# Comprehensive Study of Water Reuse Role in Integrated Resource Management – Kingdom of Saudi Arabia

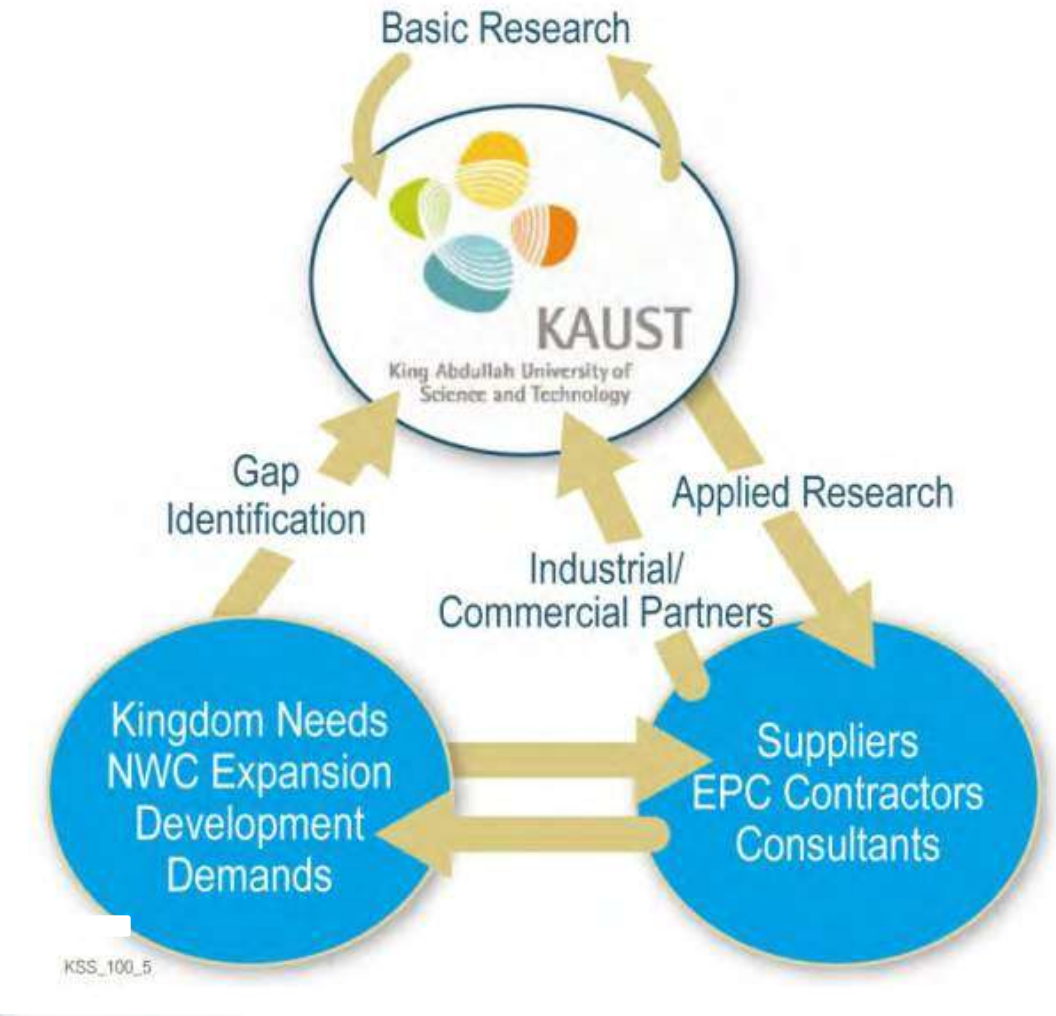
## Water Arabia 2013

6 February 2013

# Presentation Outline

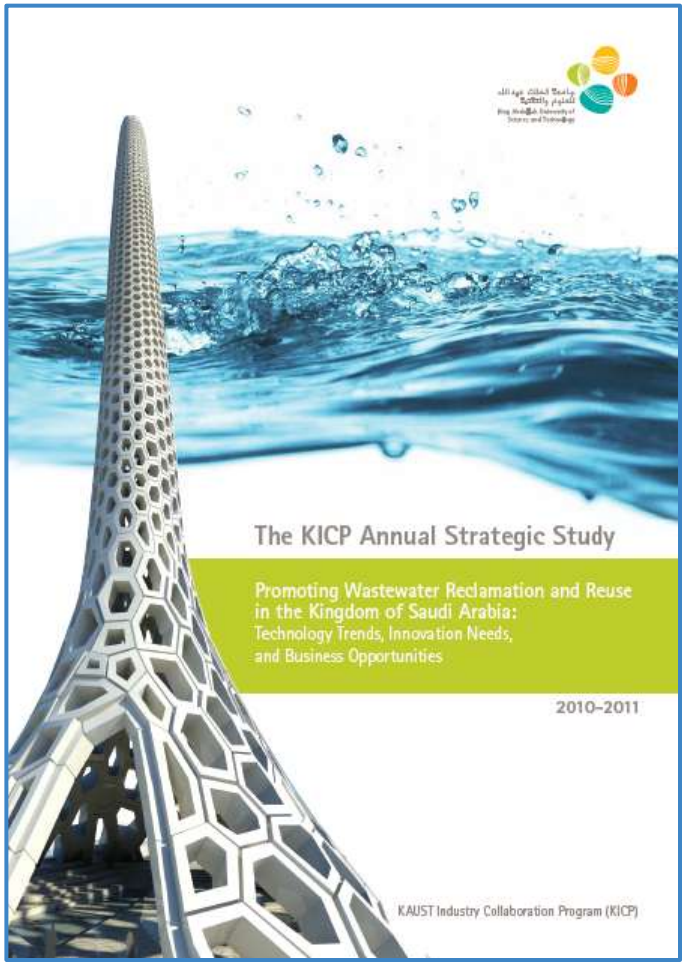
- Strategic Study Background
- Drivers for Water Reuse in Saudi Arabia
- Technology  Review
- Public Education Needs
- Business Case
- Recommended Path forward

