A Feed-In Tariff Scheme to Promote Renewable Electricity in Ecuador:

Has it Delivered Sustainability?

Sebastián Alejandro Egüez Macías

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A FEED-IN TARIFF SCHEME TO PROMOTE RENEWABLE ELECTRICITY IN ECUADOR: HAS IT DELIVERED SUSTAINABILITY?

A thesis submitted in partial fulfillment of the requirements of Lund University International Master's Programme in Environmental Studies and Sustainability Science (LUMES) for the degree of Master of Science

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ABSTRACT

Ecuador has a large potential for electricity generation from renewable energy sources. Regardless of such potential, mainly thermal (non-renewable) and large-scale hydroelectricity has been widely exploited. In order to tap the potential of other renewables, a feed-in tariff scheme has been implemented since 2000 in Ecuador and it has experienced several revisions throughout the last decade. The main objective of this thesis is to evaluate the effectiveness of Ecuador's feed-in tariff scheme in relation to sustainable development through the promotion of electricity generation from non-conventional renewable energy sources. For this, Ecuador's feed-in tariff scheme evolution and design are scrutinized. Then, its effectiveness is evaluated in terms of attracting renewable electricity investments, providing energy security, decreasing greenhouse gases emissions from electricity generation, promoting energy access, and stimulating job creation. Finally, suggestions on how to improve the design of Ecuador's feed-in tariff scheme are presented along with recommendations on complementary strategies and policies to this promising policy instrument in order to effectively achieve the final objective of promoting renewable electricity and sustainability in Ecuador.

Keywords: Feed-in tariffs, renewable electricity, energy policy, policy evaluation, sustainability, Ecuador's electricity sector.

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This thesis is a clear representation of how environmentally responsibility principles could also be applied to the way how research is carried out in pro of sustainability. Specifically, none physical travelling to Ecuador was necessary even though the thesis focus its analysis on this country. Nevertheless, this was only possible thanks to all the information providers and interviewees who were open to interchange data, information, and experiences through email, telephone and/or virtual videoconferences. In this sense, I would like to thank all my interviewees and information providers from all around the globe: Paola Andino, Gabriel Alberto Argüello Ríos, Carlos Julio Arosemena, Geovanny Bonifaz, Byron Betancourt, Fabián Calero Freire, Iván Calero Freire, Roberto Carrión, Ryan Dick, Rafael Drouet, Eduardo Escobar, Javier González, David Jacobs, Aswin W. Linsenmeyer, Elizabeth Lokey, Christian Marín Romo, Alfredo Mena, José Luis Palacios, Geovanny Pardo Salazar, Amalio Puga, Gabriel Salazar Yépez, Alfredo Samaniego, Santiago Sánchez, Mauricio Solano, Ángel Vaca, Néstor Valdospinos, Paúl Vásquez, and Luis Vintimilla.

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Alejandro Egüez
Lund, May 2012.

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LIST OF ABBREVIATIONS

CAF	Development Bank of Latin America, former Andean Corporation of Foment
CDM	Clean Development Mechanism
CENACE	Corporación Centro Nacional de Control de Energía (National Energy Control Center Corporation)
CEPSE	Comisión de Ejecución de la Política del Sector Eléctrico Ecuatoriano (Inter-institutional Committee for the Electricity Sector Policy Implementation)
CFN	Corporación Financiera Nacional (National Finance Corporation)
CIE	Coporación para la Investigación Energética (Corporation for Energy Research)
CONELEC	Consejo Nacional de Electricidad (National Electricity Council)
DPSIR	Driving forces, Pressures, State, Impacts, Responses
EMBI	Emerging Markets Bond Index
EOLICSA	Eólica San Cristóbal S.A. (San Cristóbal Wind Project Commercial Trust)
ERGAL	Energías Renovables para Galápagos (Renewable Energy for Galapagos)
FERUM	Fondo de Electrificación Rural y Urbano Marginal (Rural Electrification Fund)
FIT	Feed-in Tariff
GHG	Greenhouse gases
GWh	Gigawatt hour
IADB	Inter American Development Bank
INEC	Instituto Nacional de Estadísticas y Censos (Statistics and Census National Institute)
INECEL	Instituto Ecuatoriano de Electrificación (Ecuadorian Electrification Institute)
IPCC	Intergovernmental Panel on Climate Change
km	Kilometer
kWh	Kilowatt hour
kWp	Kilowatt-peak
LPG	Liquefied Petroleum Gas
MDG	Millennium Development Goals
MEER	Ministerio de Electricidad y Energía Renovable (Ministry of Electricity and Renewable Energy)
MICSE	Ministerio Coordinador de Sectores Estratégicos (Strategic Sectors Coordinator Ministry)
MW	Megawatt
PPA	Power Purchase Agreement
RES-E	Renewable energy sources - electricity
SENPLADES	Secretaría Nacional de Planificación y Desarrollo (Planning and Development National Secretary)
SNI	Sistema Nacional Interconectado (National Interconnected System)
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
WB	World Bank
WTO	World Trade Organization

1. INTRODUCTION

1.1. Background to the research

The importance of energy production and consumption goes beyond the standard scientific definition of energy as "the capacity to do work."[1] According to the last IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation, "[a]part from its significance for productive purposes, access to clean and reliable energy constitutes an important prerequisite for fundamental determinants of human development including health, education, gender equality and environmental safety."[2] Energy can be obtained from renewable and non-renewable sources. This thesis will focus on the former, which deployment and policies has different context specific drivers. For example, reducing carbon emissions to mitigate climate change, among others, may be an important reason for industrialized countries. Providing access to energy and prolonging the lifetime of the natural resource base are key incentives to promote renewable energy for developing countries,[3] like Ecuador.

By the late 19th and early 20th centuries, Ecuador's electricity sector had vertically integrated public and private utilities. By then, the system was not interconnected at a national level and served merely to the main urban centers. On 1961, the Ecuadorian Electrification Institute (INECEL) was created and it ruled and operated Ecuador's electricity sector as a publicly owned and vertically integrated monopolistic utility until March 31, 1999.[4] Since 1996, Ecuador's electricity sector has experienced multiple institutional changes with the implementation of its Electricity Sector Regime Law. Although this law was effective in separating the generation, transmission, and distribution activities, it was not effective in achieving its initial objective of promoting competitive markets with private participation.[5] Nowadays, the main players on the generation, transmission and distribution stages are still publicly owned on its majority.

Regardless of the property and management structure, Ecuador has large potential to develop electricity generation from renewable energy sources (RES-E), including hydroelectricity, solar, wind, geothermal, biomass, and oceanic. According to Ecuador's 2009-2020 Electrification Master Plan, the technical and economically feasible potential for hydroelectricity that has not been yet exploited is estimated in 25.000 MW.[6] For solar energy, Ecuador has between 1600 and 2000

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[1] Boyle Godfrey, Everett Bob, Ramage Janet, *Energy Systems and Sustainability, Power for a Sustainable Future*, Oxford University Press, 2004, p. 6.

[2] Sathaye, J., O. Lucon, A. Rahman, J. Christensen, F. Denton, J. Fujino, G. Heath, S. Kadner, M. Mirza, H. Rudnick, A. Schlaepfer, A. Shmakin, 2011: Renewable Energy in the Context of Sustainable Development. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 719

[3] Arvizu, D., T. Bruckner, H. Chum, O. Edenhofer, S. Estefen, A. Faaij, M. Fischedick, G. Hansen, G. Hiriart, O. Hohmeyer, K. G. T. Hollands, J. Huckerby, S. Kadner, Å. Killingtveit, A. Kumar, A. Lewis, O. Lucon, P. Matschoss, L. Maurice, M. Mirza, C. Mitchell, W. Moomaw, J. Moreira, L. J. Nilsson, J. Nyboer, R. Pichs-Madruga, J. Sathaye, J. Sawin, R. Schaeffer, T. Schei, S. Schlömer, K. Seyboth, R. Sims, G. Sinden, Y. Sokona, C. von Stechow, J. Steckel, A. Verbruggen, R. Wiser, F. Yamba, T. Zwickel, 2011: Technical Summary. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, p. 120.

[4] CAF, *Ecuador: Análisis del Sector Eléctrico,* Informes sectoriales de infraestructura, Año 5, No. 1, January 2007, p. 5.

[5] Egüez Alejandro, *Determinantes de la inversión, costos de generación eléctrica en el Ecuador y experiencia internacional en el período* 1996 - 2006, <http://repositorio.puce.edu.ec/handle/22000/1054>, p. 4.

