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INDICATOR-BASED FRAMEWORK:
A PROPOSITION TO ACHIEVE A SUSTAINABLE ENERGY FUTURE IN THE BRAZILIAN ELECTRICITY INDUSTRY

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Tese apresentada ao Programa de Pós-Graduação em Energia do Instituto de Energia e Ambiente da Universidade de São Paulo para a obtenção do título de Doutora em Ciências.

Orientadora: Prof[a.] Dr[a.] Virginia Parente

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For Mario and Reiko, for everything.

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RESUMO

TANAKA, K. T. **Índice Baseado em Indicadores: uma Proposta para Alcançar um Futuro Energético Sustentável no Setor Elétrico Brasileiro.** 2017. 149 f. Tese (Doutorado em Ciências) – Programa de Pós-Graduação em Energia da Universidade de São Paulo, São Paulo, 2017.

A tese foi inspirada pela necessidade de desenvolver um conjunto de indicadores que podem servir como um instrumento para promover um caminho mais sustentável para o setor elétrico brasileiro. Como objetivos adicionais, a pesquisa buscou analisar pontos fortes e fracos dos países e extrair lições e recomendações para que o Brasil prepare e alcance estratégias que fomentem um futuro sustentável. A questão proposta pela tese foi "quais os principais aspectos de um índice que poderiam servir como uma ferramenta estratégica para identificar caminhos para um futuro elétrico sustentável para o Brasil?" O índice final baseou-se em um conjunto de indicadores cujo objetivo foi identificar uma combinação adequada de fatores para o setor elétrico brasileiro avançar para um futuro de energia mais equilibrado. Os indicadores propostos, todos diretamente relacionados com eletricidade, foram selecionados com base em trabalhos acadêmicos anteriores e foram feitos para cobrir os três principais pilares de sustentabilidade hoje, ou seja, as dimensões econômica, social e ambiental. A escolha dos indicadores que compõem o índice final reflete preocupações políticas, acadêmicas e de mercado que são inerentes ao alcance de um futuro sustentável e elétrico. Conjuntos de dados históricos para os anos de 1990, 1995, 2000, 2005 e 2010 foram usados para compilar os resultados dos cinco indicadores finais: 1) acesso à eletricidade (IND1), 2) *perdas na transmissão e na distribuição de energia elétrica* (IND2), 3) *emissões de dióxido de carbono relativos à geração de energia elétrica* (IND3), 4) *produção de eletricidade renovável* (IND4), e 5*) capacidade de geração renovável* (IND5). Os resultados mostram os 111 países analisados para cada indicador e em grupo para o quadro final. Análises de referência cruzada também foram realizadas, posicionando o Brasil entre as melhores e as piores pontuações, entre os países da América Latina e entre os BRICS. As conclusões discutiram a importância dos indicadores e como sua escolha, peso e combinação podem afetar a posição geral no ranking e servir como uma ferramenta poderosa para tomadas de decisão mais bem informadas.

Palavras-chave: setor elétrico, setor energético, sustentabilidade, Brasil, indicadores.

ABSTRACT

TANAKA, K. T. **Indicator-Based Framework: a Proposition to Achieve a Sustainable Energy Future in the Brazilian Electricity Industry.** 2017. 149 f. PhD Dissertation – Graduate Program on Energy, Universidade de São Paulo, São Paulo, 2017.

The dissertation was inspired by the need to develop a set of indicators that could serve as an instrument to foster a more sustainable path for the Brazilian electricity industry. As additional objectives, the research aimed to assess the strengths and weaknesses of the countries assessed, and to extract lessons and recommendations for Brazil to prepare and carry out strategies to foster a sustainable future. The main question posed by the doctoral dissertation was "what are the main aspects of a framework that can work as a strategic tool to identify pathways for a sustainable electric future for Brazil?" The final indicator-based framework was based on a set of indicators whose aim was to identify a suitable combination of factors for the Brazilian electricity industry to move towards a more balanced energy future. The indicators proposed, all of which were directly related to electricity, were selected based on previous academic work, and were meant to cover the three main domains of sustainability today, namely the economic, social, and environmental domains. The choice of indicators that compose the framework reflects political, academic and market-based concerns involved in the achievement of a sustainable future for electricity. Historical sets of data for 1990, 1995, 2000, 2005, and 2010 were used to compile the results of the final five indicators: a) *access to electricity* (IND1), b) *electric power transmission and distribution losses* (IND2), c) *carbon dioxide emissions from electricity and heat production* (IND3), d) *renewable electricity output* (IND4), and e) *renewable generation capacity share* (IND5). The results show the 111 countries analyzed for each indicator and as a group for the framework. A series of cross-reference analyses were also shown, positioning Brazil among the best and worst scores, among the Latin American countries and among the BRICS. The conclusions discuss the importance of indicators and how their choice, weight and combination can affect the overall position in a ranking and serve as a powerful tool for better informed decision-making.

Keywords: electricity industry, energy sector, sustainability, Brazil, indicators.

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LIST OF ABBREVIATIONS AND ACRONYMS

ANEEL	Brazilian Electricity Regulatory Agency
BEN	Brazil's National Energy Balance
BRICS	Brazil, Russian Federation, India, China and South Africa
CO	carbon monoxide
CO_2	carbon dioxide
EDI	Energy Development Index
EEA	European Environmental Agency
EF	The Ecological Footprint
EIA	Energy Information Agency
EISD	Energy Indicators for Sustainable Development
EPE	Energy Research Company
EPI	Environmental Performance Index
ESMAP	Energy Sector Management Assistance Program
EU	The European Union
Eurostat	Statistical Office of the European Union
GDP	Gross Domestic Product
GHG	greenhouse gases
GNI	Gross National Income
GRI	Global Reporting Initiative
GSEP	Global Sustainable Energy Partnership
GTF	Global Tracking Framework
GWh	gigawatt hour
HDI	Human Development Indicators
HSDI	Human Sustainable Development Indicators
IAEA	International Atomic Energy Agency
IEA	International Energy Agency
IEE	Institute of Energy and Environment
ILO	International Labor Organization
IO	international organization
IPCC	Intergovernmental Panel on Climate Change

IRENA	International Renewable Energy Agency
kWh	kilowatt hour
LATAM	Latin American countries
MAPA	Ministry of Agriculture, Livestock and Supply of Brazil
MDG	Millennium Development Goals
MME	Ministry of Mines and Energy of Brazil
$MtCO_2$	megaton of carbon dioxide
MWh	megawatt hour
NEA	Nuclear Energy Agency
NGO	non-governmental organization
NH_3	ammonia
NMVOC	non-methane volatile organic compounds
NO_x	nitrogen oxide
OECD	Organization for Economic Co-operation and Development
R&D	research and development
R&DD	research, development and deployment
RISE	Regulatory Indicators for Sustainable Energy
ROW	rest of the world
SDG	Sustainable Development Goal
SDI	Sustainable Development Indicators
SE4All	Sustainable Energy for All
SEW	Sustainable Energy Watch
SO_2	sulphur dioxide
TWh	terawatt hour
UN	The United Nations
UNDESA	United Nations Department of Economic and Social Affairs
UNDP	United Nations Development Program
UNEP	United Nations Environment Program
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UNSC	United Nations Statistical Commission
USP	University of São Paulo
WB	The World Bank
WCED	World Commission on Environment and Development
WDI	World Development Indicators

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1. INTRODUCTION

The present research was inspired by the need to develop a broader framework that could serve as an instrument to foster a more sustainable path for the Brazilian electricity industry. In this sense, the present doctoral dissertation aimed to develop a framework based on a set of indicators. These indicators were chosen to identify a suitable combination of factors for Brazil to move towards a more balanced energy future. This work analyzes a wide gamut of indicator-based frameworks that measures sustainable development, energy sector development, electricity industry development, and human development. In a second phase, indicators were proposed, all of which directly related to energy, and selected based on previous academic work, so that view altogether can offer a better picture of how any country, and more specifically Brazil, can evaluate its electricity industry regarding its sustainability.

As it will be seen the coming chapter of this work, the proposed framework is meant to cover the three current main domains of sustainability, namely the *economic*, *social*, and *environmental* domains. The choice of indicators which compose the framework reflects the political, academic and market-based concerns involved in the achievement of a sustainable electric future.

To achieve its goal, the present dissertation is divided into five chapters: introduction, literature review, framework development, analysis and final remarks. This introductory chapter (Chapter 1) consists of making the reader familiar with the background and motivation of the chosen topic, the objectives of the dissertation, and its main question and hypotheses.

Chapter 2 discusses the main topics in a literature review covering the bases of sustainable energy and the development of indicator-based frameworks. Taking into account previous frameworks available in the literature regarding sustainability as a whole, Chapter 3 is dedicated to detail and explain the methodological basis of framework proposed to assess to sustainability of the electricity industry in Brazil.

Chapter 4 analyzes the Brazilian electricity industry in light of the proposed framework. For that, a list of cross-referencing analyses is carried out to compare Brazil to other peer countries regarding five indicators: a) *access to electricity* (IND1), b) *electric power transmission and distribution losses* (IND2), c) *carbon dioxide emissions from electricity and heat production* (IND3), d) *renewable electricity output* (IND4), and e) *renewable generation capacity share* (IND5).

Finally, in Chapter 5, summarizes final remarks of the dissertation. This chapter also points out the main limitations found throughout the research and suggests new topics to further works. The analysis undertaken may serve as subsidies to the development of public policies and incentives designs to foster a more sustainable electricity industry in the country.

1.1. Background and Motivation

There is a strong concern about achieving sustainable development while tackling climate change related to the electricity industry. In fact, energy generation and its use are considered the main sources of anthropogenic impact upon the environment. Within the energy sector, the electricity industry is responsible for approximately one third of total emissions, which is considered a major contribution (IPCC, 2010).

We considered the international agenda, focused on the need for more sustainable energy systems, for a low carbon economy, and Brazil's current status and future needs in order to establish the foundations to justify the need for improvement in different areas as stated by the proposed indicator-based framework. We also address Brazil’s position in relation to other countries, and suggest what the main factors for success in achieving sustainability in the electricity sector should be.

Besides being the focus of my academic path, sustainability has also played a major part in my professional career. It has been now nine years of consultancy and business development in areas related to sustainability, renewable energy, and management. I truly believe it has the capacity of mobilization that we need to face the utmost challenges of our current times.

1.1.1. Energy and Sustainable Development

The world today faces a large number of dichotomies and energy is one of the main ones. Today, 1.2 billion people do not have access to electricity (UNITED NATIONS, 2016). This is equivalent to approximately 20.0 per cent of the world's population or one in every five people in the world. Besides these, other 2.8 billion people rely on the so-called traditional sources of energy (such as wood, charcoal, dung and coal), considered unsustainable, unhealthy and unreliable (UNITED NATIONS, 2016). In addition, there are 1 billion more people without access to reliable electricity (RENNER; LUCKY, 2012). In sum, energy is a great challenge per se for more than half of the entire globe's population.

At the same time, while half of the world has problems in accessing and ensuring reliable energy, the other part whose energy needs are being met are not doing so sustainably. Countries make choices based mainly on economic factors, focusing on the short term. However, they should be considering the long run, the sustainability of the system as a whole and following up on decisions in order to guide changes and improvement. The unsustainable use of energy today is one of the main areas that reflect the unsustainability of our current policies (DITTMAR, 2014).

What Dittmar recommends is that we should build a roadmap to give us instructions on key areas that can demonstrate "how our unsustainable way of life will become less and less unsustainable" (DITTMAR, 2014, p. 285). The need for such a roadmap for development towards sustainability must be based on scientific principles as a *sine qua non* condition to achieve unambiguous and quantifiable definitions of sustainable goals (DITTMAR, 2014). And besides these quantifiable methods, there is the need for them to be actually used in such a way as to help us change the direction of the journey towards sustainable living.

Current policies are unsustainable, and their continuation is driving us toward collapse (DITTMAR, 2014). Physical limits to the world are already being encountered, and economies operate as if they did not exist (MARTENSEN, 2011). Nevertheless, the lack of interest or action throughout the world should not prevent the world from acting. What it needs to do is to start applying the easiest resources to implement local development towards sustainability roadmaps (DITTMAR, 2014).

Energy is directly connected to sustainable development. Energy is a key component for human development (KAHN RIBEIRO et al., 2013; THE WORLD BANK, 2014; YERGIN, 2005). Energy development is central to the political economy of countries, and its implications go beyond policies, infrastructure, generation, transmission and distribution (ESMAP, 2013). Energy affects central governments when dealing with subsidies or international trade; it affects the economy and prosperity when its lack, unreliability or unaffordability undermine investment, employment opportunities, and competitiveness.

Digging deeper into the microcosms, energy also has direct effects on families, social stability and the health of children, when the lack of access limits the number of hours a family can work or socialize, or when women have to spend hours providing for their families with some substitute for electricity, or even when they need to cook with unsustainable fuels that can affect their children's respiratory systems.

It is fundamental to induce a shift in the paradigm to move towards sustained prosperity for all (UN ENERGY, 2014). And it is possible to change our destiny, by reducing our unsustainable practices and by developing strategies that mitigate the damage while providing for our needs today and in the future (DITTMAR, 2014). In order to do so, we need to make considerable changes in what we do and the way we do it, and we need significant changes to achieve "energy systems [that] are affordable, clean, safe, secure, environmentally sound and available everywhere and for everyone" (UN ENERGY, 2014, p. 1).

Sustainable development is needed for continuing prosperity for all peoples in both current and future generations (WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT, 1987). And energy brings an opportunity to cope with the challenges related to sustainability, since it is ultimately related to the most important development targets of the future (DINCER; ACAR, 2016).

We are witnessing a myriad of new policies emerging throughout the globe, some local, some global. Despite the best of intentions, policies towards sustainable development in general show that we have failed to do what we had to do (DITTMAR, 2014). There is a lack of governance of sustainability and it results from the historical mismatch between economic activity and political order. The accelerated globalization of the first has been accompanied by resistance of the second (DA VEIGA, 2013). Sustainability should be considered a process of continuous adaptation, of addressing new and ongoing problems, and securing the needed resources for such (TAINTER, 2011). A coordinated, sustained and comprehensive energy strategy needs to be adopted along with national policies that are consistent (UN ENERGY, 2014).

Some initiatives to tackle energy and sustainability together are taking place at local, regional and global levels. We bring two examples. The first one is the Sustainable Year/ Decade of Sustainable Energy for All. Based on the fact that so many people did not have access to affordable, reliable, and safe energy sources, the United Nations General Assembly elected 2012 as the International Year for Sustainable Energy for All. After 2012, the UN General Assembly decided to declare the "Decade of Sustainable Energy for All" extending the concept from 2014 to 2024 (SUSTAINABLE ENERGY FOR ALL, 2013a).

The second and best-known is the Sustainable Development Goals (SDGs). In The 2030 Agenda for Sustainable Development, UN member states agreed to address poverty eradication and the three-dimensional pinnacle of sustainable development, namely social, environmental, and economic dimensions, including good governance. Based on the Millennium Development Goals (MDGs), launched at the Rio+20 United Nations Conference on Sustainable Development (RENNER; LUCKY, 2012), the Agenda launched the SDGs.

The SDGs are goals set to fulfill our imminent needs to achieve sustainable development in the world. They are the result of a long consultative process that involved a large number of stakeholders (ECONOMIC AND SOCIAL COUNCIL, 2015). National realities and priorities, capacities and levels of development were considered (ECONOMIC AND SOCIAL COUNCIL, 2015) since the main idea behind the goals was that they should be action oriented and universally applicable. The total number of goals is 17, and they are accompanied by 169 targets. The goals address diverse topics such as poverty, gender equality, climate, water, land, health and wellbeing, cities and others. The targets bring a way for countries to accompany their progress.

SDG number 7 states the need "to ensure access to affordable, reliable, sustainable and modern energy for all" (UNITED NATIONS, 2016). This is a global recognition that reliable and affordable energy that is sustainable and that can bring equitable development for all is a priority for a sustainable future. Moreover, in order to accompany and assess the evolution of member states, and to create a global monitoring system, the goals were given specific targets to be followed and reviewed in a timely manner, and accompanied by the so-called Global Indicator Framework.

The five targets established by the United Nations (UN ENERGY, 2014; UNITED NATIONS, 2016) for SDG number 7 relate to achieving universal access, improving energy efficiency, fostering international cooperation, research, and investment, expanding infrastructure and upgrading technology by 2030.

It will be hard to achieve all the SDGs without improving energy access, quality of supply and clean energy options. Energy is directly related to issues addressed in other SDGs, such as tackling climate change, reducing inequality, ending poverty, and fostering sustainable cities and communities, among others. Increasing access, improving quality, and ensuring clean options are essential to achieve not only SDG 7, but many if not all of the others.

1.1.2. Energy and Climate Change

According to the report by the Intergovernmental Panel on Climate Change (IPCC, 2013), the planet's climate system has already been changed by the continuous emission of greenhouse gases (GHG). Substantial reductions of these emissions are required in order to avoid the worsening of the problems caused by changes in the climate system. Since energy is the dominant contributor to climate change, accounting for approximately 60.0 per cent of total current global GHG emissions (UNITED NATIONS, 2016), and energy planning is one of the pillars for developing national policies for sustainable development (NEVES; LEAL, 2010), countries should be focusing on reducing the carbon intensity of energy in general, already in use and to be created to attend the whole world. This is a key factor in achieving the climate goals for the planet.

Correctly supporting technological advances that help to create smart energy systems is vital (DINCER; ACAR, 2016), since these technologies bring about financial, environmental and societal gains. Emissions reductions accompanied by access to energy can improve health conditions and tackle climate change. These advantages are not only local, but might have a global effect, with social, economic and environmental benefits to a much greater extent.

In the report named “Global Trends in Renewable Energy Investment”[1], the figures for global

[1] The Global Trends in Renewable Energy Investment Report was commissioned by UNEP in cooperation with Frankfurt School-UNEP Collaborating Centre for Climate & Sustainable Energy Finance and with Bloomberg New Energy Finance.

investment in renewables have been increasing in the last few years (MCCRONE et al., 2015). In 2014, a total of US$ 270.2 billion (17 per cent increase compared to 2013) were nearly equally invested in both developed countries, with US$ 139 billion, and developing countries, with US$ 131 billion. The big difference here was the rate of increase, which was 36.0 per cent, compared to the previous year for the developing world, and only 3.0 per cent for the developed one (MCCRONE et al., 2015).

According to the same report, Brazil figured as one of the biggest recipients of investment in renewable energy, with a total of US$ 7.4 billion, a 93 per cent increase compared to 2013, as a result of the wind energy auctions which took place in that year. However, Brazil is still far from the first place. China is, with a total of US$ 81 billion in investments (MCCRONE et al., 2015). Renewables (excluding large hydropower plants) now account for 15.2 per cent of the world's total generation capacity (MCCRONE et al., 2015). In global terms, the percentage of electricity generated from this capacity reached 9.1 per cent in 2014, which avoided around 1.3 gigatons of CO_2 emissions as compared to the previous year.

Despite the historical rise in investments in renewable energy facilities and smart technologies and the comparatively low investment in fossil-fuel capacity (half of that of renewables), atmospheric CO_2 concentrations are continuing to increase by at least two parts per million every year (MCCRONE et al., 2015). Fossil fuels are not desired even if carbon capture technologies are brought into the process due to their emissions and non-renewability (DINCER; ACAR, 2016). The rate of investment in renewable energies has never been higher, however, it is still not enough to help the world reach the emissions level needed for a sustainable future. According to the UN, by 2030 the world would need to triple the total investments in sustainable energy from the current US$ 400 billion to US$ 1.25 trillion (UNITED NATIONS, 2016).

1.2. Objectives, Main Question and Hypothesis of the Work

As its main objective, this dissertation aims to create a framework based on a set of indicators that can offer inputs for the assessment of suitable energy sustainability in the electricity sector for Brazil. As additional objectives, the aim of the research is to assess the strengths and weaknesses of the countries assessed regarding the selected indicators in comparison to

Brazil. Finally, it intends to extract lessons and recommendations for Brazil to prepare and carry out strategies considering its needs and the possibility of fostering a sustainable future.

The main question posed by the doctoral dissertation is:

> what are the main aspects of a framework that can work as a strategic tool to identify pathways for a sustainable electric future for Brazil?

To answer this question, we intend to undertake a challenging exercise, which is to use a wide array of information and data in order to suggest a list of indicators that to best describe a path towards a sustainable electric future. We expect the conclusions of the dissertation to contribute to the possibilities of learning from other peers, teaching others Brazil's good practices, cooperating, and influencing decision-making processes of political agents as well as of market-based agents.

The principal objective of this work is to propose a tool for Brazil to work on a path that will guide its electricity investment and strategy in a sustainable manner to achieve the goals proposed by the government and in line with new demands coming from the current international agenda, civil society, academy, NGOs, and business organizations. Embracing political and market-based concerns can help build a diversified set of selected indicators.

Thus, we have identified the following hypothesis: the main aspects of a framework that can work as a strategic tool to identify pathways for a sustainable future for Brazil should encompass indicators that take into consideration the three domains of sustainability, which are economic, social, and environmental. Such a framework can provide guidelines and benchmarking that are useful to identify pathways for an electric energy-sound and sustainable-oriented future. The research identifies indicators from a wide array of topics: for example, from the level of energy access to CO_2 emissions.

2. LITERATURE REVIEW

The present chapter presents a review of the literature concerning the main topics related to the present dissertation: sustainable energy and indicator-based frameworks. In its first part, there is a series of conceptualizations regarding how sustainable energy is crucial and should be secured for human, social, and economic development. We present a discussion on energy security and a parallel between energy and climate change.

The second part of this Literature Review addresses the main approaches for the creation process and analysis of quantitative and qualitative that are used as methodological tools in previous academic works and business initiatives. We divided this part into some sub-topics, where we address the relevance of the use of indicators; the issues and challenges concerning indicators; and present you with a list of indicators and frameworks that serve as examples of indices being used nowadays.

At the end, the main aspects explored throughout the review is summarized in context in order to set the basis for the coming chapters, in which the framework and analysis of this dissertation will be thoroughly explained.

2.1. Securing Sustainable Energy

Energy is a key component for human development (KAHN RIBEIRO et al., 2013; THE WORLD BANK, 2014; YERGIN, 2005). Energy is key to tackle the most important issues of today and tomorrow (DINCER; ACAR, 2016). It is fundamental to almost all aspects of modern life (STAMFORD; AZAPAGIC, 2011). And it is vital for poverty alleviation, human welfare and living standards improvement (UN ENERGY, 2014). In order to achieve the development goals, countries will need full access to reliable, sustainable and affordable energy services (UN ENERGY, 2014), as briefly but clearly explained in a report by the UN (UN ENERGY, 2014, p. 1):

> "Providing energy services at affordable costs, in a secure and environmentally benign manner, and in conformity with the needs for social and economic development is an essential element for poverty eradication and sustainable development."

Narula and Reddy (2015) see a common link between energy sustainability and energy security in the future. Even though they claim energy security has a different end goal to energy sustainability, both energy security without sustainability and energy sustainability without considering security matters would fail to give an accurate overview for energy planners. For these reasons, they should be treated together and carefully.

Considering the world's inequalities, regarding access to, and use of, energy the dialogue on energy access today also considers the use of energy for social purposes to productive purposes. With greater access to energy come fewer hours moving to collect other sources of energy (fuel, batteries etc.) and more hours towards educational and commercial activities. With better quality and reliable electricity, businesses can stay open longer and receive more customers, and children can study for a longer period and do better at school.

The Energy Sector Management Assistance Program (ESMAP) defines energy security as "the ability to balance supply and demand for reliable, sustainable, and affordable energy supplies and services" (ESMAP, 2005, p. 13). This is a suitable definition for two main reasons. First, the idea of balance between supply and demand is more accurate than the notion that the simply availability of energy would be sufficient for energy security. Other issues that should be concerned are energy vulnerability management and matrix diversification.

"Energy security is important for the advancement and improvement of all societies" (DINCER; ACAR, 2016, p. 3), however, energy is one of the most unequally distributed assets in the world. Table 1 shows the ten largest electricity generation installed capacities. From this, we can see that most of the developed world has the major part of the installed capacity, with the exception of three big developing countries (China, India, and Brazil). Also, it is possible to note that these ten countries altogether are responsible for nearly 67.0 per cent of the world's total installed capacity (as seen on Table 1).

Table 1 – World Electricity Generation Installed Capacity – Top Ten Countries (GW)

	2008	2009	2010	2011	2012	Δ% (2012/2011)	Part. % (2012)
World	4,529.5	4,727.7	4,964.5	5,204.7	5,550.5	6.6	100.0
China	796.2	876.7	972.7	1,082.5	1,174.3	8.5	21.2
United States	988.3	1,003.2	1,016.9	1,030.6	1,063.0	3.2	19.2
Japan	254.4	257.0	259.5	261.2	293.3	12.3	5.3
India	173.0	185.2	203.5	233.5	254.7	9.1	4.6
Russia	222.8	224.1	228.1	231.6	234.4	1.2	4.2
Germany	129.3	136.2	142.2	147.9	177.1	19.7	3.2
Canada	126.4	131.6	132.2	132.8	135.0	1.7	2.4
France	86.3	87.8	90.0	92.9	129.3	39.1	2.3
Italy	77.0	79.8	84.7	96.5	124.2	28.7	2.2
Brazil	102.9	106.6	113.3	117.1	121.0	3.3	2.2
Other	1,820.7	1,889.1	1,967.7	2,026.7	1,844.1	-9.0	33.2

Source: Statistical Yearbook of Electricity (MINISTÉRIO DE MINAS E ENERGIA, 2013).

The electricity industry is considered one of the most dynamic sectors, with growth projected all around the world (EIA, 2016). Long-run estimates by the EIA (2016) expect that the world's total electricity generation increases from 21.6 trillion kWh in 2012 to 25.8 trillion kWh in 2020, and finally to 36.5 trillion kWh by 2040. Developing countries are expected to witness the highest growth rates in generation. It is already possible to see strong increments in the big developing powers, namely China, India and somehow Brazil, even though the country has been through consequent years of low growth.

The increase in population and their living standards especially in the developing nations are the main factors for the rise in demand (EIA, 2016). More people purchasing and using more devices at home and more services outside their homes lead to increasing demand for energy.

The developed nations, on the other hand, will show lower production rates. These countries have lower population growth rates and their demand for infrastructure has reached a certain maturity (EIA, 2016).

In relation to electricity generation, the inequality remains. Asia is ranked top due to the amount generated by China in the region and therefore accounts for 42.1 per cent of total world's electricity generation as seen on Table 2. Next, in second place, with 22.5 per cent, North America, pulled mainly by the United States and Canada. Europe and Eurasia come next, with 16.1 per cent and 6.6 per cent, respectively. Brazil and its Central and South American peers responded for 5.3 per cent of the total electricity generation in 2013.

Table 1 – World Electricity Generation by Region (TWh)

	2009	**2010**	**2011**	**2012**	**2013**	**Δ% (2013/ 2012)**	**Part. % (2013)**
World	19,114.5	20,459.7	21,205.4	21,557.3	22,191.0	2.9	100.1
Asia & Oceania	7,0784	7,859.4	8,496.7	8,767.9	9,341.0	6.5	42.1
South and Central America	1,043.4	1,098.8	1,147.8	1,177.3	1,182.0	0.4	5.3
North America	4,798.6	4,974.8	5,014.4	4,948.8	4,993.0	0.9	22.5
Europe	3,475.0	3,633.4	3,579.5	3,593.6	3,564.0	-0.8	16.1
Eurasia	1,359.1	1,427.0	1,455.3	1,480.5	1,468.3	-0.8	6.6
Africa	595.3	639.0	658.9	682.3	695.2	1.9	3.1
Middle East	764.7	827.1	852.8	907.0	947.1	4.4	4.3

Source: Statistical Yearbook of Electricity (MINISTÉRIO DE MINAS E ENERGIA, 2016a).

When separated by regions of the world, it is clear the inequality persists, especially when compared to the per capita data (see Figure 1).

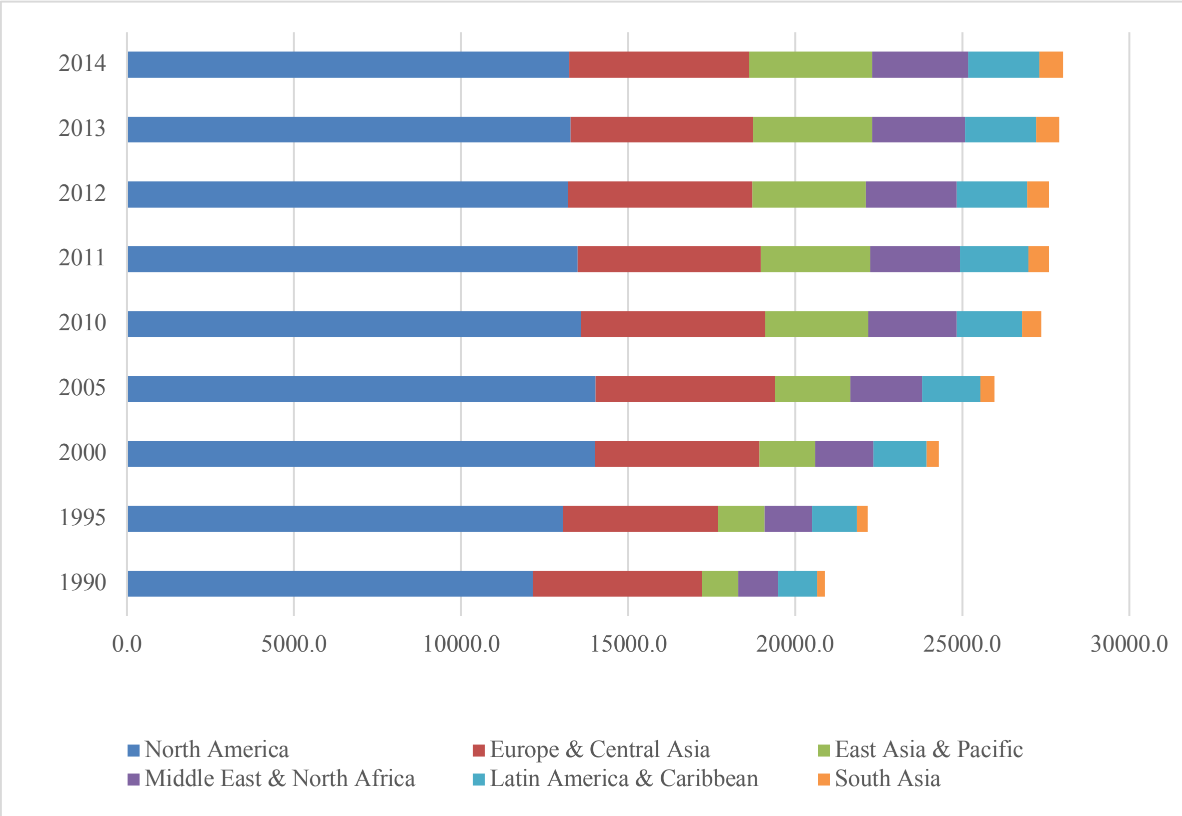

Figure 1 – Electric Power Consumption (kWh per capita) per Region[2].

Source: World Development Indicators (THE WORLD BANK, 2017).

The first reason for this is that a core problem of energy planning is related to meeting demand. In the last few decades, this problem has been accentuated by the increasing costs related to sustainability, i.e. economic, social, and environmental costs (MME Ministry of Mines and Energy of Brazil, 2014c). More action for new sources and means to attend energy demand are needed, and they should be conducted in a manner that considers implementation at a global level (DINCER; ACAR, 2016). In this sense, it is wise to identify and pursue sustainable energy options as a way to maximize social, economic, and environmental welfare (STAMFORD; AZAPAGIC, 2011).

In an article that assessed the dependence on one single source of energy, Tembo and Merven (2013) showed that 99.0 per cent of the electricity in Zambia was supplied by hydroelectricity. The article showed an example model of electricity demand typically occurring in the developing world, in which financial and climate impacts were taken into consideration. The

[2] Electric energy consumption from the production of power plants and combined heat and power plants excluding transmission, distribution, and transformation losses and own use by heat and power plants.

authors created two scenarios, namely: a dry year scenario and an average year scenario. They were used to discuss the financial impacts that a climatic change could have on the electricity generation and demand in Zambia. The average cost of generation without diversifying the portfolio increased by over 18.0 per cent, and with diversification, over 19.0 per cent, in an average year (TEMBO; MERVEN, 2013).

Their study concluded that diversification increases the average cost of generation in an average year; therefore, diversification itself could not improve Zambia's capacity of adaptation. The best option would be to import electricity and then increase the share of renewable and coal technologies into the generation mix. This dependence recalls that of Brazil although it is more concentrated (see Table 3). The authors discussed the need for diversification of the portfolio as a way to maintain a secure supply of energy, considering that the country is currently vulnerable since it is highly dependent on this one source. The conclusion is that portfolio diversification can lead to a reduction in energy vulnerability and insecurity (TEMBO; MERVEN, 2013).

The second reason is that energy should be sustainable and affordable, which means that energy should be both provided in a sustainable manner and be an economically viable option for its population and in macroeconomic terms. For ESMAP, energy security is not just a matter of having enough oil or energy at a reasonable price, but it also concerns diversifying the portfolio of energy of a country or allowing access to reliable and efficient energy for its population (ESMAP, 2013). Conventional structures are not following the needs of the current century. These are multidimensional and multidisciplinary needs. Therefore, considerable changes would be needed to attend demand in a sustainable manner (DINCER; ACAR, 2016).

Table 3 – World Hydroelectric Generation - Top Ten Countries in 2013 (TWh)

	2009	**2010**	**2011**	**2012**	**2013**	**Δ% (2013/ 2012)**	**Part. % (2013)**

World	3,234.1	3,422.2	3,489.0	3,646.1	3,761.0	3.2	100.1
China	609.5	713.8	690.6	856.4	900.0	5.1	23.9
Brazil	387.4	399.4	424.7	411.5	391.0	-5.0	10.4
Canada	365.0	347.8	371.9	376.7	388.0	3.0	10.3
United States	273.4	260.2	319.4	276.2	269.0	-2.6	7.2
Russia	172.4	164.8	164.2	164.4	179.0	8.9	4.8
India	112.0	121.8	142.1	124.6	133.0	6.8	3.5
Norway	124.0	115.6	119.1	140.5	127.0	-9.6	3.4
Venezuela	85.1	76.0	82.8	81.2	83.0	2.2	2.2
Japan	76.1	81.4	82.4	74.7	77.0	3.0	2.0
France	56.4	61.8	44.3	58.1	70.0	20.4	1.9

Source: Statistical Yearbook of Electricity (MINISTÉRIO DE MINAS E ENERGIA, 2016b).

Based on ESMAP (2005)'s definition of energy security and bearing in mind the increase in greenhouse gases (GHG) emissions caused by an increase in electricity supply, governments should focus their efforts on cleaning the current matrix, with increasing efforts to diminish losses and increase efficiency, and investing in clean renewable sources. We will present more on this topic in the coming paragraphs.

Renewable sources are currently the fastest-growing source for electricity production. According to the EIA (2016), they increased and are expected to continue at a high rate of 2.9 per cent each year between 2012 and 2040. EIA's estimates also include the share of renewable sources (excluding hydro electrical generation) to be responsible for 14.0 per cent of the total world's electricity production in 2040, as compared to 5.0 per cent in 2012 (EIA, 2016).

The development and use of renewable energy can be applied as a strategy for more sustainable economic growth (IEA INTERNATIONAL ENERGY AGENCY, 2013). The decision for investment in renewables has proved positive, and brings many desired outcomes. Renewable energy is considered a non-diminishable resource with improved quality and minimum or no environmental damage, which means it is essential when we talk about smart energy systems (DINCER; ACAR, 2016).

Renewables may reduce the need for fossil fuels, which leads to lower local air pollution, lower emissions of carbon dioxide (CO_2) and other GHG, diminishing the weight of fuel imports in the balance of payments, reducing dependency on autocratic governments, and fostering technological innovation (IEA, 2013; SCHAFFER; BERNAUER, 2014; TEMBO; MERVEN, 2013). Authors such as Lucon and Goldemberg (2009) defended the idea that a renewables-based system can work efficiently and that it may even be able to reverse the increasing trend of GHG emissions.

Moreover, widespread use of renewables could help energy security, energy equity and emissions. It has been proven that renewables resources are able to tackle poverty, employment, and water production (DINCER; ACAR, 2016). Even though these outcomes are not accounted for when estimating returns on investment, which impacts the way these are seen and weighed during processes to choose alternatives, cleaner, more reliable access to energy, decrease in economic instability, and climate change alleviation among others should be accounted for and used as parameters when deciding on investment.

2.1.1. Electricity Industry in Brazil

In 2015, Brazil's electricity production reached approximately 581.0 TWh in total, a decrease of 1.5 per cent compared to 2014, according to the Brazil Energy Balance year 2016 by the Empresa de Pesquisa Energética (EPE, 2016). A total of 34.4 TWh were of net imports, which resulted in a total domestic supply of electricity of 615.9 TWh (see Figure 2). Although the use of hydroelectricity continues to be the main source of the matrix, corresponding to around 62.0 per cent of the total national electricity supply, it has decreased in the last few years, with an increase in demand for coal and natural gas, mainly.

As for consumption, Brazil witnessed a 1.8% decrease (522.8 TWh) in demand between 2014 and 2015, represented by the residential sector (-0.7 per cent) and the industrial sector (-5.0 per cent) (EPE, 2016). Specific areas in the industrial sector showed growth in consumption: some industries of the industrial sector, which were paper and pulp, mining, and chemicals.

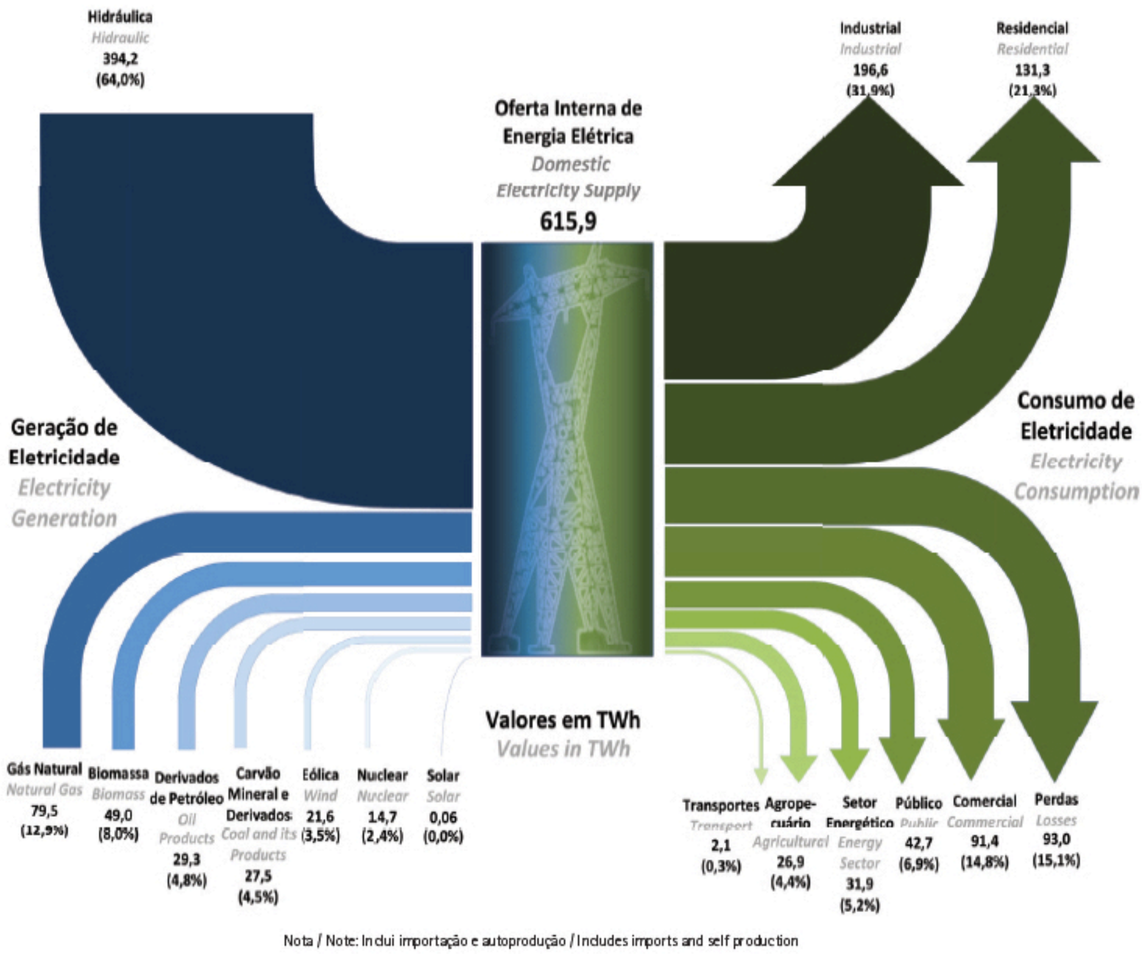

Figure 2 – Electricity Flux in Brazil (2015).

