Ministry of Foreign Affairs

# *Nexus in Kuwait*

## *OPPORTUNITIES FOR DUTCH COOPERATION*

*Commissioned by the Netherlands Enterprise Agency*

*>> Sustainable. Agricultural. Innovative. International.*

uniting water energy food

# NEXUS

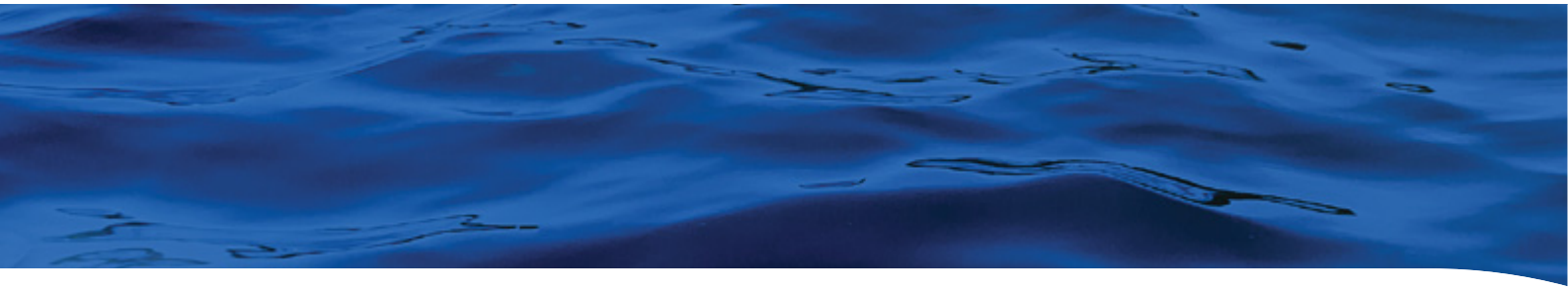
## IN KUWAIT

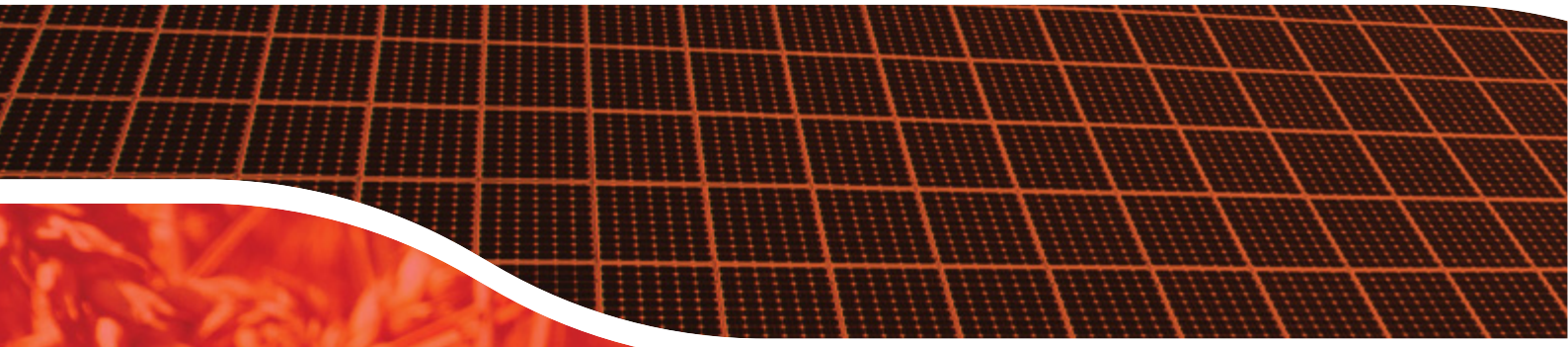
OPPORTUNITIES FOR DUTCH COOPERATION

Dutch connection in Kuwait

DUTCH GULF

Holland.





# NEXUS
## IN KUWAIT


## ACKNOWLEDGEMENTS

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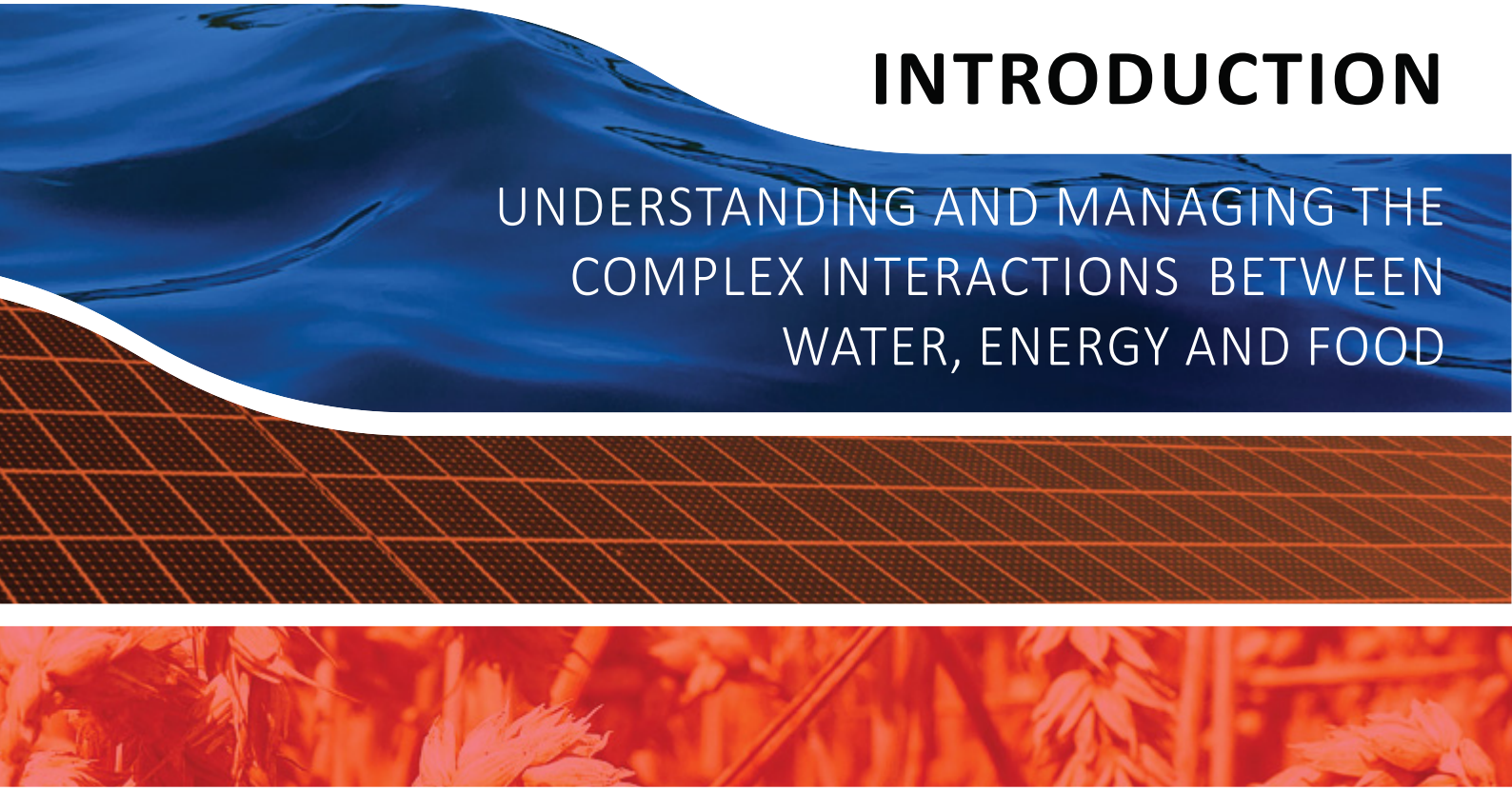

# INTRODUCTION

## UNDERSTANDING AND MANAGING THE COMPLEX INTERACTIONS BETWEEN WATER, ENERGY AND FOOD

Water, energy and food are the most essential recourses for any society to flourish. The ever-increasing global population together with the developments related to the climate change constitute challenges to these resources that need to be addressed in order to pave the way to a sustainable future for the next generation.

Water, energy and food are the three central topics of Dutch expertise. We are world leading in these three fields, and our engineers are able to integrate them when offering our services worldwide. The Gulf-region is preparing itself for the future. Many vision papers have been written. It is clear that the role of fossil energy will come to an end and that other methods to obtain fresh water have to be developed, not only for washing and drinking but even more important for agriculture.

Kuwait and the Netherlands share a long history of innovative operations. Last year our main oil-company, Royal Dutch Shell, celebrated 70 years of presence in Kuwait. And recently a high-level delegation from Kuwait visited Holland to get familiar with the different solutions we have developed to achieve a better energy-mix.
Dutch dredging companies, active in the whole Gulf-region, were also active in Kuwait, reclaiming land and keeping the waters deep enough for vessels to reach the port.

Very visible is the Dutch contribution on agriculture. It is a joy to see so much Dutch cheese, vegetables and meat in the Kuwaiti supermarkets, but far more important is our expertise in assisting Kuwait to set up its own agricultural production. Most of the healthy, fresh homegrown Kuwaiti products, eggs, dairy, veggies, have a clear link with Holland.

Both Kuwait and the Netherlands strive for a more sustainable future. In Kuwait the introduction of Vision 2035 shows the intention of Kuwait to diversify its economy. The recent opening of one of the biggest solar energy generators on the world, shows that Kuwait takes the energy transition very serious. Kuwait is a loyal partner realizing the Sustainable Development Goals of the United Nations, making the world a better place.

The coming years the Dutch focus in the Gulf will be on water, energy and food. The achievements we made in Kuwait are worthwhile to practice elsewhere in the Gulf-region. The promotion of these three themes will be central at the Dutch pavilion at the Dubai2020 World-exhibition.

I am sure many Kuwaiti's will join us.

*Frans Potuyt*
*Ambassador of the Kingdom of the Netherlands*

## COPYRIGHT



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## DISCLAIMER



- This first version was produced in April 2019 -

Table of Contents

# 1. Abbreviation List

| | |
|---|---|
| A/C | Air Conditioning |
| CAPEX | Capital expenditure |
| CO2 | Carbon Dioxide |
| CSP | Concentrated Solar Power |
| EOR | Enhanced Oil Recovery |
| ESCO | Energy Servicing Company |
| FAO | Food and Agriculture Organization |
| GCC | Gulf Cooperation Council |
| GDP | Gross Domestic Product |
| GFSI | Global Food Security Index |
| GHG | Greenhouse Gas |
| GMO | Genetically Modified Organisms |
| GW | Giga-Watt |
| ha | Hectare |
| HDI | Human Development Index |
| HLPF | High-Level Political Forum |
| IoT | Internet of Things |
| IR | Infrared |
| ISCC | Integrated Solar Combined Cycle |
| IWPP | Independent Water and Power Project |
| $km^2$ | Square kilometer |
| kWh | Kilowatt hour |
| LNG | Liquefied natural gas |
| LSD | Lumpy Skin Disease |
| m3 | Cubic meter |
| MED | Multi-Effect Distillation |
| MIGD | Million Imperial Gallon per day |
| MoU | Memorandum of Understanding |
| MSF | Multiple Stage Flash |
| MSW | Municipal Solid Waste |
| MW | Mega-Watt |
| ppm | Parts per million |
| PV | Photovoltaic |
| RAIS | Regional Aquaculture Information System |
| RO | reverse osmosis |
| ROI | Return on Investment |
| scfd | Standard Cubic Feet per Day |
| SDGs | Sustainable Development Goals |
| T&D | Transmission & Distribution |
| UF | Ultrafiltration |
| VNR | Voluntary National Review |
| WEF | Water-energy-food |
| WTRT | Wastewater Treatment And Reclamation Technologies |
| WWTP | Wastewater treatment plants |

# 2. Introduction

## 2.1 Report objective

As the WEF Nexus has risen on the agenda of various GCC countries, the Dutch government has developed partnerships with GCC governments on this strategically important topic. The Dutch government is looking to establish a bilateral cooperation on the Nexus thereby enabling business to business (B2B), knowledge to knowledge (K2K) and government to government (G2) cooperation.

With the rising challenges to meet its nationals' demands, Kuwait published several initiatives and strategies to help meet its water, energy and food security. With respect to the Nexus, it rose on the agenda of Kuwait's Third Arab Water Conference 2018, where specialists from across the Arab world convened in a working session on the WEF Nexus[1]. The objective of this report is to identify the status of Kuwait's water, energy and food security with respect to the WEF Nexus. This would be particularly in relation to the availability of primary freshwater, energy and food resources along with the challenges faced.

Thereafter, it provides a snapshot with respect to what national strategies are in place and what technologies/practices are implemented across each intersection of the Nexus, with a particular focus on food. The report concludes by highlighting some of the possible investment opportunities for Dutch companies in Kuwait and the engagement channels that can be utilized.

## 2.2 Summary

Understanding Kuwait's situation with respect to the Water-Energy-Food (WEF) Nexus helps provide insight on the type of initiatives and investment opportunities that would be applicable to the country.

Figure 1 provides a summary on Kuwait including its different resources: power and water mix, food production and acquisition. It also highlights some of the investment opportunities with respect to the different aspects of the WEF Nexus: Water-Food, Water-Energy and Food-Energy. A comprehensive list of investment opportunities can be found in chapter 3.

[1] Water, Energy and Food, *Nexus in MENA,* 2018

*Figure 1 Kuwait Summary*

# KUWAIT OVERVIEW

| | |
|---|---|
| **LAND AREA:** | 17,818 km² |
| **CLIMATE:** | Dry desert; intensely hot summers; short, cool winters |
| **TERRAIN:** | Flat to slightly undulating desert plain |
| **ARABLE LAND:** | 0.6% |
| **ENVIRONMENTAL ISSUES:** | Limited natural freshwater resources; some of world's largest and most sophisticated desalination facilities provide much of the water; air and water pollution; desertification; loss of biodiversity |
| **ENVIRONMENT AGREEMENTS:** | Biodiversity, Climate Change, Desertification, Endangered Species, Environmental Modification, Hazardous Wastes, Law of the Sea, Ozone Layer Protection |
| **NATURAL RESOURCES:** | Petroleum, fish, shrimp, natural gas |
| **POPULATION:** | 2,875,422 (July 2017 est.), 69.5% Expatriates |
| **URBANIZATION:** | 100% of total population |
| **GDP (PPP)** | USD 291.5 billion (2017 est.)<br>0.4% Agriculture, 58.7% Industry, 40.9% Services |
| **GDP - PER CAPITA (PPP):** | USD 66,200 (2017 est.) |
| **INDUSTRIES:** | Petroleum, petrochemicals, cement, shipbuilding and repair, water desalination, food processing, construction materials |

## The State of Kuwait


# KUWAIT WATER-ENERGY-FOOD RESOURCES

### Power generation in Kuwait

Kuwait generated 27 TWh of electricity in 2015, the vast majority of which came from crude oil. The residential sector is the biggest consumer, followed by commercial and public services.

| | Natural Gas | Fuel Oil | Renewables (solar, wind etc.) | Waste-to-Energy/ Biogas | Nuclear |
|---|---|---|---|---|---|
| **Power Mix** | 8% | 92% | <1% | 0% | 0% |
| **Trend** | ▲ | ▼ | ▲ | ▲ | No plans |

### Water production/withdrawal in Kuwait

Kuwait's water consumption is among the highest in the world at more than 447 litres daily per capita. Desalination provides the bulk of the water supply, followed by treated wastewater and groundwater. The agricultural sector is the biggest consumer, followed by the municipal sector.

| | Thermal Desalination (fossil fuel) | Reverse Osmosis (from Grid) | Treated Wastewater | Surface & Groundwater |
|---|---|---|---|---|
| **Water Mix** | Desalination 65% | | 18% | 17% |
| **Trend** | ▼ | ▲ | ▲ | ▼ |

### Food production and acquisition in Kuwait

**Food Imports**

- Kuwait's food imports in 2015 were worth USD 33.3 billion
- In 2016, Oman's top food partner was the UAE, followed by Singapore and Somalia.

**Foreign Direct Investment in farmland abroad**

- Kuwait has made agricultural investments primarily between Ethiopia and Sudan, at around USD 10 billion.
- FDI has not been formalized as a policy option or as part of a larger food security strategy.

**Domestic Food Production**

- Kuwait has around 2880 farms covering 141 km² that produce vegetable, crops, cattle, sheep, goat and poultry, with poultry production leading the food industry in Kuwait.