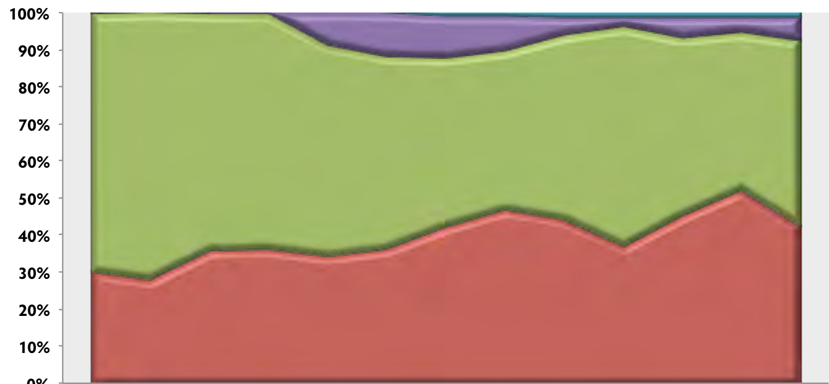
[6] CONELEC, Consejo Nacional de Electricidad, *Plan Maestro de Electrificación 2009 - 2020*, <www.conelec.gob.ec/images/documentos/PME0920.pdf>, visited on December 4, 2011 at 21:00, p. 145.

sunlight hours per year[7] and an average global (direct + diffuse) solar radiation of 4,57 kWh/m²/day.[8] Ecuador's wind potential is basically found in its Andean mountain's ridges and in locations near the Pacific coast[9] thanks to the sea breezes.[10] Ecuador, as a volcanic country, has geothermal potential due to the Continental and Nazca plates' tectonics.[11] Such potential has been located in Ecuador's central and northern areas[12] and according to its inventory around 500 MW could be exploited.[13] Since Ecuador has traditionally been an agrarian country and lies in the inner tropics, it has a clear potential to develop biomass.[14] The main biomass sources have been identified from wastes, wood, bagasse, and flowering plants like *Jatropha Curcas*. Indeed, *Jatropha Curcas* is intended to be an important bioenergy input to achieve carbon neutrality of Floreana Island in the Galapagos Archipelago.[15] Finally, regarding tidal power as one of the many oceanic alternatives available, at first Ecuador has potentiality, but studies are still required to identify and quantify such potential.[16]

1.2. Problem definition

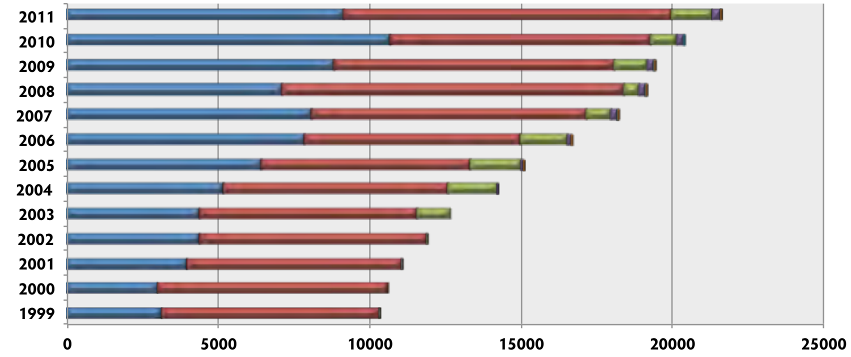
Despite such high renewable energy potential, mainly thermal (non-renewable) and large-scale hydroelectricity RES-E has been widely exploited. The remaining RES-E alternatives, including small-scale hydroelectricity, can be categorized as non-conventional RES-E[17] and their potential has not been fully developed. Moreover, and to the surprise of many, electricity demand in Ecuador has been constantly and primarily satisfied with energy from public investments in non-renewable generation capacity – mostly in fossil fuel-based technologies, and imports from Colombia as revealed in Figure 1-1.

[7] *Ibid,* p. 124.
[8] CONELEC and Corporación para la Investigación Energética (CIE), *Atlas solar del Ecuador con fines de generación eléctrica,* <www.conelec.gob.ec/archivos_articulo/Atlas.pdf>, visited on January 19, 2012 at 11:47, p. 49.
[9] *Supra* note 6, p. 21.
[10] *Ibid,* p. 193.
[11] *Ibid*, p. 195.
[12] *Ibid,* p. 124.
[13] *Ibid, p. 145.*
[14] *Ibid*, p. 194.
[15] DED Ecuador, *et al, Energía Renovable para Galápagos: Sustitución de combustibles fósiles por biocombustibles en la generación de energía eléctrica en la Isla Floreana, Estudio de Factibilidad*, April 2008, pp. 48-53.
[16] *Supra* note 6, p.124.
[17] *See* Regulation No. CONELEC 004/11. Definition of non-conventional unit: unit that uses, for its generation, energy resources that are capable of unlimited renewing and come from: sun (photovoltaics), wind, water (small scale hydroelectricity), inner earth (geothermal), biomass, biogas, tides, waves, hot and dry rocks, which, due to their relatively recent development and exploitation, have not yet reached a commercialization degree enough to freely compete with conventional sources; but that in contrast to the latter sources, have a reduced environmental impact.



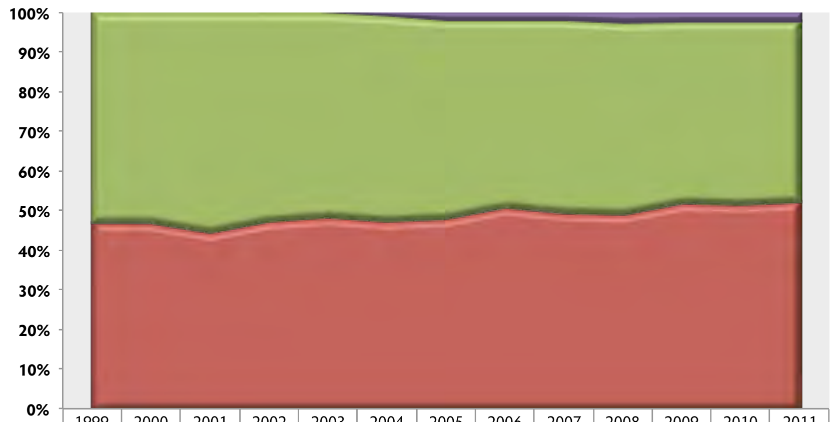
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Solar	0%	0%	0%	0%	0%	0%	0,0001%	0,0001%	0,0001%	0,0002%	0,0001%	0%	0,0002%
Wind	0%	0%	0%	0%	0%	0%	0%	0%	0,01%	0,01%	0,02%	0,02%	0,02%
Biomass	0%	0%	0%	0%	0%	0,02%	0,68%	0,87%	1,20%	1,09%	1,12%	1,16%	1,27%
Imports	0,23%	0%	0,20%	0,47%	8,84%	11,54%	11,39%	9,41%	4,73%	2,62%	5,78%	4,28%	6,28%
Hydro	69%	72%	64%	63%	57%	52%	45%	43%	50%	59%	48%	42%	50%
Thermal (Non Renewable)	30%	28%	36%	37%	34%	36%	42%	47%	44%	37%	45%	52%	43%

A) Contribution to Gross Energy Production (% GWh)



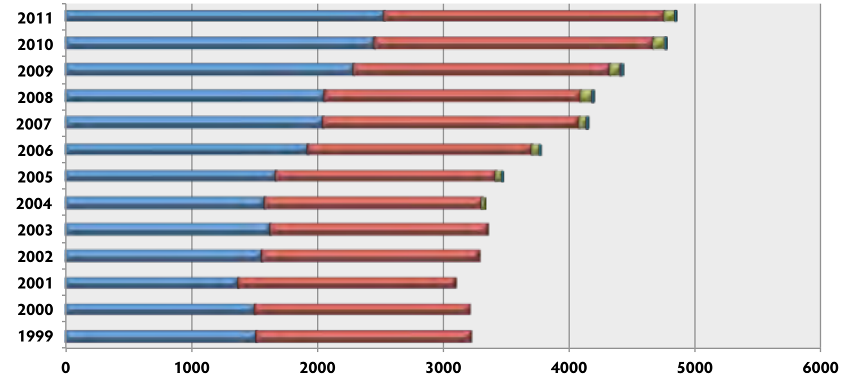
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Thermal (Non Renewable)	3131	3001	3979	4363	4366	5170	6419	7841	8079	7104	8819	10634	9138
Hydro	7177	7611	7071	7524	7180	7412	6883	7129	9038	11293	9225	8636	10801
Imports	23,76	0	22,23	56,3	1120	1642	1723	1570	861	500	1121	873	1355
Biomass	0	0	0	0	0	3,24	103	146	219	208	217	236	264
Wind	0	0	0	0	0	0	0	0	0,96	2,68	3,2	3,43	3,46
Solar	0	0	0	0	0	0	0,01	0,01	0,02	0,03	0,01	0	0,05

B) Gross Energy Production (GWh)



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Solar	0%	0%	0%	0%	0%	0%	0,0006%	0,0005%	0,0005%	0,0005%	0,0005%	0,0004%	0,0017%
Wind	0%	0%	0%	0%	0%	0%	0%	0%	0,06%	0,06%	0,05%	0,05%	0,05%
Biomass	0%	0%	0%	0%	0%	0,84%	1,60%	1,68%	1,53%	2,26%	2,14%	1,96%	1,93%
Hydro	53%	53%	56%	53%	52%	52%	50%	47%	49%	49%	46%	47%	46%
Thermal (Non Renewable)	47%	47%	44%	47%	48%	47%	48%	51%	49%	49%	52%	51%	52%

C) Contribution to Effective National Power (% MW)



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Thermal (Non Renewable)	1518	1504	1379	1560	1625	1582	1675	1921	2051	2058	2286	2450	2529
Hydro	1703	1703	1726	1733	1733	1732	1750	1786	2031	2033	2032	2215	2216
Biomass	0	0	0	0	0	28	56	63	63	95	95	93	93
Wind	0	0	0	0	0	0	0	0	2,4	2,4	2,4	2,4	2,4
Solar	0	0	0	0	0	0	0,02	0,02	0,02	0,02	0,02	0,02	0,08

D) Effective National Power (MW)

Data source: CONELEC

Figure 1-1: Evolution of Ecuador's Gross Energy Production and Power Capacity by Technology: A) %GWh, B) GWh, C) %MW, and D) MW

With the intention of deploying non-conventional RES-E and to tap the above-mentioned potential, a feed in tariff (FIT) scheme was implemented since 2000 in Ecuador and it has experienced several revisions throughout the last decade. The above-illustrated evolution of Ecuador's electricity mix casts light on the effectiveness of Ecuador's renewable energy policy and its FIT scheme as a whole. At first, one can argue that the implemented FIT scheme has performed poorly, as the contribution of RES-E, after 11 years, remain marginal in the electricity mix. Furthermore, no specific evaluation has been carried out about the success of the FIT scheme in more empirical terms. In particular, it is unclear what has been the contribution of the FIT scheme from a sustainability point of view. The lack of knowledge in this case prohibits strong assertions.