Source: Brazil Energy Balance (MINISTÉRIO DE MINAS E ENERGIA, 2016b).

The share of renewable energy in global power generation has been growing in recent years, according to the International Energy Agency (IEA, 2013). Nevertheless, it still plays a minor role in electricity generation in the world. In 2012, it represented 21.0 per cent of total production (including hydroelectric generation, and excluding traditional biomass) according to the (IEA, 2015). The share of renewables is expected to increase to 33.0 per cent of the total power generation in the world in 2040. Electricity generation from renewable sources, including hydroelectric generation, is expected to triple between 2012 and 2040. The IEA expects renewables to become the second largest source within two years.

Brazil, however, has a quite different status concerning renewables in the electricity generation mix. From the total generation of electricity (see Table 4), hydroelectricity still remains the main source, although it has decreased steadily over the last few years. In 2015, it was responsible for 61.9 per cent of all electricity generated in the country. We see a timid increase of generation from other renewable sources, such as biomass, wind and solar, which together account for 14.3 per cent. Wind energy witnessed a 77.0 per cent increase compared to the previous year because of the government bids opened in 2014.

Table 4 – Brazil Electricity Generation by Source (GWh)

	2011	**2012**	**2013**	**2014**	**2015**	**Δ% (2015/2014)**	**Part. % (2015)**
Total	531,758	552,498	570,835	590,542	581,486	-1.5	100.1
Natural Gas	25,095	46,760	69,003	81,073	79,490	-2.0	13.7
Hydropower	428,333	415,342	390,992	373,439	359,743	-3.7	61.9
Petroleum products	12,239	16,214	22,090	31,529	25,662	-18.6	4.4
Coal	6,485	8,422	14,801	18,385	19,096	3.9	3.3
Nuclear	15,659	16,038	15,450	15,378	14,734	-4.2	2.5
Biomass	31,633	34,662	39,679	44,987	47,394	5.4	8.2
Wind	2,705	5,050	6,578	12,210	21,626	77.1	3.7
Other	9,609	10,010	12,241	13,590	13,741	1.1	2.4

Source: Statistical Yearbook of Electricity (MINISTÉRIO DE MINAS E ENERGIA, 2016a).

From a total of 140,272 MW of installed capacity for electricity generation, 61.3 per cent relied on hydroelectricity in 2015 (MINISTÉRIO DE MINAS E ENERGIA, 2016b), as detailed on Table 5. This amount accounts for both the public service and self-producer plants. The country has witnessed a steady increase in the installed capacity for a few years now. In 2015, Brazil's total electricity generation installed capacity witnessed an increase of 6,359 MW compared to the previous year, an increase of 4.7 per cent.

All sources showed an increase in 2015 (see Table 5), with the exception of nuclear capacity, which has remained the same since 2013. Hydroelectricity, from the sum of capacities for hydroelectric power plants, small hydroelectric plants (SHP) and central hydroelectric generators (CHG), totaled an increase of 34.0 per cent from the previous year. Although still a timid part of the final matrix, solar and wind have shown the greatest increments in capacity, with 56.1 per cent and 40.0 per cent increases, respectively.

Table 5 – Brazil Electricity Generation Installed Capacity (MW)

	2011	**2012**	**2013**	**2014**	**2015**	**Δ% (2015/ 2014)**	**Part. % (2015)**
Total	117,136	120,974	126,743	133,913	140,272	4.7	100.0
Hydropower Plants	78,347	79,956	81,132	84,095	86,002	2.3	61.3
Thermoelectric Plants	31,243	32,778	36,528	37,827	39,393	4.1	28.1
SHP	3,896	4,101	4,620	4,790	4,840	1.0	3.5
CHG	216	236	266	308	395	28.3	0.3
Nuclear Power Plants	2,007	2,007	1,990	1,990	1,990	0.0	1.4
Solar Power Plants	1,426	1,894	2,202	4,888	7,630	56.1	5.4
Wind Power Plants	1	2	5	15	21	40.0	0.0

Source: Statistical Yearbook of Electricity (MINISTÉRIO DE MINAS E ENERGIA, 2016a).

Brazil's rate of investment in renewables has fluctuated in the last decade. It suffered with the fate of the biofuels sector, the timing of renewables auctions, and infrastructure construction delays (MCCRONE et al., 2015). However, we have witnessed a rapid increase in installed capacity both in solar and wind power in the last few years.

This phenomenon has led to a change in the path of the country's greenhouse gases (GHG) emissions in the past years. While the GHG emissions lowered in total in 2015 (see Table 6), Brazil witnessed a slight increase of emissions in self-production and a decrease in isolated and integrated systems.

Table 6 – Brazil's GHG Emissions from Electricity Generation ($MtCO_2$)

Source	**2011**	**2012**	**2013**	**2014**	**2015**	**Δ% (2015/2014)**	**Part. % (2015)**
Total	35.08	50.18	74.79	94.07	89.61	-4.7	100.0
Integrated System	14.89	28.95	52.83	71.00	68.96	-2.9	77.0
Isolated Systems	7.10	7.58	7.52	7.30	4.20	-42.4	4.7
Self-Production	13.09	13.65	14.44	15.77	16.44	4.2	18.3

Source: Statistical Yearbook of Electricity (MINISTÉRIO DE MINAS E ENERGIA, 2016a).

2.1.2. Opportunities and Challenges for Brazil

The heavy dependence of Brazil on a single source of energy can pose threats to the energy security of the country. The two main reasons lie in the choice of hydroelectricity as the main source of electricity generation, and the choice of having one single main source (see Tables 3 and 4). First, hydroelectricity production poses a dichotomous situation for Brazil. Although it is a cheaper and cleaner option, it is not an entirely secure source of energy, since hydroelectric power plants are vulnerable to periodic droughts (PEREIRA et al., 2013; TEMBO; MERVEN, 2013). Second, resilience would be achieved when multiple resources and systems are available for supply (MARTENSEN, 2011).

Hydroelectricity depends on rainfall, which is one of the phenomena whose cycle will be influenced by climate change. Besides regular droughts, many regions of the world will be impacted, quantitative and qualitatively, by altered hydrological systems (IPCC, 2013). Moreover, according to Pereira Jr. et al (2013), if there is not enough rain, there would probably be power shortages due to the low levels of reservoir storage, which could lead to increasing costs in the future (PEREIRA et al., 2013).

Many experts agree that the diversification of the energy portfolio is a basic recommendation for governments to achieve a secure supply of energy. If the diversification can include more renewable sources, it would facilitate the achievement of a more sustainable energy system in the future. The advantages that renewables bring for energy portfolio affect energy security, energy access, the economy, and the environment. (IEA, 2013; MARTENSEN, 2011; TEMBO; MERVEN, 2013)

For the future, the Ministry of Mines and Energy (MME) estimates that the Brazilian generation system might introduce a gradual reduction in the participation of hydropower in the electric generation mix in the long run. The country is already witnessing a small shift towards other sources, however not to renewable ones (MME, 2014c).

Besides this shift, Brazil currently faces other challenges concerning its energy needs. According to a recent publication by Brazil’s Energy Research Company (EPE), Brazil is undergoing a rapid demographic transition, facing infrastructure bottlenecks, and educational issues (MME, 2014b, p. 14) that directly affect the need for energy. The expected increase in demand for energy is significant until the researched period, year 2050. "The energy sector should perform a growing effort to produce an ever-increasing volume of energy" (MME, 2014c, p. 83).

In line with the increasing demand, Brazil should be investing heavily in the modernization, retrofitting and expansion of its generation system (MME, 2014c). Nevertheless, also according to the MME (2014c), the country faces two major problems: large amounts of resources needed for the large centralized projects and loss of State investment capacity. These problems may be more easily addressed by the private sector, which should be considered a crucial actor, working on its own or as a partner with governmental entities and agencies.

2.2. Review of Indicator-Based Frameworks

This section brings the different ways literature has addressed the creation, choice process, and analysis of indicators, either via quantitative and/or qualitative analyses. Relevant examples of the application of indicators used as methodological tools in previous academic works were also investigated. Based on these studies, we now present the contextual use of indicators and frameworks. We will bring a literature review following these sub-topics: (i) concept and relevance of the use of indicators; (ii) the issues and challenges concerning indicators; and (iii) a list of indicators and frameworks that serve as examples of indices being used today.

As a definition, we will use the concept by the Organization for Economic Co-operation and Development (OECD). It defines indicator as a “parameter, or a value derived from parameters, which points to, provides information about, describes the state of a phenomenon/ environment/ area, with a significance extending beyond that directly associated with a parameter value” (OECD, 1994, p. 5).

The development of indicators is an important task for public policies (MICHAEL; NOOR; FIGUEROA, 2014; SHARMA; BALACHANDRA, 2015). Indicators are useful tools for a range of purposes: decision-making, public awareness (MICHAEL; NOOR; FIGUEROA, 2014). Additionally, indicators help provide information about progress and guide decision making (SERWAA MENSAH; KEMAUSUOR; BREW-HAMMOND, 2014). Appropriate indicators can provide policymakers with information of their countries, as a way to foster sustainable development (IAEA, 2005).

And finally, given the highly complex interactions energy has with other aspects of development in general, an indicator-based approach is elegant and effective to characterize the energy system (NARULA; REDDY, 2015).

It is widely accepted and used that direct interfaces exist between energy and other development issues, as stated by the United Nations Energy (2014). A number of issues related to the SDGs and national goals consist of interrelations between energy and economy, equality, community development, health, and others. “These targets have the potential to clearly demonstrate the extraordinary benefits and synergies for poverty eradication and sustainable development that can be derived from the more holistic approach to energy programs and projects all over the world” (UN ENERGY, 2014, p. 8).

UN Energy (2014) prepared a full list of the interactions between energy and other development factors. The organization has enumerated items connecting energy to: a) health: securing energy for healthcare facilities, eliminating premature deaths due to air pollution from cooking and heating; b) education: securing sustainable energy for schools; c) gender: minimizing all risks that affect women due to energy-related activities including collection of energy resources, cooking, heating, and lighting; d) water: minimizing the use of water in energy systems, maximizing sustainable energy access in water and sanitation systems; e) food security: reducing the intensity of fossil fuel use in food systems and increasing access to modern energy services while meeting feeding requirements; f) environment: minimizing discharges of contaminants due to energy production to land, air and water bodies, minimizing the rate of deforestation due to energy use, minimizing energy-related GHG emissions; and g) industrialization: decreasing industrial energy intensity, increasing the share of renewable energy use in manufacturing processes, providing access to reliable energy services to support changes and industrialization.

2.2.1. Use of indicators

From the wide gamut of works undertaken by academia, we found studies that justified the use of indicators that traced parallels in order to specify best in class, such as the examples from Shen et al. (2011), Michael, Noor and Figueroa (2014) and Lynch et al. (2011). Moreover, some works call the attention to the fact that indicators are useful for decision-making processes at the local level, and are used for financing programs at the regional level and for comparisons at the international level, as the work by Sharma and Balachandra (2015).

Other studies compared different aspects based on indicators as examples by Kemmler and Spreng (2007) and Schlör, Fischer and Hake (2013). And finally, some work carried out comparative studies that took into consideration different frameworks, to name a few, Serwaa Mensah, Kemausuor and Brew-Hammond (2014) and Narula and Reddy (2015), for instance, who worked on a cross analysis of countries based on the ranking they were placed in in three indices, namely Energy Architecture Performance Index (EAP), the Energy Sustainability Index (ESI), and the International Index of Energy Security Risk (ESR). We will address each of them more closely further on.

The use of indicators to build a framework for analysis of quantitative and qualitative data has proven widely accepted and used throughout academia. Shen et al (2011) show that the process of development of indicators should focus not on quantity but on quality and that it is fundamental to choose well and produce the most accurate result that reflects the practice.

Indicators also serve as a means to direct human activities towards sustainability (MICHAEL; NOOR; FIGUEROA, 2014). Besides that, indicators have an important role in developing awareness of urban issues (MICHAEL; NOOR; FIGUEROA, 2014). Lynch et al. (2011) call attention to the fact that indicators are useful for decision-making processes at the local level. They also are used for financing programs at the regional level and even for comparisons at the international level (SHARMA; BALACHANDRA, 2015). Today it is one very widely accepted framework for sustainability assessment and we will present some examples of its use in the following paragraphs.

Sharma and Balachandra (2015) discussed ways for India to reach sustainable electricity consumption and production. For that task, they created National Electricity System Sustainability Index (NESSI), a set of 85 indicators to assess the electricity system in the country, with benchmarks for each dimension and India's respective position within these benchmarks. The authors measured India's sustainability status as a way to follow up on its achievements and challenges related to sustainability in the electricity industry. They concluded that the country faced challenges in the social, environmental, and institutional dimensions; and marginally better in the economic field. Sharma and Balachandra (2015) claim that there are gaps in research because empirical validation for indicator approaches is not used , which cannot be agreed upon, given the whole array of work done by the following scholars.

Neves and Leal (2010) note three important sustainable development criteria in their article: environmental, economic, and social criteria. The environmental criteria include the reduction of greenhouse gas (GHG) emissions, air pollution and the depletion of natural resources, which are caused by a limited or inefficient supply chain and inefficient energy use. Economic criteria include the reduction of fossil fuel dependence and increase in local investment in renewable energy and energy efficiency projects that generate business and wealth. Social criteria include the improvement of human health, creation of jobs, greater comfort and the involvement of citizens in decision-making processes.

The authors have built a framework based on literature review, considering feedback from local authorities and experts. Moreover, the paper by Neves and Leal (2010) reviews literature on the different aspects involved in energy planning focusing on risks, errors and uncertainty in energy planning, energy planning models, geographical level of energy planning, and validation of planning methods.

Kemmler and Spreng (2007) discussed whether it is appropriate to use one single indicator or a group of indicators to represent and measure a specific situation. In the example used by these authors, poverty, it would be satisfactory to use one single indicator for a basic orientation or for a comparison among different places. However, if a more detailed view to assess poverty were needed, considering scale and nature, a comprehensive set would be preferable.

Kemmler and Spreng (2007) measured many indicators related to energy in order to track sustainability in India. They used data, of different types i.e. social and economic data, access to energy, energy use, climate change, and poverty variables, among others. For the energy indicators, the authors used data from the past twenty years and made projections for the next twenty years. They were able to show that these energy indicators were significant to measure poverty when considering environmental, social and economic issues (KEMMLER; SPRENG, 2007).

Schlör, Fischer and Hake (2013) also affirmed that while one single indicator defines a key issue or a certain aspect, a system of indicators could capture the complexity, offering a new view of the system itself. According to Schlör, Fischer and Hake (2013), in 2002, the German government developed indicators that included information for a sustainable energy system, as part of its sustainability strategy. From this, the government was able to measure to what extent its strategy was related to the individual preference of families and companies. The measurement was undertaken by the authors through a set of indices, namely the index of sustainable development and standardized sustainability index. The purpose of these indices was to compare the political regulations to the actual behavior of society. A total of fifteen indicators were selected for the article.

For the environmental dimension, 08 (eight) indicators were chosen: air quality, emissions of carbon dioxide, Sulphur dioxide (SO_2), nitrogen oxide (NO_x), carbon monoxide (CO), dust, non-methane volatile organic compounds (NMVOC), and ammonia (NH_3). For the social dimension only one indicator was picked, namely employment in the energy sector. And finally, in the economic dimension, a total of six indicators were chosen: energy productivity, renewable energy as a share of primary energy consumption, renewable energy as a share of electricity production, transport intensity of passenger transport, and transport intensity of goods transport.

The measurements were adapted for time periods, and calculations were carried out based on forecasts for each of them, in a linear regression methodology. A two-step analysis was carried out: the first one to measure the degree of sustainability determined by each indicator; and the second one, in which the indicators were aggregated to create the final index that showed the stage of sustainability in the German energy sector.

The work proved that different calculation methods can have different results while considering the same indicators. Therefore, the level of sustainability and the gap to sustainability depend on the method, which, according to the authors, should be considered when developing sustainability goals. The article, therefore, could prove useful to draw a comprehensive picture of the current development of the sustainable energy sector in Germany. The monitoring process allowed the authors to understand better where action was needed, based on the results from the indices.

They are emphatic in affirming the importance of the role politics plays in determining goals for sustainability. In this sense, the determining of indicators and targets should be part of a "permanent learning process" by the governing body. Furthermore, this process should be based on a "communication culture", in which the government, parliament and other stakeholders contribute to adjusting the goals as the status quo changes from time to time.

The participation of different stakeholders, including community, experts and others, has divergence in the literature. Part of it agrees that it is a good thing to have inputs from specific stakeholders in the development of an indicator-based analysis (SHARMA; BALACHANDRA, 2015; TAINTER, 2011; VISVALDIS; AINHOA; RALFS, 2013). However, they also remind that the more diverse and more participation of specialists allows for a more holistic and realistic analysis.

Schaffer and Bernauer (2014) discussed the determinants for the adoption of instruments for the promotion of renewables used for electricity production. The article consisted of an analysis of 26 industrialized and developed countries from 1990 to 2010, chosen due to data availability. They divided their indicators into domestic and international factors. For the domestic factors, economic conditions, characteristics of the energy system, and of the political system were considered. For the international factors, they used the idea of spatial connectivity (both geographical and trade ties) and being part of the European Union, taking the "contagion effect", the idea that choices could spread, into consideration.

Based on both these sets of factors, the authors created a dataset that analyzed indicators that worked in favor of or against changes and/or the adoption of policy instruments to foster the use of renewable energy for electricity, in other words, the so-called "market-based support systems". For that reason, they analyzed two of these market instruments: green certificates and feed-in tariffs. They found that three indicators were crucially in favor of driving the countries towards such markets: the characteristics of the existing energy supply system, a federalist political structure, and being a member of the European Union.

The work by Schaffer and Bernauer (2014) found that federalism played a positive role in the adoption of policy instruments for supporting renewables for electricity production. In fact, the figure showed a 33.0 per cent advantage over non-federalist countries. On the other hand, they found that high economic growth and high growth in solar and wind energy capacities worked against such reforms.

Also according to Schaffer and Bernauer (2014), chances are that the characteristics of a country's energy supply system have negative influence due to opportunity costs. It means that a country would be less likely to invest in renewables if it has lower hanging fruits, such as large availability of fossil and nuclear energy. For this reason, the authors considered the hypothesis that countries with a large fossil fuel and/or nuclear share in their energy supply were less likely to adopt feed-in tariffs and/or green certificate systems (SCHAFFER; BERNAUER, 2014, p. 18), which are the two previously chosen policy instruments for supporting renewables for electricity production. The conclusion was negative for this hypothesis. The higher shares of fossil and nuclear energy in the matrix, the greater the likelihood of a country to adopt such policies for renewables will be.

In the work by Schaffer and Bernauer (2014), conclusions showed that countries with high per capita and/or high per Gross Domestic Product (GDP), greenhouse gas emissions were less likely to adopt the instruments towards renewable energy. They initially considered that total GHG emissions per capita or per GDP would serve as an opportunity cost for the country to shift to a more renewable source. However, it was proved that higher emissions rates had a negative impact on the adoption of policies for renewables (THE WORLD BANK, 2017).

In a different approach to development, Margolin (2015) gathered cases from different cities working towards more sustainable options for development. The work highlighted the work of designers as real players in social and environmental change at the micro (individual level), meso (group of individuals) and macro (cities, large companies and organizations) levels. Apart from the competition and conflicting interests among these levels, the author believes that the macro level is where potential change is possible. Failures to co-ordinate action among countries or within large corporations were considered, and as a conclusion, he considers the cities the main sites for change or, as he says the significant sites for action in creating a sustainable future.

The term “good city” (MARGOLIN, 2015) referred to the model of believing a sustainable framework to be the basis for change in such locations. Initially considered for the city of Chicago, many inputs came from examples and practices from other cities around the globe. The study entailed topics such as waste, food production, energy and others. They concluded that a bottom-up approach for projects was preferable and the connection of independent projects could bring systemic relationships beneficial to the sustainable movement.

Another article, by Visvaldis, Ainhoa and Ralfs (2013), proposed a methodology that elected sustainable development indicators through stakeholders' selection. Their research, applied in Valmiera, a town in Latvia, identified 108 indicators from three dimensions (economic, social, and environmental). The final indicators were grouped into themes, applied and reviewed. They also found that there is an ongoing need to review and add indicators from the three dimensions above mentioned. Besides, it also concluded that the process to select indicators should consider stakeholder input, rational decision-making and compromise (VISVALDIS; AINHOA; RALFS, 2013). The authors agreed that the indicators should result from stakeholder engagement and should serve as benchmarks for monitoring progress.

The suggestions from the stakeholder analysis proposed that the indicators should consider future needs and issues. Since indicators cannot always be measured due to constraints, such as financial constraints, practicality, availability, and others, their decision on the choice of indicators was based on the possibility of what was quantifiable and measurable, and also if the indicator could effectively provide information that could impact decision making processes.

One of the risks associated with a stakeholders’ assessment in order to choose issues of interest is the decision about whether to consider non-expert opinions. Another risk is the low number of stakeholders’ inputs, in which scalability could undermine specific inputs. A clear example is the work by (VISVALDIS; AINHOA; RALFS, 2013) in which the authors conducted face to face interviews with seventeen public employees and church members from a small town in Latvia. Their functions were related to the themes, but their levels of expertise were not mentioned.

The lack of expertise and the small universe chosen led to a highly questionable choice of indicators given the goal in mind. As an illustration, indicators such as the number of residents in NGOs, number of pets, and gym attendance were chosen and collected, while citizen satisfaction with life, measurements of economic inequality, and the ecological footprint were discarded. In the table showing the selected list of indicators, there were 73 in total, of which 23 were not used.

Nussbaumer et al (2013) addressed the problem of misused metrics in their work. They sustain that indicators to estimate economic performance and social progress can be misused or misinterpreted (NUSSBAUMER et al., 2013) and therefore created a new framework, which focused on finding out if a country was energy poor. The Multidimensional Energy Poverty Index (MEPI) assesses the level of deprivations a person or an entire household has in terms of simple energy needs. They are considered energy poor in case their level overcomes a certain threshold.

MEPI's indicators are grouped into five dimensions: cooking, lighting, services provided by means of household appliances, entertainment and education, and communication. The answers are binary (yes or no) and the questions are straightforward and ask if the person or the household has access to electricity, has a radio, television, refrigerator, telephone line or mobile phone, what type of cooking fuel, if food is cooked on a stove or open fire in the house, in separate building or outdoors, and if household has a chimney, hood or neither (NUSSBAUMER et al., 2013).

The index provides two results, one regards the relative number of energy poor, which is the incidence, and the other reflects the intensity of this poverty. Their findings show that has been improvement in the countries analyzed, that there are less energy poor people today than a decade ago. The authors consider the findings of great importance for policymaking and they affirm that the services are improving.

Once again, the difficulty in correlating improvement in straightforward indicators with improvement in real life should be carried out with care. Even the authors agree that effective policies are required to reach a better understanding of the energy status quo in the regions

(NUSSBAUMER et al., 2013). Next, we present the criticism on the weighting of MEPI, by Serwaa Mensah, Kemausuor and Brew-Hammond (2014).

Another country-specific article analyzed energy access indicators for Ghana (SERWAA MENSAH; KEMAUSUOR; BREW-HAMMOND, 2014). Besides being a handy piece of work showing Ghana's current energy access, the article sheds light on a widespread problem present in all continents, which is basic access to energy, including energy for cooking and household lighting. This problem mainly affects the poor and is directly related to social inequality and quality of life of these populations, hence the urgency and timeliness of the topic.

The authors review three sets of multidimensional indicators: a) Multidimensional Energy Poverty Index (MEPI), b) Energy Development Index (EDI), and c) Energy Access Index (EAI) as a way to bring good practices of measurements to the government of Ghana. The authors criticize the one-dimensional indicators approach, which measures from a single aspect of an issue, chosen by the country to analyze energy access as insufficient for its objective. Finally, it recommends the multi-dimensional approach as a more holistic alternative to have a better view of the situation in the country and a diligent data collection to keep these indices accurate in the years to come.

Analyses comparing different types of energy sources have also been made. Dincer and Acar (2016) made comparative analyses of eight sources of energy: coal, natural gas, solar power, wind power, hydroelectric power, geothermal, biomass, and nuclear power. Their comparisons addressed these options based on amount of emissions, conversion efficiency, possibility of renewal and number of products produced. For each specific source, they named the best option, and as a best in class in general, geothermal power was the chosen one. Besides this conclusion, other findings were interestingly noted, such as the fact that emissions decreased and efficiency increased with growing amounts of products from one source of energy.

There are other cases, such as the analysis of a specific type of energy. A study by Stamford and Azapagic (2011) created an indicator-based framework to assess the sustainability of nuclear energy in the United Kingdom. Their final proposal had 43 indicators distributed among techno-economic, environmental, and social dimensions. The criteria used by the authors comprised energy security and climate change issues, and others, including indicators for the context of the UK's electricity context, such as nuclear energy specific, leveled costs, and impact on human health.

The indicators were picked based on previous works combined with a stakeholder analysis, just as we intend to do in the present work. They held interviews with 30 stakeholders from different sectors, namely energy, academia, NGOs, and government. Although developed for a country-based level, most sets of indicators mentioned beforehand may be adapted or fully used for other site types and for other countries. The richness of such studies fulfills many needs of other cases around the globe. In the work by Stamford and Azapagic (2011), a framework was built for the case of nuclear power in the United Kingdom, but was generic enough to be applicable to other choices of electricity source or location.

Narula and Reddy (2015) compared three different sustainability indices to three blind men describing an elephant from their viewpoint, metaphorically representing a country sustainability level in relation to many different ways to measure it. In order to prove whether the results of the indices, namely the Energy Architecture Performance Index (EAP), the Energy Sustainability Index (ESI), and the International Index of Energy Security Risk (ESR), were similar or not, they compared a list of countries ranked in each of them separately.

The study concluded that higher ranked countries showed less sensitivity among the different indices, showing that their performance has proven robust. However, there were many differences for some countries that were more sensitive to the different approaches, proving some level of relative unreliability. In some cases, the selection of indicators affected these countries' ranking, while in others, the variation was great even with similar data coming from the same set of years, including the case of Brazil.

They criticized the construction of indices ending up with a specific numerical result and suggested the approach to organize countries according to their scores?? as a way to give more accurate and reliable results. Showing the results in such a ranking would expose the limitations of a comprehensive quantitative index but would be fairer as it accommodates uncertainties in measurements. The final conclusion was that different indices capture different information and should therefore collaborate in order to have a more complete idea of the elephant as a whole, as a connotation for the level of sustainability in any given country.

Michael et al (2014) analyzed three countries in order to show the efforts they made in order to use indicators in their urban development policies. The paper does not analyze the same indicators for all three countries chosen, Malaysia, China and Taiwan, which makes it difficult to carry out a comparative analysis among them, but it shows the different views on priorities and preferences of how sustainability can be assessed by stakeholders and countries. The author identified the need for more theoretical and operational understanding between indicators and processes. The challenges they encountered should be treated as pathways for their future policies. In conclusion, indicators are able to serve as a guide for countries for sustainable urban development.

The public availability of indicators and access to them should be considered as far as encouraging the public to seriously consider the idea of sustainability is concerned (MICHAEL; NOOR; FIGUEROA, 2014). The authors compiled processes and their resulting indicators for Malaysia, Taiwan and China in order to assess the operational capability of sustainable policies. The work analyzed whether they were implementing the indicators in their policies. Each of the countries had a specific set, so the comparison was focused on achieving each set's goals, and not in a cross-reference approach. The results show the sustainability level of each country. The paper showed how one single assessment methodology can analyze different sets of indicators in such a way as to build a valid comparison among countries' performances.

Concerning specifically the Brazilian electricity industry, there are indicators created and managed by the Brazilian Electricity Regulatory Agency (ANEEL). They are mainly technical indicators that allow the agency to grasp the level of quality of service, mainly from distribution, work-related issues, and one index for customer satisfaction. They are: Commercial Quality Indicators, Indicators of Defaults and arrears, Indicators for Call Center Services, Indicators of Continuity of Service, Compliance Indicators of the Level of Tension, Time to Respond to Emergency Incidents, Indicators of Work and Facilities Safety, and ANEEL's Customer Satisfaction Index (IASC) (ANEEL, 2017).

IASC is an indicator-based framework that assesses customer satisfaction in regards to the services provided by Brazilian electricity industry distributing companies. ANEEL collects opinions through a yearly survey that is currently undertaken with 25 thousand consumers of all distributing companies in Brazil. The results are openly shared and companies are ranked. Besides, the agency uses the results to develop and reassess regulatory tools and supervisory activities. (ANEEL, 2017).

As we could see, comparison is seen as one of the main purposes of these studies and it is carried out either by ranking, grouping or classification. These studies compared countries, cities, sources of energy, different indices per se, policy choices etc. Factors differed widely and the results showed the importance of the choice of indicators in the analyses and how each element analyzed (i.e. a country, a type of policy or indexes themselves) can be improved to the rest of the sample.

There has been an increase in the search for more holistic approaches in order to analyze sustainability and sustainable development. An important step taken was to develop indicators that show the connections among the three dimensions, not merely stating their values individually. This recognition of this interconnectivity is vital to the quality of the analyses.

The emergence of new dimensions being aggregated into the analyses have been considered by a myriad of studies. Michael et al. (2014) affirmed that institutional and governance dimensions were increasingly being considered in the sustainability analysis approach as conditions to make sustainability possible. Institutional topics such as access to information, policy execution, competitiveness and others were also included in Sharma and Balachandra (2015)'s work. As for the third type, in the context of sustainability for the energy sector, issues concerning energy as a factor for creating conditions for livability should be taken into account, according to Sharma and Balachandra (2015).

2.3. Examples of indices and frameworks

A large number of indices and frameworks have been created and are being widely used to date. They differ in their main goals, indicators chosen, reasons for creation, the amount of data and countries (or any other actors) analyzed and more. Here we list some frameworks and indices that have been used for some time in the fields of sustainability, energy, and development.

These indices and frameworks show how diverse and popular they can be. They also show how different actors can create and follow up on them, how stakeholders can use the data and rankings in their analyses, and how powerful and useful they can be for policymakers, academia and market players. We will now present frameworks created by the academia, governmental bodies, and market-based institutions.

2.3.1. Human Development Index (HDI)

Probably the best-known index in the world, the HDI calculates life expectancy at birth, years of schooling, and Gross National Income (GNI) per capita to build an index that represents the level of human development in countries around the world. The first Human Development Report was launched in 1990 and aimed to introduce a new approach to both measuring and fostering human development and wellbeing. The report introduced the index as a way to measure development among countries. The index was also shaped in order to address different indicators other than merely financial or economic indicators alone (UNDP, 2017).

The HDI is a composite index calculated by the mean measure of progress in three sub indices: long and healthy life, knowledge, and a decent standard of living. The first dimension, health, is calculated based on life expectancy at birth. The second dimension is the knowledge index, calculated by expected years of schooling and average years of schooling. The third dimension, standard of living, is measured by GNI per capita (UNDP, 2017).

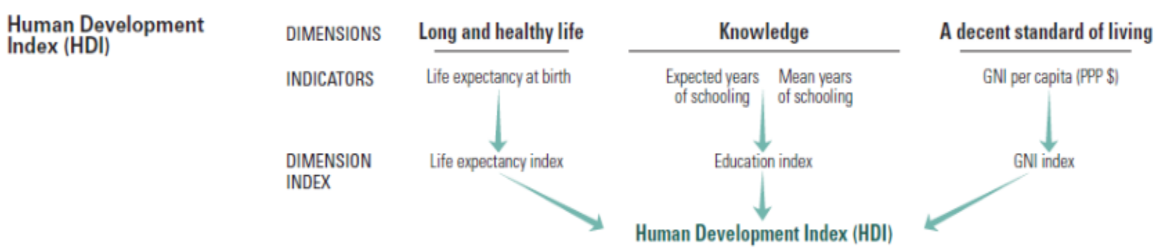

Figure 3 – Human Development Index Composition.
Source: UNITED NATIONS DEVELOPMENT PROGRAMME, 2017.

There is some disagreement about the equal value given to very different indicators and whether they alone actually represent a measure for human development. The index applies equal weight to the three dimensions, including the two sub-indices in education, based on the assumption that human beings value all three dimensions equally (UNDP, 2017). The original indicators were chosen after a long study, and throughout the years some modifications were made.

Other criticisms of the HDI, such as the one by Bartelmus (2013), concerns the fact that the index itself has shown little progress and change. Bartelmus also criticizes the unclear criteria for considering well-being and welfare. Although it does not serve to reflect inequality, poverty and other topics, the HDI is a widely-accepted tool that puts countries into low, medium, high, and very high human development categories. The index can be useful in addressing national policy choices, asking how two countries with the same level of GNI per capita can end up with different human development outcomes. These contrasts can stimulate debate about government policy priorities. The last version was launched in 2015, and a total of 188 countries were analyzed (UNDP, 2017).

2.3.2. Human Sustainable Development Index (HSDI)

This new index included an environmental dimension as an adjustment to? the United Nations' Human Development Index (HDI). The idea of building a reviewed index was to insert the environmental dimension to make it more accurate with regard to the concept of sustainable development. The original HDI includes three different series of data, which are life expectancy at birth, years of schooling, and GNI per capita. The HSDI introduced per capita carbon dioxide emissions.

All the data were recalculated and all dimensions lay between zero and one, in which higher values, i.e. closer to one, represented greater development levels. Nonetheless, the inclusion of the environmental dimension in the HSDI did not make significant changes in the final scores of the HDI. In countries with lower emissions, both indexes remained very closely related, while in those with higher emissions, there were some differences.

Bravo (2014) made a critical analysis of the HSDI and concluded that since carbon dioxide emissions are directly related to income levels, little difference was made. Therefore, the paper suggested that for an index to represent the level of sustainable development in a more accurate way, there should be greater equilibrium among the three dimensions. Besides, the article also presented information about several indexes related to the environment, such as the Ecological Footprint, the Ocean Health Index, and the Global Environment Facility Index.

2.3.3. The Ecological Footprint (EF) by Global Footprint Network

This index focuses on the effects of processes of consumption on natural systems, the so-called bio capacity compliance (BARTELMUS, 2013). The Ecological Footprint (EF) shows the amount of "land and water an individual, population, or activity requires to produce all the resources it consumes and to absorb the waste it generates, using prevailing technology and resource management practices" (GLOBAL FOOTPRINT NETWORK, 2017a, p. 1). The final index is measured in global hectares per capita (BRAVO, 2014) as a way to show a deficit or a debit considering each country's population needs. More recently, it has done the same for specific cities and regions alike (GLOBAL FOOTPRINT NETWORK, 2017b).

The organization behind it is the Global Footprint Network. This is a nonprofit organization whose mission is to help end ecological overshoot by making ecology important for decision-making. It was established in 2003 but it has been collecting data from as early as 1961. Today, it offers consultancy to local and central governments and provides open data access on their data explorer available online and for free (GLOBAL FOOTPRINT NETWORK, 2016).

The EF measures the demand and supply of natural resources according to each region's needs. On one hand, the demand side entails the ecological assets required by the population to have their needs attended. The needs include all natural resources consumed, which are agricultural products, extractive products, such as plants, greens, fiber, timber, livestock, and fish. They also include space needs for infrastructure, waste and carbon emissions. On the other hand, the supply side entails the productivity level of these assets (GLOBAL FOOTPRINT NETWORK, 2017b). So they include specific footprints such as land for crops and grazing, forest products, carbon, fish, and built up land, with indicators measured in global hectares, which is "a biologically productive hectare with world average biological productivity for a given year" (GLOBAL FOOTPRINT NETWORK, 2017a, p. 1).

The Footprint compares both sets of data to create a mean measure of these specific footprints from the supply side. The index presents annual demands for the goods and services of a country and compares them with the resources available, based on the population, and the final result is measured in global hectares per capita. The idea is to create a method to measure human demand for natural resources, in a way that is simple and easy to grasp. To date, they have collected and analyzed over 200,000 data points and transformed them into one final number (GLOBAL FOOTPRINT NETWORK, 2017b).

If the EF is smaller than the region's biocapacity, then there is profit, or what the organization calls an ecological reserve. Otherwise, if the EF is bigger than the country's biocapacity, the result is a deficit. And the country (or region) would have to either fulfill its needs by importation or over exploitation of its own resources.

2.3.4. Global Reporting Initiative (GRI) by Global Reporting

The GRI is one of the most widely accepted and used frameworks for companies and some local governments to report their sustainability efforts. It is an independent non-governmental organization that helps bodies assess and report the impact of their activities and impacts on the three pillars of sustainability: social, economic and environmental. It is also known as the world's most widely used standard for sustainability reporting (GLOBAL REPORTING INITIATIVE, 2017).

The GRI was founded in Boston, USA in 1997, and today it has its headquarters in Amsterdam, the Netherlands (GLOBAL REPORTING INITIATIVE, 2014). Originally, it was a partnership between two non governmental organizations called Coalition for Environmentally Responsible Economies and Tellus Institute (GLOBAL REPORTING INITIATIVE, 2017). Today they work as a collaborative network for individuals and organizations, including companies, associations, stock exchanges, academia, governments, and other non governmental organizations (GLOBAL REPORTING INITIATIVE, 2017). The organization has been growing ever since it was established. Today, the largest number of reports come from the USA, Brazil and Thailand, but GRI is truly an NGO with a global reach. By mid 2015, over 19,100 reports had been published following their standards by organizations in over 90 countries (GLOBAL REPORTING INITIATIVE, 2015).

In 2016, the organization launched the GRI Standards. These standards are the indicators it used before it became a world-wide reference for sustainability. It intends its standards to be the best practice and the go-to in terms of assessing sustainability reporting and to be used as a reference for policymaking and decision making in all sectors. They are designed to be used as a set by any organization that wants to report about its impacts, and how it contributes to sustainable development (GLOBAL REPORTING INITIATIVE, 2017). Its goal is to create a future where sustainability is considered part of every organization's decision-making process. They want companies and stakeholders to take more and more action in fostering a sustainable world.

Criticisms of the GRI are related to its lack of local adequacy, the fact that data reporting is totally dependent on the organization that is reporting, and the fact that it is a generic statement about the organization that chooses to report following their guidelines. The standards and guidelines are universal, with a few sectors that have specific brochures regarding their industries. The standards are sometimes too broad or not applicable to certain regions or sectors. When sector-specific, the problems because companies differ widely in business operations, making them hard to report in such a way that this does not jeopardize the company’s reputation to others. Each organization (company, city government or an NGO) can report it freely and with their understanding of the standards, regardless of closer accompaniment by the GRI. And, finally, the literature criticizes the fact that the GRI is not suitable to assess projects or technologies, on a technical level (STAMFORD; AZAPAGIC, 2011).