### Food loss in industrialized asian countries across supply chain

| Production | Handling & Storage ★ | Processing & Packaging | Distribution & Marketing | Consumption ★ |
|---|---|---|---|---|
| 17% | 23% | 2% | 11% | 46% |

★ Significant opportunities exist to reduce losses at handling & storage, and consumption. Along with biogas opportunities post consumption.

# HIGHLIGHTED INVESTMENT OPPORTUNITIES

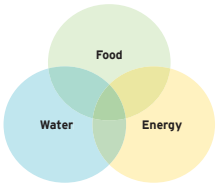
### Investment opportunities for Dutch companies (for full list, refer to Chapter 4)

**Water-Food**

- High-tech greenhouses
- Hydroponics & aquaponics
- Urban & vertical farming
- Aquaculture
- Advanced irrigation (i.e. drip)
- Food monitoring systems
- Food import derisking & early warning systems

**Water-Energy**

- Renewable powered desalination
- Sewage sludge to biogas
- T&D network efficiency
- Water fixture efficiency
- EOR alternatives (i.e. $CO_2$)
- Solar water pumps
- Solar water heaters
- District cooling




**Food-Energy**

- Greenhouse and storage cooling systems
- Biogas production from landfills
- Biomass from halophytes
- Route & inventory optimization
- Physical/emergency stockpiling (i.e. food reserves)
- Virtual stockpiling
- PV for irrigation pumps

## 2.3 The Water-Energy-Food Nexus

The Water-Energy-Food Nexus is the inextricable link between, water, energy and food: the actions in one area often have an impact on the others. For this reason, the WEF-Nexus approach has gained significant traction over the years as a holistic method of resource management and sustainable development. Figure 2 and Figure 3 have been developed have been developed to illustrate the food security and water security tradeoffs for the GCC, respectively. Information specific to Kuwait's market and resources was presented where applicable.

*Figure 2: Food Security Trade-offs in GCC*[2]

**How secure are the country's food sources? Are they resilient against climate and market shocks?**

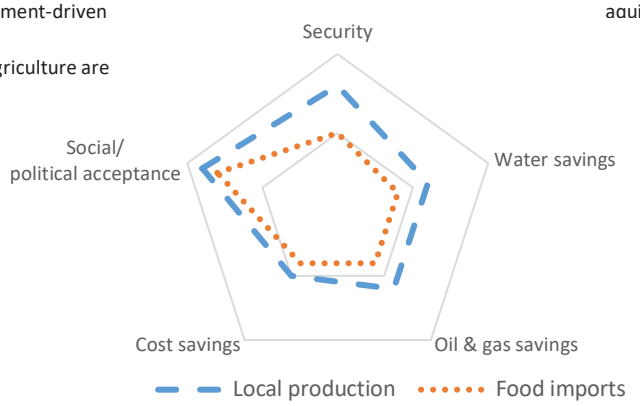
- Food imports are more prone to climate and market shocks as demonstrated by the 2007/2008 Global Food Price Crisis
- Kuwait's local food production is constrained by a number of factors, including its climate conditions, limited arable land, and increasing population
- As a small country, Kuwait has relatively limited bargaining power in international food markets

**Is there political and social support for the method of food production and acquisition? Is it in alignment with the strategy and vision of Kuwait?**

- Farmers and fishers benefit from grants and other government-driven incentives.
- Culturally, fishing and agriculture are encouraged

**How water intensive is the food production/acquisition method, is the water consumed locally, or is it virtual water?**

- Local food production uses non-renewable and limited groundwater aquifers




**What is the food production/ acquisition method cost? Are the costs likely to fluctuate?**

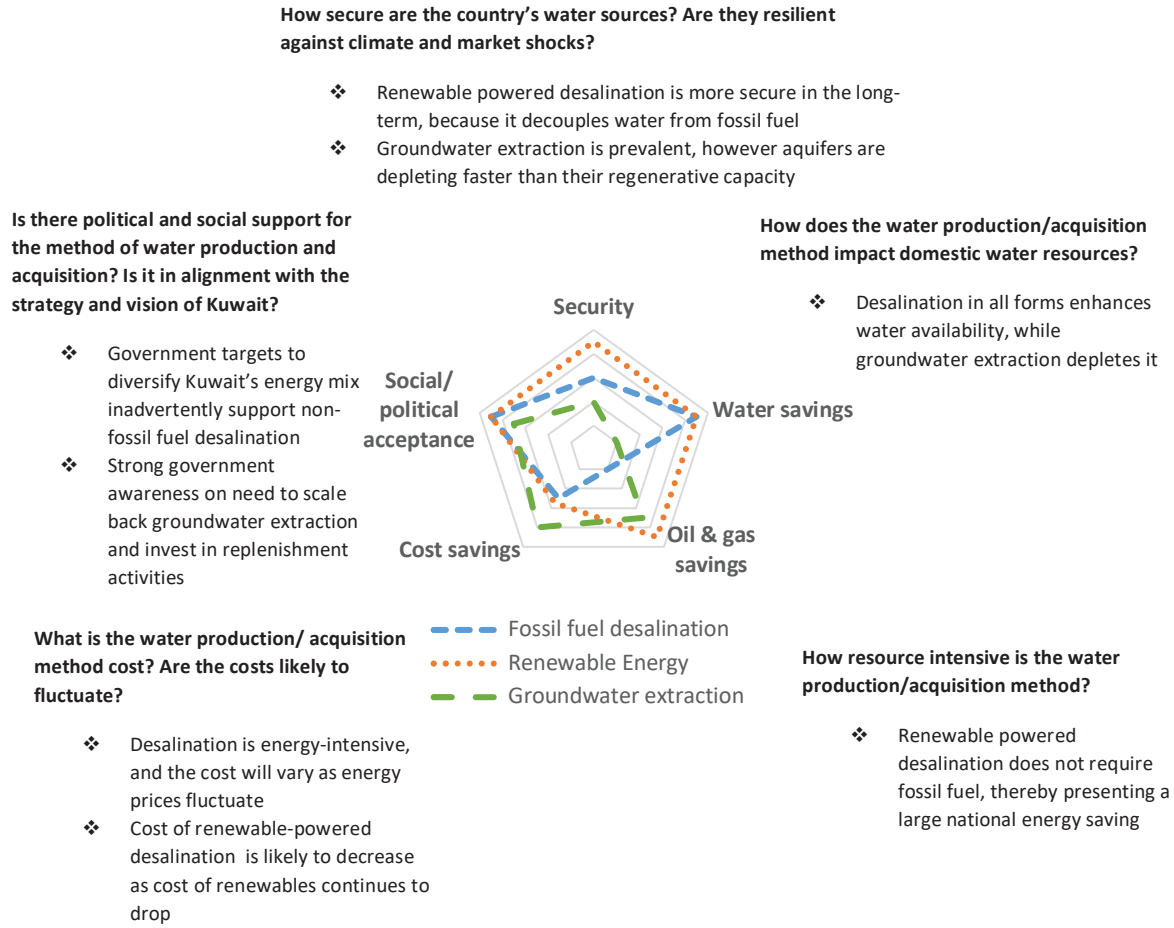
- Local food production is common in Kuwait, however it is very resource – intensive and less efficient than imported food, which are at risk of price fluctuations driven by market forces and climate change

**How energy intensive is the food production/acquisition method, considering the complete value chain of a food product?**

- Food imports are energy intensive, however this falls outside of Kuwait's energy consumption
- The need to desalinate local brackish aquifers makes local food production energy intensive

[2] Figure 2 is based on EY internal analysis

Figure 3: Water security trade-offs in GCC[3]




When analyzing food security, Kuwait has to look at fundamental tradeoffs associated with different food security strategies. For example, a strategy of local food production relative to food importation is signficantly more water and energy intensive, as water used in agriculture results from energy intensive brackwish water treatment or wastewater treatment. Consequently, while local food production provides greater security and potential cost savings, energy and freshwater are major constraints that need to be addressed.

In the case of water security, a strategy of renewable powered desalination relative to traditional cogeneration is more expensive in the immediate term, though providing greater long term security (and potentially lower costs) as it decouples water from fossiel fuels. As Kuwait looks to expand its local food production capacity, it must address the associated constraints of food, water and energy. Strategies, policies, and initiatives tackling such constraints are explored in section 2.6.

[3] Figure 3 is based on EY internal analysis

## 2.4 Background context

Kuwait is a small country in the Arabian Peninsula with a total area of 17,817 km$^2$. The history of the country is traced back to the start of the development of Kuwait City as a major trade hub in 1613. In 1899, the Sheikhdom of Kuwait became a British protectorate, before gaining sovereignty in 1961. Kuwait is a constitutional Emirate with a semi-democratic political system that allows the direct election of a National Assembly.

*Figure 4: Geographical map of Kuwait*[4]


With the discovery of oil in 1937, and the start of exploration in 1951, Kuwait transformed from a trade and boat-building hub to a major oil producer and exporter. This transformation resulted in major socio-economic and environmental changes, which continue to this day. In 1990, development in Kuwait stalled due to the Iraqi invasion of Kuwait and ensuing First Gulf War, with the impact on growth was felt throughout the 1990s. As Kuwait increased oil production, the economy of the country recovered, driving gross domestic product (GDP) and population growth as depicted in Figure 5Figure 5 and Figure 6[5].

*Figure 5: Population growth in Kuwait since 1960*[5]

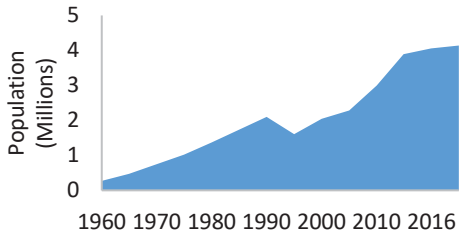
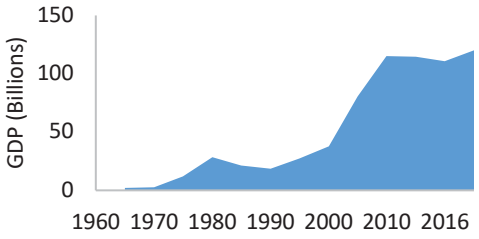



*Figure 6: GDP in Kuwait since 1975 in USD current*[5]




Kuwait's high GDP is driven by crude oil and refined petroleum exports, which constitute 81% of total exports[6]. The country's oil reserves, the fifth largest in the world[7], and its relatively small population makes Kuwait a wealthy and high-income country with large cash reserves. Such wealth has allowed

[4] Lonely Planet, *Map of Kuwait,* 2018
[5] The World Bank, *Population growth and GDP in Kuwait,* 2018
[6] United Nations Statistical Division, Comtrad, 2018
[7] OPEC, *World Share of Crude Oil Reserves,* 2017

Kuwait to maintain its water and food security through fossil fuel powered desalination, and food imports.

However, such high reliance on the country's fossil fuel and national wealth for maintaining water and food security, makes Kuwait particularly vulnerable to stresses like fluctuating oil prices, population growth, increasing standards of living, and climate change. Today, 98% of the country's 4 million inhabitants are urbanized and concentrated in the capital, Kuwait City. This demographic transformation led to an increase in demand for resources that far exceeds the country's natural carrying capacity. By 2050, the population is projected to grow by 40%, to an estimate of 5.6 million, further straining the country's scarce natural resources.

Although fossil fuel and food price linkages are a global phenomenon, the interdependence of the two is more severe and critical in Kuwait. It is important for Kuwait to adopt a water-energy-food (WEF) nexus (the Nexus) approach to manage these three vital sectors. The Nexus is an integrated and strategic management approach that can drive resource efficiency, productivity and synergy across the three interlinked sectors, thus addressing the country's future development.

## 2.5 Kuwait resources

Despite having significant economic capabilities and resilient government reserves in cash, Kuwait has very limited natural resources in water and land. These conditions results in fragile sectors that rely predominantly on oil reserves and revenues.

### 2.5.1 Freshwater

#### 2.5.1.1 Current Outlook

Kuwait's primary sources of freshwater are from underground aquifers (mostly non-renewable), seawater desalination and treated wastewater. Kuwait's water consumption per capita is one of the highest in the world, historically exacerbated by significant government subsidies on tariffs, though both water and electricity tariffs were significantly revised in 2017.

Kuwait is an arid country where freshwater is a scarce resource and the only source of natural water is groundwater. Groundwater in Kuwait is classified as one of three types: freshwater (salinity < 1,000 ppm) used for drinking and in domestic activities; brackish water (salinity ranging between 1,000 ppm and 10,000 ppm) used for irrigation; and highly saline water (salinity > 10,000 ppm)[8]. Brackish groundwater in Kuwait flows from Saudi Arabia at an annual rate of 20 million $m^3$ through two aquifers: the upper Kuwait group and the lower Dammam group[9]. Groundwater is used predominantly in agricultural and livestock-related activities. Since the 1970s, the Dammam aquifer has been over abstracted through over-irrigation resulting in seawater intrusion, water logging and soil salinization[10] - thereby endangering the aquifer.

To satisfy its freshwater demand, Kuwait has invested in seawater desalination and wastewater treatment facilities. In 1951[11], Kuwait became the first country in the world to commission a water desalination plant to meet its potable water demands. Since then, Kuwait has expanded its network

[8] E. H. AlAli, *Groundwater history and trends in Kuwait,* 2008
[9] Aquastat, *Kuwait country profile,* 2008
[10] M Al-Murad, *Waterlogging in Arid Agriculture Areas Due to Improper Groundwater Management—An Example from Kuwait*, 2017
[11] M. Hamoda, *Desalination and water resource management in Kuwait,* 2001

of seawater desalination plants to seven, with an installed capacity of 2.43 million $m^3$ of desalinated water per day[12] as of 2014.

The third source of freshwater in Kuwait is treated wastewater. The concentration of the country's urban population in one major city facilitates this approach. In fact, over 90%[10] of the population is connected to a central sewage network that gets pumped into wastewater treatment plants (WWTP). Today, 60% of Kuwait's 800,000 $m^3$/day of wastewater gets treated at The Sulaibiya Wastewater and Reclamation Plant. The plant uses ultrafiltration (UF) and reverse osmosis (RO) membrane, and is designed to meet a capacity of 600,000 $m^3$/day. The treated water is used in agriculture, industrial and groundwater replenishment activities[13].

As illustrated in Figure 7, desalination accounts for 65% of Kuwait's total freshwater demand (92% of municipal and industrial needs)[14], highlighting the country's strong energy dependence for achieving water security. In terms of consumption, agriculture comprises the major consumer of water at 54%, as shown in Figure 8[14].

*Figure 7: Sources of freshwater in Kuwait[14]*

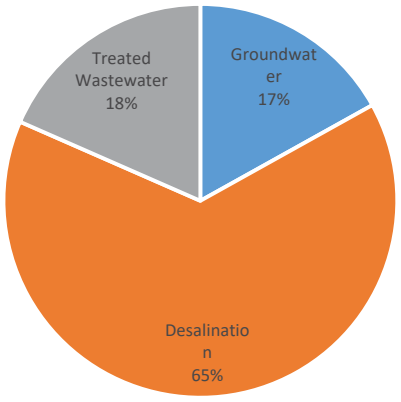
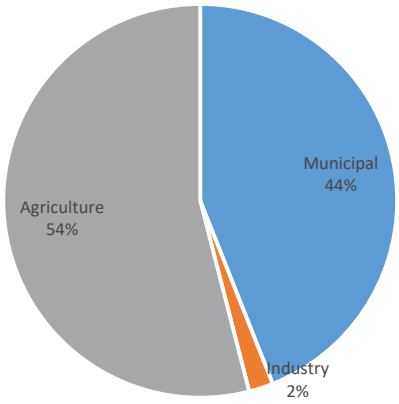



*Figure 8: Water demand by sector in Kuwait[15]*




Today, Kuwait's water consumption is among the highest in the world at more than 447 litres daily per capita[15], and it is steadily growing. To satisfy this demand, Kuwait's Ministry of Electricity and Water has commissioned 8 new desalination plants, shown in Table 1.

