NEXUS
IN THE UNITED ARAB EMIRATES
OPPORTUNITIES FOR DUTCH COOPERATION
Dutch connection in the UAE
ACKNOWLEDGEMENTS

EY’s Sustainability and Climate Change team in MENA carried out the detailed research and analysis for this report, commissioned by the Embassy of the Kingdom of the Netherlands in the United Arab Emirates.

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Water, energy and food are the most vital resources any living organism needs to survive and thrive. Global population growth, climate change and environmental stress are but a few of the challenges to these resources, and the future demand for each of them will only increase.

The Water-Energy-Food Nexus concept looks specifically at the interrelationships between water, energy and food, and uses that knowledge to enhance the effects of looking at each resource on its own, as only an integrated approach will allow for sustainable solutions. This conceptual approach helps us to better understand, and systematically analyze, the interactions between our natural environment and human activities, and to work towards a more coordinated management and use of natural resources across sectors.

Both the United Arab Emirates and the Kingdom of the Netherlands were amongst the 193 countries that signed the Sustainable Development Goals (SDGs) in 2015, as part of the wider UN 2030 Development Agenda. Several of the 17 SDGs refer to the resources mentioned above, e.g. zero hunger, clean water and sanitation, affordable and clean energy, sustainable cities and communities, responsible consumption and production, and climate action. The nexus-approach contributes to the realization of the SDGs.

The UAE and Dutch Governments signed a Memorandum of Understanding (MoU) on Innovation in 2017, including collaboration on the Nexus. The main ambition of this MoU was to encourage greater dialogue, awareness and engagement between governments, companies and knowledge institutes from the Netherlands and the UAE. With the current publication, yet another chapter will be added to bilateral engagement and reaching our shared sustainability goals.

The Embassy of the Kingdom of the Netherlands in Abu Dhabi initiated this research to explore the state of play in the United Arab Emirates in the sectors water, energy and food. Besides listing threats for the future, the findings of the report point to opportunities for the Netherlands to connect its expertise and integrated approach to the demands in the area.

The challenges of today, both regional and worldwide, can only be faced collectively if we are serious in providing sustainable solutions. Let the Netherlands and the United Arab Emirates join forces to take the next necessary steps towards sustainable development.

Sincerely,

HE Frank J. M. Mollen
Ambassador of the Kingdom of the Netherlands in the UAE, Abu Dhabi
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<th>Abbreviation</th>
<th>Description</th>
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<tbody>
<tr>
<td>CAGR</td>
<td>Compounded Annual Growth Rate</td>
</tr>
<tr>
<td>CCGT</td>
<td>Combined Cycle Gas Turbine</td>
</tr>
<tr>
<td>CSP</td>
<td>Concentrated Solar Power</td>
</tr>
<tr>
<td>ED</td>
<td>Electrodialysis</td>
</tr>
<tr>
<td>ESCO</td>
<td>Energy Servicing Company</td>
</tr>
<tr>
<td>FDI</td>
<td>Foreign Direct Investment</td>
</tr>
<tr>
<td>GDP</td>
<td>Gross Domestic Product</td>
</tr>
<tr>
<td>GMO</td>
<td>Genetically Modified Organism</td>
</tr>
<tr>
<td>GMOs</td>
<td>Genetically Modified Organisms</td>
</tr>
<tr>
<td>IoT</td>
<td>Internet of Things</td>
</tr>
<tr>
<td>LEED</td>
<td>Leadership in Energy and Environmental Design</td>
</tr>
<tr>
<td>MD</td>
<td>Membrane Distillation</td>
</tr>
<tr>
<td>MED</td>
<td>Multi-Effect Distillation</td>
</tr>
<tr>
<td>MSF</td>
<td>Multiple Stage Flash</td>
</tr>
<tr>
<td>MVC</td>
<td>Mechanical Vapour Compression</td>
</tr>
<tr>
<td>PV</td>
<td>Photovoltaic</td>
</tr>
<tr>
<td>RAS</td>
<td>Recirculating Aquaculture System</td>
</tr>
<tr>
<td>RO</td>
<td>Reverse Osmosis</td>
</tr>
<tr>
<td>WEF</td>
<td>Water-Energy-Food</td>
</tr>
<tr>
<td>WtE</td>
<td>Waste to Energy</td>
</tr>
<tr>
<td>WWTP</td>
<td>Waste Water Treatment Plant</td>
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</tbody>
</table>
2. Introduction

2.1 Report objective

The WEF Nexus has risen on the national agenda as the UAE looks to secure its future and support ongoing development. The UAE and Dutch government signed a Memorandum of Understanding (MoU) in 2017 for collaboration on the Nexus. The main ambition for the MoU is to encourage greater dialogue, awareness and engagement, between the Netherlands Government, Dutch companies and the UAE on the Nexus. This may be achieved through technology transfer, expertise, research and development, joint ventures, investments and other mechanisms.

The objective of this report is to support this arrangement by contextualizing the current state of the WEF Nexus in the UAE particularly in relation to the availability of primary freshwater, energy and food resources along with the main 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 the UAE, along with the proposed engagement channels leading up to the Expo 2020.
## UAE OVERVIEW

The United Arab Emirates

| LAND AREA: | 83,600 km² |
| CLIMATE: | Desert; cooler in eastern mountains |
| TERRAIN: | Flat, barren coastal plain merging into rolling sand dunes of vast desert; mountains in east |
| ARABLE LAND: | 0.5% |
| ENVIRONMENTAL ISSUES: | Air pollution; rapid population growth and high energy demand contribute to water scarcity; lack of natural freshwater resources; land degradation and desertification; waste generation; beach pollution from oil spills |
| ENVIRONMENT AGREEMENTS: | Biodiversity, Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Marine Dumping, Ozone Layer Protection |
| NATURAL RESOURCES: | Petroleum, natural gas (seer) |
| POPULATION: | 9,400,145 (July 2017 est.); 88% Expatriates |
| URBANIZATION: | 86.5% of total population |
| GDP (PPP): | USD 696 billion (2017 est.) - 0.9% agriculture, 49.8% industry, 49.2% service (2017 est.) |
| GDP - PER CAPITA (PPP): | USD 68,600 (2017 est.) |
| INDUSTRIES: | Petroleum and petrochemicals; fishing, aluminum, cement, fertilizer, commercial ship repair, construction materials, handicrafts, textiles |

## UAE WATER-ENERGY-FOOD RESOURCES

### Power generation in the UAE

The UAE is capable of meeting its energy demand, excluding power and water generation, which relies predominantly on imported natural gas. The commercial sector is the biggest power consumer, followed by residential. Buildings alone consume around 80% of the total generated electricity (mostly for cooling).

<table>
<thead>
<tr>
<th>Natural Gas</th>
<th>Fuel Oil (incl. solar, wind etc.)</th>
<th>Waste to Energy/ Biogas</th>
<th>Nuclear</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Mix</td>
<td>75%</td>
<td>1%</td>
<td>5%</td>
</tr>
<tr>
<td>Trend</td>
<td>Backward</td>
<td></td>
<td>Forward</td>
</tr>
</tbody>
</table>

### Water production/withdrawal in the UAE

The UAE’s water supply consists primarily of groundwater and desalinated water. The UAE’s groundwater resources are mostly utilized for agriculture, while energy-intensive seawater desalination is used for municipal and industrial needs (meeting 95% of potable water needs).

<table>
<thead>
<tr>
<th>Thermal Desalination</th>
<th>Reuse Device (from Grid)</th>
<th>Treated Wastewater</th>
<th>Surface &amp; Groundwater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Mix</td>
<td>Desalination 50%</td>
<td>5%</td>
<td>40%</td>
</tr>
<tr>
<td>Trend</td>
<td>Backward</td>
<td>Forward</td>
<td>Backward</td>
</tr>
</tbody>
</table>

### Food production and acquisition in the UAE

- **Food Imports**: In 2016, the UAE’s top food importer was China, followed by the United States and Brazil.
- **Food Imports, supplemented by agricultural FDI projects, will remain pivotal in the UAE’s food security strategy.**
- **Foreign Direct Investment in farmland abroad**
- **Domestic Food Production**

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

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

Significant opportunities exist to reduce losses at handling & storage, and consumption. Along with waste to bio gas and water to chemicals 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
- Drip irrigation
- Food monitoring systems
- Food import risk management & early warning systems

### Water-Energy
- Excessive powered desalination
- Sewage sludge to biogas
- T&D network efficiency
- Water fixture efficiency
- Industrial water discharge management
- Solar water heaters & pumps
- District cooling

### Food Energy
- Greenhouse and storage cooling systems
- Biogas production from organic waste
- Biomas from halophytes
- Route & inventory optimization
- Physical emergency stockpiling (i.e. food reserves)
- PV for irrigation pumps
2.3 Background context

With the discovery of oil in 1958, the UAE transformed from desert principalities to a modern and well-developed nation. This transformation resulted in major socio-economic and environmental changes, which continue to this day. The population and economic growth that followed, depicted in Figures 1 and 2, led to an increase in demand for resources that far exceeded the country’s natural carrying capacity. By 2050, the population is estimated to grow by a further 40%, reaching 13.1 million, further straining the country’s scarce natural resources.

![Figure 1: Population growth in the UAE since 1960](image)

![Figure 2: GDP in the UAE since 1975 in USD current](image)

With 6.5%\(^1\) of the world’s proven oil reserves, the UAE has been an energy independent nation since its founding. This has enabled the dry and arid country to meet its potable water needs via fossil fuel powered seawater desalination. In addition, with the UAE being a major oil exporter, its oil revenues have traditionally been used and invested in structures and supply chains that enable greater food supply security.

The result is that the UAE is heavily reliant on its fossil fuel and fossil aquifer resources for maintaining water and food security. This makes it vulnerable to stresses like fluctuating oil prices, population growth, increasing standards of living and climate change. Although fossil fuel and food price linkages are a global phenomenon, the interdependence of the two is even more severe and critical in the UAE and highlights the importance of adopting a water-energy-food (WEF) nexus (the Nexus) approach when considering and addressing the country’s future development.

2.4 UAE Structure

The UAE is a Federation consisting of seven Emirates: Abu Dhabi, Dubai, Sharjah, Ras Al Khaimah, Ajman, Umm Al Quwain and Fujairah. Each Emirate maintains a significant level of autonomy, power and ownership over their natural resources, having had their own governing institutions prior to the establishment of the Federation in 1971. As per the UAE Constitution, the rulers of the individual Emirates may give up certain authorities to the Federal Government and may assume or re-assume such authorities/functions accordingly.

Given the varying size, level of development, population size and other factors, the local governments of the seven Emirates differ in their structure and mechanics. However, each Emirate has an Executive Council which works under the supervision of the Ruler’s Court of that Emirate. With Abu Dhabi and Dubai being the largest two Emirates by size, population and GDP, they play a leading role in the strategic

\(^1\) The World Bank, *Population growth and GDP in the UAE*, 2018
direction of the country and steering national visions and strategies. Furthermore, from a water-energy-food nexus perspective, they represent the bulk of water, energy and food production and consumption – often servicing other Emirates.

2.5 UAE resources

2.5.1 Freshwater

Historically, the UAE relied almost entirely on two types of groundwater resources. Its shallow aquifers, recharged via rainfall, are the only source of renewable freshwater. Its deep aquifers were formed thousands of years ago and are largely considered “fossil” or non-renewable. Groundwater is predominantly used for agriculture: with productive agriculture (excluding forestry and landscape management) using 32% of all water resources in the country and 50% in Abu Dhabi, whilst comprising less than 1% of the country’s GDP.

The intensive irrigation use spurred by sector subsidies has resulted in over-abstraction of groundwater with water tables dropping anywhere between 1.5 to over 5 meters per year. Water quality degradation, seawater intrusion, and the drying of shallow aquifers are further consequences of unsustainable water use.

Seawater desalination infrastructure has therefore been developed to provide the majority of the country’s domestic water needs. This energy intensive process results in carbon emissions and in brine discharge to the sea. More recently, treated wastewater has been given greater attention as an alternative to groundwater abstraction, particularly for agriculture, forestry and landscaping.

As illustrated in Figure 3 the UAE’s water supply mix is composed of 60% groundwater, 35% desalinated water and 5% recycled water.

Figure 3: UAE’s water supply mix and breakdown of usage by sector

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3 Saif et al., Water Security in the GCC Countries: Challenges and Opportunities, 2014.
4 EWS-WWF, UAE Climate Change Risks & Resilience, 2017
5 Murad et al., Comprehensive Assessment of Water Resources in the UAE, 2006
The UAE’s water demand has been growing significantly and is expected to double by 2055\(^7\). Figure 4 forecasts water demand, presenting a potential water mix that shifts away from groundwater and fossil fuel desalination to focus more on renewable powered desalination and waste water reuse\(^3\).

**Figure 4:** Projected scenario of water demand by source

How will the UAE maintain its water security in the future?

Supply: As the demand for domestic and agricultural water increases, renewable-powered desalination is one option being considered as a replacement for current fossil fuel powered technologies. In addition, the use of treated wastewater will increasingly be employed to limit the depletion of groundwater. Finally, announcements have also been made highlighting the UAE’s intention to continue to expand its strategic water storage capacity and to improve the resilience of its utilities network.

Demand: The UAE has witnessed a number of strategies and programs that encourage and implement greater demand side management efforts across all sectors – a trend that is expected to continue and amplify. Behavioral changes, application of new technologies and the removal of existing subsidies will bring about the change that is needed to reduce overall demand for water.

