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Mundaca, Luis; Cloughley, Brian

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Measuring progress towards a 'Green Energy Economy' Proposing and scrutinising a multi-level evaluation framework for policy instruments

Luis Mundaca[1] & Brian Cloughley
International Institute for Industrial Environmental Economics at Lund University
P.O. Box 196, 221 00 Lund, Sweden

Abstract

Numerous economic recovery packages have been implemented to stimulate green economic growth through the deployment of low-carbon technologies. The emerging literature shows, however, that there is substantial ambiguity and discrepancy about how to measure the performance of policy instruments driving a Green Economy in general, and in our case, a Green Energy Economy (GEE) in particular. Identified approaches cover a spectrum from narrow concerns about job creation or growth of technological patents on the one hand, to broader aspects of sustainability on the other. Proposed evaluation approaches up to now tend to overlook policy instruments altogether, or focus on measuring the scale of 'supply-driven' policy impacts based on public and private expenditures (e.g. measuring progress according to expenditure on green initiatives as a proportion of GDP). The objective of our paper is to propose and assess a multi-level ex-post policy evaluation framework to quantitatively measure progress towards a GEE. The proposed framework aims at evaluating the performance of policy instruments encouraging a GEE, taking low-carbon energy technologies as the main focus. The evaluation framework is composed of: (1) multi-criteria policy evaluation, (2) socio-economic carbon and energy indicators; and (3) genuine (or adjusted savings) savings. We assess the proposed evaluation framework against the following criteria: policy compatibility, reliability and measurability.

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[1] Corresponding author. Tel.: +46 46 2220257; Fax: +46 46 2220240. E-mail address: Luis.Mundaca@iiiee.lu.se

1.   Introduction

The terms 'Green Economic Growth' and 'New Green Economy' have become a topic of increasing policy and media attention in the past years. This is mostly because there is growing consensus that our traditional economic growth model has created significant losses of natural capital, produced disturbances in our climatic system, triggered social inequalities and even proven to be economically unstable (Jackson 2009). The recent global financial and economic crisis —the worst in decades— encouraged numerous pledges for new ways to reform the economy towards a path that is much less damaging to society, the environment and the economic system itself (OECD 2010).

To overcome the crisis, economic recovery packages were implemented across several countries to stimulate green economic growth and support low-carbon economies, among several other policy objectives (Barbier 2010b). Within this context, the United Nations Environment Programme (UNEP) started an initiative called the 'Global Green New Deal' (GGND), which emerged as a direct response to the economic crisis mentioned above. The GGND aims to stimulate economic recovery, create more jobs, reduce poverty, decrease fossil fuel dependency, and improve environmental quality (Barbier 2010a). Like GGND, several of the economic stimulus packages under implementation have covered a wide range of issues, but have heavily focused on green energy investments (e.g. increased deployment of renewable energy technologies). In fact, it has been argued that the energy sector can play a vital role in stimulating and encouraging green economic growth (cf. E. Barbier 2010a; Huberty et al. 2011; IEA 2009a) and moving towards what we call a '*Green Energy Economy*' (GEE). To that end, several policy instruments, in particular fiscal incentives (e.g. subsidies, tax credits) and domestic policy reforms have been implemented to encourage a GEE.

The emerging literature shows, however, that there is substantial ambiguity and discrepancy about how to measure the performance of policy instruments driving a Green Economy in general, and, in our case, a GEE in particular. There is also a lack of a common understanding (or consensus) regarding the concept of New Green Economy (Huberty et al. 2011). Identified approaches to evaluating policy instruments cover a spectrum from narrow concerns about job creation or growth of patents on the one hand (Pew Charitable Trusts 2009), to larger aspects of sustainable development on the other (OECD 2010). The identified evaluation approaches tend to overlook policy instruments altogether, or focus at best on measuring the scale of 'supply-driven' policies based on public and private expenditures. For instance, one over-simplified metric that has been put forward involves measuring progress according to expenditure on green initiatives as a proportion of GDP (Barbier 2010a). This approach measures the level of investment resulting from, in this case, the GGND. While

informative in its own right, this approach fails to address the performance, outcomes, and impacts of policy instruments. Not surprisingly, the emerging literature on green economic growth is calling for the development of new accounting and evaluation frameworks (OECD 2010).

We argue that, so far, emerging evaluation policy approaches are unlikely to measure comprehensively the transition to a GEE in relation to (1) the attributes, outcomes and impacts of the particular policy instruments put in place to promote a GEE, and (2) the complexities and trade-offs arising from the promotion and development of a GEE.

Against this brief background, the objective of our paper is to propose and assess a multi-level ex-post policy evaluation framework to quantitatively measure progress towards a GEE. The proposed framework aims at evaluating the performance of energy and climate policy instruments that target low-carbon energy technologies. There are three characteristics of this framework that are especially noteworthy at this point. Firstly, the framework entails a multi-criteria evaluation approach that goes beyond the traditional economic efficiency and environmental effectiveness paradigm. Our approach aims at evaluating the specific outcomes and impacts of individual policy instruments. Here, an 'outcome' is understood as the response to the policy instrument by subject participants (e.g. adoption of new technologies, development of new business plans, etc.), and an 'impact' is understood to be the resulting changes generated by such outcomes on society and the environment (e.g. energy consumption, health problems, etc.). Secondly, the framework utilises socio-economic carbon and energy indicators (e.g. carbon emission intensity, energy intensity) that aim to capture the aggregated carbon and energy impacts resulting from the portfolio of policy instruments. Thirdly, the proposed evaluation framework builds upon green accounting and genuine savings. This is in order to capture aggregated changes, resulting from the mix of implemented policy instruments regarding the value of depletion or restoration of underlying natural assets.

We assess the proposed multi-level evaluation framework based on the experience and applications of the specific methods. We assess the evaluation framework against the following criteria: (1) policy compatibility (e.g. coverage of key features of GEE), (2) reliability (e.g. analytical soundness) and (3) measurability (e.g. data requirements). In turn, trade-offs when applying the proposed evaluation approach are identified and discussed (e.g. analytical richness vs. resource and data intensiveness). For this specific purpose, a critical literature review was undertaken.

