Economic and Social Commission for Western Asia

Water-Food-Energy nexus concept as a tool for achieving sustainable development goals“

Webinar I (14 October, 02:00pm GST, 12:00pm CET)

Technology Options for the Water-Energy- Food Nexus

UNITED NATIONS
ESCWA

Shared Prosperity Dignified Life

Ms. Radia Sedaoui
Chief Energy, Climate Change and Natural Resource Sustainability Cluster, ESCWA

Table of Contents

The Water-Energy-Food Nexus Agenda 2030

"A world where we reaffirm our commitments regarding the human right to safe drinking water and sanitation and where there is improved hygiene; and where food is sufficient, safe, affordable and nutritious. A world where human habitats are safe, resilient and sustainable and where there is universal access to affordable, reliable and sustainable energy."

United Nations, Transforming Our World: The 2030 Agenda For Sustainable Development Outcome Document of the United Nations Summit for the Adoption of the Post-2015 Development Agenda September 2015

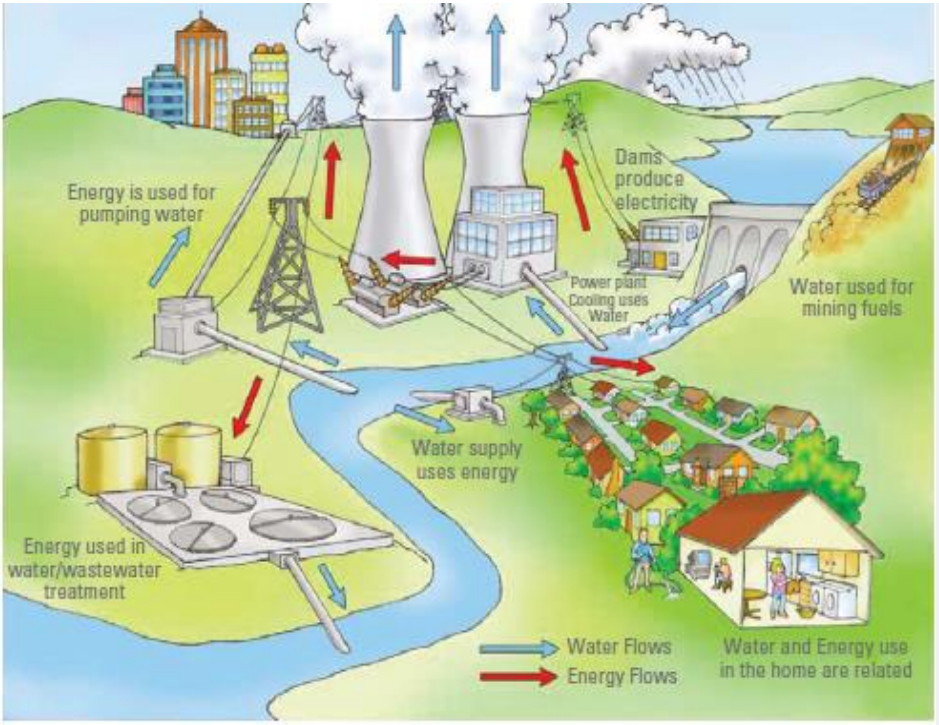
The Water-Energy-Food Nexus Agenda 2030

The 2030 Agenda for Sustainable Development clearly states that the SDGs are **integrated and indivisible** (in the preamble and in paras. 5, 18, 55 and 71 of the Declaration)

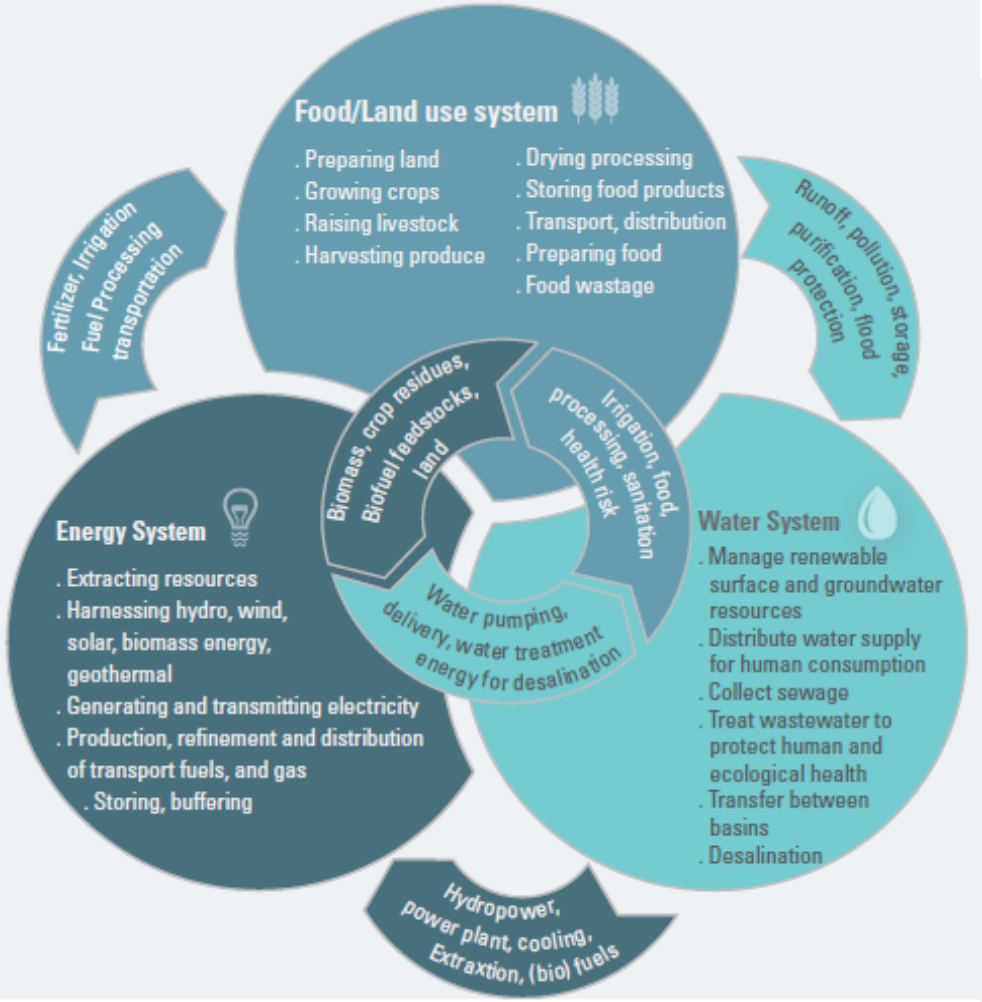
"**interlinkages and integrated** nature of the Sustainable Development Goals are of crucial importance in ensuring that the purpose of the new agenda is realized"