### 2.5.2 Energy

The UAE is capable of domestically meeting its energy demand, excluding power and water generation, which relies predominantly on imported natural gas. Fifty percent of the UAE’s electricity is generated from natural gas imported from Qatar via the Dolphin Gas pipeline\(^8\). However, the country’s recent visions and national strategies, discussed further in Section 2.7, are centred on diversifying its energy mix as represented in Figure 5. As such, the country has invested in developing its nuclear, sour gas and solar power capacity with other project development also underway in areas such as clean coal and hydropower.

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As the UAE continues to develop key industrial and manufacturing sectors, its electricity consumption will continue to increase. In Abu Dhabi, demand is forecasted to increase by 62% between 2017 and 2030. Figure 6 shows that the residential and commercial sectors are the largest power consumers in the UAE. Buildings alone consume around 80% of the total generated electricity in the country, the bulk going towards cooling.

Based on the current electricity generation infrastructure, the increase in energy demand will also result in greater greenhouse gas emissions. Figure 7 displays the expected projection up to the year 2030 by the Climate Action Tracker (CAT) which rated the UAE as insufficient in meeting the expected targets for keeping global warming below 2°C or limiting it to 1.5°C as per the Paris Climate Change Agreement.

How will the UAE maintain its energy security in the future?

Nuclear and solar power will steadily increase their contribution to the UAE’s energy mix with many projects either complete or in the pipeline. Domestic sour gas fields will be further explored and developed. Demand side management initiatives will accelerate in the form of mandatory green building codes, ESCO markets, along with a greater adoption of energy saving smart technologies and systems across sectors. Other project developments are also underway in areas such as clean coal and hydropower.

2.5.3 Food

The UAE’s arid climate and lack of arable land prevents it from achieving food independence for its growing population. As such, the country has historically leveraged its economic stability and wealth to import food (80% to 90%)[^11], ranking as the world’s 17th largest agricultural importer in 2016[^12]. Additionally, through strategic investments in ports and infrastructure, the UAE strengthened its trade

relations, easing its access to global food markets. This has gained the UAE a high rank on the Global Food Security Index (GFSI): it is 33rd globally with a score of 70.9%\textsuperscript{13}.

*Figure 8: UAE’s food import mix and import breakdown of the top 10 trading partners in 2016 (million USD)\textsuperscript{14}*

Figure 8 shows that, in 2016, food imports to the UAE totalled USD 16.21 billion, representing a compounded annual growth rate (CAGR) of 7.1% from 2010. In 2016, the UAE imported 3% of its food from the Netherlands. These imports amounted to USD 800 million and were dominated by food products, with a smaller portion of animal, fruits and vegetables.

While Figure 8 would suggest that the UAE’s food imports are well diversified, specific crops tend to be dominated by specific food exporting countries\textsuperscript{15}. For example, 88% of the country’s cereal imports (i.e. wheat, rice, barley, maize, oats, millet, and sorghum) come from India, Pakistan, Australia, Argentina, Canada, and Thailand\textsuperscript{15}. At the moment, although a newly formed ministry has been tasked to oversee this area (Ministry of Future Food Security), no clear efforts have been made by the UAE to address the climate and market risks related to its food imports and partners.

*Figure 9: Top 10 UAE Agricultural Foreign Direct Investment projects, % of total 1mn hectares in 2014\textsuperscript{16}*

\textsuperscript{13} EIU and The Economist, *Global Food Security Index*, 2018.
\textsuperscript{14} WITS-World Bank, *United Arab Emirates Food imports*, 2016
\textsuperscript{15} AEGDI, *FOOD SECURITY and Climate Change*, 2015
\textsuperscript{16} Emirates NBD, *Dubai’s agricultural sector overview*, 2014
Despite its current Food Security Index score, the UAE is highly prone to food insecurity in the future. Its poor resilience to food security pressures is highlighted in Figure 10, particularly with respect to water, oceans and adaptive capacity.

*Figure 10: UAE Food Security Index pressures*

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

With respect to local food production, the UAE’s domestic production capacity remains rather limited. In 2018, the UAE’s 469 thousand hectares of agricultural land produced:

- 20% of the country’s fruits and vegetables demand (dates are the most important agricultural crop, followed by tomatoes, capsicums and cucumbers)\(^\text{17}\)
- 80% of the country’s milk demand\(^\text{18}\)
- 40% of the country’s egg demand\(^\text{18}\)
- 15% of the country poultry demand\(^\text{19}\)

Food security has risen significantly on the national agenda in the UAE, resulting in increased technology investments in the agricultural sector. They strive to be one of the most food-secure countries by 2021\(^\text{20}\) which will help to achieve the Zero Hunger\(^\text{21}\) goal.

On the demand side, food waste and spoilage in the UAE is significant, estimated at USD 4 billion in 2016\(^\text{22}\), with some initiatives to manage food waste beginning to emerge. In January 2017, the Dubai Municipality announced the formation of the UAE Food Bank, an NGO committed to eliminating food waste across the Emirates\(^\text{23}\). Furthermore, as a major waste stream, food waste is an untapped resource for fertilizer and energy generation that is ending up in landfills.

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\(^{17}\) Gulf News, *Local produce accounts for 20% of food consumption in 2018*

\(^{18}\) DEDC, *Food and Beverages Sector in the UAE*

\(^{19}\) NetherlandsandYou, *Poultry Industry UAE, 2016*

\(^{20}\) The National, *Technology will make the UAE one of the world’s most food-secure countries by 2021*

\(^{21}\) Government.ae, *2. Zero hunger*

\(^{22}\) Gulf News, *Your leftover food is behind the large food wastage, 2017*

\(^{23}\) The UAE Food Bank, *2017*
How will the UAE maintain its food security in the future?

Food imports, supplemented by agricultural Foreign Direct Investment (FDI) projects, will remain pivotal in the UAE’s food security strategy. The UAE will look to consider climate and market risks more rigorously in its international food import strategy and adopt national risk management strategies such as early warning systems and physical stockpiling. Furthermore, Big Data will be used in Smart Farming to provide predictive insights in farming operations to drive real-time decision making. Hindered by depleting aquifers, domestic food production will shift away from animal feed and significantly modernize and leverage smarter and more efficient technologies along with more climate suitable crop variations. In March 2019, the Abu Dhabi Government announced a Dh1 billion-programme to support the establishment of agricultural technology companies in the emirate, as part of the Ghadan 21 three-year stimulus package. The “AgTech” initiative, led by the Abu Dhabi Investment Office (ADIO), focuses on projects involving algae-based biofuels, indoor farming technology, precision agriculture and ag-robotics. Efforts to curb food wastage and spoilage will continue through better education/awareness and logistics.

2.6 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.

Figures 11 and 12 illustrate conceptual, what-if scenarios of various supply side interventions in the UAE with respect to food and water security. If analyzing food security, the UAE 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 significantly more water intensive and energy intensive, as local brackish aquifers require some level of desalination. 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 natural gas.
As the UAE looks to expand its local food production capacity (see section 2.7.1.10), it must address the associated constraints of food, water and energy. Strategies, technologies and initiatives taking place following the announcement of targets and policies in prior years to tackle such constraints are explored in Chapter 3.

2.7 National strategies, visions and objectives

The run up to 2030 will witness a series of reforms and investments aimed at implementing the myriad visions and strategies of the UAE. 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.

Federal level, and Emirate specific strategies, visions and objectives are detailed in sections 2.7.1 and 2.7.2. Strategies/Visions pertinent to the Nexus are elaborated on in greater detail and often consist of both supply side and demand side elements. WEF security is ultimately about building resilience. This requires diversifying the supply and demand strategies that complement one another and engaging the population in a meaningful way to change their current behaviours.

Figures 13 and 15 summarize the main strategies, visions and plans at the federal and Emirate level respectively.

2.7.1 Federal level

*Figure 13: Federal level strategies and visions*

<table>
<thead>
<tr>
<th>Federal</th>
</tr>
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<tbody>
<tr>
<td>• The UN Agenda 2030 for Sustainable Development</td>
</tr>
<tr>
<td>• Centennial Plan 2071</td>
</tr>
<tr>
<td>• UAE Vision 2021</td>
</tr>
<tr>
<td>• National Strategy for Innovation</td>
</tr>
<tr>
<td>• The UAE Water Security Strategy</td>
</tr>
<tr>
<td>• The UAE Energy Strategy 2050</td>
</tr>
<tr>
<td>• UAE Strategy for Artificial Intelligence</td>
</tr>
<tr>
<td>• UAE Blockchain Strategy 2021</td>
</tr>
<tr>
<td>• The National ADvanced Sciences Agenda 2031</td>
</tr>
<tr>
<td>• UAE Food Security Strategy 2051</td>
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</table>

2.7.1.1 Agenda 2030 and the SDGs

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.

The UAE’s National Committee on Sustainable Development Goals monitors national data and reports the progress on the SDGs24. In 2018, 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.

2.7.1.2 Centennial Plan 2071\textsuperscript{25}

Launched in 2017, the Centennial Plan 2071 is a long-term plan, extending 5 decades post 2021. It aims to establish the UAE as the best country in the world, by focusing primarily on investing in UAE youth and addressing the issues of future generations.

2.7.1.3 UAE Vision 2021\textsuperscript{25}

Launched in 2010, the UAE Vision 2021 aims to make the UAE among the best countries in the world. The vision identifies six pillars/national priorities that represent the key focus sectors of government action in the coming years.

2.7.1.4 National Strategy for Innovation\textsuperscript{25}

Several years ago the UAE federal government launched UAE Vision 2021 and then followed this with the more recent National Strategy for Innovation. The latter focuses on innovation and technology as the center of progress. Government entities and private enterprise are encouraged to work collectively to make the UAE one of the most innovative countries of the world\textsuperscript{26}. The National Strategy for Innovation has identified water and renewable energy as two of seven priority sectors. The notion of encouraging innovation in the fields of clean technology and renewable energy, and of researching innovative solutions to the water scarcity issues are deeply rooted in this strategy.

2.7.1.5 The UAE Water Security Strategy 2036

The UAE Water Security Strategy 2036\textsuperscript{27}, was unveiled in 2017 by the Ministry of Energy and Industry. The strategy aims to reduce water demand by 21% compared to 2017, increase the reuse of treated wastewater to 95% and increasing the national water storage capacity by two days. To deliver on these objectives, the strategy focuses on detailed goals and forecasts for the following three programs: demand side management, water supply management and emergency production and distribution. The UAE water security strategy is a crucial component of the country’s long term security and growth.

The strategy has also prioritized further development of the nation’s interconnected water network and its water storing capacity, as well as increasing desalination capacity and levels of water recycling. The strategy comprises the development of six connecting water and electrical power networks across the country, which will deliver 91 L/day/capita of water during emergencies. The full implementation of this strategy is expected to bring about AED 74 million in savings in addition to the mitigation of 100 MMT of carbon dioxide emissions.

In January 2018, the Abu Dhabi Water and Electricity Authority (now the Department of Energy) announced the completion of the Liwa Strategic Water Storage and Recovery Plant. This project, which feeds desalinated freshwater from the Shuweihat desalination plant into an underground aquifer, can hold enough drinking water for 1 million people for a period of 90 days\textsuperscript{28}.

\textsuperscript{25} UAE Government, \textit{UAE Future}, 2018

\textsuperscript{26} UAE Cabinet, \textit{The National Strategy for Innovation}, 2018.


\textsuperscript{28} Khaleej Times, \textit{Abu Dhabi Water Security}, 2018.
2.7.1.6 The UAE Energy Strategy 2050\textsuperscript{25}

The UAE Energy Strategy 2050 documents the nation’s effort to diversify its energy sources with focus on renewable energy and energy efficiency. The UAE will invest AED 600 billion in alternative energy projects that are targeted at increasing clean energy use by 50%, cutting carbon dioxide emissions by 70% and improving energy efficiency by 40%. The complete implementation of this strategy is projected to result in AED 700 billion in savings. The deployment of renewables for power generation is expected to reduce water withdrawals by an estimated 20% by 2030. The targeted 2050 energy mix is depicted in Figure 14.

\textit{Figure 14 Targeted make-up of energy sources in the UAE by 2050}\textsuperscript{29}

\begin{figure}[h]
\centering
\includegraphics[width=\textwidth]{energy_mix.png}
\caption{Targeted energy mix for the UAE by 2050.}
\end{figure}

2.7.1.7 UAE Strategy for Artificial Intelligence\textsuperscript{25}

Launched in 2017, the UAE Strategy for Artificial Intelligence (AI) addresses the post-mobile government phase in which all future government services, sectors and infrastructure projects will rely on AI. It aims to enhance government performance and efficiency, with the target of having the UAE achieve 100% reliance on AI for government services and data analysis by 2031.

2.7.1.8 UAE Blockchain Strategy 2021\textsuperscript{30}

Launched in 2018, the UAE Blockchain Strategy 2021 aims to put 50% of government transactions on blockchain platform by 2021, with the objective of reducing time, costs, man-hours and paper transactions/records.

2.7.1.9 The National Advanced Sciences Agenda 2031\textsuperscript{25}

The National Advanced Sciences Agenda 2031 details the UAE’s priorities for scientific objectives to be realized by 2031. The 2031 Agenda sets out eight scientific priorities up to 2031 and 30 scientific targets up to 2021 to make the most of all strategic natural resources in the country.

2.7.1.10 National Food Security Strategy 2051\textsuperscript{31}

In October 2017 the UAE announced the creation of the Ministry of Future Food Security. The ministry is tasked with enhancing the country’s food security. The National Food Security Strategy 2051 aims to make the UAE the world’s best in the Global Food Security Index by 2051 and among the top 10 countries by 2021. It also aims to enable and enhance local food production through the use of modern technologies;

\begin{table}[h]
\centering
\begin{tabular}{|c|c|}
\hline
Clean energy & 44\%  \\
Nuclear & 6\%  \\
Natural Gas & 38\%  \\
Clean coal & 12\%  \\
\hline
\end{tabular}
\caption{Energy mix for the UAE by 2050.}
\end{table}

\textsuperscript{30} Gulf News, \textit{Mohammad Bin Rashid launches the Emirates Blockchain Strategy 2021}, 2018
develop international partnerships to diversify food sources; activate legislation and policies that contribute to improving nutrition and activate legislation and policies to reduce waste.