2.3.5. Sustainable Development Indicators (SDI) from the Statistical Office of the European Union (Eurostat)

The European Union (EU) has adopted a series of sustainability goals to form a composite indicator-based framework to monitor its sustainable development strategy (BARTELMUS, 2013). And, since measuring progress is fundamental for the organization’s strategy, a framework of indicators was created to be applied and accompanied along the years (EUROSTAT, 2017). The SDI is a framework that consists of 10 objectives for sustainable development as defined by Eurostat. This index is used nowadays to assess social and economic development in the EU.

The EU´s commitment to a sustainable development strategy was adopted by the European Council in 2001, and renewed in 2006. The renewed strategy sets out a single, coherent approach that will enable the EU to meet its long-standing commitment to meet the challenges of sustainable development (EUROSTAT, 2017). The EU has stated seven key challenges, which are the following: climate change and clean energy, sustainable transport, sustainable consumption and production, conservation and management of natural resources, public health, social inclusion, demography and migration, global poverty and sustainable development challenges. For every challenge, there are targets for sets of strategies, operational objectives, and associated actions.

The indicators analyze a series of different topics related to sustainability, including indicators that are primarily economic, such as growth rate and resource productivity, but also related to a wide array of issues, ranging from energy consumption to governance. For each choice, a rationale is given as a way to maintain the alignment to the big picture and to explain the role each indicator plays in the whole. For example, the growth rate was adopted as a way to quantify the level of dynamism of the economy, including its capacity to create job opportunities, resources, and attend present and future needs, while resource productivity was adopted to show if there is a relation between the use of natural resources and economic growth (EUROSTAT, 2017).

Over 130 indicators are analyzed in the SDI. They are split into different levels that work for different purposes. The headline indicators monitor the overall picture. These are intended to give a broad picture of the evolution of the Union as a whole. They have an educational value associated with it, they are more robust and generally available every five years. Operational indicators show the operational objectives of the strategy, and are considered lead indicators within their themes. Explanatory indicators are related to actions and can show more detailed data (EUROSTAT, 2017). They are still robust, and available for most EU members and for a period of three years. Explanatory Indicators show greater breakdown, and more granular data can be found here, separating numbers by income groups or age. There are also contextual indicators that do not have data per se associated, but offer an overview of background information (EUROSTAT, 2017).

The index also has two other kinds of indicators, namely indicators that are being developed and indicators to be developed. The former might already exist but have insufficient coverage and are expected to become available within a couple of years. The latter are those being developed (EUROSTAT, 2017). These are probably the reasons why they take into account good governance and the level of renewal of common fisheries, but have no defined indicators yet.

2.3.6. Sustainable Energy Watch (SEW) by Helio International

The SEW is a methodology based on indicators that allow the assessment and monitoring of the role played by energy systems on sustainability at a global level. The indicators measure the impact of energy policies on different realms of sustainability, namely environmental, social, economic, technical, and governance-related sustainability (HELIO INTERNATIONAL, 2017a).

There are five dimensions and two respective indicators for each of them: a) environmental: carbon dioxide emissions per capita and environmental energy-related emissions; b) social: guaranteed access to electricity and investments in clean energy; c) economic: energy resilience and burden of public energy investments; d) technological: energy intensity and renewable energy deployment; and e) civic: quality of information and participative governance.

The organization collects data that is already available, and makes simple calculations in order to create the final ranking. The index also considers stakeholders' opinions, with qualitative input from specialists (HELIO INTERNATIONAL, 2017a). For every indicator, there are examples. And as their base year, they analyze the evolution compared to 1990, the chosen reference year (HELIO INTERNATIONAL, 2017b).

2.3.7. Global Tracking Framework (GTF) by Sustainable Energy for All (SE4ALL)

The GTF is a global data platform created with information from household surveys and current energy balances. Sustainable Energy for All (SE4All) is an initiative of the United Nations' Secretary General whose aim is to ensure universal access to sustainable energy by 2030 (UNDP, 2011). The focus of the initiative is to provide over four billion people with access to energy, based on three objectives: a) to ensure universal modern energy services; b) to double the rate of improvement in energy efficiency, and c) to double the renewable energy share globally.

The GTF is an initiative coordinated by the World Bank program called Energy Sector Management Assistance Program (ESMAP) and the International Energy Agency (IEA), in collaboration with thirteen other agencies. ESMAP was set up in 1983 in answer to the oil shocks in the 1960's and 1970's. The Program is one of global knowledge and technical assistance whose aim is to assess a multitude of energy challenges in the whole world by providing services and studies to governments and other institutions (ESMAP, 2013). Today, around 70 countries have formally joined the initiative, but many more are considered in the analysis (UNDP, 2011).

Data range from 181 to 212 countries, depending on the availability of data sources. Although not completely aligned for all indicators, the final batch represents approximately 98 percent of the global population in the period. The report provides an initial system for regular global reporting based on indicators that are both technically rigorous and feasible to compute from current global energy databases, and that offer scope for progressive improvement over time.

The objectives reflect the three objectives established by ESMAP and SE4All as a way to achieve a sustainable energy future. For the first objective, energy access, they calculated two indicators, namely the percentage of the population with access to electricity and the percentage of the population with primary reliance on non-solid fuels. For the second objective, energy efficiency, the rate of improvement in energy intensity was used, since it has been widely accepted and used as an indicator for energy efficiency. And finally, as for the third objective, renewable energy, they used the share of renewable energy in total final energy consumption. The following list of sources of electricity were considered: bioenergy, aerothermal, geothermal, hydro, ocean, solar, and wind (SUSTAINABLE ENERGY FOR ALL, 2013a, 2013b).

Improvement in the methodology has been considered throughout the years. Improvement comes in the development of systems, measurement reviews to achieve more and better data, including disaggregated data. For renewable energy, the biggest challenge is to find ways to measure the sustainability level of these different sources. The program is aware of the requirements for such improvements and is working with capacity building so that governments are able both to collect the data for these indicators and to work on improving their numbers afterwards (SUSTAINABLE ENERGY FOR ALL, 2013a, 2013b).

2.3.8. Regulatory Indicators for Sustainable Energy (RISE) by The World Bank, SE4All, ESMAP and Climate Investment Funds

Another framework created by Energy Sector Management Assistance Program (ESMAP) is RISE. RISE's goal is to provide policymakers with a benchmark for the energy sector, by comparing policies and regulatory frameworks around the globe. In order to do so, the index ranks national policies for what they call the "three pillars of sustainable energy", namely access to modern energy, energy efficiency, and renewable energy (BANERJEE et al., 2016).

The index analyses over 100 indicators and 158 questions, separated into main and sub-indicators to show the evolution of sustainable energy in different countries. These indicators enable policymakers and market players to benchmark progress across countries. Since it is a set of indicator-based frameworks that include national policies and regulatory frameworks for sustainable energy, the actors can compare themselves to peers and develop better tools and regulations to foster sustainable energy (BANERJEE et al., 2016).

These indicators were agreed upon after consultations with internal and external experts, and had the following criteria: they should be objective and comparable, data should be available, there should be consensus about the indicator, and they should be cost-effective. The organizers also had information that could not be scored: administrative procedures for sustainable energy and a context that explains the adoption of practices by companies (BANERJEE et al., 2016).

Over 40 per cent of the countries are in the yellow zone for renewable energy, and over 40 per cent of the countries are in the red zone for energy efficiency (BANERJEE et al., 2016, p. 8). The results show that there are countries with good final scores in different regions and income groups. This suggests that there is room to learn from peers in all geographical regions.

The criticism of the index is the fact that sometimes countries have data for more than one option. In the example of the indicator for energy efficiency incentives, the index considers the highest score if the country reports more than one indicator. This does not affect the overall score, but it ignores the fact that this country has more data and options available. The suggestion would be for the index to somehow consider both values in such cases.

2.3.9. Global Indicator Framework for SDGs by The United Nations

The 2030 Agenda for Sustainable Development has established the development of an indicator framework to assess and follow the targets. The signees have agreed to report progress and transparency at global, national and regional levels. For the purpose of the development of this framework the Inter-Agency and Expert Group on SDG Indicators was created.

Relevance, measurability and ease of communication were the main factors in the selection of the indicators. The Group also assigned targets but understood that not all the aspects of the targets could be tackled by the indicators themselves. Thus, the Group recommended efforts in the long run to identify new indicators (ECONOMIC AND SOCIAL COUNCIL, 2015).

Specifically, for the energy component, there are a number of goals set. The United Nations has set the following goals for SDG number 7 that are supposed to be achieved by 2030: 1) to ensure universal access to affordable, reliable and modern energy services; 2) to substantially increase the share of renewable energy in the global energy mix; 3) to double the global rate of improvement of energy efficiency; 4) to enhance international cooperation to facilitate access to clean energy research and technology, including renewable energy, energy efficiency and advanced and cleaner fossil-fuel technology, and promote investment in energy infrastructure and clean energy technology; and finally 5) to expand infrastructure and upgrade technology to supply modern and sustainable energy services to all in developing countries, in particular the least developed countries, small island developing States, and landlocked developing countries, in accordance with their respective programs of support(UN ENERGY, 2014; UNITED NATIONS, 2016).

For this specific SDG, the following indicators are used to measure progress and rank countries: the percentage of the population with access to electricity, the percentage of renewable energy in the total final energy consumption, energy intensity measured in terms of primary energy and gross domestic product (GDP), mobilized amount of U.S. dollars per year starting in 2020 used for the $100 billion commitment, and ratio of value added to net domestic energy use by industry. The difficulty in collecting, following up and creating common indicators that can be used in all countries is great. It is clear that this list of indicators cannot fulfill all the desired outcomes within the goals, but they can serve as an appropriate starting point to establish some common ground among vastly different levels of development.

2.3.10. Ease of Doing Business Index by The World Bank

The World Bank's Ease of Doing Business Index ranks countries according to their difficulty or not in doing business. It measures countries' policies and regulations for market and business matters; therefore, it serves as a way to measure investment climate in different regions. The index comprises information from the following indicators: starting a business, dealing with construction permits, obtaining electricity, registering property, obtaining credit, protecting investors, paying taxes, trading across borders, enforcing contracts, resolving insolvency, and employing workers.

Other indicators include specific costs related to business operations, such as the cost of opening a business in almost 200 economies: the cost of starting a business, minimum capital requirement, the cost of obtaining a construction permit, the cost of obtaining an electricity connection, the cost of transferring a property deed, the total tax rate, and the cost of enforcing contracts. The World Bank coordinates and collects primary data on all these indicators in order to build the index (THE WORLD BANK, 2017).

2.3.11. Environmental Performance Index (EPI) by Yale University and Columbia University

The EPI is coordinated by the Yale Center for Environmental Law & Policy at Yale University and the Center for International Earth Science Information Network at Columbia University to serve as a comparative tool to assess environmental performance among different countries. It was built to rank countries and today it has become a benchmark to assess environmental policies and goals (YALE UNIVERSITY; COLUMBIA UNIVERSITY, 2016).

It measures and compares countries based on two environmental-focused domains, environmental health and ecosystem vitality. The former assesses the protection of human health from environmental damage, while the latter assesses ecosystem protection and resource management. The framework is composed of 9 issues (health impacts, air quality, water and sanitation, water resources, agriculture, forests, fisheries, biodiversity and habitat, and climate and energy) and 20 related indicators, with scores ranging from 0, the worst, to 100, the best (YALE UNIVERSITY; COLUMBIA UNIVERSITY, 2014).

The criteria for the choice of indicators respect the following six rules: relevance, performance orientation, established scientific methodology, data quality, time series availability and completeness. With regard to relevance, the indicator should be able to track the phenomenon. The indicator should be able to provide data that actually shows the results of the matter in such a way as to show how countries are performing. It should also be from a trusted source, either a peer reviewed scientific data or from a renowned institution. The quality and availability of data plays a crucial role since it should represent the best measure, be reviewed for quality purposes, and be consistent for longer periods. And, finally, the indicator should present adequate coverage, in samples of countries and time (YALE UNIVERSITY; COLUMBIA UNIVERSITY, 2016).

The index uses targets that are established by policy goals and/or scientific boundaries and are used to guide national governments (YALE UNIVERSITY; COLUMBIA UNIVERSITY, 2014). They are also used to consolidate results at a global level, allowing an analysis of the collective impact of the environmental indicators they collect. In the latest index, the results showed improvements, such as those in access to drinking water, child mortality, and access to sanitation, as well as deterioration factors such as air quality, fisheries, and wastewater treatment.

The index advocates better data and management alignment as a way to allow responsible decision-making based on trusted quantifiable results. Good quality data can help improve scores, whereas the lack of quality data and targets work against progress (YALE UNIVERSITY; COLUMBIA UNIVERSITY, 2016).

2.3.12. Energy Development Index (EDI) by the International Energy Agency (IEA)

The IEA created the EDI as a way to have an index for aggregate level that shows the level of energy access in different countries. The index was inspired by the HDI. The EDI is an example of a composite index with final scores ranging from 0 to 1, that assesses the level of energy development in the countries analyzed (IEA, 2011).

The indicators were measured based on the following data points: a) access to clean cooking facilities: percentage of modern energy use in total final consumption by residential sector; b) access to electricity: percentage of population that has access to electricity, per capita electricity consumption; c) access to energy for public services: per-capita public services electricity consumption; and d) access to energy for productive use: share of economic activities in the total final consumption (IEA, 2011).

2.3.13. Energy Indicators for Sustainable Development (EISD) by IAEA, UNDESA, IEA, Eurostat and EEA

The index assesses 30 indicators, grouped in the three dimensions of sustainability, namely social, economic, and environmental sustainability, and sub-grouped in seven themes and 19 sub-themes. The authors consider some indicators for more than one dimension or theme based on the idea of the interrelatedness of these indicators. The indicators for the social dimension are the share of households without electricity or heavily dependent on non-commercial energy, household energy use for different income groups, share of household income spent on fuel and electricity, and accident fatalities compared to energy produced.

For the economic dimension, the index collects and analyzes the following indicators: energy use per capita, energy use per unit of Gross Domestic Product (GDP), efficiency of energy conversion and distribution, reserves-to-production ratio, resources-to-production ratio, industrial, agricultural, and service energy intensities, household and transport energy intensities, fuel shares in energy and electricity, non-carbon energy share in energy and electricity, renewable energy share in energy and electricity, end-use energy prices by fuel and by sector, energy dependency, and stocks of critical fuels.

For the economic dimension, the index collects greenhouse gas (GHG) emissions from energy production and use, per capita and per unit of GDP, ambient concentrations of air pollutants in urban areas, air pollutant emissions from energy systems, contaminant discharges in effluents from energy systems, oil discharges into coastal waters, soil area with excessive acidification, rate of deforestation due to energy use, ratio of solid waste generation to units of energy produced and properly disposed of to total generated solid waste, ratio of solid radioactive waste compared to units of energy produced, and to total generated solid radioactive waste (IAEA, 2005).

2.4. Issues and Challenges Concerning Indicators

Based on the extensive literature review, we found that there is a list of common aspects that makes a good indicator-based framework: balance among the issues and indicators chosen to represent them, quality data availability, right weighting, effectiveness, accuracy in defining goals and in collecting data, and comparability among countries and throughout time. But we could also identify some challenges and fallacies discussed and presented in the literature.

The first is related to the fact that frameworks with a larger number of indicators were better off. The greater the number of indicators, the greater amount of data that will be handled, which can be positive or negative. The number of indicators does not necessarily guarantee good quality of results. A large amount of data can be negative, as happened to happen with frameworks using secondary data that end up using repeated data points. The right number of indicators and the combination among them do.

Milman and Short (2008) recalls the importance of the balance that must exist considering availability of data, complexity, scoping and accuracy in the development of such indicators. The notion that one-dimensional indicators measure the performance of an issue from a single aspect, and therefore, are straightforward and easy to interpret, but give a narrower perspective, was defended by Nussbaumer, Bazilian and Modi (2012).

Michael et al. (2014) remembered that one key challenge posed by the use of indicators lies in the integration of the triple bottom line (social, economic, and environmental) into a framework that is meaningful and effective. Bartelmus (2013) and Narula and Reddy (2015) cites problems with comparability within and among indices. Comparing countries via scores and rankings might encourage countries to improve; but more due to national pride than for a more substantial motivation (BARTELMUS, 2013). Bartelmus also defends the idea that these indices cannot provide a quantifiable definition of sustainable development. Thus, the concepts for sustainable development remain selective and judgmental.

Bartelmus (2013) defends the focus on the interface between environment and economy more than that based on human welfare and holistic development. The author clearly claims that sustainability itself is a weak benchmark for development. Since most governments continue to focus on economic growth, with less emphasis on the environment, the author concludes that making the economy greener is a more realistic concept but could only be achieved with the correct management of environmental accounting.

As for Narula and Reddy (2015), they remind us of the difficulty in pooling countries given their intrinsically different characteristics. They agree that countries' rankings are questionable. The very attractiveness of indicators for energy has brought a large number of indicators that are complex, give conflicting results, and have other limitations that need to be correctly addressed.

2.5. Final Remarks of the Literature Review

As we could see, indicators pose some problems, such as reasons for choice, measurability, applicability, validity, and other constraints. After these problems are overcome, it is possible to continue to the application of the set of indicators, the collection of data, and to double check and analyze the results. Then, indicators serve as a well-built and strong tool to represent a reality. They become even more powerful when combined, consulted on with prepared stakeholders, and finally critically analyzed. They serve as recommendations for further research into issues concerning energy sustainability.

The discussion and “confusion”, as termed by Bartelmus (2013), between green growth a and sustainable development has been underway since the first Rio Conference in 1992 and is still ongoing (BARTELMUS, 2013). The main confusion is what should be sustainable: growth, green, development, or other? The answer comes in measurability. Measurability is defined by Bartelmus (2013, p. 166) as “a reality test that can separate practical policy analysis from rhetoric”.

Measurements are also important to tackle corruption. There have been studies on the impact of corruption in the electricity industry. It has been proven that corruption affects investments negatively. Taniguchi and Kaneko (2009) assessed the political interference in the performance of a rural electrification program carried out in Bangladesh, one of the most corrupt countries in the world, according to Transparency International. Taniguchi and Kaneko (2009) proved that political interference had negative impacts on the operational efficiency of energy programs. Furthermore, this type of meddling could lead to waste of resources, low staff morale, and operational ineffectiveness (TANIGUCHI; KANEKO, 2009). Therefore, transparency and accountability play crucial roles in sound policymaking and should be reflected in indicators that are correctly gathered and reported to the public.

Being in possession of precise numbers and logical tools and models can assist the decision-making process in planning in general. However, this task of planning ahead, is one of the most difficult for planners to carry out. (NEVES; LEAL, 2010). Working in anticipation, and presenting the right energy requirements for society at the time it needs them (MME, 2014c), is the duty of energy planners. One of these tools is forecasting, through models that consider past data and build scenarios for the future.

Forecasting is a difficult task, but imperative, since it is of the utmost important to plan and prepare in advance for what will be needed in the future. This is one of the most important tasks of policymaking. The creation and ongoing assessment of indicators are also a form of predicting a path. Indicators can be a powerful tool that, by gathering great deal of data and relying on comparative analyses with successful and less successful cases, can depict realistic trends. With that, important actors can take informed decisions.

"No set of energy indicators can be final and definitive" (IAEA, 2005, p. v). This statement sums up the importance of follow-up and continuous review of any kind of indicator. Indicators can be improved, either in themselves, as they can be changed to collect more detailed information or by substituting and creating new indicators that can serve the time, the sector or the region in question best.

Indicators within a framework can also be updated either by their weight, their level of importance, and the combination in which they are used. The multidimensionality of such frameworks can play a decisive role in policymaking (NUSSBAUMER et al., 2013).

The evolution of indices and frameworks can affect measurability and comparability over time. However. this is a price to pay for better management and to adapt to changing times. Indicators should be able to suit current capabilities and priorities. Lastly, the inputs by the authors show how a multi-indicator framework, considering different aspects and different stakeholder participation can work for a more accurate and strategic analysis that can mobilize governments, the private sector, and society to act responsibly and plan for a long-lasting sustainable future.

3. INDICATOR-BASED FRAMEWORK DEVELOPMENT

For the indicator-based framework developed in this dissertation, we have gathered past data from secondary sources, in order to position the Brazilian electricity industry within a list of countries. A thorough review with contributions from previous works from academia as well as the energy and sustainability markets was undertaken as a way to construct the basis of our framework. The indicators selected, all directly related to electricity, served as the foundation for the task of positioning the electricity industry in Brazil and compare it to the rest of the world.

The main issues encountered in building a representation that was as accurate qualitatively and quantitatively as possible concerned a few criteria. Qualitatively speaking, an indicator should address the objectives and priorities of the topic of interest, and be unbiased, comparable, and measurable on a regular basis. Quantitatively speaking, the number of indicators to be used, the measurement and weighting should also be considered crucial determinants for the results (KEMMLER; SPRENG, 2007; NEVES; LEAL, 2010; SCHLÖR; FISCHER; HAKE, 2013; VISVALDIS; AINHOA; RALFS, 2013).

In our case, we adopted a comprehensive set of indicators to form a composite framework, which is a framework created from multiple indicators, as many of the scholars mentioned in Chapter 2 did. A composite framework is made up of a series of different indicators that work collectively to create one final index. It can vary in number of indicators considered as well as in their individual and total weight. In the next parts of this chapter, we address the structure of the indicator-based framework created, including explanations for the choice of indicators, their data sources, and their weight relative to total. In the next chapter, the results of the data collection and consolidation of the framework are presented along with cross-analyses and insights.

3.1. Methodology for the Framework

In order to create a realistic framework structure and base our work on previous academic studies, we have chosen criteria that reflect the main economic, social and environmental concerns to achieve a sustainable energy future in the electricity industry. As stated by previous literature, analyses based on the three so-called main dimensions of sustainability (namely social, economic, and environmental) brought more realistic results than the previously purely economic or environmental analysis.

In the past few years we have witnessed the increase of three main waves of sustainability indicators, both keeping the three-dimension model as a base: firstly, there is one whose aim is to create increasing synergy among the dimensions; the second is bringing new dimensions into the game and a third is incorporating sustainability into specific sectors. The indicators chosen to form the framework, the main resource of this dissertation, is based on the cross-referencing and links between electricity and other issues.

The final choice of indicators was predominantly made based on literature review, relevance, data availability, and data quality. In that way, we were able to use accurate datasets from recommended literature by academia, governmental bodies, and market-based institutions. A list of indicators collected and assessed, and their respective data sources, is displayed on Table 8. In the sequence, each chosen indicator is presented with an explanation, containing the rationale for its selection and how it fits into the framework as a whole.

The idea of establishing targets or thresholds for the indicators is widely accepted and used in the literature. Dincer and Acar (2016), for instance, defended the so-called smart targets, which could help societies achieve sustainability through design, development, and other factors. The goals could be achieved with better solutions, based for example on the six pillars of sustainability: better use of resources, better cost effectiveness, better security, better design and analysis, and better efficiency (DINCER; ACAR, 2016).

In our work, we pointed out the best in class for each indicator as a way to provide a type of a role model, an example to be followed. There are uncertainties related to difficulty in assigning one country as an example based solely on one single indicator, but it is a way to show something that is simple to collect, reliable and easily comparable.

The doctoral dissertation presents a composite multi-indicator framework in which different measurement units were used. There are indicators ranging from whole quantitative whole numbers, percentages, and numbers that are best when they are higher, but also best when they are the lower. For the present work, as the values differed from indicator to indicator, they were normalized later in order to align the results of the calculation. In this way, every value kept its relation to the whole framework and comparability was not affected.

In order to develop our final result, we normalized the data to transform them into one uniform and comparable scale. Therefore, in the present framework, all values range from 0 (zero) to 100 (one hundred), 0 being the worst case, and 100 being the best scenario.

In the literature, we have come across many different approaches to measuring the final results. Some authors set lower and upper limits to rank participants. Sharma and Balachandra (2015) set a benchmark with lower and upper limits, as a way to position India in this range. Then, criteria established by a stakeholder analysis helped in the prioritization of indicators and removal of outliers. The final values were derived from a database where countries were put into a ranking by value or order (best to worst). The set with the lowest values was considered the worst performers in that scale, whilst the one for the upper values reflected the best in class.

The measurement, i.e. the limits and thresholds chosen for the indicators, can directly impact on the countries' final results. Therefore, these limits should be carefully considered and developed.

In regard to the weight of the domains and indicators, we decided to utilize an already proven calculation methodology, as the one adopted by the United Nations (UN) and Schlör, Fischer and Hake (2013). The methodology determines an equal weight for each indicator in proportion to the best and the worst indicator, in a way to obtain a relative position for the performance of the indicators. Similarly, inspired by these authors and to the UN, we calculated the standardized between zero and one hundred.

It is also important that we considered an analysis during a period of time in which it is possible to enrich the analysis with the continuity of progress. As done by other scholars (MICHAEL; NOOR; FIGUEROA, 2014; SHEN et al., 2011), we have used temporal analysis, which is analysis throughout time, as a way to analyze the evolution of sustainability in the chosen indicators. The years were primarily chosen for two reasons: relatively sparse periods between the years and data availability.

Our most important data sources were the World Development Indicators (WDI), The World Bank (WB) and the International Energy Agency (IEA). As for data gathering, we use the starting year as reference year 1990, and considered a timeframe from then every five years up to 2010. In that way, it was possible to visualize the evolution of Brazil and other countries for five different periods in succession, which were years 1990, 1995, 2000, 2005 and 2010.

3.2. Final Indicators for the Framework

The final list of indicators used in the framework we present in this dissertation are as follows: a) *access to electricity* (IND1), b) *electric power transmission and distribution losses* (IND2), c) *carbon dioxide emissions from electricity and heat production* (IND3), d) *renewable electricity output* (IND4), and e) *renewable generation capacity share* (IND5). They are also shown on Table 7. We will list the indicators and provide the reader with an explanation of each of the indicators in the following pages.

Table 7 – List of Final Indicators of the Framework

Indicator	Description	Original Measure Unit	Data Source
IND1	Access to electricity	% of population	WDI
IND2	Electric power transmission and distribution losses	% of output	IEA
IND3	CO2 emissions from electricity and heat production	% of total fuel combustion	WDI
IND4	Renewable electricity output	% of total electricity output	WB
IND5	Renewable generation capacity share of total generation capacity	% of total generation capacity	WB

Source: Own elaboration.

For all of these five final indicators, we initially collected data from 215 countries. Nevertheless, due to data availability, our final framework analysis comprised 111 of them. Countries that did not have complete data for all the five indicators and for all the periods chosen were discarded, with one specific exception[3]. The full list of these 111 final countries can be found at the end of the dissertation. In the next paragraphs, we will explain the final indicators, with a description and a number of charts and tables to illustrate their relation to each other.

3.2.1. Indicator 1: Access to Electricity (IND1)

Access to electricity is part of the most urgent issue that connects energy to sustainable development. We addressed the issue of energy security in Chapter 2 (Literature Review) and used the definition by ESMAP: "the ability to balance supply and demand for reliable, sustainable, and affordable energy supplies and services" (ESMAP, 2005, p. 13). As electricity plays a vital role in addressing reliable access by the population to modern energy sources, this was the first indicator we decided upon.

This indicator also brings valuable information on energy poverty, therefore, it is responsible for showing a social dimension to energy. UN Energy used it to create targets for governments to attend the poorest segments of the population without access to energy, particularly those in rural areas (UN ENERGY, 2014, p. 3).

The original data was compiled by the IEA as the percentage of population with access to modern electricity. It is comprised of electricity production from renewable sources, including hydroelectric, geothermal, solar, tides, wind, biomass, and biofuels. Electrification data were collected from industry, national surveys and international sources. The data source for this indicator was the World Bank's database with information from the IEA.

[3] One only exception was the case for the Russian Federation that did not have complete data for one indicator in year 1990. However, the country remained in order to allow to complete the analysis for the BRICS.

3.2.2. Indicator 2: Electric Power Transmission and Distribution Losses (IND2)

Electric power transmission and distribution losses is one of the few globally available indicator that reflects the quality of service from the electricity industry companies, either public or privately owned. Therefore, it brings some weight to the economic dimension of sustainability, as it shows the effect of action and inaction from the distribution companies.

Originally, this indicator was measured as a percentage of the total electricity output ratio. Electric power transmission and distribution losses account for losses in transmission between sources of supply and transmission points and in the distribution to consumers, including non technical losses, such as theft (IEA, 2017). The source for this indicator was the IEA database.

Since less is better in the case of this indicator, i.e. a low loss rate means better service while a high loss rate means worse quality of service, the values were inverted to keep the parallelism with the remaining indicators in our final framework. In that way, it was possible to compare a good result in this indicator with the good results in the remaining. Therefore, the higher the value of this indicator specifically in the present work means that the country is doing better.

3.2.3. Indicator 3: CO_2 Emissions from Electricity (IND3)

Based on the idea that our current policies are leading to total collapse and even our own extinction (DITTMAR, 2014), we are forced to find means to decarbonize the global economy as a way to tackle global warming alongside with the growing demand (DINCER; ACAR, 2016). This is the indicator with a direct relation to environmental questions. Based on the global agenda on climate change and environmental issues, we decided to include an indicator that could represent the relation between electricity and the environment.

The primary data considered both electricity and heat generation as the percentage of total fuel combustion. This indicator shows carbon dioxide emissions per kWh, which allows the measurement of the carbon intensity. The carbon dioxide emissions from fuel combustion were calculated based on the tier 1 sectoral approach by the IPCC. The total emissions from electricity and heat production come from main activity producers, privately or publicly owned, of electricity and heat, unallocated autoproducers, and other energy industries.

For reasons of measurability and availability of data, the framework used data for carbon dioxide emissions, and not all greenhouse gases, since a more complete set of gases is not available for most of the years and countries. Carbon dioxide is considered a viable option of measurement since it is the reference gas to measure other greenhouse gases and its emissions account for the largest share of greenhouse gases. The data source for this indicator was IEA's database (IEA, 2017).

Since less is better in the case of this indicator too, i.e. a low emission rate is desired while a high emission rate is not, the values were inverted to keep the parallelism with the remaining indicators in our final framework. In that way, it was possible to compare a good result in this indicator with the good results in the remaining. Therefore, the higher the value of this indicator specifically in the present work means that the country is doing better in the matter.

3.2.4. Indicator 4: Renewable Electricity Output (IND4)

There is increasing evidence that greenhouse gas emissions are responsible for global warming (IPCC, 2014). Renewable energy sources represent an opportunity to diminish the impacts on the environment, alongside with other benefits, such as lessen imported fossil fuel dependence, with consequently less impact on the balance of payments.

Renewable electricity is the percentage of electricity produced by renewable sourced power plants of total electricity generated by all types of plants. This indicator shows the efforts from the countries in investing in renewable electricity and is therefore relevant to the overall framework. It has an environmental concern associated with the economic decision. This indicator was originally measured as a percentage of total electricity output (THE WORLD BANK, 2017).

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3.2.5. Indicator 5: Renewable Generation Capacity (IND5)

Bahr (2010) affirms that a growing demand for electricity means that the industry presents potential for growth. According to the author, Brazil has a low consumption pattern, much lower than that of developed countries'. Brazil could offer great opportunities if it could combine the great demand potential with the resources potential it has.

There is evidence of a relationship between economic growth and the expansion of Brazil's electricity system. Da Silva (2011) confirmed that there was a common trend that showed the connection between the economy and the electricity industry, which existed during times of economic growth and of crisis. This tells us that expanding the electricity industry can lead to improved economic conditions.

An increase in electricity generation capacity that involves investment in renewable sources is considered a best practice since it connects investment, policymaking and sustainable development. This indicator shows the share of renewable generation capacity in relation to total generation capacity. It is measured as the share of the installed generation capacity of power plants that use renewable resources (THE WORLD BANK, 2017).

3.3. Weighting and Aggregation

In regard to the weighting of the indicators in the framework, an equal weight was given for the performance of each of the five final indicators. Therefore, a simple median relative performance score was undertaken, standardized between zero (worst) and one hundred (best). Indicators *access to electricity* (IND1), *renewable electricity output* (IND4) and *renewable generation capacity share* (IND5) were all used as in the original measure, transforming the percentage into the scale of 0 to 100. The other two indicators, namely *electric power transmission and distribution losses* (IND2) and *carbon dioxide emissions from electricity and heat production* (IND3), had their original values inverted in order to simply align higher scores to better performance in the framework as a whole. Thus, a high result in IND2 or IND3 means good performance in relation to these factors.

In this chapter, the choice of indicators together with explanations and sources were addressed. In the coming chapter, the dissertation will bring the results of the indicators alone and as a framework. Cross analyses will also be made as to illustrate the relation between Brazil and different countries.

4. ANALYSIS BASED ON PROPOSED FRAMEWORK

As addressed in the previous chapter, this work aimed to create a framework based on a set of indicators to analyze the sustainability level and a possible path for the electricity industry. Once the indicators were picked, the work focused on calculating the aggregated data for five different years and the results are shown in this chapter.

Data were compiled, normalized, and analyzed in order to bring measurable results that could reflect the situation of the electricity industry in Brazil and in other peer countries. Following, assessments show Brazil as compared to the whole list of countries, and consequently to themselves too, and Brazil compared to the best and worst country in each indicator. Moreover, cross-reference analyses are presented in groups that reflect current market-based and political scenarios, such as the BRICS, composed by Brazil, India, China, and South Africa; and the Latin American (LATAM) countries.

The method that entails the cross-reference criteria for success in sustainable development focused on energy, and quantitative data of the countries is also presented. The analysis should show which are the best possible indicators for Brazil to work on, learn from or bring lessons to its peers, considering different perspectives, regarding energy sustainability.

4.1. Results from the Analysis of the Indicator-based Framework

In this item, we present the results from the analysis of the indicators. We included explanations on the results and a format for presenting the data in a more visually friendly manner. The complete list of results is available in the Annexes part of this work.

From the data analysis, we were able to position Brazil according to each indicator and in a general way in the final framework result. Furthermore, we were able to identify specific areas where Brazil is strong in comparison with others, serving as a competitive advantage, and also where more attention should be given.

4.1.1. Indicator 1 – Access to Electricity (IND1)

Access to electricity shows the level of access to electricity in each country. Originally measured as a percentage of people being served by electricity infrastructure. For our framework, lower values mean lower electricity access levels. Therefore, the higher the value the better the performance.

In 1990, there was a total of 45 countries with full access to electricity, which represented approximately 40.5 per cent of the countries analyzed. Twenty years later, this rate has gone up to only 48 countries. However, we should notice that the lowest score in this indicator has gone from 4.370 to 14.800, a manifold increase.

Also, the amount of countries with more than 50.0 per cent of the population without access to electricity has nearly halved, going from 18 countries in 1990 to 10 countries in 2010. As a group, the world has seen enhancement in this indicator.

Most of the countries have performed well along the years, with the exception of Libya and Angola that have decreased their rates in the period of the analysis, -1.3 per cent and -36.2 per cent, respectively, between 1990 and 2010. The biggest increase was Bangladesh's, going from a 7.576 score (in 1990) to 55.260 (in 2010).

As per Brazil, the score went from 87.475 (in 1990) to 99.160 (in 2010), approximately 13.04 per cent increase in the last twenty years. It is a good result; however, we can tell from the analysis that the rate of increase has lowered from previous periods. Out of the 13.04 per cent increase, nearly 4.09 per cent happened from 1990 to 1995 alone.

Next, the table showing the overall results for Access to Electricity (IND1) is presented.

Table 8 – Overall Results for Access to Electricity (IND1).

