

# 1st Conference on Water-Energy-Food Nexus in GCC

Organized by the Embassy of the Kingdom of the Netherlands in Riyadh, Kingdom of Saudi Arabia

Hosted by the International Energy Forum in Riyadh

16 November 2017



Towards sustainable synergy  
between water, energy and food

**TNO** innovation  
for life

Netherlands Organisation for **Applied** Scientific Research (TNO)

- › State owned
- › Independent of public and private interests
- › Non-profit organisation
- › Established by law
- › Founded in 1932
- › ± 3000 employees
- › Annual turnover 527 M.€/yr
- › “Impact” is main driver

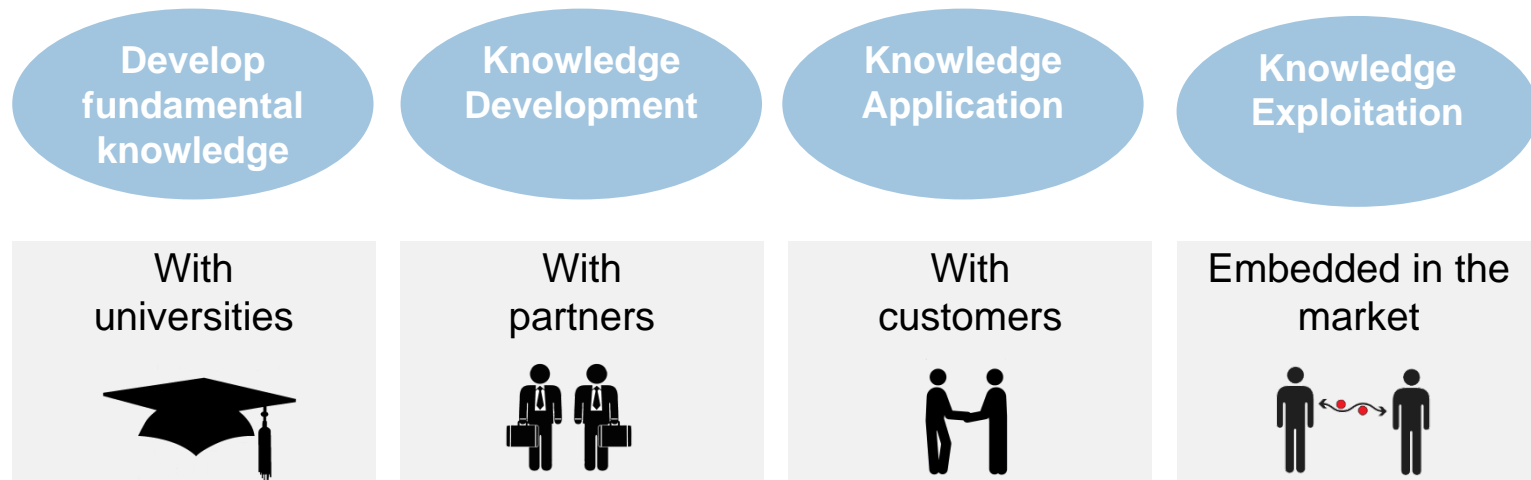


## ***OUR MISSION***

TNO connects people and knowledge to create innovations that boost the sustainable competitive strength of industry and well-being of society.

***‘INNOVATION FOR LIFE’***

- › Active in all steps of the knowledge development process



- › Multidisciplinary: combination of knowledge domains
- › Cross fertilization: tap into expertise from other markets and applications
- › Independent

# Developing innovative Solutions

Technology Readiness Level	Technology Level	
Market Certification and Sales Authorisation	9	Commercialization
Product Industrialisation	8	
Industrial Prototype	7	TNO
Field demonstration of whole system	6	
Technology Development	5	
Laboratory Demonstration	4	
Research to prove feasibility	3	
Applied Research	2	University
Fundamental research	1	

