



تحديات ترابط المياه – الغذاء – الطاقة Water – Energy – Food Nexus

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المبادرة العربية للتعليم البيئي "تمكين بيئي مستدام"



INTRODUCTION

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➤ 2011

- ✓ The WEF published a report titled "Water, Energy, Food: The Nexus Challenge" that introduced the concept of the Nexus and highlighted the importance of integrated management of these resources.

➤ 2013

- ✓ The WEF launched the Water, Energy, Food Nexus Initiative to promote the adoption and implementation of the Nexus concept globally.

➤ 2014

- ✓ The WEF held its first Global Nexus Summit in Davos, Switzerland, which brought together policymakers, business leaders, and experts from around the world to discuss the challenges and opportunities related to the Nexus.



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➤ 2015

- ✓ The WEF published a report titled "Water, Energy, Food: A Nexus Approach to Sustainable Development" that provided a more comprehensive overview of the Nexus concept and its implications for sustainable development.

➤ 2016

- ✓ The WEF launched the Nexus Platform, an online platform that provides information and resources related to the Nexus concept.

➤ 2018

- ✓ The WEF published a report titled "Water, Energy, Food: A Nexus Approach to Resilient Development" that focused on the role of the Nexus in building resilience to climate change and other global challenges.



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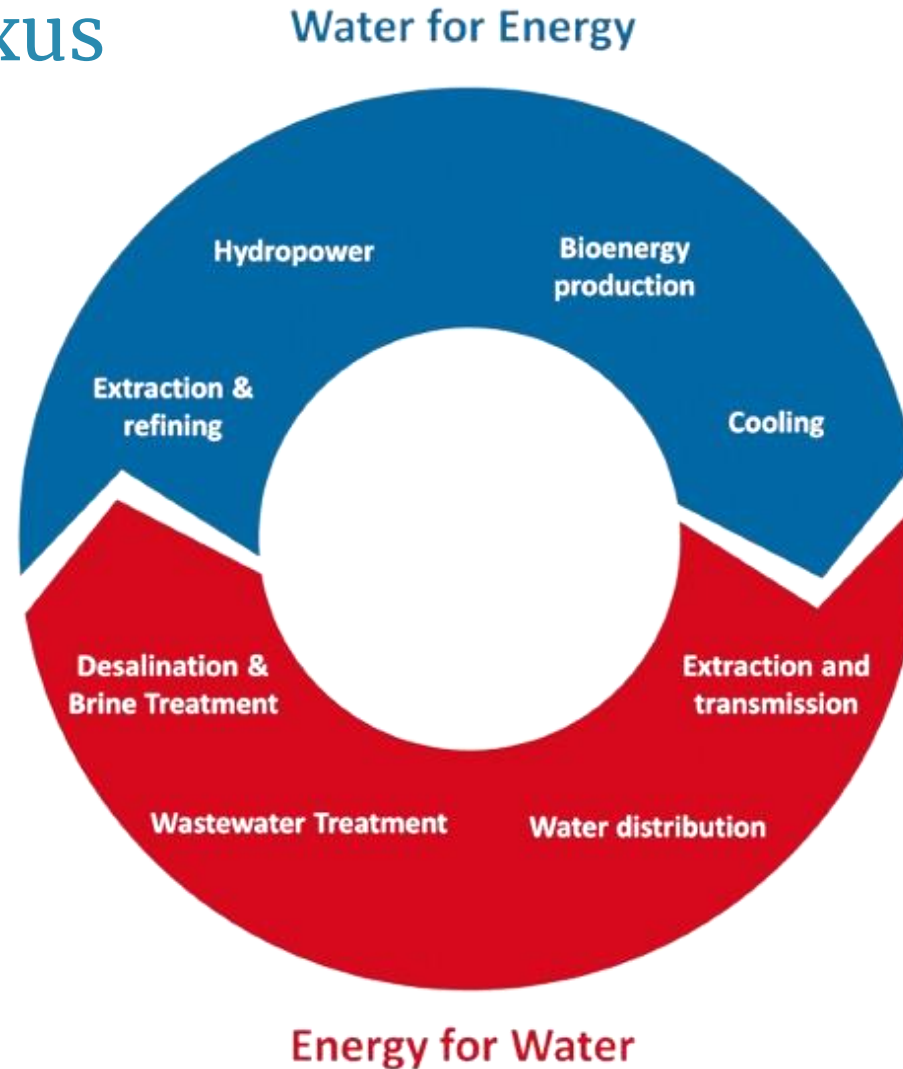
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➤ Water in nexus



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➤ Water in nexus

- ✓ Earth's oceans, which make up 96.5 % of the total water reserve, are its largest water storage area.
- ✓ 3.44 % of the overall water reserved is represented by the permanent snow covers and groundwater, which are essential freshwater sources.



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WATER CHALLENGES IN MENA REGION

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➤ Scarcity

- ✓ The MENA region is the world's most water-scarce region, with many countries receiving less than 500 cubic meters of water per person per year. This is far below the global average of 1,000 cubic meters per person per year.

➤ Inequality

- ✓ Water is not distributed equally within the MENA region. Some countries, such as Lebanon, have relatively abundant water resources, while others, such as Yemen and Somalia, face severe water shortages.



➤ Pollution

- ✓ Water pollution is a major problem in the MENA region, due to factors such as industrial waste, agricultural runoff, and sewage.
 - ❑ This pollution can make water unsafe to drink and can harm aquatic ecosystems.

➤ Climate change

- ✓ Climate change is exacerbating the water crisis in the MENA region by causing more frequent and severe droughts.
 - ❑ This is reducing the availability of water resources and increasing the demand for water.

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Energy's sources



Fossil fuel



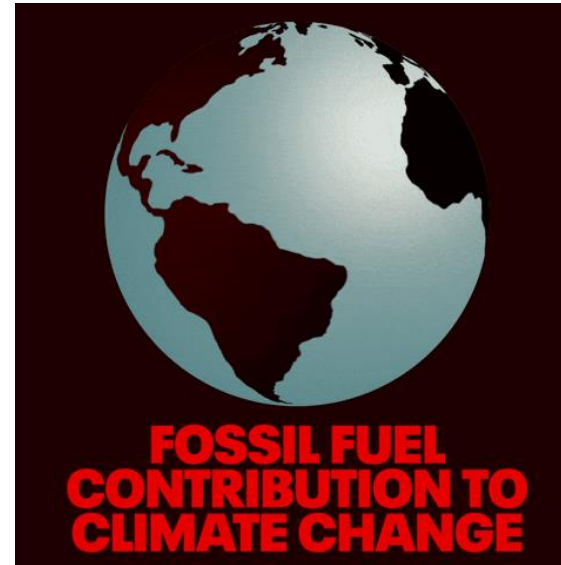
Nuclear



Renewable
Sources

➤ Fossil fuels

- ✓ Coal, oil, and gas are non-renewable resources that take hundreds of millions of years to form.
- ✓ Fossil fuels, when burned to produce energy, cause greenhouse gas emissions, such as carbon dioxide. Now using renewable energy creates lower emissions than burning fossil fuels.



