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Tracking progress towards accessible, green and efficient energy: The Inclusive Green Energy index

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HIGHLIGHTS

- Method for measuring progress towards accessible, green and efficient energy.
- Evaluation relative to idiosyncratic parameters (targets and thresholds).
- Multidimensional and flexible approach to evaluate access and use of energy.
- Empirical analysis of 157 countries relative to Sustainable Development Goal 7.
- Positive dynamics across the world but still much to be done.

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ABSTRACT

This paper presents an index to evaluate progress in achieving the key dimensions of the Sustainable Development Goal 7, which entails ensuring “access to affordable, sustainable and modern energy for all.” The key aspects of this index, called the Inclusive Green Energy index, are: (i) it focuses on changes, rather than on levels, of the access, greenness and use of energy; (ii) it exhibits a decomposability feature that permits integrating several dimensions, both positive and negative, in a friendly way; and (iii) the evaluation of progress is made relative to some reference values (targets and thresholds) that can differ between countries. We calculate the Inclusive Green Energy index of progress for 157 countries using data from 2004 to 2014 on three indicators intended to capture inclusiveness, greenness, and efficiency of energy use. The results show that progress has, on average, been positive across the world, with more than 87 per cent of the sample of countries experiencing some degree of progress. However, progress is smaller for the Middle East and North African and Sub-Saharan African countries and it is negative for most of the countries that exhibit low levels of human development, as measured by the Human Development Index. Furthermore, fewer than one in four of the countries in the sample have an Inclusive Green Energy index commensurate with having met their targets. This suggests that much remains to be done globally with regard to being on track towards meeting their Sustainable Development Goal 7 by 2030.

1. Introduction

The purpose of this study is twofold. On the one hand, to develop a method for measuring progress towards a more efficient, sustainable and inclusive use of energy. Those are dimensions of the access and use of energy contemplated in the Sustainable Development Goal 7. On the other hand, to provide an empirical analysis of the world situation regarding those aspects, using this methodology. We apply this method to a sample of 157 countries.

The Sustainable Development Goals (SDGs) were born at the UN

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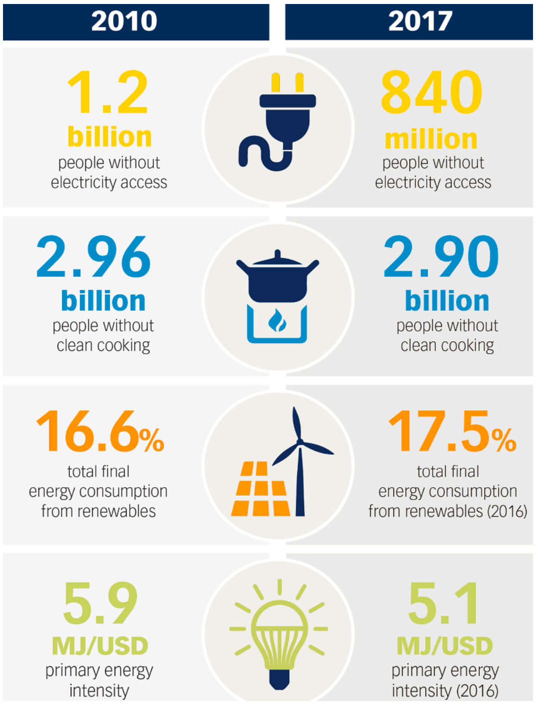

Fig. 1. Latest data on primary indicators of global progress toward SDG 7 targets. Source: Tracking SDG 7: The Energy Progress Report 2019.

Conference on Sustainable Development in Rio de Janeiro in June 2012. The two main agreements of that Conference were intended to alter the way countries approach sustainability. First, governments agreed to negotiate a set SDGs that would be universal, aspirational and transformational.[4] Second, they agreed that a green economy approach could be a tool for achieving this sustainable development by contributing to "(…) eradicating poverty as well as sustained economic growth, enhancing social inclusion, improving human welfare and creating opportunities for employment and decent work for all, while maintaining the healthy functioning of the Earth's ecosystems."[5] Sustainable development can be considered as a new paradigm to approach the socio-economic system [2], even if there are different ways of understanding this notion [3]. The most common approaches emphasize a holistic viewpoint, linking economic development, social inclusion and environmental sustainability [4].

Seventeen SDGs were identified with the aim of acting against poverty, protecting the planet and ensuring that all people enjoy peace and prosperity. They came into effect in January 2016, and they will continue to guide UN Development System policy and funding until 2030. The SDGs have been interpreted as *alarm bells* [2], which may identify particularly serious situations and call for specific response policies. Such a functionality requires suitable indicators involving targets and thresholds that can be applied not only to national levels but also adapted to sub-national realities [5,6]. SDG Goal 7 (SDG 7) refers to energy and intends to "ensure access to affordable, sustainable and modern energy for all".[6] The outstanding role of energy in the context of sustainable development had already been acknowledged at the World Summit for Sustainable Development in 2002[7]. In considering the challenges of sustainable growth, priority was given to policies for sustainable development, particularly in the areas of energy access, human health, poverty alleviation, energy security, energy efficiency, renewable energy and climate change [8].

According to the 2019 Tracking SDG7 Report,[7] the world is making progress towards achieving SDG 7, but there are some important challenges to meet these targets. For example, the number of people without access to electricity has fallen from 2010 to 2017 whereas the share of renewable energy out of total global energy consumption and energy efficiency have improved (see Fig. 1), but the report indicates that these improvements slowed in 2017 and 2018.

Different indicators have been proposed to evaluate energy use (see Applied Energy, special issue, 2016), carbon intensity [10], or energy access [11]. There are also a number of contributions that analyze the effects of different green energy policies on social welfare, with regards to employment [12,13], and energy efficiency [14,15]. The latter policies have been influential in international organizations [16].[8]

None of these initiatives, however, fully monitor the extent to which each of the individual SDG 7 goals is being achieved or not. To answer this question, we would want to construct an index that aggregates information from each of the indicators in a meaningful way, giving us an overall measure of progress. The Five UN agencies that created the Partnership for Action on Green Economy (PAGE)[9] have offered a solution to this effect: They have developed a framework for the measurement of an inclusive and green economy (UNEP, 2017a, 2017b). This framework is intended to provide countries with a comprehensive measurement system that includes an index, a dashboard and a resulting country ranking that tracks social progress, economic growth and environmental protection in a unified way, and gives heed to planetary boundaries that ought not be crossed.

In this study is to develop an Inclusive Green Energy index of progress with similar goals but circumscribed to SDG 7. The purpose of this evaluation protocol is twofold: (1) to provide a sound formula to measure progress and (2) to offer a tool that could be used as a guide for policymaking that not only uses information from the current tracking system but also provides a useful overall assessment of progress that complements the information given by the individual indicators.[10] The present work complements the Green Economy Measurement Framework developed by Page [19–20,21], by focusing on those dimensions related to SDG 7. The Green Economy Measurement framework pays special attention to what ought to be aggregated into an index, what needs to be kept separate in a dashboard, and how to use the index-dashboard combo to rank countries in terms of progress across the SDGs. We refer the readers to Herrero, Pineda, Villar and Zambrano [21] for details.

The remainder of the paper is organised as follows: Section 2 provides an overview of the literature. Section 3 presents the construction of the Inclusive Green Energy (IGE) index of progress and reviews the literature in light of our construction. Section 4 provides an empirical application that illustrates the working of this evaluation protocol focusing on SDG 7 for 183 countries. We will use three of the main indicators that correspond to SDG 7: Indicator 7.1.1- Proportion of population with access to electricity (a measure of inclusiveness of the consumption of energy); Indicator 7.2.1 Renewable energy share in the total final energy consumption (a measure of greenness of the consumption of energy); and Indicator: 7.3.1 Energy intensity measured in

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[4] The objective was to produce a set of universal goals that would meet the urgent environmental, political and economic challenges facing our world.

[5] United Nations General Assembly [1], "The Future We Want," art. 56.

[6] See https://sustainabledevelopment.un.org/sdg7.

[7] See IEA, IRENA, UNSD, WB and WHO [9], Tracking SDG 7: The Energy Progress Report 2019, Washington DC.

[8] See also the contributions by Sasse and Trutnevyte [17], and Jayadev, Leibowicz and Kutanoglu [18], discussing the cost-efficiency vs equitable results from the use of renewable energy and whether the costs of decarbonization are affordable, respectively.

[9] UN Environment, UNDP, UNIDO, UNITAR and ILO.

[10] See IEA, IRENA, UNSD, WB and WHO [9], Tracking SDG 7: The Energy Progress Report 2019, Washington DC.

terms of primary energy and GDP (a measure of efficiency in the consumption of energy). We develop and implement a methodology for the determination of the weights for these three dimensions. This methodology allows for these weights to vary depending on each country's characteristics. Section 5 illustrates the value of our methodology further by investigating how the IGE changes when making the thresholds more stringent, and also by considering an alternative calculation in which the thresholds do not play a role and all dimensions are treated symmetrically. Section 6 concludes.

2. Related literature

The need to go 'beyond GDP' at the moment of evaluating whether a given country advancing towards meeting its broad development goals has been long acknowledged.[11]

The first global Human Development Report in 1990 introduced the human development index (HDI) as an alternative to GDP in which individuals are central. The HDI has since become a widely-used measure of human progress more related to the lives of people than GDP alone. But even the HDI is lacking information on an important dimension of sustainable development, such as environmental sustainability.[12]

The search for alternatives to GDP in measuring progress have significantly expanded through the availability of new data and methodologies, including subjective measures of human well-being. The Better Life Initiative, developed by the Organization for Economic Cooperation and Development (OECD), is among the efforts to better capture what is important to people's lives. They have been significantly influenced by the Stiglitz-Sen-Fitoussi Commission, which concluded in 2009 that a broader range of indicators about development and social progress should be used alongside GDP. The Report of the United Nations Secretary-General's High-level Panel on Global Sustainability also highlights that the international community should measure development beyond GDP, and it recommends the creation of a new index or set of indices that incorporate sustainability considerations.

Below we review seven among the many initiatives aimed at tracking multidimensional progress over time.

2.1. *The Genuine Progress Indicator (GPI)*

A different way of addressing alternative indicators to the GDP is the Index of Sustainable Economic Welfare (ISEW), introduced by Daly and Cobb [24], and later reformulated as the Genuine Progress Indicator (GPI) [25]. It is an instrument able to put together traditional economic accounting with environmental and social variables under a sustainability viewpoint. In practice, it proposes some adjustments to the GDP, as personal consumption to account for inequalities, adds health and education to the public expenditure, considers domestic labour, etc. In addition, it subtracts to the final value the environmental emission costs, defensive expenditures, pollution control, social costs, and depreciation of natural capital. It has been widely studied, criticized and improved over time [26,27,28].