The structure of the paper is as follows. Section 2 provides some conceptual aspects to help define what a GEE is, or should be, all about. This is critical to guiding the selection of our proposed measurement methods. Section 3 provides a brief description of the proposed evaluation framework. We also provide more arguments about the justification of the chosen methods. Based on three

criteria, Section 4 summarises the assessment of our evaluation framework. The assessment uses the experience and applications found in the literature as the main input. Finally, Section 5 draws some conclusions.

2. Conceptualising a 'Green Energy Economy'

Before we turn our attention to the proposed evaluation approach, it is of prime importance to explicitly (yet briefly) elaborate on what we mean by Green Energy Economics. This is a fundamental input that provides conceptual guidance to our proposed methodology. First, there is extensive terminology attached to green economics. In turn, it is unclear whether there is a common understanding the term green economy, and analogous concepts, such as the low-carbon economy and the clean energy economy. Second, the lack of common understanding and interpretations of related terminology may hamper the development or implementation of methods to measure policy progress. Third, a lack of common understanding of NGE in this sense could lead to reduced performance of policy instruments due to unclear institutional arrangements or support mechanisms.

As stated earlier, the terms 'Green Economic Growth' and 'New Green Economy' (NGE) have gained political and policy momentum as a consequence of the financial turmoil and corresponding economic depression that started in 2008. The modern literature on NGE has grown quickly and numerous conceptual approaches and choices have appeared. However, the fact that the word "new" is present in the term Green Economics does not mean that NGE is a completely new field of economics, and that it cannot draw on ideas from other schools of economics (V. Anderson 2006). On the contrary, the theoretical framework and conceptual background of NGE appear to draw on a number of schools of economics: agricultural economics, environmental economics, new institutional economics, natural resource economics, etc. Welfare and ecological economics have important influences on NGE as well (Rao 2010). For instance, some of the terminology of NGE can be found in different schools of economics. The term 'Green Economics' was initially linked to agricultural economics during the so-called 'Green Revolution' in agriculture that occurred between 1940 and 1970 (Falcon 1970). At that time, agricultural economists were studying and analysing the issues that the Green Revolution brought and talked about 'land' or 'green' economics (Mellor 1970). In addition, we also have to consider the discipline of Energy Economics, which deals with "green" economy aspects as well. Durlauf and Blume (2008) define energy economics as the broad scientific discipline that covers topics related to supply and use of energy in societies, including renewable energy and energy efficiency. Energy economics is in fact the economics of fuel markets (Weyman-Jones 2009); including green (or renewable) electricity.

From a general point of view, NGE could be simply defined as the branch of knowledge concerned with the production, consumption, and transfer of wealth with ecological and social considerations. The question then is to what characterises this knowledge (i.e. facts, information, theories, and skills acquired through experience or education). It is argued that when the environmental revolution arrived in the late 1960s, "the economics profession was ready and waiting" (Cropper and Oates 1992, 675). Early work on economic answers to environmental problems (e.g. Barnett and Morse 1963; Kneese and Bower 1968) —that laid the foundations for environmental economics (D. Pearce 2002)— supported the use of the term 'green economics' for addressing environmental problems and natural resource management. A seminal example of how a broader conceptual scope was treated explicitly can be found in Pearce et al. (1989). Relying heavily on the theory, methods and policy options provided by environmental economics (e.g. externalities (Pigou 1920), economic valuation of environmental change, and market-based incentives), the authors provide a 'Blueprint for a Green Economy' (Earthscan Publications Ltd.). In that work, the authors framed Green Economics around technology innovation, resource efficiency, natural capital, ecological risks and human development. Conceptually, and given the strong orientation and focus on sustainable development, one can argue that Pearce et al. were in fact dealing with we would now classify as 'Sustainability Economics' (c.f. Baumgärtner and Quaas 2010).

In the recent literature, conceptual choices about a NGE cover a wide spectrum, from larger aspects of sustainability on the one hand, to narrow concerns about negative externalities. For instance, Costanza (2009, 20) states that the goal of green economy is sustainable human well-being. The author argues that measures of progress have to address this goal clearly, and take into account "the importance of ecological sustainability, social fairness, and real economic efficiency". A contrary position is offered by Anderson (2006, 18), who conceptualises a NGE as "the study of the externalization of costs" that is concerned with human and ecological risks. Within this spectrum, numerous choices and connotations are found in the literature, for instance:

- The European Commission (2011, 2) defines NGE as "an economy that generates growth, creates jobs and eradicates poverty by investing in and preserving the natural capital offers upon which the long-term survival of our planet depends". Like UNEP's definition of NGE (see below), EC's definition is also aligned with the three pillars sustainable development. EU Policy documents have also referred to NGE as "dynamic economy" (European Commission 2006), "sustainable and inclusive economy"(European Commission 2010), and "low-carbon economy" (European Commission 2011).

- UNEP (2011, 1) defines a 'Green Economy' as one that results in "improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities. In its simplest expression, a green economy is low-carbon, resource efficient and socially inclusive". This definition is inclusive of the three dimensions of sustainability (Elkington 1998). From the policy perspective, and in order to further promote a NGE, it is argued that increased use of renewable energy sources (RES) and improved energy efficiency (EE) are critical for energy security (UNEP 2011).

- According to European Environment Agency (EEA), NGE is an economy that "generates increasing prosperity while maintaining the natural systems that sustain us" (EEA 2011). This definition does not explicitly refer to the social aspects, but instead includes only the economic and environmental ones.

- The OECD deals with the term by addressing 'Green Growth' as economic growth and development that guarantees the capacity of natural capital to provide natural resources and environmental services overtime. Furthermore, it is argued that the orientation of NGE deals with the problem of poverty and social equity to improve the overall human well-being (OECD 2011). It also recognises the role of innovation and technological development to support the "greening" of the economy, especially in the area of resource efficiency.