# Strategic Study Goals



# Strategic Study Goals

- King Abdullah University for Science and Technology (KAUST) recognized value in promoting beneficial use of wastewater as a resource for sustainable growth
- KAUST's Industrial Collaboration Program (KICP) members recognized value and provided funding
- Goal - prepare a Strategic Study that will serve as a resource document to
  - Identify specific uses for wastewater now and in the future
  - Identify gaps in technology, education and business opportunities related to wastewater treatment and reuse
  - Increase integration of water reclamation in KSA
  - Provide recommendations for improved implementation of reclaimed water as a resource



# Baseline for Water Reuse

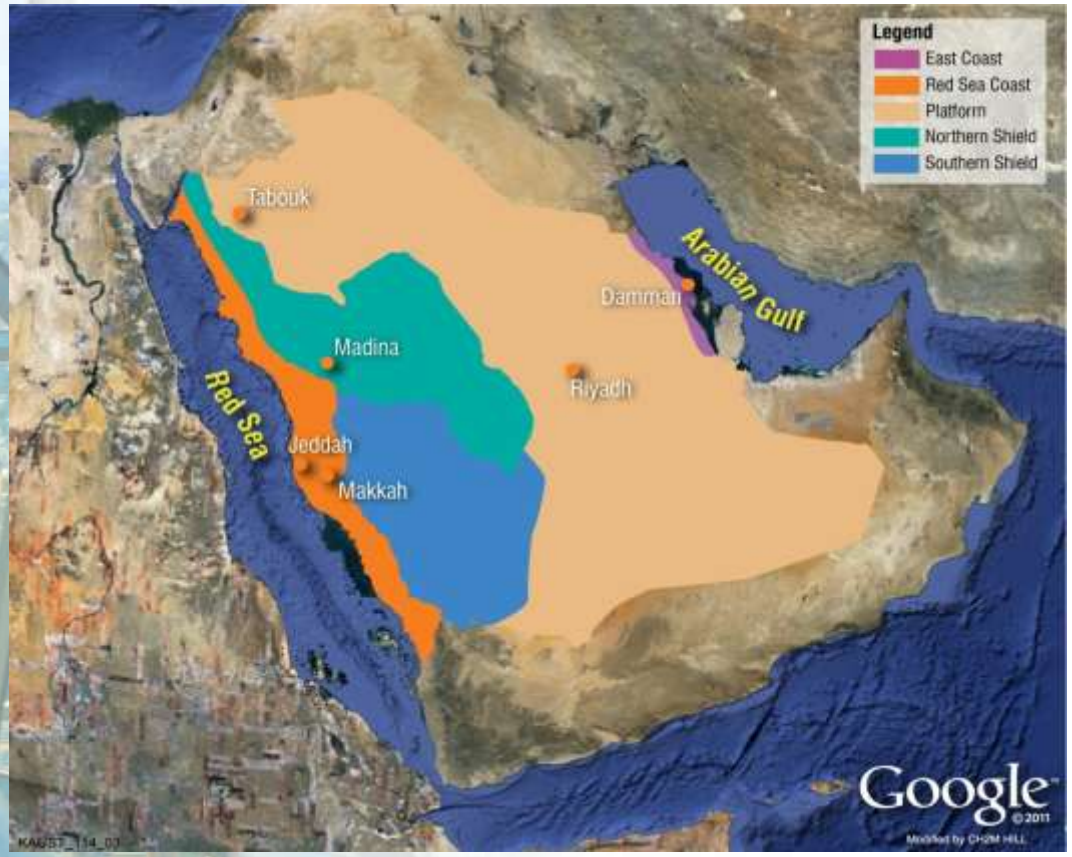
- Water reclamation and reuse is a critical component of integrated water resources management
- Saudi Arabia (KSA)
  - Potable water is produced from either non/slowly-renewable water resources such as groundwater or
  - Capital- and energy-intensive seawater desalination
- Reserving the use of expensive potable water for truly potable needs will extend the life of these valuable resources


Adapted with permission from WaterReuse Foundation

# Drivers and Benefits of Reuse in the KSA Context

| Drivers | Benefits |
|---|---|
| Increasing population and water demands | Reduces demand on non- and slowly-renewable water supplies |
| High capital cost to meet potable demands | Reduces infrastructure (and cost) needed for new potable water supplies |
| High cost of energy used to produce and convey potable water | Reduces energy used for water treatment and conveyance |
| Increase return on capital and energy investments in water treatment | Recoups a portion of initial high cost of purifying water for drinking |
| Reduce operating costs for cooling buildings – both public and private | Less expensive for industrial, commercial, and public buildings |
| Minimize discharge of pollutants to surface waters | Protects valuable aquatic resources |
| Groundwater recharge is needed to prevent seawater intrusion and to replenish groundwater sources | Appropriate application to prevent saltwater intrusion and replenish groundwater resources |