1.3. Objectives and research questions

The main objective of this thesis is to evaluate the effectiveness of Ecuador's FIT scheme and its regulatory framework in terms of the deployment of non-conventional RES-E and resulting sustainable development. In particular, this thesis aims to investigate the design and effectiveness of Ecuador's FIT scheme in terms of attracting RES-E investments, providing energy security, decreasing greenhouse gases (GHG) emissions from electricity generation, promoting energy access, and stimulating job creation. On the basis of this evaluation, a secondary objective of this thesis is to provide renewable energy policy recommendations intended to improve the design and implementation of Ecuador's FIT scheme and propose how to complement such scheme from a holistic perspective, in order to be more effective promoting sustainable development through the promotion of non-conventional RES-E. To achieve these objectives, the following research questions are proposed:

- To what extent Ecuador's FIT scheme and its regulatory framework have promoted non-conventional RES-E projects?
- How has Ecuador's FIT scheme contributed to sustainable development?
- In which aspects can Ecuador's FIT scheme be improved and complemented to deploy RES-E?

The hypothesis in this research is: if Ecuador's FIT scheme stays as a single policy instrument without the support of a long term plan that seriously incorporates the deployment of RES-E and sustainability objectives, then its capability to be effective in terms of promoting sustainable development through the promotion of RES-E would be limited. Alternatively, if Ecuador's FIT scheme and its regulatory framework respond to a long-term plan with well established RES-E and sustainability targets, and its design improves in terms of its legal status, technological choices, financing mechanisms, and communication strategies, just to mention some examples, then its likeliness to be more effective in promoting sustainable development through the promotion of RES-E would be higher.

1.4. Limitations

This study deals with energy policy, and more specifically, renewable energy policy. It aims to cover the sustainability aspects of such specific policy in the Ecuadorian context. In this sense, the absence of a standardized framework for a sustainability evaluation of renewable energy policies is a potential constraint. However, by exploring this novel area, this thesis aims to make an initial contribution for further research on this innovative field. Also, the lack of specific sustainability objectives for renewable energy policy and well-defined targets in Ecuador are important limitations to evaluate its effectiveness. Similarly, this is also an opportunity for this thesis to contribute by suggesting specific indicators for this purpose, which should be adequately defined, monitored, and evaluated so that policy makers can improve their energy policy tools and strategies in the future. Additionally, there is a FIT, RES-E, and sustainability correlation and causality limitation. Specifically, not all RES-E necessarily responds to the FIT scheme. Therefore, sustainability promoted by such RES-E, if any, cannot be entirely attributed to the FIT scheme *per se*. Finally, the lack of documentation at the national level could also represent a potential limitation, especially regarding the data required to backup the sustainability indicators of RES-E.

1.5. Target audience

This thesis has been developed in an academic setting but its target audience is not intended exclusively for scholars interested on this topic. Policymakers and all stakeholders around the electricity industry, including possible financiers and investors from public and private sectors, could find this thesis very useful for their understanding of how Ecuador's FIT scheme has evolved, its current status, and how this policy tool can be improved and complemented in order to promote sustainable development through RES-E. Sharing this thesis with this target audience aims to contribute to the discussion, and hopefully actions, of how to promote sustainability in Ecuador's electricity sector.

1.6. Thesis structure

This first section presents a background of Ecuador's electricity sector and the problematic on which this research focuses. On this basis, the objectives and research questions have been also introduced. The second section is dedicated to explain the relevant methodological aspects that have been considered for the development of this thesis. The third section offers a concise theoretical framework of the key concepts behind renewable energy policies in the sustainability context, and its evaluation. The fourth section deeply analyzes Ecuador's FIT scheme addressing the details of its evolution and design. Section five goes beyond the design of the FIT scheme and analyses the effects and status of this policy instrument regarding the promotion of renewable electricity and its sustainability components. Section six discusses, from a systemic approach, the previously analyzed elements and both: a) suggests how to improve the design of Ecuador's FIT scheme, and b) recommends complementary policies to this single policy instrument to achieve the final objective of promoting renewable electricity and sustainability. With all these elements, section seven presents the central concluding remarks.

2. METHODOLOGY

To accomplish the intended objectives and answer the proposed research questions, this study have considered a mixed methods approach. This section will introduce the methods that were used for both, data collection and analysis, respectively.

2.1. Methods for data collection

Interviews with local authorities and policy makers from Ecuador's electricity sector, as well as with current and potential public and private investors and project developers, have been useful primary sources throughout the research process. For example, on the one hand, local authorities have given useful details about the current and past FIT schemes and, moreover, have contributed with insights about possible reforms to incentive electricity generation projects from renewable energy in Ecuador. On the other hand, interviews with potential investors (local and foreign) have clarified their expectations in order to be attracted to invest in non-conventional RES-E in Ecuador. Also, their impressions about the current FIT scheme in Ecuador have been a valuable input. Finally, interviews with academic figures with research interests related to this topic have been useful, especially regarding the design of FITs and the promotion of RES-E in developing countries. Annex 1 presents the different interviewees and dates when each interview took place. Annex 2 presents a pool of questions that were targeted for each interviewee depending on its condition as local authority, potential investor / project developer, analyst, or scholar.

Complementary, the current regulatory framework has been deeply revised, as well as the relevant literature on sustainability and policy instruments (and their evaluation methods) oriented to promote investments in RES-E, like FITs. Regarding the applicable best practices, they have been primarily obtained from reports and specialized literature that have already studied countries like Spain and Germany, which are well known for their efforts in the deployment of RES-E.

2.2. Methods for data analysis

The available qualitative and quantitative data have been gathered and processed to accomplish the intended objectives and answer the proposed research questions. Regarding the FIT scheme design, the main reference was Mendonça's, *et al.* (2010) 'Feed-in Tariff Handbook'. Ecuador's evolution and current status of the following FIT design elements have been scrutinized: eligible technologies; eligible plants; tariff calculation methodology; technology and size specific tariffs; duration of tariff payment; financing mechanisms; purchase obligations; priority grid access; cost-sharing methodology for grid connection; effective administrative procedures; setting targets; and progress reports.[18]

Next, the following sustainability related policy objectives have been selected for evaluation: attract RES-E investments, provide energy security, decrease greenhouse gases (GHG) emissions from electricity generation, promote energy access, and stimulate job creation. Table 2-1 summarizes the different indicators (and their quantitative or qualitative nature) that, directly or indirectly, have been used to evaluate the effectiveness of each of the selected objectives.

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[18] Miguel Mendonça, David Jacobs, and Benjamin Sovacool, *Powering the Green Economy, The feed-in tariff handbook,* Earthscan and World Future Council, 2010, p. 16.

Table 2-1: Quantitative and qualitative indicators

OBJECTIVE	INDICATORS
Attract RES-E investments	Evolution of references that influences the investor's perception (*e.g.* World Bank's Doing Business Rankings and Ecuador's Emerging Markets Bond Index - EMBI as an indicative of 'country risk').
	Contribution of RES-E over total installed capacity (% MW).
	Contribution of RES-E over total electricity generation (% GWh).
	Legal framework to attract investments.
	Historic events that could influence investor's confidence.
Energy security	Blackouts threats.
	Evolution of fossil fuel's consumption for electricity generation in Ecuador.
	Evolution of Ecuador's fossil fuel prices and subsidies for electricity generation
	Legal framework (decrees) that supports fossil fuels subsidies.
	Evolution of international transactions of electricity (kWh and USD) with Colombia and Peru.
GHG emissions	Evolution of emissions from electricity generation plants (ton CO2 / MWh).
Energy access	Urban and rural electricity coverage (%)
	Examples of rural electrification initiatives highlighting the importance of distributed generation.
Job creation	Jobs created by RES-E technology (International references).

Legend:	Qualitative	Quantitative

The first objective has been primarily selected because it is immediately linked to the FIT scheme spirit of attracting RES-E investments. The remaining objectives have been mainly chosen considering their relevance promoting sustainable development within the specific reality of Ecuador's electricity sector. However, and as it will be noted on section 3, many other sustainability-related objectives and indicators could potentially be selected. In this sense, and considering the academic purposes of this thesis, another criterion to choose these objectives and indicators has been Ecuador's availability of gathered data.

Finally, the Driving forces, Pressure, State, Impact, Response (DPSIR) framework has been used as a system analysis tool to understand, discuss and locate all the analyzed elements, including the FIT scheme, into the complexity of Ecuador's electricity sector. According to Barry Ness, *et al.* (2010), "[t]he DPSIR framework is a functional analysis scheme for structuring the cause-effect relationships in connection with environmental and natural resource management problems."[19] Moreover, "[t]he scheme helps to structure information and makes it possible to identify important relations as well as to develop an overview and understanding of a problem."[20]

[19] Barry Ness, S. Anderberg, and L. Olsson, *Structuring problems in sustainability science: The multi - level DPSIR framework,* 2010, Geoforum 41(3), p. 480.
[20] *Id.*

3. CONCEPTUAL FRAMEWORK

This research is mainly based on the theoretical concepts and perspectives that support renewable energy policies in the sustainability context and their evaluation approaches.