- Rao (2010) argues that NGE deal with the full costs of goods and services. That is, market prices should reflect the true costs in terms of extraction of raw materials, transportation, distribution, and effects on eco-systems.

- The Asian Development Bank (UN ESCAP, ADB, and UNEP 2012, 16) defines 'Green Growth' as the "economic progress that fosters, low carbon, and socially inclusive development". It stresses the importance of economic growth because of the fact that many countries in Asia are still developing or less developed countries. By emphasising the recent financial and economic crises, this organisation also highlights the issue of 'resilience' in green economics (i.e. able to withstand or recover quickly from difficult conditions).

- ECO Canada (2010, 3) defines a green economy as "the aggregate of all activity operating with the primary intention of reducing conventional levels of resource consumption, harmful emissions, and minimizing all forms of environmental impact. From this view, green economics is the study of the "inputs, activities, outputs, and outcomes as they relate to the production of green products and services".

- According to the Pew Charitable Trusts (2009, 5) "a clean energy economy generates jobs, businesses and investments while expanding clean energy production, increasing energy efficiency, reducing greenhouse gas emissions, waste and pollution, and conserving water and other natural resources." Within this view, a clean energy economy cuts across five categories: (i) clean Energy; (ii) energy efficiency; (iii) environmentally friendly production; (iv) conservation and pollution mitigation; and (v) training and support.

The formulations presented suggest two different levels of NGE as far as its *aims* are concerned. At the cognitive level, NGE aims to (better) study, generate, understand and structure economic knowledge as applied to chosen but still related elements of sustainable development. At the applied level, NGE aims to (better) manage the relationships and interdependence of selected aspects of sustainability.

Once we merge the conceptual and the applied normative nature of NGE can include/cover the following subject matters arise:

- ✓ Economic dimension
    - o Stimulate market for low-carbon technologies
    - o Internalise negative externalities and maximise positive externalities
    - o Promote clean (energy) investments
    - o Introduce full-costing principles
    - o Improve resource efficiency
    - o Diversify economic activities
    - o Develop economic resilience
    - o Increase energy security
- ✓ Environmental dimension
    - o Preserve or increase natural capital
    - o Maintain or improve health of ecological services
    - o Reduce atmospheric pollutants (GHG emissions)
    - o Decrease biodiversity loss
    - o Improve environmental performance of economic activities
- ✓ Social dimension
    - o Eradicate poverty
    - o Increase human well-being
    - o Improve social equity
    - o Promote intergenerational fairness
    - o Create and diversify pool of jobs

From the above, it seems that the subject matters of NGE entail the human-economy-environment relationships and dimensions of sustainability. In turn, this would make the subject matters of NGE in close line with subject matters of sustainability economics (c.f. Baumgärtner and Quaas 2010). The three broad categories of NGE's aims are highly interrelated and dependent on one another. This interdependence of economy, environment, and society is what NGE takes into account in the design of a paradigm that is inclusive of the main pillars of sustainable development. However, the relatively narrow scope of the topics being considered by NGE suggests that NGE may be a sub-component of sustainability economics.

At the risk of oversimplifying, the contents of this section seem to suggest that GEE is not an isolated term or school of thought within economics, but the concept can borrow heavily from thought of other (economic) fields or disciplines. For the purpose of our paper, we (initially) conceptualise *Green Energy Economics (GEE) as*

> *the scientific subject area that focuses on how the economic system can pursue growth by bringing together economic, environmental, social, and technological aspects through the expansion of clean energy production, distribution and consumption.*

In more specific terms, and taking into account the normative aspects of NGE, a GEE covers and analyse the linkages between resource efficiency, job creation, clean energy investments, mitigation of climate change, and natural capital.

3. Proposed policy evaluation framework

As a whole, the proposed evaluation framework is guided and frame by both policy-oriented research and policy evaluation. Policy-oriented research aims to solve societal problems through improved public policies (Fischer 1995). Its focus is on actionable factors or variables, either complementing theoretical constructs or taking priority over them (Hakim 2000). Policy-oriented research usually distances itself from purely theoretical research; which aims to produce 'knowledge for understanding' and focuses on explaining causal loop processes —usually framed by a single social discipline (Hakim 2000; Majchrzak 1984).[2]

Policy evaluation is herein understood as the activity of applied social science dealing with multiple methods of investigation that support and assist policy-making in solving public problems.

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[2] Note that there is no firm dividing line between theoretical research and policy research. A number of overlaps and similarities are indeed found. See Hakim (2000) for an in-depth review of these aspects.

This research takes as its point of departure the fact that public policy, and policy instruments in particular, are the object of policy evaluation.

Finally, note that the proposed methodology attempts to merge empirical elements (e.g. use of cost-benefit analysis for the case of economic efficiency) with reference to normative issues (e.g. application of evaluation criteria).

3.1. *Multi-criteria policy evaluation*

This method is chosen for a number of reasons. Among them, it has the potential to capture a wide range of aspects entailed in a GEE. Depending on the selected criteria, it can address the performance of policy instruments in terms of, for instance, economic aspects (via economic efficiency), social aspects (via distributional equity), and environmental aspects (via environmental-effectiveness). The evaluation method, as elaborated below, provides specific tools (e.g. cost-benefit analysis) for capturing factual knowledge about the performance of policy instruments. Likewise, the method provides concrete grounds to merge the value-laden dimension of the GEE with normative judgements (via evaluation criteria) and measurement tools. Finally, the method can reveal tangible trade-off among different criteria and design policy options.

Multi-Criteria Policy Evaluation (MCPE) —a Multi-criteria Decision Making techniques[3]— is grounded in the understanding that a number of evaluation criteria are relevant for assessment the of policy instruments (Greening and Bernow 2004). Clearly, this method seems well suited to the capturing and comparing of the performance of policy instruments encouraging a GEE that is to be undertaken here.

