Report Launch

UAE Water-Energy-Food Nexus Report
&
Sustainable Technologies: GCC Market Assessment Report

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AGENDA

1 WATER-ENERGY-FOOD NEXUS IN THE UAE REPORT

Water Energy Food Nexus Report

Report Objective

This report builds off the Memorandum of Understanding (MoU) signed between the governments of the UAE and the Netherlands, and supports both by identifying investment opportunities related to the water-food-energy Nexus, leading to Expo 2020.

Report Snapshot

Contents

Water Energy Food Nexus Report - Table of Contents

The Nexus report outlines the current UAE WEF landscape and identify opportunities for Dutch companies in time for EXPO 2020

- Water, energy, food resources in the UAE
- Overview of the national strategies, visions and objectives

- Water-Food: programs, technologies & initiatives
- Water-Energy: programs, technologies & initiatives
- Energy-Food: programs, technologies & initiatives
- Scoring of technologies/ approaches

- What are the investment opportunities for Dutch companies, based on the identified opportunities and challenges

- Who are the main nexus stakeholders, what is their relevance to Dutch should they be engaged?
- Recommendations to Dutch companies on how to leverage and prepare for Expo 2020

- Case Study on Pure Harvest©, a technology-enabled agribusiness that is locally producing fresh vegetables in the UAE

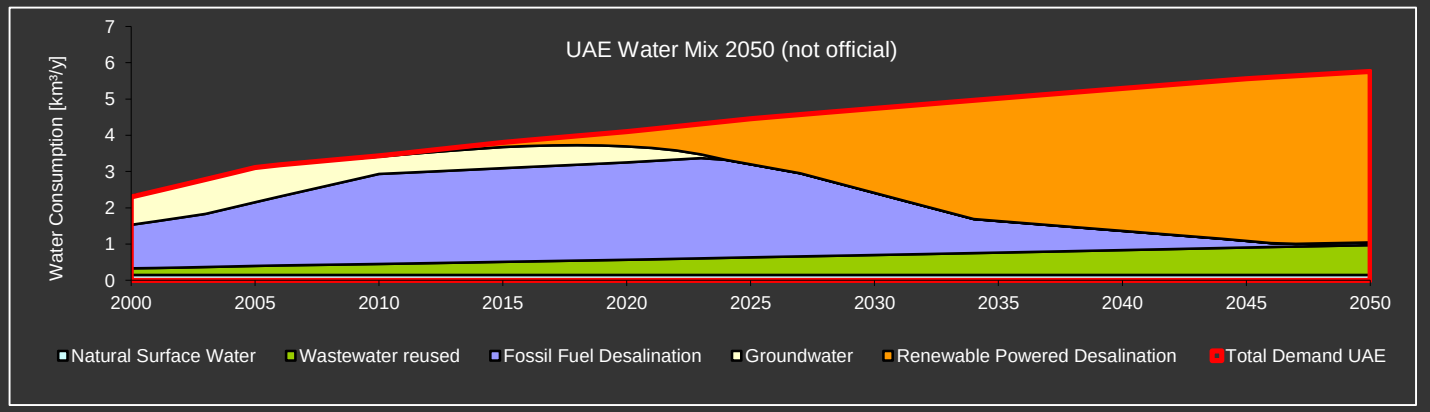
Introduction

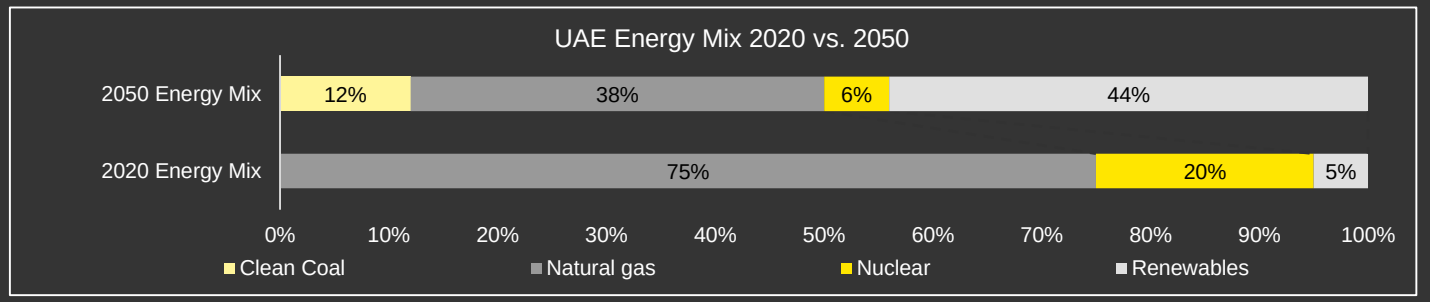
Water resources

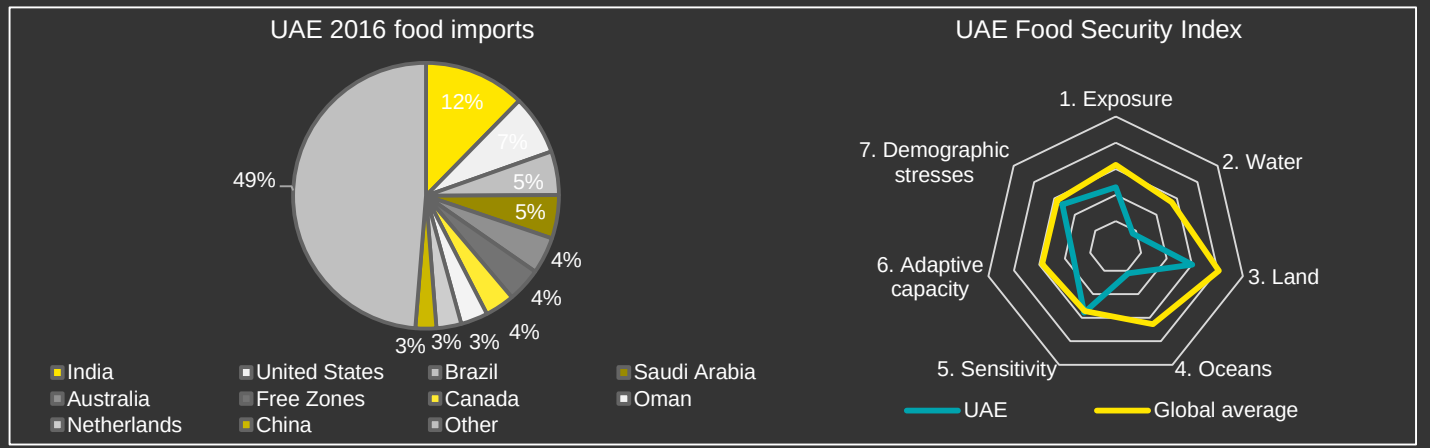
Energy resources

Food resources

Summary of UAE water, energy and food resources







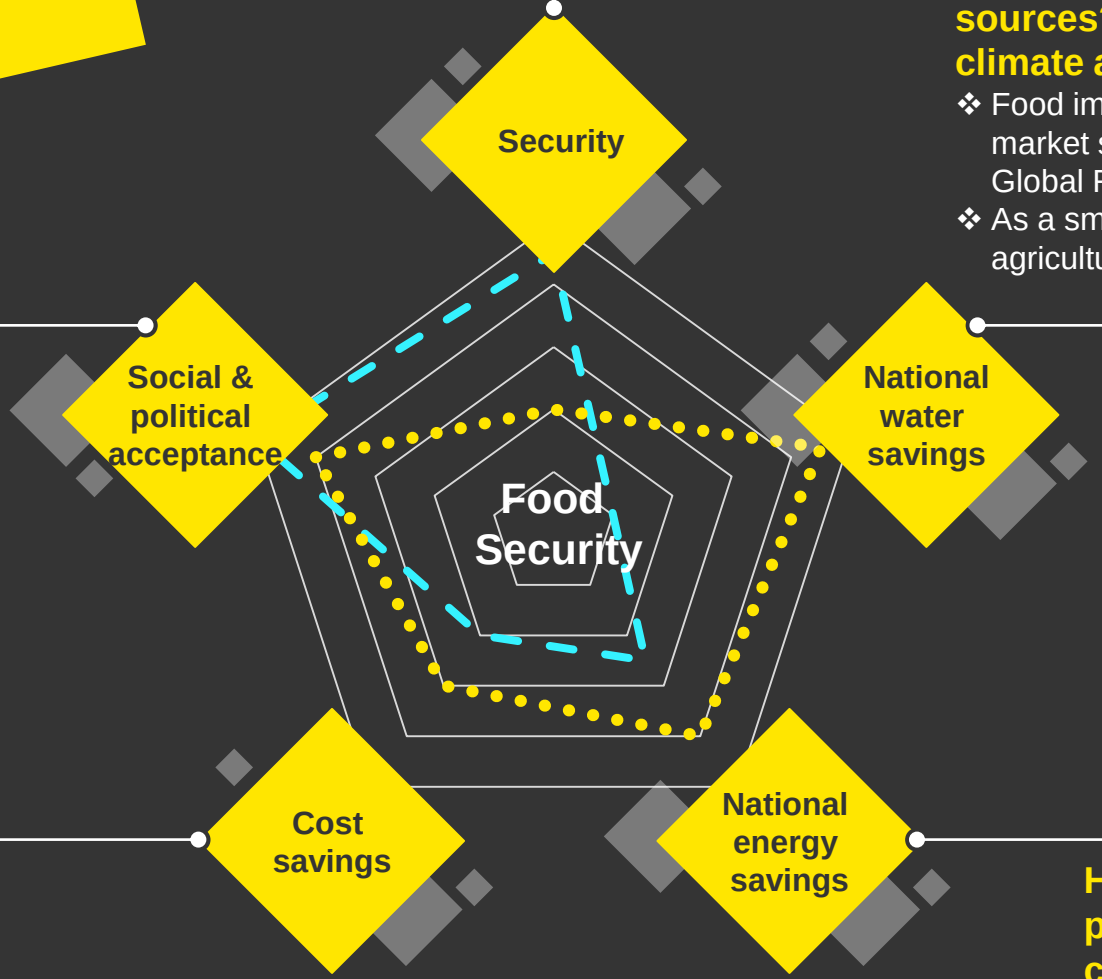
Introduction
Food Security in the UAE

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

- Food imports are more prone to climate and market shocks as demonstrated by the 2007/2008 Global Food Price Crisis
- As a small country, the UAE has relatively less agricultural bargaining power

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

- Considerable support is provided to local farmers, and is in line with various strategies/targets, including Emiratization, economic diversification, and food security
- Culturally agriculture is encouraged



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

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

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

- Local food production is much more expensive (when all factors considered) in comparison to food imports, however, more prone to price fluctuations due to market and climate

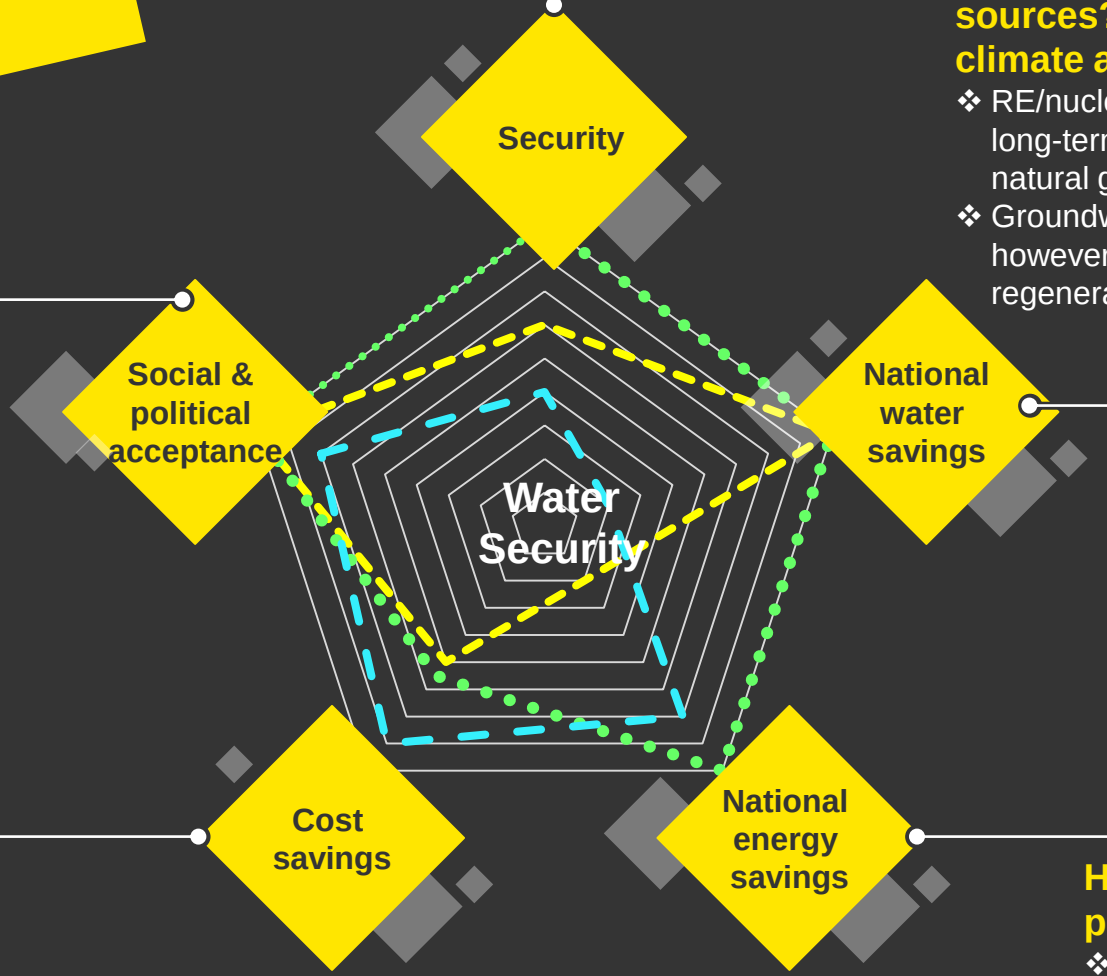
Food produced on farms within the UAE, using both standard and advanced farming practices