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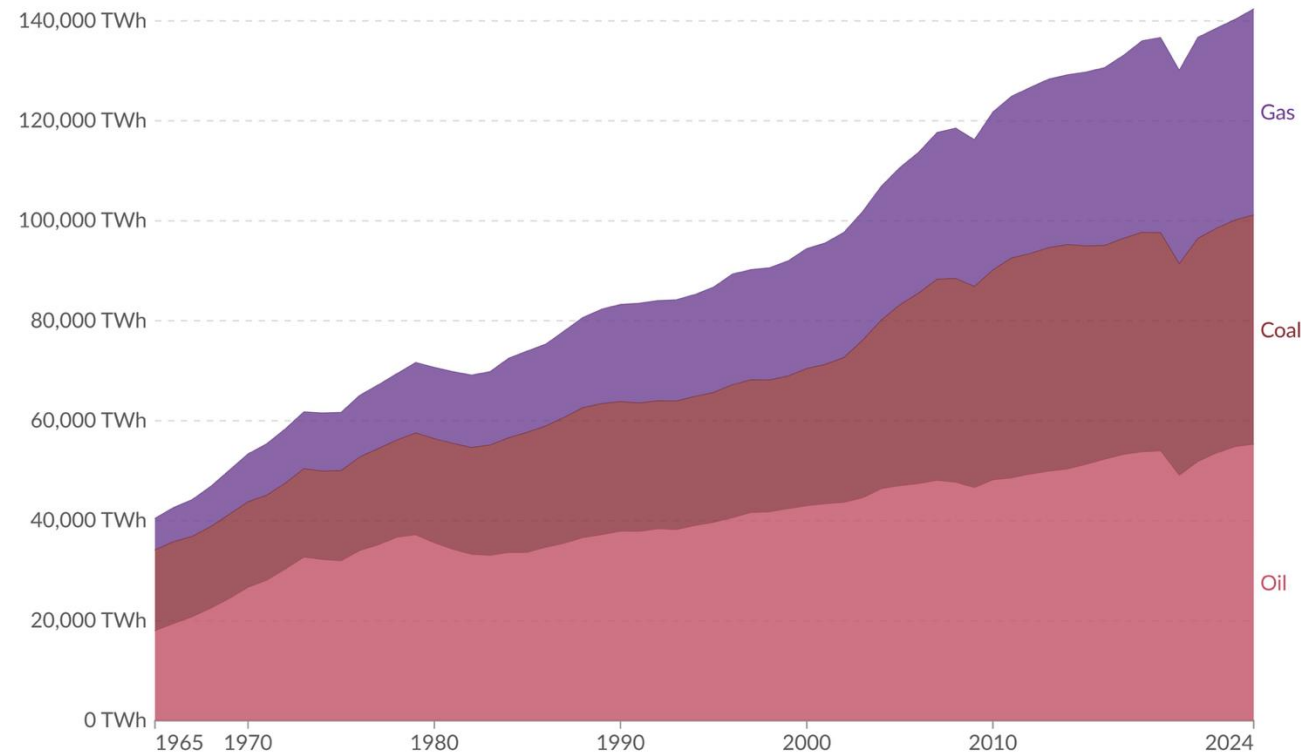
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➤ Global fossil fuel consumption

Fossil fuel consumption by fuel type, World

Fossil fuel consumption is given in terawatt-hours (TWh).



Data source: Energy Institute - Statistical Review of World Energy (2025)

OurWorldinData.org/fossil-fuels | CC BY



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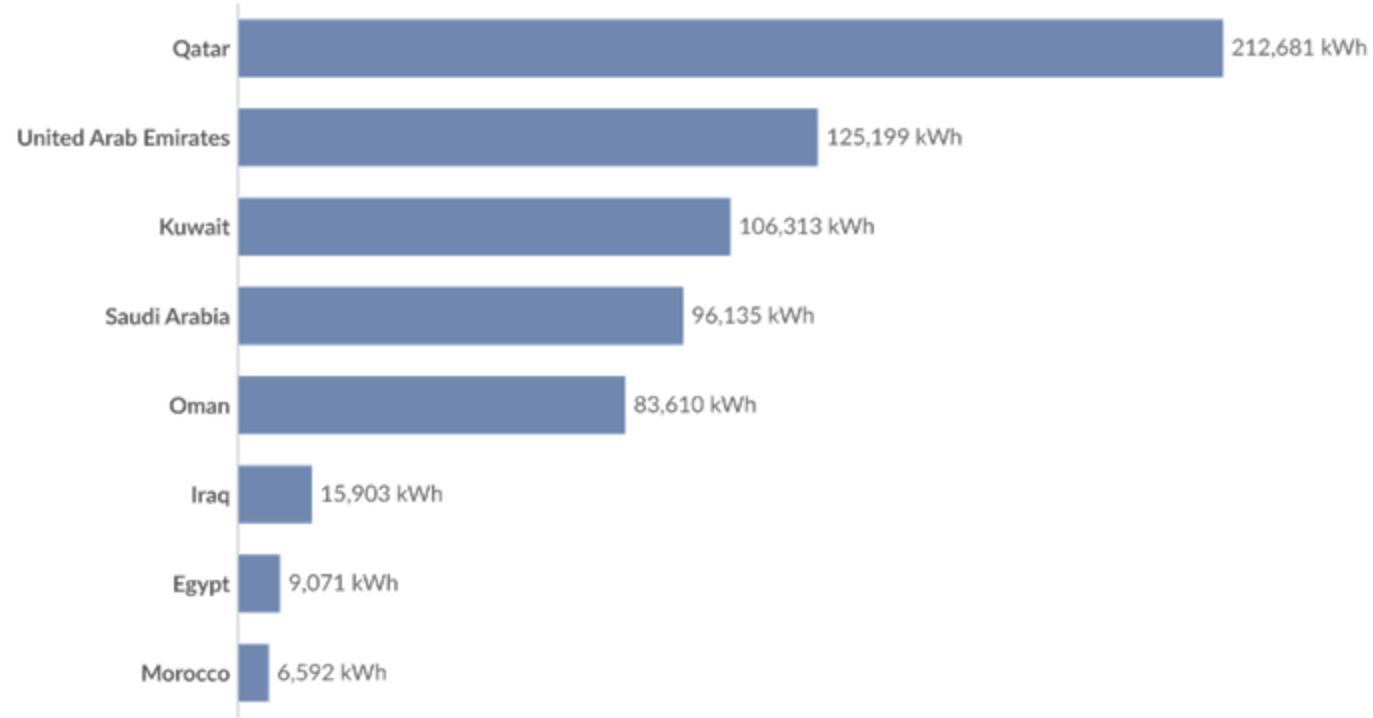
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➤ Fossil fuel consumption per capita, 2024

Fossil fuel consumption per capita, 2024

Fossil fuel consumption per capita is measured as the average consumption of energy from coal, oil and gas, in kilowatt-hours¹ per person.



