IRENA UKERC POLICY PAPER

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Researching pathways to a low carbon future

IRENA
International Renewable Energy Agency

Evaluating Renewable Energy Policy:

A Review of Criteria and Indicators for Assessment

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About IRENA

The International Renewable Energy Agency (IRENA) is an intergovernmental organisation that supports countries in their transition to a sustainable energy future, and serves as the principal platform for international cooperation, a centre of excellence, and a repository of policy, technology, resource and financial knowledge on renewable energy. IRENA promotes the widespread adoption and sustainable use of all forms of renewable energy, including bioenergy, geothermal, hydropower, ocean, solar and wind energy, in the pursuit of sustainable development, energy access, energy security and low-carbon economic growth and prosperity.

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Acronyms

BRIC	Brazil, Russia, India and China
BRICS	Brazil, Russia, India, China and South Africa
CAPEX	Capital Expenditure
CIA	Crucial Institutional Aspects
EC	European Commission
EDI	Energy Development Index
EISD	Energy Indicators for Sustainable Development
EU	European Union
FIP	Feed-in premium
FIT	Feed-in tariff
GWh	Gigawatt-hour
IEA	International Energy Agency
IPCC	Intergovernmental Panel on Climate Change
IPP	Independent Power Producer
MCA	Multi-Criteria Analysis
MW	Megawatt
MWh	Megawatt-hour
NGO	Non-Governmental Organisations
NPV	Net present value
OECD	Organisation for Economic Co-operation and Development
OPEX	Operating expenditure
PICA	Procedure for Institutional Compatibility Assessment
PII	Policy Impact indicator
PPA	Power Purchase Agreement
PV	Photovoltaic
RAI	Remuneration Adequacy indicator
R&D	Research and Development
RE	Renewable Energy
RET	Renewable Energy Technology
ROI	Return on Investment
TCI	Total Costs indicator
TEA	Total Energy Access
TGC	Tradable Green Certificates
TPA	Technology Policy Assessment
TSO	Transmission System Operators
WEO	World Energy Outlook

Executive summary

This paper investigates criteria and indicators used to evaluate renewable energy deployment policies. The focus is on application in lower income countries, and the report seeks to extend IRENA's Policy Brief on the topic "Evaluating policies in support of the deployment of renewable power". Key objectives are to explore the extent to which the literature on such criteria and indicators considers lower income country contexts and whether existing analysis makes viable 'short-hand' (simple, easy to apply) indicators for assessment.

In order to deliver these objectives the project team undertook a hybrid form of systematic review developed by the UK Energy Research Centre (UKERC) to best suit energy policy evaluation and research purposes. The review combines systematic scientific database and grey literature Boolean searches with expert elicitation and citation trail analysis. The UKERC approach has been applied to a wide range of policy topics and achieved considerable impact on policy development.

The paper follows the approach taken in IRENA's Policy Brief and divides its analysis between four core criteria[1]. These are:

1. Effectiveness
2. Efficiency
3. Equity
4. Institutional feasibility

A number of general insights were drawn from the review, including:

- The majority of indicators have been defined/developed for Organisation for Economic Co-operation and Development (OECD) countries and rely upon sophisticated models and detailed data requirements.
- Relatively simple indicators offer a useful 'initial step' and are obviously preferable to neglecting evaluation altogether. However, they are subject to important limitations.
- The additional insight offered by more complex indicators needs to be considered in unison with a country's institutional capacity and data availability.
- Availability of both data and capacity may be a barrier to deployment of complex indicators in lower income countries.
- Equity and institutional feasibility criteria are less well served by simple, quantitative indicators.
- Analysts need to look at criteria in combination. Taken alone they are of limited value.

[1] *The Policy Brief also includes replicability. This is not included here as no meaningful literature on the topic was identified through the review process.*

» In many respects, institutional feasibility is a prerequisite for success, yet can be overlooked in the literature on policy design and evaluation.

The remainder of this Executive Summary describes the principal findings for each criterion along with a number of additional considerations.

Effectiveness

The literature on evaluating policy *effectiveness* is concerned with measuring and benchmarking the outcomes renewable energy policies have delivered. Much of the literature associated with effectiveness has a developed country context, with a particular focus on the European Union (EU) where there has been an appetite for comparing policy approaches across nations within the context of successive directives and targets. Literature also originates from the International Energy Agency (IEA), which has undertaken a variety of policy evaluations and comparisons. The IEA also has a predominately developed country focus.

The simplest indicators measure installed capacity or electricity output and growth rates thereof, either in absolute or percentage terms. These measures have the potential to provide a simple proxy for effectiveness, with minimal data requirements. Measuring energy output offers advantages over measuring capacity growth, since the latter cannot capture how productive renewable installations are – for example as a result of effective siting, maintenance and grid integration. However, the simple measures are subject to obvious limitations; they say nothing about progress relative to economic or technical potential, or relative to broader policy goals, or indeed to starting points or in terms of overall market share. They also lack predictive value, since they tell the analysts little about future prospects and cannot explain causation – they do not and cannot explain *why* a policy (or policy mix) has been effective.

More sophisticated approaches assess deployment against a country's overall potential, measured over a period of time. This introduces more complexity. Estimates of resources and technical and economic constraints are needed for calculating potential. These differ between countries for a wide range of reasons, making cross-country comparison difficult. More sophisticated measures include the European Commission 'Effectiveness indicator', the 'Deployment Status indicator' and IEA 'Policy Impact indicator'. These include progress towards targets, share of electricity generated and attempts to capture the maturity of the market for renewable energy, hence allow more nuanced comparison between countries. However, these sophisticated approaches add to data and processing requirements.

Overall, effectiveness indicators exist as simple benchmarks for success. Quantitative, straightforward and readily applied in most country contexts, the simplest variants are well suited to lower income country application. Yet all variants offer limited scope and insight. Even the more sophisticated variants tell the analyst little about *why* deployment was successful, whether it will continue to be in future, or how economically efficient or socially acceptable deployment was seen to be. Measuring deployment is a first step in assessing effectiveness, but used alone, it does not provide insight into why a policy succeeded or failed in lower income country contexts. For all these reasons the literature considers effectiveness alongside other measures, to which we now turn.

Efficiency

The literature on policy *efficiency* is principally focussed upon evaluating whether policy has been economically efficient in terms of the resources expended in delivering renewable energy – whether in simple financial terms or against social costs/impacts. 'Outcomes to inputs' can be represented simply using the indicators of USD/MW of installed capacity or USD/MWh of electricity generation. Much of the literature is developed country focussed with assessments on EU and IEA countries dominating the literature.

Indicators include:

» Remuneration Level, Potential Profits and Adequacy indicators: these combine payment levels with estimates of levelised costs, allowing the extent to which support levels are cost reflective to be assessed and compared.

» Total Costs indicator: a measure of the full cost of premium payments against the amount of additional electricity generation that they incentivise.

» Consumer Costs indicator: focuses on total impact on consumer bills. This is a product of subsidy levels (subsidy per MWh) and level of overall ambition (total subsidised MWhs). It offers a simple representation of the societal dimension of economic efficiency.

Each of the above measures is focussed upon short-term efficiency, neglecting changes over time, notably cost reductions. The literature is also concerned with *dynamic efficiency,* in particular the potential for innovation and competition to reduce costs. Short-term static efficiency can conflict with longer term efficiency, for example if more expensive technologies are subsidised in the short term because of their potential for cost reduction over the long term. This would increase short-term costs to consumers and could be perceived as economically inefficient in comparison with supporting just the cheapest existing technologies. There is extensive literature on innovation and various learning effects. However, benchmarking innovation potential is beyond the scope of this paper. We do, nevertheless, note that static measures can be adapted to evaluate dynamic efficiency, principally by adjusting the temporal frame. For example, cost reduction can be assessed against expenditure both ex-ante (anticipated learning investment) and ex-post (out-turn learning investment).

Equity

The literature on *equity* is predominantly concerned with distribution of policy impacts. The review highlighted several general principles that commonly underpin renewable energy policy evaluations, but specific indicators were only identified for consumer impacts. Beyond these, the wider principles identified are: the polluter pays principle, the allocation of revenues and expenditures, the incidence and allocation of windfall profits, the ability to pay of different stakeholders and the beneficiary account.

Indicators for consumer impacts fall into three broad groups:

- Changes to energy consumption (or expenditure) can be measured most simply as absolute values, however the usefulness of these is limited since they do not differentiate the value of energy services to different social groups. Measurements expressed as a percentage of household income or adjusted with welfare weighting offer greater insights, but can be difficult to deploy in lower income country contexts due to the extent of data and expertise required.

- The targeting of consumer subsidies can be assessed by comparing the proportion of benefits accruing to the target group against the prominence of that group in the general population.

- Energy access metrics receive extensive coverage in the literature, and are relevant to renewables deployment in countries in the process of electrification. Progress may be tracked using quantitative indicators (*e.g.* the share of households with an electricity connection or per capita consumption), with Lorenz curves and Gini coefficients employed to quantify the inequity of impact distribution. Qualitative metrics compare the provision of energy services against subjective standards, measuring whether provision surpasses the deemed threshold for energy deprivation, or grading the quality of the energy supply. The former has limited use for evaluating renewable energy deployment, being unconcerned with impacts beyond thresholds and heavily reliant on the presence of domestic appliances; the latter is more pertinent, taking account of relevant supply quality issues such as intermittency.

Besides distributional impacts, equity may be interpreted based on the potential for stakeholders to participate in policy development. Such participation can not only improve the perceived equity of a policy, but can also reduce implementation costs, by allowing potential difficulties to be identified and mitigated. There is a general lack of literature that evaluates the equity of consultation processes for renewable energy deployment, and no such indicators were identified. However, there is literature that evaluates participation exercises across wider policy areas; the common pitfalls identified in these other areas could form the basis of indicators.

Definitions of equity for energy policy evaluation vary considerably between authors and can be decisive in whether a policy is judged to be equitable. This presents difficulties for the development of internationally applicable short-hand indicators. For the purpose of evaluating renewable energy deployment on a national basis, evaluations should reflect the concept of equity as understood by the policy's stakeholders and the local drivers for renewable energy deployment. For many lower income countries this may mean focussing on socio-economic development rather than climate change mitigation impacts.

Institutional feasibility

The literature on institutional feasibility is concerned with the political factors that affect support for a policy, the appropriateness of in-country institutions and the institutional and human capacity required to implement and monitor interventions. Much of the literature on renewable energy institutional feasibility in particular, has focussed on developed countries. In addition, the literature considers institutional feasibility predominantly in relation to wider environmental policy rather than renewable energy policy, for which discussion of methodological institutional feasibility evaluation issues is lacking.

Institutional feasibility is regarded by some analysts as the most important criterion of all, since it is not possible to implement policy without institutional feasibility, regardless of potential performance according to the criteria described above or success in other country contexts. Policies designed without taking account of institutional feasibility conditions may not perform as expected. In lower income countries in particular, institutional feasibility has been identified as being highly deterministic of the performance of the other criteria because of the uncertain political climate and the relatively limited institutional capacity.

Institutional feasibility provides a means of *explaining* the reasons behind the good/bad performance of a policy rather than a means of measuring policy outcomes. As a result, it is most appropriate for ex-ante evaluation of the potential of a policy to do well, and for developing a policy that is adapted to local conditions, rather than benchmarking a policy's performance ex-post.

Institutional feasibility is intrinsically difficult to measure. Evaluation is not amenable to simple metrics and tends to be qualitative, more so than for the other indicators. Three approaches to institutional feasibility assessment were identified in the review: case study, impact assessment, and multi-criteria analysis (MCA). All are relatively complicated to implement, broadly qualitative and produce much more insightful results if permitted sufficient human/time resource.

For all the above reasons, institutional feasibility is not well suited to simple or short-hand assessment. The literature identifies some institutional feasibility prerequisites, for example consistent government support, sufficiently skilled staff and the appropriate assignation of implementation responsibilities, but these are more useful for determining whether a policy is *not* institutionally feasible (if they are not present) rather than assessing institutional feasibility – their presence alone doesn't guarantee feasibility.

Though consideration of institutional issues is widely regarded as important for development of policies that have a decent chance of achieving their intended impact, there seems to be limited experience of using institutional feasibility as a key policy evaluation principle for renewable energy policy. There are few examples to follow, so it is hard for countries that have limited resources/expertise to incorporate institutional feasibility into their own evaluation. Improving this situation could offer major advances in renewable energy policy effectiveness in lower income countries.

Further criteria/indicator considerations

Preliminary fieldwork and in depth analysis is required to validate the use of any indicators, particularly short-hand indicators. Short-hand or otherwise, many of the criteria discussed in this paper are quite narrow in focus and neglect broader impacts (such as jobs, industrial change, energy security, etc.). Those conducting the evaluation need to be aware of the limited/narrow focus of considering only immediate deployment effects. Indeed, it may be the broader impacts of the deployment of Renewable Energy Technologies (RETs) that are more important for the country in question.

The effectiveness and efficiency criteria interact closely and should be considered in unison. Efficiency becomes increasingly important as the share of renewable energy rises. Equity is in part a product of efficiency and scale of aspiration but with wider social dimensions. If equity/distributional consequences are primary, relatively expensive large scale renewable energy deployment may not be the most appropriate option for lower income countries.

The four criteria are not exhaustive. A number of alternative criteria are identified as part of the review, such as political accountability, source of finance and regulatory simplicity. The expert elicitation also drew attention to the power politics and political economy of implementation. Assessment of these may help explain why deployment has been un/successful. However, identifying/designing indicators and methods for assessment is beyond the scope of this paper.

Implementation and monitoring are at least as important as policy design and evaluation. Experts were concerned that these areas may be poorly represented in lower income country policy processes and overlooked at both design and evaluation stages. Finally, there may be value in a gradual introduction of different criteria and indicators over time. Beginning with more simple criteria and indicators first and slowly increasing the sophistication is likely to improve data gathering, which in turn, will improve policy evaluation.

1. Introduction

1.1 BACKGROUND

This policy paper is concerned with the criteria and indicators used to assess renewable energy policies. It has a particular focus on application in lower income countries[2], an area that has been little researched to date. The paper provides an extension to the IRENA Policy Brief "Evaluating policies in support of the deployment of renewable power" (IRENA, 2012a). Key objectives are to explore: the extent to which the literature on indicators of policy success for renewable energy deployment considers lower income country contexts; and whether existing analysis suggests viable 'shorthand' (simple, easy to apply) indicators are available.

In order to deliver these objectives the project team undertook a hybrid form of systematic review developed by the UK Energy Research Centre (UKERC) to best suit energy policy evaluation and research purposes. The approach is described in detail below.

Four key criteria are identified in IRENA (2012a) (hereafter referred to as the Policy Brief) for evaluating government policy. The criteria reviewed in depth in this paper[1] are as follows:

- Effectiveness
- Efficiency
- Equity
- Institutional feasibility

For each criterion the Policy Brief identifies a number of indicators and methods used to conduct evaluation (see Annex 8.1 summary table from Policy Brief). This paper seeks to expand on these indicators, exploring each in detail, discussing their relative merits and critiquing them.

1.2 APPROACH

The research employs a two-part methodology:

1. Literature review – combined systematic review and citation trail based on the Policy Brief.
2. Expert elicitation – interviews with experts from universities, research institutions and international organisations. This process sought to capture greater insights into the theoretical validity and practical use of the criteria in lower income country contexts along with more general considerations for discussion and critique.

LITERATURE REVIEW

A 'rapid systematic review' of the literature was undertaken for each of the five[3] evaluation criteria defined in the Policy Brief. The method was based on the approach employed for systematic reviews by UKERC's Technology Policy Assessment (TPA) function. The TPA's rigorous and transparent method has been developed by UKERC specifically to meet the needs of energy policy analysis, drawing on best practice from the wider

[2] *For the purpose of this report, 'lower income countries' are defined to be those classed as 'low-income economies' or 'lower-middle-income economies' by the World Bank (2013), specifically those with a gross national income per capita of USD 4,035 or less.*

[3] *The Policy Brief also considers replicability. However whilst this was considered within the systematic review it is excluded from further discussion because no relevant literature was revealed and there is no meaningful potential for extending the discussion in the Policy Brief.*

field of ‘Evidence Based Policy and Practice’ (Davies, Nutley and Smith, 2000; Solesbury, 2001; Sorrell, 2007). Further details of the TPA methodology are available on UKERC’s website[4].

Each of the policy evaluation criteria were combined with 9 search terms in 32 different search *strings* using “and” as a Boolean operator[5]. These strings were used with three search engines: Web of Knowledge, Science Direct and Google Scholar (see Annex 8.2 for full table of search results). The search terms and strings were chosen based on their association to the research question and pilot searches that sought to balance the requirement of combining breadth with specificity and manage the overall number of results. The following 9 search terms, truncated or elongated, were used in combination to build the search strings:

“Renewable energy” “policy” “evaluation” “low income country” “developing country” “criteria” “analysis” “framework” “support”

For example, “’effectiveness” and “renewable energy” and “policy’” constitutes one search string. All searches were limited to research published in and after the year 1990. Research focussed on renewable electricity generation. Other low carbon technologies, such as carbon capture and sequestration and nuclear were excluded.

The systematic review revealed 41,539 search results in total. Eleven of the search strings revealed over 150 search results, in these cases the top 150 results were reviewed. This reduced the total number of search results to 2397. Out of these, 182 were identified as suitable for further review, based on the title, abstract, author and keywords of the papers. These constitute the systematic review component of the literature review.

The citation trail was drawn from the IRENA Policy Brief. The references from the Policy Brief were checked for relevant material. Additional material, sourced independently from the systematic review and citation trail (for example through expert recommendation) was also included.

EXPERT ELICITATION INTERVIEWS

Experts from a number of academic and non-academic institutions were interviewed to gain additional insights (see Annex 8.3 for further details). Semi-structured interviews were used for this exercise.

1.3 STRUCTURE OF THE PAPER

Parts 2 – 5 discuss each criteria in turn: effectiveness, efficiency, equity, and institutional feasibility. Part 6 discusses the findings from the expert elicitation and Part 7 presents the review’s overall conclusions.

4 *www.ukerc.ac.uk/support/TPA+Overview&structure=TPA+Overview*

5 *The use of ‘and’ ensured that results found for any string would contain all of the search terms.*

2. Effectiveness

2.1 IRENA POLICY BRIEF DEFINITION AND CHARACTERISATION OF THE LITERATURE

The Policy Brief defines effectiveness using the Intergovernmental Panel on Climate Change's (IPCC) Special Report on Renewable Energy Sources and Climate Change Mitigation definition, as "the extent to which intended objectives are met, for instance the actual increase in the amount of renewable electricity generated or share of renewable energy in total energy supply within a specified time period" (Mitchell, *et al.*, 2011 in IRENA, 2012a).

The literature on effectiveness indicators identified through the review process is almost entirely drawn from European Union's (EU) research organisations and the International Energy Agency (IEA). Very little academic research examines the indicators themselves in detail. In general, research focuses on government policies using the term *effectiveness* in a qualitative form (Agnolucci, 2007; Dijk, *et al.*, 2003).

2.2 SIMPLE INDICATORS

INSTALLED CAPACITY AND ELECTRICITY GENERATION

Installed capacity (measured in absolute terms or growth rates, see below) offers the simplest and possibly the most common metric used for assessing the effectiveness of renewable energy policies. Nevertheless, installed capacity does not provide any indication on utilisation, for example whether capacity is grid connected and securing appropriate load factors. For this reason analysts also assess electricity generated (MWh/year). It can, however, be difficult to gather accurate generation data, and in some cases generation data is not based on metered electricity measurement but installed capacity and load factor estimates. This obviously undermines the desire to assess real rather than theoretical performance.

Both capacity and output growth can be assessed in both absolute (MW/MWh) and relative (percentage) growth terms. The principal limitations are as follows:

- No link to potential or aspiration, although these can be factored in through extensions to the basic indicator, such as a link to policy goals (IEA, 2008).
- No indication of likely future development, although pipeline data on future planned projects could be considered to indicate how consistent the deployment rate is over time.
- Absolute growth can obviously be great in larger or more resource-rich countries, but this does not in itself demonstrate that policy is effective. Similarly percentage growth may appear extremely rapid, but when it is coming from a very small base may not provide a good indication of policy effectiveness (IEA, 2008).
- Neither of the simplest indicators provide an indication as to share of renewables in the energy mix overall or a link to wider issues such as demand growth, hence whether the share of renewables is expanding.

SIMPLE INDICATORS AND USE IN LOWER INCOME COUNTRIES

Despite their obvious limitations the simplest indicators have equally obvious benefits: minimal data requirements (particularly for monitoring capacity growth), simple implementation with little requirement for specialist knowledge. The principal limitations for lower income country application are common with developed country applications, as listed above.

Although installed capacity and electricity generation growth are simple measures and used widely, "Taken alone ... they convey little about the success of a policy, because there is no comparison with intent" (IRENA, 2012a). Furthermore, comparing such achievements with pre-existing government targets can indicate whether national renewable energy goals are likely to be achieved, but does not give any indication of ambition. A low target is more easily met than a high one and targets may or may not be achievable. For example, Wilson (2013) expressed concern that there have been some cases in both Organisation for Economic Co-operation and Development (OECD) and non-OECD countries where targets have not been realistically set. For these reasons a variety of more sophisticated indicators have been developed, which we explore below.

2.3 THE EC EFFECTIVENESS INDICATOR AND THE POLICY IMPACT INDICATOR

THE EC EFFECTIVENESS INDICATOR

In a comparison of different EU member state policies, the European Commission (EC) defines effectiveness "as the electricity delivered [by a specific renewable energy technology (RET)] in GWh compared to the potential of the country for each technology" (EC, 2005). The associated Effectiveness indicator measures the additional generation achieved by a technology (i) in a given year (n) as a percentage of the total additional 'realisable potential' that is considered achievable between that year and 2020 (*ibid.*; IEA, 2008). It is calculated as follows (IEA, 2008):

where $$E^i_n = \frac{G^i_n - G^i_{n-1}}{ADDPOT^i_n} = \frac{G^i_n - G^i_{n-1}}{POT^i_{2020} - G^i_{n-1}}$$

E^i_n = Effectiveness indicator for RET i for the year n

G^i_n = Electricity generation by RET i in year n

$ADDPOT^i_n$ = Additional generation potential of RET i in year n until 2020

POT^i_{2020} = Total generation potential of RET i until 2020

An 'effective' policy result is regarded by the EC (2005) to be a score of above 7% for mature technologies (wind and hydro), above 3% for biogas and other moderate technologies and above 0.5% for solar photovoltaic (PV) and immature technologies. However, the values calculated represent only a snapshot of effectiveness over a specified timeframe, which may not align with overall effects of a policy over its lifetime. It is important to recognise and expect that the indicator values calculated will change as the national market matures: they are likely to be low until the supply chain and administrative systems are established, then to grow until the market becomes saturated, and to fall as project opportunities become rarer (IEA, 2011). This calls into question the concept of benchmarking 'effective policy results' if market maturity is not considered.

Figure 1 demonstrates the results of the indicator for onshore wind in the EU between 1998-2004.