2.7.1.1 Expo 2020

Between October 2020 and April 2021, Dubai will host the next world Expo under the theme of “Connecting Minds, Creating the Future”. The event recognizes the importance of worldwide collaboration in generating sustainable technologies that are aimed at solving global problems, including water scarcity, food security and renewable energy.

2.7.2 Emirate level

Figure 15 captures the multiple visions, strategies and plans by each Emirate in the UAE. Emirate specific activities that are pertinent to the Nexus are explored in the subsections below.

Figure 15: Emirate level visions, strategies and plans²⁵

<table>
<thead>
<tr>
<th>Abu Dhabi</th>
<th>Sharjah</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Abu Dhabi Economic Vision 2030</td>
<td>• Sharjah Tourism Vision 2021</td>
</tr>
<tr>
<td>• Surface Transport Master Plan</td>
<td></td>
</tr>
<tr>
<td>• Abu Dhabi Transportation Mobility Management Strategy</td>
<td></td>
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<tr>
<td>• Plan Abu Dhabi 2030</td>
<td>• Ajman 2021</td>
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<tr>
<td>• Environment Vision 2030</td>
<td></td>
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<tr>
<td>• Tomorrow 2021</td>
<td></td>
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<td></td>
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<tr>
<td>Dubai</td>
<td>Ajman</td>
</tr>
<tr>
<td>• Dubai Plan 20021</td>
<td>• No formalized strategies/visions</td>
</tr>
<tr>
<td>• Dubai Autonomous Transport Strategy 2030</td>
<td></td>
</tr>
<tr>
<td>• Smart Dubai 2021</td>
<td></td>
</tr>
<tr>
<td>• Dubai Clean Energy Strategy 2050</td>
<td>• No formalized strategies/visions</td>
</tr>
<tr>
<td>• Dubai 3D Printing Strategy 2030</td>
<td></td>
</tr>
<tr>
<td>• Dubai Industrial Strategy 2030</td>
<td></td>
</tr>
<tr>
<td>• Dubai Health Strategy 2021</td>
<td>• Fujairah 2040 Plan</td>
</tr>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>Fujairah</td>
</tr>
<tr>
<td>• No formalized strategies/visions</td>
<td>• No formalized strategies/visions</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ras Al Khaimah</td>
</tr>
<tr>
<td>• No formalized strategies/visions</td>
<td>• No formalized strategies/visions</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Um Al Quwain</td>
</tr>
<tr>
<td>• No formalized strategies/visions</td>
<td>• No formalized strategies/visions</td>
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<tr>
<td></td>
<td>Abu Dhabi</td>
</tr>
<tr>
<td>• No formalized strategies/visions</td>
<td>• No formalized strategies/visions</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sharjah</td>
</tr>
<tr>
<td>• No formalized strategies/visions</td>
<td>• No formalized strategies/visions</td>
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<td></td>
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<tr>
<td></td>
<td>Dubai</td>
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<tr>
<td>• No formalized strategies/visions</td>
<td>• No formalized strategies/visions</td>
</tr>
<tr>
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</tr>
</tbody>
</table>

2.7.2.1 Dubai desalination and water security targets

During the fifth edition of the World Government Summit 2018, DEWA announced its ambition to reduce the cost of freshwater production through the implementation of solar-powered reverse osmosis desalination technologies. With the ambition to generate 305 million gallons per day by 2030, the Emirate has projected to achieve USD 13 billion in savings. To improve water security, DEWA will also look to develop underground reservoirs that can store 50 million gallons of freshwater. These will be able to supply the Emirate of Dubai for 75 days³².

2.7.2.2 Dubai Clean Energy Strategy³³

Dubai aims to generate 75% of its total power output from clean sources by 2050, with gas constituting 61%. To promote investments in the clean energy sector, Dubai created the Dubai Green Fund worth of

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AED 100 billion in 2015. The Mohammed bin Rashid Al Maktoum Solar Park, which is built to generate 5,000 MW by 2030, is one key elements for the successful implementation of this strategy.

2.7.2.3 Ghadan 21 (Tomorrow 21)

Ghadan 21 (Tomorrow 21) is a AED 50 billion investment plan with the aim of diversifying the UAE economy. Ghadan 21 is anchored around four main pillars: Social, Economic, Liveability and Knowledge. An integral part of the Knowledge pillar is the recently announced AgTech investment, worth 1bn AED\(^34\). Besides the AgTech investments, plans have been announced for projects in the tourism sector\(^35\) (i.e. removing all tourism and municipality fees on any tourist attraction tickets sold by the hotels), but also a series of projects worth AED 5 billion to improve quality of life\(^36\) (i.e. new parks and cycle paths will be created, transport links improved and efforts made to safeguard residents against the searing summer heat).

3. UAE WEF Nexus Snapshot

This chapter aims to provide a snapshot of the current state of the WEF Nexus within the UAE. 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 Figures 16, 17 and 18. 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 2, 3 and 4 outline the various technologies and approaches currently utilized in the UAE for each Nexus intersect in detail, coupled with corresponding initiatives and programmes within the past 5 years. The references for the initiatives can be found in Appendix A.

Table 1: Scoring criteria of WEF Nexus approaches/technologies

<table>
<thead>
<tr>
<th>Approach/technology maturity</th>
<th>Score</th>
<th>Description</th>
<th>Approach/technology growth potential</th>
<th>Score</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>Non-existent</td>
<td>1</td>
<td></td>
<td>Declining growth</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>Interest/awareness present</td>
<td>2</td>
<td></td>
<td>No growth</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>Pilot project or significant research on the area exists</td>
<td>3</td>
<td></td>
<td>Low growth</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>Emerging in the market</td>
<td>4</td>
<td></td>
<td>Medium growth</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>Well established</td>
<td>5</td>
<td></td>
<td>High growth</td>
</tr>
</tbody>
</table>

The strengths and limitations of each approach/technology are outlined and scored as per the criteria in Table 1. The criteria is based on maturity level and growth potential. Maturity level relates to how well-established a particular approach/technology is in the country while growth potential considers strengths and limitations (i.e. environment, laws and regulations, consumer preferences etc.). The scoring for each criteria were based on extensive research and interviews of the different initiatives and programs carried out across all seven Emirates of the UAE. The scores are presented in Tables 2, 3 and 4 and were validated through consultation with various knowledge experts in the UAE.

\(^{34}\) Gulf News, *Mohammad bin Zayed approved dh 1 billion to boost UAE’s agtech sector*, 2019.

\(^{35}\) Zawya, *Abu Dhabi Department of Culture and Tourism announces strategic initiatives to drive tourism and sector investment*, 2019.

