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SUSTAINABLE PRODUCTION AND CONSUMPTION PATTERNS IN ENERGY AND WATER SECTORS IN THE ESCWA REGION

11-0087

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ABBREVIATIONS

10YFP	10-Year Framework of Programmes on Sustainable Consumption and Production
AMWC	Arab Ministerial Water Council
bcm	Billion cubic meter
boe/d	Barrels of oil equivalent per day
CDM	Clean Development Mechanism
CSP	Concentrating solar power
CSD	Commission on Sustainable Development
CAMRE	Council of Arab Ministers Responsible for the Environment
ENCPC	Egypt National Cleaner Production Center
ESCWA	Economic and Social Commission for Western Asia
ESES	Egyptian Solar Energy Society
GCC	Gulf Cooperation Council
GDP	Gross domestic product
GHG	Greenhouse gas
IWRM	Integrated Water Resources Management
JCEDAR	Joint Committee for Environment and Development in the Arab Region, Egypt
KACST	King Abdul-Aziz City for Science and Technology
kgoe	Kilogram of oil equivalent
kWh	Kilowatt hour
mbd	Million barrels a day
MDGs	Millennium Development Goals
MTI	Egyptian Ministry of Trade and Industry
MW	Megawatt
MWh	Megawatt hour
OAPEC	Organization of Arab Petroleum Exporting Countries
ppm	Parts per million
SIDA	Swedish International Development Cooperation Agency
SCP	Sustainable consumption and production
toe	Ton of oil equivalent
UNIDO	United Nations Industrial Development Organization
WSSD	World Summit on Sustainable Development

I. INTRODUCTION

A. SUSTAINABLE CONSUMPTION AND PRODUCTION AND SUSTAINABLE DEVELOPMENT

Sustainable consumption and production (SCP) can be defined as a strategy to minimize the negative environmental impacts of these activities so that social and economic development can be pursued within the capacity of ecosystems, through the decoupling of economic growth from environmental degradation.[1] While many countries in the world seek social and economic development, traditional patterns of growth have been associated with the depletion of natural resources and threats to sustainability. Thus, the decoupling of these aspects through a transition towards more sustainable patterns of consumption and production is a prerequisite to achieving sustainable development.

Energy and water are critical natural resources, necessary for satisfying basic human needs and are of primary concern in the development of sustainable social and economic growth in harmony with the environment. The ninth session of the United Nations Commission on Sustainable Development (CSD-9) in May 2000 and April 2001 identified five main energy strategies directed towards sustainable development and the Millennium Development Goals (MDGs); these include: (a) increasing access to modern energy services; (b) improving energy production and consumption efficiency; (c) promoting the use of renewable energy resources; (d) developing cleaner fossil fuel technologies; and (e) improving energy efficiency in the transport sector. Increased access is required to improve the standard of living in many developing countries and in most of the least developed countries, particularly in rural areas where many people lack access to adequate modern energy services. However, given the current deficit in their provision, population growth and dominant patterns of energy production and consumption, world energy demand is expected to continue to increase, extending dependence on such fossil fuels as oil and natural gas for many years to come.

Water resources are vital for human welfare and sustainable development as well. Clean water and sanitation are essential for basic human health, while access to adequate water resources is needed to support agriculture, industry and other important economic activities. In order to meet the growing demand for freshwater resources in a water-scarce environment, countries in the Economic and Social Commission for Western Asia (ESCWA) region have drawn upon renewable and non-renewable surface and groundwater and have invested heavily in the production of alternative water resources through various technologies, particularly desalination. Nevertheless, consumption rates continue to outpace the natural rate of recharge of renewable freshwater resources and the production of non-conventional water resources, resulting in the over extraction of water from fossil aquifers and reduction in renewable water resource availability per capita. This situation is likely to worsen in the face of climate change and the continued challenges associated with the management and use of shared water resources that originate outside the region. Ensuring SCP of freshwater resources is thus a fundamental component of sustainable development.

Furthermore, it is important to examine SCP of energy and water in relation to one another since the production and consumption of energy and water are closely linked. A cross-sectoral perspective can also uncover mutual benefits, potential costs and positive synergies of pursuing integrated policies and approaches for SCP.

B. SUSTAINABLE CONSUMPTION AND PRODUCTION AND GREEN ECONOMY

Before focusing on SCP of energy and water, it may be useful to briefly discuss its relation to the emerging concept of green economy and the ways in which progress in this direction complements the transition towards more sustainable patterns of consumption and production. Although there is still no clear definition of what constitutes a green economy, global momentum is building in its support. For example, the global financial crisis of 2008 and 2009 prompted such countries as China and South Korea to adopt economic stimulus packages that were largely concentrated on the expansion of the so-called green economic sectors.

[1] Economic Commission for Africa (2009).

Arguably, a green economy seeks to promote and invest in activities that can foster economic and social development while safeguarding the environment. Since SCP is a strategy to delink social and economic development from environmental degradation and the depletion of natural resources, green economy policies and SCP are closely related and mutually reinforcing. However, while investments in green economic sectors can lead to environmental improvement, they do not necessarily guarantee environmental sustainability since other economic activities remain tied to increasing consumption, increasing output and extraction of natural resources. Sustainable consumption and production patterns also target interventions by producers and consumers of goods and services at the macroeconomic and microeconomic levels, through changes in policies, behaviour and personal choice. Therefore, while wise investment and economic restructuring through the promotion of green economy strategies can encourage more environment-friendly growth, the transition towards SCP patterns is still needed in order to ensure overall long-term environmental sustainability across all levels of society for the benefit of current and future generations.

C. SUSTAINABLE CONSUMPTION AND PRODUCTION IN THE ESCWA REGION

The vital importance of natural resources for sustainable development was raised at the United Nations Conference on Environment and Development in 1992 and, as a result, chapter 4 of Agenda 21 entitled, Changing Consumption Patterns called for the need to change unsustainable patterns of production and consumption and to develop national policies and strategies to encourage alternatives.[2] Subsequently, the 2002 World Summit on Sustainable Development (Rio+10) (WSSD) called for the development of a 10 Year Framework of Programmes on Sustainable Consumption and Production (10YFP) to encourage such a shift. In order to support the preparation of 10YFP, the Marrakech Process was launched in 2003, involving different stakeholder groups. Now in its third draft, 10YFP was reviewed by countries at the eighteenth session of the United Nations Commission on Sustainable Development (CSD) in May 2010 and will be negotiated at CSD during its nineteenth session in May 2011.[3]

The Arab region recognized this urgent need for transition towards SCP during regional preparations for WSSD. This is articulated in the Sustainable Development Initiative for the Arab Region, which was adopted by the Council of Arab Ministers Responsible for the Environment (CAMRE) of the League of Arab States in 2001, and calls for the "promotion of the concept of sustainable production and consumption in the Arab region and encouraging the use of products that contribute to the protection of the natural resources". Following WSSD and subsequent launching of the Marrakech Process, Arab Governments and regional organizations that serve on the Joint Committee on Environment and Development in the Arab Region (JCEDAR), which advises CAMRE, initiated the formulation of the Arab Regional Strategy for Sustainable Consumption and Production. The strategy identifies the following SCP priorities for the Arab region:

(a) Energy for Sustainable Development;
(b) Water Resources Management;
(c) Waste Management;
(d) Rural Development and Eradication of Poverty;
(e) Education and Sustainable Lifestyles.

While the Arab Strategy identifies these five priorities for pursuing SCP in the twenty-two countries of the Arab region, this paper limits itself to examining SCP in the energy and water sectors as it relates to the fourteen Arab countries that are also ESCWA member states. The paper is organized as follows: after, this introduction, chapter II and III analyse the energy and water indicators elaborated in The Arab Regional Strategy for Sustainable Consumption and Production respectively. Chapter IV discusses energy and water linkages and in recognition of these linkages, policies are recommended in chapter V. Chapter VI seeks to promote an integrated approach towards SCP in the ESCWA region. Chapter VII closes the paper with conclusions.

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[2] Department of Economic and Social Affairs of the United Nations (DESA), (1993).

[3] More about the Marrakech Process available at: http://esa.un.org/marrakechprocess/.

II. ENERGY SUSTAINABLE CONSUMPTION AND PRODUCTION INDICATORS

Indicators of SCP of energy should be correlated to the environment as well as to energy production and consumption. Accordingly, the Arab Regional Strategy for Sustainable Consumption and Production identified the following indicators for SCP in energy sectors, which are analysed in this chapter.

- Annual energy consumption (toe) and share of renewable energy (per cent);
- Energy intensity (toe/US$1000);
- Per capita energy consumption (toe per capita);
- CO_2 per GDP (ton/US$1000);
- CO_2 per capita (ton per capita);
- Percentage of leaded gasoline in total (per cent);
- Sulphur content in diesel oil (ppm).

A. ANNUAL ENERGY CONSUMPTION

1. *Oil and gas*

Energy production in ESCWA member countries contributes significantly to satisfying regional and global energy needs for economic and social development. In 2009, ESCWA member countries produced nearly 18.5 million barrels/day (mbd) of oil and 331.7 billion cubic meters (bcm) of gas, thereby accounting for about 26.3 per cent and 11.1 per cent of the total global oil and gas production respectively.[4] The energy demand of the region has risen due to rapidly increasing population levels, increased travel and widespread energy subsidies. Indeed, annual consumption of oil and gas increased at an average of 5.52 per cent and 6.74 per cent respectively between 2005 and 2009, while the annual production of oil and gas changed by an average of -1.41 per cent and 6.65 per cent respectively.[5] This trend is likely to continue as the annual average growth rates of total energy consumption and energy consumption per capita by 2020 are expected to be about 3.7 per cent and 2.1 per cent respectively.[6]

Average primary energy consumption per capita in the ESCWA region reached 1,862 kilograms of oil equivalent (kgoe) in 2009, compared to 1,608 kgoe in 2005, with an average annual growth of 4 per cent.[7] The average electricity consumption per capita reached 2,244 kilowatt hours (kWh) in 2009, compared to 1,859 kWh in 2006,[8] representing an average annual growth rate of 6.48 per cent.

However, wide disparities exist in levels of energy consumption within the ESCWA region with consumption levels positively correlated to GDP per capita. Although per capita energy consumption among countries of the Gulf Cooperation Council (GCC) is among the highest in the world, large segments of the population in rural and poor urban areas across the Arab region still do not have adequate access to energy services, while almost one fifth of the Arab population relies on non-commercial fuels for different energy uses.[9] For instance, Qatar consumed almost 20,000 kgoe of energy per capita in 2007, while the United Arab Emirates and Bahrain consumed over 10,000 kgoe per capita. In contrast, the Sudan and Yemen consumed less than 500 kgoe per capita during the same year, as presented in figure 1.

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[4] Calculated by Economic and Social Commission for Western Asia (ESCWA) staff from tables 11 and 14 in Organization of Arab Petroleum Exporting Countries (OAPEC) (2010).

[5] Calculated by ESCWA staff from tables 11, 14, 28, and 29 in OAPEC (2010).