**INDUSTRY**

**HEALTHY LIVING**

**DEFENCE, SAFETY & SECURITY**

**URBANISATION**

**ENERGY**



**FLEXIBLE & FREE-FORM PRODUCTS**  
**SPACE & SCIENTIFIC INSTRUMENTATION**  
**SUSTAINABLE CHEMICAL INDUSTRY**  
**SEMICONDUCTOR EQUIPMENT**  
**NETWORKED INFORMATION**



**FOOD & NUTRITION**  
**PREDICTIVE HEALTH TECHNOLOGIES**  
**PREVENTION, WORK & HEALTH**



**MISSIONS & OPERATIONS**  
**FORCE PROTECTION**  
**INFORMATION SUPERIORITY**  
**HUMAN EFFECTIVENESS**  
**CYBER SECURITY & RESILIENCE**  
**NATIONAL SECURITY & CRISIS MANAGEMENT**

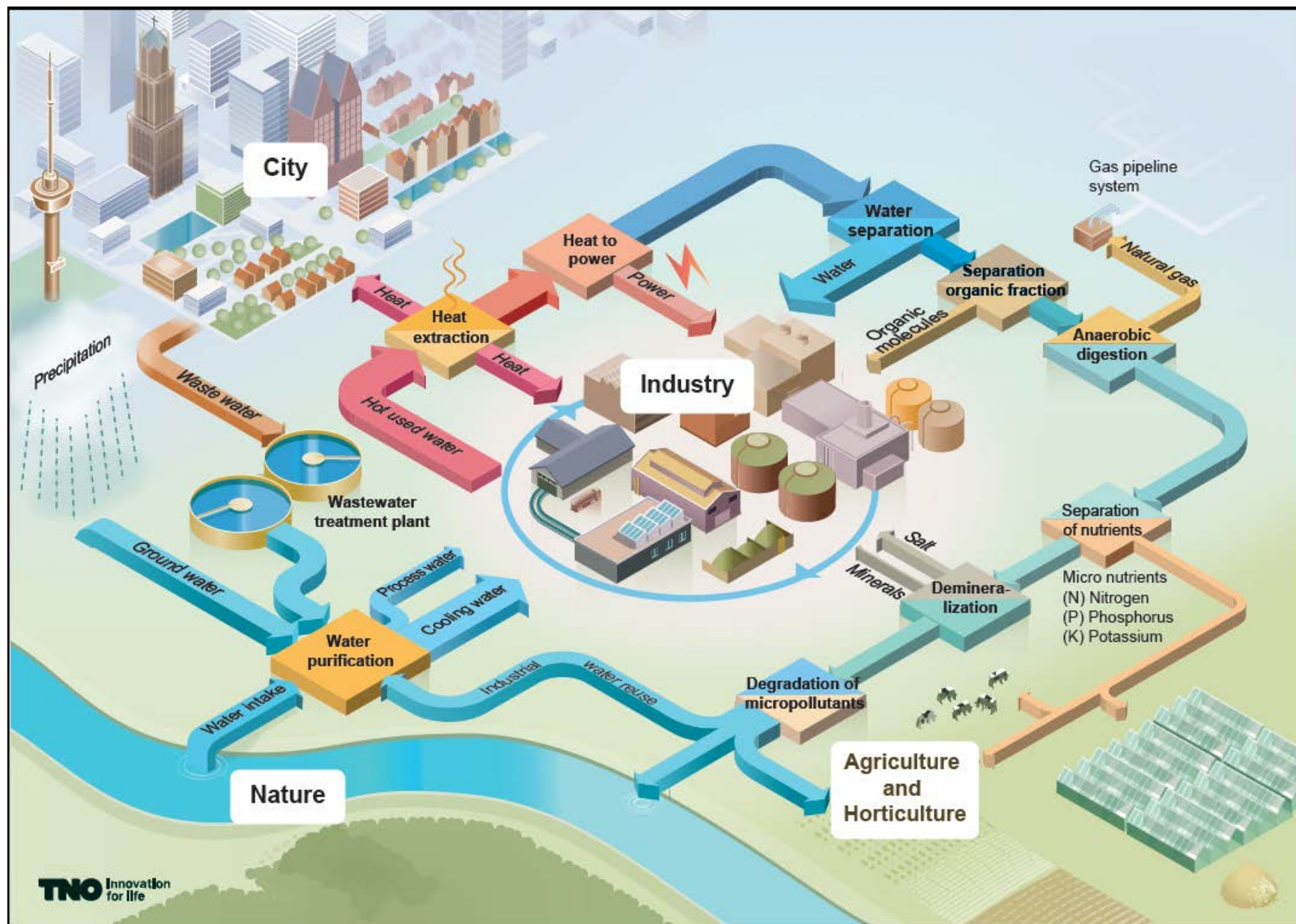


