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Water Security from a Nexus Perspective – 2

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Presentation Outline

1. Introduction to the Nexus

2. Energy for water

   - case study of municipal water supply
   - desalination

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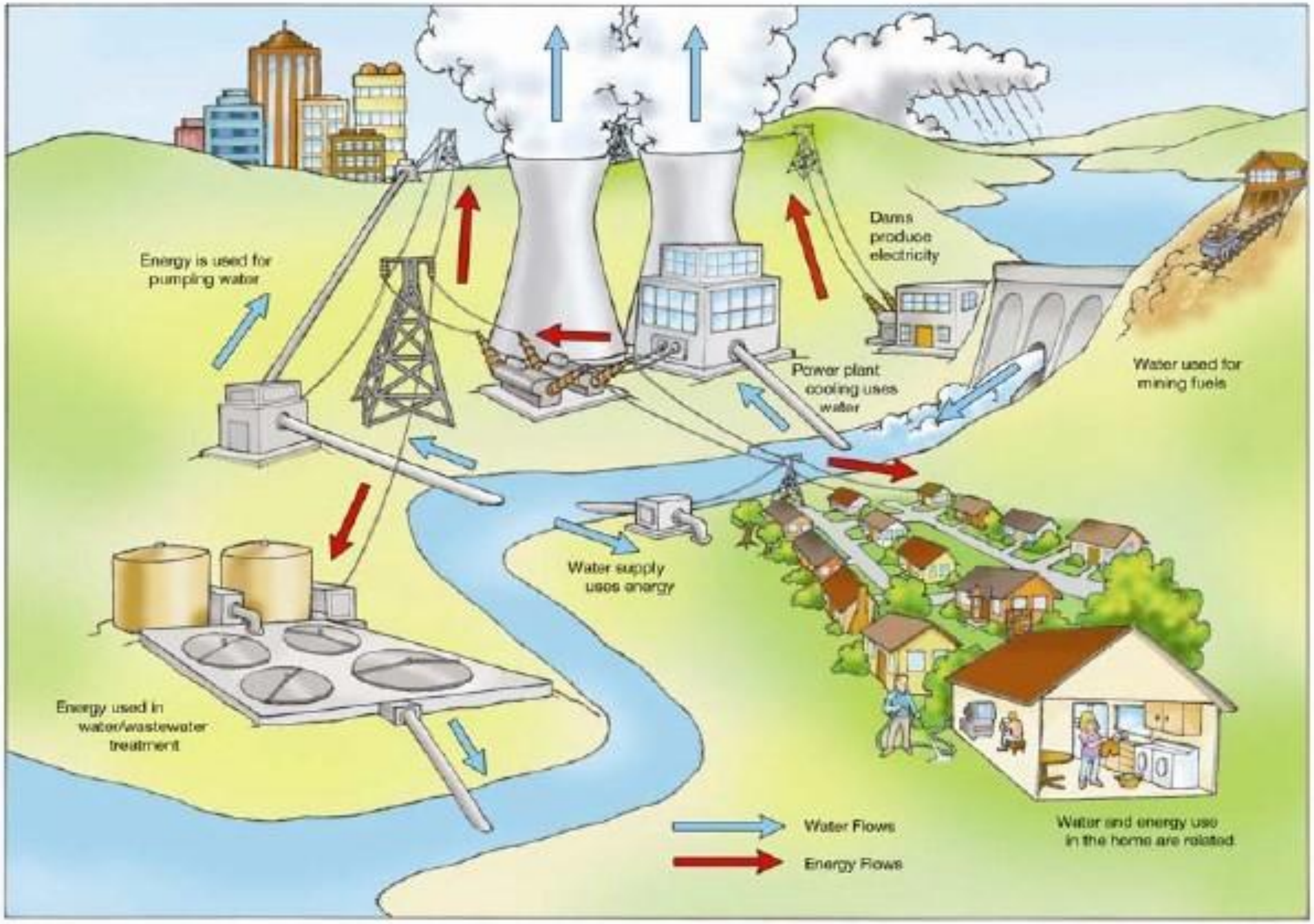

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Energy for Water

The process of purification, transportation and delivery of water resources to the appropriate standard required by the end user.

