Ministry of Natural Resources and Environment
WATER RESOUCES INSTITUTE

A circular economy approach to water resource management - Implementation potential in industrial parks

Presented by: Tu Anh Nguyen, Ph.D
Tra Van Tran, Ph.D

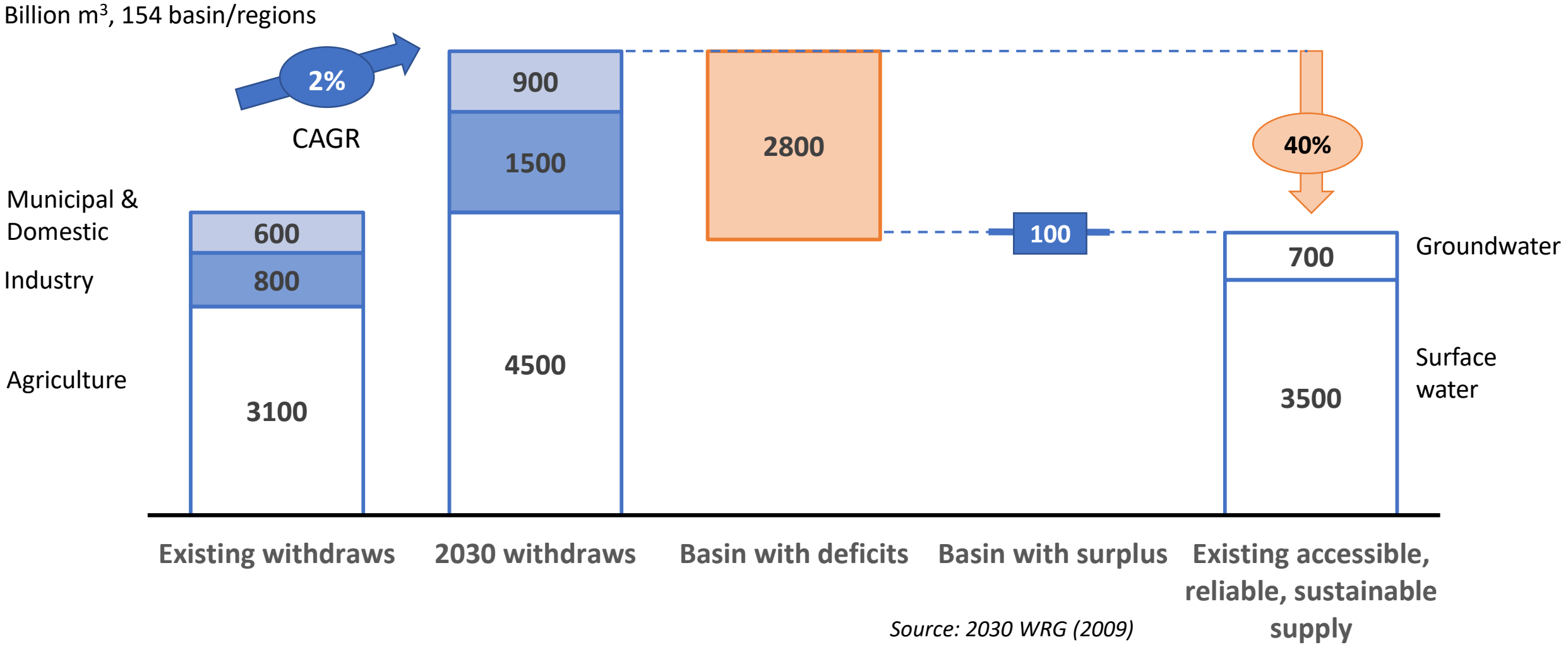
Ho Chi Minh, 9/2022

Contents

Water usages in industrial facilities

- ✓Incorporation in the final product
- ✓Washing or rinsing of raw materials, intermediates, or final products
- ✓Preparation of solvents or slurries
- ✓Cleaning equipment and space
- ✓Removing or providing heat
- ✓Meeting hygienic and domestic needs
- ✓Irrigation of landscape space

Aggregated global gap between existing accessible, reliable supply and 2030 water withdrawals

