interdependency among water, food, and energy in the Arab region are strongly and closely interlinked and expected to be intensified with population growth and changing consumption patterns. Moreover, the challenges of meeting growing demand for water, energy and food, are expected to be further compounded by the impacts of climate change and climate variability. Such conditions create immense challenges to the governments of Arab countries; trying to achieve the

security of one of these sectors independently and without due consideration to the trade-offs with the other two sectors will be on the expense of the security of one or the two components of the nexus, and eventually endangering the security of the sector itself. For example, achieving food security by domestic production without due consideration to the limitations of water resources will not only lead to the over-exploitation, deterioration, and loss of water resources, but eventually it will also lead to the loss of agricultural productivity and the deterioration of the agriculture sector itself.



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Despite containing 43% of the world's oil reserves and immense potential for renewable energy, 35 million people in the Arab region remain without access to electricity. A challenge which needs to be addressed in view of the seventh Sustainable Development Goal (SDG7) commitments calling for access to affordable, reliable, sustainable and modern energy for all. Additionally, the region only contains 1.4% of the world's freshwater resources, making it one of the world's most water-scarce region. Over half of Arab countries are already below the acute water poverty level of 500 cubic meters per capita per year and water availability is expected to decrease by 50% by 2050, while water demand will only continue to grow. With respect to food, the Arab Region is the world's largest importer of wheat and recent economic instability has left its population even more vulnerable to food insecurity.

With such strong inter-dependence and close interlinkages of these three sectors, the utilization of the "WEF Nexus Approach" (Policy Brief 1) in the Arab region has the potential to benefit all three sectors and to move toward more sustainable inter-sectoral and coordinated management.

**The Water-Energy-Food Nexus Securities Energy Security (IEA):** "The uninterrupted availability of energy sources at an affordable price".

**Water security (UNU):** "The capacity of a population to safeguard sustainable access to adequate quantities of, and acceptable quality water for sustaining livelihoods, human well-being, and socio-economic development, for ensuring protection against water-borne pollution and water-related disasters, and for preserving ecosystems in a climate of peace and political stability".

**Food security (FAO):** "When all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life".

**WEF Nexus Drivers in the Arab Region**

The water-energy-food nexus in the Arab region is driven by many natural, demographic, and socio-economic factors that do not only intensify the nexus interlinkages in the region, but also increase the risks on each other.

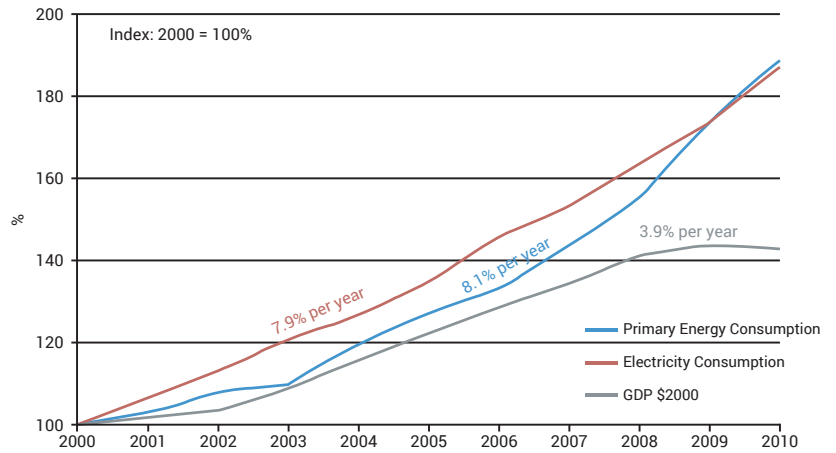
**Demographics and Consumption Patterns**

In the last three decades, the Arab region has experienced rapid population growth and accelerated socio-economic development; the population of the region has doubled from about 170 million inhabitants in 1980 to more than 350 million in 2010. This growth was associated with a substantial increase in water, food, and energy demands. However, the increase is not attributed only to population growth, but also to consumption patterns and low efficiencies in the production, supply, and use, of these three vital resources.