Data source: Energy Institute - Statistical Review of World Energy (2025); Population based on various sources (2024)
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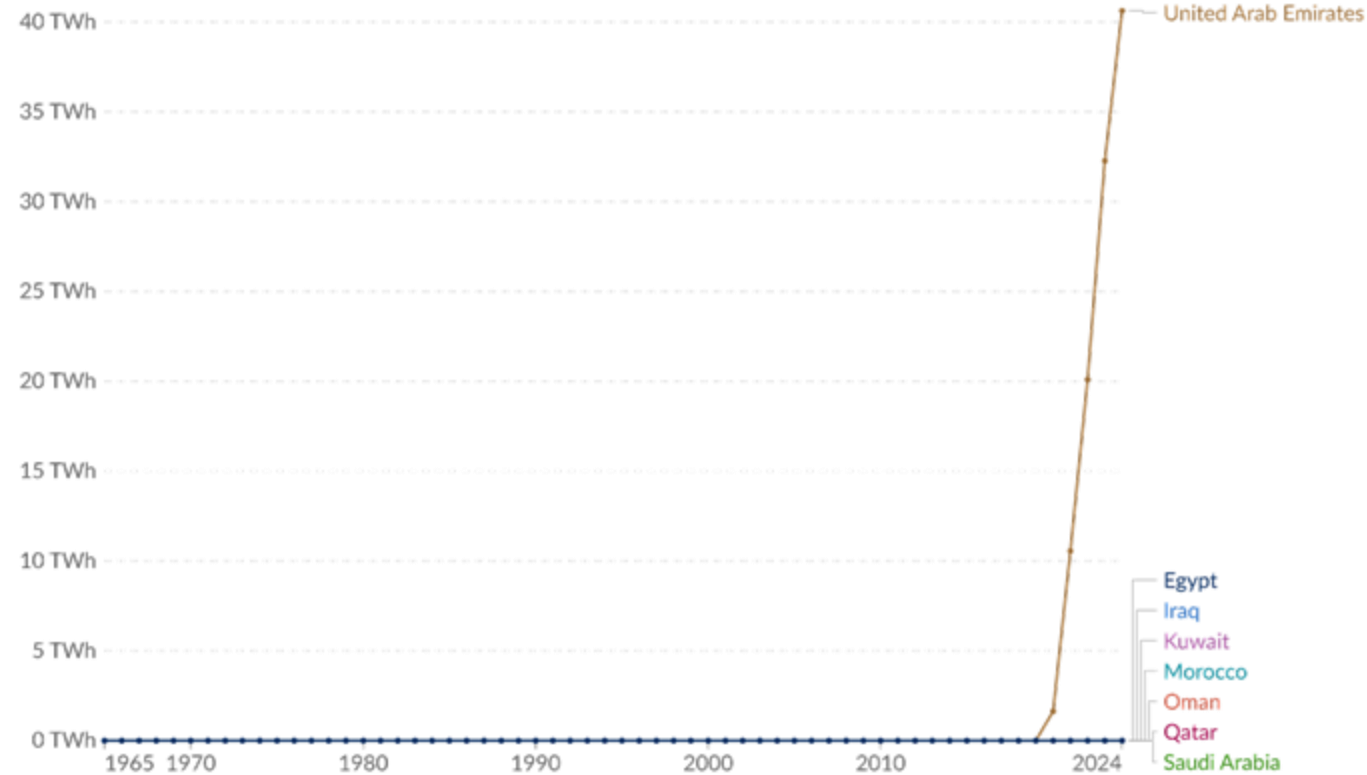
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➤ Nuclear power generation

Nuclear power generation

Measured in terawatt-hours¹.



Data source: Ember (2025); Energy Institute - Statistical Review of World Energy (2025)

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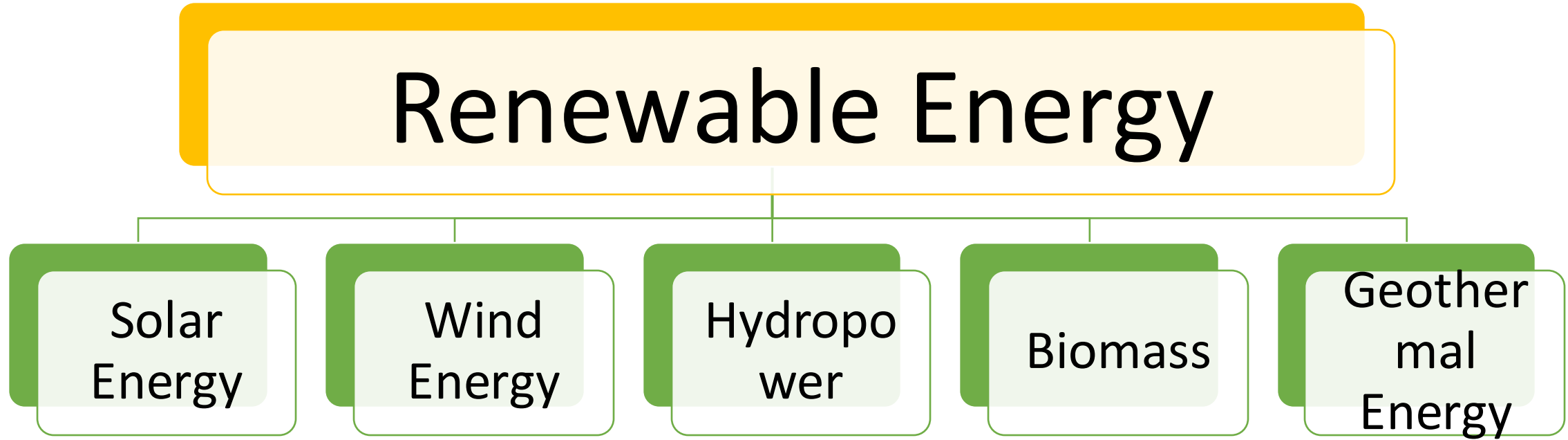


➤ Renewable Energy

- ✓ Energy taken from natural sources that regenerate itself at a rate higher than it consumes.
- ✓ It is still costly although they are all around us.



➤ Renewable Energy



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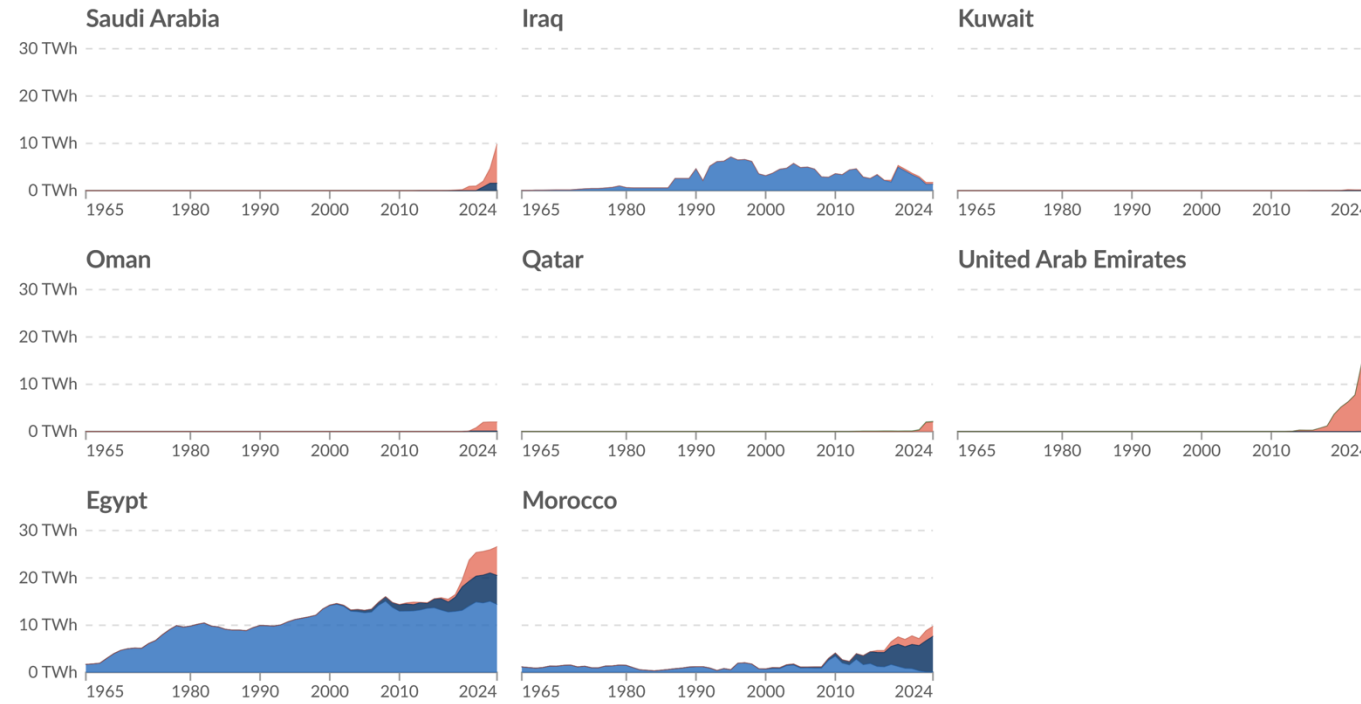


➤ Renewable electricity generation

Renewable electricity generation

Our World
in Data

Hydropower Other renewables Solar Wind



Data source: Energy Institute - Statistical Review of World Energy (2025)