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Factors that impact energy intensity

Water Quality:

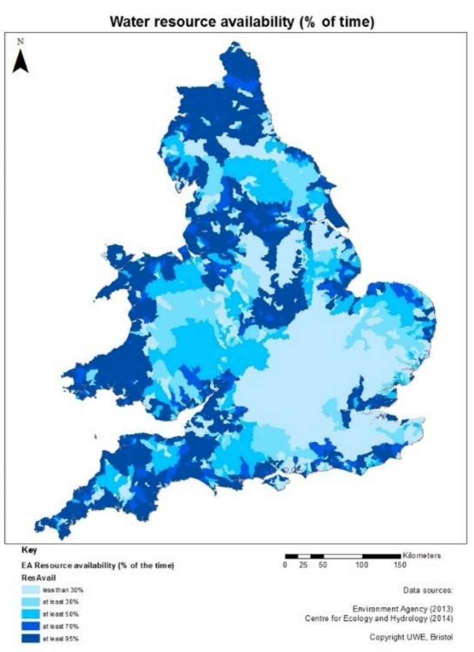
Different water sources require different treatment intensities

- Drinking water high in salinity or contains large amounts of organic material relatively high energy requirements from **100 – 16,000 kWh/MG**
- Waste water treatment can vary between 1,1000 – 4,6000 kWh/MG

Elevation and location:

Inter-basin transfer can be an order of magnitude higher in energy intensity than local distribution or groundwater pumping

- Water supply pumping can vary between 0 – 14,000 kWh/MG (DoE,2014; CEC,2005)



Bristol Water

Bristol Water treats and supplies:

- **300,000 tonnes** or water per day
- Across an area of almost **2,400 square kilometers**
- To approximately **1.2 million people**, with ONS estimating this shall increase to nearly **1.5 million by 2040**

Operations include the abstraction, storage, treatment and distribution of water to homes, businesses and other premises.

Bristol Water

- Since 2009, Bristol Water has used 810-820 kWh/Ml put into supply
- Over the past four years, company emissions have been relatively stable at **35,000 tonnes CO2 pa**
- The largest contribution to CO2 comes from the **power required to transfer water across the supply and distribution system.**
- A reduction in the quantity of energy needed to treat water is outlined in the key national strategies from 'Water for Life'
- BW owned Purton solar PV system produced **454,878 kWh of electricity** in 2014/15 resulting in a carbon saving over **244,000 kg CO2.**
- Helping customers save water has reduced usage by **260 million litres** saving **15,000 kg CO2**

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Wessex Water Supply

Water Supply – scope of operation

- Wessex Water supplies on average over 284 million litres of water each day (c114 Olympic sized swimming pools) to 1.3 million customers
- 97 water sources, 110 water treatment plants, 340 service reservoirs and 11,509 kilometres of mains
- Around 75% of water is groundwater with the remaining 25% from rivers and impounding reservoirs