# Driver: Water Supply Options are Unsustainable or Energy-Intensive



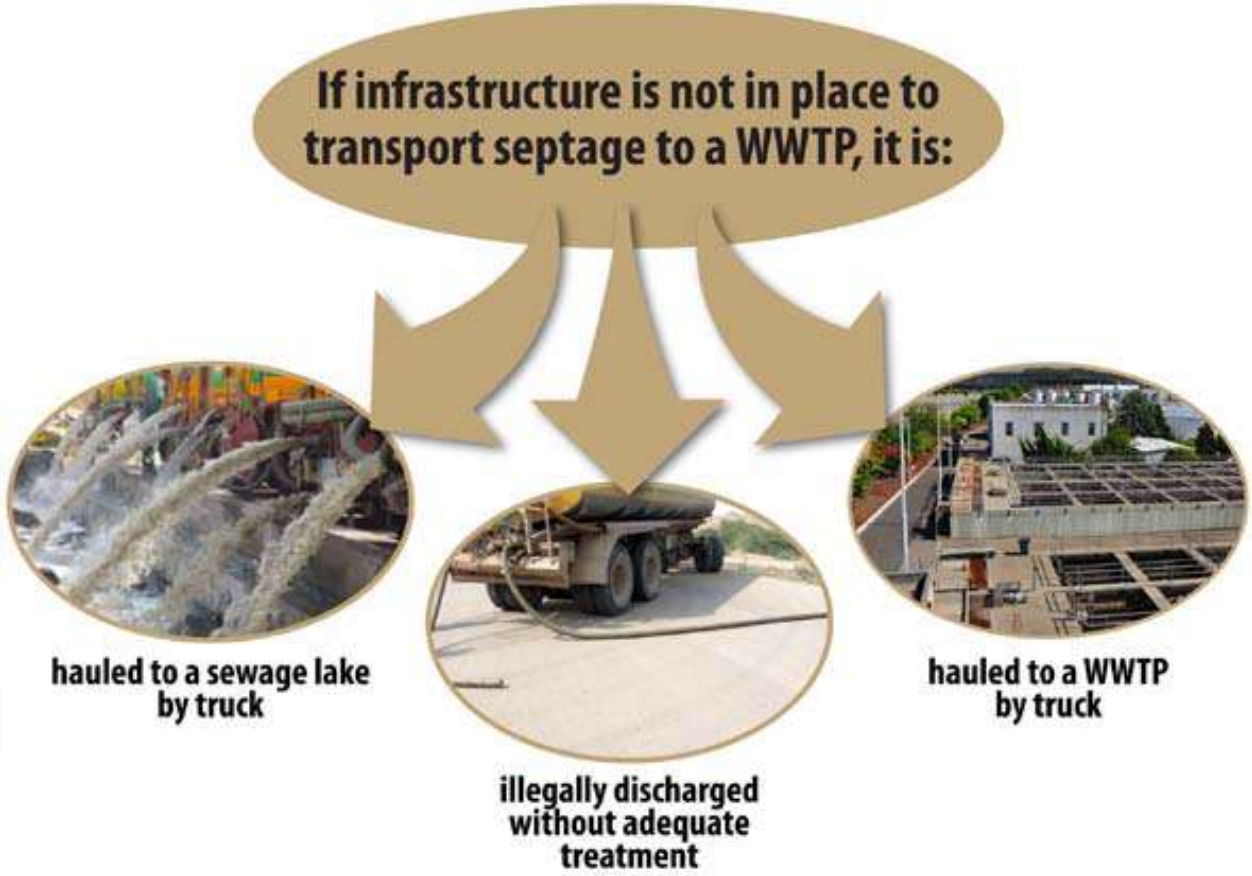

- **East Coast**: Primary source is desalinated seawater; also non-renewable groundwater resources
- **Red Sea Coast**: Desalinated seawater and renewable water resources
- **Platform**: Non-renewable groundwater resources only; desalinated water is supplied from the East Coast water province
- **Northern Shield**: Renewable water resources, although rainfall is much lower than in the Southern Shield
- **Southern Shield**: Renewable water resources due to significant rainfall amounts (up to 500 millimeters (mm)/year)