Energy consumption in the region continues to be dominated by fossil-fuels. However, this pattern needs to change in light of the outcomes of the global climate summit in Paris during the COP21 in December 2015 where 195 nations agreed to follow a low carbon economy with lower ecological footprints, as well as to meet the SDG7, which calls for enhancing energy efficiency. In 2011, the primary energy

consumption mix was dominated by oil products (48.5%) and natural gas (50%), with coal (0.7%) playing a minor role and hydro electricity (0.8%) being the only form of renewable energy to make a measurable impact. Current trends and patterns of energy use put the Arab economies among the least efficient ones in global comparisons. Unlike the case of some European countries, there has been no decoupling between economic growth and energy demand in the Arab region in the past decade. Growth in energy consumption has been faster than economic growth during the past decade. During the period 2000-2010, the increase in primary energy and electricity demand has been about 8% while average annual GDP growth was around 4%, implying energy is not being used effectively to produce value within the regional economies.

**Primary Energy Consumption, Electricity consumption and GDP trends in the Arab region, 2000 and 2010**

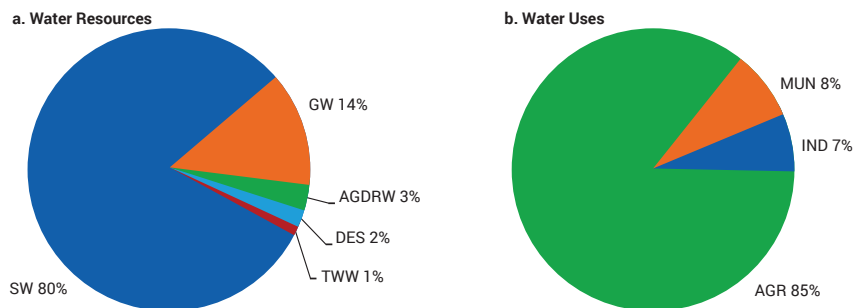


Data Sources: OAPC, 2005, 2007, 2012; EIA, 2013; World Bank, 2013

Fossil fuel subsidies are a contributing factor to the inefficient use of energy. In Arab electricity markets, price subsidies represent one of the major challenges to progress of efficiency measures. Another factor is the prevalence of inefficient electricity infrastructure in most countries of the region. Average Arab electric energy losses in generation, transmission and distribution is 19.4%, which are higher than the world average (8.3%), and much higher than the EU average (5.8%), presenting an ample opportunity for achieving energy savings.

During the past three decades, water demands in all the Arab countries have increased dramatically as a result of increasing population and urbanization growth, improvements in the standard of living, industrial development and efforts to increase food self-sufficiency. The total water use for all sectors in the Arab region increased dramatically from about 190 Billion cubic meters (BCM) in the mid 1990s to about 255 BCM in 2010. The majority of water resources in the region are being used for agriculture (85%), while the municipal and the industrial sectors consume about 8% and 7% of the total water use, respectively.

**Water Resources and Water Uses in the Arab Region (UNDP, 2013)**



(SW: surface water, GW: groundwater, AGDRW: agricultural drainage water, DES: desalinated water, and TWW: treated wastewater; AGR: agricultural sector, MUN: municipal sector, IND: industrial sector)

In the municipal sector, in addition to rapid population growth and urbanization, the rapid increase in urban water demands in the region could be explained by many factors, including rise in per capita consumption, large losses in the supply network, and lack of recycling programs within the sector. In many Arab countries, water efficiency in both the supply-side and the demand-side is generally very low. On the supply side the physical leakage in the municipal networks could reach more than 40%. Moreover, reuse rates of treated wastewater are at their minimal. On the demand side, the per capita water consumption in

the domestic sector in many countries ranks amongst the highest in the world.