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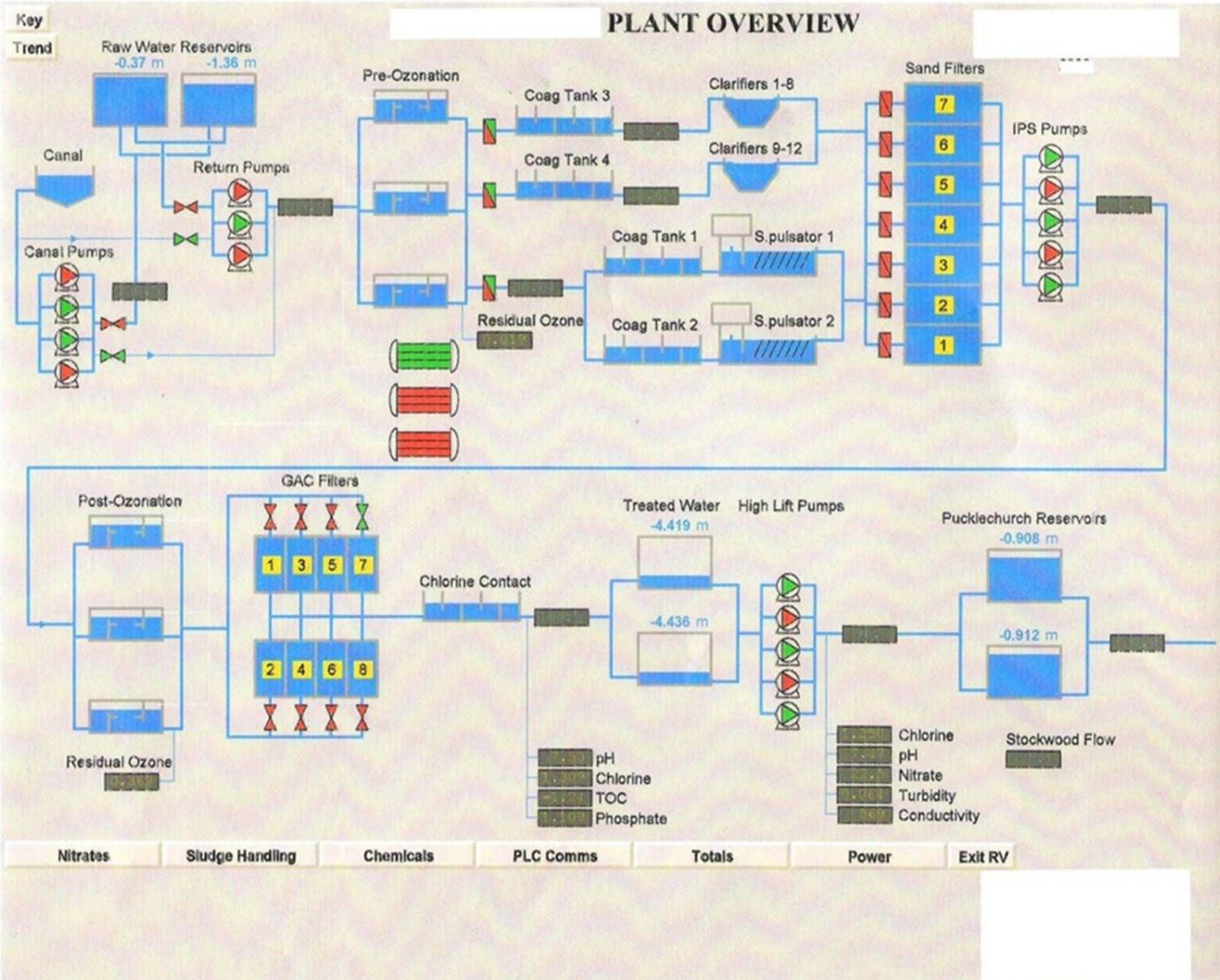

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- Standards
  - 99.95% compliance with EU standards
  - No hosepipe bans since 1976
  - ISO 9000 quality assurance for water production and distribution
  - Leakage targets met

- Supply - Demand Balance
  - 25 years Water Resources Management Plan
  - 10,000 new properties pa; population increasing by 1.0% pa
  - Increased demand offset by leakage control, metering and decline in non-household use

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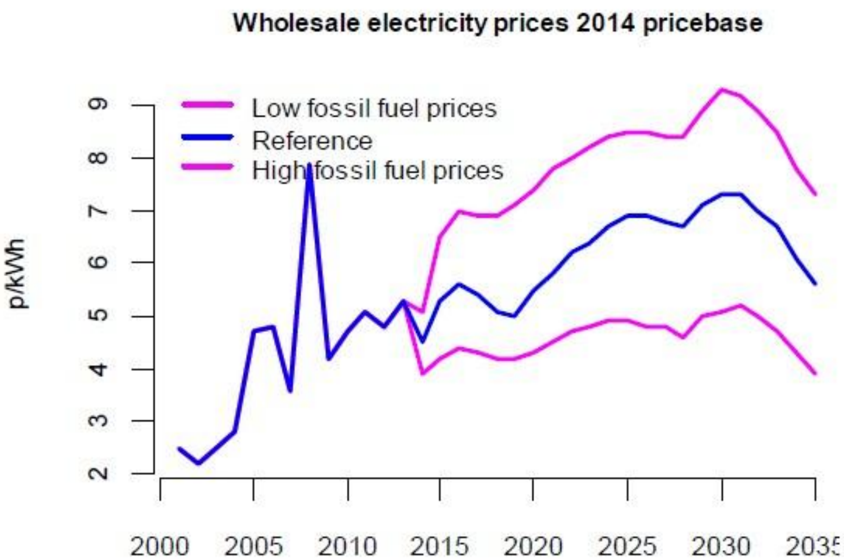
RISING ENERGY COSTS

What's the evidence base?

- Global energy demand is set to grow by 37% by 2040.
- Geopolitical issues continue to cause uncertainty in oil and gas markets.
- The future of coal is limited by pollution and emissions control measures.
- Fossil fuel subsidies of $550 billion in 2013 are holding back investment in efficiency and renewables which received less than a quarter of this.



Energy costs are forecast to almost certainly increase in the short term. The question is, by how much?

Data: https://www.gov.uk/government/publications/updated-energy-and-emissions-projections-2014

What are the potential implications?