Food imported predominantly from abroad and shipped to the UAE for local consumption

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

- While food imports require energy for transport, it is not the UAE's
- The need to desalinate brackish aquifers makes local food production energy intensive

Introduction
Water Security in the UAE



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

- RE/nuclear desalination is more secure in the long-term, because it decouples water from natural gas
- Groundwater extraction is widely prevalent, however aquifers are depleting faster than their regenerative capacity

Is there political and social support for the method of water production/acquisition? Is it in alignment with the strategy and vision of the UAE?

- Government targets to diversify the UAE energy mix inadvertently support non-fossil fuel desalination
- Strong government awareness on need to scale back groundwater extraction, though opposition will exist by farmers

How does the water production/acquisition method, impact domestic water resources?

- Desalination in all forms enhances water availability, while groundwater extraction depletes it

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

- Desalination is energy-intensive, and the cost will vary as energy prices fluctuate, but likely to decrease with time, as cost of renewables continues to drop, and natural gas prices go up

How resource intensive is the water production/acquisition method?

- Renewable and/or nuclear powered desalination does not require natural gas, thereby presenting a large national energy saving

Introduction
Visions & Strategies

UAE

- Agenda 2030 and the SDGs
- Centennial Plan 2071
- UAE Vision 20021
- National Strategy for Innovation
- UAE Water Security Strategy
- UAE Energy Strategy 2050
- UAE Strategy for Artificial Intelligence
- UAE BlockChain Strategy 2021
- The National Advanced Sciences Agenda 2031
- UAE Food Security Strategy

UAE national strategies, visions and objectives

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 SDGs[19]. 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.

Centennial Plan 2071[20]

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.

UAE Vision 2021[20]

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.

National Strategy for Innovation[20]

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[21]. The National Strategy for Innovation has identified water and renewable energy as two of seven priority sectors. The notion of encouraging

Introduction
Visions & Strategies

UAE federal strategies, visions and objectives

Abu Dhabi
- Abu Dhabi Economic Vision 2030
- Surface Transport Master Plan
- Abu Dhabi Transportation Mobility Management Strategy
- Plan Abu Dhabi 2030
- Environment Vision 2030

Dubai
- Dubai Plan 20021
- Dubai Autonomous Transport Strategy 2030
- Smart Dubai 2021
- Dubai Clean Energy Strategy 2050
- Dubai 3D Printing Strategy 2030
- Dubai Industrial Strategy 2030
- Dubai Health Strategy 2021

Sharjah
- Sharjah Tourism Vision 2021

Ajman
- Ajman 2021

Um Al Quwain
- No formalized strategies/visions

Ras Al Khaimah
- No formalized strategies/visions

Fujairah
- Fujairah 2040 Plan

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 days[27].

Dubai Clean Energy Strategy[28]

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 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.

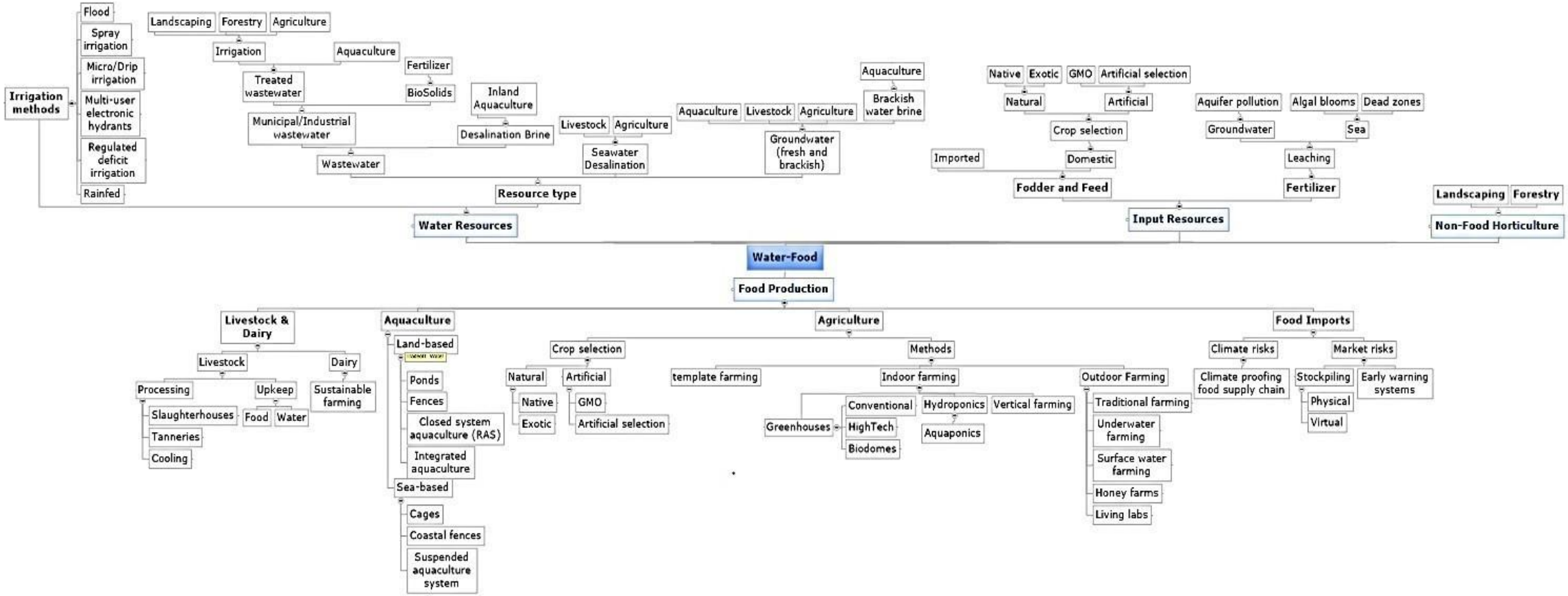
Expo 2020

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.

UAE Water-Food Nexus Snapshot

Mapping of Nexus intersections

UAE Water-Food Nexus Map



UAE Water-Food Nexus Snapshot

Mapping of Nexus intersections

SN	Category 1	Category 2	Approach/ technology	Approach strengths	Approach limitations	Maturity	Growth opportunity	Initiative(s)/Programme(s)
WF-1	Livestock, Poultry & Dairy	Livestock (cow, sheep, goat and camel)	Livestock protection & development	- Improved licensing and monitoring of veterinary products/medicine results in higher product quality, lower disease outbreaks and therefore higher yields	- No significant limitations	4	3	- Livestock Chain Monitoring Committee, Ministry of Climate Change and Environment, UAE
WF-2			Sustainable breed selection	- Particular breeds can be less resource intensive (i.e. water) and more heat tolerant	- Consumers may prefer particular breeds based on quality - Farmers are inclined to raise those with the highest profit margins	3	3	- The Abu Dhabi Farmers' Services Centre Breeding Programme
WF-3			Production systems	- The design and choice of particular production systems (meat or dairy production) can reduce costs, disease outbreaks, environmental impact and resource requirements	In the UAE, certain production systems are constrained by: - Climate (i.e. temperature, rainfall etc.) - lack of natural shrub/vegetation for grazing	4	3	- Various production systems for livestock and poultry exist across the UAE (i.e. caged livestock vs. free range)
WF-4			GMOs	- Opportunities to improve yields through disease resistance, saline water tolerance and heat tolerance	- Public hesitation/resistance towards GMOs	2	4	- Discussions on GMO use in the UAE are taking place, however no conscious efforts have been made towards GMO livestock production
WF-5		Poultry	Farming of poultry	- Suitable for the climate conditions - Less resource intensive than livestock - Relatively low maintenance costs	- Prone to disease outbreaks due to poor ventilation - Low profit margin on poultry	5	3	- Poultry farms are widespread throughout the UAE with various setup types (i.e. commercial farmed eggs vs. free-range organic eggs)
WF-6	Agriculture	Crop Selection	Native and climate compatible species	- Salt and heat tolerant crops - Reduced need for freshwater - Synergy with voluntary and mandatory green building standards	- Limited variety of crops - Legal challenges in registering new crop varieties	4	4	- Date palm salinity tolerance, Biosaline institute - Quinoa initiative, UAE
WF-7			Seaweed and macro-algae farming for animal feed	- Low input requirement - High in nutrients	- Requires controlled conditions - May prove difficult to scale up	1	5	- No initiatives. Approach is still in its early stage within the UAE
WF-8			Domestic production of Fodder and feed	- High demand for fodder - Reduced reliance on imports - Emergence of fodder irrigated by saline waters	- Fodder cultivation competes with other crops for water resources - Fodder crops are generally water intensive (such as Rhodes grass)	5	2	- End of water intensive fodder subsidies, ADFCA, Abu Dhabi - Support for fodder imports, ADFCA, Abu Dhabi
WF-9			Artificial (Artificial Selection & GMOs)	Opportunities for improved yields, and disease, draught, heat and salt resistance	- Public hesitation/resistance towards GMOs	2	4	- Discussions on GMO crop use in the UAE taking place, but no conscious efforts are made towards GMO crop production
WF-10		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 killing 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-11			Seawater greenhouses	- Creates ideal growing conditions for crops while producing fresh water for irrigation	- Fine tuning of complex system - Potential aquifer contamination from se	2	4	- The Sahara Forest Project (2009), UAE
WF-12			Bio-domes	- Energy & cost efficient - Synergies with voluntary & mandatory green buildings standards - Can serve educational purposes	- Systems need to be thoroughly d and fine-tuned - Significant maintenance is requi	2	4	- EAD-Philippine Global School, Abu Dhabi
WF-13			Hydroponic farming	- High irrigation efficiency compared to traditional methods - Increased crop productivity - Reduced use of pesticide & fertilizer	- High CAPEX - Risk of m icro anisms conta ation - D te p ation	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-14			Aquaponics	- Reduced water consumption - No addition of fertilizer required - When combined with hydroponics, reduces overall water requirement stem	Hig PEX eed be coupled with hydroponic systems, which may be difficult ot fe le at times	3	5	- Bani Yas center growing tilapia fish, Abu Dhabi - Jebel Ali resort & hotel growing cherry fish & cherry tomatoes, Dubai
WF-15		Farming	Urban Farming	- Controlled growing environment - Maximize resource efficiency - Increase variety of crops - Synergies with voluntary & mandatory green buil standards	h CAPEX - Maintenance of systems may be more complicated than traditional farming	2	4	- Urban Agriculture research center, Dubai
WF-16			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-17			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-18			Organic Fertilizers	- Reduced environmental damage caused by eutrophica and leaching into aquifers	- Potentially more expensive - Potentially more difficult to collect and process	4	4	- Adfert organic fertilizer made of seaweed, Abu Dhabi
WF-19			Organic Farming	- Reduced environmental damage and wide public/commercial appeal	- Could result in reduced yields and higher disease outbreaks if not properly managed	5	5	- 54 organic farms in the UAE due to government initiatives, UAE
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	- 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	Land-scaping & Forestry	Landscaping & Forestry	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	- 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
WF-28			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			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	Food import	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	- 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

