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# Sustainable development based energy policy making frameworks, a critical review

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ABSTRACT

This paper, in the first step, presents an overview of the origination and formulation of sustainable development (SD) concept and the related policy making frameworks. The frameworks include Pressure–State–Response (PSR), Driving Force–State–Response (DSR), Driving Force–Pressure–State–Impact–Response (DPSIR), Driving Force–Pressure–State–Effect–Action (DPSEA) and Driving Force-Pressure-State-Exposure-Effect-Action (DPSEEA). In this regard, 40 case studies using the reviewed frameworks reported during 1994–2011 are surveyed. Then, their application area and application intensity are investigated. It is concluded that PSR, and DPSEA & DPSEEA have the higher and lower application intensities, respectively. Moreover, using Analytical Hierarchy Process (AHP) with a set of criteria, it is shown that PSR and DPSIR have the highest and lowest priorities. Finally, the shortcomings of frameworks applications are discussed. The paper is helpful in selecting appropriate policy making frameworks and presents some hints for future research in the area for developing more comprehensive models especially for sustainable electric energy policy making.



## 1. Introduction

United Nations organization initially used the concept of Sustainable Development (SD), in 1972 for the conservation of nature (UN-DSD, 2005). World Commission on Environment and Development (WCED) brought the SD into public policy making procedures in 1987 by a report entitled as "Our Common Future". Brundtland commission described the SD as "development that meets the needs of the present without compromising the ability of future generations to meet their own needs" (Waheed et al., 2009). SD is a dynamic pattern of social, economical, technological and environmental indicators that makes the countries to move toward a better life. Because future generations, with greater knowledge, more technology and different needs, will define SD's goals in their own points of view, cultures and values, there is no final fixed sustainable condition or state for a system (OECD Environment Directorate, 2004). Some authors argue that SD is about achieving a balance among the dimensions of each system like environmental, economic and social dimensions over temporal and spatial horizons which require multidisciplinary actions in a decision making process (Waheed et al., 2009; Meyar-Naimi and Vaez-Zadeh, submitted for publication). SD is also extended to sustainable pattern of production and consumption, especially in the industrialized countries as a major preventive measure of the deterioration of global environment (Veleva and Ellenbecker, 2001).

Providing rational and logical structures, policy frameworks present a platform in which indicators can be identified and classified, for every purpose (OECD Environment Directorate, 2004). Organization of Economic Cooperation and Development (OECD) defines indicators as the values that give information about the situation of a system, and simplify the communications of its components (Kemmler and Spreng, 2007). Many studies try to use indicators to track systems progress towards the SD goals and refer them as Sustainable Development Indicators (SDIs) (Afgan et al., 2000; IISD, 1995, 1997, 1999, 2004, 2005; World Bank, 2002). Using SDIs, the spatial and temporal trends of a system states can be evaluated and its future conditions are predicted and a set of warning signals are provided.

Review papers have been published to present integrated accounts of the SD methodologies, frameworks and indicators. The drawbacks of Pressure–State–Response (PSR) framework in modeling complex and causal relationships of system behavior are presented (Kelly, 1998). A review of the methodologies is given and an operational framework is proposed to support policy makers and analysts towards a sustainable energy policy (Patlitzianas et al., 2007). The SD based frameworks are also studied and an enhanced Driving Force–Pressure–State–Impact–Response (DPSIR) framework is proposed (Niemeijer and Groot, 2008). Another study

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focuses on DPSEEA framework and discusses different approaches. It also identifies challenges and selects a framework for delivering effective sustainability assessments (Waheed et al., 2009). Various sustainability indices and frameworks applied in policy practices are reviewed (Singh et al., 2009).

This paper, in the first step, presents an overview of the origination and formulation of SD concept and the related policy making frameworks. The frameworks include PSR, DSR, DPSIR, DPSEA and DPSEEA. In this regard, 40 case studies using the reviewed frameworks reported during 1994–2011 are surveyed. Then, their application area and application intensity are investigated. Moreover, using AHP with a set of criteria, the frameworks are prioritized. Finally, the shortcomings of frameworks applications including single trajectory, linear and static modeling; neglecting historical constrains; ignoring carrying capacity constraints; lack of social modeling; dealing with assessment instead of policy making; ignoring the balance of the dimensions; ignoring national visions; lack of time scale policies and lack of policy evaluation are discussed. The paper is helpful in selecting appropriate policy making frameworks and presents some hints for future research in the area for developing more comprehensive models especially for sustainable electric energy policy making.

