



**POLITECNICO
DI TORINO**

Department of Environment, Land
and Infrastructure Engineering

Open/Big Data and Citizen Science for Managing the Water, Energy, Food, and Environment (WEFE) Nexus

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Daniele GANORA

daniele.ganora@polito.it

Unconventional water resources:

*the role of large-scale desalination
(and other water-energy nexus issues)*

Energy-for-Water side of the Nexus



energy use for (conventional) urban water cycle,
i.e. abstraction, pre-treatment, distribution and
wastewater treatment

~2-4% of the overall energy use

population equivalent
x
average unit consumption

Global/continental scale

Aggregated data
(country-level or larger)

Bottom-up approaches

Sum of plant's components consumption
(on-site measurements, LCA, ...)

Plant/city scale

- **A lot** of single **case studies** in the scientific literature, but no standardized analyses (mainly WWT data)
- Few databases in the scientific literature, only **aggregated** data available (mainly WWT data)
- Few **proprietary** database

Example: focus on WWTP energy use in Europe

The screenshot shows the European Environment Agency (EEA) website interface. The main content area is titled "Waterbase - UWWTD: Urban Waste Water Treatment Directive - reported data". Below the title, it provides metadata: "Data — Prod-ID: DAT-106-en — Created 14 Dec 2017 — Published 14 Dec 2017 — Last modified 01 Feb 2019 — 22 min read" and "Topics: Water and marine environment". A summary paragraph states: "Urban Waste Water Treatment Directive concerns the collection, treatment and discharge of urban waste water and the treatment and discharge of waste water from certain industrial sectors. The objective of the Directive is to protect the environment from the adverse effects of the above mentioned waste water discharges." Below this, there are tabs for "European data", "Additional information", and "Metadata". The "European data" tab is active, showing a sub-heading "Waterbase-UWWTD (12 data tables, 3 codelists)" and a description: "The dataset contains data selected from the reporting of Member States as part of the UWWTD implementation. The dataset is divided into tables on: reported period, receiving areas, agglomerations, urban waste water treatment plants (UWWTPs), links agglomerations - UWWTPs, discharge points, and (at Member State level) sludge handling and treated wastewater reuse." On the right side, there is a "Data and maps" sidebar with sections for "Global search", "Datasets" (containing "Interactive data viewers", "External datasets catalogue", and the current dataset), "Maps and graphs", "Interactive maps", and "Indicators".

Open data: all plants ($\geq 2,000$ PE) in Europe, plant size (PE) and few other (non systematic) info

A model of energy use

- ENERWATER project (Horizon2020)

