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# The viability of hydrogen storage to supplement renewable energy when used to power municipal scale reverse osmosis plant

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ARTICLE INFO

*Article history:*
Received 10 April 2014
Received in revised form
4 June 2014
Accepted 6 June 2014
Available online 8 July 2014

*Keywords:*
Reverse osmosis desalination
Renewable energy
Energy storage

ABSTRACT

This paper investigates the viability of using hydrogen energy storage to supplement renewable energy when used to meet a significant and fundamental human need, in this case, large-scale drinking water supplies for around 50,000 people in Newhaven, in South East England, and in Massawa in Eritrea.

Modelling was conducted to derive the amount of water that various reverse osmosis plants would deliver from various combinations and amounts of renewable power and hydrogen storage input, at varying feedwater temperatures.

Analysis was then conducted to assess the cost effectiveness of using renewable energy with hydrogen storage in comparison to using renewable power without energy storage to power the reverse osmosis plant.

The cost of the hydrogen storage scenarios were compared with the costs associated with the equivalent conventionally powered scenario:

- Coal fired plant with carbon capture and storage (CCS) at Newhaven.
- Diesel generator at Massawa.

This comparison was made with and without the external costs associated with conventional energy production and use.


## Introduction

This paper sets out the investigation of the use of renewable energy sources and hydrogen energy storage in such a way that they could be justified for use without reliance on conventional energy sources and to stand alone as an independent and viable power source in their own right.

The scenario used to investigate the technical and financial viability of renewable energy and energy storage was its use to power reverse osmosis (RO) desalination plants to provide water for the personal use of 50,000 people at Massawa Eritrea

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http://dx.doi.org/10.1016/j.ijhydene.2014.06.035

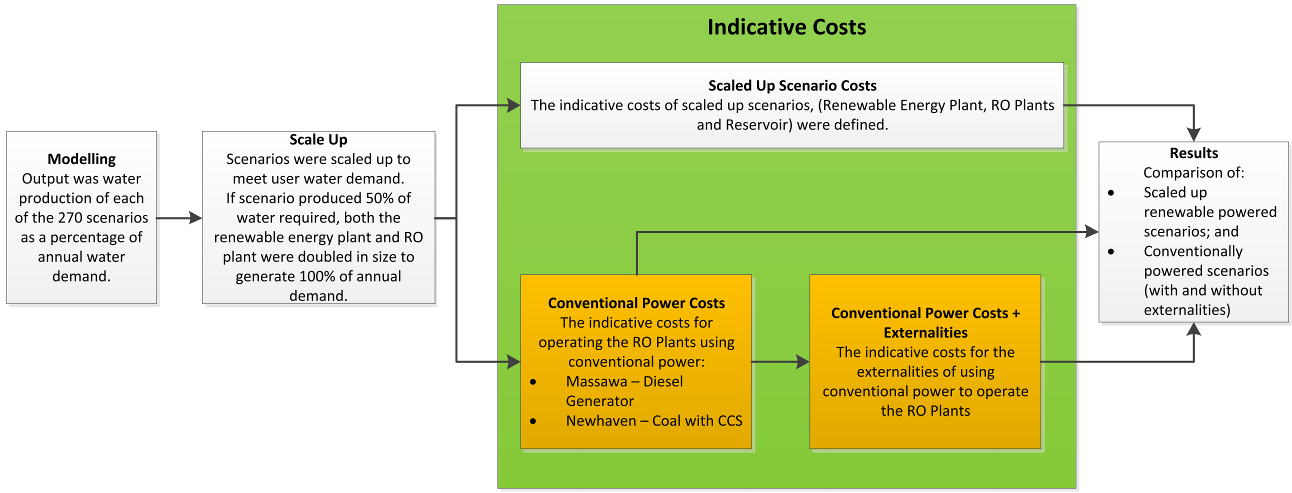


**Fig. 1 – Process overview.**

and Newhaven South East England. The overall process employed is shown below in Fig. 1.

## Modelling

The modelling exercise was conducted in 4 main stages using a range of scenarios to simulate varying amounts and types of renewable power being applied to various RO plants as shown below in Fig. 2 and explained in the following text.

### *Stage 1*

Stage 1 employed the most reliable renewable resource at each of the sites in question (Solar at Massawa and Tidal Current at Newhaven) as shown below in Fig. 3 with the No Brine Stream Recovery (BSR) RO plant.

A schematic diagram of the No BSR plant employed for the modelling within this research is shown below.

An overview diagram of the water and energy processes modelled is shown in the following diagram, Fig. 4.

The No BSR RO plant water production profile at varying input power and feedwater temperatures, derived using Dow Industries RO design software, ROSA, is shown below in Fig. 5.

Sufficient solar and tidal current power was installed at Massawa and Newhaven, respectively, so that their maximum power output during the year would achieve the maximum flowrate of the RO plant, sized to deliver 7000 $m^3$/day (292 $m^3$/h) when operated continuously. Additional power was then added in discrete levels, up to (and including), the power required to achieve five times maximum flowrate of the RO plant. This plant had a minimum flowrate to operate of around 75 $m^3$/h to provide an acceptable brine flowrate and provide permeate with acceptably low salt concentration. To

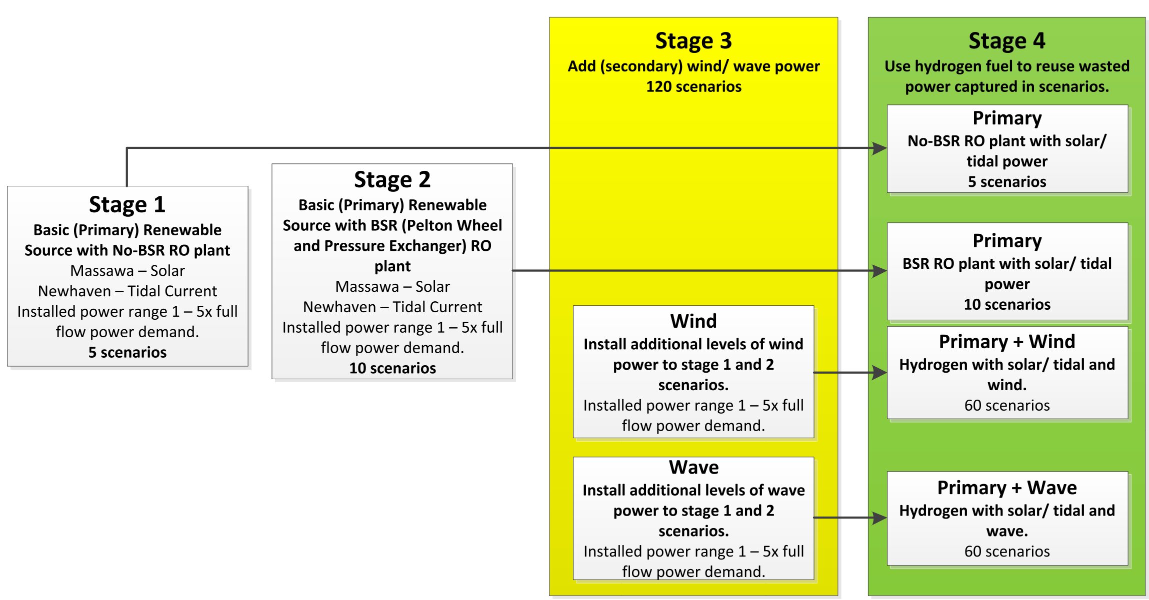


**Fig. 2 – Four stages of the modelling exercise.**