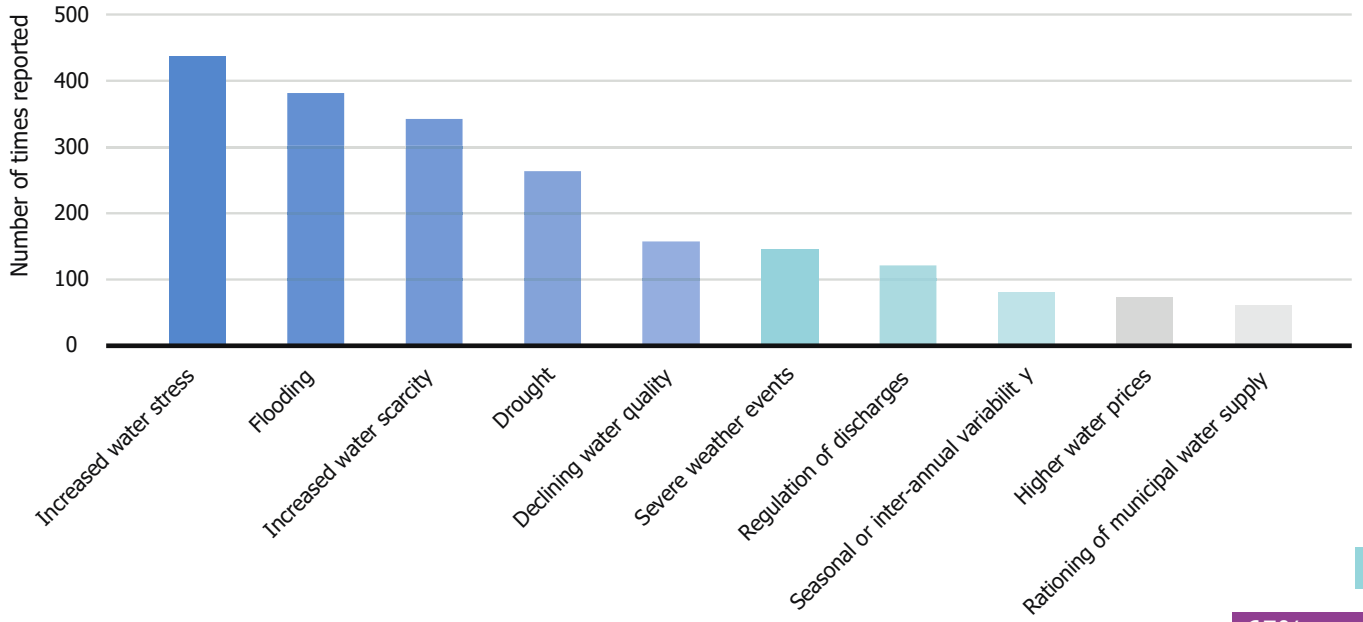


Source: 2030 WRG (2009)