- Energy costs and price volatility present an uncertain future, and growing risk to the water industry.
- We need to reduce reliance on traditional energy sources while affordably maintaining and enhancing services to a growing number of customers.
- There are opportunities to pursue renewable technologies opening up potential investment opportunities.
- Many water companies are significant landholders. What has previously been seen as undesirable land may now provide development opportunities for renewable technologies.

What are the key questions?

- How do we secure customer, political and regulatory support, and associated investment, for the necessary innovation to develop low energy intensive processes, and new energy generation schemes?
- How do we change the behaviours of customers, suppliers and employees to drive the required reduction in energy consumption?

- **Optimizing system processes**, such as modifying pumping and aeration operations and implementing monitoring and control systems through SCADA (supervisory control and data acquisition) systems to increase the energy efficiency of equipment. EPRI has estimated that drinking water facilities can achieve energy savings of 5%-15% through adjustable speed drives and high- efficiency motors and drives and 10%-20% through process optimization and SCADA systems. In wastewater facilities, EPRI estimates that 10%-20% energy savings are possible through process optimization.

- **Upgrading to more efficient equipment** and **right-sizing equipment** for the capacity of the facility (plants and pipes often are oversized, to accommodate future peak load). Pumps and other equipment used beyond their expected life operate well below optimal efficiency. In addition, energy is embedded through pipe systems, since leaking drinking water pipes require more energy to deliver water to the end user. Leaky sewer lines allow groundwater to infiltrate and increase the flow of water into the wastewater treatment plant. All water systems have losses, which are cumulative along segments of the water-use cycle. Projects to address water loss and improve end-use efficiency can be promoted as both water- and energy-savings investments.

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- **Improved energy management**. It is widely recognized that water utilities need to develop better understanding of their current energy use, and public and private research and programs have focused on this goal. For example, some states have developed programs to help water utilities better manage energy use. The New York State Energy Research and Development Authority has done extensive work to help water utilities benchmark their energy use and supports arrange of initiatives through its Focus on Municipal Water and Wastewater Treatment program. It developed a best practices handbook for the water and wastewater sectors, including methods to track performance and assess program effectiveness. Energy Star, a joint program of the Department of Energy and EPA, has developed a Portfolio Manager, an online benchmarking tool that allows drinking water and wastewater utilities to evaluate their energy use and compare their operations to similar facilities. Others have contributed research on best practices, energy conservation, and benchmarking energy use, including the Water Environment Research Foundation, the Water Research Foundation, and the American Council for an Energy-Efficient Economy.

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- Some water utilities are **generating energy on-site** to offset purchased electricity. Beyond efficiency measures, they illustrate ways in which water utilities are reducing their energy costs by recovering energy from municipal waste and using the resulting biogas to generate electricity, heat the plant, and in some cases sell electricity back to the grid. For example, DC Water, the wastewater utility in Washington, DC, is constructing a project to convert residuals that remain after wastewater is treated into fuel for combined heat and power operations at the facility. The utility estimates that when the project is completed, it will save $10 million per year on electricity (powering one-third of the treatment plant) and another $10 million annually in solid waste management.

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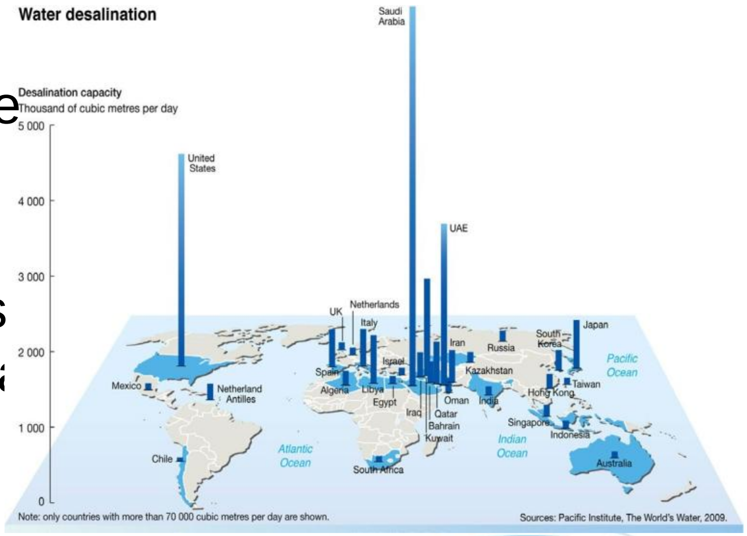
Desalination

Desalination is the process of removing minerals from saline waters to provide potable, fresh water for human consumption or irrigation.

