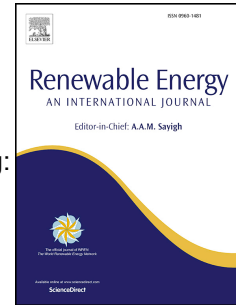


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Modelling different types of uncertainty in biofuel supply network design and planning:  
A robust optimization approach

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# 1 **Modelling different types of uncertainty in biofuel supply network design and** 2 **planning: A robust optimization approach**

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## 6 **Abstract**

7 This article proposes a mixed-integer programming (MILP) model to determine the strategic and  
8 tactical level decisions of lignocellulosic bioethanol supply chain subject to different sources and  
9 types of uncertainty. A comprehensive classification, including sources of uncertainty,  
10 corresponding parameters and possible reasons which may cause the uncertainty, as well as an  
11 up to date and systematic literature review of biofuel supply chain optimal design and planning  
12 studies which consider uncertain input data are presented. To handle different types of  
13 uncertainty, including randomness, epistemic and deep uncertainties, a hybrid robust  
14 optimization model is proposed. Uncertainty in technology is presented as imprecise conversion  
15 rates, which are expressed as probabilistic scenarios. Biomass yield is treated as fuzzy numbers  
16 while demand is assumed to vary in a known interval. Furthermore, fixed costs of the  
17 biorefineries are calculated according to the piecewise linear functions in which segments are  
18 capacity level intervals. In order to investigate the performance of the proposed models a case  
19 study is developed for bioethanol supply chain located in Iran. Computational results show that  
20 the proposed robust model outperforms deterministic model in terms of given performance  
21 measures.

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22 *Keywords:* Lignocellulosic biomass; Supply chain network design; Robust optimization; Second  
23 generation bioethanol; Biorefinery

## 25 **1. Introduction**

26 Renewable energy sources, including wind, solar, biomass, geothermal, and hydro has attracted  
27 increasing attention due to increasing energy demand, as well as significant environmental

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