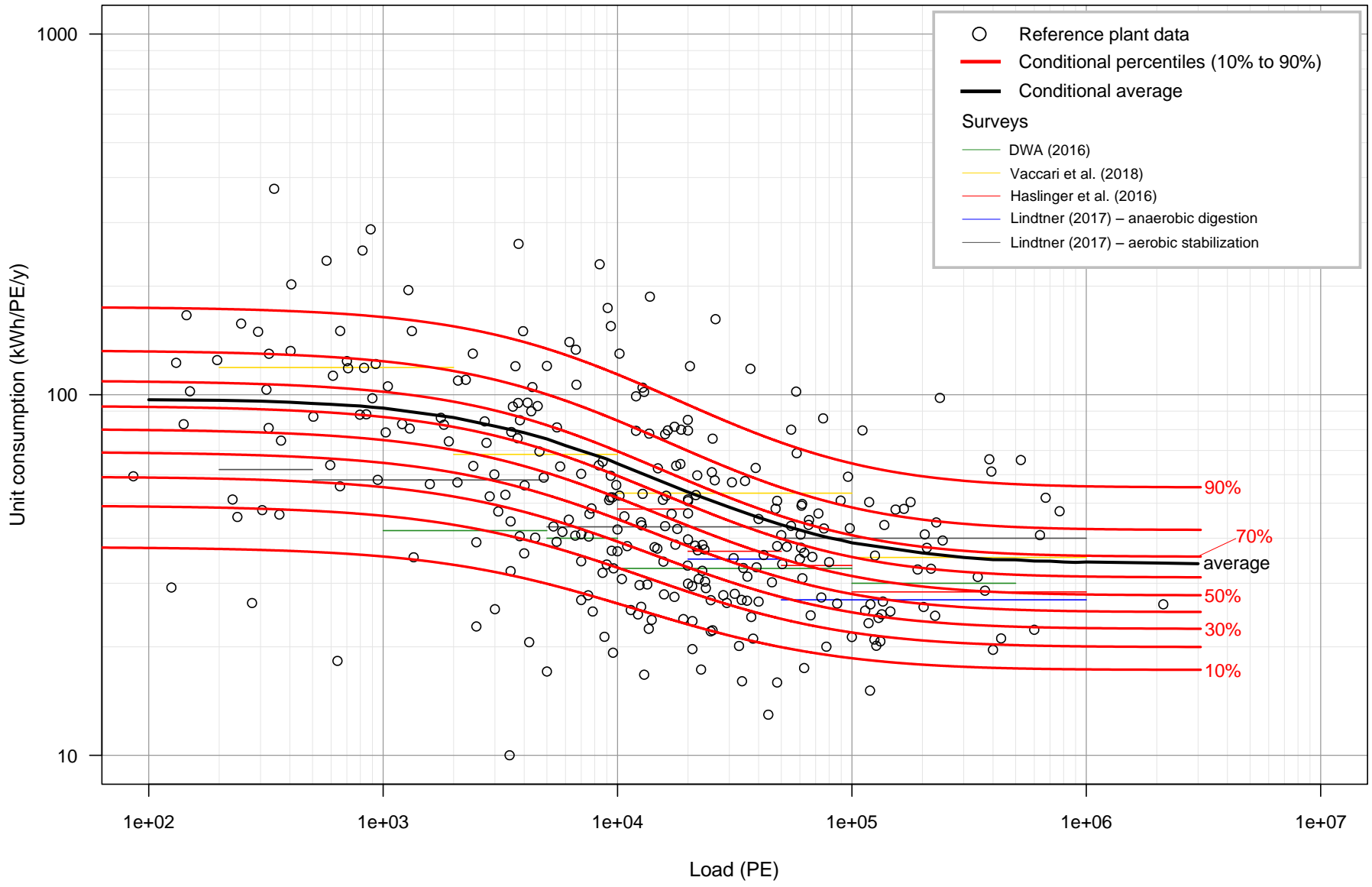
Data collected from literature and made available in disaggregated form ~ 300 plants

Used for calibration

- Surveys at national scale

Data available only in aggregated form only
3 surveys

Used for validation



- expected overall WWTP energy use in Europe was estimated at 24747 GWh yr⁻¹
- about 0.8% of the electricity generation in the EU-28 in 2015
- variability between plants "Plants of small size (less than 50 000 PE) represent almost 90% of the total, but process only 31% of the PE, while they require 42% of electricity use. Plants from mid to very large size, being only the 10% of the plants, process about 70% of the PE with 58% of the total electricity use. "

Not only WE Nexus

Confirm large-scale estimates, and allows more detailed policies (e.g. energy saving measures)

But, **no/poor dataset** about

- Biogas production
- Water reuse (unconventional water resource, further energy for high-quality product)
- Nutrients recovery (may compete with biogas production)
- Emissions (difficult to measure)





based only on current demand, current quality standards and current impacts **Energy for Water** is rather **small** compared to other energy users

Unconventional water resources

key element to support SDG 6 achievement

mainly **desalination** (water production vs water transfer)