*Table 1: Planned desalination plants in Kuwait[16]*

| Facility | Capacity (MIGD) | Expected tender release |
|---|---|---|
| Doha RO Phase 1 | 60 | Awarded June 2016 |
| Zour IWPP North Phase 2 | 107 | Under evaluation |
| Kheran IWPP Phase 1 | 125 | 2018 |
| Zour North IWPP Phases 3 & 4 | 75 | 2019 |
| Al Nwaiseeb Phase 1 | 75 | 2020 |
| New Shuaiba South | 50 | 2021/2 |
| New Doha East | 100 | 2022/3 |
| Doha RO Phase 2 | 60 | 2024/5 |

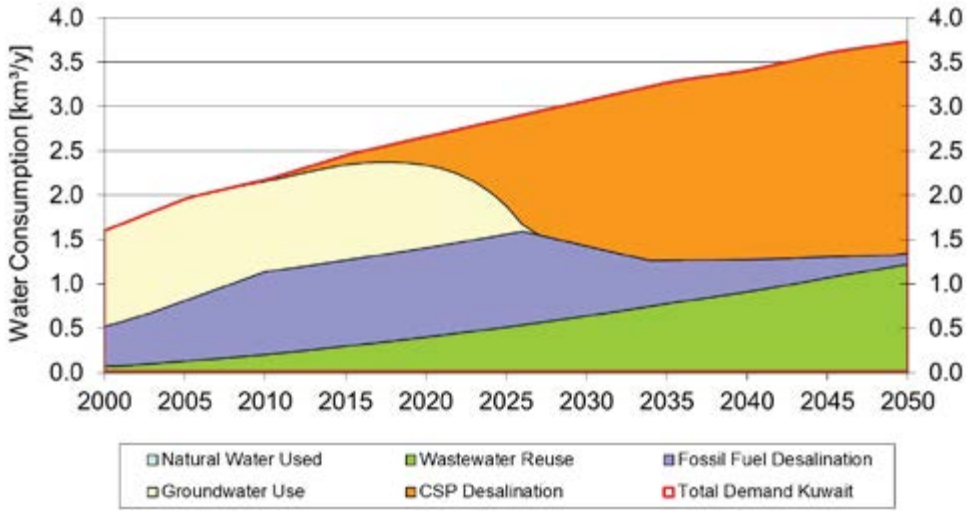
[12] The Cooperation Council for the Arab States of the Gulf, *Desalination in the GCC*, 2014
[13] 13A. Abusam, A. Shahalam, *Wastewater reuse in Kuwait: Opportunities and constraints*, 2013
[14] FutureDirections, Kuwait: Food and Water Security, 2015
[15] Business Year, *Kuwait*, 2018.
[16] MEW, *International Water Summit,* 2018.

| | | |
|---|---|---|
| **Total** | **652** | |

### 2.5.1.2 Future Outlook

Desalination plants are both capital and energy intensive, with negative environmental consequences that include greenhouse gas emissions along with brine discharge into the sea. Kuwait's water demand has been growing significantly and is expected to increase by 6% annually until 2030[16]. Figure 9 demonstrates Kuwait's projected water demand under a scenario in which fossil fuel desalination shifts towards renewable energy powered desalination, and in which treated wastewater is better utilized, thereby reducing the burden on the country's groundwater aquifers.

*Figure 9 Projected demand in freshwater in Kuwait*[17]




For Kuwait to ensure water security in the future, an adoption of a combination of the below measures and initiatives is proposed to overcome the existing and speculated future challenges.

**How will Kuwait maintain its water security in the future?**

Supply: As demand for domestic and agricultural water increases, renewable-powered desalination is one option that could replace current fossil fuel powered technologies. In addition, the use of treated wastewater will increasingly be employed to limit the depletion of the country's groundwater aquifers. Kuwait will also look toward expanding and reinforcing the country's water storage, transmission and distribution infrastructure.

Demand: Kuwait must develop national strategies and programs that encourage greater demand side management efforts across sectors. The government must continue its efforts of subsidy and tariff structure reform, thereby rationalizing consumption of water resources across sectors. Behavioural changes and application of new technologies will bring about the change that is needed to reduce overall water demand.

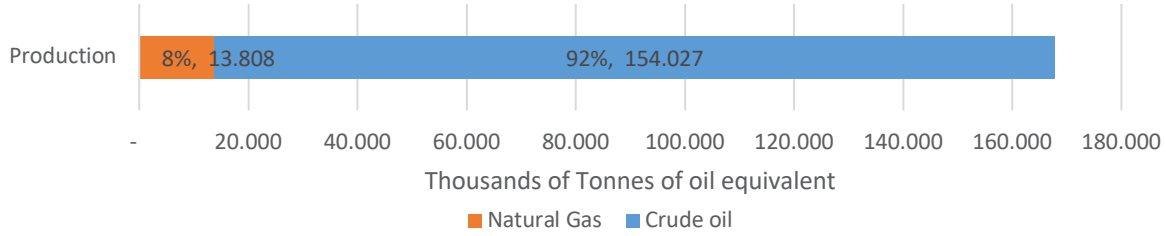
[17] Saif et al., *Water Security in the GCC Countries: Challenges and Opportunities,* 2014

### 2.5.2 Energy

#### 2.5.2.1 Current Outlook

Kuwait is blessed with abundant Oil and Gas reserves, the fifth largest in the world[7]. Crude oil production dominates Kuwait's total primary energy production as depicted in Figure 10. To diversify its Oil & Gas products, Kuwait has recently increased its efforts to develop its natural gas fields, which were historically left unexplored due to cheap and prevalent crude oil. The Kuwaiti government approved a plan to develop non-associated gas fields in the country's northern Jurassic formation and to increase production to 510 million scfd up from its current 180 million scfd output[15].

*Figure 10: Total Production of Energy in thousand tonnes of oil equivalent[18]*




Kuwait is capable of meeting the bulk of its energy demand via its domestic fossil fuel reserves. However, the country is increasingly replacing fuel oil with imported natural gas for its power generation. Per capita consumption of electricity in Kuwait is one of the highest in the world, historically exacerbated by significant government subsidies and an under developed tariff system.

Kuwait suffers from summertime electricity blackouts due to high cooling load requirements and a shortage of supply in natural gas to operate the power plants. To eliminate blackouts, Kuwait has recently signed a 15-year purchase agreement for LNG to secure gas supplies, while it develops its domestic natural gas fields.

At present, Kuwait has 18.3 GW of installed capacity[19], dominated by steam turbine and gas turbines. Future power plants will consist of combined cycle gas turbines that will be operated by natural gas, and that will reserve fuel oil for emergencies.

As per the Kuwait Vision 2035, the country aims to generate 15% of its electricity demand from renewable sources by 2030. As such, Kuwait is constructing the Shagaya Renewable Energy Park, the country's first renewable energy project. Once the first phase of this project is complete, Kuwait will produce 50 MW CSP, 10 MW PV and 10 MW from wind[20].

Another significantly non-utilized energy resource lies in the organic fraction of MSW. Kuwait currently produces about 1,056,120 tonnes of organics or about 44.4% of total MSW waste[21]. This waste stream has a theoretical electrical energy potential of 203 GWh, 0.3% of total generation in 2015. The separation of the organic fraction and its anaerobic fermentation would also lead to improvements in Kuwait's planned WtE facility at Kabd Solid Waste Treatment Plant by decreasing the moisture content. Further benefits of the application of biogas technology include:

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[18] International Energy Agency, *Kuwait Energy Balance,* 2015
[19] King Abdullah Petroleum Studies and Research Center, *GCC Energy System Overview,* 2017
[20] HELIOSCSP, Kuwait's 1st Concentrated Solar Power Plant
[21] Al-Fadhli, A, Assessment of Environmental Burdens of the Current Disposal Method of Municipal Solid Waste in Kuwait vs. Waste-to-Energy Using Life Cycle Assessment (LCA), 2016

- Reduced risk of landfill fires
- Reduced landfill volume, and therefore lengthening of existing landfill lifetime
- Contribution to Kuwait's renewable energy target
- By-production of organic fertilizer that can be used for landscaping

From a demand perspective, Kuwait is one of the highest per capita consumers of electricity in the world, where in 2014 each inhabitant consumed 15,213 kWh daily[5]. Between 2000 and 2015, the residential consumption in electricity has consistently increased at around 4% annually with no sign of slowing down, as shown in Figure 11.

*Figure 11: Growing residential electricity consumption in Kuwait between 2000 and 2015[22]*

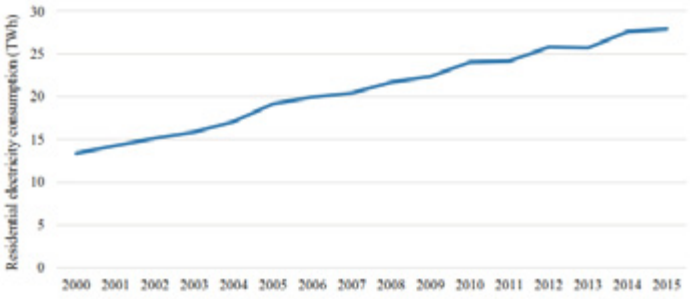
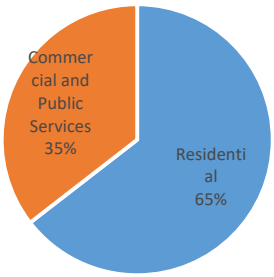



*Figure 12: Breakdown of electricity consumption in Kuwait by sector[23]*




The anticipated peak electricity demand in 2025 is expected to reach 25GW[24]. In order to satisfy this demand, Kuwait has commissioned the five-phase Al-Zour North Independent Water and Power Project (IWPP), which uses both natural gas and gas oil for power production.

At present, Kuwait is starting to develop renewable energy infrastructure. As 85% of the energy demand is satisfied through fossil fuels, the projected growth will result in greater greenhouse gas emissions.

#### 2.5.2.2 Future Outlook

For Kuwait to ensure energy security in the future, an adoption of a combination of the below measures and initiatives is proposed to overcome the existing and speculated future challenges.

[22] Hussain A., *Residential Electricity Consumption in the State of Kuwait*, 2018
[23] IEA, *Kuwait Electricity and Heat*, 2015
[24] Wood, M., Electricity and Water Demand Behavior in Kuwait, 2012

**How will Kuwait maintain its energy security in the future?**

Supply: Renewable energy will steadily increase in contribution to Kuwait's energy mix with the Shagaya Renewable Energy Park project under development. Kuwait Vision 2035 aims to increase this share of renewable energy in the total energy mix to 15% by 2035. Additionally, Kuwait will increasingly use natural gas to meet its demand in energy.

Demand: Kuwait is undergoing major revisions to utilities tariffs and subsidies to encourage rationalized consumption. Policies and laws new will encourage greater demand side management efforts across all sectors – with private sector involvement and investment required. Initiatives will increase in the form of distributed energy resources (e.g. solar cooling and power), mandatory green building codes, ESCO markets, as well as the greater adoption of energy saving smart technologies and systems across sectors. Behavioural changes, brought on by awareness and tariff reform will also reduce the overall demand for energy.

### 2.5.3 Food

#### 2.5.3.1 Current Outlook

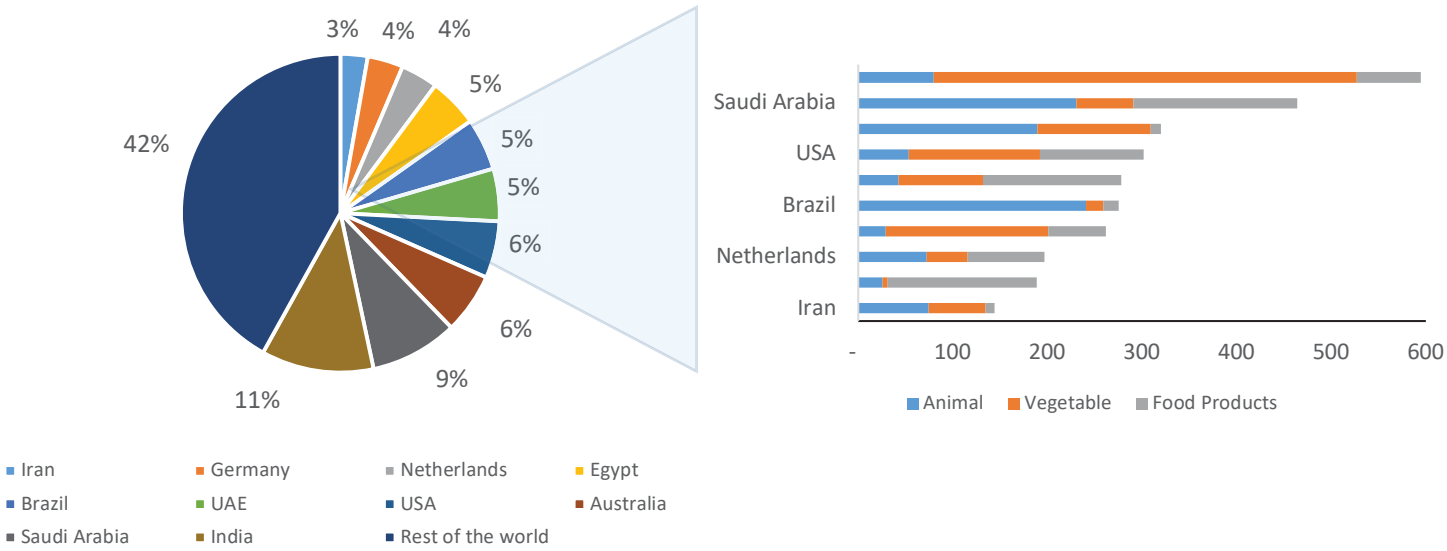
Kuwait is a small country of 1.8 million ha, where only 11% or 200,000 ha are cultivable and around 107,000 ha are suitable for irrigation development[25]. Currently, less than 1% of the land is cultivated and agriculture contributes less than 0.5% to the country's GDP[9]. Although domestic agricultural production exists, its capacity is limited and the country relies heavily on imports to meet national demand.

Kuwait has around 2880 farms stretching 141 $km^2$ that produce vegetable, crops, cattle, sheep, goat and poultry. Poultry production leads the food industry in Kuwait[26] and the country is the global leader for the halal food industry[27].These agricultural areas are located in Wafra in the south, Al-Abdali in the north and Al-Sulaibiya in the centre of Kuwait[28]. Kuwait is home to many hydroponic facilities and was the first country in the Middle East to establish hydroponic farming back in 1955. Today, the majority of the hydroponic farms are private organizations that have established a presence in Kuwait. Faisaliya, the country's largest hydroponic facility, produces most of Kuwait's vegetables, fruits, herbs and flowers.

Aquaculture has a long history in Kuwait, and government assistance supports many marine fisheries that catch shrimp, tilapia and other types of finfish. In recent years, new aquaculture sites boosted the country's tilapia production to more than 250 tons per year, and fish have become a larger component of the country's food supply mix[155]. One of the projects under the Government's 2018 to 2019 Development plan is the Economic Fish Farming Project aims to domestic production of fish (farmed or otherwise) local demand[29]. The program is headed by the Public Authority for Agricultural Affairs and Fish Resources (PAAFR), and involves a number of initiatives including education and training.

[25] WTO, *Trade Policies by Sector,* 2011
[26] A. Al-Nasser, *Poultry industry in Kuwait*, 2006
[27]IHAG, *Kuwait cements position as global Halal industry leader,* 2018
[28]FAO, *Family Farming Knowledge Platform*, 2018
[29] Kuwait Times, Kuwait eyes fish self-sufficiency to narrow supply, demand gap, 2017

*Figure 13: Breakdown of food imports in Kuwait[30]*

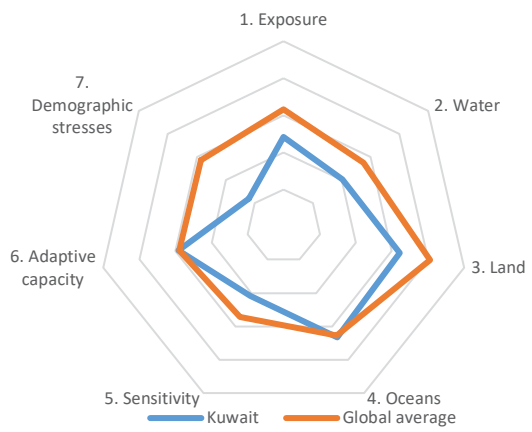



Kuwait's lack of arable land, coupled with an arid climate and the absence of rivers and limited rainfall makes it ill-suited for large-scale traditional crop cultivation. To satisfy the growing demand for food, the small country has historically leveraged its oil revenues to finance agricultural imports, which constitute 91% of the country's food supply[31]. In 2015, Kuwait ranked as the 59th largest food importer in the world by import value. Between 2010 and 2015, food imports have increased by 12.7% annually, from USD $17.6 to $33.3 billion[32] and have fared around 16%[33] of total imports. Kuwait's main food trade partners are India, Saudi Arabia and Australia, as depicted in Figure 13. The Netherlands is ranking 8-th in food exporting nations to Kuwait in which the export of vegatables&fruits and food products is still relatively low.

Kuwait performs well on the Global Food Security Index (GFSI): it is ranked 26th globally (highest in GCC) with a score of 74.6%[34]. Despite its current Food Security Index score, Kuwait is still highly prone to food insecurity in the future. Its poor resilience to food security pressures is highlighted in Figure 14 particularly with respect to water, oceans and demographic stress.