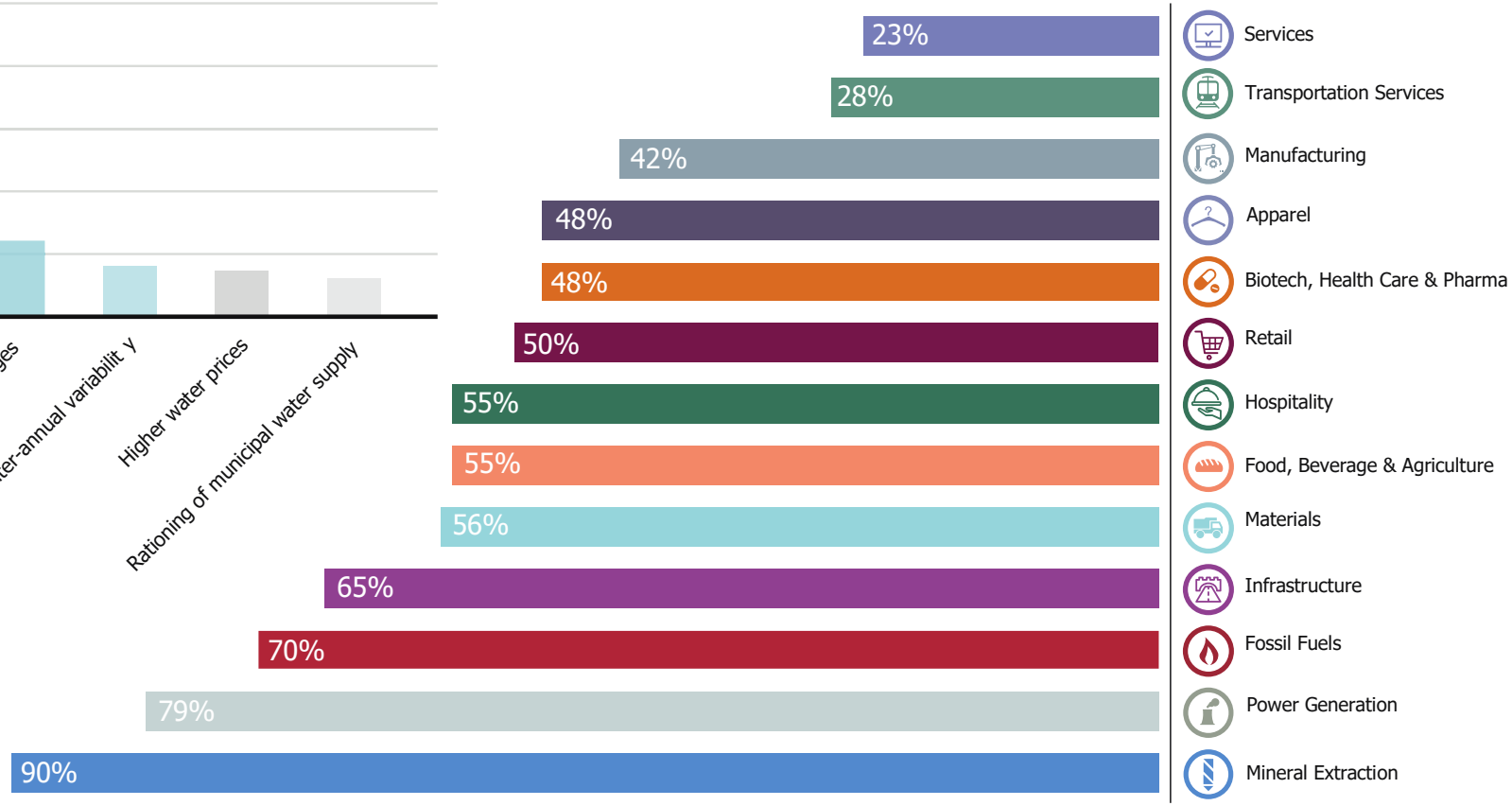
Water risk insights

Risk to business value: US$425 billion

Top 10 water risk drivers



Exposure to water-related risks by sector

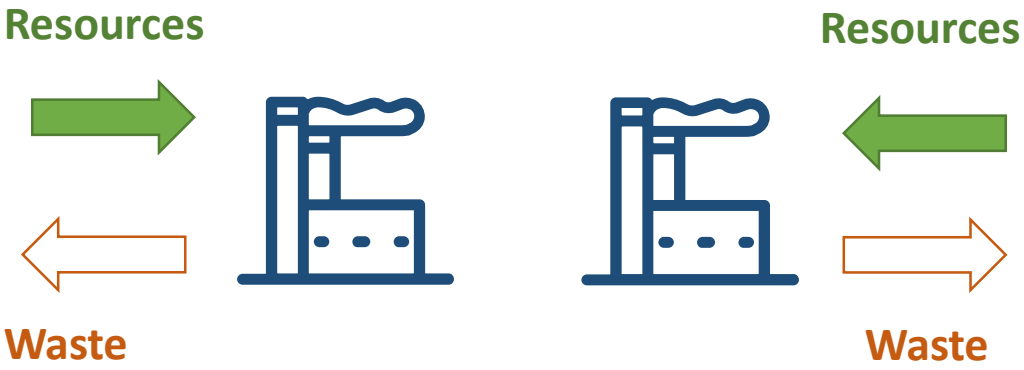


Source: CDP (2020)

Circular economy and Eco-industrial park

Images by Pro Carton (2018)