# Driver: Water Quality in Red Sea and Arabian Gulf

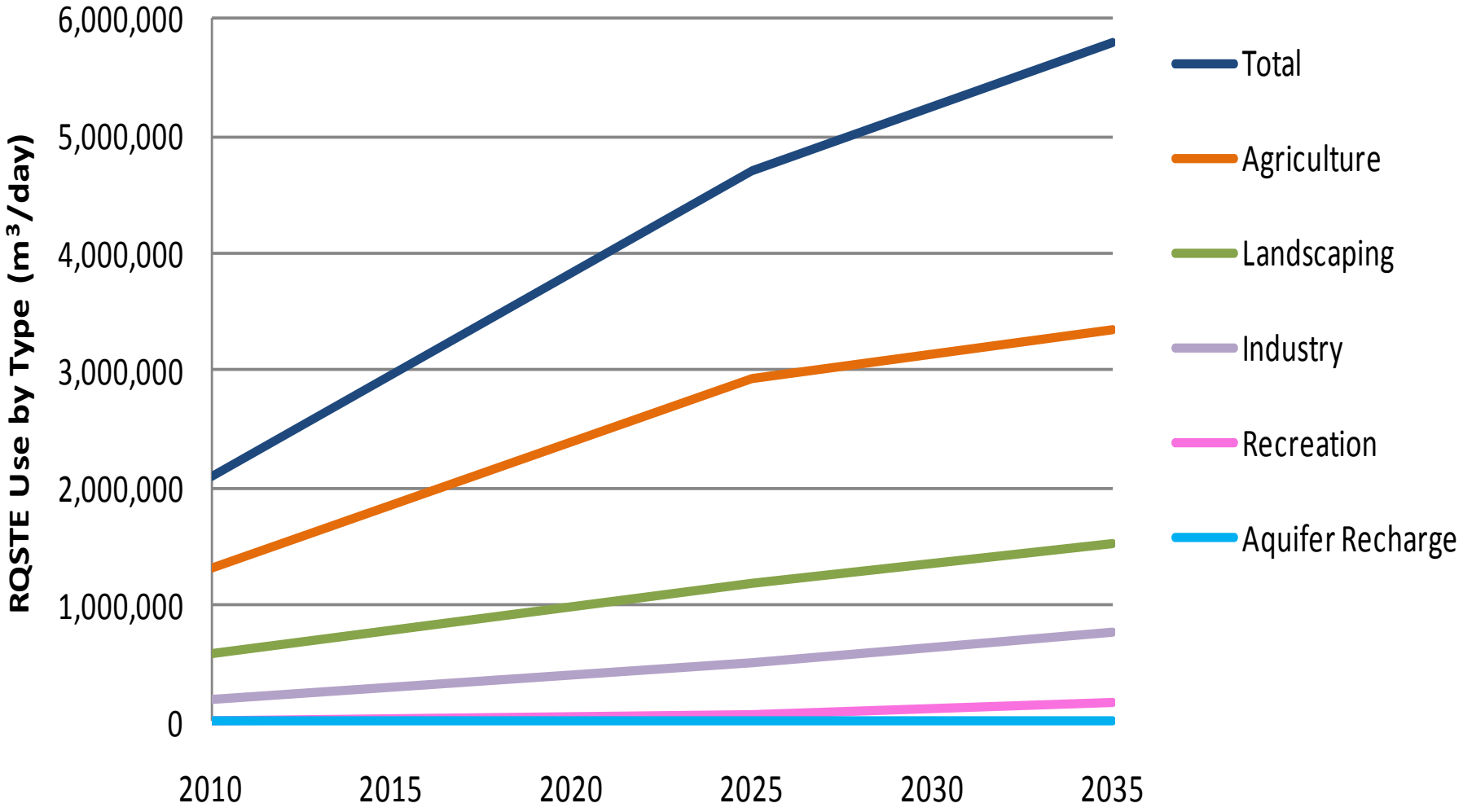
- Economically important resources
  - Commercial and recreational fishing
  - Aquaculture
  - Tourism and recreation
- Critical transportation routes
  - High volumes of shipping traffic
  - Higher in Arabian Gulf due to oil and gas industry
- Water supply sources via desalination
- Significant coastal development occurring

# Driver: Septage Disposal is a critical Wastewater Management Issue

- Septage issues in nearly all Cities
  - ~50 % of population served by central collection systems
  - Independent of city size



# Driver: Increasing TSE Demand by Application Area



# Business Driver: Energy Usage for Reuse Treatment versus Desalination

| | Electrical Energy ($kWh/m^3$) | Thermal Energy ($kWh/m^3$) | Equivalent Thermal Energy ($kWh/m^3$) |
|---|---|---|---|
| Reuse Technologies | | | |
| Tertiary Treatment (gravity media filtration coupled with chlorine disinfection)[a] | 0.01-0.02 | 0 | 0.04-0.08 |
| Reuse RO[b] | 0.5-1.5 | 0 | 2-6 |
| Desalination Technologies | | | |
| Brackish Water RO[a] | 1 | 0 | 4 |
| Seawater Reverse Osmosis (SWRO)[c] | 4 | 0 | 15 |
| Multiple Effect Distillation (MED)[c] | 1 | 70 | 74 |
| Multi-Stage Flash (MSF)[c] | 5 | 80 | 100 |

