# Promoting renewable energy through green procurement and impact assessment

Kedar Uttam[1,*], Berit Balfors[1], Ulla Mörtberg[1]

[1] *Royal Institute of Technology, Department of Land and Water Resources Engineering Stockholm, Sweden*
** Corresponding author. Tel: +46 87907328, E-mail:kedar@kth.se*

**Abstract:** With urbanization, the construction sector (CS) has been consuming great quantities of energy and contributing to almost 50 percent of the global GHG emissions. Thus, it is imperative for the CS to adopt a sustainable energy system (SES). Renewable energy (RE) is foreseen as a viable option to promote SES. However, adopting RE in CS involves challenges within the areas of both RE development and infrastructure planning (IP). These challenges call for research not only on technology, but also on policy aspects and systems thinking. Thus, the aim of this paper is to understand the scope for incorporating discussions on RE use within the policy instruments (PIs) used in the IP process. The method involved literature review from the perspective of the synthesis of PIs that have the capacities to accommodate discussions on sustainability during planning. The paper highlights a PI called green procurement (GP), which involves procuring services and products that meet environmental requirements. GP could go far to ensure that the energy procured is renewable. The paper indicates that the discussion on procuring RE could be routed through synthesis of GP and impact assessment, which is a PI for evaluating environmental impacts, with the capacity to assist IP.

***Keywords:*** *Infrastructure, urbanization, sustainable energy, impact assessment.*

## 1. Introduction

The planning, construction and management of major infrastructure projects such as mass transit systems or international airport complexes essentially deals with large scale human-activity centred systems capable of continual growth and expansion [1], involves key players such as the construction sector (CS), and has accelerated urbanization. Consequentially, urbanization has been responsible for substantial consumption of energy, especially by the CS. Significant amount of energy is consumed during manufacturing and transportation of building materials, installation, construction activities [2] and operation. According to the Organization for Economic Co-operation and Development (OECD), the operation of buildings accounts for 25 to 40 percent of the total final energy use in OECD countries [3]. The CS annually generates 50 percent of the global greenhouse gases [4]. The use of non-renewable energy by the sector is one of the causes for its $CO_2$ emission [5]. However, the emission of $CO_2$ is noticeable during different phases of a building life cycle, such as, in the construction process, exploitation, renovations, and also during demolition stage [6]. Emissions are also associated with the *use of energy* in construction related activities that precedes site activities, primarily in the construction procurement supply chain [7]. As to what Dimoudi and Tompa [8] highlight, the energy required for construction and consequently, for the material production, is gaining importance. They argue that the selection of materials for the building construction is determinant for the energy required for the construction and for the environmental consequences. It is, therefore, imperative for the CS to adopt a sustainable energy system. Sustainable energy system can be regarded as a "cost-efficient environment-friendly energy system", which efficiently uses local resources and networks, and promotes the introduction of new techno-economic and political solutions [9]. The implementation of such a system by the CS calls for a decrease in the dependency on oil/ other fossil fuels, $CO_2$ emissions reduction, efforts to curtail social costs and a transition towards renewable energy (RE) such as wind energy or bioenergy.

However, the adoption of RE for construction activities involves challenges both within the ambit of RE development, and in the area of infrastructure planning. Thus, the effort needed to address these challenges and to shift towards a sustainable energy system requires research not only on technology, but also on policy aspects and systems thinking. The two important policy instruments, relevant to infrastructure planning, primarily from an environmental perspective, are *green procurement* (GP) and *environmental impact assessment* (EIA). Due to the links that GP and EIA have with infrastructure planning, this study focuses on them for the promotion of RE in the CS. Further, EIA adopts several analytical tools such as multi-criteria decision analysis (MCDA) in order to achieve its purposes. MCDA is highly suitable for analyzing the intersecting systems of energy and environment [10-13]. Although there is an increasing focus on integration and integrative approaches in EIA [14], the systems perspective needs to be strengthened during its application.

GP, within the context of this study, involves the procurement of construction projects that meet environmental requirements, which must be stipulated such that it facilitates the contractor to comply with them, and further enables verification by the client [5]. In the public sector, GP is termed as green public procurement, which according to the European Commission is a mechanism wherein public authorities intend to procure goods and services with a reduced environmental impact throughout their life cycle [15]. EIA is a process that evaluates the impacts likely to arise from a development project significantly affecting the environment [16], and involves the introduction of mitigation measures to avoid, reduce, remedy or compensate for any adverse impacts [17]. Sánchez and Hacking [18] highlight that ideally, EIA is applied during the planning stage of a new project so as to choose the economically and environmentally feasible technological alternative, and plan management measures to mitigate negative impacts and enhance positive effects. Several authors have investigated the link between EIA and planning (for instance, [19, 20]). The effective *implementation* of strategies and mitigation measures identified through EIA process (during planning), however, remains a challenge [21]. This is where the systems perspective in EIA needs to be strengthened. *In this study, we envisage that integrating GP and EIA could be one way to strengthen the systems perspective. This means that discussions on GP should commence at the stage of EIA. Such integration could be an option to strengthen the link between project planning and implementation.*