3.1 Water-Food

Figure 16 shows the UAE’s Water-Food Nexus Map which explores food production and its various inputs from the perspective of water. Various food production/acquisition methods are captured, including: livestock and dairy, aquaculture, agriculture and food imports. These categories are further broken down by practice of production. The required input resources include the material used in food production such as fodder and feed, fertilizer and water. Water resources were 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 16: UAE Water-Food Nexus Map
<table>
<thead>
<tr>
<th>SN</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Approach/technology</th>
<th>Approach strengths</th>
<th>Approach limitations</th>
<th>Maturity</th>
<th>Growth opportunity</th>
<th>Initiative(s)/Programme(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF -1</td>
<td>Livestock, Poultry &amp; Dairy</td>
<td>Livestock (cow, sheep, goat and camel)</td>
<td>Livestock protection &amp; development</td>
<td>- Improved licensing and monitoring of veterinary products/medicine results in higher product quality, lower disease outbreaks and therefore higher yields</td>
<td>- No significant limitations</td>
<td>4</td>
<td>3</td>
<td>- Livestock Chain Monitoring Committee, Ministry of Climate Change and Environment, UAE</td>
</tr>
<tr>
<td>WF -2</td>
<td>Sustainable breed selection</td>
<td>- Particular breeds can be less resource intensive (i.e. water) and more heat tolerant</td>
<td>- Consumers may prefer particular breeds based on quality - Farmers are inclined to raise those with the highest profit margins</td>
<td></td>
<td>3</td>
<td>3</td>
<td>- The Abu Dhabi Farmers’ Services Centre Breeding Programme</td>
<td></td>
</tr>
<tr>
<td>WF -3</td>
<td>Production systems</td>
<td>- The design and choice of particular production systems (meat or dairy production) can reduce costs, disease outbreaks, environmental impact and resource requirements</td>
<td>In the UAE, certain production systems are constrained by: - Climate (i.e. temperature, rainfall etc.) - lack of natural shrub/vegetation for grazing</td>
<td></td>
<td>4</td>
<td>3</td>
<td>- Various production systems for livestock and poultry exist across the UAE (i.e. caged livestock vs. free range)</td>
<td></td>
</tr>
<tr>
<td>WF -4</td>
<td>GMOs</td>
<td>- Opportunities to improve yields through disease resistance, saline water tolerance and heat tolerance</td>
<td>- Public hesitation/resistance towards GMOs</td>
<td></td>
<td>2</td>
<td>4</td>
<td>- Discussions on GMO use in the UAE are taking place, however no conscious efforts have been made towards GMO livestock production</td>
<td></td>
</tr>
<tr>
<td>WF -5</td>
<td>Poultry</td>
<td>Farming of poultry</td>
<td>- Suitable for the climate conditions - Less resource intensive than livestock - Relatively low maintenance costs</td>
<td>- Prone to disease outbreaks due to poor ventilation - Low profit margin on poultry</td>
<td>5</td>
<td>3</td>
<td>- Poultry farms are widespread throughout the UAE with various setup types (i.e. commercial farmed eggs vs. free-range organic eggs)</td>
<td></td>
</tr>
<tr>
<td>WF -6</td>
<td>Agriculture</td>
<td>Crop Selection</td>
<td>Native and climate compatible species</td>
<td>- Salt and heat tolerant crops - Reduced need for freshwater - Synergy with voluntary and mandatory green building standards</td>
<td>- Limited variety of crops - Legal challenges in registering new crop varieties</td>
<td>4</td>
<td>4</td>
<td>- Date palm salinity tolerance, Biosaline institute - Quinoa initiative, UAE</td>
</tr>
<tr>
<td>WF -7</td>
<td>Seaweed and macro-algae farming for animal feed</td>
<td>- Low input requirement - High in nutrients</td>
<td>- Requires controlled conditions - May prove difficult to scale up</td>
<td></td>
<td>1</td>
<td>5</td>
<td>- No initiatives. Approach is still in its early stage within the UAE</td>
<td></td>
</tr>
<tr>
<td>WF -8</td>
<td>Domestic production of fodder and feed</td>
<td>- High demand for fodder - Reduced reliance on imports - Emergence of fodder irrigated by saline waters</td>
<td>- Fodder cultivation competes with other crops for water resources - Fodder crops are generally water intensive (such as Rhodes grass)</td>
<td></td>
<td>5</td>
<td>2</td>
<td>- End of water intensive fodder subsidies, ADFCA, Abu Dhabi - Support for fodder imports, ADFCA, Abu Dhabi</td>
<td></td>
</tr>
<tr>
<td>WF -9</td>
<td>Artificial Selection &amp; GMOs</td>
<td>Opportunities for improved yields, and disease, draught, heat and salt resistance</td>
<td>- Public hesitation/resistance towards GMOs</td>
<td></td>
<td>2</td>
<td>4</td>
<td>- Discussions on GMO crop use in the UAE taking place, but no conscious efforts are made towards GMO crop production</td>
<td></td>
</tr>
<tr>
<td>SN</td>
<td>Category 1</td>
<td>Category 2</td>
<td>Approach/technology</td>
<td>Approach strengths</td>
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</tr>
</tbody>
</table>
| WF |            |            | Greenhouses and Hydroponics | High-tech greenhouses | - Increased crop productivity  
- Improved water and energy efficiency  
- Increased crop variety | - In extreme heat, acts as a heat trap  
- Kills crops  
- Does not facilitate pollination | 3       | 5 | A number of smart greenhouses are emerging in the UAE, such as:  
- Pure Harvest, UAE  
- Van der Hoeven in Al Ain |
| WF |            |            | Seawater greenhouses | - Creates ideal growing conditions for crops while producing fresh water for irrigation | - Fine tuning of complex system  
- Potential aquifer contamination from seawater | 2       | 4 | - The Sahara Forest Project (2009), UAE |
| WF |            |            | Bio-domes | - Energy & cost efficient  
- Synergies with voluntary & mandatory green buildings standards  
- Can serve educational purposes | - Systems need to be thoroughly designed and fine-tuned  
- Significant maintenance is required | 2       | 4 | - EAD-Philippine Global School, Abu Dhabi |
| WF |            |            | Hydroponic farming | - High irrigation efficiency compared to traditional methods  
- Increased crop productivity  
- Reduced use of pesticide & fertilizer | - High CAPEX  
- Risk of water microorganisms contamination  
- Does not facilitate pollination | 4       | 5 | - ADFSC, Abu Dhabi  
- Emirates hydroponics farms, Dubai and Abu Dhabi  
- Pegasus agriculture group, UAE  
- Bani Yas Agricultural Research Center  
- Hydroponic Agriculture Project  
- Hydroponic initiative, Ajman, 2009 |
| WF |            |            | Aquaponics | - Reduced water consumption  
- No addition of fertilizer required  
- When combined with hydroponics, reduces overall water requirements of system | - High CAPEX  
- Needs to be coupled with hydroponic systems, which may be difficult or not feasible at times | 3       | 5 | - Bani Yas center growing tilapia fish, Abu Dhabi  
- Jebel Ali resort & hotel growing cherry fish & cherry tomatoes, Dubai |
| WF |            |            | Urban Farming | - Controlled growing environment  
- Maximize resource efficiency  
- Increase variety of crops  
- Synergies with voluntary & mandatory green building standards | - High CAPEX  
- Maintenance of systems may be more complicated than traditional farming | 2       | 4 | - Urban Agriculture research center, Dubai |
| WF |            |            | Surface Water Farming | - Extensive coastline and access to sea | - Uncontrolled conditions  
- Dependent on availability of salt and heat tolerant crops | 2       | 5 | - No initiatives. The concept is still in its early stage within the UAE |
| WF |            |            | Honey Farms | - Opportunities for coupling for pollination  
Strong cultural interest & demand | - Weather conditions, including temperatures, dust and humidity | 4       | 3 | - Al Najeh honey, UAE |
| WF |            |            | Organic Fertilizers | - Reduced environmental damage caused by eutrophication and leaching into aquifers | - Potentially more expensive  
- Potentially more difficult to collect and process | 4       | 4 | - Adfert organic fertilizer made of seaweed, Abu Dhabi |
<p>| WF |            |            | Organic Farming | - Reduced environmental damage and wide public/commercial appeal | - Could result in reduced yields and higher disease outbreaks if not properly managed | 5       | 5 | - 54 organic farms in the UAE due to government initiatives, UAE |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Category 1</th>
<th>Category 2</th>
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<th>Maturity</th>
<th>Growth opportunity</th>
<th>Initiative(s)/Programme(s)</th>
</tr>
</thead>
</table>
| WF -20 | Aqua-culture | Integrated multi-trophic aquaculture (IMTA) | Land-based | - Usage of existing brackish water  
- Utilization of brine discharge from onsite brackish water reverse osmosis  
- Declining fish stocks | - Temperature may be too harsh for certain species  
- Risk of disease and contamination in closed systems, if not properly managed | 4 | 5 | - Dubai Center for Research and Development of Fisheries (DCRDF), Dubai  
- Sheikh Khalifa Bin Zayed Marine Research Center, Umm Al Quwain  
- Advanced technological production of caviar & sturgeon meat, Abu Dhabi |
| WF -21 | Sea-based | | Sea-based | - Extensive coastline available for coastal aquaculture  
- Declining fish stocks | - Heat and salinity threat  
- Risk of invasive species | 3 | 5 | - Aquaculture project for 3 sea cage aquaculture sites, Dalma Island, Abu Dhabi |
| WF -22 | Landscaping & Forestry | Landscaping | Landscaping | - Widespread landscaping across the UAE  
- Opportunities for improvements in soil, irrigation efficiency and crop selection (water, heat and salt tolerance) | - Landscaping directly competes for food production water resources unless properly managed and maintained | 5 | 5 | - Green Abu Dhabi initiative, Abu Dhabi |
| WF -23 | Forestry | | Forestry | - Strong support due to the late Sheikh Zayed’s vision of greening the UAE | - High water use with no tangible benefit towards food security | 5 | 1 | - Barari Forest Management, Abu Dhabi Emirate |
| WF -24 | Water Resources | Smart Irrigation | Drip irrigation | - High water efficiency  
- Smart monitoring and scheduling | - Relatively high maintenance and replacement cost | 4 | 5 | - Drip irrigation project initiative by Dubai Silicon Oasis  
- Dacom intelligent irrigation system pilot study by ADFCA  
- ADFCA project fund of $ 133 million for advanced irrigation  
- Barari research & development center on irrigation technologies |
| WF -25 | | Spray irrigation | - Ease of installation, use and maintenance  
- Smart monitoring and scheduling | - Less water efficient than some other irrigation methods (high evapotranspiration) | 5 | 3 | - Efficient sprinkler system for reduced water consumption in Masdar City, Abu Dhabi |
| WF -26 | Cooling | Misting fans for animal cooling | - Widespread on farms | - High water use | 4 | 3 | - Al Rawabi Dairy Farm, UAE |
| WF -27 | Wastewater | Treated/ recycled wastewater | - Conservation of freshwater sources  
- Reduced use of synthetic fertilizer  
- No tertiary treatment of wastewater required  
- Current policies promoting usage of treated wastewater in agriculture | - Risks of heavy metal contamination to soil, crops & groundwater  
- Some cultural/public backlash to practice | 4 | 5 | - Sewage used in landscaping, Ajman  
- Environmental impact assessment of TWW in agriculture, Abu Dhabi  
- Treatment of municipal wastewater for agricultural use, UAE  
- ADFCA project on wastewater treatment use for irrigation of 143 farms, Abu Dhabi |
<table>
<thead>
<tr>
<th>SN</th>
<th>Category 1</th>
<th>Category 2</th>
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<th>Approach limitations</th>
<th>Maturity</th>
<th>Growth opportunity</th>
<th>Initiative(s)/Programme(s)</th>
</tr>
</thead>
</table>
| WF -28 | Food imports | Aquaculture effluent | - Use effluent with salt tolerant crops  
- Cultivation of otherwise barren lands | - Salt tolerant crops are not widespread | 3 | 3 | - Aquaculture effluents for cultivation of halophytes in coastal desert areas, Umm al Quwain |
| WF -29 | Food monitoring systems | Brine | - Potential for redirection towards aquaculture  
- Potential for mining of minerals in brine through solar ponds, WAIV, brine concentrators, ohmic evaporators, MD & ZLD  
- Availability of technologies for dealing with the environmental impacts of brine discharge to sea | - Brine discharge is a byproduct of the desalination process in the UAE, which can negatively impact marine ecosystems and fisheries through thermal, chemical and saline pollution. | 3 | 5 | - Dilution/dispersion already exists in the UAE at many desalination plants  
- Usage of brine for aquaculture exists inland as byproduct from BWRO |
| WF -30 | Food imports | International trade partnerships | - Ability to import food from various countries based on quality, price, availability etc. thereby constantly balancing the UAE’s supply-demand gap | - Significant market and climate risks associated with over dependence on imports | 5 | 5 | - Represents the major mechanism for food acquisition in the UAE |
| WF -31 | 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  
- Reduce food loss and wastage through monitoring | - Not well established yet, and will require significant stakeholder buy in across the food supply chain. | 3 | 5 | - Food Watch, Dubai |
| WF -32 | Early warning systems | 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  
- Requires dedicated task force to own the early warning system. | 2 | 5 | - No current system in existence but discussed as a policy option by Emirates Diplomatic Academy |
3.2 Water-energy

Figure 17 shows the UAE’s Water-Energy Nexus Map. This was developed based on two main aspects: the use of energy for water production and treatment and the use of water in energy production. The use of energy in water production/treatment was classified based on two main areas of use, the transmission and distribution of water and the treatment of different sources of water. The sources included were groundwater, wastewater and desalinated water (segmented by technology type). The water used in the energy value chain was classified based on its predominant areas of consumption, namely power generation, industry/oil and gas activities and wastewater treatment facilities. The different forms of water used are also identified, be it for steam, cooling, cleaning or as a raw material.

Figure 17: UAE Water-Energy Nexus Map
<table>
<thead>
<tr>
<th>SN</th>
<th>Category 1</th>
<th>Approach/ technology</th>
<th>Approach strengths</th>
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<th>Maturity</th>
<th>Growth opportunity</th>
<th>Initiative(s)/Programme(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WE-1</td>
<td>Waste to Energy</td>
<td>Wastewater sludge to methane based biogas</td>
<td>- Significant sewage generated across UAE  - Anaerobic digestion of sludge is a net energy producing process, in the form of biogas  - Nutrient recovery (phosphate and nitrogen) can be used in agriculture/industrial applications  - Local climate favourable to technology</td>
<td>- High investment cost for anaerobic digestion tanks and system</td>
<td>3</td>
<td>5</td>
<td>- Taqa Technology incubation unit, Abu Dhabi  - Date pits and sludge, University of Sharjah</td>
</tr>
<tr>
<td>WE-2</td>
<td>Renewable energy powered desalination</td>
<td>MED/MSF/MEE with solar thermal</td>
<td>- High solar irradiance in UAE  - Dropping costs of CSP brought on by largescale national projects like Shams 1  - Thermal storage is already being implemented in the UAE alongside most CSP projects</td>
<td>- High energy requirement  - Solar thermal systems (such as CSP) are yet to be integrated with desalination commercially  - Higher CAPEX of systems (MSF/MED compared to RO and CSP compared to PV)</td>
<td>3</td>
<td>5</td>
<td>- RO plants currently receive renewable sources of electricity through the existing energy mix (which includes PV, CSP and Nuclear) however only one project exists that directly couples renewables and desalination, the Masdar Renewable Energy Water Desalination Programme at Ghantoot, Abu Dhabi</td>
</tr>
<tr>
<td>WE-3</td>
<td></td>
<td>Reverse Osmosis with PV/nuclear/storage</td>
<td>- High solar irradiance in UAE  - Dropping costs of PV brought on by largescale national and regional projects like the Mohammed bin Rashid Al Maktoum Solar Park  - RO has lower CAPEX compared to thermal desalination and is gaining market share in total installed capacity  - Combining PV directly with RO addresses the intermittency issue as it allows for addition of RE into energy mix without the associated challenges</td>
<td>- Reduced RO membrane lifetime due to high salinity and high temperature of Arabian gulf seawater  - High OPEX (associated with membrane replacement)  - PV is yet to be directly combined with RO</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>WE-4</td>
<td>Cogeneration</td>
<td>Combined cycle - MSF/MED</td>
<td>- Cogeneration (combined cycle with MSF/MED) is the predominant technology utilized in the UAE  - Availability of coastline makes power and water generation coupling easy  - Low natural gas costs (through the Dolphin pipeline)  - Use of by-product steam from power generation for thermal desalination  - Energy storage (i.e. batteries), can be used to optimize the cogeneration process, thereby reducing the energy requirements for thermal desalination</td>
<td>- Inherent risks associated with coupling water supply to natural gas  - High CAPEX  - Cogeneration facilities are designed for an optimal MW to MGD generation ratio, which often don’t match water and electricity demand, leading to inefficient burning of natural gas</td>
<td>5</td>
<td>3</td>
<td>- Various plants across the UAE (i.e. Jabal Ali M)</td>
</tr>
<tr>
<td>WE-5</td>
<td>Industrial water discharge</td>
<td>Water discharge management</td>
<td>- 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</td>
<td>- Current regulations on discharge may not be conducive to technology/solution adoption  - Cost of systems  - Technical challenges related to the Arabian Gulf (depth, high temperature and salinity)</td>
<td>4</td>
<td>5</td>
<td>- All industries, power plants and desalination plants on the coast that discharge cooling water, treated wastewater or brine into the sea</td>
</tr>
<tr>
<td>WE-6</td>
<td>RE powered WWTP</td>
<td>Solar powered WWTP</td>
<td>- High solar irradiance in UAE</td>
<td>- Intermittency, unless a hybrid system  - Currently, higher cost than grid connection</td>
<td>1</td>
<td>4</td>
<td>- No initiatives</td>
</tr>
<tr>
<td>SN</td>
<td>Category 1</td>
<td>Approach/ technology</td>
<td>Approach strengths</td>
<td>Approach limitations</td>
<td>Maturity</td>
<td>Growth opportunity</td>
<td>Initiative(s)/Programme(s)</td>
</tr>
<tr>
<td>-----</td>
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<td>-------------------------------------------------------------------------------------</td>
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<td>-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>WE-7</td>
<td>Water pumping and transport</td>
<td>Solar water pumps</td>
<td>- High solar irradiance in UAE &lt;br&gt; - Off-grid usage makes system mobile, and avoids electrification costs</td>
<td>- Intermittency, unless a hybrid system</td>
<td>4</td>
<td>5</td>
<td>- SunEnergy solar pumps, Dubai and Abu Dhabi &lt;br&gt; - DUSOL solar pumps, Dubai</td>
</tr>
<tr>
<td>WE-8</td>
<td></td>
<td>Biofuel water pump</td>
<td>- Algae biofuel production and application being researched in UAE</td>
<td>- Dependent on maturity of biofuel technology</td>
<td>2</td>
<td>4</td>
<td>- No initiatives</td>
</tr>
<tr>
<td>WE-9</td>
<td></td>
<td>Piping efficiency and T&amp;D monitoring</td>
<td>- Water system savings &lt;br&gt; - Identification of system nodes requiring maintenance and/or replacement through monitoring system (i.e. SCADA)</td>
<td>- Pipe replacement and/or maintenance can be costly and disruptive &lt;br&gt; - High marginal cost of improvement due to existing high network efficiency</td>
<td>5</td>
<td>4</td>
<td>- Water pipeline project contract of AED 248 Million for DEWA using remote control &amp; monitoring systems Dubai</td>
</tr>
<tr>
<td>WE-10</td>
<td>Water heating &amp; cooling</td>
<td>Solar-water heaters</td>
<td>- High solar irradiance in the UAE well suited for technology &lt;br&gt; - High cost savings and quick ROI &lt;br&gt; - Emerging supporting regulations at national level &lt;br&gt; - High growth market</td>
<td>- Higher installation costs than conventional water heating systems &lt;br&gt; - High requirement for proper insulation</td>
<td>4</td>
<td>5</td>
<td>- Solar hot water system per Estidma’s Pearl Villa Rating System, Abu Dhabi &lt;br&gt; - Solar water heater system implemented at IRENA, Abu Dhabi</td>
</tr>
<tr>
<td>WE-11</td>
<td></td>
<td>Solar-Cooling systems</td>
<td>- High solar irradiance in UAE &lt;br&gt; - High cooling load in UAE &lt;br&gt; - Dropping PV and other solar technology costs</td>
<td>- Intermittency, unless a hybrid system</td>
<td>3</td>
<td>5</td>
<td>- SOLAB, Ras al Khaima &lt;br&gt; - Green Technologies FZCO, Dubai</td>
</tr>
<tr>
<td>WE-12</td>
<td>Cooling</td>
<td>District Cooling</td>
<td>- District cooling reduces energy consumption to about 40% compared to traditional cooling &lt;br&gt; - Strong market growth and interest, with well-established regional players</td>
<td>- Highly linked to booms and busts of real-estate sector</td>
<td>5</td>
<td>5</td>
<td>- EMPOWER, Dubai &lt;br&gt; - Tabreed, Abu Dhabi</td>
</tr>
<tr>
<td>WE-13</td>
<td>Water fixtures</td>
<td>Water fixture efficiency</td>
<td>- Market adoption of existing voluntary green building codes such as LEED &lt;br&gt; - Emergence and adoption of mandatory green building codes such as Estidama and Saa’fat &lt;br&gt; - Rising water tariffs among all Emirates and sectors</td>
<td>- No significant constraints</td>
<td>5</td>
<td>5</td>
<td>- Estidama green building code, Abu Dhabi &lt;br&gt; - Saa’Tat green building code, Dubai &lt;br&gt; - Energy efficient fixtures by ESMA, Abu Dhabi &lt;br&gt; - Water flow reducers initiative by DEWA, Dubai</td>
</tr>
<tr>
<td>WE-14</td>
<td>Water use in Oil &amp; Gas</td>
<td>Fossil fuel extraction</td>
<td>- Water steam savings from EOR process by CO2 injection substitution &lt;br&gt; - Reduced aquifer pollution compared to using produced water &lt;br&gt; - Form of carbon sequestering</td>
<td>- Risk of CO2 contamination into aquifers</td>
<td>3</td>
<td>4</td>
<td>- Al Reyadah CCUS project partnership between ADNOC &amp; Masdar &lt;br&gt; - Rumaitha North CO2 injection facility, Abu Dhabi</td>
</tr>
<tr>
<td>WE-15</td>
<td>Monitoring systems</td>
<td></td>
<td>- Ability to monitor and analyse water and energy consumption and losses across Oil &amp; Gas value chain</td>
<td>- Challenges in data collection and integration of assets across value chain</td>
<td>3</td>
<td>4</td>
<td>- Atmata’ automation initiative (partnership between ENOC and MoE), Dubai, UAE</td>
</tr>
</tbody>
</table>
3.3 Energy-Food