**MOBILITY & LOGISTICS**  
**ENVIRONMENT & SUSTAINABILITY**  
**BUILDINGS & INFRASTRUCTURES**  
**SMART CITIES**

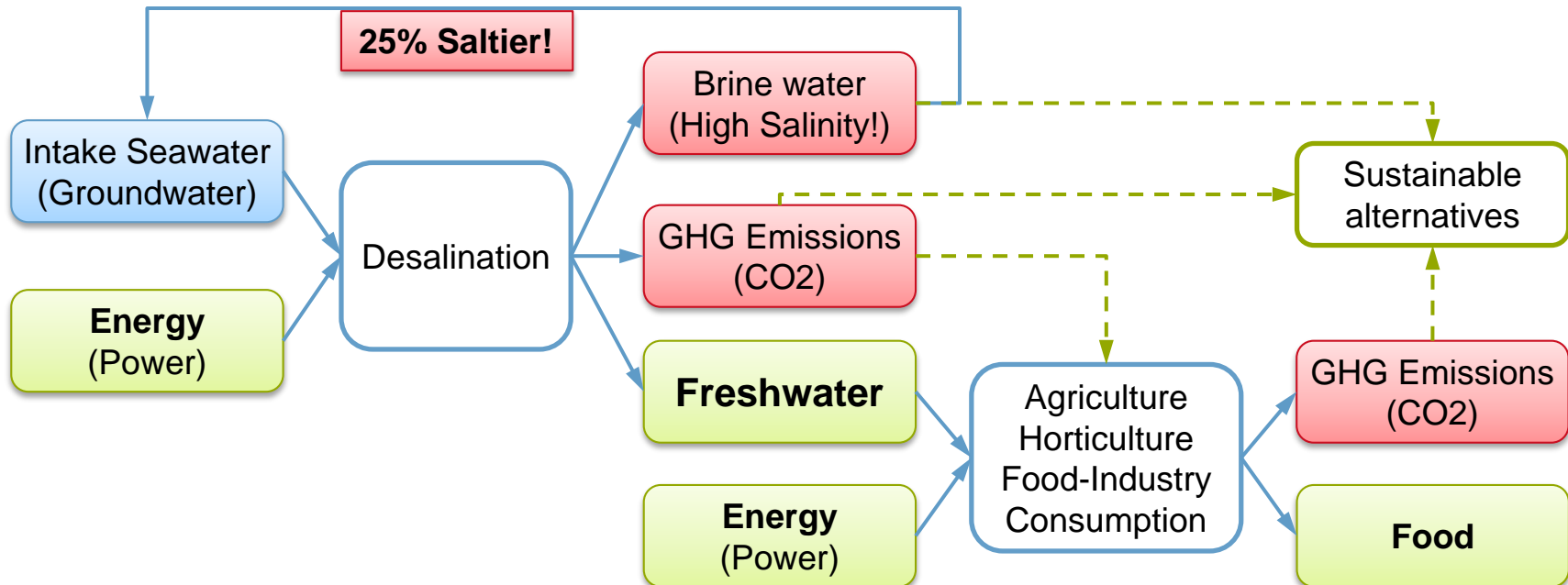


**SUSTAINABLE ENERGY**  
**GEO ENERGY**  
**GEOLOGICAL SURVEY OF THE NETHERLANDS**  
**MARITIME & OFFSHORE**





# Holistic approach of Water-Energy-Food: Freshwater challenge in KSA



## Scarcity of Freshwater:

- Exhausted groundwater sources and less rainfall

## High Salinity & Temperatures in Arabian Gulf and Red Sea:

- 70% of world desalination in the Middle East

## Socio-Economic Viability:

- Consumption, Farming & Food sector
- Brine Water & GHG Emissions
- High expenses of freshwater desalination