IEA (2008) defines 'realisable potential' as 'the maximum achievable potential, assuming that all existing barriers can be overcome and all development drivers are active'. It takes account of medium-term constraints on the rate of change such as market growth rates and planning constraints, and varies from year-to-year, tending towards the technical potential over the long-term (see Figure 2). The percentage of realisable potential achieved is considered a fairer metric for international comparison of policies than absolute or percentage changes to generation and capacity, since it takes account of 'different [country] sizes, starting points in terms of renewable energy deployment and degrees of ambition of renewable energy policies and targets' (*ibid.*). However, the complexity of the modelling method and significant data requirements may limit its usefulness for lower-income countries, unless estimates can be obtained from existing international studies. Estimates of realisable potential have been calculated for European countries using the 'Green-X'[6] model, and for other OECD and BRIC (Brazil, Russia, India and China) countries using the 'WorldRES model'[7] (EC, 2005; IEA, 2008).

THE POLICY IMPACT INDICATOR

The Policy Impact indicator (PII) is an adaptation of the Effectiveness indicator by the IEA (IEA, 2011). Rather than measure progress towards estimates of realisable potential in 2020 using the current year as a baseline, the PII measures progress towards the IEA World Energy Outlook (WEO) 2010's 450 projections for 2030, from the base year of 2005. The indicator is expressed as the percentage of the gap between generation in 2005 and the WEO 2030 figure that was closed in any given year. It is calculated as follows (*ibid.*):

[6] *The Green-X was developed by the EU. It is a dynamic national energy system modelling framework based on general equilibrium principles, which enables quantitative and comparative investigation of the future renewable energy deployment in all energy sectors based on the application of energy policy strategies (Green X, 2007; IEA, 2008). Further details are available from www.green-x.at.*

[7] *The 'WorldRES' model was developed to estimate projection's for the IEA's World Energy Outlook 2007 by the Energy Economics Group (EEG) at Vienna University of Technology, in cooperation with the Wiener Zentrum fürEnergie, Umwelt und Klima (IEA, 2008).*

Figure 1: Effectiveness indicator for onshore wind electricity in the period 1998-2004. The relevant policy schemes during this period are shown in different colour codes. Source: EC (2005) Annex 2.

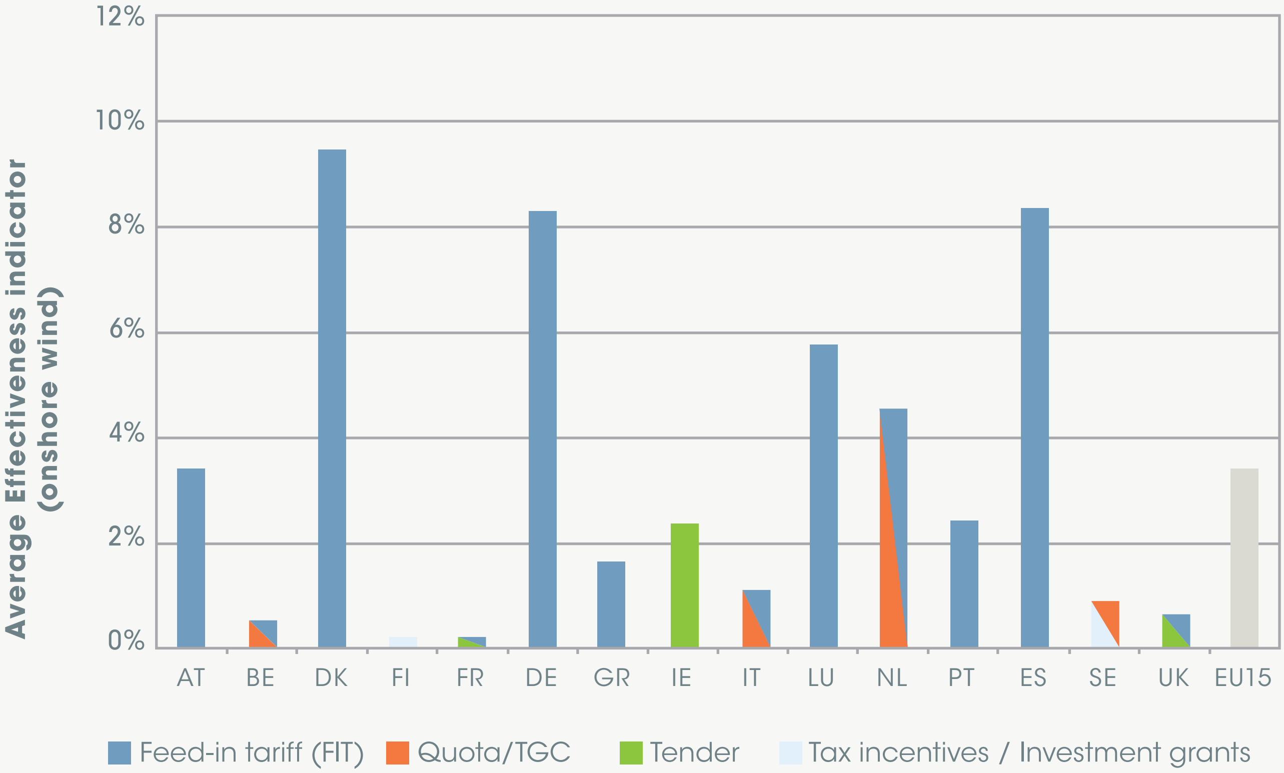
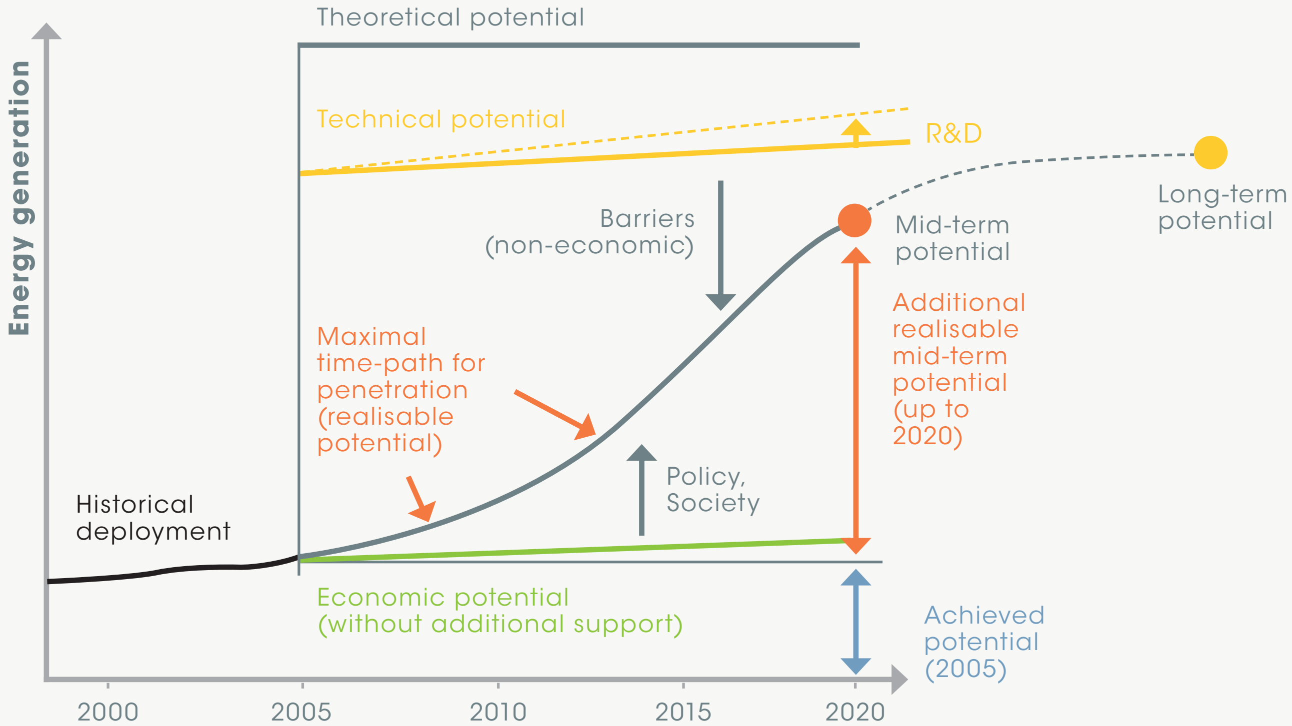


Figure 2: Realisable Resource Potential. Source: IEA (2008).



where $$PII^i_n = \frac{G^i_n - G^i_{n-1}}{WEO^i_{2030} - G^i_{2005}}$$

G^i_n = electricity generation of RET i in year n

WEO^i_{2030} = WEO 450 generation projections for 2030 of RET i.

The use of the WEO projections instead of realisable potential estimations conceptually alters the terms by which policy effectiveness is judged. Whilst the Effectiveness indicator is concerned with progress towards a nation state's maximum 'realisable' exploitation of renewable technologies, the PII focuses on the WEO's projected pathway for stabilising global carbon dioxide concentrations at 450 parts per million, with the relative extent of deployment in different regional and national contexts reflecting local technological cost constraints. National policy priorities will dictate which approach is considered the most relevant in different contexts.

THE EFFECTIVENESS INDICATOR AND THE POLICY IMPACT INDICATOR: USE IN LOWER INCOME COUNTRIES

Both the Effectiveness indicator and the PII introduce complexity and data requirements that may make utilisation in lower income countries challenging. Estimations of either realisable potentials or projections require detailed techno-economic data, energy system modelling capacity and a comprehensive understanding of related socio-political issues affecting deployment of renewables. This in itself may not prohibit use in lower income countries, but the quality and accuracy of data will affect the usefulness of the results generated.

Both indicators have primarily been used to assess policy performance through comparisons with other countries. They work well for groups of countries such as the EU, where member states share renewable energy targets and have broadly similar economic circumstances. This highlights the need to identify, and simultaneously assess, peer countries that have similar ambitions and capacity to act.

As previously noted a particular limitation of the PII is that the WEO national-level projections are not available for all countries; the IEA recognises that disaggregation of the regional projections would be challenging (IEA, 2011). This may make it inappropriate for use in lower income country contexts. However, the PII's static base year denominator is more suitable for longitudinal study of policy impacts than the moving based year of the Effectiveness indicator. This has the effect of accentuating results calculated, which could lead to misinterpretation, particularly if time or technical capacity for analysis is constrained. Given the relative limitations of both the Effectiveness indicator and the PII, a hybrid combining the realisable potentials of the former with the static year base of the latter may offer a more readily interpretable means of evaluating longitudinal national policy impacts in lower-income countries.

2.4 DEPLOYMENT STATUS INDICATOR

Intelligent Energy Europe has developed a Deployment Status indicator that aims to quantify the maturity of national renewable energy markets for individual technologies. It is intended to enhance understanding of the results of the Effectiveness indicator, which - as previously noted - are influenced by market maturity. Additionally it allows generic policy advice to be better-differentiated, since the barriers faced by technologies – and the suitability of policy frameworks to overcome these – vary according to the maturity of renewable energy markets (Held, *et al.*, 2010).

The indicator is composed of three weighted sub-indicators, representing different aspects of RET deployment:

» Sub-indicator A: Production of RET as share in total sector consumption.

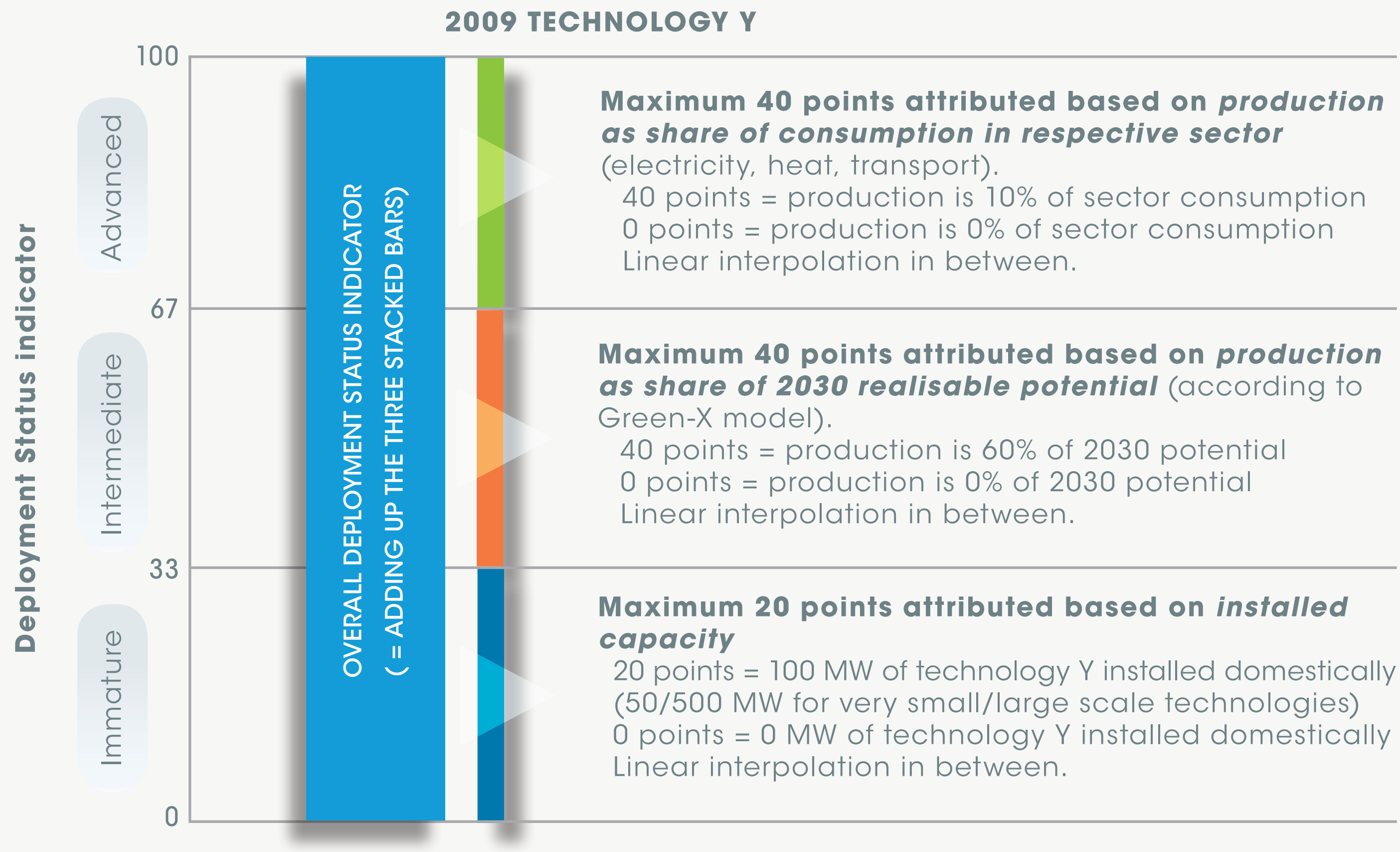
» Sub-indicator B: Production as share of 2030 realisable potential.

» Sub-indicator C: Installed capacity of RET (*ibid.*).

Figure 3 summarises the composition of the Deployment Status indicator, including the weightings assigned to sub-indicators, the methods of calculating the sub-indicator values and the range of scores for which markets are considered to be immature, intermediate and advanced stages of maturity. Note that sub-indicator C is considered relevant during the early phases of market development when deployment levels are very low[8].

[8] *A low value for sub-indicator C combined with a high value for sub-indicator B may suggest that the total potential for a technology is low, in which case the market is unlikely to further mature significantly. Further details on the composition of the Deployment Status indicator are available in Annex 8.4*

Figure 3: Composition of Deployment Status indicator. Source: Held, *et al.* (2010).



THE DEPLOYMENT STATUS INDICATOR AND USE IN LOWER INCOME COUNTRIES

Like the Effectiveness indicator and the PII, the Deployment Status indicator has been developed for application in EU/OECD countries, to make use of known data sources and available human/technical capacity. This may present difficulties for application in lower income countries where such resources are more limited. The scoring systems, weightings and thresholds for each of the sub-indicators have also been derived for EU countries. These would need to be calibrated to reflect country circumstances (for example, the installed capacity threshold of sub-indicator C). Ölz (2013) endorsed the proposal that the sub-indicators should be tailored for groups of countries with similar characteristics, such as GDP, energy security and ability to pay for RETs. Further, Ölz (2013) stated that although deployment status is recorded as a national measure, the extent to which national markets can be understood without consideration of global markets and international supply chains is limited.

2.5 EFFECTIVENESS CONCLUSIONS

What we have seen from the literature review on renewable energy policy effectiveness indicators is an on-going effort, led by a number of EU research institutions, to develop a set of increasingly sophisticated indicators for evaluation (EC, 2005; Resch, *et al.*, 2007; IEA, 2008; Held, *et al.*, 2010; Steinhilber, *et al.*, 2011).

It is important to reiterate that the complex indicators have been developed within and for the EU where cross-country directives and policies are in operation. Use in a wider context, particularly in lower income countries, is likely to be challenging – primarily as a result of limited data availability. Cross-country comparisons are necessary to make judgements based on relative merit. To this end, the identification of groups of peer countries is required for successful evaluations to be made.

The analysis suggests that the Effectiveness indicator be used as the primary complex indicator adapted to include a static base year (following the PII indicator). This indicator is identified, as it is the least data heavy and is a fairly uncomplicated step beyond the simple indicators. The Deployment Status indicator would need to be recalibrated for use in lower income countries.

All the effectiveness indicators identified in the review offer useful but limited scope and insight. Even the most sophisticated tell the analyst little about *why* deployment was successful, whether it will continue to be in future, or how economically efficient or socially acceptable deployment was seen to be. Measuring deployment is a first step in assessing effectiveness and comparing to a variety of objectives and comparable countries enriches the analysis. Ultimately effectiveness needs to be weighed against other goals, to which we now turn.

Table 1: Summary of effectiveness indicators

INDICATOR	COMMENTS
Installed capacity (MW)	Simplest indicator to employ: very low data requirements. Pipeline data may be included. Does not capture operational performance.
Electricity generated (MWh)	Low data requirements. Captures operational performance.
Meeting pre-existing government targets	Assesses link between achievements and targets, but without indication of scale of policy ambition.
EC effectiveness indicator	Measures deployment achieved in a given year as a percentage of remaining unexploited realisable potential to 2020. Considerable data and technical capacity requirements to estimate realisable potential. Does not take into account learning rates. Moving base year hinders longitudinal comparison.
Policy Impact indicator	Measures deployment achieved in given year as a percentage of new deployment required between 2005 and 2030 to meet IEA WEO 450 projections. National-level IEA WEO 450 projections not available for all non-OECD/BRIC countries, and difficult to disaggregate from regional projections. Use of static base year facilitates longitudinal comparison.
Deployment Status indicator	Quantifies maturity of national RET markets. Composite indicator combining: RET production as share of consumption; production as share of 2030 realisable potential; installed capacity. Considerable data requirements.

3. Efficiency

3.1 IRENA POLICY BRIEF DEFINITION AND CHARACTERISATION OF THE LITERATURE

The IRENA Policy Brief defines efficiency as "the ratio of outcomes to inputs, for example, renewable energy targets realised for economic resources spent, mostly measured at one point of time (static efficiency), and also called cost-effectiveness. Dynamic efficiency adds a future time dimension by including how much innovation is triggered to improve the ratio of outcomes to inputs" (Mitchell, *et al.*, 2011 in IRENA, 2012a).

The literature on efficiency considers both static and dynamic efficiency. In a number of cases static efficiency is discussed as a qualitative concept (Menanteau, Finnon and Lamy, 2003; Verbruggen and Lauber, 2012), however, in most cases some form of quantitative metric is defined (IEA, 2008 and 2011; Held, *et al.*, 2010). These quantitative indicators are considered in detail here. Research identified on dynamic efficiency tends to consider it at the conceptual level, quantitative indicators are not defined (Dijk, *et al.*, 2003; Verbruggen and Lauber, 2012). A general discussion on the component of dynamic efficiency is considered (IEA, 2000; Pablo and Bleda, 2012), however, the review did not identify any additional indicators that could be adopted for short-hand policy evaluation.

3.2 STATIC EFFICIENCY

Static efficiency can be measured simply using USD/MW of installed capacity or USD/MWh of electricity generation. As discussed in the context of effectiveness, power generation is usually more informative than capacity installed since it takes account of the efficiency of utilisation. Input costs must be clearly defined if interventions are to be fairly compared, both in terms of the capital investment that is included (*e.g.* generation plant, improvements to transmission and distribution networks, associated civil works) and the sources of finance for which efficiency will be considered (full costs or government subsidy).

REMUNERATION LEVEL, POTENTIAL PROFITS AND THE REMUNERATION ADEQUACY INDICATORS

A key factor in any assessment of the efficiency of a RET policy is the extent of financial support paid to the energy producer. This needs to provide a sufficient and predictable return on investment (ROI) in order to stimulate capacity growth, but also should be moderated to avoid windfall profits, which occur when support levels exceed requirements. The IEA's 2008 *Deploying Renewables* report notes that direct comparison of support levels between countries is not always possible due to gaps in generation cost data (IEA, 2008). It therefore suggests that annualised levels of the projected discounted lifetime remuneration (combining wholesale electricity revenues and subsidy support) received by generators be evaluated and compared instead. Figure 4 illustrates such a comparison of remuneration levels for the case of onshore wind in 2005.

These estimates are not considered a fair means of assessing the static efficiency of remuneration, since local contextual factors (*e.g.* renewable energy resource levels) are not accounted for. However, they can be combined with estimates of levelised generation costs to ascertain potential profit levels for investors – a fairer metric for comparison. Figure 5 compares the minimum to average range of generation costs and the average to maximum range of remuneration (support) levels for onshore wind in the EU in 2009; the difference between the two variables represents potential profits to investors. Potential profits vary significantly across countries, being negative in Austria yet over EUR 0.50/MWh in Italy and Romania.

The Remuneration Level indicator was further developed with the creation of the Remuneration Adequacy indicator (RAI) in the 2011 update to *Deploying Renewables* (IEA, 2011). This update notes the difficulties associated with setting appropriate support levels for technologies that are developing rapidly; specifically that support levels may need to change significantly and quickly in response to local or global developments; and that requirements will vary between

Figure 4: Annualised remuneration level for onshore wind in selected countries. Source: IEA (2008).