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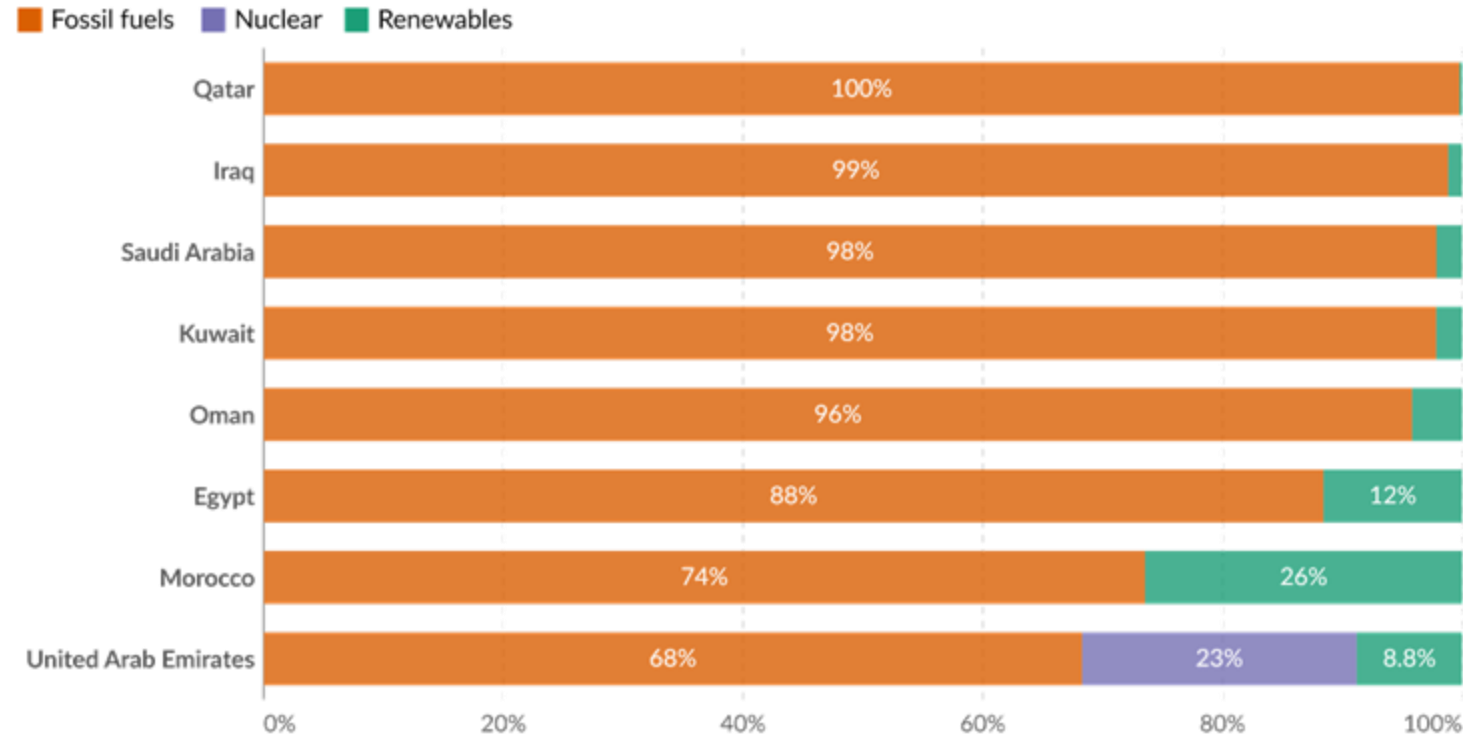


➤ Energy 2024 Per capita

Per capita electricity generation from fossil fuels, nuclear and renewables, 2024

Our World
in Data

Per capita electricity generation from fossil fuels (coal, gas, and oil), nuclear, and renewables (solar, wind, hydropower, bioenergy, geothermal, wave, and tidal).



Data source: Ember (2025); Energy Institute - Statistical Review of World Energy (2025); Population based on various sources (2024)



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➤ Dependence on fossil fuels

- ✓ The MENA region is heavily reliant on fossil fuels, particularly oil and natural gas, to meet its energy needs.

➤ Growing energy demand

- ✓ The MENA region's population is growing rapidly, and its economies are becoming more industrialized. This is leading to a growing demand for energy, which is putting a strain on existing energy resources.



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➤ Climate change

- ✓ Climate change is exacerbating the energy challenges in the MENA region. It is causing more frequent and severe droughts and heat waves, which can reduce the availability of hydropower.
- ✓ It is also increasing the demand for energy for cooling, which can put a strain on electricity grids.
- ✓ The reliance on oil and gas is also a key producer of green house emissions.



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➤ Food in nexus

- ✓ Agriculture is a major consumer of water, and inefficient irrigation practices can exacerbate water scarcity.
- ✓ Modern agriculture relies heavily on energy-intensive processes like fertilizer production, machinery, and food processing.
- ✓ The transportation and storage of food products require significant energy inputs.
- ✓ Climate change can exacerbate land degradation through increased erosion, salinization, and desertification.



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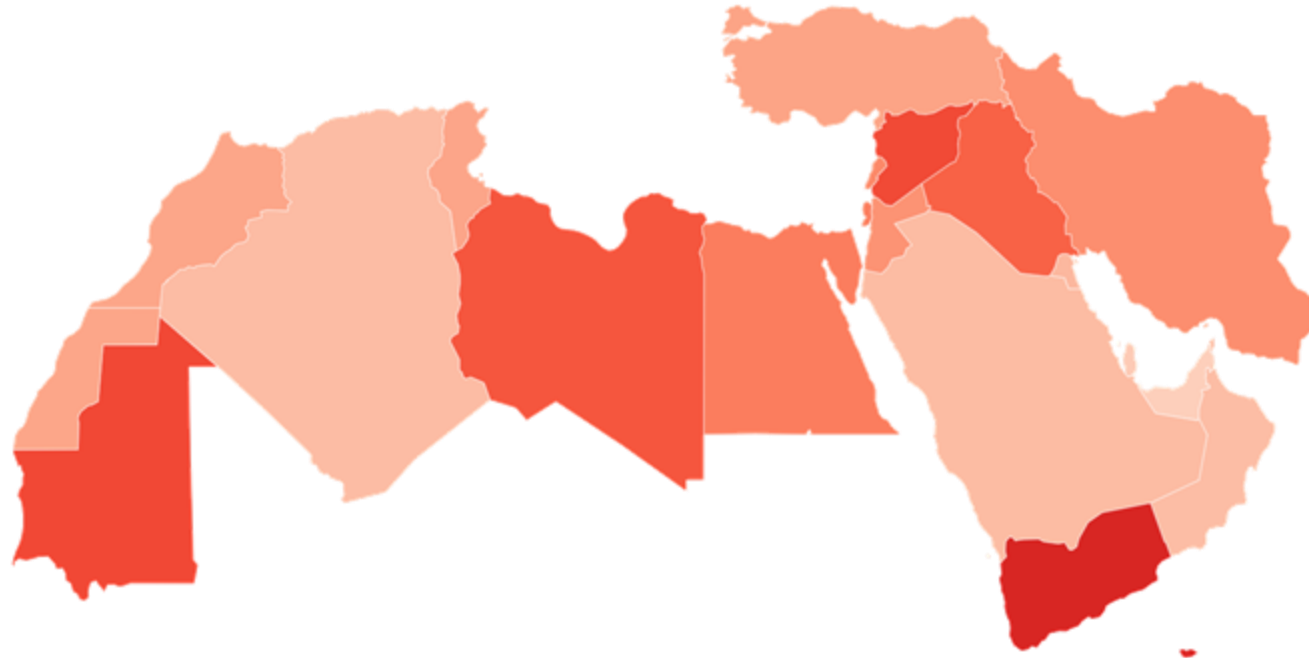
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➤ Food challenges in MENA region

✓ Map of Food Insecurity in MENA

Least Food Secure 2.9  8 Most Food Secure



➤ Food challenges in MENA region

- ✓ Limited water resources
- ✓ climate change
- ✓ political conflicts
 - ❑ Palestine
 - ❑ Sudan
 - ❑ Yemen
- ✓ Over 80% of the countries in the MENA region depend on imported food.
- ✓ A lack of stable food production can lead to price increases and market instability, threatening food access for the region's poorest inhabitants.