2.2. *The human development index (HDI)*

Constructed by the UNDP, the HDI methodology takes three indicators of interest (longevity, education attainment, and national income) and normalizes them to a zero-one interval (based on reference values one could interpret as 'thresholds' and 'targets' for the levels of those variables). Since 2010, the HDI is computed as the geometric mean of those normalized values. This methodology can be used to measure progress by tracking the changes in the value of the index over time. The HDI has been extensively studied. See, in particular, Herrero, Martínez and Villar [29], Zambrano [30], and Kawada, Nakamura and Otani [31].

2.3. *The extractives dependence index (EDI)*

The EDI methodology, developed by Hailu and Kipgen [32], calculates the geometric mean of three discounted indicators, which are intended to capture how dependent a country's exports, fiscal account and GDP are on extractive industries. The discounting accounts for the country's level of development. This methodology can be used to measure progress by tracking the changes in the value of the index over time.

2.4. *The Yale environmental performance index (EPI)*

The EPI was designed by Yale (Center for Environmental Law & Policy) and Columbia University (Center for International Earth Science Information Network).[13] EPI is divided into two main environmental protection objectives: environmental health and ecosystem vitality. These two areas are further divided into ten issue categories: Air Quality, Water and Sanitation, Heavy Metals, Biodiversity and Habitat, Forests, Fisheries, Climate and Energy, Air Pollution, Water Resources, and Agriculture. These are further divided into 24 individual metrics of environmental performance. Normalization is done by mapping each indicator to the 0–100 interval, where zero indicates worst performance, and 100 indicates that the country has met a target specified by the methodology. The partial indices are aggregated through a system of weighted arithmetic mean, for some pre-specified weights.

2.5. *The global sustainable competitiveness index (GSCI)*

The GSCI is developed by the World Economic Forum (WEF) and it is based on 116 quantitative indicators grouped into five pillars of sustainable competitiveness: Natural Capital, Resource Efficiency & Intensity, Intellectual Capital, Governance Efficiency, and Social Cohesion.[14] Data sets have been scored both for the current levels as well as the recent development of the indicator in order to not only reflect current standing, but also development potential. The GSCI aims to evaluate the ability of countries to create and sustain wealth that does not negatively affect the underlying fundament of wealth creation, based on the definition of Sustainable Development. The data, taken from international organizations and an internal survey, was aggregated in countries through a sector-weighted country average procedure. The normalization of the variables is made through a min-max transformation, while aggregation of indices in the categories is made by arithmetic mean.

2.6. *The human green development index (HGDI)*

Human green development is captured by this index through many types of indicators regarding welfare, green economy, and environmental/resource/ecology, involving more than 20 indicators in total.[15] The indicators used are separated into two dimensions, a social dimension and an economic sustainable development dimension. The weight system adopted for the HGDI within each dimension was based on the aggregation of subjective opinion of experts. The final value of HGDI is obtained by the geometric mean of the two dimensions.

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[11] See, e.g, Fleurbaey and Blanchet [22].

[12] See Pineda [23] for a proposal on how to adjust the HDI to environmental sustainability and Fleurbaey and Blanchet [22] for an in-depth exploration of the advantages and disadvantages of those adjustments.

[13] Wendling, Emerson, Esty, Levy and de Sherbinin [33].

[14] http://solability.com/the-global-sustainable-competitiveness-index/methodology

[15] [15] DOI: https://doi.org/10.1007/978-3-662-43591-5.

2.7. Index number theory

The theory of Index Numbers, as applied to the measurement of progress, aims to understand how to aggregate information about a large collection of 'quantities' (possibly denoting consumption or production of certain goods) into a single indicator. The fundamental problem is one of knowing what weight to assign to the different quantities. Because the theory has been developed in the context of measuring the growth of consumption or production of goods in a market economy, the natural point of departure is to use price information to construct weights for the different quantities. The rationale is fairly clear, goods that are viewed as more valuable by individuals and organizations typically command a high market price, and ought to have a greater weight on the index. Balk [34] provides a very comprehensive and modern review of index number theory.

3. The index

In this section we present the Inclusive Green Energy (IGE) focusing on the internal logic of this indicator, without discussing the specific dimensions involved (that will be addressed in Section 4). The formal model is presented in Appendix A. We also discuss how this index relates to others that appear in the literature.

The main features of the IGE index are the following: (i) It focuses on the measurement of relative changes in the variables of interest rather than on their levels (it is an index of *progress*); (ii) it evaluates realizations relative to some targets, which are an expression of underlying policy goals; (iii) it involves the use of thresholds that describe the existence of some barriers (related to sustainability) that must not be violated; (iv) it allows for different societies to value the dimensions included in the evaluation differently; and (v) it is flexible enough so that one can encompass dimensions that contribute towards progress and dimensions that count against progress. Let us briefly comment on the relevance of these features.

Focussing on changes allows us to stress the dynamic nature of environmental, economic and social considerations related to the achievement of SDG 7, and to compare societies with very different levels of development in terms of their contributions to *improving* the planet's sustainability. Introducing targets into the evaluation problem brings forth a policy dimension as these targets are a reflection of society's goals. Introducing thresholds into the evaluation problem brings forth the existence of planetary boundaries that should be taken into account. The introduction of differences in the way we ponder different dimensions allows us to specify precise ways in which the evaluation should vary for countries depending on their varying initial conditions and goals. Finally, allowing for positive ("goods") and negative ("bads") dimensions reflects the fact that a comprehensive evaluation should evaluate the negative, often unintended, consequences that come with economic development.

3.1. The basic formula: achievements, targets, and thresholds

Let us consider a multidimensional index intended to evaluate the performance of a single society with respect to K dimensions. Each dimension is measured in terms of a quantitative variable that approximates a society's achievement in that dimension, in the understanding that achievements may refer to "goods" and "bads" (see below). We assume from the outset that achievements are measured relative to some reference values that we call *targets*.

We provide here an evaluation formula that is characterised by a set of simple and intuitive requirements. To evaluate the outcomes given by a k-dimensional vector × , relative to a vector of targets **z,** we look for a continuous function $\varphi : \mathbb{R}_+^K \times \mathbb{R}_{++}^K \rightarrow \mathbb{R}$ that associates with each evaluation problem, defined by the pair $(\boldsymbol{x}, z)$, a real number $\varphi(\boldsymbol{x}, z)$ that tells us about the extent to which a society is fulfilling its objectives (see [35]. We obtain this function from an intuitive set of properties that we require the index to satisfy.

The first property, **homogeneity**, establishes that our evaluation formula is cardinal in nature so that a proportional change in the realisations, keeping targets constant, implies a proportional change of the evaluation. The second property, **normalisation**, determines a scale for our evaluation function. It says that the value of the function is equal to one when all outcomes match the targets. The third property, **factor decomposability**, establishes that we can express our index as the weighted sum of its constituent components. This is a property that permits one to build partial indices for a subset of variables or to integrate some of them into a broader indicator.

We show (see Appendix A for a formal proof) that an evaluation function $\varphi : \mathbb{R}_+^K \times \mathbb{R}_{++}^K \rightarrow \mathbb{R}$, satisfies the (independent) properties of homogeneity, normalisation, and factor decomposability, if and only if, it takes the form:

$$\varphi(\boldsymbol{x}, z) = \sum\nolimits_{k=1}^{K} w_k \frac{x_k}{z_k}$$

(with $w_k \geq 0$ for all k, $\sum\nolimits_{k=1}^{K} w_k = 1$).

This result shows that the aforementioned properties lead to a precise and very intuitive formula that evaluates a vector of outcomes relative to some given targets as the (weighted) average of the relative achievements across dimensions.

Focusing on progress amounts to defining realizations and targets in terms of *changes*. It is worth recognising from the very beginning that these dimensions may refer to "goods" (variables that improve social welfare) and "bads" (variables that diminish social welfare). Progress in an indicator that represents a **good** is described by an increase in the value of the variable, whereas progress in the case of a **bad** amounts to a reduction in the value of the variable.

Let y_k^1, y_k^0 stand for the current and the past reference values of the variable that approximates the kth dimension in society. We define the ***improvement rate*** of this society in the kth dimension, $\widehat{y}_k$, as follows:

$$\widehat{y}_k = \begin{cases} \dfrac{y_k^1 - y_k^0}{y_k^0}, & \text{for the case of goods} \\ -\dfrac{y_k^1 - y_k^0}{y_k^0}, & \text{for the case of bads} \end{cases}$$

The improvement rate in a given dimension is simply the corresponding growth or reduction rate.

The ***target rate*** for the kth dimension, δ_k, refers to the desired improvement rate of the kth variable.

Remark. We explicitly work here with dimensions in which there is a desired change (i.e.$\delta_k > 0$). Those variables for which no change is intended are set aside of the index.

Therefore, applying the evaluation formula presented above we obtain the following Inclusive Green Energy index:

$$IGE = \sum_{k=1}^{K} w_k \frac{\widehat{y}_k}{\delta_k}$$

That is, progress corresponds to a weighted average of the ratios between actual and desired increment rates (for the case of **goods**) or reduction rates (for the case of **bads**) of the variables that measure the different dimensions.

To make this formula an operational tool we have to specify how to determine the targets and the weights of those dimensions. Depending on the specific application, targets could be provided by policymakers according to their planning processes. This is the case for one of the indicators used in Section 3, for which the international community has agreed on a specific target. The choice of those w_k coefficients is always a difficult modelling decision. Here we propose to set those weights as a policy tool that induces *balancing progress* across dimensions. That is,

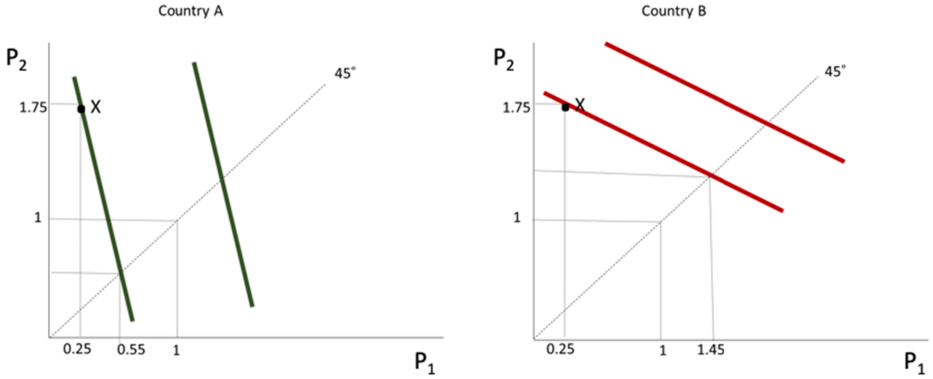

Fig. 2. Level curves for the index of progress for two countries. Source: Own elaboration.

choose the coefficients w_k, $k = 1, 2, \ldots$, K, in order to give more weight to progress in indicators for which the initial conditions were less favourable with respect to some reference values (thresholds) that identify ecological boundaries.[16]

Let t_k denote the ***threshold*** deemed relevant for the kth dimension, to be understood as an absolute value (a sort of planetary boundary). These thresholds correspond to minimal values for the case of **goods** and to maximal values for the case of **bads**. Given these thresholds, we can define the ***reference threshold ratio***, θ_k, to be equal to $\frac{t_k}{y_k^0}$ in the case of goods and $\frac{y_k^0}{t_k}$ in the case of **bads**. Notice that we wish the threshold ratios to be smaller than one in either case.