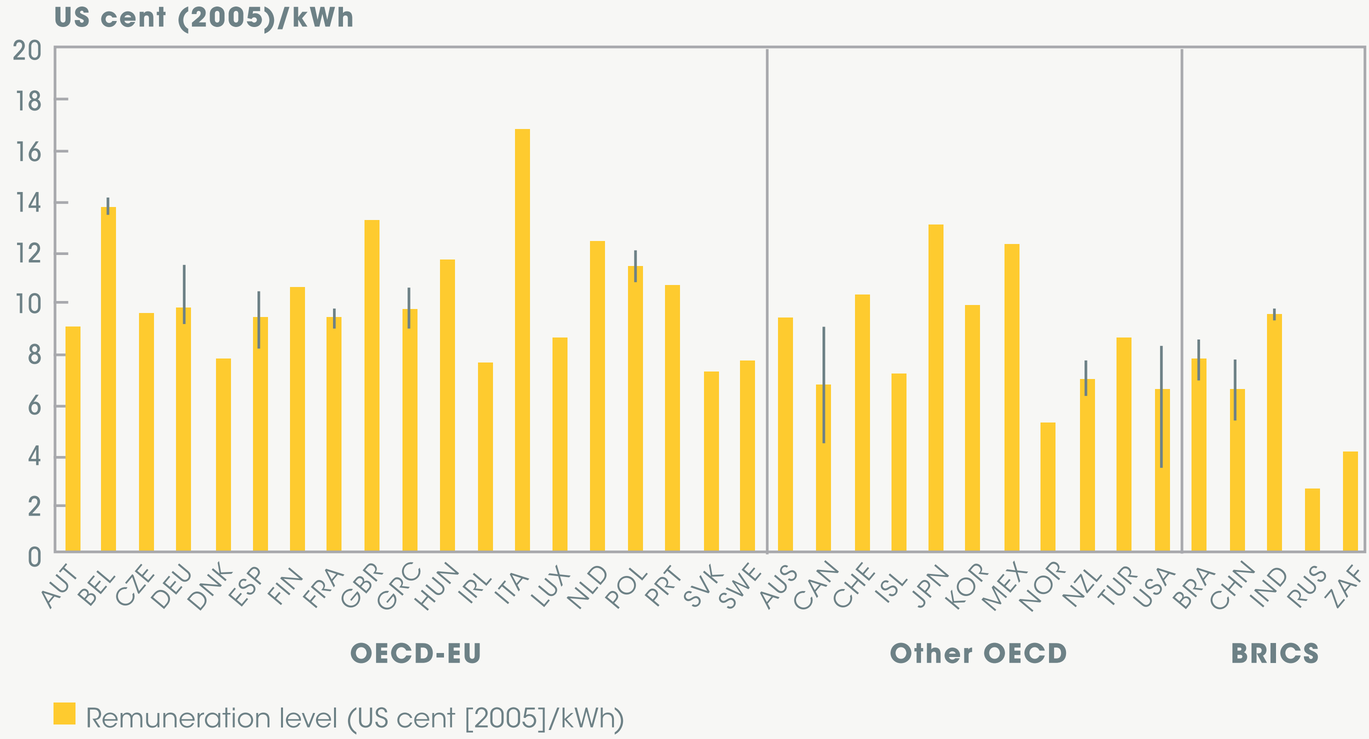
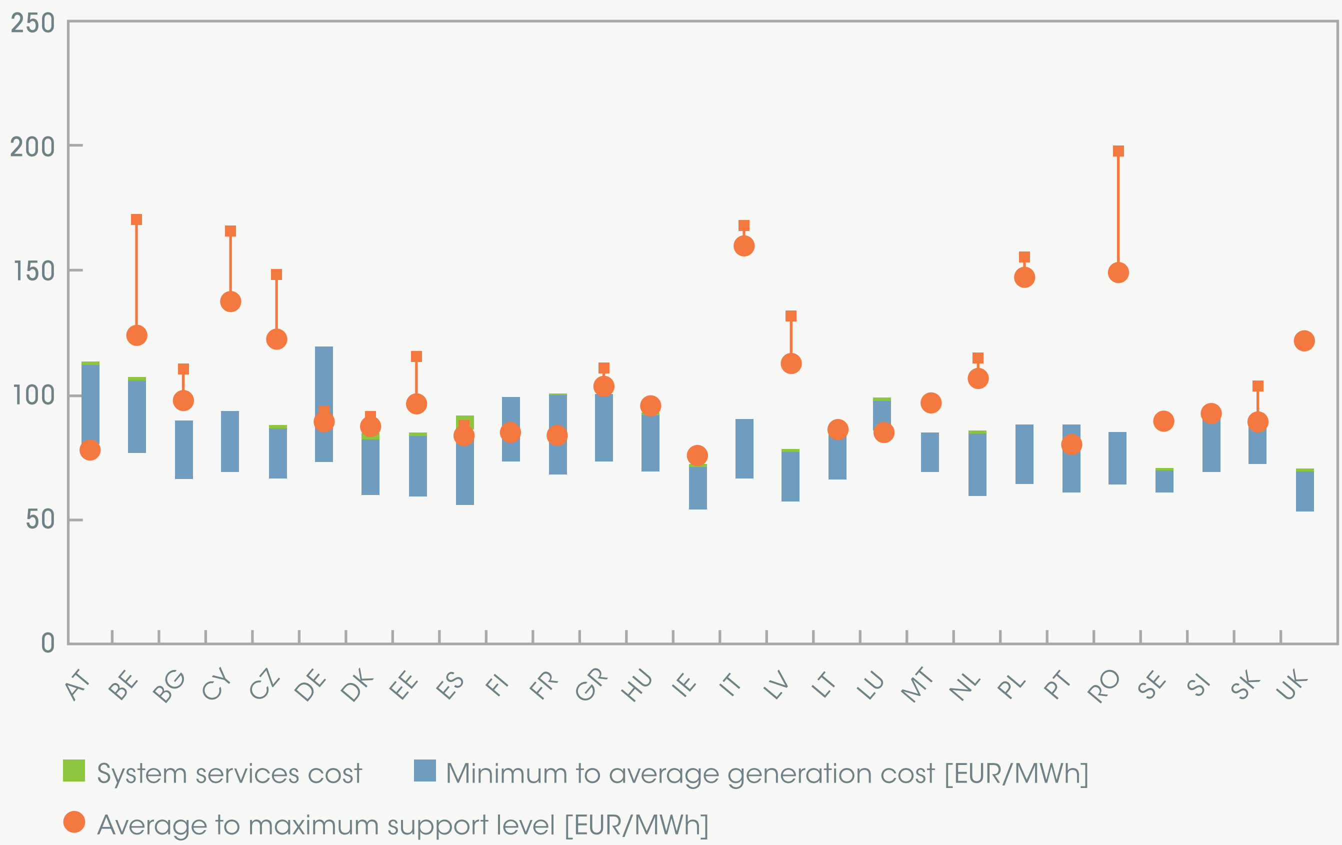


Figure 5: Support level ranges (average to maximum support) for onshore wind in the EU-27 member states in 2009 (average tariffs are indicative) compared to the long-term marginal generation costs (minimum to average costs). Source: Held, *et al.* (2010).



countries and technologies depending on issues such as resource availability, global market prices, global and local market maturity, supply chain availability, institutional capacity, etc. The RAI has been designed to be a fairer metric of comparison than the Remuneration Level indicator. It mitigates the effects of differing resource endowment by multiplying the annualised net present value (NPV) of remuneration (expressed as USD/MWh) by the expected full-load hours equivalent, generating a remuneration value in terms of capacity installed (USD/MW). This figure is compared against a range of pre-modelled 'reasonable' minimum and maximum RAIs, in an attempt to highlight the existence of significant interactions between incentive levels and system prices that may influence potential profits. For further details of the RAI calculations see IEA (2011).

It might seem peculiar that the RAI indicator is given in terms of capacity (MW), taking into account the previously noted limitations with simple indicators for effectiveness; that capacity metrics do not capture utilisation. For efficiency and remuneration adequacy, however, capacity is important. Most renewables have high capital expenditure (CAPEX) and low operating expenditure (OPEX). Further, CAPEX per MW is broadly comparable across different sites but generation is highly dependent on local renewable energy resource. The RAI takes account of remuneration per MWh, but expresses it per MW for ease of comparison between different locations.

One limitation of the RAI is that it does not account for different support levels applied to the same technology (*e.g.* for domestic and utility scale applications), but is based on the average revenue level. This limits its usefulness when analysing the appropriateness of particular incentives within a national context as support levels for one scale of technology may be appropriate, whilst for another they may not.

LINKS BETWEEN EFFICIENCY AND EFFECTIVENESS INDICATORS

Comparison and combination of criteria can facilitate the identification of best practice policies. They help to identify whether a policy's success depends primarily on financial incentives, or whether other factors are more influential on development of RET markets. The results of both of the remuneration indicators show a correlation with those of their contemporary Effectiveness/Policy Impact indicator, indicating that policies with the most efficient levels of remuneration are those that have the greatest impact in terms

Figure 6: Potential profit ranges (Average to maximum support and minimum to average generation costs) available for investors and policy Effectiveness indicator for onshore wind in 2009. The colours represent the main financial policy instruments in a country; blue represents FITs, red represents quotas / transferable green certificates. Source: Held, *et al.* (2010).

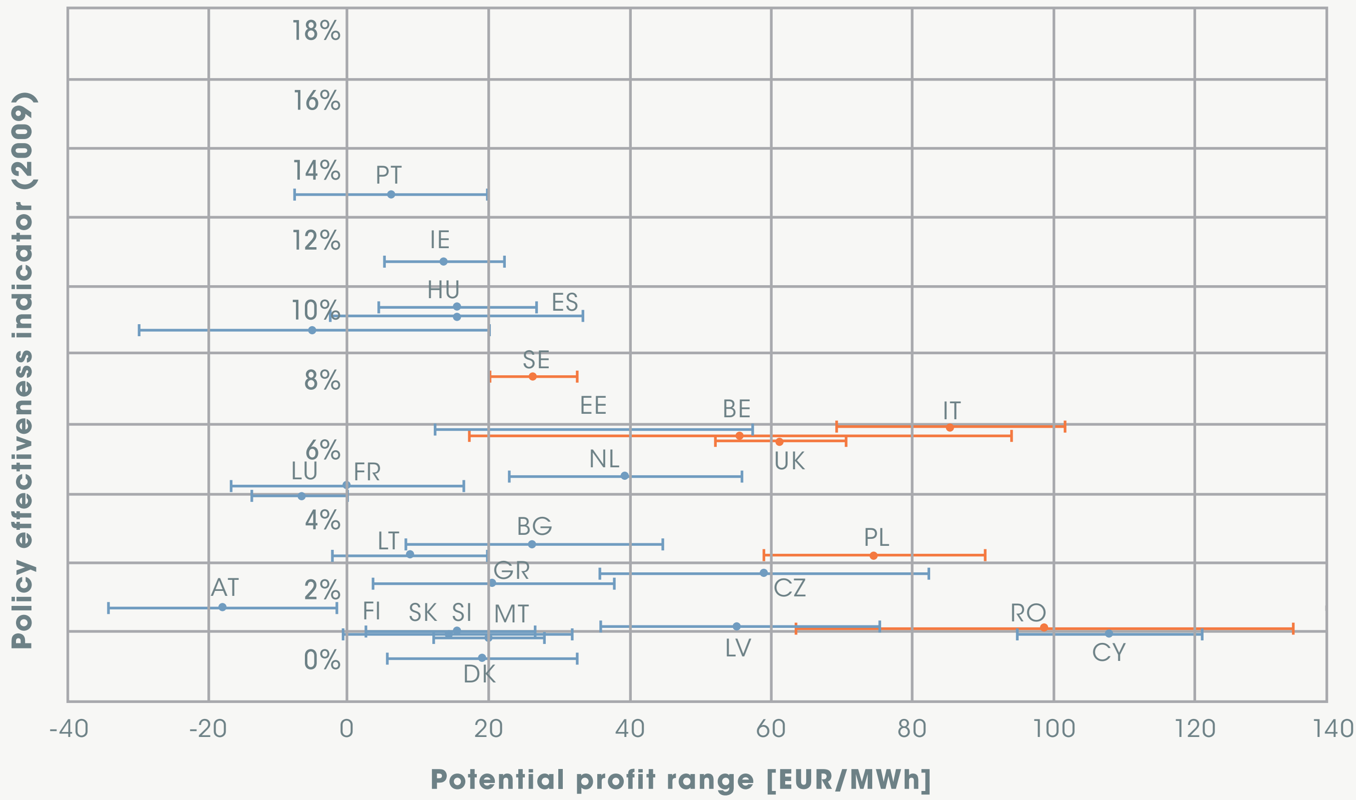
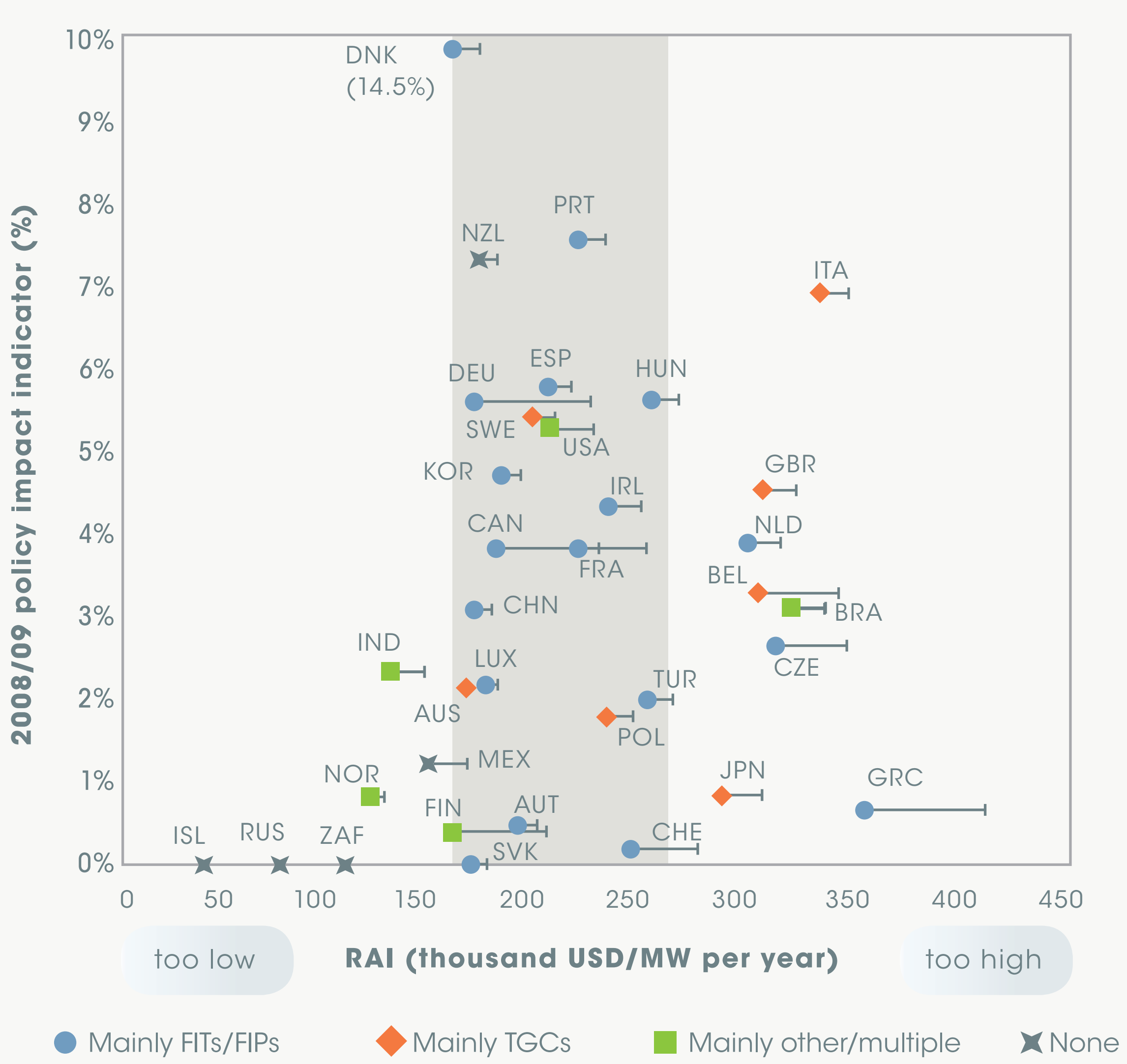


Figure 7: Comparison of the RAI with the PII for onshore wind support policies in OECD and BRICS countries, 2008/2009. Policies implemented are characterised by country as mainly FITs/feed-in premiums (FIPs), Tradable Green Certificates (TGCs) or other/multiple policies. The shaded area represents the range of 'reasonable' RAI values defined by the IEA. Source: IEA (2011).



of effectiveness (illustrated in Figure 6 and Figure 7 for onshore wind) (Held, *et al.*, 2010; IEA, 2011). This analysis has led Held, *et al.* (2010) to conclude that FITs are generally more effective and more economically efficient than quota systems.

The IEA acknowledges the difficulty in defining what is meant by 'reasonable' incentive level. As discussed above, they stress that a multitude of factors affect what is considered adequate. Nevertheless, a benchmark is included on the grounds that it enables judgements to be made. This benchmark (shaded area in Figure 7) is based on specific technology cost estimates that include a number of system and financial costs, which are likely to become outdated as technology costs change over time and will need to be revised.

THE REMUNERATION INDICATORS IN LOWER INCOME COUNTRIES

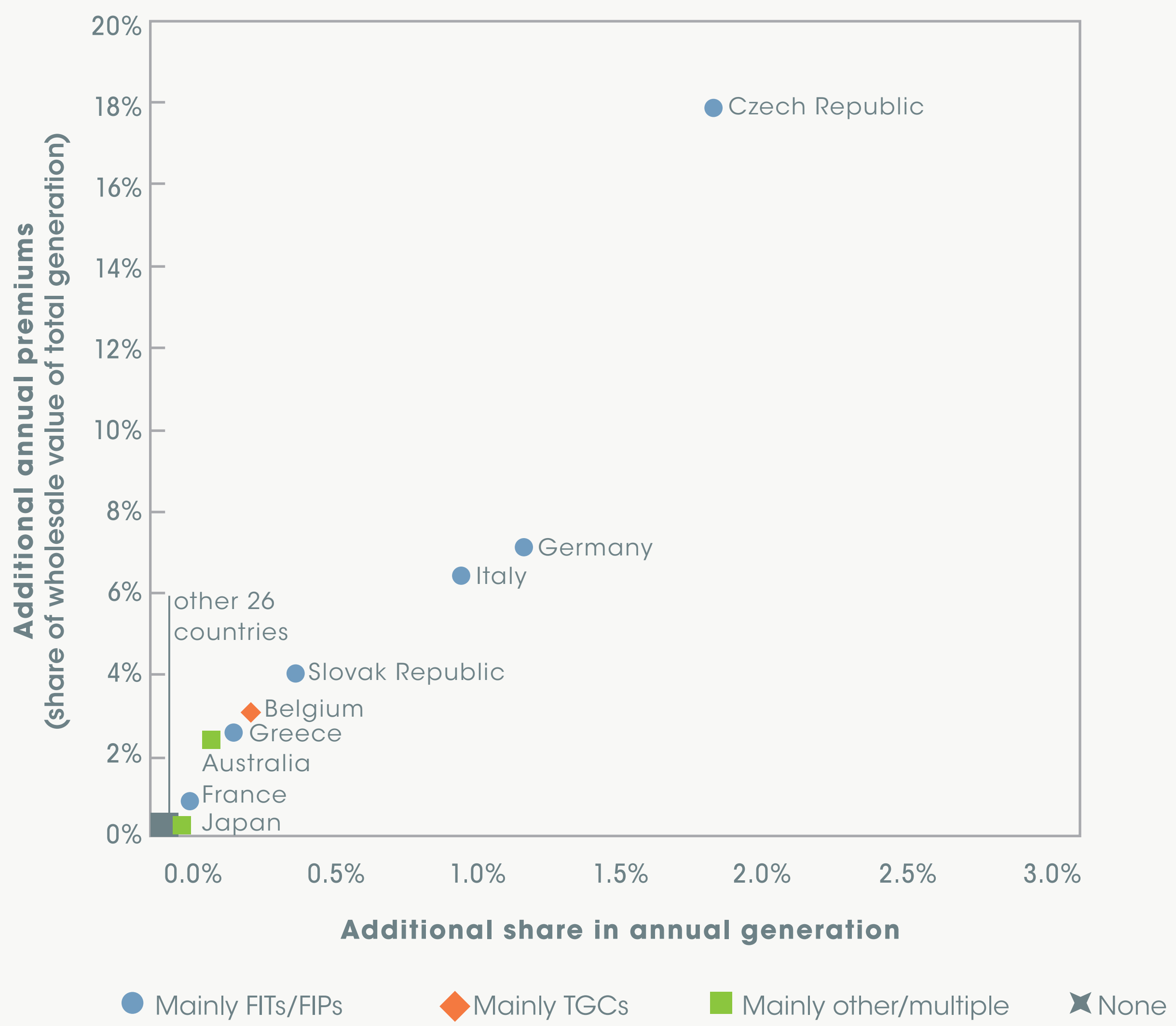
The remuneration indicators have both significant data requirements and are subject to commonly acknowledged weaknesses of NPV assumptions, such as projections of future electricity prices and the selection of discount rates. Attempts have been made to mitigate the effects of resource endowment and to identify both inadequate and windfall profits, being two key factors influencing revenue efficiency in EU and OECD contexts. However, there are other influences which the indicators do not account for, and which may be particularly significant in lower income countries, *e.g.* difficulties in revenue collection and energy theft; transmission and distribution limitations, affecting the delivery of electricity to customers. These, and wider political and economic uncertainties, increase the risk to foreign investors of RET in lower income countries, necessitating a higher projected ROI. As for other indicators that evaluate policy by comparison with other countries, it is therefore important that revenues be compared between peer countries. It may also be necessary to model several sets of 'reasonable' comparative RAI values, reflecting the differing circumstances of developing, emerging and developed economies. However, as discussed above, this may not be a necessary step for useful policy evaluations to be conducted.

The issue of how revenues and profits are funded is not addressed by the revenue indicators, but this can have feedback effects on revenue adequacy. Some consumers may be limited in their ability to pay for energy services, so are more likely to default on bills if prices are set too high, reducing revenue streams. Consumers may not only be affected by direct costs, but also indirect policy impacts, for example redirection of official development assistance from other programmes to finance RETs. This is associated with the evaluation of equity, discussed in section 4.

TOTAL COSTS INDICATOR

The Total Costs indicator (TCI) has been developed by the IEA (2011) in response to increasing renewable energy penetration rates and the associated increasing magnitude of support costs. It is intended to address the difficulties of comparing premiums between different electricity market structures. The indicator

Figure 8: Total Cost indicator for solar PV in major markets, 2010. Source: IEA (2011).



Note: Only countries with sufficiently high deployment levels are shown.

provides a graphical comparison of the full cost of premium payments (measured as a percentage of the total wholesale value of generation) with the amount of additional electricity generation that they incentivise (as a percentage of total generation per annum). Figure 8 illustrates the TCI for solar PV in 2010.

The TCI highlights the burden of support costs where policies lead to very rapid growth in RET deployment, as experienced for solar PV in Spain in 2008 and the Czech Republic in 2011 (IEA, 2011). Such booms may cause particular problems for lower income countries with limited public resources. The impact on public spending (or consumer bills) can be controlled by capping the total support available to a policy (and generation eligible for support) or by allocating support through tenders, the volume of deployment being specified in the tender. Policies without explicit controls need to be carefully designed to avoid the potential windfall profits that encourage sudden, unsustainable increases in generation capacity. What constitutes 'windfall profits' in contrast to efficient profit levels is, of course, open to interpretation.

The TCI does not account for the reduction in wholesale prices that can occur as zero marginal cost renewable energy penetration increases (merit order effect), which can be substantial and can partially offset the cost of an intervention to consumers (IEA, 2011). Detailed discussion of this issue is beyond the scope of this paper but is discussed in the UK context by the authors elsewhere (Steggals, Gross and Heptonstall, 2010).

3.3 DYNAMIC EFFICIENCY

As noted above, "dynamic efficiency adds a future time dimension by including how much innovation is triggered to improve the ratio of outcomes to inputs" (Mitchell, *et al.*, 2011 in IRENA, 2012a).