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WATER-ENERGY-FOOD NEXUS

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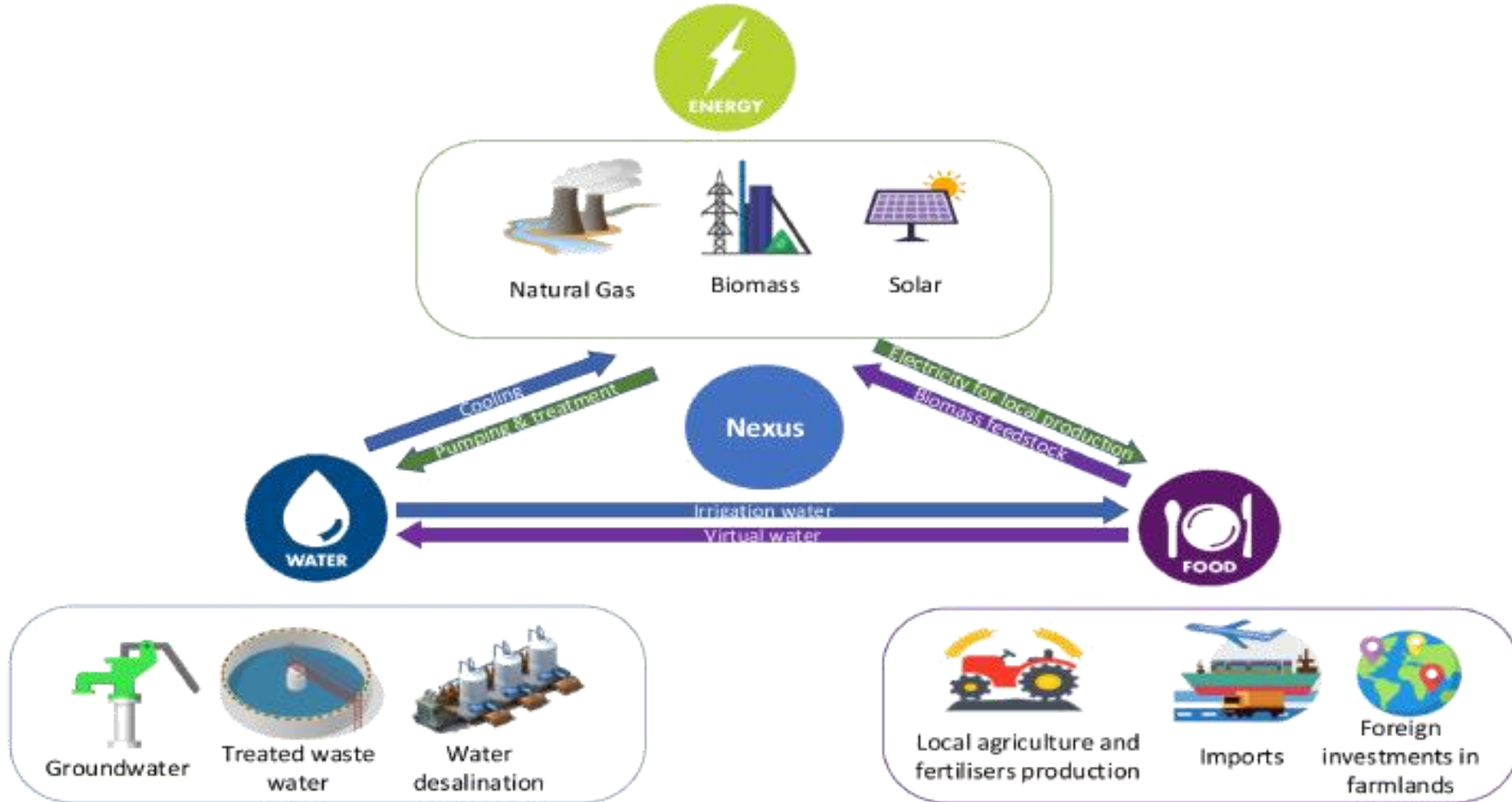
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➤ Example 1: Growing Rice

✓ Water

- ❑ Rice needs a lot of water to grow (irrigation).

✓ Energy

- ❑ Pumps and machinery need energy (usually electricity or fuel) to deliver that water.

✓ Food

- ❑ Rice is a food crop.

✓ Nexus Insight

- ❑ If energy becomes expensive or water becomes scarce, rice production is affected.



➤ Example 2: Producing Drinking Water

✓ Water

- ❑ Clean drinking water is needed for people and farming.

✓ Energy

- ❑ Desalination plants (turning seawater into freshwater) or water treatment facilities need a lot of energy.

✓ Food

- ❑ Clean water is also essential for crops and livestock.

✓ Nexus Insight

- ❑ If energy is limited, water purification slows down, affecting food and public health.

➤ Example 3: Building power station

✓ Water

- ❑ Power stations need large amounts of water for cooling.

✓ Energy

- ❑ The power station generates electricity.
- ❑ Energy is needed during construction and operation.

✓ Food

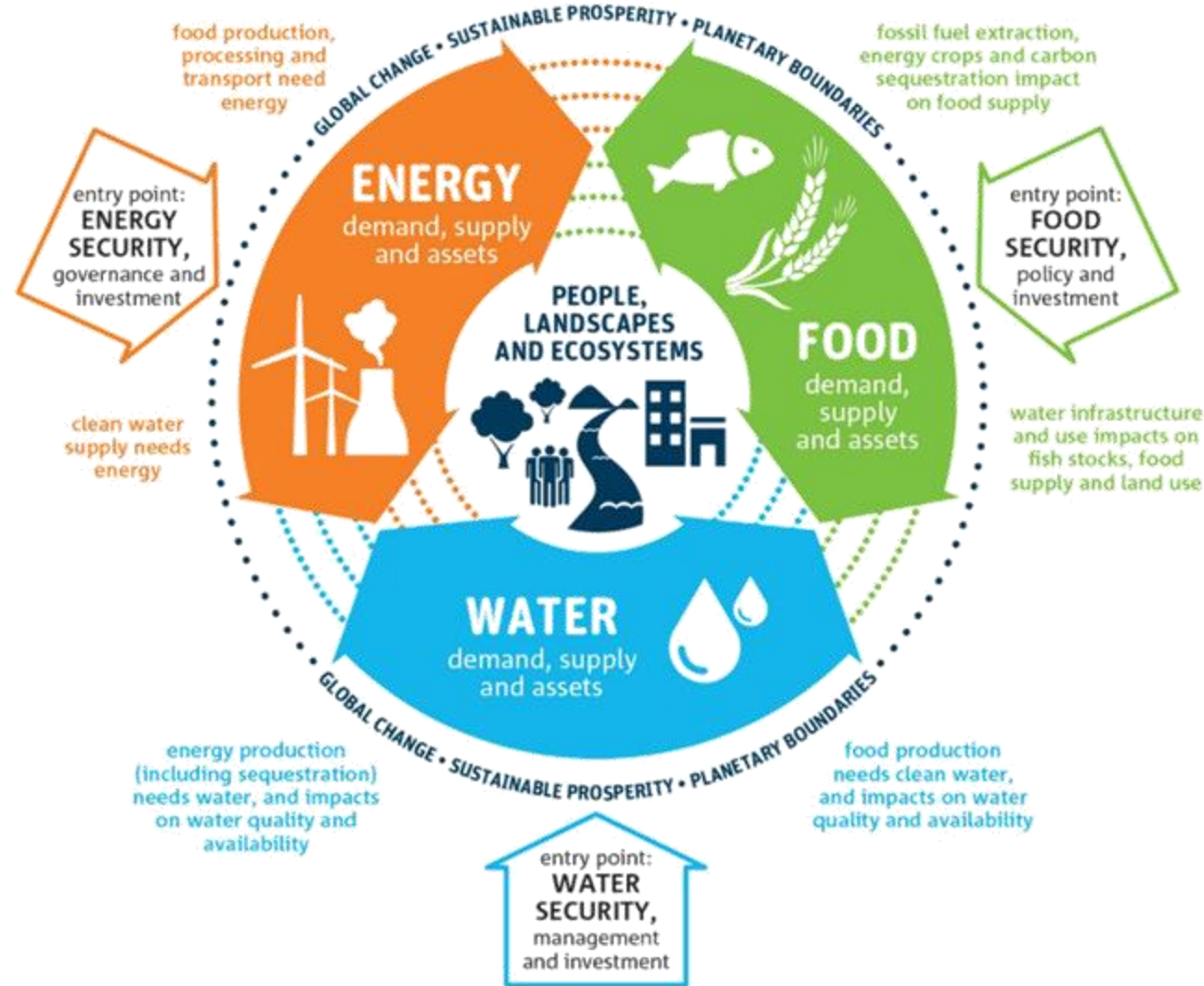
- ❑ Reliable electricity supports irrigation and food processing