In many Arab countries, agricultural sector performance indicators are very low and agriculture is considered unsustainable due to the continuous deterioration of limited water resources and the limited capacity of arable lands, many having low productivity per unit area. Overall irrigation efficiency is generally low and averages around 45%, while crop productivity is generally low, particularly that of staple cereals, averaging about 1,133 kg/ha in five major cereal producers (Algeria, Iraq, Morocco, Sudan, and Syria), compared to a world average of about 3,619 kg/ha. Moreover, some Arab countries face serious challenges in their objectives to achieve food security locally emanating from a backdrop of constraining factors, including aridity, limited cultivable land, scarce water resources and serious implications of climate change. Weak policies, insufficient investment in science and technology and agricultural development have contributed to the impoverished state of agricultural resources and to their inefficient use and low productivity. Population growth, rising demand for food, degradation of natural resources, and conversion of farmland to urban uses pose further challenges to the enhancement of the food security goal in the Arab region.

Moreover, post-harvest losses (PHL) in the Arab region are considered high. It is estimated that the annual losses of grains in Arab countries amounted to about 6.6 million tons in 2012. In addition, loss in imported wheat in some Arab countries translates to about 3.3 million tons due to inefficient import logistics. These national post-harvest losses represent an opportunity cost due to waste of water and energy resources used in production.

### **Economic Factors**

Water, food and energy form a complex web of inter-linkages. Due to their strong interdependence, subsidy policies in one sector strongly influence the other two sectors. For example, energy policies and subsidies influence water use for food production. Generally, in the Arab region the three sectors of water, energy and food sectors are highly subsidized. Moreover, the subsidy system implemented in many Arab countries is across-the-board subsidy system, or common blanket subsidies, which works in favour of the rich rather than the poor, and does not encourage conservation in resources use (**Policy Brief 4**). The key policy reform to be considered is to “treat unequals unequally” and to design pro-poor policies.

### **Climate Change and Variability**

The challenges of meeting growing demand for water, energy and food are expected to be further compounded by the impacts of climate change. Extreme weather events, precipitation shifts, increasing temperatures, rising sea level, and many other climate change related manifestations are expected to impact food production, water renewability and consumption, and energy production and consumption (IPCC, 2007; IPCC, 2014). The impacts of climate change will potentially place acute strains on the three sectors in terms of resource availability, service delivery as well as intensifying their interconnections. Thus, climate policies can have impact on water, energy and food security, and adaptation action can in fact be maladaptive if not well aligned in a nexus approach and implemented by appropriately interlinked institutions. Climate change, hence, underpins the triple context of water security, food security and energy security.

### **Technology & Innovation**

Water, energy and food scarcities and competitions have resulted in technological solutions contributing to some WEF nexus challenges. The introduction of new and appropriate technologies can improve resource efficiency in the water, energy, food sectors, and contribute to their security and sustainability. Introducing renewable energy and improving energy efficiency, modern and precision agriculture, water recycling, and wastewater reuse are just few examples of such driving force between the nexus three components and technology. However, technological and innovative solutions within the WEF nexus, where two of, or the three components of the nexus are integrated as inputs to each other not only enhance resource efficiency, but also expand the available natural resource base and thus have even more contribution to the sustainability and security of the three resources. There are some good examples of the adoption of these in many Arab countries (**Policy Brief 6**). Under the current constraining conditions in the Arab region, such technological and innovative solutions may lend themselves as one of the most important drivers for the WEF nexus approach adoption by various stakeholders.

### **Transboundary Issues**

While the WEF-nexus complexities are evident at the sectoral levels within a given Arab country, the situation becomes even more intense when it is considered at the regional level between two or more states with different and/or conflicting

development priorities that are intermingled with each country national drivers and set-up, as well as international and regional politics. With more than 60% of surface water resources originate from outside the Arab region, the issue of shared water basins remains a major concern impacting not only planning and management in the water sector, but also food production and energy generation, thus threatening the region’s food and energy security and stability. Furthermore, some Arab countries are deprived of their water resources by occupying powers, which is another major issue in the region and is constraining the security and development of these populations. Hence, it is imperative to enhance the regional water institutions along river basin to promote collective action and reasonable and equitable water allocation among riparian states.