3.1. Sustainability and energy systems

In essence, sustainable development has an intra and inter-generational equity nature. Regarding the latter, on 1983 the General Assembly of the United Nations established the World Commission on Environment and Development to make the Brundtland Report, which was published on 1987. This report is generally known because it formally defines sustainable development as the "development that meets the needs of the present without compromising the ability of future generations to meet their own needs."[21]

Due to its transdisciplinary and action oriented nature, sustainable development has deserved special attention in practice, as well as in the academic field, so sustainability science has arose. Regarding sustainability science, Kasemir, *et al.* (2003) "describe this research area as combining work in the area of environmental science with work in economic, social and development studies to better understand the *complex dynamic interactions between environmental, social and economic issues*."[22] (Emphasis mine). Such transdisciplinary, complex, and dynamic interactions are, indeed, a latent characteristic of energy systems, which have a significant role on sustainable development.

For instance, on 2000 the United Nations Millennium Declaration established the following as the Millennium Development Goals (MDG): eradicate extreme poverty and hunger; achieve universal primary education; promote gender equality and empower women; reduce child mortality; improve maternal health; combat HIV/AIDS, malaria and other diseases; ensure environmental sustainability; and develop a global partnership for development.[23] As it is well noted in the UNDP's World Energy Assessment: Overview 2004 Update, "[n]one of the MDGs can be achieved without much greater access to improved quality and an increased quantity of energy services."[24] Annex 3 presents a systematization that this assessment exposes of the direct and indirect contributions of energy to achieve these development goals. According to Orecchini (2011),

> A clear definition of energy sustainability within the common platform of Sustainability Science is to be based on the following pillars:
> 1. Renewability of energy resources;
> 2. Efficiency in energy conversion, distribution, use;
> 3. Lowering of environmental impact;
> 4. Increasing of energy accessibility;
> 5. Tailor making of energy systems on local social-economic-environmental conditions.[25]

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[21] United Nations, General Assembly, *Brundtland Report*, A/42/427, August 4, l987, <http://worldinbalance.net/pdf/1987-brundtland.pdf>, visited on 25 October 2011 at 09:28.
[22] *Cited in:* Barry Ness, *et al*, *Categorising tools for sustainability assessment*, Ecological Economics 60, 2007, p. 498.
[23] United Nations, *The Millennium Development Goals Report 2011*, <www.un.org/millenniumgoals/pdf/(2011_E)%20MDG%20Report%202011_Book%20LR.pdf>, visited on 9 May 2012 at 19:32.
[24] UNDP, *World Energy Assessment: Overview 2004 Update*, <www.undp.org/content/dam/aplaws/publication/en/publications/environment-energy/www-ee-library/sustainable-energy/world-energy-assessment-overview-2004-update/World%20Energy%20Assessment%20Overview-2004%20Update.pdf>, visited on 9 May 2012 at 19:43.
[25] Fabio Orecchini, *Energy Sustainability Pillars*, International Journal of Hydrogen Energy 36, 2011, p. 7748.

Similarly, in an attempt to link energy systems and sustainability, Godfrey Boyle, *et al.* (2004), states that:

> In the context of energy, sustainability has come to mean the harnessing of those energy sources:
> - that are not substantially depleted by continued use;
> - the use of which does not entail the emission of pollutants or other hazards to the environment on a substantial scale; and
> - the use of which does not involve the perpetuation of substantial health hazards or social injustices.[26]

Moreover, "[r]enewable energies are also relatively 'sustainable' in the additional sense that their environmental and social impacts are generally more benign than those of fossil or nuclear fuels."[27]

Finally, it is noteworthy renewable energy effects could be supported from both weak and strong sustainability perspectives:

> "Energy access, social and economic development and energy security concerns are very often considered under the weak sustainability paradigm, because trade-offs are taken into account allowing for a balance between these goals. Environmental impacts, on the other hand, are usually evaluated under the strong sustainability paradigm because they are very often understood as constraints for transformation pathways."[28]

3.2. Renewable energy policy objectives and sustainability evaluation

Energy policy objectives, as well as the selection of the indicators used for its evaluation, are specific for each country and its reality. According to Karl Mallon (2006):

> There are many reasons (and therefore many potential objectives) for accelerating renewable energy development. They include sustainability objectives, energy policy reform, renewable energy production, new generating capacity, indigenous fuel manufacture, greenhouse gases (GHG) mitigation, distributed generation, increment size, energy cost and least-cost planning (internalization), energy security, new industry/manufacturing development, development of intellectual property in new technologies, job creation, rural development and nuclear phase-out.[29]

From these, and considering Ecuador's reality and requirements, objectives like development of intellectual property in new technologies or nuclear phase-out may not be as relevant as, for example, pursuing sustainability objectives, distributed generation, energy security, and rural development. As Elizabeth Lokey accurately suggests: "… the best policy choice for each country is case- and site-specific. The country's current electrical sector structure, portfolio mix and investment climate should be considered when making this decision."[30] In this sense, energy policies and their design play a key role for achieving the particular objectives related with the deployment of renewable energy and its effects on sustainability.

The evaluation of these context specific based energy policies, and their instruments like FITs, would be desirable not only to follow their effectiveness, but the monitoring process could also be useful to improve the desired effectiveness achieving the established objectives. According to Evert Vedung (1997), evaluation is a "careful retrospective assessment of the merit, worth and value of

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[26] *Supra* note 1.
[27] *Supra* note 1, p. 34.
[28] *Supra* note 2, p. 715.
[29] Karl Mallon (ed.), *Renewable Energy Policy and Politics, A handbook for decision – making,* Earthscan, 2006, p. 39.
[30] Elizabeth Lokey, *Renewable Energy Project Development Under the Clean Development Mechanism, A Guide for Latin America*, Earthscan, 2009, p. 312.

administration, output, and outcome of government interventions, which is intended to play a role in future, practical action situations."[31] For Kornelis Blok (2007), policies can be evaluated considering the following criteria: effectiveness, efficiency, and/or side effects. Additionally, "policy evaluation can take place before a policy is implemented (ex-ante evaluation) or after the policy has been implemented or has been in place for some time (ex-post evaluation)."[32] Since FITs in Ecuador have been in place since 2000, this thesis mainly focuses on an ex-post effectiveness evaluation, including the relevant positive or negative side effects that could have occurred. For this author, theory-based evaluation and/or econometric approaches could be used for the ex-post analysis of the effectiveness of policies. With respect to the former "[t]his assumes that policy instruments are based on an underlying 'theory' about how the policy is expected to work, or at least some implicit assumptions about the mechanisms of policy instruments."[33] In relation to this thesis, FITs are expected to promote sustainable development by encouraging RES-E. Regarding the econometric approach, within the data limitations of this research it should be considered that "[r]eliable econometric analysis is only possible when the available datasets are large enough."[34]

Regarding effectiveness, Vedung (1997) defines effectiveness assessment (evaluation) as "[t]he activity of finding out and appraising actual program impacts *without taking costs into account* … Effectiveness assessment also covers evaluation of outputs."[35] (Emphasis mine.) To evaluate such outputs, setting indicators is useful to monitor, in this case, the sustainability impacts of renewable energy. The IPCC has accurately recognized this as a challenge by stating that the currently available "[a]ggregate indicators of sustainability integrate many aspects of social and economic development, and hence, are ignorant of the specific sustainability impact of RE deployment."[36] Moreover, since policies, and their objectives, can be as wide as 'public policies', or as specific as 'energy', or even 'renewable energy' policies, it is important to clearly establish the specific policy and objectives that will be evaluated. In this sense, and since some objectives of Ecuador's renewable energy policy may have clearly defined targets, while others may not, then goal and/or goal-free evaluation, where applicable, have been used for the purposes of this research.

3.3. FITs: a policy instrument to promote RES-E

There are many policy instruments to promote RES-E, including: renewable portfolio standards and quotas, tradable certificates and Guarantees of Origin, voluntary green power programmes, net metering, public research and development expenditures, system benefit charges, tax credits, tendering, among others.[37] Between all these alternatives, Mendonça, *et al.* (2010) concludes that Feed-in tariffs (FITs) "are indeed the best single tool that governments can use to promote renewable energy."[38] Moreover, and with some exceptions, "[f]eed-in tariffs (FITs) have proven to be the best support mechanism to rapidly increase the share of renewable energy production and use."[39]

The main feature of a FIT scheme is the regulatory establishment of preferential prices to selected RES-E technology mixes during a determined period of time. In addition, according to Klein

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[31] Evert Vedung, *Public Policy and Program Evaluation*, Transaction Publishers, 1997, p.3.
[32] Kornelis Blok, *Introduction to Energy Analysis*, Techne Press, 2007, p. 247.
[33] *Ibid*, p. 248.
[34] *Id.*
[35] *Supra* note 31, p. 295.
[36] *Supra* note 2, p. 716.
[37] *Supra* note 18, p. 150.
[38] *Ibid.*
[39] *Supra* note 18, p. xiii.

