Energy Policy 90 (2016) 154–171

Contents lists available at ScienceDirect

Energy Policy

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

Opinion paper

Improving appraisal of sustainability of energy options – A view from Slovenia

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ARTICLE INFO

Article history:
Received 18 May 2015
Received in revised form
3 December 2015
Accepted 21 December 2015
Available online 1 January 2016

Keywords:
Energy policy
Sustainability
Spatial feasibility
Qualitative multi-criteria modelling

ABSTRACT

The new Slovenian approach to systematic, transparent, and reproducible appraisal of sustainability as related to electricity production is presented. The common sustainability components, i.e. economy, environment, and society, are integrated into evaluation of the feasibility, rationality, and uncertainty of the energy mix alternatives. A three stage model has been applied for this sustainability appraisal. The first level deals with alternative technologies for electricity production, the second with alternative mixtures of technologies for meeting electricity needs by 2050, and the third takes into account the expected timing of shutting-down existing old power plants and constructing the new ones. Technology alternatives cover both conventional and renewable energy sources: coal fired, gas fired, biomass fired, oil fired, nuclear, hydro, wind, and photovoltaic. The results show that only mixtures of nuclear, hydro, and gas fired technologies are reliable and rational in the context of meeting expected energy needs. The expected share of energy produced by wind and photovoltaic technology is between 8% and 15%, which makes them less sustainable than other technologies. Eventually, they do not meet sustainability goals from the economic and social points of view.

1. Introduction

The worldwide issue of vague and predominantly abstract presentation and argumentation of the phrase “sustainable energy policy” calls for improvement, clarification, and effective application in the decision-making process. This paper is aimed at contributing to these goals. On the concrete level it is about a transparent and reproducible process of identifying and securing reliable, rational, and environmentally sound production of electric energy in Slovenia by 2050. Environment in this context is meant not only about pollution, waste, biodiversity-nature conservation, noise and other isolated topics and views, but about wider/strategic and integrated treatment of environmental interests related to prudent use of space, economic and free time potentials of the environment, public health improvement, development of urban areas that are attractive to work and live in, etc.

Sustainability appraisal is complex and can be, as a consequence of a number of factors influencing the evaluation process, unclear and uncertain. This is the reason why is it difficult to reach a general consensus about its conceptualization, results and, consequently, effective inclusion in the decision-making process. The Slovenian approach to systematic, transparent, and reproducible sustainability appraisal related to electricity production is presented here. The common sustainability components, i.e. economy, environment and society, have been integrated into the evaluation of feasibility, rationality, and uncertainty of the alternatives. A three stage model has been applied for this evaluation. The first level deals with alternative technologies for electricity production, the second with alternative mixtures of technologies for meeting electricity needs by 2050, and the third takes into account the expected timing of shutting-down existing old power plants and constructing new ones. Overall, the model is time dependent, i.e. dynamic. Technology alternatives cover both conventional and renewable energy sources: coal fired, gas fired, biomass fired, oil fired, nuclear, hydro, wind, and photovoltaic (PV).

Comparative information about the good and weak points of various energy systems can assist in the evaluation of energy options and subsequent decision-making. Over the last thirty years a number of studies have attempted to qualify and quantify characteristics and impacts for a wide range of energy sources. These estimations have taken different approaches, from the fuel chain concept (impacts of fuel acquisition through to waste disposal) over the general life-cycle analysis (LCA) to the concept of externalities and multi-criteria evaluation (ExternE, 2005;

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http://dx.doi.org/10.1016/j.enpol.2015.12.022
0301-4215/