We propose the following restriction for defining the target rates, which involves the corresponding reference threshold ratios.

For the case of **goods**, we would like $(1+\delta_k)y_k^0 > t_k$. This implies that target rates should satisfy

$$1+\delta_k > \theta_k$$

The interpretation is that the target rate for a **good** should always be high enough to ensure that y_k^1 is above the threshold t_k whenever the target is met.

For the case of **bads**, we would like $(1-\delta_k)y_k^0 < t_k$. This implies that the target rates should satisfy

$$1-\delta_k < \frac{1}{\theta_k}$$

That is, the target rate for a **bad** should always be ambitious enough to ensure that y_k^1 is below the threshold t_k whenever the target is met.

In either case, the targets are to be set so that, if met, all variables would have threshold ratios less than one, implying the country would is on the beneficial side of all relevant thresholds.

Let $P_k = \frac{\widehat{y_k}}{\delta_k}$ denote the ratio of improvement and target rates for dimension k and define $w_k = \frac{\theta_k}{\sum_{k=1}^{K}\theta_k}$. The Inclusive Green Energy index can therefore be expressed as follows:

$$IGE(P_1, \cdots, P_K) = \sum_{k=1}^{K} w_k P_k \tag{1}$$

Positive values of this equation indicate that there has been progress in energy use whereas negative values are a sign of overall regress.

Remark. Note that when comparing several societies this implies that each society may well have different weights for the same dimension and therefore be subjected to different trade-offs among the different dimensions used to calculate overall progress. We discuss this important issue below.

3.2. The embedded trade-offs between different dimensions

Let us now consider the case in which we compare the overall performance of N different societies with respect to K common dimensions. Our choice of weights entails that each society will attach an idiosyncratic vector of weights to the different dimensions, which implies that different societies may have different weights for each of the K dimensions, and therefore different trade-offs between the K dimensions.[17] Let us briefly discuss the rationale of this type of comparison.

This approach to weighting dimensions preserves the priorities that each country may set for itself, increasing the policy relevance of the index. In other words, this type of comparison agrees with the desideratum that different societies may value progress in certain dimensions more than in others, depending on their initial conditions and other factors. One may argue that this approach then makes it harder to interpret comparisons, because indicators are then expressed “in different units”, so to speak. We will show that the type of comparison we do here can be given sensible interpretations in terms of “equivalent progress” values.

According to equation (1) the evaluation for country J is given by $IGE_J(P_1^J, \cdots, P_K^J) = \sum_{k=1}^{K} w_k^J P_k^J$. The ***equivalent progress*** is the scalar value p^J such that $IGE_J(P_1^J, \cdots, P_K^J) = IGE_J(p^J, \cdots, p^J)$. Now observe that:

$$IGE_J(P_1^J, \cdots, P_K^J,) = w_1^J p^J + \cdots + w_K^J p^J = p^J$$

Fig. 2 illustrates the case of two countries with identical progress in a two-dimensional problem. The slope of the level surfaces of $IGE(P_1, \cdots, P_K)$ in any two dimensions is determined by the weights attached to those dimensions. In the simplest two-dimensional case, this slope corresponds to the ratio $-(w_1/w_2)$ which in turn is equal to the ratio $-(\theta_1/\theta_2)$. The different slopes of these level curves reflect the fact that the two countries attach different weights to the two dimensions and therefore experience different trade-offs between them. The intersection with the 45° line of the level curve that crosses point **X** in the Figure identifies the country’s equivalent progress, that is, the common value for progress in both dimensions for each country that would yield the same evaluation as the actual progress measure that the country receives.

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[16] Needless to say, there is not a unique way of choosing these parameters, and the proposal below is one among many other possible ways.

[17] This is not a problem when we compare societies with respect to a single dimension, as there is no need of a weighting system in this case (even though different societies may be using different reference targets).

In summary, comparing societies with their own weights amounts to comparing them along the 45° line in Fig. 2, which is to compare their equivalent progress levels, a conventional way of making comparisons in many economic problems.[18]

We now discuss how Fig. 2 was constructed in some detail. This will not only illustrate how the methodology operates in the context of a simple example but will also highlight the importance of differentiating the position of countries depending on how far or how close they may be to certain planetary thresholds.

In the example depicted in Fig. 2 variable 1 is a **good** and variable 2 is a **bad**. For both countries we have that $P_1 = .25$, $P_2 = 1.75$, which means that both countries increased their levels of variable 1 and reduced their levels of variable 2. Both countries exceeded their targets in dimension 2 and failed to meet their targets in dimension 1 (although they both made progress in this dimension as well). The thresholds for all variables are set equal to 1 for both countries. For country A, we also have that $y_1^0 = y_2^0 = .5$, whereas for country B we have that $y_1^0 = y_2^0 = 2$. It follows that, for country A, the reference threshold ratios for each dimension are 2 and 0.5, respectively, whereas for country B they are 0.5 and 2, respectively. This means that country A is 'on the right side' of the threshold in dimension 2 and 'on the wrong side' of the threshold in dimension 1, whereas the opposite is true for country B. The weights on progress for country A are, therefore, $w_1^A = .8$ and $w_2^A = .2$, while they are $w_1^B = .2$ and $w_2^B = .8$ for country B. As a result, the slope of the level curves of the countries' IGE index are: -4 for country A and -0.25 for country B, highlighting that country B is willing to trade-off more progress in dimension 1 to obtain extra progress in dimension 2 than country A. For this reason, the IGE for country B (1.45) is larger than the IGE for country A (0.55), even though they both made the same degree of progress in dimension 1 (0.25) and dimension 2 (1.75). That $IGE_B > IGE_A$ makes sense in this case, since it was more important for country B to make progress in dimension 2, which is exactly what happened.

It is precisely the differences in the weights that these two countries assign to the progress achieved in the different dimensions that allows us to reach this conclusion. With a common set of weights for the two countries, we would be forced to assign the same IGE index to both countries, even though their positions arguably need to be differentiated. This is true as long as we believe that countries ought to readily move away from any undesirable planetary thresholds to which they may come dangerously close.

The example illustrates the following principle about the implicit trade-offs that applies generally across countries in our formalism: Country A is willing to give up more progress in dimension 2 to obtain extra progress in dimension 1 relative to country B when $\theta_1^A/\theta_2^A > \theta_1^B/\theta_2^B$. The higher the threshold ratio in a dimension for a country, the worse the position of that country is relative to the threshold for that dimension, and therefore the more important it is for that country to make progress in that dimension, relative to progress made in the other dimensions. The advantage of our formalism is therefore that it makes the computation, interpretation and comparison of trade-offs between dimensions across countries quite transparent and straightforward.

Remark. It is important to distinguish between the trade-offs that arise when trying to meet conflicting objectives (such as the one discussed above) and the trade-offs that arise when trying to meet a resource constraint. The essence of the policy problem in each country is precisely about the comparison between these trade-offs in order to decide how to best allocate its resources in order to obtain the most 'multidimensional progress' out of the country's limited resources.

3.3. Discussion

In Section 2 we reviewed seven initiatives aimed at tracking multidimensional progress over time. We now briefly focus on how those methodologies compare, conceptually, with our proposed methodology.

3.3.1. The Genuine Progress Indicator (GPI)

The GPI was designed to reveal the full trade-offs between costs and benefits of economic growth, i.e., it deals with "good and bads", and consider targets, but it does so in monetary terms. The GPI satisfies versions of homogeneity and factor decomposability but not normalization. Furthermore, in our formalism the weight on a measure of dimensional progress is determined by how the associated threshold ratio compares to the threshold ratios of all of the other relevant dimensions. These considerations do not play a role when calculating and evaluating the GPI.

3.3.2. The human development index (HDI)

In the context of our proposal, the HDI does not satisfy homogeneity or factor decomposability. Furthermore, it is difficult to use the HDI methodology as we do to track progress, since the HDI would report no progress unless all variables of interest (that are 'goods') are above their corresponding thresholds. Our methodology is able to track progress in these cases, and it will give more importance to dimensional improvements the more these improvements are needed, that is, the larger the threshold ratios happen to be.

3.3.3. The extractives dependence index (EDI)

When compared with our proposal, we notice that the EDI also does not satisfy homogeneity or factor decomposability. Furthermore, it is difficult to use the EDI methodology as we do to track progress, since there are no parameters in the EDI that could be viewed as identifying thresholds for the levels of the relevant indicators or targets for the rates of change of those indicators.

3.3.4. The Yale environmental performance index (EPI)

When compared with our proposal, we notice the following: (i) the EPI satisfies homogeneity and factor decomposability, (ii) it is applied to the levels of the indicators, as opposed to their changes, as in our proposal, (iii) it is not clear what the rationale is behind the specific weights given to the different variables, (iv) the concept of thresholds does not play a role in the methodology.

3.3.5. The global sustainable competitiveness index (GSCI)

When compared with our proposal, we notice that the concept of thresholds or targets does not play a role in the methodology behind the calculation of the GSCI. Also, it is not clear what the rationale is behind the specific weights given to the different variables.

3.3.6. The human green development index (HGDI)

When compared with our proposal, we notice that the concept of thresholds or targets does not play a role in the methodology behind the calculation of the HGDI. Notably, while the goals and targets of MDGs and SDGs provided direct guidance on how to choose indicators to include in the index, the index does not use specific target information to ascertain when the index ought to take a particular desirable value when the targets are met, as in our methodology.

3.3.7. Index number theory

While extremely attractive in what it aims to do, index number theory is of limited use for our purposes, the main reason being that, in the presence of large environmental and social externalities, whatever prices we may have available for the variables that enter the Inclusive Green Energy Index need not be appropriate measures of the marginal social value (or cost) of what the variable is intended to capture. Our proposed methodology nevertheless draws direct inspiration from both

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[18] This 'equivalence approach' is used extensively in Economics, in the context of the study of choices involving risk, social choice, welfare economics, and the theory of fair allocation, among others.

the theory of index numbers and the welfare economics literature.[19] In the absence of reliable information about the worth of meeting certain kinds of growth targets, we argue that this worth is closely related to the corresponding reference threshold ratios for those variables.