There is an extensive literature on technological innovation and cost reduction over time and through market growth (IEA, 2000; UKERC, 2010; ICEPT, 2012; Candelise, Winskel and Gross, 2013). Stimulating markets to precipitate cost reductions is a key rationale for renewable energy policies (IEA, 2000)[9]. Assessments of cost reduction potential can be based upon so called learning curves (or experience curves) or engineering assessment and parametric modelling. Learning curves chart the level of 'experience' in using a technology (using as its proxy a cumulative measure of production or use), against changes in cost and/or price (Candelise, 2009). They can be used to assess the extent of 'learning investments' required for technological improvements, which are expected to reduce unit cost (see for example, IEA, 2000). Assessments such as this could be utilised to assess dynamic efficiency, for example in comparing expected learning investments with out-turns, or anticipated and actual cost reductions. However, the literature review did not reveal any explicit attempt to formulate a short-hand indicator of dynamic efficiency or to link policy efficiency evaluation to learning/cost reduction outcomes.

The literature also discusses the relationship between intervention design and market structure, for example the extent to which feed-in tariffs (FITs) encourage new entrants (IEA, 2011). Pablo (2012) maintains that dynamic efficiency needs to be understood as a multifaceted concept consisting of numerous variables, including: competition, technological innovation, technological diversity, learning effects and private research, development and deployment. However, the literature review did not reveal any explicit link to policy assessment indicators for these.

The Policy Brief proposes that dynamic efficiency can be tracked using a time series of static efficiency evaluations, employing indicators such as those previously discussed. Analysis using technology learning curves and data on market expansion can be used to estimate the volume of 'learning investment' needed to reduce costs to given level (for example to bring costs down to so called 'grid parity', where subsidies are no longer needed) (IEA, 2000). For example, FIT levels for residential solar PV could be tracked until the FIT is equal to domestic tariff levels. In principle it would be possible to compare ex-ante estimates of expected 'learning investments' and anticipated cost reductions with out-turns, and hence assess the extent to which policies delivered against a dynamic objective (cost reduction through time). However, the review did not reveal any explicit attempt to link learning curve analysis to policy effectiveness or efficiency evaluation in this way.

[9] *UKERC has a forthcoming report on sources of cost reduction in energy technologies and methodologies for assessing their future prospects: www.ukerc.ac.uk/support/tiki-index.php?page_ref_id=2863.*

It is important to note that short-run cost effectiveness and longer term factors can be in tension. For example, more expensive technologies may be supported in preference to cheaper alternatives because of expected cost reductions over the longer term. This tension raises the question as to which of the two is more important for policy evaluation in lower income countries. This question is beyond the scope of this paper, and will vary between countries depending on national context and priorities.

3.4 EFFICIENCY CONCLUSIONS

Like effectiveness, the efficiency indicators identified through the literature review were developed by EU research collaborations (Held, *et al.*, 2010) and the IEA (IEA, 2008 and 2011) primarily for a developed country context. These are solely focussed on static efficiency: how cost reflective remuneration schemes are, in terms of the degree to which premium payments align with estimates of generation costs. The following indicators were identified for static efficiency:

- » Remuneration Level/Adequacy indicators, these combine payment levels with estimates of levelised costs, allowing the extent to which support levels are cost reflective to be assessed and compared.
- » Total Costs indicator, a measure of the full cost of premium payments against the amount of additional electricity generation that they incentivise.

The review identified no simple indicators for dynamic efficiency, which requires detailed analysis. However, there is scope to use static efficiency indicators in a time series to assess changes in the ratio of inputs to outputs. It is important to note that the relationship between short-term static efficiency and longer term dynamic efficiency can be in tension.

Table 2: Summary of efficiency indicators

INDICATOR	COMMENTS
Cost of installed capacity (USD/MW)	Simplest indicator to employ: very low data requirements. Does not capture operational costs.
Cost of generation (USD/MWh)	Low data requirements. Captures operational costs.
Remuneration Level indicator	Remuneration level indicator is annualised NPV of total remuneration (wholesale electricity prices + incentives), for international comparison. Considered fairer than comparing incentives alone data is not available for generation costs (which affect level of incentive required). Most appropriate for comparison with peer countries. Assumptions necessary for NPV calculations influence results.
Potential Profits indicator	Measures difference between remuneration levels and generation costs, for international comparison. Most appropriate for comparison with peer countries. Considerable data requirements.
Remuneration Adequacy indicator	Extension of remuneration level indicator to take account of load factor. Compares remuneration received with pre-modelled 'reasonable' ranges. Considerable data requirements.
Total Costs indicator	Compares full cost of premium payments (measured as a percentage of the total wholesale value of generation) with the amount of additional electricity generation that they incentivise (as a percentage of total generation per annum). Highlights burden of support costs where policies lead to rapid growth in RET deployment. Does not account for reduction in wholesale prices as penetration increases. Considerable data requirements.

4. Equity

4.1 IRENA POLICY BRIEF DEFINITION AND CHARACTERISATION OF THE LITERATURE

The Policy Brief defines equity as "the incidence and distributional consequences of a policy, including dimensions such as fairness, justice and respect for the rights of indigenous peoples", following Mitchell, *et al*. (2011) in IRENA (2012a). It notes that a policy's equity may be evaluated in terms of the distribution of impacts across different groups, or the fairness of its design and the extent to which different stakeholders may participate in its development. The same division is used to categorise equity evaluations in this section.

The literature on equity is wide ranging and diverse. Considerable attention is paid to impacts according to income distribution in developed countries (often referred to as 'fuel poverty'). There is substantial literature with a developing country focus, but it tends to avoid discussing renewable energy policy per se. Instead, the focus is upon wider energy subsidies (and possible removal thereof), and on increasing access to modern energy services. A substantial body of literature analyses the equity of RETs in the context of global greenhouse gas (GHG) emissions reductions, with discussion focussing on the 'fair' distribution of mitigation and adaptation costs internationally and intergenerationally (Shukla, 1999; Konidari and Dimitrios, 2007; Fischer and Morgenstern, 2008).

Interpretations of equity vary considerably across the energy policy literature, with many being less inclusive than the broad definition proposed above. Two key contentions are the groups of stakeholders for whom equity impacts are considered and the threshold of equity that is being targeted. The definition adopted for an evaluation may determine whether a policy is judged to be equitable, therefore it is important to understand the different perspectives if equity is to be judged in different international contexts.

The stakeholder groups considered in evaluations vary according to the underlying drivers of the policy and the interests of the evaluating agent. Social, sectoral, intergenerational and international groupings of stakeholders are commonly considered (Jacobson, Milman and Kammen, 2005; Bazilian, *et al.*, 2010; Macintosh and Wilkinson, 2010; Sovacool, 2010; DECC, 2011). Arguably social and commercial/industrial equity are the most pertinent to the national RET policies that are the focus of this paper (Konidari and Dimitrios, 2007). However, as stated earlier, a substantial body of literature analyses the equity of RETs in the context of GHG emissions reductions. The factors influencing equity in this context are much wider reaching than those directly associated with renewable energy deployment, but they may be worth consideration given the role of climate change as a driver for RETs.

The diversity of interpretations of equity makes it difficult to conceive a distribution system for RET costs and benefits that might be widely viewed as acceptable. It is therefore difficult to comparatively evaluate the equity of policies applied in countries using different distributional criteria. This presents real challenges for the development of short-hand equity indicators to be used internationally, as arguably, indicators for the evaluation of domestic policy should reflect the concept of equity as understood by the policy's stakeholders and implied by the policy's objectives. These may not necessarily correspond to definitions applied in other regions or contexts; for example, whilst GHG emissions reductions are a priority issue in many OECD countries, countries with large welfare disparities may give more weight to local distributional and development impacts (Sterner, 2003).

4.2 THE DISTRIBUTION OF POLICY IMPACTS

The relative advantages of renewable technologies over thermal generation are highly dependent on local conditions. In areas with particularly favourable renewable energy resources, RETs can provide a lower levelised cost of generation than fossil fuels. In remote locations they can facilitate human development, offering a means of generation where conventional technologies would not be commercially viable. However, in many situations the cost of generation from RETs is greater than that from fossil fuel plants. It is anticipated that these costs will fall over time, but until RETs reach parity with conventional technologies the questions of how and by whom the additional expense should be funded are likely to remain contentious – and a key issue in evaluations of equity.

Verbruggen and Lauber (2012) and Moss, *et al*. (2011) have considered core issues that should be addressed by evaluations of equity impacts in renewable energy and climate change mitigation policies. In combination, the primary issues identified are: the polluter pays principle, the allocation of revenues and expenditures, the incidence and allocation of windfall profits, the ability to pay of different stakeholders and the beneficiary account (actors that have profited most from GHG pollution should contribute most to mitigation efforts). These are recurrent themes in the evaluations of policy equity impacts consulted for the systematic review. For example:

- Renewable energy quotas (trading schemes such as the UK Renewables Obligation) are largely viewed as less equitable than FITs for those looking to invest in the renewable electricity generating industry. Being complex in operation, they are less favourable to small companies and new entrants and may be associated with persistent windfall profits that usually accrue to incumbent power companies or other well-established industrial actors. They may also have higher regulatory and administrative costs than FITs (Farrell, 2009; Batlle, Pérez-Arriaga and Zambrano-Barragán, 2011; Mitchell, *et al.,* 2011; Verbruggen and Lauber, 2012).

- Policies funded through consumer bills (rather than income taxes) are viewed as regressive in countries where it is the poor that spend the highest percentage of their income on energy – and so are disproportionately burdened. The effect is worsened when consumer bills are used to finance policies, whose benefits accrue primarily to richer households, such as energy efficiency measures funded by charges on gas and electric bill (Owen, 2008; Lensink, 2009).

Evaluations of renewable energy policies commonly refer to such issues when discussing equity. However, few documents have been identified that refer to the specific indicators or methods by which judgements have been made, and those that do are concerned primarily with the distribution of benefits amongst consumers (Owen, 2008; Bacon and Kojima, 2010; Bazilian, *et al*., 2010; Macintosh and Wilkinson, 2010; Moss, *et al*., 2011; Nussbaumer, *et al*., 2011). These are therefore the focus of the discussion that follows, which will in turn consider changes to energy consumption and expenditure, the targeting of consumer subsidies, and energy access metrics. The absence of wider aspects – such as the distribution of costs, impacts on producers and other players, and the remaining issues noted above – does not imply that they are any less important in equity evaluations; it simply reflects the lack of methodological discussion in the literature. A study of the indicators and methods employed to evaluate such aspects would necessitate consultation with the actors conducting the evaluations, as the review did not reveal a robust literature to draw from.

CHANGES TO ENERGY CONSUMPTION AND EXPENDITURE

One means of assessing the equity of policy impact distribution is to compare the relative importance of policy-induced changes to energy consumption and expenditure across different social or income groups. These data are most readily available as absolute values, which can be used either to track progress longitudinally or to compare a policy's impacts against specific equity benchmarks (such as those used for energy access - see below) (Bacon and Kojima, 2010). However, measuring changes can be difficult where renewable technology deployment represents the introduction of modern energy services, since equity analyses of expenditure changes should consider the fuels they are replacing. This may require the valuation of non-purchased energy (*e.g.* firewood) and associated non-monetary costs (*e.g.* time spent collecting fuel, health impacts). Indirect impacts can also be difficult to identify and quantify, although they have the potential to be as, if not more, significant than direct ones. Policies supporting RETs may affect costs in other areas of the energy system, requiring upgrades to existing transmission and distribution grids or measures to manage intermittent generation that may be funded through different structures (Owen, 2008). Taxes or subsidies applied to major energy supplies can have knock-on effects on energy prices across the market, which may or may not support the ultimate goals of the policy.

The usefulness of absolute values is limited by the fact that they express little about the perceived worth of a unit of energy to individual households and so the fairness of the changes observed. Two approaches that offer more insight are the measurement of energy expenditure as a percentage of household income, and the application of welfare weightings to energy expenditure. Both emphasise the significance of energy costs to the poor, who are the primary group of concern in most equity evaluations. Both approaches are discussed below.

Expressing energy expenditure as a percentage of household income can demonstrate its relative importance across different social groups and in comparison to other commodities. This can inform the appraisal of taxes or subsidies, potentially allowing interventions to be redirected. For example, a survey of household spending on energy, food and transport across Asian and African countries found that the greatest impacts of fuel prices on poor households were felt through food prices (the indirect costs of transport and distribution) (Bacon and Kojima, 2010). The authors concluded that in the countries studied, funds currently used to subsidise fuel would be more equitably distributed through cash hand-outs for food, because the very poor rely upon traditional fuels, have low levels of service and hence spend a small fraction of their income on fossil fuels and electricity compared to wealthier groups (who benefit most directly from fuel subsidies). Collecting the data required for such analyses, estimating the effects of potential interventions on proportional household expenditure and interpreting the implications of these with regard to equity are not, however, simple tasks. In lower income countries in particular, data on income levels may be hard to obtain, and whilst household expenditure can be used as a proxy it is not necessarily accurate, being affected by activities such as saving-up for long-lasting or expensive goods (*ibid.*).

Welfare weightings offer a more sophisticated means of modelling the relative importance of energy to different social groups, recognising that the marginal demand for, and utility of, a unit of currency (or energy) diminishes with increasing per capita income (Sezer, 2006; Owen, 2008). The effect of consumer preferences may be accounted for by modelling the elasticity of demand or marginal utility (sometimes termed the 'inequity aversion parameter') in the weighting estimation. A downside of weightings, however, is that they are complex to calculate, requiring significant expertise and data. Further, there is little agreement amongst economists regarding the suitability of different methods for estimating either the weightings themselves or the elasticity of the variables that inform them. Different methods for the former are reviewed by Sezer (2006) and Cowell and Gardiner (1999) whilst Evans, Kula and Sezer (2005) critique approaches to assessing the elasticity of marginal utility. It is important that both the method and assumptions employed are reflective of the evaluating agent's understanding of equity and the real socio-economic conditions of the population, since these can dramatically affect the result obtained. Two comparative evaluations of electricity sector reform in the Philippines by Toba (2003) produced significantly different conclusions with regard to equity, due to the use of different weighting sets, even though both appeared justified.

Cowell and Gardiner (1999) suggest that short-hand welfare weightings for democracies with an effective tax regime could be based on income tax schedules: such schedules should (in theory) be closely linked to income distribution and considered broadly socially acceptable by the electorate; and the method reduces the demand on data requirements and expertise to select an appropriate calculation methodology. Of course, such an approach would be inappropriate for nations where taxes do not reflect income level or are very light, or where the tax regime is poorly enforced – an issue in many lower income countries.

Whatever the methods selected to measure impacts on energy consumption and/or expenditure, it should be remembered that the observed changes (and any associated implications for equity) may not necessarily be the result of the policy under investigation. Consumer preferences and behaviours are obviously decisive factors, and may be hard to predict for interventions that significantly upgrade the availability and accessibility of energy services (Bacon and Kojima, 2010; Moss, *et al.*, 2011).

THE TARGETING OF CONSUMER SUBSIDIES

Another approach to policy equity considered by the literature is how effectively subsidy is targeted to the poor. This offers insights, since evaluating subsidies that protect consumers from increased energy prices (caused by renewables) is analogous to evaluating subsidies to the poor, because the poor are disproportionately affected by energy price increases. Further, in some situations there may be potential to redirect such subsidies; rather than just supporting the poorest, they could encourage RETs.

Bacon and Kojima (2010) present a Benefit-Targeting Indicator, which can be used to formally calculate how well-targeted an intervention is at its intended recipients. The author employs the indicator to investigate the suitability of consumption subsidies on fuels in several lower income countries, but it could also be adapted and applied to support mechanisms for renewable power. The indicator is defined as 'the ratio of the share of total benefits received by poor households to the proportion of households that are poor' (*ibid.*). Interventions are considered to be progressive if the indicator's value is greater than 1 (poor households receive a greater share of the benefits than their proportion in the population), neutral if it is equal to 1 (poor households receive benefits proportional to their numbers), and regressive if it is less than 1 (non-poor households receive a relatively greater share of the benefits). The indicator (Ω) is calculated as follows:

$$\Omega = (A_p / A_n) \times (U_p / U_n) \times (T_p / T_n) \times (R_p / R_n) \times (Q_p / Q_n)$$

where

A = percentage of households that have potential access to the energy source

U = percentage of households with access that are connected to the energy source

T = share of households that are connected that are eligible for the subsidy

R = average rate of subsidisation for eligible households

Q = average quantity consumed by subsidy recipients

p = group of poor households

n = group of all households (*ibid.*).

An alternative means of assessing the targeting of subsidies is utilised by Macintosh and Wilkinson (2010) in an evaluation of Australia's solar PV rebate scheme. Rather than quantifying the relative level of subsidy received by low-income households, the author groups beneficiaries according to the socio-economic profile of their home postcode, using Australia's Index of Relative Socio-economic Advantage and Disadvantage (which is calculated from census data). This method recognises that income is not the only determinant of either welfare or capability to access support mechanisms, an issue which applies to lower income countries as much as industrialised ones. Although it is desirable to consider broader factors of welfare, this may be harder to realise in poorer countries, due to the limitations of data gathered systematically at the national level through census or other procedures.

Both of the studies discussed above investigate whether the policy mechanisms concerned are effective for targeting the intended beneficiary group. Clearly, this group needs to be well-defined for such evaluation to be meaningful, a concern noted by Bacon and Kojima (2010) who specify 'poor' households to be the bottom 40% with regard to income. The importance of targeting is high for interventions requiring beneficiaries to self-elect, as is the case for both tax rebates and fuel purchase. However, aside from self-generation, consumers tend to have little control over the source of their electricity – and may have little interest, given the homogeneity of the power provided. In most instances it is government authorities or private investors that choose which communities will benefit from large scale renewable energy generation, and therefore any associated subsidies; consumers control only the quantity of energy purchased. Evaluating how well-targeted policies are in such situations may measure the equity of the beneficiary selection process rather than the fairness of the intervention's design itself.

ENERGY ACCESS METRICS

The incentives to deploy renewable technologies depend in part on a country's socio-economic situation. Industrialised and emerging economies may be keen to decarbonise their energy system or to improve energy security. Least Developed Countries, whilst sharing such motivations, are likely to be more concerned with improving human development, which involves increasing rates of energy access. Many Least Developed Countries have deployed RETs as a cost-effective means of electrifying parts of their territory; in such situations equity indicators developed for energy access can be a suitable means of assessing the equity of RET policy.

The literature on metrics for energy access is extensive; Bazilian, *et al.* (2010) and Nussbaumer, *et al.* (2011) provide detailed overviews. Approaches can be broadly split into two groups, discussed below: those that track developments in access according to quantitative indicators, and those that compare the provision of energy services against subjective qualitative development standards.

QUANTITATIVE INDICATORS

Many different quantitative approaches for evaluating equity in energy access have been developed (Bazilian, *et al.*, 2010; Moss, *et al.*, 2011; Nussbaumer, *et al.*, 2011). Two prominent ones are the International Atomic Energy Agency's Energy Indicators for Sustainable Development (EISD) and the IEA's Energy Development Index (EDI) (Vera and Lucille, 2007; IEA, 2013). Both track progress across similar indicators including: the share of the population with access to electricity; energy consumption or expenditure (by household or per capita); and fuel mix in the residential sector. The EISD also notes differences in these indicators across income groups. Either set of indicators could be used longitudinally to track the contribution of a RET deployment policy towards energy access rates within a country. Composite indicators do, however, suffer drawbacks, notably that important insights (captured by singular indicators) can be lost at the expense of having a simple means to rank countries.

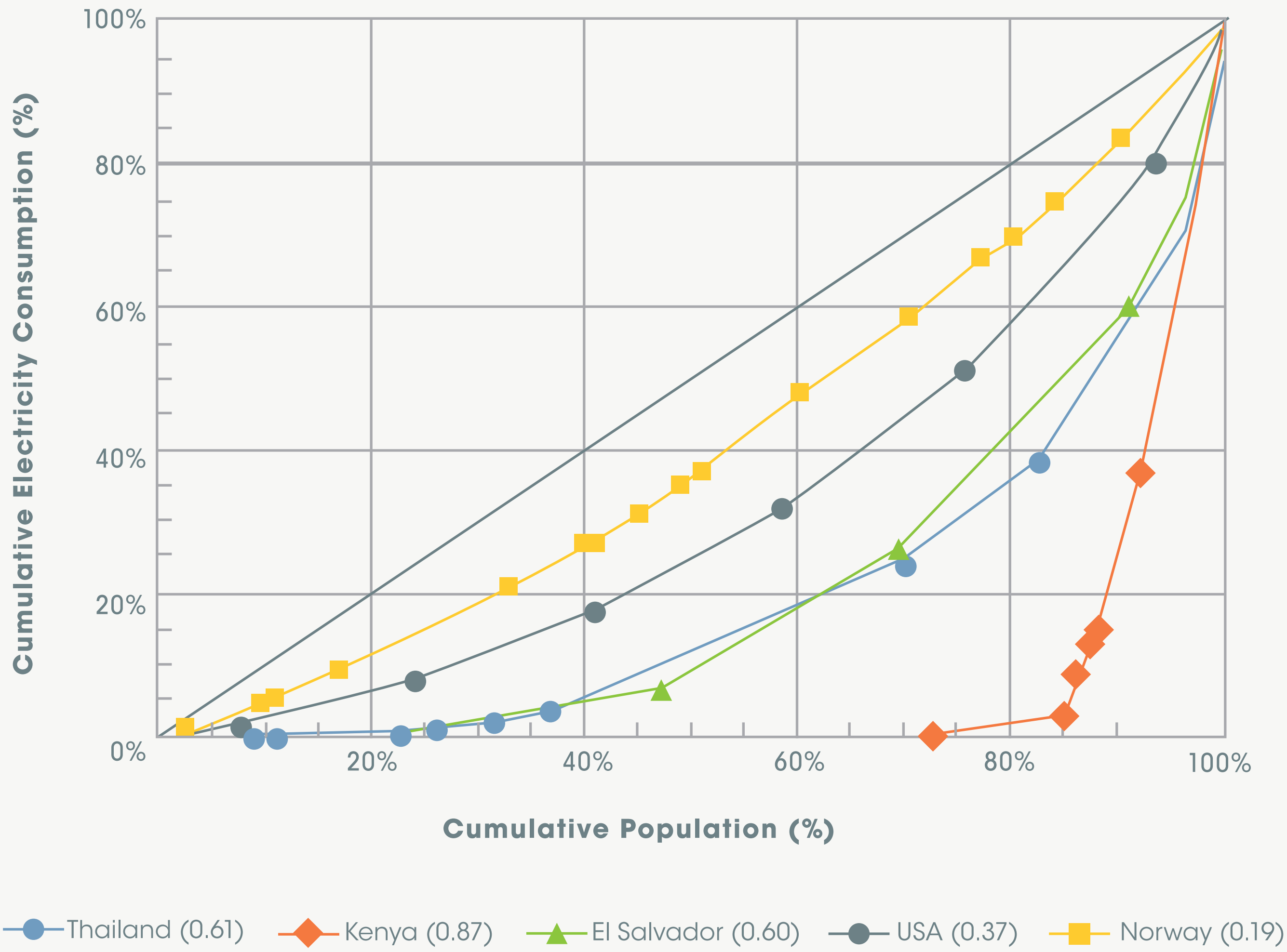
Lorenz curves offer a graphical means of representing the inequity of quantitative datasets such as those investigated by the EISD and the EDI. Although they are rarely applied to energy analysis, Jacobson, Milman and Kammen (2005) have used Lorenz curves to compare energy equity across different countries (Figure 9). The same approach could equally be used longitudinally to track progress within a single nation. The curves plot cumulative electricity consumption against cumulative population, whilst the associated Gini coefficient is a numerical measure of the inequity of the distribution; specifically, half the expected difference in electricity consumption between any two randomly chosen members of the population, expressed as a percentage of the average consumption (Borooah, 2013).