Employed when sustainable, freshwater supplies are not available to meet demand

- Seagoing ships and submarines
- Water-stressed areas
  e.g. Saudi Arabia, UAE and United State



Two classes of desalination:

- **Thermal** or distillation – boiling/condens
- **Reverse osmosis** – membrane desalin

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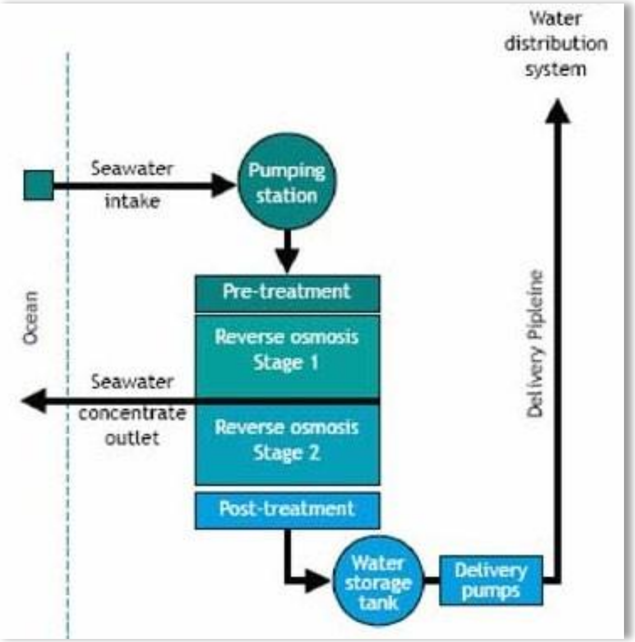
Desalination: Reverse Osmosis

Salt water (34,000-40,000ppm) is forced through cartridges that contain thin-film composite polyamide membranes, which trap salt and other impurities but allow the fresh water through

Pressure of about 80 bar (40 times more than car tyres)

Produces relatively pure water on the downstream side and leaves saline-rich water on the source side.

- Environmental impact associated with saline disposal



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Desalination: Saudi Arabia

About 24 million cubic meters of water abstracted from the Persian Gulf/day

Provides >70% of the country's water requirements with the aim of being completely desalination dependent in the coming decades

Hosts the world's largest plant

- 800,000 cubic meters of water a day
- 2,500 miles of pipes

Plans to power plants by solar power with an investment of $500 billion

- Harness approximately 60 terawatts of energy
- Increase production by a factor of 5 to meet growing population

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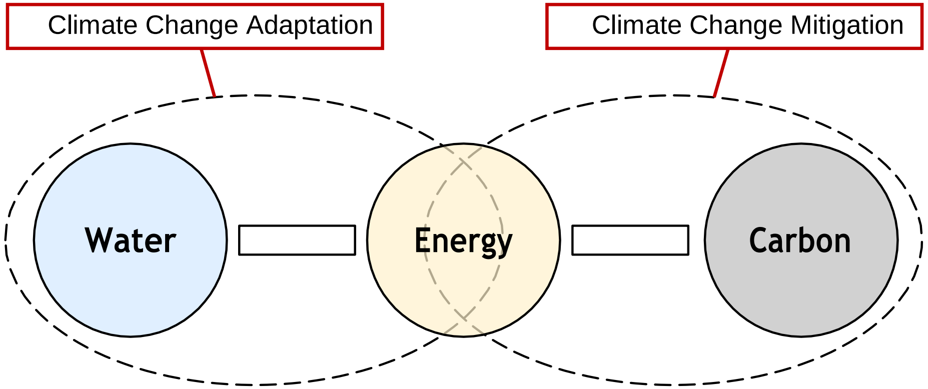
W-E Nexus Conclusion (1)

Although the link between water and energy is now evident, these two sectors have historically been regulated and managed separately



The complexity of the system requires a more systematic approach

There is an array of opportunities and technical solutions to reduce water use in power plants and to exploit the benefits of possible synergies in water and energy.

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W-E Nexus Conclusion (2)

Technical Opportunities:

- Combined power and desalination plants
- Combined heat and power (CHP) plants
- The utilisation of alternative water sources

Institutional Reform and Integrating Models for Planning and Design of Investments

- Integrated Water-Energy Management
- Accurate qualities of water and energy usage would facilitate informed decisions
- Models to address the wider social, economic, and environmental impacts of the energy-water nexus

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Thanks!

– and please get in touch for more information!

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