UAE Water-Energy Nexus Snapshot

Mapping of Nexus intersections

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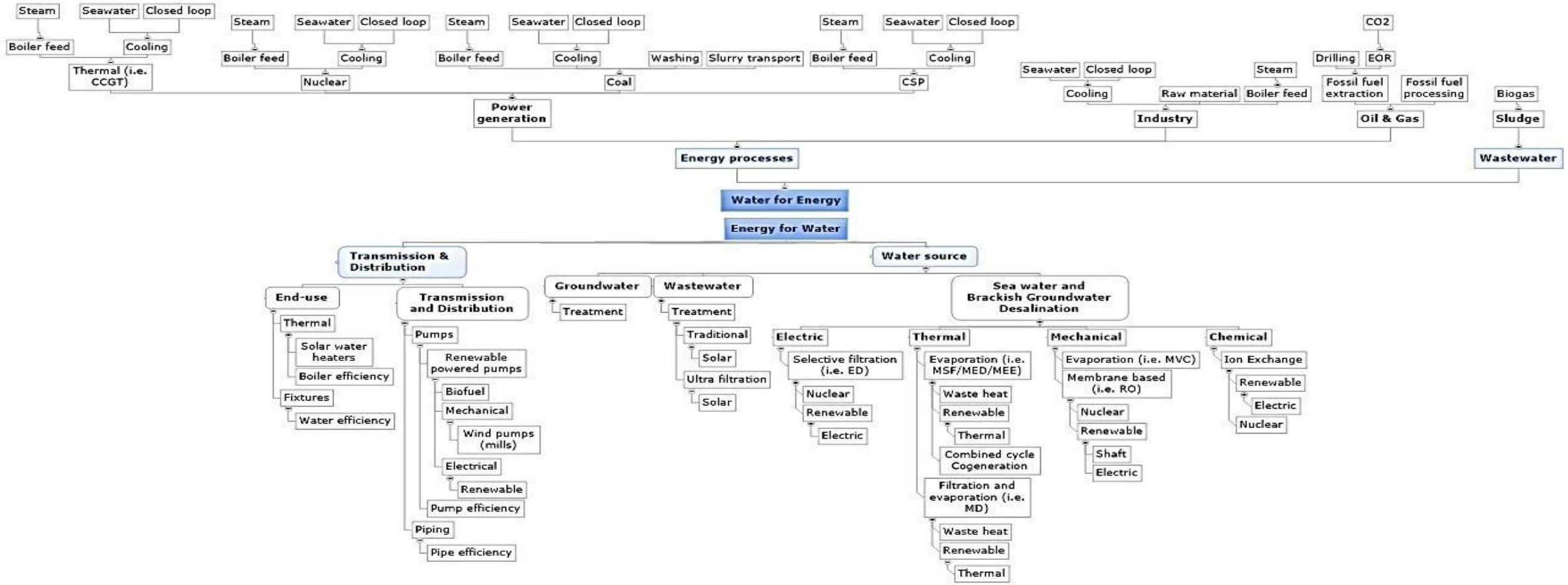

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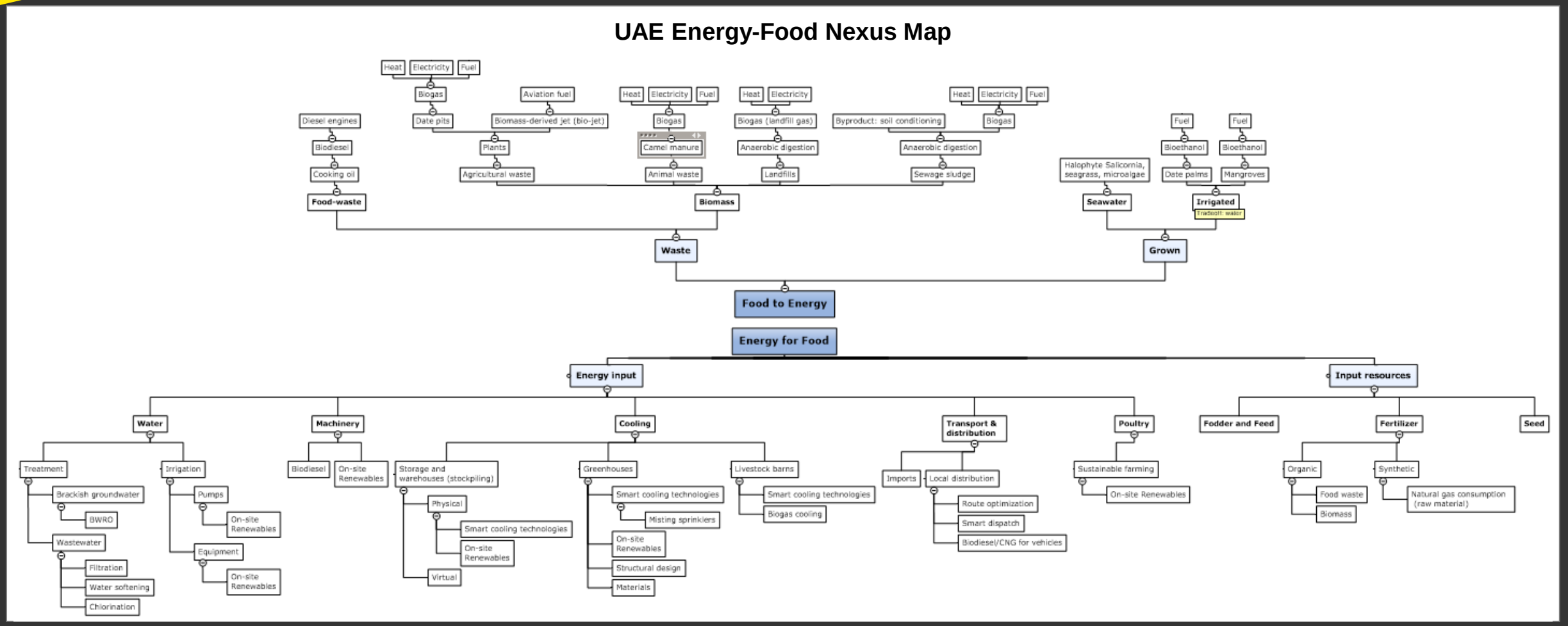
WE-1	Waste to Energy	Wastewater sludge to methane based biogas	- Significant sewage generated across UAE - Anaerobic digestion of sludge is a net energy producing process, in the form of biogas - Nutrient recovery (phosphate and nitrogen) can be used in agriculture/industrial applications - Local climate favorable to technology	- High investment cost for anaerobic digestion tanks and system	3	5	- Taqa Technology incubation unit, Abu Dhabi - Date pits and sludge, University of Sharjah
WE-2	Renewable energy powered desalination	MED/MSF/MEE with solar thermal	- 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	- 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)	3	5	- 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
WE-3		Reverse Osmosis with PV/nuclear/storage	- 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	- 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	3	5	
WE-4	Cogeneration	Combined cycle - MSF/MED	- 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	- 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 does not match water and electricity demand leading to inefficient burning of natural gas	5	3	- Various plants across the UAE (i.e. Jabal Ali M)
WE-5	Industrial water discharge	Water discharge management	- Availability of technologies for managing the environmental impacts (i.e. chemical, thermal and saline pollution) associated with water use for industrial, power and desalination processes	- 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)	4	5	- All industries, power plants and desalination plants on the coast that discharge cooling water, treated wastewater or brine into the sea
WE-6	RE powered WWTP	Solar powered WWTP	- High solar irradiance in UAE	- Intermittency, unless a hybrid system - Currently, higher cost than grid connection	1	4	- No initiatives
WE-7	Water pumping and transport	Solar water pumps	- High solar irradiance in UAE - Off-grid usage makes system mobile, and avoids electrification costs	- Intermittency, unless a hybrid system	4	5	- SunEnergy solar pumps, Dubai and Abu Dhabi - DUSOL solar pumps, Dubai
WE-8		Biofuel water pump	- Algae biofuel production and application being researched in UAE	- Dependent on maturity of biofuel technology	2	4	- No initiatives
WE-9		Piping efficiency and T&D monitoring	- Water system savings - Identification of system nodes requiring maintenance and/or replacement through monitoring system (i.e. SCADA)	- Pipe replacement and/or maintenance can be costly and disruptive - High marginal cost of improvement due to existing high network efficiency	5	4	- Water pipeline project contract of AED 248 Million for DEWA using remote control & monitoring systems Dubai
WE-10	Water heating & cooling	Solar-water heaters	- High solar irradiance in the UAE well suited for technology - High cost savings and quick ROI - Emerging supporting regulations at national level - High growth market	- Higher installation costs than conventional water heating systems - High requirement for proper insulation	4	5	- Solar hot water system per Estidma's Pearl Villa Rating System, Abu Dhabi - Solar water heater system implemented at IRENA, Abu Dhabi
WE-11		Solar-Cooling systems	- High solar irradiance in UAE - High cooling load in UAE - Dropping PV and other solar technology costs	- Intermittency, unless a hybrid system	3	5	- SOLAB, Ras al Khaima - Green Technologies FZCO, Dubai
WE-12	Cooling	District Cooling	- District cooling reduces energy consumption to about 40% compared to traditional cooling - Strong market growth and interest, with well-established regional players	- Highly linked to booms and busts of real-estate sector	5	5	- EMPOWER, Dubai - Tabreed, Abu Dhabi
WE-13	Water fixtures	Water fixture efficiency	- Market adoption of existing voluntary green building codes such as LEED - Emergence and adoption of mandatory green building codes such as Estidama and Saa'fat - Rising water tariffs among all Emirates and sectors	- No significant constraints	5	5	- Estidama green building code, Abu Dhabi - Saa'fat green building code, Dubai - Energy efficient fixtures by ESMA, Abu Dhabi - Water flow reducers initiative by DEWA, Dubai
WE-14	Water use in Oil & Gas	Fossil fuel extraction	- Water steam savings from EOR process by CO2 injection substitution - Reduced aquifer pollution compared to using produced water - Form of carbon sequestering	- Risk of CO2 contamination into aquifers	3	4	- Al Reyadah CCUS project partnership between ADNOC& Masdar - Rumaitha North CO_2 injection facility, Abu Dhabi
WE-15		Monitoring systems	- Ability to monitor and analyze water and energy consumption and losses across Oil & Gas value chain	- Challenges in data collection and integration of assets across value chain	3	4	- Atmata' automation initiative (partnership between ENOC and MoE), Dubai, UAE

UAE Energy-Food Nexus Snapshot

Mapping of Nexus intersections

UAE Energy-Food Nexus Map



UAE Energy-Food Nexus Snapshot

Mapping of Nexus intersections

SN	Category 1	Category 2	Approach/ technology	Approach strengths	Approach limitations	Maturity	Growth opportunity	Initiative(s)/Programme(s)
FE-1	Biofuels	Grown biofuels	Biomass from halophytes	- Salt tolerant (use of Salicornia Halophyte) - 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	- Large potential of landfill gas in UAE (100m3 of gas/tonne of MSW)	- Large infrastructural investments required	3	5	- Tadweer/Taqa 100 MW WtE facility in Abu - 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	- 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	- Limited by ability to collect [illegible]d waste at co[illegible] scale - More exp[illegible] than conventional fuels	3	4	- Neutral Fuels, UAE - ENOC Biodiesel 5, Dubai - Lootah fuels, Dubai - Biodiesel from date pits, UAE - Cooking oil to biodiesel fueling 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 [illegible]p) in th[illegible] - High energy requirement for cooli[illegible] maintain optima[illegible]	- [illegible] of proper cooling can result in loss of livestock, [illegible]mals, disease or decreased output	2	4	- No initiatives
FE-7			Cooling of greenhouses	- Large consumers of energy for cooling Opportunities exist for more energy efficient coo[illegible]tec[illegible]ologies, coupled with smart systems for monitoring and [illegible]mization	- Cooling systems may present high initial investment cost with a long ROI - Inherent tradeoffs of some cooling systems (i.e. high water efficiency but high energy or vice versa)	3	5	- Active air cooling, PureHarvest, UAE
FE-8			Cooling of storage			3	4	- Smartcool, Dubai
FE-9		Greenhouses	Reducing cooling load through design and materials	- Greenhouses are widespread in the UAE and the main viable method of non-animal food production in the country - Greenhouses consume significant amounts of energy for cooling - Opportunities for synergies with other technologies and setups (i.e. aquaculture)	- Materials must be tolerant to harsh UAE climate - Potentially higher cost	3	4	- No initiatives
FE-11		Fertilizer	Synthetic fertilizer production	- Improves crop yields - Haber process is net CO2 consuming	- Can result in eutrophication of water bodies - Haber process is natural gas consuming	5	2	- No initiatives
FE-12		Onsite renewables	PV for irrigation & pumps	- Off-grid solution for water pumps, reducing maintenance and electrical connection	- Low electricity tariffs for agricultural sector - Intermittency, unless a hybrid system	2	5	- No initiatives
FE-13			PV for water treatment	- Off-grid solution for water treatment and onsite brackish water RO	- Low electricity tariffs for agricultural sector - Intermittency, unless a hybrid system	2	4	- No initiatives
FE-14			Biodiesel for equipment	- Renewable source of fuel that can be generated from onsite agricultural waste streams and byproducts	- More expensive than conventional fuels if purchased	1	4	- No initiatives
FE-15	Energy inputs for transport & distribution of food	Stockpiling	Virtual Stockpiling	- 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)	- Cost of storage/stockpiling abroad	1	4	- No initiatives
FE-17			Physical/ emergency stockpiling	- Strategic storage reserves allow for release of stockpiles during emergencies or price hikes	- Investment cost and maintenance - Cooling and humidity control	4	5	- Al Wathba Mega Production & Distribution Complex, Abu Dhabi
FE-18		Local distribution	Route & inventory optimization	- Route optimization can reduce energy cost of transport and lengthen freshness and lifetime of food products - Reduced inventory time can reduce food wastage and costs for businesses - Emerging technology (i.e. IoT) can enable the above solutions in a cost effective and integrated way	- No significant constraints	4	5	- No initiatives