QUALITATIVE DEVELOPMENT STANDARDS

An alternative approach to measuring the equity of energy access is to measure access against subjective, qualitative standards. Two such methods are proposed by the Oxford Poverty and Human Development Initiative (the Multi-dimensional Energy Poverty Index, MEPI) and Practical Action (the standards for Total Energy Access, TEA) (Nussbaumer, *et al.*, 2011; Practical Action, 2012). These specify thresholds of energy service provision deemed necessary for households to escape energy poverty or deprivation. Both the MEPI and the TEA include indicators that set minimum household standards for lighting, refrigeration, information, communication and cooking, for example the number of lumen-hours of lighting available per day or having access to a functioning fridge. These indicator sets may be considered more meaningful measures of equity in energy access than the EDI and the EISD, because they focus on energy services delivered rather than energy consumed. This recognises that willingness to pay and energy requirements to meet the same basic goals will differ between communities, according to factors such as geographical location, personal circumstances, etc. (Moss, *et al.*, 2011). However, since they do not detail the extent to which individuals are failing or exceeding the poverty threshold, they may be of limited use for evaluating the equity of wider renewable energy deployment policies which are not solely focussed on minimising the number of households considered to be energy deprived. The focus of the standards on services provided by household appliances further limits their relevance, since poor households are likely to experience a considerable delay between the introduction of an (renewable) electricity connection and the purchase of expensive electricity-consuming devices.

Practical Action has also developed an Energy Supply Index (ESI), a grading scale for the quality of electrical, fuel, and mechanical energy supplies received by households (Practical Action, 2012). This may be more pertinent for analysing the equity of RET deployment, for which quality issues such as generation intermittency are frequently raised by stakeholders and are often ill-understood. Regarding equity of energy access, RET systems should be deployed with provision to minimise any deficiency in the quality of service delivered as compared with that which would otherwise be provided by more conventional generation technologies.

Figure 9: Lorenz curves for residential electricity in five countries.



Note: The greater the distance of a curve from the 45° diagonal (representing a perfectly even distribution of energy consumption), the greater the inequality of energy consumption across its population. The Gini coefficients for residential electricity consumption are presented in the legend of the graph in parentheses. Source: Jacobson, Milman and Kammen (2005).

4.3 STAKEHOLDER PARTICIPATION IN DECISION-MAKING PROCESSES

Stakeholder participation in environmental decision-making processes is internationally recognised as a public right by the Rio Declaration on Environment and Development and the Aarhus Convention (UNCED, 1992; UNECE, 1998). The impact of participation processes is commonly measured using scales such as Arnstein's ladder, which grade the real extent of influence that participants have over the decision-making process (Videira, *et al.*, 2006; Reed, 2008). Such scales note that not all stakeholder consultation processes are effective or sufficiently inclusive. Regarding equity, there are concerns that deprived communities are generally poorly represented in policy development processes, having little access to high-level social and political power, and lacking the internal capacity to otherwise influence policy development processes. This is a particular concern since the most deprived communities may also be the most marginalised by authorities, and thus subjected to a disproportionate share of a policy's risks (Ikeme, 2003). Explicit representation of all stakeholder groups in decision making processes is therefore considered an important means of promoting the interests of different groups (*ibid.*). Several authors have suggested that its social benefits may be self-reinforcing: growing social capital and enhancing the ability of communities to collaboratively address their problems reduces the risk of them being marginalised in the future (Videira, *et al.*, 2006).

Taking account of stakeholder preferences not only improves the perceived equity of a policy, but it can also reduce implementation costs, by promoting stakeholder ownership and support (Reed, 2008). A study by Higgs, *et al.* (2008) combines multi-criteria analysis (MCA) with Geographical Information Systems (GIS), mapping social concerns alongside technical factors to select wind farm sites that are both technically viable and unlikely to be faced with serious opposition from the local community. Understanding and respecting differences in local attitudes can help to minimise the costs associated with lengthy, disputed planning applications. The value of incorporating stakeholder preferences is not limited to the local level. A study by Mendonca, Lacey and Hvelplund (2009) suggests that the successful promotion of renewable energy in Denmark has consistently coincided with, and been influenced by, periods when participative political processes have been prioritised.

Stakeholder participation processes are not generally used to evaluate the equity of a policy, but rather to increase the equity of the policy development and implementation process itself, allowing different perspectives to be considered and incorporated. Evaluating the equity of the consultation process and the consequent representation of these views in policy development is a qualitative exercise. There is little discussion of such evaluation in renewable energy literature, and consultation of wider literature has not identified any specific indicators for this. However, several authors have noted potential equity pitfalls of consultation exercises, notably: lack of genuine consideration of stakeholders' views by policy makers (due to poor timing of exercise or policy maker disinterest); exclusion of affected parties; inaccessible participation methods (being either overly formal, technical, insensitive to social dynamics or insufficiently publicised); consultation fatigue arising from overexposure to ineffective participation processes (Mabiza, *et al.*, 2006; Videira, *et al.*, 2006; Reed, 2008). These could be used to develop indicators of success for stakeholder participation exercises and their ability to promote equitable decision-making.

4.4 EQUITY CONCLUSIONS

The literature on equity is predominantly concerned with distribution of policy impacts. The review highlighted several general principles that commonly underpin renewable policy evaluations, but specific indicators were only identified for consumer impacts. Beyond these, the wider principles identified are: the polluter pays principle, the allocation of revenues and expenditures, the incidence and allocation of windfall profits, the ability to pay of different stakeholders and the beneficiary account.

Indicators for consumer impacts fall into three broad groups:

- Changes to energy consumption or expenditure can be measured most simply as absolute values, however the usefulness of these is limited since they do not differentiate the value of energy services to different social groups. Measurements expressed as a percentage of household income or adjusted with welfare weighting offer greater insights, but can be difficult to deploy in lower income country contexts due to the extent of data and expertise required.
- The targeting of consumer subsidies can be assessed by comparing the proportion of benefits accruing to the target group with the prominence of that group in the general population.
- Energy access metrics receive extensive coverage in the literature, and are relevant to renewable energy deployment in countries in the process of electrification. Progress may be tracked using quantitative indicators (*e.g.* the share of households with an electricity connection or per capita consumption), with Lorenz curves and Gini coefficients employed to quantify the inequity of impact distribution. Qualitative metrics compare

the provision of energy services against subjective standards, measuring whether provision surpasses the deemed threshold for energy deprivation, or grading the quality of the energy supply. The former has limited use for evaluating renewable energy deployment, being unconcerned with impacts beyond thresholds and heavily reliant on the presence of domestic appliances; the latter is more pertinent, taking account of relevant supply quality issues such as intermittency.

Besides distributional impacts, equity may be interpreted based on the potential for stakeholders to participate in policy development. Such participation cannot only improve the perceived equity of a policy, but can also reduce implementation costs, by allowing potential difficulties to be identified and mitigated. There is a general lack of literature that evaluates the equity of consultation processes for renewable energy deployment, and no such indicators were identified. However, there is literature that evaluates participation exercises across wider policy areas; the common pitfalls identified by this could form the basis of indicators.

Definitions of equity for energy policy evaluation vary considerably between authors and can be decisive in whether a policy is judged to be equitable. This presents difficulties for the development of internationally-acceptable short-hand indicators. For the purpose of evaluating renewable energy deployment on a national basis, evaluations should reflect the concept of equity as understood by the policy's stakeholders and the local drivers for renewable energy deployment. For many lower income countries this may mean focussing on socio-economic development rather than climate change mitigation impacts. Whatever the definition and approach adopted, there is a need for a transparent explanation of the rationale and its suitability for the country concerned.

5. Institutional feasibility

5.1 IRENA POLICY BRIEF DEFINITION AND CHARACTERISATION OF THE LITERATURE

Institutional feasibility is defined in the Policy Brief as "the extent to which a policy or policy instrument is seen as legitimate, able to gain acceptance and able to be adopted and implemented" (Mitchell, *et al.*, 2011 in IRENA, 2012a). As noted in the Policy Brief, this is not just dependent on the specifics of the policy under consideration, but is very much a factor of the administrative, economic and political environment in which the policy will function (IRENA, 2012a).

The review revealed that theoretical discussion of institutional feasibility evaluation is particularly lacking within the field of renewable energy policy. Only two documents offering a detailed discussion of assessment methods were identified (Konidari and Dimitrios, 2007). Other documents simply present an overview of possible approaches or indicators (CIF, 2009; Mitchell, *et al.*, 2011; IRENA, 2012a), or examine the findings of institutional feasibility assessments without explaining their methodology in detail (RCREEE, 2010; Haas, *et al.*, 2011; PwC, 2011). The scope of the review was therefore expanded to consider institutional feasibility evaluation in other policy areas, to provide a broader survey of possible evaluation options. Most of this literature considered evaluation in an OECD country context. Some higher-level studies considered the importance of institutional feasibility to successful policy implementation and its role in policy evaluation.

In contrast to the other criteria, the literature for institutional feasibility did not discuss particular 'core' indicators with associated, specific assessment methods. Instead it focussed on general methods suitable for evaluating numerous indicators simultaneously. This is reflected in the structure of this chapter.

5.2 INDICATORS

The systematic review identified a large number of qualitative indicators that are used in evaluations of institutional feasibility. Such indicators are, however, incapable of estimating the institutional feasibility of a policy in isolation. Rather they are used in sets to create a multifaceted understanding of the institutional environment and its interactions with policy. A selection of individual indicators is presented in Table 3. These are drawn from various indicator sets and grouped according to the specific institutional issues that they are intended to represent. The table is not an exhaustive list of indicators, nor is it suggested that an evaluation of institutional feasibility should address all of these indicators; rather it highlights the diversity of issues considered pertinent to institutional feasibility by different authors. The specific set of indicators selected for any given evaluation has been noted to vary significantly according to the objectives of the evaluation, the resources available to conduct it, the nature of the policy under review and any preconceptions of the institutional environment.

Four schemes to categorise indicators within sets were identified by the systematic review:

- **Political viability and organisational capacity** Indicators are divided according to whether they represent the political viability of a policy (*i.e.* its public acceptability and the issues that influence this) or the potential organisational capacity available to implement and enforce it (Holt, Subedi and Garforth, 2002; Solomon and Hughey, 2007; Karol and Domnanvitch, 2010; Mawhood, 2012; Richter, 2012).

- **Endogenous and exogenous** Indicators are divided according to whether they are endogenous to the policy (relating to its complexity, *e.g.* indicators of transparency and predictability) or exogenous to it (the conditions required for the policy to perform well) (Verbruggen and Lauber, 2012).

- **Rules, governance structures, characteristics of actors and characteristics of transactions** Indicators are divided according to whether they represent 'rules' (such as incentives and legislation, both informal and formal); governance structures (their existence, appropriateness of design and functional capacity); actors' characteristics (beliefs and values, resources, skills and knowledge, including interdependencies between actors) and characteristics of transactions targeted by the policy (uncertainties, asset specificity) (Theesfeld, Schleyer and Aznar, 2010).

» **Capacity levels and observation fields** Indicators are split into numerous 'observation fields' for each of four hierarchical 'capacity levels' (namely, system, organisation, individual or network). This categorisation is used by IRENA's CaDRE methodology for capacity needs assessment (IRENA, 2012b).

These categorisations raise some interesting considerations:

» The division of indicators between political viability and organisational capacity effectively separates less immediately tangible issues (such as stakeholder motivations, beliefs, values and power relations) from more tangible factors (human capacity, time and financial resource). Both are crucial for effective policy implementation and should be tracked as deployment evolves. The political viability of a policy can change dramatically in response to domestic and international pressures[10], though this may not always be immediately obvious.

» The status of an indicator as endogenous or exogenous to a policy has important implications regarding the form of corrective actions required to address related deficiencies in institutional feasibility. However, if this is used as an overarching classification there is a risk that interdependencies between endogenous and exogenous indicators could be missed: the appropriateness of a policy's design, including its complexity, is highly dependent on the conditions in which it is operating.

» Schemes with a larger number of possible classifications such as IRENA's observation fields and the categories identified by Theesfeld, Schleyer and Aznar (2010) can form the basis of checklists regarding the breadth of areas that might be addressed by institutional feasibility evaluation.

In what follows (and also in Table 3) indicators are considered in terms of political viability and organisational capacity. This is by far the most common categorisation amongst the documents reviewed.

Since this paper has an explicit focus on potential short-hand indicators, those judged to be the simplest to assess have been marked (S) in Table 3. These are predominantly characteristics that would normally be visible in an institutionally strong environment, and which could be verified through observation or desk-based research. Such an exercise would not be expected to improve understanding of a given policy's political viability or the extent of organisational capacity, but it could help to gauge the necessity for more detailed investigation, and thus could be valuable for bodies facing difficult decisions about how best to allocate limited resources for policy assessment. It should not however be viewed as a replacement for more thorough evaluation if there is suspicion that existing institutional feasibility needs to be improved. Methodological options for conducting a more thorough evaluation are discussed in the following section.

5.3 METHODS

Most authors take a qualitative approach to institutional feasibility assessment, which contrasts with the generally quantitative approach taken to some of the other criteria. One reason institutional feasibility tends to be evaluated qualitatively is that the criterion does not measure success, rather it helps to explain a policy's potential to succeed or the reasons behind its success or failure. For example, neither an understanding of whether an agency's human capital is sufficient to implement a policy, nor the real governmental motivation for legislating it, will indicate *whether* a policy achieved its objectives. However, both could help to explain *why* the eventual outcome occurred.

Qualitative methods are well-suited to institutional feasibility analysis because they allow detailed investigation of complex situations, taking account of multiple perspectives to contextualise process deployment, events

[10] *As an example, FITs were widely opposed by groups with neoliberal economic governance structures (e.g. IEA, World Bank, Anglo-Saxon countries) before 2008, but they are now widely deployed by the same parties (Verbruggen and Lauber, 2012).*

Table 3: Some indicators used in evaluations of institutional feasibility. Those marked (S) could be used for short-hand evaluations. Sources: Holt, Subedi and Garforth (2002), Solomon and Hughey (2007), Karol (2010), Theesfeld, Schleyer and Aznar (2010), IRENA (2012b), Mawhood (2012), Richter (2012), Verbruggen (2012).

Issues addressed	Indicators
POLITICAL VIABILITY	
Issues addressed	**Indicators**
Existence of stakeholder support	» Existence of related policies, programmes, plans, strategies, laws and activities (S) » Register of stakeholders involved and their official viewpoints (S) » Policy origins: developed internally in response to local ambition, or response to pressures from external bodies
Stability of stakeholder support	» Consistency of government targets (S) » Longevity of financial and political commitments (S) » Existence of incentives for stakeholders to comply with policy (S)
Influence of stakeholder groups	» Ownership concentration of key industries » Power and organisation of the public
Credibility of the policy	» Results achieved/anticipated according to the evaluation of other criteria
Political appropriateness and acceptability of new development	» Political system » Importance of (renewable) energy to public » Stage of the electoral cycle (S) » Rationale for deploying renewable technologies – compatibility or conflicts with other policy priorities
ORGANISATIONAL CAPACITY	
Issues addressed	**Indicators**
Resources available to staff	» Extent of workspace (S) » Provision and quality of telecommunications (S) » Access to budget (S) » Authority to act
Human capital	» Education, experience and skills of staff at different levels » Number of staff (S)
Investor interest	» Number and quality of tender applications received (S) » Proportional balance of funds from different sources (S) » Comparison of financing conditions with other policies/countries.
Quality of stakeholder communications	» Frequency of misunderstandings » Speed of communications » Trust levels
Deployment record	» Historical record of achieving targets (S) » Historical performance in compliance enforcement
INDICATORS AFFECTING BOTH POLITICAL VIABILITY AND ORGANISATIONAL CAPACITY	
Issues addressed	**Indicators**
Potential to implement policy	» Existence or creation of institutions required to perform different activities (S)
Wider perceptions of national institutional environment	» Results of externally-calculated indices from international organisations (corruption, ease-of-business, regulatory risks, etc.) (S) » Country-specific reports (by NGOs, investors, etc.) » Performance reports for other policies
Dependability of policy concept	» Existence of similar policies elsewhere (S) » Performance of similar policies in similar country contexts
Sufficiency of resources	» Comparison of resources available with estimated needs
Ownership of policy	» Clear assignation of responsibilities and ownership for implementation and enforcement » Governance level for project ownership

and experiences. However, they are time-intensive and often more sensitive to subjectivity than quantitative methods, requiring an additional level of methodological safeguards to minimise bias. Their results can also be more difficult to interpret rapidly since they do not incorporate a metric benchmark against which comparisons can be made. These difficulties can make institutional feasibility harder to evaluate than other criteria for which quantitative methods are more suitable.

The remainder of this section discusses some of the methods used to evaluate institutional feasibility in a range of policy contexts. It is not intended to be an exhaustive catalogue of all suitable methods but a summary of the options identified as being actively used for renewable energy policy evaluation by the systematic review and citation trail, as well as those found by the rapid, broader survey of the wider policy literature. The principal methods revealed by the review are: case studies, impact assessment and multi-criteria assessment. We discuss each in turn.

CASE STUDIES

Case studies involve the investigation of contemporary events in light of their contextual conditions. They are the only method suggested for institutional feasibility assessment by the Policy Brief, which notes that they can aid in the development of a policy implementation plan (IRENA, 2012a). Case studies are suitable for situations affected by a large number of variables, or where the boundaries between the event under examination and its context are blurred (Yin, 2003). Hence they are appropriate for studying the nebulous relations between endogenous and exogenous aspects of institutional feasibility, or indeed political viability and organisational capacity. The approaches employed to gather, analyse and present data will depend in part on the overall role of the case study in policy evaluation, be it to describe performance, illustrate specific strengths or weaknesses, explain causal links or explore situations with unclear outcomes. There are different varieties of case study, for example comparative (where several cases are compared along particular dimensions) or, nested (where the same issues are studied at different levels *e.g.* national, industy and project level). Case study is therefore both a flexible approach, and one that has potential to provide very detailed assessment, assuming sufficient resources are available for the analysis.

Approaches to case study are very broad. There is a lack of prescriptive methods and the requisite skill-set for the method is ill-defined, with the result that case studies are sometimes regarded as a technically-light option. This is a dangerous misconception since the value of case studies is dependent on the rigour applied to data collection and analysis processes. Equivocal evidence, bias or carelessness in the application of procedures can all detrimentally affect the quality of conclusions derived (Yin, 2003). According to Yin (2003), good case studies should demonstrate significance, completeness, consideration of alternative perspectives and sufficient evidence and should be engagingly presented. For the purpose of internal policy evaluation, it is arguable that the first of these will be automatically achieved. The importance of the last characteristic depends on the intended audience and their inherent interest in the subject. The remaining three are worthy of effort to maximise the case study's utility: a 'complete' review of institutional feasibility will consider as much of the available evidence as possible, and with full attention paid to the most critical elements; considered perspectives should include those that are in sharpest contrast to the overriding conclusions of the study; and obviously, conclusions need to be evidence-based, taking account of multiple sources, if they are to be credible.

Several case study examples that take account of institutional feasibility for energy policy deployment were identified by the literature review, however none offer a detailed discussion of the method from a theoretical perspective (Holt, Subedi and Garforth, 2002; CIF, 2009; RCREEE, 2010; Mitchell, *et al.*, 2011; PwC, 2011; Richter, 2012). It is therefore difficult to judge the suitability of the case study approaches that are currently adopted for evaluation in this policy area. Yin (2003) suggests that the absence of theoretical discussion may be because case study is often used as a subcomponent of other strategies, rather than a formal research method in itself. Case study can be a useful input for the methods described in the rest of this chapter, as well as being an effective stand-alone research strategy. Whether it is appropriate to use case study as an independent or contributory method depends on the objectives of, and the resource available for, the evaluation.

IMPACT ASSESSMENT

Impact assessment is a process for identifying the likely or actual effects of a policy, both intentional and unintentional, on the social, economic and/or environmental factors surrounding it (EDIAIS, 2001). Regarding institutional feasibility, impact assessment can shed light on issues such as whether the effects of a policy are influencing its political viability, or if the cost of administering the policy is efficient and within the capacity of the administering agency (Richter, 2012).

Approaches to impact assessment vary in complexity depending on the researcher's objectives and resources available. A simple approach geared towards identifying impacts might involve triangulation of results from a small-scale survey of beneficiaries, interviews with other stakeholders, and a rapid or participatory appraisal of the intervention. A more complex approach focussed on proving the causality of impacts could involve a large survey across a fully-representative sample of beneficiaries, repeat interviews at different stages of the policy's development, interval measurements, case studies and econometric analysis of the data collected (EDIAIS, 2001). Three specific variations of impact assessment were identified by the systematic review:

» Integrated impact assessment considers multiple factors affected by the policy, often at more than one stage of the policy's life, *e.g.* ex-ante, during implementation, and ex-post (Lee, 2006).

» Intervention analysis specifically seeks to map the causal chains between actors, inputs, outputs and outcomes of a policy intervention (Richter, 2012). This chain should include positive and negative, experienced, expected and possible (unanticipated) outcomes, over different timeframes. The intervention theory for the policy's expected implementation and functioning is used to identify the data and sources that must be consulted to verify whether the policy is performing as expected and which impacts have been detected (Mickwitz, 2003; Richter, 2012).

» A 'stakeholder approach' to impact assessment can broaden the range of effects identified (Vedung, 2009). Outcomes as perceived by stakeholders are collected and compared with those anticipated by the intervention theory. Limitations of this approach include potential bias in the stakeholders' perceptions and expression of impacts. The expected impacts generated by the intervention theory too may be affected by subjective interpretation of policy by the assessor. The approach can help to identify where stakeholder knowledge and capacity needs to be developed.

An impact assessment could be specifically focussed on institutional issues, or precedence could be given to these within a wider assessment. Several authors have specifically considered institutional feasibility in impact assessments, both for ex-ante modelling (Capello and Spairani, 2004; Takasaki, 2007) and ex-post review (Noble, 2009). Regardless of focus, the results of any impact assessment are necessarily limited by the scope of its inputs. Since institutional feasibility evaluation is most valuable in terms of explaining the reasons for performance levels, it is worthwhile undertaking a more involved approach where resources allow. In particular, care should be taken to seek out unanticipated effects (Paté-Cornell, 2002); a case study of Senegalese rural electrification policy by Mawhood (2012) suggests that at least some of the barriers encountered by the policy could have been foreseen had expert consultation processes taken a more thorough approach to impact consideration.

Impact assessment is widely used as a risk management tool across different industrial and organisational settings. Many institutions have published advice for its use in a variety of settings including step-by-step guides, for example BIS (2011), HELI (2013) and IAIA (2013). The existence of clear methodological frameworks for impact assessment, together with the availability of guidance on their deployment, may make impact assessment easier to adopt than case study for organisations that either lack expertise or confidence in conducting institutional feasibility evaluation. They can also ease the comparison of evaluations conducted for different policies or at different points in time. Although obviously focussed on the effects provoked by a policy, the structure of impact assessment is flexible enough to be adapted to different evaluation objectives or levels of resource.