Evaluation criteria (or value criteria) are advocated as a basis for normative judgements about any significant effect of public policy (Mickwitz 2003). In simple terms, policy evaluation criteria (e.g. economic efficiency, administrative burden, distributional equity) are evaluative standards that are the framework upon which a policy choice or instrument is judged and eventually made (more details in the next section). This means that evaluation needs some form of measure upon which the merit or success can be determined or verified (cf. M.-L. Bemelmans-Videc, Rist, and Vedung 2003; Rossi, Lipsey, and Freeman 2004)

For the particular case of policy instruments, MCPE facilitates the assessment of the broad set of impacts and outcomes (potentially) attributed to policies (Mundaca and Neij 2009). It supports comparative evaluations of competing policy options. It provides a framework to rank the performance of decision options against multiple objectives, even when measured in different forms

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[3] For and overview of multi-criteria methods see e.g. Bell et al. (2001).

(Hajkowicz 2008). In turn, the application of evaluation criteria to outcomes and impacts also allows the identification of alternative policy instruments that are more likely to achieve their specific objective(s). Criteria are often weighted by decision markers.

From a theoretical point of view, a great variety of criteria for the evaluation of policy instruments are suggested when reviewing the literature on economics, public policy and evaluation theory. Commonly found criteria address economic efficiency and cost-effectiveness (e.g. EEA 2001; Hildén et al. 2002; Mickwitz 2003). While the economics literature focuses greatly on cost-effectiveness, Bardach (2005) suggests that commonly used criteria in public policy address legality, political acceptability and robustness. Along these lines, Bemelmans-Videc (1998) argues that dominant evaluation criteria refer to effectiveness, economic efficiency, legality and democracy. Addressing institutional rational choice in policy formulation, Ostrom (1999) mentions criteria such as economic efficiency, fiscal equivalence, equity, accountability, and adaptability.

If we focus on the evaluation criteria often cited for market-based instruments applied in the energy/environmental policy field, similar criteria are suggested. The reviewed literature usually mentions economic efficiency, cost- and environmental-effectiveness, legitimacy, equity, administrative burden, transaction costs, and side-effects (e.g. on industrial competitiveness) (F. Anderson et al. 1997; Faure and Skogh 2003; Nordhaus and Danish 2003; Opschoor and Turner 1994; Sterner 2003; T. Tietenberg 1996). In the specific field of energy policy, Blok (2006) suggests effectiveness, efficiency and side-effects. In its third assessment report, the Intergovernmental Panel on Climate Change (IPCC) (Toth et al. 2001) acknowledges many of the criteria listed above, but emphasises the focus on cost-effectiveness. More recently, the fourth assessment from the IPCC (Halsnæs et al. 2007) has broadened its evaluation analysis beyond cost-effectiveness to elaborate explicitly on environmental effectiveness, distributional considerations, and institutional feasibility.

3.2. *Socio-economic carbon and energy indicators*

This method is chosen for several reasons. It conveys in a simple manner a wide range of complex economy-wide aspects that drive, or have an impact on, energy production and carbon emissions. These are critical aspects entailed in a GEE. In turn, the indicators we propose can help to measure and illustrate (relative) progress, or lack of progress, toward a GEE for the particular field of (green) energy production and carbon emissions. In turn, historical trends and changes associated with energy production and carbon emissions can support a better understanding of aggregated determinants of a GEE, including related trade-offs and national/regional policy conditions. Third, the quantitative nature of the evaluation framework we propose calls for measurement tools that

focus on performance, including innovation activity. Energy and carbon intensity indicators can reveal, for instance, the carbon performance associated with the energy supply mix and aggregated technology level. Last but no least, indicators can be applied to any national/regional context, and require additional information (e.g. delivered or supported via MCPE) to facilitate their interpretation.

That said, socio-economic carbon and energy indicators depart from the I=PAT equation, which was initially used to put emphasis on the contribution of a rising global population on environmental impacts (Ehrlich and Holdren 1971; Holdren and Ehrlich 1974). The IPAT equation addresses the contribution of population (P), affluence or level of consumption (A) and technology (T) to environmental impacts (I). The latter can be expressed in terms of resource depletion or waste accumulation; population. To arrive to specific indicators (details below), one approach is to the use the 'Kaya Identity' (Baumert, Herzog, and Pershing 2005) which builds upon the IPAT equation, to perform a structural decomposition analysis. The Kaya Identity is used as a macro decomposition evaluation method to quantitatively estimate and assess trends for key energy, economic, demographic and environmental aspects driving CO_2 emission levels (Kaya 1990). It is given by:

$$CO_2 \, emissions = Pop \times \frac{GDP}{Pop} \times \frac{Energy}{GDP} \times \frac{CO_2}{Energy} \tag{1}$$

where the equation conveys the level of CO_2 emissions as a function of four indicators: (i) population (Pop), (ii) Gross Domestic Product (GDP) per capita4, (iii) energy intensity (Total Primary Energy Supply [TPES] per unit of GDP) and (iv) carbon intensity (CO_2 emissions per unit of energy).

It is argued that all energy (and environmental) decomposition analyses entail the application of different indices or indicators to decompose the evolution in energy use (or aggregate intensity) into various components (Greening et al. 1997). In our case, the Kaya Identity aims to represent the dynamics and correlations between CO_2 emissions and GDP, energy use and population growth at the economy-wide level.[5] This method is suggested —and further analysed— because of the importance given by GEE to GHG emissions and the role of energy production and consumption. The importance of economic growth as driver for emissions is very explicit in the Kaya Identity. In turn, the term *intensity* embedded in the indicators means that the level of emissions or energy use is measured in per unit of economic output (often given in purchasing power parity). The methodology we propose focuses on three specific intensity indicators:

- Energy intensity (*E_int*) = Total Primary Energy Supply (*TPES*) per unit of GDP_{ppp}

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[4] Note that in this section, GDP is measured in units of purchasing power parity (GDPppp).

[5] Note that it only accounts for energy-related CO_2 emissions.