Let us conclude this section by stressing that, to our knowledge, ours is the first measurement system proposed in the literature that combines (i) targets for the growth rates of the variables, (ii) thresholds for the levels of the variables, (iii) the computation of reference threshold ratios for **goods** and **bads**, and (iv) the setting of weights on the dimensional measures of progress proportional to these reference threshold ratios. No other system of measurement, to our knowledge, offers such principled implementation of the basic desire that an evaluator may wish to place a higher weight to progress on those dimensions in which the respective initial condition is less favourable relative to the threshold.

4. From theory to practice: an application to the evaluation of energy use

In this section we provide an application of our methodology for the purpose of evaluating the extent to which a country is contributing towards meeting SDG 7: *Ensure access to affordable, reliable, sustainable and modern energy for all*. As explained in the Introduction, we define the Inclusive Green Energy index of progress for 157 countries in terms of the following dimensions (all from SDG 7):

- Indicator 7.1.1 (Energy inclusivity). Measured by the percentage of the population with access to electricity. This indicator measures a *good*, in the sense that an increase in its value represents progress.
- Indicator 7.2.1 (Greenness). Measured by the percentage of the renewable energy share in the total final energy consumption. This indicator is also a *good.*
- Indicator 7.3.1 (Efficiency). Energy intensity measured in kg of oil equivalent per $1000 of GDP in 2001 PPP terms. This indicator measures a *bad*, in the sense that a decrease in its value will represent progress in the inclusive green energy index.

For all these countries we have been able to produce values for at least two out of the three indicators, which is the minimum number of indicators for which the IGE index is calculated. Only 52 countries have values for all three indicators, while 157 countries have values for at least two indicators. In terms of the full sample, we have 135 countries with data on progress on energy intensity, 129 countries with data on progress on renewable energy, and 179 countries with data on progress in access to electricity. Appendix A reviews some characteristics of the data in more detail.

We broadly follow the methodological specifications in PAGE [20] in this application, but there are some important departures given the specificity of the indicators and the focus on SDG 7. The Inclusive Green Energy (IGE) Index was calculated for two composite moments in time, 2004 and 2014, and the data are averaged over a five-year period around these years (2000–2004 and 2010–2014) due to data limitations and to smooth any cyclical variations. For the sake of simplicity in exposition, the averaged data over 2000–2004 is referred to as “the 2004 data” and the averaged data over 2010–2014 is referred to as “the 2014 data.” Given data availability, it was possible to calculate progress for the three indicators and the two data points of analysis, 2004 and 2014, for a total of 157 countries. All the data were obtained from the World Development Indicators of the World Bank.

Thresholds in our application are determined based on certain characteristics of the world distribution of outcomes in each of the relevant dimensions, given the lack of internationally recognized scientific sources that can be used to determine such thresholds. We use a similar approach as that in PAGE [20], for **goods** (**bads**), the value of the threshold is set at the value of the 25th (75th) percentile of the world distribution in 2004. Countries should not go below (or above) the value achieved by the bottom 25 per cent (top 75 per cent) of countries in 2004 for this indicator.

When quantified, we used the internationally agreement upon targets for SDG 7.[20] The specific strategy we follow to set the **targets** is the following. The target for ‘energy intensity’ was determined using the globally accepted target SDG 7.3, “By 2030, double the global rate of improvement in energy efficiency.” This is why for each country we impose the most ambitious target between a magnitude equal to twice the observed median global reduction in the period 1994–2004 or the rate of growth that will at least allow the country to achieve the threshold for this indicator.

To illustrate, consider the case of Spain, which exhibits an energy intensity of 99.55 kg. Spain is below the threshold for this variable, which equals 177.65 kg (recall that energy intensity is a ‘bad’). The observed median global reduction of energy intensity in the period 1994–2004 was 6.19 percent. Therefore, the target for the percent reduction in the energy intensity for Spain is 12.38 percent. Moldova, in turn, exhibits an energy intensity of 326.74 kg, which is above the threshold for this variable. Consequently, the target for the percent reduction in the energy intensity for Moldova is 45.63 percent.

The result of applying the rule is an average (median) target for the percent reduction in the energy intensity indicator of 16.45 (12.38) percent across countries.

For the indicator ‘access to electricity’ we use targets for the growth rate of the indicator commensurate with reaching 100% access to electricity, according to the target of universal access by 2030. To illustrate, consider the case of Bolivia, which has a ratio of access to electricity of 0.703. Therefore, the target for the percent increase of this indicator for Bolivia is 42.22 percent. The result of applying the rule is a median target for the percent increase of the electricity access indicator of 63.49%.

For the indicator ‘share of renewable energy’ the SDG 7.3 target is not specific enough, “By 2030, increase substantially the share of renewable energy in the global energy mix.” For the purpose of this paper, we set targets that are ambitious but feasible according to specific country characteristics of the relevant comparison group (the “quartile” group of countries with similar initial share of renewable energy). We proceed as follows: for each country, the target is calculated on the basis of the percentile 90% of the distribution of growth rates between 1994 and 2004 in the country’s relevant comparison group. In case the resulting desired rate of growth is remains insufficient for achieving the threshold for this indicator, we choose as a target the rate of growth that will at least achieve the threshold for the indicator.

To illustrate, consider the case of Georgia, which exhibits a renewable energy share of 0. 534. Georgia is above the threshold for this variable, which equals 0.072 (this variable is a ‘good’). Georgia belongs to the group of countries with high share of renewable energy (specifically, the third quartile). The percentile 90% of the distribution of growth rates between 1994 and 2004 of the third quartile of countries is 15.14 percent, and we identify this as the target for Georgia in this case. Kazakhstan, in turn, exhibits a renewable energy share of 0.024, which is below the threshold for this variable. Consequently, the target for Kazakhstan’s percent increase of renewable energy share is 204.95 percent, which is the percentile 90% of the distribution of growth rates distribution of the group of countries with low shares of renewable energy (the first quartile). Notice that, if this target is met, Kazakhstan’s renewable energy share would be 0.072, which is above the threshold for this variable, as desired.

The result of applying the rule is a median target for the percent increase of the renewable energy consumption indicator of 50.86

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[19] And, in fact, is developed using similar conceptual tools (namely, the axiomatic method).

[20] See https://sustainabledevelopment.un.org/sdg7.

Table 1
The IGE index and its components.

	Energy intensity	Renewable energy	Access to electricity	IGE
Obs	121	155	90	157
Mean	0.915	−0.262	0.398	0.506
Std. Dev.	1.563	1.223	0.436	0.620
Min	−7.161	−4.303	−1.783	−2.015
1%	−5.895	−3.627	−1.783	−1.351
5%	−1.038	−2.785	0.027	−0.278
10%	−0.346	−1.949	0.088	−0.075
25%	0.405	−0.859	0.189	0.113
50%	1.112	−0.077	0.395	0.409
75%	1.621	0.491	0.687	0.836
90%	2.276	1.000	0.880	1.283
95%	2.621	1.824	0.963	1.609
99%	3.421	2.428	0.996	2.230
Max	4.702	3.246	0.996	2.657

Source: Authors' calculations.

Table 2
Summary statistics of the IGE index and two variants.

	Inclusive Green Energy Index: Base	Inclusive Green Energy Index: Case 1	Inclusive Green Energy Index: Case 2
Obs	157	157	157
Mean	0.506	0.231	0.091
Std. Dev.	0.620	0.405	0.285
Min	−2.015	−0.908	−2.066
1%	−1.351	−0.780	−0.687
5%	−0.278	−0.432	−0.358
10%	−0.075	−0.115	−0.191
25%	0.113	0.029	0.001
50%	0.409	0.210	0.115
75%	0.836	0.419	0.224
90%	1.283	0.712	0.384
95%	1.609	0.919	0.448
99%	2.230	1.315	0.757
Max	2.657	1.444	0.781

Source: Authors' calculations.

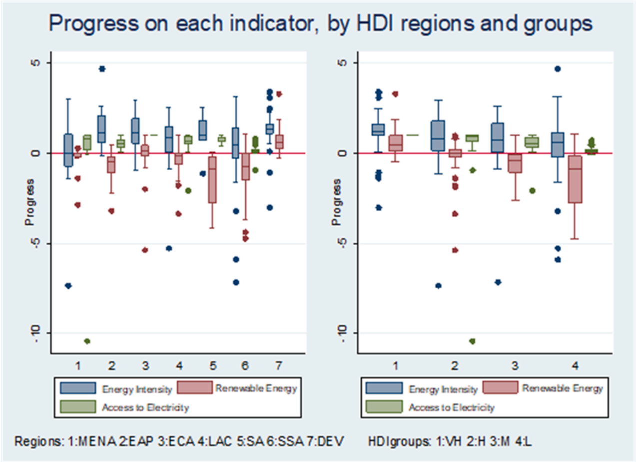

Fig. 3. Progress on indicators by HDI regions and groups. Source: Authors' calculations. Note: The four categories of human development achievement, 1 VH: Very High HDI; 2 H: High HDI; 3 M: Medium HDI; 4 L: Low HDI, are obtained using the following cut-offs: 0.800 for Very High, 0.700 for High and 0.550 for Medium. See UNDP [36]. The regions are: 1 MENA: Middle East and North Africa; 2 EAP: East Asia and the Pacific; 3 ECA: Europe and Central Asia; 4 LAC: Latin America and the Caribbean; 5 SA: South Asia; 6 SSA: Sub-Saharan Africa; 7 DEV: "Developed countries" are all countries with very high HDI (>0.8) that do not belong to any of the Developing regions according to UNDP's Human Development Report Office. See UNDP [36]. Human Development Indices and Indicators 2018 Statistical Update. New York.

percent, which corresponds to a median value for the target share of renewable energy consumption of 0.331.

Remark. From our perspective, the choices of targets and thresholds presented above are meant as "placeholders" for the values of these parameters that the decision makers in each country would use. In other words, the intended use of the IGE methodology is prospective, that is, as an instrument geared towards monitoring whether the desired targets the countries wish to meet become a reality over a particular planning horizon. More than reaching any definitive conclusions about how any particular country has fared, we wish to illustrate in this Section how the methodology can be used in practice by any country, given their normatively determined target and threshold values for each dimension of interest.

The first three columns of Table 1 present summary statistics for the three progress indicators in our sample of countries, based on the choices of targets and thresholds for these countries described above. On average, there has been progress in energy use (0.915) and access to energy (0.398), but not for renewable energy (−0.262).[21]

We investigate how the results vary across world regions. All regions on average, except those in the Developed countries group, experience regress on renewable energy, with South Asia and Sub-Saharan Africa experiencing the highest average regress, while Europe and Central Asia was the region where the average regress was the lowest (see the left panel of Fig. 3). We can also see how results vary depending on whether a country has a high or low HDI. The very high HDI group was the only group that, on average, made progress on all areas, with the highest average progress experienced on energy intensity. It is also important to highlight the progress of this group on the share of renewable energy, since this was the only HDI group that on average experienced progress on such indicator. On the other hand, the group with the largest average decline in the share of renewable was the Low HDI group (see the right panel of Fig. 3).