(2008), "[t]ypically the purchase of the renewable electricity is guaranteed."[40] The following FIT design checklist proposed by Mendonça, *et al.* (2010) implicitly reveals the FIT features for a basic FIT scheme:

- Choose the eligible technologies based on the resource availability in your country.
- Determine which kind of power production plants shall be eligible.
- Establish a transparent tariff calculation methodology based on the generation costs of each technology.
- Set technology -and size- specific FITs.
- Fix the duration of tariff payment (usually 20 years).
- Create a robust financing mechanism, sharing the additional costs among all electricity consumers.
- Oblige the grid operator to purchase all renewable electricity.
- Grant priority grid access.
- Regulate the cost sharing for grid connection and reinforcement based on the 'shallow' or 'super-shallow' connection charging approach.
- Create effective administrative procedures.
- Set renewable energy targets and mention them explicitly in the FIT legislation.
- Establish a progress report as the scientific basis for future adjustments.[41]

FITs have different social, economic, environmental, and political advantages and challenges that are interlinked, affecting the conditions how a FIT scheme is designed and implemented. Mendonça's, *et al.* (2010) systematization of such advantages and challenges are presented in Annexes 4 and 5, respectively. However, many of these FIT's advantages and challenges proposed by these authors should not necessarily be strictly categorized as purely economic, social, political, or environmental, due to the complex nature and linkages between these dimensions from a sustainability perspective. Also, note that some of these proposed advantages and challenges are directly derived from FITs and some are derived from the development of RES-E, which is a desired consequence of an effective FIT scheme. In other words, this indistinctness can be explained since the main purpose of a FIT scheme is to promote RES-E, and further, the development of RES-E in itself has its own sustainability related objectives and effects. So, in principle, a FIT scheme offers the potential to ultimately promote sustainable development by fostering the deployment of RES-E, which objectives can also be implicitly found in Mendonça's, *et al.* (2010) proposed advantages of FITs (See Annex 4).

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[40] Arne Klein, *Feed-in Tariff Designs: Options to Support Electricity Generation from Renewable Energy Sources,* VDM Verlag Dr. Mueller e.K., 2008, p.9.

[41] *Supra* note 18, pp. 36-37.

4. THE FEED-IN TARIFF SCHEME IN ECUADOR

4.1. RES-E Legal Framework

Several legal bodies, directly or indirectly, support and deal with RES-E in Ecuador, starting from its Constitution, in force since October 20, 2008, to specific laws, regulations, and decrees.[42] In a nutshell, the legal bodies relevant for RES-E, and their effects over Ecuador's sustainable development, will be referenced below.

4.1.1. Constitution

According to Ecuador's Constitution, energy in all its forms is considered a strategic sector.[43] Particularly for RES-E and their sustainability, several articles from Ecuador's Constitution are relevant. Article 15 prescribes that "[t]he State shall promote, in the public and private sectors, the use of environmentally clean technologies and nonpolluting and low-impact alternative sources of energy.[44] Energy sovereignty shall not be achieved to the detriment of food sovereignty nor shall it affect the right to water." In the same spirit, article 413 establishes that "[t]he State shall promote energy efficiency, the development and use of environmentally clean and healthy practices and technologies, as well as diversified and low-impact renewable sources of energy that do not jeopardize food sovereignty, the ecological balance of the ecosystems or the right to water." Regarding the social sustainability aspect of RES-E, in numeral 6 of article 57 it is specified that indigenous communes, communities, people and nations are recognized and guaranteed the collective right to participate in the use, administration and conservation of natural renewable resources located on their lands.[45]

Finally, article 280 states that "[t]he National Development Plan is the instrument to which public policies, programs and projects, the programming and execution of the State budget, and the investment and allocation of public resources shall adhere." The last available National Development Plan was developed for the period 2009-2013. Table 4-1 extracts the role of RES-E in this plan from the strategic to the target level.

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[42] *Note* that article 425 of Ecuador's Constitution prescribes the hierarchy of the Ecuadorian legal system as follows: "[t]he order of precedence for the application of the regulations shall be as follows: the Constitution; international treaties and conventions; organic laws; regular laws; regional regulations and district ordinances; decrees and regulations; ordinances; agreements and resolutions; and the other actions and decisions taken by public authorities."

[43] *See* paragraph 2 from article 313 of Ecuador's Constitution.

[44] *Note* that such promotion is preserved from Ecuador's previous 1998 Constitution. *See* numeral 1 of article 89. This is relevant since the first FIT scheme to promote RES-E in Ecuador was approved in 2000.

[45] *Note* that this last collective right is preserved from Ecuador's previous 1998 Constitution. *See* numeral 4 of article 84. This is relevant since the first FIT scheme to promote RES-E in Ecuador was approved in 2000.

Table 4-1: RES-E on Ecuador's National Development Plan 2009-2013

Strategy	Objective	Policy	Policy guideline	Goal
Change energy mix.[46]	Guarantee the rights of nature and promote a healthy and sustainable environment.[47]	Diversify the national energy matrix by promoting and efficient and greater participation of sustainable sources of renewable energy.[48]	Encourage RES-E with social and environmental sustainability focus.[49]	Raise the share of alternative energy in the total installed energy capacity by 6% by 2013.[50]

Data source: SENPLADES

4.1.2. Laws

When it comes to non-conventional RES-E, article 63 from Ecuador's Electricity Sector Regime Law, in force since 1996, stipulates that "[t]he State will promote the development and use of non-conventional energy resources through public organizations, development banks, universities, and private institutions." Ecuador's FIT scheme is not explicitly incorporated into this law, but in specific regulations that will be described further. According to Mendonça, *et al.* (2010), "[a]ctivists and FIT advocates should fight for FITs being established by law and not just by a ministerial order or a vaguely articulated policy … For example, renewable electricity producers under the Spanish FIT scheme have had bad experiences with their FITs not having the legal status of a law."[51] In this sense, a new version of Ecuador's electricity law is being drafted and hopefully, it will incorporate specific legislation for its FIT scheme.[52]

Ecuador's Production, Commerce, and Investments Organic Code, in force since December 29, 2010, in its sixth book gives a general framework for sustainable production and its relationship with the ecosystem, for which non conventional RES-E plays a key role.[53] However, this general framework still needs to be complemented with secondary legislation in order to completely enable its implementation and enforcement.[54] In addition to this general framework, this code reformed Ecuador's Internal Tax Regime Organic Law, and gave an income tax exemption holiday for five years to new upcoming renewable energy investment projects that will be developed outside the urban jurisdictions of Quito and Guayaquil, Ecuador's main cities.[55] Moreover, the depreciation and amortization from RES-E technology and machinery will have an additional 100% tax deduction.[56] Besides, this code reformed the above-mentioned Electricity Sector Regime Law and explicitly gave the opportunity to the private sector to participate in non-conventional RES-E projects.[57]

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[46] *See* strategy 6.7 of SENPLADES, *National Plan for Good Living 2009 - 2013.*
[47] *Ibid,* objective 4.
[48] *Ibid,* policy 4.3.
[49] *Ibid,* policy guideline 4.3.c.
[50] *Ibid,* goal 4.3.3.
[51] *Supra* note 18, p. 64.
[52] Interview with Geovanny Pardo Salazar, Sectorial Management Control Undersecretary for Ecuador's Ministry of Electricity and Renewable Energy, February 9, 2012.
[53] *Note* that Ecuador's FIT scheme to support RES-E is highly compatible with the spirit of this general framework. Indeed, Ecuador's last revision of its FIT scheme (Regulation No. CONELEC 004/11) considered, among others, elements from this Code for its motivation.
[54] *Note* that the first general disposition of this Code, which is in force since December 29, 2010, established that "to legislate the different matters that are part of this Code, specific rules related with each of its books will be emitted within 90 days, according to the Constitution."
[55] *See* article 9.1 of Ecuador's Internal Tax Regime Organic Law.
[56] *See* numeral 7 from article 10 of Ecuador's Internal Tax Regime Organic Law.
[57] *See* paragraph 2 from article 2 of Ecuador's Electricity Sector Regime Law and Regulation No. CONELEC 002/11.

Ecuador's environmental legislation does not distinguish between non-conventional RES-E and other electricity generation projects in terms of their environmental requirements[58] and social participation mechanisms.[59] Regarding the latter, Ecuador has since 2008 a specific regulation and instructive to apply the participation mechanisms established in its environmental management law.[60]

4.1.3. Regulations

Ecuador's FIT scheme is governed by specific regulations approved by the board of directors of CONELEC, Ecuador's public regulatory institution for the electricity sector. Table 4-2 summarizes the approval evolution of these regulations, which main revisions will be further discussed in detail.

Table 4-2: Evolution of Ecuador's FIT scheme revisions

FIT Regulation No.	Date and CONELEC's Resolution No.
CONELEC 000/08	Approved on September 27, 2000 (Resolution No. 161/00)
CONELEC 003/02	Approved on March 26, 2002 (Resolution No. 074/02)[61]
CONELEC 004/04	Approved on December 24, 2004 (Resolution No. 280/04); in force since January 1, 2005.
CONELEC 009/06	Approved on December 19, 2006 (Resolution No. 292/06); in force since January 1, 2007.
CONELEC 004/11	Approved on April 14, 2011 (Resolution No. 023/11) and updated on January 12, 2012 (Resolution No. 017/12)

Data source: CONELEC

In addition to these regulations that are specific for the FIT scheme, Regulation No. CONELEC 002/11[62] enables private actors to participate in non-conventional RES-E projects in accordance to the above-mentioned primary legislation. Also, Regulation No. CONELEC 003/11[63] establishes authorization periods for non-conventional RES-E projects. *See* Annex 6. These authorization periods should not be confused with the FIT's validity periods that will be further exposed.