✓ Nexus Insight

- ❑ If water is scarce, energy production drops.
- ❑ If food demand increases, more water and energy are needed.

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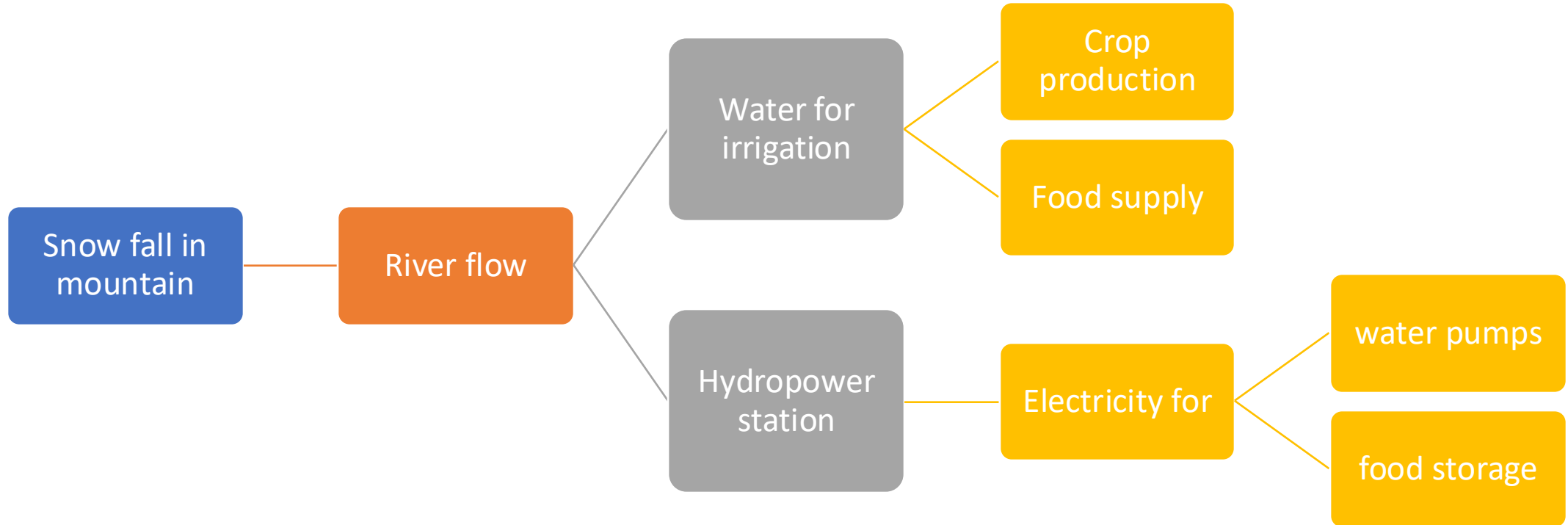


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➤ Example 4

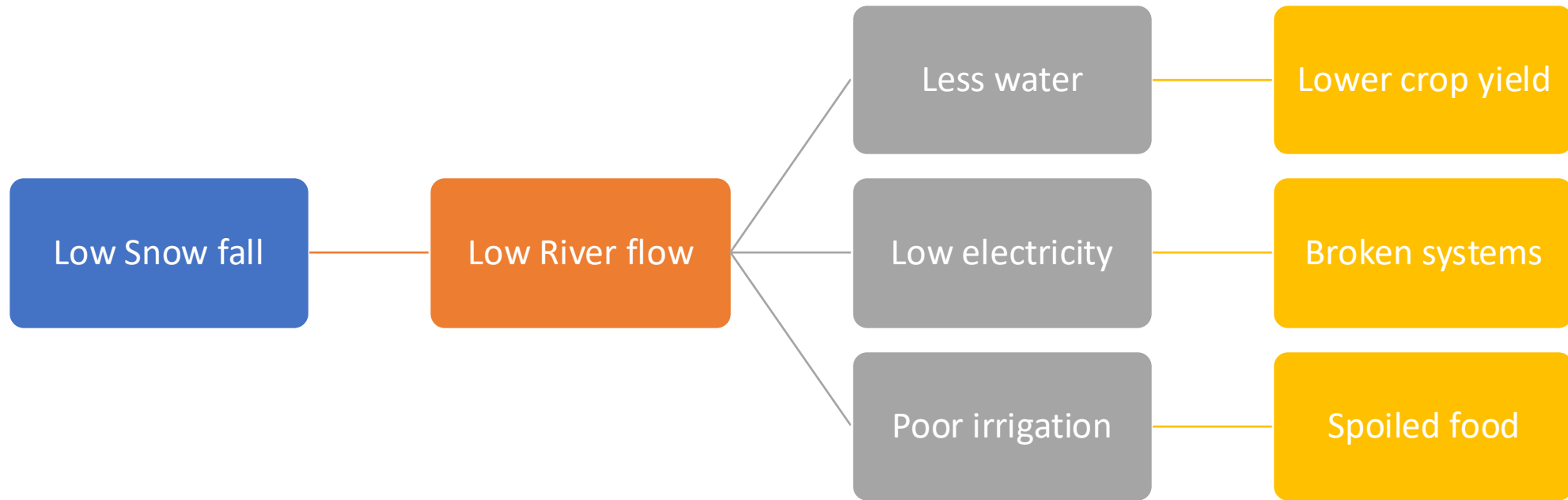


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➤ Example 4



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➤ Example 4

✓ Solution

☐ Solar Panels

- Backup electricity for pumps and storage

☐ Rainwater Tanks

- Extra water during dry seasons

☐ Drought-resistant Crops

- Less water needed for food]

☐ Water Recycling

- More efficient use of limited water



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➤ Sustainable Water

- ✓ Access to water resources for different uses
- ✓ Sustainable use and management of water resources
- ✓ Resilient societies and ecosystems to water-related disasters

➤ Sustainable Energy

- ✓ Access to modern energy services
- ✓ Efficient use of energy
- ✓ The energy produced and consumed is clean/renewable



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- Sustainable Food
 - ✓ Food Availability
 - ✓ Food Access
 - ✓ Food Utilization & Nutrition
 - ✓ Stability of Food Prices and Supply