United Nations, Transforming Our World: The 2030 Agenda For Sustainable Development Outcome Document of the United Nations Summit for the Adoption of the Post-2015 Development Agenda September 2015

The Water-Energy-Food Nexus Framework



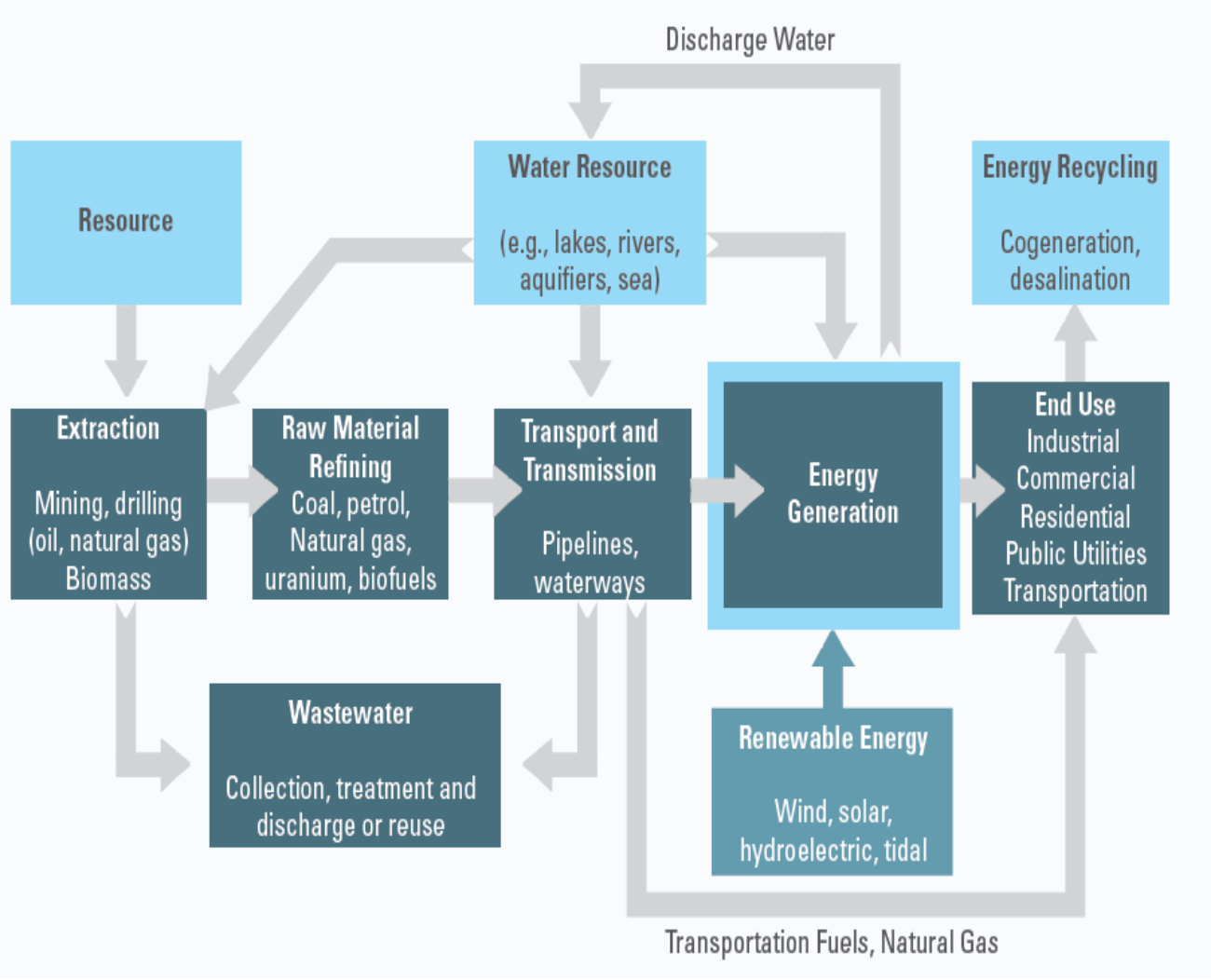
Source: United States Department of Energy, 2006.



Source: SE4All, n.d.