Investment Opportunities

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

Filtering Nexus approaches/technologies into prioritized opportunities

Nexus	Approach/ technology	Scoring		Category Type	
		Maturity	Growth Opportunity	1	2
WF-19	Organic farming	5	5	X	
WF-22	Landscaping	5	5	X	
WF-30	International trade partnerships on food imports	5	5	X	
WF-20	Land-based aquaculture	4	5	X	
WF-13	Hydroponic farming	4	5	X	
WF-24	Drip irrigation	4	5	X	
WF-10	High-tech greenhouses	3	5		X
WF-14	Aquaponics	3	5		X
WF-21	Sea-based aquaculture	3	5		X
WF-29	Brine management	3	5		X
WF-31	Food safety monitoring systems for food imports	3	5		X
WF-16	Surface water farming	2	5		X
WF-32	Early warning systems for food import monitoring	2	5		X
WF-7	Agricultural seaweed and macro-algae farming for animal feed	1	5		X
WF-27	Treated/recycled wastewater applications	4	5	X	
WF-6	Native and climate compatible crops for agricultural use	4	4	X	
WF-18	Organic fertilizer use in farming	4	4	X	
WE-12	District cooling	5	5	X	
WE-13	Water fixture efficiency	5	5	X	
WE-5	Industrial water discharge management	4	5	X	
WE-7	Solar water pumps	4	5	X	
WE-10	Solar water heaters	4	5	X	
WE-1	Wastewater sludge to methane based biogas	3	5		X
WE-2	Solar thermal integrated MED/MSF/MEE desalination	3	5		X
WE-3	PV/nuclear integration with RO	3	5		X
WE-11	Solar cooling systems	3	5		X
WE-9	Water piping efficiency and T&D monitoring	5	4	X	
FE-17	Physical/emergency stockpiling for food transport and distribution	4	5	X	
FE-18	Route & inventory optimization of local food distribution	4	5	X	
FE-2	Bioethanol production	3	5		X
FE-4	Biogas production from landfills	3	5		X
FE-7	Cooling of greenhouses	3	5		X
FE-12	PV for irrigation and pumps	2	5		X

Road to Expo 2020

Theme of Dubai Expo 2020 and channels of communication

Business

- **Business Connect**
- Small and Medium Enterprises (SMEs)
- **Procurement**

Expo Live

- Innovation
- **Partnerships**
- Engagement
- Impact

Legacy

- **Economic Legacy**
- Social Legacy
- Reputational Legacy
- Physical Legacy

Youth Connect

- Schools
- Universities and Young Professionals

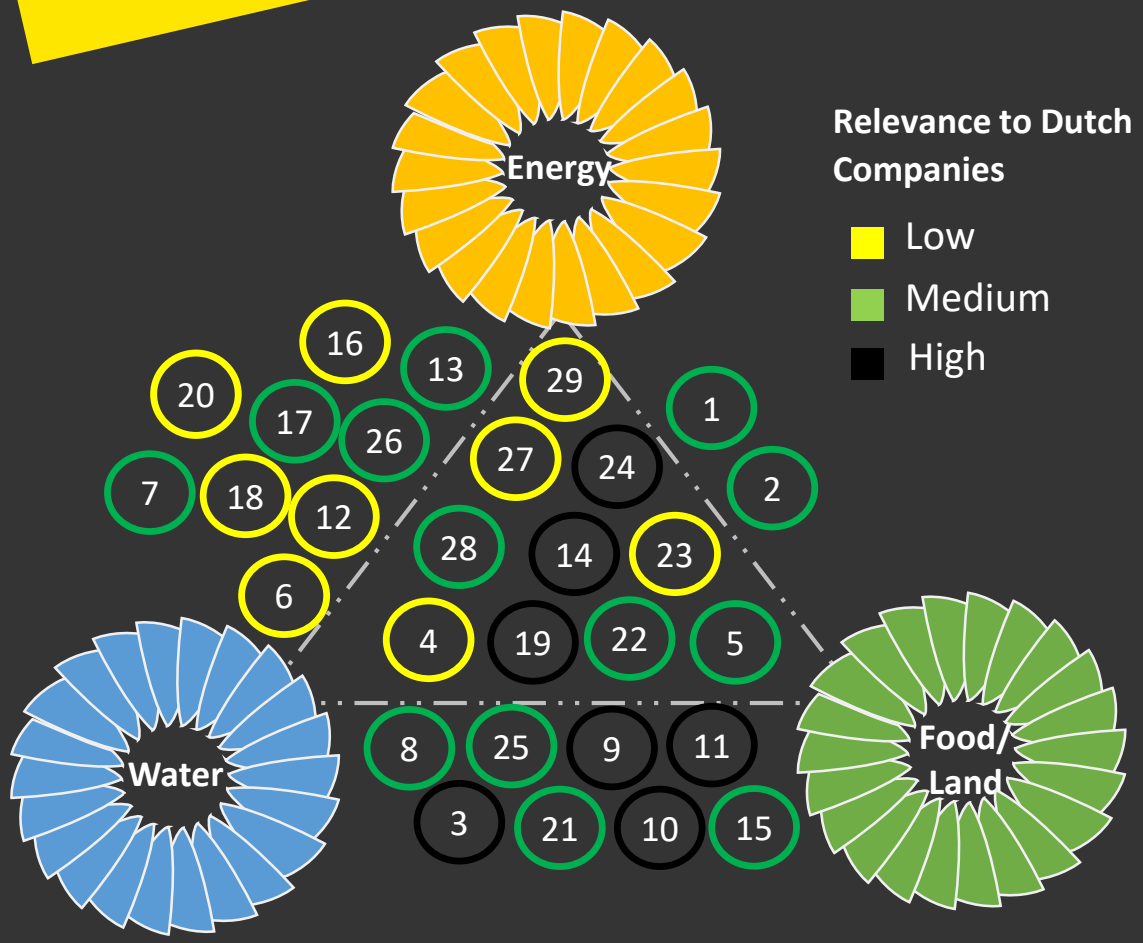
World Majlis

- Global Conversations

Pavilion

- **Dutch Pavilion**

Stakeholder mapping and engagement strategy



	Government regulator entities	Engagement Strategy
8	The Environment Agency of Abu Dhabi	1. **Establish focal point**: Dutch companies should establish a key focal point within their organization that will regularly engage with the UAE government regulator entities to improve communications and access to information. This should be complemented with meetings in person to establish key contact points within priority departments in UAE government entities to build a trust-based relationship. Dutch companies can capitalize on UAE-Dutch diplomatic channels (i.e. the Dutch embassy) for introductions where relevant/possible.
9	UAE Ministry of Climate Change & Environment	
10	Abu Dhabi Food Control Authority	
11	Food Security Centre Abu Dhabi	
12	The Regulation & Supervision Bureau	
13	Ministry of Energy and Industry	2. **Consult regularly:** Regular consultations are important and should be followed up at regular intervals to help UAE government regulators familiarize themselves with new information. As the UAE is a dynamic environment in which regulations are regularly updated, Dutch companies can benefit from regular consultations to remain up to date with regulatory changes.
14	Ministry of Food Security	
15	Emirates Authority for Standardization and Metrology	3. **Share insights:** 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. 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.

Case study

Interview with Pure Harvest: a UAE technology enabled agri-business

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.

What are the challenges to local food production?

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

What are the drivers for producing food domestically?

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**.

What is Pure Harvests vision for future of food production in 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 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**.

Q&A

2

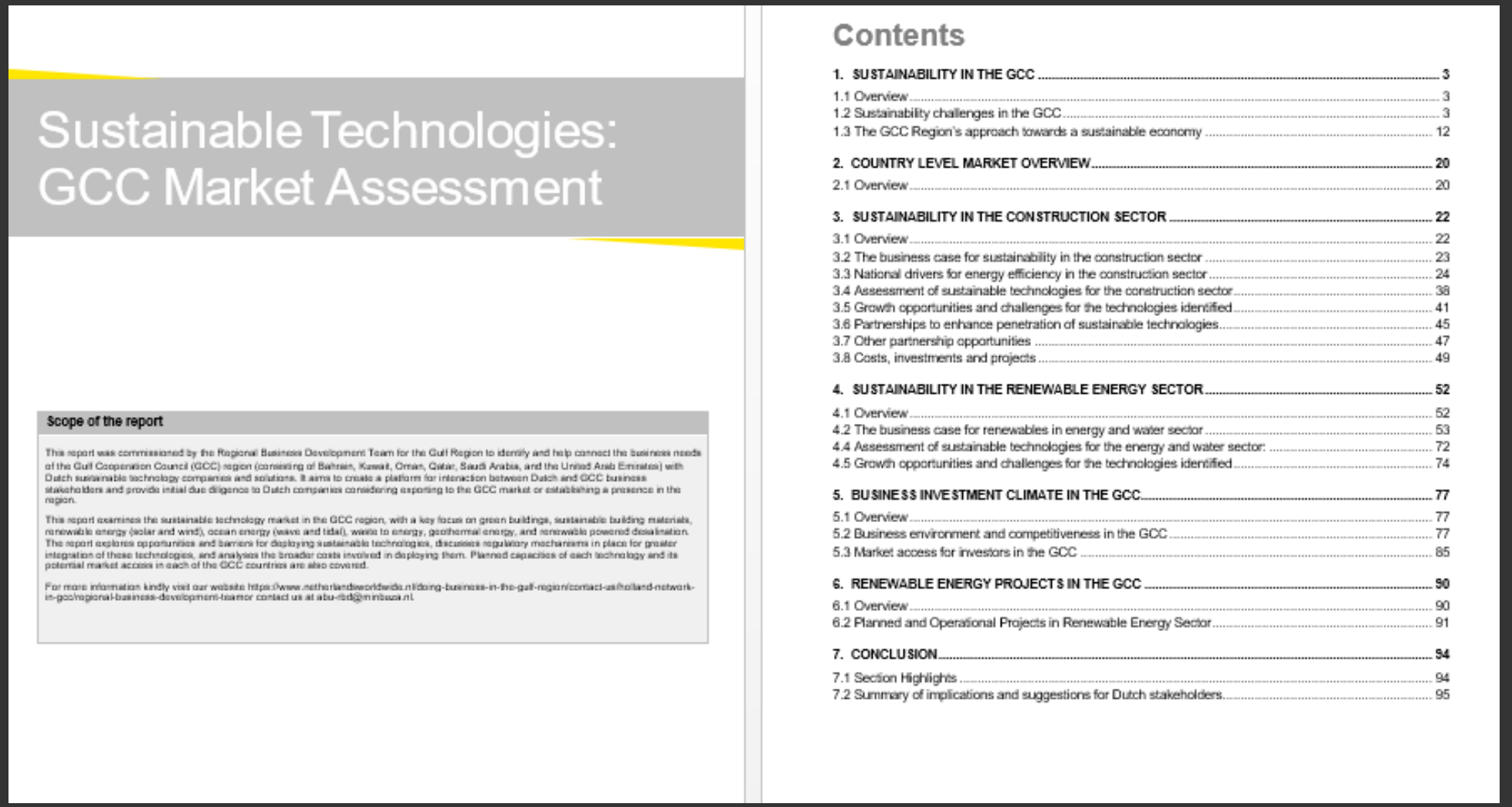
Sustainable Technologies: GCC Market Assessment Report

Sustainable Technologies: GCC Market Assessment Report

Report Snapshot

Report Objective

This report highlights investments opportunities in the GCC for Dutch companies to help them navigate the rapidly changing environment in the renewable energy and construction sectors.