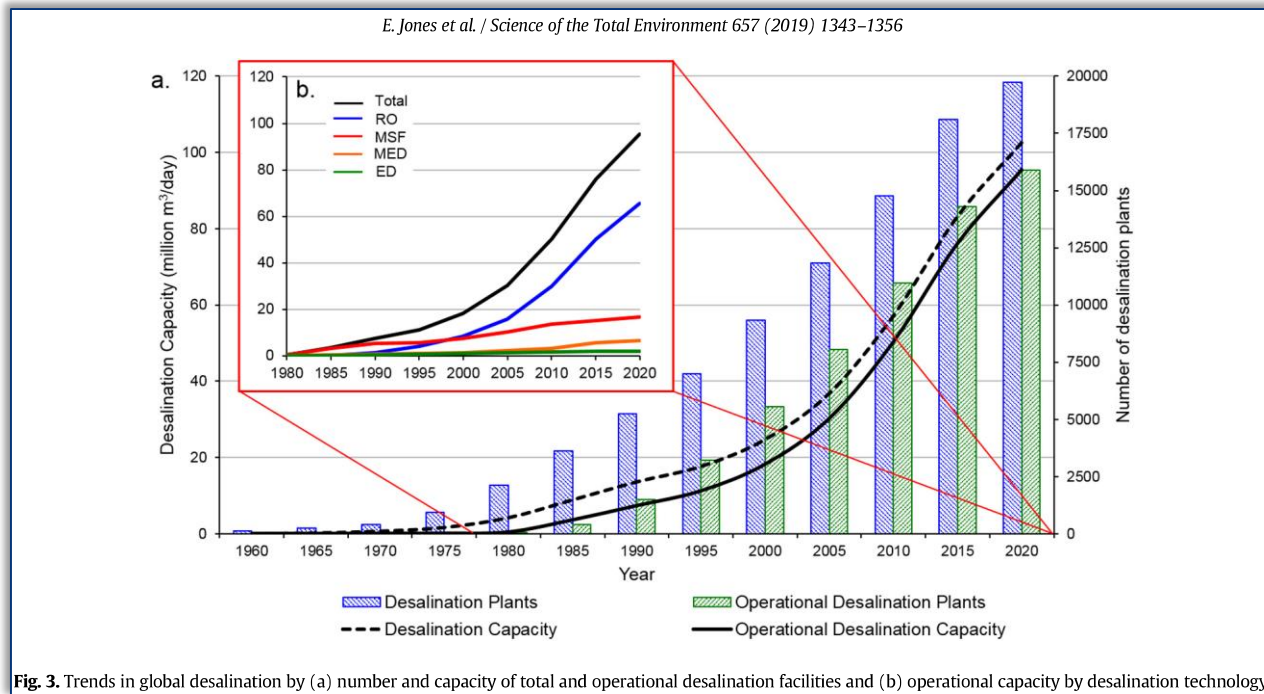
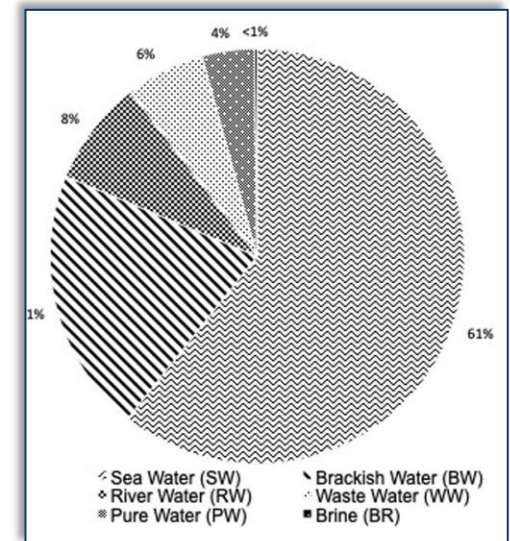


Fig. 3. Trends in global desalination by (a) number and capacity of total and operational desalination facilities and (b) operational capacity by desalination technology.



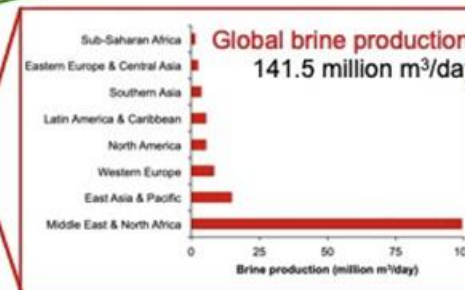
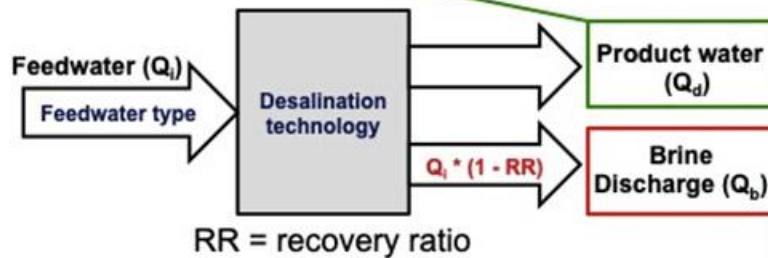
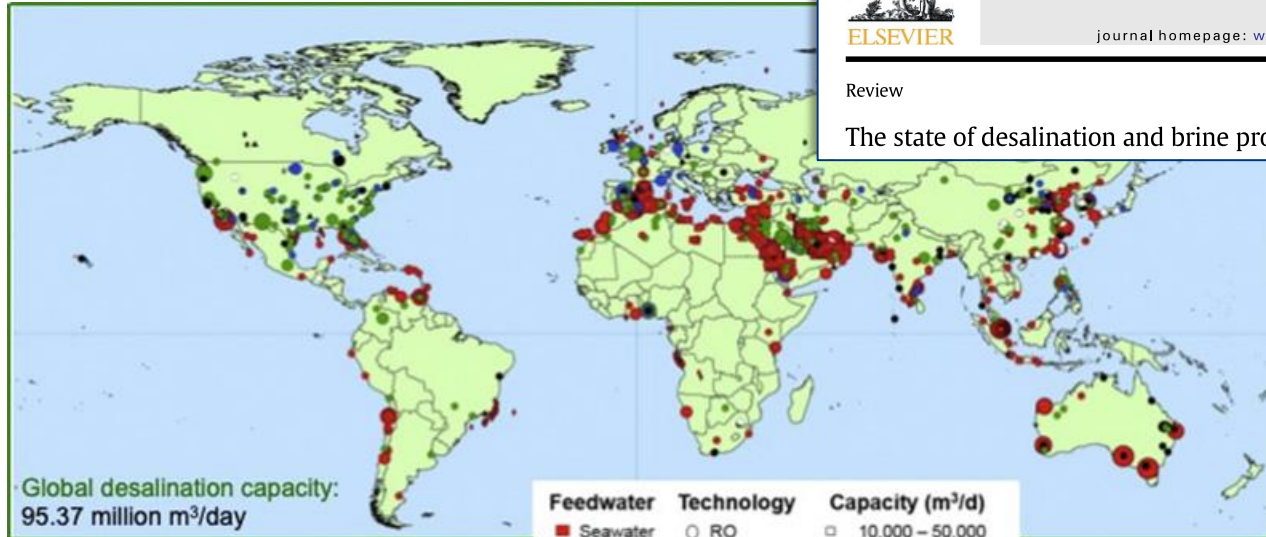
~16,000 operational desalination plants
Analyses based close datasets