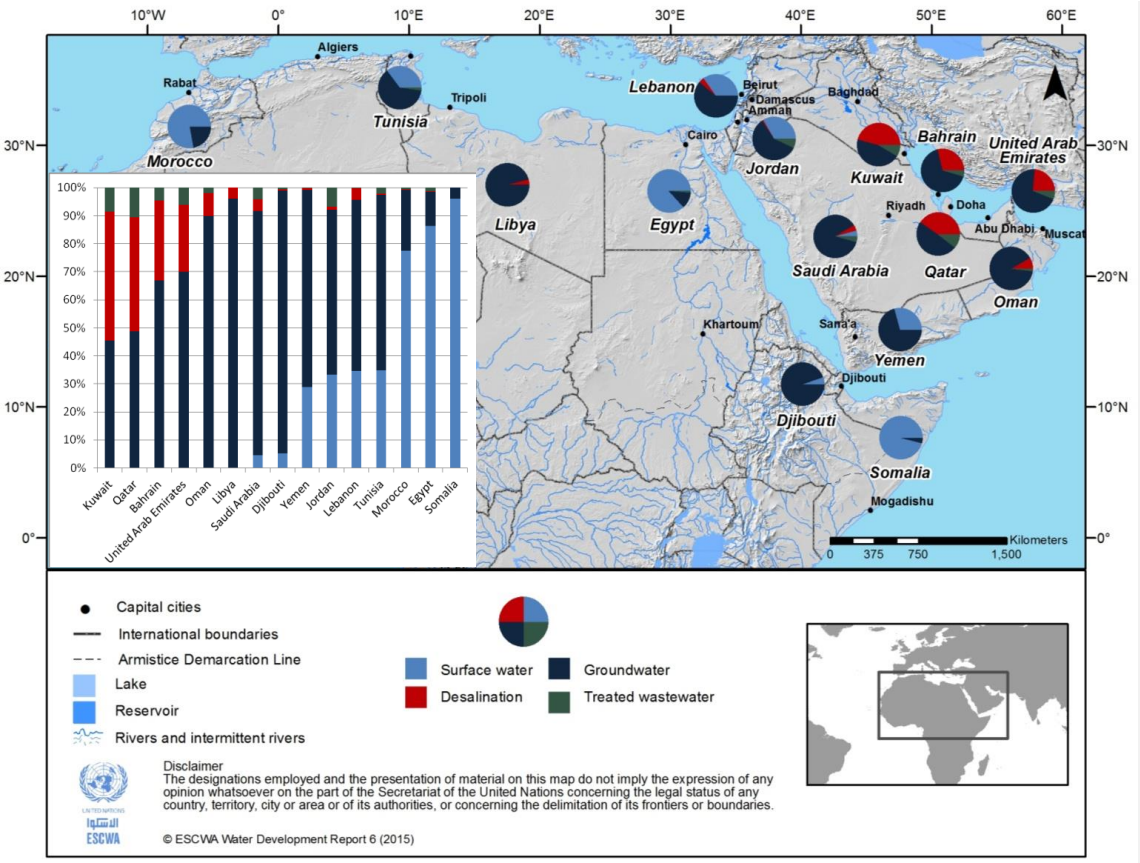
Embedded water in energy

- **Energy production is the 2nd largest use of water (after agriculture).**
- **Globally, 90% of power generation is water-intensive.**
- **80% of global electricity is produced by thermal power generation.**
- **75% of all industrial water withdrawals are for power production.**



Source: Water in the West, 2013.

Embedded water in energy: Some figures in Arab region



- Jordanian water sector accounts for ~**15%** of total annual electricity generated
- Saudi Arabia: Groundwater pumping accounts for **10%** of total fuel consumption
- Libya: Groundwater pumping accounts for **14%** of total fuel consumption
- Bahrain: **30%** of total energy use is for desalination

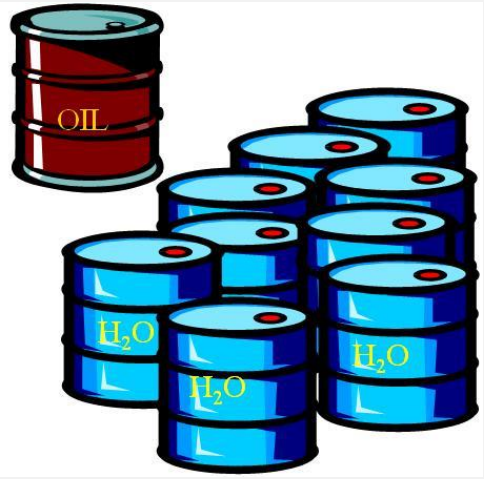
The Water Conundrum in Oil & Gas Sector

In the GCC region, we suffer from too little water and too much water at the same time!

Too little water

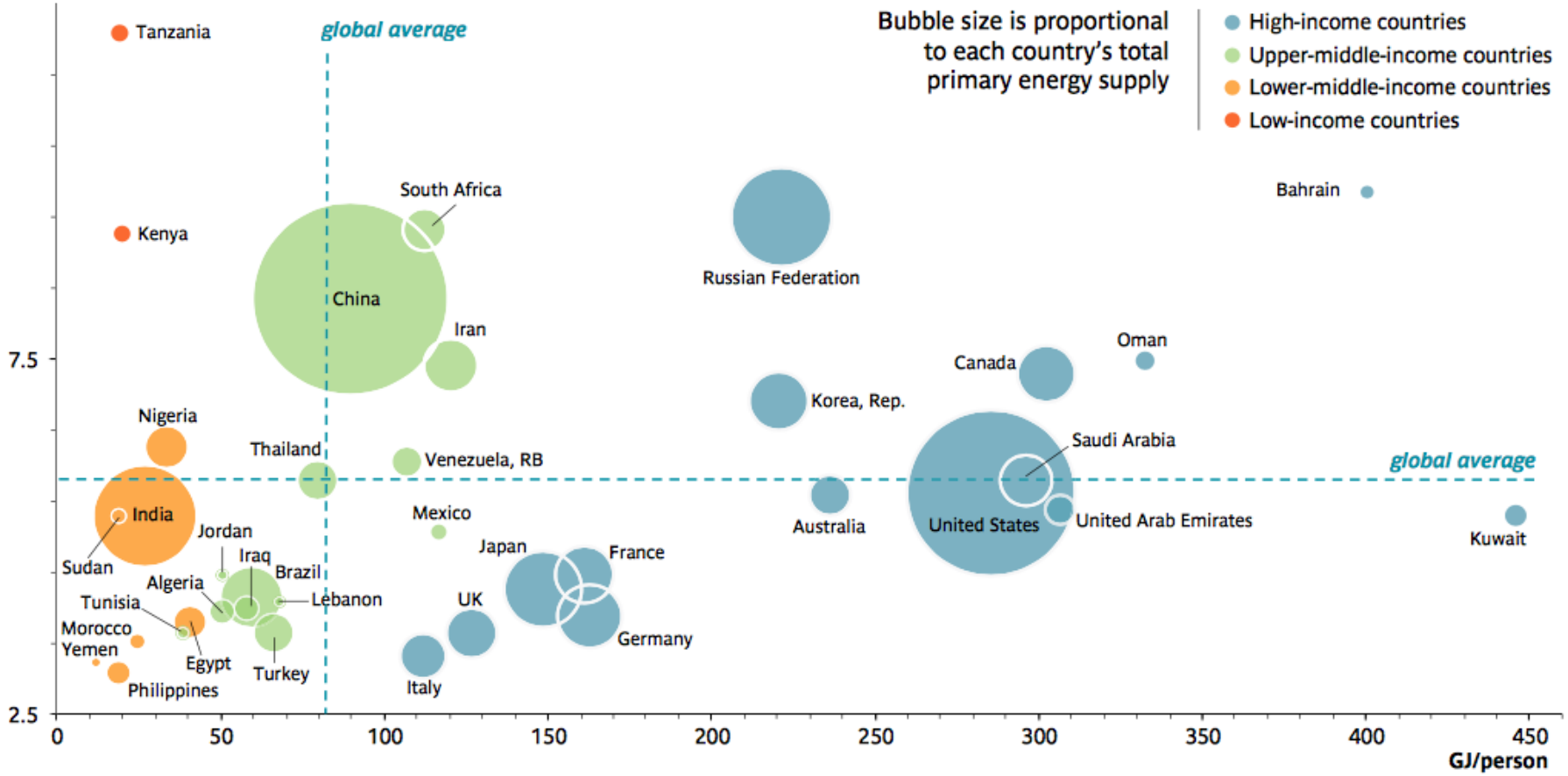
…. A very large area of the GCC is arid desert