The indicator where the most of the countries have experienced progress is access to electricity (87 out of 90 countries), where Europe and Central Asia are the regions with the highest average progress on this indicator (where all countries achieved complete access). [22]These results seem to suggest that countries ought to focus the bulk of their efforts in increasing the share of renewables in their consumption of energy.

4.1. Overall progress: the IGE index

The last column of Table 1 presents a detailed summary of statistics for the Inclusive Green Energy index of progress, calculated using equation (1). Notice that the Inclusive Green Energy index of progress is positive on average (0.506), with 137 countries (87.3 per cent of the sample) with positive values for the Inclusive Green Energy index of progress (with an average IGE index of 0.638), while 20 countries exhibit negative values (with an average IGE index of −0.393). Results for the entire sample of 157 countries shown in Table 2 indicate an estimated median value of progress is 0.409, with the bottom 10

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[21] Notice that the sample of countries with observations for access to electricity is smaller because many countries, particularly those with very high HDI, have values for this indicator already around 100, so progress should not be expected on this indicator for these countries. See Tables 2.A through 5.A for all the underlying data for the calculation of the IGE index.

[22] Notice that there is no measure of progress for access to electricity for developed countries, since they have values for this indicator already around 100, so progress should not be expected on this indicator for these countries.

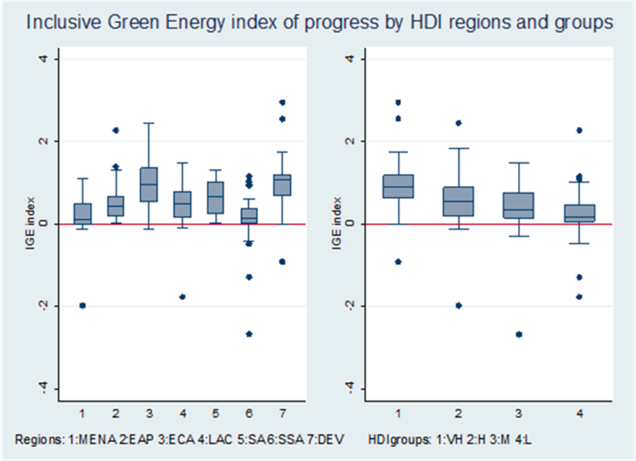

Fig. 4. The IGE index by HDI regions and groups. Source: Authors' calculations. Note: The four categories of human development achievement are: 1 VH. Very High HDI; 2H. High HDI; 3 M. Medium HDI; 4 L. Low HDI, are obtained using the following cut-offs: 0.800 for Very High, 0.700 for High and 0.550 for Medium. See UNDP [36]. The country regions are the following: 1 MENA. Middle East and North Africa; 2 EAP. East Asia and the Pacific; 3 ECA. Europe and Central Asia; 4 LAC. Latin America and the Caribbean; 5 SA. South Asia; 6 SSA. Sub-Saharan Africa; 7 DEV. "Developed countries" are all countries with very high HDI (>0.8) that do not belong to any of the Developing regions according to UNDP's Human Development Report Office. See UNDP [36]. Human Development Indices and Indicators 2018 Statistical Update. New York.

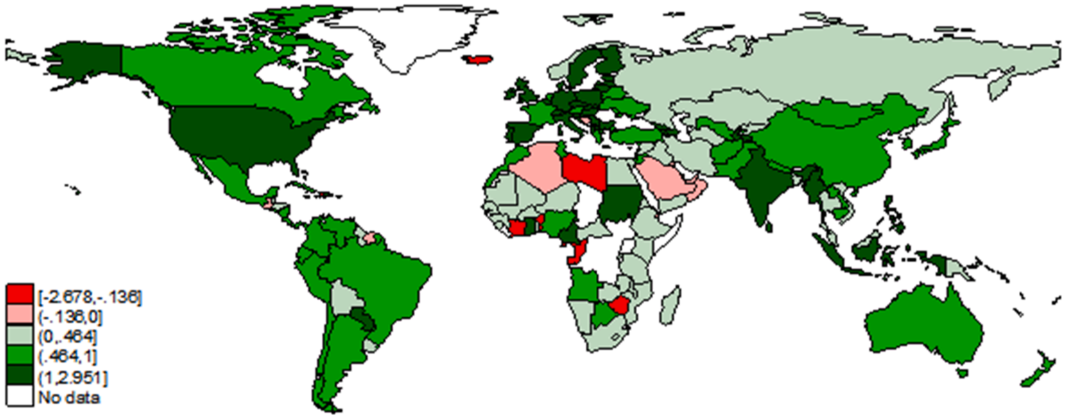

Fig. 5. The IGE index across the globe. Source: Authors' calculations.

percentile having a value lower than −0.075, and the top 90 percentile having a value above 1.283. Notably, close to 20 percent (31 out of 157) of the countries in the sample reach a level of IGE of one or greater, which means that although much remains to be done there is a group of countries making significant progress with regards to being on track towards meeting their energy sustainable development goals.

The left panel of Fig. 4 shows how the results differ by region. The results are on average positive for all regions, but smaller for the Middle East and North African and Sub-Saharan African countries. Developed countries have the highest share of countries with an IGE greater that one (16 out of 35 countries), while no country has an IGE greater than one in the Middle East and North African and Sub-Sahara African regions. In terms of the HDI group (see the right panel of Fig. 4), the results are positive for most countries in the very high HDI group (30 out of 36 countries), which is the group with the highest average progress. All HDI groups have countries with an IGE index greater that one, particularly the very high HDI countries (with 16 out of 38 countries). While only 1 country from the low HDI group (with 4 out of 36 countries) have an IGE index greater that one.

Fig. 5 shows a global map of Inclusive Green Energy index of progress for the 157 countries in the sample. The red area indicates high regress on Inclusive Green Energy, as measured by the Inclusive Green Energy index of progress, with a total of 20 countries experiencing regress. The red area is divided into two sub-areas, the dark red area for high regress (between −2.678 and −0.136), while the light red area is for moderate regress (between −0.136 and 0). The green area is divided into 3 sub-areas. Moderate progress is represented by the light green, countries between the 0 and 0.464 (the median of the IGE distribution). High progress cases, between 0.464 and 1, are presented in green, with darker green areas denoting countries with the most significant cases of progress (countries with progress greater than 1). There is a mix of reasons why these countries achieved such high progress. For example, Lithuania, Serbia and Tajikistan achieved this progress mainly by reducing their energy intensity by 42%, 32% and 47% with respect to their respective 2004 values.[23] On the other hand, Denmark and Sweden achieved high progress mostly by increasing their share of renewable energy in total consumption by 15 and 12.1 percentage points, respectively.[24] We report the IGE for all of the countries in our sample alongside the weights used for the aggregation of the dimensional measures of progress in Appendix 3.

5. More stringent thresholds and the symmetric case

One of the unique components of our methodology is the system of thresholds we use to calibrate the weights that the indicators receive in the index. For our baseline case, we followed the approach of PAGE [20]: for **goods** (**bads**), the value of the threshold is set at the value of the 25th (75th) percentile of the world distribution in 2005. In this section, we present two alternative specifications of the system of thresholds, in which these are made more stringent. In case 1, for **goods** and **bads**, the value of the threshold is set at the value of the median of the world distribution in 2004. In case 2, for **goods** (**bads**), the value of the threshold is set at the value of the 75th (25th) percentile of the world

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[23] Lithuania lowered its energy intensity from 173.8 to 100.2, Serbia lowered its energy intensity from 234.6 to 159.2, while Tajikistan lowered its energy intensity from 244.9 to 129.9, where energy intensity is measured as indicated in Section 4.

[24] Italy increased its share of renewable energy in total consumption from 0.122 to 0.272, while Sweden did from 0.369 to 0.490.

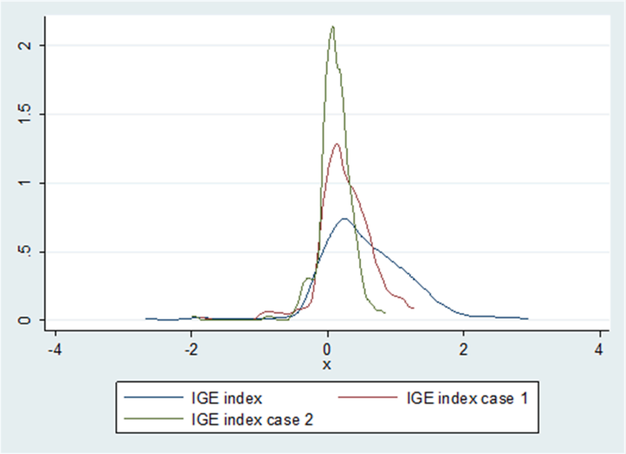

Fig. 6. IGE index: Robustness checks. Source: Authors' calculations.

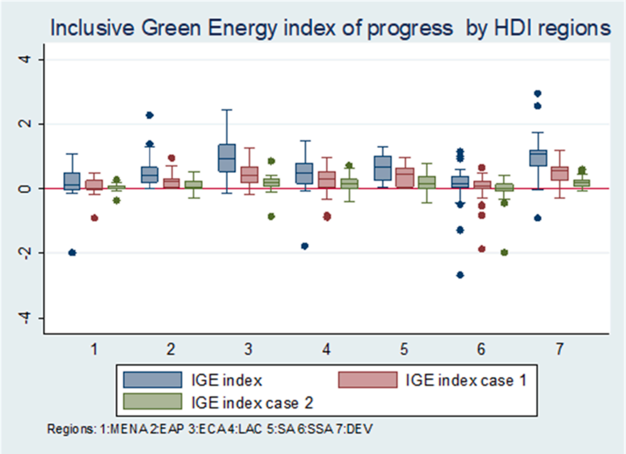

Fig. 7. IGE index by Regions: Robustness checks. Source: Authors' calculations. Note: The regions are: 1 MENA: Middle East and North Africa; 2 EAP: East Asia and the Pacific; 3 ECA: Europe and Central Asia; 4 LAC: Latin America and the Caribbean; 5 SA: South Asia; 6 SSA: Sub-Saharan Africa; 7 DEV: "Developed countries" are all countries with very high HDI (>0.8) that do not belong to any of the Developing regions according to UNDP's Human Development Report Office. See UNDP [36]. Human Development Indices and Indicators 2018 Statistical Update. New York.

distribution in 2004. These choices will increase the reference threshold ratios for all variables across all countries, and this will have the practical effect of increasing the weights for those variables in which the countries are performing comparatively worse.