[30] WITS-World Bank, *Kuwait Food imports*, 2015
[31] Arab News, *Kingdom imports 80% of food products*, 2014
[32] Kuwait Food, 2017
[33] Index Mundi, Kuwait – Food Imports
[34] EIU and The Economist, *Global Food Security Index,* 2017

*Figure 14: Kuwait Food Security Index pressures[34]*



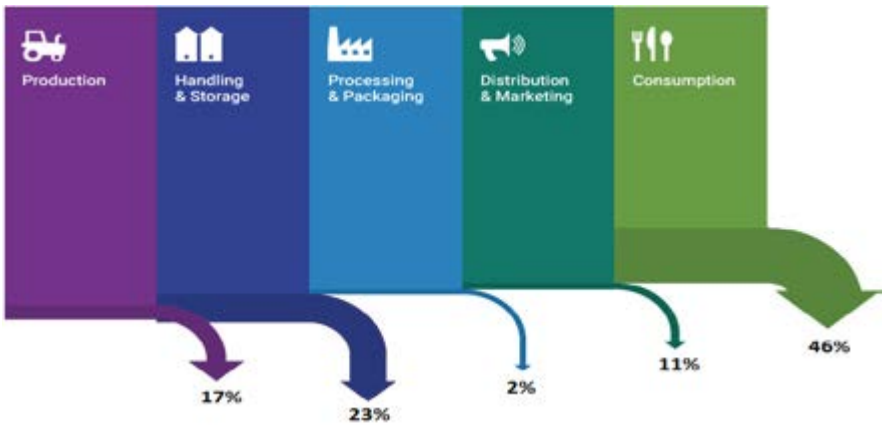

| Pressure | Food Security pressure components |
|---|---|
| 1. Exposure | Temperature rise, sea level rise, drought, flooding, storm severity |
| 2. Water | Agricultural water availability, water quality |
| 3. Land | Soil erosion, soil salinity |
| 4. Oceans | Eutrophication/hypoxia, marine biodiversity and protected areas |
| 5. Sensitivity | Food import dependency, disaster risk management, natural capital dependence |
| 6. Adaptive capacity | Early warning measures, climate smart agriculture, National agricultural risk management system |
| 7.Demographic stresses | Population growth, urbanization |

### 2.5.3.2 Future Outlook

On the demand side, food waste and loss in Kuwait is significant. Kuwait is one of the largest waste producers in the world, and over half all household waste consists of foodstuff[35]. As a major waste stream, food waste is an untapped resource for fertilizer and energy generation that is ending up in landfills with associated negative effects such as increased amounts of landfill gas.

In addition, significant quantities of foodstuff is lost throughout the supply chain. Food loss in Industrialized Asia, which includes Kuwait, is predominantly concentrated in the stages of handling, storage and, at a later stage, consumption, as illustrated in Figure 15[36].

*Figure 15: Food waste across supply chain in industrialized Asia[36]*




As Kuwait's population continues to increase, it will face a challenge in meeting growing demand in addition to the lack of sufficient arable land for growing fruits and vegetables domestically. For Kuwait to ensure food security in the future, an adoption of a combination of the below measures and initiatives is proposed to overcome the existing and speculated future challenges.

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[35] P. A. Koushki & A. L. Al-Khaleefi, *An Analysis of Household Solid Waste in Kuwait: Magnitude, Type, and Forecasting Models, 2011*

[36] M. Kummu et Al., L*ost food, wasted resources: Global food supply chain losses and their impacts on freshwater, cropland, and fertiliser use*, 2012

**How will Kuwait maintain its food security in the future?**

Supply: Food imports will remain important in Kuwait food security strategy. The development of the agriculture sector, although limited, will shift towards biotechnology, high-tech greenhouses and improved farming practices and crop selection. Aquaculture will continue to dominate, as seafood becomes an increasingly important component of the food supply mix. Kuwait will also look to consider climate and market risks more rigorously in its international food import strategy and adopt national risk management strategies such as physical stockpiling and early warning systems.

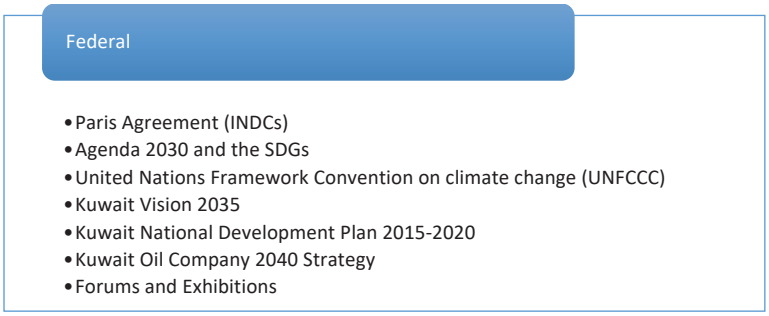
Demand: Efforts to curb food wastage and loss will continue through better education/awareness and logistics. Storage and distribution of food will become more efficient, utilizing IoT to monitor, control and manage food quality and loss. Additionally, more food waste will be diverted from landfills to more productive uses, such as fertilizer production and waste to energy, as well as controlling wastage in post-harvest processes.

## 2.6 National strategies, visions and objectives

### 2.6.1 Federal level

The run up to 2035 will witness a series of reforms and investments aimed at implementing the visions and strategies of Kuwait. Although these strategies target different sectors, they all share similar overarching components: sustainable use of resources, diversification of the economy and sources of water, energy and food security, innovation, education and awareness. National visions, plans and objectives are detailed below, consisting of both supply side and demand side elements.

WEF security is ultimately about building resilience, which requires diversifying the supply and demand strategies that complement one another and engaging the population in a meaningful way to change their current behaviours.




#### 2.6.1.1 Paris Agreement (INDCs)[37]

Kuwait, among other parties to the UN Framework Convention on Climate Change (UNFCCC), have formally submitted their Intended Nationally Determined Contributions (INDCs), outlining their national circumstances and climate actions they plan to take to. The INDCs came before the Paris Agreement, which is a universal climate change agreement that required all parties to put forward their best efforts through nationally determined contributions and to strengthen these efforts in the coming years. In November 2015, Kuwait published its INDCs[37] highlighting their planned projects such as reducing their GHG emissions from the most contributing sector, energy.

#### 2.6.1.2 Agenda 2030 and the SDGs[38]

The UN Agenda 2030 for Sustainable Development is the central UN action plan that embeds 17 Sustainable Development Goals (SDGs) and 169 targets that are critical for humanity and the planet. The successful implementation of Agenda 2030 is founded on efficient peer learning and knowledge sharing between nations.

Kuwait's National Committee on Sustainable Development Goals monitors national data and reports the progress on the SDGs[38]. In 2019, this progress will be reported as part of the first Voluntary National Review (VNR) submission to the High-Level Political Forum (HLPF). The VNRs provide a platform for partnerships and are intended to accelerate the implementation of the Agenda 2030 worldwide.

[37] INDCs, State of Kuwait, 2015
[38] UN Sustainable Development Platform, *High-Level Political Forum*, 2018

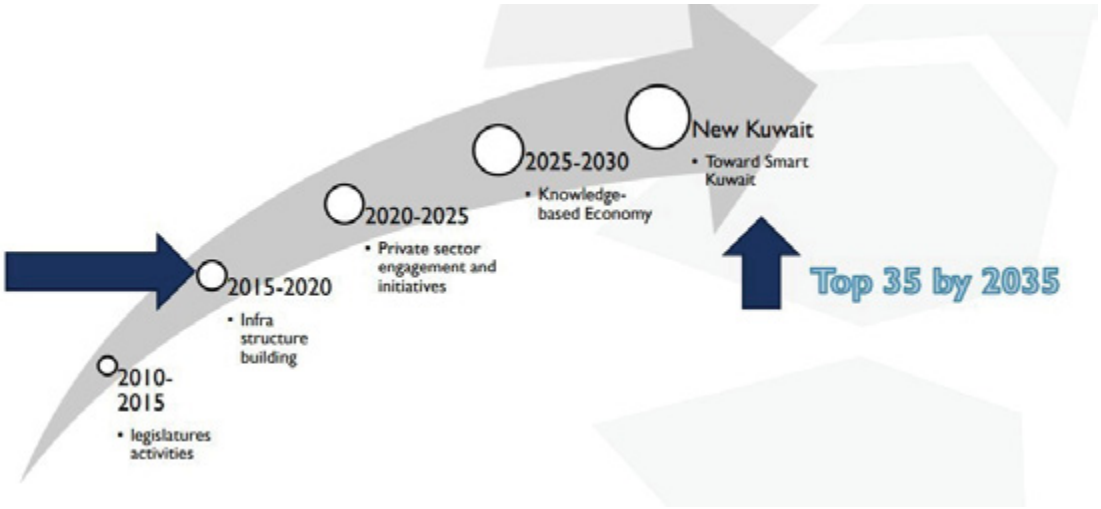
#### 2.6.1.3 United Nations Framework Convention on climate change (UNFCCC)[39]

Kuwait has always shared the concerns of the international community with regards to the changing climate and the risks that this phenomena is posing globally. In December 1994, Kuwait joined the UNFCCC and, ten years later, it ratified the Kyoto Protocol in 2005[39].

#### 2.6.1.4 Kuwait Vision 2035[40]

The Kuwait Vision 2035 is a long-term policy vision that was launched in order to reduce the reliance on oil and to create a resilient economy through diversification, private sector participation and improved effectiveness of government administration. Kuwait Vision 2035 is focused on transforming the country into a regional financial and cultural hub by 2035 through 279 projects and 28 programs. These programs include topics such as growing non-oil economic activities, improving GDP and Human Development Index (HDI)[40].

*Figure 16: Kuwait Vision 2035 roadmap[40]*




#### 2.6.1.5 Kuwait National Development Plan 2015-2020[41]

The Kuwait's National Development Plan (KNDP) was prepared to achieve the ambitions of the Kuwait Vision 2035 and to implement national transformation. The plan comprises five strategic directions aimed at improving citizens' engagement, creating a more effective government, prosperous economy and nurturing nation while becoming a more relevant global player. To achieve these ambitions, the KNDP defines twenty indicators (with sub-indicators) aligned with the seven key pillars which are: global position, human capital, healthcare, living environment, infrastructure, economy and public administration. KNDP's targets include increasing the share of renewable energy to 15% by 2035, investing an additional 11% to develop national assets and infrastructures, as well as adding more than 3,500 new small businesses in order to boost innovation and competition.

[39] UNFCC, Kuwait Ratification Status
[40] Kuwait Direct Investment Promotion Authority (KDIPA), *Kuwait's Plan for the Future,* 2018
[41] Kuwait National Development Plan, *New Kuwait*, 2018

*Figure 17: The Kuwait National Development Plan or "New Kuwait"*[41]


### 2.6.1.6 Kuwait Oil Company 2040 Strategy[42]

Kuwait Oil Company (KOC), responsible for the exploration and production of hydrocarbons in Kuwait, has developed a strategy to ensure its sustainable operation by 2040. Some of the main objectives of the strategy include efficiently providing energy security to the State of Kuwait through energy management, energy efficiency, reduced greenhouse gas (GHG) emissions and a reduction in energy costs.

### 2.6.1.7 Forums and Exhibitions[43,44]

In more recent years, Kuwait has hosted a number of forums and exhibitions to attract international businesses to its energy, water and agriculture sector. The Conference on Energy and Water Efficiency in Kuwait and Kuwait Green Building Conference and Exhibition are annual events that attract speakers and business representatives from across the industry. In 2018, the first Kuwait International Agro Good Expo was held and attracted exhibitors from across the GCC and the world. In addition, the Kuwait Investment Forum 2018[43], organized by the Kuwait Direct Investment Promotion Authority, was a widely successful event that attracted over 1,000 participants from 55 countries.

It is worth to note that, UAE's Expo 2020[44], Connecting Minds, Creating the Future, will occur between October 2020 and April 2021. This event acts as a gateway to encourage worldwide collaboration to generate sustainable technologies to solve global problems, including water, energy and food security. The main themes of the Expo are Business, Expo Live, Legacy, Youth Connect and World Majlis.

[42] Kuwait Oil Company, 2040 Strategy, 2018
[43] Kuwait Investment Forum 2018
[44] Expo 2020 Dubai UAE, 2018

# 3. Kuwait WEF Nexus Snapshot

This chapter aims to provide a snapshot of the current state of the WEF Nexus within Kuwait. The chapter is structured according to the Nexus intersects of Water-Food, Water-Energy and Energy-Food. Though not exhaustive, the way in which WEF security is achieved in the country is captured through the Nexus Maps illustrated in Figure 18, Figure 19 and Figure 20. The Nexus Maps help structure the complex interactions and interlinkages of the Nexus, providing a high level understanding of WEF dynamics and security. Meanwhile, Tables, 3, 4 and 5 outline the various technologies and approaches currently utilized in Kuwait for each Nexus intersect in detail, coupled with corresponding initiatives and programs within the past 5 years. The references for the initiatives can be found in Appendix A.

*Table 2: Scoring criteria of WEF Nexus approaches/technologies*

| Approach/technology maturity | |
|---|---|
| Score | Description |
| 1 | Non-existent |
| 2 | Interest/awareness present |
| 3 | Tender, MOU, pilot project or significant research |
| 4 | Emerging in the market |
| 5 | Well established |

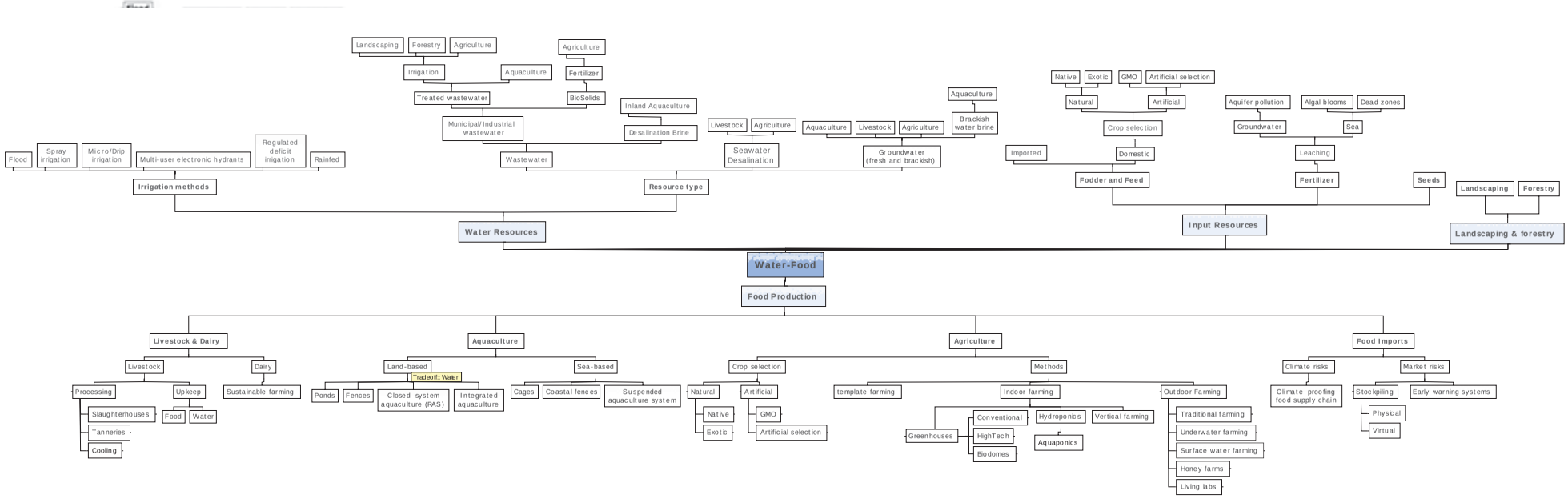
| Approach/technology growth potential | |
|---|---|
| Score | Description |
| 1 | Declining growth |
| 2 | No growth |
| 3 | Low growth |
| 4 | Medium growth |
| 5 | High growth |

The strengths and limitations of each approach/technology are outlined and scored as per the criteria in Table 2. The criteria is based on maturity level and growth potential. Maturity level relates to how well-established a particular approach and technology is in the country while growth potential considers strengths and limitations (e.g. environment, laws and regulations, consumer preferences). The scoring for each criteria were based on extensive research and interviews of the different initiatives and programs carried out across the country. The scores are presented in Table 3, Table 4 and Table 5.