## To illustrate

### Desalination in KSA (2010)

- 1,721 (Million m<sup>3</sup>/year)
- +/- 200,000 (m<sup>3</sup>/hour)
- 0.80 – 1.5 USD/m<sup>3</sup>
- **1.4 – 2.6 Billion USD/year!**

### Desalination in KSA (2010)

- **5,163 Million kWh/year \***
- +/- 600,000 kWh/hour
- **2,715 Million kg CO<sub>2</sub>/year \*\***
- +/- 315.000 kg CO<sub>2</sub>/hour

### **Desalination Capacity of 2010 should Double in 2030!**

- To enable economic and population growth

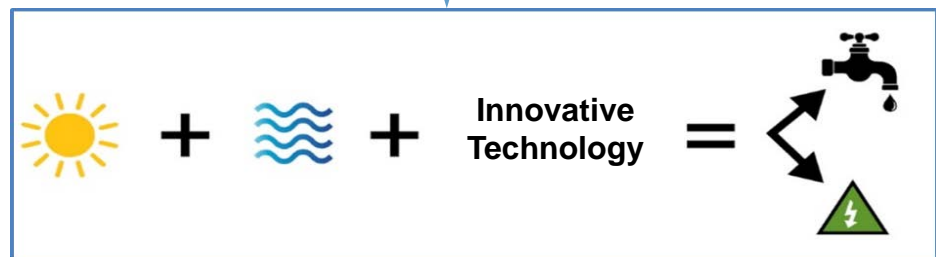
### **High Salinity & Temperatures in Arabian Gulf and Red Sea!**

- 70% of world desalination in the Middle East

## **What if:**

We can exploit  
**Renewable Resources**  
(Saving kWh, CO<sub>2</sub>, Costs)

We can reach  
**Zero Liquid Discharge**  
(Brine Crystalization)



\* 1 m<sup>3</sup> → 3 kWh (required kWh based on Reverse Osmosis)

\*\* 1 kWh → 0.526 kg CO<sub>2</sub> (production of CO<sub>2</sub> based on fossil-energy)