Sustainable Technologies: GCC Market Assessment

Scope of the report

This report was commissioned by the Regional Business Development Team for the Gulf Region to identify and help connect the business needs of the Gulf Cooperation Council (GCC) region (consisting of Bahrain, Kuwait, Oman, Qatar, Saudi Arabia, and the United Arab Emirates) with Dutch sustainable technology companies and solutions. It aims to create a platform for interaction between Dutch and GCC business stakeholders and provide initial due diligence to Dutch companies considering exporting to the GCC market or establishing a presence in the region.

This report examines the sustainable technology market in the GCC region, with a key focus on green buildings, sustainable building materials, renewable energy (solar and wind), ocean energy (wave and tidal), waste to energy, geothermal energy, and renewable powered desalination. The report explores opportunities and barriers for deploying sustainable technologies, discusses regulatory mechanisms in place for greater integration of these technologies, and analyses the broader costs involved in deploying them. Planned capacities of each technology and its potential market access in each of the GCC countries are also covered.

For more information kindly visit our website https://www.netherlandsworldwide.nl/doing-business-in-the-gulf-region/contact-us/holland-network-in-gcc/regional-business-development-teamor contact us at abu-rbd@minbuza.nl.

Contents

Sustainable Technologies: GCC Market Assessment Report – Table of Contents

The Market Assessment report outlines the current investment landscape in the GCC's construction and renewable energy sectors for Dutch companies

- Sustainability in the GCC, challenges and the region's approach towards a sustainable economy

- A snapshot of each country's sustainably targets and programme's
- A look at each country's business challenges and opportunities

- Overview of sectors
- Business case for sustainability and renewable energy
- Assessment of sustainable technologies
- Growth opportunities and challenges of technologies

- Detailed country level assessment of investment climate in GCC
- Gap analysis of each sector's market structure, Policy framework, institutional capacity and finance/investment

- List of planned/ operational projects by country

- Overview of sectors
- Business case for sustainability

Sustainability Highlights & Challenges in the GCC

Sustainability Highlights

- The GCC region has achieved impressive economic and social advances over the last few decades, largely due to the region's oil and gas revenues. However, over-dependence on the oil and gas sector has also resulted in long term economic, social and environmental challenges in the region including high GHG emissions and limited diversification of industry and employment opportunities.
- To achieve greater economic diversification, governments in the GCC are now adopting more measures to promote private sector investment, boost foreign direct investment in non-oil sectors, and encourage entrepreneurship and SME development. These measures include ensuring access to easy loans, entrepreneurship training and awarding government tenders to preferred industries to get more of the population involved in a more diverse set of business activities.
- These measures and activities fit within recently developed national strategic visions and action plans. It is encouraging that all of these include a focus on sustainable development largely as a result of international commitments that have been made by the region's Governments on sustainable development and increasing disclosure requirements from capital markets.
- The resulting increase in interest and the adoption of renewable energy and energy efficiency in the GCC present significant opportunities for international investors in sustainable technologies in the years to come.

An overview of the risks that the GCC countries must overcome to achieve their global sustainable development agenda commitments

Sustainability Risks

Over dependence on oil and gas revenues	►The drop in oil and gas prices has strained the GCC's economies resulting in challenging fiscal balance and decreased government revenues ►Decreased revenues have led to macroeconomic fluctuations and financial instability impacting national economic growth
Increasing energy use	►Primary energy consumption has been increasing by 6% per year since 2000 ►Around 60% of electricity is consumed by buildings ►High energy subsidies have given way to wasteful energy and water consumption
Carbon emissions	►Qatar (35.73 tCO_2e), Kuwait (21.93 tCO_2e), Bahrain (21.8 tCO_2e), United Arab Emirates (UAE) (19.31 tCO_2e), and Saudi Arabia (KSA) (18.1 tCO_2e) are considered the highest per capita greenhouse gas emitters in the world ►Electricity, construction, and transport sectors represent 85% of the total CO_2 emissions in the GCC region
Lack of natural sources of water	►The GCC is one of the driest regions in the world with low availability of natural water sources, and yet it has one of the highest per capita water consumption in the world ►Average GCC water consumption stands at 816 m^3 per annum whereas the average GCC renewable water resources availability stands at 92 m3 per annum. This is below the water scarcity line of 1,000 m^3 per capita per annum ►Rising population and urbanisation is likely to increase the water supply-demand gap in the GCC to increase between 43 cubic kilometres and 127 cubic kilometres by 2020-30
Waste generation	►With rapid urbanisation, there is a corresponding increase in waste production. Municipal solid waste and e-waste is now a major concern in the GCC ►Total waste generated is likely to increase from 94 Mm MT per annum in 2015 to 120 Mm MT per annum by 2020 predominantly due to the rapid increase in waste generation in Saudi Arabia and the UAE
Air pollution	►The GCC region is considered the most polluted region in the world ►KSA, Qatar, Kuwait, and UAE are ranked among the top 10 polluted nations in the world
Population growth	►The GCC population is estimated to rise to 64.9 million by end of 2030 ►High population growth in the region has led to an exceedingly large youth population. Between one-third to one-half of the GCC's populations are under the age of 25 ►Energy, food and water resources will be affected by growing population. It will also have implications for existing and new infrastructure requirements and employment opportunities among GCC nationals
Over urbanized cities	►The GCC is one of the most urbanized regions in the world. Kuwait and Qatar are 100% urbanised while UAE, KSA and Oman are 85%, 83% and 77% urbanised respectively ►By 2020, 85% of the region's population will live in cities. The global average for 2020 is 56.2% ►Over urbanisation will put added strain on physical infrastructure and natural resources
Youth unemployment	►Youth unemployment rates in many GCC countries are amongst the highest in the world

Country Level Strategy Overview

A snapshot into UAE and KSA's strategic direction and vision

UAE Vision 2021 and Abu Dhabi Vision 2030

National strategic vision: UAE

VISION 2021

Key highlights of UAE Vision 2021

- Decrease the share of oil-revenues in GDP to 5% by
- UAE aims for a sustainable and responsible growth th grown entrepreneurship and attracting FDI
- In order to address ecological challenges, UAE intend consciousness of its worldwide responsibility

Abu Dhabi رؤية 2030 Vision

9 pillars

- A large empowered private sector
- A sustainable knowledge-based economy
- An optimal, transparent regulatory environment
- Strong and diverse international relationships
- Optimisation of the Emirate's resources
- Premium education, healthcare and infrastructure assets
- Complete international and domestic security
- Maintaining values, culture and heritage
- A significant and ongoing contribution to the federation of UAE

Key Highlights of Abu Dhabi Economic Vision 2030

- One of the objectives under Vision 2030 is to reduce GDP volatility through diversification by minimising impact of oil price fluctuations and ensuring a more predictable and stable economic growth
- Achieve non-oil GDP contribution of about 64% by 2030
- Build a sustainable economy by driving economic activity in sectors such as tourism, entertainment and SME businesses
- Develop a sufficient, resilient infrastructure while enhancing energy security as well as incorporating environmental sustainability in all projects
- Encourage financing of other economic sectors and projects
- Develop skilled and productive workforce and increase the percentage of UAE nationals in the labour market

The UAE's economic transformation is largely driven by Dubai and Abu Dhabi.[1617]

KSA Vision 2030

National strategic vision: Saudi Arabia

VISION رؤية 2030 المملكة العربية السعودية KINGDOM OF SAUDI ARABIA

Saudi Arabia Vision 2030

3 themes

A vibrant society
- Strong roots
- Fulfilling lives
- Strong foundations

A thriving economy
- Rewarding opportunities
- Open for business
- Investing for the long term
- Leveraging its unique position

An ambitious nation
- Effectively governed
- Responsibly earned

Key highlights of Saudi Vision 2030

- Increase the share of non-oil exports from 16% to 50% by 2030
- Raise private sector Gross Domestic Product (GDP) contribution from 40% to 65% by 2030
- Increase Foreign Direct Investment (FDI) from 3.8% to the international benchmark of 5.7% by 2030
- Boost the infrastructure sector to meet the growing number of people visiting KSA on pilgrimages

Sustainability in Construction Sector - UAE

National drivers for energy efficiency in the construction sector along with key stakeholders

UAE

Strategic initiatives for the construction sector

Plans	Targets and initiatives	Status	Implementation progress
Sustainable cities[44]	► Design and construct cities that conserve energy and harness renewable energy	Active (since 2010)	► Completed the development of Masdar city and Dubai Sustainable City ► Currently developing 'Desert Rose City', 'Dubai Silic Oasis' and 'Dubai uti District'
Energy Efficiency Standardization and Labelling Program (EESL)[45]	► Standards and Labels for appliances and equipment to raise the bar on energy efficiency minimum requirements	Active (since 2013)	► A OEMs, rs and retailers re mandated to meet EE equirements for appliances and equipment (HVAC, lighting) ► Emirates Authority for Standardization & Metrology (ESMA) has been authorized for monitoring the EESL program
ESMA lighting regulation[46]	► Sales ban of inefficient incandescent lamps	Active (since 2014)	► Entered into force since January 2015
Emirates Green Building Council (EGBC) 'Existing building guideline'	► Technical guideline for retrofitting existing buildings across UAE	Active (since 2015)	► N/A

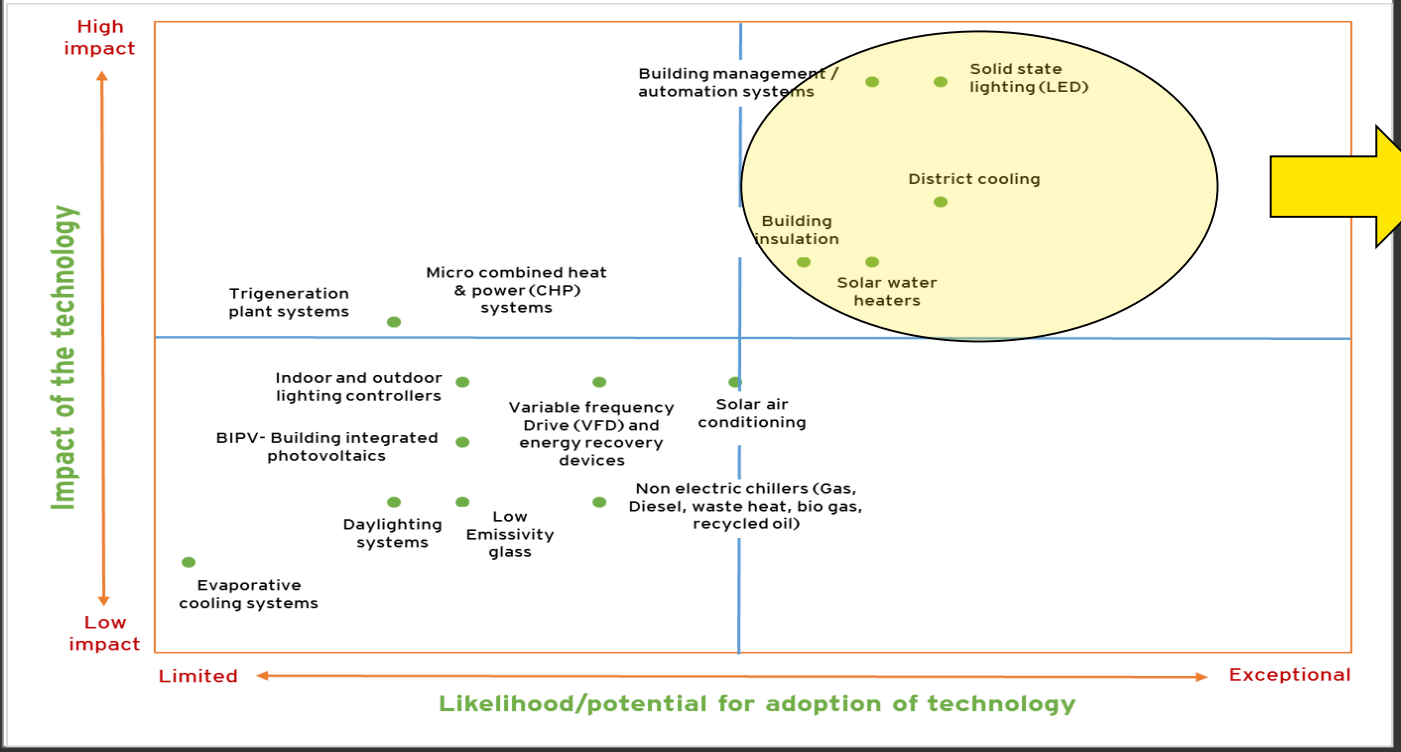
Key national institutions supporting the construction sector

Nature of stakeholder	Name of the body	Focus area
Regulators	Ministry of Infrastructure Development	Regulator agency governing federal infrastructure and development schemes
	Dubai Regulatory and Supervisory Bureau (RSB)	Regulatory agency governing existing building retrofits through Etihad ESCO
	Dubai Supreme Council of Energy (DCSE)	DSM, carbon abatement strategy and emission reduction programmes
	Etihad ESCO	Government-facilitated energy service company undertaking building retrofits
	Abu Dhabi Electricity Water Authority (ADWEA)	Initiatives and programs for meeting DSM targets
	Federal Electricity and Water Authority (FEWA)	Initiatives and targets related to energy efficiency
	Dubai Water and Electricity Authority (DEWA)	Initiatives and programs for meeting DSM targets
	Sharjah Electricity & Water Authority (SEWA)	Demand side management and reducing energy consumption in buildings
	Emirates Authority for Standardization & Metrology (ESMA)	Monitor Emirates Energy (and water) labelling program

Sustainability in Construction Sector - UAE

Assessment of sustainable technologies in the GCC construction sector

Potential technologies/solutions relevant to GCC construction sector



Shortlisted technologies for the GCC construction sector

Solid State Lighting (LED)	Technology in which light-emitting diodes (LEDs) replace conventional incandescent and fluorescent lamps for general lighting purposes.
Solar water heaters (SWH)	A low-energy intensive system to heat water through use of thermal collectors.
Building Management and Automation Systems	A computer-based control system installed in buildings that controls and monitors the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems.
Building Insulation	A material which creates thermal resistance around the building. An insulation material is used to reduce heating and cooling costs by reducing thermal losses.
District Cooling (DC)	A system which produces and distributes chilled water from a central source to facilitate air conditioning. This is done by producing chilled water at a central plant and then piping the water to customers through an underground, insulated-pipe network.

