TECHNOLOGIES TO IMPROVE WATER EFFICIENCY

Water-Energy Nexus Operational Toolkit : Resource Efficiency

20/02/2017

Economic and Social Commission for Western Asia

Prof. Hassan Arafat

ESCWA Consultant

UNITED NATIONS

الاسكوا

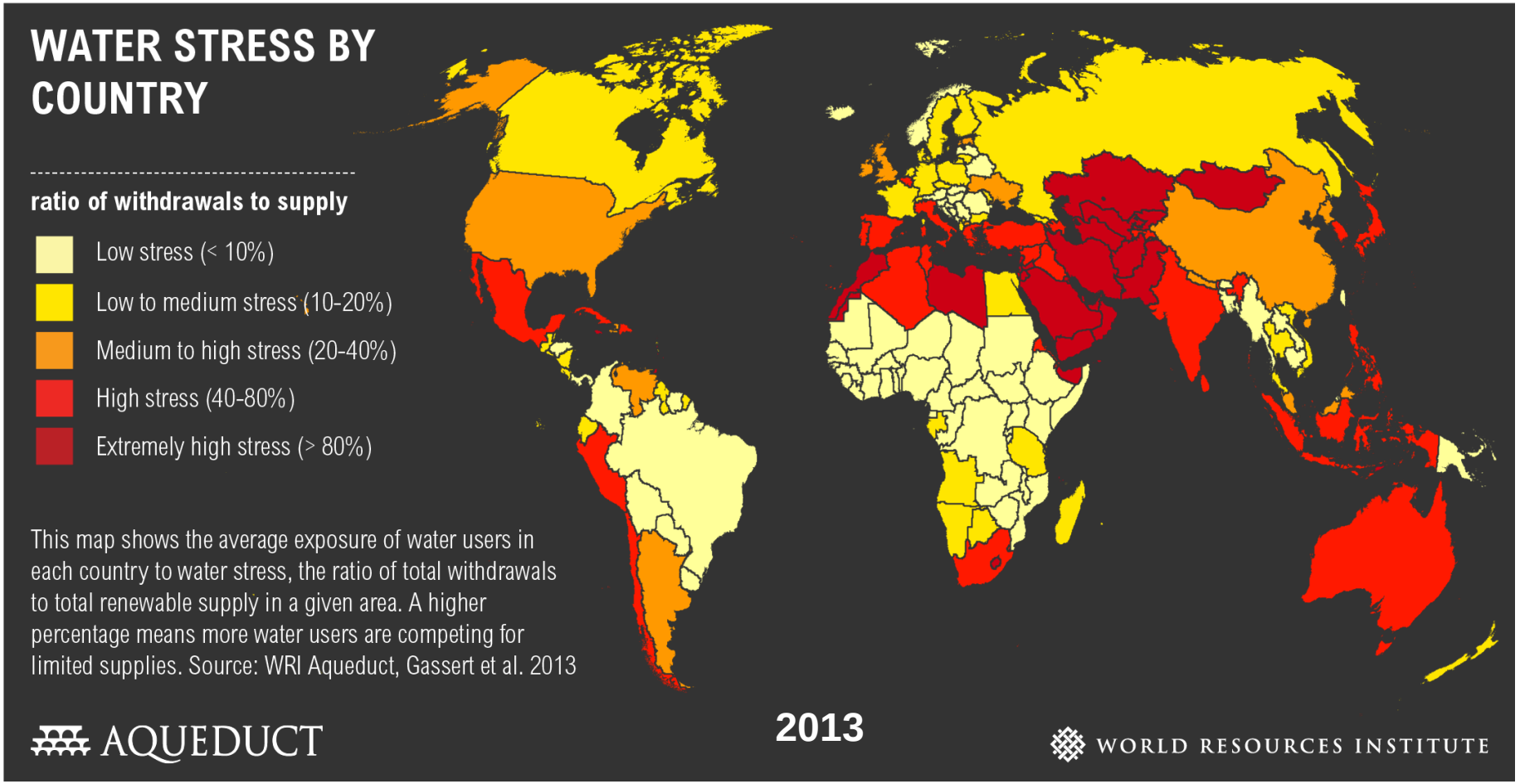
ESCWA

Outline

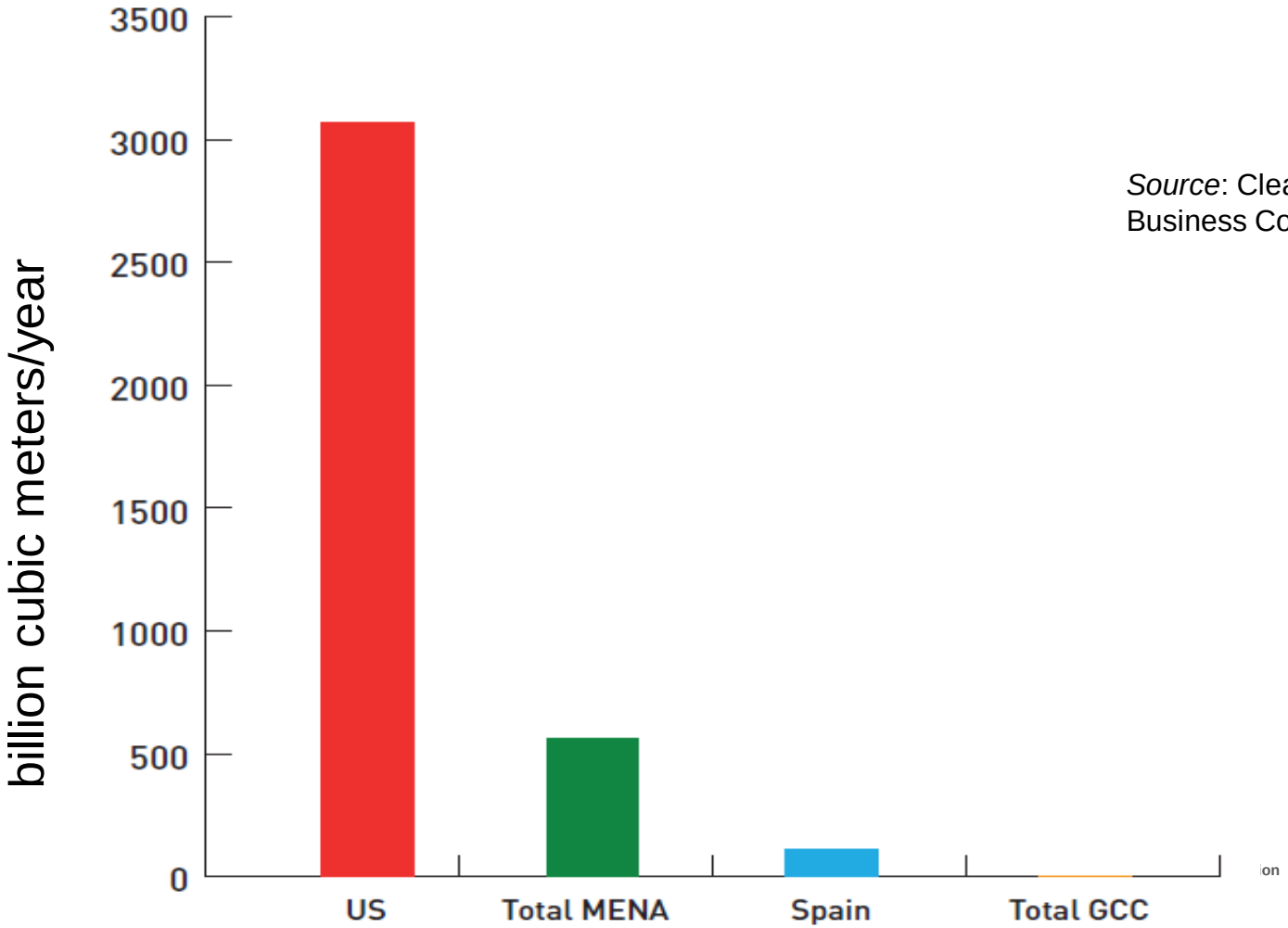
- Introduction
- Water efficiency in electricity production
- Water efficiency in oil and gas industry
- Water efficiency in industrial, commercial & institutional sectors
- Water efficiency in water production and distribution systems
- Key messages

Introduction

Water stress in the Arab countries

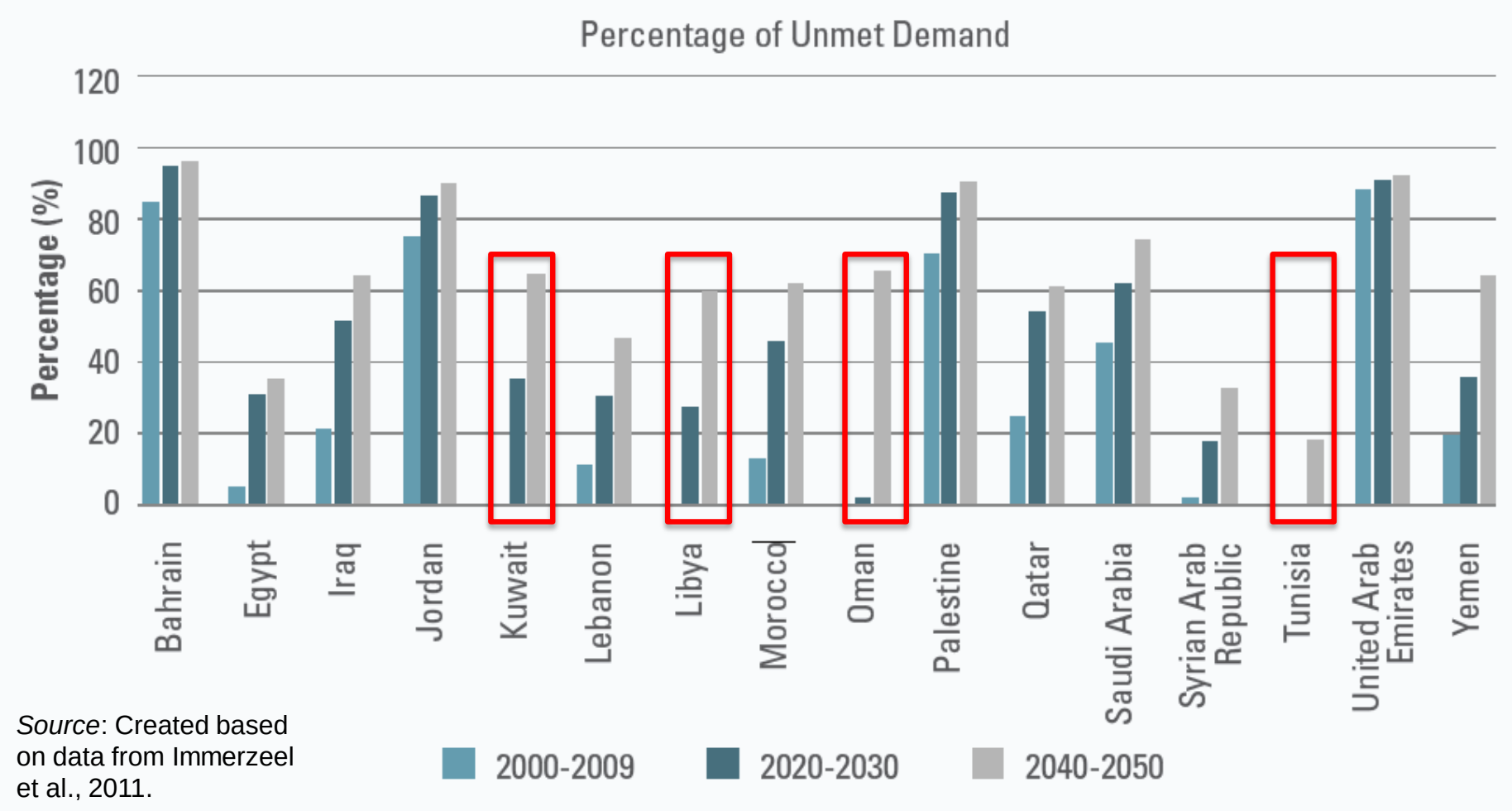


Total renewable water resources



Source: Clean Energy Business Council, 2011.