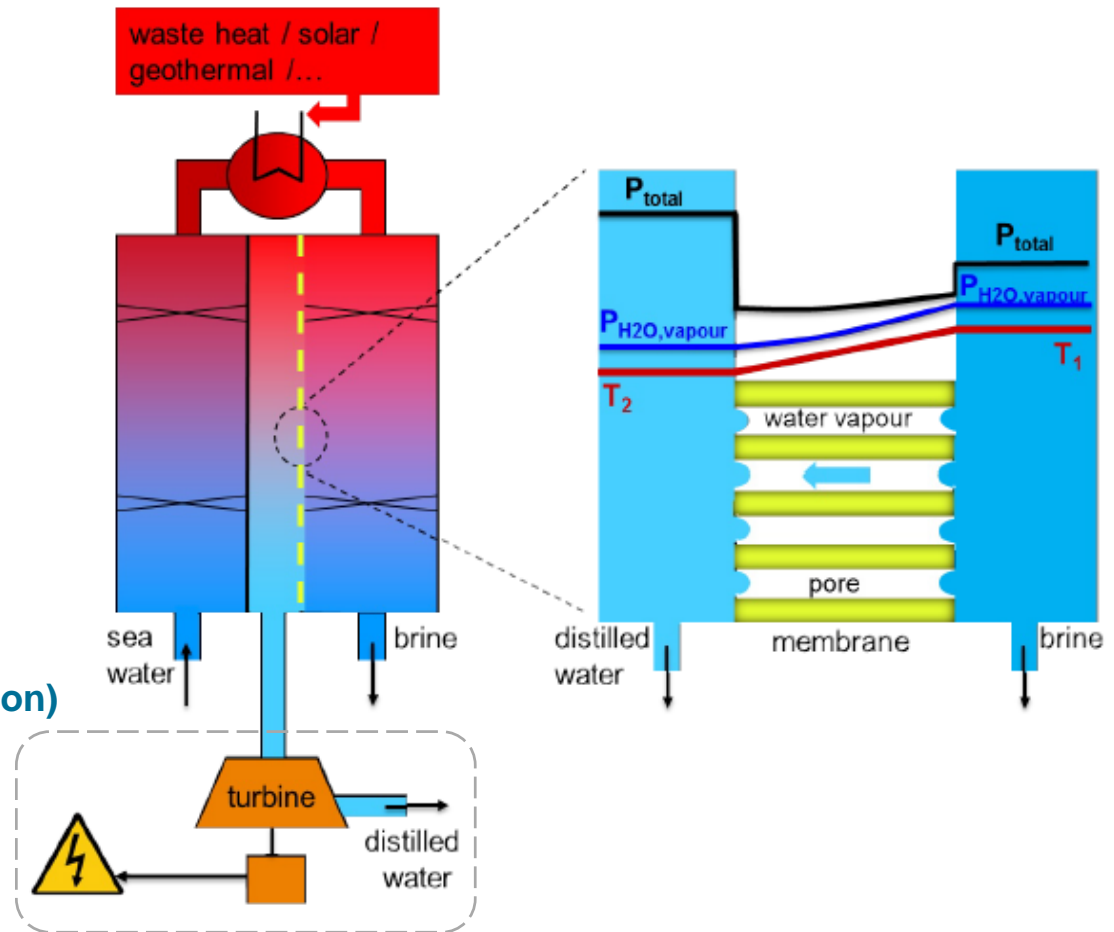
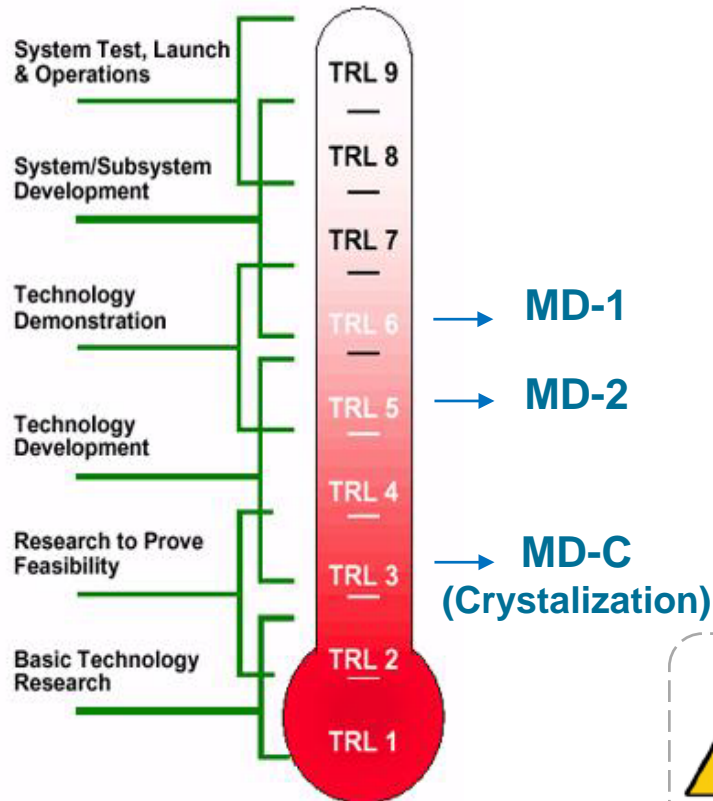