Sustainability in Construction Sector - UAE

Growth opportunities and challenges of shortlisted technologies

Shortlisted technologies for the GCC construction sector

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Solar Water Heaters (SWH)

Opportunities	► Utility subsidy reforms would increase the penetration of SWH in the GCC ► Mandatory regulations on the installation of solar water heaters in all new buildings across the UAE[62] ► Low cost, easy to maintain and effective means of reducing electricity bills in both new and existing buildings (through a phased retrofit program) ► High solar irradiance levels across the GCC ► Switching from an electric heater to solar water heater could save 3.6 kWh of electricity per person per day in the UAE alone[63]
Challenges	► Lack of regulation and national level targets specifically on solar water heating adoption except in the UAE ► Perception among the owners and developers that SWH is not a viable option for existing building
Suggestive measures to overcome challenges	► Engage with the GCC regulatory agencies and organize awareness sessions on the benefits of SWH ► Partner with construction industry associations to increase awareness among the owners and developers that SWH solutions can be effectively retrofitted into an existing building

Example of project implemented with SWH

Name of the project	Description	Benefits
Wheels India Limited	► A leading wheel manufacturer decided to use solar water heater to replace conventional boilers (which use furnace oil) for heating purposes	► The solar system was capable of saving amounting to US$ 107,000 per annum. The project was also able to save 240 tCO_2e per annum

Sustainability in Construction Sector - KSA

National drivers for energy efficiency in the construction sector along with key stakeholders

KSA

Strategic initiatives for the construction sector

Plans	Targets and initiatives	Status	Implementation progress
Saudi Building Code (SBC)[39]	► Development of Saudi building code to improve efficiency, safety, strength and sustainability of buildings	Active (since 2000)	Mandatory for government buildings since 2009
Saudi Energy Efficiency Program (SEEP)[40]	► Energy efficiency initiatives for new buildings ► Energy efficiency standard for appliances ► Increase public awareness on the usage of energy efficient appliances ► Develop thermal insulation standards and regulation ► Mandate the incorporation of thermal insulation regulation for all new buildings	Active (since 2012)	Designed and issued 18 mandatory energy efficiency standards and regulations for the buildings secto In addition, 68 initiatives a fferen stages of executi
Saudi Standards, Metrology and Quality Organization (SASO) Lighting Regulation 2870:2015 (Part 1)[42]	► Standard for lighting sources having a luminous flux above 60–12,000 lumens ► Mandated for all suppliers	Active (since 2016)	SASO has listed energy efficiency, functionality and labelling requirements for lighting products

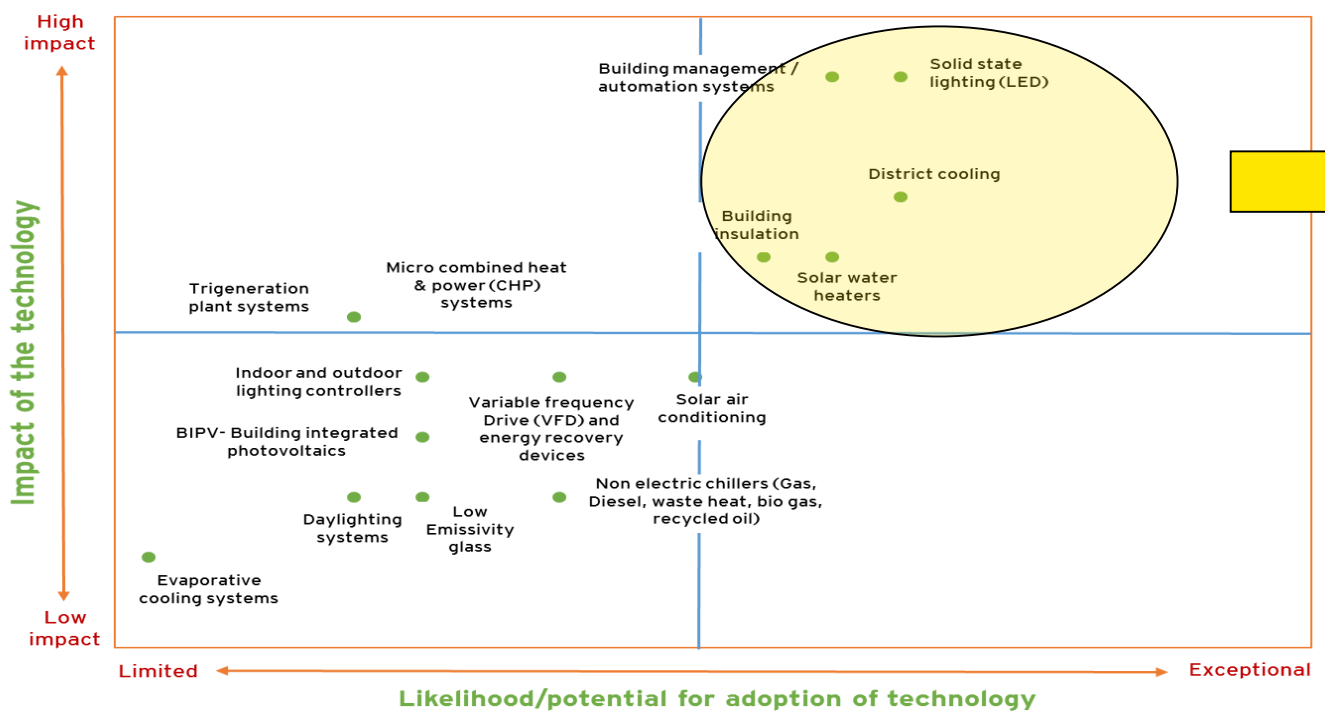
Key national institutions supporting the construction sector

Nature of stakeholder	Name of the body	Focus area
Regulators	The Electricity & Cogeneration Regulatory Authority (ECRA)	Regulates the electricity industry and monitors performance of service providers in accordance with the laws and regulations
	Saudi Building Code National Committee (SBNC)	Development and implementation of national building code
	Saudi Standards, Metrology and Quality Organization (SASO)	Regulations and standards for design of building equipment
R ch bodi	Saudi Energy Efficiency Centre (SEEC)	Strategies and initiatives for energy efficiency in building sector
	King Abdullah Petroleum Studies and Research Centre (KASPARAC)	Facilitate research studies on solutions related to energy efficiency in buildings
	King Abdullah University of Science and Technology (KAUST)	Facilitate research on solutions related to energy efficiency and alternative energy

Sustainability in Construction Sector - KSA

Assessment of sustainable technologies in the GCC construction sector

Potential technologies/solutions relevant to GCC construction sector



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Sustainability in Construction Sector - KSA

Growth opportunities and challenges of shortlisted technologies

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District Cooling (DC)

Opportunities[11][12]	► GCC governmental targets and initiatives to reduce emissions and electricity demand ► By 2020, Dubai has a DSM target of meeting 40% cooling demand through DC systems ► Nationally driven 'District cooling design & water management code' in Qatar[13] ► In the UAE alone, DC systems are expected to provide cooling amounting to 377 petajoule (PJ) out of the total cooling demand of 1373 PJ[14] ► DC systems have superior electrical efficiencies (0.9-1.0 kWh/TR-h) over conventional HVAC systems (1.7–1.8 kWh/TR-h) thereby reducing electricity consumption by 50%[15] ► DC systems powered by renewable energy offers a cost-effective mechanism for reducing CO_2 emissions ► Realization of co-benefits such as fresh water savings through usage of treated sewage effluents (TSE), reduced urban air pollution and space savings through centralized cooling facilities
Challenges[16]	► Lack of experience and limited policy focus in countries like Kuwait, Oman and Bahrain on both conventional and centralized cooling ► Minimum capacity of 10,000 Tons of Refrigeration is required to realize benefits of scale through DC systems ► Appropriate phasing of DC capacity in line with future expansion of the project is critical for optimal utilization of the DC systems ► Well defined and regulated financing schemes are required to minimize credit risk and ensure bankability of the DC project
Suggested measures to overcome challenges	► Partner with government institutions (Tabreed, UAE) to identify synergies for integrating existing energy infrastructure with district networks ► Organize capacity building sessions for urban planners, architects and the wider construction fraternity in partnership with the government institutions to set the business case for a synergised integrated cooling network

Sustainability in Renewable Energy Sector - UAE

National drivers for renewable energy sector along with key stakeholders and projects

UAE

Some of the plans and strategies in place across UAE to promote the adoption of renewable energy sources are mentioned in the following table.

Strategic national initiatives for the energy sector

Plans	Targets and initiatives	Status	Projects* implemented
Abu Dhabi RE target	► At least 7% of its energy from clean energy sources by 2020	Active (launched in 2009)	► SHAMS 1 (100MW operational since 2013) ► Masdar City 10MW ► Abu Dhabi Water and Electricity Authority (ADWEA), signed a 25 [illegible] power purchase agreement for a 1.17GW solar
Dubai Carbon Centre of Excellence	► Carbon abatement and GHG emission reduction in Dubai Emirate	Active (launched in 2011)	► Several projects have been initiated across Dubai Emirate to register energy efficiency and renewable projects under UNFCCCs Carbon Development Mechanism (CDM)
Renewable energy desalination pilot program, MASDAR	► Implement renewable energy-powered desalination plants in the United Arab Emirates ► Commercial scale facility by 2020	Active (launched in 2013)	► 4 commercial partners are operating next-generation pilot seawater desalination plants as part of pilot phase ► Scaling up of technologies to take place after 2017
Dubai Clean Energy Strategy 2050	► 7% of Dubai's total power output will come from clean energy by 2020, 25% by 2030 and 75% by 2050 ►	Active-Officially launched in 2015 Implementation plan announced in Jan 2017.	► Will invest US$14 billion in the 2nd phase of Mohammad Bin Rashid Al Maktoum Solar Park by 2030 ► Shams Dubai Initiative-Aims to connect solar energy to buildings, a part of Distributed Renewable