Too much water



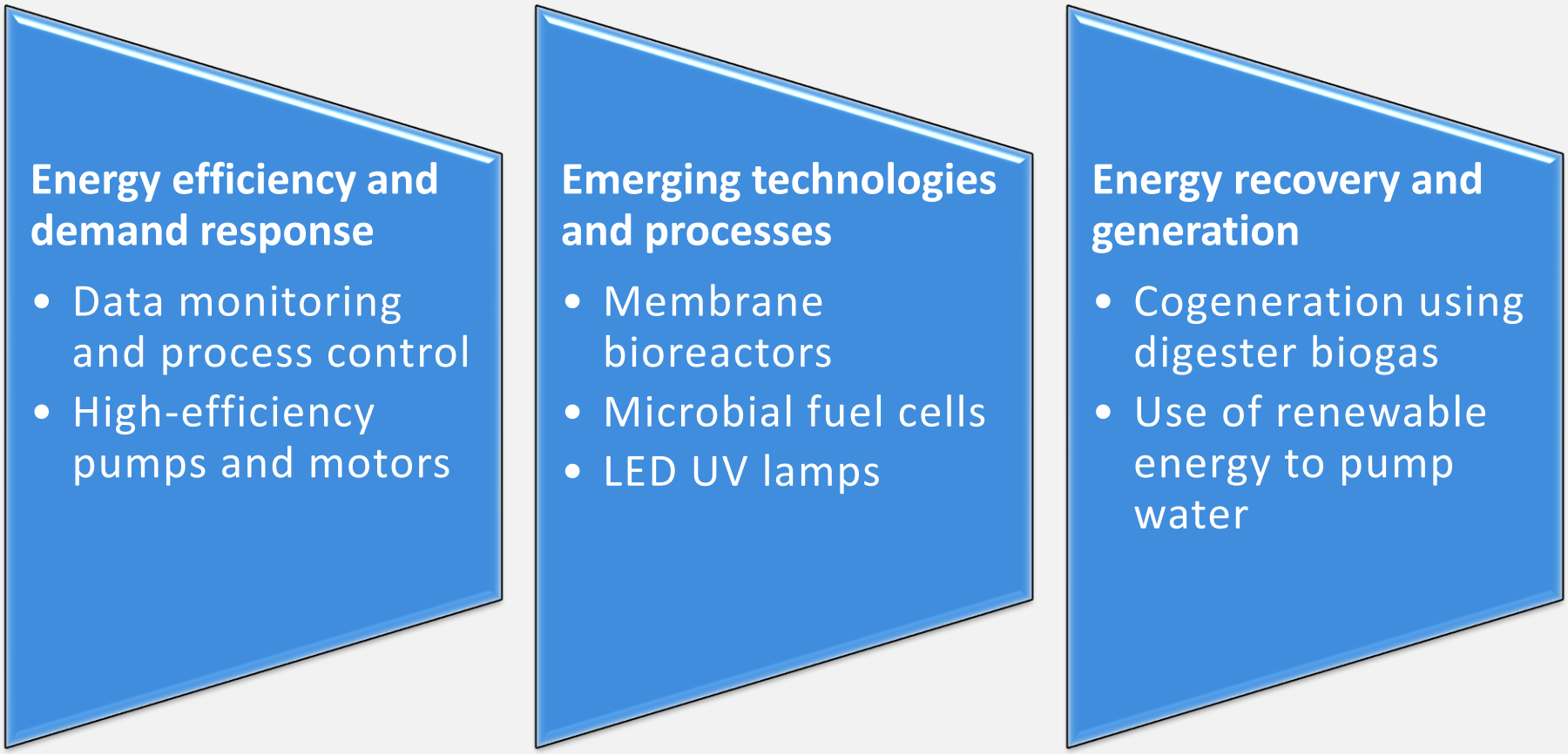
…. In the GCC countries, for every barrel of oil produced, up to 10 barrels of water are extracted at the same time. And it gets worse with time!

Primary energy intensity vs. primary energy consumption per capita, selected countries



Source: World Development Indicators database; IEA database. Note: The scale does not allow depiction of Qatar, which had per capita energy consumption in 2012 of over 770 GJ per person, and energy intensity of 6 MJ/2011 USD, just above the world average.

Energy management opportunities in the water and wastewater industries



Source: Reekie, 2013

Water efficiency in electricity production

	Once-through		Recirculating		Dry-cooling	
	W	C	W	C	W	C
Coal (conventional)	20,000-50,000	100-317	500-1,200	480-1,100	N/A	N/A
Natural gas (combined cycle)	7,500-20,000	20-100	150-283	130-300	0-4	0-4
Nuclear	25,000-60,000	100-400	800-2,600	600-800	N/A	N/A