4.1.4. Decrees

On July 17, 2009, climate change adaptation and mitigation was declared by Ecuador as a State policy through Executive Decree No. 1815. This is relevant for RES-E considering the impact of non-renewable electricity on climate change. Decrees have also been useful in order to create and organize the different institutions around RES-E.[64] Finally, and in contradiction of RES-E deployment, subsidies to fossil fuels for electricity generation are also normed through Executive Decree.[65]

[58] *See* Ecuador's Environmental Regulation for Electricity Activities, which is in force since August 23, 2001.
[59] Interview with Paola Andino, Chief of the Environmental Control Unit at CONELEC, February 17, 2012.
[60] Ecuador's environmental management law is in force since September 10, 2004; the regulation to apply the participation mechanisms established in the environmental management law is in force since May 8, 2008; and its instructive is in force since July 17, 2008.
[61] *See* also CONELEC's Resolution No. 046/05.
[62] Regulation No. CONELEC 002/11: "Exceptionality for private participation in electricity generation" was approved on April 14, 2011 through Resolution No. 021/11.
[63] Regulation No. CONELEC 003/11 was approved on April 14, 2011 through Resolution No. 022/11.
[64] On January 3, 2008, the Strategic Sectors Coordination Ministry was created with Executive Decree No. 849. Since electricity is a strategic sector, this Ministry is responsible for the Ministry of Electricity and Renewable Energy, which was created on July 23, 2007 with Executive Decree No. 475. Under this Ministry of Electricity and Renewable Energy, on February 28, 2012, the Renewable Energy and Energy Efficiency National Institute, was created with Executive Decree No. 1048. Among others, the objective of this entity is to promote an increase in the share of sustainable renewable energy.
[65] Executive Decree 338 'Reglamento de Regulación de Precios de Derivados del Petróleo', Official Registry No. 73, August 2, 2005.

4.2. Evolution of Ecuador's FIT scheme design and its characteristics

A FIT scheme goes beyond setting preferential prices for RES-E and its design involves strategic selections over a range of aspects from validity periods to technological choices. This section examines the evolution and current status of these aspects based on the different elements considered by Mendonça, *et al.* (2010) for basic FITs design options. Finally, the relevant 'advanced' and 'bad' FIT design options are also explored.

4.2.1. Evolution of basic FIT design options

Recalling section 3.3, "basic FIT design options include: eligible technologies; eligible plants; tariff calculation methodology; technology - specific tariffs; size - specific tariffs; duration of tariff payment; financing mechanisms; purchase obligations; priority grid access; cost-sharing methodology for grid connection; effective administrative procedures; setting targets; and progress reports."[66]

Eligible technologies:

The technologies promoted in the FIT should be compatible with the country's RES-E potentiality. Detailed and updated potentiality maps are useful to determine the beneficiary technologies. Regarding these maps, on August 2008 CONELEC and the Corporation for Energy Research (CIE) published a solar radiation map for electricity generation purposes.[67] Ecuador does not have, yet, an official wind map but its development is expected to start during 2012.[68]

Figure 4-1 shows the evolution of the eligible technologies of the different revisions of Ecuador's FIT scheme. Here it is evidenced that each time, more technologies have been chosen to benefit from the proposed FIT scheme. For instance, the first FIT scheme in 2000 benefited four technologies: wind, geothermal, biomass/biogas, and photovoltaic RES-E. Later, on 2004 small hydroelectricity was incorporated into the scheme. Finally, in the 2012 update, marine currents and solar thermal were also integrated. Whilst desirable, this gradual addition of new technologies does not mean that the possibilities to improve in this aspect are over. According to Mendonça, *et al.* (2010), "[w]hen defining the technologies eligible under the FIT legislation, it is important to include precise definitions. This is especially true for biomass/waste and PV installations."[69] Regarding these cases, Ecuador's FIT scheme does not distinguish between the different biomass technological alternatives. The difference in availability and transport costs of the biomass input, to mention some examples, would require to be reflected on an accurate FIT design. Similarly, Ecuador's FIT scheme does not differentiate between freestanding and building-integrated photovoltaic alternatives. Such differentiation could determine the attractiveness and effectiveness, or not, of the existing FIT scheme.

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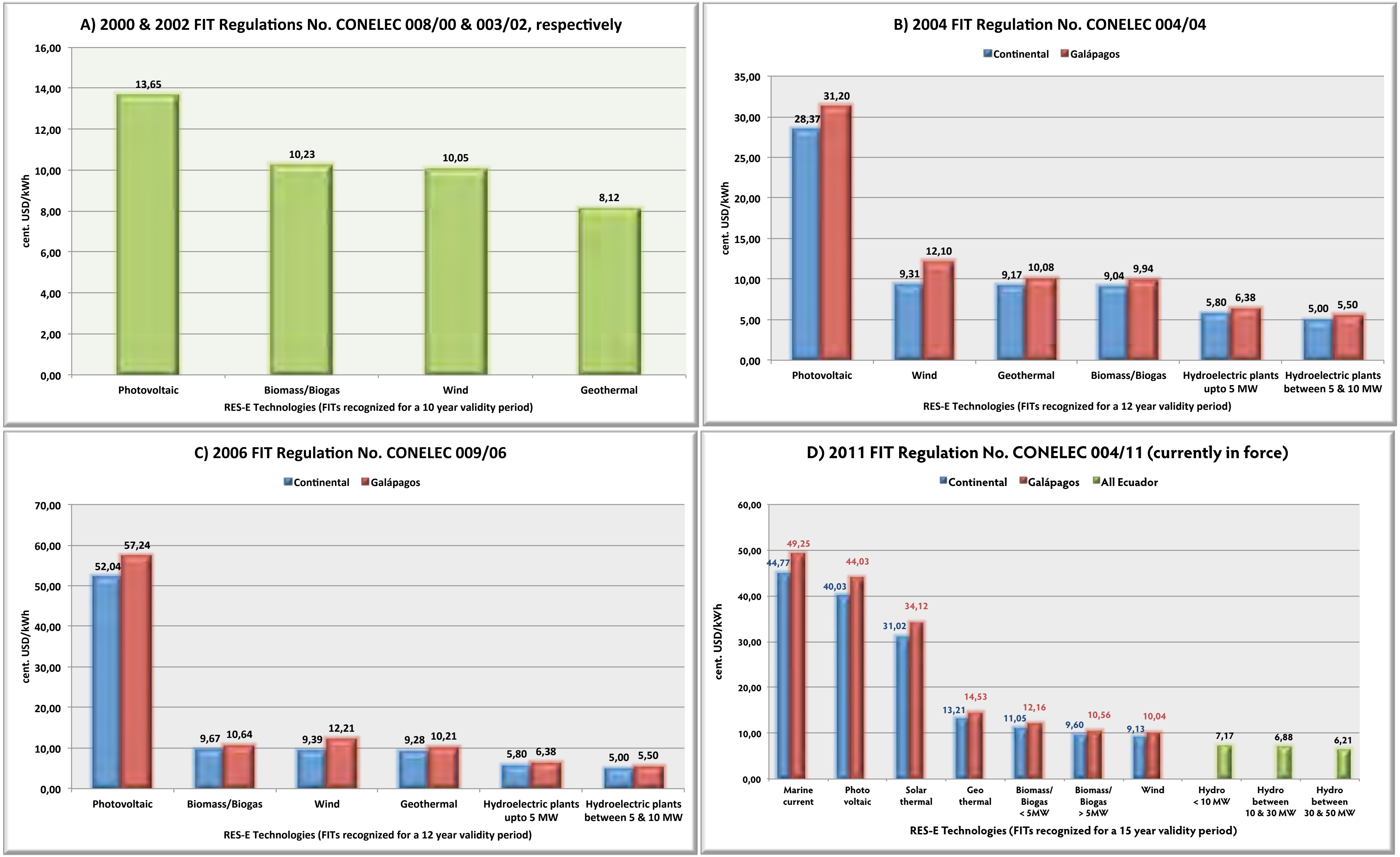
[66] *Supra* note 18.
[67] *Supra* note 8.
[68] Personal communication with Alfredo Samaniego, Renewable Energy and Energy Efficiency Undersecretary for Ecuador's Ministry of Electricity and Renewable Energy, December 7, 2011.
[69] *Supra* note 18, p. 17.



Data source: CONELEC

Figure 4-1: Evolution of Ecuador's FIT schemes revisions: A) 2000 & 2002, B) 2004, C) 2006, and D) 2011

Eligible plants:

Plants' eligibility in Ecuador's FIT scheme is in principle linked to the above-mentioned eligible RES-E technologies. Nevertheless, power size limitations have been traditionally considered in Ecuador's former FIT schemes in order to be eligible. Specifically, since 2000 Ecuador's FIT regulations have only recognized a preferential price for RES-E projects up to 15 MW, unless otherwise stated (*e.g.* hydroelectricity up to 10 MW). Moreover, if the size of the plant exceeded this limit, the FIT was only applied to the generation produced with the first beneficiary power. However, such restriction was eliminated in the FIT Regulation currently in force.

Regarding the eligibility of the plants according to their property nature (*e.g.* public and/or private), it can be deducted from the preamble of the different FIT regulation revisions that the traditional spirit of Ecuador's FIT scheme has been to stimulate private RES-E investments. However, the FIT regulation do not explicitly discriminates between public and/or private plants in terms of their eligibility for the FIT scheme. In this sense, Mendonça, *et al.* (2010), "… recommend avoiding the exclusion of any producer group from tariff payment. The open, participatory and democratic nature of FITs is one of their most important characteristics."[70]

Finally, each of Ecuador's FIT schemes have also established specific due dates in order to be eligible to the correspondent FIT scheme. Table 4-3 summarizes the evolution of these due dates' eligibility criteria among the different FIT scheme revisions.

Table 4-3: Due dates' eligibility criteria on Ecuador's FIT scheme revisions

FIT Regulation No.	Due date eligibility criteria
CONELEC 000/08	RES-E producers needed to start their operations until 2004.
CONELEC 003/02	
CONELEC 004/04	RES-E producers needed to subscribe their permit contracts before December 31, 2006.
CONELEC 009/06	RES-E producers needed to subscribe their permit contracts before December 31, 2008.
CONELEC 004/11	RES-E producers need to be granted the qualifying permit before December 31, 2012.