## 3.1 Water-Food

Figure 18 shows the Water-Food Nexus Map in the GCC which explores food production and its various inputs from the perspective of water. Various food production and acquisition methods are identified including: livestock and dairy, aquaculture, agriculture and food imports. These categories are further broken down by practice of production. The required input resources includes the material used in food production such as fodder and feed, fertilizer and water. Water resources are covered in a separate section of the map due to the extensive consideration of water resources ranging from irrigation methods, wastewater, seawater desalination and groundwater.

*Figure 18: GCC Water-Food Nexus Map*[45]




[45] Figure 18 is based on EY internal analysis

*Table 3: Kuwait Water-Food Nexus Initiatives*

| SN | Category 1 | Category 2 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|---|
| WF-1 | Livestock, Poultry & Dairy | Livestock (ram, lamb, cow and goat) | Livestock protection & development | - Improved licensing and monitoring of veterinary products/medicine results in higher product quality, lower disease outbreaks and therefore higher yields | - Shortage of arable land | 3 | 3 | - MOU on livestock diseases between Kuwait & FAO |
| WF-2 | | | Sustainable breeding | - Particular breeds can be less resource intensive and more heat tolerant<br>- Breeding method: certain breeding methods such as artificial insemination can be more sustainable, reducing the need for livestock imports and increasing local production | - Consumers may prefer particular breeds based on quality<br>- Farmers are inclined to raise those with the highest profit margins | 1 | 3 | - No initiatives |
| WF-3 | | | Production systems | - The design and choice of particular production systems (meat or dairy production) can reduce costs, disease outbreaks, environmental impact and resource requirements | In Kuwait, certain production systems are constrained by:<br>- Climate (i.e. temperature, rainfall etc.)<br>- lack of natural shrub/vegetation for grazing | 3 | 4 | - 2880 Farms spread in three areas of the country |
| WF-4 | | | GMOs | - Opportunities to improve yields through disease resistance, saline water tolerance and heat tolerance | - Public hesitation/resistance towards GMOs | 1 | 3 | - No initiatives |
| WF-5 | | Poultry | Farming of poultry | - Suitable for the climate conditions<br>- Resource efficient<br>- Lading the food security net | - Prone to disease outbreaks due to poor ventilation<br>- Low profit margin on poultry | 5 | 5 | - Poultry farms are widespread throughout Kuwait with various setup types (i.e. commercial farmed eggs vs. free-range organic eggs)<br>- Al Wuhaib Farm<br>- Kuwait United Poultry Company |
| WF-6 | Agriculture | Crop Selection | Native and climate compatible species | - Salt and heat tolerant crops<br>- Reduced need for freshwater<br>- Opportunities for use as fodder, reducing irrigation requirements<br>- Synergy with voluntary and mandatory green building standards | - Limited variety of crops<br>- Legal challenges in registering new crop varieties | 4 | 4 | - Over 600,000 registered date palms<br>- Cultivation of over 20,000 native plants, Faisaliya Farm |
| WF-7 | | | Seaweed and macro-algae farming for animal feed | - Low input requirement<br>- High in nutrient content<br>- Opportunities for use as fodder, reducing irrigation requirements | - Requires controlled conditions<br>- May prove difficult to scale up | 2 | 5 | - Topic of the KISR-seminar 2018 |
| WF-8 | | | Domestic production of fodder and feed | - High demand for fodder<br>- Reduced reliance on imports | - Fodder cultivation competes with other crops for water resources<br>- Fodder crops are generally water intensive (such as Rhodes grass) | 5 | 2 | - Kuwait Animal Feed Factory (KAFEED) |

| SN | Category 1 | Category 2 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|---|
| WF-9 | | | Artificial selection & biotechnology (i.e. GMOs) | - Opportunities for improved yields, and disease, draught, heat and salt resistance | - Public hesitation/resistance towards GMOs | 3 | 3 | - KISR's biotechnology program: pilot scale development of unique date palm technologies, KISR |
| WF-10 | | Greenhouses and Hydroponics | High-tech greenhouses | - Increased crop productivity<br>- Improved resource efficiency<br>- Increased crop variety | - Does not facilitate pollination<br>- Large energy requirements for cooling | 2 | 5 | - Al Owaini experimental greenhouses |
| WF-11 | | | Seawater greenhouses | - Creates ideal growing conditions for crops while producing fresh water for irrigation | - Fine tuning of complex system<br>- Potential aquifer contamination from seawater | 1 | 3 | - No initiatives |
| WF-12 | | | Bio-domes | - Energy & cost efficient<br>- Synergies with voluntary & mandatory green buildings standards<br>- Can serve educational purposes | - Systems need to be thoroughly designed and fine-tuned<br>- Significant maintenance is required | 1 | 3 | - No initiatives |
| WF-13 | | | Hydroponic farming | - High irrigation efficiency compared to traditional methods<br>- Increased crop productivity<br>- Reduced use of pesticide & fertilizer | - High CAPEX<br>- Consistent monitoring<br>- Risk of water microorganisms contamination<br>- Lack of pollination | 4 | 4 | - Faisalya farm Independent hydroponics "terrace" farming |
| WF-14 | | | Aquaponics | - Reduced water consumption<br>- No fertilizer required<br>- When combined with hydroponics, reduces overall water requirements of system | - High CAPEX<br>- Needs to be coupled with hydroponic systems, which is not always feasible | 2 | 4 | - No initiatives/pilots within Kuwait, however a DIY community exists for home based projects |
| WF-15 | | Farming | Urban Farming | - Controlled growing environment<br>- Maximize resource efficiency<br>- Increase variety of crops<br>- Synergies with voluntary & mandatory green building standards | - High CAPEX<br>- Complex maintenance may require skilled workforce | 1 | 4 | - No initiatives |
| WF-16 | | | Surface Water Farming | - Extensive coastline and access to sea | - Uncontrolled conditions<br>- Dependent on availability of salt and heat tolerant crops | 1 | 5 | - No initiatives |
| WF-17 | | | Urban beekeeping | - Opportunities for coupling for pollination Strong cultural interest & demand | - Weather conditions, including temperatures, dust and humidity<br>-Kuwait has limited unbuilt land that can be utilized for honey farms | 3 | 4 | - Just Bee company (urban bee keeping installations) |
| WF-18 | | | Organic Fertilizers | - Minimizes environmental damages associated with chemical fertilizers | - High costs<br>- Potentially more difficult to collect and process | 3 | 4 | - Al Mawashi biogenic organic fertilizers |
| WF-19 | | | Organic Farming | - Reduced environmental damage and wide public/commercial appeal | - Could result in reduced yields and higher disease outbreaks if not properly managed | 4 | 3 | - Yasmin Farms<br>- Faisalya Farms<br>- NatureLand |

| SN | Category 1 | Category 2 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|---|
| WF-20 | Aquaculture | Land-based | Integrated agriculture | - Usage of existing brackish water<br>- Utilization of brine discharge from onsite brackish water reverse osmosis<br>- Declining fish stocks in Kuwait<br>- Strong government support for local fish production | - Temperature may be too harsh for certain species<br>- Risk of disease and contamination in closed systems, if not properly managed | 4 | 5 | - Integrated tilapia and alfalfa agriculture<br>- Regional Aquaculture Information System (RAIS), Kuwait and FAO<br>- Tilapia hatchery, RAIS<br>- Amkara fisheries research laboratory, RAIS<br>- MOU on improved food security through aquaculture, Kuwait & FAO<br>- Economic Fish Farming Project, PAAAFR |
| WF-21 | | Sea-based | Integrated multi-trophic aquaculture (IMTA) | - Extensive coastline available for coastal aquaculture<br>- Declining fish stocks<br>- Strong government support for local fish production | - Heat and salinity threat<br>- Risk of invasive species<br>- Disease outbreaks from high density of cages<br>- Coastal algal blooms from nutrients<br>- Lower fish prices from regional imports | 5 | 4 | - Cage farming has been well established in Kuwait since 1992, with an average production of 130 tonnes/year<br>- Al Kiran cage farming<br>- Economic Fish Farming Project, PAAAFR |
| WF-22 | Landscaping & Forestry | Landscaping & Forestry | Landscaping | - Widespread landscaping across Kuwait<br>- Opportunities for improvements in soil, irrigation efficiency and crop selection (water, heat and salt tolerance). Also for smart water-use efficient cultivation systems. | - Landscaping directly competes for food production water resources unless properly managed and maintained | 5 | 4 | - Landscaping is widespread across Kuwait<br>- Greenfields Agriculture |
| WF-23 | | | Forestry | - Opportunity for eco-tourism<br>- Supports local biodiversity and conservation | - High water use with no tangible benefit towards food security | 1 | 2 | Kuwait Oasis Initiative |
| WF-24 | Water Resources | Smart Irrigation | Drip irrigation | - High water efficiency<br>- Smart monitoring and scheduling<br>- Prevents disease and water logging<br>- improved submerged techniques to reduce water even more | - Relatively high maintenance and replacement cost | 3 | 5 | Drip irrigation commonly used in most farms (e.g. Yasmin Farms, Bohayra Farms, Sadeer Farms) |
| WF-25 | | | Spray irrigation | - Ease of installation, use and maintenance<br>- Smart monitoring and scheduling<br>- Prevents disease and water logging (when timed) | - Less water efficient than some other irrigation methods (high evapotranspiration) | 5 | 2 | - Widely used in landscaping across the country |
| WF-26 | | Cooling | Misting fans for animal cooling | - Easy to integrate and install within any farm | - High water use | 5 | 3 | Commonly used in most farms (e.g. Yasmin Farms) |

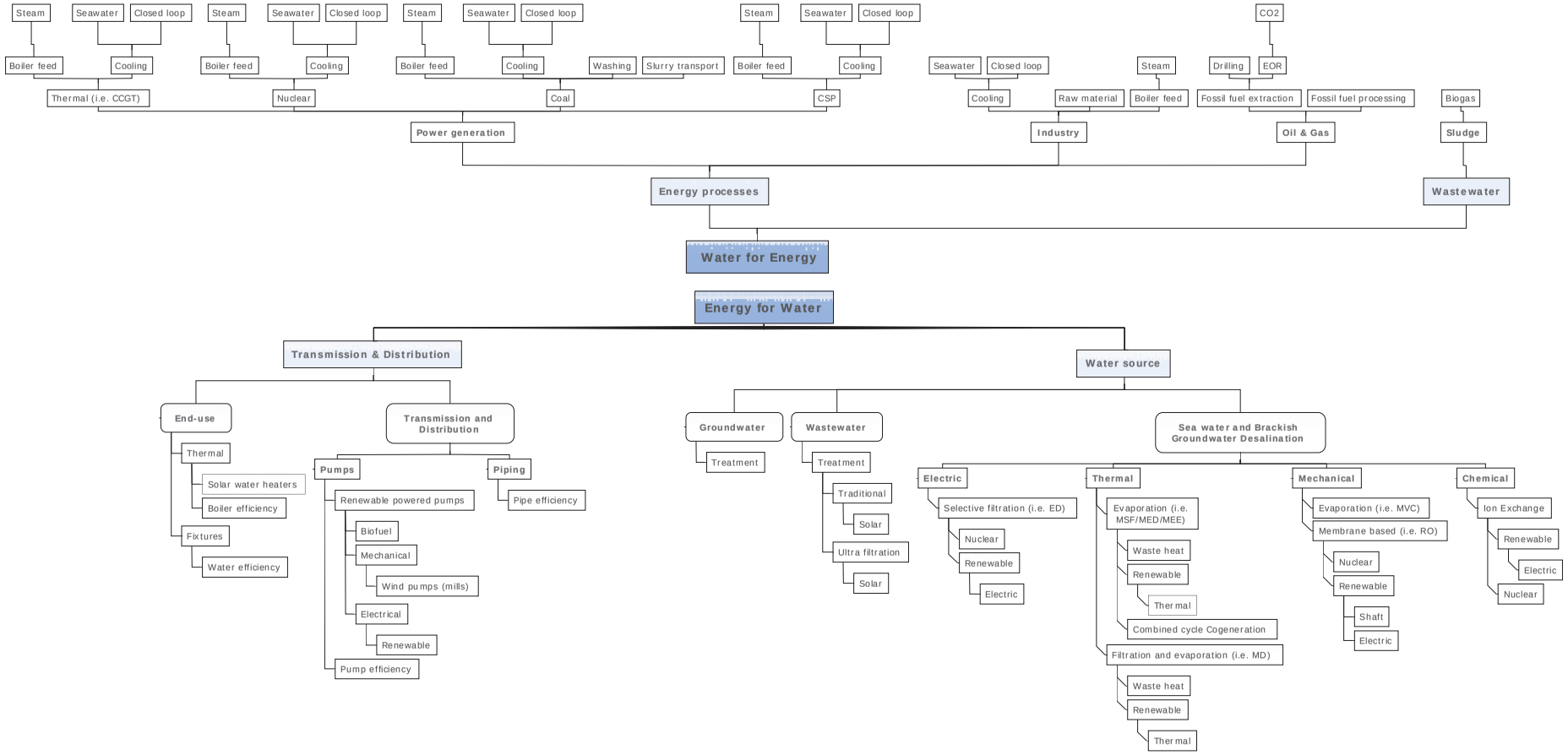
| SN | Category 1 | Category 2 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|---|
| WF-27 | | Wastewater | Treated/ recycled wastewater | - Conservation of freshwater sources<br>- Reduced use of synthetic fertilizer<br>- No tertiary treatment of wastewater required<br>- Current policies promoting usage of treated wastewater in agriculture<br>- Synergies exist with artificial aquifer recharge | - Risks of heavy metal contamination to soil, crops & groundwater<br>- Some cultural/public backlash to practice | 3 | 5 | - Kuwait's current water mix constitutes around 20% treated waste water, with around 57% of it being used in agriculture, a value that is expected to increase<br>- Wastewater Treatment And Reclamation Technologies (WTRT) Program at KISR |
| WF-28 | | | Aquaculture effluent | - Use effluent with salt tolerant crops<br>- Cultivation of otherwise barren lands | - Salt tolerant crops are not widespread | 1 | 3 | - No initiatives |
| WF-29 | | | Brine management | - Potential for redirection towards aquaculture<br>- Potential for creating value from the minerals in brine<br>- Availability of technologies for dealing with the environmental impacts of brine discharge to sea | - Brine negatively impacts marine ecosystems and fisheries through thermal, chemical and saline pollution if released in the environment | 3 | 4 | - Appraisal of Extraction of Valuable Minerals from Concentrated Brine |
| WF-30 | | Groundwater | Replenishing aquifers | - Technically and economically feasible<br>- Available water for emergency | - Associated risks with safety<br>- Efficiency and losses may be significant<br>- Quality of extracted replenished water may be poor | 3 | 4 | - Assessing Artificial Aquifer Recharge Using Reverse Osmosis Treated Wastewater at the Dammam formation |
| WF-31 | Soil | Soil quality | Soil monitoring | - Technology-enable real-time monitoring of soil moisture<br>- identify and optimize soil condition | - Scalability<br>- Shortage in skilled workforce | 3 | 4 | - Monitoring of soil moisture using remote sensing techniques |
| WF-32 | Food imports | Food import diversification and de-risking | International trade partnerships | - Ability to import food from various countries based on quality, price, availability etc. thereby constantly balancing Kuwait's supply-demand gap | - Significant market and climate risks associated with over dependence on imports<br>- As a small country, Kuwait's bargaining power is limited in in the international food market | 5 | 5 | - Kuwait will remain heavily reliant on food imports to 2025 |
| WF-33 | | Food monitoring systems | Food safety monitoring systems | - Ability to track and monitor the value chain of food products from "farm to fork", thereby protecting public health and safety from possible foodborne disease outbreaks<br>- Reduce food loss and wastage through monitoring | - Not well established yet, and will require significant stakeholder buy in across the food supply chain. | 4 | 5 | - Rapid assessment of Lumpy Skin Disease (LSD) outbreak in dairy cattle, Kuwait and FAO<br>- Issuance of phytosanitary certificates for fruits and vegetables at Kuwait port of entry, Public Authority for Food and Nutrition |

| SN | Category 1 | Category 2 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|---|
| WF-34 | | | Early warning systems | - Ability to monitor and forecast market and climate related risks of major food import partners, offering resilience in case of price shocks, droughts, natural disasters etc. | - Will require government support and buy in<br>- Requires dedicated task force to own the early warning system. | 1 | 3 | - No initiatives |

## 3.2 Water-Energy

Figure 19 shows the Water-Energy Nexus Map in the GCC, developed based on two main aspects: the use of energy in water production and the use of water in energy production. The use of energy in water production is classified based on two main areas of use, the transmission and distribution of water and the treatment of different sources of water. The sources include groundwater, wastewater and desalinated water, segmented by technology type. The water used in the energy production is classified based on areas of consumption, such as power generation, industry, oil and gas activities and wastewater treatment.