- Emission intensity (Em_int) = CO_2 emissions per unit of GDP_{ppp}

- Carbon intensity (C_int) = CO_2 emissions per unit of *TPES*

Note that for the latter, CO_2 emission are measured in per unit of energy output (measured in TPES). This specific indicator attempts to measure the degree of decarbonisation of the energy supply (or fuel) mix.

3.3. Green accounting and genuine (or adjusted) savings

This method is considered because of the importance given by GEE to preservation of natural resources, reduction of environmental problems (climate change in particular), and the need for new knowledge, skills, and competences embodied in individuals that are relevant to fostering a GEE. The OECD (2010) recognises four aspects of green growth to be measured when considering performance indicators: (*i*) environmental and resources productivity (production and consumption), (*ii*) natural assets base, (*iii*) quality of life, and (*iv*) policy responses and economic opportunities.

Green Accounting (GA) departs from the fact that our traditional national accounting system is misleading because resource depletion and natural environment degradation often appear as "wanted" for economic growth (Vincent 2000). GA entails both market and non-market valuation approaches, integrating social and environmental welfare measures into macro-economics by explicitly considering, for example, physical natural resource accounts, accounts of pollution emissions, and environmental protection expenditure accounts (Kirk Hamilton 1994). GA has most commonly been used to assess the sustainability of national economies in their entirety, as opposed to focusing on specific sectors.

Building upon GA national methods (e.g. Lange 2003; Mäler 1991; Weitzman 1976) 'Genuine (or adjusted) Savings' (GS) is a measure, or indicator, that aims to determine the true rate of savings in an economy system after due consideration of (*i*) depletion of natural capital, (*ii*) damage caused by environmental pollution, and (*iii*) investments in produced and human capital (Ferreira and Vincent 2005; D. W. Pearce and Atkinson 1993). The World Bank first published country-specific estimates of GS. Estimates are based on adjustments to gross national savings by (*i*) subtracting a depreciation allowance for produced capital stocks, and depletion allowances for natural resources (fossil fuels, minerals, timber), and (*ii*) adding investment in human capital (K. Hamilton and Clemens 1999).

4. Assessment

In this section we use three criteria to assess the degree of suitability and inclusivity of the proposed methods as applied to the case of a Green Energy Economy. To that end, we review the literature

about the experience and criticism of the proposed methods for policy evaluation. By no means exhaustive, we have tried to cover a variety of aspects that are in line with the criteria.

4.1. Policy compatibility

This criterion aims to assess the extent, or coverage, of the key features of the applied nature GEE. It looks at whether the policy evaluation methods provide, or not, a balanced treatment of the key aspects of GEE.

4.1.1. Multi-criteria policy evaluation

There is growing popularity and applicability with MCPE in energy and climate policy as well as natural resource management (e.g. Konidari and Mavrakis 2007; Mendoza and Martins 2006). The range of criteria, geographical coverage and the number of policies under assessment is very wide – and growing. Several applications are found in the field of renewable energy and energy efficiency (e.g. Pohekar and Ramachandran 2004). It has been suggested as an adequate assessment framework for sustainability (Munda 2005).

In principle, one can argue that MCPE can cover most, if not all, of the key features of GEE. Economic aspects can be covered via economic efficiency; carbon emissions via environmental effectiveness; the expansion of clean technologies via technological change; social issues via distributional equity; and so on. Despite the great variety of criteria suggested above, the reviewed literature does not offer much direction about their suitability for energy/environmental policy evaluation (Halsnæs et al. 2007). However, the reviewed literature (e.g. Rossi, Lipsey, and Freeman 2004) strongly indicates that the selection of evaluation criteria should be guided by several aspects, including the policy objectives and goals targeted by the policies under evaluation, multiple attributes of policy instruments, the availability and reliability of data, the ambition level of the evaluation, the human and technical resources involved, the budget, etc. The selection of criteria can also be cased on a prescriptive or descriptive approach (Shadish, Cook, and Leviton 1991).

Hajkowitcz (2008, 20) argues that, in general, multi-criteria analysis supports decision makers to resolve policy trade-offs (or 'compensability') in a "transparent, auditable, and analytically robust manner". The issue of transparency is often mentioned in the literature (e.g. Munda 2005); however values and interests under consideration need to be clear and explicit.

When applied to the case of tradable certificates for energy efficiency improvements, Mundaca and Neij (2009, 4570–4571) identified the following advantages when using this method:

- A multi-criteria evaluation policy framework allows researchers to better understand the broad effects, attributes and complexities of policy instruments.

- The evaluation process allows the inclusion not only of economic and energy-related aspects, but also socio-political, organisational and commercial factors, which help to identify trade-offs and co-benefits.

With MCPE, the identification of decision-maker preferences (approached via a weighting method) is crucial, and often (very) subjective and hidden (Mendoza and Martins 2006). Assessing the usefulness of MCPE for Integrated Assessment of climate policy, Bell et al. (2001) found that decision makers must have confidence in attributing value, which can be rather challenging in certain areas of climate change. The authors also identified the fact-value dichotomy, in particular the difficulty for users to separate value judgements from how the policy (or policies) under evaluation really works.

It is also argued that MCPE needs reasonable, appropriate and answerable policy questions (cf. Mickwitz 2006). In addition, experience shows that as policy instruments do no work in isolation, it is necessary that selected criteria provide indications about the interaction within policy portfolios (Mundaca and Neij 2009). This is critical to identify synergies and avoid overlaps. Because the object of each criterion used is not completely apparent or totally independent from the rest, MCPE often leads to trade-off analysis (Sterner 2003), which can be complex and extensive.

When using MCPE to evaluate policy, it is likely that some of inputted values will be obtained through surveys or interaction with stakeholders. When such values are derived through a focus group, Munda (2006) argues that there is a risk of biases as more powerful stakeholders may influence intensely all the opinion/views of other participants.