MULTI-CRITERIA ANALYSIS

Multi-criteria analysis (MCA) is a tool to facilitate decision-making for problems with multiple criteria and possible solutions. It can be used to reduce arrays of complex, often conflicting, qualitative factors to simple numerical values, providing a common unit for comparison. Several authors have included institutional feasibility within MCA for environmental problems (Konidari and Dimitrios, 2007; Solomon and Hughey, 2007; Karol and Domnanvitch, 2010; Venmans, 2012), with two methodologies designed specifically for institutional feasibility evaluation, discussed in further detail below (Karol and Domnanvitch, 2010; Theesfeld, Schleyer and Aznar, 2010). Although both are concerned with ex-ante evaluation of policy risks, they are interesting examples of the different approaches that may be taken, and which could be adapted to ex-post analysis.

- A MCA specifically tailored to assess the institutional feasibility of different policy scenarios (for urban planning) is proposed by Karol and Domananovitch (2010). This follows the organisational capacity/political viability categorisation of indicators. Organisational capacity[11] is assessed through four institutional risk criteria (and associated sub-criteria), namely: interrelations (of the policy with other initiatives); resources; capacity of the implicated agents and management capacity. Political viability is evaluated in light of: '(i) actors' antagonisms and affinities … (ii) need for, likelihoods of, and possible instruments for stimulating and channelling transactions, (iii) need for modifying the composition and/or sequence of proposed strategy's components' (Karol and Domnanvitch, 2010). The method aims to identify which aspects of organisational capacity present the greatest risks for different policy elements, and the relative favour of these with different stakeholders. Combined with an understanding of political power relations, the results can highlight particular strengths and weaknesses of the policy regarding institutional feasibility and so help decision makers to identify specific aspects that could be reformed to improve its chances of success. According to the author, experiences with similar approaches have proved effective in unstable and disjointed governance situations, making the method particularly appropriate to many lower income countries.

- An innovative 'Procedure for Institutional Compatibility Assessment' (PICA) is proposed by Theesfeld, Schleyer and Aznar (2010). This is intended to assess, ex-ante, the compatibility of a policy with its institutional setting – and thus to aid in the choice between policy options. PICA is a complex, systematic process[12], designed to help policy makers to focus on the organisational and political factors most likely to influence the implementation of a policy. Policy compatibility is judged through comparison of the anticipated impact of factors with that expected in other institutional settings, *e.g.* at other geographical scales or in different regional contexts. PICA should allow analytical resources to be concentrated on the institutional factors most likely to affect a given policy-type's performance, and its exploratory framework is expected to identify influential variables that might escape consideration under a more conventional MCA process. It has performed well in a test situation, with ex-ante predictions comparing favourably with difficulties experienced. However, the complexity of the PICA process and the limited number of indicators that have been assigned to 'crucial institutional aspects' CIAs may hinder its application, particularly where technical human resources are limited. PICA does not explore the causality of incompatibilities in depth; this aspect could be worth developing if it were to be used for ex-post evaluation.

MCA's ability to generate rapidly interpretable comparisons of hard-to-measure issues such as power relations or cultural constraints is attractive, however the very premise of estimating simple numerical values for such complex factors is the subject of some dispute (Theesfeld, Schleyer and Aznar, 2010). Although MCA effectively 'grades' different solutions, the ranked output generated should be seen as an

[11] *This is labelled 'institutional feasibility' in Karol and Domnanvitch's paper, but broadly aligns with this report's definition of 'organisational capacity'.*

[12] *Theesfeld, Schleyer and Aznar (2010) explain the complexities of the PICA process. It may be summarised in four working steps:*

1. The policy options are classified to reveal their generic type. This involves classification by intervention type (regulatory/economic/voluntary), the governance structure it is acting on (hierarchy/market/self-organised networks), and whether it is expected to induce changes to property rights.

2. This classification is used to identify a set of 'crucial institutional aspects' (CIAs), considered influential in the implementation of particular policy types. The CIAs are drawn from a library of factors that has been specifically developed for PICA. As an example, the bargaining powers of trade associations is a CIA considered to influence regulatory policies intervening in markets.

3. Indicators are selected and used to measure the potential of each CIA to limit or facilitate the implementation of a policy option. E.g. membership of trade associations could be an indicator for the aforementioned 'bargaining power' CIA (assuming greater membership numbers increase the political influence of trade associations).

4. The indicator results inform the qualitative assessment of each CIA. These are aggregated to produce qualitative statements about the likely effectiveness of a policy option and the compatibility of policy options with the institutional context. This takes account of the performance of similar policies in different contexts, or different policies in similar contexts.

aid only and not a decision-making tool in itself. Users must remember that MCA is designed only to 'help (planners) to think' (Calcagno, Sainz and De Barbieri (1972) cited in Karol and Domnanvitch (2010)); expert oversight remains necessary to review the different factors and make a reasoned judgement. A revised approach to MCA that attempts to recognise and incorporate this constraint is multi-criteria mapping developed by Stirling (2013). This approach emphasises the 'opening up' of the policy process by exploring a variety of policy options and the different opinions of stakeholders in depth: 'By contrast with other social elicitation methods, multi-criteria mapping retains a central focus on the concrete implications for the relative performance of different strategic or policy options' (*ibid.*). In turn, the approach attempts to avoid focusing attention on a 'single definitive picture of option performance'.

5.4 ISSUES AFFECTING EVALUATION

INSTITUTIONAL FEASIBILITY IN POLICY EVALUATION: AN IMPORTANT BUT FREQUENTLY NEGLECTED CRITERION

Several authors have argued that institutional feasibility is the primary criterion for policy deployment (Gupta and Tirpak, 2007; Richter, 2012). Bell and Russell (2002) highlight the particular pertinence of this for lower income countries, where the extent of governmental institutional capacity may be highly deterministic of the effectiveness and efficiency of a policy. A policy will not be initiated without sufficient political support and it cannot be implemented without adequate organisational capacity. This applies irrespective of whether it is effective, efficient, equitable or replicable. However, increasing the institutional feasibility of a policy, for example by lowering its administrative costs or by garnering political support, may impact the performance of these other criteria, possibly to their detriment (Keohane, Revesz and Stavins, 1998; Nordhaus and Danish, 2005; Hey, 2010).

Despite the recognised importance of institutional feasibility, the literature suggests that understanding of political processes and the operation of institutions, and their impacts on environmental policy development and performance, is poor (Stephan and Paterson, 2012) and frequently neglected in policy evaluation[13] (Richter, 2012). Institutional conditions conducive to implementation are often assumed to exist (Theesfeld, Schleyer and Aznar, 2010; Mitchell, *et al.,* 2011), although in reality they are frequently absent. Evaluations making such assumptions are likely to result in unrealistic predictions of a policy's impacts (Richter, 2012). There is substantial empirical research that demonstrates that the anticipated and realised outcomes of environmental policy can differ significantly, and further, that incompatibility between policy design and the institutional environment is a key cause of this dissonance (Theesfeld, Schleyer and Aznar, 2010).

Thorough consideration of institutional realities is therefore fundamental for developing policies that have a reasonable chance of realising their intended impacts across the different criteria. As such, institutional feasibility may be considered a particularly important component of ex-ante, rather than ex-post, evaluation. Although this is widely recognised, relatively few experiences of assessing institutional feasibility as a policy evaluation principle seem to have been documented, and the lack of examples to replicate makes it difficult for countries with limited resources and/or expertise to incorporate institutional feasibility into their own evaluations. The development of standardised methods linking institutional feasibility with other, more common elements of policy evaluation could thus be a worthwhile exercise to facilitate its inclusion in policy evaluations; one attempt at linking aspects of institutional feasibility evaluation with effectiveness evaluation is embodied in the Electricity Market Preparedness Indicator, detailed in Box 1. Lack of resource or expertise is not, however, the only reason for which institutional conditions are misrepresented in evaluations: this can sometimes be a political choice, for example if stakeholders have an incentive to ignore particular institutional difficulties. Resolving such issues with the need to improve evaluation accuracy will be a much more complex task than developing international standards, although if widely endorsed these could increase pressure for institutional feasibility to form a staple part of policy evaluation.

[13] *The issue is not limited to evaluation. A previous working paper by UKERC on renewable energy toolkits found that very few offer practical support for the assessment or improvement of institutional capacity in lower income countries.*

Box 1

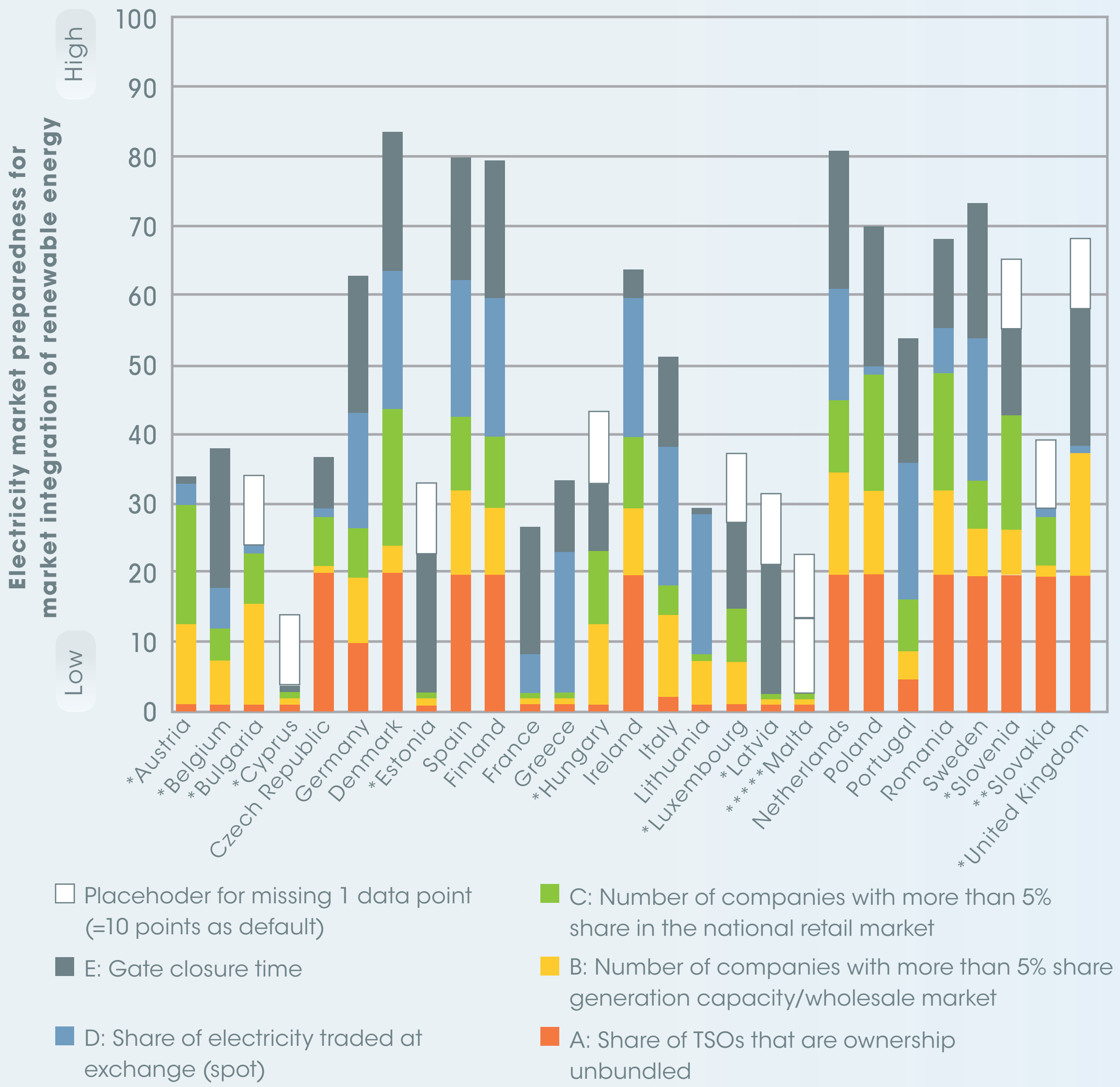
ELECTRICITY MARKET PREPAREDNESS INDICATOR

A particular view on market development is encapsulated in the electricity market preparedness indicator developed by Held, *et al.* (2010) and Steinhilber, *et al.* (2011). This aims to assess the preparedness, or potential of a market for renewable energy deployment; as such it is more directed towards ex-ante rather than ex-post evaluation. The central idea is that the more the market structure is adapted to variable renewable energy sources the lower the risks and associated costs of deployment and integration. The indicator is composed of five equally-weighted sub-indicators:

- Share of Transmission System Operators (TSOs) that are ownership unbundled
- Number of companies with more than 5% share in generation capacity/wholesale market
- Number of companies with more than 5% share in retail market
- Share of electricity traded at exchange (spot) in power consumption
- Gate closure time

Scores for the sub-indicators are assigned by comparing to the market's characteristics against pre-defined thresholds (see Annex 8.5 for further details). Figure 10 illustrates the results calculated in 2010 for the EU-27 markets (*ibid.*); those with a higher score are considered more prepared for the integration of RETs.

FIGURE 10: ELECTRICITY MARKET PREPAREDNESS INDICATOR FOR EU-27. SOURCE: STEINHILBER, *ET AL.* (2011)



If coloured segment is missing for a Member State, data was unavailable in used sources. This is indicated by a *in front of Member State name.

SHORT-HAND EVALUATION

The task of evaluating institutional feasibility appears inherently more difficult than evaluating the other criteria, with authors noting that the availability of time and human resource can be heavily influential on the quality and usefulness of the results generated (Theesfeld, Schleyer and Aznar, 2010). This is not surprising: institutional feasibility indicators do not offer a metric for how the policy studied is performing, but instead describe how well the policy is suited to its institutional environment, which may help to explain why the policy is performing in a certain way.

The intangibility of institutional feasibility as a concept and its explanatory role in policy evaluation both present barriers to the development of short-hand indicators. It is neither easy to pinpoint 'key' institutional characteristics required for a policy to be feasible, nor to conceive of simple metrics that are able to explain the intricacies of the relationship between a policy and its institutional environment. Short-hand indicators could however be used as a precursor to full evaluation, to highlight whether or not institutional feasibility is likely to be problematic for a policy. With this in mind, the simplest indicators to evaluate in Table 3 have been labelled (S). A selection of these could form the basis of a short-hand evaluation checklist, the indicators representing characteristics that would normally be present in an institutionally strong policy environment. Verification of their presence can only however denote the *possibility* of sufficient institutional feasibility. The checklist is therefore likely to be more useful as a rapid warning system of institutional *unfeasibility*: if a significant number of the indicators are not present, institutional feasibility is likely to be inadequate for successful policy deployment.

This kind of rapid 'unfeasibility' check cannot fulfil the role of institutional feasibility to explain policy performance, and should not be used as a replacement for more thorough evaluation. Where there is a real need to assess institutional feasibility rapidly, the most pragmatic short-cut may ultimately be to employ experts familiar with both the policy domain and the national context, who together can identify potential institutional pitfalls and propose possible solutions.

5.5 INSTITUTIONAL FEASIBILITY CONCLUSIONS

Institutional feasibility does not measure policy success, but it can help to explain the reasons for the success or failure of a policy. This explanatory role is one reason institutional feasibility tends to be assessed qualitatively rather than quantitatively.

Three major methods for evaluating institutional feasibility have been identified: case studies, impact assessment and multi-criteria analysis. These are intensive processes which produce much more insightful results if accorded sufficient time and human resource. The methods are flexible and can be adapted to assess many different aspects of institutional feasibility using multiple qualitative indicators. However, they are not suitable for short-hand evaluation. Indeed there is a general lack of simple metrics for estimating institutional feasibility, a result of the criterion's explanatory function. Some indicators that may be simply evaluated for short-hand purposes have been identified in Table 3, but the wide ranging and complex issues associated with institutional feasibility suggest that these are used as a precursor to more detailed evaluation, rather than a replacement for full assessment. In some respects they provide the means only for a negative assessment – analysts can determine relatively easily whether key institutional feasibility requirements are *absent,* but their presence does not ensure feasibility and this 'checklist' cannot fulfil institutional feasibility's role in explaining policy performance.

Institutional feasibility is widely considered a crucial prerequisite for successful policy, since a policy that is not institutionally feasible is unlikely to be successfully implemented. As such, institutional feasibility may be more suitable as principle of ex-ante evaluation than ex-post. Often policy performance is predicted presuming conducive institutional conditions, but if these are not present the policy is unlikely to perform as expected. In lower income countries in particular, institutional feasibility has been identified as being highly deterministic of the performance of other evaluation criteria. Nonetheless, institutional feasibility is frequently excluded from evaluations. The lack of exemplar institutional feasibility evaluations to imitate makes inclusion of this criterion in new evaluation processes all the more difficult, especially for countries with limited evaluation resources and/or expertise.

6. Expert elicitation

The expert elicitation interviews with fifteen academics and researchers raised many interesting points that were excluded from the main body of text to prevent overloading. These are briefly considered below.

6.1 COMBINING EVALUATION CRITERIA AND APPLICATION IN LOWER INCOME COUNTRIES

Scott (2013) observed that if policies are found to be equitable, efficient and effective in their implementation it is plausible to assume that institutional arrangements (feasibility) are satisfactory.

Diaz-Chavez (2012) proposed that support policies should be reviewed annually. In many cases evaluations are made too late for any meaningful revisions to take place.

Veit (2012) raised the issue of verifying indicators. He maintained that the more simple the indicator the more easily they would be to verify. In his opinion simple indicators should be prioritised over more complex ones.

Scott (2013) was concerned that data availability for equity would be particularly lacking in lower income countries. Monitoring and measuring equity would remain taxing until improved data collection methods were in operation.

Wilson (2013) was concerned that governments may not have sufficient funds to generate, monitor and evaluate policies. In her opinion, the entire policy process needs to be considered from early ex-ante development to ex-post evaluation. These need to be linked to institutional feasibility considerations.

Ölz (2013) forwarded the idea that criteria and certain indicators should be introduced gradually over time as data availability improves. It was suggested that data availability would be improved partly as a result of the introduction of policy evaluation indicators.

Lemaire (2013) stressed that indicators that consider long term time horizons are more appropriate for use in lower income countries where progress towards developmental goals is ongoing.

6.2 ALTERNATIVE CRITERIA

Several interviewees questioned the exhaustiveness of the criteria. Alternative criteria and evaluation methodologies are listed below. The experts raised questions over the suitability of the four criteria considered here. The source of these criteria appears to be the IPCC Fourth Assessment Report (AR4) published in 2007. Mitchell (2013), a Coordinating Lead Author for the IPCC special report (Mitchell, *et al.,* 2011), where the same criteria were used, acknowledged that the criteria were inherited from AR4. In her view alternative criteria (especially non-economic criteria) would be beneficial, however, due to a limited academic peer reviewed literature there is a lack of evidence from which alternatives could be drawn.

Diaz-Chavez (2012), Rossilo-Calle (2012) and Mitchell (2013) further questioned how such criteria are chosen and on what grounds they are justified. For these experts it was important that the criteria were explicitly defended as part of the research process.

A number of alternative criteria were identified as part of the review. These are:

» Lemaire (2013) raised the notion of *regulatory simplicity.* In his opinion there is not enough consideration given to the coherency between different policies.

» Lemaire (2013) also proposed *regulatory stability.* He recommended that a long-term strategy would be evidence to this end.

- Veit (2012) proposed *accountability*. He felt that this is a crucial factor preventing development from occurring in many lower income countries. He maintained that this should be applied to all actors operating with the energy sector involved in some way in the deployment of RETs, including donor agencies, banks and government.

- Scott (2013) proposed the need for specific indicators representing the *state and capacity of the transmission and distribution networks*. These could function as sub-indicators for effectiveness.

- Scott (2013) and Sanchez (2013) were concerned with the *source of finance* used for RET deployment. This is important for equity and could be linked to accountability.

- Scott (2013) raised the issue of *energy efficiency.*

- Ölz (2013) considered the World Bank indicator linked to the *ease of doing business* as potentially useful to associate with institutional feasibility.

- Ölz (2013) and Sanchez (2013) raised the notion of *financial market maturity.*

- Veit (2012) was concerned with capturing *basic infrastructure* and *legal system development*.

- Mitchell (2013) was concerned that the indicators explored in this analysis are too economically focussed. In her perspective it was necessary to include indicators that explore *social dimensions.* The impacts the policies have on social relations, communities and society at large, over time.

- Byrne (2013) stressed the importance of capturing the *unintended consequences* of support policies.

6.3 ADDITIONAL DISCUSSION POINTS

Woods (2012) was concerned that there is a danger that those carrying out the evaluation may prejudge the outcome based on the criteria in use, with their selection having been based on preconceived personal perspectives. Again, justification of criteria should take place. A linked issue raised by Cherni (2012), Veit (2012) and Wilson (2013) was the consideration of who carries out the evaluation and what is the point of it. Wilson (2013) was also strongly in favour of an external group carrying out the evaluation, fundamentally not those who have implemented the policy. Veit (2012) was concerned that evaluations may have limited impact if they are not linked to the ministry/organisation, as he put it “you only believe what you do yourself”.

A number of the experts felt that more in-depth analysis including the use of fieldwork was essential. Such in-depth research could be used to validate or refute theoretical hypothesis. Rossilo-Calle (2012) was particularly concerned with developing research beyond the theoretical dimension, he stressed that research remains limited if it does not move into empirical research. Finally, Scott (2013) was concerned that policy evaluation should avoid being turned into a tick box assessment that achieves little and takes up precious time of ministry officials.

Woods (2012), Mitchell (2013), Byrne (2013) and Newell (2013) all discussed the political nature of renewable energy policies. They stressed that evaluation should include a political component, rather than entirely focus on techno-economic factors. Many experts raised examples of the influence of political actions or particular market conditions on energy policy (for example Byrne, 2011). Some form of political economy approach could be employed to benefit policy evaluation (see, for example, Tanner and Allouche, 2011; Newell, 2012).

7. Conclusions

This paper sought to identify and examine indicators used to represent four criteria for evaluation of renewable energy deployment policies in lower income countries. A further aim was to consider if such indicators could be used for 'short-hand' evaluation; where time and resources were constrained. The literature identified as part of the review was more supportive of these aims for effectiveness and efficiency. For both criteria a number of indicators were identified and in many cases these could be applied to lower income countries. However, adapting such indicators to function as part of a short-hand evaluation raises challenges and is not always possible or appropriate.

A number of general insights can be drawn from the literature review, including:

- The majority of indicators have been defined/developed for OECD countries and rely upon sophisticated models and detailed data requirements.
- Relatively simple indicators offer a useful 'initial step' and are obviously preferable to neglecting evaluation altogether. However, they are subject to important limitations.
- The additional insight offered by more complex indicators needs to be considered in unison with a country's institutional capacity and data availability.
- Availability of both data and capacity may be a barrier to deployment of complex indicators in lower income countries.
- Equity and institutional feasibility criteria are less well served by simple, quantitative indicators.
- Analysts need to look at criteria in combination. Taken alone they are of limited value.
- In many respects, institutional feasibility is a prerequisite for success, yet can be overlooked in the literature on policy design and evaluation.