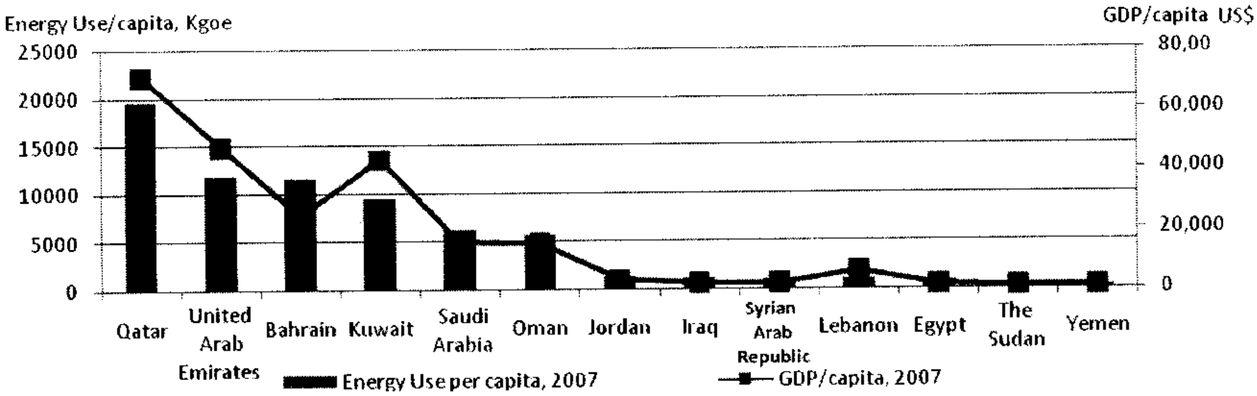
[6] ESCWA, (2008), p. 4.

[7] Calculated by ESCWA staff from OAPEC (2010), p. 42.

[8] Calculated from ESCWA (2010).

[9] ESCWA, United Nations Environment Programme (UNEP), Council of Arab Ministers Responsible for the Environment (CAMRE) and OAPEC (2005), p. 19.

Figure 1. Energy consumption per capita of the ESCWA region

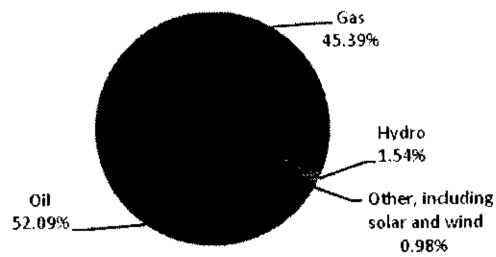


Source: World Bank, World Development Indicators. Available at: http://data.worldbank.org/indicator.

2. *Renewable energy*

The ESCWA region has the potential to generate a significant amount of renewable energy, mainly from solar, wind and water resources. There are close to 9,000 MW of installed hydro-electric capacity in the region, while solar radiation varies between 1,460-3,000 kWh/m^2/year. Wind energy is also available in several ESCWA countries and commercialized in Egypt.[10] Hydropower consumption increased from 94,400 barrels of oil equivalent per day (boe/d)[11] in 2005 to 127,900 boe/d in 2009, which represents an average annual growth rate of 7.89 per cent.[12]

Figure 2. Energy consumption distribution by resources in 2009



Source: Organization of Arab Petroleum Exporting Countries (OAPEC), (2010), tables 27, 28, 29 and 30.

However, the production of renewable energy is not yet fully developed. As such, oil and gas represented about 52 per cent and 45 per cent of the total energy consumption respectively in 2009 in the ESCWA region, while other energy resources represented less than 3 per cent as shown in figure 2. In this regard, several ESCWA countries announced targets for increasing their share of energy consumption from renewable energy sources by 2020 or 2030, or, as in the case of the Sudan, by 2011 as shown in table 1, expressing the commitment of ESCWA member countries to sustainable consumption and production of energy resources.

[10] ESCWA, League of Arab States, United Nations Environment Programme, Regional Office for West Asia (UNEP/ROWA), (2009).

[11] 1 boe is equal to 140 kgoe.

[12] Calculated from table 30 in OAPEC (2010), p. 44.

TABLE 1. ANNOUNCED TARGETS OF RENEWABLE ENERGY SHARE IN SELECTED ESCWA COUNTRIES

Country	Year	Target
Egypt	2020	20 per cent from electrical energy
Jordan	2020	10 per cent from primary energy
Kuwait	2020	5 per cent from electrical energy
Lebanon	2020	12 per cent from electrical energy
The Sudan	2011	1 per cent from electrical energy
Syrian Arab Republic	2030	4.3 per cent from primary energy
United Arab Emirates	2030	7 per cent from electrical energy

Source: League of Arab States (2010).

B. ENERGY INTENSITY

Energy intensity is a measure of the amount of energy it takes to produce one dollar's worth of economic output and varies widely between countries, depending on their national incomes, levels of industrialization, the mix of services and manufacturing in their economies and the attention they pay to energy efficiency. The energy intensity in the ESCWA region was recorded as 0.51 kgoe per US$ in 2003 and 0.24 kgoe per US$ in 2007.[13] However, this reduction is mainly due to an increase in the gross domestic product (GDP) in oil-producing countries in the region because of high oil prices during the last few years rather than to an improvement in energy efficiency.

C. CARBON DIOXIDE EMISSIONS

Rapidly increasing energy consumption has resulted in the increase of CO_2 emissions. In the ESCWA region, the increase of emissions is not only due to industrial expansion and the use of fossil fuel in electricity generation, but also to the growing number of vehicles on the road, poor traffic management and congestion, inefficient public transportation systems, widespread energy subsidies, as well as an ageing vehicle fleet and the continued use of other aging equipment.

In the GCC countries, it is reported that electricity generation and the petrochemical, aluminium and fertilizer industries, as well as vehicles are the primary sources of carbon emissions.[14] As a result, Qatar, Kuwait, the United Arab Emirates and Bahrain were among the top five countries in the world in terms of CO_2 emission per capita with around 55, 32, 31 and 29 metric tons of CO_2 emission per capita respectively in 2007.[15]

As shown in figure 3, CO_2 emission per capita in the ESCWA region varies greatly from country to country. While all the GCC countries greatly exceed the world average, other ESCWA countries recorded lower emissions per capita than the world average of 4.3 metric tons.[16]

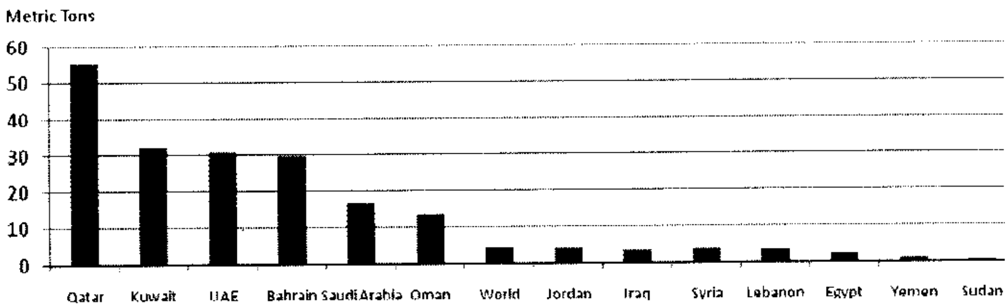
[13] ESCWA (2009c).

[14] ESCWA, League of Arab States, UNEP/ROWA, 2009, pp. 3-4.

[15] World Bank, World Development Indicators. Available at: http://data.worldbank.org/indicator.

[16] Ibid.

Figure 3. Carbon dioxide emissions per capita in the ESCWA region in 2007



Source: World Bank, World Development Indicators. Available at: http://data.worldbank.org/indicator.

D. LEAD AND SULPHUR CONTENTS IN GASOLINE AND DIESEL OIL

In 2005, about 20 per cent of gasoline used in ESCWA member countries was leaded,[17] but by 2009 almost all gasoline consumed was unleaded.[18] Sulphur content in fuel is still reported as being very high compared to international standards. While the emission standard, Euro 4, limited sulphur content to 50 ppm in diesel and 0 ppm in gasoline in 2005, the content of sulphur in ESCWA member countries ranges between 300 and 10,000 ppm in diesel and between 40 and 500 ppm in gasoline.[19]

Nevertheless, several ESCWA member countries are trying to comply with European standards, which decreased the maximum content of sulphur in diesel to 10 ppm in 2009.[20] Kuwait established new units in the Mina Al-Ahmadi and Mina Abdulla petroleum refineries to reduce sulphur content to 50 ppm and Lebanon limited sulphur content in diesel to 350 ppm. Jordan also set a plan to reduce sulphur in diesel in line with international standards and limited maximum sulphur content in refined crude oil to 2 per cent.[21] Moreover, Bahrain decreased the content of sulphur in diesel to 500 ppm and plans to reduce content levels to 50 ppm in the future and Qatar planned to reduce the content of sulphur in gasoline to between 14 and 20 ppm and in diesel to 300 ppm, while Palestine is trying to improve diesel specifications to comply with Euro 4.[22]

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[17] ESCWA (2005).

[18] Data received from a survey on sustainable transport in ESCWA countries (2009).

[19] ESCWA (2005), tables 4 and 5.

[20] ESCWA (2005), table 4.

[21] Data received from a survey on sustainable transport in ESCWA countries (2009).

[22] Ibid.

III. WATER SUSTAINABLE CONSUMPTION AND PRODUCTION INDICATORS

As is well known, water scarcity in the ESCWA region is exceptional. The average annual precipitation of the region was just above 200 mm in 2008, which was less than 20 per cent of the world average precipitation level of 1,162.93 mm. Five out of fourteen ESCWA member countries, namely Bahrain, Egypt, Qatar, Saudi Arabia and the United Arab Emirates experienced less than 100 mm of annual precipitation that same year, which has increased their dependence on non-conventional water and shared water resources.[23] In recognition of this challenge, The Arab Regional Strategy for Sustainable Consumption and Production identified water resource management as one of its five priorities for action and the following indicators, analysed in this chapter, were suggested for monitoring progress towards SCP in the water sector.

- Annual withdrawal of ground and surface water as a percentage of renewable water (per cent);
- Domestic consumption of water per capita (m^3);
- Domestic water use as a percentage of total water demand (per cent);
- Agriculture water use as a percentage of total water demand (per cent);
- Industrial water use as a percentage of total water demand (per cent);
- Irrigation water-use efficiency;
- Domestic water-use efficiency;
- Industrial water-use efficiency;
- Percentage of water bodies conforming with national standards.

A. ANNUAL WITHDRAWAL AS A PERCENTAGE OF RENEWABLE WATER

As can be seen from table 2, annual water withdrawal of surface and groundwater resources as a percentage of total actual renewable water resources has been unsustainably high in the region. Although Lebanon and a few other countries maintain a relatively low level of withdrawal compared to their total renewable water supply, many countries in the ESCWA region have already well exceeded their freshwater balance with withdrawal rates surpassing the natural renewable recharge rate nearly to the point of depletion. This means that surface and ground water resources are becoming increasingly scarce and have required investments in non-conventional resources and alternatives to meet growing demand.

TABLE 2. ANNUAL FRESHWATER WITHDRAWAL AS A PERCENTAGE OF TOTAL RENEWABLE WATER (ACTUAL)
(Percentage)

	2002	2007
Bahrain	220.6	219.8
Egypt	119	n/a
Iraq	87.28	n/a
Jordan	n/a	99.37
Kuwait	2 465	n/a
Lebanon	30.65	28.05
Palestine	33.33	49.94
Oman	94.71	86.57
Qatar	329.3	455.2
Saudi Arabia	n/a	943.3
The Sudan	57.86	n/a
Syrian Arab Republic	97.38	99.35
United Arab Emirates	n/a	2 032
Yemen	161.4	n/a

Source: Food and Agriculture Organization of the United Nations (FAO), AQUASTAT. Available at: www.fao.org.

Note: Calculated from: Total freshwater withdrawal/Total renewable water resources (actual) x 100.