4.1.2. *Socio-economic carbon intensity indicators*

The literature on decomposition analysis in general, and the use of intensity indicators in particular, is substantial (Ang and Zhang 2000). Applications in the field of energy-related environmental issues have grown substantially since the 1980s (Ang 2004). It is argued that decomposition analysis and the use of indicators is a widely accepted analytical approach for policy making (Ang, 2004). In combination with time series analysis, Greening et al. (1997) found that decomposition analysis captures more information about how energy use changes over time.

One can safely argue that this method has a limited scope as far as the GEE is concerned: it aims to cover the aggregated dynamics of energy and carbon emissions, or collective impacts of policy portfolios, at the economy-wide level. Chertow (2000) examines the IPAT equation and its variants, including the intensity indicators we propose, and concludes that the approach stresses the critical

importance of technology. From the policy perspective, it highlights needed efforts to promote technology change and innovation, while putting less pressure on the controversial issue of population control. In particular, Baumer et al. (2005) argue that population growth, as a relevant factor in achieving (or failing to achieve) a national target, can be eliminated if emission targets are framed in terms of emission per capita, and not in absolute terms.

Following on from climate policy aspects, Baumer et al. (2005) mention that framing a target in carbon intensity terms, may reduce (cost) uncertainty and, consequently, may be a more attractive policy option than fixed targets.

The compatibility (and usefulness) in policy terms of intensity indicators is however severely questioned when planetary boundaries are taken into account. The use of intensity indicators is also often linked to the issue of *decoupling*, which has become a central policy argument to bridge the contentious debate about continuous economic growth, increased energy use, and resulting negative environmental impacts (cf. Jackson 2009; Princen 2003). Decoupling can be broadly understood as the capability of an economic system to grow without greater or equal increases in ecosystem pressure or damage. This view has been largely defined in terms of *relative decoupling*, which refers to a situation in which resource or environmental impacts decline relative to economic growth (Daly 1996), e.g. GHG emissions can still rise but at a lower pace than Gross Domestic Product (GDP). Largely confined to the technology paradigm (or 'technology optimism'), the main argument in favour of relative decoupling is that technological efficiency improvements alone are sufficient to satisfy ever-growing demand for energy services while permitting significant reductions in energy use and resulting levels of GHG emissions.[6] However, it is also argued that policy efforts addressing *absolute* reductions in energy consumption and resulting carbon emissions need to be realised to move towards a low-carbon economy. This arguments states that technology optimism and incremental improvements that intensity targets may portray, or measure, are not enough to drive a more sustainable development future (Jackson 2009). This is critical if we are to overcome challenges such as climate change and secure sustainable energy systems (Goldemberg and Johansson 2004). Considering resource constraints and the health of both humans and ecosystems, it is argued that socio-economic carbon indicators addressing absolute decoupling are urgently needed (Jackson 2009).

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[6] The term *energy service* refers to the delivered benefits of useful energy consumption, such as heating, refrigeration, lighting, cooking, transportation, etc., as opposed to the simple provision of units of energy as such (kWh).

4.1.3. *Green accounting and genuine savings*

Regarding GA and GS, the reviewed literature suggests that the policy compatibility can be framed in terms of natural, produced, and human capital. That is, respectively, investments and/savings in terms of renewable energy sources, low-carbon technology infrastructure, and education expenditure related to green technology jobs.

It is argued that corrected national accounting systems can lead to policies (whether economic, developmental or with a broader remit) with a lesser environmental impact (Repetto et al. 1989). Several examples in the literature are found when applied to low-carbon technology policies (e.g. You 2011).

Hamilton and Clemens (K. Hamilton and Clemens 1999) used GS to evaluate the progress of sustainable development in developing countries, emphasising that positive genuine savings are necessary for sustainability to be achieved. The analysis is restricted to oil, coal, natural gas and forestry – areas of import to the evaluation of green energy economies. The paper espouses support for unified policy measures, aimed not at eliminating resource extraction and pollution entirely, but instead jointly addressing environmental and economic matters by maximising GS.

The Stilgitz Commission[7] (Stiglitz, Sen, and Fitoussi 2009) has argued that GA is best used at a supra-national policy level and be focused on the global economy, in part because of the trans-boundary nature of many environmental problems. The Commission are particularly critical of the genuine savings approach of the World Bank. They argue that their GS methodology misses the global nature of sustainability, leading to the counter-intuitive situation where countries can maintain a positive GS estimate while exporting significant quantities of fossil fuels (Stiglitz, Sen, and Fitoussi 2009). The conception of GA as a macro tool may suggest difficulties in narrowing the focus of these measurements to specific policies or specific sectors of the economy.

Estimating GS implies a broad definition of asset and in this respect, the most relevant element lies in the asset base composed by human capital: knowledge, experience, and skills (K. Hamilton and Clemens 1999). Considering the aggregate nature of GS, we were in the position to find whether or how education and research expenditures on clean technologies are considered. While not in the context of GS as such, however, there is emerging literature on the use of quantitative indicators to evaluate whether policy instruments targeting a GEE can create "green" jobs (e.g. number of jobs created per billion of dollars) (e.g. Huberty et al. 2011; UNEP and MISI 2009).

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[7] For details visit http://www.stiglitz-sen-fitoussi.fr/en/index.htm

4.2. Reliability

This criterion aims to assess the consistency and analytical soundness of the proposed methods; including their effectiveness in communicating critical outcomes to users. With due limitations, it also focuses on the on scientific knowledge of the problems and relationships the methods aims to address.

4.2.1. Multi-criteria policy evaluation

The literature highlights the importance of MCPE in supporting multi-disciplinary research (Munda 2005). Experience shows the usefulness of MCPE in bringing up clear trade-offs and evaluating risks in relation to policies (Bell et al., 2001). It is also argued that MCPE can be simple, reliable, and flexible for climate policy evaluation (Konidari and Mavrakis 2007). Depending on the scope and ambition level, the approach requires a group of evaluators with skills in a variety of conceptual tools and social research methods (Mundaca and Neij 2009).