Data source: CONELEC

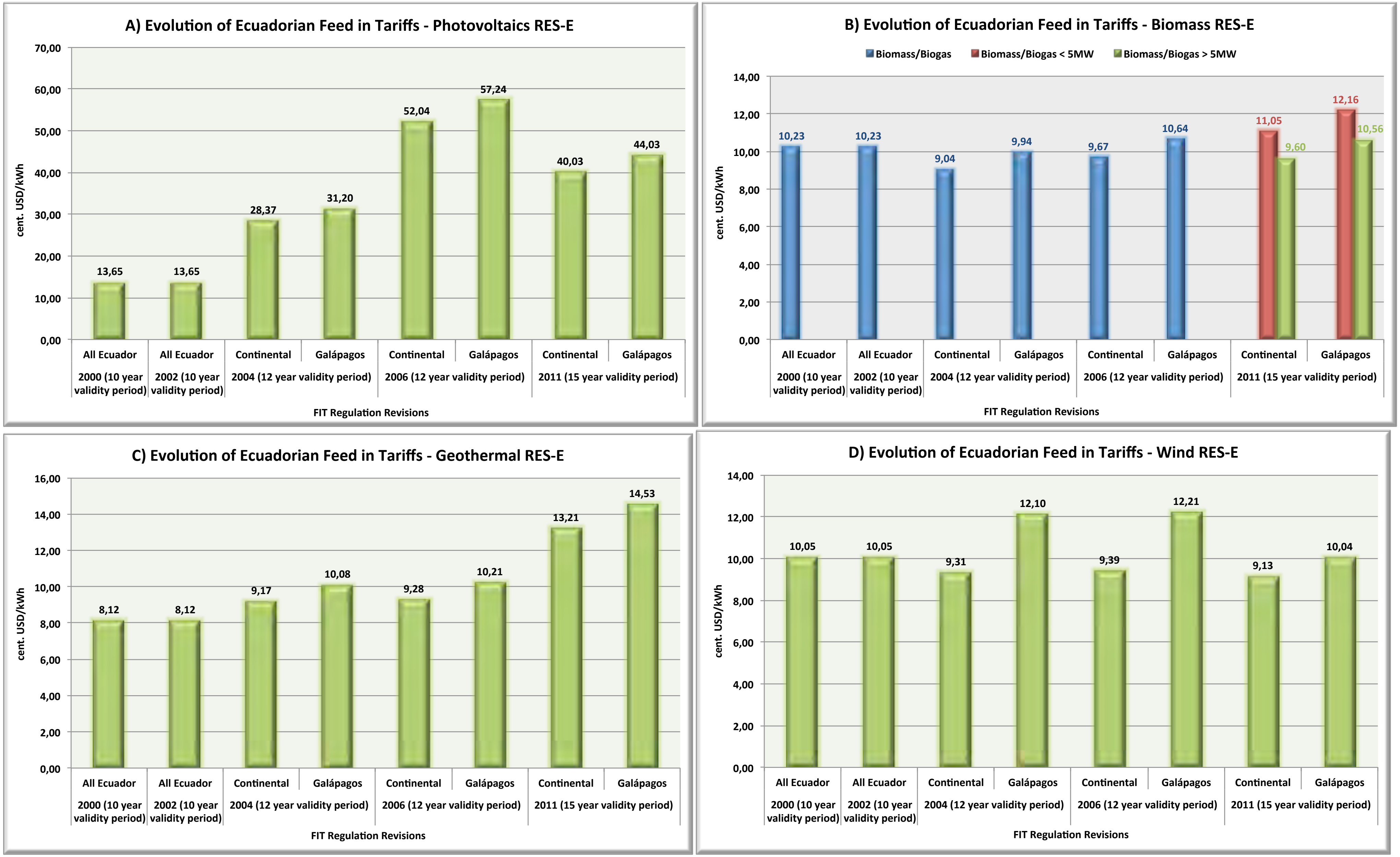
Tariff calculation methodology:

Ecuador's FIT calculation methodology has been mainly based on international experiences throughout its different FIT revisions. For example, article 9 of Ecuador's last FIT Regulation establishes that for the next FIT scheme revision to be in force since 2013, "… CONELEC will develop the respective study based on international references for these types of energies, the price reality of Ecuador's electricity market, or other procedure that could be considered convenient."

Technology and size specific tariffs:

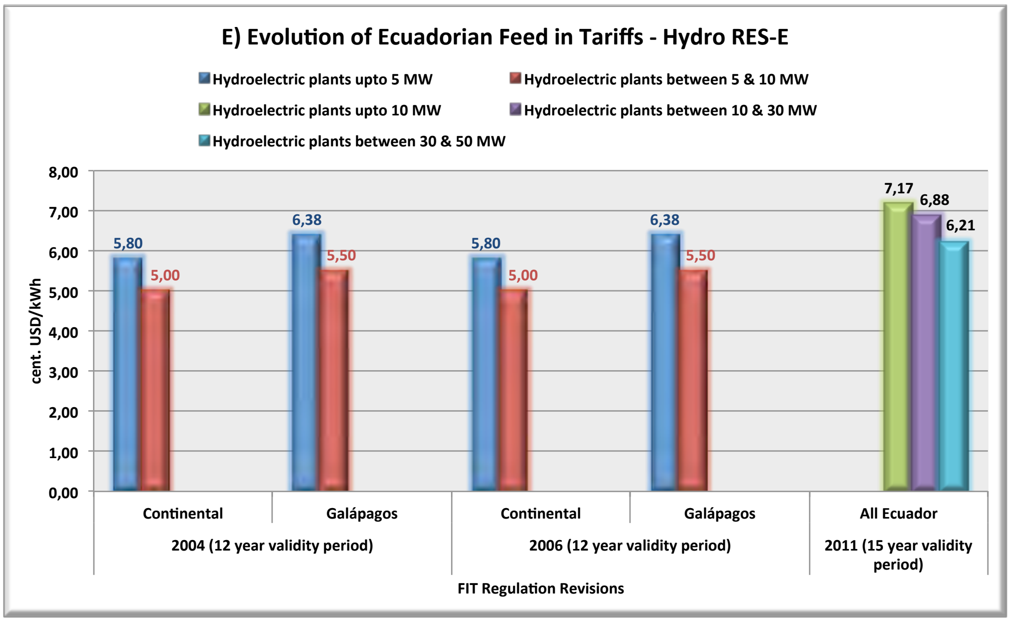
Figure 4-2 shows how the preferential tariffs for each of the beneficiary technologies have evolved throughout the different revisions of Ecuador's FIT scheme. In addition to the technological differentiation of tariffs, it can be seen that size specific tariffs have also been incorporated in Ecuador's FIT scheme. Such differentiation started for hydroelectricity with Ecuador's 2004 FIT revision. Specifically, it assigned a specific tariff for hydroelectric plants up to 5 MW and a slightly lower tariff for those between 5 and 10 MW. Later, these size ranges were revised in the last FIT Regulation. Now, hydroelectricity tariffs are divided in the following size specific groups:

[70] *Supra* note 18, p. 19.



Data source: CONELEC

Figure 4-2: Evolution of technology and size specific tariffs throughout Ecuador's FIT scheme revisions: A) Photovoltaic, B) Biomass, C) Geothermal, D) Wind



Data source: CONELEC

Figure 4-2: Evolution of technology and size specific tariffs throughout Ecuador's FIT scheme revisions: E) Hydroelectricity

up to 10 MW, between 10 and 30 MW, and between 30 and 50 MW. Additionally, this FIT revision incorporated size specific tariffs for biomass/biogas technologies below and above 5 MW, respectively. Regarding marine current and solar thermal RES-E technologies, specific tariffs for these alternatives were recently introduced in the last FIT scheme revision, which is currently in force as exposed on figure 4-1D.

Duration of tariff payment:

The duration of tariff payment has increased throughout the different revisions of Ecuador's FIT scheme. Table 4-4 summarizes such evolution:

Table 4-4: Duration of tariff payment on Ecuador's FIT scheme revisions

FIT Regulation No.	Duration of tariff payment
CONELEC 000/08	10 years, which started with the approval of the regulation on September 27, 2000.
CONELEC 003/02	10 years, which started with the scheduled entrance in operation of the plant.[71]
CONELEC 004/04	12 years, which started with the subscription of the permit contract.
CONELEC 009/06	
CONELEC 004/11	15 years, which started with the subscription of the qualifying permit.[72]

Data source: CONELEC

Table 4-5 also reveals that the condition from when these periods started to run has also evolved throughout the different revisions. In the current scheme, there is a strong incentive for the RES-E generator to avoid delays and start producing as soon as possible since the FIT validity period starts

[71] *Note* that the scheduled date of entrance in operation of the plant could differ from the effective date of entrance.
[72] In Spanish: 'Título habilitante'. According to Regulation No. CONELEC 002/11, this qualifying title enables the electricity producer to subscribe regulated Power Purchase Agreements (PPAs) with the distribution utilities.

with the subscription of the qualifying permit, and not with the plant's entry into operation. Project developers should carefully consider this particularity in their project formulation.