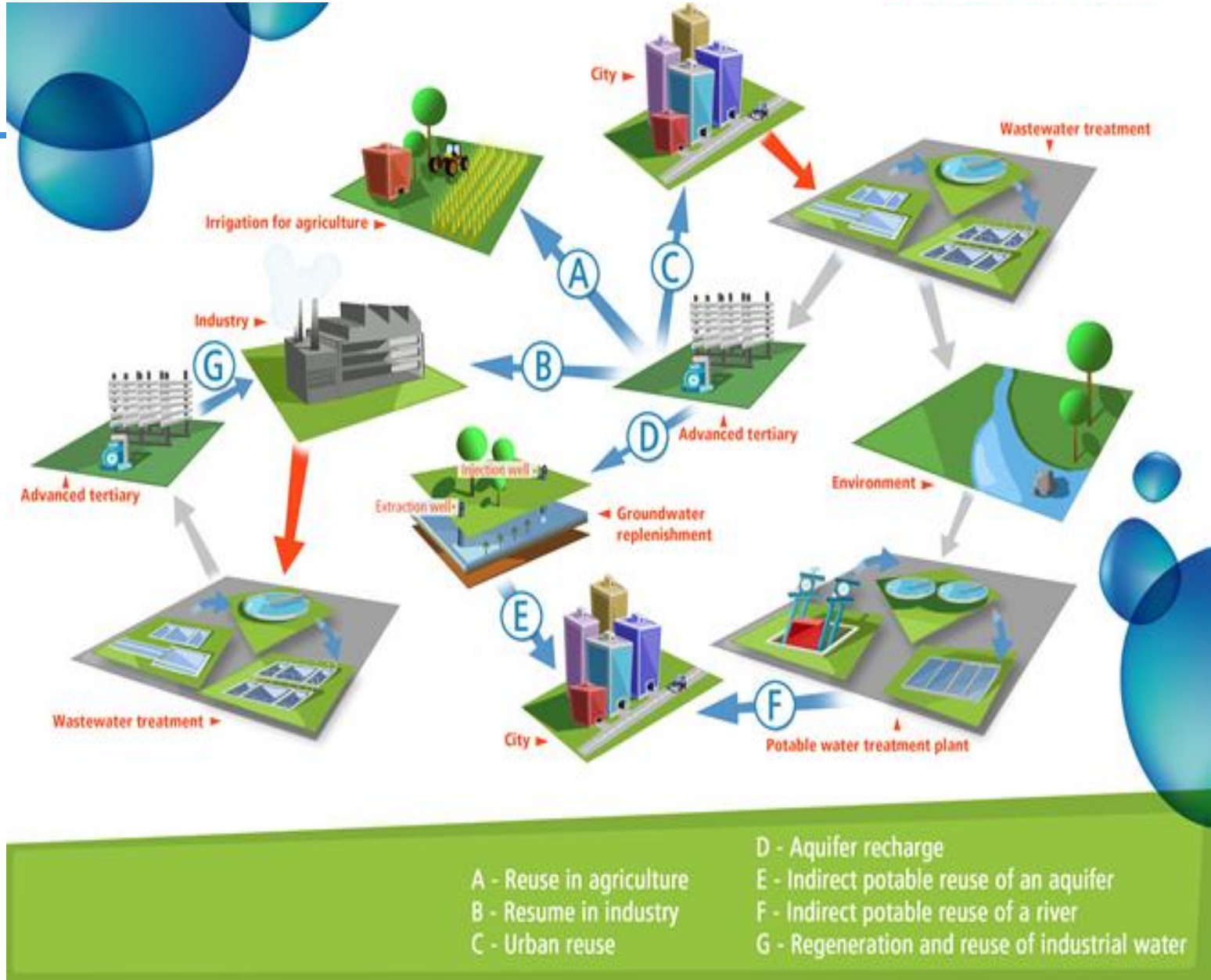
Sources: Created based on data from Macknick et al., 2012; Union of Concerned Scientists, n.d.

Unit: Gallons of water required per megawatt-hour of electricity produced
W: Withdrawal; C: Consumption.

- **Water consumption can be reduced in electricity generation processes by addressing various parameters.**
  - **Cooling types**
  - **Combined cycle arrangements**

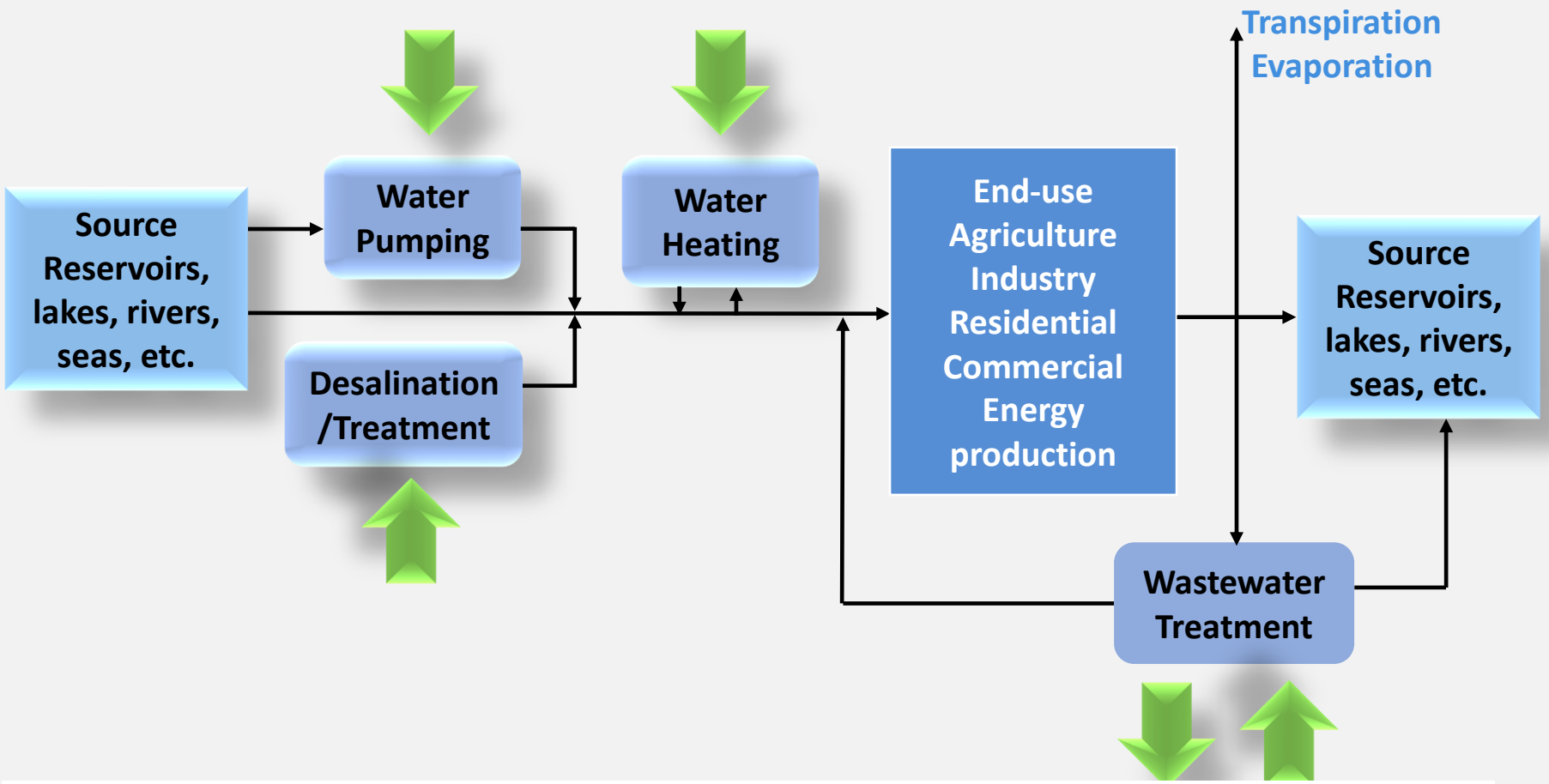
Water reuse

Example: minimum estimate of potential savings from increased water efficiency in the industrial, commercial and institutional sectors of California would be sufficient to fulfil the annual water requirements of the whole city of Los Angeles



Source: Abengoa Water, 2012.