ACCESS TO ELECTRICITY (IND1)

1990			1995			2000			2005			2010		
WORST SCORE		4.370	WORST SCORE		7.722	WORST SCORE		9.854	WORST SCORE		11.738	WORST SCORE		14.800
BEST SCORE		100.000	BEST SCORE		100.000	BEST SCORE		100.000	BEST SCORE		100.000	BEST SCORE		100.000
AVERAGE SCORE		80.215	AVERAGE SCORE		82.618	AVERAGE SCORE		85.049	AVERAGE SCORE		87.246	AVERAGE SCORE		89.149
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
1	Albania	100.000	1	Albania	100.000	1	Albania	100.000	1	Albania	100.000	1	Albania	100.000
1	Australia	100.000	1	Australia	100.000	1	Australia	100.000	1	Australia	100.000	1	Australia	100.000
1	Austria	100.000	1	Austria	100.000	1	Austria	100.000	1	Austria	100.000	1	Austria	100.000
1	Belarus	100.000	1	Belarus	100.000	1	Belarus	100.000	1	Belarus	100.000	1	Azerbaijan	100.000
1	Belgium	100.000	1	Belgium	100.000	1	Belgium	100.000	1	Belgium	100.000	1	Belarus	100.000
1	Brunei Darussalam	100.000	1	Brunei Darussalam	100.000	1	Brunei Darussalam	100.000	1	Brunei Darussalam	100.000	1	Belgium	100.000
1	Bulgaria	100.000	1	Bulgaria	100.000	1	Bulgaria	100.000	1	Bulgaria	100.000	1	Brunei Darussalam	100.000
1	Canada	100.000	1	Canada	100.000	1	Canada	100.000	1	Canada	100.000	1	Bulgaria	100.000
1	Croatia	100.000	1	Croatia	100.000	1	Croatia	100.000	1	Croatia	100.000	1	Canada	100.000
1	Cyprus	100.000	1	Cyprus	100.000	1	Cyprus	100.000	1	Cyprus	100.000	1	Croatia	100.000
1	Czech Republic	100.000	1	Czech Republic	100.000	1	Czech Republic	100.000	1	Czech Republic	100.000	1	Cyprus	100.000
1	Denmark	100.000	1	Denmark	100.000	1	Denmark	100.000	1	Denmark	100.000	1	Czech Republic	100.000
1	Estonia	100.000	1	Estonia	100.000	1	Estonia	100.000	1	Estonia	100.000	1	Denmark	100.000
1	Finland	100.000	1	Finland	100.000	1	Finland	100.000	1	Finland	100.000	1	Estonia	100.000
1	France	100.000	1	France	100.000	1	France	100.000	1	France	100.000	1	Finland	100.000
1	Germany	100.000	1	Germany	100.000	1	Germany	100.000	1	Germany	100.000	1	France	100.000
1	Gibraltar	100.000	1	Gibraltar	100.000	1	Gibraltar	100.000	1	Gibraltar	100.000	1	Germany	100.000
1	Greece	100.000	1	Greece	100.000	1	Greece	100.000	1	Greece	100.000	1	Gibraltar	100.000
1	Hong Kong SAR, China	100.000	1	Hong Kong SAR, China	100.000	1	Hong Kong SAR, China	100.000	1	Hong Kong SAR, China	100.000	1	Greece	100.000
1	Hungary	100.000	1	Hungary	100.000	1	Hungary	100.000	1	Hungary	100.000	1	Hong Kong SAR, China	100.000
1	Iceland	100.000	1	Iceland	100.000	1	Iceland	100.000	1	Iceland	100.000	1	Hungary	100.000
1	Ireland	100.000	1	Ireland	100.000	1	Ireland	100.000	1	Ireland	100.000	1	Iceland	100.000
1	Israel	100.000	1	Israel	100.000	1	Israel	100.000	1	Israel	100.000	1	Ireland	100.000
1	Italy	100.000	1	Italy	100.000	1	Italy	100.000	1	Italy	100.000	1	Israel	100.000
1	Japan	100.000	1	Japan	100.000	1	Japan	100.000	1	Japan	100.000	1	Italy	100.000
1	Kuwait	100.000	1	Kuwait	100.000	1	Kuwait	100.000	1	Kuwait	100.000	1	Japan	100.000
1	Libya	100.000	1	Lithuania	100.000	1	Lithuania	100.000	1	Lithuania	100.000	1	Kuwait	100.000
1	Lithuania	100.000	1	Luxembourg	100.000	1	Luxembourg	100.000	1	Luxembourg	100.000	1	Lithuania	100.000
1	Luxembourg	100.000	1	Malta	100.000	1	Malta	100.000	1	Malta	100.000	1	Luxembourg	100.000
1	Malta	100.000	1	Netherlands	100.000	1	Netherlands	100.000	1	Netherlands	100.000	1	Malta	100.000
1	Netherlands	100.000	1	New Zealand	100.000	1	New Zealand	100.000	1	New Zealand	100.000	1	Netherlands	100.000
1	New Zealand	100.000	1	Norway	100.000	1	Norway	100.000	1	Norway	100.000	1	New Zealand	100.000

ACCESS TO ELECTRICITY (IND1)

1990			1995			2000			2005			2010		
WORST SCORE		4.370	WORST SCORE		7.722	WORST SCORE		9.854	WORST SCORE		11.738	WORST SCORE		14.800
BEST SCORE		100.000	BEST SCORE		1995.000	BEST SCORE		2000.000	BEST SCORE		2005.000	BEST SCORE		2010.000
AVERAGE SCORE		70.673	AVERAGE SCORE		138.948	AVERAGE SCORE		142.389	AVERAGE SCORE		145.522	AVERAGE SCORE		148.308
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
1	Netherlands	100.000	1	New Zealand	100.000	1	New Zealand	100.000	1	New Zealand	100.000	1	Netherlands	100.000
1	New Zealand	100.000	1	Norway	100.000	1	Norway	100.000	1	Norway	100.000	1	New Zealand	100.000
1	Norway	100.000	1	Poland	100.000	1	Poland	100.000	1	Poland	100.000	1	Norway	100.000
1	Poland	100.000	1	Portugal	100.000	1	Portugal	100.000	1	Portugal	100.000	1	Poland	100.000
1	Portugal	100.000	1	Qatar	100.000	1	Qatar	100.000	1	Qatar	100.000	1	Portugal	100.000
1	Qatar	100.000	1	Romania	100.000	1	Romania	100.000	1	Romania	100.000	1	Qatar	100.000
1	Romania	100.000	1	Russian Federation	100.000	1	Russian Federation	100.000	1	Russian Federation	100.000	1	Romania	100.000
1	Russian Federation	100.000	1	Singapore	100.000	1	Singapore	100.000	1	Singapore	100.000	1	Russian Federation	100.000
1	Singapore	100.000	1	Spain	100.000	1	Spain	100.000	1	Spain	100.000	1	Singapore	100.000
1	Spain	100.000	1	Sweden	100.000	1	Sweden	100.000	1	Sweden	100.000	1	Spain	100.000
1	Sweden	100.000	1	Switzerland	100.000	1	Switzerland	100.000	1	Switzerland	100.000	1	Sweden	100.000
1	Switzerland	100.000	1	United Arab Emirates	100.000	1	United Arab Emirates	100.000	1	United Arab Emirates	100.000	1	Switzerland	100.000
1	United Arab Emirates	100.000	1	United Kingdom	100.000	1	United Kingdom	100.000	1	United Kingdom	100.000	1	Turkey	100.000
1	United Kingdom	100.000	1	United States	100.000	1	United States	100.000	1	United States	100.000	1	Turkmenistan	100.000
1	United States	100.000	45	Libya	99.947	45	Libya	99.800	45	Armenia	99.800	1	United Arab Emirates	100.000
46	Georgia	99.004	46	Kazakhstan	99.900	46	Georgia	99.751	46	Georgia	99.766	1	United Kingdom	100.000
47	Mauritius	98.638	47	Georgia	99.505	47	Turkmenistan	99.600	47	Turkmenistan	99.733	1	United States	100.000
48	Turkmenistan	98.154	48	Mauritius	99.023	48	Lebanon	99.114	48	Lebanon	99.711	1	Lebanon	100.000
49	Kazakhstan	97.655	49	Turkmenistan	98.928	49	Mauritius	99.000	49	Azerbaijan	99.673	49	Cuba	99.998
50	Venezuela, RB	97.486	50	Lebanon	98.281	50	Kazakhstan	98.960	50	Bosnia and Herzegovina	99.462	50	Bosnia and Herzegovina	99.997
51	Armenia	97.252	51	Armenia	98.217	51	Armenia	98.900	51	Egypt, Arab Rep.	99.400	51	Georgia	99.907
52	Costa Rica	97.240	52	Jordan	98.140	52	Jordan	98.723	52	Tunisia	99.300	52	Egypt, Arab Rep.	99.841
53	Lebanon	97.194	53	Venezuela, RB	98.099	53	Bosnia and Herzegovina	98.637	53	Kazakhstan	99.251	53	Armenia	99.800
54	Jordan	96.800	54	Costa Rica	98.029	54	Costa Rica	98.555	54	Libya	99.089	54	Chile	99.739
55	Bosnia and Herzegovina	96.265	55	Bosnia and Herzegovina	97.587	55	Venezuela, RB	98.450	55	Jordan	99.072	55	Algeria	99.711
56	Iran, Islamic Rep.	96.152	56	Iran, Islamic Rep.	97.113	56	Azerbaijan	98.016	56	Costa Rica	99.053	56	China	99.700
57	Uruguay	95.740	57	Uruguay	96.855	57	Mexico	98.007	57	Cuba	99.039	57	Thailand	99.700
58	Iraq	95.334	58	Iraq	96.330	58	Chile	97.939	58	Mauritius	99.021	58	Kazakhstan	99.674
59	Mexico	94.035	59	Azerbaijan	96.051	59	Iran, Islamic Rep.	97.900	59	Mexico	98.933	59	Jordan	99.553
60	Azerbaijan	93.816	60	Mexico	95.640	60	Uruguay	97.709	60	Venezuela, RB	98.552	60	Tunisia	99.500

ACCESS TO ELECTRICITY (IND1)

	1990			1995			2000			2005			2010	
	WORST SCORE	4.370		WORST SCORE	7.722		WORST SCORE	9.854		WORST SCORE	11.738		WORST SCORE	14.800
	BEST SCORE	93.799		BEST SCORE	1995.000		BEST SCORE	2000.000		BEST SCORE	2005.000		BEST SCORE	2010.000
	AVERAGE SCORE	56.357		AVERAGE SCORE	96.447		AVERAGE SCORE	101.495		AVERAGE SCORE	106.087		AVERAGE SCORE	110.133
#	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**
61	Egypt, Arab Rep.	93.799	61	Chile	95.522	61	Egypt, Arab Rep.	97.700	61	Chile	98.377	61	Trinidad and Tobago	99.426
62	Malaysia	93.446	62	Egypt, Arab Rep.	95.500	62	Iraq	97.063	62	Uruguay	98.313	62	Malaysia	99.316
63	Algeria	92.990	63	Malaysia	95.197	63	Cuba	97.000	63	Iran, Islamic Rep.	98.261	63	Mexico	99.237
64	Chile	92.257	64	Algeria	94.977	64	Algeria	96.702	64	Algeria	98.184	64	Brazil	99.160
65	Cuba	92.066	65	Cuba	94.648	65	Malaysia	96.687	65	Malaysia	97.927	65	Uruguay	99.066
66	Argentina	90.759	66	Argentina	93.058	66	Colombia	95.200	66	Iraq	97.547	66	Mauritius	99.043
67	Colombia	89.900	67	China	92.227	67	Argentina	95.096	67	China	97.118	67	Costa Rica	98.996
68	China	89.395	68	Brazil	91.729	68	Tunisia	94.800	68	Turkey	97.110	68	Iran, Islamic Rep.	98.859
69	Ecuador	88.814	69	Turkey	91.393	69	China	94.797	69	Brazil	97.094	69	Argentina	98.820
70	Turkey	88.147	70	Colombia	91.200	70	Brazil	94.457	70	Argentina	96.884	70	Venezuela, RB	98.803
71	Tunisia	88.009	71	Ecuador	89.830	71	Turkey	94.376	71	Colombia	96.800	71	Libya	98.675
72	Brazil	87.475	72	Tunisia	88.700	72	Ecuador	93.336	72	Vietnam	96.100	72	Iraq	98.180
73	Trinidad and Tobago	82.417	73	Trinidad and Tobago	87.032	73	Trinidad and Tobago	91.290	73	Ecuador	95.833	73	Dominican Republic	98.145
74	Dominican Republic	79.112	74	Dominican Republic	83.806	74	Dominican Republic	88.765	74	Trinidad and Tobago	95.491	74	Vietnam	97.718
75	Paraguay	79.013	75	Syrian Arab Republic	81.255	75	Paraguay	88.667	75	Paraguay	94.687	75	Ecuador	97.462
76	Syrian Arab Republic	77.069	76	Jamaica	80.128	76	Indonesia	86.300	76	Thailand	90.733	76	Paraguay	97.431
77	Vietnam	73.858	77	Vietnam	80.107	77	Vietnam	86.093	77	Dominican Republic	90.141	77	Colombia	96.789
78	El Salvador	72.167	78	Paraguay	77.469	78	Syrian Arab Republic	85.180	78	Jamaica	88.982	78	Indonesia	94.150
79	Jamaica	70.335	79	El Salvador	76.996	79	Jamaica	84.679	79	Syrian Arab Republic	88.855	79	Jamaica	93.432
80	Panama	70.190	80	Panama	76.742	80	El Salvador	84.519	80	El Salvador	87.526	80	Syrian Arab Republic	92.700
81	Nicaragua	66.922	81	Thailand	73.940	81	Thailand	82.100	81	Indonesia	87.127	81	El Salvador	91.580
82	Thailand	65.157	82	Nicaragua	69.993	82	Panama	81.401	82	Mongolia	86.200	82	Pakistan	91.034
83	Gabon	63.898	83	Gabon	69.506	83	Pakistan	75.193	83	Panama	84.482	83	Peru	88.123
84	Mongolia	63.820	84	Mongolia	68.626	84	Gabon	73.600	84	Pakistan	83.850	84	Panama	86.850
85	Philippines	61.985	85	Philippines	67.914	85	Philippines	73.582	85	Gabon	81.600	85	Morocco	85.691
86	Indonesia	60.343	86	Peru	67.148	86	Guatemala	73.318	86	South Africa	80.900	86	Sri Lanka	85.300
87	Peru	60.290	87	Pakistan	67.098	87	Nicaragua	72.803	87	Philippines	79.000	87	Gabon	85.193
88	Guatemala	60.159	88	Indonesia	66.860	88	Peru	72.496	88	Guatemala	78.351	88	Philippines	84.568
89	Pakistan	58.741	89	Honduras	66.122	89	South Africa	70.551	89	Sri Lanka	77.396	89	Bolivia	84.492
90	South Africa	56.506	90	South Africa	63.660	90	Bolivia	69.963	90	Peru	77.174	90	Guatemala	84.311

ACCESS TO ELECTRICITY (IND1)

1990			1995			2000			2005			2010		
	WORST SCORE	4.370		WORST SCORE	7.722		WORST SCORE	9.854		WORST SCORE	11.738		WORST SCORE	14.800
	BEST SCORE	55.107		BEST SCORE	62.472		BEST SCORE	69.383		BEST SCORE	76.067		BEST SCORE	82.900
	AVERAGE SCORE	30.671		AVERAGE SCORE	36.409		AVERAGE SCORE	41.603		AVERAGE SCORE	46.544		AVERAGE SCORE	51.231
#	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**
91	Honduras	55.107	91	Bolivia	62.472	91	Sri Lanka	69.383	91	Morocco	76.067	91	South Africa	82.900
92	Bolivia	54.754	92	Sri Lanka	61.121	92	Honduras	67.509	92	Nicaragua	73.822	92	Mongolia	81.908
93	Sri Lanka	52.597	93	Guatemala	60.800	93	Mongolia	67.300	93	Honduras	68.903	93	Honduras	80.985
94	Angola	47.834	94	Morocco	56.500	94	Morocco	66.591	94	Bolivia	68.288	94	Nicaragua	78.073
95	Morocco	46.879	95	India	52.444	95	India	59.562	95	India	66.432	95	India	76.300
96	India	45.063	96	Angola	44.942	96	Yemen, Rep.	50.822	96	Cote d'Ivoire	58.900	96	Yemen, Rep.	65.861
97	Myanmar	41.323	97	Myanmar	43.735	97	Cote d'Ivoire	47.617	97	Yemen, Rep.	58.267	97	Ghana	65.123
98	Cote d'Ivoire	36.659	98	Yemen, Rep.	43.128	98	Myanmar	45.886	98	Ghana	54.890	98	Cote d'Ivoire	57.964
99	Yemen, Rep.	35.171	99	Cote d'Ivoire	42.270	99	Ghana	44.806	99	Nigeria	47.876	99	Bangladesh	55.260
100	Sudan	32.800	100	Nigeria	37.178	100	Nigeria	42.651	100	Myanmar	47.787	100	Senegal	53.461
101	Cameroon	30.064	101	Cameroon	36.079	101	Angola	41.789	101	Cameroon	47.337	101	Cameroon	52.990
102	Zimbabwe	29.889	102	Ghana	34.472	102	Cameroon	41.000	102	Senegal	47.100	102	Myanmar	48.800
103	Haiti	28.440	103	Sudan	32.975	103	Senegal	36.811	103	Bangladesh	44.230	103	Nigeria	48.000
104	Nigeria	27.300	104	Zimbabwe	31.601	104	Sudan	34.597	104	Angola	38.386	104	Sudan	37.490
105	Ghana	23.877	105	Haiti	31.300	105	Haiti	33.700	105	Sudan	35.969	105	Haiti	36.322
106	Senegal	19.548	106	Senegal	28.310	106	Zimbabwe	33.051	106	Haiti	34.430	106	Zimbabwe	35.602
107	Zambia	13.900	107	Bangladesh	19.653	107	Bangladesh	32.000	107	Zimbabwe	34.253	107	Angola	35.132
108	Bangladesh	7.576	108	Zambia	16.606	108	Zambia	16.700	108	Korea, Dem. People's Rep.	21.924	108	Korea, Dem. People's Rep.	27.671
109	Kenya	5.608	109	Kenya	10.794	109	Korea, Dem. People's Rep.	16.326	109	Zambia	20.421	109	Zambia	22.000
110	Tanzania	5.327	110	Korea, Dem. People's Rep.	10.479	110	Kenya	15.718	110	Kenya	20.393	110	Kenya	19.200
111	Korea, Dem. People's Rep.	4.370	111	Tanzania	7.722	111	Tanzania	9.854	111	Tanzania	11.738	111	Tanzania	14.800

Source: Own elaboration.

4.1.2. Indicator 2 – Electric Power Transmission and Distribution Losses

Table 9 – Overall Results for Electric Power Transmission and Distribution Losses (IND2).

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION LOSSES (IND2)

1990			1995			2000			2005			2010		
	WORST SCORE	48.817		WORST SCORE	47.273		WORST SCORE	55.393		WORST SCORE	60.904		WORST SCORE	41.567
	BEST SCORE	99.695		BEST SCORE	1995.000		BEST SCORE	2000.000		BEST SCORE	2005.000		BEST SCORE	2010.000
	AVERAGE SCORE	86.442		AVERAGE SCORE	162.772		AVERAGE SCORE	163.820		AVERAGE SCORE	165.037		AVERAGE SCORE	165.464
#	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**	**#**	**Country**	**Score**
1	Paraguay	99.695	1	Paraguay	98.423	1	Brunei Darussalam	98.860	1	Gibraltar	97.241	1	Israel	97.242
2	Ghana	96.854	2	Gibraltar	97.222	2	Paraguay	97.330	2	Israel	97.142	2	Gibraltar	97.175
3	Zambia	96.768	3	Zambia	97.173	3	Zambia	96.820	3	Singapore	96.875	3	Singapore	97.145
4	Singapore	96.627	4	Ghana	96.664	4	Gibraltar	96.800	4	Luxembourg	96.535	4	Trinidad and Tobago	96.877
5	Germany	95.703	5	Brunei Darussalam	96.490	5	Israel	96.629	5	Cyprus	96.253	5	Finland	96.573
6	Netherlands	95.653	6	Israel	96.460	6	United Arab Emirates	96.618	6	Denmark	95.787	6	Luxembourg	96.223
7	Brunei Darussalam	95.478	7	Iraq	96.181	7	Singapore	96.362	7	Japan	95.733	7	Germany	96.174
8	Japan	95.328	8	Singapore	96.165	8	Finland	96.239	8	Finland	95.692	8	Iceland	95.902
9	Israel	95.306	9	Japan	95.445	9	Iceland	95.888	9	Iceland	95.614	9	Cyprus	95.866
10	Iraq	95.000	10	Cyprus	95.394	10	Japan	95.685	10	Paraguay	95.372	10	Japan	95.862
11	Finland	94.922	11	Finland	95.287	11	Belgium	95.422	11	Germany	95.237	11	Belgium	95.436
12	Belgium	94.873	12	Germany	95.257	12	Austria	94.660	12	Belgium	95.151	12	Netherlands	95.277
13	Qatar	94.811	13	Belgium	95.004	13	Netherlands	94.514	13	Brunei Darussalam	94.669	13	Austria	95.067
14	Lithuania	94.536	14	Netherlands	94.888	14	Cyprus	94.421	14	Austria	94.640	14	Czech Republic	94.766
15	Cyprus	94.377	15	Morocco	94.269	15	France	94.318	15	Zambia	94.628	15	United States	94.006
16	Norway	94.338	16	Austria	93.969	16	United States	94.309	16	Netherlands	94.591	16	China	93.881
17	Austria	94.093	17	France	93.862	17	Denmark	94.164	17	Trinidad and Tobago	94.489	17	Malaysia	93.831
18	South Africa	93.969	18	Australia	93.858	18	Germany	94.043	18	France	94.357	18	Paraguay	93.769
19	Australia	93.842	19	South Africa	93.779	19	Switzerland	93.822	19	Czech Republic	93.864	19	France	93.724
20	Sweden	93.692	20	Denmark	93.629	20	Czech Republic	93.203	20	United States	93.695	20	Qatar	93.722
21	Gibraltar	93.671	21	Iceland	93.415	21	Costa Rica	93.164	21	Morocco	93.634	21	Thailand	93.655
22	Czech Republic	93.583	22	Sweden	93.207	22	China	93.091	22	Australia	93.277	22	Australia	93.523
23	France	93.360	23	United States	93.009	23	Qatar	93.070	23	China	93.175	23	Malta	93.472
24	Lebanon	93.333	24	Canada	92.918	24	Italy	92.886	24	New Zealand	93.069	24	Greece	93.406
25	Estonia	93.324	25	Switzerland	92.800	25	Australia	92.862	25	Italy	93.051	25	Switzerland	93.381
26	Kuwait	93.251	26	New Zealand	92.765	26	Chile	92.707	26	United Kingdom	92.944	26	Denmark	93.248
27	Honduras	93.014	27	China	92.613	27	Trinidad and Tobago	92.691	27	Qatar	92.922	27	Italy	93.115
28	China	93.005	28	Italy	92.605	28	Sweden	92.553	28	United Arab Emirates	92.825	28	New Zealand	93.090
29	Canada	92.924	29	Costa Rica	92.481	29	New Zealand	92.241	29	Norway	92.714	29	United Kingdom	92.971
30	Zimbabwe	92.886	30	Greece	92.315	30	Canada	92.194	30	Switzerland	92.679	30	Sweden	92.870

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION LOSSES (IND2)

1990		1995		2000		2005		2010	
WORST SCORE	48.817	WORST SCORE	47.273	WORST SCORE	55.393	WORST SCORE	60.904	WORST SCORE	41.567
BEST SCORE	92.596	BEST SCORE	1995.000	BEST SCORE	2000.000	BEST SCORE	2005.000	BEST SCORE	2010.000
AVERAGE SCORE	84.016	AVERAGE SCORE	146.068	AVERAGE SCORE	147.300	AVERAGE SCORE	148.787	AVERAGE SCORE	149.436

#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
31	New Zealand	92.596	31	Qatar	92.269	31	Thailand	92.092	31	Sweden	92.606	31	United Arab Emirates	92.824
32	Switzerland	92.595	32	Norway	92.139	32	Greece	92.002	32	Bangladesh	92.566	32	Mauritius	92.785
33	Italy	92.419	33	Czech Republic	92.129	33	Malaysia	92.001	33	Ireland	92.004	33	Ireland	92.553
34	Russian Federation	92.214	34	United Kingdom	91.924	34	Norway	91.803	34	Malaysia	92.000	34	Poland	92.456
35	Poland	92.144	35	Thailand	91.877	35	South Africa	91.795	35	Thailand	91.895	35	Norway	92.299
36	United Kingdom	92.123	36	Ireland	91.405	36	United Kingdom	91.681	36	Canada	91.702	36	Portugal	92.028
37	Greece	91.758	37	Mauritius	90.995	37	Morocco	91.596	37	South Africa	91.506	37	Kazakhstan	91.974
38	Costa Rica	91.724	38	United Arab Emirates	90.901	38	Portugal	91.587	38	Lithuania	91.474	38	Estonia	91.924
39	Trinidad and Tobago	91.641	39	Malta	90.686	39	Jamaica	91.477	39	Chile	91.350	39	Chile	91.781
40	Jordan	91.534	40	Jordan	90.598	40	Ireland	91.467	40	Spain	91.031	40	Canada	91.325
41	Turkmenistan	91.513	41	Zimbabwe	90.552	41	Iraq	91.411	41	Mauritius	91.021	41	Spain	90.815
42	Morocco	91.473	42	Malaysia	90.388	42	Spain	91.279	42	Portugal	90.881	42	Bosnia and Herzegovina	90.645
43	Iceland	91.242	43	Trinidad and Tobago	90.365	43	Mauritius	91.001	43	Peru	90.662	43	Indonesia	90.602
44	Ireland	91.032	44	Spain	90.363	44	Luxembourg	90.284	44	Poland	90.626	44	South Africa	90.466
45	Mauritius	91.026	45	Russian Federation	90.283	45	Poland	90.058	45	Greece	90.580	45	Brunei Darussalam	90.295
46	United Arab Emirates	91.001	46	Tunisia	90.103	46	Bolivia	89.820	46	Bolivia	89.869	46	Bulgaria	90.264
47	Malaysia	90.915	47	Portugal	89.956	47	Tunisia	89.458	47	Romania	89.767	47	Cameroon	90.168
48	Malta	90.909	48	Chile	89.556	48	Jordan	89.031	48	Kazakhstan	89.762	48	Vietnam	89.888
49	Romania	90.780	49	Egypt, Arab Rep.	89.346	49	Kuwait	88.999	49	Estonia	89.192	49	Costa Rica	89.878
50	United States	90.737	50	Jamaica	89.158	50	Peru	88.516	50	Costa Rica	89.165	50	Peru	89.875
51	Spain	90.717	51	Kuwait	88.998	51	Indonesia	88.486	51	Hungary	88.978	51	Russian Federation	89.872
52	Korea, Dem. People's Rep.	90.653	52	Romania	88.631	52	Lithuania	88.481	52	El Salvador	88.907	52	Egypt, Arab Rep.	89.838
53	Kazakhstan	90.636	53	Bolivia	88.440	53	Russian Federation	88.403	53	Bulgaria	88.895	53	Hungary	89.829
54	Denmark	90.501	54	Indonesia	87.706	54	Malta	87.741	54	Indonesia	88.836	54	Bangladesh	89.458
55	Mongolia	90.352	55	Turkmenistan	87.694	55	Dominican Republic	87.485	55	Kuwait	88.643	55	Belarus	89.185
56	Indonesia	90.256	56	Tanzania	87.214	56	Romania	87.236	56	Malta	88.571	56	Georgia	89.105
57	Egypt, Arab Rep.	90.044	57	El Salvador	87.009	57	Hong Kong SAR, China	87.067	57	Dominican Republic	88.518	57	Uruguay	88.977
58	Iran, Islamic Rep.	89.733	58	Poland	86.814	58	Belarus	86.935	58	Jamaica	88.494	58	Armenia	88.754
59	Tunisia	89.658	59	Guatemala	86.224	59	El Salvador	86.615	59	Albania	88.462	59	Morocco	88.687
60	Bosnia and Herzegovina	89.612	60	Korea, Dem. People's Rep.	86.113	60	Hungary	86.246	60	Egypt, Arab Rep.	88.404	60	Tunisia	88.554

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION LOSSES (IND2)

1990			1995			2000			2005			2010		
	WORST SCORE	48.817		WORST SCORE	47.273		WORST SCORE	55.393		WORST SCORE	60.904		WORST SCORE	41.567
	BEST SCORE	89.457		BEST SCORE	1995.000		BEST SCORE	2000.000		BEST SCORE	2005.000		BEST SCORE	2010.000
	AVERAGE SCORE	80.684		AVERAGE SCORE	112.016		AVERAGE SCORE	113.611		AVERAGE SCORE	115.442		AVERAGE SCORE	116.449
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
61	Bulgaria	89.457	61	Hungary	86.040	61	Egypt, Arab Rep.	86.243	61	Vietnam	88.337	61	Angola	88.493
62	Thailand	89.438	62	Mexico	86.000	62	Vietnam	86.232	62	Belarus	88.263	62	Philippines	88.486
63	Chile	89.424	63	Iran, Islamic Rep.	85.796	63	Mexico	86.151	63	Russian Federation	88.163	63	Bolivia	88.446
64	Gabon	89.264	64	Azerbaijan	85.667	64	Kazakhstan	86.036	64	Philippines	87.949	64	Romania	88.357
65	Belarus	89.076	65	Belarus	85.408	65	Philippines	85.990	65	Mongolia	87.716	65	Mongolia	88.291
66	Portugal	88.849	66	Hong Kong SAR, China	85.231	66	Turkmenistan	85.749	66	Libya	87.465	66	Dominican Republic	88.190
67	Hong Kong SAR, China	88.576	67	Lithuania	85.148	67	Lebanon	85.643	67	Hong Kong SAR, China	87.246	67	Lebanon	88.105
68	Yemen, Rep.	88.455	68	Bulgaria	85.092	68	Cote d'Ivoire	85.438	68	Lebanon	87.137	68	Kuwait	87.913
69	Turkey	88.390	69	Kazakhstan	84.784	69	Estonia	85.422	69	Algeria	86.805	69	Albania	87.341
70	Mexico	87.058	70	Lebanon	84.170	70	Angola	85.398	70	Jordan	86.627	70	Hong Kong SAR, China	87.321
71	Cameroon	86.948	71	Turkey	84.035	71	Azerbaijan	85.186	71	Tunisia	86.518	71	Turkmenistan	87.203
72	Azerbaijan	86.571	72	Senegal	83.922	72	Argentina	85.167	72	Turkmenistan	86.154	72	El Salvador	87.149
73	Peru	86.363	73	Cote d'Ivoire	83.814	73	Bangladesh	84.674	73	Turkey	85.154	73	Guatemala	86.652
74	Uruguay	86.083	74	Bangladesh	83.380	74	Bulgaria	84.525	74	Mexico	85.076	74	Argentina	86.575
75	Hungary	85.807	75	Brazil	83.256	75	Sudan	84.469	75	Argentina	84.875	75	Jordan	86.540
76	Brazil	85.773	76	Algeria	83.059	76	Cuba	84.227	76	Cuba	84.787	76	Croatia	86.334
77	Algeria	85.637	77	Philippines	82.914	77	Korea, Dem. People's Rep.	84.196	77	Tanzania	84.698	77	Sri Lanka	86.233
78	Luxembourg	85.577	78	Argentina	82.298	78	Iran, Islamic Rep.	84.176	78	Georgia	84.395	78	Iran, Islamic Rep.	85.808
79	Cuba	85.510	79	Croatia	82.104	79	Algeria	83.846	79	Korea, Dem. People's Rep.	84.196	79	Turkey	85.691
80	Jamaica	85.435	80	Sri Lanka	81.966	80	Bosnia and Herzegovina	83.229	80	Armenia	84.154	80	Panama	85.670
81	Guatemala	85.041	81	Kenya	81.667	81	Georgia	83.176	81	Panama	84.040	81	Syrian Arab Republic	84.696
82	Kenya	84.977	82	Uruguay	81.402	82	Brazil	82.342	82	Sri Lanka	83.870	82	Colombia	84.624
83	Philippines	84.882	83	Peru	81.355	83	Gabon	82.205	83	Croatia	83.679	83	Korea, Dem. People's Rep.	84.190
84	Sudan	84.620	84	India	81.267	84	Croatia	81.692	84	Brazil	83.406	84	Cuba	84.089
85	Armenia	84.086	85	Mongolia	80.898	85	Uruguay	81.471	85	Zimbabwe	83.145	85	Kenya	84.041
86	El Salvador	83.634	86	Bosnia and Herzegovina	80.845	86	Turkey	80.983	86	Cameroon	82.567	86	Mexico	83.940
87	Sri Lanka	83.302	87	Cuba	80.344	87	Ghana	80.521	87	Azerbaijan	82.376	87	Pakistan	83.774
88	Nicaragua	83.185	88	Venezuela, RB	79.177	88	Mongolia	80.448	88	Bosnia and Herzegovina	82.328	88	Senegal	83.615
89	Georgia	83.001	89	Estonia	78.891	89	Honduras	80.367	89	Guatemala	82.085	89	Myanmar	83.389
90	Senegal	82.540	90	Yemen, Rep.	78.819	90	Zimbabwe	79.671	90	Iran, Islamic Rep.	81.842	90	Brazil	83.374

ELECTRIC POWER TRANSMISSION AND DISTRIBUTION LOSSES (IND2)

1990			1995			2000			2005			2010		
WORST SCORE		48.817	WORST SCORE		47.273	WORST SCORE		55.393	WORST SCORE		60.904	WORST SCORE		41.567
BEST SCORE		82.520	BEST SCORE		78.687	BEST SCORE		79.041	BEST SCORE		81.016	BEST SCORE		83.136
AVERAGE SCORE		74.483	AVERAGE SCORE		70.509	AVERAGE SCORE		72.695	AVERAGE SCORE		74.879	AVERAGE SCORE		76.612
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
91	Croatia	82.520	91	Panama	78.687	91	Sri Lanka	79.041	91	Kenya	81.016	91	Ecuador	83.136
92	Venezuela, RB	82.000	92	Vietnam	78.297	92	Kenya	78.357	92	Gabon	80.940	92	Nigeria	82.784
93	Argentina	81.687	93	Cameroon	78.169	93	Cameroon	78.132	93	Syrian Arab Republic	80.630	93	Zambia	82.312
94	Cote d'Ivoire	81.644	94	Colombia	77.617	94	Tanzania	77.872	94	Colombia	80.493	94	Nicaragua	81.525
95	India	80.692	95	Pakistan	77.188	95	Colombia	77.614	95	Cote d'Ivoire	80.074	95	Sudan	80.691
96	Tanzania	80.037	96	Libya	76.759	96	Libya	76.820	96	Sudan	79.509	96	Gabon	80.487
97	Pakistan	79.274	97	Georgia	76.674	97	Panama	76.141	97	Yemen, Rep.	77.454	97	Zimbabwe	80.462
98	Colombia	78.807	98	Ecuador	75.039	98	Ecuador	75.867	98	Uruguay	76.673	98	Lithuania	80.196
99	Bolivia	78.667	99	Honduras	74.707	99	Venezuela, RB	75.736	99	Nigeria	76.295	99	Tanzania	80.167
100	Ecuador	77.461	100	Gabon	73.486	100	Pakistan	75.733	100	Angola	76.238	100	India	80.137
101	Dominican Republic	75.473	101	Sudan	73.015	101	Guatemala	75.298	101	Pakistan	75.963	101	Algeria	80.122
102	Angola	74.911	102	Nicaragua	72.992	102	Armenia	74.622	102	Ghana	75.427	102	Venezuela, RB	79.888
103	Vietnam	74.600	103	Luxembourg	72.074	103	India	72.779	103	Honduras	75.352	103	Cote d'Ivoire	79.816
104	Panama	73.995	104	Syrian Arab Republic	71.847	104	Albania	72.750	104	India	74.834	104	Azerbaijan	79.530
105	Syrian Arab Republic	73.835	105	Dominican Republic	71.627	105	Yemen, Rep.	72.386	105	Ecuador	73.199	105	Jamaica	79.120
106	Myanmar	73.567	106	Angola	71.563	106	Nicaragua	69.545	106	Nicaragua	72.960	106	Ghana	76.778
107	Haiti	69.347	107	Nigeria	62.282	107	Syrian Arab Republic	69.302	107	Venezuela, RB	72.953	107	Yemen, Rep.	76.093
108	Libya	68.797	108	Myanmar	61.899	108	Myanmar	68.699	108	Iraq	70.000	108	Honduras	75.697
109	Bangladesh	66.425	109	Armenia	60.529	109	Senegal	62.656	109	Senegal	69.851	109	Libya	64.245
110	Nigeria	61.584	110	Albania	48.960	110	Nigeria	61.852	110	Haiti	61.691	110	Iraq	64.100
111	Albania	48.817	111	Haiti	47.273	111	Haiti	55.393	111	Myanmar	60.904	111	Haiti	41.567

Source: Own elaboration.

4.1.3. Indicator 3 – CO_2 Emissions from Electricity

Table 10 – Overall Results for CO_2 Emissions from Electricity (IND3).

CO2 EMISSIONS FROM ELECTRICITY (IND3)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
1	Iceland	100.000	1	Iceland	99.490	1	Paraguay	100.000	1	Paraguay	100.000	1	Iceland	100.000
2	Cameroon	98.485	2	Cameroon	98.780	2	Iceland	99.537	2	Iceland	99.552	2	Paraguay	100.000
3	Paraguay	98.446	3	Ghana	97.196	3	Costa Rica	98.667	3	Zambia	95.283	3	Albania	97.455
4	Honduras	97.706	4	Paraguay	96.848	4	Cameroon	98.566	4	Costa Rica	94.669	4	Zambia	95.732
5	Ghana	97.244	5	Zambia	94.000	5	Luxembourg	97.146	5	Cameroon	94.539	5	Switzerland	91.323
6	Sri Lanka	95.913	6	Sri Lanka	93.394	6	Zambia	95.152	6	Albania	92.147	6	Costa Rica	90.772
7	Switzerland	93.940	7	Switzerland	93.176	7	Switzerland	92.251	7	Haiti	91.414	7	Sudan	88.978
8	Zambia	93.750	8	Kenya	91.449	8	Ghana	88.554	8	Switzerland	90.911	8	Luxembourg	87.981
9	Costa Rica	92.692	9	Angola	90.026	9	Albania	87.662	9	Luxembourg	88.240	9	Haiti	86.603
10	Guatemala	92.523	10	Luxembourg	88.929	10	Tanzania	87.356	10	Angola	84.065	10	Armenia	84.444
11	Kenya	92.391	11	Uruguay	87.244	11	Haiti	86.232	11	Korea, Dem. People's Rep.	83.751	11	Korea, Dem. People's Rep.	84.150
12	El Salvador	91.943	12	Brazil	86.211	12	Uruguay	86.051	12	Ghana	81.406	12	Angola	82.816
13	Sudan	90.359	13	Korea, Dem. People's Rep.	85.102	13	Korea, Dem. People's Rep.	83.448	13	Brazil	81.375	13	Brazil	81.346
14	Ecuador	87.988	14	France	83.725	14	Brazil	82.885	14	France	80.163	14	Georgia	79.960
15	Angola	87.755	15	Vietnam	83.643	15	Peru	81.887	15	Uruguay	77.476	15	Uruguay	79.866
16	Albania	87.125	16	Haiti	82.222	16	Sweden	81.278	16	Sweden	77.246	16	France	79.684
17	Korea, Dem. People's Rep.	86.159	17	New Zealand	81.864	17	France	80.955	17	Kenya	77.139	17	Kenya	79.661
18	Uruguay	85.556	18	Guatemala	81.229	18	Angola	79.914	18	Armenia	76.998	18	El Salvador	76.460
19	Brazil	84.803	19	Peru	80.773	19	Ecuador	77.827	19	Panama	76.071	19	Tanzania	76.020
20	Luxembourg	83.892	20	Costa Rica	80.631	20	El Salvador	77.563	20	Colombia	75.789	20	Guatemala	74.709
21	Tanzania	82.635	21	Sweden	79.445	21	Honduras	76.837	21	El Salvador	75.680	21	Bolivia	72.774
22	France	81.572	22	Sudan	79.350	22	Colombia	74.617	22	Ecuador	75.627	22	Sri Lanka	72.500
23	Sweden	81.233	23	Albania	78.378	23	Vietnam	74.016	23	Peru	74.109	23	Belgium	72.492
24	New Zealand	79.209	24	Ecuador	76.393	24	Bolivia	73.944	24	Gibraltar	73.171	24	Gibraltar	72.340
25	Peru	79.206	25	Bosnia and Herzegovina	75.915	25	Panama	73.770	25	Tanzania	73.069	25	New Zealand	72.026
26	Panama	78.516	26	Tanzania	75.904	26	Sudan	73.175	26	Bolivia	72.988	26	Sweden	71.981
27	Cote d'Ivoire	77.778	27	Iran, Islamic Rep.	74.812	27	New Zealand	72.730	27	Sudan	72.110	27	Colombia	71.234
28	Iran, Islamic Rep.	75.546	28	Gabon	74.809	28	Belgium	72.620	28	Belgium	72.008	28	Ghana	70.335
29	Yemen, Rep.	74.603	29	Honduras	74.790	29	Kenya	71.778	29	Yemen, Rep.	71.269	29	Gabon	69.925
30	Haiti	74.194	30	Colombia	74.472	30	Guatemala	71.678	30	Myanmar	70.766	30	Ecuador	69.766

CO2 EMISSIONS FROM ELECTRICITY (IND3)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
31	United Arab Emirates	73.684	31	Chile	72.801	31	Iran, Islamic Rep.	70.842	31	Nigeria	70.035	31	Honduras	69.210
32	Norway	73.379	32	Lebanon	71.697	32	Gibraltar	70.588	32	Vietnam	69.301	32	Panama	69.118
33	Colombia	73.154	33	Yemen, Rep.	71.686	33	Myanmar	70.151	33	Guatemala	69.209	33	Pakistan	68.240
34	Jamaica	72.099	34	Gibraltar	71.429	34	Gabon	69.178	34	Georgia	68.966	34	Cameroon	67.525
35	Philippines	72.003	35	United Arab Emirates	70.994	35	Norway	68.842	35	Iran, Islamic Rep.	68.773	35	Iran, Islamic Rep.	67.134
36	Vietnam	71.922	36	Argentina	70.850	36	Nigeria	68.670	36	Tunisia	68.362	36	Vietnam	67.095
37	Pakistan	71.390	37	Belgium	70.286	37	Sri Lanka	68.441	37	Argentina	68.213	37	Croatia	66.941
38	Syrian Arab Republic	70.794	38	El Salvador	70.241	38	Austria	68.321	38	Pakistan	67.957	38	Spain	66.349
39	Turkmenistan	70.715	39	Panama	69.193	39	Argentina	67.700	39	Honduras	67.737	39	Nigeria	65.896
40	Bolivia	70.680	40	Philippines	69.182	40	Yemen, Rep.	67.316	40	Norway	65.990	40	Ireland	65.700
41	Nigeria	70.599	41	Bolivia	68.940	41	Chile	65.954	41	Austria	65.755	41	Myanmar	65.570
42	Belgium	70.202	42	Cote d'Ivoire	68.712	42	Egypt, Arab Rep.	65.470	42	Sri Lanka	65.347	42	Peru	65.004
43	Turkey	69.260	43	Canada	67.183	43	Indonesia	65.013	43	New Zealand	65.015	43	Venezuela, RB	64.857
44	Armenia	69.254	44	Nigeria	66.860	44	Iraq	64.628	44	Ireland	64.783	44	Austria	64.672
45	Nicaragua	69.022	45	Egypt, Arab Rep.	66.491	45	Tunisia	64.152	45	Croatia	64.289	45	Argentina	64.115
46	Iraq	68.200	46	Pakistan	66.397	46	Pakistan	64.110	46	Hungary	64.163	46	Yemen, Rep.	63.835
47	Egypt, Arab Rep.	67.429	47	Tunisia	66.287	47	Georgia	63.715	47	Gabon	63.584	47	Tunisia	63.761
48	Tunisia	67.186	48	Norway	66.083	48	Italy	63.636	48	Venezuela, RB	62.816	48	Portugal	63.281
49	Canada	67.098	49	Turkey	65.993	49	Canada	63.380	49	Turkey	62.445	49	Norway	63.225
50	Gabon	65.934	50	Austria	65.279	50	Croatia	63.170	50	Iraq	62.379	50	Hungary	62.750
51	Argentina	65.486	51	Turkmenistan	64.481	51	Turkey	62.771	51	Canada	62.271	51	Turkmenistan	62.091
52	China	65.060	52	Indonesia	63.635	52	Cote d'Ivoire	62.559	52	Chile	61.742	52	Algeria	62.076
53	Austria	64.641	53	Venezuela, RB	63.081	53	Philippines	62.546	53	Turkmenistan	61.323	53	Senegal	61.355
54	Indonesia	64.351	54	Syrian Arab Republic	63.078	54	Morocco	61.950	54	Italy	61.057	54	Morocco	61.328
55	Hungary	64.327	55	Myanmar	62.946	55	Ireland	61.597	55	Indonesia	61.048	55	Italy	60.935
56	Chile	63.948	56	Italy	62.594	56	Turkmenistan	61.484	56	Nicaragua	61.042	56	Canada	60.129
57	Ireland	63.932	57	Thailand	62.208	57	United Arab Emirates	61.167	57	Jordan	60.961	57	Chile	59.965
58	Mexico	63.320	58	Nicaragua	62.151	58	Spain	60.213	58	Spain	60.906	58	United Arab Emirates	59.947
59	Italy	63.161	59	Spain	60.876	59	Cuba	60.022	59	Jamaica	58.268	59	Indonesia	59.671
60	Finland	63.099	60	Netherlands	59.818	60	Zimbabwe	59.669	60	Senegal	58.009	60	Jamaica	58.874