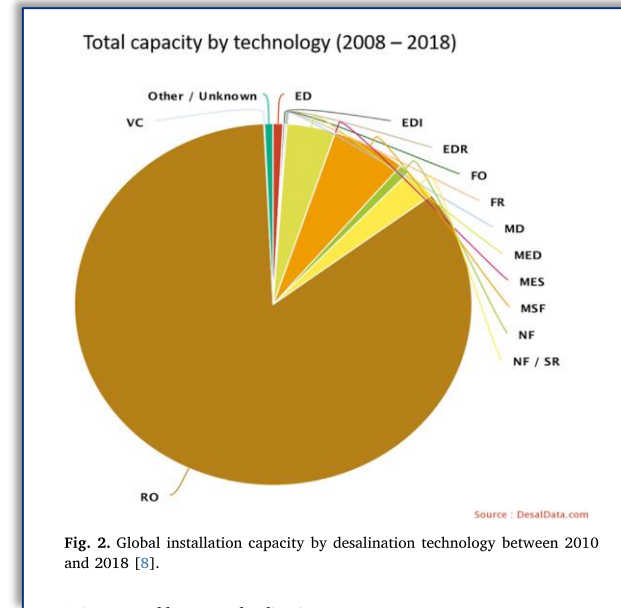
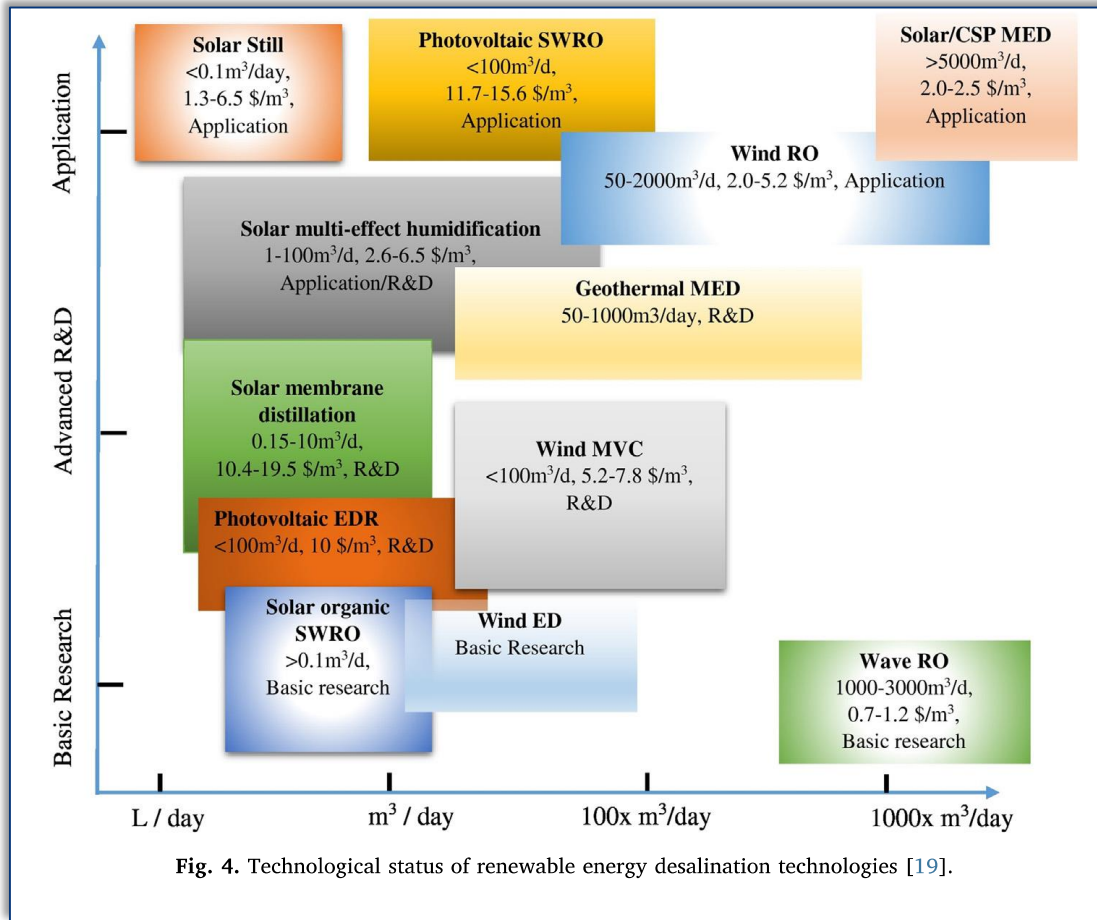
ELSEVIER