GP can go far to ensure that the energy used for construction is renewable and green [15]. It can also involve the procurement of low energy consuming materials for construction. Therefore, the central concern of this paper is to discuss on planning for GP at the stage of EIA. This discussion could be channeled through MCDA, which seeks to identify the plurality of perspectives [17]. MCDA includes "formal approaches" that intend to "take explicit account of multiple criteria" [22] during impact assessment. The decision making procedure under MCDA is based on the concept of making a choice between different actions or alternatives that the decision maker examines and assesses through a set of criteria [11]. These criteria could be defined by objectives or attributes [23], involve qualitative or quantitative data [24], include conflicting factors such as technological, economic, social, risk, and environmental, with different groups of decision makers participating in the process [10]. With these instruments and their synthesis as the focus, the aim of this study is to understand the 'scope' within the infrastructure planning process for incorporating discussions on the utilization of RE in the construction sector. The objective of the study is twofold. Firstly, to envisage the synthesis of GP and EIA. During this process, the paper uses the standpoint of "innovation system perspective" (ISP) [25], wherein networks, strategies and institutional mechanisms play an important role. While exploring the role of EIA and GP,

this study also attempts to understand the potential role of MCDA in presenting the deliberation on energy inclusive GP. The second objective is to explore the role that the construction sector could play in RE development. The paper also discusses areas for future research from the perspectives of both GP and EIA.

### *1.1. Methodology*

The study is largely based on review of literature and content analysis. The review attempted to systematically examine previous research on innovation system perspective, EIA and planning, drivers and barriers for GP, MCDA adoption in energy planning, institutional mechanisms, and social innovation. This is in order to analyze the state of the art situation, and to investigate the scope for outlining the synthesis of the policy instruments under consideration. The study is explorative, in the sense that the literature has been reviewed from a systems perspective in order to establish how the policy instruments, concepts and institutional settings can allow and shape the synthesis. This also opened areas for future research for further understanding on the synthesis of the (policy) mechanisms. As described by Weber [26], the content analysis method was used to understand the focus in communication content. The European Commission's Communication on public procurement for better environment [15] was analyzed to understand the purview of GP. The method also involved semi-structured interviews, which included open-ended questions (cf. [27]), and were conducted with experts on energy issues. This was a pre-understanding process (cf. [28]) to investigate further on the second objective concerning the role that the construction sector could play. The analysis of the information obtained during the interview strengthened the key findings that emerged during the literature review. These key findings were useful in understanding the potential role of the construction sector.

## 2. Results

### *2.1. Synthesis of GP and EIA*

In this study, the rationale behind the contemplation of synthesizing EIA and GP has its link with the ISP. Jacobsson and Johnson [25] highlight on ISP for investigating the change in energy system towards RE. The ISP emphasizes that the determinants of technology choice is present in an "innovation system". Such innovation systems facilitate as well as constrain the individual actors making a decision on the technology. In general, innovation systems consist of stakeholders, markets, networks and institutions, and many other components than the relative prices of various alternatives [29]. Innovation is not only about a new product; it could also be the introduction of an improved process, marketing method or organizational method in business practices [30]. As per OECD, dealing with innovation systems is about addressing systemic failures that block the functioning of innovation systems, and obstruct the information flow. These systemic disruptions emerge from institutional rigidities that are based on communication gaps, and lack of networking [29]. Such gaps and lack of integration are evident in the construction sector. The various stages of project development such as design and assessment, construction, operation and maintenance are not yet integrated. There may be considerable difference between project plans (and related EIA reports) and their implementation [30]. The "new environmentally friendly solutions" [31] set during the planning phase need to be effectively communicated at the project implementation stage. Thus, the link between EIA and the structure of the environmental tasks (during project implementation stage) need to be strengthened. For instance, in a Swedish tunnel project, requirements that were based on the environmental impacts identified in the EIA (report) were communicated to the construction contractors through the tender documents [32]. However, planning for GP during the EIA process is still not evident. *Such a planning can be related to*