# Freshwater challenge in KSA:

## TNO Sustainable Membrane Distillation (MD)

9

### Technology Research Levels of TNO Sustainable MD



MD-1 → MD-2 → MD-C: more freshwater recovery & less brine

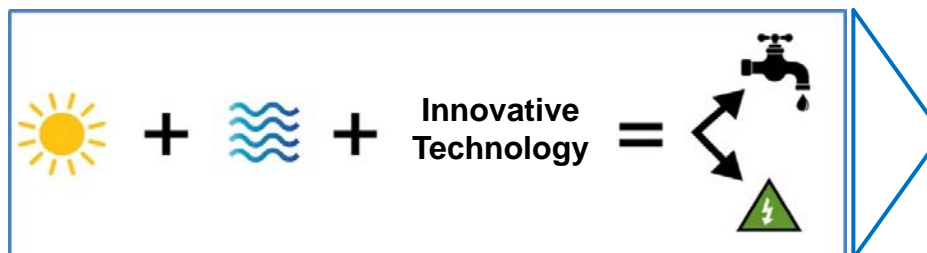
## Freshwater Recovery:

- Recovery range similar to best practices (RO), with higher efficiency (renewable energy).
- Standalone for remote villages/area's, where power supply is expensive.
- Successfully piloted in Singapore, Malta, Belgium and The Netherlands.
- Ready for piloting in Arabian Gulf & Red Sea.

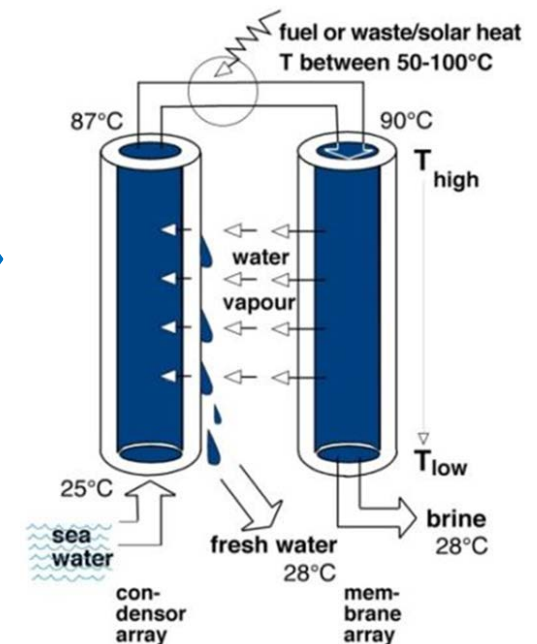
## Brine/Seawater Treatment:

- Towards zero liquid discharge (brine crystallization).
- Brine treatment of current RO, MSF or MED plants.
- 90% recovery is ready for pilots with local partners.