### **Food self-sufficiency in the Arab countries (AMF 2014)**

Food Commodity	2005	2011
Cereals	49.7	45.6
Sugar	38.5	36.9
Fats and Oils	28.1	54.4
Meat	80.8	76.2
Fruits and Vegetables	98.5	106.2
Fish	103.1	97.5
Other Commodities	77.8	82.5
<b>Average</b>	<b>70.5</b>	<b>71.7</b>

### **Human Needs, SDGs, and the WEF Nexus**

The Provision of basic human needs, such as food and water, as well as the right to development, are core tenants of the human rights policy framework adopted by the member states of the United Nations and its respective institutions. In general, the right to good quality water, right to food and right to energy (in various forms such as electricity) is embedded and/or used synonymously with the word security.

Moreover, in the Sustainable Development Goals (SDGs) agreed in September 2015 by 193 UN member states, including all LAS member states, the three components of the WEF security nexus are clearly laid out (SDG2 on food security; SDG6 on water and sanitation; and SDG7 on energy). In other words, access to water, energy and food are considered as inalienable rights. Furthermore, the 17 goals of the SDGs have to be approached not separately but “as a package”. This clearly internalise the WEF-Nexus approach where one security shall not be reached at the cost of others (**Policy Brief 4**).

This highlights the necessity of the WEF nexus approach and perspective and the important role it can play in policy formulation for achieving these rights and eventually sustainable development. By acknowledging sustainable development inter-linkages among the environmental, social, and economic dimensions, the SDGs are better achieved through an integrated approach. The WEF security nexus approach, with its holistic systems approach is a building block of the sustainable development goals. It can assist along this path providing the necessary foundation for informing (and reforming) policy and decision making process of potential synergies and win-win situations for achieving sustainable development.

### **Opportunities**

Water, energy and food together form a highly complex and intertwined nexus. It is clear that each of the three sectors impacts the other two. Demand for the three commodities is expected to increase, competition and scarcity become more prevailing. This will affect the supply chain security across all sectors. Hence, by

developing integrated WEF nexus policies and solutions, these challenges can be converted into opportunities. By minimizing wastage and losses in the production, supply, and utilization of water, energy and food the Arab countries can help bridge the projected demand increases, save substantial amounts of embedded resources consumed in their production, reduce environmental impacts, and achieve the targets of both the SDGs and Paris Climate Summit. Improving efficiency and reducing waste across supply chains of any of the three resources would result in substantial savings in one or both of the nexus components. However, economic efficiency evaluation has to be made within the WEF nexus framework, otherwise it may backfire and may lead to unintended consequences if not appropriately designed (**Policy Brief 6**).

Improving efficiency and productivity is more cost-effective than increasing supply capacity, as available efficiency options have a lower unit cost than increasing supply and would produce a level of benefits that exceed the cost required to undertake these options. For example, in the GCC countries, where municipal water supply rely mainly on desalination, reducing desalination plants production or delaying their capacity expansion by implementing water efficiency measures, such as reduction of the leakage in the distribution network, or households water-saving devices and recycling, would be reflected directly in savings in natural energy resources assets (oil and gas). Furthermore, in addition to the increase in the added-value per cubic meter and freeing up water for other uses and reducing the sector financial burdens, this will reduce the environmental costs in terms of greenhouse gases emissions and effluents discharged to the marine environment by desalination plants, thus reducing environmental degradation. In addition, such reduction would be reflected on the generated municipal wastewater and treatment cost and carryover volumes to the marine environment, thus contributing to maintaining marine ecosystem services and functions to the societies of the region. These measures accordingly will contribute to enhancing the resilience of ecosystems - our natural capital - and support mitigation and adaptation to climate change risks.