*the integration of project planning and EIA.* For instance, in Sweden, during the first stage of the planning process, a decision is taken on whether the new investment in infrastructure is required or not. This stage is crucial because it clarifies the requirements for the EIA that will be carried out if the planning process proceeds [20]. *These requirements could provide the necessary space for emphasizing on the need for GP planning.* Also, since EIA has a legal mandate, by shouldering on EIA [14], there is an opportunity for GP planning to receive more attention than it receives as a stand-alone policy instrument. In the context of RE, as Gutermuth [33] highlights, legislation can have a direct beneficial effect on the diffusion of RE. Reciprocally, procurement policies have the potential to direct the search process of firms by recognizing the way forward for growth and through guiding the selection of technology [34], which indicates that GP planning within an instrument such as EIA might result in better environmental outcomes. According to the European Commission, green public procurement can be a powerful instrument to stimulate innovation that leads to enhanced environmental performance [15]. *This agenda of the Commission could add value to the integration of GP and EIA.*

This paper proposes a conceptual model (Fig.1) for RE procurement planning within the whole EIA process using a decision process flow chart designed by Haralambopoulos and Polatidis [10]. The first stage in this model should be collection and assessment of data.

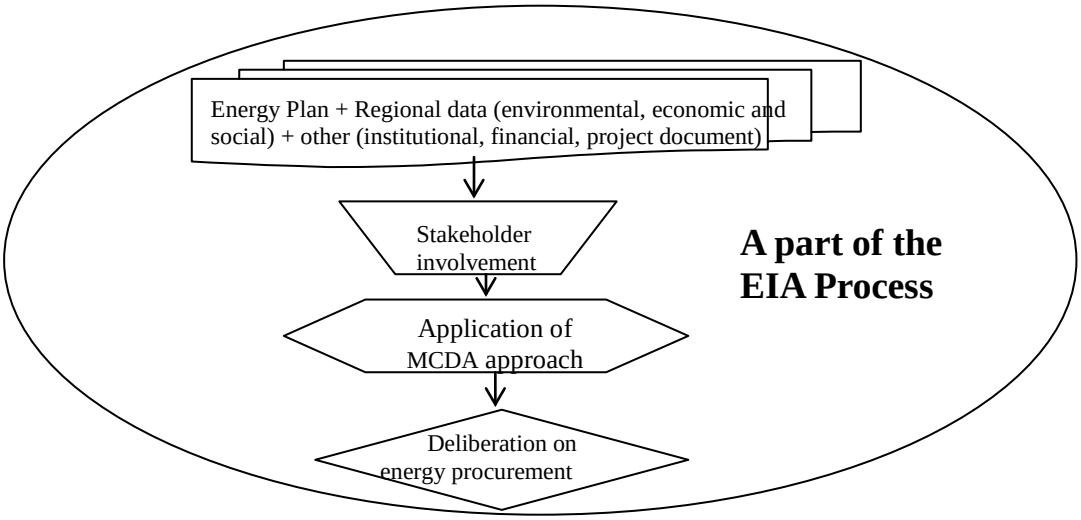


*Fig.1. Conceptual model for renewable energy procurement planning within the EIA process.*
*Source:* adapted from [10]

The data includes, inter alia, local energy plan. Tyskeng's [35] study on the Swedish local energy plans reveals that they discuss goals concerning oil reduction and reductions and/or restrictions on $CO_2$ emissions from a regional and local perspective, and also the use of different energy resources from both regional and local standpoint, energy efficiency, sustainable societies and biodiversity. Subsequent to the collection and assessment of data, the stakeholders need to be identified. The stakeholders consist of several people associated with planning, energy experts, public and statutory consultees, and "have the legitimate responsibility to participate and/or add a socio-political dimension to the decision-making process" [10]. During this stage of the model, it is also important to establish a "planning platform" for incorporating the socio-economic aspects of energy systems in conjunction with their technological attributes [12]. MCDA approach can facilitate the formation of this platform.

### *2.2. Multi-criteria decision analysis (MCDA) approach and group deliberation*

Given the level of conflict that exists between criteria adopted for decision-making (DM), or the intensity of the debate between different stakeholders on the relevancy and the importance of different criteria, tools that seek to facilitate the deliberation and DM process are highly essential. MCDA approach is an umbrella term to describe such tools or methods that take into consideration multiple criteria and assist individuals or groups to explore decisions that matter [22]. It intends to "allow for a pluralist view of society, composed of diverse stakeholders with diverse goals and with differing values concerning environmental changes" [17] and can be an aid in making better decisions. An advantage of adopting MCDA is that it can simultaneously evaluate a number of alternatives, referring to an array of perspectives [11]. In the conceptual model (Fig.1), the MCDA approach has been proposed. However, the various methods that could be used under the MCDA approach needs to be further elaborated. These methods should be such that it can be easily accommodated within the mechanism of EIA integrated with GP. Also, it has to be noted that MCDA is not the only tool that could be used within EIA. There are several other tools such as geographical information systems and life cycle analysis that could be used within EIA (and in certain cases together with MCDA) [23,36]. Further, as Richardson points out, together with stakeholder participation in environmental assessment, there is a need to consider the ethics of practice [37]. *The stakeholder group deliberation on energy procurement, which is the last stage in the conceptual model, should evolve considering, inter alia, ethics and sustainability objectives.*