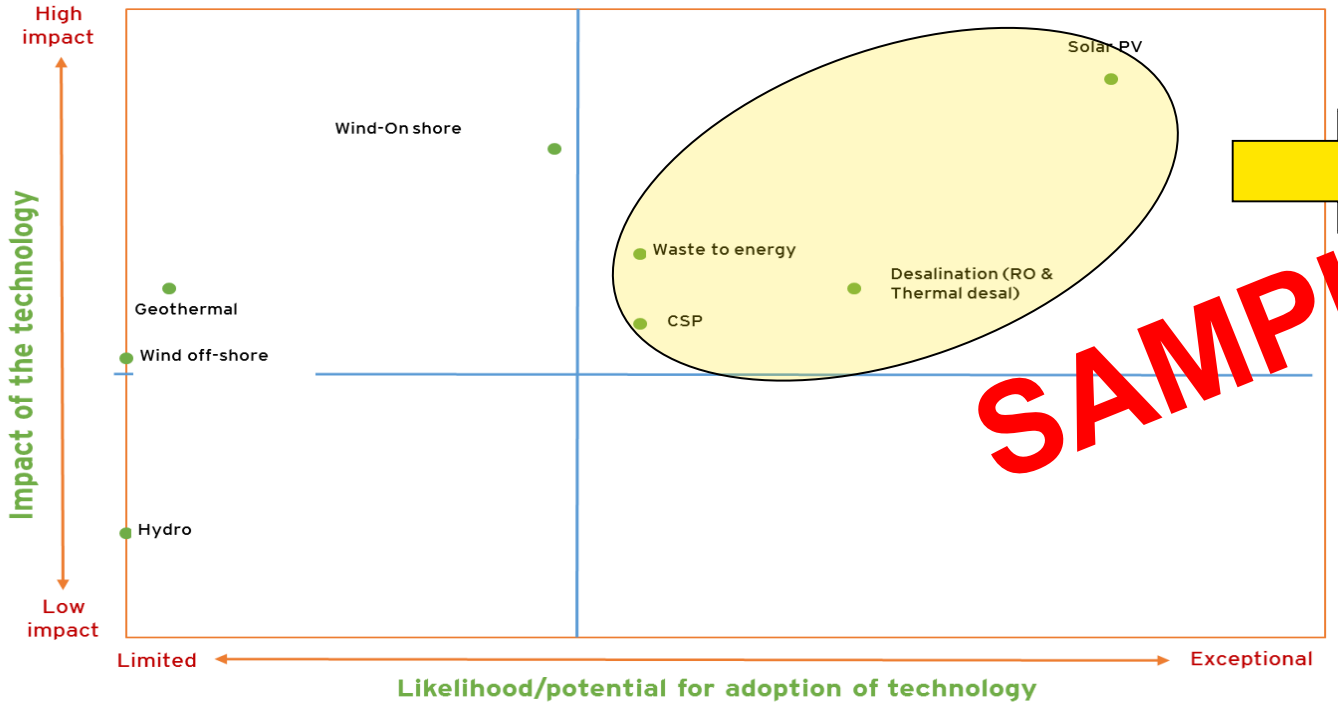
Key national institutions supporting the energy sector

Nature of stakeholder	Name of the body	Focus area
Regulators/Policy makers	Ministry of Energy	► Organizes and develops general policies and legislations under the consultation of the stakeholders involved to fit the energy sector as per the international standards and following up its implementation
	Emirates Nuclear Energy Corporation (ENEC)	► In the 2030 UAE goals, Nuclear Energy has been included with a set target of 30% clean energy by 2030. ENEC has ambitious plans to expand their nuclear power development programme.
	Dubai Supreme Council of Energy	► Focuses on policy development, planning and coordinating with concerned authorities and energy bodies to deliver new energy sources
	Abu Dhabi center for waste management (TADWEER)	► Works on collection, transportation and sorting of waste. Operates a Material Recovery Facility ► Issues licenses for companies providing environmental services ► Enforces waste tariff in the emirate
	Dubai Municipality	► As a part of its strategic plan, it has objectives to focus on environment protection, sustainability of natural resources and integrated waste management
	Federal Electricity and Water Authority (FEWA)	► Caters to the needs of Electricity and potable Water for the population of the Northern Emirates
	Sharjah electricity and Water Authority (SEWA)	► Generates and distributes electricity, water and gas to the population of Sharjah
	Abu Dhabi Water and Electricity Authority (ADWEA)	► Focuses on research and development for ways to produce, distribute and consume water and electricity efficiently
	Dubai Electricity and Water Authority (DEWA)	► Produces electricity using solar energy (MBR solar park, SHAMS Dubai initiatives) ► Developes sustainable solutions to desalinate water using

Sustainability in Renewable Energy Sector - UAE

Assessment of sustainable technologies in the GCC construction sector

Potential technologies/solutions relevant to GCC renewable energy sector



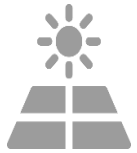
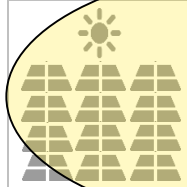
Shortlisted renewable energy technologies for the GCC

Solar PV	PV technology converts sunlight into electricity. It is amongst the fastest growing RE technologies owing to the decrease in the costs of modules. It exists in a number of forms but crystalline and thin film are the most proven. It can be used in utility as well as smaller standalone rooftop application.
CSP	These systems harness solar energy by using solar radiation to generate heat that can later be used for power generation and other applications. It exists in a number of forms but trough and tower are amongst the most proven and are typically only used at utility scale. It can also be combined with Storage technologies enabling it to act as a baseload source.
Desalination (RO & thermal desalination)	RO is a water purification technology that uses a semi-permeable membrane to remove ions, molecules and larger particles from drinking water. The thermal desalination process uses energy to evaporate water and subsequently condense it again. There are two main thermal desalination technologies used in the region namely: Multi Stage Flash (MSF) and Multi Effect Distillation (MED).

Sustainability in Renewable Energy Sector - UAE

Growth opportunities and challenges of shortlisted technologies

Shortlisted renewable energy technologies for the GCC

 Solar PV	PV technology converts sunlight into electricity. It is amongst the fastest growing RE technologies owing to the decrease in the costs of modules. It exists in a number of forms but crystalline and thin film are the most proven. It can be used in utility as well as smaller standalone rooftop application.
 CSP	These systems harness solar energy by using sol radiation to generate heat that can later be used for power generation and other applications. It exists in a number of forms but trough and tower are amongst the most proven and are typically only used at utility scale. It can also be combined with Storage technologies enabling it to act as a baseload source.
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Concentrated Solar Power (CSP)

Opportunities	► CSP plants have the ability to meet the load demand curve at any time if combined with storage facilities e.g. molten salt. ► Can participate in primary and secondary grid frequency control ► CSP targets in place by certain countries such as Kuwait and UAE ► High solar irradiance throughout the region ► Availability of power off-takers in many countries in the region ► CSP can be used for enhanced oil recovery (EOR) to boost the production from oil wells.
Challeng	► C paratively higher LCOE as compared to solar PV ► No guaranteed grid access, priority access or priority dispatch ► Supporting policies are either absent or are in nascent stage in the region ► CSP technologies require water (for cooling and steam generation) which might be a limiting factor in GCC countries which are water scarce
Suggested measures to overcome challenges	► Collaborate with government to address policy challenges related to grid access, financial incentives, subsidies, and financial institution funding ► Opportunities to reuse water need to be explored for the back-end of thermal cycle ► Develop dry cleaning options for mirrors ► Entering into a power purchase agreement (PPA) as an Independent Power Producer (IPP) with an off-taker can be an attractive prospect for investors as well as project proponents since it guarantees grid access as well as a steady cash flow for a determined period

Example of project where CSP was used

Name of the project	Description	Benefits
Shams 1 CSP project	Shams 1 is a 100MW CSP plant located in the western region of the Abu Dhabi Emirate.	► Expected to displace 175,000 tonnes of CO_2 per year ► Produces energy to power 20,000 UAE homes

Sustainability in Renewable Energy Sector - KSA

National drivers for renewable energy sector along with key stakeholders and projects

KSA

The National Renewable Energy Program (NREP) is in line with KSA's Vision 2030 program and is estimated to cost US$ 30-50 billion by 2023[112].

Strategic national initiatives for the energy sector

Plans	Targets and initiatives	Status	Projects* implemented
National Renewable Energy Program (NREP), Saudi Arabia[113]	► 3.45GW of renewable energy by 2020 under the National Transformation Program (NTP), and 9.5GW by 2023, towards Vision 2030. ► The NREP will target 700MW, 1.02GW and 1.73GW respectively across the three rounds starting in 2017. ► Further target of 6.05GW by 2023.	Active	► Bidding process has begun for the 400MW Midyan Wind IPP and the 300MW Sakaka Solar PV IPP

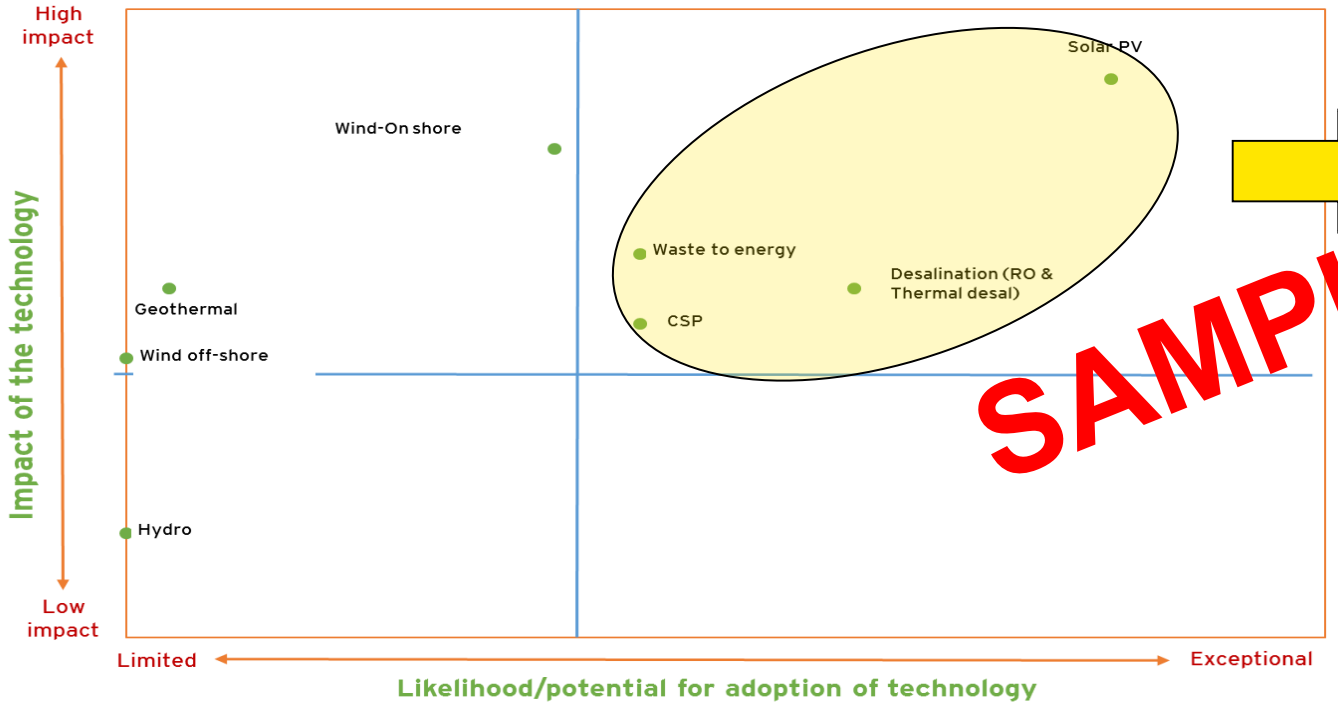
Key national institutions supporting the energy sector

Nature of stakeholder	Name of the body	Focus area
Regulators/Policy makers	Renewable Energy Project Development Office (REPDO)	► Serves to deliver renewable energy across the Kingdom in line with Vision 2030
	The Electricity and Co-generation Regulatory Authority (ECRA)	► Regulates the electricity and water desalination industry in Saudi Arabia ► Monitor performance of service providers
	Saudi Electricity Company	► Has a monopoly on the generation, transmission and distribution of electric power in Saudi Arabia through 45 plants in the country.
Research bodies	King Abdullah City for Atomic and Renewable Energy (K.A.CARE)	► Develops a substantial alternative energy capacity fully supported by world-class local industries ► Research and development of technologies to generate renewable power at affordable rates
	King Abdullah University of Science and Technology (KAUST)	► KAUST Solar Centre focuses on the generation, storage and conversion of solar energy
	King Abdul Aziz City for Science and Technology	► Carries out research in the field of energy and desalination technologies
	King Abdullah Petroleum Studies and Research Centre (KAPSARC)	► Conducts independent research and develops insight with international research centres, public policy organisations and government institutions in the field of energy.

Sustainability in Renewable Energy Sector - KSA

Assessment of sustainable technologies in the GCC construction sector

Potential technologies/solutions relevant to GCC renewable energy sector



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Sustainability in Renewable Energy Sector - KSA

Growth opportunities and challenges of shortlisted technologies

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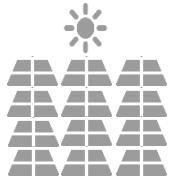
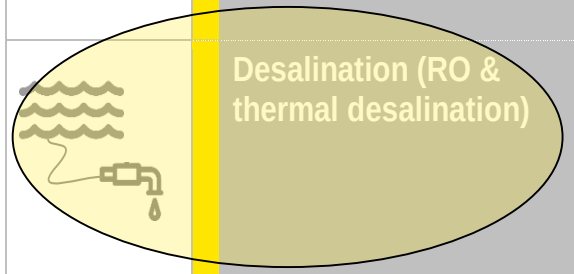
	CSP	These systems harness solar energy by using solar radiation to generate heat that can later be used for power generation and other applications. It exists in a number of forms but trough and tower are amongst the most proven and are typically only used at utility scale. It can also be combined with Storage technologies enabling it to act as a baseload source.
	Desalination (RO & thermal desalination)	RO is a water purification technology that uses a semi-permeable membrane to remove ions, molecules and larger particles from drinking water. The thermal desalination process uses energy to evaporate water and subsequently condense it again. There are two main thermal desalination technologies used in the region namely: Multi Stage Flash (MSF) and Multi Effect Distillation (MED).