Unmet water demand in Arab countries



Source: Created based on data from Immerzeel et al., 2011.

Water reuse in the Arab countries

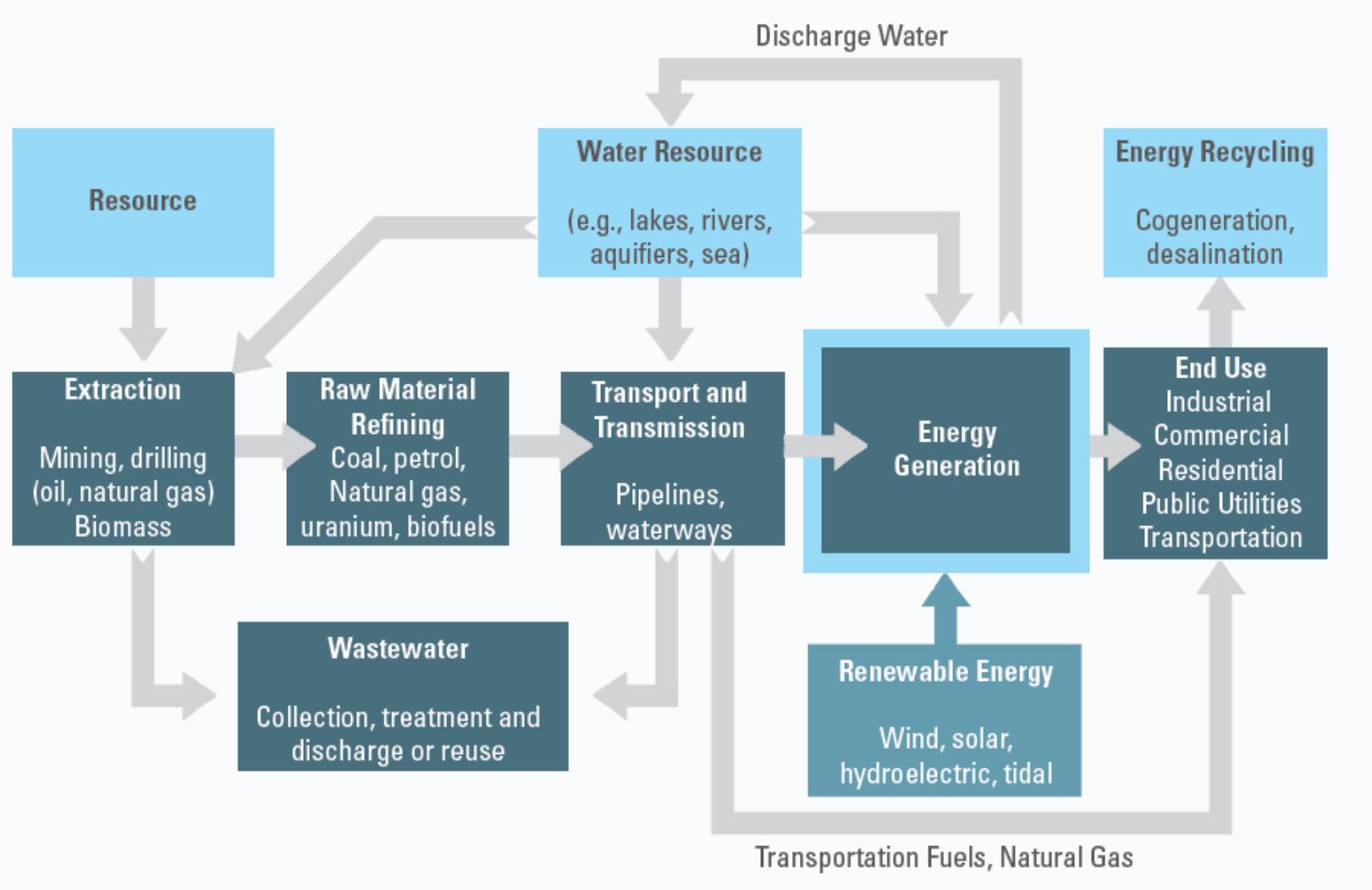
Countries	Percentage of wastewater **treated**	Percentage of treated wastewater **reused**	Reused water as a percentage of total water withdrawn
Algeria	85.37	7.29	0.84
Bahrain	100.00	**36.30**	4.56
Egypt	79.79	23.33	1.02
Iraq	17.04	5.61	0.01
Jordan	94.87	91.89	10.84
Kuwait	95.60	**32.64**	8.54
Lebanon	1.29	50.00	0.15
Libya	**7.33**	100.00	0.92
Morocco	25.29	45.20	0.63
Oman	37.76	6.22	0.17
Qatar	14.86	65.15	7.82
Saudi Arabia	89.32	25.46	0.70
Syria	**40.15**	100.00	3.29
Tunisia	52.06	28.33	2.39
UAE	90.80	**54.63**	6.20
West Bank & Gaza	60.00	18.13	1.30
Yemen	62.16	13.04	0.18

Source: The World Bank, 2011. .

Water efficiency in electricity production

Water efficiency in electricity production

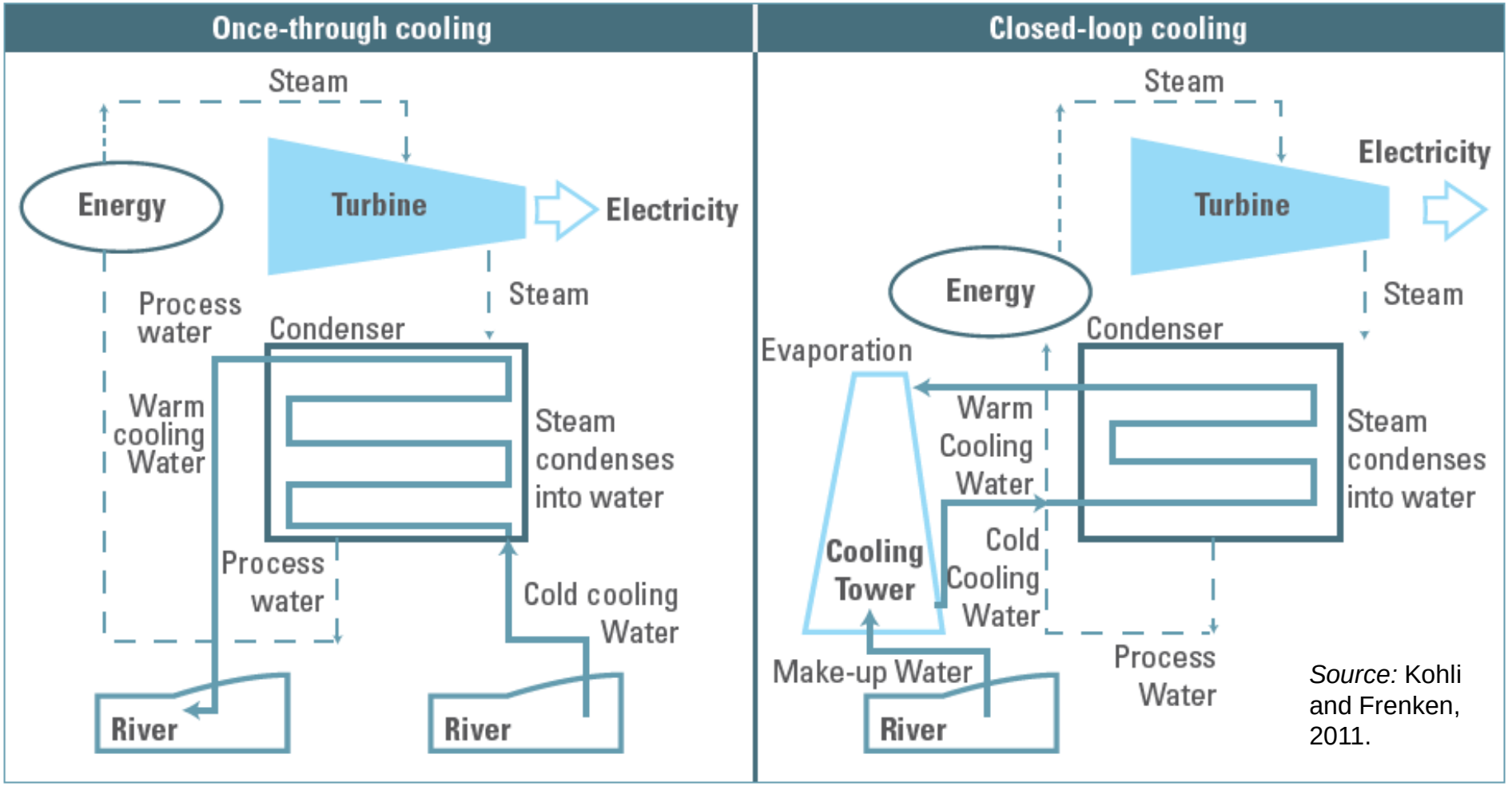
Embedded water in energy



Source: Water in the West, 2013.

Water efficiency in electricity production

Types of cooling processes



Source: Kohli and Frenken, 2011.