# Promoting the Business Case: Technology Links Source with Use


Domestic Wastewater

Industrial Wastewater

Cooling Water

Agricultural Drainage

Industrial

Agriculture

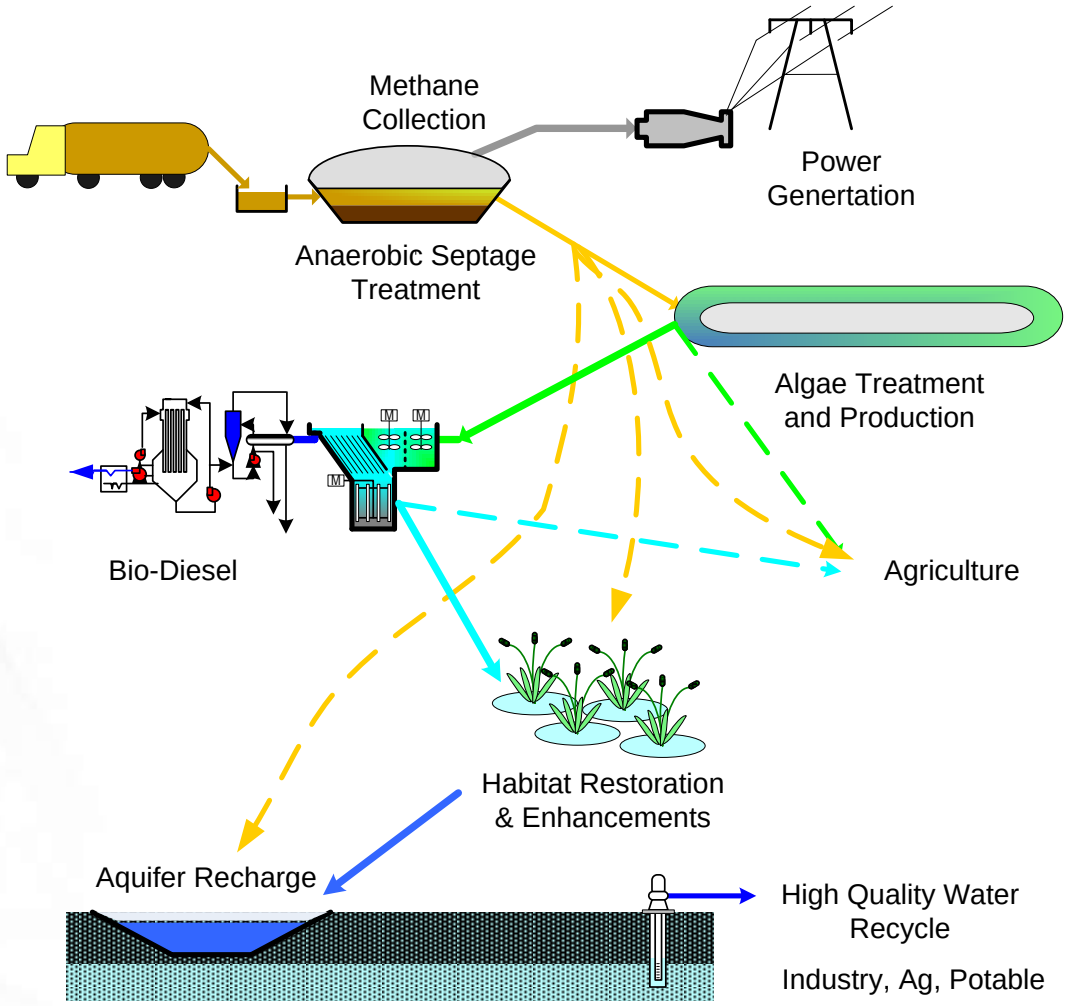
Landscape Irrigation

Recreational

Recharge

# Promoting the Business Case

- Innovation can be Achieved by Linking Established and New Technologies



# Innovative Technology Examples- Forward Osmosis

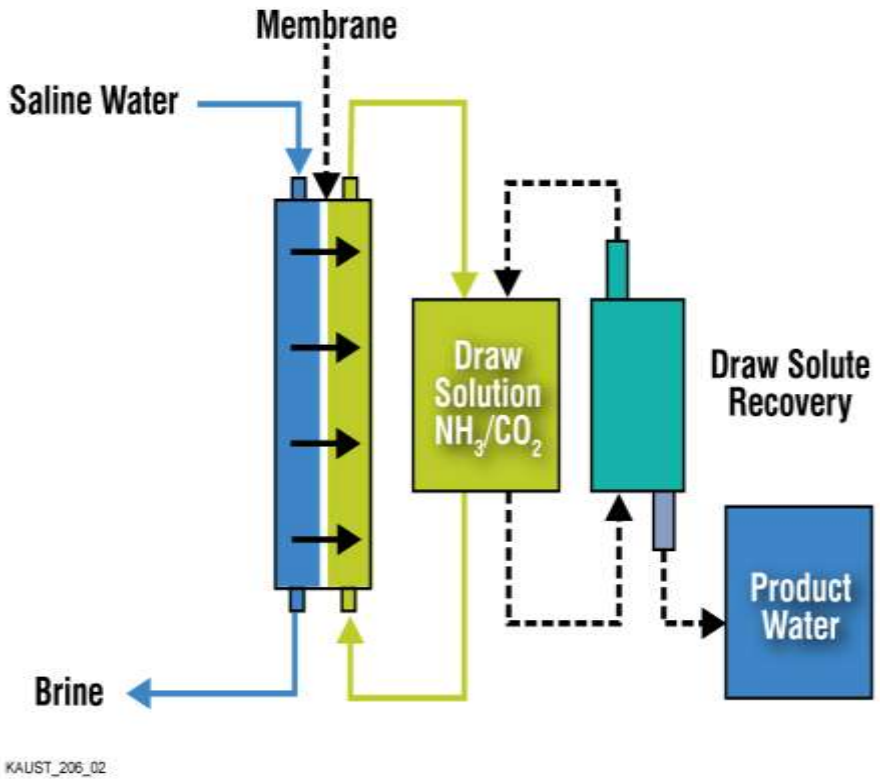
**Application Area:** Desalination of seawater, brackish water