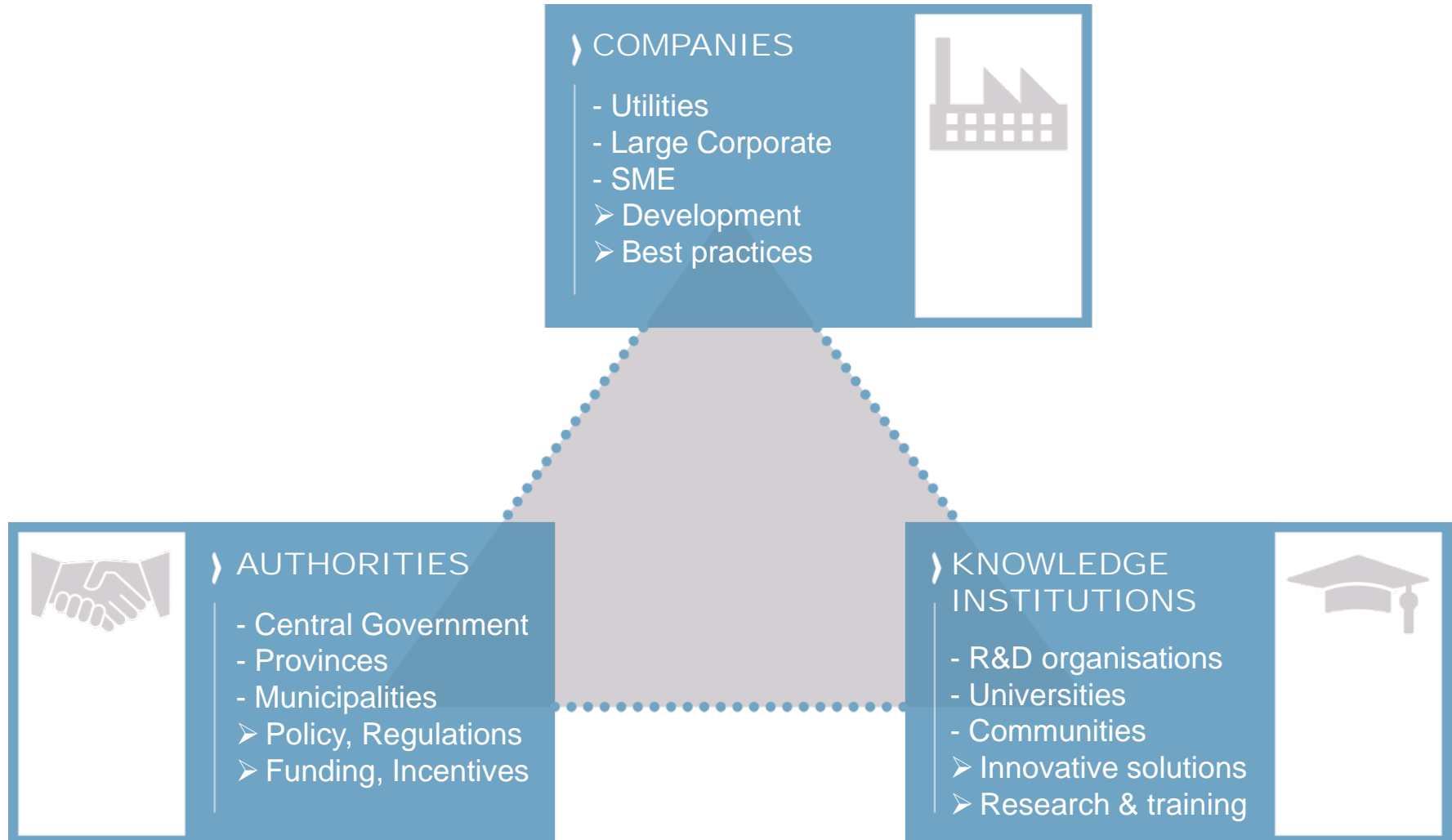
- ✓ Solar Energy / Waste heat (low grade)
- ✓ Low DT
- ✓ Very clean water (near-distilled)
- ✓ Environmental benign
- ✓ Flexible in feedstock
- ✓ Simple, compact, modular
- ✓ Minimal pre-treatment
- ✓ No additives
- ✓ No corrosion



Sustainable Synergy: Energy-Water.  
**Essential for Farming & Food-Industry!**



# Triple helix: Water-Energy-Food challenges



## Innovative Solutions

### *Flexibility in Hybrid Energy Grids*

- ✓ PowerMatcher
- ✓ HeatMatcher
- ✓ Multi-Utility Matcher

### *Solar Technologies & Innovations*

- ✓ Clean Water with Solar heat
- ✓ SolaRoad

### *Planning, Design & Op. Control*

- ✓ Tools for Energy Modelling

### *Privacy & Security of Energy Supply*

- ✓ Distributed Control data mgt.
- ✓ Cyber Security

### *Support & Consulting*

- ✓ Regulatory, Strategy, Policy
- ✓ Economic & Social Interaction
- ✓ Feasibility & Asset Integrity/Mgt

## Together with Partners!

Energy Efficiency

Sustainable Water & Electricity

Support Tools

Enabling Technologies

Decision Making & Implementation

# THANK YOU

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