Based on an ex-post policy evaluation, Mundaca and Neij (2009) state that MCPE can be very multi-disciplinary in nature. Thus, a variety of specific results can be produced, allowing a broader analysis compared to an evaluation using a single criterion and/or discipline. This avoids generalisations. Likewise, the authors elaborate about the variety of detailed results that MCPE can provide. However, and due to the multi-disciplinary nature of the approach, the authors also stress that results can be criticised for being too broad, as opposed to an evaluation performed using a single criterion from a single discipline—which would likely yield a more detailed but narrower analysis. In fact, although there is a need to use different evaluation methods, these are likely to yield conflicting results, which may add complexity to the overall analysis (Mundaca and Neij 2009). In addition, there are also risks of incorrect problem structure and duplicate (or overlapping) criteria (Hajkowicz 2008).

Criticism towards MCPE seems to be heavily linked to intrinsic methodological challenges. For instance, experience shows the difficulties faced by practitioners when confronting the issues implicit in MCPE, including the selection and justification of criteria, the choosing weighting and aggregation methods (Munda 2005).

Mundaca and Neij (2009) mention that MCPE offers a wider basis for a more balanced discussion concerning policy design, choice and implementation aspects, which can contribute to better communication among stakeholders.

4.2.2. Socio-economic carbon intensity indicators

Kemp-Benedict (2011) uses intensity indicators, as derived from the Kaya Identity, to analyse investment and capital stock. The author departs from the view of the usefulness of the approach in

terms of (quickly) estimating the scale of economic, technological, and demographic changes required to reduce carbon emissions.

York et al. (2003) analyse different methods (including the IPAT equation) for unpacking the driving forces of environmental impacts. The authors evaluates the analytic usefulness of IPAT, which forms a critical base for the indicators we suggest, and state that the approach provides a prudent specification of key drivers behind environmental problems; including the identification of (statistical) relationships among those drivers.

Kemp-Benedict (2011) mentions that when considering large-scale economic transformation, as with a shift to a low-carbon economy, indicators derived from the IPAT equation or Kaya Identity fail to capture the impacts of existing investment capital, and the need for new investment. The author argues that detailed bottom-up models can capture these factors. However, bottom-up models do not allow for rapid exploration of key drivers, which is the appeal of the indicators derived from the Kaya identity.

Baumert et al. (2005) argue that intensity indicators may be helpful for establishing emission targets, but also involve some challenges, like for example, the incorporation of non-CO_2 gases.

4.2.3. *Green accounting and genuine savings*

Green accounting and genuine savings were designed specifically to measure the sustainability of a whole economy, so there are likely to be methodological problems when applying these techniques to individual policies or policy packages. Nevertheless, just as GDP can be used as a blunt indicator of a major policy's success, so green national accounting could serve the same purpose while additionally factoring in environmental matters. Brouwer et al. (1999) noted of their own green national accounting model that, although it cannot represent detailed levels of policy evaluation, the model was a useful approach to lay out critical aspects of economic feasibility and policy trade-offs.

There has also been recent research that suggests at other ways in which national accounting can be useful at a policy level, ex-ante. You (2011) uses a methodology that involves modelling future GDP and GS in China, and introducing changes in energy provision and consumption to examine their impact. This approach, then, involved estimating the activity of the Chinese economy as a whole, then using shocks in the form of energy consumption changes to predict how GDP and GS may be affected. This raises the possibility of estimating the likely 'shocks' from a particular policy or policy package, and using their model to find the resulting changes in green national accounts. In most circumstances, such a methodology would require a large amount of resources since researchers would have to address an economy as a whole, before focusing on the targeted policies.

Ferreira and Vincent (2005) assess GS as an adequate indicator for sustainable development. Analysing the World Bank's estimates, the authors conclude the most error-ridden aspect relates to the accumulation of human capital. In turn, this and other aspects reduce the predictive value or power of GS as indicator so estimated values from the World Bank need to be taken with due caution (Ferreira and Vincent 2005).

Stanojevic et al. (2010) offer a bottom-up, project-level GA method, and introduce their own tool for facilitating this. This micro-economic approach essentially involves performing a comprehensive multi-criteria analysis for a project (they use the construction of a combined heat and power plant as an example) encapsulating a wide range of environmental, social, technological and financial criteria, which is then aggregated according to green accounting standards. It would be relatively straightforward to utilise this technique for evaluating a policy with easily traceable immediate outputs (e.g. providing funding for renewable energy plants.) However this methodology would almost certainly be too elaborate for policies with more diverse immediate effects (e.g. a tradable certificate scheme.).

There is an also a significant theoretical issue concerning GA and GS in this context. A key attribute of GA and GS is that they are measures of 'weak sustainability'. Genuine savings are calculated by subtracting the depreciation of natural capital from the investment in produced and human capital. This implies substitutability between forms of capital, and allows the depletion of natural capital to be classified as sustainable so long as matching investment is made in produced or human capital (S. Dietz and Neumayer 2006). Thus, GA and GS may be a first step to assist 'weak' or 'income sustainability' policies (i.e. ratio of savings to income is larger than the sum of the ratios of depreciation of human-made capital and natural capital) (El-Serafy 1997). The criticism stresses that GA methods, such as GS, do not adequately account for irreversible environmental degradation and resource depletion (S. Dietz and Neumayer 2004; Mayer 2008; Pillarisetti 2005). Pearce et al. (1996) counter this argument by insisting that even if a certain amount of natural resources must be set aside to ensure strong sustainability, genuine savings can be a useful tool in assessing how the remaining capital flows are distributed (D. Pearce, Hamilton, and Atkinson 1996).

4.3. *Measurability*

This criterion aims to assess the complexity of input and output data. In particular, it focuses on the intensity of data requirements.

