Environmental Impact Assessment Review 32 (2012) 82–87

Contents lists available at SciVerse ScienceDirect

Environmental Impact Assessment Review

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

Life cycle assessment as an analytical tool in strategic environmental assessment. Lessons learned from a case study on municipal energy planning in Sweden

Anna Björklund *

Environmental Strategies Research – fms, Royal Institute of Technology, Drottning Kristinas väg 30, SE-100 44 Stockholm, Sweden

ARTICLE INFO

Article history:
Received 2 August 2010
Received in revised form 4 April 2011
Accepted 6 April 2011
Available online 7 July 2011

Keywords:
Strategic environmental assessment (SEA)
Life cycle assessment (LCA)
Scenarios
Public participation
Municipal energy plan

ABSTRACT

Life cycle assessment (LCA) is explored as an analytical tool in strategic environmental assessment (SEA), illustrated by case where a previously developed SEA process was applied to municipal energy planning in Sweden. The process integrated decision-making tools for scenario planning, public participation and environmental assessment. This article describes the use of LCA for environmental assessment in this context, with focus on methodology and practical experiences. While LCA provides a systematic framework for the environmental assessment and a wider systems perspective than what is required in SEA, LCA cannot address all aspects of environmental impact required, and therefore needs to be complemented by other tools. The integration of LCA with tools for public participation and scenario planning posed certain methodological challenges, but provided an innovative approach to designing the scope of the environmental assessment and defining and assessing alternatives.

1. Introduction

1.1. Systems perspective in SEA

The EU Directive on the assessment of the effects of certain plans and programmes on the environment (Directive 2001/42/EC; the SEA Directive), as embodied in Swedish legislation (SFS 1998:808), requires SEA to be performed for certain municipal plans. An explicit purpose of the SEA Directive is to ensure that significant effects on the environment are taken into account in the preparation and adoption of plans and programs, but since it is not precise in terms of defining system boundaries of the environmental assessment, there is some room for interpretation.

In a review of municipal energy plans, which are subject to the requirement of SEA, Stenlund (2006) found that in general these plans rely on a narrow perspective and environmental assessments that are not very comprehensive. A narrow planning perspective brings with it a risk of environmental sub-optimisation, meaning the risk of reducing one impact at the cost of increasing another. This is the case in particular for plans that may influence activities far beyond the immediate technical and geographical boundaries of the plan itself, as is the case for municipal waste plans (Ekvall et al., 2007) and energy plans. The wide systems perspective of life cycle assessment (LCA) (ISO, 2006a,b), ranging from "cradle to grave" and taking into account both direct and indirect impacts, should be valuable to the environmental assessment of SEA to avoid such sub-optimisation. This idea is supported by Tukker (2000), who recognises that "Including such secondary effects in an EIA,[1] which may be crucial for a proper comparison of alternatives, requires a *system approach* that takes into account *all relevant effects*. This is, in fact, LCA." Similar conclusions were presented by Nilsson et al. (2005) and Manuilova et al. (2009). A methodological framework for SEA by Finnveden et al. (2003) suggests the use of LCA for environmental assessment in SEA, but there are few documented practical examples of this. Nilsson et al. (2005) and Björklund and Finnveden (2007) describe the use of LCA in SEA of a policy proposal for waste-to-energy taxation in Sweden. Another example is Salhofer et al. (2007), who describe the use of LCA in SEA of a regional waste management plan in Austria.

1.2. Objectives

This article introduces the use of LCA in SEA of municipal energy planning. A process for SEA in local energy planning was designed and tested in Finspång municipality in Sweden (Björklund et al., 2006; Ivner, 2009; Ivner et al., 2010). The process is characterised by a combination of planning tools, including LCA, scenario planning, and participative tools. Its purpose was to improve energy planning in terms of legitimacy and ability to direct local energy systems towards less environmental impact, among other things by introducing a wider systems perspective through the use of LCA for environmental assessment.

* Tel.: +46 8 790 8621.
E-mail address: annab@abe.kth.se.

[1] In this context, Tukker (2000) refers to both project EIA and strategic EIA (SEA).

0195-9255/$ – see front matter © 2011 Elsevier Inc. All rights reserved.
doi:10.1016/j.eiar.2011.04.001

Drawing on experiences from the previously designed and tested SEA process, the specific aim of this article is to describe how LCA can be implemented as an analytical tool for environmental assessment in SEA. Focus is on methodology and practical experiences of integrating LCA with other tools in the SEA process, and on conclusions on the role and contribution of LCA in this context. The LCA model and results are only briefly described for illustrative purposes.

2. LCA as an integrated part of the SEA process

This section outlines the design and scope of the SEA process, the LCA model developed for this purpose, the integration of LCA with the other tools of the SEA process, and the results of the environmental assessment with LCA.