The following criteria-specific conclusions have been drawn.

Effectiveness

Effectiveness indicators function as a simple benchmark for successful deployment of RETs. The simple indicators identified, including installed capacity and electricity generated, are easily employed and are commonly used. Nevertheless, simple indicators do not account for differences in resource potentials and other variables. Comparisons between countries provide a means to assess relative success. Identification of peer countries helps useful comparisons to be made.

More sophisticated measures include the EC 'Effectiveness indicator', the 'Deployment Status indicator' and IEA 'Policy Impact indicator'. These include progress towards targets, share of electricity generated and attempts to capture the maturity of the market for renewable energy, hence allow more nuanced comparison between countries. However, these indicators create considerable data and processing requirements that may make use in lower income countries more challenging.

All variants of effectiveness indicators offer limited explanatory insights. The indicators provide a means to track deployment. Even the more sophisticated variants tell the analyst little about *why* deployment was successful, whether it will continue to be in future, or how economically efficient or socially acceptable deployment was seen to be. Measuring deployment is a first step in assessing effectiveness. But used alone also does not provide insight into why a policy succeeded or failed. Interpretation of the indicators is necessary. This requires deeper understanding of the country context and can be improved by employing the criteria in combination.

Efficiency

The literature on policy efficiency is principally focussed upon evaluating whether policy has been economically efficient in terms of the resources expended in delivering renewable energy – whether in simple financial terms or against social costs/impacts. Simple 'outputs to inputs' can be represented using the indicators of USD/MW of installed capacity or USD/MWh of electricity generation. Like the simple effectiveness indicators these provide limited insight through relative difference via international or longitudinal comparisons.

More complex indicators, developed predominately by EU institutions, introduce a comparison against what is considered an adequate level of remuneration. This can be assessed through the consideration of profit levels (remuneration efficiency and potential profits indicator) or can be assessed through a techno-economic costing (as with the remuneration level adequacy indicator). However, as with the effectiveness indicators, these complex indicators do not explain *why* policies have or have not been efficient. Data availability is likely to remain a significant obstacle for use of the more complex indicators in lower income countries.

Dynamic efficiency has been identified as an important concern relevant to policy evaluation. Dynamic efficiency can be tracked using static efficiency indicators in a time series, but this does not explain what has led to improvements or deteriorations in efficiency over the time period. The results of dynamic and static efficiency evaluations may be in conflict, for example if more expensive technologies are supported with a view to longer term cost reductions. The review did not identify any readily available indicators for evaluating dynamic efficiency.

Equity

The literature on equity is predominantly concerned with distribution of policy impacts. The review highlighted several general principles that commonly underpin renewable policy evaluations (the polluter pays principle, the allocation of revenues and expenditures, the incidence and allocation of windfall profits and the ability to pay of different stakeholders and the beneficiary account), but specific indicators were only identified for consumer impacts; for which three broad groups where identified: changes to energy consumption, the targeting of consumer subsidies and energy access metrics.

Besides distributional impacts, equity may be based on the potential for stakeholders to participate in policy development. Such participation can not only improve the perceived equity of a policy, but can also reduce implementation costs, by allowing potential difficulties to be identified and mitigated. There is a general lack of literature that evaluates the equity of consultation processes for renewable energy deployment, and no such indicators were identified. However, there is literature that evaluates participation exercises across wider policy areas; the common pitfalls identified by this could form the basis of indicators in the RET area.

Definitions of equity for energy policy evaluation vary considerably between authors and can be decisive in whether a policy is judged to be equitable. This presents difficulties for the development of internationally-applicable short-hand indicators. For the purpose of evaluating renewable energy deployment on a national basis, evaluations should reflect the concept of equity as understood by the policy's stakeholders and the local drivers for renewable energy deployment. For many lower income countries this may mean focussing on socio-economic development rather than climate change mitigation impacts.

Institutional feasibility

The literature on institutional feasibility is concerned with the political factors that affect support for a policy, the appropriateness of in-country institutions and the institutional and human capacity required to implement and monitor interventions. Much of the literature on renewable energy institutional feasibility in particular has focussed on developed countries. In addition, the literature considers institutional feasibility predominantly in relation to wider environmental policy rather than renewable energy policy, for which discussion of methodological institutional feasibility evaluation issues is lacking.

Institutional feasibility is regarded by some analysts as the most important criterion of all, since it is not possible to implement a policy successfully without institutional feasibility, regardless of potential performance according to the criteria described above or success in other country contexts. Policies designed without taking account of institutional feasibility conditions may not perform as expected. In lower income countries in particular, institutional feasibility has been identified as being highly deterministic of policy performance as evaluated through other criteria, since political climate and institutional capacity can pose significant hurdles.

Institutional feasibility provides a means of *explaining* the reasons behind the good/bad performance of a policy rather than a means of measuring policy outcomes. As a result, it is most appropriate for ex-ante evaluation of the potential of a policy to do well, and for developing a policy that is adapted to local conditions, rather than benchmarking a policy's performance ex-post.

Institutional feasibility is intrinsically difficult to measure. Evaluation is not amenable to simple metrics and tends to be qualitative, more so than for some of the other indicators. Three approaches to institutional feasibility assessment were identified in the review: case study, impact assessment, and multi-criteria assessment (MCA). All are relatively complicated to implement, broadly qualitative and produce much more insightful results if permitted sufficient human/time resource.

For all the above reasons, institutional feasibility is not well suited to simple or short-hand assessment. The literature identifies some institutional feasibility prerequisites, for example consistent government support, sufficiently skilled staff and the appropriate assignation of implementation responsibilities, but these are more useful for determining whether a policy is not institutionally feasible (if they're not present) rather than assessing institutional feasibility – their absence may lead to failure but their presence alone doesn't guarantee feasibility.

Further criteria/indicator considerations

Preliminary fieldwork and in depth analysis is required to validate the use of any indicators, particularly short-hand indicators. Short-hand or otherwise, many of the criteria discussed in this paper are quite narrow in focus and neglect broader impacts (such as jobs, industrial change, energy security, etc.). Those conducting the evaluation need to be aware of the limited/narrow focus of considering only immediate deployment effects. Indeed, it may be the broader impacts of the deployment of RETs that are more important for the country in question.

The effectiveness and efficiency criteria interact closely and should be considered in unison. Efficiency becomes increasingly important as the share of renewable energy rises. Equity is in part a product of efficiency and scale of aspiration but with wider social dimensions. If equity/distributional consequences are primary, relatively expensive large scale renewable energy deployment may not be the most appropriate option for lower income countries.

The four criteria are not exhaustive. A number of alternative criteria are identified as part of the review, such as political accountability, source of finance and regulatory simplicity. The expert elicitation also drew attention to the power politics and political economy of implementation. Assessment of these may help explain why deployment has been successful. However, identifying/designing indicators and methods is beyond the scope of this paper.

Implementation and monitoring are at least as important as policy design and evaluation. Experts were concerned that these areas may be poorly represented in lower income country policy process and overlooked at both design and evaluation stages. Finally, there may be value in a gradual introduction of different criteria and indicators over time. Beginning with more simple criteria and indicators first and slowly increasing the sophistication is likely to improve data gathering, which in turn, will improve policy evaluation.

The evidence reviewed for this paper demonstrates that there is a wide ranging literature on policy evaluation criteria and important lessons for deploying such criteria in lower income countries. The literature is also clear that the process of evaluation is valuable for improving policy and that simple indicators are preferable to neglecting evaluation altogether. Effective evaluation can identify constraints and barriers, provide better understanding of how to deploy RETs as cost effectively as possible, help assess social welfare issues and a range of other impacts. But more complex indicators may run into data and capacity constraints. There is a pressing need to build the capacity to implement evaluation in lower income countries. It is also important to ensure that evaluation criteria (and indeed policy design) are context specific and reflect in-country political and institutional reality. This need is greatest in countries where renewable energy deployment is likely to begin in earnest, where policies play a defining role in deployment and where support policies are at an early stage of development.

Bibliography

Agnolucci, P. (2007), "Wind electricity in Denmark: A survey of policies, their effectiveness and factors motivating their introduction", *Renewable and Sustainable Energy Reviews,* Vol. 11, No. 5, pp. 951–963.

Bacon, R.B.S., and M. Kojima (2010), "Expenditure of Low-income Households on Energy. Evidence from Asia and Africa", *Extractive Industries for Development Series*, Washington, D.C.

Batlle, C., I.J. Pérez-Arriaga and P. Zambrano-Barragán (2011), "Regulatory Design for RES-E Support Mechanisms: Learning Curves, Market Structure, and Burden-Sharing, Massachusetts.

Bazilian, M., *et al*. (2010), *Measuring Energy Access - Supporting a Global Target,* Columbia University, New York, pp. 22.

Bell, R. G., and C. Russell (2002), "Environmental Policy for Developing Countries." Issues Science Technology, Vol. 18, No. 3, pp. 63-70.

BIS (H.M. Government, Department for Business, Innovation and Skills) (2011), IA (Impact Assessment) Toolkit: How to do an Impact Assessment, *www.gov.uk/government/uploads/system/uploads/attachment_data/file/200442/Green_Book_impact_assessment_toolkit.pdf*.

Borooah, V. K. (2013), *Measuring Inequality*, University of Ulster, Ulster.

Byrne, R. (2011), *Learning Drivers: rural electrification regime building in Kenya and Tanzania*, PhD Thesis. University of Sussex.

Byrne, R. (2013), *Interview with Jack Nicholls*, February 2013.

Calcagno, A.E., P. Sainz and J. De Barbieri (1972), *Estilos Políticos Latinoamericanos*, FLACSO ((Facultad Latinoamericana de Ciencias Sociales), Santiago de Chile/Buenos Aires.

Candelise, C. (2009), *Learning and cost reductions for PV: Narratives for UKERC 2050 project*, working paper, UK Energy Research Centre, London.

Candelise, C., M. Winskel and R. Gross (2013), "The dynamics of solar PV costs and prices as a challenge for technology forecasting", *Forthcoming in Renewable and Sustainable Energy Review*.

Candelise, C. (2013), *Interview with Jack Nicholls and Rebecca Mawhood,* March 2013.

Capello, R. S. and A. Spairani (2004), *Ex-ante Evaluation of European ICTs Policies: Efficiency vs. Cohesion Scenarios,* Working paper for ERSA (European Regional Science Association) conference.

Cherni, J. (2012), *Interview with Jack Nicholls and Rebecca Mawhood,* December 2012.

CIF (Climate Investment Funds) (2009), "Clean Technology Fund: Investment Criteria for Public Sector Operations", *www.climateinvestmentfunds.org/cif/sites/climateinvestmentfunds.org/files/Kenya%20IP_0.pdf*.

Cowell, F. A., and K. Gardiner (1999), "Welfare Weights", *STICERD,* London School of Economics, *www.oft.gov.uk/shared_oft/reports/consumer_protection/oft282.pdf*.

Davies, H.T.O., S.M. Nutley and P.C. Smith (2000), *What Works: evidence-based policy and practice in public services*. Policy Press, Bristol.

DECC (Department of Energy & Climate Change) (2011), "Energy Act 2011", Green Deal Impact Assessment, *www.gov.uk/government/uploads/system/uploads/attachment_data/file/48196/3223-EA2011-green-deal-impact-assessment.pdf*.

Diaz-Chavez, R. (2012), *Interview with Jack Nicholls and Rebecca Mawhood*, December 2012.

Dijk, A.L., *et al*. (2003), "Renewable Energy Policies and Market Developments", *www.ecn.nl/docs/library/report/2003/c03029.pdf*.

EC (European Commission) (2005), "The support of electricity from renewable energy sources: Impact assessment", SEC (2005) 1571, pp. 55, Brussels, *http://ec.europa.eu/governance/impact/ia_carried_out/docs/ia_2005/sec_2005_1571_en.pdf*.

EC (2008), "The support of electricity from renewable energy sources", SEC, Vol. 57, pp. 38, Brussels. *http://ec.europa.eu/energy/climate_actions/doc/2008_res_working_document_en.pdf.*

EDIAIS (Enterprise Development Impact Assessment Information Service) (2001), "Basic Impact Assessment at Project Level", Manchester, *www.sed.manchester.ac.uk/research/iarc/ediais/whatis/index.shtml*

Evans, D., E. Kula, and H. Sezer (2005), "Regional welfare weights for the UK: England, Scotland, Wales and Northern Ireland", *Regional Studies* Vol. 39, No. 7, pp. 923-937.

Farrell, J. (2009), "Feed-in tariffs in America: Driving the Economy with Renewable Energy Policy that Works". Institute for Local Self Reliance, Minneapolis, MN, *www.ilsr.org/feedin-tariffs-america-driving-economy-renewable-energy-policy-works/.*

Fischer, C.M. and R. Morgenstern (2008), "Metrics for Evaluating Policy Commitments in a Fragmented World: The Challenges of Equity and Integrity", Harvard Project on International Climate Agreements, Harvard Kennedy School, Cambridge, Mass.

Green X (2007), "Short Characterisation of the model Green X", *www.green-x.at/downloads/Short%20characterisation%20of%20the%20Green-X%20model%20(March%202007).pdf*

Gupta, S. and D. A. Tirpak (2007), "Policies, Instruments and Co-operative Arrangements", Climate Change 2007: *Mitigation. Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change*, Cambridge University Press, Cambridge, and New York.

Haas, R.R., *et al*. (2011), "Efficiency and effectiveness of promotion systems for electricity generation from renewable energy sources", *Lessons from EU countries. Energy* Vol. 36, No. 4, pp. 2186-2193.

Held, A., *et al*. (2010), "RE-Shaping: Shaping an effective and efficient European renewable energy market", D5 & D6 Report: Indicators assessing the performance of renewable energy support policies in 27 Member States, *www.reshaping-res-policy.eu/downloads/RE-Shaping%20D5D6_Report_final.pdf.*

HELI (Health and Environment Linkages Initative) (2013), "Impact assessment", *www.who.int/heli/impacts/en/*, accessed January, 2013.

Hey, C. (2010), "The German Paradox: Climate Leader and Green Car Laggard" in Oberthur, S. and M. Pallemaerts, (eds.), *New Climate Policies of the European Union,* Brussels University Press, Brussels.

Higgs, G., *et al*. (2008), "Using IT approaches to promote public participation in renewable energy planning: Prospects and challenges", *Land Use Policy* Vol. 25, No. 4, pp. 596-607.

Holt, G., A. Subedi, and C. Garforth (2002), "Working Paper 2: Engaging with the Policy Process in Nepal", *Developing supportive policy environments for improved land management strategies – Nepal*, Department of International and Rural Development University of Reading, Reading.

IAIA (International Association for Impact Assessment) (2013), "Publications and Resources", *www.iaia.org/publications-resources/*, accessed January 2013.

ICEPT (Imperial Centre for Energy Policy and Technology) (2012), "On picking winners: The need for targeted support for renewable energy", *ICEPT Working Paper*, Imperial College, London.

IEA (International Energy Agency) (2000), *Experience Curves for energy technology policy*, IEA, Paris.

IEA (2008), *Deploying Renewables Principles for Effective Policies*, IEA, Paris.

IEA (2011), "Deploying Renewables 2011 - Best and Future Policy Practice", *Renewable Energy Markets and Policies*. Paris.

IEA (2013) "The Energy Development Index", *www.iea.org/publications/worldenergyoutlook/resources/energydevelopment/theenergydevelopmentindex/*, accessed January 2013.

Ikeme, J. (2003), "Equity, environmental justice and sustainability: incomplete approaches in climate change politics", *Global Environmental Change* Vol. 13, No. 3, pp. 195-206.

IRENA (International Renewable Energy Agency) (2012a), "Policy Brief: Evaluating Policies in Support of the Deployment of Renewable Power", *www.irena.org/DocumentDownloads/Publications/Evaluating_policies_in_support_of_the_deployment_of_renewable_power.pdf*.

IRENA (2012b), *CaDRE Handbook*, Abu Dhabi, IRENA.

Jacobson, A., A.D. Milman and D.M. Kammen (2005), "Letting the (energy) Gini out of the bottle: Lorenz curves of cumulative electricity consumption and Gini coefficients as metrics of energy distribution and equity", *Energy Policy,* Vol. 33, No. 14, pp. 1825-1832.

Jager, D., *et al*. (2011), *Financing Renewable Energy in the European Energy Marke*t, Ecofys. *http://ec.europa.eu/energy/renewables/studies/doc/renewables/2011_financing_renewable.pdf*.

Karol, J.L. and R. Domnanvitch (2010), *Building-up urban scenarios: assessing institutional feasibility and political viability of strategic trajectories*.

Keohane, N.O., R.L. Revesz and R.N. Stavins (1998), "The choice of regulatory instruments in environmental policy." *Harvard Environmental Law Review*, Vol. 22, pp. 313-367.

Keppley, J.M. (2012), "A Comparative Analysis of California and German Renewable Energy Policy", *The Josef Korbel Journal of Advanced International Studies*, Vol. 4, No. 1, pp. 1-26.

Konidari, P. and D. Mavrakis (2007), "A multi-criteria evaluation method for climate change mitigation policy instruments". *Energy Policy*, Vol. 35, No. 12, pp. 6235-6257.

Lee, N. (2006), "Bridging the gap between theory and practice in integrated assessment", *Environmental Impact Assessment Review,* Vol. 26, No. 1, pp. 57-78.

Lemaire, X. (2013), *Interview with Jack Nicholls and Rebecca Mawhood,* January 2013.

Lensink, S.M. (2009), "Walking the tightrope: balancing effectiveness against cost in the Netherlands' feed-in tariffs", *www.iisd.org/gsi/news/walking-tightrope-balancing-effectiveness-against-cost-netherlands-feed-tariffs*, accessed January 2013.

Mabiza, C., *et al*. (2006), "An Evaluation of Stakeholder Participation in Catchment Planning: A Case Study of Manyame Catchment Area", *Journal of Sustainable Development in Africa,* Vol. 8, No. 1, Zimbabwe.

Macintosh, A., and D. Wilkinson (2010), "The Australian Government's solar PV rebate program*,* An evaluation of its cost-effectiveness and fairness", *Policy Brief No. 21*, The Australian Institute, Manuka.

Mawhood, R. (2012), "The Senegalese Rural Electrification Action Plan: A 'good practice' model for increasing private sector participation in Sub-Saharan rural electrification?", Thesis, *Centre for Environmental Policy*, Imperial College London.

Menanteau, P., D. Finnon and M.-L. Lamy (2003), "Prices versus quantities: choosing policies for promoting the development of renewable energy", *Energy Policy*, Vol 31, pp. 799–812.

Mendonca, M., S. Lacey and F. Hvelplund (2009), "Stability, participation and transparency in renewable energy policy; Lessons from Denmark and the United States". *Policy and Society*, Vol. 27, Issue 4, March 2009, pp 379-398.

Mickwitz, P. (2003), "A Framework for Evaluating Environmental Policy Instruments: Context and Key Concepts", *Evaluation,* Vol. 9, No. 4, pp. 415-436.

Mitchell, C., *et al*. (2011), "Chapter 11: Policy, Financing and Implementation", *IPCC (Intergovernmental Panel on Climate Change) Special Report on Renewable Energy Sources and Climate Change Mitigation,* Cambridge University Press, Cambridge and New York, pp. 865-950.

Mitchell, C. (2013), *Interview with Jack Nicholls and Rebecca Mawhood*, January 2013.

Moss, J., *et al*. (2011), *Energy Equity and Environmental Security*, Bangkok.

Newell, P. (2012), *Globalization and the Environment*. Polity Press, Cambridge.

Newell, P. (2013), *Interview with Jack Nicholls,* February 2013.

Noble, B.F. (2009), "Promise and dismay: The state of strategic environmental assessment systems and practices in Canada", *Environmental Impact Assessment Review*, Vol. 29, No. 1, pp. 66-75.

Nordhaus, R.D. and K.W Danish (2005), "Assessing the Options for Designing a Mandatory U.S. Greenhouse Gas Reduction Program", *Boston College Environmental Affairs Law Review*, Vol. 32, No. 1, pp. 97-163.

Nussbaumer, P., *et al*. (2011), "Measuring Energy Poverty: Focusing on What Matters", *OPHI (Oxford Poverty & Human Development Initiative)*, Working Paper No. 42, pp. 27, Oxford.

Ölz, S. (2013), *Interview with Jack Nicholls and Rebecca Mawhood*, January 2013.

Owen, G. (2008), "Towards an Equitable Climate Change Policy for the UK: the Costs and Benefits towards Low Income Households of UK Climate Change Policy", EAGA, *www.carillionenergy.com/downloads/pdf/3867 eaga Equity & Climate 36ppg PROOF.pdf*.

Pablo, D. (2012), "The dynamic efficiency of feed-in tariffs: The impact of different design elements", *Energy Policy*, Vol. 41, pp. 139–151.

Pablo, D. and M. Bleda (2012), "Comparing the innovation effects of support schemes for renewable electricity technologies: A function of innovation approach", *Energy Policy*, Vol. 50, pp. 272–282.

Paté-Cornell, E. (2002), "Risk and Uncertainty Analysis in Government Safety Decisions." *Risk Analysis,* Vol. 22, No. 3, pp. 633-646.

Practical Action (2012), "Poor people's energy outlook 2012: Energy for earning a living", Practical Action Publishing Ltd., Rugby, *http://cdn1.practicalaction.org/p/p/4f1ea5d5-024c-42a1-b88d-026b0ae4f5bb.pdf*.

PwC (Price water Coopers) (2011), "How does organised crime misuse EU funds?" Brussels, *www.europarl.europa.eu/meetdocs/2009_2014/documents/cont/dv/crime_misuse_/crime_misuse_en.pdf.*

Ragwitz, M., *et al*. (2007), "OPTRES Assessment and optimisation of renewable energy support schemes in the European electricity market", Final Report, *http://ec.europa.eu/energy/renewables/studies/doc/renewables/2007_02_optres.pdf*.

RCREEE (Regional Center for Renewable Energy and Energy Efficiency) (2010), *Policies for Energy Efficiency and Renewable Energy in the RCREEE Group of Countries*, Cairo.

Reed, M.S. (2008), Stakeholder participation for environmental management: A literature review. *Biological Conservation*, Vol. 141, No. 10, pp. 2417-2431.

Resch, G., *et al*. (2007), "OPTRES Assessment and optimisation of renewable energy support schemes in the European electricity market", Recommendations for implementing effective and efficient renewable energy electricity policies, For the European Commission, *http://ec.europa.eu/energy/renewables/studies/doc/renewables/2007_02_optres_recommendations.pdf.*

Richter, J.L. (2012), "Institutional Feasibility – the end or the means in emissions trading?" *Evaluating the New Zealand Emissions Trading Scheme*, International Institute for Industrial Environmental Economics, Lund University, Lund.

Rossilo-Calle, F. (2012), *Interview with Jack Nicholls and Rebecca Mawhood,* December 2012.

Sanchez, T. (2013), *Interview with Jack Nicholls and Rebecca Mawhood*, January 2013.

Scott, A. (2013), *Interview with Jack Nicholls and Rebecca Mawhood*, January 2013.

Sezer, H. (2006), "A Discussion of Different Methods of Constructing Regional Welfare Weights", Oxford, *http://wp.demm.unimi.it/tl_files/wp/2006/DEMM-2006_021wp.pdf*.