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➤ Nexus examples

- ✓ Green Belt of Algiers —Algeria
- ✓ Al Khafji Solar PV-SWRO Desalination Plant—KSA
- ✓ Seawater Greenhouse—Qatar
- ✓ Kenana Sugar Company—Sudan



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EXAMPLE: WEBSITE FOR WEF NEXUS

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➤ <https://wefnexus tool.org/mainpage.html>

← → ↺ <https://wefnexus tool.org/mainpage.html> 🔍 ☆ ABP 📄 📌 Verify it's you

☰ All Bookmarks

 **The Resource Management Strategy Guiding Tool**

The Resource Management Strategy Guiding tool

Home Resources Contact WEF Nexus Studies Reports

Welcome to the WEF Nexus Tool
Start with Adjusting the Values in the Input Field

CURRENT SCENARIO
Scenario 1

🔄 Reset Data 📄 Show Tables



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➤ <https://wefnexusustool.org/mainpage.html>

Scenario Building

FOOD

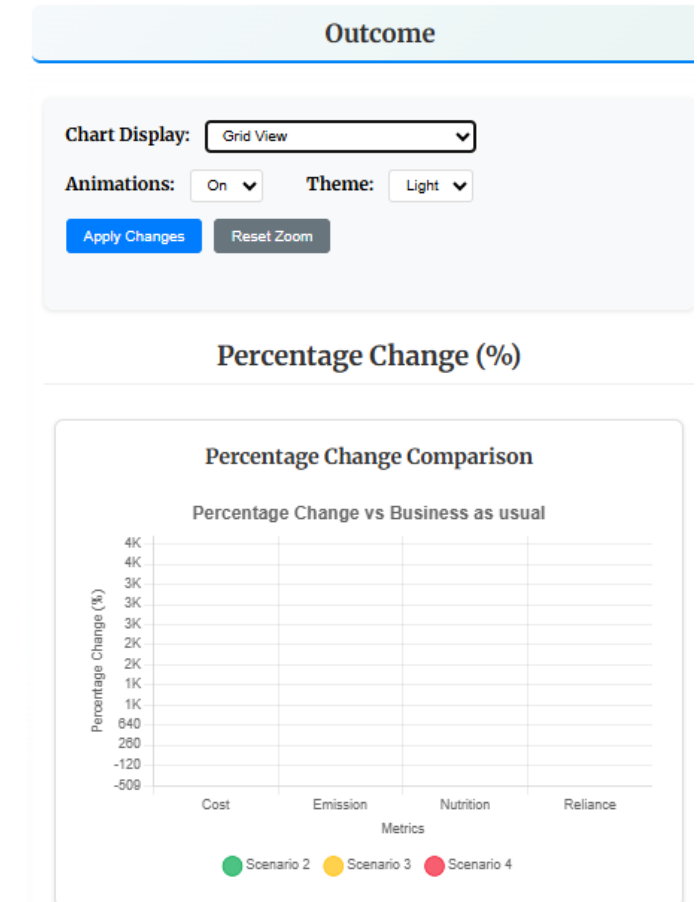
Select	Crop	Self Sufficiency (%)	Action
☐	Almond	101	<button>Edit</button>
☐	Apple	230	<button>Edit</button>
☐	Apricot	107	<button>Edit</button>
☐	Avocado	104	<button>Edit</button>
☐	Banana	145	<button>Edit</button>
☐	Barley	24	<button>Edit</button>
☐	Beans (dry)	48	<button>Edit</button>
☐	Beans (green)	89	<button>Edit</button>

WATER FOR FOOD

Water Type	Baseline (%)	Scenario (%)
Ground Water	80	0
Surface Water	20	0
Treated Wastewater	0	0

ENERGY

Energy Type	Energy Source	Baseline (%)	Scenario (%)
Energy for Ground Water	Diesel	100	100
	Gasoline	0	0
	Wind	0	0
	Solar	0	0
	Hydropower	0	0



EXAMPLE CASE STUDY: A PROPOSED SUSTAINABLE WATER-ENERGY-FOOD NEXUS SYSTEM FOR ABOU ZENIMAH CITY, SOUTH SINAI, EGYPT

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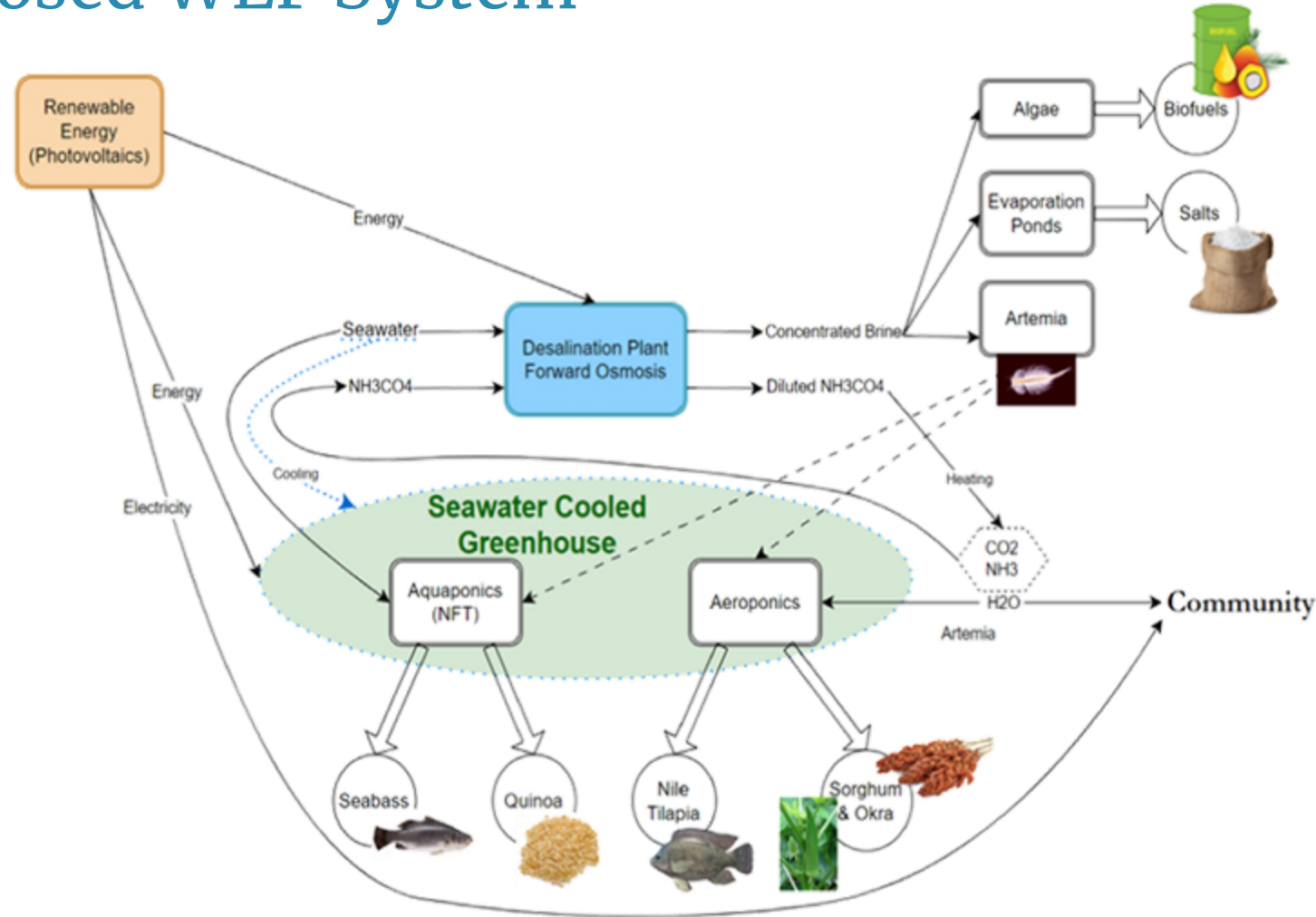
- Abou Zenimah, a Red Sea coastal city in South Sinai, faces water scarcity and food shortage.
- Primary causes: seawater intrusion and limited rainfall.