**Objective:** To lower the carbon footprint of desalination

**Description:** Uses an osmotic pressure gradient instead of hydraulic pressure, which is used in RO, to create the driving force

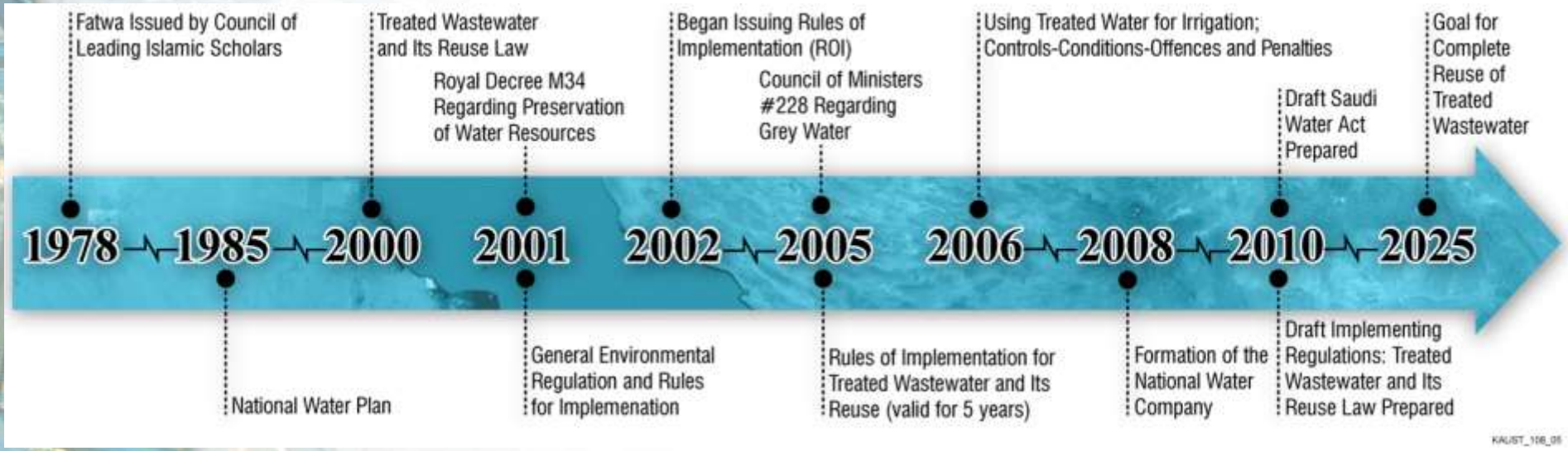
**Potential Advantages over Established Technologies:**

- Operates around 1 atm pressure
- Membrane compaction is not typically an issue
- Less fouling propensity compared to RO



# Promoting Reuse: Public Perception

- Timeline of Actions in the KSA to Promote Water Reuse



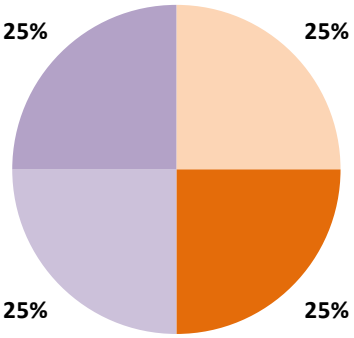
# Promoting Reuse:
# Public Education & Outreach Programs

- Public-Private Partnerships
- Green mosques programs to recycle TSE water
- Green schools program to teach next generation how to save and reuse water to increase food and greenery.
- TV Open Debate on Dec.6, 2011

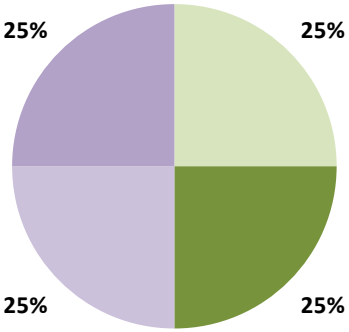
# Theoretical Business cases were reviewed through adaptation ProjectSelect™ Tool

- Business Case Scenarios
  - 5 distinct scenarios reflect different allocations of TSE to the five reuse categories
  - Chosen to be consistent with the types of situations that currently exist or can be fostered in KSA