## 2. Policy making frameworks

Several SD policy making frameworks have been developed in various fields, including energy, environment and health mainly by international organizations. Their main differences come from their subjects of policy making and assessment and the interlinkages between their components. For instance, OECD framework mainly emphasizes sustainable environment development and associated dimensions like economy, society and politics (Nathan and Reddy, 2008). In the following subsections, a few commonly used frameworks, their developers, application areas and their intensity of uses are discussed.

### 2.1. PSR framework

PSR framework was initially proposed by OECD for analyzing the environmental issues in 1970 (OECD Environment Directorate, 2004). Developing a set of indicators and applying PSR framework, International Energy Agency (IEA) of OECD have also been trying to consider environmental concepts in sustainable energy policy making (Berger and Hodge, 1998; OECD, 1993, 1997, 1999; IAEA et al., 2005).

The PSR framework consists of three components, i.e. Pressure, State and Response as shown in Fig. 1. Pressures on environment are due to human activities such as exploration, exploitation and especially consumption of energy resources in different sectors (OECD Environment Directorate, 2004). States describe the conditions of natural resources, ecosystems and human health. Responses comprise the preventing, precautionary and awareness activities in environmental, economical and social sectors.

PSR has been used mainly for sustainability assessment of environment. In this regard, one of its most widely used applications is the evaluation of ecological security. Based on the PSR framework and using the fuzzy optimization and AHP methods, an ecological security pre-warning model is constructed for assessing a province and an agricultural ecosystem in a county as depicted in Table 1 (Kai-ya et al., 2005; Zhu et al., 2009). Moreover, combining PSR framework and an AHP method, a model is developed to assess the land ecological security of a region (Su et al., 2009).

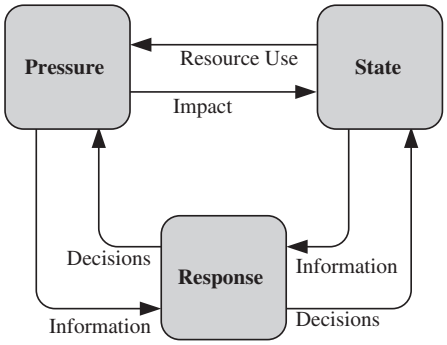


**Fig. 1.** PSR framework.

**Table 1**
PSR framework for assessment of ecological security (modified from Zhu et al., 2009).

| Pressure | State | Response |
|---|---|---|
| Population | Landscape vulnerability | Reduce influences |
| Social | Landscape stability | Improve states |
| Economy | Landscape integrity | |

Based on the PSR framework and using entropy method, a land ecological security assessment index is also constructed (Hua et al., 2011). In addition, using the PSR framework, a model is extended to assess the coastal systems of four countries and two agricultural areas of China from SD point of view (Ferreira et al., 2007; Zhen et al., 2009).

Moreover, PSR framework is used for sustainability study of New Zealand environment and study of the resources of a city in India (Hughey et al., 2004; Nathan and Reddy, 2008). PSR framework is used to measure change of land cover, landscape features, freshwaters, habitats and the vegetation of Britain (Firbank et al., 2003). Using PSR framework and AHP and Analytical Network Process (ANP) methodologies, forest management strategies are planned and their sustainability are assessed (Xiaodan et al., 2010; Wolfslehner and Vacik, 2008). Also, PSR framework and sustainability indicators are used to analyze the interactions of energy and ecological systems in a province of Italy and for a national assessment program (Ridolfi et al., 2008; Whitall et al., 2007). A modified institutional analysis is developed based on PSR framework for ecosystem-based sustainable fisheries' policy design and monitoring (Rudd, 2004).

### 2.2. DSR framework

DSR framework is developed by the United Nations Commission on SD (UNCSD) to provide a consistent set of indicators and to assess progress towards a sustainable energy future (DSD-UNDESA, 1998, 2001a, 2001b; Vera and Abdalla, 2005b). The effort is reinforced by International Atomic Energy Agency (IAEA) during 1999–2005 by developing an original set of Indicators for Sustainable Energy Development (ISED), and then implementing and testing in 15 countries as shown in Fig. 2 (IAEA et al., 2005; Vera et al., 2005a, 2005b; Vera and Langlois, 2007). These efforts are conducted with other international organization including United Nations Department of Economic and Social Affairs (UNDESA), the IEA, the Statistical Office of the EU (Eurostat) and the European Environment Agency (EEA), with the aim of promoting effective energy, environmental and economical policies and measures (Vera and Abdalla, 2005b).