Water use in cooling processes

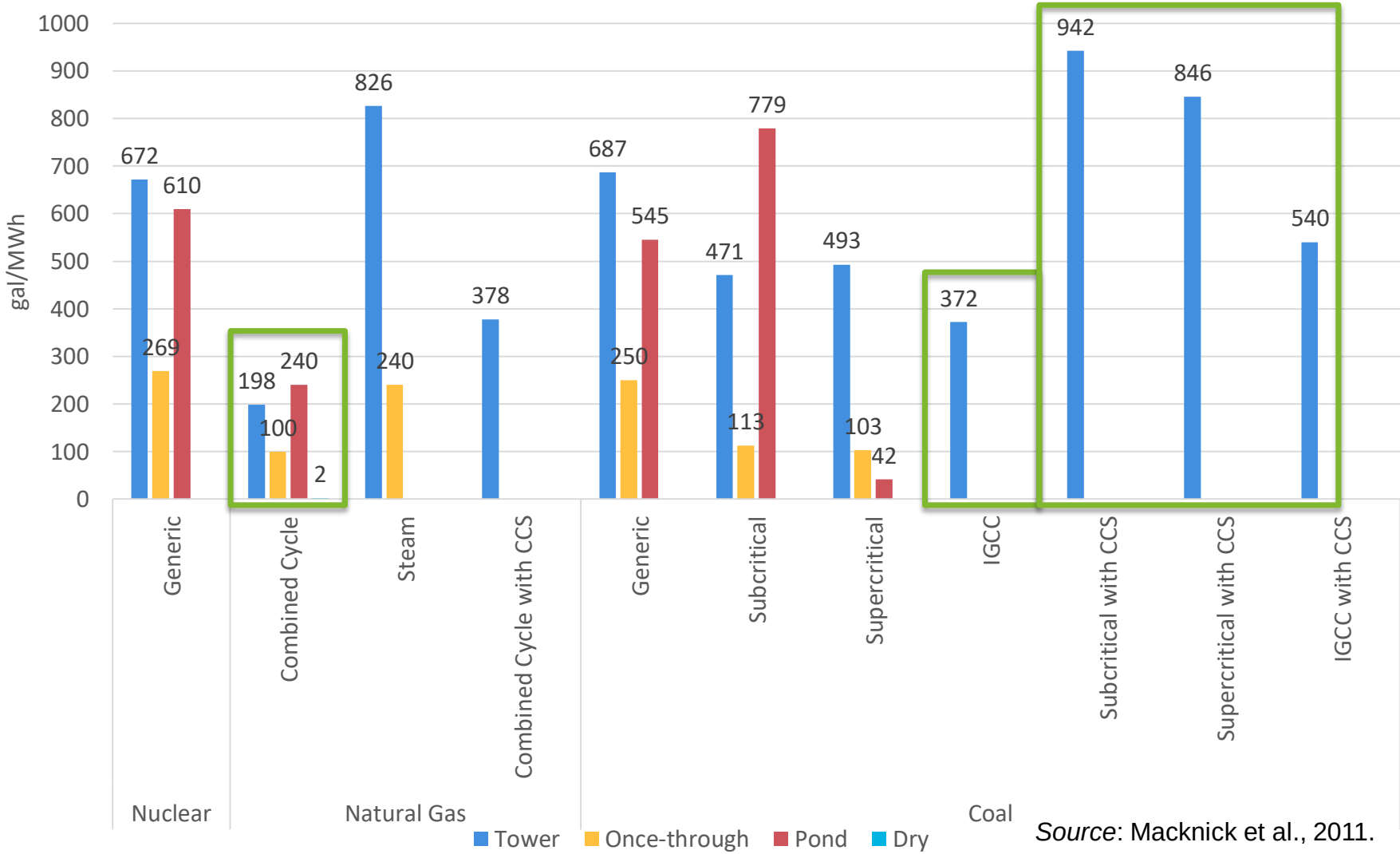
	Once-through		Recirculating		Dry-cooling	
	W	C	W	C	W	C
Coal (conventional)	20,000-50,000	100-317	500-1,200	480-1,100	N/A	N/A
Natural gas (combined cycle)	7,500-20,000	20-100	150-283	130-300	0-4	0-4
Nuclear	25,000-60,000	100-400	800-2,600	600-800	N/A	N/A

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

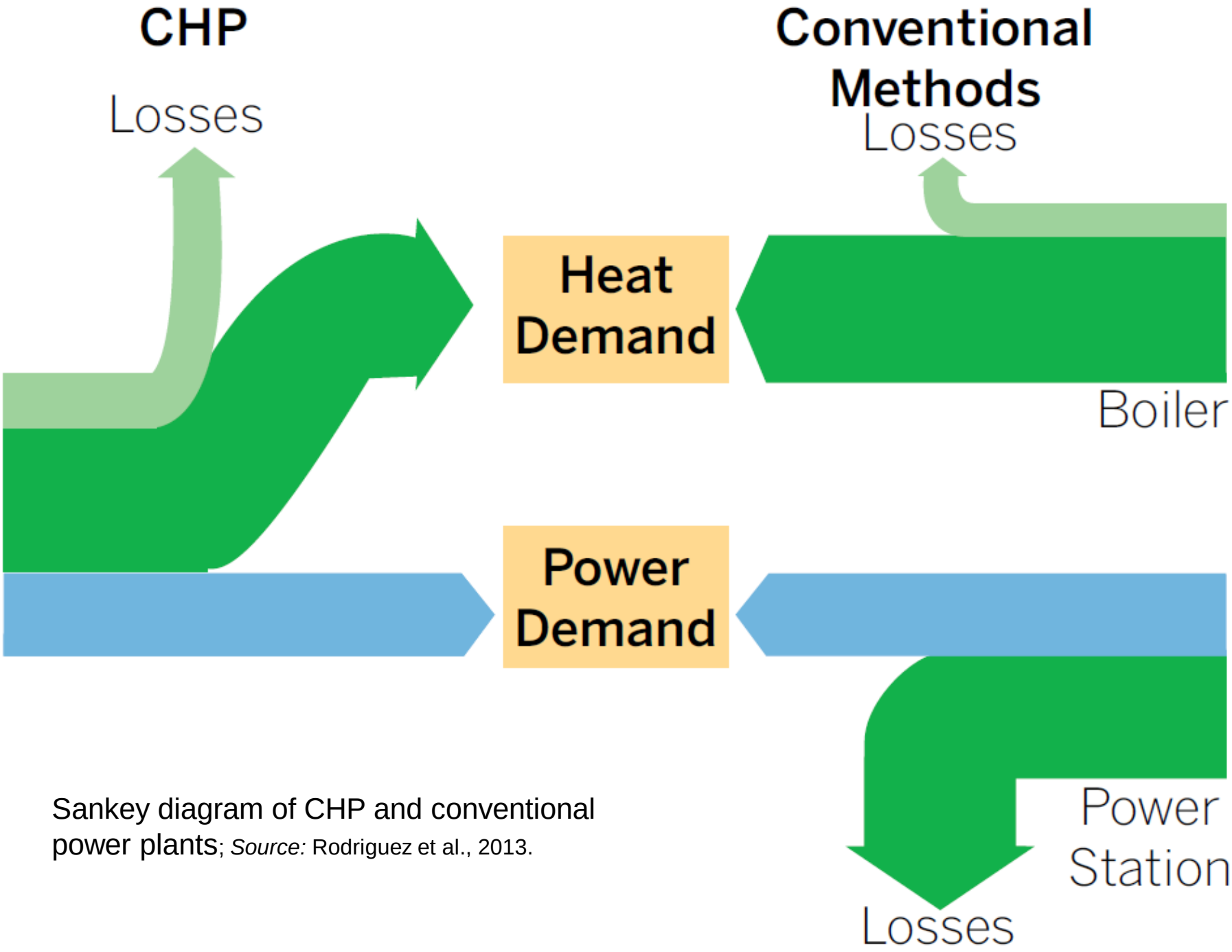
Unit: Gallons of water required per megawatt-hour of electricity produced
W: Withdrawal; C: Consumption.

Water efficiency in electricity production

Water consumption factors of conventional power plants



Source: Macknick et al., 2011.

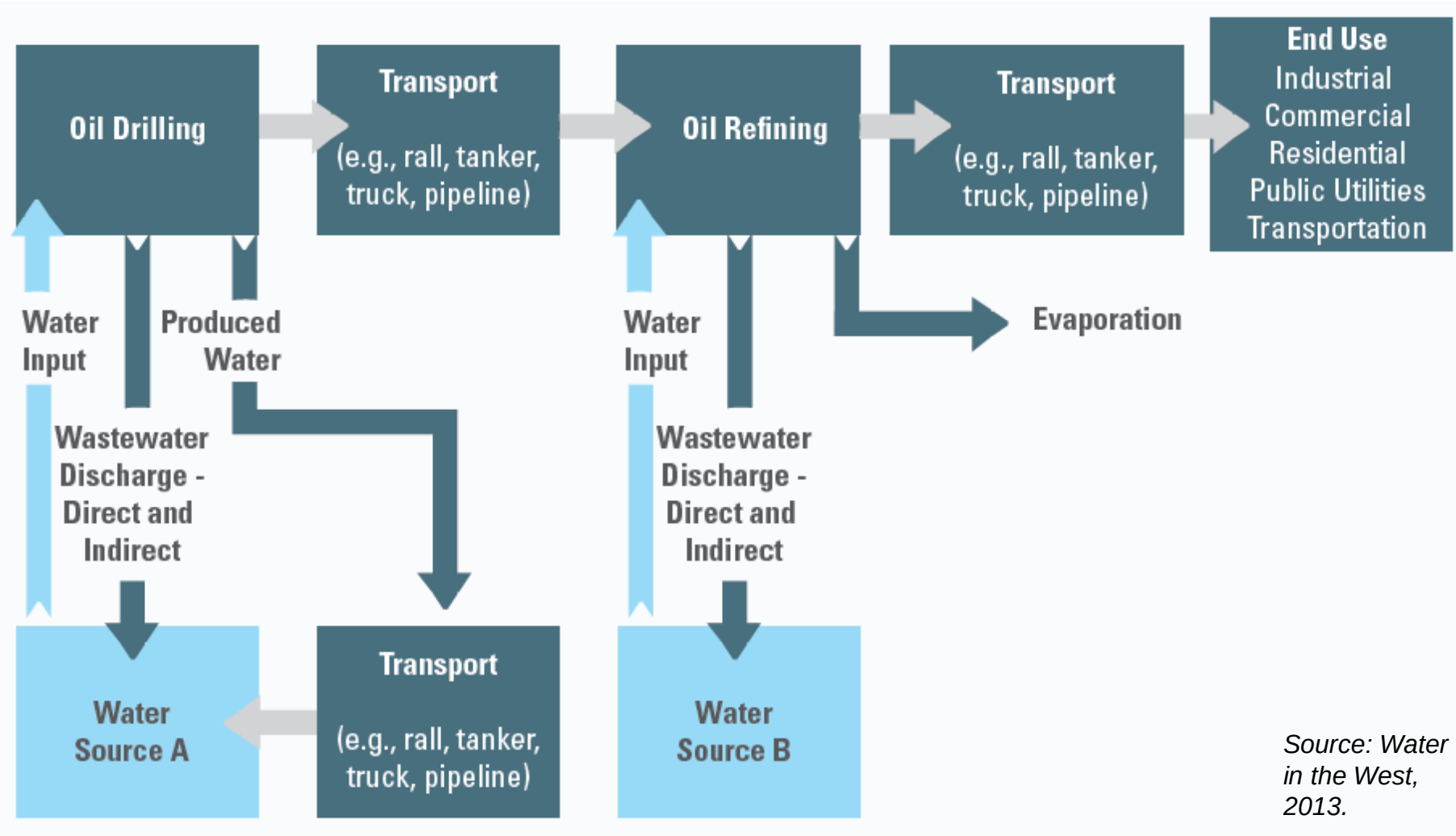


Sankey diagram of CHP and conventional power plants; *Source:* Rodriguez et al., 2013.

