Sustainable Energy Technologies and Assessments 22 (2017) 65–73

Contents lists available at ScienceDirect

Sustainable Energy Technologies and Assessments

journal homepage: www.elsevier.com/locate/seta

Original article

Selection of sustainable development indicators for the assessment of electricity production in Egypt

Mostafa Shaaban *, Jürgen Scheffran

Research Group Climate Change and Security (CLISEC), Institute of Geography, Center for Earth System Research and Sustainability (CEN), University of Hamburg, Grindelberg 7, 20144 Hamburg, Germany

ARTICLE INFO

Article history:
Received 20 September 2016
Revised 20 May 2017
Accepted 17 July 2017

Keywords:
Sustainable development
Electricity
Technology assessment
Egypt

ABSTRACT

Rather than being solely concerned with the technical and economic aspects, a wide scope should be considered in the planning of new power supply projects, including the social and environmental aspects. Thus we will be able to satisfy the needs of both current and future generations achieving a real sustainable development. Previous studies have nominated the used indicators in their sustainability assessment with a focus on renewable energy projects that are already installed in their case studies without clarifying the exact methodology used in their selection process. Additionally, Egypt as our case study has been previously investigated under the scope of technical and economic aspects only. In order to fill this gap, this paper aims to implement a systematic approach to identify and select major indicators for the sustainability assessment of different electricity supply technologies including conventional ones that suit our case study. Our conceptual approach analyzes the frequency of indicators in a sample of 30 studies and screens them against selection criteria and their applicability in Egypt. The results reveal that 13 indicators with strong relevance for the assessment of sustainable development can be used by decision makers for the investment in and installation of new power plants.

Introduction

Energy represents one of the major pillars for the economic development of countries. All countries try to exploit their energy resources and import energy from other countries in order to serve their needs, maximize their production capacity and enhance their quality of life. Electricity is the second most widely consumed form of secondary energy all over the world after oil with a total final consumption value of 18% [1]. In order to produce electricity, a combination of primary energy resources with different characteristics can be used. According to the status quo in the Egyptian energy sector, citizens have been complaining about frequent electricity blackouts for more than four years, because of rising energy demand, shortages of natural gas supply (a main resource for electricity systems in Egypt), aging infrastructure, and inadequate generation and transmission capacity [2], with negative consequences for vital demand areas and the country's economic development. As a result, policy makers make efforts in order to fix this issue and secure energy supply for citizens.

To reduce dependence on natural gas, the government issued the feed-in tariff law for renewable energy projects in 2014 [3] as a first step of liberalization of the electricity market and allowing the involvement of the private sector. However, decision makers and investors need confidence that their benefits will outweigh the costs they pay. Until recently, policy makers were concerned only with the technical and economic aspects of electricity supply technologies in electricity planning, as evidenced by the study project "*Technical Assistance to support the reform of the Energy Sector*" (TARES). This study aims to anticipate the most economic energy mix for Egypt till the year 2035 using the TIMES energy model generator [4], developed as part of the Energy Technology Systems Analysis Program (ETSAP) implemented by the International Energy Agency (IEA). This model uses long term energy scenarios to conduct detailed analyses of energy systems [5]. It combines two complementary approaches to modelling energy: a technical engineering approach and an economic approach [6]. However, it does not take into consideration the environmental and social aspects of energy. With growing concern about the consequences of climate change and their close relationship to energy development, in addition to the need to involve key stakeholders, including end users, in the decision making process, the concept of sustainable development (SD) has been introduced. This concept draws the attention to economic, environmental and social dimensions, in addition to the technical or institutional aspects of a product or a geographical region respectively, in order to continuously

* Corresponding author.
E-mail address: mostafa.shaaban@uni-hamburg.de (M. Shaaban).

http://dx.doi.org/10.1016/j.seta.2017.07.003
2213-1388/

maintain their development. In our perspectives, the electricity market in Egypt shows an urgent need for applying this concept to flourish.

The article is organized as follows: The next section presents sustainable development as a framework for energy technology assessment, including the historical evolution of the SD concept, the components and sub-components of SD, the correlation between renewable energy and sustainability in the literature, and different approaches for assessing energy sustainability. The following section describes the methods applied for identifying and selecting the indicators, while the results section presents the results of the applied methodology. Then, we give a brief description about the selected indicators and their importance, and finally we summarize the research outcomes and the recommendations implied by these results, followed by the conclusions.

Sustainable development as a framework for energy technology assessment

Throughout the last three decades, there has been a great worldwide concern about indicators of sustainable energy development assessment by many local, regional, national and international organizations as shown in Fig. 1. Starting in 1987, the Brundtland Commission identified sustainable development as "development which meets the needs of current generations without compromising the ability of future generations to meet their own needs" [7,8]. Recently 17 Sustainable Development Goals (SDGs) of the 2030 Agenda for Sustainable Development adopted in September 2015 came into force on January 1, 2016 aiming at accelerating efforts worldwide to end all forms of poverty, fight inequalities and tackle climate change, while ensuring that no one is left behind. The seventh goal of these SDGs is to ensure access to affordable, reliable, sustainable and modern energy fostering the objectives of the SE4A initiative [7].