Review

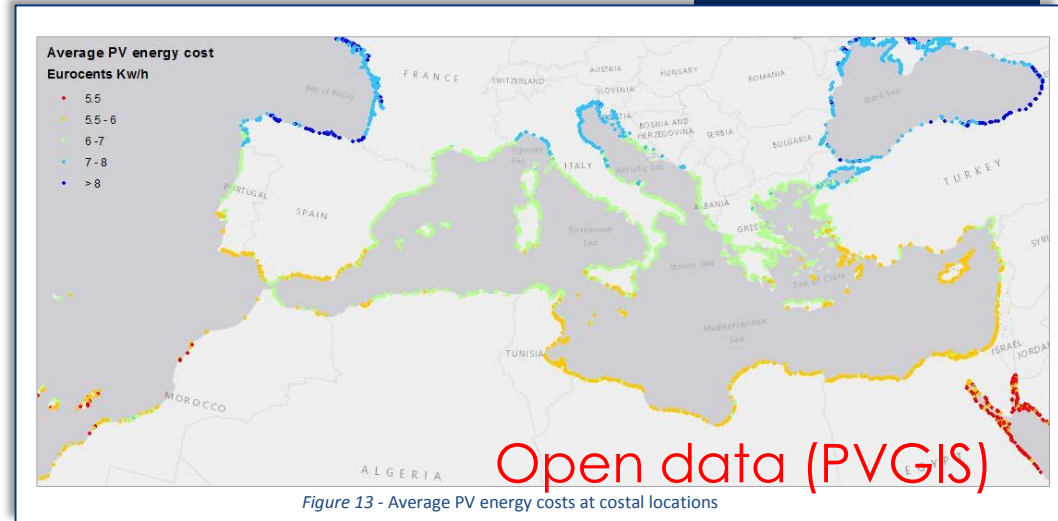
The state of desalination and brine production: A global outlook



Desalination + renewables



PV-RO desal.