CO2 EMISSIONS FROM ELECTRICITY (IND3)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
61	Cuba	62.317	61	Ireland	59.761	61	Jordan	58.974	61	Algeria	57.921	61	Netherlands	58.273
62	Mauritius	62.069	62	Mauritius	59.355	62	Netherlands	58.592	62	Thailand	57.717	62	Nicaragua	58.178
63	Thailand	61.973	63	Bangladesh	59.223	63	Venezuela, RB	58.478	63	Netherlands	57.422	63	Azerbaijan	57.501
64	Malaysia	61.726	64	China	58.933	64	Portugal	58.420	64	Philippines	57.009	64	Turkey	57.401
65	Jordan	61.613	65	Croatia	58.863	65	Nicaragua	58.192	65	Morocco	56.673	65	United Kingdom	56.194
66	Spain	61.515	66	Armenia	58.754	66	Thailand	57.791	66	Syrian Arab Republic	56.501	66	Thailand	56.108
67	Croatia	61.171	67	Senegal	58.468	67	Senegal	57.386	67	Egypt, Arab Rep.	56.030	67	Mexico	55.949
68	Venezuela, RB	61.041	68	Mexico	58.158	68	Bangladesh	56.972	68	Portugal	54.424	68	Egypt, Arab Rep.	55.873
69	Bangladesh	61.033	69	United Kingdom	57.949	69	United Kingdom	56.717	69	United Kingdom	54.226	69	Lithuania	55.537
70	Morocco	59.695	70	Japan	57.352	70	Syrian Arab Republic	56.012	70	Bangladesh	53.772	70	Philippines	54.831
71	Myanmar	59.335	71	Jordan	57.259	71	Japan	55.571	71	Mexico	53.754	71	Cote d'Ivoire	53.140
72	Azerbaijan	59.229	72	Cyprus	57.228	72	Hungary	55.320	72	Lithuania	53.545	72	Germany	52.319
73	Senegal	59.155	73	Malaysia	56.365	73	Germany	55.165	73	Japan	53.090	73	Jordan	51.589
74	Netherlands	59.144	74	Hungary	56.114	74	Malaysia	54.195	74	Germany	52.238	74	Bangladesh	51.354
75	Lithuania	57.591	75	Germany	55.689	75	Armenia	53.216	75	United Arab Emirates	52.003	75	United States	51.203
76	Japan	57.380	76	Dominican Republic	55.526	76	Mexico	53.192	76	Dominican Republic	51.848	76	Dominican Republic	51.017
77	Gibraltar	57.143	77	Finland	55.422	77	Cyprus	53.175	77	Malaysia	51.621	77	Japan	50.291
78	Zimbabwe	56.985	78	Morocco	55.159	78	Finland	52.576	78	Finland	51.460	78	Cuba	50.275
79	Portugal	56.468	79	Portugal	53.643	79	Algeria	52.561	79	Denmark	51.280	79	Libya	49.490
80	India	56.253	80	Algeria	53.254	80	Mauritius	52.263	80	United States	51.058	80	Denmark	48.518
81	Germany	56.173	81	Kazakhstan	53.026	81	United States	51.889	81	Cyprus	50.496	81	India	48.497
82	Dominican Republic	55.811	82	Azerbaijan	52.318	82	Lithuania	50.489	82	China	49.775	82	China	48.432
83	Bosnia and Herzegovina	55.250	83	Lithuania	52.271	83	China	48.962	83	Lebanon	49.170	83	Romania	48.154
84	United States	55.029	84	United States	52.234	84	Lebanon	48.606	84	Cuba	47.784	84	Cyprus	47.796
85	United Kingdom	55.027	85	Cuba	50.936	85	Denmark	47.921	85	Romania	47.518	85	Syrian Arab Republic	47.721
86	Czech Republic	54.949	86	Zimbabwe	50.630	86	Dominican Republic	47.593	86	Mauritius	46.959	86	Zimbabwe	47.021
87	Algeria	54.867	87	India	48.382	87	Greece	45.681	87	Greece	46.770	87	Greece	45.696
88	Cyprus	54.756	88	Greece	44.858	88	Libya	45.539	88	Cote d'Ivoire	46.127	88	Poland	45.071
89	Romania	52.807	89	Australia	44.587	89	India	44.786	89	India	44.440	89	Iraq	44.508
90	Kazakhstan	51.429	90	Poland	44.243	90	Hong Kong SAR, China	43.803	90	Libya	43.322	90	Kazakhstan	44.077

CO2 EMISSIONS FROM ELECTRICITY (IND3)

	1990			1995	1995		2000	2000		2005	2005		2010	2010
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
91	Lebanon	49.183	91	Denmark	44.210	91	Jamaica	43.718	91	Azerbaijan	43.226	91	Malaysia	43.902
92	Georgia	48.895	92	Czech Republic	44.095	92	Romania	42.614	92	Czech Republic	42.850	92	Finland	43.217
93	Mongolia	48.445	93	Iraq	43.557	93	Czech Republic	42.537	93	Poland	41.482	93	Singapore	39.883
94	Denmark	47.911	94	Libya	43.109	94	Trinidad and Tobago	41.485	94	Zimbabwe	41.188	94	Mauritius	39.617
95	Greece	46.867	95	Romania	40.733	95	Australia	41.147	95	Australia	37.898	95	Czech Republic	39.393
96	Australia	44.997	96	Israel	39.091	96	Poland	40.513	96	Bulgaria	37.871	96	Lebanon	38.187
97	Russian Federation	43.076	97	Russian Federation	38.121	97	Azerbaijan	40.256	97	Qatar	37.440	97	Belarus	37.872
98	Trinidad and Tobago	40.380	98	Jamaica	37.693	98	Bulgaria	37.118	98	Kazakhstan	36.803	98	Russian Federation	37.476
99	South Africa	40.189	99	Trinidad and Tobago	36.887	99	Russian Federation	36.894	99	Russian Federation	36.031	99	Australia	37.077
100	Israel	39.774	100	Kuwait	36.024	100	Kazakhstan	36.259	100	Belarus	34.466	100	Mongolia	36.961
101	Qatar	37.812	101	Mongolia	35.610	101	Qatar	34.918	101	Bosnia and Herzegovina	33.228	101	Qatar	36.480
102	Belarus	37.688	102	Belarus	35.564	102	Bosnia and Herzegovina	34.913	102	Trinidad and Tobago	33.181	102	Israel	35.628
103	Libya	37.050	103	South Africa	34.753	103	Israel	34.306	103	South Africa	32.574	103	Trinidad and Tobago	35.139
104	Bulgaria	35.255	104	Qatar	34.403	104	Belarus	34.178	104	Israel	31.247	104	Hong Kong SAR, China	32.913
105	Poland	33.602	105	Georgia	33.948	105	South Africa	31.575	105	Kuwait	31.063	105	Bosnia and Herzegovina	32.260
106	Hong Kong SAR, China	26.577	106	Malta	33.613	106	Kuwait	30.179	106	Mongolia	30.273	106	Kuwait	30.518
107	Estonia	25.438	107	Hong Kong SAR, China	33.297	107	Mongolia	26.615	107	Singapore	29.847	107	Bulgaria	29.955
108	Kuwait	25.396	108	Bulgaria	32.783	108	Malta	25.352	108	Hong Kong SAR, China	28.478	108	South Africa	29.616
109	Malta	23.377	109	Estonia	24.436	109	Brunei Darussalam	22.851	109	Estonia	23.424	109	Malta	27.626
110	Brunei Darussalam	22.086	110	Brunei Darussalam	22.889	110	Estonia	21.778	110	Brunei Darussalam	23.029	110	Brunei Darussalam	24.781
111	Singapore	20.097	111	Singapore	17.940	111	Singapore	21.629	111	Malta	13.971	111	Estonia	19.249

Source: Own elaboration.

4.1.4. Indicator 4 – Renewable Electricity Output

Table 11 – Overall Results for Renewable Electricity Output (IND4).

RENEWABLE ELECTRICITY OUTPUT (IND4)														
1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
1	Ghana	100.000	1	Iceland	99.819	1	Paraguay	100.000	1	Paraguay	100.000	1	Paraguay	99.998
2	Paraguay	99.974	2	Paraguay	99.718	2	Iceland	99.935	2	Iceland	99.942	2	Iceland	99.988
3	Iceland	99.867	3	Ghana	99.689	3	Norway	99.715	3	Norway	99.472	3	Albania	99.987
4	Sri Lanka	99.841	4	Norway	99.662	4	Zambia	99.384	4	Zambia	99.407	4	Zambia	99.876
5	Norway	99.792	5	Zambia	99.331	5	Costa Rica	99.147	5	Albania	98.714	5	Norway	95.733
6	Zambia	99.226	6	Cameroon	98.851	6	Cameroon	98.908	6	Costa Rica	96.719	6	Costa Rica	93.311
7	Cameroon	98.480	7	Brazil	94.157	7	Albania	96.149	7	Cameroon	94.206	7	Georgia	92.523
8	Honduras	98.275	8	Albania	93.986	8	Uruguay	93.384	8	Uruguay	87.503	8	Uruguay	87.622
9	Costa Rica	97.520	9	Angola	93.750	9	Ghana	91.499	9	Brazil	87.125	9	Brazil	84.724
10	Tanzania	95.147	10	Uruguay	93.547	10	Brazil	89.493	10	Georgia	85.813	10	Sudan	82.704
11	Uruguay	94.949	11	Sri Lanka	92.711	11	Tanzania	86.367	11	Ghana	82.926	11	Cameroon	73.216
12	Brazil	94.501	12	Kenya	89.831	12	Peru	81.988	12	Colombia	80.170	12	New Zealand	73.164
13	El Salvador	93.192	13	New Zealand	83.853	13	Georgia	78.933	13	Angola	79.648	13	Colombia	72.121
14	Kenya	92.859	14	Bosnia and Herzegovina	82.777	14	Colombia	75.525	14	Venezuela, RB	73.283	14	Kenya	69.070
15	Guatemala	91.629	15	Costa Rica	82.749	15	Venezuela, RB	73.748	15	Peru	72.270	15	Ghana	68.811
16	Albania	86.408	16	Peru	80.296	16	Austria	72.544	16	Kenya	71.662	16	Zimbabwe	68.009
17	Angola	86.207	17	Tanzania	79.990	17	Ecuador	71.702	17	Panama	64.304	17	Angola	67.957
18	Panama	85.269	18	Colombia	76.405	18	New Zealand	71.501	18	New Zealand	64.236	18	Myanmar	67.679
19	New Zealand	80.006	19	Chile	72.405	19	Panama	70.432	19	Austria	63.389	19	Venezuela, RB	67.490
20	Haiti	79.397	20	Vietnam	72.242	20	Angola	63.114	20	Canada	59.433	20	Austria	66.212
21	Ecuador	78.548	21	Austria	70.506	21	Honduras	61.911	21	El Salvador	58.242	21	El Salvador	65.040
22	Peru	76.803	22	Gabon	70.237	22	Gabon	61.597	22	Korea, Dem. People's Rep.	57.315	22	Guatemala	63.848
23	Colombia	76.384	23	Venezuela, RB	70.051	23	Canada	60.600	23	Switzerland	55.858	23	Croatia	62.841
24	Gabon	72.393	24	Panama	69.139	24	El Salvador	58.069	24	Ecuador	55.116	24	Korea, Dem. People's Rep.	61.854
25	Cote d'Ivoire	66.667	25	Guatemala	66.440	25	Croatia	57.303	25	Croatia	54.071	25	Canada	61.441
26	Austria	66.202	26	Georgia	63.809	26	Sweden	57.247	26	Chile	53.883	26	Peru	57.721
27	Sudan	63.234	27	Korea, Dem. People's Rep.	61.739	27	Switzerland	57.000	27	Zimbabwe	52.432	27	Panama	57.104
28	Canada	62.379	28	Croatia	61.363	28	Vietnam	54.783	28	Gabon	52.097	28	Switzerland	56.730
29	Venezuela, RB	62.344	29	Honduras	61.327	29	Korea, Dem. People's Rep.	52.577	29	Sweden	51.294	29	Sweden	55.302
30	Vietnam	61.848	30	Ecuador	61.229	30	Haiti	51.737	30	Tanzania	50.014	30	Sri Lanka	53.115

RENEWABLE ELECTRICITY OUTPUT (IND4)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
31	Nicaragua	61.359	31	Canada	61.004	31	Guatemala	51.720	31	Myanmar	49.817	31	Portugal	52.808
32	Korea, Dem. People's Rep.	56.318	32	Cote d'Ivoire	60.536	32	Bolivia	51.521	32	Haiti	47.662	32	Tanzania	51.688
33	Georgia	55.210	33	El Salvador	57.825	33	Bosnia and Herzegovina	48.845	33	Bosnia and Herzegovina	47.596	33	Honduras	47.809
34	Switzerland	54.983	34	Switzerland	57.430	34	Chile	48.548	34	Guatemala	47.484	34	Gabon	47.412
35	Chile	53.837	35	Sudan	52.146	35	Kenya	46.980	35	Bolivia	41.258	35	Bosnia and Herzegovina	46.870
36	Bolivia	52.445	36	Haiti	51.111	36	Sudan	46.049	36	Sri Lanka	37.227	36	Ecuador	45.492
37	Sweden	51.000	37	Sweden	47.579	37	Sri Lanka	45.802	37	Nicaragua	34.612	37	Chile	40.203
38	Myanmar	48.144	38	Nicaragua	45.445	38	Zimbabwe	45.661	38	Romania	34.021	38	Armenia	39.485
39	Zimbabwe	46.667	39	Bolivia	43.326	39	Philippines	42.890	39	Argentina	33.525	39	Nicaragua	37.005
40	Croatia	45.553	40	Turkey	41.566	40	Luxembourg	40.995	40	Finland	33.249	40	Bolivia	33.953
41	Philippines	45.425	41	Pakistan	40.743	41	Nigeria	38.216	41	Nigeria	33.001	41	Pakistan	33.704
42	Pakistan	44.926	42	Argentina	40.213	42	Myanmar	36.968	42	Pakistan	32.962	42	Romania	33.488
43	Turkey	40.366	43	Myanmar	40.049	43	Cote d'Ivoire	36.750	43	Sudan	32.959	43	Spain	32.776
44	Argentina	35.441	44	Philippines	36.844	44	Finland	33.410	44	Honduras	32.947	44	Denmark	31.982
45	Portugal	34.745	45	Nigeria	34.685	45	Argentina	33.159	45	Philippines	32.365	45	Haiti	30.153
46	Lebanon	33.333	46	Armenia	34.508	46	Portugal	29.669	46	Vietnam	31.674	46	Finland	29.991
47	Nigeria	32.586	47	Finland	30.522	47	Mauritius	29.640	47	Armenia	28.067	47	Vietnam	29.140
48	Mauritius	31.154	48	Zimbabwe	29.254	48	Romania	28.455	48	Cote d'Ivoire	27.231	48	Argentina	28.585
49	Finland	29.452	49	Portugal	28.322	49	Pakistan	25.242	49	Denmark	27.071	49	Cote d'Ivoire	28.282
50	Mexico	24.693	50	Romania	28.166	50	Turkey	24.939	50	Mauritius	25.000	50	Turkey	26.378
51	India	24.489	51	Mauritius	26.844	51	Nicaragua	21.395	51	Turkey	24.542	51	Philippines	26.298
52	Egypt, Arab Rep.	23.504	52	Mexico	23.650	52	Armenia	21.165	52	Iraq	19.737	52	Italy	25.760
53	Syrian Arab Republic	23.495	53	Luxembourg	21.971	53	Mexico	19.804	53	Dominican Republic	19.418	53	Nigeria	24.402
54	Indonesia	20.917	54	Egypt, Arab Rep.	21.948	54	Italy	18.848	54	Russian Federation	18.203	54	Mauritius	24.321
55	Bosnia and Herzegovina	20.899	55	Russian Federation	20.427	55	Russian Federation	18.730	55	Portugal	17.883	55	China	18.622
56	China	20.408	56	China	19.214	56	Egypt, Arab Rep.	17.703	56	India	16.619	56	Azerbaijan	18.423
57	Romania	17.744	57	Italy	17.466	57	China	16.639	57	Italy	16.318	57	Greece	18.342
58	Malaysia	17.331	58	India	17.261	58	Indonesia	15.956	58	China	16.175	58	Lithuania	18.242
59	Spain	17.216	59	Indonesia	16.463	59	Spain	15.614	59	Mexico	15.180	59	Morocco	17.434
60	Italy	16.376	60	France	15.361	60	Denmark	15.455	60	Spain	14.601	60	Germany	16.727

RENEWABLE ELECTRICITY OUTPUT (IND4)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
61	Russian Federation	15.338	61	Syrian Arab Republic	15.102	61	Kazakhstan	14.673	61	Indonesia	13.606	61	Mexico	16.603
62	Armenia	15.007	62	Spain	14.720	62	India	13.591	62	Azerbaijan	13.156	62	Russian Federation	16.121
63	France	13.370	63	Malaysia	13.686	63	France	12.968	63	Senegal	12.657	63	India	16.044
64	Luxembourg	13.301	64	Lebanon	13.577	64	Syrian Arab Republic	12.813	64	Syrian Arab Republic	12.380	64	Indonesia	15.854
65	Morocco	12.671	65	Kazakhstan	12.498	65	Malaysia	10.058	65	Egypt, Arab Rep.	12.141	65	France	13.857
66	United States	11.529	66	Dominican Republic	11.777	66	Dominican Republic	9.722	66	Kazakhstan	11.579	66	Ireland	13.081
67	Bangladesh	11.433	67	United States	10.801	67	Japan	9.116	67	Greece	10.780	67	Bulgaria	12.578
68	Thailand	11.264	68	Australia	9.624	68	Australia	8.382	68	Germany	10.150	68	Dominican Republic	12.476
69	Japan	11.255	69	Japan	9.416	69	United States	8.206	69	Bulgaria	9.874	69	Senegal	10.728
70	Iraq	10.833	70	Azerbaijan	9.129	70	Azerbaijan	8.204	70	France	9.861	70	Japan	10.538
71	Iran, Islamic Rep.	10.292	71	Thailand	8.742	71	Greece	7.757	71	Iran, Islamic Rep.	9.080	71	United States	10.120
72	Cuba	10.250	72	Greece	8.630	72	Cuba	6.872	72	Australia	8.804	72	Egypt, Arab Rep.	10.048
73	Dominican Republic	10.114	73	Iran, Islamic Rep.	8.576	73	Thailand	6.811	73	United States	8.578	73	Iraq	9.747
74	Australia	9.656	74	Cuba	6.132	74	Bulgaria	6.576	74	Lebanon	8.478	74	Kazakhstan	9.706
75	Kazakhstan	8.430	75	Bulgaria	5.537	75	Germany	6.199	75	Japan	8.407	75	Netherlands	9.388
76	Jamaica	7.567	76	Jamaica	5.164	76	Morocco	6.079	76	Netherlands	7.451	76	Australia	8.612
77	Azerbaijan	7.161	77	Morocco	5.053	77	Ireland	5.006	77	Ireland	7.309	77	Luxembourg	8.266
78	Greece	5.093	78	Denmark	5.036	78	Jamaica	4.844	78	Luxembourg	6.302	78	Hungary	8.081
79	Ireland	4.898	79	Germany	4.867	79	Bangladesh	4.749	79	Malaysia	6.280	79	Estonia	8.053
80	Turkmenistan	4.791	80	Ireland	4.141	80	Lebanon	4.654	80	Morocco	6.143	80	Jamaica	7.685
81	Senegal	4.656	81	Senegal	4.064	81	Netherlands	3.316	81	Thailand	5.545	81	Poland	6.931
82	Bulgaria	4.456	82	Czech Republic	3.974	82	Senegal	3.304	82	Hungary	5.230	82	Belgium	6.921
83	Germany	3.486	83	Bangladesh	3.443	83	Czech Republic	3.133	83	United Kingdom	4.283	83	Czech Republic	6.918
84	Denmark	3.175	84	Lithuania	2.759	84	Lithuania	3.057	84	Czech Republic	3.823	84	United Kingdom	6.848
85	Czech Republic	1.864	85	United Kingdom	2.067	85	Iran, Islamic Rep.	3.038	85	Jamaica	3.692	85	Malaysia	5.993
86	United Kingdom	1.829	86	Iraq	1.916	86	United Kingdom	2.663	86	Lithuania	3.191	86	Thailand	5.610
87	Lithuania	1.457	87	Netherlands	1.731	87	Iraq	1.915	87	Cuba	3.181	87	Syrian Arab Republic	5.585
88	Netherlands	1.120	88	Poland	1.427	88	Poland	1.629	88	Bangladesh	2.832	88	Lebanon	5.340
89	Poland	1.095	89	Singapore	1.101	89	Belgium	1.261	89	Poland	2.476	89	Iran, Islamic Rep.	4.163
90	Trinidad and Tobago	0.867	90	Algeria	0.979	90	Tunisia	0.821	90	Belgium	2.457	90	Cuba	3.242

RENEWABLE ELECTRICITY OUTPUT (IND4)														
1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
91	Algeria	0.838	91	Belgium	0.909	91	Singapore	0.774	91	Algeria	1.636	91	Bangladesh	1.787
92	Tunisia	0.792	92	Trinidad and Tobago	0.766	92	Hungary	0.691	92	Tunisia	1.477	92	Cyprus	1.372
93	Belgium	0.790	93	Hungary	0.644	93	South Africa	0.677	93	Singapore	1.251	93	Singapore	1.305
94	Hungary	0.686	94	Tunisia	0.509	94	Jordan	0.569	94	Estonia	1.088	94	Tunisia	1.161
95	South Africa	0.611	95	Jordan	0.338	95	Trinidad and Tobago	0.366	95	Jordan	0.673	95	South Africa	0.948
96	Singapore	0.541	96	South Africa	0.285	96	Algeria	0.212	96	South Africa	0.665	96	Jordan	0.494
97	Jordan	0.330	97	Estonia	0.092	97	Estonia	0.211	97	Trinidad and Tobago	0.312	97	Algeria	0.380
98	Belarus	0.051	98	Israel	0.082	98	Belarus	0.103	98	Belarus	0.120	98	Belarus	0.373
99	Israel	0.014	99	Belarus	0.080	99	Israel	0.073	99	Israel	0.080	99	Israel	0.290
100	Brunei Darussalam	0.000	100	Turkmenistan	0.041	100	Brunei Darussalam	0.000	100	Cyprus	0.023	100	Hong Kong SAR, China	0.242
101	Cyprus	0.000	101	Brunei Darussalam	0.000	101	Cyprus	0.000	101	Yemen, Rep.	0.000	101	Malta	0.047
102	Estonia	0.000	102	Cyprus	0.000	102	Gibraltar	0.000	102	United Arab Emirates	0.000	102	Brunei Darussalam	0.000
103	Gibraltar	0.000	103	Gibraltar	0.000	103	Hong Kong SAR, China	0.000	103	Turkmenistan	0.000	103	Gibraltar	0.000
104	Hong Kong SAR, China	0.000	104	Hong Kong SAR, China	0.000	104	Kuwait	0.000	104	Qatar	0.000	104	Kuwait	0.000
105	Kuwait	0.000	105	Kuwait	0.000	105	Libya	0.000	105	Mongolia	0.000	105	Libya	0.000
106	Libya	0.000	106	Libya	0.000	106	Malta	0.000	106	Malta	0.000	106	Mongolia	0.000
107	Malta	0.000	107	Malta	0.000	107	Mongolia	0.000	107	Libya	0.000	107	Qatar	0.000
108	Mongolia	0.000	108	Mongolia	0.000	108	Qatar	0.000	108	Kuwait	0.000	108	Trinidad and Tobago	0.000
109	Qatar	0.000	109	Qatar	0.000	109	Turkmenistan	0.000	109	Hong Kong SAR, China	0.000	109	Turkmenistan	0.000
110	United Arab Emirates	0.000	110	United Arab Emirates	0.000	110	United Arab Emirates	0.000	110	Gibraltar	0.000	110	United Arab Emirates	0.000
111	Yemen, Rep.	0.000	111	Yemen, Rep.	0.000	111	Yemen, Rep.	0.000	111	Brunei Darussalam	0.000	111	Yemen, Rep.	0.000

Source: Own elaboration.

4.1.5. Indicator 5 – Renewable Generation Capacity

Table 12 – Overall Results for Renewable Generation Capacity (IND5).

Renewable generation capacity share of total generation capacity (IND5)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
1	Paraguay	99.342	1	Paraguay	99.378	1	Paraguay	99.482	1	Paraguay	99.918	1	Paraguay	99.932
2	Zambia	98.235	2	Zambia	99.110	2	Zambia	99.110	2	Zambia	99.529	2	Zambia	99.583
3	Norway	95.393	3	Norway	97.136	3	Norway	94.845	3	Norway	94.697	3	Iceland	95.308
4	Ghana	90.312	4	Brazil	90.506	4	Ghana	92.096	4	Iceland	90.826	4	Norway	93.601
5	Brazil	89.744	5	Ghana	90.312	5	Iceland	89.371	5	Brazil	82.619	5	Brazil	78.656
6	Iceland	84.958	6	Iceland	86.494	6	Brazil	87.224	6	Costa Rica	79.017	6	Austria	72.866
7	Costa Rica	83.651	7	Kenya	80.222	7	Costa Rica	82.794	7	Uruguay	75.134	7	Sudan	69.290
8	Sri Lanka	78.898	8	Costa Rica	76.384	8	Uruguay	70.432	8	Switzerland	69.121	8	Switzerland	68.865
9	Kenya	78.278	9	Cote d'Ivoire	76.300	9	Switzerland	68.962	9	Ghana	68.535	9	New Zealand	68.272
10	Cote d'Ivoire	76.300	10	Sri Lanka	74.168	10	Kenya	68.622	10	New Zealand	68.109	10	Costa Rica	67.647
11	Colombia	74.689	11	New Zealand	71.432	11	New Zealand	67.648	11	Colombia	67.265	11	Colombia	67.079
12	Honduras	72.603	12	Honduras	71.311	12	Tanzania	64.965	12	Venezuela, RB	65.945	12	Tanzania	66.825
13	El Salvador	72.306	13	Uruguay	71.008	13	Colombia	63.515	13	Tanzania	63.003	13	Georgia	62.803
14	Uruguay	71.148	14	Switzerland	68.218	14	Cote d'Ivoire	62.398	14	Austria	62.384	14	Sweden	62.080
15	New Zealand	69.383	15	Vietnam	65.011	15	Venezuela, RB	62.238	15	Georgia	61.706	15	Venezuela, RB	61.485
16	Switzerland	68.621	16	Tanzania	63.790	16	Cameroon	61.697	16	Cameroon	60.417	16	Uruguay	60.201
17	Angola	66.775	17	Colombia	62.305	17	Georgia	61.139	17	Angola	59.957	17	Ghana	59.446
18	Guatemala	65.646	18	Guatemala	60.766	18	Austria	60.056	18	Kenya	59.431	18	Cameroon	58.942
19	Tanzania	65.020	19	Georgia	59.982	19	Sri Lanka	54.705	19	Sweden	59.233	19	Kenya	58.079
20	Chile	60.661	20	Ecuador	58.980	20	Sweden	54.264	20	Panama	55.873	20	Korea, Dem. People's Rep.	52.633
21	Peru	58.632	21	Angola	58.192	21	Vietnam	52.680	21	Bosnia and Herzegovina	55.349	21	Sri Lanka	51.955
22	Cameroon	57.748	22	Austria	57.838	22	Korea, Dem. People's Rep.	52.632	22	Sri Lanka	53.773	22	Cote d'Ivoire	49.427
23	Panama	57.576	23	Panama	57.576	23	El Salvador	52.431	23	Korea, Dem. People's Rep.	52.632	23	Bosnia and Herzegovina	49.187
24	Austria	57.533	24	Sudan	57.562	24	Croatia	52.392	24	Cote d'Ivoire	51.487	24	Panama	47.368
25	Venezuela, RB	54.773	25	Chile	57.322	25	Ecuador	51.526	25	Peru	51.412	25	El Salvador	47.365
26	Ecuador	54.518	26	Cameroon	56.837	26	Bosnia and Herzegovina	50.330	26	El Salvador	50.727	26	Croatia	46.999
27	Gabon	53.548	27	Venezuela, RB	55.978	27	Angola	49.488	27	Ecuador	49.594	27	Myanmar	46.702
28	Korea, Dem. People's Rep.	52.632	28	Peru	54.887	28	Panama	49.123	28	Croatia	46.887	28	Portugal	45.536
29	Sudan	51.754	29	El Salvador	54.435	29	Honduras	47.667	29	Portugal	44.351	29	Ecuador	44.721
30	Sweden	50.139	30	Korea, Dem. People's Rep.	52.632	30	Peru	47.150	30	Myanmar	44.142	30	Guatemala	43.461

Renewable generation capacity share of total generation capacity (IND5)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
31	Bolivia	44.803	31	Sweden	50.766	31	Chile	44.997	31	Chile	41.808	31	Angola	43.117
32	Philippines	44.341	32	Bosnia and Herzegovina	50.644	32	Sudan	44.893	32	Gabon	40.964	32	Gabon	40.964
33	Turkey	41.561	33	Croatia	49.023	33	Gabon	41.687	33	Sudan	39.476	33	Peru	39.926
34	Nicaragua	41.315	34	Turkey	47.220	34	Turkey	41.472	34	Guatemala	35.679	34	Spain	38.778
35	Nigeria	40.584	35	Gabon	45.652	35	Portugal	39.554	35	Nicaragua	35.051	35	Chile	37.986
36	Portugal	40.251	36	Portugal	43.679	36	Zimbabwe	38.372	36	Honduras	33.955	36	Denmark	36.959
37	Haiti	39.416	37	Haiti	42.759	37	Armenia	34.870	37	Zimbabwe	33.915	37	Vietnam	36.367
38	Pakistan	37.447	38	Pakistan	39.884	38	Guatemala	33.566	38	Bolivia	33.914	38	Honduras	36.288
39	Argentina	32.760	39	Nigeria	39.806	39	Argentina	33.295	39	Vietnam	33.905	39	Germany	36.257
40	Vietnam	31.323	40	Bolivia	38.868	40	Nigeria	32.914	40	Turkey	33.597	40	Turkey	35.114
41	Zimbabwe	31.060	41	Nicaragua	38.512	41	Philippines	31.929	41	Philippines	33.459	41	Armenia	33.547
42	Mexico	30.361	42	Armenia	36.561	42	Nicaragua	29.710	42	Pakistan	33.414	42	Zimbabwe	33.415
43	Malaysia	28.926	43	Argentina	36.391	43	Myanmar	29.540	43	Nigeria	32.859	43	Philippines	33.088
44	Morocco	28.613	44	Philippines	35.283	44	Bolivia	28.909	44	Armenia	32.321	44	Nigeria	32.884
45	Mauritius	28.045	45	Zimbabwe	29.469	45	Pakistan	28.187	45	Romania	31.940	45	Nicaragua	31.632
46	Finland	27.262	46	Mexico	28.790	46	Spain	28.158	46	Argentina	31.725	46	Finland	31.503
47	Spain	26.411	47	Finland	27.227	47	Finland	27.200	47	Denmark	31.446	47	Romania	30.873
48	Thailand	26.269	48	Romania	26.984	48	Romania	27.134	48	Spain	30.749	48	Bolivia	30.099
49	China	26.158	49	Spain	26.120	49	Mexico	26.747	49	Finland	29.396	49	Pakistan	29.629
50	Indonesia	25.428	50	Greece	25.554	50	Morocco	26.322	50	Morocco	28.322	50	Argentina	27.752
51	Syrian Arab Republic	25.388	51	Morocco	24.536	51	Mauritius	26.316	51	India	27.412	51	India	27.048
52	Romania	25.207	52	Mauritius	24.505	52	Haiti	25.828	52	Mauritius	25.876	52	Greece	26.679
53	Greece	25.188	53	China	24.026	53	China	24.685	53	Haiti	25.820	53	Bulgaria	26.666
54	India	25.140	54	Myanmar	23.979	54	Greece	24.165	54	Iraq	24.302	54	China	25.854
55	Myanmar	23.519	55	Dominican Republic	23.551	55	India	23.886	55	Mexico	23.015	55	Iraq	24.857
56	Egypt, Arab Rep.	23.406	56	Indonesia	22.626	56	Indonesia	22.051	56	China	22.999	56	Italy	24.659
57	Italy	23.298	57	India	22.314	57	Denmark	21.854	57	Greece	22.148	57	Mauritius	24.348
58	Lebanon	21.885	58	Lebanon	21.885	58	Russian Federation	21.338	58	Germany	22.062	58	Morocco	23.717
59	Australia	20.059	59	Russian Federation	20.952	59	Italy	19.968	59	Russian Federation	20.917	59	Mexico	21.607
60	Bulgaria	17.728	60	Egypt, Arab Rep.	20.921	60	Azerbaijan	19.272	60	Italy	20.373	60	France	21.526

Renewable generation capacity share of total generation capacity (IND5)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
61	France	17.365	61	Syrian Arab Republic	20.785	61	Australia	17.735	61	Syrian Arab Republic	19.881	61	Haiti	20.690
62	Dominican Republic	15.646	62	Italy	20.718	62	Iraq	17.137	62	Azerbaijan	19.666	62	Russian Federation	20.501
63	United States	11.887	63	Australia	19.025	63	Egypt, Arab Rep.	16.467	63	Indonesia	19.281	63	Ireland	20.246
64	Iran, Islamic Rep.	10.879	64	Thailand	17.489	64	France	16.331	64	Australia	18.583	64	Australia	18.744
65	Japan	10.833	65	France	16.859	65	Syrian Arab Republic	16.088	65	France	17.232	65	Indonesia	17.832
66	Bangladesh	9.127	66	Malaysia	16.604	66	Bulgaria	16.083	66	Bulgaria	16.006	66	Belgium	16.925
67	Iraq	8.933	67	Azerbaijan	14.946	67	Malaysia	14.925	67	Egypt, Arab Rep.	14.334	67	Azerbaijan	15.498
68	Algeria	6.141	68	Iraq	13.169	68	Dominican Republic	13.283	68	Netherlands	12.196	68	Netherlands	14.454
69	Ireland	5.858	69	United States	12.270	69	Thailand	12.169	69	Ireland	12.159	69	Iran, Islamic Rep.	13.832
70	Germany	5.789	70	Kazakhstan	11.718	70	Lebanon	11.887	70	Lebanon	12.069	70	United States	12.850
71	Tunisia	4.641	71	Bulgaria	11.591	71	United States	11.760	71	Thailand	12.011	71	Egypt, Arab Rep.	12.448
72	Denmark	4.520	72	Japan	9.762	72	Kazakhstan	11.229	72	Kazakhstan	11.834	72	Lebanon	12.100
73	Jamaica	3.261	73	Denmark	8.436	73	Germany	10.543	73	Iran, Islamic Rep.	11.454	73	Kazakhstan	11.837
74	Luxembourg	3.226	74	Iran, Islamic Rep.	7.350	74	Japan	9.324	74	United States	10.187	74	Syrian Arab Republic	10.821
75	Poland	2.760	75	Bangladesh	7.004	75	Iran, Islamic Rep.	8.120	75	Japan	9.670	75	Japan	10.561
76	Belgium	2.107	76	Czech Republic	6.578	76	Ireland	7.776	76	Malaysia	8.962	76	Czech Republic	10.364
77	Netherlands	1.760	77	Germany	5.863	77	Bangladesh	6.402	77	Dominican Republic	8.693	77	United Kingdom	10.037
78	United Kingdom	1.682	78	Ireland	5.739	78	Czech Republic	6.219	78	Czech Republic	6.834	78	Hungary	9.818
79	South Africa	1.625	79	Algeria	4.578	79	Luxembourg	5.053	79	Luxembourg	6.298	79	Dominican Republic	9.352
80	Cuba	1.229	80	Tunisia	3.797	80	Netherlands	4.858	80	United Kingdom	5.681	80	Thailand	8.912
81	Hungary	1.002	81	Netherlands	3.276	81	Algeria	4.283	81	Belgium	5.436	81	Malaysia	8.300
82	Jordan	0.670	82	Luxembourg	3.197	82	Tunisia	3.091	82	Hungary	5.066	82	Lithuania	8.224
83	Trinidad and Tobago	0.433	83	Belgium	2.682	83	United Kingdom	2.915	83	Bangladesh	4.952	83	Luxembourg	7.835
84	Singapore	0.139	84	United Kingdom	2.498	84	Poland	2.726	84	Jamaica	4.162	84	Estonia	6.582
85	Israel	0.121	85	Poland	2.315	85	Belgium	2.678	85	Algeria	3.735	85	Poland	6.548
86	Armenia	0.000	86	Jamaica	2.024	86	Lithuania	2.008	86	Canada	3.509	86	Cyprus	5.828
87	Azerbaijan	0.000	87	Lithuania	1.936	87	Jamaica	1.716	87	Poland	3.392	87	Jamaica	5.167
88	Belarus	0.000	88	South Africa	1.615	88	South Africa	1.450	88	Lithuania	2.710	88	Bangladesh	3.951
89	Bosnia and Herzegovina	0.000	89	Cuba	1.229	89	Cuba	1.280	89	Tunisia	2.573	89	Tunisia	3.176
90	Brunei Darussalam	0.000	90	Hungary	1.053	90	Hungary	0.954	90	South Africa	2.067	90	Canada	3.118

Renewable generation capacity share of total generation capacity (IND5)

1990			1995			2000			2005			2010		
#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score	#	Country	Score
91	Canada	0.000	91	Jordan	0.621	91	Jordan	0.686	91	Estonia	1.876	91	Algeria	2.489
92	Croatia	0.000	92	Trinidad and Tobago	0.433	92	Senegal	0.353	92	Cuba	1.135	92	South Africa	1.982
93	Cyprus	0.000	93	Singapore	0.107	93	Trinidad and Tobago	0.352	93	Jordan	0.885	93	Israel	1.872
94	Czech Republic	0.000	94	Turkmenistan	0.101	94	Singapore	0.302	94	Senegal	0.393	94	Cuba	1.268
95	Estonia	0.000	95	Belarus	0.097	95	Israel	0.127	95	Trinidad and Tobago	0.337	95	Jordan	0.554
96	Georgia	0.000	96	Israel	0.072	96	Belarus	0.102	96	Belarus	0.212	96	Senegal	0.313
97	Gibraltar	0.000	97	Estonia	0.037	97	Estonia	0.043	97	Singapore	0.198	97	Trinidad and Tobago	0.312
98	Hong Kong SAR, China	0.000	98	Yemen, Rep.	0.000	98	Turkmenistan	0.032	98	Israel	0.123	98	Malta	0.279
99	Kazakhstan	0.000	99	United Arab Emirates	0.000	99	Brunei Darussalam	0.000	99	Cyprus	0.089	99	Belarus	0.260
100	Kuwait	0.000	100	Senegal	0.000	100	Canada	0.000	100	Turkmenistan	0.032	100	Singapore	0.195
101	Libya	0.000	101	Qatar	0.000	101	Cyprus	0.000	101	Mongolia	0.025	101	Mongolia	0.144
102	Lithuania	0.000	102	Mongolia	0.000	102	Gibraltar	0.000	102	Brunei Darussalam	0.000	102	United Arab Emirates	0.043
103	Malta	0.000	103	Malta	0.000	103	Hong Kong SAR, China	0.000	103	Gibraltar	0.000	103	Turkmenistan	0.035
104	Mongolia	0.000	104	Libya	0.000	104	Kuwait	0.000	104	Hong Kong SAR, China	0.000	104	Hong Kong SAR, China	0.006
105	Qatar	0.000	105	Kuwait	0.000	105	Libya	0.000	105	Kuwait	0.000	105	Brunei Darussalam	0.000
106	Senegal	0.000	106	Hong Kong SAR, China	0.000	106	Malta	0.000	106	Libya	0.000	106	Gibraltar	0.000
107	Turkmenistan	0.000	107	Gibraltar	0.000	107	Mongolia	0.000	107	Malta	0.000	107	Kuwait	0.000
108	United Arab Emirates	0.000	108	Cyprus	0.000	108	Qatar	0.000	108	Qatar	0.000	108	Libya	0.000
109	Yemen, Rep.	0.000	109	Canada	0.000	109	United Arab Emirates	0.000	109	United Arab Emirates	0.000	109	Qatar	0.000
110	Russian Federation	NA	110	Brunei Darussalam	0.000	110	Yemen, Rep.	0.000	110	Yemen, Rep.	0.000	110	Yemen, Rep.	0.000

Source: Own elaboration.