There are many approaches that have been proposed to identify the main sustainable development indicators in different applications. The United Nations Commission on Sustainable Development (CSD) constructed a sustainability indicator framework for the evaluation of governmental progress towards sustainable development goals. The Wuppertal Institute proposed indicators for the dimensions of sustainable development, together with inter-linked indicators between these dimensions [9]. Based on different constructions of the SD concepts, Fig. 2 shows the major dimensions of SD together with examples of the main indicators

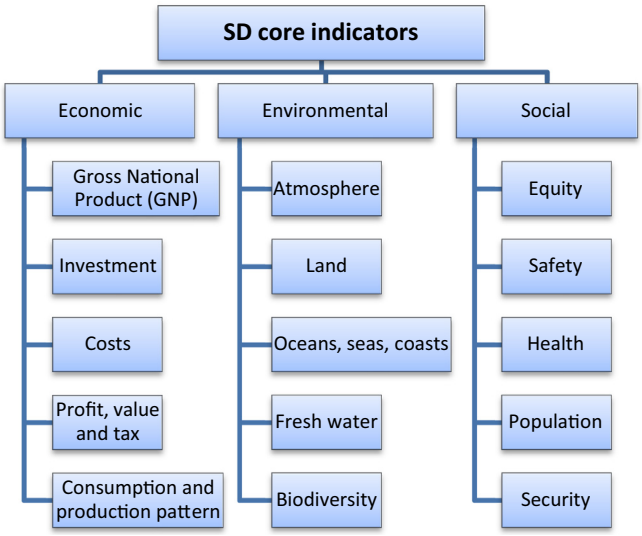

Fig. 2. Sustainable development core indicators and sub-indicators [9].

under each dimension. These indicators can be further extended to more precise and measurable sub-indicators.

Exploring previous studies, we found numerous energy indicators that have been used for the SD assessment. The International Atomic Energy Agency (IAEA), the United Nations Department of Economic and Social Affairs (UNDESA), the International Energy Agency (IEA), the European Environment Agency (EEA), and the Statistical Office of the European Communities (EUROSTAT) have developed together 30 indicators covering social, economic and environmental dimensions for the purpose of evaluating energy sustainability [10]. The United Nations Commission on Sustainable Development (UNCSD) derived 58 indicators from a working list of 134 indicators for applications worldwide [9]. Neves and Leal (2010) proposed a framework of 18 local energy sustainability indicators to be used both as an assessment and as an action-planning tool [11]. Table 9 in Appendix A shows a list of 72 indicators covering four dimensions (21 economic indicators, 17 environmental indicators, 26 social indicators and 8 technical indicators) that we collected from a sample of 30 studies to be used as a pool of indicators from which we select the most suitable ones for our case study.

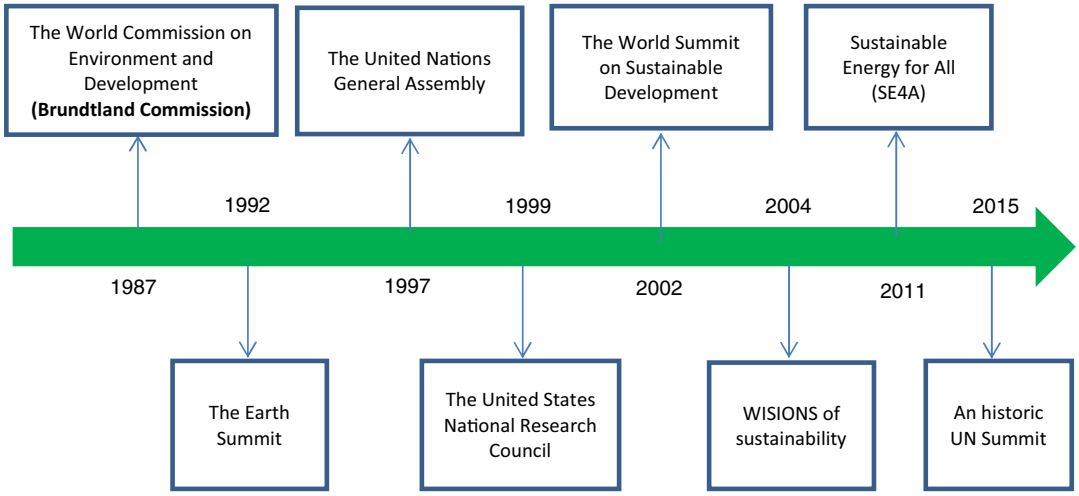

Fig. 1. A historical overview about international meetings concerned with sustainable development.