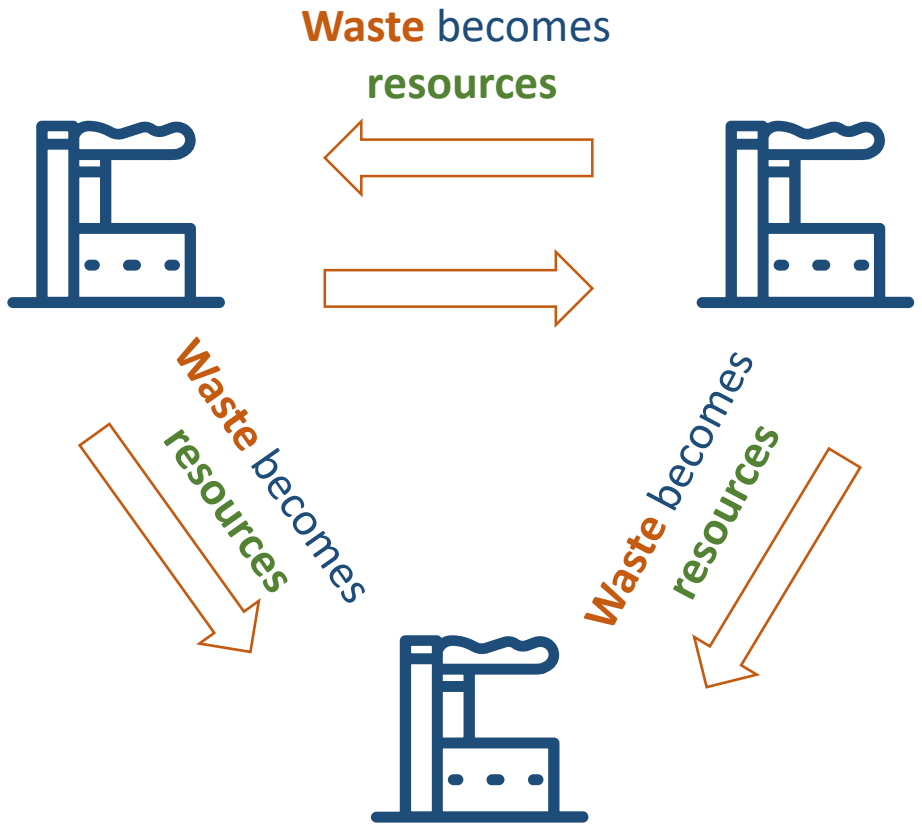
Traditional model



90% of the **raw materials** extracted for the global economy are **utilized once and then discarded.**

(Cairns and Patel 2020)

Eco-industrial park – Industrial symbiosys



Source: Transition ApS (2021)

Kalundborg Symbiosis, Denmark

Gyproc ***produces plaster boards*** from natural and recycled gypsum

ARGO ***receives waste from all citizens and businesses***

Kalundborg Municipality

Kalundborg Utility

AVISTA Green: ***only refinery for recycling waste oil from primarily garages, industrial companies and recycling sites***

Asnæs Power Plant: ***produces steam, electricity and heat***

Kalundborg Utility

Unibio: ***protein production technology***

Kalundborg Refinery is the ***largest refinery*** in Denmark

Novo Nordisk **Biopharmaceutical products**

Novozymes: ***biological solutions and supplier of enzymes and microbial technology***

Chr. Hansen: ***production of HMO*** (Human Milk Oligosaccharides).