4.2. Overall Results for the 20 Best Ranked Countries

The indicators proposed have shown that Brazil has a lot to teach other peers. The country has also been losing momentum, which means it has shown decrease in some indicators. Please see tables 13 to 17 that shows the overall scores for each year, showing the positioning of Brazil.

The country is well ranked in all time periods, for the overall rank, which considers the five indicators. Brazil is among the top 6 performers for all years, however it has shown a decrease in its final score, going against the highest score that has increased throughout the periods.

The first and second places are disputed by Paraguay and Iceland and this shows how countries in very different economic and development stages can be comparable when using the right indicators. It also shows that the weight of decision for one source of energy to another can make a big difference in the final result.

Table 13 – Overall Score for Year 1990

OVERALL SCORE FOR YEAR 1990		
RANK	COUNTRY	SCORE
1	Paraguay	95.294
2	Iceland	95.213
3	Norway	92.580
4	Costa Rica	92.566
5	Brazil	88.459
6	Uruguay	86.695
7	New Zealand	84.239
8	Honduras	83.341
9	El Salvador	82.648
10	Sri Lanka	82.110
11	Albania	82.102
12	Switzerland	82.028
13	Ghana	81.657
14	Zambia	80.376
15	Guatemala	79.000

Table 14 – Overall Score for Year 1995

OVERALL SCORE FOR YEAR 1995		
RANK	COUNTRY	SCORE
1	Iceland	95.844
2	Paraguay	94.367
3	Norway	91.004
4	Brazil	89.172
5	Costa Rica	86.055
6	Uruguay	86.011
7	New Zealand	85.983
8	Ghana	83.667
9	Switzerland	82.325
10	Albania	81.581
11	Zambia	81.244
12	Sri Lanka	80.672
13	Bosnia and Herzegovina	77.553
14	Chile	77.521
15	Austria	77.519

16	Colombia	78.587
17	Ecuador	77.466
18	Austria	76.494
19	Sweden	75.213
20	Cameroon	74.345

16	Colombia	76.400
17	Vietnam	75.860
18	Sweden	74.199
19	Cameroon	73.743
20	Venezuela, RB	73.277

Source: Own elaboration.

Table 15 – Overall Score for Year 2000

OVERALL SCORE FOR YEAR 2000		
RANK	COUNTRY	SCORE
1	Paraguay	97.096
2	Iceland	96.946
3	Costa Rica	94.465
4	Norway	91.041
5	Albania	88.474
6	Brazil	87.280
7	Uruguay	85.809
8	Switzerland	82.407
9	Zambia	81.433
10	New Zealand	80.824
11	Ghana	79.495
12	Austria	79.116
13	Georgia	77.343
14	Colombia	77.294
15	Sweden	77.068
16	Cameroon	75.661
17	Peru	74.407
18	Ecuador	74.052
19	Venezuela, RB	73.730
20	El Salvador	71.839

Table 16 – Overall Score for Year 2005

OVERALL SCORE FOR YEAR 2005		
RANK	COUNTRY	SCORE
1	Paraguay	97.995
2	Iceland	97.187
3	Albania	93.855
4	Costa Rica	91.725
5	Norway	90.575
6	Brazil	86.324
7	Uruguay	83.020
8	Zambia	81.854
9	Switzerland	81.714
10	Georgia	80.129
11	Colombia	80.103
12	New Zealand	78.086
13	Austria	77.234
14	Sweden	76.076
15	Cameroon	75.813
16	Venezuela, RB	74.710
17	Peru	73.125
18	Panama	72.954
19	Ghana	72.637
20	El Salvador	72.216

Source: Own elaboration.

Table 17 – Overall Score for Year 2010

OVERALL SCORE FOR YEAR 2010		
RANK	COUNTRY	SCORE
1	Iceland	98.240
2	Paraguay	98.226
3	Albania	94.983
4	Norway	88.971
5	Costa Rica	88.121
6	Brazil	85.452
7	Georgia	84.859
8	Uruguay	83.146
9	Switzerland	82.060
10	New Zealand	81.310
11	Zambia	79.901
12	Austria	79.763
13	Colombia	78.369
14	Sweden	76.447
15	Venezuela, RB	74.505
16	El Salvador	73.519
17	Croatia	72.623
18	Sudan	71.831
19	Portugal	70.731
20	Guatemala	70.596

Source: Own elaboration.

4.3. Cross-Reference Analyses

In this item, we present the results from the analysis of the indicators making cross-reference analyses among countries, results, and indicators. The first analysis will position Brazil among the best and the worst scored country. Second, we will position Brazil in Latin

America (LATAM), considering countries from North, Central and South America. And, finally, we show an analysis of Brazil within the BRICS[4] countries.

IND1 stands for Indicator 1 (access to electricity), IND2 stands for Indicator 2 (electric power transmission and distribution losses), IND3 stands for Indicator 3 (carbon dioxide emissions from electricity), IND4 stands for Indicator 4 (renewable electricity output), and IND5 stands for Indicator 5 (renewable generation capacity).

4.3.1. Results for Brazil compared to Best and Worst in Class

In this part, we will present the results comparing Brazil, the best and worst country in class, and the average score for the five indicators separated by year. For this analysis, we used all five periods, years 1990, 1995, 2000, 2005, and 2010.

In 1990 (see Figure 5), Brazil had an 87.5 score out of 100.0 what positioned the country in the upper limit, but beyond the best in class for all the five indicators. For one indicator (IND2 – electric power transmission and distribution losses), Brazil is actually worse off than the average of the 111 countries in the sample.

As for IND4 (renewable electricity output), Brazil appears the closest to the best in class. A total number of 45 countries scored 100.0 for IND1 in 1990. On the other hand, Dem. People's Rep. Korea scored the lowest, 4.4.

[4] Brazil, Russian Federation, India, China, and South Africa.

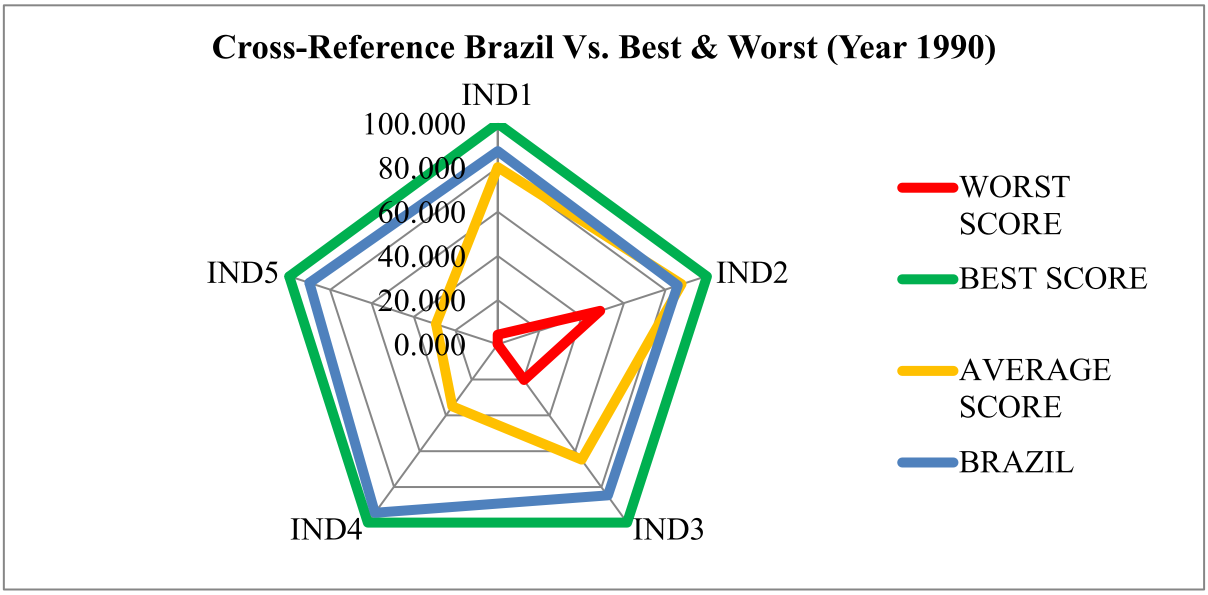

Figure 4 – Chart for Brazil Vs Best & Worse in Year 1990.

Source: Own elaboration.

In 1995 (please refer to Figure 5), Brazil shows improvement in IND1 (nearly +5.0 per cent), IND3 (+1.7 per cent), and IND5 (+0.8 per cent), and setbacks in IND2 (-3.0 per cent) and IND4 (-0.4 per cent). The worst score for IND1 belongs to Tanzania and the average scores are approached by the scores Syrian Federation and Dominican Republic.

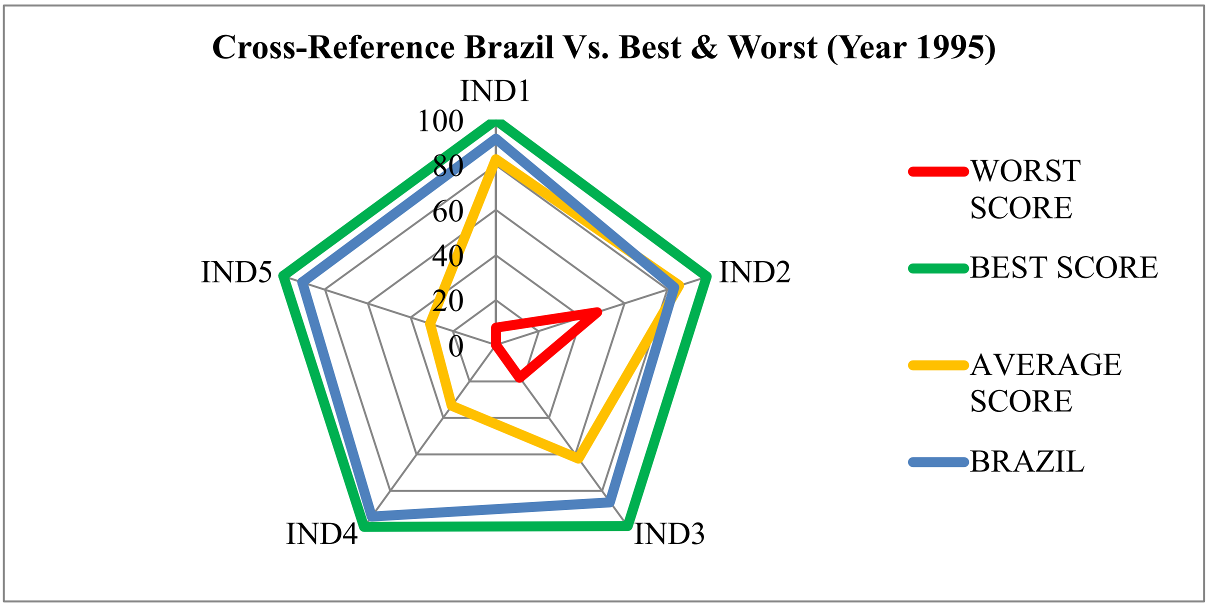

Figure 5 – Chart for Brazil Vs Best & Worse in Year 1995.

Source: Own elaboration.

In 2000 (please refer to Figure 6), Brunei and Paraguay rank as best in class respectively, with scores of 98.860 and 97.330 for IND2, while the worst ones are Myanmar and Haiti. The biggest gaps are in IND1, IND4 and IND5. For IND1, Albania and Australia are leaders, for IND4, Ghana, Paraguay and Iceland outperform the rest of the countries, and finally, for IND5, Paraguay and Zambia are the leaders.

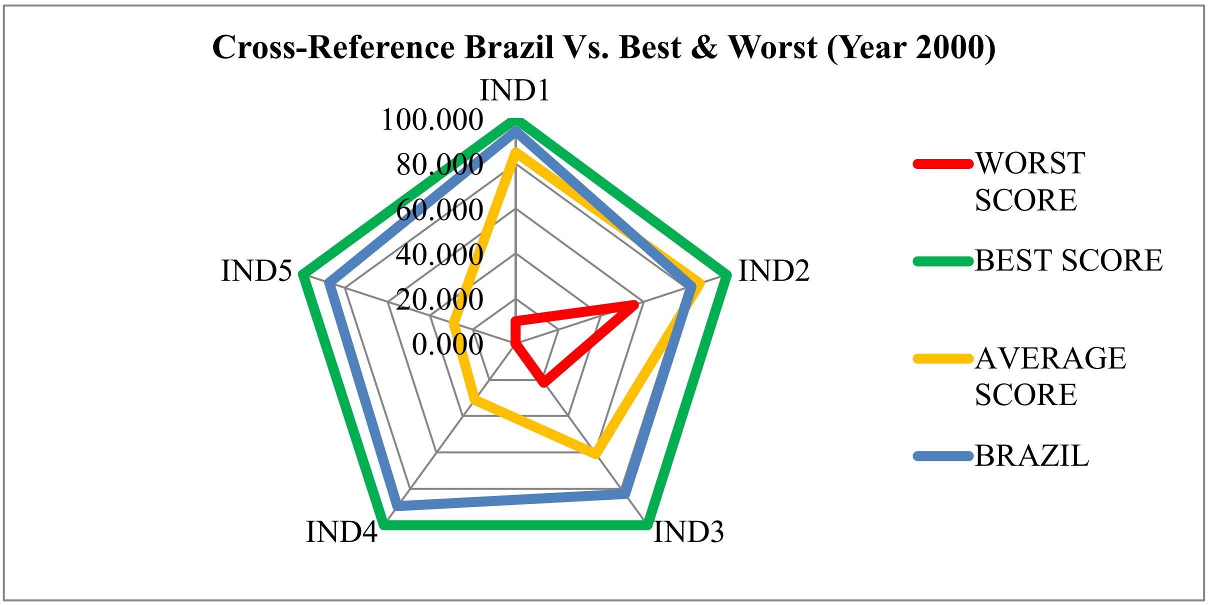

Figure 6 – Chart for Brazil Vs Best & Worse in Year 2000.

Source: Own elaboration.

In 2005 (please refer to Figure 7), the worst scores of 0.000 for IND4 and IND5 belong to Brunei, Gibraltar, Hong Kong, Kuwait, Libya, Malta, Mongolia, Qatar, Turkmenistan, United Arab Emirates and Yemen, these including many among the biggest owners of petroleum resources.

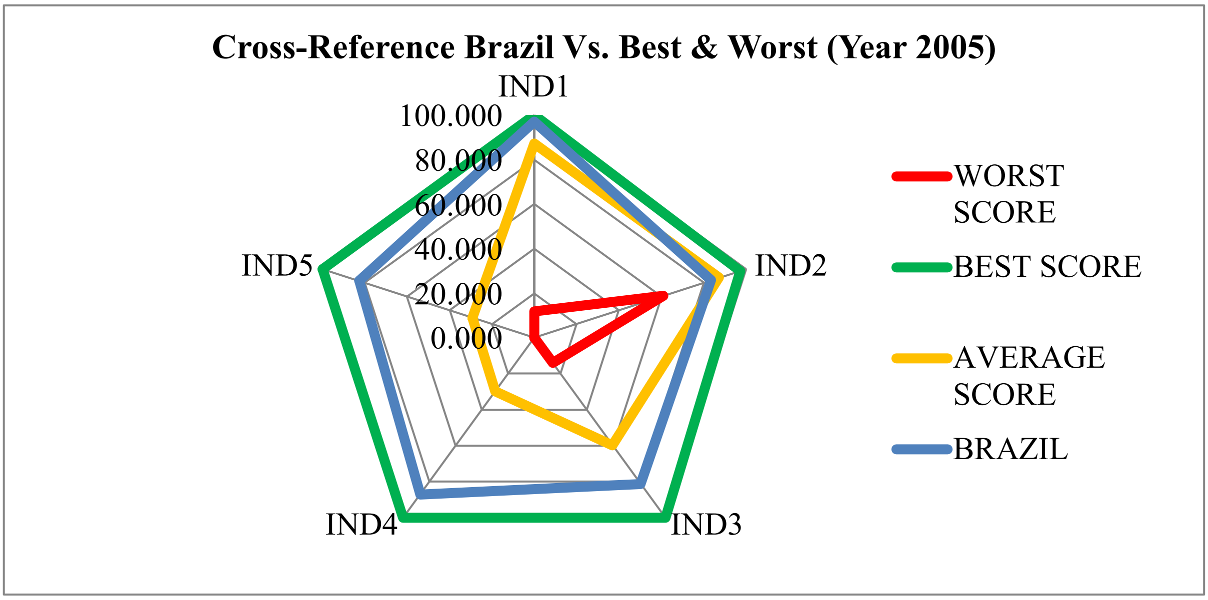

Figure 7 – Chart for Brazil Vs Best & Worse in Year 2005.

Source: Own elaboration.

And finally, in 2010 (please refer to Figure 8), the worst scores of 0.000 for IND4 and IND5 belong to Brunei, Gibraltar, Hong Kong, Kuwait, Libya, Qatar, United Arab Emirates and Yemen, these last ones among the biggest owners of petroleum resources.

In years 2000 and 2005, the worst performer in *electric power transmission and distribution losses* (IND2) improved significantly, they were Haiti and Myanmar, respectively. However, there was a decrease in the worst score in 2010 (Figure 8), which came back to Haiti, and that reflects the earthquake in the beginning of the year and consequent infrastructure and humanitarian crisis.

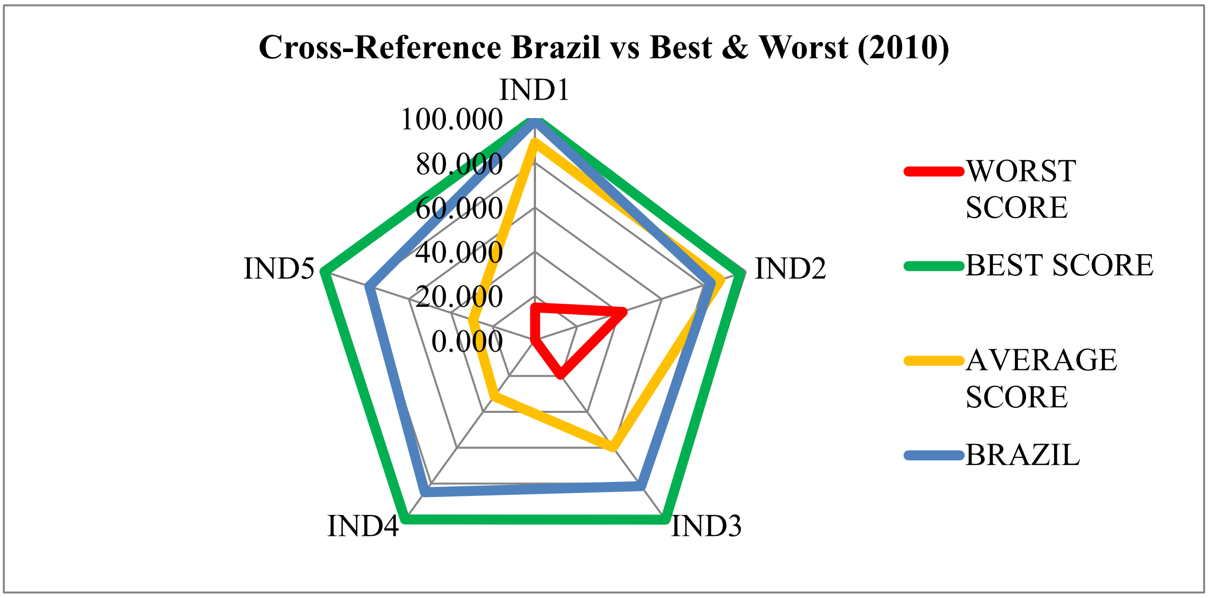

Figure 8 – Chart for Brazil Vs Best & Worse in Year 2010.

Source: Own elaboration.

For all five periods, Brazil has been under the average line for IND2. The best improvement was in *access to electricity* (IND1). But the country has shown signs of improvement in most of the indicators throughout the years.

4.3.2. Results for Brazil Compared to Latin America

The following charts are poor in visualization of single countries, but our intent was to show the data in a way as to provide the reader with an overview of the movement taking place along the years with the Latin American countries (LATAM).

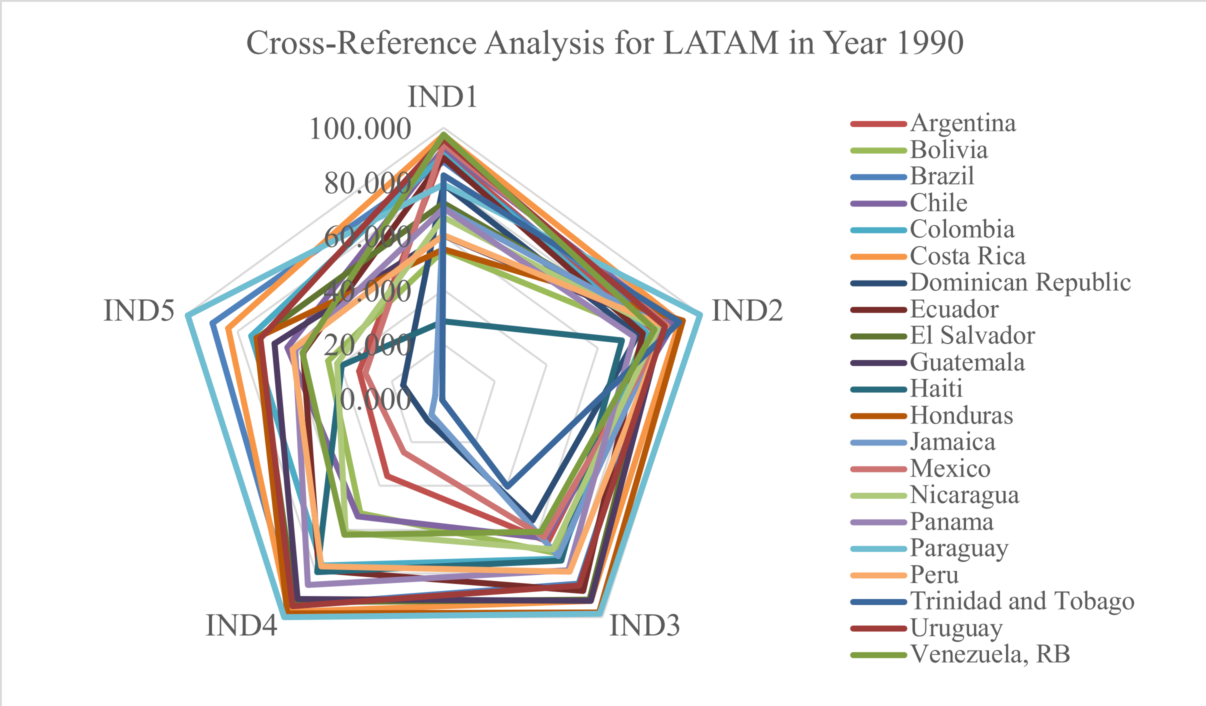

Figure 9 – Chart for LATAM in Year 1990.

Source: Own elaboration.

For these analyses among LATAM countries, we considered two different decades, aiming to have a look at more drastic changes that would not be visible in shorter periods of time. Overall, we can affirm that the best performance of the LATAM groups in general is for *access to electricity* (IND1). The worst ones for the region are *renewable electricity output* (IND4) and *renewable generation capacity share* (IND5), both related to renewable electricity.

The worst scores in 1990 were Jamaica with 3.3 (*renewable generation capacity share* IND5) and Trinidad and Tobago with 0.9 (*renewable electricity output* IND4) and 0.4 (IND5 in 1990). For more detail, please refer to Figure 9.

No country has achieved the highest score for the two years. Paraguay has three 100.0 scores, which are IND3 in 2000 and 2010, and IND4 in 2000. For the final year of our analysis, year 2010, the highest average scores for all five indicators belong to Paraguay (98.226), Costa Rica (88.121), Brazil (85.452) and Uruguay (83.146).

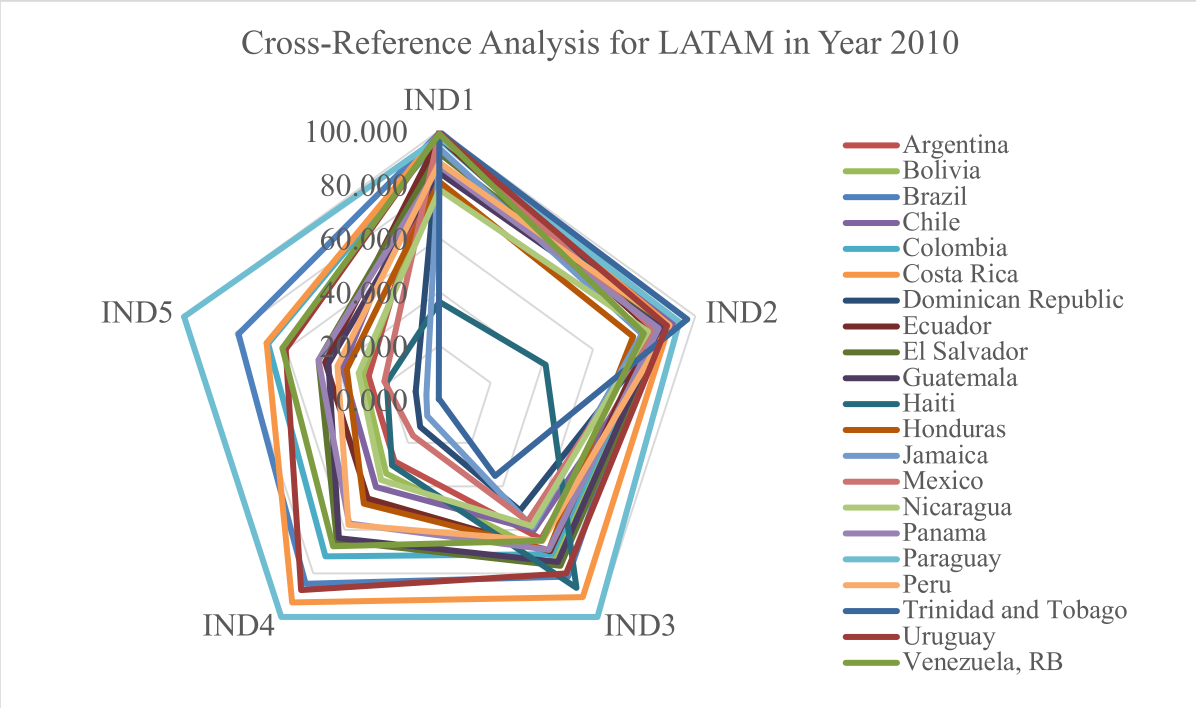

Figure 10 – Chart for LATAM in Year 2010.
Source: Own elaboration.

4.3.3. Results for Brazil Compared to BRICS

The following analyses shows the differences and similarities within an economic point of view, in which we considered Brazil, Russian Federation, India, China, and South Africa (BRICS). These five nations were grouped into the BRICs as they were a group of countries that were big economies, while still struggling with social and economic development. They are all considered part of the developing world, but have figures of big economic powers in some areas. Here we will analyze them by their evolution in each indicator.

On Figure 11, the BRICS have shown improvement in *access to electricity* (IND1), with India and South Africa a little behind the other three countries, namely Brazil, China and Russian Federation. As the best in class, Russian Federation, shows a score of 100 for all five periods.

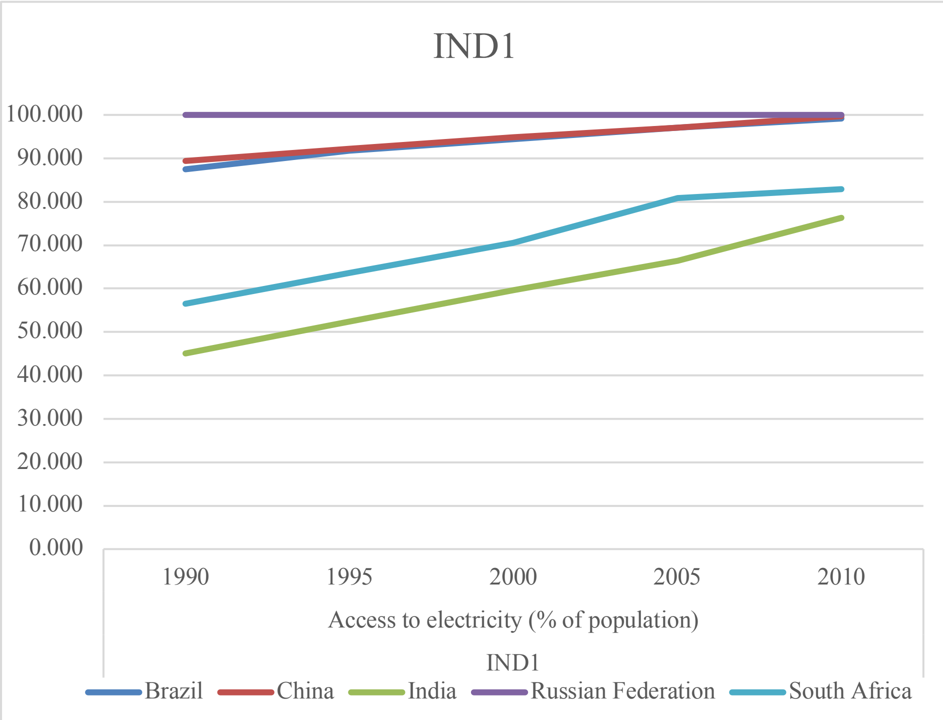

Figure 11 – Chart for BRICS in Year 1995.

Source: Own elaboration.

The indicator *electric power transmission and distribution losses* (IND2) is the one in which most of the countries perform well (Figure 12), with China leading the group for the last three periods, 2000, 2005 and 2010. Brazil is in fourth for all five periods and is only outperformed by India.

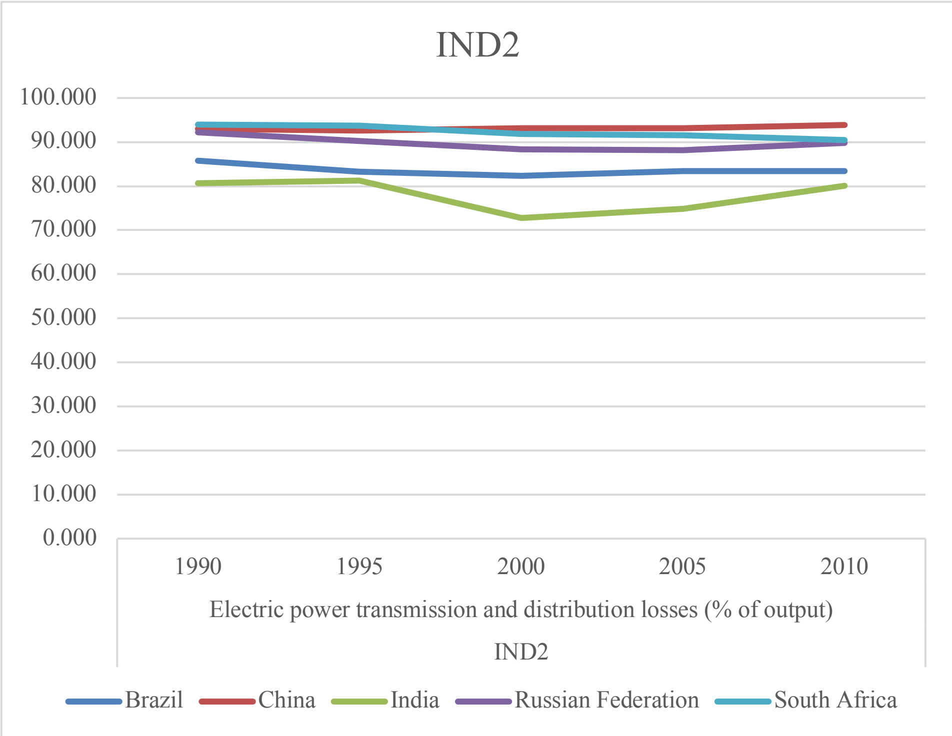

Figure 12 – Electric Power Transmission and Distribution Losses (IND1) for BRICS.

Source: Own elaboration.

As for the indicator *Carbon dioxide emissions from electricity and heat production* (IND3), Brazil is nearly twice as well as the second and third places (please refer to Figure 13), tied by China and India in 2010. China, Brazil and South Africa have shown a decline in this indicator throughout the years and India and Russian Federation have shown an increase.

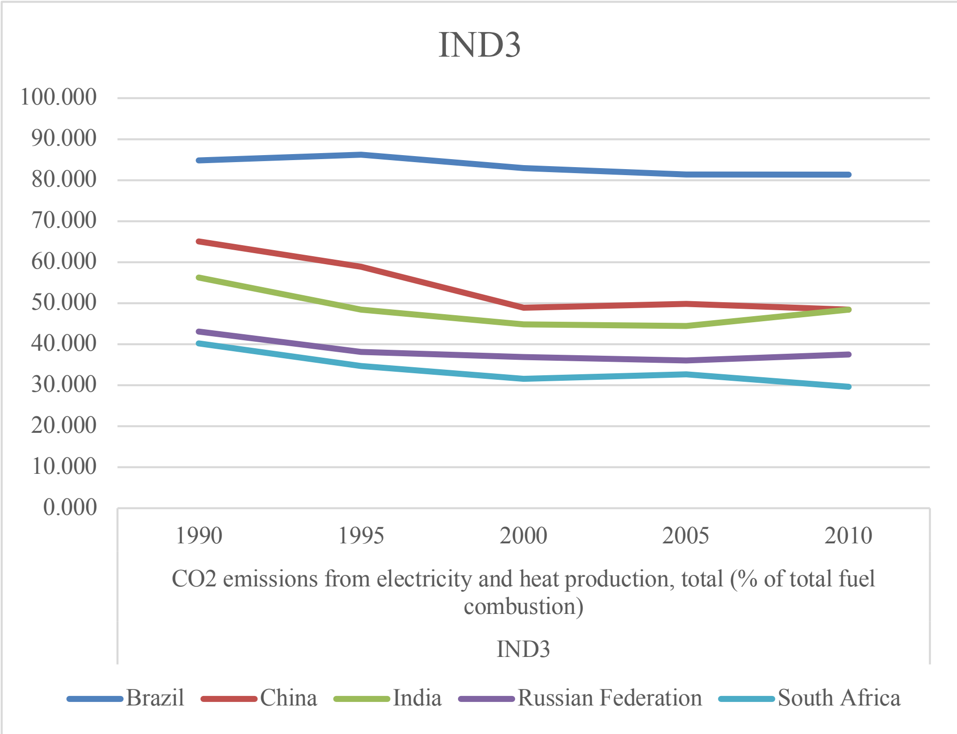

Figure 13 – Carbon Dioxide Emissions from Electricity and Heat Production (IND3) for BRICS.

Source: Own elaboration.

On Figure 14, the indicator *renewable electricity output* (IND4) shows Brazil outperforming the group, even with the decrease in its score, while South Africa underperforming with very low scores for all periods, even with the increase in its score. China is showing a small improvement in the last years, while the other two countries, India and Russian Federation are showing constant decline.

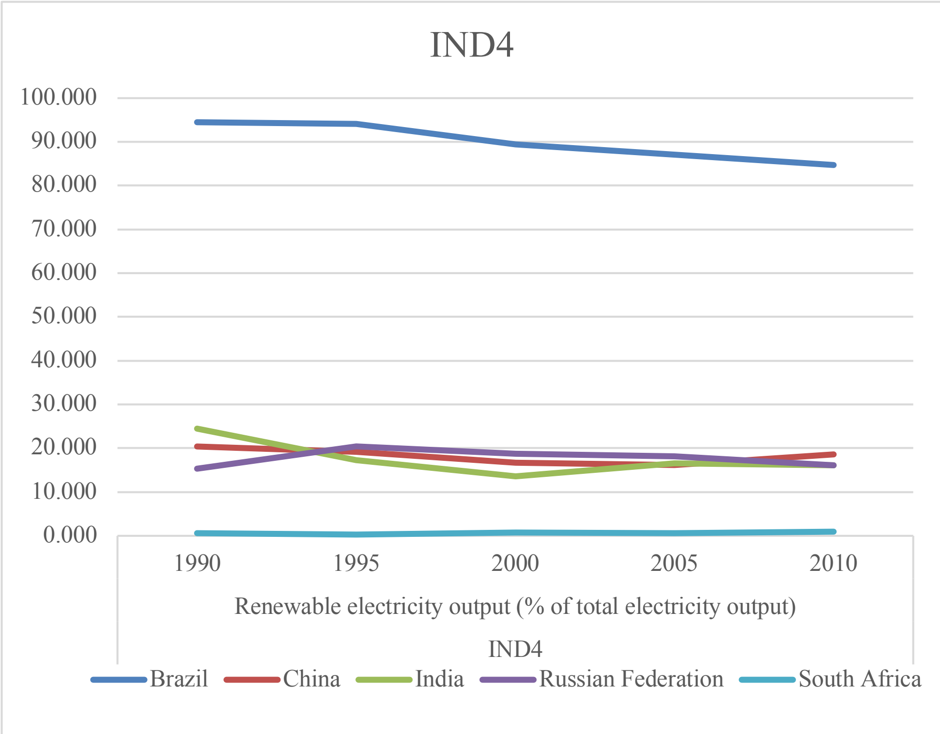

Figure 14 – Renewable Electricity Output (IND4) shows for BRICS.

Source: Own elaboration.

Indicator *renewable generation capacity share* (IND5), on Figure 15, also shows Brazil outperforming and South Africa underperforming the group. Here, however, China and India are tying up in the last period, while Russian Federation is slightly decreasing.