Water efficiency in oil and gas industry

Oil and gas industry

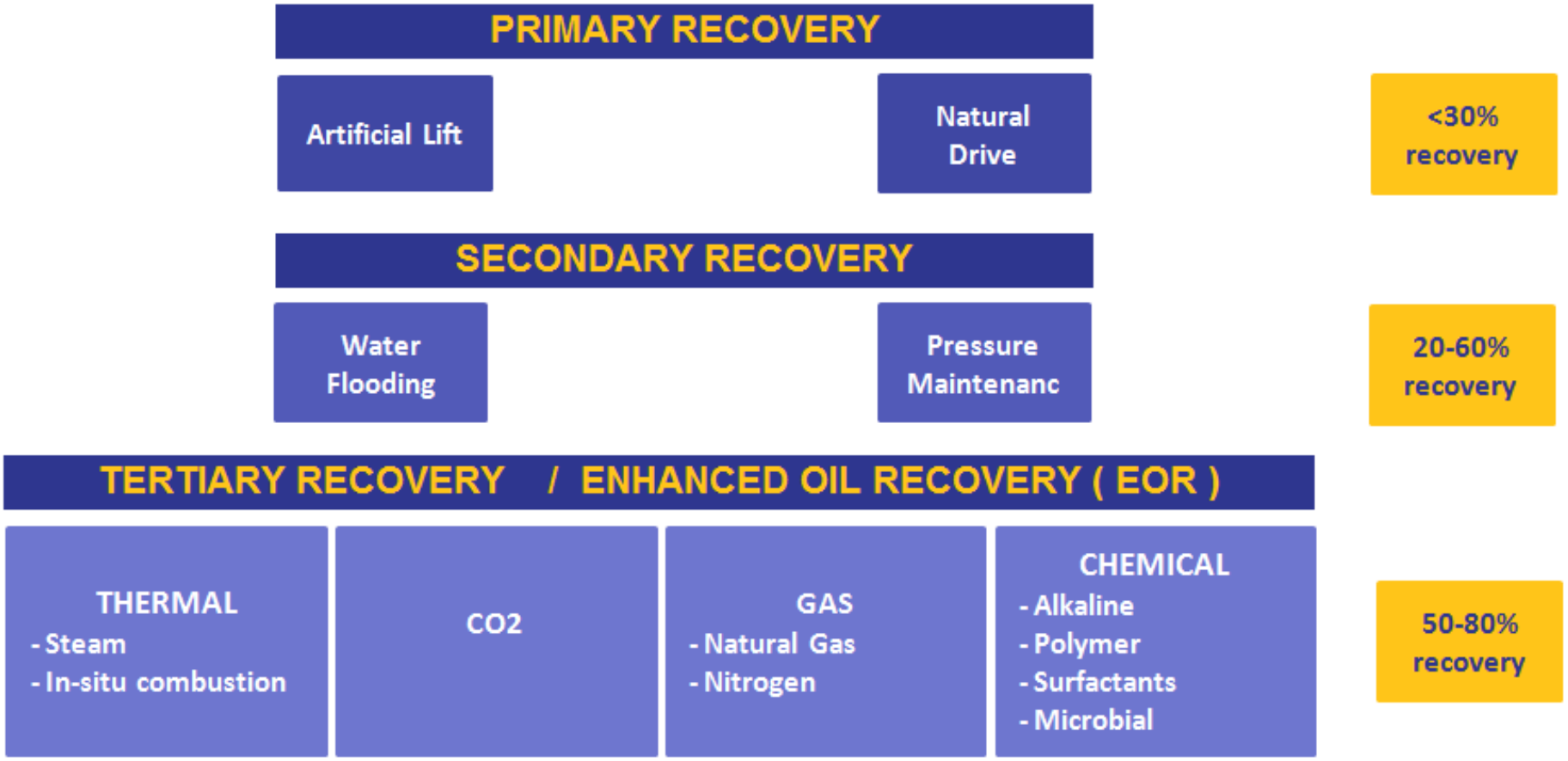
Embedded water in oil and gas processes



Source: Water in the West, 2013.

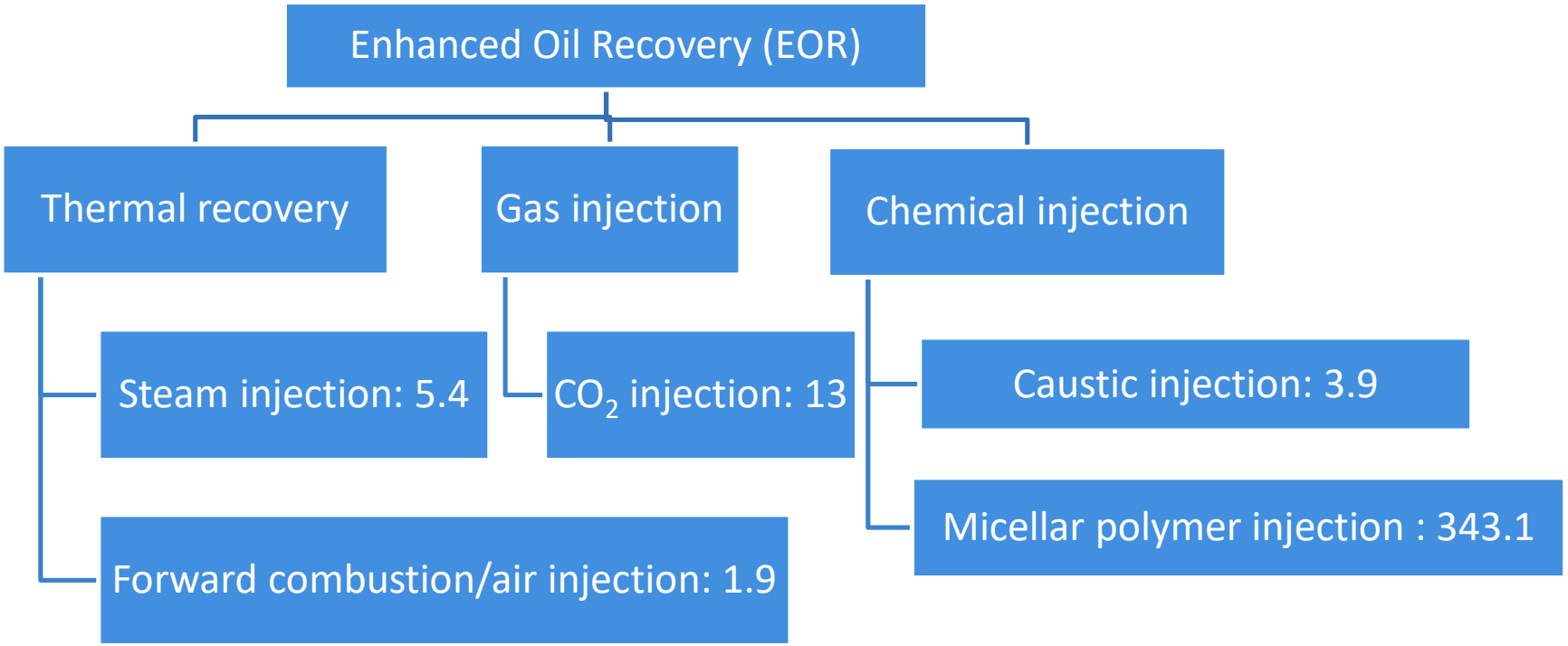
Oil and gas industry

Water coefficients in primary energy production



Enhanced Oil Recovery (EOR)

Injection water required (gallons of water/gallons of crude oil) for various oil recovery technologies.



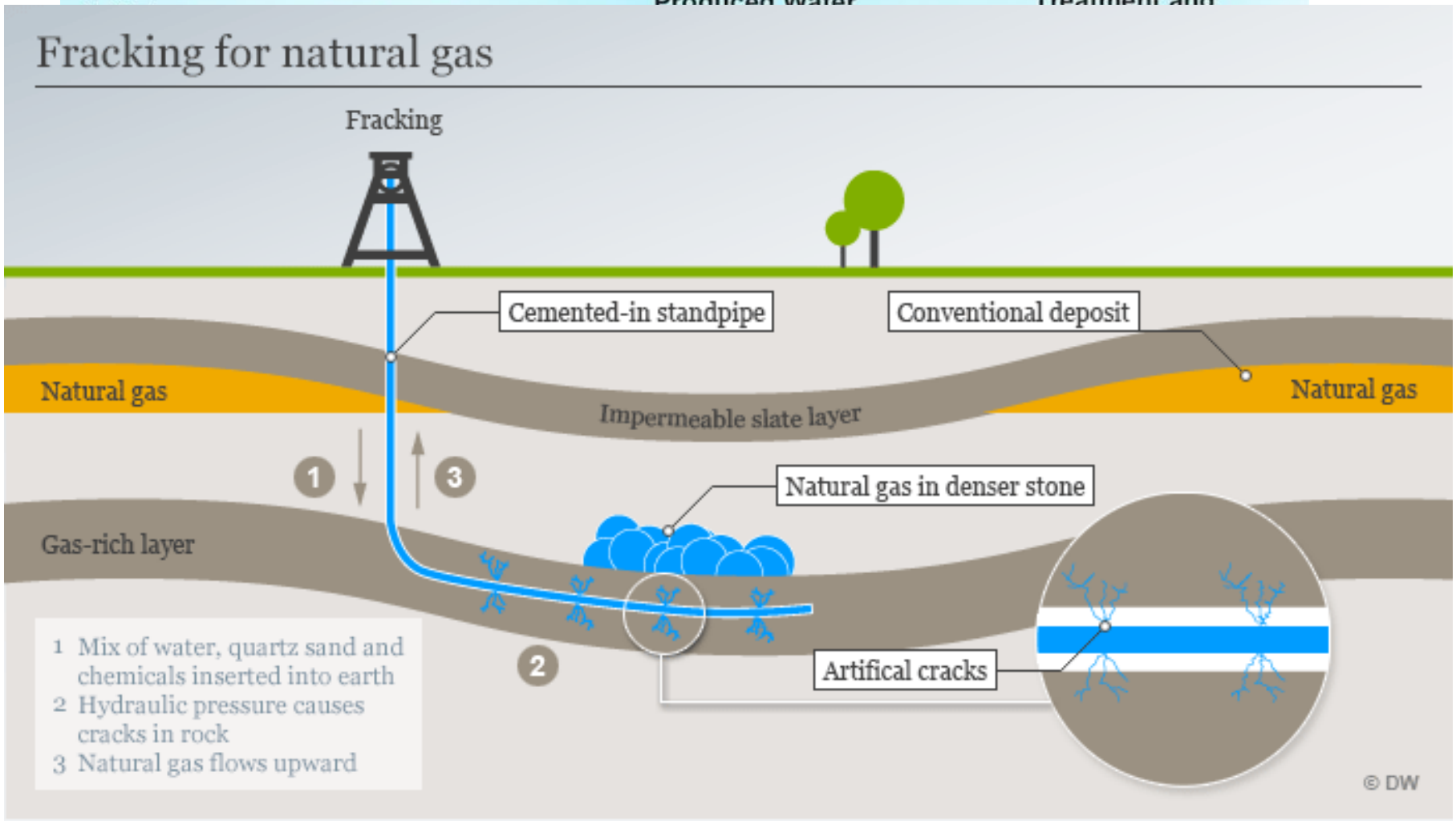
Source: Xylem, 2014.