European Commission

JRC TECHNICAL REPORTS

Hydro-economic assessment of the potential of PV-RO desalinated seawater supply in the Mediterranean region

Modelling concept and analysis of water transport costs

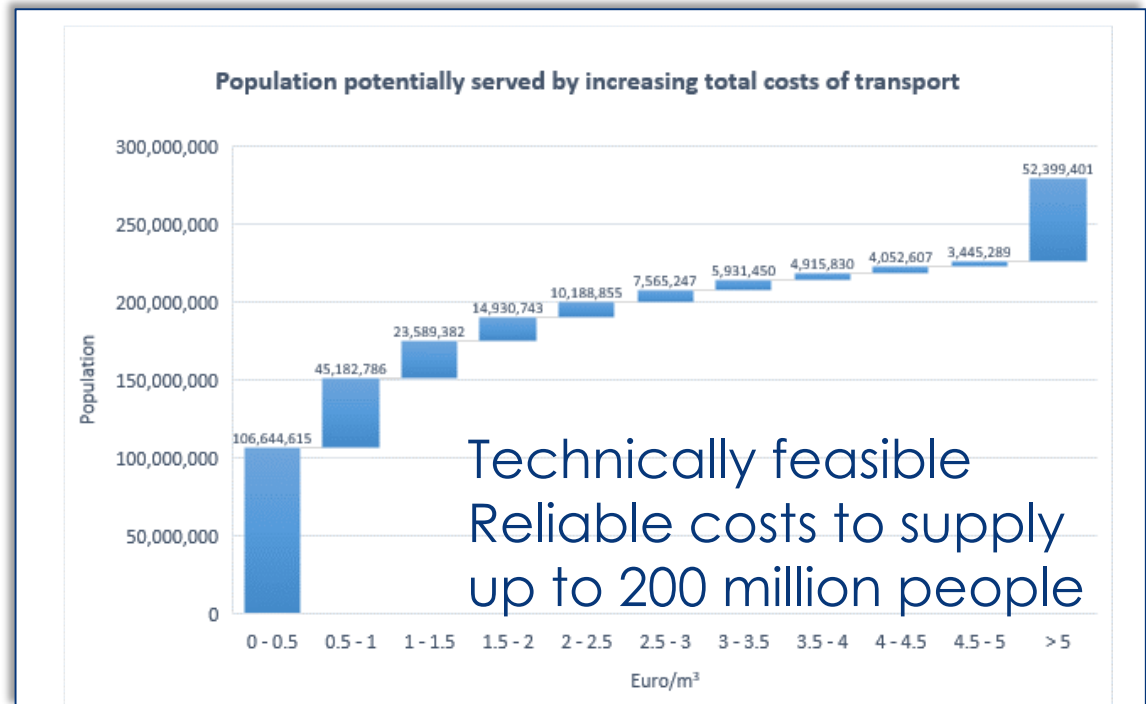
Pistocchi, A., Dorati, C., Huid, T.A., Salas Herrero, F.

AL MARE

2018

JRC Research Centre

EUR 28992 EN



- Social/political aspects
- Rebound effect
- "Nuclear power plant" effect

A screenshot of the Clean Water Center website. The top navigation bar includes the CWC logo and menu items: 'CWC', 'TEAM', 'EVENTS', 'RESEARCH & EDUCATION', and 'OPEN POSITIONS'. The main content area has a dark blue background with a faint pattern of water droplets. It features the CWC logo, the Politecnico di Torino logo, and the text: 'ADVANCING TRL of HIGHLY INNOVATIVE TECHNOLOGIES aimed at WATER AND WASTEWATER MANAGEMENT'. At the bottom, the website URL <http://cleanwater.polito.it> is displayed in yellow.

The relevance of the water-energy nexus for EU policies

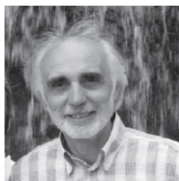
SETIS Magazine, October 2018

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The Water-Energy-Food-Ecosystems (WEFE) Nexus project at the Commission's Joint Research Centre (JRC)



GIOVANNI BIDOGLIO

Giovanni Bidoglio currently leads the Water and Marine Resources Unit at the Joint Research Centre of the European Commission, where he provides science-based support to the implementation of EU Directives related to water resources and marine and coastal environments.

Better together: the need for cross-sectoral collaboration

With the combined effects of growing population, rising incomes and expanding cities, demand for water will continue to grow, while in many regions water availability is becoming more uncertain. The pressure will be further exacerbated by climate change, which will strongly affect the EU's neighbouring regions, such as Africa and the Middle East. This increasing water stress will intensify competition



<https://setis.ec.europa.eu/setis-reports/setis-magazine/relevance-of-water-energy-nexus-eu-policies/water-energy-food>

Coping with water scarcity in a globalized world, funded by ERC

which aims at studying the main characteristics and implications of the virtual water flows associated to the international trade of food. The project has the following **main goals**:

- > **understanding the dynamics of virtual water flows;**
- > **investigating the international water trade network;**
- > **evaluating impacts and feedbacks for food security;**
- > **assessing the vulnerability of the system to crises.**