*Figure 19: GCC Water-Energy Nexus Map[46]*




[46] Figure 19 is based on EY internal analysis

*Table 4: Kuwait Water-Energy Nexus Initiatives*

| SN | Category 1 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|
| WE-1 | Bio-gas | Bio-gas from sewage sludge | - Significant sewage generated across Kuwait<br>- Anaerobic digestion of sludge in the form of biogas is a net energy producing process<br>- Recovered nutrients (phosphate and nitrogen) can be used in agriculture/industrial applications<br>- Local climate favourable to technology | - High investment cost for anaerobic digestion tanks and system | 2 | 5 | - No initiatives |
| WE-2 | Renewable energy powered desalination | Thermal desalination (i.e. MED/MSF/MEE) with solar thermal (i.e. CSP) | - High solar irradiance in Kuwait<br>- Reduced costs of CSP and PV<br>- Improved thermal storage | - High energy requirement<br>- Solar thermal systems (such as CSP) are yet to be integrated with desalination commercially<br>- Higher CAPEX of systems (MSF/MED compared to RO and CSP compared to PV)<br>- Slowing adoption of thermal desalination in Kuwait | 3 | 4 | - As Kuwait diversifies its energy mix, RO plants (such as Shuwaikh) will be supplied more and more by renewable energy via the grid<br><br>- Some initiatives exist at improving current thermal desalination processes through the Thermal Desalination Technologies (TDT) Program at KISR:<br>1- Pilot MED system for seawater desalination<br>2- Plate Heat Exchanger (PHE)- based MED<br>3- Adsorption (AD) technology |
| WE-3 | | Reverse Osmosis with PV/storage | - High solar irradiance Kuwait<br>- Dropping costs of PV brought on by largescale national and regional projects<br>- RO has lower CAPEX compared to thermal desalination and is gaining market share in total installed capacity<br>- Combining PV directly with RO addresses the intermittency issue as it allows for addition of RE into energy mix without the associated challenges | - Reduced RO membrane lifetime due to high salinity and high temperature of Arabian gulf seawater<br>- High OPEX (associated with membrane replacement)<br>- PV is yet to be directly combined with RO | 3 | 5 | |
| WE-4 | Cogeneration | Combined cycle - MSF/MED | - Cogeneration (combined cycle with MSF/MED) is the predominant technology utilized in Kuwait<br>- Availability of coastline makes power and water generation coupling easy<br>- Low fuel oil costs<br>- Use of by-product steam from power generation for thermal desalination<br>- Energy storage (e.g. batteries), can be used to optimize the cogeneration process, thereby reducing the energy requirements for thermal desalination | - Inherent risks associated with coupling water supply to natural gas<br>- High CAPEX<br>- Cogeneration facilities are designed for an optimal MW to MIGD generation ratio, which often don't match water and electricity demand, leading to inefficient burning of natural gas | 5 | 3 | - Az-Zoor IWPP (MED)<br>- Al Abdaliyah ISCC |

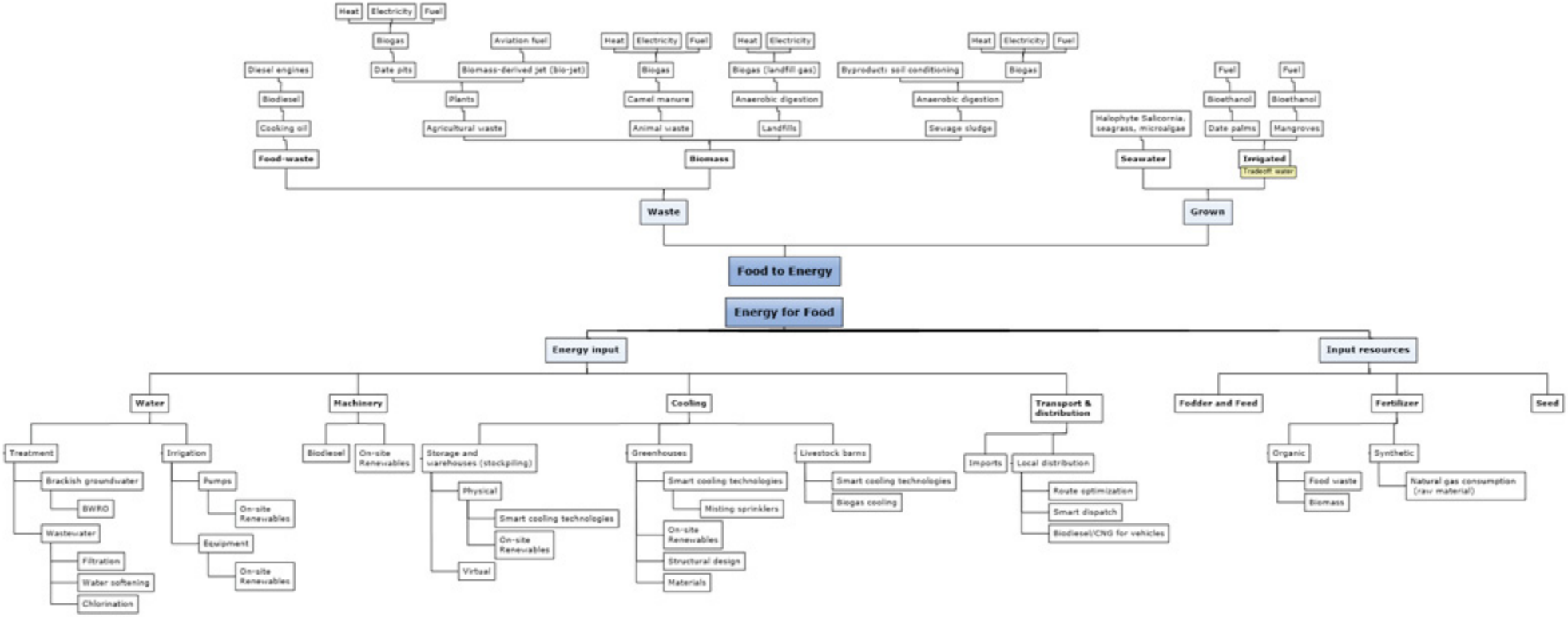
| SN | Category 1 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|
| WE-5 | Industrial water discharge | Water discharge management | - Availability of technologies for managing the environmental impacts (i.e. chemical, thermal and saline pollution) associated with water use for industrial, power and desalination processes<br>- Industrial discharge in Kuwait is largely unutilized | - Current regulations on discharge may not be conducive to technology/solution adoption<br>- Cost of systems<br>- Technical challenges related to the Arabian Gulf (depth, high temperature and salinity) | 3 | 5 | - All industries, power plants and desalination plants on the coast that discharge cooling water, treated wastewater or brine into the sea are regulated by the Kuwait Environmental Protection Agency (KEPA)<br>- No initiatives on zero-liquid discharge for brine<br>- Pilot scale study on the use of RO treated wastewater for artificial aquifer recharge, MEW & KISR |
| WE-6 | RE powered WWTP | Solar powered WWTP | - High solar irradiance in Kuwait | - Intermittency, unless a hybrid system<br>- Currently, higher cost than grid connection | 3 | 4 | -As the national energy mix is diversified, the share of renewables used in WWTP will naturally increase |
| WE-7 | Water pumping and transport | Solar water pumps | - High solar irradiance in Kuwait<br>- Off-grid usage makes system mobile, and avoids electrification costs | - Intermittency, unless a hybrid system | 4 | 5 | Ensiyaab engineering<br>Aqua Solutions Solar Water Pumps |
| WE-8 | | Biofuel water pump | - Various native bio-matter available in Kuwait including algae and seaweed that can be used for biofuel production<br>- Carbon neutral, and renewable source of energy<br>- No issues with intermittency | - Dependent on maturity of biofuel technology<br>- Costlier than conventional fuel options | 1 | 4 | No initiatives |
| WE-9 | | Piping efficiency and T&D monitoring | - Water system savings<br>- Identification of system nodes requiring maintenance and/or replacement through monitoring system (i.e. SCADA)<br>- High room for network efficiency improvement | - Pipe replacement and/or maintenance can be costly and disruptive<br>- High marginal cost of improvement due to existing high network efficiency | 3 | 5 | Pilot study on the reduced scaling of water piping systems through magnetic treatment, KISR |
| WE-10 | Water heating & cooling | Solar-water heaters | - High solar irradiance in Kuwait well suited for technology<br>- High cost savings and quick ROI<br>- Emerging supporting regulations at national level<br>- High growth market | - Higher installation costs than conventional water heating systems<br>- High requirement for proper insulation | 4 | 5 | Solar water heaters are sold in Kuwait through a number of companies including:<br>- Ensiyaab engineering<br>- Aqua Solutions Solar Water Heaters |
| WE-11 | | Solar-cooling systems | - High solar irradiance in Kuwait<br>- High cooling load in Kuwait<br>- Dropping PV and other solar technology costs<br>- Lower OPEX compared to traditional system | - Intermittency, unless a hybrid system | 3 | 5 | - TVP Solar cooling system<br>- KFAS partners with Co-ops to install solar PV on rooftops for A/C |

| SN | Category 1 | Approach or Technology | Strengths | Limitations | Maturity | Growth opportunity | Initiative(s)/Program(s) |
|---|---|---|---|---|---|---|---|
| WE-12 | Cooling | District Cooling | - District cooling reduces energy consumption to about 40% compared to traditional cooling | - Associated with booms and busts of real-estate sector | 2 | 5 | - district cooling is being used for private developments in Kuwait, but there is not yet a utility company providing district cooling |
| WE-13 | Water fixtures | Water fixture efficiency | - Market adoption of existing voluntary green building codes such as LEED<br>- Emergence and adoption of mandatory green building codes such as Estidama and Saa'fat<br>- Rising water tariffs among all Emirates and sectors | - No significant constraints | 5 | 5 | - Kuwait Green Building Council<br>- Energy Conservation Code of Practice revised for all buildings in 2014<br>- Energy Efficiency Technologies (EET) Program, KISR |
| WE-14 | Water and energy use in Oil & Gas and Industry | Fossil fuel extraction | - Water steam savings from EOR process by $CO_2$ or treated waste water injection substitution<br>- Reduced aquifer pollution compared to using produced water<br>- Form of carbon sequestering when $CO_2$ is used | - Risk of $CO_2$ contamination into aquifers<br>- Risk of increased earthquake activity | 3 | 5 | - KISR, Improved Oil recovery Program |
| WE-15 | | Monitoring systems | - Ability to monitor and analyse resource consumption and losses across Oil & Gas value chain<br>- Can result in significant cost savings to K-Group and the government | - Challenges in data collection and integration of assets across value chain<br>- May require capital investments in metering and other systems | 3 | 5 | - Data Monitoring Systems are being developed across K-Group companies in Kuwait to varying levels, though no centralization exists to date -<br>- Data monitoring system exists for Sulaibya Wastewater treatment plant |

## 3.3 Energy-Food

Figure 20 shows Energy-Food Nexus Map in the GCC, developed based on two main aspects: the use of energy in food production and the use of organic material in energy production. The use of energy in food production is categorized based on inputs of energy and resources required for production. The energy inputs are classified based on the energy used to operate water treatment plants, irrigation systems, industry machinery, cooling systems in addition to the energy used in the transport and distribution food across the production process. The organic material used in energy production is classified into two types: organic waste and grown food. For organic waste, the map presents the different waste streams e.g. food waste, agricultural waste, animal waste and landfill. On the other hand, grown food was grouped based on method of production (e.g. seawater grown or freshwater irrigated). Seawater grown includes microalgae and seagrass production while irrigated includes the cultivation of date palms and mangroves for the production of bioethanol.

*Figure 20: GCC Energy-Food Nexus Map*[47]




[47] Figure 20 is based on EY internal analysis

*Table 5: Kuwait Food-Energy Nexus Initiatives*

| SN | Category 1 | Category 2 | Approach/ technology | Approach strengths | Approach limitations | Maturity | Growth opportunity | Initiative(s)/Programme(s) |
|---|---|---|---|---|---|---|---|---|
| FE-1 | Biofuels | Grown biofuels | Biomass from halophytes | - Salt tolerant (use of Salicornia Halophyte)<br>- Wide availability of seawater and avoided use of freshwater<br>- Strong demand and support by local airlines for green/renewable jet fuel | - Commercialization and scaling up<br>- More expensive than conventional fuels | 3 | 5 | - Study on Salicornia production in Kuwait |
| FE-2 | | | Bioethanol | - Strong market interest in sustainable fuels | - Unless resulting from a waste stream or introduction of speciality plants (i.e. Jatropha), the process will be water intensive<br>- Limited number of native species that can be used at commercial scale<br>- More expensive than conventional fuels | 1 | 4 | - No initiatives |
| FE-3 | | Biofuels from Waste | Biogas from animal waste | - Animal waste is a significant and un-utilized waste stream in Kuwait | - Biomass yield is dependent on the kind of bio-waste (e.g. cattle or camel manure, chicken droppings etc.) and whether animals are held in stables or not<br>- Not feasible for all farms given size | 2 | 5 | - No bio-gas projects exist in Kuwait, though a few Kuwaiti companies such as Al-Dhow offer bio-gas solutions |
| WE-1 | | | Biogas from sewage sludge | Please refer to WE-1 for the details of this approach. | | | | |
| FE-4 | | | Biogas or Waste to Energy from Landfills | - Large potential of landfill gas in Kuwait (100 $m^3$ of gas per tonne of waste)<br>- Organic fraction of MSW may provide a source for organic fertilizer/soil improver depending on waste stream purity | - Depending on the conditions of the landfill (sanitary landfill vs. unregulated landfill) Large infrastructural investments may be required | 3 | 5 | - Kabd Solid Waste Treatment Plant, KAPP (once commissioned will process 50% of Kuwait's MSW) |
| FE-5 | | | Biodiesel from food waste | - Significant food waste exists in Kuwait (45% of MSW), such as waste cooking oil<br>- Hotels are a major source of food waste in the country, offering potential food waste collection partnerships | - Limited by ability to collect food waste at commercial scale<br>- More expensive than conventional fuels | 3 | 4 | - Kuwait seeks support of Punjab Food Authority on the use of cooking oil for biofuels |
| FE-6 | Onsite energy inputs for food production | Smart Cooling Technologies | Cooling of animal farms | - Large number of farms (cow, camel, goat, sheep) in the country<br>- High energy requirement for cooling to maintain optimal range for animals<br>- Opportunities exist for more energy efficient cooling technologies, coupled with smart systems for monitoring and process optimization<br>- Rising electricity tariffs in Kuwait | - Lack of proper cooling can result in loss of livestock, disease or decreased output | 2 | 4 | - No initiatives |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| FE-7 | | | Cooling of greenhouses and food storage | - Large consumers of energy for cooling<br>- Opportunities exist for more energy efficient cooling technologies, coupled with smart systems for monitoring and process optimization<br>- Rising electricity tariffs in Kuwait | - Cooling systems may present high initial investment cost with a long ROI<br>- Inherent tradeoffs of some cooling systems (e.g. high water efficiency but high energy or vice versa) | 4 | 4 | - No initiatives |
| FE-8 | | Greenhouses | Reducing cooling load through design and materials | - Greenhouses are widespread in Kuwait<br>- Greenhouses consume significant amounts of energy for cooling<br>- Opportunities for synergies with other technologies and setups (e.g. aquaculture)<br>- Rising electricity tariffs in Kuwait | - Materials must be tolerant to harsh Kuwait climate<br>- Potentially higher cost | 2 | 4 | - Evaluating IR reflective glass for improved greenhouse performance pilot project, KISR |
| FE-9 | | Fertilizer | Synthetic fertilizer production | - Improves crop yields<br>- Haber process is net $CO_2$ consuming | - Can result in eutrophication of water bodies<br>- Haber process is natural gas consuming<br>- Kuwait's Petrochemical Industries Company (PIC) has shut down its main fertilizer pant | 5 | 1 | - Kuwait's Petrochemical Industries Company (PIC), Urea Fertilizer plant (Now closed) |
| FE-10 | | Onsite renewables | PV for irrigation & pumps | - Off-grid solution for water pumps, reducing maintenance and electrical connection | - Low electricity tariffs for agricultural sector<br>- Intermittency, unless a hybrid system | 4 | 5 | - Jyoty Solar Water Pumps<br>Aqua Solutions Solar Water Pumps |
| FE-11 | | | PV for water treatment | - Off-grid solution for water treatment and onsite brackish water RO | - Low electricity tariffs for agricultural sector<br>- Intermittency, unless a hybrid system | 1 | 4 | No initiatives |
| FE-12 | | | Biodiesel for equipment | - Renewable source of fuel that can be generated from onsite agricultural waste streams and by-products | - More expensive than conventional fuels if purchased | 1 | 4 | No initiatives |
| FE-13 | Energy inputs for transport & distribution of food | Stockpiling | Virtual Stockpiling | - Utilization of warehouses abroad avoid infrastructure investment domestically<br>- Enhanced energy saving initiative for reduced cooling requirements<br>- Cost saving (buying during low prices)<br>- Added food security (emergency preparedness) | - Cost of storage/stockpiling abroad | 1 | 5 | No initiatives |
| FE-14 | | | Emergency physical stockpiling | - Strategic storage reserves allow for release of stockpiles during emergencies or price hikes | - Investment cost and maintenance<br>- Cooling and humidity control | 4 | 5 | KFMB grain storage reserves |
| FE-15 | | Local distribution | Route & inventory optimization | - Route optimization can reduce energy cost of transport and lengthen freshness and lifetime of food products<br>- Reduced inventory time can reduce food wastage and costs for businesses<br>- Emerging technology (e.g. IoT) can enable the above solutions in a cost effective and integrated way | - No significant constraints | 3 | 5 | - May exist with private sector companies. However, no initiatives disclosed on the matter |

# 4. Investment and Engagement Opportunities

Investment/engagement opportunities in Kuwait were identified for Dutch companies based on the technologies and approaches outlined in the previous chapter. The maturity and growth opportunity scoring of each technology/approach was used to identify the most suitable opportunities.