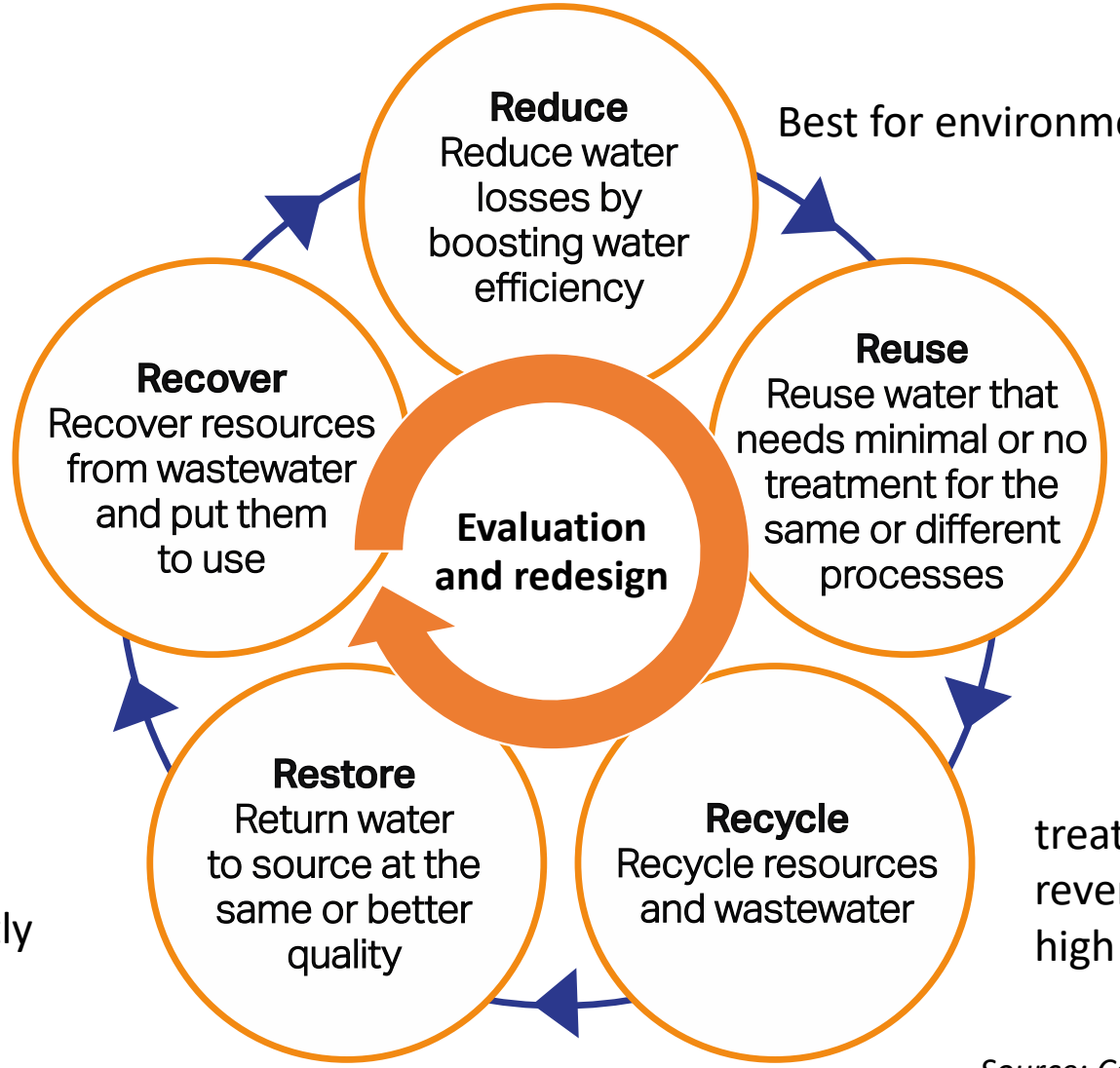
Meliora Bio ***bioethanol plant***

Water
Energy
Material

Remilk: sữa không có nguồn gốc thực vật

Gas và phân bón

xRs in circular water management (CVM)



Best for environmental quality

within and outside the fence for the same or different processes

treated by membrane or reverse osmosis to a very high quality

directly/indirectly

E.g. nitrogen, phosphorus, energy …

Source: Cairns and Patel (2020); WBCSD (2017)

Key options

Water use efficiency

- Improved production planning and sequencing
- Good housekeeping: Introducing more sensible and more resource-conscious routines in operations
- Process/equipment modifications: Changing procedures or equipment with retrofits if needed
- Product/material changes: Changing feedstocks used or designing completely new products -> reduced water demand and/or less effluent generation
- Replacing equipment/technology

- Rainwater harvesting: To suit end-user needs, contaminants must be treated
- Desalination

Restore/Recover

Reuse

- Direct reuse within a business: the quality of wastewater is sufficient for the intended use.
  - Process water: such as form cooling and heating - contains few contaminants after use
  - Cooling towers: washing processes
- Industrial symbiosis: reducing the inputs - water, or reducing the costs of wastewater treatment
  - the exchange of process water from one business to another
  - reuse of organic waste or wastewater: biogas production
  - reuse of wastewater for aquaculture of plants/animals

Recycle

- Decentralized wastewater treatment systems may be used to reduce the level of contaminants to a level that is safe for reuse.
- Specific treatment options depend on the desired outcome quality:
  - Irrigation water can be treated in a manmade wetland
  - Sophisticated technologies such as membrane filtration and activated carbon can provide treated wastewater of a higher grade
- Other materials are recoverable with treatment

Source: World Bank 2021, Brears (2020); Pain and Spuhler (n.d)

Regulations and practices concerning water reuse in some countries

Country	Regulation

United Kingdom	- Environmental Permitting Regulations require demonstrating best avaiable technique (BAT);
	- Regulations with respect to water quality are captured in Water Supply – Water Quality and Water Fittings regulations
	- Water reuse is stipulated but no target are set
	- Tax incentives were provided through the Enhanced Capital Allowances (ECA) scheme under which businesses can claim first-year capital allowances on certain water-efficient plant and machinery
	  - The UK government updates an annual list of eligible water technologies, products, and the criteria for claiming.
	  - Rainwater harvesting is considered one of the eligible technologies and practices

Spain	- First draft National Plan for Water Reuse published in 2010 and Guidelines on Reuse of Treated Wastewater in 2007 - Goal was to increase reuse from 450 millions m^3 in 2007 to 1.2 billion m^3 in 2015. Actual application was only 300 million m^3 in 2015 - Water reuse is seen as expensive

Source: World Bank (2021), WBCSD (2017)

Regulations and practices concerning water reuse (cont.)

Country	Regulation
Poland	- Environmental law refrs to “adequate use of the environment” - No specific legislation available on water reuse - Only corporate requirement in place - Water prices are low
India	- Water reuse is regulated through the direction under section 18(1) of the Water Prevention and Control of Pollution Act - Guidelines on techno-economic feasibility of implementation of Zero Liquid Discharge (ZLD) regulation for water polluting industries are available - Water reuse is require since any new expansion needs to consider ZLD - The municipal government mandated that buildings with a built-up area exceeding 100 m2 were required to install a rainwater harvesting system
Australia	- State Water Plan 2007 regulated water reuse - The water quality is regulated through National Water Quality Management Strategy Australian Guidelines for Water Recycling - Water recycling targets is 30% of all wastewater by 2030 - A need for water reuse/recycling since the demand will increase by 40%, as predicted, while it’s already facing water stress

Source: World Bank (2021), WBCSD (2017)

Regulations and practices concerning water reuse (cont.)

