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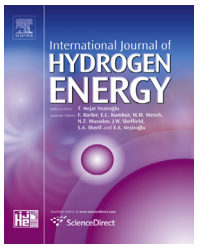

Viability of hydrogen pathways that enhance energy security: A comparison of China and Denmark

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ABSTRACT

Abstract: When designed and built properly, hydrogen energy systems can enhance energy security through technological diversification and minimizing dependence on foreign imports of energy fuels. However, hydrogen can be produced from different feedstocks according to separate pathways, and these different pathways create particular consequences on a nation's overall energy security. The objective of this study is to investigate the superiorities and inferiorities of hydrogen pathways from the perspective of China and Denmark, and to determine which pathways best contribute to national energy security objectives. The results are useful for stakeholders and energy analysts so that they can correctly plan and research the most socially optimal portfolio of hydrogen technologies.

Introduction

Energy security has become an increasingly important topic for almost all nations globally. Access to abundant energy is a prerequisite for economic growth and national development [1]. Energy security is, as the International Energy Agency (IEA) notes, "the uninterrupted availability of energy sources at an affordable price" [2]. In order to increase energy security, many nations are in the process of cultivating self-sufficiency, diversification, and domestic energy production. This process requires for most countries building up renewable energy technologies and increasing forms of energy storage [3].

In order to accommodate future challenges for a stable, secure and affordable global energy system, planners and institutions have been backing sustainable transitions in a number of countries. The development of the future energy regime, however, is characterized by technological competition and contestation, and is in this way still inherently open ended. There is nonetheless an agreement that the system will not be as simple as the conventional, fossil fueled system which it is replacing, both in terms of decentralization and in diversification. Hydrogen energy is one technology that has received a considerable degree of attention, and which is being heavily researched and developed in industrialized countries. This is partly because of the characteristics of the

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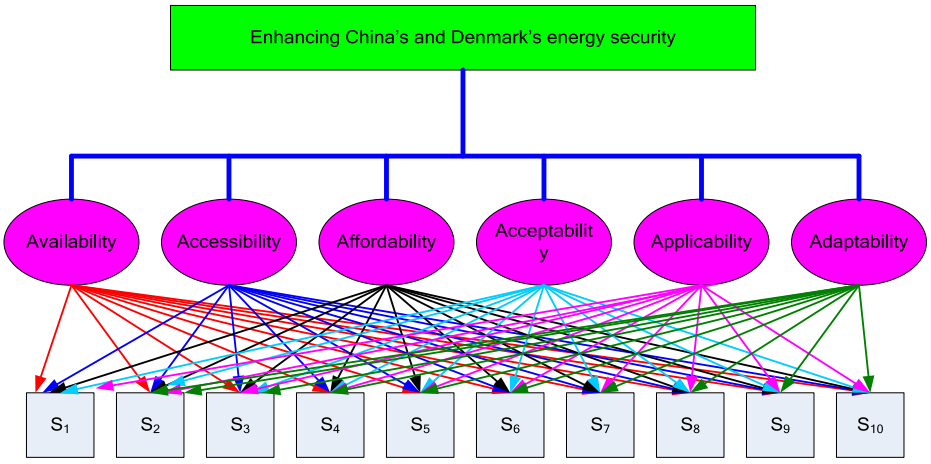

Fig. 1 – Prioritization of hydrogen pathways for energy security optimization.

technology: Hydrogen energy systems have the potential, under certain assumptions, to assist countries with enhancing the energy security through diversifying low-carbon sources of energy and also offer forms of storage and balancing; they can also provide energy in stationary (power plant) and mobile (automobiles) applications.

The purpose of this study is to identify the most viable hydrogen production pathways that can best enhance China's

Table 1 – Comparison matrix for evaluation of the ten scenarios with respect to availability in China.

Availability	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}	Weights
S_1	1	1	1/5	1/5	1/7	1/9	1/9	1/3	1/3	1/3	0.0182
S_2	1	1	1/5	1/5	1/7	1/9	1/9	1/3	1/3	1/3	0.0182
S_3	5	5	1	1	1/3	1/5	1/5	3	3	3	0.0832
S_4	5	5	1	1	1/3	1/5	1/5	3	3	3	0.0832
S_5	7	7	3	3	1	1/3	1/3	4	4	4	0.1498
S_6	9	9	5	5	3	1	1	5	5	5	0.2622
S_7	9	9	5	5	3	1	1	5	5	5	0.2622
S_8	3	3	1/3	1/3	1/4	1/5	1/5	1	1	1	0.0410
S_9	3	3	1/3	1/3	1/4	1/5	1/5	1	1	1	0.0410
S_{10}	3	3	1/3	1/3	1/4	1/5	1/5	1	1	1	0.0410
λ_{max}=10.4797, CI=0.0533, CR=0.0358<0.1											

Note: λ_{max} is the maximal eigenvalue of the comparison, CI represents the consistency index, and CR represents the consistency ratio. If it is less than 10% it means that the comparison matrix is acceptable for consistency check.

Sources: [6,7,25].