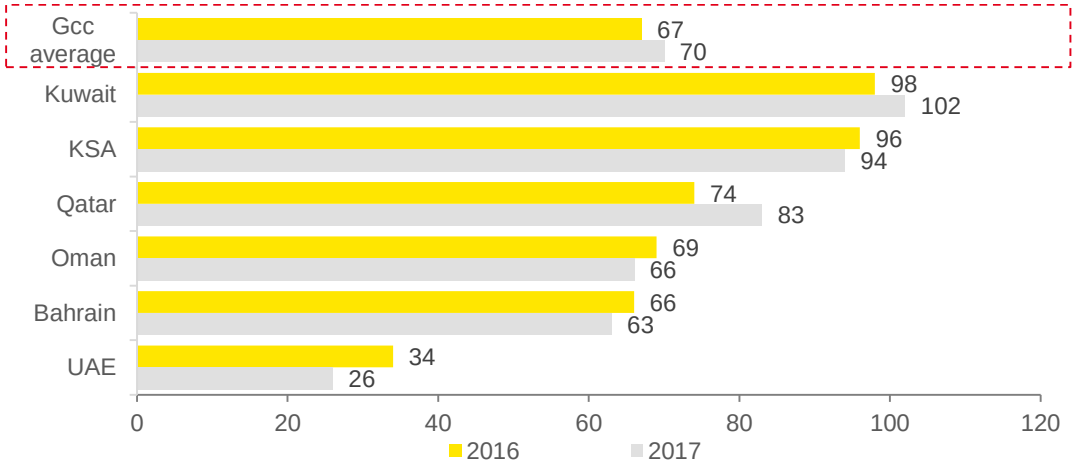
Desalination (RO and Thermal desalination)

Opportunities	► Increasing demand for desalinated water due to scarcity of fresh water sources across the region ► GCC has nearly US$42 billion worth of water and wastewater projects (in the study and design phase) planned for the next 10 years ► Rationalisation of fuel subsidies (and increasing electricity prices) will make desalination using fossil fuels even more costly ► Coupling renewable with desalination can reduce dependence on fossil fuel and alleviate the carbon footprint of desalination ► CSP can be coupled with thermal desalination technologies such as MSF and MED while wind and PV can be used with membrane technologies such as RO
Challenges	► CSP technology requires water for its operation (cooling, cleaning) which can be a limiting factor in water scarce GCC region ► Most utility scale desalination units operate on a continuous basis, rendering most RE supply options (especially PV and Wind due to their intermittent nature) unfit for direct energy supply ► Lack of component for small-scale desalination, typical of many renewable based desalination combinations ► Back-up fuel and/or energy storage is needed to supplement energy supply during non-operational period, leading to additional cost ► Significant capital investment ► Renewable based desalination units require advanced skills and strong institutional capacity to operate ► Adverse impact on the marine environment due to brine discharge, increasing Gulf salinity increases effort of plants
Suggested measures to overcome challenges	► Investors can choose to focus on renewable energy powered desalination projects ► Investors/project proponents lacking experience in the field of desalination can form a JV with a regional player to gain expertise in this area

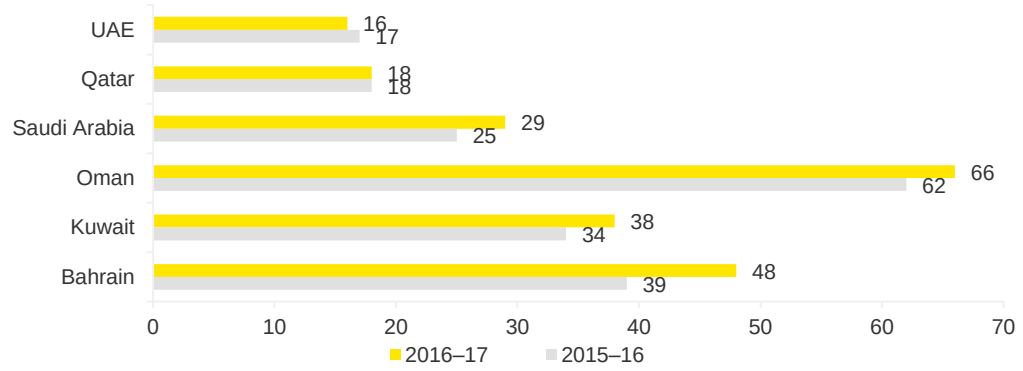
Business Investment Climate in the GCC

Business investment climate by country, looking at ease of doing business and global competitiveness

Ease of doing business ranking



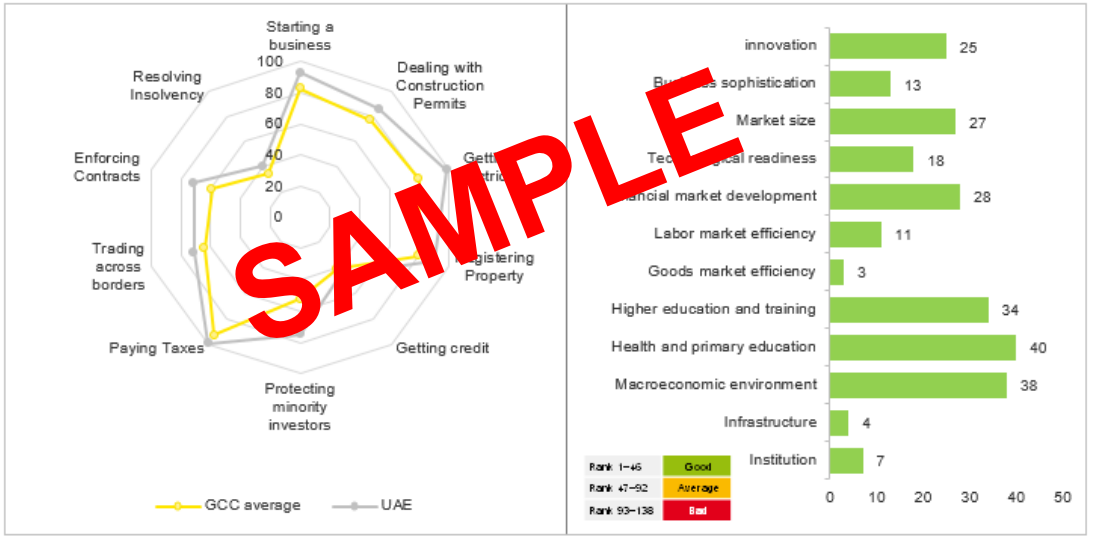
Global Competitiveness Index



Country level analysis (UAE)

The UAE has continued to improve its business environment through legislative and regulatory reforms, and is among the top 10 global improvers in Ease of Doing Business ranking in 2017. The country is globally ranked 21st in the Foreign Direct Investment Confidence Index and the government remains committed to diversifying its economy and attracting new sources of FDI.

The UAE leads the GCC and MENA region in competitiveness and is ranked 16th on the GCI. The country's competitive strengths include world class infrastructure and open, efficient goods and labour market.



Renewable Energy Projects

Known renewable energy projects that are implemented or that are planned in the GCC

Operational projects	Technology type	Capacity	Country	Status
Mohammed bin Rashid Al Maktoum Solar Park Phase I & II	Solar PV	5GW by 2030	Dubai, UAE	► Phase 1 has 13MW capacity which is operational since 2013 ► Phase 2 has 200MW capacity which is operational since 2017
Shams 1	CSP	100MW	Abu Dhabi, UAE	► Operational since March 2013
Domestic Solid Waste Management Centre	Waste to energy (WtE)	34MW	Qatar	► In operation
Sidrah 500 (utility scale PV plant)	Solar PV	10MW	Kuwait	► In operation since 2016
MASDAR city solar PV plant	Solar PV	10MWp	UAE	► Operational since 2009
Abu Dhabi solar rooftop solar program	Solar PV	2.3MWp	Abu Dhabi, UAE	► Operational since 2012
BAPCO Bahrain PV plant	Solar PV	5MW	Bahrain	► In operation since 2014

Planned projects	Technology type	Capacity	Country	Status
Mohammed bin Rashid Al Maktoum Solar Park Phase III and Phase IV (project details up-to-date as of Sept 2017) ,	Solar PV and CSP	5GW by 2030	Dubai, UAE	► Phase 3 has 800MW capacity will be developed by Masdar-led consortium in 3 stages Stage 1: 200MW by April 2018 Stage 2: 300MW by April 2019 Stage 3: 300MW by April 2020. ► Phase 4: 700MW single-site CSP project. Awarded to ACWA Power and Shanghai Electric at US 7.3 cents/kWh. First stage to be commissioned in 2020
DEWA CSP tower project (project details up-to-date as of June 2017)	CSP	200MW	Dubai, UAE	► Received a bid of $9.45 cents/kWh in June 2017 ► Expected to be operational by April 2021
AL Warsan 2 (project details up-to-date as of June 2016)	WtE	60MW	Dubai, UAE	► To be completed by 2020
Sweihan solar power plant (project details up-to-date as of May 2017)	Solar PV	1.17GW	Abu Dhabi, UAE	► Under construction, expected to begin commercial operation by April 2019
FEWA Solar project (project details up-to-date as of September 2016)	Solar PV	200MW	UAE	► Announced in 2016 ► To be built by 2025
WtE demonstration facility (developed by TAQA and TADWEER) (project details up-to-date as of March 2013)	WtE	100MW	Abu Dhabi, UAE	► Under development at a cost of US$850m
Sharjah WtE facility, Masdar and Bee'ah (Project details up-to-date as of May 2017)	WtE	30MW	Sharjah, UAE	► Announced in 2017
Sajja WtE facility, Beeah (Project details up-to-date as of March 2017)	WtE	80MW	Sharjah, UAE	► Announced in 2016
Sakaka (Project details up-to-date as of October 2017)	Solar PV	300MW	Saudi Arabia	► Received a lowest bid of US$ 1.786 cents by Masdar and EDF, a French company in 2017 ► Project to be awarded in Jan 2018 ► Expected commissioning date: 2019
Taiba (project details up-to-date as of October 2016)	CSP	180MW	Saudi Arabia	► Bids were invited in Oct 2016
Duba-1 (project details up-to-date as of January 2017)	CSP	50MW	Saudi Arabia	► Under construction and expected to start operation in 2017
Al-Shamal ISCC (project details up-to-date as of February 2017)	CSP	50MW	Saudi Arabia	► To start production in 2018
Al-Aflaj park (project details up-to-date as of July 2016)	Solar PV	50MW	Saudi Arabia	► Announced in 2015
Dumat Al Jandal wind power project (project details up-to-date as of July 2017)	Wind	400MW	Saudi Arabia	► Bidding is set to close in Jan 2018
JV project between KAHRAMAA and Qatar petroleum (Siraj Power) (project details up-to-date as of May 2017)	Solar PV	200MW	Qatar	► Construction to commence in 2017 and to be operational by 2020.
Al Duhail Solar park (project details up-to-date as of September 2017)	Solar PV	10MW	Qatar	► Expected to be operational by 2018
Miraah solar thermal project (project details up-to-date as of November 2017)	Solar PV	1021MW	Oman	► Construction of first block completed in Nov 2017
Al Dakhilia solar project (project details up-to-date as of September 2017)	Solar PV and CSP	200MW	Oman	► Tenders floated in 2016
Dhofar wind farm (project details up-to-date as of July 2017)	Wind	50MW	Oman	► Likely to be commissioned in 2017
Shagaya Renewable Energy Park (project details up-to-date as of July 2017)	Solar PV, CSP and wind	2GW	Kuwait	Phase 1: ► 50MW CSP plant under construction, to commence operation in 2018 ► 10MW PV plant ► 10MW wind plant-contract awarded
Al-Dibdibah solar project (project details up-to-date as of June 2017)	Solar PV	2500GWh	Kuwait	► Tender to be issued in the first quarter of 2018
Al Abdaliyah Integrated Solar Combined Cycle (ISCC) (project details up-to-date as of July 2017)	CSP	60MW	Kuwait	► Expected commissioning in 2018

Conclusion

Summary of implications and suggestions for Dutch stakeholders

Strategic outlook

Technology opportunities

Business Approach

Q&A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