Figure 18 shows the UAE Energy-Food Nexus Map. This was developed based on two main aspects: the use of energy for food production and the use of organic material in the production of energy. The use of energy in food production was categorized based on inputs of energy and resources required for production. The energy inputs were categorized based on the energy used to operate water treatment and irrigation systems, machinery, cooling systems as well as the transport and distribution of the energy for the production of food. The organic material used in energy production was classified into two types: organic waste and grown food. For the organic waste, the map presents the different sources of waste, i.e. food-waste, agricultural waste, animal waste and waste from landfills. On the other hand, grown food was grouped based on method of production (i.e. 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 18: UAE Energy-Food Nexus Map
<table>
<thead>
<tr>
<th>SN</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Approach/technology</th>
<th>Approach strengths</th>
<th>Approach limitations</th>
<th>Maturity</th>
<th>Growth opportunity</th>
<th>Initiative(s)/Programme(s)</th>
</tr>
</thead>
</table>
| FE-1 | Biofuels | Grown biofuels | Biomass from halophytes | - Salt tolerant (use of Salicornia Halophyte)  
- Wide availability of seawater and avoided use of freshwater  
- Strong demand and support by local airlines for green/renewable jet fuel | - Commercialization and scaling up  
- More expensive than conventional fuels | 2 | 4 | - Biojet initiative, Abu Dhabi  
- Integrated Seawater Energy and Agriculture System (ISEAS), Masdar City, Abu Dhabi |
| FE-2 | Bioethanol | | | - Strong market interest in sustainable fuels (i.e. existing CNG taxis in Abu Dhabi) | - Unless resulting from a waste stream, process will be water intensive  
- Limited number of native species that can be used at commercial scale  
- More expensive than conventional fuels | 3 | 5 | - ISEAS Masdar project on bioethanol production from oil rich native plants  
Study on bioethanol potential of lignocellulosic biomass such as date palm & mangroves |
| FE-3 | Biofuels from Waste | Biogas from animal waste | | - Animal waste is a significant and un-utilized waste stream in the UAE | - Biomass yield is dependent on the kind of bio-waste (e.g. cattle or camel manure, chicken droppings etc.)  
- Not feasible for all farms given size | 2 | 4 | - Opportunities discussed by EAD policy brief  
`High potential of camel manure in biogas production`, Abu Dhabi |
| WE-1 | | Biogas from sewage sludge | | | Please refer to WE-1 for the details of this approach as it is categorized under Water-Energy as well as Food-Energy |
| FE-4 | Biogas from Landfills | | Biogas from Landfills | | - Large potential of landfill gas in UAE (100m3 of gas/tonne of MSW) | 3 | 5 | - Tadweer/Taqa 100 MW WtE facility in Abu Dhabi  
- Masdar/Bee‘ah 30 MW WtE facility in Sharjah (to start in 2020)  
- Dubai Municipality, 180 MW WtE facility in Dubai (to start in 2020) |
| FE-5 | Biodiesel from food waste | | Biodiesel from food waste | | - Significant food waste exists in the UAE, such as waste cooking oil  
- Hotels are a major source of food waste in the country, offering potential food waste collection partnerships | 3 | 4 | - Neutral Fuels, UAE  
- ENOC Biodiesel 5, Dubai  
- Lootah fuels, Dubai  
- Biodiesel from date pits, UAE  
- Cooking oil to biodiesel fuelling station in Jebel Ali, Dubai  
- Cooking oil to biodiesel at Tadweer, Abu Dhabi |
| 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  
- High energy requirement for cooling to maintain optimal range for animals | 2 | 4 | - No initiatives |
<p>| FE-7 | | Cooling of greenhouses | | | - Lack of proper cooling can result in loss of livestock, disease or decreased output | 3 | 5 | - Active air cooling, PureHarvest, UAE |</p>
<table>
<thead>
<tr>
<th>SN</th>
<th>Category 1</th>
<th>Category 2</th>
<th>Approach/technology</th>
<th>Approach strengths</th>
<th>Approach limitations</th>
<th>Maturity</th>
<th>Growth opportunity</th>
<th>Initiative(s)/Programme(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>FE-8</td>
<td></td>
<td></td>
<td>Cooling of storage</td>
<td>Opportunities exist for more energy efficient cooling technologies, coupled with smart systems for monitoring and process optimization</td>
<td>- Inherent tradeoffs of some cooling systems (i.e. high water efficiency but high energy or vice versa)</td>
<td>3</td>
<td>4</td>
<td>- Bani Yas Greenhouses, Abu Dhabi</td>
</tr>
<tr>
<td>FE-9</td>
<td></td>
<td></td>
<td>Greenhouses</td>
<td>Reducing cooling load through design and materials</td>
<td>- Greenhouses have a high cooling load, particularly in the UAE, where mechanical cooling is required</td>
<td>3</td>
<td>5</td>
<td>- Bani Yas Greenhouses, Abu Dhabi</td>
</tr>
<tr>
<td>FE-11</td>
<td></td>
<td></td>
<td>Fertilizer</td>
<td>Synthetic fertilizer production</td>
<td>- Improves crop yields - Haber process is net CO2 consuming - Can result in eutrophication of water bodies - Haber process is natural gas consuming</td>
<td>5</td>
<td>2</td>
<td>- No initiatives</td>
</tr>
<tr>
<td>FE-12</td>
<td>Onsite renewables</td>
<td>PV for irrigation &amp; pumps</td>
<td>Off-grid solution for water pumps, reducing maintenance and electrical connection</td>
<td>- Low electricity tariffs for agricultural sector - Intermittency, unless a hybrid system</td>
<td>- Low electricity tariffs for agricultural sector - Intermittency, unless a hybrid system</td>
<td>2</td>
<td>5</td>
<td>- No initiatives</td>
</tr>
<tr>
<td>FE-13</td>
<td></td>
<td></td>
<td>PV for water treatment</td>
<td>Off-grid solution for water treatment and onsite brackish water RO</td>
<td>- Low electricity tariffs for agricultural sector - Intermittency, unless a hybrid system</td>
<td>2</td>
<td>4</td>
<td>- No initiatives</td>
</tr>
<tr>
<td>FE-14</td>
<td></td>
<td></td>
<td>Biodiesel for equipment</td>
<td>Renewable source of fuel that can be generated from onsite agricultural waste streams and byproducts</td>
<td>- More expensive than conventional fuels if purchased</td>
<td>1</td>
<td>4</td>
<td>- No initiatives</td>
</tr>
<tr>
<td>FE-15</td>
<td>Energy inputs for transport &amp; distribution of food</td>
<td>Stockpiling Virtual Stockpiling</td>
<td>- Utilization of warehouses abroad avoid infrastructure investment domestically - Enhanced energy saving initiative for reduced cooling requirements - Cost saving (buying during low prices) - Added food security (emergency preparedness)</td>
<td>- Cost of storage/stockpiling abroad</td>
<td>- No initiatives</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>FE-17</td>
<td></td>
<td></td>
<td>Physical/ emergency stockpiling</td>
<td>- Strategic storage reserves allow for release of stockpiles during emergencies or price hikes</td>
<td>- Investment cost and maintenance - Cooling and humidity control</td>
<td>4</td>
<td>5</td>
<td>- Al Wathba Mega Production &amp; Distribution Complex, Abu Dhabi</td>
</tr>
<tr>
<td>FE-18</td>
<td>Local distribution</td>
<td>Agro-logistics optimization</td>
<td>- Supply chain optimization can reduce energy cost of transport and lengthen freshness and lifetime of food products - Reduced inventory time can reduce food wasteage and costs for businesses - Emerging technology (i.e. IoT) can enable the above solutions in a cost effective and integrated way</td>
<td>- No significant constraints</td>
<td>4</td>
<td>5</td>
<td>- No initiatives</td>
<td></td>
</tr>
</tbody>
</table>
CASE STUDY: Pure Harvest Smart Farm, an up-and-coming technology enabled agri-business in the UAE

An interview with Majed Halawi, Chief of Staff at Pure Harvest Smart Farms Ltd. was conducted to provide an understanding of: (a) the main drivers and challenges faced in local fresh fruits & vegetables production; (b) the vision for food production in the UAE; and (c) the potential areas in which companies abroad can support.

What is Pure Harvest?

Pure Harvest is a technology enabled agri-business in the UAE that focuses on the production of locally grown, fresh fruits and vegetables all year-round – overcoming the challenges presented by the harsh, arid climate in the Middle East. The business aims to deliver the best possible quality products through investing in and deploying world-leading controlled environment agriculture (CEA) technologies.

What are the challenges to local food production?

One of the most important drivers for local food production is the UAE’s unusually high dependence on food imports. However, the UAE is blessed with abundant sunlight, land (with limited alternative uses), low-cost & reliable energy supply, low labor costs, near-zero taxes and high domestic purchasing power. Once you control for climate (using technology), these factors together make the UAE an attractive place to produce fresh produce. This is compounded by new technological innovations and changing cost curves. For example, the decreasing cost of renewable energy sources is expected to enable the production of freshwater via renewable-powered desalination – which would be extremely valuable to local producers like Pure Harvest.

What are the drivers for producing food domestically?

There are a number of challenges to local food production that need to be addressed. These include physical, financial and regulatory challenges.

<table>
<thead>
<tr>
<th>Physical</th>
<th>Financial</th>
<th>Regulatory</th>
</tr>
</thead>
<tbody>
<tr>
<td>Availability of freshwater</td>
<td>Nascence of industry – no ‘proof points’ to influence investors/ government leaders</td>
<td>Access to land</td>
</tr>
<tr>
<td>Salinity of water and soil</td>
<td>Dearth of investment into ‘hardware’ technology companies in the region (including tech-enabled food production)</td>
<td>Indistinct permitting regulations</td>
</tr>
<tr>
<td>Temperature and humidity</td>
<td>Lack of sector commercialization</td>
<td>Forced use of high salinity aquifers</td>
</tr>
<tr>
<td>Significant energy requirements to manage climate</td>
<td>Costly set-up of new businesses</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Access to skilled local labor</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Availability of equipment financing and leasing</td>
<td></td>
</tr>
</tbody>
</table>

What is Pure Harvest’s vision for the future of food production in the UAE?

Pure Harvest’s vision is the large-scale commercialization of the sector into agricultural complexes that are inclusive of easy access to land for the setup of greenhouses and utilities such as high quality irrigation water, low-cost/renewable power sources, food-grade CO2 supply and (potentially) district cooling (optimize energy consumption).

How can companies’ abroad support and what should they consider before engaging the UAE market?

Companies/entities outside the UAE with the right expertise can support through their technical expertise as well as offering financial schemes or partnering through investments with local food producers. Prior to entering the UAE market, companies need to understand the market in terms of the specific market & non-market constraints of the country and its technological capabilities/skill gaps & limitations as well as an understanding of the business culture.
4. Investment and Engagement Opportunities

Investment/engagement opportunities in the UAE were identified for Dutch companies based on the technologies and approaches outlined in Tables 2, 3 and 4 of the previous chapter. The maturity and growth opportunity scoring of each technology/approach was used to identify the most suitable opportunities.