*Table 6: Investment/engagement opportunity type for Dutch companies*

| Opportunity Category | Category description | Maturity | Growth opportunity |
|---|---|---|---|
| Category 1 | High growth potential and mature market, ready for entry | > 3 | ≥4 |
| Category 2 | High growth potential market, but requires knowledge partner(s) | ≤ 3 | 5 |

The technologies/approaches identified in the previous chapter are categorized into two opportunities; Category 1 or Category 2 as per Table 6. Category 1 represents well established markets with good growth potential, where Dutch companies can enter directly as technology or solution providers. Category 2 technologies/approaches demonstrate high growth potential but are considered less mature commercially, either because they are still in research or testing phase in Kuwait. For Dutch companies, Category 2 technologies/approaches present an attractive market with positive growth potential, however they may require knowledge partners to maximize their growth. These knowledge partnerships may include one or many local or Dutch partners.

Applying the criteria in Table 6 to the technologies/approaches in the previous chapter yields the prioritized list of investment opportunities for Dutch companies presented in Table 7 and Table 8. These opportunities often comprise of two parts where Dutch companies can contribute towards. The first part being technical and engineering solutions and the second part being complimentary knowledge sharing and transfer of expertise. Taking hydroponics as an example, Dutch companies can deliver technical solutions with respect to different components such as irrigation, cooling, and system automation. Alternatively, Dutch companies may also offer knowledge sharing and expertise on, for example, choice of suitable crops, best practices in system maintenance, analysis of data. The latter can be delivered via training, consulting and joint research projects.

*Table 7: Category 1 approaches and technologies*

| SN | Category | Approach or Technology | Scoring | |
|---|---|---|---|---|
| | | | Maturity | Growth opportunity |
| WF-5 | Livestock, poultry & dairy | Farming of poultry | 5 | 5 |
| WF-32 | Food imports | International trade partnerships | 5 | 5 |
| WE-13 | Water fixtures | Water fixture efficiency | 5 | 5 |
| WF-20 | Aquaculture | Integrated agriculture | 4 | 5 |
| WF-33 | Food Imports | Food safety monitoring systems | 4 | 5 |
| WE-7 | Water pumping and transport | Solar water pumps | 4 | 5 |
| WE-10 | Water heating & cooling | Solar-water heaters | 4 | 5 |
| FE-10 | Onsite renewables | PV for irrigation & pumps | 4 | 5 |
| FE-14 | Stockpiling | Emergency physical stockpiling | 4 | 5 |

*Table 8: Category 2 approaches and technologies*

| SN | Category | Approach or Technology | Scoring | |
|---|---|---|---|---|
| | | | Maturity | Growth opportunity |
| WF-24 | Smart irrigation | Drip irrigation | 3 | 5 |
| WF-27 | Wastewater | Treated/ recycled wastewater | 3 | 5 |
| WE-3 | Renewable energy powered desalination | Reverse Osmosis with PV/storage | 3 | 5 |
| WE-5 | Industrial water discharge | Water discharge management | 3 | 5 |
| WE-9 | Water pumping and transport | Piping efficiency and T&D monitoring | 3 | 5 |
| WE-11 | Water heating & cooling | Solar-cooling systems | 3 | 5 |
| WE-14 | Water use in Oil & Gas | Fossil fuel extraction | 3 | 5 |
| WE-15 | Water use in Oil & Gas | Monitoring systems | 3 | 5 |
| FE-1 | Grown biofuels St | Biomass from halophytes | 3 | 5 |
| FE-4 | Biofuels | Biogas or Waste to Energy from Landfills | 3 | 5 |
| FE-15 | Local distribution | Route & inventory optimization | 3 | 5 |
| WF-7 | Agriculture | Seaweed and macro-algae farming for animal feed | 2 | 5 |
| WF-10 | Agriculture | High-tech greenhouses | 2 | 5 |
| WE-1 | Waste to energy | Bio-gas from sewage sludge | 2 | 5 |
| WE-12 | Cooling | District Cooling | 2 | 5 |
| FE-3 | Biofuels | Biogas from animal waste | 2 | 5 |
| WF-16 | Agriculture | Surface Water Farming | 1 | 5 |
| FE-13 | Stockpiling | Virtual Stockpiling | 1 | 5 |

# 5. Success through Engagement

The success of the Netherlands in the area of food production has placed it as the second largest global exporter of food in terms of dollar value after the United States. With the Netherlands being 3rd in the Global Innovation Index 2017 and Kuwait at 56 and fast rising, in addition to ranking 18th in the innovation efficiency ratio[48]. Furthermore, Kuwait has the opportunity to become a global innovation hub. The country can benefit from its human and financial capital to boost innovative research and development in addition to attracting foreign investments. Kuwait can focus on creating an environment of innovation for food production technologies in arid climates. Kuwait is uniquely situated to propel this due to its well established regional and global partnerships, ease of doing business, and strong national commitment towards food security, innovation and sustainability.

One of the main areas Kuwait can adopt from the Netherlands is their Dutch Triple Helix approach that strengthens synergies between government, industry, academia and society. For Dutch companies looking to enter Kuwait WEF market, engaging with the right stakeholders is pivotal. Doing business in Kuwait and wider region requires a certain level of adaptiveness and fluidity – brought on by sharp climatic, regulatory and cultural contrasts when compared to Europe and other regions. In Kuwait, the ministries are driving the strategies on resource conservation and diversification linked to the WEF Nexus. While water, energy and food security is high on the Kuwaiti government agenda, Dutch companies will also need to showcase their best practices, solutions and expertise by actively engaging with local entities and cultivating long term relationships.

## 5.1 Direct engagement with local entities

Figure 21 and Table 9 illustrate some of the key WEF stakeholders in Kuwait. Briefs about the entities and website links can be found in Appendix B. The level to which they should be engaged will vary significantly from company to company, based on criteria such as the level of required support and value proposition. Nonetheless, a qualitative prioritization was conducted to showcase the stakeholders that the Dutch companies may find the most relevant and the preferred engagement strategy.

[48] Cornell University, INSEAD, and the World Intellectual Property Organization (WIPO), *Global Innovation Index,* 2017

*Figure 21 Kuwait WEF stakeholders map*

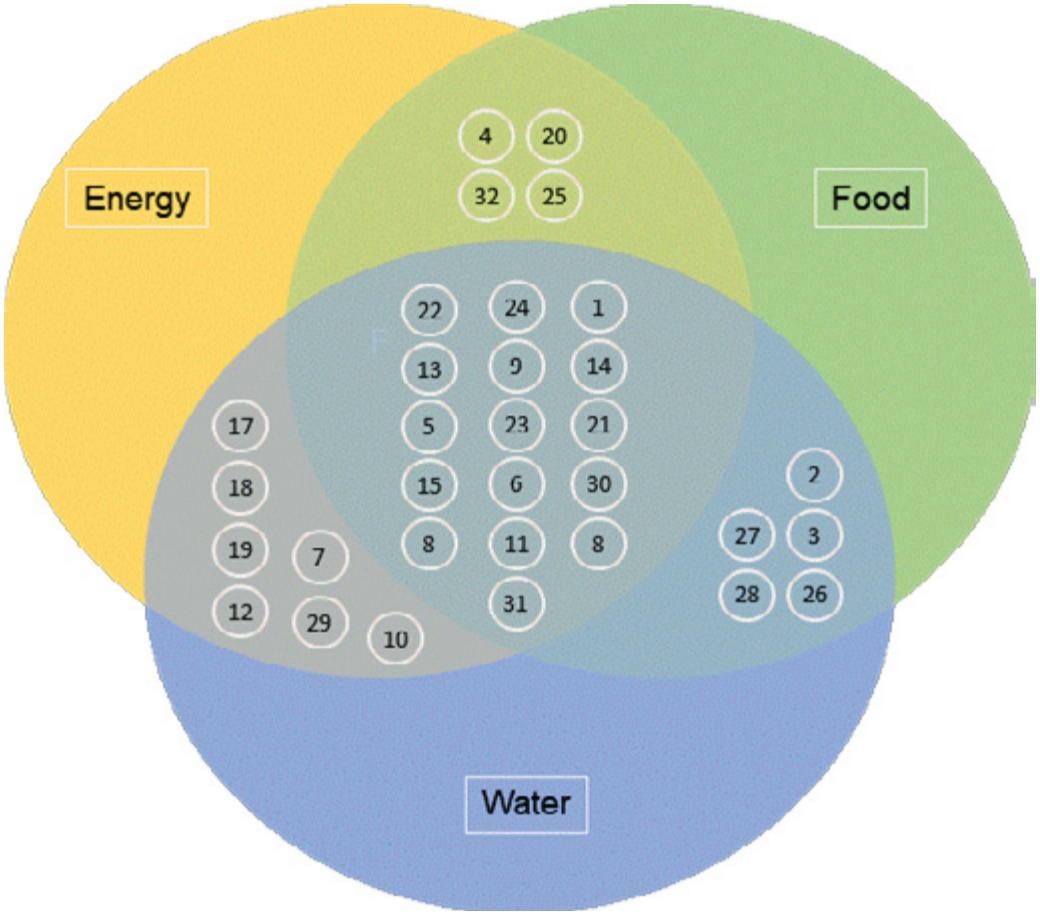



*Table 9: Engagement strategy of WEF stakeholder groups in Kuwait*

| Entity Type | Engagement Strategy |
|---|---|
| **Government operator entities**<br>1. Kuwait Authority for Partnership Projects (KAPP)<br>2. Public Authority For Food And Nutrition (PAFN)<br>3. Public Authority For Agricultural Affairs And Fish Resources (PAAAFR)<br>4. Public Authority for Industry (PAI)<br>5. Supreme Council for Planning and Development (SCPD)<br>6. Public Authority for Applied Education and Training (PAAET)<br>7. Public Authority for Housing Welfare (PAHW)<br>8. Kuwait Direct Investment Promotion Authority (KDIPA) | 1. Information collection: Dutch Companies need to form a solid understanding of the various government operators in Kuwait if they wish to collaborate successfully, for example their strategic direction, action plan, objectives and level authority.<br>2. Involve senior management: Dutch companies need to utilize the information collected in their research to connect with government operators based on their most pressing issues. Dutch companies should employ their senior management to connect with government operators and capitalize on Kuwait-Dutch diplomatic channels for introductions wherever relevant.<br>3. Share insights: Dutch Companies need to share their insights and experiences with government operators. This is best done in an interactive manner that emphasizes demonstration. This may include: meetings, conferences, workshops and invitations to see leading best practices abroad. |

| Entity Type | Engagement Strategy |
|---|---|
| **Government regulator entities**<br>9. Kuwait Environment Public Authority<br>10. Ministry of Electric and Water (MEW)<br>11. Ministry of Commerce and Industry (MOCI)<br>12. Minister of Oil (MOO)<br>13. Kuwait Municipality (KM)<br>14. Ministry of Public Works | 1. Establish focal point: Dutch companies may establish a key focal point from their organization that regularly engages with the Kuwaiti government regulator entities to improve communications and access to information. This may be complemented with face-to-face meetings to establish key contact points within priority departments in the Kuwait's government entities and to build a trust-based relationship. Dutch companies may also capitalize on Kuwait-Dutch bilateral channels (e.g. the Dutch embassy) for introductions.<br>2. Consult regularly: Regular consultations are important and should be followed up at regular intervals to familiarize government regulators with new information. As Kuwait is a dynamic environment in which regulations are regularly updated, Dutch companies can benefit from regular consultations to remain up to date with regulatory changes.<br>3. Share insights: Dutch entities can share their experience and insights with regulators regarding the regulatory enablers that could support agricultural sector growth and innovation in Kuwait. This allows Dutch entities to be proactive through interaction and demonstration, such as meetings, conferences, workshops and particular invitations to see leading best practices abroad.<br>4. Awareness building: As Dutch companies look to introduce novel ideas and solutions to Kuwait, awareness building will play a key part of any engagement strategy. Developing promotional material for regulators is key to refresh the memories of officials who are aware of ongoing discussions and to provide introductory information to those who are not. |
| **Unions and federations**<br>15. Kuwaiti Farmers Federation (KFF)<br>16. Agricultural Financing Portfolio | Awareness building: As Dutch companies look to introduce novel ideas and solutions to Kuwait, awareness building will play a key part of any engagement strategy. Developing promotional material for union members and federations is key to gain buy-in from farmers and workers who are directly engaged in and impacted by any developmental change that occurs in the sector. |
| **Industry**<br>17. EnerTech<br>18. Green Energy<br>19. KPC and subsidiaries<br>20. Agribusinesses (i.e. Kuwait Agriculture Company) | 1. Identify O&G drivers: Dutch companies should research and understand the scope and operations of the industries they wish to engage with to identify the key challenges and drivers before engaging.<br>2. Establish focal point: Dutch companies may nominate a key focal point to directly engage with key industry personnel in order to establish a trust based relationship and maintain an open line of communication.<br>3. Share insight: Dutch companies may personalize all pitches to Kuwaiti industry leaders to increase their chances of success. Sharing new insight may be challenging as Kuwaiti companies might initially resist change. However, interactive strategies such as meetings, conferences, workshops and particularly invitations to see leading best practices abroad that emphasize demonstration are often successful. Additionally, pilot projects and key collaborations opens the way for market acceptance/adoption of new technologies and practices. |
| **Funds and investment entities**<br>21. Kuwait Free Trade Zone<br>22. Kuwait Chamber of Commerce and Industry<br>23. Kuwait Investment Authority<br>24. Kuwait Investment Company<br>25. Markaz Energy Fund | 1. Establish focal point: Dutch companies may nominate a key focal point to directly engage with key fund and investment representatives in order to establish a trust based relationship and maintain an open line of communication.<br>2. Identify opportunities for collaborations: Companies can establish channels for investment opportunities in terms of the water, energy and food security of the country. For instance, companies can collaborate on initiatives for Kuwaiti agricultural investment through the existing national funds and investments to support food security as a long term strategy. |
| **International organizations and NGOs**<br>26. International Halal Accreditation Forum (IHAF)<br>27. Food and Agriculture Organization (FAO)<br>28. Arab Authority for Agricultural Investment & Development | Signing a MoU: Companies can establish effective partnerships with international organizations by signing a Memorandum of Understanding (MoU) to develop further cooperation in different areas. For instance, companies can share their know-how but also improve oversight of Kuwait market which could support companies in their engagement with government operators/regulators. |

| Entity Type | Engagement Strategy |
|---|---|
| **Universities and Research Institutes**<br>29. Kuwait Institute of Scientific Research (KISR)<br>30. Kuwait Foundation for the Advancement of Sciences (KFAS)<br>31. Kuwait University (KU)<br>32. Kuwait Science Club | 1. Building local relationships: Dutch companies may engage with local universities and research institutes to gain national and regional insights. This will help tailor their solutions when engaging with stakeholders such as government regulators/operators and local companies. Building such relationship may be achieved through direct partnership, or by bringing in Dutch universities to Kuwait.<br>2. Nominate a key contact: Companies should ensure that universities and research institutes have a champion who understands the importance of collaboration in guaranteeing endorsement for the project and helping in securing legitimacy and access to resources. |

## 5.2 The Dutch Economic Network in the Gulf

The Dutch Economic Network in the Gulf Region, which is established to help Dutch businesses in identifying business opportunities within the Gulf Countries[49], is the only channel that is operational in Kuwait. The network advises Dutch businesses on how to enter the Gulf market and set up business in the Gulf as well as offering advice based on the market context and potential partners.