Oil and gas industry

Fracking

4. Flowback and Produced Water

5. Wastewater Treatment and

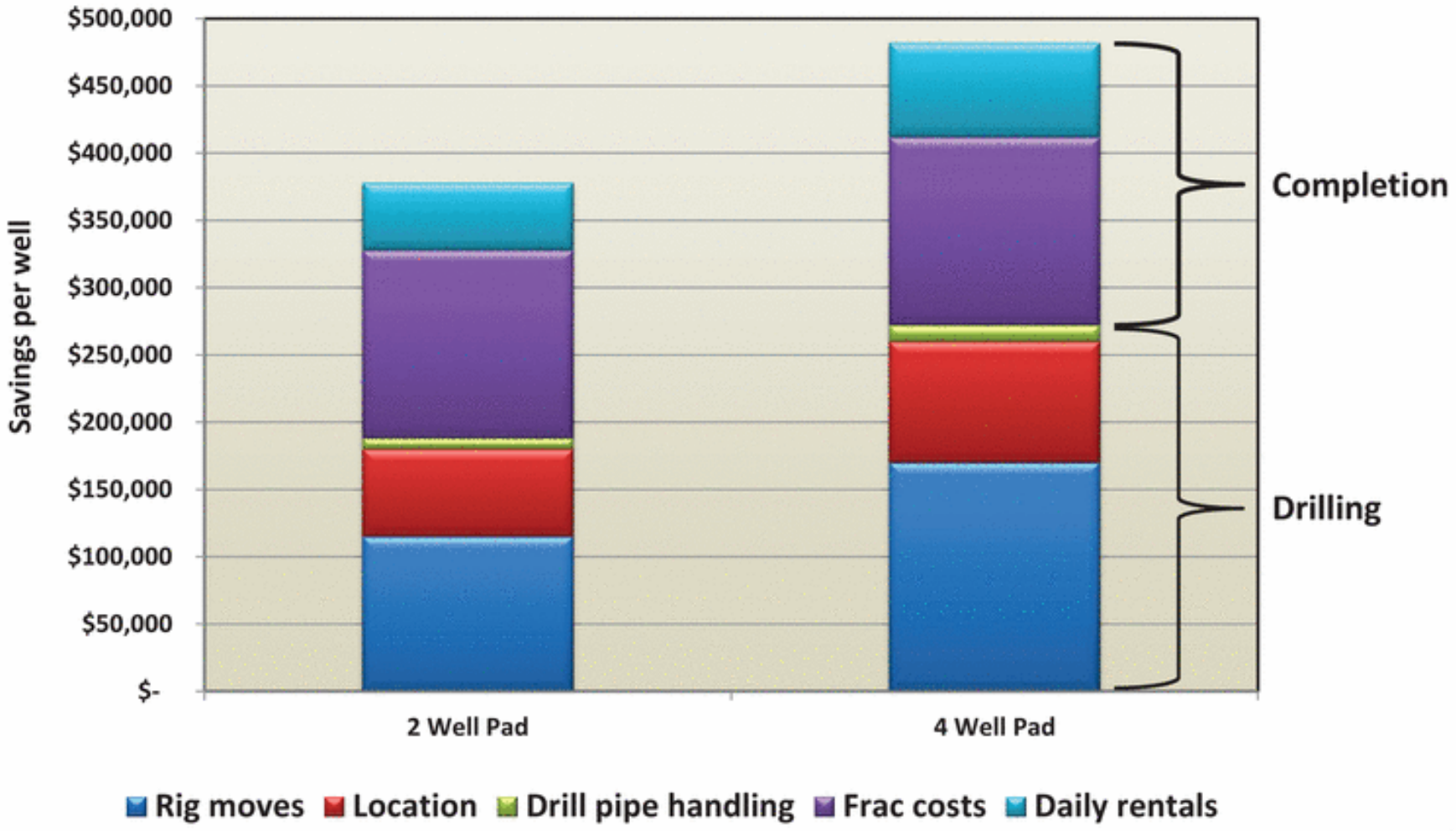


Water reuse in the oil and gas industry

Water efficiency in the oil and gas industry can be improved by using pipelines, onsite treatment, and reusing wastewater and produced water.

- Reusing produced water facilitates automated water resources management.
- Reusing produced water provides a stable water supply and more resilient operations.
- Produced water reuse is becoming more prevalent as policies on water use and discharge are become more stringent.

Multi-Well Pad Savings

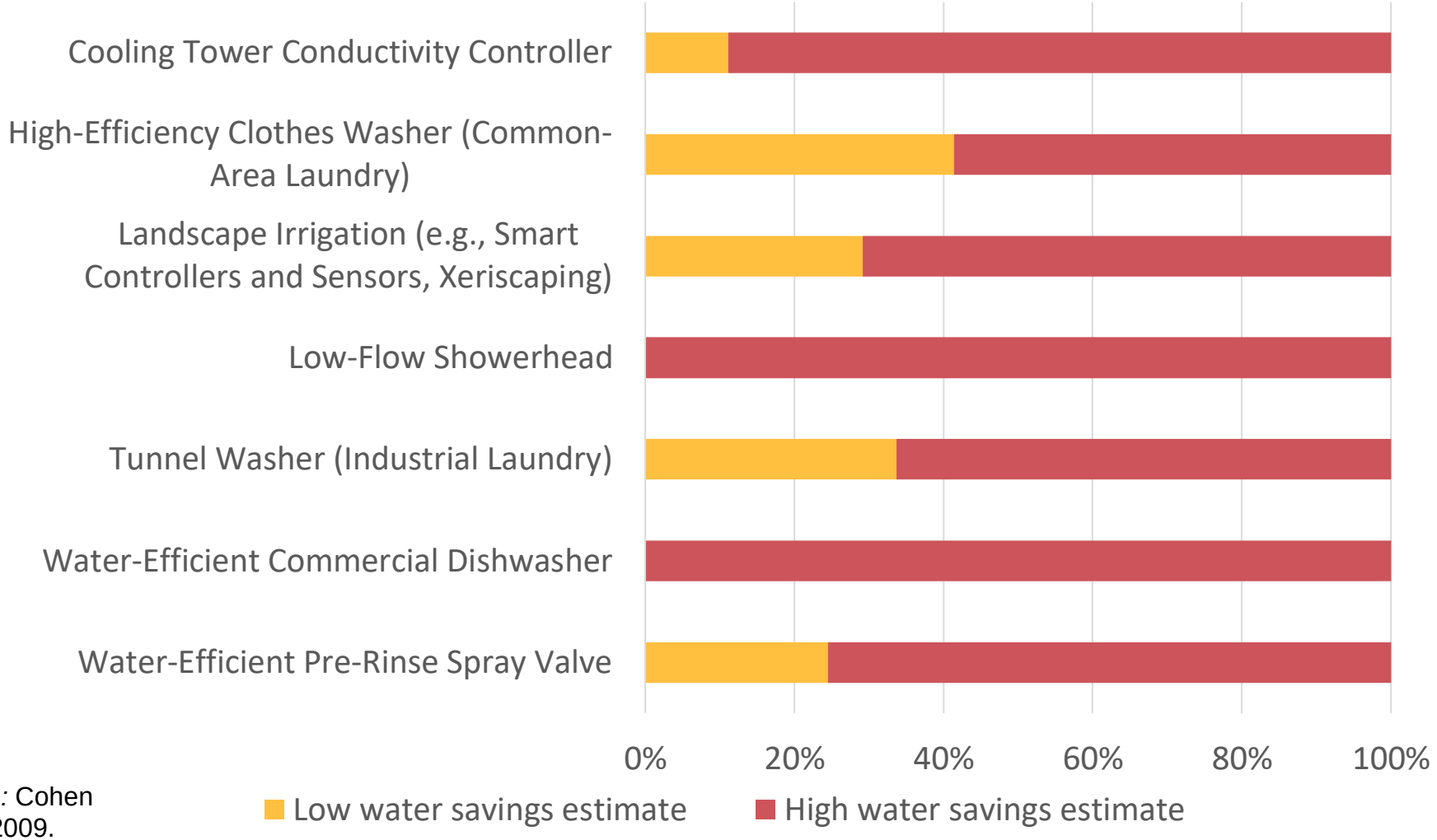


Water efficiency in industrial, commercial & institutional sectors

Example: The 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 (both residential and non-residential applications).