5.1. More stringent thresholds

Table 2 presents a detailed summary of statistics for the Inclusive Green Energy index of progress, for the baseline case, as well as for cases 1 and 2 with the more stringent thresholds. Notice that for all cases progress is positive when we average across countries. However, the average progress is smaller as the critical thresholds are made more stringent (0.269 for case 1 and 0.106 for case 2), lowering the share of countries that experienced overall progress (for the baseline, 88.5 per cent of the sample of countries is experiencing progress, while these values drop to 84.6 per cent for case 1 and 75.4 per cent for case 2), as well as the share of countries that are meeting their targets, as measured by the IGE (for the baseline, 31 countries had an IGE greater than one, while these values drop to six for case 1[25] and zero for case 2).

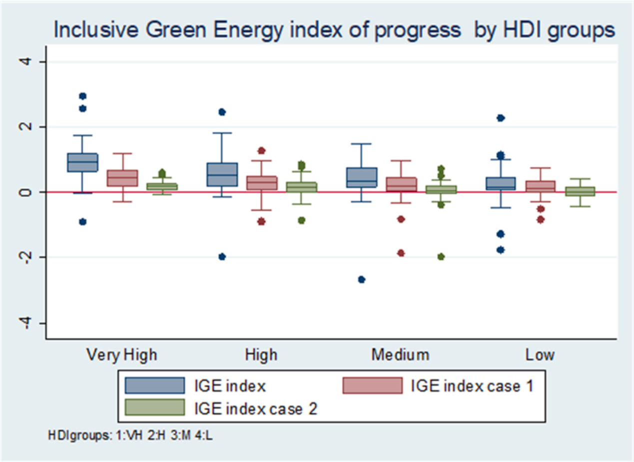

Fig. 8. IGE index by HDI group: Robustness checks. Source: Authors' calculations. Note: The four categories of human development achievement, 1 VH: Very High HDI; 2 H: High HDI; 3 M: Medium HDI; 4 L: Low HDI, are obtained using the following cut-offs: 0.800 for Very High, 0.700 for High and 0.550 for Medium. See UNDP [36]. Human Development Indices and Indicators 2018 Statistical Update. New York.

Fig. 6 presents the kernel density estimations of the distributions of the Inclusive Green Energy index of progress for the entire sample, comparing the baseline case with cases 1 and 2 with more stringent critical thresholds. The distribution of the IGE index of progress is positively skewed for the baseline case, but it moves towards the center for cases 1 and 2.[26] Fig. 7 shows how the results differ by region. The results are on average positive for all regions, but smaller for the Middle East and North African and Sub-Saharan African countries. In terms of HDI groups, Fig. 8 shows that results are positive for most countries in the very high HDI group across our three specifications (the baseline, case 1 and case 2). For the rest of the HDI groups the results are mixed, with results mostly positive for the high HDI group, while results were more mixed (with the median close to zero) for the medium and low HDI group. These results illustrate the importance of further refining the selection of critical thresholds, since for some regions their average assessment will depend on how stringent these critical thresholds ultimately are.

5.2. The symmetric case

In the evaluation of multidimensional progress towards reaching certain growth rate targets it is perhaps natural to do so by calculating a simple average of ratios of actual to desired growth rates. This is, however, not what we end up doing in this paper, as we use asymmetric weights that are proportional to the reference threshold ratios, for the reasons explained in Section 3.2. Therefore, to better assess the added value behind our methodology, in this sub-section we compare our results with those that we would obtain if we calculated the IGE as a simple arithmetic average. The purpose of this sub-section is therefore to make the case that the system of asymmetric weights that we propose produce much more valuable results than a simple computation of an arithmetic mean of the dimensional measures of progress.

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[25] These countries are Sweden (1.444), Latvia (1.315), Romania (1.306), Albania (1.244), Denmark (1.160), and Lithuania (1.088).

[26] As the threshold is made more stringent, the distribution also reduces its variability, because this gives more relative weight to those indicators with worse initial conditions relative to the critical threshold.

Table 3
Summary statistics of IGE index with symmetric common weights.

	Inclusive Green Energy Index (symmetric common weights)
Obs	157
Mean	0.325
Std. Dev.	0.765
Min	−2.094
1%	−1.984
5%	−0.887
10%	−0.610
25%	−0.112
50%	0.341
75%	0.789
90%	1.262
95%	1.608
99%	1.977
Max	2.122

Source: Authors' calculations.

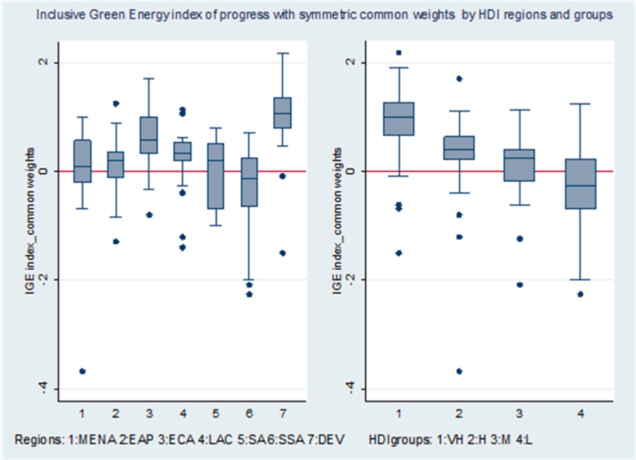

Fig. 9. IGE index with symmetric common weights by HDI group and regions. Source: Authors' calculations. Note: The four categories of human development achievement, 1 VH: Very High HDI; 2 H: High HDI; 3 M: Medium HDI; 4 L: Low HDI, are obtained using the following cut-offs: 0.800 for Very High, 0.700 for High and 0.550 for Medium. See UNDP [36]. The regions are: 1 MENA: Middle East and North Africa; 2 EAP: East Asia and the Pacific; 3 ECA: Europe and Central Asia; 4 LAC: Latin America and the Caribbean; 5 SA: South Asia; 6 SSA: Sub-Saharan Africa; 7 DEV: "Developed countries" are all countries with very high HDI (>0.8) that do not belong to any of the Developing regions according to UNDP's Human Development Report Office. See UNDP [36]. Human Development Indices and Indicators 2018 Statistical Update. New York.

Table 3 presents a detailed summary of statistics for the Inclusive Green Energy index of progress with symmetric common weights (the symmetric IGE in what follows), which was also calculated for the same sample of countries and using the same three indicators discussed above.

We saw in Section 4 that the average IGE index was 0.506, with positive values for 137 countries (with an average IGE index for this group of 0.638), while 20 countries exhibited negative values (with an average IGE index for this group of −0.393). In contrast, according to the symmetric IGE the average declines to 0.325, negative values are more prominent (44 countries) and more severe (average IGE index −0.594). Only 113 countries have positive values (with an average IGE index for this group of 0.683).

The left panel in Fig. 9 shows how the symmetric IGE results differ by region, where results are more heterogeneous across regions than in the baseline case of the IGE. Results show progress for most countries in Europe and Central Asia, Latin America and the Caribbean, and Developed countries, while they show regress for most countries in Sub-Saharan Africa. For other regions, results are more mixed. In terms of the HDI group (see the right panel of Fig. 9), results are mostly positive for the very high and high HDI groups, while somewhat mixed for the medium HDI and low HDI groups.

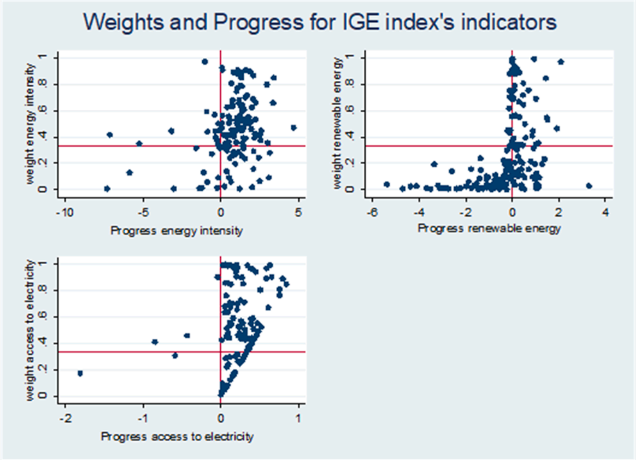

Fig. 10. Weights and Progress for indicators on the IGE index. Source: Authors' calculations.

The source of the differences we observe between the IGE and the symmetric IGE are due to the fact that, by construction, the IGE is a weighted average of dimensional progress measures whereas the symmetric IGE is a simple average of those same measures, and it turns out that most countries made more progress in the dimensions "in which they needed it the most" according to the individual weights those dimensions receive in our methodology. Recall that in our formulation the weights are proportional to the reference threshold ratios, and this implies that the dimensions that tend to receive greater weight are those in which the countries are predominantly "on the wrong side" of their thresholds. This makes sense, because that is precisely when progress ought to matter more, and where regress would be all the more inconvenient.

Fig. 10 illustrates this argument in the context of our calculations. We compare the dimensional progress measures against the weights these measures receive in the calculation of the IGE. We see that most countries made progress in the dimensions that received a weight greater than 1/3 (the weight used in the calculation of the symmetric IGE), whereas most countries regressed in the dimensions that received a weight smaller than 1/3. This is clearly seen in the case of renewable energy, which is the indicator for which more than half of the countries experienced regress (85 out of 155 countries), with an average progress of −0.262. To better understand the comparison, let's discuss the cases of Georgia and Tajikistan, which have IGE values greater than one for the baseline case, but negative for the equal weights case. The reason for this is that both Georgia and Tajikistan present significant negative progress on their share of renewable energy (−2.587 and −1.949, respectively). However, according to the baseline case, both countries have a low weight on having progress on the share of renewable energy, because they have a relatively high initial condition (53.40 percent and 63.34 percent, respectively). The asymmetric weight case -which is the formulation we prefer- is explicitly designed to combine information across dimensions in a way that is sensitive to particular aspects of the realities of the countries under consideration, as it allocates higher weight to the dimensions in which the initial conditions (relative to the thresholds) are less favourable, which is arguably where progress is more urgently needed.

6. Conclusion

We have presented here a procedure to evaluate progress towards achieving the key dimensions of the Sustainable Development Goal 7, which intends to "ensure access to affordable, sustainable and modern energy for all." The key aspects of our methodology are: (i) a focus on the change of the corresponding variables, rather than on their levels; (ii) a decomposability feature, which allows us to integrate several dimensions in a simple way, allowing for the inclusion of **goods** and **bads**; and (iii) an evaluation of progress relative to some normatively determined reference values: targets, which can differ between countries, and thresholds -that are to be interpreted as planetary boundaries that ought not to be crossed.

We have also provided an empirical application to illustrate how this evaluation protocol works and permits the identification of countries that are performing particularly well (or particularly poorly), and why. The application highlights the unique features of our approach as it aims to give more weight to progress on those indicators in which the initial condition is less favourable with respect to the threshold.