Eurelectric, 2011; Gagnon et al., 2002; IAEA, 1999, 2000, 2006; Krewitt, 2002; NEA OECD, 2000, 2010). Recent major studies have been completed and new studies begun (DECC, 2010; DIACORE, 2013; GEA, 2012; IAEA, 2012; IEA, 2014; IRENA, 2013; IRENA UKERC, 2014; PWC, 2010; Santoyo-Castelazo and Azapagic, 2014; Stern et al. 2012; Verbruggen et al., 2014; Verbruggen and Laes, 2015; WEC, 2012) in which sustainability appraisal is a leading concept. Sound, sustainable options are justified by e.g. climate change issues or low-carbon society, prudent use of resources, orientation to renewable energy sources as well as by uncertainties and major consequences related to potential accidents in nuclear power plants (NPP), e.g. Chernobyl and Fukushima. The results of the studies provide useful insights, and help to promote further studies of appropriateness for many technologies and sites. However, the majority of the evaluations change discussion from the level of policy consideration to very specific levels, like discussion on heated water discharge, changes to flora and fauna (biodiversity), noise, impact on cultural heritage, etc., without specifying either the sites or the technical characteristics of potential power plants. Conclusions of the studies are therefore vague and are usually postponed until a project for a specific power plant is made and a location for its implementation almost approved. Such situations leave consideration of strategic policy without a clear and trustworthy technical basis about the sustainability of the options, and a number of questions still remain unanswered. One of the exceptions is a synthesis and a comparison, for which technical data were collected from 296 studies made throughout the world (out of 2165 references that passed screens) as described in Eurelectric Summary Report (Eurelectric, 2011), and the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation (SRREN) (IPCC SRREN, 2011). However, it lacked discussion of the value system aimed at answering transparently the question of aggregation of the different good and weak points of the alternatives, and was directed at identifying/suggesting the best option. The present paper, by contrast, is aimed as a contribution to filling these gaps. A set of issues and questions that indicate how evaluation has been conceptualized, is provided in Table 1 (Kontić 2012, 2013). Additionally, general guidance is presented for establishing an approach and framework of comparative sustainability appraisal of electricity production alternatives, and development of the evaluation criteria is presented in Table 2.

2. Method

The approach in general builds on recent experience in the area of sustainability appraisal in the electric energy sector. The following studies guided drafting of the hierarchical evaluation process and initial selection of eligible evaluation attributes: DECC (2010), Demirtas (2013), Madlener et al. (2007), Pohekar and Ramachadran (2004), The Royal Academy of Engineering (2006), SPRIng (2011), OECD IEA (2013), OPG 2009 were the sources of information about hierarchy and strategy of the evaluation, Banerjee and Solomon, (2003), US DOE (2008), WEC (2012) about world energy status and outlook with alternative ways of sustainable energy presentation and interpretation, AREVA (2008), Hennike (2004), Hirschberg et al. (2004), Hong et al. (2013), IAEA (2013), IPCC SRRN (2011), Kemmler and Spreng (2007) about technology specific information as a source of possible environmental impacts and externalities with land-use requirements and climate change adaptation, and Hansson (2011), Sjöberg (1999), Slovic (2000) about risk perception and associated uncertainties in energy policy considerations. The approach combines strategic assessment, sustainability appraisal, and comparative evaluation of alternatives through an interconnected and uniform procedure.

Table 1
Questions and issues in strategic considerations of energy options, see Kontić (2012, 2013) for extended discussion. Major part of the text has been copied from Kontić (2012, pp.163) for transparency and exhaustiveness reasons (instead of providing just citation).

Questions/issues	Comments/specification
What are the energy needs? What are the energy issues? What are the strategic energy goals?	The questions are inter-connected. At the country level these questions need to be answered in a solid, transparent and inter-disciplinary way. It is the responsibility of politics to ensure full and proper involvement of societal[a] planners in answering these questions. In the process of answering the questions it is necessary to know where to obtain information/data and whom to involve; the answers should be reliable, valid, and trustworthy.
Sustainability appraisal, spatial planning and strategic assessment; territorial impact assessment	Energy policy should be integrated with spatial planning procedures at high planning levels. Planning and strategic environmental impact evaluations should be integrated.
What are the expected outcomes of strategic considerations? What forms of auditing have to be implemented to achieve trust in the answers about strategic policy? Who are the decision-makers?	Early involvement of interested parties, early input by decision-makers with their guiding elements, and clarification/agreement on representation issues associated with different social groups should be resolved and implemented in the process of creating a trustworthy energy policy.
Tiering of comparative assessments?	A solid and transparent comparative assessment of the various options should first be made at the strategic level, i.e. without detailed information on environmental status at potential sites for different options. This requires proper comparative environmental indicators. For example, indicators on specific air emission from different technologies (e.g., radioactivity from NPPs, and CO_2 from coal fired power plants) should not be directly used for comparison. Rather, common consequences in the environment with links to e.g. public health indicators, which these emissions may cause, should be the subject of comparison with appropriate association to the overall societal impacts. In certain cases specific consequences may also be considered.
Which uncertainties have to be considered when deciding about energy options? Is trustworthiness of planners and scientists just another imperative? How to distinguish between facts and values? What is the role and credibility of regulators in the process of approving long-term predictions of environmental and health impacts?	At least the sources and types of uncertainty should be clearly explained when their quantification is not feasible (e.g., long-term future predictions cannot be checked/verified at the present time, so performance assessment results of a particular radioactive waste repository for the next thousands years cannot be quantified, either in terms of environmental or societal changes). Scientific truth and trustworthiness related to siting of the repository should be tested in the communication process at international, regional and local levels.

[a] By societal planning is here meant an integration of all sectoral planning, including environmental.