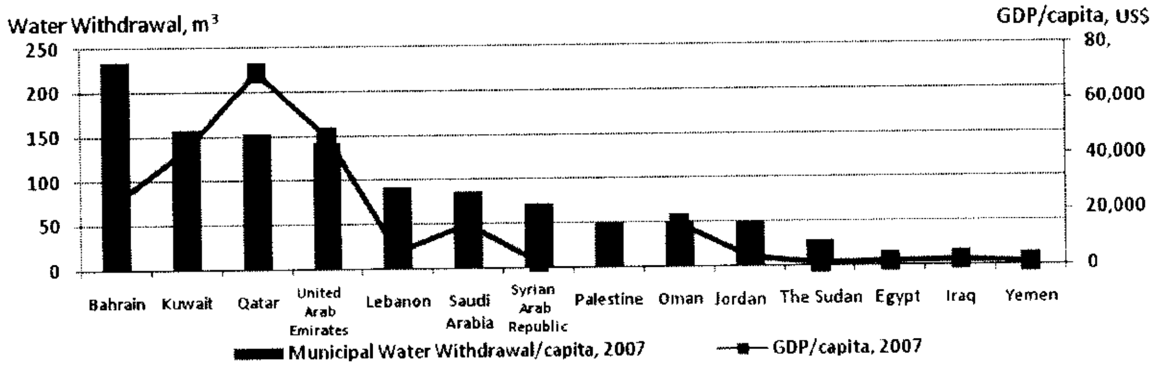
[23] Data from the Food and Agriculture Organization of the United Nations (FAO) and AQUASTA. Available at: www.fao.org.

B. DOMESTIC CONSUMPTION OF WATER PER CAPITA

Although municipal water withdrawal per capita is not necessarily equivalent to domestic water consumption per capita, it can serve as a proxy for understanding this SCP indicator because of the difficulty of accurately measuring water loss through water supply networks and the gaps related to water metering and associated data collection on domestic water usage in the region. Additionally, according to the AQUASTAT definition, "the ratio between the net consumption and the water withdrawn can vary from 5 to 15% cent in urban areas and from 10 to 50% cent in rural areas",[24] which illustrates data challenges associated with compiling national domestic water consumption averages.

Figure 4 shows municipal water withdrawal per capita in the ESCWA countries. While the region generally suffers from water shortages, the inter-regional imbalance of municipal water withdrawal is not negligible. In particular, municipal water withdrawal per capita in Bahrain in 2007 was almost nine times greater than that of the Sudan. Although these were measured in different years, this still exposes a significant imbalance in terms of municipal water withdrawal per capita. When viewed in relation to the previous water indicator, it also shows that renewable freshwater availability is not tied to municipal water withdrawals in the region, primarily due to technological solutions made possible by desalination. Moreover, it seems that municipal water withdrawal per capita is closely related to the income levels of ESCWA member countries as high income GCC countries consumed a significantly larger amount of water compared to other countries in the ESCWA region in 2007. This analysis suggests that regionally, domestic water consumption can significantly increase with the rise of living standards if demand management polices and interventions are not put into place.

Figure 4. Municipal water withdrawal per capita in 2007



Sources: Compiled by ESCWA based on data from World Bank, World Development Indicators. Available at: http://data.worldbank.org/indicator and FAO, AQUASTAT, available at: www.fao.org.

C. WATER USE BY SECTOR AS A PERCENTAGE OF TOTAL WATER DEMAND

Sectoral water withdrawal patterns in ESCWA member countries are heavily oriented towards the agricultural sector. Growing demand for food due to increasing population levels, as well as the recent food crisis manifested by the severe volatility of world agricultural commodity prices have increased the incentive for most ESCWA member countries to expand agricultural output. Socio-economic development priorities have also led Governments to maintain allocations of water resources to the agricultural sector in view of fostering agricultural income and employment opportunities in rural areas so as to avoid rural-to-urban migration. Limited employment opportunities in industrial and service sectors have also kept a significant share of the regional population engaged in agricultural activities. As a result, water resources withdrawn for agricultural purposes represent a very high share of total water withdrawal, even in water-scarce countries, as shown in figure 5.

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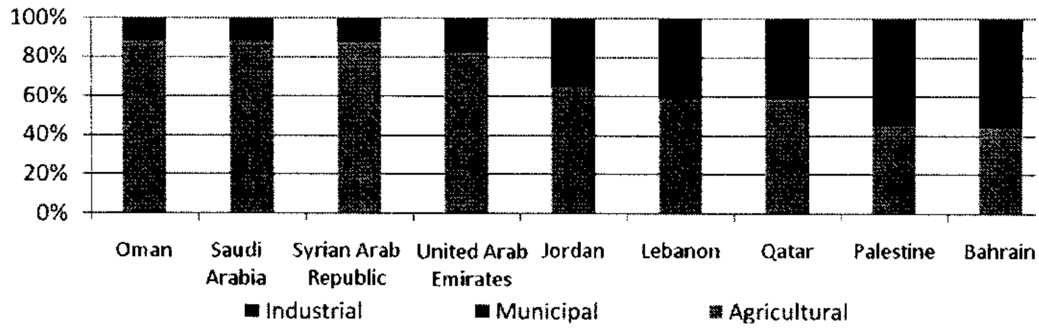
[24] Food and Agriculture Organization of the United Nations (FAO), AQUASTAT Glossary. See http://www.fao.org/nr/water/aquastat/data/glossary/search.html.

Figure 5. Sectoral water withdrawal as a percentage of total water withdrawal (2003-2006)



Source: FAO, AQUASTAT. Available at: www.fao.org.

In comparison, municipal and industrial water withdrawals in the ESCWA region are significantly smaller than agricultural water withdrawals. During the mid-2000s, municipal water withdrawals of the nine countries in figure 5 were recorded to have ranged between 8 per cent and 31 per cent, except in Bahrain where they reached 49.78 per cent, Palestine (47.85 per cent) and Qatar (39.19 per cent).[25] Contrarily, industrial water withdrawal has consistently represented less than 10 per cent of total water use in most ESCWA member countries.[26] However, these shares are likely to increase in the face of growing population levels, increasing calls for economic diversification and efforts to improve agricultural water-use efficiency.

D. WATER-USE EFFICIENCY

Water-use efficiency, for irrigation, domestic and industrial use is among the indicators included in the Arab Regional Strategy for Sustainable Consumption and Production for monitoring and reporting on water-use efficiency. However, as there is no agreed-upon methodology for measuring water-use efficiency in the region across these sectors it is suggested that these indicators require further elaboration.

Broadly speaking, water-use efficiency can be classified as technical or economic efficiency. Technical water-use efficiency may be measured as the percentage of water loss (or water used) in each sector to produce a specific quantity of output. If a minimum and consistent amount of water is required to produce a certain quantity of agricultural and industrial output, it would be possible to measure irrigation and industrial water-use efficiency from a technical perspective. However, this would be a challenging undertaking since every crop has a different minimum water requirement, which varies between countries due to differences in climate and soil conditions. Cropping patterns also change over time. As such, while it is not impossible to measure technical water-use efficiency in principle, it would be difficult to get consistent and comparable national or regional data that can inform decision-making. Nevertheless, sampling the technical water-use efficiency of certain crops and products would be meaningful to identify opportunities for efficiency improvements.

In comparison, economic water use efficiency can be measured as a monetary value (US$) that is produced per additional unit of 1 m^3 of water consumed. As such, it is possible to measure agricultural and industrial water-use efficiency at the national level by comparing sectoral GDP with sectoral water use as presented in table 3. Columns (a) and (c) represent economic water-use efficiency in each sector, and the column (e) represents the efficiency gap, namely how many times more efficient the industrial sector is compared to the agricultural sector in terms of economic water-use efficiency. For example, in Jordan, 1 m^3 of water delivered to the agricultural sector only generated US$0.62 (column (a)), while the same amount of water generated over US$95 in the industrial sector (column (c)). It can thus be said that in Jordan, 154

[25] FAO, AQUASTAT. Available at: www.fao.org.

[26] Ibid.

times more water was used by the agricultural sector to generate the same amount of economic value (measured in US$) as the industrial sector in 2005 (column (e)).

Thus, if only economic efficiency of water use is concerned, it can be said that the agricultural sector is far less efficient than the industrial sector in the ESCWA region. It is noteworthy that agricultural water-use in the United Arab Emirates, Saudi Arabia, Jordan and the Syrian Arab Republic was far less efficient than in Lebanon in 2005, while the United Arab Emirates outshone the other countries in terms of industrial water-use efficiency. However, a direct comparison of the estimated economic water-use efficiency across sectors can be misleading since each sector consumes a different combination of natural resources and the industrial mix differs between countries.

TABLE 3. ECONOMIC WATER-USE EFFICIENCY

	(a) Agricultural value added per m^3 of water (US$)[a/]	(b) Agricultural water use (percentage of total water use)	(c) Industrial value added per m^3 of water (US$)[b/]	(d) Industrial water use (percentage of total water use)	(e) Sectoral water use efficiency gap = (c)/(a)
United Arab Emirates	0.80	(82.84)	1 098.69	(1.73)	1368
Saudi Arabia*	0.51	(88)	316.45	(3)	616
Jordan	0.62	(64.96)	95.07	(4.08)	154
Syrian Arab Republic	0.39	(87.53)	16.24	(3.67)	42
Lebanon	1.68	(59.54)	30.57	(11.45)	18

Sources: Calculated by ESCWA based on the data collected from World Bank, World Development Indicators. Available at: http://data.worldbank.org/indicator and FAO, AQUASTAT, available at: www.fao.org.

* *Figures for United Arab Emirates, Jordan, the Syrian Arab Republic and Lebanon are for the year 2005 and for Saudi Arabia for the year 2006.*

a/ Calculated: Agriculture, value added/Agriculture water use.

b/ Calculated: Industry, value added/Industrial water use.

Nevertheless, time series analysis of economic water-use efficiency for a certain sector in a given country can provide a useful indication of improvement. Table 4 presents economic water-use efficiency in Lebanon in the agricultural sector and the industrial sector in 1994, 2000 and 2005. It can be seen that from 1994 to 2005, while water resources were redirected from the agricultural sector to the industrial sector (column (b) and (d)); agricultural water-use efficiency improved significantly (column (a)). On the other hand, industrial water-use efficiency decreased and this suggests that during 1994 and 2005, the industrial sector in Lebanon engaged in more water-intensive industries. As a result, the sectoral water-use efficiency gap in Lebanon decreased rapidly from 62.34 in 1994 to 18.20 in 2005.

TABLE 4. ECONOMIC WATER-USE EFFICIENCY IN LEBANON

Year	(a) Agricultural value added per $1m^3$ of water (US$)[a/]	(b) Agricultural water use (percentage of total water use)	(c) Industrial value added per $1m^3$ of water (US$)[b/]	(d) Industrial water use (percentage of total water use)	(e) Sectoral water use efficiency gap = (c)/(a)
1994	0.77	(67.67)	48	(3.87)	62.34
2000	1.31	(64.2)	50.32	(5.51)	38.41
2005	1.68	(59.54)	30.57	(11.45)	18.20

Source: Calculated by ESCWA based on the data collected from World Bank, World Development Indicators, available at: http://data.worldbank.org/indicator and FAO, AQUASTAT, available at: www.fao.org.

a/ Calculated: Agriculture, value added/Agriculture water use.

b/ Calculated: Industry, value added/Industrial water use.

