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Maximizing the Sustainability Net Present Value of Renewable Energy Supply Networks

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Abstract

This study presents an extension of a recently proposed concept and metric by the authors named “Sustainability profit” to “Sustainability net present value” for the purpose of synthesizing more sustainable large-scale energy supply networks. The concept and metric are based on a composite sustainability measurement considering economic, environmental and social pillars and expressed in monetary terms from a wider macro-economic perspective that combines both the governmental and the industrial view. By using the proposed metric, it is possible to obtain answers regarding the advisability of a particular investment in terms of sustainability. The concept is illustrated by two examples: i) a smaller case study presenting an electricity supply network consuming fossil and/or renewable energy sources, and ii) a larger-scale renewable energy supply network considering biomass, waste, solar, wind and geothermal energies on an EU continental scale. Solutions obtained to problems regarding maximizing Sustainability net present value occur at the trade-off between economic profitability, environmental (un)burdening, and new jobs created, considering the time value of the money involved.

Keywords: Sustainability net present value; Energy supply network; System-Wide Supply network; Systems Synthesis; Sustainability; Optimization

1 Introduction

The development of human society has caused an unacceptable level of environmental pollution and depletion of natural resources (Steffen et al., 2015). Nitrogen, biodiversity, and phosphorus footprints present especially high risks, while beyond the safe limits there are also greenhouse gas and land footprints (Čuček et al., 2015). There are several reasons for unsustainability, among them the growing world population (Bradshaw and Brook, 2014) which has reached almost 7.5 × 10^9 people (Worldometers, 2017). The average ecological footprint was 2.8 global hectare (gha) per person in the year 2012, while biocapacity available was only 1.7 gha per person, (Ewing et al., 2010) which means that humanity has already surpassed the natural performance or capacity of the

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