Country	Regulation
Other countries	Policies to reduce water consumption in the industry sector: - **Singapore**: Penalty by way of higher tariffs charged when a factory exceeds a certain limit of water usage from the public supply network. The creation of funds (e.g., the Water Efficiency Fund in Singapore) can also motivate industries to pursue water efficiency projects. These funds can be utilized for feasibility studies, water audits, recycling efforts, use of alternate sources of water, and communitywide water conservation programs. - **Mexico**: Use of alternative water sources such as rainwater may also be incentivized and reflected in local water prices for the industry to factor in water scarcity - **China**: Set a policy target - defined under the 12th five-year plan (2011–15) to reduce water consumed per unit of value-added industrial output by 30 percent by 2015. In case of non-compliance, penalties were levied, or in extreme cases, closures ordered.

Source: World Bank (2021), WBCSD (2017)

Regulations and practices concerning water reuse (cont.)

Country	Regulation
United State	- Regulations for water reuse are created at the state level, supported by two federal agencies: US Environmental Protection Agency (USEPA) and the Bureau of Reclamation (USDOI) - In the US Senate, the Committee on Energy and Natural Resources is responsible for federal laws governing water reuse - Rules to regulate and promote water reuse vary by state - Many states do not yet have regulations in place to allow for direct potable reuse - There are no targets for reuse
United Arab Emirates	- Collaboration between 8 government agencies working under the Permanent Committee for Setting and Implementing Water and Agricultural Strategies in the Emirate of Abu Dhabi to preserve water resources - Regulation & Supervision Bureau has issued criteria for guidance on reuse (the first step in direction of establishing legislation) - About 60% of treated sewage effluent is used for landscaping irrigation

Source: World Bank (2021), WBCSD (2017)

Main drivers for recycling water

1. Emerging regulatory frameworks

- Regulatory compliance (site level): encouraging water reuse (e.g., India and Australia) through regulations requiring zero liquid discharge (ZLD)
- Internal compliance (corporate level, site level): The global strategies of many companies set internal standards reflecting emerging issues (regulatory and social responsibility

2. Risks to water supplies (now and in the future)

- Securing license to operate (corporate, site): Recycled water can replace or reduce the freshwater input needed for operations -> reduces business risks associated with a lack of available water and strengthens resilience to disruptions in supplies (e.g., droughts) caused by climate change or geographical conditions (e.g., water scarcity).
- Opportunity for growth (site): less dependent on a particular water supply -> more opportunities for growth
- Reducing operating risks (corporate, site): Pressure to shrink water footprints and an increasing awareness of the need to ensure sustainable water resources systems