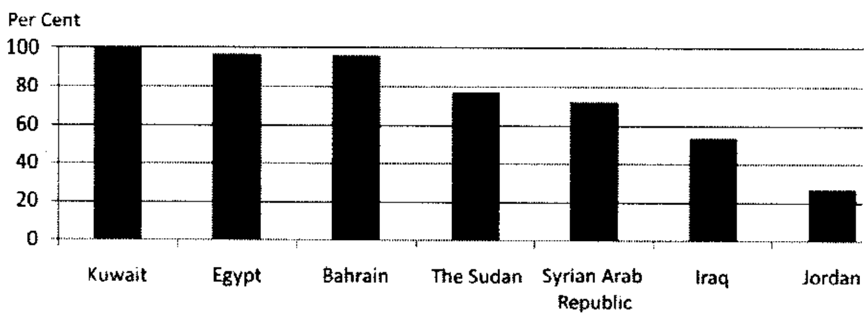
E. Percentage of water bodies conforming with national standards

The percentage of water bodies conforming to national standards is presented as the final indicator for SCP of the water sector in The Arab Regional Strategy for Sustainable Consumption and Production. However, the methodology for calculating this indicator is not elaborated in the text. The strategy makes reference to the increasing importance of water quality as an issue of concern for the Arab region, noting that "sewage discharges, industrial wastes and agricultural effluents represent a serious threat to human health and further aggravate water scarcity by reducing clean water availability".[27] This section in the strategy also refers to water resources that are shared by two or more countries. However, it is not clear which water bodies are covered by the indicator and which national standards should be included in the scope of analysis. Thus, the purpose and scope of this indicator for monitoring SCP of the regional water sector needs clarification prior to data collection, monitoring, reporting and analysis.

F. Dependency ratio

In view of the limitations associated with the previous indicator, a proposed alternative indicator is offered that can help monitor regional conditions related to the availability and consumption of freshwater originating from a shared water resource. The dependency ratio represents the percentage of total renewable water resources originating outside the country and can be useful for disaggregating sustainable consumption and production figures in relationship to water security. The value of this indicator is evident when one examines the dependency ratios for Bahrain (96.6 per cent), Egypt (96.9 per cent) and Kuwait (100 per cent) in figure 6, which show that the freshwater resources used by these countries originate outside of their borders. This indicator, when viewed within the context of water scarcity, can also expose whether sustainability of the water sector can be threatened by external factors.

Figure 6. Dependency ratio in selected ESCWA member countries*



Source: FAO, AQUASTAT. Available at: www.fao.org.

* Dependency Ratio: the percentage of total renewable water resources originating outside the country.

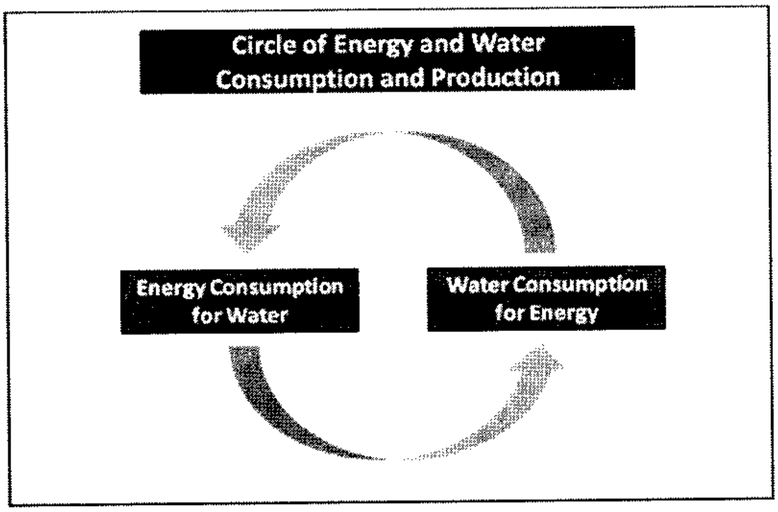
[27] League of Arab States (2009), p. 8.

IV. WATER AND ENERGY LINKAGES

As evidenced by the Marrakech Process and in the Arab Regional Strategy for Sustainable Consumption and Production, SCP concerns are generally addressed at the sectoral level. This limits the identification and pursuit of integrated approaches to more sustainable patterns of consumption and production at the national, regional and global levels. For instance, the Regional Arab Strategy for Sustainable Consumption and Production identifies five sectors and recommends indicators and policies for each of them. While this is not to discount the value of sectoral approaches and interventions, this paper argues that since a sectoral approach can neglect cross-sectoral or multi-sectoral linkages, an integrated approach to SCP could generate innovative and efficient ways for improving natural resource management and progressing towards sustainable development. This chapter examines energy and water linkages with a view to exposing opportunities presented by pursuing SCP through a more integrated approach.

The production, consumption, and management of energy and water resources are interdependent in many ways and should be dealt with in an integrated manner in order to facilitate the identification of opportunities for sustainable practices resulting from those linkages.

Figure 7. Circulation of energy and water



A. ENERGY CONSUMPTION BY THE WATER SECTOR

Energy is required in the production (or extraction), distribution and consumption of water resources. Surface and ground water are extracted, in most cases, using water pumps operated by diesel generators or electricity, while desalination facilities consume large amounts of energy for the separation of salt and minerals from seawater and brackish water resources. Since the ESCWA region is home to the highest desalination capacity in the world, with some countries nearly fully dependent upon desalinated water for domestic use, energy consumption by the water sector is not only a question of sustainability, but a fundamental component of human security in the ESCWA region. Table 5 shows the amount of energy generally consumed by different types of desalination facilities based on various technological options. The amount of water produced and energy consumed depends on the technology adopted.

TABLE 5. ESTIMATED ENERGY CONSUMPTION OF MAJOR DESALINATION PROCESSES

Process	Heat (Megajoule per cubic metre)	Electrical (kWh/m^3)	Total electric equivalent (kWh/m^3)
Multi-stage flash	250-300	3.5-5	15-20
Multi-effect distillation	150-220	1.5-2.5	8-20
Vapour compression			
Thermal vapour compression	220-240	1.5-2	
Mechanical vapour compression	None	11-12	11-12
Reverse osmosis			
Seawater	None	5-9	5-9
Brackish water		0.5-2.5	0.5-2.5
Electrodialysis	None	2.6-5.5	2.6-5.5

Source: Banat and Qiblawey (2007), table 1.

Energy is also required for distributing water through supply networks. In order to transport water resources from extraction, production or storage sites to consumers, vertical and horizontal pumping is required. Accordingly, energy consumption is not negligible, particularly if the distance and increase in elevation is significant. For instance, when assessing energy consumption needs for desalination, it is not only important to consider the amount of energy required to operate the facility, but also the geographic relationship between consumers and the plant, which is most often located on the coast. As evident in table 6, energy needs would be particularly significant for cities such as Sana'a, which is situated on a high plateau 130 km from the sea. As further elaborated in the table, this also has an implication for CO_2 emissions, one of the SCP indicators related to the energy sector in the Arab Regional Strategy for Sustainable Consumption and Production.

TABLE 6. ENERGY CONSUMPTION AND COST OF CO_2 EMISSIONS FOR WATER TRANSPORT

City	Distance from sea (km)	Elevation (m)	Energy (litres-diesel/m^3)	$Kg\text{-}CO_2/m^3$	CO_2 abatement ($\$/m^3$)
Sana'a	130	2 250	2.0	5.4	0.11
Amman	270	890	0.83	2.2	0.04
Riyadh	360	600	0.58	1.5	0.03
Damascus	180	680	0.63	1.7	0.03
Gaza City	0	35	0.03	0.08	0.00
Muscat	0	15	0.01	0.04	0.00

Source: ESCWA (2009b), table 9.

Although energy requirements for the transport of water differ depending on the type of water pump used, it is estimated that approximately 0.36 kWh is needed to lift one cubic meter of water 100 meters.[28] While this has evident implications for the pumping and long-distance transfer of groundwater or desalinated water to in-land urban centres, this also demonstrates the energy requirements associated with the pumping of water from groundwater and lower-lying surface water resources for agricultural purposes. An assessment by ESCWA of the diesel expenditures paid for the pumping of groundwater to supply fields of *zaatar* in Southern Lebanon found that energy inputs can represent 6 per cent of production costs in small-scale farming activities and thus have direct implications for agricultural income generation and rural development.[29]

Energy is also required to pump water through municipal water distribution networks. The operation and maintenance of water networks and the coverage of associated energy costs must normally be borne by

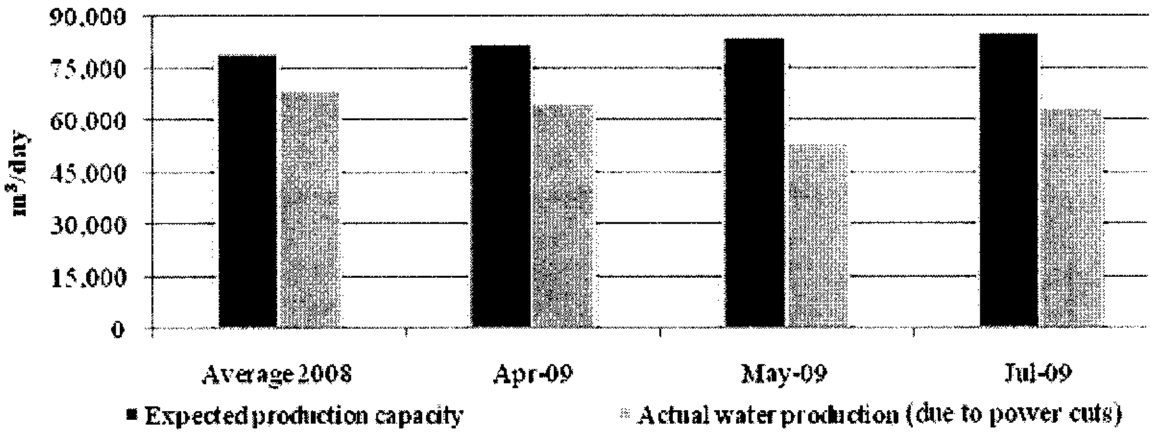
[28] ESCWA (2009b), p. 25.

[29] ESCWA (2009f).

water operators and can be particularly expensive in mountainous countries such as Lebanon and Yemen. Accordingly, as energy prices increase, so does the cost of water supply and sanitation, though the costs are rarely transferred to the consumer in the ESCWA region. This in turn reduces the financial sustainability of the water-service operator and the funds available to invest in improving the monitoring and delivery of water services.

Moreover, studies have found that the intermittent supply of water through distribution networks can increase the volume of unaccounted-for water that is lost through the network as water-pressure variability increases the stress on pipes and joints, resulting in cracks in the network and associated leaks. While intermittency is sometimes caused by water rationing due to water scarcity, limited access to reliable and adequate energy supplies by water operators due to electricity rationing or high energy costs have also constrained their ability to provide water services on a continuous basis throughout the network. This condition is commonly experienced in Jordan, Lebanon, Palestine and Yemen. The case of Yemen is elaborated in figure 8 which shows that the actual water supplied to the capital city of Sana'a was far less than expected due to power cuts that limited the ability of the operator to distribute freshwater throughout the network.

Figure 8. Water and energy linkages affecting water supply delivery in Sana'a, Yemen



Source: Sana'a Water Supply and Sanitation Local Corporation and ESCWA in (ESCWA 2009f).

Intermittency of service provision also has implications for human health as variable pressure levels within the water supply network can result in the suction and infiltration of external contaminates and sewage water into the networks, which are then flushed through the system to consumers once freshwater is released back into the system.

Frequently water pumps are used in sanitation networks to transfer untreated wastewater to treatment plants where energy is also consumed. In order to promote SCP of water, treated wastewater should be considered as a valuable water resource that can be used for groundwater recharge, irrigation and other industrial and municipal purposes. Considering that groundwater resources are being depleted in the region and agricultural water use remains high, the use of treated wastewater presents an important opportunity for increasing SCP of water and energy sectors, particularly if energy-efficient wastewater treatment technologies and pumping systems are considered during investment planning and decision-making.