Table 5: Investment/engagement opportunity type for Dutch companies

<table>
<thead>
<tr>
<th>Category Category</th>
<th>Category description</th>
<th>Maturity</th>
<th>Growth opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Category 1</td>
<td>High growth potential and mature market, ready for entry</td>
<td>&gt; 3</td>
<td>≥4</td>
</tr>
<tr>
<td>Category 2</td>
<td>High growth potential market, but requires knowledge partner(s)</td>
<td>≤ 3</td>
<td>5</td>
</tr>
</tbody>
</table>

The technologies/approaches identified in the previous chapter are categorized into two opportunities; Category 1 or Category 2 as per Table 5. Category 1 represents well established technologies/approaches with good growth potential, as such Dutch companies can engage with those markets directly as technology/solution providers.

Category 2 technologies/approaches demonstrate high growth potential but are considered less mature commercially (still in research/testing phase within the UAE). For Dutch companies, Category 2 presents good growth potential, but will require knowledge partner(s) (Dutch and/or local) to further develop such markets within the UAE. Knowledge partnerships can include more than one local or Dutch partner. The WEF stakeholder groups in the UAE identified in Table 8 are to be considered for these potential partnerships.

Applying the criteria in Table 5 to the technologies/approaches in the previous chapter yields a prioritized list of investment opportunities for Dutch companies presented in Tables 6 and 7. It is worth noting that such opportunities often comprise of two parts which Dutch companies can contribute towards. Such opportunities consist of technical solutions and complimentary knowledge sharing/expertise. Taking hydroponics as an example, Dutch companies can deliver technical solutions with respect to irrigation, cooling, system automation etc., while also providing knowledge sharing/expertise on the most suitable choice of crops, best practices in system maintenance, analysis of data and so forth. The latter can be delivered via training, consulting, joint research projects etc.

Table 6: Category 1 opportunities

<table>
<thead>
<tr>
<th>Nexus category</th>
<th>ID</th>
<th>Approach/ technology</th>
<th>Scoring</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water - Food</td>
<td>WF-19</td>
<td>Organic farming</td>
<td>Maturity: 5 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-22</td>
<td>Landscaping</td>
<td>Maturity: 5 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-30</td>
<td>International trade partnerships on food imports</td>
<td>Maturity: 5 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-20</td>
<td>Land-based aquaculture</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-13</td>
<td>Hydroponic farming</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-24</td>
<td>Drip irrigation</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-27</td>
<td>Treated/recycled wastewater applications</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-6</td>
<td>Native and climate compatible crops for agricultural use</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WF-18</td>
<td>Organic fertilizer use in farming</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
<tr>
<td>Water - Energy</td>
<td>WE-12</td>
<td>District cooling</td>
<td>Maturity: 5 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WE-13</td>
<td>Water fixture efficiency</td>
<td>Maturity: 5 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WE-5</td>
<td>Industrial water discharge management</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
<tr>
<td></td>
<td>WE-7</td>
<td>Solar water pumps</td>
<td>Maturity: 4 Growth Opportunity: 5</td>
</tr>
</tbody>
</table>
### Table 7: Category 2 opportunities

<table>
<thead>
<tr>
<th>Nexus Category</th>
<th>ID</th>
<th>Approach/ technology</th>
<th>Scoring</th>
<th>Maturity</th>
<th>Growth Opportunity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water - Food</td>
<td>WF-10</td>
<td>High-tech greenhouses</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WF-14</td>
<td>Aquaponics</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WF-21</td>
<td>Sea-based aquaculture</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WF-29</td>
<td>Brine management</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WF-31</td>
<td>Food safety monitoring systems for food imports</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WF-16</td>
<td>Surface water farming</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WF-32</td>
<td>Early warning systems for food import monitoring</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WF-7</td>
<td>Agricultural seaweed and macro-algae farming for animal feed</td>
<td>1</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Water - Energy</td>
<td>WE-1</td>
<td>Wastewater sludge to methane based biogas</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WE-2</td>
<td>Solar thermal integrated MED/MSF/MEE desalination</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WE-3</td>
<td>PV/nuclear integration with RO</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>WE-11</td>
<td>Solar cooling systems</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>Food - Energy</td>
<td>FE-2</td>
<td>Bioethanol production</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FE-4</td>
<td>Biogas and chemical production from landfills</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FE-7</td>
<td>Cooling of greenhouses</td>
<td>3</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>FE-12</td>
<td>PV for irrigation and pumps</td>
<td>2</td>
<td>5</td>
<td></td>
</tr>
</tbody>
</table>

#### 5. Road to EXPO 2020

The success of the Netherlands in the area of food production has placed them as the second largest global exporter of food in terms of dollar value after the United States. With the Netherlands being 3\textsuperscript{rd} in the Global Innovation Index 2017 and the UAE at 35 and fast rising, the Expo 2020 presents the two countries with a timely opportunity to collaborate on developing and implementing innovative solutions.

Furthermore, the UAE has the opportunity to become a global innovation hub, in line with its National Strategy for Innovation. The country can benefit from its human and financial capital to drive innovative research and development in addition to attracting foreign investments. The UAE can focus on creating an environment of innovation for food production technologies in arid climates. The UAE 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 the UAE can adopt from the Netherlands is their Dutch Triple Helix approach that strengthens synergies between government, industry, and knowledge institutes.

#### 5.1 Success through engagement

For Dutch companies looking to enter the UAE WEF market, engaging with the right stakeholders is pivotal. Doing business in the UAE 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 the UAE, the ministries are driving the strategies on resource conservation and diversification
linked to the WEF Nexus. While WEF security is high on the government agenda in the UAE, Dutch companies will also need to showcase their best practices, solutions and expertise – by actively engaging with local entities and cultivating those relationships in the long term.

5.1.1 Direct engagement with local entities

Though by no means exhaustive, Table 8 highlights some of the key WEF stakeholders in the UAE. Briefs about the entities and website links can be found in Appendix B. The level to which they should be engaged will vary dramatically from company to company, based on the support required, value proposition etc. Nonetheless, a qualitative prioritization was conducted to showcase the stakeholders whom Dutch companies might find the most relevant. Additionally, Table 8 identifies high level engagement strategies by stakeholder group.

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Engagement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government operator entities</strong></td>
<td></td>
</tr>
<tr>
<td>1 Centre for Waste Management</td>
<td>1. <strong>Information collection</strong>: Dutch companies need to form a solid understanding of</td>
</tr>
<tr>
<td>Abu Dhabi (Tadweer)</td>
<td>the strategies, objectives and operations of the various government operators in the</td>
</tr>
<tr>
<td>2 Bee’ah</td>
<td>UAE if they wish to collaborate successfully</td>
</tr>
<tr>
<td>3 Abu Dhabi Sewerage Services</td>
<td>2. <strong>Involves senior management</strong>: Dutch companies need to utilize the information</td>
</tr>
<tr>
<td>Company (ADSSC)</td>
<td>collected in their research to connect with government operators based on their most</td>
</tr>
<tr>
<td>4 Dubai Municipality</td>
<td>pressing issues. Dutch companies should employ their senior management to connect</td>
</tr>
<tr>
<td>5 Water &amp; Electricity Authorities</td>
<td>with government operators and capitalize on the UAE-Dutch diplomatic channels</td>
</tr>
<tr>
<td>(DoE, DEWA, SEWA &amp; FEWA) and</td>
<td>(i.e. the Dutch embassy, Majlis) for introductions where relevant/possible.</td>
</tr>
<tr>
<td>relevant subsidiaries</td>
<td>3. <strong>Share insights</strong>: Dutch companies need to share their insights and experiences</td>
</tr>
<tr>
<td>6 Department of Urban Planning &amp;</td>
<td>with government operators. This is best done in an interactive manner that emphasizes</td>
</tr>
<tr>
<td>Municipalities</td>
<td>demonstration. This may include: meetings, conferences, workshops and invitations to</td>
</tr>
<tr>
<td>7 Abu Dhabi Department of Transport</td>
<td>build a trust-based relationship. Dutch companies can capitalize on UAE-Dutch</td>
</tr>
<tr>
<td>8 Dubai Road Transport Authority</td>
<td>diplomatic channels (i.e. the Dutch embassy) for introductions where relevant/possible.</td>
</tr>
<tr>
<td><strong>Government regulator entities</strong></td>
<td></td>
</tr>
<tr>
<td>9 The Environment Agency of Abu</td>
<td>1. <strong>Establish focal point</strong>: Dutch companies need to establish a key focal point within</td>
</tr>
<tr>
<td>Dhabi (EAD)</td>
<td>their organization that will regularly engage with the UAE government regulator entities</td>
</tr>
<tr>
<td>10 Ministry of Climate Change &amp;</td>
<td>to improve communications and access to information. This can be complemented with</td>
</tr>
<tr>
<td>Environment (MoCCE)</td>
<td>meetings in person to establish key contact points within priority departments in UAE</td>
</tr>
<tr>
<td>11 Abu Dhabi Agriculture &amp; Food</td>
<td>government entities to build a trust-based relationship. Dutch companies can</td>
</tr>
<tr>
<td>Safety Authority (ADAFSA is the</td>
<td>capitalize on UAE-Dutch diplomatic channels (i.e. the Dutch embassy) for introductions</td>
</tr>
<tr>
<td>consolidation of Abu Dhabi Food</td>
<td>where relevant/possible.</td>
</tr>
<tr>
<td>Control Authority and Abu Dhabi</td>
<td>2. <strong>Consult regularly</strong>: Regular consultations are important and should be followed</td>
</tr>
<tr>
<td>Farmers Services Centre)</td>
<td>up at regular intervals to help UAE government regulators familiarize themselves with</td>
</tr>
<tr>
<td>12 Abu Dhabi Department of Energy</td>
<td>new information. As the UAE is a dynamic environment in which regulations are regularly</td>
</tr>
<tr>
<td>13 Ministry of Energy and Industry</td>
<td>updated, Dutch companies</td>
</tr>
<tr>
<td>14 Ministry of Food Security</td>
<td></td>
</tr>
</tbody>
</table>
### Entity Type

<table>
<thead>
<tr>
<th>Entity Type</th>
<th>Engagement Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emirates Authority for Standardization and Metrology</td>
<td>can benefit from regular consultations to remain up to date with regulatory changes.</td>
</tr>
<tr>
<td></td>
<td>3. <strong>Share insights:</strong> Dutch entities can share their experience and insights with UAE regulators with respect to which regulatory enablers would support agricultural sector growth and innovation in the UAE. This will allow Dutch entities to play a proactive role in the UAE as envisioned by the signed MoU on Innovation Cooperation. This is best done in an interactive manner that emphasizes demonstration. This may include: meetings, conferences, workshops and particularly invitations to see leading best practices abroad etc.</td>
</tr>
<tr>
<td></td>
<td>4. <strong>Awareness building:</strong> As Dutch companies look to introduce novel ideas and solutions to the UAE, awareness building will play a key part of any engagement strategy. Developing promotional material for regulators is key to refresh memories of officials who are aware of on-going discussions and provide introductory information to those who are not.</td>
</tr>
</tbody>
</table>

### Industry

<table>
<thead>
<tr>
<th>Industry</th>
<th>1. <strong>Identify industry drivers:</strong> 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.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emirates Nuclear Energy Corporation</td>
<td>2. <strong>Establish focal point:</strong> Companies should nominate a focal point to directly engage with key industry personnel in order to establish a trust based relationship and maintain an open line of communication.</td>
</tr>
<tr>
<td>ADNOC Group Companies</td>
<td>3. <strong>Share insight:</strong> Dutch companies should focus on personalizing all pitches to UAE industry leaders to increase their chances of success. Sharing new insight might be challenging as UAE companies might initially resist change. However, interactive strategies that emphasize demonstration often work well. This may include: meetings, conferences, workshops and particularly invitations to see leading best practices abroad. Additionally, pilot projects and key collaborations opens the way for greater market acceptance/adoption of new technologies and practices.</td>
</tr>
<tr>
<td>Emirates National Oil Company</td>
<td></td>
</tr>
<tr>
<td>Agribusinesses</td>
<td></td>
</tr>
<tr>
<td>Masdar company</td>
<td></td>
</tr>
<tr>
<td>Industrial Zones</td>
<td></td>
</tr>
<tr>
<td>Holding groups</td>
<td></td>
</tr>
<tr>
<td>Private developers</td>
<td></td>
</tr>
<tr>
<td>Hospitality (hotel chains)</td>
<td></td>
</tr>
<tr>
<td>Port Authorities (AD Ports, DP World)</td>
<td></td>
</tr>
</tbody>
</table>

### International organizations and NGOs

<table>
<thead>
<tr>
<th>International organizations and NGOs</th>
<th>1. <strong>Signing a MoU:</strong> 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 the UAE market which could support companies in their engagement with government operators/regulators.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arab Authority for Agricultural Investment &amp; Development</td>
<td></td>
</tr>
<tr>
<td>IRENA</td>
<td></td>
</tr>
<tr>
<td>Food and Agriculture Organization</td>
<td></td>
</tr>
</tbody>
</table>

### Other

<table>
<thead>
<tr>
<th>Other</th>
<th>1. See section 5.2.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expo 2020</td>
<td></td>
</tr>
</tbody>
</table>

### Universities and Research Institutes

<table>
<thead>
<tr>
<th>Universities and Research Institutes</th>
<th>1. <strong>Building local relationships:</strong> Dutch companies may want to engage with local universities and research institutes to gain country/region specific context, which will help them tailor their solutions when engaging with stakeholders such as government regulators/operators and local companies etc. This can be achieved through direct partnership, or by bringing in Dutch universities as well.</th>
</tr>
</thead>
<tbody>
<tr>
<td>International Centre of Biosaline Agriculture</td>
<td>2. <strong>Nominate a key contact:</strong> Companies should ensure there is a champion within the university/research institute who understands the importance of the collaboration to guarantee endorsement for the project and help in securing legitimacy and access to resources</td>
</tr>
<tr>
<td>National Centre of Meteorology</td>
<td></td>
</tr>
<tr>
<td>Abu Dhabi Global Environmental Data Initiative</td>
<td></td>
</tr>
<tr>
<td>Khalifa University</td>
<td></td>
</tr>
<tr>
<td>Emirates Diplomatic Academy</td>
<td></td>
</tr>
</tbody>
</table>

### 5.1.2 Dutch Business Councils and the Economic Network

Dutch Business Councils in the UAE are useful channels of entry for Dutch companies looking to enter the UAE’s WEF market. These councils are established as a means of networking and promoting business links between the UAE and the Netherlands. Currently, two councils exist, the BeNeLux Business Council (BBC)
in Abu Dhabi\textsuperscript{37} and the Netherlands Business Council (NBC) in Dubai\textsuperscript{38}. Dutch companies can strengthen their trade and investment opportunities in the region, by becoming members of these business councils, connecting with over 200 registered companies, and gaining valuable insights from the region.