### *2.3. The role that the construction sector (CS) could play*

The legitimacy of RE technology is a key issue, and might involve a political struggle between the new innovation system and the established one. Such a struggle calls for the participation of politically and financially strong actors, who can have a major influence on the innovation process. These actors can be called prime movers [29]. The CS could be 'prime movers' in promoting RE diffusion and development. Prime movers perform four crucial tasks to promote new technology: create awareness, plan and undertake investments, ensure legitimacy and diffuse the new technology. The new technology here refers to new renewables such as wind power and bioenergy that have not yet reached a wide spread market [25]. Carlsson and Jacobsson [38] indicate that if the consumer/user firms possess significant problem-identifying and problem-solving capabilities in the field of new technology and systems integration, then they can facilitate in strengthening the supplier industry. They noticed this type of user-supplier linkage in the system for factory automation in Sweden. The users in this Swedish factory automation example have been argued to be prime movers [25].
*The CS as one of the large energy users would need to strengthen its link with the energy suppliers. Considering their financial and political capacities, the CS could contribute to the diffusion and development of RE.* However, the influence of managerial concerns and stakeholder pressures play an important role in the contractors' green innovation [39]. Prime mover may also be cluster of actors if several actors share an interest in promoting a new technology [25]. *Thus, future research should identify other actors for this cluster and investigate the ideal conditions and framework for such a cluster to function effectively*.

## 3. Discussion

The synthesis of GP and EIA is novel and not a simple task. The conceptual model (e.g. Fig.1) that has been proposed and presented in this paper is a GP planning process that can be accommodated within the EIA process. However, the future questions and challenges are concerned with a strategic mechanism, that is where and how in the EIA should this synthesis with GP occur. EIA has three phases: predecision, post decision and transition [40]. The

phase that is of particular interest in the future study is the predecision phase, which involves designing, developing the EIA report, its review and decision-making. The predecision phase could provide the necessary space for RE planning, and this needs future investigation. The effort towards the synthesis of energy inclusive GP and EIA also requires sufficient scope in the local energy plans prepared by the municipality. So the objectives concerning RE in the local energy plans have an impact on the link between energy inclusive green procurement and EIA, which needs to be investigated further. If the CS through the synthesis of GP and EIA is able to push the development of sustainable energy systems, then it has not only demonstrated its role as a prime mover but also intervened with the issue of urbanization. Being a significant contributor to the process of urbanization, the efforts towards transitioning to a sustainable energy system is not optional, but an inevitability for the CS.

## References

[1] Yeo K. Planning and learning in major infrastructure development: systems perspectives. International Journal of Project Management 13, 1995,pp. 287-293.

[2] Yan H, et al., Greenhouse gas emissions in building construction: A case study of One Peking in Hong Kong. Building and Environment 45, 2010,pp. 949-955.

[3] OECD. Environmentally Sustainable Buildings: Challenges and Policies. Paris, France: OECD Publications Service, 2003.

[4] Integrated Waste Management Board. Designing with Vision. California Environmental Protection Agency; 2000.

[5] Sterner E. 'Green procurement' of buildings: a study of Swedish clients' considerations. Construction Management and Economics 20, 2002, pp.21 - 30.

[6] González MJ, Navarro JG. Assessment of the decrease of $CO_2$ emissions in the construction field through the selection of materials. Building and Environment 41, 2006, pp.902-909.

[7] Acquaye AA, Duffy AP. Input-output analysis of Irish construction sector greenhouse gas emissions. Building and Environment 45, 2010,pp.784-791.

[8] Dimoudi A, Tompa C. Energy and environmental indicators related to construction of office buildings. Resources, Conservation and Recycling 53, 2008,pp.86-95.

[9] Alanne K, Saari A. Distributed energy generation and sustainable development. Renewable and Sustainable Energy Reviews 10, 2006, pp.539-558.

[10] Haralambopoulos DA, Polatidis H. Renewable energy projects: structuring a multi-criteria group decision-making framework. Renewable Energy 28, 2003,pp.961-973.