B. WATER CONSUMPTION BY THE ENERGY SECTOR

Water resources are also used at several stages of energy production. In hydroelectric and thermoelectric power plants water is required for power generation. In mining, water is used during the washing and extraction of minerals. It is reported that approximately 200 litres of freshwater can be consumed for every ton of coal produced.[30]

Oil production also consumes vast amounts of water resources. In oil extraction, water is injected into the oil well to raise the pressure or to soften oil shale and tar for extraction.[31] Since the ESCWA region supplies a large share of global oil production, the accompanying water consumption should be studied carefully as satisfying global energy demand has implications for local water supplies. Efforts are thus underway to develop more water-efficient oil production technologies and alternatives. Further analysis is necessary to compare currently available technologies in terms of their water consumption in order to promote SCP of water and energy in the ESCWA region. Moreover, reuse of oilfield wastewater should be studied. In November 2010, Shimizu Corporation, a Japanese company, announced the operation of a pilot plant for oilfield wastewater treatment in Oman with the capacity of 50 m^3 of water per day for use in irrigation.[32]

In addition, water is commonly used for cooling. The evaporative water cooling method which is the most common cooling technique for concentrated solar power (CSP) generation consumes a large amount of water. In the United States of America, 1 MWh of electricity generated by CSP through parabolic-trough technology consumes around 3,000 litres of water, while the dry cooling method and hybrid cooling method can reduce the consumption of water by 90 per cent and 80 per cent respectively.[33]

With a vast amount of sunshine, the region has great potential for solar energy production, considered as one of the most feasible future energy sources. However, as water is the resource most lacking in the region, investment in more water-efficient solar energy production technologies is needed and water-efficient dry or hybrid cooling systems should be considered to delink solar energy production from water consumption. It may be possible to find alternative materials or methods to cool solar panels, or to integrate solar energy production plants with other facilities consuming hot water.

Water is also used in steam-operated systems found in industrial processes and electrical power generation and during other cooling and heating processes, washing and other phases of industrial production and manufacturing. Reviewing these relationships in an integrated manner can assist with the transition towards more sustainable consumption and production of both energy and water resources.

C. INTEGRATED MANAGEMENT OF ENERGY AND WATER FOR SUSTAINABLE CONSUMPTION AND PRODUCTION

Links in production and consumption of energy and water present a variety of opportunities to improve sustainable production and consumption patterns of energy and water resources. An integrated approach can help to identify mutual benefits for each sector, as well as prevent the adoption of conflicting policies that might increase the sustainability of one sector to the detriment of the other. For instance, the pursuit of sustainable solar energy should be considered with a view towards appreciating water scarcity and the existing demands on water resources in the region; while the desalinization and transport of water should take into consideration energy consumption patterns and costs. The integrated management of energy and water resources can further improve policy coherence for SCP.

Governments can promote integrated energy and water resource management through policy initiatives that engage both water and energy operators and gather diverse stakeholder groups around the

[30] The Greens, Greens Mining. Available at: http://nonewcoal.greens.org.au/coal/toxicity/water-concerns/water-use-in-coal-mines.

[31] Belden et al. (2008).

[32] Japan for Sustainability. Available at: http://www.japanfs.org/en/pages/030782.html.

[33] ESCWA staff calculation from table 2, United States Department of Energy (2009) and p. 5.

table. Cross-sectoral financing and investment that seek more integrated and streamlined planning of water and energy related infrastructure and services presents another opportunity. From an engineering vantage point, improving energy efficiency during the production and transport of freshwater can contribute to SCP of both energy and water. Investing in energy-efficient or renewable energy desalination technologies and water-pumping schemes can also result in mutual benefits that advance the sustainable consumption and production of energy and water resources.

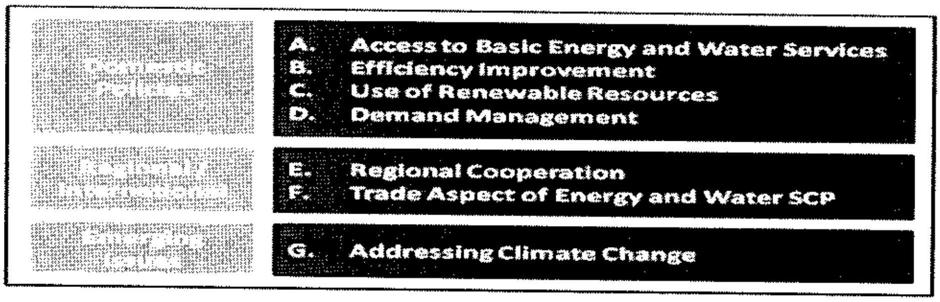
In addition, policy coherence should be central to efforts seeking to promote integrated energy and water resource management for SCP. By pursuing SCP across both sectors simultaneously, policy-makers can minimize the potential for conflicting policies, support priority-setting and ensure consistency and coherence during planning and investment decision-making. For example, when seeking to increase the provision of water services in an urban area, investing in a reliable energy source might result in increasing the quantity of water delivered and reduce operation costs to a greater extent than additional investments in water infrastructure. Efficiency gains can also be achieved by the private sector based on integrated energy and water resource management options with an SCP framework.

V. POLICY RECOMMENDATIONS FOR SUSTAINABLE CONSUMPTION AND PRODUCTION OF ENERGY AND WATER

As reviewed in chapters II and III, while the ESCWA region has suffered from extreme energy disparities and water scarcity, sustainability of energy and water has not yet been guaranteed. Thus, national and regional efforts to ensure SCP patterns of energy and water are required. For this purpose, the Arab Regional Strategy for Sustainable Consumption and Production has recommended a list of policies for each sector.

However, as discussed in chapter IV, since production and consumption of energy and water are closely linked, it is necessary to follow an integrated approach towards SCP of both sectors and to promote policy coherence across sectors. This chapter presents policy recommendations for SCP of energy and water in an integrated manner based on the following structure.

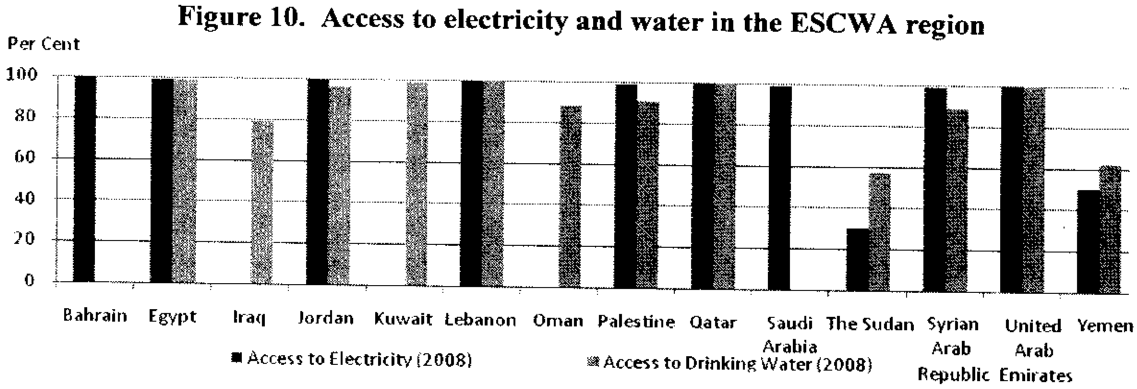
Figure 9. Integrated policy approach for sustainable consumption and production of energy and water



A. ACCESS TO BASIC ENERGY AND WATER SERVICES

Greater access to energy and water services is both a goal and a necessary condition for sustainable development. Proper provision of energy and water raises living standards and enriches human capability and is a prerequisite for most economic activity, while access to stable energy is essential for SCP of water. In 2002, about 20 per cent of the population in the region suffered from a shortage of electrical energy services and almost an equal amount from the absence of a steady and vigorous energy supply in general.[34] In 2008, although it was reported that several ESCWA member countries, including Egypt, Jordan, Lebanon, Qatar and the United Arab Emirates recorded close to 100 per cent access to electricity and water, many countries in the region could still not provide these services to considerable portions of their population. In 2008, only 30 per cent and 50 per cent of population had access to electricity in the Sudan and Yemen respectively. Also, as can be seen in figure 10, more than one fifth of the population did not have access to an improved drinking water source in Yemen, the Sudan or Iraq in 2008.

Figure 10. Access to electricity and water in the ESCWA region



Sources: Combined from Arab Union of Electricity, *Statistical Bulletin 2009*, Issue 18; World Health Organization (WHO) and United Nations Children's Fund (UNICEF), (2010) and ESCWA (2009a).

[34] ESCWA, UNEP, CAMRE and OAPEC (2005), p. 44.

While energy and water access can primarily be achieved through expanding energy and water networks, particularly electrical grids, natural gas pipelines and water networks, policies and investment decisions for energy and water accessibility should be implemented in an integrated manner. In particular, energy efficiency should be taken into consideration during the design and implementation of policies for increasing access to water supplies and sanitation services, so that increased access is not achieved at the expense of energy sustainability and vice versa. If the value of energy sustainability is taken into consideration during water infrastructure investment decision-making, a more energy- efficient infrastructure may be the more economically reasonable choice.

B. EFFICIENCY IMPROVEMENT

1. *Energy efficient desalination technologies*

The application of energy-efficient practices for producing alternative water resources is significant in shifting towards SCP of energy and water in the ESCWA region. Gulf countries have invested in alternative water resources to address water scarcity. As a result, the production of desalinated freshwater has quickly increased during the last decade as indicated in table 8 and it is reported that ESCWA countries account for around 44 per cent of global desalination capacity.[35]

TABLE 7. DESALINATION CAPACITY OF THE ESCWA REGION

Country	Installed capacity (*thousands of m³/day*) 2000	2008	Capacity increase (*percentage*)
Saudi Arabia	5 153	10 598	106
United Arab Emirates	2 669	8 743	228
Kuwait	1 153	2 390	107
Qatar	511	2 049	301
Bahrain	409	783	91
Iraq	343	310	-10
Oman	173	960	455
Egypt	253	712	182
Yemen	43	58	35
Lebanon	26	28	9
Jordan	14	227	1 549
Syrian Arab Republic	12	13	17
Palestine	11	11	0
The Sudan	2	44	1 841
Total	10 771	26 927	150

Source: ESCWA (2009b), table 2.

If desalinated water can be produced in a more energy-efficient way, it would be particularly relevant for SCP of energy and water in the ESCWA region, contributing to increasing both energy and water sustainability. One of the possible ways to improve energy efficiency in desalination facilities is their integration with energy production plants. Indeed, the Jebel Ali Power and Desalination Station 'L' (Phase II), located in the United Arab Emirates and the largest desalination plant in world, is a dual-purpose desalination facility using multi-stage flash distillation and capable of producing approximately 250 million litres of water per day while simultaneously producing 1,137 MW of electricity based on figures from 2009.[36]

[35] ESCWA, (2009b) pp. vi and 9.

[36] Dubai Electricity and Water Authority. Available at: www.dewa.gov.ae/aboutus/electstats2009.aspx.

In addition, there is great potential for desalination technology powered by renewable energy. Recognizing this opportunity, the King Abdul-Aziz City for Science and Technology launched a national initiative for water desalination using solar energy, applying advanced nanotechnology techniques in the production of solar energy systems and membranes for water desalination. One of the main objectives of this initiative is to desalinate seawater at a cost of less than 1.5 Saudi Riyals (1 Saudi Riyal = US$0.27)[37] per cubic meter compared to the current cost of desalination of seawater by thermal technology, which is in the range of 2.5 to 5.5 Saudi Riyals per cubic meter.[38]

Box 1. Wind-powered desalination in Bahrain

On 31 January 2011, a memorandum of understanding was signed between Jade Consultancy of Bahrain and Synlift Systems GmbH of Germany to promote wind-powered desalination technology in Bahrain. Extensive studies show that this technology is technically feasible, locally suited and economically profitable in the Gulf Cooperation Council region.