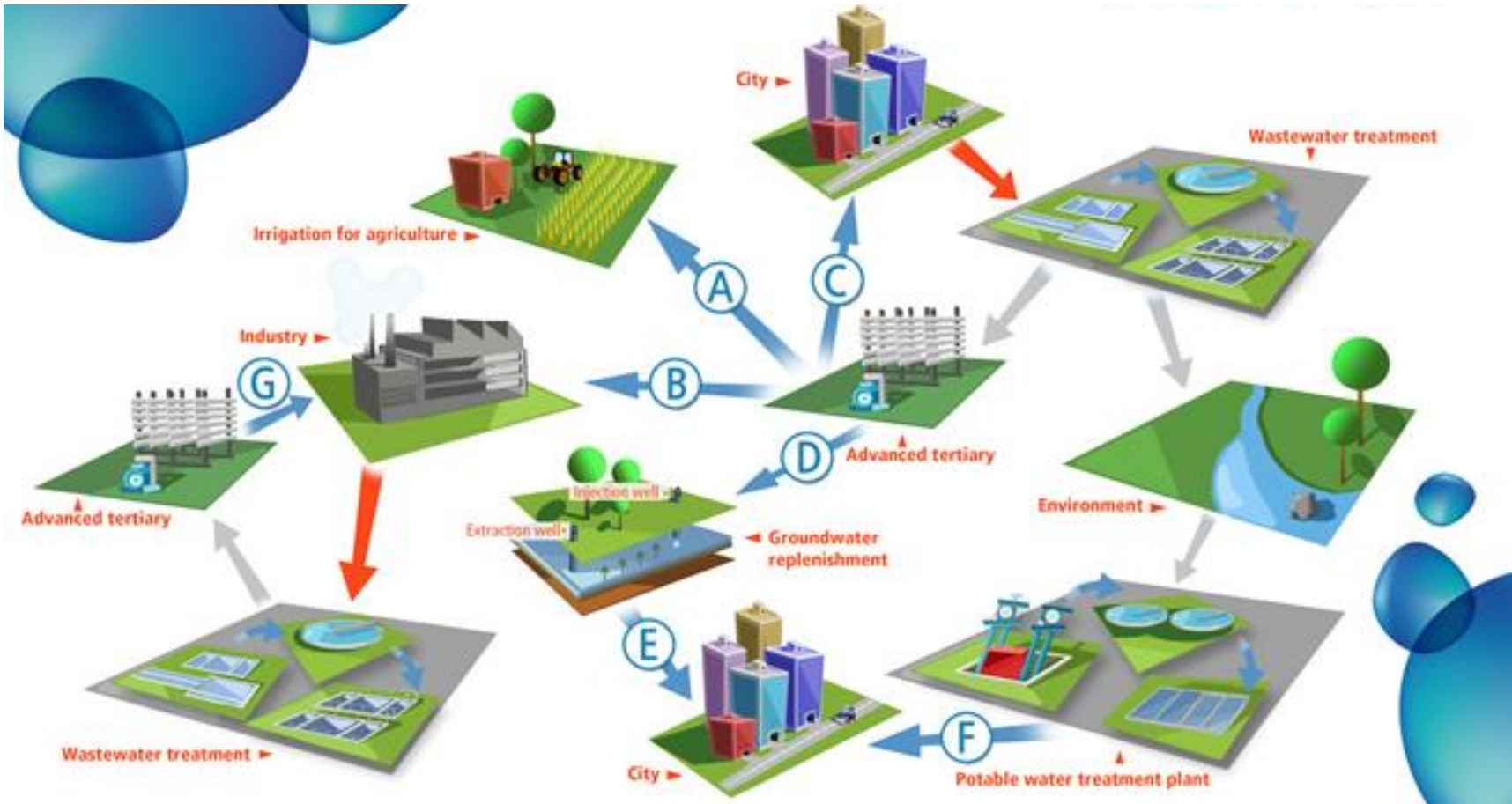
Industrial, commercial & institutional sectors

Potential savings from water efficient technologies



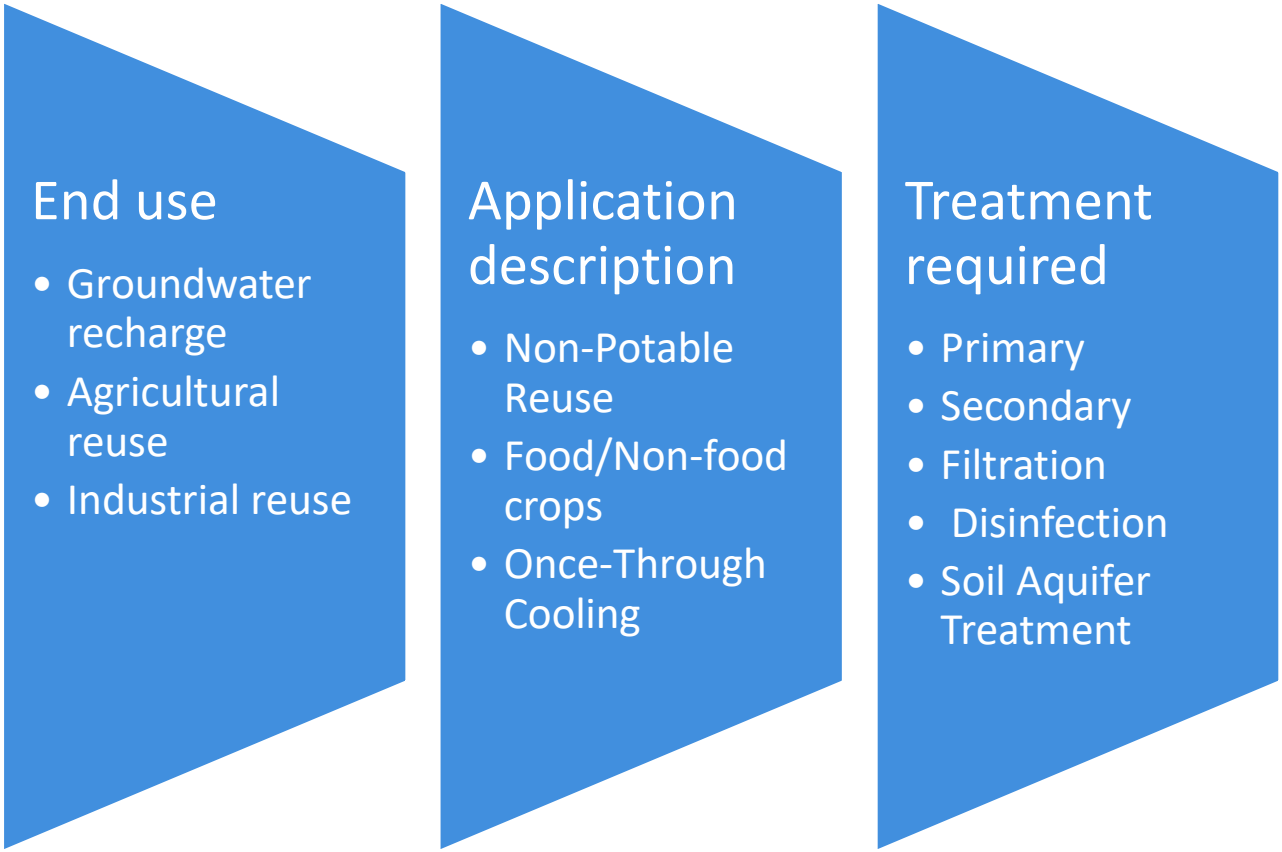
Source: Cohen et al., 2009.

Water reuse



Source: Abengoa Water, 2012.

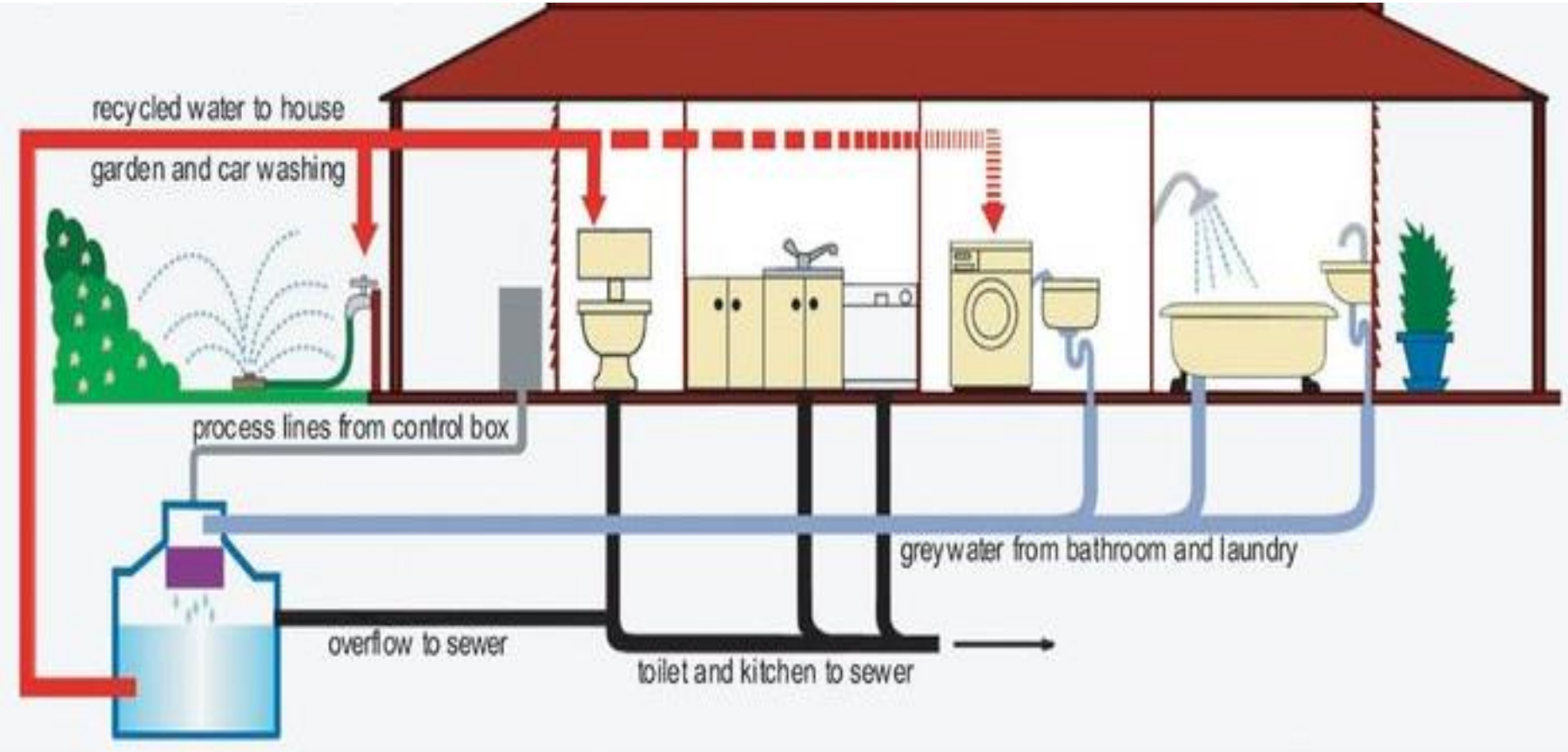
Recycling water – Considerations



Source: Water in the West, 2013.

Industrial, commercial & institutional sectors

Greywater recycling systems



Schematic diagram of a greywater recycling system; *Source*: Tanked Australia, 2007.