Another entry channel for Dutch companies is the Dutch Economic Network in the Gulf Region, including Abu Dhabi and Dubai, which is established to help Dutch businesses in identifying business opportunities within the Gulf Countries. \textsuperscript{39} The aim of this network is to provide advice to Dutch businesses in terms of setting up a business in the Gulf where they advise based on the market as well as potential partners.

5.2 EXPO 2020 engagement channels

Between October 2020 and April 2021, Dubai will host the next world Expo under the theme of “Connecting Minds, Creating the Future”. This event recognizes the importance of worldwide collaboration in generating sustainable technologies that are aimed at solving global problems, including water, energy and food security.

The UAE is working towards becoming a global innovation hub, in line with the country’s National Strategy for Innovation. As a part of this, the UAE can act as a living innovation lab for food production technologies in arid climates.

The Expo 2020 presents the UAE and the Netherlands with a timely opportunity whereby the two nations can work together on developing and implementing innovative solutions. This Expo provides opportunities of collaborations for Dutch companies over the short-term six month period of the Expo as well as the long-term pre-Expo period starting from today. The Dubai Expo has a number of main themes which are illustrated in Figure 19. The figure also highlights the several channels by which Dutch companies can engage with the Expo, be it before or during the event.

\textit{Figure 19: Dubai Expo 2020 main themes for collaborations and interactions}\textsuperscript{40}

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\textsuperscript{37} BeNeLux Business Council, 2018.
\textsuperscript{39} Kingdom of the Netherlands, \textit{Dutch Economic Network in the GCC}, 2018.
\textsuperscript{40} Expo 2020 Dubai UAE, 2018.
5.2.1 Business Connect

One of the main objectives of the Expo 2020 is to connect people and ideas in order to allow businesses to progress. The Expo underlines this under the theme ‘Business Connect’ allowing businesses to share ideas and experiences to facilitate recommendations that allow them to bring about the best solutions. Business connect has already been put in place where it helped bring together senior representatives across 1,300 businesses from a wide variety of industries.41 This channel is an opportunity for Dutch companies to get involved pre-Expo and provide valuable opportunities for the Expo in meeting its objectives in which potential areas of partnership and collaboration can arise.

5.2.2 Procurement

The Dubai Expo 2020 has an online portal for companies (small, medium and large) to submit bids for tenders through the Expo committee.42 Over 100 tenders are available on a monthly basis thereby providing Dutch companies with a vast amount of opportunities. Through the online tender portal of the Expo, the supplier quick guide option will help the user to search and respond to online tenders.

5.2.3 Expo Live

One of the opportunities that are open for collaboration in which Dutch companies can get involved is the Expo Live Innovation Impact Grant Programme launched by the Expo organisation in Dubai. This programme is based on innovation and partnership in which it invites anyone to get involved by sharing their innovative ideas both pre-Expo and during the Expo. The initiative not only promotes creative solutions for a more prosperous future but also helps accelerate these solutions through funding43. The main focus themes identified as drivers of progress by the Expo are ‘Opportunity, Mobility and Sustainability’, which Dutch companies can align with.

5.2.3.1 Partnerships

Expo 2020 is constantly encouraging organizations of all shapes and sizes, across a range of industries and from all over the world to become involved with the variety of projects. Partnerships are key for the Expo to meet their targets for an event of such proportion where it invites partners from different sectors to become involved. Dutch companies can add value to the activities of the Expo through this program. Using this channel, Dutch companies can directly contact the organizers and identify the areas in which they can add value such as innovation and advanced technologies. Table 9 summarizes the different levels of partnership according to the Expo. Figure 20 highlights existing Expo partners along with their strategic contributions to the Expo.

42 Expo2020 Dubai UAE, Supplier Quick Guides, 2018.
Table 9: Different levels of partnerships available for the Expo and their criteria

<table>
<thead>
<tr>
<th>Official Provider</th>
<th>Official Partner</th>
<th>Premier Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Local rights</td>
<td>• Global rights</td>
<td>• Global rights</td>
</tr>
<tr>
<td>• Lowest level of partnership and visibility</td>
<td>• Second level of partnership and visibility</td>
<td>• Highest level of partnership and visibility</td>
</tr>
<tr>
<td>• Focus on delivery of Value in Kind (VIK)</td>
<td></td>
<td>• Prioritized assets and offering</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Making significant contributions to the vision, delivery and legacy of the Expo</td>
</tr>
</tbody>
</table>

**Figure 20: Premium Partners of the Expo along with their value added through partnership**

**Accenture**
Virtual assistance, business intelligence and analytics, mobile applications and technologies to support guest relations.

**Nissan**
Feature advanced technologies for next generation cars such as electric vehicles. Used to help accelerate the electrification of mobility in the region.

**Linking people and their technology so they can connect, share, innovate and create.**

**DP World**
DP world partnerships to use ports in their home countries and Jebel Ali Port for their transport requirements.

**Providing a wide range of innovative solutions, technologies and products for technical and site operations.**

**Siemens**
Partnered for a healthier and more sustainable future to inspire and educate millions in areas such as water stewardship, sustainable packaging, agriculture and nutrition.

**Partnered for a greater opportunity and mobility.**

**PepsiCo**
Latest smart technologies based on digital innovation to offer a superior banking experience as the ‘Bank of the Future’.

**Global super-connector in which its forward-thinking and innovative outlook works towards offering a greater opportunity and mobility.**

**Cisco**
To provide cutting edge digital connectivity to millions of visitors ensuring a rich and tailored experience through secure and reliable connectivity.

**Economic legacy: Collaborative entrepreneurship**

One of the channels identified for Dutch companies to become involved pre-Expo is the collaborative entrepreneurship programme established to maintain the economic legacy of the Expo. This initiative seeks to support economic growth both regionally and internationally by creating partnerships for value creation through fostering entrepreneurship. The aim is to get corporations, SMEs, start-ups and investors involved so as to create mutually beneficial business partnerships for a positive impact on the economy.45

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5.2.5 Pavilions

The overall theme of the Expo is guided by the three pillars ‘Opportunity, Mobility and Sustainability’, each theme having its own Pavilion. Along with the thematic pavilions, Dutch companies can utilize the Dutch Pavilion to showcase their country’s innovative technologies, solutions and ideas.

5.2.5.1 The Dutch Pavilion

Dutch Pavilion Focus:

As in every World Expo, each country is requested to identify a theme for its national pavilion. After consultations with Dutch businesses, knowledge institutions and governmental bodies, the theme ‘Dutch Connection in the Gulf Uniting Water, Energy Food’ was chosen as the theme of not only the Dutch participation to the World Expo 2020, but also of the wider engagement of the Netherlands with the Gulf.

Pavilion Opportunities:

The World Expo 2020 provides Dutch businesses and knowledge institutions, active in the field of the water, energy & food with the following opportunities:

1. To contribute to and profit from the calendar of activities that is being set up for the period running up to during and beyond the EXPO 2020 Dubai.
2. To participate in the tender for the design, construction, content/experience, maintenance and deconstruction of the Dutch pavilion;
3. To use the Dutch pavilion at World Expo 2020 as a meeting point with customers or platform with experts, and for events like business seminars, congresses, etc.

Calendar of Activities:

In the years leading up to Expo 2020, and during the Expo itself, a calendar of events will be developed, consisting of activities (e.g. trade missions, seminars, projects and workshops) organized by Dutch government institutions, businesses and knowledge institutions related to the WEF Nexus theme. The aim of the calendar is to coordinate the activities organized by the public and private sector, to enhance the Dutch visibility on the WEF Nexus, and to strengthen the Dutch profile in the Gulf region. Dutch businesses, knowledge institutions and governmental bodies that are interested to share information on their activities related to the Nexus theme or one of the three sectors (water, energy, food), can do so by e-mailing: DIO-EXPO2020@minbuza.nl.

Use of the Dutch pavilion during the six months of the EXPO 2020 Dubai

The Dutch pavilion will be used to showcase the best Dutch innovations and sustainability projects with respect to the WEF Nexus. Apart from an area in which the general public is drawn into a WEF ‘experience’, the pavilion will also have a number of special features, including a VIP/business area that will be available for rent by Dutch businesses. The business facilities area can be used to host business meetings, seminars etc. Dutch businesses interested in renting the pavilion facilities for corporate events during the Expo 2020, can contact the Dutch project team Expo 2020 through DIO-EXPO2020@minbuza.nl.
### 6. Appendix A

The tables below include the sources of all the initiatives cited in chapter 3, and are listed by initiative number, mirroring Tables 2, 3 and 4.