Source: http://www.desalination.biz/news/news_story.asp?id=5724.

2. *Energy efficiency in the transportation sector*

Generally, improving energy efficiency can reduce energy consumption while mitigating global greenhouse gas (GHG) emissions. Although efficiency-improvement efforts should take place in various sectors, improving the efficiency of energy used for transportation is particularly relevant in the ESCWA region; not only because it is crucial for trade at national, regional and global levels as well as for a wide variety of public and social services but also because transportation consumes more than 50 per cent of total oil consumption in the region.[39] Thus, sustainable transport was among the five thematic areas of CSD-18 and CSD-19.

Improving energy efficiency in the transport sector and reducing emissions in the ESCWA region requires the improvement of (i) vehicle operation and maintenance, and (ii) gasoline and diesel oil specifications. While it is reported that GCC countries have improved fuel specifications considerably to meet international norms, Iraq and Yemen are currently working towards improvement.[40]

Also, advanced transport technologies should be considered in the ESCWA region. Although use of electric vehicles has not been globally widespread, active research and development is ongoing to produce economically feasible electric cars, and hybrids are already available in international car markets. Natural gas vehicles are widely driven in Egypt and several pilot projects have been initiated in other ESCWA member countries.

In addition, use of public transport should be encouraged and Governments need to provide better public transportation systems. There are good regional examples, including the underground metro project of Cairo, Egypt and light rail construction plans are under preparation in Amman and Damascus. Nevertheless, public transportation systems in such ESCWA member countries as Yemen and Lebanon are not yet well established, encouraging people to drive private vehicles.

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[37] Xe: The World's Favourite Currency Site. Available at: http://www.xe.com/?c=SAR (retrieved on 12 April 2011).

[38] King Abdul-Aziz City for Science and Technology. Available at: http://www.kacst.edu.sa/en/about/media/news/Pages/news49.aspx.

[39] ESCWA (2009d), p. 8.

[40] Ibid., p. 22.

While the transportation sector requires special attention in the ESCWA region, it is also worth considering other sectors that consume large quantities of energy. There are opportunities to improve energy efficiency in the building sector through efficient lighting, power factor correction, electrical load management, proper thermal insulation and double glassing, promotion of home appliances labelling and standardization and the promotion of building codes. It is also possible to enhance energy efficiency in the industrial sector by waste-heat recovery, improvement of combustion and steam system efficiency, energy cogeneration, power factor correction and high efficiency motors.

3. *Oil and gas production efficiency*

Improving energy efficiency in production sectors should include activities related to oil and gas exploration and production since these activities consume considerable amounts of energy and thus have large potential for energy saving in the ESCWA region. According to a study conducted by Stepanov and Stepanova for Russia in 2007, the minimum amount of electricity required for oil production was calculated to be at 5.483 kWh/t, while average electricity consumption for oil production was 49.5 kWh/t.[41] Although the result may be different in the oil production sector of the ESCWA region, it still indicates a huge energy loss. Thus, considering the weight of the ESCWA region in the world oil-production sector, conservation of energy during oil production should be a priority and can play a critical role in SCP.

In addition, possibilities for enhancing efficiency in energy conversion facilities (mainly oil refineries and electrical power plants) and reducing energy losses in electrical energy networks and oil and natural gas pipelines should be priorities for SCP in the ESCWA region.

4. *Integrated water resources management*

The integrated management of energy and water resources can improve planning and the efficient use of natural resources in the ESCWA region. The economic, environmental, social and technical aspects of energy and water should be considered together in decision-making processes concerning their production and consumption, with participation from Government ministries, energy and water producers, consumers, civil society and academic communities.

In this regard, it is worth noting the importance of adopting integrated water resources management (IWRM) "a process which promotes the co-ordinated development and management of water, land and related resources, in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems".[42] Adopting a holistic approach with multi-sectoral perspectives can help to reduce water management inefficiency resulting from separate decision-making by various stakeholders.

This integrated approach is essential in the ESCWA region where the challenges of water resources are multifaceted and multi-sectoral. Various stakeholders compete for extremely limited water resources, rendering water allocation decisions sensitive, with huge social, economic and environmental impact. Continuous technological development and efficiency enhancement for alternative water resource production is needed while also considering water quality. Food production to feed the increasing regional population is a concern as well, necessitating the adoption of IWRM principles and tools to ensure good water governance and improved water management.

C. PROMOTING RENEWABLE RESOURCES

1. *Developing and widening use of solar energy*

During the past two decades, several renewable energy technologies have been developed. Some have been tested and are ready for application in the field, particularly for small capacities in remote applications,

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[41] Stepanov and Stepanova (2007), pp. 1219-1220.

[42] Global Water Partnership (2000), p. 22.

while others are still being developed. However, these technologies have not been widely utilized to satisfy energy services, since constraints, especially financial constraints and barriers exist.

The Middle East and North Africa is reported to be one of the most promising regions for solar energy generation and it has been suggested that the solar energy potential in this region is greater than the total global electricity demand.[43] If the implications for water sustainability were to be adequately considered and incorporated into the planning, design and execution of potential projects for realizing such regional potential, it would contribute greatly to SCP of energy and potentially of water.

Accordingly, ESCWA member countries have implemented several solar energy projects. Egypt constructed the first concentrating solar power (CSP) system generating 20 MW of solar power and two additional CSP projects of 50MW each are planned to be constructed by 2017.[44] In the United Arab Emirates, the Abu Dhabi Future Energy Company, also known as Masdar, is currently testing the use of different photovoltaic (PV) solar energy technologies with a view to improving the efficiency of energy production in the face of dust and sand particles that reduce the performance of such systems in desert-like environments. Masdar is seeking to connect a PV plant to the electricity grid and two CSP facilities are expected to start operation by late 2011 and mid 2013; while ESCWA, in cooperation with the Ministry of Energy and Electricity completed the Ka'awa Village Photovoltaic Electrification Project in Yemen in 2010.[45]

While enhancing SCP, the generation of energy from renewable sources can provide job opportunities in related industries. There are about 3 million directly-related jobs in renewable energy industries globally, approximately 50 per cent of them in the biofuel industry.[46] In recognition of these positive impacts, the European Union has set a target of 20 per cent of energy consumption coming from renewable sources by 2020. Achieving this target is expected to provide full-time employment for an additional 2,023,000 people, a 728 million ton/year reduction in CO_2 emissions representing a 17.6 per cent decrease in total GHG emissions in Europe compared with 1990 levels and savings of €115.8 billion in fuel costs.[47]

2. *Encouraging use of biogas energy*

Wastewater treatment and reuse has significant importance considering water scarcity in the region and the impact of untreated wastewater on water quality. Indeed, certain ESCWA member countries have reused municipal wastewater for agricultural purposes. For example, in Jordan, it is reported that treated municipal water is reused for irrigation and comprises an important part of the national water supply with 19 wastewater treatment plants providing service to about two thirds of the urban population.[48]

However, as the treatment of wastewater consumes relatively large amounts of energy, investment in a wastewater treatment facility should take energy efficiency into consideration, so that an increase in wastewater treatment does not lead to an energy deficit in the region. Biogas energy can be produced during wastewater treatment and its use can improve energy efficiency.

Biogas energy also can be used to fill the energy gap in remote rural areas. Studying the feasibility of family biogas production from mixed organic wastes in Palestinian rural areas was carried out by a field survey and experiment. The field survey pointed out the importance of constructing family biogas plants in

[43] German Aerospace Center (DLR), (2005), p. 8.

[44] ESCWA (2009e), p. 5.

[45] Ibid., p. 5.

[46] Renewable Energy Policy Network for the 21 Century (REN21), (2010), p. 9.

[47] European Renewable Energy Council (EREC), p. 3.

[48] United Nations Department of Economic and Social Affairs (DESA), (2005), p. 23.

Palestinian rural areas where the average size of a family is 6.85 persons. Data from the field survey also detailed the availability of organic wastes for rural families, since the majority are engaged in both animal raising (72.47 per cent) and cultivation activities (87.45 per cent), which can increase the quantity of biogas generated from domestic waste.[49]

3. *Pumping water using wind energy*

Water pumping using renewable energy resources should be further examined for its possible application in the region. Indeed, water pumping with wind power is not a new idea and windmills have been used to pump water for more than a millennium. As certain countries in the region rely heavily on groundwater resources, while water production and storage facilities in other countries are located quite far from major cities, it is important to identify ways to reduce energy consumption for water extraction and transportation using renewable energy sources such as wind energy.

The potential for the development of wind-energy water pumping was studied in Jordan. The results show that wind energy for water pumping is "favorable" in some sites (Ras Muneef, Mafraq and Aqaba), while other sites (Irbid and Ma'an) are considered to be "promising". The rest of the sites studied including Amman, Queen Alia's Airport, Shoubak and Deiralla are found to be "poor" for this application.[50]

In addition, the Egyptian Solar Energy Society (ESES) implemented a project for the use of wind energy to meet water access and electricity needs. The project, carried out from September 1995 to September 1997, resulted in the design and manufacture of four small-scale wind turbines for water pumping. Together with the Arab Manufacturing Authority, ESES, designed and built the turbines and installed them in four village areas in the period between September 1996 and June 1998. They are capable of pumping from 700-2,400 liters of water per hour for agricultural use.[51]

D. ENERGY AND WATER DEMAND MANAGEMENT

As can be seen from figure 11, countries in the ESCWA region have significantly different energy and water consumption patterns. High consumption of energy is found in Qatar, the United Arab Emirates, Bahrain and Kuwait with energy consumption hovering around and above 10,000 kgoe per capita in 2007, while people living in most other ESCWA member countries consumed less than one fourth of that amount. Likewise, water withdrawal per capita varies greatly. Although this gap of energy and water consumption within the region mostly stems from differences in their national endowments, extremely high consumption of energy and water in a few ESCWA countries suggests that regionally there is good potential for demand management.

Although adequate energy tariffs are an important condition for promoting energy efficiency, the ESCWA region has not properly managed energy based on economic principles, as prices have been highly subsidized in most countries. This has led to economic losses, accelerated energy demand growth rates, increased need for investment and low energy efficiency, as well as environmental impacts. Energy subsidies represent a considerable share of the total budget in several ESCWA member countries. For example, petroleum product subsidies represented 17 per cent of the total budget in Egypt in the fiscal year 2008/2009, exceeding spending on infrastructure investment.[52] It is essential to introduce economic instruments to support the management of the energy sector, with a focus on enhancing existing energy tariffs, rationalizing energy subsidies and providing appropriate incentives. Such measures should take into

[49] Hassan (2004), p. 11.

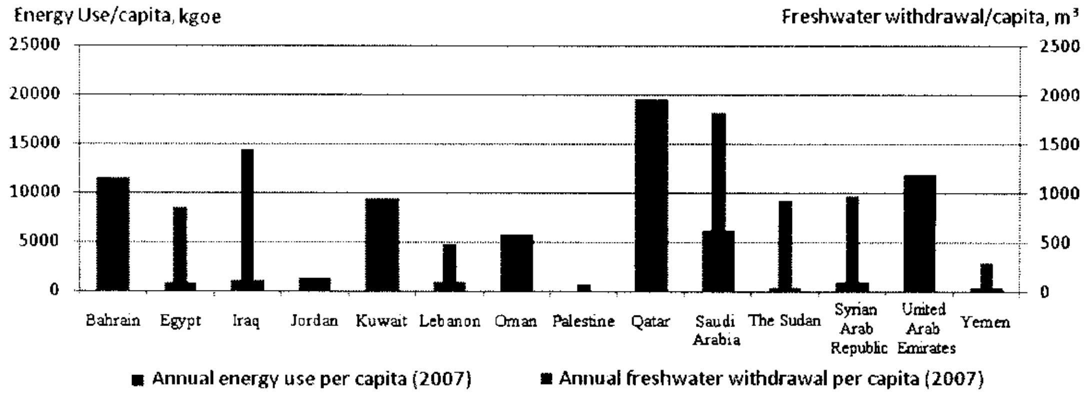
[50] Mohsen and Akash (1998).