We calculated the Inclusive Green Energy index of progress for 157 countries using data from 2004 to 2014 on three indicators intended to capture inclusiveness, greenness, and efficiency regarding energy use. The results show that progress has, on average, been positive across the world, with more than 88 per cent of the sample of countries experiencing some degree of progress. However, progress is smaller for the Middle East and North African and Sub-Saharan African countries and it is negative for most of the countries that exhibit low levels of human development, as measured by the Human Development Index. Furthermore, fewer than one in four of the countries in the sample have an IGE commensurate with having met their respective country-level targets. This suggests that much remains to be done by almost all countries worldwide with regard to being on track towards meeting their Sustainable Development Goal 7 by 2030.

These results also suggest that countries ought to focus the bulk of their efforts in increasing the share of renewable in their consumption of energy, since this was the indicator where more countries/regions move on the wrong direction. This is particularly relevant for South Asia and Sub-Saharan Africa, since they experienced the highest average regress on renewable energy.

There are many aspects of the model presented here that could and should be refined further. The choice of weights, targets and thresholds proposed here might be sensible, but other options are certainly possible, even as we have used, availability permitting, policy relevant targets, as those corresponding to the Sustainable Development Goal 7.3. All these are aspects that can be improved greatly by obtaining concrete information at the country level about the relevant targets and thresholds, and then using the Inclusive Green Energy index methodology as an instrument geared towards monitoring whether the desired targets the countries wish to meet become a reality in the not so distant future.

CRediT authorship contribution statement

Carmen Herrero: Conceptualization, Methodology, Formal analysis. **José Pineda:** Conceptualization, Methodology, Data curation, Visualization. **Antonio Villar:** Conceptualization, Methodology, Formal analysis. **Eduardo Zambrano:** Conceptualization, Methodology, Formal analysis.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. The formal model

Let $\mathbb{R}_{+}^{K} \times \mathbb{R}_{++}^{K}$stand for the joint space of realizations and targets. An evaluation problem, or simply a ***problem***, is a point $(\boldsymbol{x}, z) \in \mathbb{R}_{+}^{K} \times \mathbb{R}_{++}^{K}$. To evaluate the outcomes given by a vector $\times$, relative to a vector of targets **z,** we look for a continuous function $\varphi_K : \mathbb{R}_{+}^{K} \times \mathbb{R}_{++}^{K} \rightarrow \mathbb{R}$. Sub-index K in the function specifies the dimensionality.

Consider now the following properties:

- **Homogeneity:** $\varphi_K(\lambda \boldsymbol{x}, z) = \lambda \varphi_K(\boldsymbol{x}, z)$ for all $K \in \mathbb{N}$, all$(\boldsymbol{x}, z) \in \mathbb{R}_{+}^{K} \times \mathbb{R}_{++}^{K}$ and all $\lambda \in \mathbb{R}_{++}^{K}$.
- **Symmetry:** $\varphi_K\left(\left(x_{\sigma(1)}, \cdots, x_{\sigma(K)}\right), \left(z_{\sigma(1)}, \cdots, z_{\sigma(K)}\right)\right) = \varphi_K(\boldsymbol{x}, z)$ for all $K \in \mathbb{N}$, all $(\boldsymbol{x}, z) \in \mathbb{R}_{+}^{K} \times \mathbb{R}_{++}^{K}$ and all permutation functions $\sigma : K \rightarrow K$.
- Normalisation: $\varphi_K(z, z) = 1 \mathrm{forall} K \in \mathbb{N}$ and all $z \in \mathbb{R}_{++}^{K}$.

Let $\varphi_1 : \mathbb{R}_{+} \times \mathbb{R}_{++} \rightarrow \mathbb{R}$ is the function that evaluates a society's performance when there is a single dimension. Then,

- **Factor decomposability:**$\varphi_K(\boldsymbol{x}, z) = \sum_{k=1}^{K} w_k \varphi_1(x_k, z_k)$ for all $K \in \mathbb{N}$, all $(\boldsymbol{x}, z) \in \mathbb{R}_{+}^{K} \times \mathbb{R}_{++}^{K}$ and for some $w_k \in \mathbb{R}_{+}$ for $k = 1, \cdots, K$ such that $\sum_{k=1}^{K} w_k = 1$.

The following result is obtained:

Theorem. *A multilevel evaluation function* $\varphi_K : \mathbb{R}_{+}^{K} \times \mathbb{R}_{++}^{K} \rightarrow \mathbb{R}$*, satisfies the properties of homogeneity, normalisation, and factor decomposability, if and only if, it takes the form:*

$$\varphi_K(\boldsymbol{x}, z) = \sum_{k=1}^{K} w_k \frac{x_k}{z_k}$$

Moreover, these properties are independent.

Proof. (i) We can immediately check that this function satisfies all these properties. Let us now prove the converse implication.

By homogeneity and normalisation, we deduce that, for $K=1$ and $(x,z)\in\mathbb{R}_{+}\times\mathbb{R}_{++}$,

$$1=\varphi_1(z,z)=\varphi_1\left(\frac{z}{x}x,z\right)=\frac{z}{x}\varphi_1(x,z)$$

$$\Rightarrow\varphi_1(x,z)=\frac{x}{z}$$

By factor decomposability we have that for all $K\in\mathbb{N}$, all $(\boldsymbol{x},\boldsymbol{z})\in\mathbb{R}_{+}^{K}\times\mathbb{R}_{++}^{K}$ and for some $w_k\in\mathbb{R}_{+}$ for, $k=1,\cdots,K$, such that $\sum_{k=1}^{K}w_k=1$, $\varphi_K(\boldsymbol{x},\boldsymbol{z})=\sum_{k=1}^{K}w_k\varphi_1(x_k,z_k)$

Hence,

$$\varphi_K(\boldsymbol{x},\boldsymbol{z})=\sum\nolimits_{k=1}^{K}w_k\frac{x_k}{z_k}$$

(ii) Let us show now that these three properties are independent. To do so consider the following functions:

- $\varphi_K^A(\boldsymbol{x},\boldsymbol{z})=\sum_{k=1}^{K}\frac{x_k}{z_k}$.
- $\varphi_K^B(\boldsymbol{x},\boldsymbol{z})=\min_k\left\{\frac{x_k}{z_k}\right\}$.
- $\varphi_K^C(\boldsymbol{x},\boldsymbol{z})=\frac{1}{K}\sum_{k=1}^{K}\left(\frac{x_k}{z_k}\right)^2$.

φ_K^A satisfies homogeneity and factor decomposability but not normalisation. φ_K^B satisfies homogeneity and normalisation but not factor decomposability. φ_K^C satisfies factor decomposability and normalisation but not homogeneity.■

Appendix B. Data pre-processing

Table B.1 presents the three indicators selected to capture progress on SDG7. All indicators come from the World Bank's World Development Indicators (WDI). The annual data is averaged over a five-year period. For example, the value for 2004 is the average of the observations between 2000 and 2004, the value for 2009 is the average of the observations between 2005 and 2009, while the value for 2014 is the average of the observations between 2010 and 2014 (or more recent information -up to 2016, if available).

Table B1
Components of the IGE index.

Indicator	Description	Country coverage	Data Source
Renewable energy	Share of renewable energy in the total final energy consumption	129	WDI
Energy intensity	Energy intensity (kg of oil equivalent) per USD 1,000 GDP (constant 2011 PPP).	135	WDI
Access to electricity	Percentage of the population with access to electricity	179	WDI

Source: The World Bank [37].

Some amount of data pre-processing was in order. First, progress on access to electricity is calculated for those countries for whom their initial share is below the value of the percentile 95 of the distribution in 2004 (which was 0.9945). In addition, any country whose final share of access to electricity is greater than or equal to 0.9945 will be assigned a share of access equal to 1. Second, progress on the share of renewable energy is calculated for those countries where their initial share is below the value of the percentile 95 of the distribution in 2004 (which was 0.9022). In addition, there are countries whose initial share of renewable energy is zero. For the purpose of calculating the reference threshold ratios for those countries, we assign, as the initial condition for these countries, the value of the percentile 1% of the distribution of these shares, after excluding the zeros.

Appendix C. The index and its components

Table C.1 presents the results of the Inclusive Green Energy Index and each of the sub-components, as well as all the underlying weights for its construction.

Table C1
IGE index by country.

