Integrated renewable energy systems for sustainable energy, water and crop production in arid and semi-arid regions

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We consider a novel integrated system for the combined purpose of energy, water and biofuel production. Our configuration combines complementary sub-systems in a closed-loop design, exploiting a positive feedback mechanism that increases system efficiency and output. This is not present when the components are considered separately. We evidence our claim via a demonstration configuration that combines models for Concentrating Solar Thermal, Steam Generation, Multi-Stage Flash, wheat production and biofermentation. We consider system performance at Ahmedabad, India. Use of desalted water for irrigation results in a 40% increase over baseline in crop yield and compost production in the first year. The feedback mechanism in year two provides a further 25.9% increase in water, a 5.3% increase in grain and compost production and a 13% increase in electricity. Year three corresponds to equilibrium conditions with biogas production permitting nominal overnight operation of the plant throughout the year. Secondary benefits may include: Carbon abatement – bio-fermentation of crop residue releases less CO2 into the atmosphere than burning. Solar and biofuel electricity production replaces fossil-fuels. Groundwater improvements – sea/brackish water as a secondary source for irrigation and drinking water may alleviate pressure on water reserves in arid and semi-arid areas. Land regeneration – composting biofermentation by-products and low TDS in irrigation water increases humic and nutrient content and reduces soil salinity. Matching supply with demand – the best locations for solar supply tend to be hot and arid having low population densities and low demand: production of food and water provides essentials for economic regeneration and energy demand.

Biography

Noel McWilliam is founder and director of Mitravitae. After studying Environmental Science at UEA he completed a Mathematics PhD at Warwick University, UK developing novel parameterisation techniques for non-linear dynamical systems that included applications to in-vitro anti-cancer drug pharmacokinetics and rainforest canopy models. His subsequent work on extreme value theory in financial risk-management has featured in major financial publications.

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