3. Costs and resources

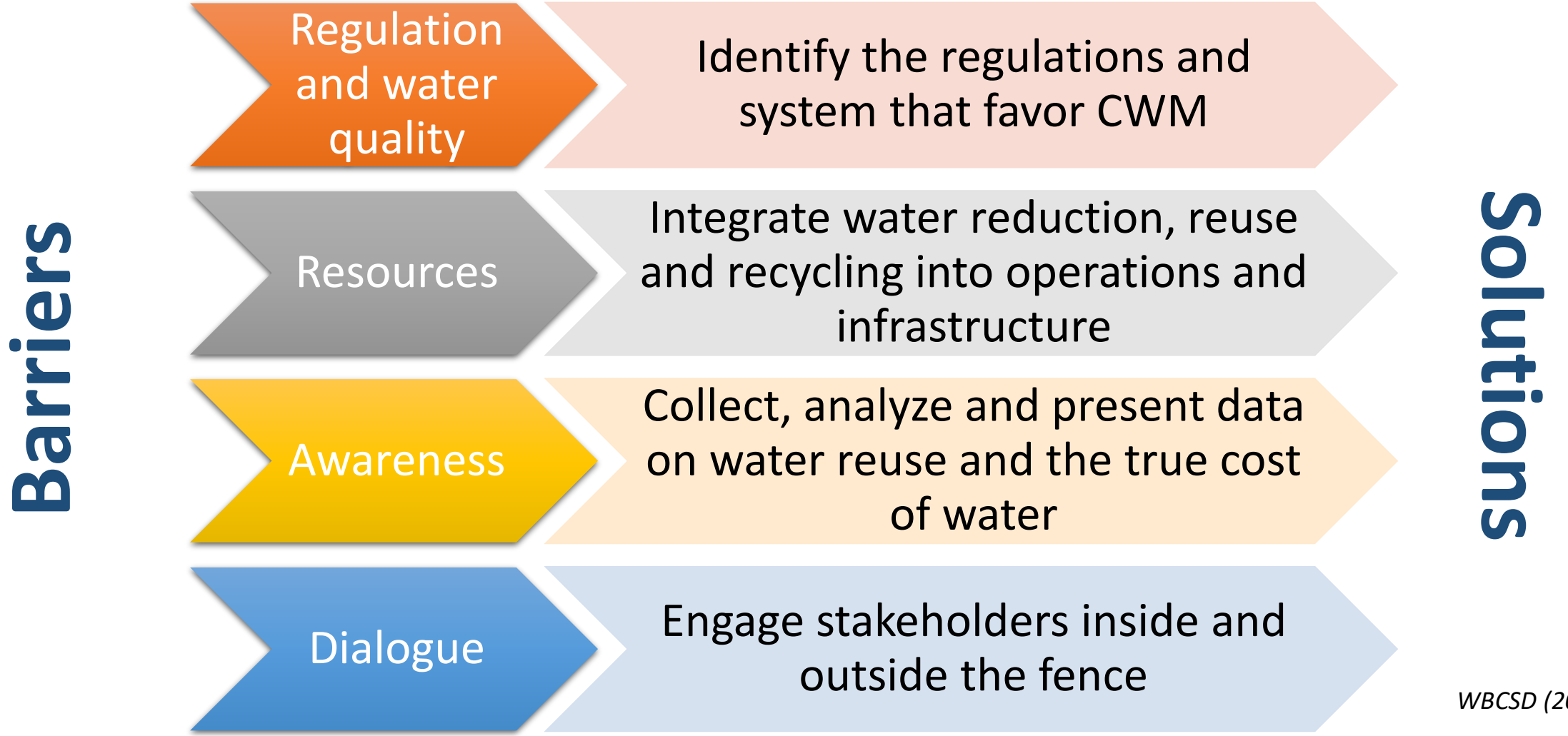
- Significant savings (site): savings in energy and chemicals, and can reduce effluent discharge fees
- Financial incentives such as reduced taxes or tax exemptions can encourage firms and park operators to adopt water reuse/recycling technologies

4. Corporate policy

- Reputation enhancement (corporate, site): maintain their reputation as responsible water users

Source: World Bank (2021), WBCSD (2017)

Challenges in recycling water



WBCSD (2017)

Regulatory and quality barriers

Barrier	Potential solutions
Water quality does not meet process needs	- Understand the specific water-quality needs and determine whether the proposed project will pose a risk to the water quality required by the process. - Evaluate or draft a standard operating procedure (SOP) that specifies concentration limits for influent water. - Check whether there is expertise at other sites that can be leveraged to work on water-quality issues..
Regulatory barriers to process change	- Incorporate the cost of the process change into the overall project capital expense (CAPEX) when developing a business case. - l Understand the exact requirements of the regulating agency.

WBCSD (2017)

Regulatory and quality barriers (cont.)

Barrier	Potential solutions
Water reduction will create regulatory risk for concentration- based effluent limits	- Negotiate with regulators to move away from concentration-based discharge requirements. To prove that the benefits outweigh the challenges of modifying permits. - Participate in the regulatory process to ensure that business concerns are considered. - Maintain a good relationship with the regulating agency to position the business to negotiate permit changes on effluent constituent levels that accommodate water conservation concerns..
Negative public reaction could impact branding and product sales (e.g., using purified wastewater to wash beverage containers)	- Confirm the exact specifications for water quality for the specific use and continuously monitor water quality to confirm that quality is maintained. - Consider an appropriate marketing plan that emphasizes sustainable development. - Implement less controversial projects first.

WBCSD (2017)

Resource barriers

Barriers	Potential solutions
No funding for water reduction Or The return on investment (ROI) is too low	- Ensure evaluation takes account of the full cost of water. - Build a case around non-financial benefits (public perception, risk avoidance, benefits to community from reducing water use). - Consider developing an alternative ROI that reflects the intrinsic value and business risks associated with water. - Investigate whether there are government grants that could be leveraged
Lack of corporate infrastructure to reuse water	- Benchmark competitors to justify a culture of sustainability. - Identify personnel performance metrics that incentivize sustainable practices
Lack of operational controls to optimize water conservation	- Develop specifications for operating equipment that incorporate controls. - Benchmark similar operations to identify and justify the most effective control strategies
Inability to sustain water reductions <- lack of maintenance or change in operations	- Incorporate water use and conservation into commissioning practices. - Automate maintenance systems to ensure regular essential maintenance. Add maintenance to processes to ensure correct, water-efficient operations
Lack of implementation and follow-up	- If not already part of business operations, implement a formal post-verification program for all water projects to confirm that they have met performance expectations. - Incorporate water savings from projects into future plant budgets.