Economic and Trade Affairs Officers are available at each of the 5 Embassies and 1 Consulate-General in the Gulf Region as well as a regionally operating Agricultural Office in Riyadh[50], Saudi Arabia. A newly appointed regionally operating Nexus expert in Abu Dhabi, UAE, is also available to provide support or advice Dutch companies wanting to do business in Kuwait.

For more information on the Dutch Economic Network in the Gulf region kindly visit our website

www.dutchgulf.com or https://www.netherlandsworldwide.nl/doing-business-in-the-gulf-region.

[49] Kingdom of the Netherlands, Dutch Economic Network in the GCC, 2018.
[50] Kingdom of the Netherlands, Agricultural Department for the GCC-countries

# 6. Appendix A

The tables below include the sources of all the initiatives cited in chapter 3, and are listed by initiative number.

| SN | Initiative(s)/Programme(s) | Links |
|---|---|---|
| WF-1 | MOU on tackling livestock diseases, Kuwait & FAO | www.kuna.net.kw/ArticleDetails.aspx?id=2499153&Language=en |
| WF-2 | No initiatives | Not applicable |
| WF-3 | Kuwait has 2880 farms | www.fao.org/family-farming/countries/kwt/en/ |
| WF-4 | No initiatives | Not applicable |
| WF-5 | Kuwait United Poultry Company | www.kupco.net/ |
| WF-6 | Date palms | www.reuters.com/article/us-iraq-kuwait-investment/on-former-battlefield-kuwaiti-investor-plans-date-palm-groves-ostrich-and-deer-reserve-idUSKCN1IM1AO |
| | Cultivation of over 20,000 native plants, Faisaliya Farm | www.faisaliyafarm.com/ |
| WF-7 | Seaweed cultivation was the topic of the KISR seminar 2018 | www.netherlandsworldwide.nl/countries/kuwait/about-us/ambassadors-blogs/may-2018 |
| WF-8 | Local feed production in Kuwait | www.alsayeronline.com/eng/animalfeed/animalfeed.asp |
| WF-9 | KISR's biotechnology program: pilot scale development of unique date palm technologies, KISR | www.kisr.edu.kw/en/program/12/ |
| WF-10 | Field of experiments inside Al-Owaini greenhouse | news.kuwaittimes.net/website/field-experiments-inside-al-owaini-greenhouse/ |
| WF-11 | No initiatives | Not applicable |
| WF-12 | No initiatives | Not applicable |
| WF-13 | Independent terrace farming<br>Faisaliya farms | www.indiansinkuwait.com/ShowArticle.aspx?ID=38057&SECTION=31<br>www.faisaliyafarm.com/ |
| WF-14 | No initiatives | Not applicable |
| WF-15 | No initiatives | Not applicable |
| WF-16 | No initiatives | Not applicable |
| WF-17 | Just Bee urban beekeeping | www.justbeekw.co/ |
| WF-18 | Al Mawashi biogenic organic fertilizers | www.almawashi.com.kw/site/pages/fertilizers/ |
| WF-19 | Yasmin Farms | kuwaitagro.com/EN/yasmin.html |
| | Faisalya Farms | www.faisaliyafarm.com/ |
| | NatureLand | kwt.natureland.net/en/ |
| WF-20 | Regional Aquaculture Information System (RAIS), Kuwait and FAO | www.raisaquaculture.net |
| | Tilapia hatchery, RAIS | www.fao.org/3/a-az573e.pdf |
| | MOU on improved food security through aquaculture, Kuwait & FAO | www.kuna.net.kw/ArticleDetails.aspx?id=2499153&Language=en |
| | Pilot study on technology development and application of shrimp culture for commercial production | www.kisr.edu.kw/en/search/?q=+farming |
| | Economic Fish Farming Project, PAAAFR | http://news.kuwaittimes.net/website/kuwait-eyes-fish-self-sufficiency-narrow-supply-demand-gap/ |
| WF-21 | Al Kiran identified for cage aquaculture, RAIS | www.fao.org/fishery/countrysector/naso_kuwait/en |
| | Economic Fish Farming Project, PAAAFR | http://news.kuwaittimes.net/website/kuwait-eyes-fish-self-sufficiency-narrow-supply-demand-gap/ |
| WF-22 | Greenfields Agriculture for landscaping | www.gfac.com.kw |
| WF-23 | Kuwait Oasis Initiative | www.kuwait-oasis.com/ |
| WF-24 | Drip irrigation commonly used in farms | kuwaitagro.com/EN/yasmin.html |
| WF-25 | No initiatives | Not applicable |
| WF-26 | Misting fans for animal cooling | kuwaitagro.com/EN/yasmin.html |
| WF-27 | Wastewater Treatment And Reclamation Technologies (WTRT) Program at KISR | www.kisr.edu.kw/en/program/7/ |
| WF-28 | No initiatives | Not applicable |
| WF-29 | Appraisal of Extraction of Valuable Minerals from Concentrated Brine | www.kisr.edu.kw/en/program/10/ |
| WF-30 | Assessing Artificial Aquifer Recharge Using Reverse Osmosis Treated Wastewater at the Dammam formation | www.kisr.edu.kw/en/program/8/ |
| WF-31 | Kuwait will remain heavily reliant on food imports to 2025 | www.futuredirections.org.au/publication/kuwait-food-and-water-security/ |

| SN | Initiative(s)/Programme(s) | Links |
|---|---|---|
| WF-32 | Issuance of phytosanitary certificates for fruits and vegetables at Kuwait port of entry, Public Authority for Food and Nutrition | www.kuwaitlocal.com/news/public-authority-for-food-and-nutrition-has-adopted-a-mechanism-to-test-fresh-fruits-and-vegetables |
| | Rapid assessment of Lumpy Skin Disease (LSD) outbreak in dairy cattle, Kuwait and FAO | www.fao.org/3/a-az573e.pdf |
| WF-33 | No initiatives | Not Applicable |

| SN | Initiative(s)/Programme(s) | Links |
|---|---|---|
| WE-1 | No initiatives | Not Applicable |
| WE-2 | Solar desalination MOU signed by French Foreign Minister and Kuwait | www.desalination.biz/news/0/French-and-Kuwaitis-sign-solar-desalination-agreement/7911/ |
| WE-3 and WE-4 | Az-Zour North Gas-Fired Combined Cycle Power Plant | www.power-technology.com/projects/az-zour-north-gas-fired-combined-cycle-power-plant/ |
| | Subiya CCGT | www.protenders.com/projects/subiya-power-plant-expansion-phase-3 |
| | Al Abdaliyah ISCC | www.kapp.gov.kw/en/Al-Abdaliyah-Integrated-Solar-Combined-Cycle-(ISCC) |
| WE-5 | Pilot scale study on the use of RO treated wastewater for artificial aquifer recharge, MEW & KISR | www.kisr.edu.kw/en/program/8/ |
| WE-6 | No initiatives | Not Applicable |
| WE-7 | Ensyiaab engineering keen on engaging with solar pumps market | www.ensiyaab.com |
| | Aqua Solutions Solar Water Pumps | www.greenenergy.com.kw/portfolio/aqua-solutions/ |
| WE-8 | No initiatives | Not Applicable |
| WE-9 | Pilot study on the reduced scaling of water piping systems through magnetic treatment, KISR | www.kisr.edu.kw/en/program/10/ |
| WE-10 | Ensyiaab engineering keen on engaging with solar water heaters market | www.ensiyaab.com |
| | Aqua Solutions Solar Water Heaters | www.greenenergy.com.kw/portfolio/aqua-solutions/ |
| WE-11 | TVP solar cooling system | www.tradearabia.com/news/OGN_338940.html |
| | KFAS partners with Co-ops to install solar PV on rooftops for A/C | www.kfas.org/About-Us/Initiatives?Detail=fa46f671-44be-4f00-8fca-52766dec78ff |
| WE-12 | District cooling is being used for private developments in Kuwait, but there is not yet a utility company providing district cooling | Not Applicable |
| WE-13 | Kuwait Green Building Council | www.kuwaitgbc.com/ |
| | Energy Conservation Code of Practice revised for all buildings in 2014 | www.mew.gov.kw/ |
| | Energy Efficiency Technologies (EET) Program, KISR | www.kisr.edu.kw/en/research/energy-and-building/programs/energy-efficiency-technologies-program/ |
| WE-14 | KISR, Improved Oil Recovery Program | http://www.kisr.edu.kw/en/program/3/ |
| WE-15 | Data Monitoring System (DMC) connected to the distribution system from the Sulaibya Wastewater treatment plant | www.udcsulaibiya.com/sulaibiya%20project/projects_facilities.html |

| SN | Initiative(s)/Programme(s) | Links |
|---|---|---|
| FE-1 | Study on Salicornia production in Kuwait | pdfs.semanticscholar.org/fd53/2adeb870028d19b527f48a20d724eaff4257.pdf |
| FE-2 | No initiatives | Not Applicable |
| FE-3 | Al-Dhow Biogas Pilot Project | www.aldhow-kw.com/renewable-energies/biogas-energy/ |
| FE-4 | Kabd Solid Waste Treatment Plant, KAPP | www.protenders.com/companies/kuwait-authority-for-partnership-projects/projects/kabd-solid-waste-treatment-plant |
| FE-5 | Kuwait seeks support of Punjab Food Authority on the use of cooking oil for biofuels | www.dawn.com/news/1350326 |
| FE-6 | Commonly used in farms across the country | |
| FE-7 | No initiatives | Not Applicable |
| FE-8 | No initiatives | Not Applicable |
| FE-9 | Evaluating IR reflective glass for improved greenhouse performance pilot project, KISR | www.kisr.edu.kw/en/search/?q=greenhouse# |
| FE-10 | - Kuwait's Petrochemical Industries Company (PIC), Urea Fertilizer plant (Now closed) | https://www.icis.com/resources/news/2018/07/04/10238275/kuwait-s-pic-closes-urea-plant-permanently/ |
| FE-11 | Aqua Solutions Solar Water Pumps | www.greenenergy.com.kw/portfolio/aqua-solutions/ |
| | Jyoty Solar Water Pumps | www.jyotysolarpower.com/solarwaterpump/solar-water-pump-suppliers-in-kuwait |
| FE-12 | No initiatives | Not Applicable |
| FE-13 | No initiatives | Not Applicable |
| FE-14 | No initiatives | Not Applicable |
| FE-15 | KFMB grain storage reserves | www.world-grain.com/articles/news_home/World_Grain_News/2018/06/Kuwaits_milling_giant.aspx?ID=%7BD1B0E0C8-2EE0-4C9B-876D-8132B0BBDAD4%7D&cck=1 |
| FE-16 | No initiatives | Not Applicable |

# 7. Appendix B

The table below elaborates on the stakeholder entities identified in Chapter 5, providing entity descriptions and links.

| Entity type | | Entity Responsibility | Link |
|---|---|---|---|
| Government operator entities | | | |
| 1 | Kuwait Authority for Partnership Projects (KAPP) | Develops partnership program to promote collaborations between the public and private sectors and to promoting scientific research and technological development. | http://www.kapp.gov.kw/ |
| 2 | Public Authority For Food And Nutrition (PAFN) | Controls the food producers, importers and sellers in Kuwait to ensure food safety and healthy living. | https://www.informea.org/en/legislation/law-no112-2013-establishing-public-authority-food-and-nutrition |
| 3 | Public Authority For Agricultural Affairs And Fish Resources (PAAFR) | Regulates cage fish culture activities in the country. | https://www.unescwa.org/public-authority-agriculture-affairs-and-fish-resource |
| 4 | Public Authority for Industry (PAI) | Oversees the industrial base to achieve the goals of Kuwait's economy including food security. | https://www.pai.gov.kw/el/web/pai/vision-mission |
| 5 | Supreme Council for Planning and Development (SCPD) | Improves the global competitiveness of Kuwait in line with Kuwait's National Development Plan towards attracting investments. | https://www.scpd.gov.kw/ |
| 6 | Public Authority for Applied Education and Training (PAAET) | Develops national manpower to meet human resources needs through education and training. | https://unevoc.unesco.org/go.php?q=UNEVOC+Network+-+Centre&id=403 |
| 7 | Public Authority for Housing Welfare (PAHW) | Provides housing welfare for eligible citizens, and recently promotes rooftop solar PV. | https://www.pahw.gov.kw/ |
| 8 | Kuwait Direct Investment Promotion Authority (KDIPA) | Aims at contributing towards the economic diversification of Kuwait and its sustainable development. | https://kdipa.gov.kw/en/ |
| Government regulator entities | | | |
| 9 | Environment Public Authority | Sets and applies general policy on environmental protection. | www.epa.org.kw |
| 10 | Ministry of Electric and Water (MEW) | Provides water and power, and engages the private sector in the development of new utilities infrastructure. | www.mew.gov.kw |
| 11 | Ministry of Commerce and Industry (MOCI) | Supports and supervises commercial and industrial activities. | www.moci.gov.kw |
| 12 | Minister of Oil (MOO) | Protects petroleum resources, exploiting and developing with the best available methods. | www.moo.gov.kw |
| 13 | Kuwait Municipality (KM) | Provides municipal services, and aims at fulfilling the objectives of sustainable development. | www.baladia.gov.kw |
| 14 | Ministry of Public Works | Provides advanced infrastructure and public buildings with the highest standards to promulgate sustainable urban leadership. | www.mpw.gov.kw |
| Unions and federations | | | |

| | | | |
|---|---|---|---|
| 15 | Kuwaiti Farmers Federation (KFF) | Develops the national agriculture sector in order to achieve self-sufficiency and food security. | www.kff.org.kw |
| 16 | Agricultural Financing Portfolio | Finances agricultural production projects and raising of cattle with a capital of KD 50 million. | www.ibkuwt.com/ibk/web/en/Managed_Portfolios/Agriculture_Finance_Portfolio/ |
| Industry | | | |
| 17 | EnerTech | Leads the cleantech industry in the country. | www.enertech.com.kw |
| 18 | Green Energy | Provides integrated sustainable solutions provider specializing in LED, water, renewable, and smart solutions. | www.greenenergy.com.kw |
| 19 | KPC and subsidiaries | Develops the national oil and gas sector. | www.kpc.com.kw |
| 20 | Agribusinesses (i.e. Kuwait Agriculture Company) | Leads the food imports and distribution sector in Kuwait. | www.ktagr.com |
| Funds and investments | | | |
| 21 | Kuwait Free Trade Zone | Located in Shuwaikh, the free zone allows 100% foreign ownership of businesses within the zone. | www.nuwait.net.kw/article/kuwait-free-trade-zone-past-future-developments |
| 22 | Kuwait Chamber of Commerce and Industry | A non-government institution representing business establishment. The Chamber acts on the behalf of, represents and lobbies for the interests of businesspersons and industrialists in Kuwait. | www.kuwaitchamber.org.kw/ |
| 23 | Kuwait Investment Authority | Oldest sovereign fund in the world, invests. | www.kia.gov.kw |
| 24 | Kuwait Investment Company (KIC) | Supports the national economic development process. | www.kic.com.kw |
| 25 | Markaz Energy Fund | Invests in prudent and innovative energy solutions to create sustainable wealth. | www.markaz.com |
| International organizations and NGOs | | | |
| 26 | International Halal Accreditation Forum (IHAF) | Protects halal food consumers and facilitate international trade of halal food products. | www.ihaf.org.ae |
| 27 | Food and Agriculture Organization (FAO) | Promotes sustainable and productive agriculture and fisheries to combat hunger and food insecurity. | www.fao.org |
| 28 | Arab Authority for Agricultural Investment & Development | Engages in a range of Agricultural Investment activities including plant processing, animal production, agricultural processing and other related activities to reinforce food security. | www.aaaid.org |
| Universities and Research Institutes | | | |
| 29 | Kuwait Institute of Scientific Research (KISR) | National scientific institute that drives innovation in industry and the resolution of national challenges such as sustainable development. | www.kisr.edu.kw |
| 30 | Kuwait Foundation for the Advancement of Sciences (KFAS) | Drives progress in all fields of science and technology, and engages with the private sector. | www.kfas.org |

| | | | |
|---|---|---|---|
| 31 | Kuwait University (KU) | Kuwait's first public institution for higher innovation and research. | www.kuniv.edu |
| 32 | Kuwait Science Club | Sponsor scientific activities and improve the quality of education in sciences. | www.ksclub.org |

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