

A Multi-Criteria Strategic Decision Making Model to Assess Renewable Energy Forms

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ABSTRACT

Renewable energy can potentially be a source of competitive advantage, reduce greenhouse gases, and counter climate change. This study utilizes Multi-Criteria Decision Analysis to systematically assess the relative attractiveness of multiple renewable energy forms based on three factors: 1. business (economic), 2. technical (environmental), and 3. social (regulatory). It uncovers the relative attractiveness of various renewable energy forms and suggests strategies for their development for providers and customers. After considering multiple factors, the study found hydro, geothermal, and wind power to be relatively attractive renewable energy sources.

KEYWORDS

Climate Change, Innovation Adoption, Multi Criteria Decision Analysis, Renewable Energy, Sustainable

INTRODUCTION

A fundamental global problem is the rapid climate change resulting from increasing greenhouse gases emitted by fossil fuels. There is growing interest in reducing fossil fuels whose use is unsustainable because they threaten the biosphere and because their rate of utilization results will result in their depletion. A natural alternative is for the world to utilize more sustainable, renewable energy sources. However, both entrepreneurs who are developing these new renewable energy forms and their potential customers face difficulties in developing, evaluating, and committing to these new energy sources.

Renewable energy forms are those resources that are replaced by a natural process at a rate that is equal to or faster than the rate at which that resource is being consumed. According to the International Renewable Energy Agency (2015, p. 7), renewable energy sources include solar, wind, geothermal, hydro, ocean and biomass energy sources to deliver power and heat (space, water and process heat) to end-users, as well as the use of biomass sources to provide fuels for transportation, cooking and other purposes". While these renewable resources are abundant and sustainable, they are not yet extensively utilized to generate useful energy.

Entrepreneurs who are purveying new types of renewal energy are wrestling with technical problems, scaling up operations, and gaining widespread adoption. Meanwhile, potential customers

DOI: 10.4018/IJSDS.2017040101

of renewable energy are concerned with technical uncertainty, costs, and choosing the right energy form for the future in the face of multiple, conflicting factors and alternatives. This research provides a framework to systematically evaluate the relative attractiveness of various renewable energy forms based on multiple factors - business (economic), technical (environmental), and social (regulatory) - so that entrepreneurs and customers can comprehensively make strategic decisions.

The study proposes the Multi-Criteria Decision Analysis (MCDA) as a potentially valuable framework for analyzing multiple factors and choosing among various renewable energy forms. Decision-makers have to evaluate or choose among various energy forms. The prospects of each energy form are influenced by multiple, disparate, and possibly conflicting criteria which should be considered. There is a need for structuring the decision, for systematically integrating data on multiple criteria, and for choosing or at least reducing the number of alternatives. Up to now, renewable energy questions have been approached mostly through narrow, piecemeal, and intuitive ways instead of through a broad, comprehensive, and rational approach. Using the latter approach will provide greater legitimacy and confidence in renewal energy development and commitment.

The study examines the relative attractiveness of various renewable energy forms for producers and customers. For entrepreneurs, the study provides a competitive assessment of various renewable energy forms. It uncovers where are the bottlenecks to widespread adoption with respect to economic (business), technical (environmental), and social (regulatory) factors. It reveals remaining bottlenecks that still need to be resolved. For customers, it provides a visual summary of the overall attractiveness of various renewal energy forms to help them evaluate and choose among these energy alternatives. It also identifies needed areas where they may collaborate with producers to resolve impasses and gain wider adoption.

A risk versus benefit balance need to be considered when implementing a renewable energy strategy. Though renewable energy sources are plentiful, their implementation and use carry economic, technical, and social risks. Sahabmanesh and Saboohi (2017, p. 66) noted that “Sustainable economic growth and improvement of the social welfare depend upon the sufficient supply of energy resources, while the utilization of energy resources is one of the main factors of environmental degradation”. This study maps the position of various renewable energy forms, identifies bottlenecks, and focuses attention and resources where they are needed most. This improved picture, allocation of resources, and strategy guidelines will increase momentum towards reducing fossil fuel use and help reverse climate change.

THE STUDY

The study is based on detailed analysis of the development of various renewable forms of energy: solar, wind, bio, hydro, and geothermal. (Other renewal energy forms - ocean/tidal, hydrogen/fuel cell and green power – are in their infancy and insufficient data exist on the three factors to permit metric estimation and inclusion in the Multi-Criteria Decision Analysis (MCDA)).

The literature has identified three broad factors that influence the adoption and diffusion of new technologies: 1. business (economic), 2. technical (environmental), and 3. social (regulatory). The study uses this three-factor framework to assess the progress to date and remaining bottlenecks for each renewable energy form. Data sources include secondary published accounts as well as primary sources of information. Primary data sources include interviews with subject matter experts, consultants and researchers, with deep knowledge of each renewable energy form.

RENEWABLE ENERGY FORMS

A renewable energy strategy is based mainly upon choosing the technology to be deployed. This section provides a brief overview of the types of renewable energy technologies and some key attributes. Table 1 summaries and describes the major sources of renewable energy. These energy

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