[11] Cavallaro F, Ciraolo L. A multicriteria approach to evaluate wind energy plants on an Italian island. Energy Policy 33, 2005,pp.235-244.

[12] Polatidis H, Haralambopoulos DA. Renewable energy systems: A societal and technological platform. Renewable Energy 32, 2007,pp.329-341.

[13] Løken E. Use of multicriteria decision analysis methods for energy planning problems. Renewable and Sustainable Energy Reviews 7, 2007,pp. 584-1595.

[14] Vanclay F. The Triple bottom line and impact assessment: How do TBL, EIA, SIA, SEA AND EMS relate to each other? J. Env. Asses. Pol. Mgmt 6. 2004, pp.265-288.

[15] Commission of the European Communities (CEC). COM (2008). Public Procurement for a better environment. 2008.

[16] Jay S et al., EIA: Retrospect and prospect. EIA Review 27, 2007,pp. 287-300.

[17] Glasson J, Therivel R, Chadwick A. Introduction to EIA. 3rd ed. NY: Routledge; 2007.

[18] Sánchez LE, Hacking T. An approach to linking EIA and EMS. Impact Assessment and Project Appraisal 20, 2002 pp.25-38.

[19] McDonald GT, Brown L. Going beyond EIA: Environmental input to planning and design. EIA Review. 15, 1995, pp.483-495.

[20] Isaksson K et al., From consultation to deliberation? Tracing deliberative norms in EIA frameworks in Swedish roads planning. EIA Review 29, 2009,pp.295-304.

[21] Slotterback CS. Evaluating the implementation of environmental review mitigation in local planning and development processes. EIA Review 28, 2008,pp.546-561.

[22] Belton V, Stewart TJ. MCDA. An Integrated Approach. Netherlands: Kluwer Publishers 2002

[23] Malczewski J. GIS-based multicriteria decision analysis: a survey of the literature. International Journal of Geographical Information Science 20, 2006,pp.703 - 726.

[24] Mendoza G, Martins H. Multi-criteria decision analysis in natural resource management: A critical review of methods and new modelling paradigms. Forest Ecology and Management 15, 2006,pp.1-22.

[25] Jacobsson S, Johnson A. The diffusion of renewable energy technology: an analytical framework and key issues for research. Energy Policy 28, 2000,pp.625-640.

[26] Weber R. Basic Content Analysis. Quantitative Applications in the Social Sciences. Newbury Park: Sage Publications; 1990.

[27] Frankfort-Nachmias C, Nachmias D. Research Methods in the Social Sciences. London: Arnold; 1996.

[28] Gummesson E. Qualitative methods in management research. California: Sage Publications; 2000.

[29] Bergek A. Shaping and Exploiting Technological Opportunities: The Case of Renewable Energy Technology in Sweden. Chalmers University of Technology, 2002.

[30] Bröchner J. Construction contractors as service innovators. Building Research & Information 38, 2010, pp.235 - 246.

[31] Swedish EPA. En mer miljöanpassad offentlig upphandling – förslag till handlingsplan. 2005.

[32] Varnäs A et al., Linking EIA,EMS and green procurement in construction projects: lessons from the City Tunnel Project in Malmo, Sweden. Impact Assessment and Project Appraisal 27, 2009,pp.69-76

[33] Gutermuth P. Regulatory and institutional measures by the state to enhance the deployment of renewable energies: German experiences. Solar Energy 69, 2000, pp.205-213.

[34] Johnson A, Jacobsson S. Inducement and blocking mechanisms in the development of a new industry: the case of renewable energy technology in Sweden.In:Technology and the market: demand, users and innovation. UK: Edward Elgar Publishing, Inc.; 2001. pp.

89-111.

[35] Tyskeng S. Environmental assessments of projects and local plans in the energy and waste sectors in Sweden - Practice and potential for improvement. 2006.

[36] Li X, Zhu Y, Zhang Z. An LCA-based environmental impact assessment model for construction processes. Building and Environment 45, 2010,pp.766-775.

[37] Richardson T. Environmental assessment and planning theory: four short stories about power, multiple rationality, and ethics. EIA Review 25,2005,pp.341-365.

[38] Carlsson B, Jacobsson S. Technological systems and economic policy: the diffusion of factory automation in Sweden. Research Policy 23, 1994,pp. 235-248.

[39] Lam PT, et al., Factors affecting the implementation of green specifications in construction. Journal of Environmental Management 91, 2010, pp 654-661.

[40] Morrison-Saunders A, Bailey J. Exploring the EIA/Environmental Management Relationship. Environmental Management 24, 1999, pp. 281-295.