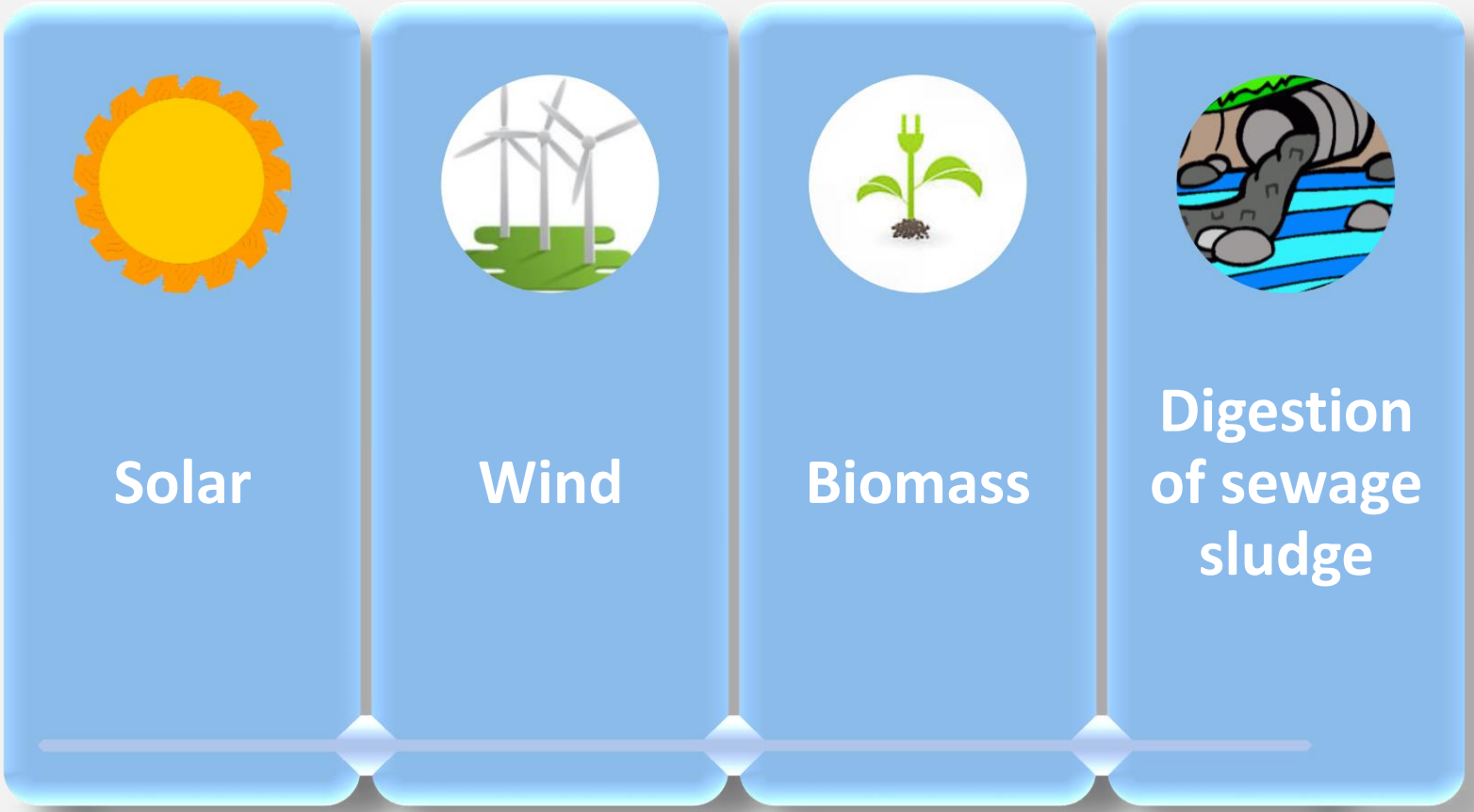
Renewable Energy (RE) across the water supply chain



Green arrows indicate potential RE inputs.