<table>
<thead>
<tr>
<th>SN</th>
<th>Initiative(s)/Programme(s)</th>
<th>Links</th>
</tr>
</thead>
<tbody>
<tr>
<td>WF-3</td>
<td>Various production systems for livestock and poultry exist across the UAE (i.e. caged vs. free range livestock)</td>
<td><a href="http://www.deenafarms.com/about-us/">http://www.deenafarms.com/about-us/</a></td>
</tr>
<tr>
<td>WF-4</td>
<td>Poultry farms are widespread throughout the UAE with various setup types (i.e. caged vs. free range)</td>
<td><a href="http://www.greenheartuae.com/product/eggs-organic-free-range/">http://www.greenheartuae.com/product/eggs-organic-free-range/</a></td>
</tr>
<tr>
<td>WF-5</td>
<td>Date palm salinity tolerance, Biosaline institute</td>
<td><a href="http://www.biosaline.org/sites/default/files/Projectbrieffiles/Project_Brief_Investigation%20of%20Date%20Palm.pdf">http://www.biosaline.org/sites/default/files/Projectbrieffiles/Project_Brief_Investigation%20of%20Date%20Palm.pdf</a></td>
</tr>
<tr>
<td>WF-6</td>
<td>- Quinoa initiative, UAE</td>
<td><a href="http://www.biosaline.org/sites/default/files/Projectbrieffiles/Quinoa-Project_Brief-Final-2.pdf">http://www.biosaline.org/sites/default/files/Projectbrieffiles/Quinoa-Project_Brief-Final-2.pdf</a></td>
</tr>
<tr>
<td>WF-7</td>
<td>- No initiatives, approach is still in its infancy within the UAE</td>
<td></td>
</tr>
<tr>
<td>WF-8</td>
<td>- End of water intensive fodder subsidies, ADFCA, Abu Dhabi</td>
<td><a href="https://www.thenational.ae/uae/environment/end-to-subsidy-for-farmers-rhodes-grass-1.567671">https://www.thenational.ae/uae/environment/end-to-subsidy-for-farmers-rhodes-grass-1.567671</a></td>
</tr>
<tr>
<td>WF-9</td>
<td>- Support for fodder imports, ADFCA, Abu Dhabi</td>
<td>[<a href="https://www.adfca.ae/English/MediaCenter/News/">https://www.adfca.ae/English/MediaCenter/News/</a> Archived%20News/Imported.aspx](<a href="https://www.adfca.ae/English/MediaCenter/News/">https://www.adfca.ae/English/MediaCenter/News/</a> Archived%20News/Imported.aspx)</td>
</tr>
<tr>
<td>WF-11</td>
<td>- A number of smart greenhouses are emerging in the UAE, such as those done by Pure Harvest, UAE</td>
<td><a href="http://pureharvest.ae/">http://pureharvest.ae/</a></td>
</tr>
<tr>
<td>WF-15</td>
<td>- Pegasus agriculture group, UAE</td>
<td><a href="http://pegasusagriculturegroup.com/the-project/">http://pegasusagriculturegroup.com/the-project/</a></td>
</tr>
<tr>
<td>WF-19</td>
<td>- Bani Yas center growing tilapia fish, Abu Dhabi</td>
<td><a href="https://www.thenational.ae/uae/aquaponics-project-hailed-as-a-success-1.394940">https://www.thenational.ae/uae/aquaponics-project-hailed-as-a-success-1.394940</a></td>
</tr>
<tr>
<td>WF-22</td>
<td>- No initiatives, concept is still in its infancy within the UAE</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>WF-23</td>
<td>- Al Najeh honey, UAE</td>
<td><a href="http://alnajeh.ae/">http://alnajeh.ae/</a></td>
</tr>
<tr>
<td>SN</td>
<td>Initiative(s)/Programme(s)</td>
<td>Links</td>
</tr>
<tr>
<td>----</td>
<td>----------------------------</td>
<td>-------</td>
</tr>
<tr>
<td>WF-23</td>
<td>Barari Forest Management, Abu Dhabi Emirate</td>
<td><a href="http://www.barari.ae/forest-management.html">Link</a></td>
</tr>
<tr>
<td>WF-24</td>
<td>Drip irrigation project initiative by Dubai Silicon Oasis</td>
<td><a href="https://oxfordbusinessgroup.com/analysis/developing-and-maintaining-efficient-forms-irrigation">Link</a></td>
</tr>
<tr>
<td>WF-25</td>
<td>Efficient sprinkler system for reduced water consumption in Masdar City, Abu Dhabi</td>
<td><a href="http://www.masdar.ae/en/initiatives/detail/masdar-innovating-for-a-water-secure-future">Link</a></td>
</tr>
<tr>
<td>WF-26</td>
<td>Al Rawabi Dairy Farm, UAE</td>
<td><a href="http://www.biosaline.org/sites/default/files/Projectbrieffiles/project_brief_ajman_sewerage_v1-eng-pages-bleeds.pdf">Link</a></td>
</tr>
<tr>
<td>WF-27</td>
<td>Sewage used in landscaping, Ajman</td>
<td><a href="http://www.fao.org/3/i8527en/I8527EN.pdf">Link</a></td>
</tr>
<tr>
<td>WF-28</td>
<td>Aquaculture effluents for cultivation of halophytes in coastal desert areas, Umm al Quwain</td>
<td><a href="http://www.biosaline.org/sites/default/files/project_brief_ajman_sewerage_v1-eng-pages-bleeds.pdf">Link</a></td>
</tr>
<tr>
<td>WF-29</td>
<td>Dilution/dispersion already exists in the UAE at many desalination plants</td>
<td><a href="http://www.biosaline.org/sites/default/files/project_brief_ajman_sewerage_v1-eng-pages-bleeds.pdf">Link</a></td>
</tr>
<tr>
<td>WF-30</td>
<td>Usage of brine for aquaculture exists inland as byproduct from BWRO</td>
<td><a href="http://www.biosaline.org/sites/default/files/project_brief_ajman_sewerage_v1-eng-pages-bleeds.pdf">Link</a></td>
</tr>
<tr>
<td>WF-31</td>
<td>Represents the major mechanism for food acquisition in the UAE</td>
<td><a href="http://www.biosaline.org/sites/default/files/project_brief_ajman_sewerage_v1-eng-pages-bleeds.pdf">Link</a></td>
</tr>
<tr>
<td>WF-32</td>
<td>Food Watch, Dubai</td>
<td><a href="http://www.barari.ae/research.html">Link</a></td>
</tr>
<tr>
<td>WF-33</td>
<td>No current system in existence but discussed as a policy option by Emirates Diplomatic Academy</td>
<td><a href="http://eda.ac.ae/images/pdf/EDA_Insight_Food_and_Climate_Synergies_EN.pdf">Link</a></td>
</tr>
<tr>
<td>SN</td>
<td>Initiative(s)/Programme(s)</td>
<td>Links</td>
</tr>
<tr>
<td>----</td>
<td>----------------------------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td>- Date pits and sludge, University of Sharjah</td>
<td><a href="http://sesam-uae.com/quality14/presentations/Wameed_Mohamad_Ali_Rafeet.pdf">http://sesam-uae.com/quality14/presentations/Wameed_Mohamad_Ali_Rafeet.pdf</a></td>
</tr>
<tr>
<td>WE-2</td>
<td>- RO plants currently receive renewable sources of electricity through the existing energy mix (which includes PV, CSP and Nuclear) however only one project exists that directly couples renewables and desalination, the Masdar Renewable Energy Water Desalination Programme at Ghantoot, Abu Dhabi</td>
<td><a href="http://www.masdar.ae/assets/downloads/content/3588/desal_lr.pdf">http://www.masdar.ae/assets/downloads/content/3588/desal_lr.pdf</a></td>
</tr>
<tr>
<td>WE-3</td>
<td>- Date pits and sludge, University of Sharjah</td>
<td><a href="http://sesam-uae.com/quality14/presentations/Wameed_Mohamad_Ali_Rafeet.pdf">http://sesam-uae.com/quality14/presentations/Wameed_Mohamad_Ali_Rafeet.pdf</a></td>
</tr>
<tr>
<td>WE-4</td>
<td>- Cogeneration performed at various plants across the UAE (i.e. Jabal Ali M cogeneration plant, Dubai)</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>WE-5</td>
<td>- All industries, power plants and desalination plants on the coast that discharge cooling water, treated wastewater or brine into the sea</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>WE-6</td>
<td>- No initiatives</td>
<td>Not Applicable</td>
</tr>
<tr>
<td>WE-8</td>
<td>- No initiatives</td>
<td>Not Applicable</td>
</tr>
<tr>
<td></td>
<td>- Solar water heater system implemented at IRENA, Abu Dhabi</td>
<td><a href="http://www.masdar.ae/assets/downloads/content/4996/irena_hq.pdf">http://www.masdar.ae/assets/downloads/content/4996/irena_hq.pdf</a></td>
</tr>
<tr>
<td></td>
<td>- Tabreed, Abu Dhabi</td>
<td><a href="https://www.tabreed.ae/">https://www.tabreed.ae/</a></td>
</tr>
<tr>
<td>SN</td>
<td>Initiative(s)/Programme(s)</td>
<td>Links</td>
</tr>
<tr>
<td>----</td>
<td>--------------------------</td>
<td>-------</td>
</tr>
</tbody>
</table>
| FE-1 | - Biojet initiative, Abu Dhabi  
| FE-2 | - ISEAS Masdar project on bioethanol production from oil rich native plants  
| FE-3 | - Opportunities discussed by EAD policy brief  
| WE-1 | Please refer to WE-1 | Not applicable |
| FE-4 | - Tadweer/Taqa 100 MW WtE facility in Abu Dhabi  
- Masdar/Bee’ah 30 MW WtE facility in Sharjah (to start in 2020)  
| FE-5 | - Neutral Fuels, UAE  
- ENOC Biodiesel 5, Dubai  
- Lootah fuels, Dubai  
- Biodiesel from date pits, UAE  
- Cooking oil to biodiesel fuelling station in Jebel Ali, Dubai  
[http://www.lbf.ae/](http://www.lbf.ae/)  
| FE-6 | - No initiatives | Not Applicable |
| FE-7 | - No initiatives | Not Applicable |
| FE-8 | - Smartcool, Dubai | [http://smartcool.ae/](http://smartcool.ae/) |
| FE-11 | - No initiatives | Not Applicable |
| FE-12 | - No initiatives | Not Applicable |
| FE-13 | - No initiatives | Not Applicable |
| FE-14 | - No initiatives | Not Applicable |
| FE-15 | - No initiatives | Not Applicable |
| FE-18 | - No initiatives | Not Applicable |
7. Appendix B

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

<table>
<thead>
<tr>
<th>Entity type</th>
<th>Entity Description</th>
<th>Link</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Government operator entities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 Centre for Waste Management Abu Dhabi (Tadweer)</td>
<td>Safe and effectual waste management in Abu Dhabi</td>
<td><a href="https://www.tadweer.ae/en/Pages/default.aspx">https://www.tadweer.ae/en/Pages/default.aspx</a></td>
</tr>
<tr>
<td>2 Bee’ah</td>
<td>Environmental management, systematic waste management, renewable energy utilization and community engagement initiatives to set a benchmark for sustainability</td>
<td><a href="https://beeah.ae/en">https://beeah.ae/en</a></td>
</tr>
<tr>
<td>3 Abu Dhabi Sewerage Services Company</td>
<td>Collection and treatment of all commercial and residential wastewater in Abu Dhabi for safe waste disposal</td>
<td><a href="https://www.adssc.ae/en-us/Pages/default.aspx">https://www.adssc.ae/en-us/Pages/default.aspx</a></td>
</tr>
<tr>
<td>4 Dubai Municipality</td>
<td>Plan and develop Dubai as a happy and sustainable city</td>
<td><a href="https://www.dm.gov.ae/wps/portal/home">https://www.dm.gov.ae/wps/portal/home</a></td>
</tr>
<tr>
<td>7 Abu Dhabi Department of Transport</td>
<td>Organizing, planning, developing, operating and maintaining a safe, smart, integrated and efficient transport sector for a sustainable environment</td>
<td><a href="https://www.dot.abudhabi.ae/en/home">https://www.dot.abudhabi.ae/en/home</a></td>
</tr>
<tr>
<td>8 Dubai Road Transport Authority</td>
<td>Improve public transport facilities and develop roads across the emirate of Dubai</td>
<td><a href="https://www.rta.ae/wps/portal/rta/ae/home?lang=en">https://www.rta.ae/wps/portal/rta/ae/home?lang=en</a></td>
</tr>
<tr>
<td><strong>Government regulator entities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9 The Environment Agency of Abu Dhabi</td>
<td>To protect and improve the environment for sustainable development through policy measures</td>
<td><a href="https://www.ead.ae/SitePages/home.aspx">https://www.ead.ae/SitePages/home.aspx</a></td>
</tr>
<tr>
<td>10 UAE Ministry of Climate Change &amp; Environment</td>
<td>The development of policies and regulations to address environmental issues locally and globally</td>
<td><a href="https://www.moccae.gov.ae/en/home.aspx">https://www.moccae.gov.ae/en/home.aspx</a></td>
</tr>
<tr>
<td>11 Abu Dhabi Food Control Authority</td>
<td>To ensure safe and good quality food for human consumption</td>
<td><a href="https://www.adfca.ae/English/AboutADFCA/Pages/default.aspx">https://www.adfca.ae/English/AboutADFCA/Pages/default.aspx</a></td>
</tr>
<tr>
<td>12 Abu Dhabi Department of Energy</td>
<td>Department of Energy is responsible for the planning and direction of Abu Dhabi’s energy sector, which includes the formulation and implementation of public policies that drive the future direction and provisioning of the energy sector in all its forms.</td>
<td><a href="http://www.doe.gov.ae/en/about-us/">http://www.doe.gov.ae/en/about-us/</a></td>
</tr>
<tr>
<td>13 Ministry of Energy and Industry</td>
<td>To develop policies for stakeholders in the energy sector for the conservation of the country’s energy sources</td>
<td><a href="https://www.moei.gov.ae/en/home.aspx">https://www.moei.gov.ae/en/home.aspx</a></td>
</tr>
<tr>
<td>14 Ministry of Food Security</td>
<td>To enhancing the country’s food security</td>
<td>No current website</td>
</tr>
<tr>
<td>No.</td>
<td>Organization</td>
<td>Description</td>
</tr>
<tr>
<td>-----</td>
<td>--------------</td>
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</tr>
<tr>
<td>15</td>
<td>Emirates Authority for Standardization and Metrology</td>
<td>To develop and present national strategies that include protecting the UAE's economy and environment</td>
</tr>
<tr>
<td>16</td>
<td>Emirates Nuclear Energy Corporation</td>
<td>To provide the UAE with clean and efficient nuclear energy</td>
</tr>
<tr>
<td>17</td>
<td>ADNOC Group Companies</td>
<td>To provide energy worldwide contributing to the UAE's economic and social development while taking necessary measures for environmental protection</td>
</tr>
<tr>
<td>18</td>
<td>Emirates National Oil Company</td>
<td>To provide energy at a global level contributing to Dubai's economic diversification and sustainable development</td>
</tr>
<tr>
<td>22</td>
<td>Holding groups</td>
<td>Often times, holding groups are family owned in the UAE with a number of product and service companies existing within the group</td>
</tr>
<tr>
<td>23</td>
<td>Private developers</td>
<td>Private property developers responsible for construction or refurbishment of residential, commercial and retail development (i.e. Al Dar and Emaar)</td>
</tr>
<tr>
<td>24</td>
<td>Hospitality industry</td>
<td>Hotels, resorts and country clubs (chains and individual)</td>
</tr>
<tr>
<td>25</td>
<td>Port authorities</td>
<td>Companies responsible for the operation of the largest ports in the UAE</td>
</tr>
<tr>
<td>26</td>
<td>Arab Authority for Agricultural Investment &amp; Development</td>
<td>To invest in agricultural activities for food security in the Arab World</td>
</tr>
<tr>
<td>27</td>
<td>IRENA</td>
<td>To provide data on renewable energy and promote economic, social and environmental benefits of renewables</td>
</tr>
<tr>
<td>28</td>
<td>Food and Agriculture Organization</td>
<td>To contribute to the sustainable production of agriculture and fisheries to combat poverty</td>
</tr>
<tr>
<td>29</td>
<td>Expo 2020</td>
<td>To create collaborations and partnerships to promote innovation</td>
</tr>
<tr>
<td>30</td>
<td>International Center of Biosaline Agriculture</td>
<td>Research focused on innovative technologies and non-traditional crops to address food security</td>
</tr>
<tr>
<td>32</td>
<td>Abu Dhabi Global Environmental Data Initiative</td>
<td>Interpret environmental data for best practice implementation and support policymakers in their decision-making</td>
</tr>
<tr>
<td>34</td>
<td>Emirates Diplomatic Academy</td>
<td>Research focused on national security through innovative solutions and partnerships</td>
</tr>
</tbody>
</table>
8. Endnotes


20 The National. (2019) Technology will make the UAE one of the world’s most food-secure countries by 2021. Retrieved June 12, 2019, from https://www.thenational.ae/opinion/comment/technology-will-make-the-uae-one-of-the-world-s-most-food-secure-countries-by-2021-1.814174