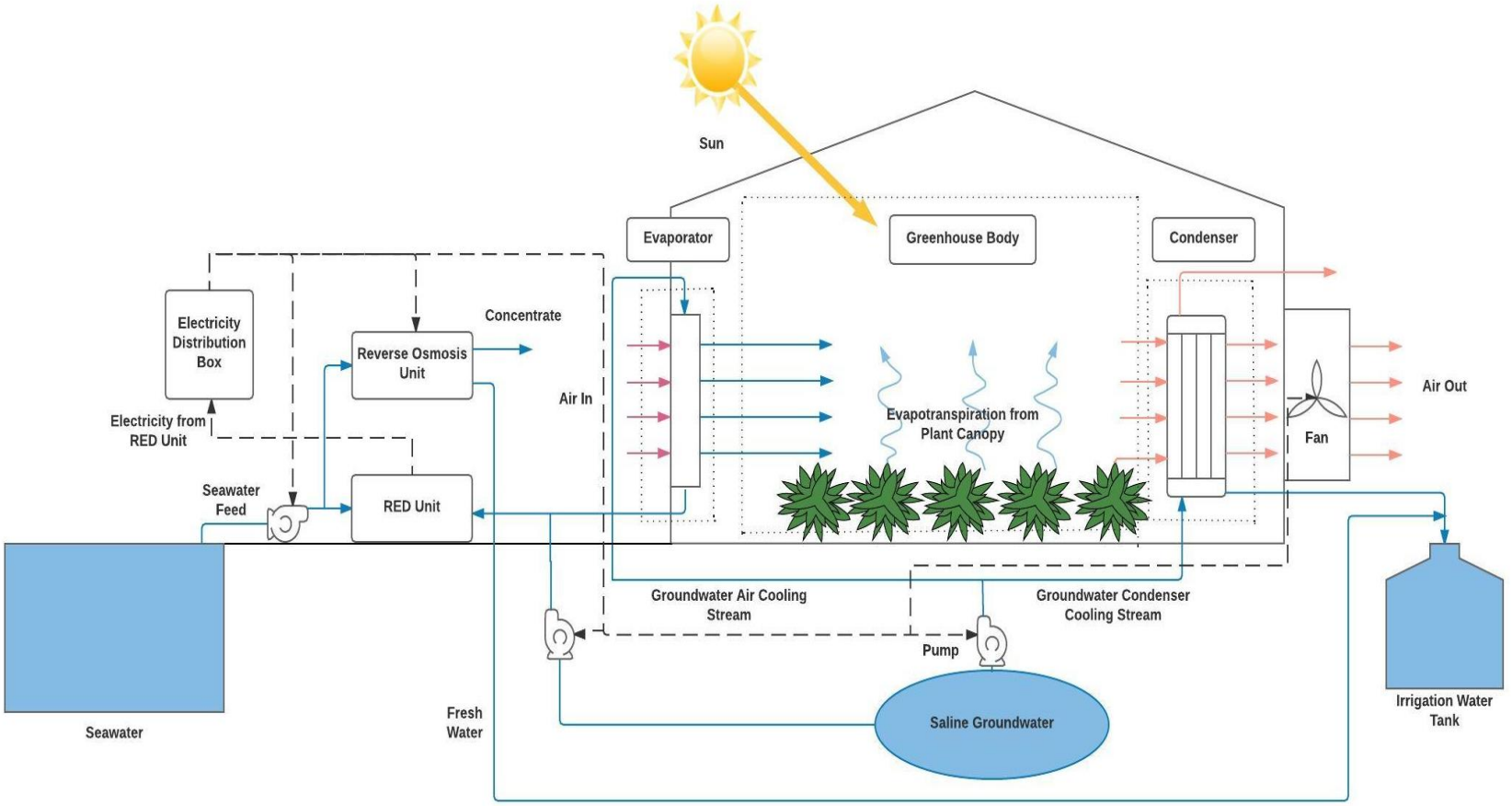
Industrial, commercial & institutional sectors

Faucets and Toilets

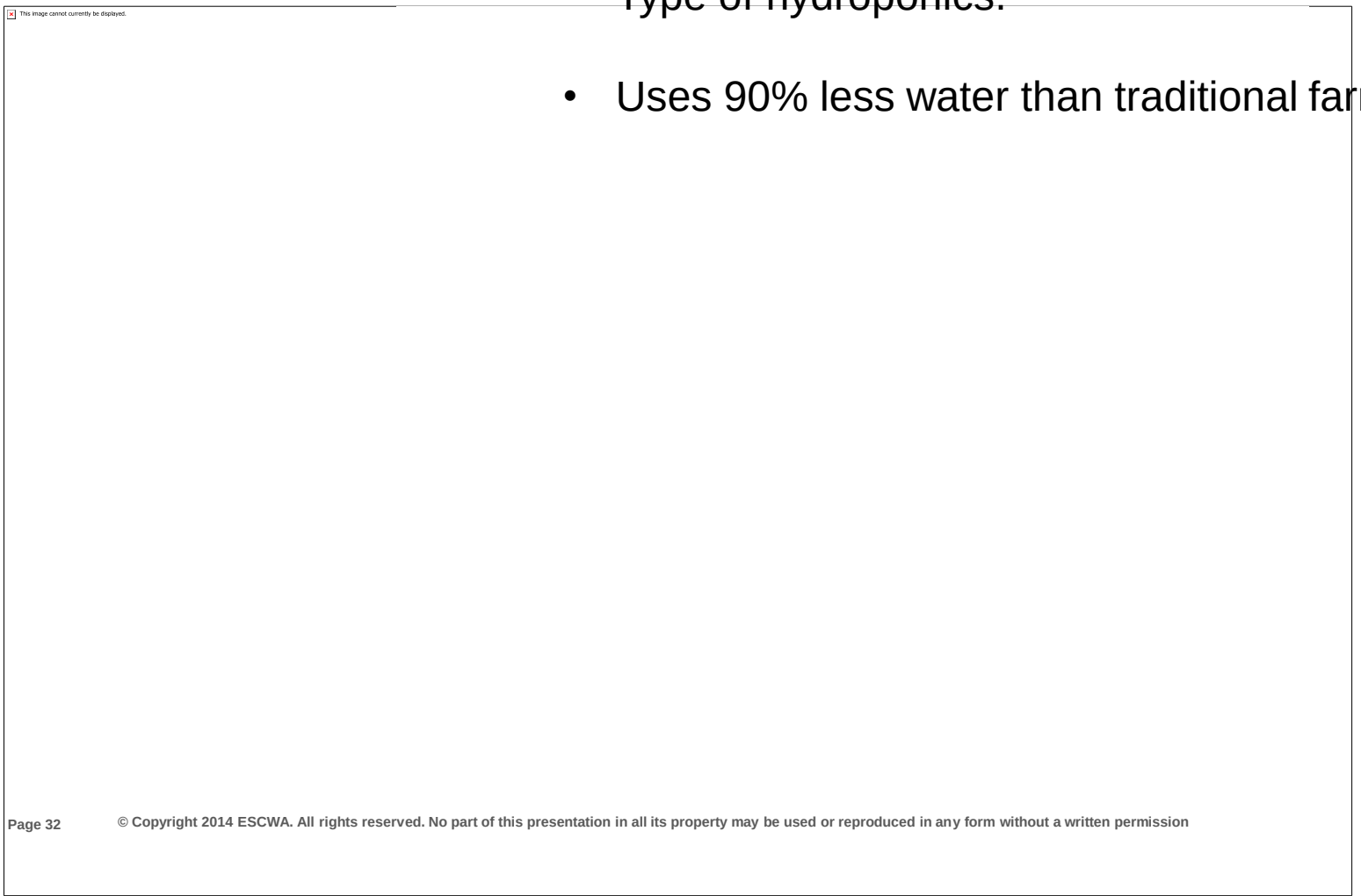
The Aqus(TM) WaterSaver technology which uses sink greywater for toilets; *Source*: Lepisto, 2006.

Water efficiency in water production and distribution systems

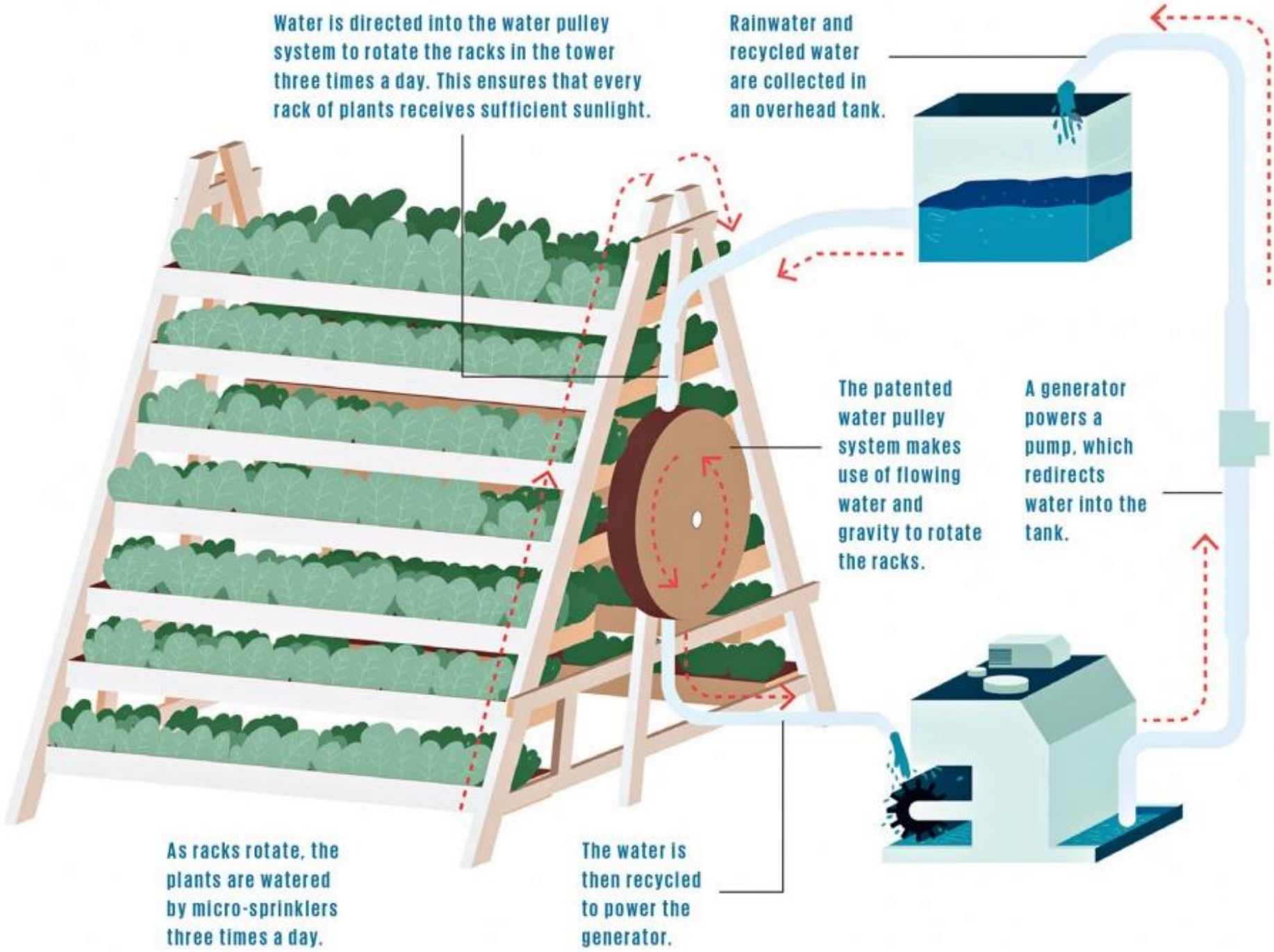
Water efficient greenhouses



Aquaponics



- Type of hydroponics.
- Uses 90% less water than traditional farming.