2.1. SEA process

The SEA process was designed in part based on the methodological framework for SEA proposed by Finnveden et al. (2003), using a selection of the tools proposed by this framework. Participative tools were combined with scenario planning tools to handle uncertainties due to the long-term planning perspective, and LCA to introduce a wide systems perspective in the environmental assessment. In short, the SEA process consisted of the following steps (Björklund et al., 2006; Ivner et al., 2010):

- Participative workshops with a citizens' panel to develop a vision and future scenarios, and to suggest measures for a more sustainable local energy system.
- Selection of measures for further analysis, by civil servants of the municipality.
- Environmental assessment with LCA and qualitative indicators of selected measures.
- Valuation and choice of robust measures to include in the energy plan.
- Final feedback to the citizens' panel.
- Compilation, remittance, adoption, and evaluation of municipal energy plan.

2.2. Scope of the environmental assessment

Environmental assessment in SEA should be done of the current state, the no-action alternative, and the likely evolution if implementing the measures proposed by a plan or programme; in this case meaning implementing the proposed measures of the energy plan.

No-action alternatives typically build on prognoses of likely future development. However, the longer the time horizon, the more difficult it is to make reliable prognoses (Börjesson et al., 2006). To handle the long time perspective of an energy plan (10 years or more), the SEA process included scenario planning with future external scenarios (e.g. Dreborg, 2004; Eriksson, 2004) that describe possible future developments of factors affecting the local energy system, but not determined by local decisions. Two main dimensions; "Life style" and "Policy on resource use," were combined in a so-called scenario cross, from which four different but equally important no-action future scenarios emerged. As a consequence, four no-action alternatives were included in the environmental assessment.

More than 90 measures to reduce energy use in the municipality were suggested by the citizens' panel. Ten of these measures were eventually selected by civil servants to be included in the environmental assessment (Table 1).

2.3. Structure of the LCA model

An LCA model of the local energy use and supply was developed. The model was designed to allow for key parameters to be adjusted to represent the current state, the four no-action alternatives, and the implementation of suggested measures of the local energy plan. Municipal energy use indicators that describe energy use in terms of final demand of a number of energy carriers in a number of sectors (Statistics Sweden, 2004) were used as data source for inventory of the current state. This format was also used to develop the LCA model (Björklund, 2008), which was implemented in SimaPro 6 (PRé Consultants, 2004). Fig. 1 describes the foreground system in terms of energy carriers, energy conversion technologies, and end-use sectors. The background system, including up-stream processes of resource extraction and down-stream processes of slag and ash landfilling, was also included.

Table 1
Suggested measures that were selected for quantitative environmental assessment with LCA.

Suggested measure	Description
Expansion of district heating	Defined as a 50% increase in supply of district heating in the residential and private service sectors, reducing the demand for other heat sources.
Introduction of combined heat and power	Existing heat plant in Finspång is converted to combined heat and power production.
Increased public transport	Information measures which are assumed to lead to significantly increased use of public transport (bus) at the expense of cars for personal transportation by inhabitants of the municipality.
Guidelines for biofuel combustion	Information measures which are assumed to lead to more efficient use of old residential biofuelled heating systems issued by the municipality.
Biofuel pellets instead of heat pumps	Measures taken to have modern biofuelled heating systems be installed instead of heat pumps in the residential, private service, and public sectors.
Install solar collectors	Measures taken to have solar heat collectors installed in all residential buildings that are not within reach to be connected to the district heating system.
Individual measurement and billing of hot water	Introduction of individual measurement and billing in multi-family residential buildings is assumed reduce consumption by 15%.
Improve energy efficiency in existing building stock	By introducing already available techniques for reducing energy use in residential buildings, energy use reduced by 50% (electricity) and 20% (heat) on average.
Introduce ethanol cars in municipal transport fleet	The car fleet owned by the municipality would run entirely on ethanol fuel (E85).
Change outdoor lighting to low-energy bulbs	All publicly owned outdoor lighting would be replaced with low-energy bulbs.

2.4. Life cycle inventory data

The external future scenarios defining the no-action alternatives were initially qualitative, but had to expressed quantitatively in the LCA model with numerical estimates of important factors such as; relative increase or decrease in personal transport; ratio between travel by car and public transport; relative use of different vehicle fuels; fuel mix in district heating; or fuel mix in electricity production. As an example, in a scenario characterised by governmental interference in resource use and a rooted life style, it was estimated that public transport would increase by 25% compared to the current state. This was motivated by an assumed combination of regional expansion and increased commuting, higher fuel prices, more limited consumption margins, and improved public transport. Such quantifications were based in part on other scenario studies of the transportation and energy sectors, in part on discussions within the project team.

Some of the proposed measures were quantitatively defined by the citizens' panel, for instance "Introduce ethanol cars in municipal transport fleet," as a result of which 100% of all cars in the municipal fleet would run on ethanol. Other measures had to be further specified