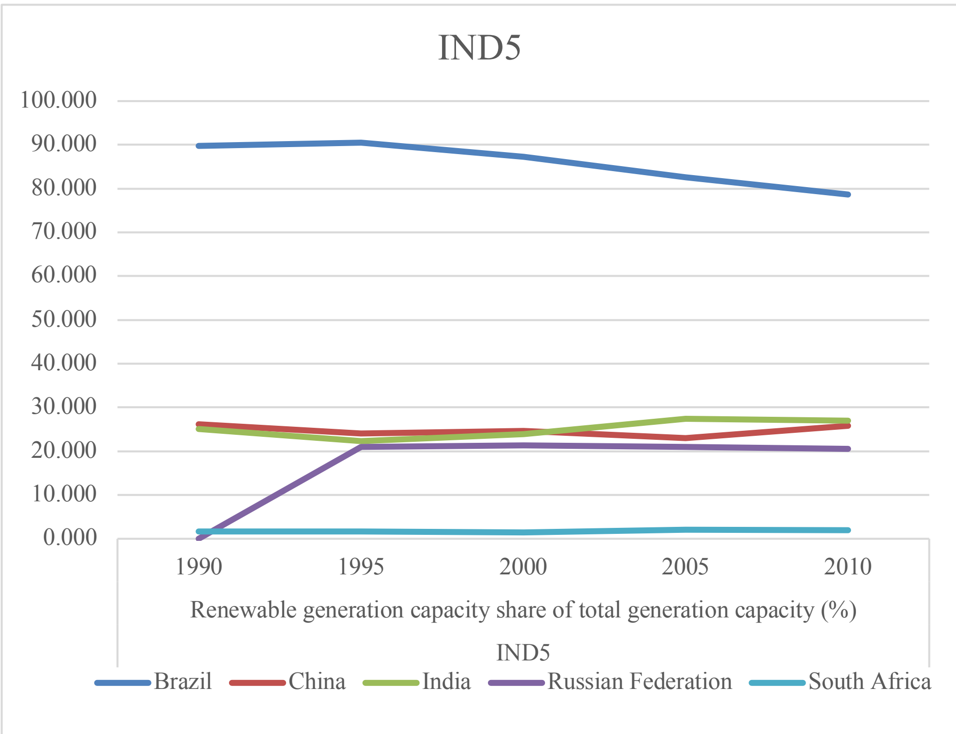

Figure 15 – Renewable Generation Capacity Share (IND5) for BRICs.

Source: Own elaboration.

5. FINAL REMARKS

This dissertation aimed to develop a framework based on indicators that served as an instrument to foster a more sustainable path for the Brazilian electricity industry. To reach this objective, the dissertation started with a literature review, passed on to data collection and analysis. Finally, the results brought lessons and points to be improved for Brazil and other countries.

The starting point to develop this was a framework based on a set of indicators whose aim was to identify a suitable combination of factors that could demonstrate the path towards a sustainable electric future.

Chapter 1 was the introductory part; whose main goal was to make the reader familiar with the topic in question by presenting an overview of energy and sustainable development and the objectives of the work. Next, in Chapter 2, the concepts related to sustainable energy, indicator-connected to sustainable development and climate change were introduced in a literature review. The chapter also covered the development and some examples of real indicator-based frameworks. The main issues and challenges concerning these topics were discussed and we had a brief conclusion on the literature review.

In Chapter 3, the indicator-based framework proposed was explained based on its choice and methodological basis, showing the set of indicators and the final data used to create a framework for a sustainable electric future for Brazil. The final list of indicators used in the framework were the following: a) *access to electricity* (IND1), b) *electric power transmission and distribution losses* (IND2), c) *carbon dioxide emissions from electricity and heat production* (IND3), d) *renewable electricity output* (IND4), and e) *renewable generation capacity share* (IND5).

Chapter 4 brought the results of the analysis and a list of cross-referencing analyses to show the behavior of Brazil and peer countries for each indicators and timeframe. Finally, in Chapter 5, we presented the final remarks of the dissertation. This chapter brought the main conclusions of the research, in which we shed light on the contributions of the dissertation to academia, its limitations, and possible political and economic implications for policy- and decision makers.

Frameworks like the one developed in this work are popular in the literature. They are used for different purposes by so many authors, and vary widely in their goals, as to assess inequality, human development, energy issues, poverty, and others. In our specific case, we used an approach to select and work with indicators related to electricity and issues concerning sustainability in the electricity industry.

The indicators proposed covered the three main domains of sustainability, namely economic, social, and environmental. The choice of indicators which compose the framework reflects the political, academic and market-based concerns involved in the achievement of a sustainable electric future.

This chapter is dedicated to the research's final remarks. Moreover, it is intended to shed light onto the possibilities and implications of the previous findings perceived as recommendations for Brazil, so that the country can work on public policies and planning towards a path for a sustainable future. In this sense, specific propositions are made to serve as the basis for creating and enhancing strategies and incentives for the electricity industry. Additionally, the chapter summarizes the main results and contributions, main constraints and limitations that were found throughout the research, and suggestions for future work in this field.

5.1. Results and Contributions

The choice of indicators individually or in group belonging to a framework can affect the position of the sample countries. Indicators should be able to suit current capabilities and priorities. The results shown here reflect each choice of indicator, timeframe and country involved. The following indicators: a) *access to electricity* (IND1), b) *electric power transmission and distribution losses* (IND2), c) *carbon dioxide emissions from electricity and heat production* (IND3), d) *renewable electricity output* (IND4), and e) *renewable generation capacity share* (IND5) were used to analyze 111 countries during a period of twenty years, 1990, 1995, 2000, 2005, and 2010.

According to the framework proposed, Brazil is better off than the majority of the countries regarding sustainability of its electricity industry. Results pointed out that Brazil ranked amongst the top performers in the five indicators that compose the framework (please see Table 18 and Figure 16). However, the country has shown decline in four out of the five indicators: *access to electricity* (IND1), *carbon dioxide emissions from electricity and heat production* (IND3), *renewable electricity output* (IND4), and *renewable generation capacity share* (IND5).

Table 18 – Brazil's Final Results per Indicator

	1990	1995	2000	2005	2010
IND1	87.5	91.7	94.5	97.1	99.2
IND2	85.8	83.3	82.3	83.4	83.4
IND3	84.8	86.2	82.9	81.4	81.3
IND4	94.5	94.2	89.5	87.1	84.7
IND5	89.7	90.5	87.2	82.6	78.7

Source: Own Elaboration.

The only improvement perceived was in *electric power transmission and distribution losses* (IND2) from 87.5% to 99.2 % of the total population between years 1990 and 2010. This is very clear when presented in a more visually interesting manner as shown on the figure below.

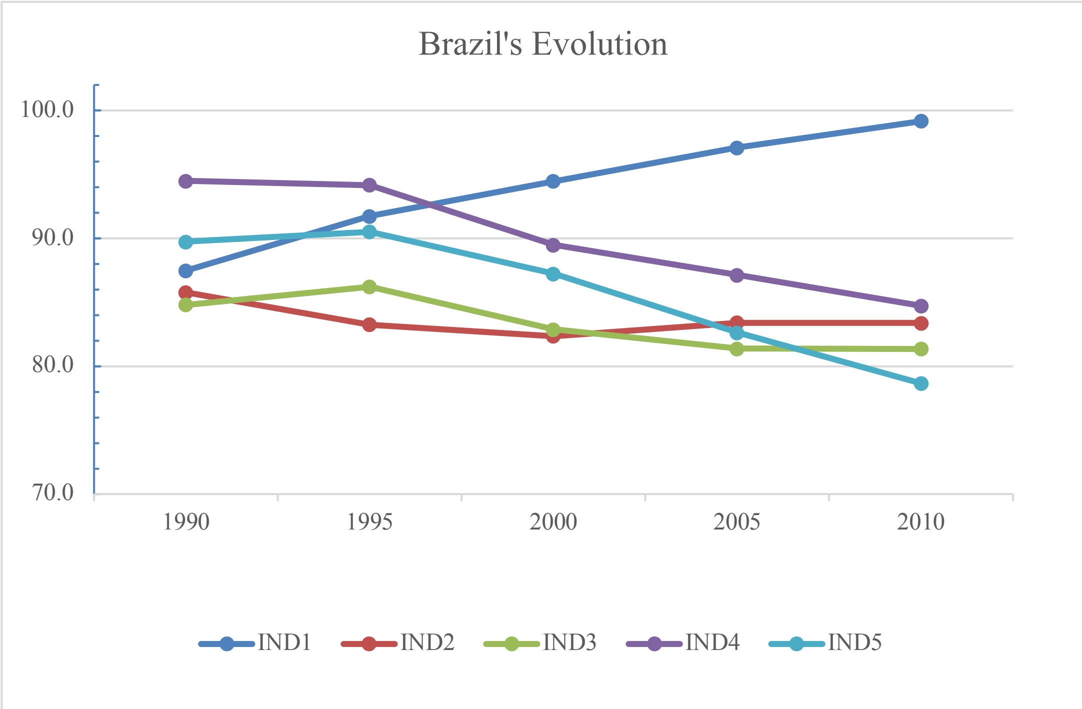

Figure 16 – Brazil's Evolution in the Indicators in All Years.

Source: Own Elaboration.

According to the realist theory of International Relations, States were the main actors in the international scenario for a long time. However, new actors, also known as non-state actors, started to play significant roles in society, some of which compete and even substitute part of the role of the governments. Companies, non-governmental organizations, civil society and international institutions are good and current examples. Institutions, such as the international organizations or bilateral agreements, can reinforce reciprocity, create incentives for maintaining governments' commitments, and allow a more predictable behavior.

Being part of an indicator-based framework can be compared to belonging to a group. These frameworks allow for comparison and for healthy competition, as it allows for win-win situations, for learning from each other and for working together in the pursuit of a common goal. The forces of cooperation and competition are not really opposing, they are in fact part of the same balance, according to Axelrod (1984).

According to Axelrod (1984), these forces act upon the same interaction. As confirmed by Watson (2002), most situations contain both elements of conflict and cooperation. Da Veiga (2013) has discussed the role of cooperation on multilateral environmental agreements. The author has noticed that we, humans, we assume ourselves as conditional collaborators at the same time that we act as altruistic punishers (DA VEIGA, 2013).

In the coming future, joint and cooperative efforts could help to collect more quality data and to find deeper and more meaningful interrelations between energy and these issues we have just addressed of environmental, social and economic dimensions. Additionally, more work could be done with inter-relational indicators between energy and issues such as water, education, gender, governance, transparency, poverty reduction and others. The Sustainable Development Goals (SDG) have brought a series of targets to be connected among the 17 goals. Based on them, on the literature review, and on the limitations of this work, we suggest the following list of indicators for governments and other actors, such as IOs, academia and private sector, to consider:

a) Impact of electricity outages on schooling, health services, emergency services, different sectors of the economy;
b) Level of energy efficiency of the electricity industry, categorized by type of business;
c) Initiatives to tackle GHG emissions in all electricity-related business areas, from generation, transmission to distribution, but also think of commercialization and internationalization;
d) Affordability of electricity by different segments of income, but mainly the poor;
e) Level of energy intensity from electricity consumption separated by industry: chemicals, manufacturing, food and beverage and so on;
f) Level of investment in social and environmental projects related to the investments in energy;
g) Water footprint of all energy sources, separated by type, region, and end use;
h) Risk level of climate change on electricity generation, transmission and distribution;
i) Impact of renewable and nonrenewable electricity sources on health of population, on biodiversity and forest land;
j) R&DD investments in electricity focused innovation;
k) Satisfaction level from customers, by sector and region, as a way to depict the quality of utilities services;
l) Impact from electric energy-related activities on women, children, elderly, and the very poor population, such as cooking and lighting due to the lack of reliable electricity supply;
m) Impact of corruption on electricity pricing;

n) Impact of corruption on non-technical losses;
o) Initiatives for energy security in making electricity sustained, reliable and affordable for public transportation, healthcare and educational facilities;
p) Waste level, treated and not treated, as a result of electricity generation;
q) Reliability of supply, by hours per day, by industry, and region.

These indicators (and any other that is suggested by the literature) should be measured as granularly as possible, in order to facilitate the identification and tackling of challenges, allowing directed action on specific sectors, entities, populations or goals.

The main limitations found by the work involved primarily two issues, namely data availability and quality, and precision in comparison. There is a great variety of indicators being created and collected in the private and public sectors. However, a great number of them were either incomplete or not really adopted by countries. So, data was scarce and not reliable.

As for precision in comparison, the indicators used were broad and considered universal. For that, they considered some assumptions as to make them viable for most countries and situations. Attention should be given to the generalization of some assumptions, because they can risk the quality of final results. Indicators that are truly universal are welcome as they serve as a great basis of comparability between different actors and along time.

Indicators are powerful tools, they provide us with information that can bring deep insights. They are powerful tools for communication, accountability, transparency, and management. In well designed combinations, they can even help create estimates and foster countries (and any other actor, such as companies, people and others) to learn and grow. Indicators can show a path to be invested, both technically and socially speaking. They can show issues that are most urgent or that need most attention, with more technical and human resources, and time wisely invested.

Making use of data with rigorous attention to quality and reliability is a way to combat information scarcity and a way to address management strategy taking into account sustainability in its core meaning, to be sustained and sustainable in the long run. As for securing a sustainable electricity strategy, many actors should be involved in the pursue of this task.

Suggestions for further research include running stakeholder engagement surveys, utilizing correlation analyses, such as Pearson and others, and including cross-analyses with works from other authors.

There is a sense of urgency in addressing global sustainable development and local populations' basic needs. National governments play decisive role in terms of implementing policies, and academia has its role in addressing urgent issues. Countries can and should learn from each other. Strongminded action and ongoing efforts will support Brazil and all of the others in this long journey.

In light of two of the most imminent challenges of today, climate change and energy security, a sustainable oriented strategy can help countries achieve a future wished for in their long term strategical planning and on the SDGs. With the increasing pressure of civil society on governments, using the scarce resources wisely and based on robust, transparent, reliable, and comparable data can contribute to a successful policy.

REFERENCES

ANEEL. **Indicadores Aneel**. Disponível em: <http://www.aneel.gov.br/indicadores>. Acesso em: 20 mar. 2017.

AXELROD, R. **The Evolution of Cooperation**. New York: Basic Books, 1984.

BANERJEE, S. G. et al. **Regulatory Indicators for Sustainable Energy - A Global Scorecard for Policy Makers**, 2016. (Nota técnica).

BARTELMUS, P. The future we want: Green growth or sustainable development? **Environmental Development**, v. 7, n. 1, p. 165–170, 2013.

BRAVO, G. The Human Sustainable Development Index: New calculations and a first critical analysis. **Ecological Indicators**, v. 37, n. PART A, p. 145–150, 2014.

DA SILVA, B. G. **Evolução do Setor Elétrico Brasileiro no contexto econômico nacional: uma análise histórica e econométrica de longo prazo**. [s.l.] University of Sao Paulo, 2011.

DA VEIGA, J. E. **A Desgovernança Mundial da Sustentabilidade**. 1a Edição ed. São Paulo: Editora 34, 2013.

DINCER, I.; ACAR, C. Smart energy systems for a sustainable future. **Applied Energy**, p. 1–11, 2016.

DITTMAR, M. Development towards sustainability: How to judge past and proposed policies? **Science of the Total Environment**, v. 472, p. 282–288, 2014.

ECONOMIC AND SOCIAL COUNCIL. **Report of the Inter-Agency and Expert Group on Sustainable Development Goal Indicators**. E/CN.3/2016/2. **Anais**...United Nations, 2015Disponível em: <https://unstats.un.org/unsd/statcom/47th-session/documents/2016-2-

IAEG-SDGs-E.pdf>

EIA. **International Energy Outlook 2016 - Executive Summary**. [s.l: s.n.]. Disponível em: <https://www.eia.gov/outlooks/archive/ieo16/pdf/exec_summ.pdf>.

ESMAP. **2005 Annual Report**. [s.l: s.n.]. Disponível em: <https://www.esmap.org/sites/default/files/esmap-files/AR_2005.pdf>.

ESMAP. **2013 Annual Report**. Washington, DC: [s.n.]. Disponível em: <http://www.woolworthslimited.com.au/phoenix.zhtml?c=144044&p=irol-reportsannual>.

EUROSTAT. **The indicator framework for monitoring the EU Sustainable Development Strategy**.

GLOBAL FOOTPRINT NETWORK. **Ecological Footprint**. Disponível em: <http://www.footprintnetwork.org/our-work/ecological-footprint/>. Acesso em: 12 fev. 2016.

GLOBAL FOOTPRINT NETWORK. **Webpage Glossary**. Disponível em: <http://www.footprintnetwork.org/resources/glossary/>. Acesso em: 7 set. 2017a.

GLOBAL FOOTPRINT NETWORK. **Ecological Footprint**. Disponível em: <http://www.footprintnetwork.org/our-work/ecological-footprint/>. Acesso em: 3 mar. 2017b.

GLOBAL REPORTING INITIATIVE. **Forward thinking Future focus**. [s.l: s.n.]. Disponível em: <https://www.globalreporting.org/resourcelibrary/GRI-CombinedReport-2013-2014-forward-thinking-future-focus.pdf>.

GLOBAL REPORTING INITIATIVE. **Leading for a New Era of Sustainability**. [s.l: s.n.]. Disponível em: <https://www.globalreporting.org/resourcelibrary/GRIs Combined Report 2014-2015.pdf>.

GLOBAL REPORTING INITIATIVE. **Global Reporting Initiative Webpage**. Disponível em: <https://www.globalreporting.org/>. Acesso em: 5 maio. 2017.

HELIO INTERNATIONAL. Sustainable Energy Watch indicators. 2017a.

HELIO INTERNATIONAL. Sustainable Energy Watch (SEW) Indicator Selection and Rationale. p. 1–10, 2017b.

IAEA. Energy Indicators for Sustainable Development : Guidelines and Methodologies. p. 1–171, 2005.

IEA. International Energy Agency. Energy and Development Methodology. n. October, p. 1–6, 2011.

IEA. Chapter 6 - Renewable Energy Outlook. In: **World Energy Outlook 2013**.

IEA. World Energy Outlook 2014 Factsheet. p. 1–5, 2015.

IEA. **IEA Database**. Disponível em: <http://www.iea.org/stats/index.asp>. 2017.

IPCC. **Climate Change 2013: The physical Science Base. Summary for PolicymakersClimate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change**. [s.l: s.n.]. Disponível em: <http://www.ipcc.ch/pdf/assessment-report/ar5/wg1/WGIAR5_SPM_brochure_en.pdf>.

IPCC. **Summary for Policymakers**. Climate Change 2014: Synthesis Report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. 2014.

KAHN RIBEIRO, S. et al. Energy systems in the context of sustainable development. **Current Opinion in Environmental Sustainability**, v. 5, n. 2, p. 136–140, 2013.

KEMMLER, A.; SPRENG, D. Energy indicators for tracking sustainability in developing countries. **Energy Policy**, v. 35, n. 4, p. 2466–2480, 2007.

LUCON, O.; GOLDEMBERG, J. Crise financeira, energia e sustentabilidade no Brasil. **Estudos Avançados**, v. 23, n. 65, p. 121–130, 2009.

LYNCH, A. J. et al. Sustainable Urban Development Indicators for the United States. p. 62, 2011.

MARGOLIN, V. The Good City: Design for Sustainability. **She Ji: The Journal of Design, Economics, and Innovation**, v. 1, n. 1, p. 34–43, 2015.

MARTENSEN, C. **The Crash Course: the unsustainable future of our economy, energy, and environment**. Hoboken, NJ: John Wiley and Sons Inc., 2011.

MCCRONE, A. et al. **Global Trends in Renewable Energy Investment 2015Global Trends Reports**. 2015.

MICHAEL, F. L.; NOOR, Z. Z.; FIGUEROA, M. J. Review of urban sustainability indicators assessment - Case study between Asian countries. **Habitat International**, v. 44, p. 491–500, 2014.

MILMAN, A.; SHORT, A. Incorporating resilience into sustainability indicators: An example for the urban water sector. **Global Environmental Change**, v. 18, n. 4, p. 758–767, 2008.

MINISTÉRIO DE MINAS E ENERGIA. **Anuário Estatístico de Energia Elétrica 2013**. [s.l: s.n.]. Disponível em: <http://www.epe.gov.br/AnuarioEstatisticodeEnergiaEletrica/20130909_1.pdf>.

MINISTÉRIO DE MINAS E ENERGIA. **Anuário Estatístico de Energia Elétrica 2016 - Workbook**. [s.l: s.n.]. Disponível em: <http://www.epe.gov.br/AnuarioEstatisticodeEnergiaEletrica/Forms/Anurio.aspx>.

MINISTÉRIO DE MINAS E ENERGIA. **Balanço Energético Nacional 2016**. [s.l: s.n.]. Disponível em: <https://ben.epe.gov.br/downloads/Relatorio_Final_BEN_2016.pdf>.

NARULA, K.; REDDY, B. S. Three blind men and an elephant : The case of energy indices to measure energy security and energy sustainability. **Energy**, v. 80, p. 148–158, 2015.

NEVES, A. R.; LEAL, V. Energy sustainability indicators for local energy planning: Review of current practices and derivation of a new framework. **Renewable and Sustainable Energy Reviews**, v. 14, n. 9, p. 2723–2735, 2010.

NUSSBAUMER, P. et al. Global Insights Based on the Multidimensional Energy Poverty Index (MEPI). **Sustainability**, n. May, p. 2060–2076, 2013.

NUSSBAUMER, P.; BAZILIAN, M.; MODI, V. Measuring energy poverty: Focusing on what matters. **Renewable and Sustainable Energy Reviews**, v. 16, n. 1, p. 231–243, 2012.

OECD. **OECD Environmental Indicators - Development, Measurement and Use**. [s.l: s.n.]. Disponível em: <https://www.oecd.org/env/indicators-modelling-outlooks/24993546.pdf>.

PEREIRA, A. O. et al. Perspectives for the expansion of new renewable energy sources in Brazil. **Renewable and Sustainable Energy Reviews**, v. 23, p. 49–59, 2013.

RENNER, M.; LUCKY, M. **Energy Poverty Remains a Global Challenge for the Future**. Disponível em: <http://vitalsigns.worldwatch.org/vs-trend/energy-poverty-remains-global-challenge-future>.

SCHAFFER, L. M.; BERNAUER, T. Explaining government choices for promoting renewable energy. **Energy Policy**, v. 68, p. 15–27, 2014.

SCHLÖR, H.; FISCHER, W.; HAKE, J. F. Methods of measuring sustainable development of the German energy sector. **Applied Energy**, v. 101, p. 172–181, 2013.

SERWAA MENSAH, G.; KEMAUSUOR, F.; BREW-HAMMOND, A. Energy access indicators and trends in Ghana. **Renewable and Sustainable Energy Reviews**, v. 30, n. 2014, p. 317–323, 2014.

SHARMA, T.; BALACHANDRA, P. Benchmarking sustainability of Indian electricity system: An indicator approach. **Applied Energy**, v. 142, p. 206–220, 2015.

SHEN, L. Y. et al. The application of urban sustainability indicators - A comparison between various practices. **Habitat International**, v. 35, n. 1, p. 17–29, 2011.

STAMFORD, L.; AZAPAGIC, A. Sustainability indicators for the assessment of nuclear power. **Energy**, v. 36, n. 10, p. 6037–6057, 2011.

SUSTAINABLE ENERGY FOR ALL. **SE4ALL - Global Tracking Framework 2013 - Executive Summary**. Disponível em: <http://www.se4all.org/sites/default/files/l/2013/09/2-gtf_exec_sum.pdf>.

SUSTAINABLE ENERGY FOR ALL. **SE4ALL - Global Tracking Framework 2013 - Data Annex**. 2013. Disponível em: <http://www.se4all.org/sites/default/files/l/2013/09/11-gtf_data_annex.pdf>.

TAINTER, J. A. Energy, complexity, and sustainability: A historical perspective. **Environmental Innovation and Societal Transitions**, v. 1, n. 1, p. 89–95, 2011.

TANIGUCHI, M.; KANEKO, S. Operational performance of the Bangladesh rural electrification program and its determinants with a focus on political interference. **Energy Policy**, v. 37, n. 6, p. 2433–2439, 2009.

TEMBO, B.; MERVEN, B. Policy options for the sustainable development of Zambia's electricity sector. **Journal of Energy in Southern Africa**, v. 24, n. 2, p. 16–27, 2013.

THE WORLD BANK. **World Development Indicators 2014**. [s.l: s.n.].

THE WORLD BANK. **The World Bank Database**. Disponível em: <http://data.worldbank.org/indicator>.

UN ENERGY. **Energy: A Brief Discussion on Goals, Targets and Indicators**. [s.l: s.n.]. Disponível em: <http://www.se4all.org/sites/default/files/l/2014/02/Background_Note_Energy_Goals_Targets_Indicators.pdf>.

UNDP. **Sustainable Energy for All: A vision statement by Ban Ki-Moon, UN Secretary-General**. New York: 2011.

UNDP. **Human Development Indicators**. Disponível em: <http://hdr.undp.org/en/content/human-development-index-hdi>. Acesso em: 5 jul. 2017.

UNITED NATIONS. **Affordable and Clean Energy - Why it matters**. Sustainable

Development Goals - 17 Goals to Transform Our World. **Anais**...2016Disponível em: <http://www.un.org/sustainabledevelopment/wp-content/uploads/2016/08/7_Why-it-Matters_Goal-7_CleanEnergy_2p.pdf>

VISVALDIS, V.; AINHOA, G.; RALFS, P. Selecting indicators for sustainable development of small towns: The case of valmiera municipality. **Procedia Computer Science**, v. 26, n. December, p. 21–32, 2013.

WORLD COMMISSION ON ENVIRONMENT AND DEVELOPMENT. **Our Common Future**. [s.l.] The United Nations, 1987. Disponível em: <http://www.un-documents.net/ocf-ov.htm#I>.

YALE UNIVERSITY; COLUMBIA UNIVERSITY. **The 2014 Environmental Performance Index. Full Report and Analysis**. [s.l: s.n.]. Disponível em: <http://archive.epi.yale.edu/files/2014_epi_report.pdf>.

YALE UNIVERSITY; COLUMBIA UNIVERSITY. **Global Metrics for the Environment - 2016 Report**.

YERGIN, D. Energy Security and Markets. In: DAVID L. GOLDWYN, J. H. K. (Ed.). . **Energy and Security: Toward a New Foreign Policy Strategy**. Baltimore, MD: Woodrow Wilson Center Press with Johns Hopkins University Press, 2005.

ANNEXES

A – Complete List of Final Indicators

Indicator	Description	Original Measure Unit	Data Source
IND1	Access to electricity	% of population	WDI
IND2	Electric power transmission and distribution losses	% of output	IEA
IND3	CO_2 emissions from electricity and heat production	% of total fuel combustion	WDI
IND4	Renewable electricity output	% of total electricity output	WB
IND5	Renewable generation capacity share of total generation capacity	% of total generation capacity	WB

B – Complete List of Results from Year 1990

	YEAR 1990				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Albania	100.000	48.817	87.125	86.408	88.161
Algeria	92.990	85.637	54.867	0.838	6.141
Angola	47.834	74.911	87.755	86.207	66.775
Argentina	90.759	81.687	65.486	35.441	32.760
Armenia	97.252	84.086	69.254	15.007	0.000
Australia	100.000	93.842	44.997	9.656	20.059
Austria	100.000	94.093	64.641	66.202	57.533
Azerbaijan	93.816	86.571	59.229	7.161	0.000
Bangladesh	7.576	66.425	61.033	11.433	9.127
Belarus	100.000	89.076	37.688	0.051	0.000
Belgium	100.000	94.873	70.202	0.790	2.107
Bolivia	54.754	78.667	70.680	52.445	44.803
Bosnia and Herzegovina	96.265	89.612	55.250	20.899	0.000
Brazil	87.475	85.773	84.803	94.501	89.744
Brunei Darussalam	100.000	95.478	22.086	0.000	0.000
Bulgaria	100.000	89.457	35.255	4.456	17.728
Cameroon	30.064	86.948	98.485	98.480	57.748
Canada	100.000	92.924	67.098	62.379	0.000
Chile	92.257	89.424	63.948	53.837	60.661
China	89.395	93.005	65.060	20.408	26.158
Colombia	89.900	78.807	73.154	76.384	74.689
Costa Rica	97.240	91.724	92.692	97.520	83.651
Cote d'Ivoire	36.659	81.644	77.778	66.667	76.300
Croatia	100.000	82.520	61.171	45.553	0.000
Cuba	92.066	85.510	62.317	10.250	1.229
Cyprus	100.000	94.377	54.756	0.000	0.000
Czech Republic	100.000	93.583	54.949	1.864	0.000
Denmark	100.000	90.501	47.911	3.175	4.520
Dominican Republic	79.112	75.473	55.811	10.114	15.646
Ecuador	88.814	77.461	87.988	78.548	54.518
Egypt, Arab Rep.	93.799	90.044	67.429	23.504	23.406
El Salvador	72.167	83.634	91.943	93.192	72.306
Estonia	100.000	93.324	25.438	0.000	0.000
Finland	100.000	94.922	63.099	29.452	27.262
France	100.000	93.360	81.572	13.370	17.365

	YEAR 1990				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Gabon	63.898	89.264	65.934	72.393	53.548
Georgia	99.004	83.001	48.895	55.210	0.000
Germany	100.000	95.703	56.173	3.486	5.789
Ghana	23.877	96.854	97.244	100.000	90.312
Gibraltar	100.000	93.671	57.143	0.000	0.000
Greece	100.000	91.758	46.867	5.093	25.188
Guatemala	60.159	85.041	92.523	91.629	65.646
Haiti	28.440	69.347	74.194	79.397	39.416
Honduras	55.107	93.014	97.706	98.275	72.603
Hong Kong SAR, China	100.000	88.576	26.577	0.000	0.000
Hungary	100.000	85.807	64.327	0.686	1.002
Iceland	100.000	91.242	100.000	99.867	84.958
India	45.063	80.692	56.253	24.489	25.140
Indonesia	60.343	90.256	64.351	20.917	25.428
Iran, Islamic Rep.	96.152	89.733	75.546	10.292	10.879
Iraq	95.334	95.000	68.200	10.833	8.933
Ireland	100.000	91.032	63.932	4.898	5.858
Israel	100.000	95.306	39.774	0.014	0.121
Italy	100.000	92.419	63.161	16.376	23.298
Jamaica	70.335	85.435	72.099	7.567	3.261
Japan	100.000	95.328	57.380	11.255	10.833
Jordan	96.800	91.534	61.613	0.330	0.670
Kazakhstan	97.655	90.636	51.429	8.430	0.000
Kenya	5.608	84.977	92.391	92.859	78.278
Korea, Dem. People's Rep.	4.370	90.653	86.159	56.318	52.632
Kuwait	100.000	93.251	25.396	0.000	0.000
Lebanon	97.194	93.333	49.183	33.333	21.885
Libya	100.000	68.797	37.050	0.000	0.000
Lithuania	100.000	94.536	57.591	1.457	0.000
Luxembourg	100.000	85.577	83.892	13.301	3.226
Malaysia	93.446	90.915	61.726	17.331	28.926
Malta	100.000	90.909	23.377	0.000	0.000
Mauritius	98.638	91.026	62.069	31.154	28.045
Mexico	94.035	87.058	63.320	24.693	30.361
Mongolia	63.820	90.352	48.445	0.000	0.000

	YEAR 1990				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Morocco	46.879	91.473	59.695	12.671	28.613
Myanmar	41.323	73.567	59.335	48.144	23.519
Netherlands	100.000	95.653	59.144	1.120	1.760
New Zealand	100.000	92.596	79.209	80.006	69.383
Nicaragua	66.922	83.185	69.022	61.359	41.315
Nigeria	27.300	61.584	70.599	32.586	40.584
Norway	100.000	94.338	73.379	99.792	95.393
Pakistan	58.741	79.274	71.390	44.926	37.447
Panama	70.190	73.995	78.516	85.269	57.576
Paraguay	79.013	99.695	98.446	99.974	99.342
Peru	60.290	86.363	79.206	76.803	58.632
Philippines	61.985	84.882	72.003	45.425	44.341
Poland	100.000	92.144	33.602	1.095	2.760
Portugal	100.000	88.849	56.468	34.745	40.251
Qatar	100.000	94.811	37.812	0.000	0.000
Romania	100.000	90.780	52.807	17.744	25.207
Russian Federation	100.000	92.214	43.076	15.338	NA
Senegal	19.548	82.540	59.155	4.656	0.000
Singapore	100.000	96.627	20.097	0.541	0.139
South Africa	56.506	93.969	40.189	0.611	1.625
Spain	100.000	90.717	61.515	17.216	26.411
Sri Lanka	52.597	83.302	95.913	99.841	78.898
Sudan	32.800	84.620	90.359	63.234	51.754
Sweden	100.000	93.692	81.233	51.000	50.139
Switzerland	100.000	92.595	93.940	54.983	68.621
Syrian Arab Republic	77.069	73.835	70.794	23.495	25.388
Tanzania	5.327	80.037	82.635	95.147	65.020
Thailand	65.157	89.438	61.973	11.264	26.269
Trinidad and Tobago	82.417	91.641	40.380	0.867	0.433
Tunisia	88.009	89.658	67.186	0.792	4.641
Turkey	88.147	88.390	69.260	40.366	41.561
Turkmenistan	98.154	91.513	70.715	4.791	0.000
United Arab Emirates	100.000	91.001	73.684	0.000	0.000
United Kingdom	100.000	92.123	55.027	1.829	1.682
United States	100.000	90.737	55.029	11.529	11.887

YEAR 1990

COUNTRY	IND1	IND2	IND3	IND4	IND5
Uruguay	95.740	86.083	85.556	94.949	71.148
Venezuela, RB	97.486	82.000	61.041	62.344	54.773
Vietnam	73.858	74.600	71.922	61.848	31.323
Yemen, Rep.	35.171	88.455	74.603	0.000	0.000
Zambia	13.900	96.768	93.750	99.226	98.235
Zimbabwe	29.889	92.886	56.985	46.667	31.060

C – Complete List of Results from Year 1995

	YEAR 1995				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Albania	100.000	48.960	78.378	93.986	86.579
Algeria	94.977	83.059	53.254	0.979	4.578
Angola	44.942	71.563	90.026	93.750	58.192
Argentina	93.058	82.298	70.850	40.213	36.391
Armenia	98.217	60.529	58.754	34.508	36.561
Australia	100.000	93.858	44.587	9.624	19.025
Austria	100.000	93.969	65.279	70.506	57.838
Azerbaijan	96.051	85.667	52.318	9.129	14.946
Bangladesh	19.653	83.380	59.223	3.443	7.004
Belarus	100.000	85.408	35.564	0.080	0.097
Belgium	100.000	95.004	70.286	0.909	2.682
Bolivia	62.472	88.440	68.940	43.326	38.868
Bosnia and Herzegovina	97.587	80.845	75.915	82.777	50.644
Brazil	91.729	83.256	86.211	94.157	90.506
Brunei Darussalam	100.000	96.490	22.889	0.000	0.000
Bulgaria	100.000	85.092	32.783	5.537	11.591
Cameroon	36.079	78.169	98.780	98.851	56.837
Canada	100.000	92.918	67.183	61.004	0.000
Chile	95.522	89.556	72.801	72.405	57.322
China	92.227	92.613	58.933	19.214	24.026
Colombia	91.200	77.617	74.472	76.405	62.305
Costa Rica	98.029	92.481	80.631	82.749	76.384
Cote d'Ivoire	42.270	83.814	68.712	60.536	76.300
Croatia	100.000	82.104	58.863	61.363	49.023
Cuba	94.648	80.344	50.936	6.132	1.229
Cyprus	100.000	95.394	57.228	0.000	0.000
Czech Republic	100.000	92.129	44.095	3.974	6.578
Denmark	100.000	93.629	44.210	5.036	8.436
Dominican Republic	83.806	71.627	55.526	11.777	23.551
Ecuador	89.830	75.039	76.393	61.229	58.980
Egypt, Arab Rep.	95.500	89.346	66.491	21.948	20.921
El Salvador	76.996	87.009	70.241	57.825	54.435
Estonia	100.000	78.891	24.436	0.092	0.037
Finland	100.000	95.287	55.422	30.522	27.227
France	100.000	93.862	83.725	15.361	16.859

COUNTRY	YEAR 1995 IND1	IND2	IND3	IND4	IND5
Gabon	69.506	73.486	74.809	70.237	45.652
Georgia	99.505	76.674	33.948	63.809	59.982
Germany	100.000	95.257	55.689	4.867	5.863
Ghana	34.472	96.664	97.196	99.689	90.312
Gibraltar	100.000	97.222	71.429	0.000	0.000
Greece	100.000	92.315	44.858	8.630	25.554
Guatemala	60.800	86.224	81.229	66.440	60.766
Haiti	31.300	47.273	82.222	51.111	42.759
Honduras	66.122	74.707	74.790	61.327	71.311
Hong Kong SAR, China	100.000	85.231	33.297	0.000	0.000
Hungary	100.000	86.040	56.114	0.644	1.053
Iceland	100.000	93.415	99.490	99.819	86.494
India	52.444	81.267	48.382	17.261	22.314
Indonesia	66.860	87.706	63.635	16.463	22.626
Iran, Islamic Rep.	97.113	85.796	74.812	8.576	7.350
Iraq	96.330	96.181	43.557	1.916	13.169
Ireland	100.000	91.405	59.761	4.141	5.739
Israel	100.000	96.460	39.091	0.082	0.072
Italy	100.000	92.605	62.594	17.466	20.718
Jamaica	80.128	89.158	37.693	5.164	2.024
Japan	100.000	95.445	57.352	9.416	9.762
Jordan	98.140	90.598	57.259	0.338	0.621
Kazakhstan	99.900	84.784	53.026	12.498	11.718
Kenya	10.794	81.667	91.449	89.831	80.222
Korea, Dem. People's Rep.	10.479	86.113	85.102	61.739	52.632
Kuwait	100.000	88.998	36.024	0.000	0.000
Lebanon	98.281	84.170	71.697	13.577	21.885
Libya	99.947	76.759	43.109	0.000	0.000
Lithuania	100.000	85.148	52.271	2.759	1.936
Luxembourg	100.000	72.074	88.929	21.971	3.197
Malaysia	95.197	90.388	56.365	13.686	16.604
Malta	100.000	90.686	33.613	0.000	0.000
Mauritius	99.023	90.995	59.355	26.844	24.505
Mexico	95.640	86.000	58.158	23.650	28.790
Mongolia	68.626	80.898	35.610	0.000	0.000

YEAR 1995

COUNTRY	IND1	IND2	IND3	IND4	IND5
Morocco	56.500	94.269	55.159	5.053	24.536
Myanmar	43.735	61.899	62.946	40.049	23.979
Netherlands	100.000	94.888	59.818	1.731	3.276
New Zealand	100.000	92.765	81.864	83.853	71.432
Nicaragua	69.993	72.992	62.151	45.445	38.512
Nigeria	37.178	62.282	66.860	34.685	39.806
Norway	100.000	92.139	66.083	99.662	97.136
Pakistan	67.098	77.188	66.397	40.743	39.884
Panama	76.742	78.687	69.193	69.139	57.576
Paraguay	77.469	98.423	96.848	99.718	99.378
Peru	67.148	81.355	80.773	80.296	54.887
Philippines	67.914	82.914	69.182	36.844	35.283
Poland	100.000	86.814	44.243	1.427	2.315
Portugal	100.000	89.956	53.643	28.322	43.679
Qatar	100.000	92.269	34.403	0.000	0.000
Romania	100.000	88.631	40.733	28.166	26.984
Russian Federation	100.000	90.283	38.121	20.427	20.952
Senegal	28.310	83.922	58.468	4.064	0.000
Singapore	100.000	96.165	17.940	1.101	0.107
South Africa	63.660	93.779	34.753	0.285	1.615
Spain	100.000	90.363	60.876	14.720	26.120
Sri Lanka	61.121	81.966	93.394	92.711	74.168
Sudan	32.975	73.015	79.350	52.146	57.562
Sweden	100.000	93.207	79.445	47.579	50.766
Switzerland	100.000	92.800	93.176	57.430	68.218
Syrian Arab Republic	81.255	71.847	63.078	15.102	20.785
Tanzania	7.722	87.214	75.904	79.990	63.790
Thailand	73.940	91.877	62.208	8.742	17.489
Trinidad and Tobago	87.032	90.365	36.887	0.766	0.433
Tunisia	88.700	90.103	66.287	0.509	3.797
Turkey	91.393	84.035	65.993	41.566	47.220
Turkmenistan	98.928	87.694	64.481	0.041	0.101
United Arab Emirates	100.000	90.901	70.994	0.000	0.000
United Kingdom	100.000	91.924	57.949	2.067	2.498
United States	100.000	93.009	52.234	10.801	12.270