Water is directed into the water pulley system to rotate the racks in the tower three times a day. This ensures that every rack of plants receives sufficient sunlight.
Rainwater and recycled water are collected in an overhead tank.
The patented water pulley system makes use of flowing water and gravity to rotate the racks.
A generator powers a pump, which redirects water into the tank.
As racks rotate, the plants are watered by micro-sprinklers three times a day.
The water is then recycled to power the generator.

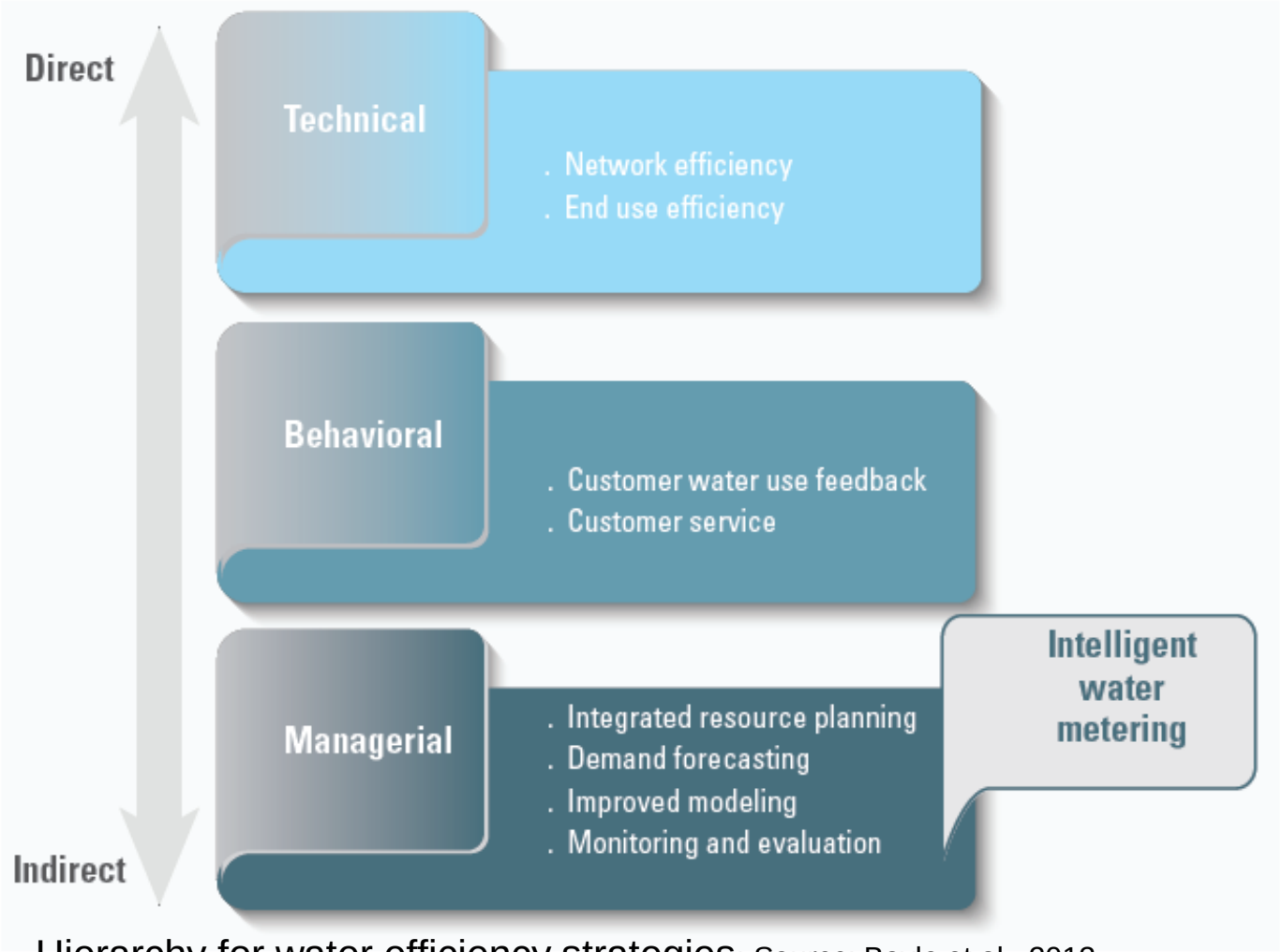
Irrigation systems

Efficiency of application for various irrigation methods; *Source*: Heatley and Ritchie, 2006.

Typical water losses from a pressurized irrigation system; *Source*: Heatley and Ritchie, 2006.

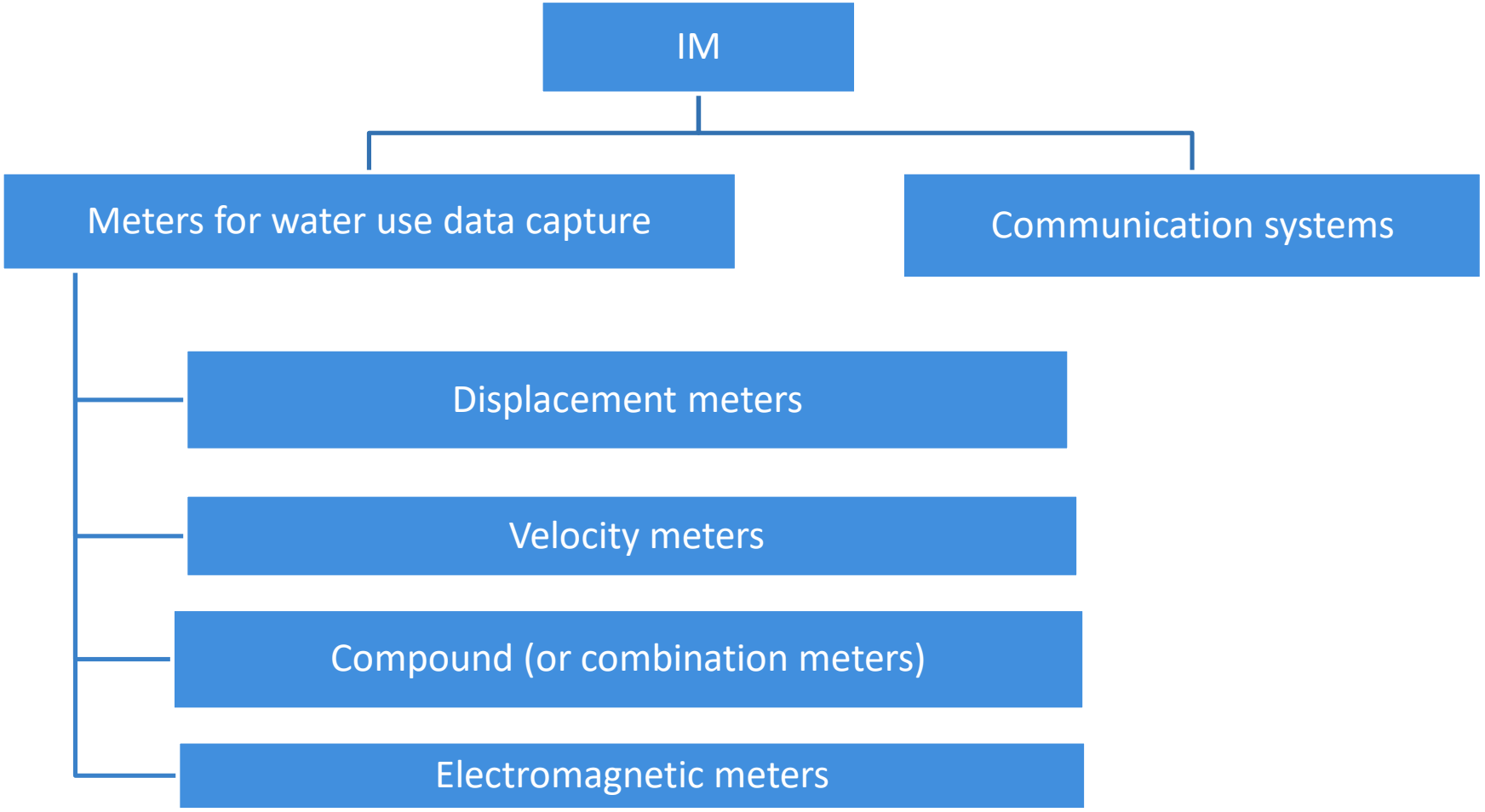
Loss component	Range	Typical
Leaking pipes	0-10%	0-1%
Evaporation in the air	0-10%	<3%
Wind-drift out of target area	0-20%	<5%
Interception and evaporation from the crop/pasture	0-10%	<5%
Surface run-off	0-10%	<2%
Uneven/excessive application depths and rates	5-80%	5-30%

Intelligent metering systems



Hierarchy for water efficiency strategies; *Source*: Boyle et al., 2013.

Intelligent water metering systems



Key messages

- There is no ideal efficiency solution for all ESCWA member countries.
  - Strategies must be assessed with reference to the respective situation.
- Recycling of wastewater is a strategy that can be implemented by various sectors.
  - As environmental standards for discharged waters become more stringent, recycling water becomes more feasible.
- Water consumption can be reduced in electricity generation processes by addressing various parameters. Examples:
  - Cooling types
  - Combined cycle arrangements
- Several technological options for more water efficient water distribution (e.g., IM systems), particularly in the agricultural sector, are becoming more popular.

THANK YOU

Economic and Social Commission for Western Asia

UNITED NATIONS

الاسكوا

ESCWA

40 YEARS