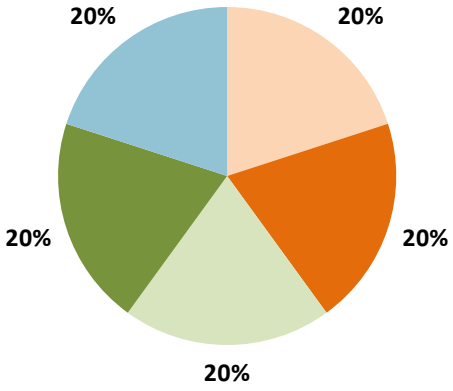
1. Industry + Agriculture



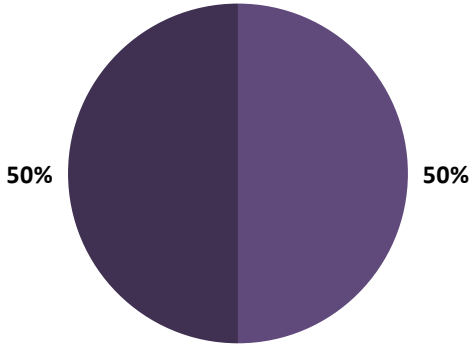

2. Industry + Landscaping



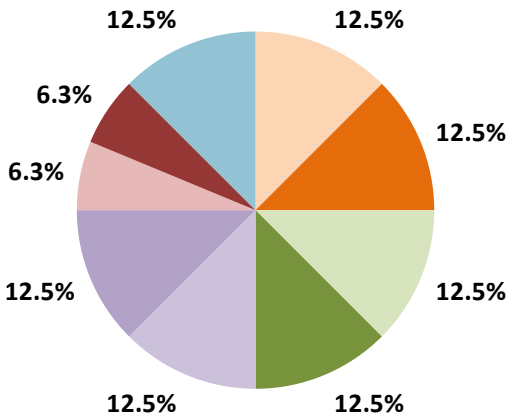

3. Ag + Land + Recharge




4. Industry High & Very High Quality

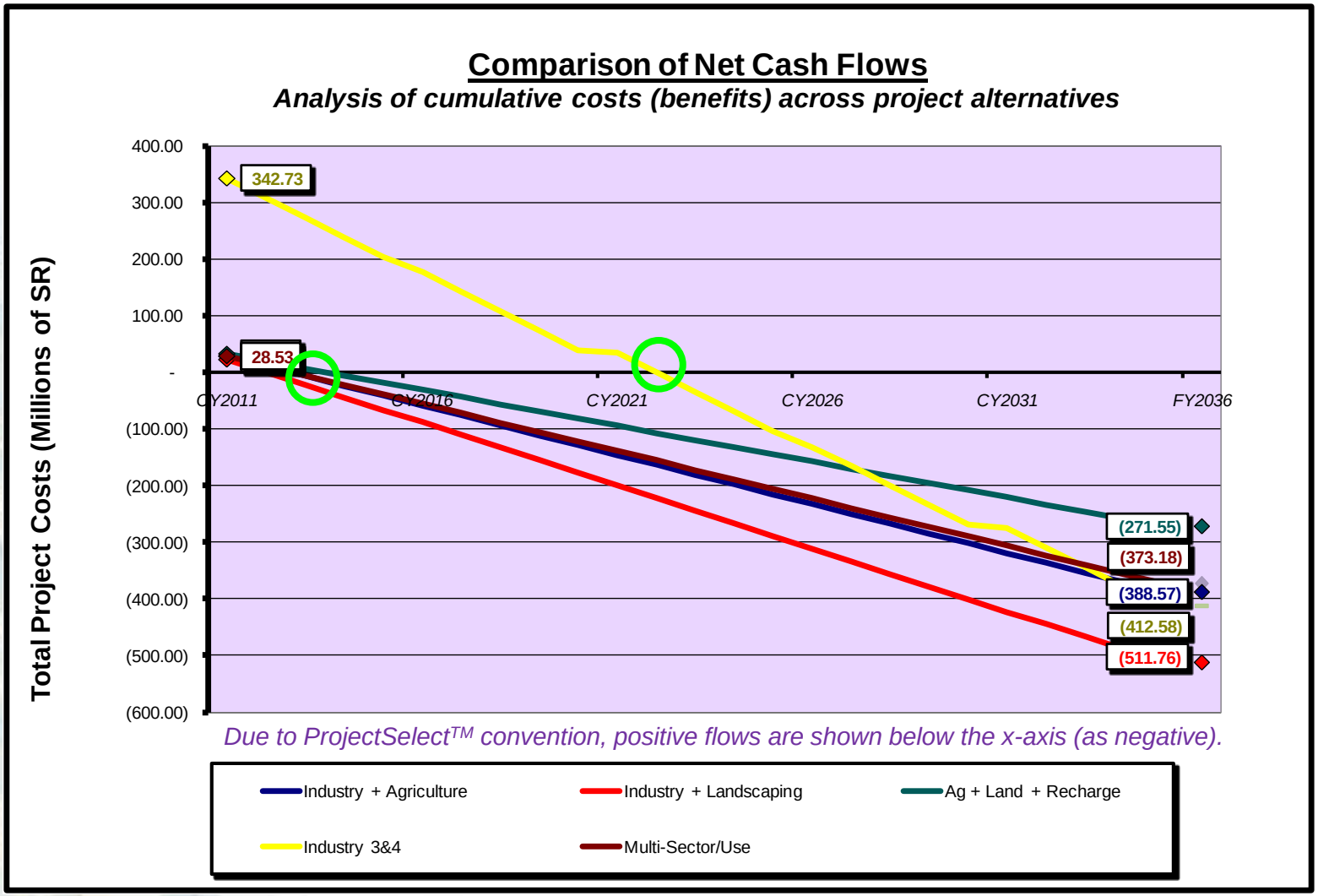



5. Multi-Sector/Use

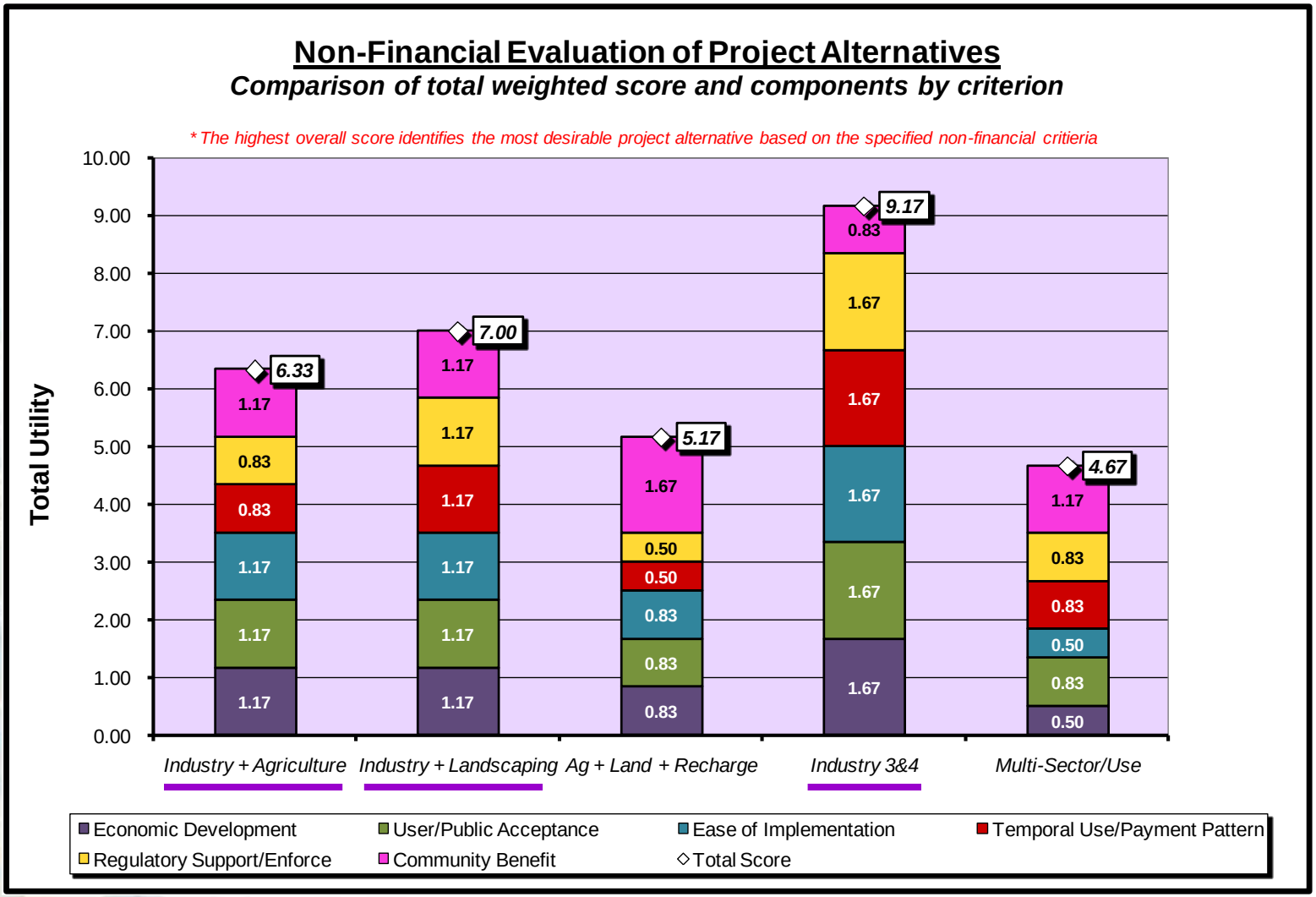


# Net Cash Flows Are All Positive:

## 4 of 5 scenarios show profit after just a few years



# Scenarios With Significant Industrial Reuse Score Highest Overall, Others At Least Average



# Business Case Findings

## Overall Results

- All five distinct reuse portfolios are financially viable without subsidies
- Payback periods can be short if advanced treatment not needed, and are acceptable even if it is
- Reasonable tariff structure is needed to achieve this
- All portfolios deliver important non-financial benefits to the users, reclaimed water providers, and larger community

# Summary Findings: Implications

- The commitment to significantly expand the availability of TSE for a wide variety of uses will be critical to meeting future water demand, can be cost-effective for users, and can be profitable for providers
- Capturing these business opportunities and supporting overall resource sustainability goals will depend in large part on
  - Instituting rational tariff structures for both first use water and TSE that support the significant capital and operational investments that will be made
  - Creating the proper economic relationship between different sources of water to make TSE sufficiently attractive as a source, and to recognize differences in ability and willingness to pay in a manner consistent with social and cultural considerations

# Recommended Path Forward to Successfully Promoting Reuse in Saudi Arabia

- Instituting rational tariff structures
- Recognizing differences in the ability and willingness to pay consistent with social and cultural considerations
- Adopting regulations to support an integrated water resources planning approach.
- Facilitating collaborative planning by getting better data
- Increasing public awareness of the need for TSE and gaining acceptance for its use.
- Coordinating specific actions and milestones, including strengthened regulations, to ensure that local, regional, and national goals are met

# Authors and Acknowledgements

- Involved Organizations






- This Strategic Study was prepared with published and unpublished information from individuals within universities, agencies, and private companies as follows:
  - **KAUST Center for Water Desalination and Reuse**
  - **KAUST Red Sea Research Center**
  - **KAUST Coastal and Marine**
  - **National Water Company**
  - **Ministry of Water and Electricity (MOWE)**
  - **Saudi Geological Survey**
  - **Presidency of Meteorology and Environment**
  - **The Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden**
  - **KAUST Industrial Collaboration Program (KICP).**