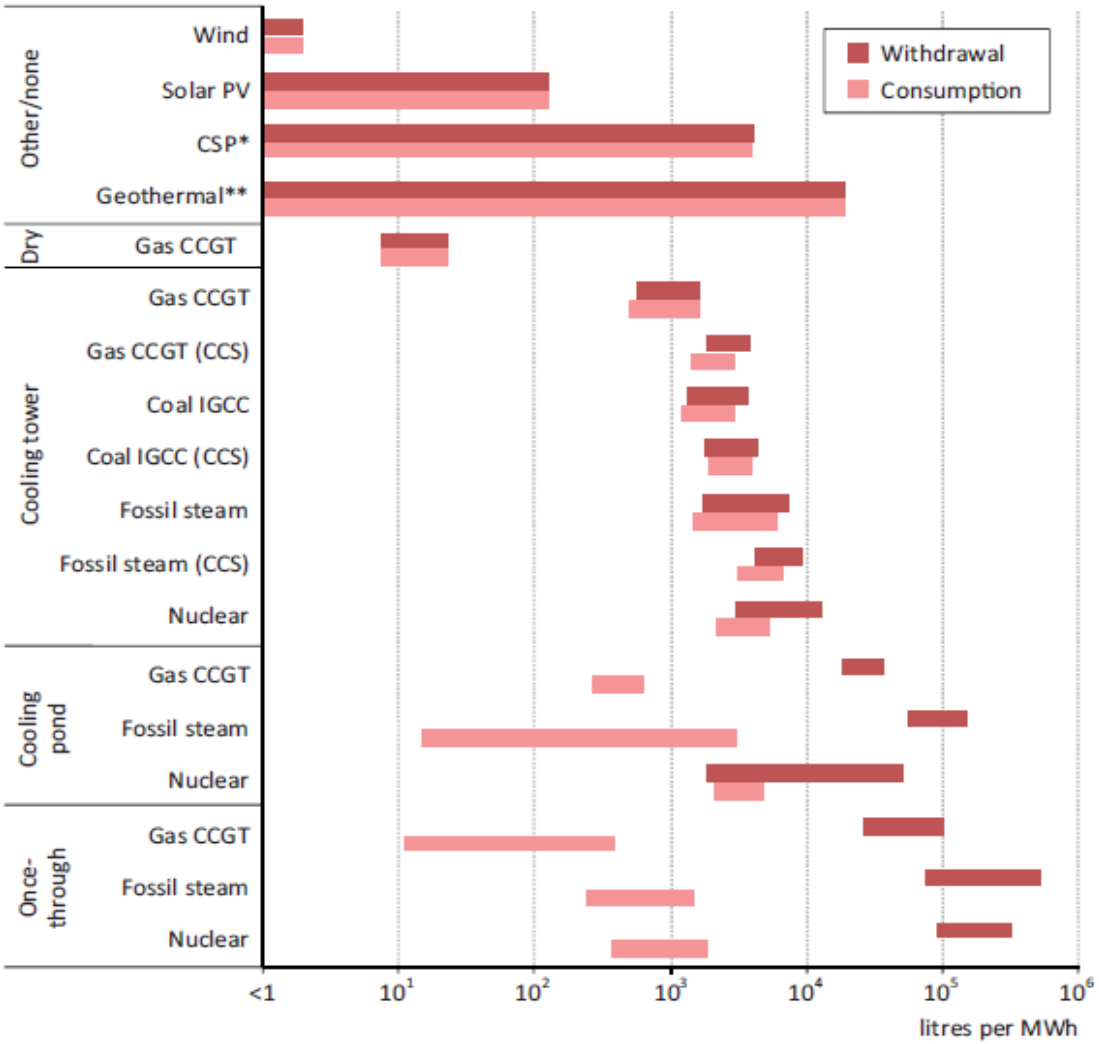
Source: IRENA, 2015a

RE sources for wastewater treatment processes



Water use for electricity generation by cooling technology

- All the RE technologies have the potential to generate electricity with greater amounts of water efficiency, as compared to fossil fuel resources.

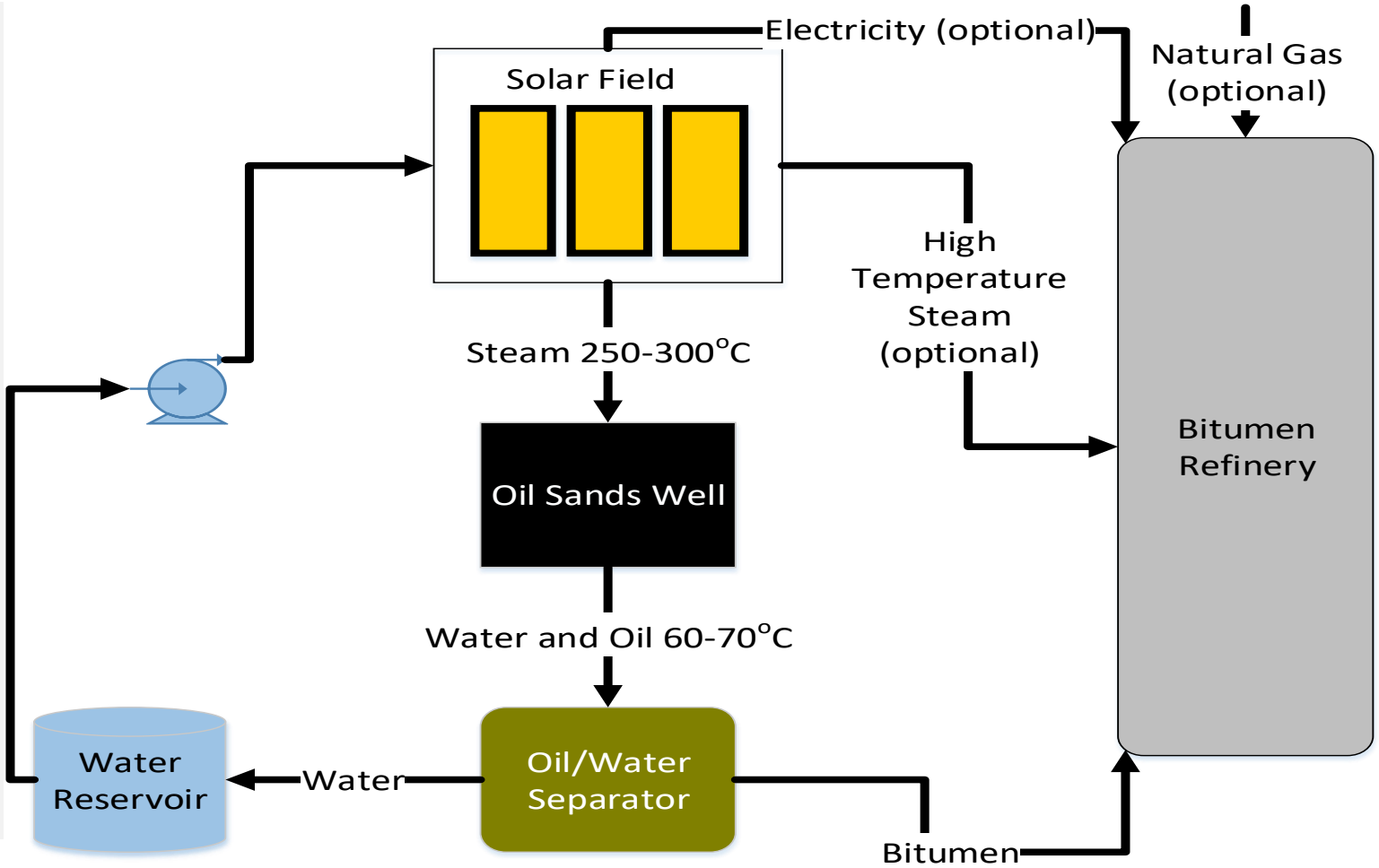


Source: International Energy Agency, 2012.

RE in the oil & gas sector

There are many opportunities for the use of RE technology to strengthen **the security of the water-energy-food nexus.**

Solar EOR system for oil sands



Source: Absi Halabi et al., 2015.