### The WEF Nexus Opportunity Areas

The consultations that took place around the landmark Bonn 2011 Nexus Conference clearly highlighted the importance of integrated solutions for sustainable development – a paradigm wherein economic growth is decoupled from resource depletion. The conference laid out a set of “Nexus Opportunity Areas”, intended to “support sustainable growth and achievement of water, energy and food security by cutting across interlinked decision spaces and identifying win-win solutions” (BMU, 2012). These opportunity areas are:

- Increase policy coherence: integrated policies, non-siloed thinking, linking up across sectors and ministries.
- Accelerate access to basic water, food and energy: recognize human rights-based considerations in access to water, food and energy.
- Create more with less: improve productivity and sustainable intensification
- End waste and minimize losses: reduce waste across supply chains to capture significant environmental gains.
- Value natural infrastructure: invest in multi-functional nature of ecosystems.
- Mobilize consumer influence: engage and actively involve consumers to change behaviours and influence the way business is done

The same analogy can be said in the agricultural and food sector, where about half of the irrigation water is wasted due to the use of inefficient irrigation methods, and where post-harvest losses in the food supply chain are high. With about 85% of the water used in the Arab region consumed by the agricultural sector, and where water losses are the highest in this sector, it becomes imperative for the Arab countries to focus their efforts on improving the water efficiency in this sector, as the opportunity to save water is notably higher there than in other sector.

Improving overall irrigation efficiency and reducing post-harvest losses would result in huge water savings as well as energy resources used in production and distribution.

Similarly, in the energy sector, where residential inefficient use of energy and inefficient electricity infrastructure are widespread in many Arab countries, the potential gains from economically feasible efficiency measures are substantial. Various studies show that implementation of energy efficiency building codes, reducing losses in the transmission and distribution electricity network, and transition to efficient lighting (CFLs) in the region would result in tremendous savings in primary energy, new investments, as well as reduction in carbon emissions. These measures, in turn, serve to achieve the corresponding targets for both the SDGs and the Paris COP21 Climate Summit mandates.

On the supply-side, there is growing importance of integrated solutions that enhance security and sustainability across all three sectors, while supporting global climate commitments and contributions as per COP21. What contributes greatly to the sustainability of an existing nexus system is essentially the sustainability of the resource inputs along different stages of the supply chain. Energy, for example, is a critical input along different stages of the water and food supply chain, and the negative impacts of growing reliance on unsustainable energy sources are increasingly evident. These energy sources are characterized by increasingly volatile prices, they cause spill-over effects (externalities) to the environment and they are intrinsically more resource intensive to extract, process, and deliver. Renewable energy technologies offer integrated solutions that simultaneously enhance water, energy and food security by addressing trade-offs and leveraging on synergies between sectors. Renewable energy technologies now represent a mainstream energy strategy for a transition to low carbon economy in a new era after COP21 climate agreement. Clean energy and resilient ecosystems provide natural solutions that are compatible with the broader green growth objectives towards achieving the SDGs and the Paris 2015 climate mandates. A nexus approach can support a transition to sustainability, by negotiating fair trade-offs and generating additional benefits that outweigh the transition costs associated with stronger integration across sectors.

### Conclusion

Adopting the WEF nexus approach will provide great benefits for the Arab region in their pursuit to achieve the SDGs and the mandates of the 2015 Paris Climate Change Agreement. Moreover, the WEF nexus enables system thinking and organizational learning among the three sectors. It could substantially improve the sustainable use of scarce resources and improve supply risks to the essential human needs of water, food and energy. Adopting the WEF nexus approach will help identify mutually beneficial responses, provide an informed and transparent framework for determining fair trade-offs to meet demand without compromising sustainability and exceeding environmental tipping points. In addition, it will result in bringing economic benefits through more efficient use and management of the resources, productivity gains, and reduced waste. To achieve water, energy and food nexus security goals, there is need for a coordinated harmonized nexus knowledge-base and sustainability indicators and metrics beyond GDP that cover all relevant spatial and temporal scales and planning horizons. The resource limitations in all the three sectors require a shift towards a low carbon economy, resource use efficiency, demand management and more sustainable consumption patterns. Finally, there is an urgent need for de-coupling energy use and economic growth by a transition to a “resource-efficient” Arab economy where societies value water, energy and food resources, participate in the decision making processes, and manage natural resources wisely and efficiently.

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