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➤ Proposed WEF System



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➤ Water production

- ✓ The Abou Zenimah desalination plant addresses water scarcity and community food needs with Red Sea seawater (salinity 35,000–40,000 ppm).

➤ Energy generation

- ✓ A hybrid system integrating photovoltaic (PV) panels and solar concentrators is designed to efficiently generate solar energy, meeting a daily demand of 6.39 MWh.



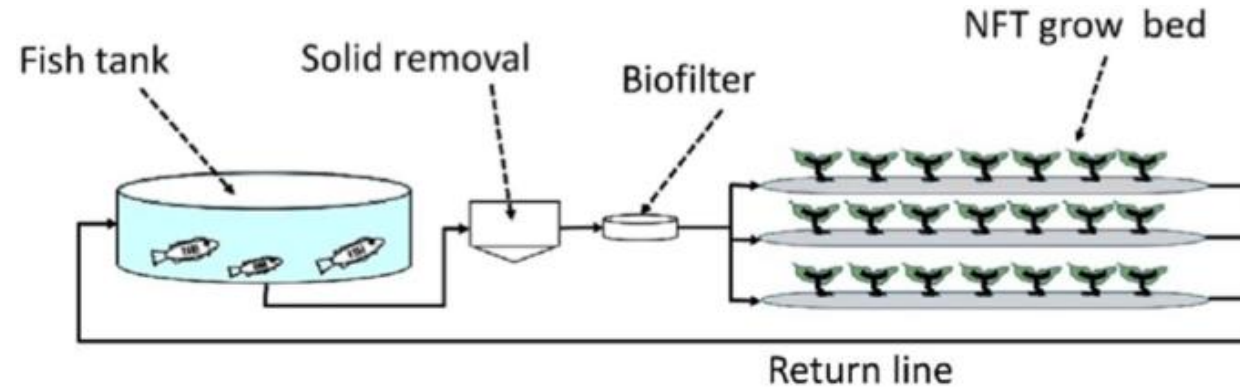
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➤ Food production

- ✓ Fish Tank
- ✓ Crops



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WATER-ENERGY-FOOD ECOSYSTEM (WEFE)

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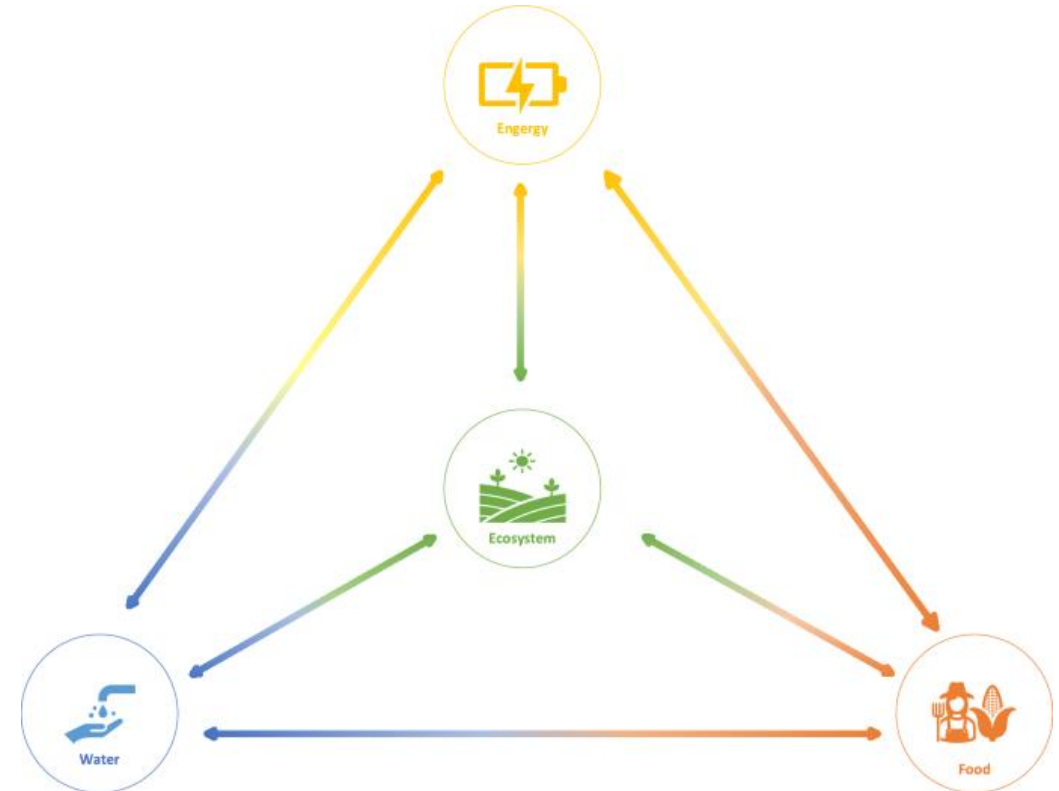
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➤ Water-Energy-Food-Ecosystem (WEFE)

- ✓ WEF → Prioritizes resource security (water, energy, food).
- ✓ WEFE → Prioritizes both resource security and ecosystem sustainability, making it more holistic.



➤ WEFE Example 1: The Nile Basin (Egypt)

✓ Water–Energy–Food

- ❑ Dams along the Nile generate hydropower (energy) and provide irrigation (water) for crops (food).

✓ Ecosystems

- ❑ Over-damming and irrigation reduce water flow downstream, threatening wetlands and fisheries (ecosystem services that millions rely on for food and livelihoods).

✓ WEFE lesson

- ❑ Policies must balance hydropower and agriculture with ecosystem protection to sustain biodiversity and long-term water security.

➤ WEFE Example 2: Desert Agriculture – Saudi Arabia

✓ Water–Energy–Food

- ❑ Farming (food) in arid lands depends on groundwater (water) pumping and desalination (energy).

✓ Ecosystems

- ❑ Over-extraction leads to aquifer depletion, desertification, and loss of natural habitats.

✓ WEFE lesson

- ❑ Balancing food security with renewable energy use and ecosystem conservation is vital for sustainability under Vision 2030.

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➤ References

- ✓ <https://ourworldindata.org/>
- ✓ <https://link.springer.com/article/10.1007/s44274-025-00303-w>
- ✓ https://www.researchgate.net/profile/Abdelhamid_Esmail/publication/395567847_Transitioning_the_Energy_Mix_in_Saudi_Arabia_Pathways_Toward_Sustainability_and_Vision_2030/links/68ca8746508ac7086f5a7382/Transitioning-the-Energy-Mix-in-Saudi-Arabia-Pathways-Toward-Sustainability-and-Vision-2030.pdf
- ✓ https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5082894
- ✓ https://uploads.water-energy-food.org/legacy/policy_briefs_6_english.pdf



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➤ References

- ✓ <https://www.bing.com/ck/a?!&&p=e78c865d5b0bccf2531294a9f8c0242e466c6fcca7f1ac8e19bd34010229ba03JmltdHM9MTc1OTE5MDQwMA&pptn=3&ver=2&hsh=4&fclid=3699fd13-59ee-6897-0c85-e8d758926945&psq=optimizing+dynamics+of+water-energy-food+nexus+in+a+desert+climate&u=a1aHR0cHM6Ly93d3cuc2NpZW5jZWRpcmVjdC5jb20vc2NpZW5jZS9hcnRpY2xlL3BpaS9TMdMwMTQyMTUyMjAwMTA5NA>



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Thank You

Welcome to questions, comments and suggestions