RE in the oil & gas sector

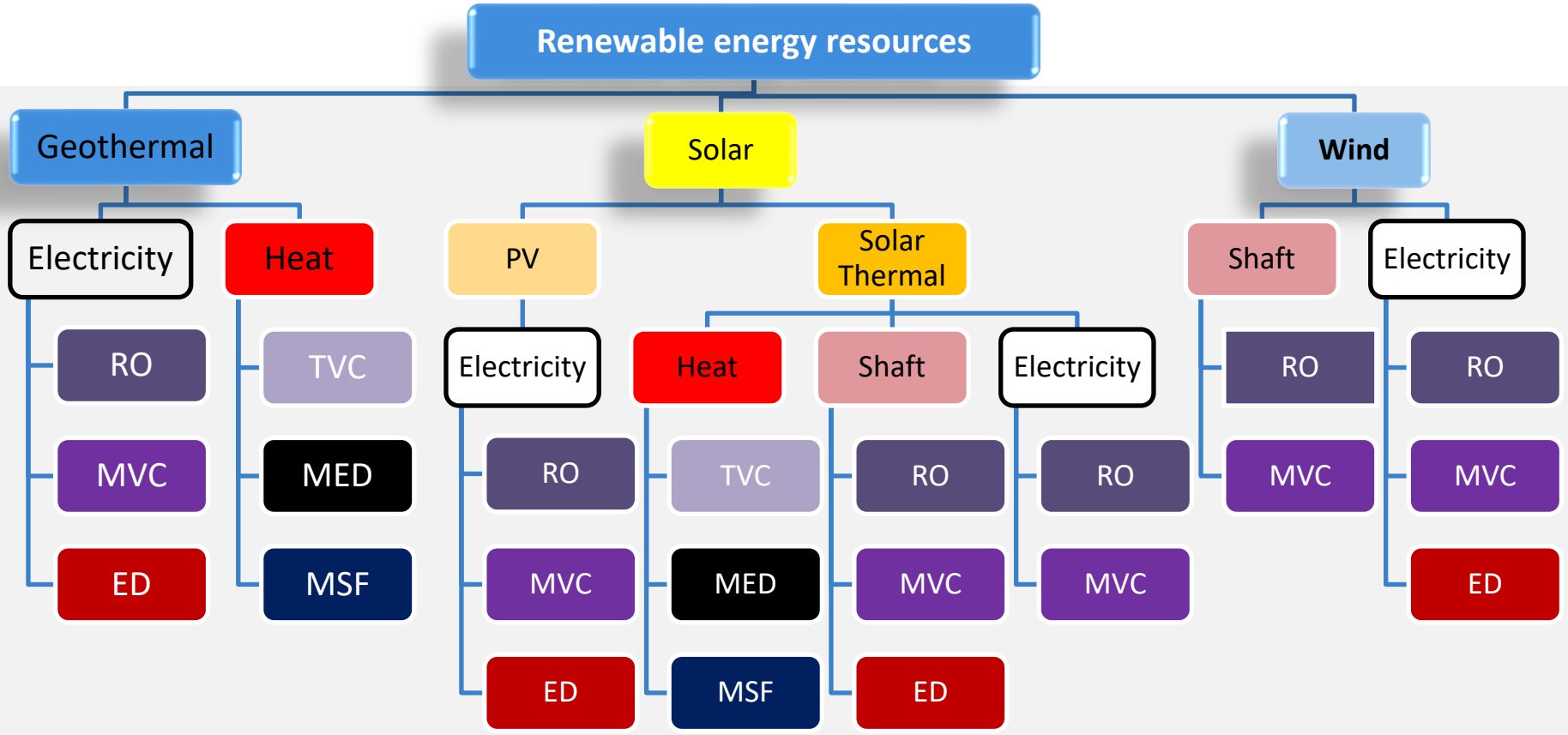
Oil & Gas, Offshore Wind Joint Industry Project Leads to WIN WIN Situation

Most of the major oil companies power their special field applications using PV panels and Shell using combination of wind turbines and PV panels to help power some of its monotower platforms.

The DNV GL-led **WIN WIN** (WINd-powered Water INjection) project, which gathered industry players from oil & gas and offshore wind sectors, including ExxonMobil, ENI Norge, Nexen Petroleum UK Ltd., Statoil, VNG Norge, PG Flow Solutions and ORE Catapult, is on the right track to make the best use of both offshore energy industries in a single project.

(Curtesy of offshorewind.biz website)

Possible pathways for integrating RE resources with different desalination technologies



Source: Al-Karaghouli & Kazmerski, 2011; IRENA, 2015a.

Solar stills, solar-multiple effect humidification, PV- RO, wind-RO, and CSP/MED are the combinations which are currently being applied as RE powered desalination or have more potential to be applied.

Pathways for RE integration with desalination technologies

Solar energy is the most popular type of RE for powering desalination

	Technical Capacity (m^3/d)	Energy Demand (kWh/m^3)	Development Stage
Solar stills	< 0.1	Solar passive	Application
Solar-Multiple Effect Humidification	1-100	thermal: 100 electrical: 1.5	R&D; Application
Solar- MD	0.15-10	thermal: 150–200	R&D
Solar/CSP-MED	> 5,000	thermal: 60–70 electrical: 1.5–2	R&D
PV-RO	< 100	electrical: BW: 0.5–1.5; SW: 4-5	R&D; Application
PV - Electrodialysis Reversed	< 100	electrical: only BW:3–4	R&D
Wind- RO	50-2,000	electrical: BW: 0.5–1.5; SW: 4–5	R&D; Application
Wind- MVC	< 100	electrical: only SW:11–14	Basic Research

Source: Al-Karaghouli & Kazmerski, 2011; IRENA, 2015a.

Promoting WEF nexus through cooperation, policy, field projects and capacity development in the Arab region

https://www.unescwa.org/

REGEND

https://www.unescwa.org/sub-site/renewable-energy-rural-arab-region-regend

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Sweden Sverige

Food and Agriculture Organization of the United Nations

ICARDA Science for Better Livelihoods in Dry Areas

AUB American University of Beirut

Arab Countries

Key Recommendations:
WEF Nexus – from Technology and operational implementation perspective

- The **costs associated with RE technologies have decreased** over the past few years and become comparable with those of fossil fuels.
- **More energy-efficient desalination technologies can play a pivotal role in improving the overall energy consumption, especially in the Arab region.**
- **Cost sharing between energy and water utilities must be facilitated in support of efficiency measures. Water avoided costs must be considered with embedded energy analysis.**
- **By regulating tariffs more effectively, the investment required for the adoption of more energy- and water-efficient technologies can be facilitated, and End-use consumption can be better influenced**.
- WEF indicators **are vital to measure progress with respect to the water-energy nexus**.
- The data required for these indicators can be difficult to obtain **depending on the complexity of the indicator. KPIs need to be developed in line with SDGs**
- The level of **coordination and collaboration** between the water and energy and agricultural sectors in all stages of planning and implementation must be increased.

Radia Sedaoui
Climate Change and Natural Resource Sustainability Cluster
ESCWA
Sedaoui@un.org

Thank you

https://www.unescwa.org/sub-site/renewable-energy-rural-arab-region-regend