Shukla, P.R. (1999), "Chapter 9, Justice, Equity and Efficiency in Climate Change: A Developing Country Perspective", in *Fairness Concerns in Climate Change*, Toth F. (ed.), Earthscan Publications, London.

Solesbury, W. (2001), "Evidence based policy: whence it came and where it's going", *Working Paper 1*, ESRC UK Centre for Evidence Policy and Practice, Queen Mary College, University of London, pp. 11.

Solomon, D.S., and K.F.D. Hughey (2007), "A proposed Multi Criteria Analysis decision support tool for international environmental policy issues: a pilot application to emissions control in the international aviation sector", *Environmental Science & Policy,* 10, No. 7–8, pp. 645-653.

Sorrell, S. (2007), "Improving the evidence base for energy policy: The role of systematic reviews", *Energy Policy*, Vol. 35, No. 3, pp. 1858–1871.

Sovacool, B.K. (2010), "A comparative analysis of renewable electricity support mechanisms for Southeast Asia", *Energy,* Vol. 35, No. 4, pp. 1779–1793.

Steggals W, R. Gross and P. Heptonstall (2010), "Winds of change: How High Wind Penetrations will Affect Investment Incentives in the GB Electricity Sector", *Energy Policy*, Vol. 39, pp. 1389-1396.

Steinhilber, S., *et al*. (2011), "RE-Shaping: Shaping an effective and efficient European renewable energy market", *D17 Report: Indicators assessing the performance of renewable energy support policies in 27 Member States*. www.reshaping-res-policy.eu/downloads/RE-Shaping%20D17_Report_update%202011_final.pdf

Stephan, B. and M. Paterson (2012), "The politics of carbon markets: an introduction", *Environmental Politics*, Vol. 21, No. 4, pp. 545-562.

Sterner, T. (2003), *Policy Instruments for Environmental and Natural Resource Management,* Washington, D.C., RFF Press.

Stirling, A. (2013), "Multicriteria Mapping", *www.multicriteria-mapping.org/process/,* accessed May 2013

Tanner, T., and J. Allouche (2011), "Towards a New Political Economy of Climate Change and Development", *IDS Bulletin*, Vol. 42, No. 3, www.ids.ac.uk/files/dmfile/PolitEc_Theory.pdf.

Takasaki, Y. (2007), "Dynamic household models of forest clearing under distinct land and labor market institutions: can agricultural policies reduce tropical deforestation?", *Environment and Development Economics*, Vol. 12, No. 03, pp. 423-443.

Theesfeld, I., C. Schleyer and O. Aznar (2010), "The procedure for institutional compatibility assessment: ex-ante policy assessment from an institutional perspective", *Journal of Institutional Economics*, Vol. 6, No. 03, pp. 377-399.

Toba, N. (2003), *Welfare Impacts of Electricity Generation Sector Reform in the Philippines*, DAE (Department of Applied Economics) Working Paper 0316, DAE, University of Cambridge.

UKERC (UK Energy Research Centre) (2010), "Great Expectations: The cost of offshore wind in UK waters", *www.ukerc.ac.uk/support/tiki-download_file.php?fileId=1164.*

UNCED (United Nations Conference on Environment and Development) (1992), "Rio Declaration on Environment and Development", *www.un.org/documents/ga/conf151/aconf15126-1annex1.htm.*

UNECE (United Nations Economic Commission for Europe) (1998), "Convention on Access to Information, Public Participation in Decision-making and Access to Justice in Environmental Matters", Aarhus, *www.unece.org/fileadmin/DAM/env/pp/welcome.html.*

Vedung, E. (2009), *Public policy and program evaluation, Transaction Publishers*, New Brunswick, pp. 341.

Venmans, F. (2012), "A literature-based multi-criteria evaluation of the EU ETS", *Renewable and Sustainable Energy Reviews,* Vol. 16, No. 8, pp. 5493-5510.

Vera, I., and L. Lucille (2007), "Energy indicators for sustainable development", *Energy* Vol. 32, No. 6, pp. 875-882.

Verbruggen, A., and V. Lauber (2012), "Assessing the performance of renewable electricity support instruments", *Energy Policy,* Vol. 45, pp. 635-644.

Videira, N., *et al*. (2006), "Public and stakeholder participation in European water policy: a critical review of project evaluation processes", *European Environment*. Vol. 16, pp. 19-31.

Veit, S. (2012), *Interview with Jack Nicholls and Rebecca Mawhood*, December 2012.

Wilson, E. (2013), *Interview with Jack Nicholls and Rebecca Mawhood,* January 2013.

Woods, J. (2012), I*nterview with Jack Nicholls and Rebecca Mawhood,* December 2012.

World Bank (2013), "How we classify countries", *http://data.worldbank.org/about/country-classifications, accessed April 2013.*

Yin, R.K. (2003), *Case Study Research: Design and Methods, Thousand Oaks,* London, New Delhi, SAGE Publications.

8. Annexes

8.1 IRENA CRITERIA TABLE FROM POLICY BRIEF

CRITERION	INDICATORS	METHODOLOGIES
Effectiveness	» Growth in capacity/generation vs. ambition » Growth in capacity or generation vs. realisable or projected potential by a given date	Measuring growth against targets is simple and useful for individual countries. Country comparisons require data and analysis to levelize country and policy differences. The EU's method, based on estimates of 'realisable potential', is described in Jager, *et al.*, (2011). See EC (2008) and IEA (2008) for examples of how to create indicators. Alternatively, IEA (2011) uses World Energy Outlook (WEO, 2010) projections to benchmark growth potential.
Efficiency	Fiscal incentives and public finance: » USDs spending per USDs private investment leveraged Other policies: » Total USDs per unit of capacity or generation » Total USDs per unit of generation vs. cost of generation » Time series of the above, to track dynamic efficiency » Competitiveness indicators, e.g. market diversity, judgments of developers.	Leverage can be assessed by accounting studies of projects. See for examples LSE Grantham Research Institute (2009), UNEP (2008), UNEP and BNEF (2011), UNEP-SEFI (2008) and NORAD (2008). Comparing support to generation or the cost of generation requires good data on support levels, production costs and system costs. As with effectiveness, country comparisons require levelization of policy differences and are more technical than individual country studies. Much detail on efficiency evaluation can be found in EC (2005) and (2008), and Jager, et al., (2011). The approach has been used in modified form by the IEA (2008) and recently refined by Steinhilber, *et al.* (2011). Recently, the IEA (2011b) has developed a new indicator, though using a similar approach. Competitiveness can be a useful supplementary indicator for efficiency. This requires analysis of market players or consultation through surveys and questionnaires.
Equity	» Fair access to support policies » Incidence of support costs » Incidence of costs, with welfare weights » Change in spending on electricity as a % of total household spending, broken down by income-group » Participation of stakeholders	Access to instruments (*e.g.* tax credits) may favour some actors more than others. This can be assessed through abstract policy analysis, surveys and interviews. Reporting the incidence of support costs requires good data and may involve estimates regarding opportunity costs and impacts on communities. There is considerable experience with estimating welfare weights from studies on rural electrification and other economic development studies (Independent Evaluation Group (IEG), 2008). Multi-criteria decision analysis can elucidate and consolidate stakeholder preferences, though it is a cumbersome exercise. See NEEDS (2009).
Institutional feasibility	» Policy complexity » Existence of required institutions » Capacity of required institutions » Clear and appropriate ownership and commitment	These indicators can be assessed by detailed case-studies to identify obstacles and provide road-maps to implementation. A methodology would include identification of objectives, economic analysis of potential, institutional analysis of capacity, preparation of options and consultation. See RECREE (2010) for an assessment of Middle East and North African (MENA) countries.
Replicability	There is no single indicator of replicability. Any instrument has to be analysed in the context of the possibilities of the country concerned.	Requires analysis of the factors that made the policy successful elsewhere and verification that they exist in the country to which it is transferred. It also requires analysis of factors in the recipient country that might impede transfer.

Note: The literature referred to in this table can be found in the bibliography of the Policy Brief (IRENA, 2012a).

8.2 RAPID SYSTEMATIC REVIEW SEARCH RESULTS

DATABASE	BOOLEAN OPERATOR	SEARCH RESULTS	SELECTED	CUMULATIVE
Web of knowledge	ENERGY POLICY: "policy evaluation" and "developing countr*	42	4	4
	"evaluation framework" and "renewable energ*"	4	1	5
	"evaluation of renewable energy policies" and "low income countr*"	0	0	5
	"developing country" and "renewable energy" and "policy evaluation"	0	0	5
	"developing country and renewable energ*" and policy evaluation	25	4	9
	"policy analysis" and renewable energ* and developing country	6	3	12
	"policy evaluation criteria" and "renewable energ*" and "developing countr*"	0	0	12
	developing country policy evaluation and "renewable energy"	58	1	13
	"effectiveness" and "renewable energy polic*" and "criteria" and "low income countr*"	0	0	13
	"effectiveness" and "renewable energy polic*" and "evaluation"	1	1	14
	"effectiveness of renewable energy policy" and "low income countr*"	0	0	14
	"effectiveness" and "evaluation" and "criteria" and "renewable energ*"	0	0	14
	"effectiveness" and "renewable energy" and polic*	125	18	32
	"efficiency" and "renewable energy polic*" and "criteria" and low income countr*"	0	0	32
	"efficiency" and "renewable energy polic*"	29	5	37
	"efficiency" and "evaluation criteria" and "renewable energy polic*" and "low income country"	0	0	37
	"efficiency" and "renewable energy polic*" and "evaluation	6	1	38
	"efficiency" and "renewable energy support policy" and "criteria"	1	1	39
	"equity" and "renewable energy polic*" and "criteria"	1	1	40
	"equity" and "developing countr*" renewable energy polic*"	0	0	40
	"equity" and "renewable energy polic*"	3	2	42
	"equity" and "low* income countr*" and "renewable*"	1	1	43
	equity renewable energy policies developing countries	13	5	48

DATABASE	BOOLEAN OPERATOR	SEARCH RESULTS	SELECTED	CUMULATIVE
	"institutional feasibility" and "renewable energy polic*" and "criteria"	1	0	48
	"institutional feasibility" and "low* income countr*" and "renewable*"	0	0	48
	"institutional feasibility policy analysis" and "renewable*"	0	0	48
	institutional feasibility and renewable energy	16	6	54
	institutional feasibility criteria" and "renewable*"	0	0	54
	"replicability" and "criteria" and "renewable energy" and "developing countr*"	1	1	55
	"replicability" and "renewable energy polic*" and "criteria"	0	0	55
	"replicability" and "renewable energy polic*"	0	0	55
	"replicability" and "low* income countr*" and "renewable energy"	0	0	55
	replicability renewable enery policies developing countr*	0	0	55
Total minus duplicates			**49**	
Science Direct	"evaluation framework" and "renewable energ*"	2	1	50
	"evaluation of renewable energy policies" and "low income countr*"	0	0	50
	"developing country" and "renewable energy" and "policy evaluation"	0	0	50
	"developing country and renewable energ*" and policy evaluation	0	0	50
	"policy analysis" and renewable energ* and developing country	3	3	53
	"policy evaluation criteria" and "renewable energ*" and "developing countr*"	0	0	53
	developing country policy evaluation and "renewable energy"	10	3	56
	"effectiveness" and "renewable energy polic*" and "criteria" and "low income countr*"	0	0	56
	"effectiveness" and "renewable energy policy*" and "evaluation"	3	2	58
	"effectiveness of renewable energy policy" and "low income countr*"	0	0	58
	"effectiveness" and "evaluation" and "criteria" and "renewable energ*"	2	0	58
	"effectiveness" and "renewable energy" and polic*	87	54	112
	"efficiency" and "renewable energy polic*" and "criteria" and "low income countr*"	0	0	112
	"efficiency" and "renewable energy polic*"	28	11	123
	"efficiency" and "evaluation criteria" and "renewable energy polic*" and "low income country"	0	0	123

DATABASE	BOOLEAN OPERATOR	SEARCH RESULTS	SELECTED	CUMULATIVE
	"efficiency" and "renewable energy polic*" and "evaluation"	4	0	123
	"efficiency" and "renewable energy support policy" and "criteria"	2	0	123
	"equity" and "renewable energy polic*" and "criteria"	1	0	123
	equity and "developing countr*" "renewable energy polic*"	0	0	123
	"equity" and "renewable energy polic*"	5	2	125
	"equity" and "low* income countr*" and "renewable*"	0	0	125
	equity renewable energy policies developing countries	3	3	128
	"institutional feasibility" and "renewable energy polic*" and "criteria"	1	0	128
	"institutional feasibility" and "low* income countr*" and "renewable*"	0	0	128
	"institutional feasibility policy analysis" and "renewable*"	0	0	128
	institutional feasibility and renewable energy	7	1	129
	institutional feasibility criteria and "renewable*"	0	0	129
	"replicability" and "criteria" and "renewable energy" and "developing countr*"	0	0	129
	"replicability" and "renewable energy polic*" and "criteria"	0	0	129
	"replicability" and "renewable energy polic*"	0	0	129
	"replicability" and "low* income countr*" and "renewable energy"	0	0	129
	"replicability" and "renewable energy policies" "developing countr*"	0	0	129
Total minus duplicates			85	
Google scholar	"evaluation framework" and "renewable energy"	1020	26	111
	"evaluation of renewable energy policies" and "low income county"	0	0	111
	"developing country" and "renewable energy" and "policy evaluation"	169	5	116
	"policy analysis" and renewable energ* and developing country	1410	11	127
	"policy evaluation criteria" and "renewable energy" and "developing country"	10	0	127
	developing country policy evaluation and "renewable energy"	0	0	127
	effectiveness and "renewable energy policy" and "criteria" and "low income countries"	49	5	132
	effectiveness and "renewable energy policy" and "evaluation"	1710	6	138
	"effectiveness of renewable energy policy" and "low income countries"	0	0	138

DATABASE	BOOLEAN OPERATOR	SEARCH RESULTS	SELECTED	CUMULATIVE
	"effectiveness" and "evaluation" and "criteria" and "renewable energy"	22,600	2	140
	"effectiveness" and "renewable energy policy"	2870	21	161
	"efficiency" and "renewable energy policy" and "criteria" and "low income country"	7	0	161
	"efficiency" and "renewable energy policy"	5920	6	167
	"efficiency" and "evaluation criteria" and "renewable energy policy" and "low income country"	1	0	167
	"efficiency" and "renewable energy policy" and "evaluation"	3060	7	174
	"efficiency" and "renewable energy support policy" and "criteria"	35	1	175
	equity and "renewable energy policy" and "criteria"	1020	3	178
	"equity" and "developing countries" and "renewable energy policy"	882	6	184
Google Scholar - change to title search	"equity" and "renewable energy policy"	0	0	184
Google Scholar - return to full search	"equity" and "low* income countr*" and "renewable*"	0	0	184
	equity renewable energy policies developing countries	0	0	184
	institutional feasibility and "renewable energy policy" and "criteria"	2	0	184
	institutional feasibility and "low income country" and "renewable"	2	1	185
	institutional feasibility policy analysis and "renewable"	0	0	185
	institutional feasibility and renewable energy	0	0	185
	institutional feasibility criteria and "renewable"	0	0	185
	"replicability" and "criteria" and "renewable energy" and "developing country"	161	4	189
	"replicability" and "renewable energy policy" and "criteria"	47	1	190
	"replicability" and "renewable energy policy"	61	1	191
	"replicability" and "low income country" and "renewable energy"	5	1	192
	replicability "renewable energy policies" "developing country"	7	0	192
Total minus duplicates			**182**	
Total search results		**41539**		
Search results reviewed		**2397**		

8.3 EXPERT ELICITATION INTERVIEWS

EXPERTS		
INTERNAL/EXTERNAL	NAME	ORGANISATION
Internal	Dr Rob Gross	Imperial College
Internal	Dr Jem Woods	Imperial College
Internal	Dr Rocio Diaz-Chavez	Imperial College
Internal	Dr Judith Cherni	Imperial College
Internal	Dr Frank Rossilo-Calle	Imperial College
External	Sebastian Veit	African Development Bank
External	Dr Emma Wilson	International Institute for Environment and Development
External	Andrew Scott	Overseas Development Institute
External	Dr Catherine Mitchell	Exeter University
External	Samantha Ölz	The Light House Group (previously IEA)
External	Teo Sanchez	Practical Action
External	Dr Xavier Lemaire	University College London
External	Dr Rob Byrne	Sussex University
External	Dr Peter Newell	Sussex University
Internal	Dr Chiara Candelise	Imperial College

8.4 DEPLOYMENT STATUS INDICATOR VALUES AND INTERPRETATION

Source: Held, et al., 2010:

> 'For each sub-indicator it is defined how it relates to Deployment Status:
>
> A. If production as share of sector consumption reaches 10%, a market is considered to be very advanced and the maximum amount of 40 points is attributed. Whereas, 0% production as share of sector consumption corresponds to a very immature market and the minimum amount of 0 points is attributed. For values in between the minimum and the maximum threshold a linear interpolation is applied.
>
> B. If production as share of 2030 potential reaches 60% a market is considered to be very advanced and the maximum amount of 40 points is attributed. Whereas, 0% production as share of 2030 potential corresponds to a very immature market and the minimum amount of 0 points is attributed. For values in between the minimum and the maximum threshold a linear interpolation is applied.
>
> C. If installed capacity reaches 100 MW the maximum amount of 20 points is attributed. Reaching the 100 MW threshold indicates that a significant number of projects have been realised in that market and thus that the technology can be considered to be proven to some extent in that market and that initial market entrance barriers have been overcome, which means the market is not completely immature anymore. In very large scale technologies like wind offshore, grid-connected biomass heat or

large hydro, 100 MW can be reached with very few or just one project. Therefore for these technologies 500 MW is applied as a threshold. For technologies with rather small average project sizes like photovoltaics, biogas, solar thermal heat, heat pumps and non-grid connected biomass heat, 50 MW is used as a threshold. For all other RET the default value of 100 MW is applied. Within this indicator set the sub-indicator Installed capacity is of no relevance in assessing markets whose deployment status is higher (intermediate or advanced), and therefore only a maximum of 20 points is attributed as compared to the 40 points for the other two sub-indicators. Receiving the maximum amount of 20 points for 100 MW installed capacity does not mean that 100 MW are considered to reflect an advanced deployment status – especially in larger countries this is certainly not the case. 0 MW In-stalled capacity corresponds to a very immature market and the minimum amount of 0 points is attributed. For values in between the minimum and the maximum threshold a linear interpolation is applied.'

8.5 ELECTRICITY MARKET PREPAREDNESS INDICATOR AND SUB-INDICATORS

Source: Held, et al. (2010)

'Sub-indicator A: Share of TSOs that are ownership unbundled

This sub-indicator indicates how independent TSOs operate and thus how likely equal treatment of renewable energy based Independent Power Producers (IPPs) is. In some Member States more than one TSO exists and some are ownership unbundled (former "integrated" companies, which owned both production and distribution infrastructure, completely sold off their transmission networks) and others not. The share of TSOs that are ownership unbundled is used as sub-indicator, although ownership unbundling goes beyond the present requirements of legal and functional TSO unbundling required by European law. This is due to missing data availability on softer forms of unbundling. Thus, sub-indicator A is based on information provided by the European Commission's 2010 *Report on progress in creating the internal gas and electricity market,* covering only full ownership unbundling.

Sub-indicator B: Number of companies with more than 5% share in generation capacity / wholesale market

This sub-indicator indicates whether market prices for electricity are competitive or might be influenced by market power of large producers. The more companies with a significant market share in a market operate, the more prices can be considered to be competitive. 5% is used as a threshold here because these data are collected by the used source, the European Commission *Report on progress in creating the internal gas and electricity market.*

Sub-indicator C: Number of companies with more than 5% share in retail market

This sub-indicator also indicates whether market prices are competitive or might be influenced by market power of large retailers. It indicates also whether retailers might be willing to buy from renewable energy based IPPs (Power Purchase Agreement, PPA, availability from incumbents) – the more retailers with a significant market share, the more competition and chance that they are willing to engage with renewable energy based IPPs. As for sub-indicator B, 5% market share is used as a threshold.

Sub-indicator D: Share of electricity traded at exchange (spot) in power consumption

This sub-indicator indicates the relevance and liquidity of the spot market at the power exchange and thus whether it can be a relevant sales channel for renewable energy based IPPs (independence from PPA availability from incumbents).

Sub-indicator E: Gate closure time

This sub-indicator indicates the level of balancing cost that renewable energy based IPPs have to cover if they sell power independently: The shorter the gate closure time the better the production forecast quality and the lower the balancing energy demand.

MORE SUB-INDICATORS ON ELECTRICITY MARKET DESIGN WOULD BE VALUABLE

Sub-indicators A to D rather represent the *electricity market structure,* whereas sub-indicator E represents *electricity market design*. Regarding *electricity market design* more aspects than gate closure time only are of relevance, *e.g.*:

- National market design aspects like
    - the balancing pricing system (dual/single pricing, penalties),
    - the existence of competitive balancing markets,
    - the options for intraday redispatch and/or intraday trading.
- International market integration/design aspects like
    - the existence of cross-border congestion management,
    - the existence of international balancing markets.

So far, for these issues no aggregated data could be detected that are available for all EU-27 Member States. Therefore these issues cannot yet be covered in the indicator. As soon as additional EU-wide data regarding *electricity market design* become available, it will be considered to include them in the *Electricity Market Preparedness indicator,* potentially establishing two complementing indicators, one on *market structure* and one on *market design.*

Aggregation of sub-indicators to one overall indicator

Figure 2-3 shows how the five sub-indicators are aggregated into one overall *Electricity Market Preparedness Indicator:*

- All five sub-indicators have the same weight in the overall *Electricity Market Preparedness Indicator:* All have a weight of 20%, and can contribute a maximum of 20 points to the maximum of 100 points for the overall indicator.

- For each sub-indicator it is defined how the points are attributed. For each sub-indicator at least one point is attributed in order to increase readability of the figure.

  If 100% of TSOs are ownership unbundled 20 points are attributed. If 0% of TSOs are ownership unbundled one point is attributed. If 8 companies have a market share of more than 5% in generation capacity / wholesale market (which is the highest value observed in the EU-27 in 2009 = best practice) 20 points are attributed. If this applies to only one company one point is attributed.

  If 7 companies have a market share of more than 5% in the retail market (which is the highest value observed in the EU-27 in 2009 = best practice) 20 points are attributed. If this applies to only one company one point is attributed.

  If the power exchange (spot) trade volume is above 30% of power consumption the EC (source see below) considers a market to be liquid and therefore 20 points are attributed. If this value is below 5%, the market is considered to be illiquid and one point is attributed. If gate closure time is one hour or below 20 points are attributed. If gate closure time is 24 hours or above one point is attributed.

- For some Member States not for all sub-indicators data are available in the used sources shown below. In the results figure this is indicated by a * in front of the country name. For these countries the stacked bar indicating the overall indicator is lower than it would be if all data were available. In order to indicate the fact that the stacked bar is incomplete, a segment is added to the stacked bar titled *Placeholder missing data points.* The height of that segment is 10 points by default.'

See Figure 11 for an illustration of the indicator and sub-indicators.

Figure 11: Electricity Market Preparedness indicator – Aggregation of sub-indicators. Source: Steinhilber, *et al.* (2011).

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