YEAR 1995

COUNTRY	IND1	IND2	IND3	IND4	IND5
Uruguay	96.855	81.402	87.244	93.547	71.008
Venezuela, RB	98.099	79.177	63.081	70.051	55.978
Vietnam	80.107	78.297	83.643	72.242	65.011
Yemen, Rep.	43.128	78.819	71.686	0.000	0.000
Zambia	16.606	97.173	94.000	99.331	99.110
Zimbabwe	31.601	90.552	50.630	29.254	29.469

D – Complete List of Results from Year 2000

	YEAR 2000				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Albania	100.000	72.750	87.662	96.149	85.808
Algeria	96.702	83.846	52.561	0.212	4.283
Angola	41.789	85.398	79.914	63.114	49.488
Argentina	95.096	85.167	67.700	33.159	33.295
Armenia	98.900	74.622	53.216	21.165	34.870
Australia	100.000	92.862	41.147	8.382	17.735
Austria	100.000	94.660	68.321	72.544	60.056
Azerbaijan	98.016	85.186	40.256	8.204	19.272
Bangladesh	32.000	84.674	56.972	4.749	6.402
Belarus	100.000	86.935	34.178	0.103	0.102
Belgium	100.000	95.422	72.620	1.261	2.678
Bolivia	69.963	89.820	73.944	51.521	28.909
Bosnia and Herzegovina	98.637	83.229	34.913	48.845	50.330
Brazil	94.457	82.342	82.885	89.493	87.224
Brunei Darussalam	100.000	98.860	22.851	0.000	0.000
Bulgaria	100.000	84.525	37.118	6.576	16.083
Cameroon	41.000	78.132	98.566	98.908	61.697
Canada	100.000	92.194	63.380	60.600	0.000
Chile	97.939	92.707	65.954	48.548	44.997
China	94.797	93.091	48.962	16.639	24.685
Colombia	95.200	77.614	74.617	75.525	63.515
Costa Rica	98.555	93.164	98.667	99.147	82.794
Cote d'Ivoire	47.617	85.438	62.559	36.750	62.398
Croatia	100.000	81.692	63.170	57.303	52.392
Cuba	97.000	84.227	60.022	6.872	1.280
Cyprus	100.000	94.421	53.175	0.000	0.000
Czech Republic	100.000	93.203	42.537	3.133	6.219
Denmark	100.000	94.164	47.921	15.455	21.854
Dominican Republic	88.765	87.485	47.593	9.722	13.283
Ecuador	93.336	75.867	77.827	71.702	51.526
Egypt, Arab Rep.	97.700	86.243	65.470	17.703	16.467
El Salvador	84.519	86.615	77.563	58.069	52.431
Estonia	100.000	85.422	21.778	0.211	0.043
Finland	100.000	96.239	52.576	33.410	27.200
France	100.000	94.318	80.955	12.968	16.331

	YEAR 2000				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Gabon	73.600	82.205	69.178	61.597	41.687
Georgia	99.751	83.176	63.715	78.933	61.139
Germany	100.000	94.043	55.165	6.199	10.543
Ghana	44.806	80.521	88.554	91.499	92.096
Gibraltar	100.000	96.800	70.588	0.000	0.000
Greece	100.000	92.002	45.681	7.757	24.165
Guatemala	73.318	75.298	71.678	51.720	33.566
Haiti	33.700	55.393	86.232	51.737	25.828
Honduras	67.509	80.367	76.837	61.911	47.667
Hong Kong SAR, China	100.000	87.067	43.803	0.000	0.000
Hungary	100.000	86.246	55.320	0.691	0.954
Iceland	100.000	95.888	99.537	99.935	89.371
India	59.562	72.779	44.786	13.591	23.886
Indonesia	86.300	88.486	65.013	15.956	22.051
Iran, Islamic Rep.	97.900	84.176	70.842	3.038	8.120
Iraq	97.063	91.411	64.628	1.915	17.137
Ireland	100.000	91.467	61.597	5.006	7.776
Israel	100.000	96.629	34.306	0.073	0.127
Italy	100.000	92.886	63.636	18.848	19.968
Jamaica	84.679	91.477	43.718	4.844	1.716
Japan	100.000	95.685	55.571	9.116	9.324
Jordan	98.723	89.031	58.974	0.569	0.686
Kazakhstan	98.960	86.036	36.259	14.673	11.229
Kenya	15.718	78.357	71.778	46.980	68.622
Korea, Dem. People's Rep.	16.326	84.196	83.448	52.577	52.632
Kuwait	100.000	88.999	30.179	0.000	0.000
Lebanon	99.114	85.643	48.606	4.654	11.887
Libya	99.800	76.820	45.539	0.000	0.000
Lithuania	100.000	88.481	50.489	3.057	2.008
Luxembourg	100.000	90.284	97.146	40.995	5.053
Malaysia	96.687	92.001	54.195	10.058	14.925
Malta	100.000	87.741	25.352	0.000	0.000
Mauritius	99.000	91.001	52.263	29.640	26.316
Mexico	98.007	86.151	53.192	19.804	26.747
Mongolia	67.300	80.448	26.615	0.000	0.000

	YEAR 2000				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Morocco	66.591	91.596	61.950	6.079	26.322
Myanmar	45.886	68.699	70.151	36.968	29.540
Netherlands	100.000	94.514	58.592	3.316	4.858
New Zealand	100.000	92.241	72.730	71.501	67.648
Nicaragua	72.803	69.545	58.192	21.395	29.710
Nigeria	42.651	61.852	68.670	38.216	32.914
Norway	100.000	91.803	68.842	99.715	94.845
Pakistan	75.193	75.733	64.110	25.242	28.187
Panama	81.401	76.141	73.770	70.432	49.123
Paraguay	88.667	97.330	100.000	100.000	99.482
Peru	72.496	88.516	81.887	81.988	47.150
Philippines	73.582	85.990	62.546	42.890	31.929
Poland	100.000	90.058	40.513	1.629	2.726
Portugal	100.000	91.587	58.420	29.669	39.554
Qatar	100.000	93.070	34.918	0.000	0.000
Romania	100.000	87.236	42.614	28.455	27.134
Russian Federation	100.000	88.403	36.894	18.730	21.338
Senegal	36.811	62.656	57.386	3.304	0.353
Singapore	100.000	96.362	21.629	0.774	0.302
South Africa	70.551	91.795	31.575	0.677	1.450
Spain	100.000	91.279	60.213	15.614	28.158
Sri Lanka	69.383	79.041	68.441	45.802	54.705
Sudan	34.597	84.469	73.175	46.049	44.893
Sweden	100.000	92.553	81.278	57.247	54.264
Switzerland	100.000	93.822	92.251	57.000	68.962
Syrian Arab Republic	85.180	69.302	56.012	12.813	16.088
Tanzania	9.854	77.872	87.356	86.367	64.965
Thailand	82.100	92.092	57.791	6.811	12.169
Trinidad and Tobago	91.290	92.691	41.485	0.366	0.352
Tunisia	94.800	89.458	64.152	0.821	3.091
Turkey	94.376	80.983	62.771	24.939	41.472
Turkmenistan	99.600	85.749	61.484	0.000	0.032
United Arab Emirates	100.000	96.618	61.167	0.000	0.000
United Kingdom	100.000	91.681	56.717	2.663	2.915
United States	100.000	94.309	51.889	8.206	11.760

	YEAR 2000				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Uruguay	97.709	81.471	86.051	93.384	70.432
Venezuela, RB	98.450	75.736	58.478	73.748	62.238
Vietnam	86.093	86.232	74.016	54.783	52.680
Yemen, Rep.	50.822	72.386	67.316	0.000	0.000
Zambia	16.700	96.820	95.152	99.384	99.110
Zimbabwe	33.051	79.671	59.669	45.661	38.372

E – Complete List of Results from Year 2005

COUNTRY	YEAR 2005				
	IND1	IND2	IND3	IND4	IND5
Albania	100.000	88.462	92.147	98.714	89.950
Algeria	98.184	86.805	57.921	1.636	3.735
Angola	38.386	76.238	84.065	79.648	59.957
Argentina	96.884	84.875	68.213	33.525	31.725
Armenia	99.800	84.154	76.998	28.067	32.321
Australia	100.000	93.277	37.898	8.804	18.583
Austria	100.000	94.640	65.755	63.389	62.384
Azerbaijan	99.673	82.376	43.226	13.156	19.666
Bangladesh	44.230	92.566	53.772	2.832	4.952
Belarus	100.000	88.263	34.466	0.120	0.212
Belgium	100.000	95.151	72.008	2.457	5.436
Bolivia	68.288	89.869	72.988	41.258	33.914
Bosnia and Herzegovina	99.462	82.328	33.228	47.596	55.349
Brazil	97.094	83.406	81.375	87.125	82.619
Brunei Darussalam	100.000	94.669	23.029	0.000	0.000
Bulgaria	100.000	88.895	37.871	9.874	16.006
Cameroon	47.337	82.567	94.539	94.206	60.417
Canada	100.000	91.702	62.271	59.433	3.509
Chile	98.377	91.350	61.742	53.883	41.808
China	97.118	93.175	49.775	16.175	22.999
Colombia	96.800	80.493	75.789	80.170	67.265
Costa Rica	99.053	89.165	94.669	96.719	79.017
Cote d'Ivoire	58.900	80.074	46.127	27.231	51.487
Croatia	100.000	83.679	64.289	54.071	46.887
Cuba	99.039	84.787	47.784	3.181	1.135
Cyprus	100.000	96.253	50.496	0.023	0.089
Czech Republic	100.000	93.864	42.850	3.823	6.834
Denmark	100.000	95.787	51.280	27.071	31.446
Dominican Republic	90.141	88.518	51.848	19.418	8.693
Ecuador	95.833	73.199	75.627	55.116	49.594
Egypt, Arab Rep.	99.400	88.404	56.030	12.141	14.334
El Salvador	87.526	88.907	75.680	58.242	50.727
Estonia	100.000	89.192	23.424	1.088	1.876
Finland	100.000	95.692	51.460	33.249	29.396
France	100.000	94.357	80.163	9.861	17.232

COUNTRY	YEAR 2005 IND1	IND2	IND3	IND4	IND5
Gabon	81.600	80.940	63.584	52.097	40.964
Georgia	99.766	84.395	68.966	85.813	61.706
Germany	100.000	95.237	52.238	10.150	22.062
Ghana	54.890	75.427	81.406	82.926	68.535
Gibraltar	100.000	97.241	73.171	0.000	0.000
Greece	100.000	90.580	46.770	10.780	22.148
Guatemala	78.351	82.085	69.209	47.484	35.679
Haiti	34.430	61.691	91.414	47.662	25.820
Honduras	68.903	75.352	67.737	32.947	33.955
Hong Kong SAR, China	100.000	87.246	28.478	0.000	0.000
Hungary	100.000	88.978	64.163	5.230	5.066
Iceland	100.000	95.614	99.552	99.942	90.826
India	66.432	74.834	44.440	16.619	27.412
Indonesia	87.127	88.836	61.048	13.606	19.281
Iran, Islamic Rep.	98.261	81.842	68.773	9.080	11.454
Iraq	97.547	70.000	62.379	19.737	24.302
Ireland	100.000	92.004	64.783	7.309	12.159
Israel	100.000	97.142	31.247	0.080	0.123
Italy	100.000	93.051	61.057	16.318	20.373
Jamaica	88.982	88.494	58.268	3.692	4.162
Japan	100.000	95.733	53.090	8.407	9.670
Jordan	99.072	86.627	60.961	0.673	0.885
Kazakhstan	99.251	89.762	36.803	11.579	11.834
Kenya	20.393	81.016	77.139	71.662	59.431
Korea, Dem. People's Rep.	21.924	84.196	83.751	57.315	52.632
Kuwait	100.000	88.643	31.063	0.000	0.000
Lebanon	99.711	87.137	49.170	8.478	12.069
Libya	99.089	87.465	43.322	0.000	0.000
Lithuania	100.000	91.474	53.545	3.191	2.710
Luxembourg	100.000	96.535	88.240	6.302	6.298
Malaysia	97.927	92.000	51.621	6.280	8.962
Malta	100.000	88.571	13.971	0.000	0.000
Mauritius	99.021	91.021	46.959	25.000	25.876
Mexico	98.933	85.076	53.754	15.180	23.015
Mongolia	86.200	87.716	30.273	0.000	0.025

	YEAR 2005				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Morocco	76.067	93.634	56.673	6.143	28.322
Myanmar	47.787	60.904	70.766	49.817	44.142
Netherlands	100.000	94.591	57.422	7.451	12.196
New Zealand	100.000	93.069	65.015	64.236	68.109
Nicaragua	73.822	72.960	61.042	34.612	35.051
Nigeria	47.876	76.295	70.035	33.001	32.859
Norway	100.000	92.714	65.990	99.472	94.697
Pakistan	83.850	75.963	67.957	32.962	33.414
Panama	84.482	84.040	76.071	64.304	55.873
Paraguay	94.687	95.372	100.000	100.000	99.918
Peru	77.174	90.662	74.109	72.270	51.412
Philippines	79.000	87.949	57.009	32.365	33.459
Poland	100.000	90.626	41.482	2.476	3.392
Portugal	100.000	90.881	54.424	17.883	44.351
Qatar	100.000	92.922	37.440	0.000	0.000
Romania	100.000	89.767	47.518	34.021	31.940
Russian Federation	100.000	88.163	36.031	18.203	20.917
Senegal	47.100	69.851	58.009	12.657	0.393
Singapore	100.000	96.875	29.847	1.251	0.198
South Africa	80.900	91.506	32.574	0.665	2.067
Spain	100.000	91.031	60.906	14.601	30.749
Sri Lanka	77.396	83.870	65.347	37.227	53.773
Sudan	35.969	79.509	72.110	32.959	39.476
Sweden	100.000	92.606	77.246	51.294	59.233
Switzerland	100.000	92.679	90.911	55.858	69.121
Syrian Arab Republic	88.855	80.630	56.501	12.380	19.881
Tanzania	11.738	84.698	73.069	50.014	63.003
Thailand	90.733	91.895	57.717	5.545	12.011
Trinidad and Tobago	95.491	94.489	33.181	0.312	0.337
Tunisia	99.300	86.518	68.362	1.477	2.573
Turkey	97.110	85.154	62.445	24.542	33.597
Turkmenistan	99.733	86.154	61.323	0.000	0.032
United Arab Emirates	100.000	92.825	52.003	0.000	0.000
United Kingdom	100.000	92.944	54.226	4.283	5.681
United States	100.000	93.695	51.058	8.578	10.187

	YEAR 2005				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Uruguay	98.313	76.673	77.476	87.503	75.134
Venezuela, RB	98.552	72.953	62.816	73.283	65.945
Vietnam	96.100	88.337	69.301	31.674	33.905
Yemen, Rep.	58.267	77.454	71.269	0.000	0.000
Zambia	20.421	94.628	95.283	99.407	99.529
Zimbabwe	34.253	83.145	41.188	52.432	33.915

F – Complete List of Results from Year 2010

COUNTRY	YEAR 2010 IND1	IND2	IND3	IND4	IND5
Albania	100.000	87.341	97.455	99.987	90.130
Algeria	99.711	80.122	62.076	0.380	2.489
Angola	35.132	88.493	82.816	67.957	43.117
Argentina	98.820	86.575	64.115	28.585	27.752
Armenia	99.800	88.754	84.444	39.485	33.547
Australia	100.000	93.523	37.077	8.612	18.744
Austria	100.000	95.067	64.672	66.212	72.866
Azerbaijan	100.000	79.530	57.501	18.423	15.498
Bangladesh	55.260	89.458	51.354	1.787	3.951
Belarus	100.000	89.185	37.872	0.373	0.260
Belgium	100.000	95.436	72.492	6.921	16.925
Bolivia	84.492	88.446	72.774	33.953	30.099
Bosnia and Herzegovina	99.997	90.645	32.260	46.870	49.187
Brazil	99.160	83.374	81.346	84.724	78.656
Brunei Darussalam	100.000	90.295	24.781	0.000	0.000
Bulgaria	100.000	90.264	29.955	12.578	26.666
Cameroon	52.990	90.168	67.525	73.216	58.942
Canada	100.000	91.325	60.129	61.441	3.118
Chile	99.739	91.781	59.965	40.203	37.986
China	99.700	93.881	48.432	18.622	25.854
Colombia	96.789	84.624	71.234	72.121	67.079
Costa Rica	98.996	89.878	90.772	93.311	67.647
Cote d'Ivoire	57.964	79.816	53.140	28.282	49.427
Croatia	100.000	86.334	66.941	62.841	46.999
Cuba	99.998	84.089	50.275	3.242	1.268
Cyprus	100.000	95.866	47.796	1.372	5.828
Czech Republic	100.000	94.766	39.393	6.918	10.364
Denmark	100.000	93.248	48.518	31.982	36.959
Dominican Republic	98.145	88.190	51.017	12.476	9.352
Ecuador	97.462	83.136	69.766	45.492	44.721
Egypt, Arab Rep.	99.841	89.838	55.873	10.048	12.448
El Salvador	91.580	87.149	76.460	65.040	47.365
Estonia	100.000	91.924	19.249	8.053	6.582
Finland	100.000	96.573	43.217	29.991	31.503
France	100.000	93.724	79.684	13.857	21.526

COUNTRY	YEAR 2010 IND1	IND2	IND3	IND4	IND5
Gabon	85.193	80.487	69.925	47.412	40.964
Georgia	99.907	89.105	79.960	92.523	62.803
Germany	100.000	96.174	52.319	16.727	36.257
Ghana	65.123	76.778	70.335	68.811	59.446
Gibraltar	100.000	97.175	72.340	0.000	0.000
Greece	100.000	93.406	45.696	18.342	26.679
Guatemala	84.311	86.652	74.709	63.848	43.461
Haiti	36.322	41.567	86.603	30.153	20.690
Honduras	80.985	75.697	69.210	47.809	36.288
Hong Kong SAR, China	100.000	87.321	32.913	0.242	0.006
Hungary	100.000	89.829	62.750	8.081	9.818
Iceland	100.000	95.902	100.000	99.988	95.308
India	76.300	80.137	48.497	16.044	27.048
Indonesia	94.150	90.602	59.671	15.854	17.832
Iran, Islamic Rep.	98.859	85.808	67.134	4.163	13.832
Iraq	98.180	64.100	44.508	9.747	24.857
Ireland	100.000	92.553	65.700	13.081	20.246
Israel	100.000	97.242	35.628	0.290	1.872
Italy	100.000	93.115	60.935	25.760	24.659
Jamaica	93.432	79.120	58.874	7.685	5.167
Japan	100.000	95.862	50.291	10.538	10.561
Jordan	99.553	86.540	51.589	0.494	0.554
Kazakhstan	99.674	91.974	44.077	9.706	11.837
Kenya	19.200	84.041	79.661	69.070	58.079
Korea, Dem. People's Rep.	27.671	84.190	84.150	61.854	52.633
Kuwait	100.000	87.913	30.518	0.000	0.000
Lebanon	100.000	88.105	38.187	5.340	12.100
Libya	98.675	64.245	49.490	0.000	0.000
Lithuania	100.000	80.196	55.537	18.242	8.224
Luxembourg	100.000	96.223	87.981	8.266	7.835
Malaysia	99.316	93.831	43.902	5.993	8.300
Malta	100.000	93.472	27.626	0.047	0.279
Mauritius	99.043	92.785	39.617	24.321	24.348
Mexico	99.237	83.940	55.949	16.603	21.607
Mongolia	81.908	88.291	36.961	0.000	0.144

	YEAR 2010				
COUNTRY	IND1	IND2	IND3	IND4	IND5
Morocco	85.691	88.687	61.328	17.434	23.717
Myanmar	48.800	83.389	65.570	67.679	46.702
Netherlands	100.000	95.277	58.273	9.388	14.454
New Zealand	100.000	93.090	72.026	73.164	68.272
Nicaragua	78.073	81.525	58.178	37.005	31.632
Nigeria	48.000	82.784	65.896	24.402	32.884
Norway	100.000	92.299	63.225	95.733	93.601
Pakistan	91.034	83.774	68.240	33.704	29.629
Panama	86.850	85.670	69.118	57.104	47.368
Paraguay	97.431	93.769	100.000	99.998	99.932
Peru	88.123	89.875	65.004	57.721	39.926
Philippines	84.568	88.486	54.831	26.298	33.088
Poland	100.000	92.456	45.071	6.931	6.548
Portugal	100.000	92.028	63.281	52.808	45.536
Qatar	100.000	93.722	36.480	0.000	0.000
Romania	100.000	88.357	48.154	33.488	30.873
Russian Federation	100.000	89.872	37.476	16.121	20.501
Senegal	53.461	83.615	61.355	10.728	0.313
Singapore	100.000	97.145	39.883	1.305	0.195
South Africa	82.900	90.466	29.616	0.948	1.982
Spain	100.000	90.815	66.349	32.776	38.778
Sri Lanka	85.300	86.233	72.500	53.115	51.955
Sudan	37.490	80.691	88.978	82.704	69.290
Sweden	100.000	92.870	71.981	55.302	62.080
Switzerland	100.000	93.381	91.323	56.730	68.865
Syrian Arab Republic	92.700	84.696	47.721	5.585	10.821
Tanzania	14.800	80.167	76.020	51.688	66.825
Thailand	99.700	93.655	56.108	5.610	8.912
Trinidad and Tobago	99.426	96.877	35.139	0.000	0.312
Tunisia	99.500	88.554	63.761	1.161	3.176
Turkey	100.000	85.691	57.401	26.378	35.114
Turkmenistan	100.000	87.203	62.091	0.000	0.035
United Arab Emirates	100.000	92.824	59.947	0.000	0.043
United Kingdom	100.000	92.971	56.194	6.848	10.037
United States	100.000	94.006	51.203	10.120	12.850

YEAR 2010

COUNTRY	IND1	IND2	IND3	IND4	IND5
Uruguay	99.066	88.977	79.866	87.622	60.201
Venezuela, RB	98.803	79.888	64.857	67.490	61.485
Vietnam	97.718	89.888	67.095	29.140	36.367
Yemen, Rep.	65.861	76.093	63.835	0.000	0.000
Zambia	22.000	82.312	95.732	99.876	99.583
Zimbabwe	35.602	80.462	47.021	68.009	33.415

G – Final Ranking of the 111 Countries in the Indicator-Based Framework by Year

OVERALL SCORE FOR YEAR 1990			OVERALL SCORE FOR YEAR 1995			OVERALL SCORE FOR YEAR 2000			OVERALL SCORE FOR YEAR 2005			OVERALL SCORE FOR YEAR 2010		
RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE
1	Paraguay	95.294	1	Iceland	95.844	1	Paraguay	97.096	1	Paraguay	97.995	1	Iceland	98.240
2	Iceland	95.213	2	Paraguay	94.367	2	Iceland	96.946	2	Iceland	97.187	2	Paraguay	98.226
3	Norway	92.580	3	Norway	91.004	3	Costa Rica	94.465	3	Albania	93.855	3	Albania	94.983
4	Costa Rica	92.566	4	Brazil	89.172	4	Norway	91.041	4	Costa Rica	91.725	4	Norway	88.971
5	Brazil	88.459	5	Costa Rica	86.055	5	Albania	88.474	5	Norway	90.575	5	Costa Rica	88.121
6	Uruguay	86.695	6	Uruguay	86.011	6	Brazil	87.280	6	Brazil	86.324	6	Brazil	85.452
7	New Zealand	84.239	7	New Zealand	85.983	7	Uruguay	85.809	7	Uruguay	83.020	7	Georgia	84.859
8	Honduras	83.341	8	Ghana	83.667	8	Switzerland	82.407	8	Zambia	81.854	8	Uruguay	83.146
9	El Salvador	82.648	9	Switzerland	82.325	9	Zambia	81.433	9	Switzerland	81.714	9	Switzerland	82.060
10	Sri Lanka	82.110	10	Albania	81.581	10	New Zealand	80.824	10	Georgia	80.129	10	New Zealand	81.310
11	Albania	82.102	11	Zambia	81.244	11	Ghana	79.495	11	Colombia	80.103	11	Zambia	79.901
12	Switzerland	82.028	12	Sri Lanka	80.672	12	Austria	79.116	12	New Zealand	78.086	12	Austria	79.763
13	Ghana	81.657	13	Bosnia and Herzegovina	77.553	13	Georgia	77.343	13	Austria	77.234	13	Colombia	78.369
14	Zambia	80.376	14	Chile	77.521	14	Colombia	77.294	14	Sweden	76.076	14	Sweden	76.447
15	Guatemala	79.000	15	Austria	77.519	15	Sweden	77.068	15	Cameroon	75.813	15	Venezuela, RB	74.505
16	Colombia	78.587	16	Colombia	76.400	16	Cameroon	75.661	16	Venezuela, RB	74.710	16	El Salvador	73.519
17	Ecuador	77.466	17	Vietnam	75.860	17	Peru	74.407	17	Peru	73.125	17	Croatia	72.623
18	Austria	76.494	18	Sweden	74.199	18	Ecuador	74.052	18	Panama	72.954	18	Sudan	71.831
19	Sweden	75.213	19	Cameroon	73.743	19	Venezuela, RB	73.730	19	Ghana	72.637	19	Portugal	70.731
20	Cameroon	74.345	20	Venezuela, RB	73.277	20	El Salvador	71.839	20	El Salvador	72.216	20	Guatemala	70.596
21	Panama	73.109	21	Peru	72.892	21	Croatia	70.912	21	Ecuador	69.874	21	Sri Lanka	69.821
22	Angola	72.696	22	Ecuador	72.294	22	Vietnam	70.761	22	Croatia	69.785	22	Panama	69.222
23	Peru	72.259	23	Angola	71.694	23	Panama	70.173	23	Chile	69.432	23	Armenia	69.206
24	Chile	72.026	24	Guatemala	71.092	24	Chile	70.029	24	Angola	67.659	24	Cameroon	68.568
25	Venezuela, RB	71.529	25	Kenya	70.793	25	Honduras	66.858	25	Armenia	64.268	25	Peru	68.130
26	Kenya	70.823	26	Croatia	70.271	26	Luxembourg	66.696	26	Vietnam	63.863	26	Ecuador	68.115
27	Gabon	69.007	27	Panama	70.267	27	Gabon	65.654	27	Gabon	63.837	27	Ghana	68.098
28	Cote d'Ivoire	67.810	28	Honduras	69.651	28	Tanzania	65.283	28	Bosnia and Herzegovina	63.593	28	Chile	65.935
29	Tanzania	65.633	29	El Salvador	69.301	29	Angola	63.940	29	Sri Lanka	63.522	29	Spain	65.744
30	Turkey	65.545	30	Georgia	66.784	30	Portugal	63.846	30	Canada	63.383	30	Gabon	64.796
31	Sudan	64.554	31	Gabon	66.738	31	Sri Lanka	63.474	31	Argentina	63.044	31	Vietnam	64.041
32	Canada	64.480	32	Cote d'Ivoire	66.326	32	Canada	63.235	32	Guatemala	62.562	32	Bosnia and Herzegovina	63.792
33	Nicaragua	64.360	33	Turkey	66.041	33	Bosnia and Herzegovina	63.191	33	Finland	61.959	33	Angola	63.503
34	Portugal	64.063	34	Argentina	64.562	34	Argentina	62.883	34	Kenya	61.928	34	Canada	63.203
35	Finland	62.947	35	Canada	64.221	35	Bolivia	62.831	35	Portugal	61.508	35	Myanmar	62.428
36	Vietnam	62.710	36	Portugal	63.120	36	Finland	61.885	36	Bolivia	61.263	36	Denmark	62.141
37	Russian Federation	62.657	37	Tanzania	62.924	37	Guatemala	61.116	37	Denmark	61.117	37	Korea, Dem. People's Rep.	62.099
38	Mauritius	62.186	38	France	61.961	38	France	60.914	38	Romania	60.649	38	Kenya	62.010
39	Philippines	61.727	39	Finland	61.692	39	Turkey	60.908	39	Turkey	60.570	39	Honduras	61.998
40	Argentina	61.227	40	Bolivia	60.409	40	Mauritius	59.644	40	France	60.323	40	Bolivia	61.953

OVERALL SCORE FOR YEAR 1990			OVERALL SCORE FOR YEAR 1995			OVERALL SCORE FOR YEAR 2000			OVERALL SCORE FOR YEAR 2005			OVERALL SCORE FOR YEAR 2010		
RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE	RANK	COUNTRY	SCORE
41	France	61.133	41	Mauritius	60.144	41	Philippines	59.387	41	Korea, Dem. People's Rep.	59.964	41	France	61.758
42	Bolivia	60.270	42	Korea, Dem. People's Rep.	59.213	42	Italy	59.068	42	Luxembourg	59.475	42	Pakistan	61.276
43	Mexico	59.893	43	Sudan	59.010	43	Spain	59.053	43	Spain	59.458	43	Argentina	61.169
44	Egypt, Arab Rep.	59.636	44	Egypt, Arab Rep.	58.841	44	Cote d'Ivoire	58.953	44	Pakistan	58.829	44	Turkey	60.917
45	Spain	59.172	45	Italy	58.677	45	Korea, Dem. People's Rep.	57.836	45	Italy	58.160	45	Italy	60.894
46	Italy	59.051	46	Mexico	58.448	46	Romania	57.088	46	Philippines	57.957	46	Germany	60.295
47	Lebanon	58.986	47	Philippines	58.428	47	Mexico	56.780	47	Mauritius	57.576	47	Finland	60.257
48	China	58.805	48	Spain	58.416	48	Egypt, Arab Rep.	56.717	48	Tanzania	56.505	48	Romania	60.174
49	Malaysia	58.469	49	Pakistan	58.262	49	Sudan	56.637	49	Germany	55.938	49	Luxembourg	60.061
50	Pakistan	58.356	50	Lebanon	57.922	50	Armenia	56.555	50	China	55.848	50	Belgium	58.355
51	Haiti	58.159	51	Nicaragua	57.819	51	Kenya	56.291	51	Honduras	55.779	51	Ireland	58.316
52	Korea, Dem. People's Rep.	58.026	52	Armenia	57.714	52	Denmark	55.879	52	Nicaragua	55.497	52	Tanzania	57.900
53	Croatia	57.849	53	China	57.403	53	China	55.635	53	Ireland	55.251	53	Philippines	57.454
54	Romania	57.308	54	Luxembourg	57.234	54	Indonesia	55.561	54	Mexico	55.191	54	China	57.298
55	Georgia	57.222	55	Romania	56.903	55	Iraq	54.431	55	Belgium	55.010	55	Nicaragua	57.282
56	Luxembourg	57.199	56	Iran, Islamic Rep.	54.729	56	Belgium	54.396	56	Iraq	54.793	56	Greece	56.824
57	Iran, Islamic Rep.	56.521	57	Malaysia	54.448	57	Japan	53.939	57	Myanmar	54.683	57	Mauritius	56.023
58	Iraq	55.660	58	Japan	54.395	58	Greece	53.921	58	Netherlands	54.332	58	Indonesia	55.622
59	Japan	54.959	59	Greece	54.271	59	Pakistan	53.693	59	Gibraltar	54.082	59	Netherlands	55.478
60	Syrian Arab Republic	54.116	60	Russian Federation	53.957	60	Malaysia	53.573	60	Egypt, Arab Rep.	54.062	60	Mexico	55.467
61	United States	53.836	61	Belgium	53.776	61	Gibraltar	53.478	61	Greece	54.056	61	Morocco	55.371
62	Greece	53.781	62	Gibraltar	53.730	62	United States	53.233	62	Indonesia	53.980	62	Azerbaijan	54.190
63	Australia	53.711	63	United States	53.663	63	Germany	53.190	63	Iran, Islamic Rep.	53.882	63	Hungary	54.096
64	Belgium	53.594	64	Australia	53.419	64	Ireland	53.169	64	Japan	53.380	64	Iran, Islamic Rep.	53.959
65	Ireland	53.144	65	Kazakhstan	52.385	65	Russian Federation	53.073	65	Cote d'Ivoire	52.764	65	Gibraltar	53.903
66	Armenia	53.120	66	United Arab Emirates	52.379	66	Iran, Islamic Rep.	52.815	66	United States	52.704	66	Cote d'Ivoire	53.726
67	Turkmenistan	53.035	67	Germany	52.335	67	Netherlands	52.256	67	Hungary	52.687	67	United States	53.636
68	United Arab Emirates	52.937	68	Ireland	52.209	68	Australia	52.025	68	Russian Federation	52.663	68	Egypt, Arab Rep.	53.610
69	Bosnia and Herzegovina	52.405	69	Netherlands	51.943	69	United Arab Emirates	51.557	69	Haiti	52.203	69	Japan	53.450
70	Indonesia	52.259	70	Azerbaijan	51.622	70	Zimbabwe	51.285	70	Morocco	52.168	70	United Kingdom	53.210
71	Germany	52.230	71	Indonesia	51.458	71	United Kingdom	50.795	71	Nigeria	52.013	71	Zimbabwe	52.902
72	Netherlands	51.536	72	Haiti	50.933	72	Haiti	50.578	72	Sudan	52.004	72	Thailand	52.797
73	Zimbabwe	51.497	73	United Kingdom	50.888	73	Morocco	50.508	73	Dominican Republic	51.724	73	Russian Federation	52.794
74	Thailand	50.820	74	Thailand	50.851	74	Tunisia	50.464	74	Australia	51.712	74	Lithuania	52.440
75	Lithuania	50.717	75	Cyprus	50.524	75	Nicaragua	50.329	75	Syrian Arab Republic	51.650	75	Bulgaria	51.893
76	Hungary	50.364	76	Syrian Arab Republic	50.414	76	Myanmar	50.248	76	Tunisia	51.646	76	Dominican Republic	51.836
77	Cuba	50.274	77	Denmark	50.262	77	Thailand	50.193	77	Azerbaijan	51.619	77	Australia	51.591
78	Jordan	50.189	78	Turkmenistan	50.249	78	Azerbaijan	50.187	78	Thailand	51.580	78	Kazakhstan	51.454
79	Gibraltar	50.163	79	Iraq	50.231	79	Lebanon	49.981	79	United Kingdom	51.427	79	Tunisia	51.230
80	United Kingdom	50.132	80	Tunisia	49.879	80	Cuba	49.880	80	Malaysia	51.358	80	Nigeria	50.793

OVERALL SCORE FOR YEAR 1990		
RANK	COUNTRY	SCORE
81	Czech Republic	50.079
82	Tunisia	50.057
83	Cyprus	49.827
84	Kazakhstan	49.630
85	Bulgaria	49.379
86	Azerbaijan	49.356
87	Denmark	49.221
88	Myanmar	49.178
89	Algeria	48.095
90	Morocco	47.866
91	Jamaica	47.739
92	Dominican Republic	47.231
93	Israel	47.043
94	Nigeria	46.530
95	Qatar	46.525
96	India	46.327
97	Poland	45.920
98	Belarus	45.363
99	Estonia	43.752
100	Kuwait	43.729
101	Brunei Darussalam	43.513
102	Singapore	43.481
103	Trinidad and Tobago	43.147
104	Hong Kong SAR, China	43.030
105	Malta	42.857
106	Libya	41.169
107	Mongolia	40.523
108	Yemen, Rep.	39.646
109	South Africa	38.580
110	Senegal	33.180
111	Bangladesh	31.119

OVERALL SCORE FOR YEAR 1995		
RANK	COUNTRY	SCORE
81	Jordan	49.391
82	Czech Republic	49.355
83	Dominican Republic	49.257
84	Hungary	48.770
85	Lithuania	48.423
86	Nigeria	48.162
87	Algeria	47.369
88	Israel	47.141
89	Morocco	47.103
90	Bulgaria	47.001
91	Poland	46.960
92	Cuba	46.658
93	Myanmar	46.522
94	Zimbabwe	46.301
95	Qatar	45.334
96	Kuwait	45.004
97	Malta	44.860
98	India	44.334
99	Belarus	44.230
100	Libya	43.963
101	Brunei Darussalam	43.876
102	Hong Kong SAR, China	43.706
103	Trinidad and Tobago	43.097
104	Singapore	43.063
105	Jamaica	42.833
106	Estonia	40.691
107	South Africa	38.818
108	Yemen, Rep.	38.727
109	Mongolia	37.027
110	Senegal	34.953
111	Bangladesh	34.540

OVERALL SCORE FOR YEAR 2000		
RANK	COUNTRY	SCORE
81	Jordan	49.597
82	Cyprus	49.519
83	Kazakhstan	49.431
84	Turkmenistan	49.373
85	Dominican Republic	49.370
86	Czech Republic	49.018
87	Nigeria	48.861
88	Bulgaria	48.860
89	Lithuania	48.807
90	Hungary	48.642
91	Syrian Arab Republic	47.879
92	Algeria	47.521
93	Poland	46.985
94	Israel	46.227
95	Hong Kong SAR, China	46.174
96	Qatar	45.597
97	Jamaica	45.287
98	Trinidad and Tobago	45.237
99	Libya	44.432
100	Brunei Darussalam	44.342
101	Belarus	44.264
102	Kuwait	43.836
103	Singapore	43.813
104	India	42.921
105	Malta	42.619
106	Estonia	41.491
107	South Africa	39.210
108	Yemen, Rep.	38.105
109	Bangladesh	36.960
110	Mongolia	34.873
111	Senegal	32.102

OVERALL SCORE FOR YEAR 2005		
RANK	COUNTRY	SCORE
81	Lebanon	51.313
82	Bulgaria	50.529
83	Lithuania	50.184
84	Kazakhstan	49.846
85	Algeria	49.656
86	Jordan	49.644
87	Czech Republic	49.474
88	Turkmenistan	49.448
89	Cyprus	49.372
90	Zimbabwe	48.987
91	United Arab Emirates	48.966
92	Jamaica	48.719
93	Poland	47.595
94	Cuba	47.185
95	Qatar	46.072
96	Libya	45.975
97	India	45.947
98	Israel	45.718
99	Singapore	45.634
100	Trinidad and Tobago	44.762
101	Belarus	44.612
102	Kuwait	43.941
103	Brunei Darussalam	43.540
104	Hong Kong SAR, China	43.145
105	Estonia	43.116
106	South Africa	41.542
107	Yemen, Rep.	41.398
108	Mongolia	40.843
109	Malta	40.508
110	Bangladesh	39.670
111	Senegal	37.602

OVERALL SCORE FOR YEAR 2010		
RANK	COUNTRY	SCORE
81	United Arab Emirates	50.563
82	Czech Republic	50.288
83	Malaysia	50.268
84	Poland	50.201
85	Cyprus	50.172
86	Turkmenistan	49.866
87	India	49.605
88	Algeria	48.956
89	Jamaica	48.856
90	Lebanon	48.746
91	Syrian Arab Republic	48.305
92	Iraq	48.278
93	Cuba	47.775
94	Jordan	47.746
95	Singapore	47.706
96	Israel	47.006
97	Trinidad and Tobago	46.351
98	Qatar	46.040
99	Belarus	45.538
100	Estonia	45.162
101	Malta	44.285
102	Hong Kong SAR, China	44.096
103	Kuwait	43.686
104	Haiti	43.067
105	Brunei Darussalam	43.015
106	Libya	42.482
107	Senegal	41.895
108	Mongolia	41.461
109	South Africa	41.182
110	Yemen, Rep.	41.158
111	Bangladesh	40.362