Country name	Weight Energy intensity	Weight Renewable energy	Weight Access to electricity	Progress Energy intensity	Progress Renewable energy	Progress Access to electricity	Inclusive Green Energy index
Lithuania	0.71	0.29	.	3.42	0.82	.	2.66
Romania	0.63	0.37	.	2.96	0.96	.	2.23
Denmark	0.44	0.56	.	1.37	2.43	.	1.96
Slovak Republic	0.46	0.54	.	3.37	0.58	.	1.86
Myanmar	0.38	0.03	0.58	4.70	−1.08	0.15	1.85
Sweden	0.81	0.19	.	1.62	2.17	.	1.73
Spain	0.39	0.61	.	1.38	1.83	.	1.66
Albania	0.74	0.26	.	2.08	0.25	.	1.61
Latvia	0.79	0.21	.	1.88	0.49	.	1.58
Poland	0.46	0.54	.	2.26	1.00	.	1.58
Bulgaria	0.61	0.39	.	1.34	1.72	.	1.49
Tajikistan	0.92	0.08	.	1.71	−1.95	.	1.43
Georgia	0.87	0.13	.	1.99	−2.59	.	1.41
Macedonia, FYR	0.67	0.33	.	1.80	0.47	.	1.36
Czech Republic	0.49	0.51	.	2.07	0.52	.	1.29
Hungary	0.34	0.66	.	1.62	1.11	.	1.28
Armenia	0.53	0.47	.	2.19	0.25	.	1.28
Jamaica	0.40	0.25	0.34	2.28	0.57	0.61	1.28
Finland	0.81	0.19	.	1.11	1.86	.	1.25
Ireland	0.12	0.88	.	2.43	1.01	.	1.18
Dominican Republic	0.31	0.23	0.46	2.57	−0.13	0.85	1.17
Belgium	0.17	0.83	.	1.45	1.10	.	1.16
Sri Lanka	0.29	0.08	0.64	2.56	−0.81	0.65	1.09
Philippines	0.35	0.12	0.53	2.62	−0.79	0.48	1.07
Estonia	0.75	0.25	.	1.23	0.58	.	1.07
Serbia	0.78	0.22	.	1.32	0.15	.	1.06
Indonesia	0.42	0.10	0.48	1.94	−0.91	0.70	1.06
Slovenia	0.62	0.38	.	1.25	0.74	.	1.05
Germany	0.28	0.72	.	1.46	0.89	.	1.05
Croatia	0.71	0.29	.	1.30	0.38	.	1.03
Switzerland	0.50	0.50	.	1.57	0.44	.	1.01
Cyprus	0.19	0.81	.	1.39	0.89	.	0.99
France	0.46	0.54	.	1.18	0.78	.	0.96
Portugal	0.59	0.41	.	1.09	0.76	.	0.95
Paraguay	0.43	0.07	0.50	1.29	−1.06	0.82	0.89
New Zealand	0.77	0.23	.	1.01	0.50	.	0.89
India	0.41	0.07	0.53	1.81	−1.69	0.47	0.88
Ghana	0.32	0.05	0.63	2.47	−4.30	0.45	0.88
United Kingdom	0.08	0.92	.	2.12	0.77	.	0.88
Cameroon	0.34	0.03	0.63	2.19	−1.18	0.21	0.84
Sudan	0.28	0.03	0.70	3.01	−2.78	0.11	0.83
Italy	0.27	0.73	.	0.71	0.86	.	0.82
Nigeria	0.45	0.03	0.52	1.61	0.36	0.16	0.82
United States	0.40	0.60	.	1.52	0.33	.	0.81
Pakistan	0.41	0.08	0.51	1.16	−0.46	0.71	0.80
Azerbaijan	0.34	0.66	.	1.95	0.11	.	0.74
Nepal	0.36	0.02	0.62	0.83	−0.51	0.70	0.72
Angola	0.21	0.03	0.76	3.15	−3.63	0.16	0.70
Austria	0.65	0.35	.	0.69	0.71	.	0.70
El Salvador	0.42	0.09	0.49	1.51	−2.84	0.59	0.68
Australia	0.48	0.52	.	1.17	0.20	.	0.67
Luxembourg	0.18	0.82	.	1.44	0.50	.	0.67
Netherlands	0.15	0.85	.	1.13	0.58	.	0.66
Cambodia	0.22	0.02	0.76	2.11	−2.17	0.30	0.66
Moldova	0.59	0.41	.	0.72	0.57	.	0.65
Canada	0.78	0.22	.	0.81	0.07	.	0.64
Belarus	0.56	0.44	.	1.03	0.15	.	0.64
Colombia	0.29	0.18	0.53	1.59	−0.72	0.55	0.62
Venezuela, RB	0.63	0.37	.	1.04	−0.11	.	0.61
Samoa	.	0.17	0.83	.	−0.56	0.85	0.61
China	0.57	0.12	0.31	0.76	−1.04	0.97	0.61
Argentina	0.33	0.31	0.37	1.03	−0.28	0.91	0.58
Turkey	0.29	0.26	0.45	0.84	−0.46	1.00	0.57
Lebanon	0.35	0.65	.	1.76	−0.11	.	0.55
Chile	0.73	0.27	.	1.02	−0.81	.	0.53
Korea, Dem. People's Rep.	.	0.15	0.85	.	2.30	0.22	0.53
Nicaragua	0.43	0.07	0.50	1.00	−0.52	0.25	0.52
Greece	0.35	0.65	.	0.52	0.52	.	0.52
Eswatini	.	0.06	0.94	.	2.11	0.41	0.51
Panama	0.30	0.14	0.56	2.16	−2.63	0.42	0.50
Brazil	0.37	0.12	0.51	0.07	0.07	0.88	0.48
Japan	0.26	0.74	.	1.36	0.17	.	0.48

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Table C1 (*continued*)

Country name	Weight Energy intensity	Weight Renewable energy	Weight Access to electricity	Progress Energy intensity	Progress Renewable energy	Progress Access to electricity	Inclusive Green Energy index
Botswana	0.18	0.07	0.76	1.55	−0.97	0.35	0.47
Uzbekistan	0.46	0.54	.	0.73	0.22	.	0.45
Costa Rica	0.67	0.33	.	0.18	1.00	.	0.45
Comoros	.	0.09	0.91	.	0.07	0.47	0.44
Ecuador	0.31	0.24	0.45	0.80	−0.57	0.69	0.42
Mauritius	0.54	0.46	.	1.44	−0.76	.	0.42
Ukraine	0.31	0.69	.	0.54	0.35	.	0.41
Thailand	0.39	0.19	0.43	−0.15	0.25	0.96	0.40
Lao PDR	.	0.06	0.94	.	−3.13	0.60	0.39
Jordan	0.17	0.83	.	1.35	0.20	.	0.39
Peru	0.24	0.14	0.62	0.53	−1.18	0.69	0.39
Ethiopia	0.44	.	0.56	0.62	.	0.19	0.38
Mongolia	0.35	0.36	0.29	1.14	−0.23	0.22	0.37
Israel	0.36	0.64	.	1.23	−0.10	.	0.37
Dominica	.	0.44	0.56	.	−0.27	0.88	0.37
Morocco	0.25	0.23	0.52	0.28	−0.55	0.82	0.37
Bangladesh	0.19	0.05	0.76	0.74	−1.98	0.42	0.36
Honduras	0.41	0.07	0.52	0.09	0.15	0.58	0.35
Zambia	0.28	0.01	0.70	0.98	−0.05	0.09	0.34
Tunisia	0.52	0.48	.	0.80	−0.17	.	0.34
Uruguay	0.69	0.31	.	−0.35	1.82	.	0.34
Solomon Islands	.	0.02	0.98	.	−0.57	0.34	0.33
St. Vincent and the Grenadines	.	0.57	0.43	.	−0.05	0.83	0.33
Vietnam	0.46	0.08	0.46	0.12	−2.04	0.95	0.33
Kenya	0.22	0.02	0.76	0.80	−0.81	0.21	0.32
Fiji	.	0.15	0.85	.	−1.94	0.71	0.32
South Africa	0.51	0.15	0.34	0.40	−0.14	0.38	0.32
Russian Federation	0.43	0.57	.	0.75	−0.01	.	0.31
Cabo Verde	.	0.17	0.83	.	−1.37	0.65	0.31
Belize	.	0.23	0.77	.	0.68	0.15	0.27
Korea, Rep.	0.10	0.90	.	0.92	0.19	.	0.26
Eritrea	0.23	0.03	0.74	0.39	1.10	0.17	0.25
Marshall Islands	.	0.28	0.72	.	−0.70	0.62	0.25
Niger	0.92	0.08	.	0.38	−1.50	.	0.23
Namibia	0.20	0.09	0.72	0.90	−0.94	0.17	0.22
Grenada	.	0.46	0.54	.	0.10	0.31	0.21
Timor-Leste	.	0.05	0.95	.	−3.04	0.39	0.21
Tanzania	0.18	.	0.82	0.59	.	0.09	0.18
Kiribati	.	0.57	0.43	.	−0.10	0.51	0.16
Mali	.	0.02	0.98	.	−3.30	0.20	0.15
Malaysia	0.38	0.62	.	0.57	−0.13	.	0.14
Bahamas, The	.	0.92	0.08	.	0.06	0.97	0.13
Gambia, The	.	0.05	0.95	.	−0.75	0.18	0.13
Syrian Arab Republic	.	0.82	0.18	.	−0.02	0.79	0.13
Vanuatu	.	0.05	0.95	.	−1.86	0.22	0.12
Mauritania	.	0.05	0.95	.	−1.42	0.19	0.11
Senegal	0.29	0.07	0.64	−0.26	0.27	0.26	0.11
St. Kitts and Nevis	.	0.28	0.72	.	−1.86	0.86	0.11
Micronesia, Fed. Sts.	.	0.83	0.17	.	0.05	0.40	0.11
Hong Kong SAR, China	0.03	0.97	.	2.49	0.03	.	0.10
Guinea	.	0.02	0.98	.	−1.22	0.13	0.10
Togo	0.36	0.02	0.62	−0.14	−1.25	0.26	0.09
Yemen, Rep.	0.05	0.80	0.15	−0.17	0.04	0.34	0.08
St. Lucia	.	0.79	0.21	.	−0.08	0.58	0.06
Burkina Faso	.	0.01	0.99	.	−0.80	0.07	0.06
Norway	0.82	0.18	.	0.10	−0.13	.	0.06
Sao Tome and Principe	.	0.09	0.91	.	−1.39	0.20	0.05
Papua New Guinea	.	0.02	0.98	.	−1.73	0.09	0.05
Maldives	.	0.83	0.17	.	−0.15	0.93	0.04
Kosovo	0.51	0.14	0.35	1.34	−0.33	−1.73	0.03
Mexico	0.46	0.54	.	0.39	−0.30	.	0.02
Guatemala	0.35	0.08	0.58	−0.84	0.48	0.46	0.01
Sierra Leone	.	0.01	0.99	.	−1.38	0.03	0.01
Madagascar	.	0.02	0.98	.	−0.86	0.02	0.01
Turks and Caicos Islands	.	0.94	0.06	.	−0.01	0.19	0.00
Trinidad and Tobago	0.18	0.77	0.05	−0.10	−0.05	0.98	−0.01
Iran, Islamic Rep.	0.07	0.93	.	−1.12	0.04	.	−0.03
Tonga	.	0.79	0.21	.	−0.20	0.57	−0.04
Kazakhstan	0.29	0.71	.	0.36	−0.21	.	−0.04
Guyana	.	0.16	0.84	.	−2.07	0.29	−0.08
Bolivia	0.34	0.14	0.52	−0.36	−2.08	0.65	−0.08

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Table C1 (*continued*)

Country name	Weight Energy intensity	Weight Renewable energy	Weight Access to electricity	Progress Energy intensity	Progress Renewable energy	Progress Access to electricity	Inclusive Green Energy index
Djibouti	.	0.15	0.85	.	−0.27	−0.04	−0.08
Libya	0.18	0.82	.	−0.59	−0.02	.	−0.12
Zimbabwe	0.48	0.02	0.50	−0.38	1.01	0.03	−0.14
Kyrgyz Republic	0.84	0.16	.	0.10	−1.42	.	−0.14
Equatorial Guinea	.	0.21	0.79	.	−1.44	0.10	−0.23
Suriname	0.39	0.16	0.45	1.68	−0.69	−1.78	−0.26
Congo, Rep.	0.09	0.03	0.87	−5.89	−0.39	0.33	−0.28
Benin	0.24	0.03	0.73	−1.60	−2.91	0.19	−0.33
Egypt, Arab Rep.	0.33	0.67	.	−0.19	−0.49	.	−0.39
Bosnia and Herzegovina	0.73	0.27	.	−0.90	0.48	.	−0.52
Iceland	0.94	0.06	.	−1.04	3.25	.	−0.76
Cote d'Ivoire	0.36	0.05	0.60	−3.20	1.03	0.21	−0.97
Haiti	0.27	0.03	0.70	−5.28	1.00	0.07	−1.35
Gabon	0.33	0.06	0.61	−7.16	0.38	0.49	−2.02

Source: Authors' calculations.

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