4.3.1. Multi-criteria policy evaluation

At the general level, it is argued that MCPE facilitates, and indeed provides, comparable evaluation outcomes (Konidari and Mavrakis 2007). Although MCPE offers a wide basis for policy design and implementation, the literature stresses that it is highly-resource intensive and requires vast amount of data and estimates (e.g. for economic efficiency) (T. H. Tietenberg 2006). In line with this argument, Mundaca and Neij (2009) conclude that for an ex-post evaluation, there is a great need for available, reliable, timely and useful data—in particular for quantitative analyses. Therefore, with a lack of data, solid assumptions or expert input (often a practical reality), an assessment of all aspects can prove rather challenging – and expensive.

4.3.2. Socio-economic carbon intensity indicators

Given the quantitative orientation of intensity indicators, data requirements are high, in particular for energy and carbon aspects – much less for GDP and population. Most of the studies reviewed relied on data provided by the IEA, UN, IPCC, US EPA, UNFCC and other (inter)national organisations. However, there is explicit mention of data uncertainties (e.g. Baumert, Herzog, and Pershing 2005). For the particular case of GHG emissions, non-CO_2 emissions (e.g. CH_4 and N2O) are often not taken into account. In addition, input data for CO_2 emissions often relate to fuel combustion, and excludes emissions from biomass (see IEA 2009b). Uncertainties for developing countries are estimated to be higher (Baumert, Herzog, and Pershing 2005).

4.3.3. Green accounting and genuine savings

The type of green accounting undertaken by the World Bank can only be as accurate as the measurement tools that populate its calculations. Dietz and Neumayer (2006) identify two measurement issues that are particularly relevant to the GS undertaken by the World Bank and to the green energy economy approach.

The first key issue concerns the difficulties of calculating the extent and the value of natural capital deterioration. Dietz and Neumayer (2006) demonstrate that the valuation of deprecation (and thus the resulting GS estimates) is highly sensitive to the calculation methods employed. The World Bank methodology is based on the average cost of resource depletion, and the writers demonstrate that if marginal costs were used instead – which they present as more theoretically correct - the GS estimates would be significantly different (S. Dietz and Neumayer 2006).

The second issue identified by Dietz and Neumayer concerns accounting for environmental pollution. The World Bank uses a damage cost approach, whereby net emissions of pollutants and

carbon are multiplied by their specific shadow price. Externalities such as pollution and carbon emissions are not naturally accounted for in a free market, so the World Bank calculate a shadow price, using a willingness-to-pay methodology. This approach, then, has many of the problems typically associated with contingent valuation (information biases, biases introduced by survey wording, and so on). Most significantly for the energy sector, the effects of emissions are typically time-delayed so there may be a propensity to undervalue them (S. Dietz and Neumayer 2006).

5. Concluding remarks

The green economy and comparable concepts, such as the low-carbon economy and the clean energy economy, have become increasingly relevant in policy-making and economic political discourse. In our case, where we limit the scope to a "Green Energy Economy" (GEE), the reviewed literature provides no guidance about the suitability of policy evaluation approaches within this context. It may well be that this absence is caused by the lack of common understanding about the term green economy and analogous concepts. Clear or concrete evaluation frameworks may arise as long as there are common conceptual grounds.

We have proposed an evaluation framework that aims to cover all (or the majority of) the aspects entailed in a GEE simultaneously. Using three assessment criteria, we have reviewed the application of three specific methods. The proposed framework seems to perform well when looking at policy compatibility. A MCPE may cover critical economic, environmental, technological and even distributional aspects. It can also explicitly confront policy trade-offs. However, it can fail to assess policy effects on natural capital or job creation, for instance. Intensity indicators and genuine savings can then support a MCPE by focusing on these specific issues. When it comes to reliability and measurability, the proposed framework shows several advantages and limitations. As a whole, our assessment strongly indicates that the proposed framework is a complex and very resource intensive process. Nevertheless, it seems to be a doable exercise that can provide, among many other benefits, continuous policy learning opportunities for both policy makers and stakeholders. As whole, the proposed evaluation framework may attempt to provide an inclusive portrait of both facts and values regarding the policy instruments being used to promote a GEE. It has the potential to better reveal the complexity of the instruments' effects and to identify inevitable policy trade-offs. Further research and specific applications will cast light on this. The assessment of our proposed evaluation frameworks suggests that there is no single-best method and discipline that can cover of all the aspects (potentially) rooted in a GEE.

Due to the challenging task of separating (normative) values from facts attached to a GEE, the proposed evaluation framework methodology seems to support criticism towards the positivist view of evaluation, in particular the one addressing the 'Fact-value Dichotomy' (see Fischer 1995). A key point for arguing against the positivist approach of policy evaluation (i.e. it aims to develop factual knowledge of policy instruments via analytical techniques) is the inherently normative, value-laden nature of social and political phenomena and evaluation itself. Detractors of the positivist view of policy evaluation argue, for instance, that the very process of establishing the concepts and tools to be employed in evaluations rests upon implicit value judgements (e.g. Cook and Shadish 1986; Fischer 1980; Strauss 1988). Furthermore, the post-positivist view argues that the concept of value neutrality is in itself a value orientation approach that has clear implications and consequences for evaluation (Fischer 1980; Proctor 1991; Strauss 1988). Critics of the fact-value dichotomy call for the design of adequate methodological frameworks that can amalgamate the mix of facts and values —as attempted by the proposed framework. In turn, this underscores the term "triangulation" for GEE policy evaluation, understood as "the attempt to get a fix on a phenomenon or measurement (and, derivatively, an interpretation) by approaching it via several independent routes" (Scriven 1991, 364–365).

Finally, we need to further scrutinize the capability of the proposed framework in relation to policy evaluation questions and corresponding applications. In addition, we also need to establish how these methodologies would fit together in the proposed framework —f and when it is used for practical purposes. Clear policy objectives and available resources may guide the suitability of the proposed framework or prompt modification (e.g. to be case- or country-specific). There is also the strong need for several disciplines to be involved in the evaluation process. We suggest that a comprehensive evaluation approach still requires a portfolio of analytical methods and much greater collaboration across disciplines.

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