WBCSD (2017)

Lack of awareness barriers

Barriers	Potential solutions
Difficulty getting support because water is considered to be 'cheap' by decision-makers or key site personnel	- Develop charts of total water use or water use per product made showing where a site ranks in the business relative to other sites - Consider performing a total cost analysis - Build a case around non-financial benefits (public perception, risk avoidance, community benefits from reduced water usage by facility, etc.)
Resistance to change by key personnel, stakeholders or decision-makers	- Understand and address the concerns being raised - Establish recognition awards (either at site level or for individual personnel) - Develop a business case to convey the financial value of the project
Misunderstanding of regional water supply and demand	- Use local information to calibrate water-stress models - Participate in local water boards - Incorporate regional water stresses in the business case - Develop forecasts of the impact of water stress on the site
Lack of data	- Incorporate water meters into pre-planning and design - Develop global or site strategies for installing water meters for new equipment that uses water - Integrate water meters into data gathering systems (e.g., electronic data, operator log sheets, etc.)

WBCSD (2017)

Lack of supporting dialouge

Barriers	Potential solutions
Lack of stakeholder engagement	- Establish open dialogue and ensure stakeholders have the same end-goal in mind
Misunderstandings about regional water supply	- Develop a regional water balance and identify water use on site. - Showcase opportunities for reusing water outside the fence

WBCSD (2017)

Conclusions

- The efficient use of water and management of water and wastewater circulation are crucial components of eco-industrial models, as numerous industries rely on water as a material and energy carrier.
- Circular water management necessitates the integration of all initiatives to implement circular economy principles in the water and wastewater sector, including technological, organizational, and societal transformations
- The selection and application of various groups of solutions vary based on the requirements and conditions of each country and region.

Conclusion (cont.)

- Barriers to the adoption of water reduction, reuse and recycling practices include
  - Regulatory and water-quality issues. Lack of trust in water quality continues to prevail in many industries, in particular in the case of wastewater reuse.
  - Cost of water. Many businesses rarely account for the true cost and value of water. An understanding of the true cost of water used in a factory and consideration of the value of water to water users outside the company makes projects to reduce, reuse and recycle water more likely to succeed.
  - Lack of awareness. A lack of understanding of water issues in general, and of the opportunities that water reduction, reuse and recycling practices present hinders projects to reuse and recycle water
  - Lack of supporting dialogue. Dialogue among industries, governments and other water users at the watershed level is still not common practice.

Area of action for policy interventions

- **Understanding water availability and water balance at basin level**: evidence-based decision making
  - Comprehensive water resource assessment to identify the quality and quantity of available water
  - Technical studies preparing future scenarios of water availability based on existing water consumption trends
  - Water security: Risks and uncertainty
- **Water consumption and supply**: reduce water consumption and diverse water supply
  - When a factory exceeds a certain threshold of water consumption from the public supply network, it is subject to a surcharge
  - Supporting funds (e.g., the Water Efficiency Fund in Singapore): motivate industries to pursue water efficiency projects
  - Policy targets to reduce water consumption per unit of value-added industrial output, as well as charges for noncompliance
  - Through regulations and tax incentives, increase the use of alternative water sources (rainwater, stormwater and desalination)

Area of action for policy interventions (cont.)

- **Wastewater treatment**:
  - Regulations/rules specifying the pollutant level for wastewater
  - Environmental policy measures ensure compliance with environmental regulations, such as fines for illegal wastewater discharge and periodic/random audits of industrial facilities.
- **Water reuse/recycle**
  - Policies to mandate water reuse/recycling wastewater for non-potable uses including process water usage
  - Financial incentives such as reduced taxes or tax exemptions can encourage firms and park operators to adopt water reuse/recycling technologies
- **Value of water**
  - Recognizing the true value of water (total cost and other non-economic values) to demonstrate a higher water price and the economic potential of water conservation, reuse, and recycling technologies/solutions
- **Enhancing stakeholder engagement**
  - Facilitate policy dialogues and interaction platforms between water policymakers and businesses, as well as between businesses.

Tra Van Tran, Ph.D.
Deputy Director General
Water Resources Institute
Ministry of Natural Resources and Environment
tranvantra@gmail.com

Tu Anh Nguyen, Ph.D.
Deputy Director in charge
Department of Water Resources Economics and Management
Water Resources Institute
Ministry of Natural Resources and Environment
tuanh.evp@gmail.com
linkedin.com/in/tu-anh-nguyen-54929a63