[51] United Nations Development Programme (UNDP) and Global Environment Facility (GEF), p. 1.

[52] German Technical Cooperation (GTZ), (2010), pp. 7-8.

account the specific needs and conditions of each country. Specifically, the tariff structure of the region should address electrical peak clipping and shifting or energy conservation goals. These measures can lead to reduced electricity generation and thus reduced investment required for installing new power plants.

Figure 11. Energy and water consumption per capita in ESCWA member countries



Sources: World Bank, World Development Indicator, and FAO, AQUASTAT.

Proper level of water pricing is needed, though difficult to determine since water has aspects of both public and economic value; considering the high production cost of water in the ESCWA region, a higher water pricing system is probably needed. While Saudi Arabia recorded the highest water consumption per capita in 2007, it is worth noting that it was recently decided to raise the price of water for non-residential users, in order to promote conservation.[53]

In addition, as indicated before, water use in the agricultural sector, important for providing jobs and securing food production in the ESCWA region, is exceptionally high. However, since current water-intensive practices are not likely to be sustainable in the area, either a transition to alternative crops or a shift to labour-intensive light industry which can absorb the large labour force currently employed in the agricultural sector is required.

E. REGIONAL COOPERATION

1. *Enhancing energy networks among the ESCWA member countries*

Through enhancing energy networks between the ESCWA countries, several economic, technical and environmental benefits can be realized. The most significant projects in the region are: (a) an Arab Gas Pipeline project, the total length of which will be 1,200 km once completed, at a cost of US$1.2 billion;[54] (b) Dolphin Energy Limited of Abu Dhabi, which connects Qatar, Oman and the United Arab Emirates; and (c) the Electrical Grid Interconnections projects, all of which encourage the exchange of energy between ESCWA member countries.

As a result, energy availability and reliability has improved and the necessary reserve margin and thus the installed electrical capacities of participating countries have been reduced. By reducing the total amount of fuel consumed, energy networks between ESCWA member countries, also enhance energy efficiency and reduce GHG emissions. Thus, expansion and improvement of this type of interconnectivity would promote SCP of energy regionally.

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[53] The current water price for non-residential users is 0.1 Saudi riyal (1 Saudi riyal =US$0.27) per m^3 for amounts less than 50 m^3 per month. Bloomberg, 25 Dec 2010, 'Saudi Arabia Plans Water-Price Rise for Non-Residential Users'. Available at: www.bloomberg.com/news/2010-12-25/saudi-arabia-plans-water-price-rise-for-non-residential-users.html.

[54] http://yalibnan.com/site/archives/2008/02/_the_meeting_co.php.

2. *Transboundary water basin management*

Water resources do not respect man-made borders and many are internationally shared. As discussed in chapter III, the region shows the highest dependency ratio, which can threaten SCP of water. Thus, it is critical for ESCWA member countries to establish mechanisms to ensure sustainable management of these shared water resources. In this regard, establishment of joint management institutions has been encouraged; the Southern African Development Community (SADC) member countries successfully established river basin organizations in most of their shared water basins within the regional legal framework for shared water resources.

However, the ESCWA region does not have a successful record in this regard and is yet to ratify the United Nations Convention on the Law of the Non-navigational Uses of International Watercourses-which was opened for signature in 1997. Nevertheless, it is worth mentioning that the Arab Ministerial Water Council (AMWC) adopted a resolution to prepare a draft legal framework on shared water within the Arab Region in July 2010 which will foster the establishment of joint river-basin organizations as in the case of SADC.

F. SUSTAINABLE CONSUMPTION AND PRODUCTION OF ENERGY AND WATER WITH RESPECT TO TRADE

1. *Maximum use of virtual water*

The concept of virtual water provides a new way of addressing water issues in the region. Virtual water represents the amount of water embedded in a particular food or product, with amounts varying significantly. For example, it is reported that 16,000, 3,000, and 900 litres of water are embedded in 1 kg of beef, rice and maize respectively.[55] Thus, if countries with insufficient water resources, like ESCWA member countries, import food or products in which a large quantity of water is embedded, while exporting food or products requiring a small quantity of water for their production, it is principally possible to reduce the water imbalances of the world through international trade. As the volume of international trade has increased significantly during the last half century, trading of virtual water can have significant impact on balancing water resources of the world and thus contribute to SCP of water in the ESCWA region.

Certainly, balancing the water account of the world is not the only concern motivating the various players engaged in international trade and the purpose behind international trade of food or products is not primarily to trade in virtual water. Nevertheless, it is still relevant to assess the current trade structures of ESCWA member countries and to seek a better balance without reducing other economic and social benefits. In particular, the energy embedded in raising and transporting food or other products should be considered simultaneously and harm to energy-poor countries should be avoided.

Table 8 summarizes the virtual water flow of ESCWA member countries from 1997 to 2001 presented by Hoekstra and Chapagain. According to their study, most of countries in the region received virtual water from international trade, which demonstrates how countries have had to turn to trade to satisfy their food needs. Contrarily, the Sudan, the Syrian Arab Republic and the United Arab Emirates recorded virtual water losses due to international trade. While re-exports through ports and free trade zones may account for the majority of these virtual water outflows from the United Arab Emirates, the exports of livestock products and primary agricultural commodities from the Sudan and the Syrian Arab Republic respectively account for much of these outflows. Virtual water figures can help to mainstream the analysis of water consumption needs and requirements for economic development, trade and food security. This analysis could be enhanced by also considering the energy requirements that are necessary to treat or deliver the water to produce the goods as well.

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[55] Water Footprint homepage: www.waterfootprint.org.

TABLE 8. VIRTUAL WATER AND TOTAL RENEWABLE WATER RESOURCES

Country	Net virtual water import, 1997-2001 (Million m^3/yr)	Total renewable water resources per capita, 2008 (m^3/yr)
Kuwait	1 899 (47)[a/]	6.852 (1)[b/]
United Arab Emirates	-3 527 (176)	33.44 (2)
Qatar	425 (69)	45.28 (3)
Yemen	3 659 (32)	91.64 (5)
Saudi Arabia	13 254 (10)	95.23 (6)
Bahrain	604 (61)	149.5 (11)
Jordan	4 506 (28)	152.7 (12)
Palestine		201.8 (13)
Oman	2 858 (38)	502.7 (20)
Egypt	10 917 (16)	702.8 (23)
Syrian Arab Republic	-1 176 (152)	791.4 (24)
Lebanon	4 212 (29)	1 074 (31)
The Sudan	-6 960 (188)	1 560 (43)
Iraq	3 055 (36)	2 512 (66)

Sources: Hoekstra and Chapagain (2008) and FAO, AQUASTAT. Available at: www.fao.org.

a/ Rank from highest net virtual water import to lowest, (204 countries).

b/ Rank from lowest total renewable water resources per capita to highest, (174 countries).

Although most countries in the region had a virtual water gain through trade, this does not mean that the current trade structures are desirable. If net virtual water import is compared with total renewable water resources per capita it can be said that countries in the ESCWA region do not enjoy enough net virtual water import through international trade. For example, while Kuwait, the United Arab Emirates and Qatar are the top three poorest countries in the world in terms of total renewable water resources per capita, in their net virtual water import they are only ranked at forty-seventh, 176th and sixty-ninth place respectively. Certainly, direct comparison of these two figures is limited as international trade is not only about water and the net virtual water import in the table does not reflect trade volume as well as population. However, this comparison of total renewable water resources per capita and net virtual water imports still indicates that it is worthwhile for ESCWA member countries to consider their economic structure and international trade policies to reduce water stress in the region.

2. *Carbon dioxide emission trade*

Trade policy and in particular, trade in CO_2 emissions should also consider regional energy sustainability. The Kyoto Protocol identified three mechanisms for emissions reduction; namely Emissions Trading, Joint Implementation and the Clean Development Mechanism (CDM). CDM allows Annex I Parties (mainly developed countries) to implement projects that reduce GHG emissions in non-Annex I Parties (mainly developing countries). This has a twin goal of assisting non-Annex I Parties to achieve sustainable development and contributes to the ultimate objective of the United Nations Framework Convention on Climate Change, which focuses on the stabilization of GHG emissions at levels that are not dangerous to human development.

Despite the fact that the ESCWA region has good potential for CDM projects, particularly in renewable energy and energy efficiency, the actual implementation of CDM projects is very limited due to the procedural complexity of the CDM validation process as well as a lack of awareness on the part of stakeholders. As a result, at the time of this writing, there are only about 24 CDM projects in the pipeline stage in the region (15 in Egypt, 5 in Jordan and 4 in the Syrian Arab Republic).[56] Facilitating regional implementation of CDM projects will assist the transition towards SCP of energy.

[56] CDM/JI Pipeline Analysis and Database. Available at: http://cdmpipeline.org/.

G. ADDRESSING CLIMATE CHANGE

1. *Climate change impact assessment*

While energy and water sustainability are already threatened in the ESCWA region, it is essential to assess the current and expected impacts of climate change on the sustainable consumption and production of natural resources and in particular on the water sector. Climate change is expected to exacerbate water scarcity, with most models predicting a reduction in the availability of freshwater resources in the region due to less precipitation, higher temperatures, higher rates of evapotranspiration and more frequent extreme climatic events. Unless properly and promptly addressed, these impacts will hamper the achievement of sustainable development and threaten efforts to eradicate poverty, improve health and ensure environmental sustainability.

Thus, it is essential to study and monitor the impacts of climate change on water resources and their vulnerability and develop proper adaptation strategies for the region based on this information. In recognition of this urgent need, the Arab Ministerial Declaration on Climate Change adopted by CAMRE in December 2007 calls for the preparation of an assessment of the impact of climate change on water resources in view of supporting the development of adaptation strategies and measures in the Arab Region. This call was reiterated at the twenty-fifth ministerial session of ESCWA in May 2008 which adopted a resolution requesting the preparation of an assessment of the vulnerability of economic and social development in the region to climate change with particular emphasis on freshwater resources. As a result, ESCWA launched and is leading the Regional Initiative for the Assessment of the Impact of Climate Change on Water Resources and Socio-Economic Vulnerability in the Arab Region through an inter-agency process that involves United Nations and League of Arab States organizations. Among the components of the Regional Initiative is a project funded by the Swedish International Development Cooperation Agency (SIDA) and implemented by ESCWA in collaboration with the League of Arab States, the Swedish Meteorological and Hydrological Institute, the World Meteorological Organization and the Arab Center for the Studies of Arid Zones and Dry Lands.

Box 2. Climate neutral United Nations

On 5 June (World Environment Day) 2007, Secretary-General Ban Ki-moon called on all United Nations agencies, funds and programmes to become climate neutral and 'go green'. Subsequently, in October 2007, the United Nations System Chief Executives Board for Coordination made a commitment to move towards climate neutrality.

Since then, all United Nations organizations have been working together to put in place systems and procedures to measure and reduce the environmental impacts of the United Nations family. The Economic and Social Commission for Western Asia (ESCWA) has also undertaken a comprehensive carbon footprint assessment and a greenhouse gas inventory of its operations including emissions from official travel, office vehicles, electricity consumption from buildings and refrigerant losses from air-conditioning systems. Moreover, ESCWA has implemented a series of measures to reduce energy and water consumption and to encourage recycling of paper.

