

## Stand-alone groundwater desalination system using reverse osmosis combined with a cooled greenhouse for use in arid and semi-arid zones of India

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### ABSTRACT

In many areas of northern India, salinity renders groundwater unsuitable for drinking and even for irrigation. Though membrane treatment can be used to remove the salt, there are some drawbacks to this approach e.g. (1) depletion of the groundwater due to over-abstraction, (2) saline contamination of surface water and soil caused by concentrate disposal and (3) high electricity usage. To address these issues, a system is proposed in which a photovoltaic-powered reverse osmosis (RO) system is used to irrigate a greenhouse (GH) in a stand-alone arrangement. The concentrate from the RO is supplied to an evaporative cooling system, thus reducing the volume of the concentrate so that finally it can be evaporated in a pond to solid for safe disposal. Based on typical meteorological data for Delhi, calculations based on mass and energy balance are presented to assess the sizing and cost of the system. It is shown that solar radiation, freshwater output and evapotranspiration demand are readily matched due to the approximately linear relation among these variables. The demand for concentrate varies independently, however, thus favouring the use of a variable recovery arrangement. Though enough water may be harvested from the GH roof to provide year-round irrigation, this would require considerable storage. Some practical options for storage tanks are discussed. An alternative use of rainwater is in misting to reduce peak temperatures in the summer. An example optimised design provides internal temperatures below 30EC (monthly average daily maxima) for 8 months of the year and costs about €36,000 for the whole system with GH floor area of 1000 m<sup>2</sup>. Further work is needed to assess technical risks relating to scale-deposition in the membrane and evaporative pads, and to develop a business model that will allow such a project to succeed in the Indian rural context.

*Keywords:* Reverse osmosis; Photovoltaic; Concentrate disposal; Brackish water; Greenhouse

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