2. *Promoting the wider use of cleaner fuels*

In addition to climate change monitoring, further efforts are needed to mitigate GHG emissions. Annual CO_2 emissions in the ESCWA region (excluding Palestine) represented only 3.73 per cent of world total CO_2 emissions in 2008.[57] Although the impact of climate change is global, irrespective of regional emissions, local efforts at reduction are still necessary and widening the use of cleaner fuels is one of the most important climate change mitigation measures possible.

[57] Calculated by ESCWA staff from International Energy Agency (2010).

The substantial reduction in GHG emissions, both directly through improved fuel specifications and indirectly by enhancing catalytic-converter efficiency also provides the economic benefit of fuel conservation. As fuel specifications in several ESCWA member countries are far from international standards and contribute to the regional deterioration of air quality, the use of reformulated gasoline and oxygenated fuel should be encouraged and gasoline volatility as well as sulphur content in diesel and gasoline should be limited. Upgraded oil refinery technologies can produce cleaner fuels while the use of fuels additives to improve fuel specification needs and reliance on natural gas in various sectors can greatly contribute to the reduction of emissions.

VI. PROMOTION OF AN INTEGRATED APPROACH TOWARDS SUSTAINABLE CONSUMPTION AND PRODUCTION

A. ENGAGING STAKEHOLDERS

The involvement of all stakeholders is required to ensure SCP of energy and water. Governments in the ESCWA region should take the lead in direction with policies and regulations to facilitate transition towards SCP, accompanied by active participation of energy and water producers and individual users. Civil society and academic communities must contribute through the monitoring of production and consumption processes, raising public awareness and conducting relevant research.

Particularly, Governments of the ESCWA region should adopt integrated and coordinated approaches towards SCP of energy and water, with other ministries joining the ministries of energy and water in coherent policy design and implementation. Taking infrastructure investment as an example, energy and water ministries must closely coordinate with their counterparts in planning and finance together with policymakers in agriculture, industry and transportation; while science and technology ministries must be involved to discuss research and development for required technologies.

Also, energy and water providers must be included in the transition towards SCP of energy and water and be involved in the planning of energy and water infrastructure, developing energy and water equipment and setting energy and water policies and standards. Considering the extent of reliance on desalinated water in the ESCWA region in particular, the industry itself must understand the energy-water linkage and try to further develop and implement energy-efficient desalination technologies in close communication with Governments and other stakeholders. Since water intermittency is linked with unstable energy provision in the ESCWA region, providers need to work closely to find proper solutions.

In addition, individual consumers must play an important role. While employing energy- and water-saving technology in home and office appliances can make a huge savings in energy and water use, the concept of 'green consumption' has not yet been fully promoted in the ESCWA region. The relatively simple additional lifestyle changes of buying more green products and choosing public transportation and cleaner fuels can have significant impact on energy and water sustainability.

Civil society and the academic community must also promote the need for an integrated approach through monitoring policy design and implementation, business practices and public consumption patterns. While there are already a number of NGOs working to improve environmental status and to facilitate behavioural changes in the ESCWA region, more integrated programs and projects for SCP, linking water and energy sectors need to be pursued. International organizations need to promote an integrated approach and encourage regional and international coordination to this end. Within the framework of their mandates and by maximizing the use of available regional expertise, United Nations organizations in collaboration with regional organizations, including the League of Arab States, must support Governments and NGOs of the region to build capacity for an integrated management of natural resources.

Momentum is already increasing in this regard through public and private sectors and the international community. A seminar organized by SIDA and the Swedish International Water Institute during Stockholm World Water Week 2009 examined Water and Energy Linkages in the Middle East Regional Collaboration Opportunities and included a contribution by ESCWA. The Sixth International Water Association Specialist Conference on Efficient Use and Management of Water in March 2011 at the Dead Sea in Jordan also examined the water and energy nexus. The (Re)sources Water and Energy Network for Development, which is a private sector initiative, held a seminar in Abu Dhabi entitled "Water and Energy – a Couple under Stress?" in March 2011 and included a presentation by ESCWA, while the Government of the United Arab Emirates organized a World Water Day event on 22 March 2011 in New York City in collaboration with the Green Group to discuss the water and energy connection. The United States Agency for International Development is supporting a private sector-led initiative in Jordan. Titled EDAMA, the initiative seeks to improve energy sector performance, increase private sector participation and investment and reduce the environmental impacts of energy and water production and use.[58] The Bonn 2011 Conference organized by the Government of the Federal Republic of Germany through its Ministries for Economic Cooperation and Development and the Environment aims to focus on the water, energy and food security nexus, with a view towards examining water resources in a green economy as part of preparations for Rio+20, the United Nations Conference on Sustainable Development in 2012. In recognition of this emerging paradigm, the intergovernmental ESCWA Committee on Water Resources adopted a recommendation during its ninth session in March 2011, in Beirut, requesting ESCWA to consider the water-energy nexus, particularly in the light of the integrated management of shared water resources, in its future activities.

B. ENHANCING INSTITUTIONS

Enhancing the institutional framework is essential for promoting an integrated approach for SCP in the ESCWA region as regular dialogue and exchange of data is needed to facilitate the ongoing task of managing natural resources in an integrated manner.

The recent establishment of the AMWC is relevant for the SCP of water since it provides a regional forum for consensus-building and cooperation on regional water priorities. The Secretariat of the Arab Ministerial Council of Electricity provides a regional forum for the discussion of regional energy priorities. To date, planning for SCP has been organized under the auspices of CAMRE and its associated advisory committee, JCEDAR, through collaborative partnerships among concerned regional organizations, including ESCWA, the Regional Office for West Asia of the United Nations Environment Programme and the Organization of Arab Petroleum Exporting Countries. The potential to strengthen institutional frameworks and cross-sectoral dialogue through these regional forums thus exists.

Efforts to this end have already been initiated with several Arab declarations expressing the concerns and commitments of Arab countries to achieving progress towards sustainable development, particularly as related to water and energy. In addition, energy and water-related intergovernmental and expert group meetings being carried out by ESCWA and other United Nations organizations are increasingly taking note of SCP needs and processes.

In addition to regional institutions, it is important to set up proper institutions at the national level. While discussion channels among ministries can be essential, it is also vital to engage stakeholders of energy and water. In this regard, establishment of national cleaner production centres can be also helpful to encourage multi-stakeholder engagement, in particular, the participation of energy and water producers. The Egyptian Ministry of Trade and Industry and the United Nations Industrial Development Organization (UNIDO) jointly launched the Egypt National Cleaner Production Center (ENCPC). Currently several services related to SCP of energy and water including an 'Energy Efficient Program' are provided.[59] As the focus of ENCPC is efficiency improvement, it is relevant to adopt integrated approaches recognizing energy and water linkages in its activities.

C. TECHNOLOGICAL DEVELOPMENT AND TRANSFER

The role of technology development and transfer is critical in the transition towards SCP and must accompany many of the above-mentioned policies. Although original technology development may be costly for the ESCWA region, adopting existing advanced technology to local conditions and encouraging technological transfer to disadvantaged regions is possible.

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[58] EDAMA sets an innovative road map for energy, water and environment productivity, 15 January 2009. Available at: http://www.ameinfo.com/181216.html.

[59] For the homepage of the Egypt National Cleaner Production Center, see www.tic.gov.eg/cleaner/main_ar.htm.

As earlier discussed, technological development and transfer of solar and wind energy can improve sustainability of energy and water resources greatly. However, the great regional potential for solar energy production is limited by current technologies consuming relatively large amounts of water resources to cool solar panels. Technological development is required to reduce this dependency and to adopt existing technology to regional specificities, while energy-efficient desalination technology, the use of biogas energy, the use of wind energy for water pumping and the use of cleaner fuels cannot be promoted and implemented without the support of technological development and transfer.

Therefore, countries in the ESCWA region should exert more effort in identifying technological development and transfer needs according to such regional specificities as the huge potential for solar energy production and the heavy reliance on desalination. Also, more work is needed to monitor global technological developments having potential applications for the ESCWA region and to guide investment on technological development and transfer.

D. OPPORTUNITIES AND CHALLENGES

Despite progress achieved in the field of energy and water, more efforts are still required to ensure their sustainability by applying integrated and coherent policies and tools. Although the ESCWA region is facing serious challenges, the following opportunities have been identified:

(a) The region enjoys good natural endowment of renewable energy resources, mainly solar and wind and development and application of related technology can reduce sustainability challenges;

(b) Following WSSD, the global and regional environment is favourable for transition towards SCP. In this respect, the Arab Ministerial Declaration on Climate Change was adopted in 2007, while energy and water linkages are increasingly discussed inside and outside of the region;

(c) Regional and subregional institutions exist to promote SCP of energy and water and their integrated management can be addressed through intergovernmental and expert group meetings of ESCWA and other United Nations organizations as well as the Arab Ministerial Council of Electricity, AMWC, CAMRE, JCEDAR and the League of Arab States secretariat;

(d) Several regional energy network projects on electricity and natural gas networking exist, having a positive role in achieving sustainability in the energy sector. In the meantime, the water sector has witnessed a regional integration effort through AMWC and other organizations. This regional integration in energy and water sectors presents the ESCWA member countries with favourable conditions to cooperate in promoting SCP.

While these opportunities should be further developed, the following challenges for integrated management of energy and water for SCP should be addressed at the same time.

(a) The particular concerns and attitudes of different energy and water stakeholders have impeded regional planning and implementation of policies and regulations for ensuring SCP of natural resources in an integrated manner;

(b) Certain ESCWA member Governments do not have enough capacity to coherently design and implement policies and regulations due to a lack of understanding concerning energy and water linkages, financial, domestic and political instability or external threats. The region particularly lacks sufficient human and technical capacity to develop and apply enhanced technologies in various production and consumption procedures of energy and water;

(c) Lack of financial resources for SCP projects in some ESCWA countries is also a significant challenge.

VII. CONCLUSION

As discussed, ensuring SCP of natural resources, in particular energy and water, is essential for the ESCWA region to achieve sustainable development and protect development goals that have already been achieved. In recognition of this urgent need, international as well as regional societies have called for a transition towards SCP patterns of natural resources with regional priorities being identified through *The Arab Regional Strategy for Sustainable Consumption and Production*.

As shown in the chapters II and III, the energy and water resources of the ESCWA region have been threatened by rapid population growth over the last few decades with increasing CO_2 emission, energy consumption and total water withdrawal putting pressure on resource sustainability. Though countries have designed and implemented certain policies to address these problems, policy coherency is not ensured for energy and water.

Accordingly, this paper promotes the integrated management of energy and water and of natural resources in general, suggesting several integrated and coherent policies for the ESCWA region. The large amounts of both energy used in the production, transportation and consumption of water resources and water resources used in the production and consumption of energy have great developmental implications, particularly for the ESCWA region; unless they are managed in a coherent manner, the resulting inefficiency and loss of opportunities can be substantial. The roles of both stakeholders and technology in the transition towards SCP have been examined, as well as regional opportunities and challenges.

Energy and water are not the only important resources requiring integrated management for SCP. Management of land resources and waste flows are also an important priority as the ESCWA region faces rapid urbanization trends, and an increasingly vocal, active and engaged civil society that is committed to achieving a better and brighter future. Waste management is also closely related to the production and consumption of energy and water, while forests, mineral ores and other natural resources should be managed to ensure sustainability. Further study is needed to understand the linkages of production and consumption of these resources so that coherent policies can be designed and implemented.

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