According to Mendonça, *et al.* (2010), "FITs around the world usually guarantee tariff payment for a period of 10-20 years, while a period of 15-20 years is the most common and successful approach."[73] These preferential tariff periods are key evaluation criteria especially for the involved financiers and/or investors since they will determine the payback time. In Ecuador's current FIT scheme revision, when these preferential tariff payment periods are over, and until the authorization periods from the qualifying permit expire, the beneficiary non-conventional RES-E will be treated similarly as conventional generation and their tariffs will be negotiated with the respective normative to be in force at that time.[74]

Financing mechanisms:

Traditionally, and irrespective of Ecuador's FITs for non-conventional RES-E, the real costs of all the electricity supply chain have not been entirely financed with the income resultant from the tariffs billed to the final consumers, which are subsidized. Specifically, the difference between these final consumer's prices and the real costs of the system represent a tariff deficit, which is recognized to the different electricity utilities by the central State as a subsidy.[75] Since FITs represent the 'real' costs to be recognized to the beneficiary non-conventional RES-E producers, then a portion of the resources required to finance these preferential prices will also come from the central State as a tariff deficit that complements the subsidized tariffs billed to the final consumers. Therefore, the reliability of such financing mechanism is dependent on the country's available fiscal resources, which, in an oil exporter country like Ecuador, are highly linked to the current international oil prices.[76] According to Mendonça, *et al.* (2010), "[a]s soon as governmental money is included in the financing scheme, there will be a stronger 'incentive' for governments to reduce the support of renewable energies, especially in times of economic downturn."[77]

Besides the above-mentioned subsidized tariff, in general Ecuador's electricity sector financing mechanisms have traditionally been complex and problematic, affecting its reputation to attract investments.[78] One of the reasons for this is that the electricity distribution public utilities still have much to improve regarding their technical and non-technical[79] losses and commercial performance (*e.g.* increase their billing recovery rates). Annex 7 shows the overall evolution of the distribution technical and non-technical losses, while Annex 8 shows the overall evolution of the distribution billing and recovery rates. For all these reasons, Ecuador's electricity sector has been characterized for a constant incapacity to completely fulfill its money flow requirements and obligations throughout the entire supply chain, including electricity generation.

Despite of this reputation, a positive consideration that is worth mentioning in the context of RES-E is that the Inter-institutional Committee for the Electricity Sector Policy Implementation, CEPSE,[80] has established a hierarchic payment mechanism to distribute the money flows throughout

[73] *Supra* note 18, p. 27.

[74] The price for non-conventional hydroelectricity RES-E will be settled according to the average prices of the regulated PPAs in force for each particular technology operating at that time.

[75] *See* Article 9 of Regulation No. CONELEC 006/08.

[76] In 2011, incomes from oil exports represented 41% of Ecuador's fiscal income according to Ecuador's Ministry of Finance. See <www.mef.gov.ec/documents/10156/83804/Información_SPNF_Historica_2001_2011>, visited on March 16, 2012 at 12:43.

[77] *Supra* note 18, p. 70.

[78] Interview with Rafael Drouet, February 13, 2012.

[79] Energy provided but not measured and/or billed to the final consumers.

[80] *See* Executive Decree No. 711 (October 2004) published on the Official Registry No. 140 of November 8, 2005.

the whole supply chain in the case that the available resources are not enough to compensate all the involved actors. On such mechanism, non-conventional RES-E has the second highest payment priority of all the generation just immediately after the payments for generation from electricity imports. Annex 9 shows the current payment order of this prioritization scheme. Potential RES-E financiers and/or investors should carefully consider in their risk analysis that with this mechanism the payment risk for non-conventional RES-E could be substantially diminished, and hopefully eliminated, at least from the electricity system's financial gap standpoint.

As a financial alternative for RES-E projects, the Clean Development Mechanism (CDM) is an option to complement revenues from FIT schemes. Here, it should be noted that the CDM Executive Board has provided guidance to the effect that, in cases where support policies like FITs have been implemented after 11 November 2001, the impact of those policies are not to be taken into account when developing a baseline scenario.[81] Otherwise, "if a feed-in tariff for renewable energy makes a project financially viable, then its financial additionality is negated"[82] under the CDM.[83]

Purchase obligations:

Non-conventional RES-E purchase obligation is linked to its dispatch mechanism. Specifically, dispatched electricity is purchased among the distribution utilities proportionally to their economic transactions in the wholesale market.[84] In this sense, Ecuador's FIT scheme has established that non-conventional RES-E should be mandatorily and preferentially dispatched until a certain limit by its market operator, CENACE. Before the last FIT scheme revision, such boundary was limited to 2% of the installed and operative capacity of the national interconnected system (SNI). In the last FIT reform currently in force, this limit has been expanded to 6%. Hydroelectricity is excluded from this cap. As a reference, by March 1, 2012, the total installed capacity of the SNI was 4.46 GW, which means that the share for non-conventional RES-E (excluding hydroelectricity) could be up to 268 MW in order to be mandatorily and preferentially dispatched and purchased.[85] If this limit is exceeded, the surpassed generation will be dispatched and settled like conventional generation. The increase of this limit from 2% to 6% in the last FIT scheme revision was a clear evidence that, for the future, such cap is not carved in stone. Moreover, article 6.3 of the current FIT regulation establishes an open window by stating that "in the case that subsidy or tariff compensation policies are dictated by the State for the promotion of non conventional RES-E, there could be a preferential dispatch over the 6% and up to the cap defined in these policies."

Priority grid access:

Once the RES-E producer is connected to the grid, its access priority depends on CENACE's dispatch instruction, which generally responds to a merit order according to technical and economic optimization criteria. Regarding the latter, a special condition for the preferential dispatch of non-conventional RES-E should be taken into account. Specifically, article 21 of Ecuador's substitutive regulation for the operation of the electricity wholesale market establishes that "[a]ll energy from non conventional RES-E delivered to the National Interconnected System, SNI, will not be part of the

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[81] UNFCCC, *Annex 3: Clarifications on the Consideration of National and/or Sectoral Policies and Circumstances in Baseline Scenarios,* <http://cdm.unfccc.int/EB/022/eb22_repan3.pdf>, visited on May 11, 2012 at 10:21.
[82] *Supra* note 30, p. x.
[83] Note that Ecuador's first FIT scheme dates back to 2000.
[84] *See* Article 21 of Ecuador's substitutive regulation for the operation of the electricity wholesale market; Original name in Spanish: 'Reglamento Sustitutivo para el Funcionamiento del Mercado Eléctrico Mayorista.'
[85] *See* <www.conelec.gob.ec/contenido.php?cd=10167&l=1>, visited on March 19, 2012 at 09:33.

economic dispatch; this is: their costs will not be considered to establish the marginal cost."[86] In this sense, the priority grid access is implicit in Ecuador FIT scheme regulation when it establishes that non-conventional RES-E should be mandatorily and preferentially dispatched into the grid.

Cost-sharing methodology for grid connection:

Until Ecuador's 2006 FIT Regulation, in cases where RES-E producers required a transmission line to get connected to the grid and assumed its total investment costs, the FIT was complemented with an extra payment of 0.0006 USD/kWh/km with a maximum limit of 0.015 USD/kWh, equivalent to up to 25 kilometers. Such monetary recognition was eliminated on the current FIT Regulation, which instead establishes that the required grid for getting connected into the distribution or transmission system, will be considered in the respective expansion and transmission plans. This approach is compatible with Mendonça, *et al.* (2010) recommendation of "using the shallow grid connection approach or even the super-shallow grid connection approach."[87] However, in Ecuador's case it is not enough that the grid connection costs are considered on these plans, but also an adequate implementation of such plans would be highly desirable from the RES-E producer perspective.

Effective administrative procedures:

Annex 10 shows the main current administrative procedures for non-conventional RES-E projects that would expect to get a qualifying title, which enables them to subscribe a Power Purchase Agreement (PPA) with the distribution utilities in the terms established by the FIT scheme regulation. In this aspect, the RES-E producer subscribes a PPA with a representative of the demand in the name of all the involved distribution utilities.[88]

Setting targets:

According to Mendonça, *et al.* (2010), "targets are important in signaling long-term political commitment to investors … Targets can be formulated as a certain share of renewable energies in the overall energy or electricity mix … We recommend establishing targets for the short, mid and long term…"[89] In Ecuador's case, the National Development Plan's short term goal for the period 2009-2013 is to reach a 6% participation of RES-E over the total installed capacity. This target should not be confused with the current capacity cap established in the current FIT scheme regulation.

Beyond this short-term time horizon, Ecuador has two relevant documents with an extended time horizon until 2020: the Ministry's of Electricity and Renewable Energy "Policies and strategies to change Ecuador's energy matrix"[90] released on May 2008 and CONELEC's Electrification Master Plan for the period 2009-2020. They both clearly mention the potential of non-conventional RES-E, but none of them establish for this period an explicit participation target of RES-E over the total electricity generation installed capacity. Nevertheless, the latter shows specific projects for the expansion of electricity generation until 2020. A summary of projects that were considered when this Master Plan was elaborated and that fit with the technological choices that are eligible with the current FIT scheme is presented on Annex 11.

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[86] *Supra* note 84.
[87] *Supra* note 18, p. 33.
[88] See Resolution No. CONELEC 023/12 approved on March 15, 2012.
[89] *Supra* note 18, p. 35.
[90] Ministerio de Electricidad y Energía Renovable, *Políticas y Estrategias para el cambio de la matriz energética del Ecuador*, May 2008.

Although the time horizon of CONELEC's Electrification Master Plan is until 2020, the last non-conventional RES-E project in this plan is expected to enter into operation on September 2014. This evidences lack of medium and long term planning regarding non-conventional RES-E.[91] Moreover, there is a clear inconsistency between electricity generation expectations of the FIT scheme as a policy instrument to promote non-conventional RES-E and the currently available official planning, which, besides large scale hydroelectricity and a couple of wind projects, does not contemplates at all the remaining non conventional RES-E technological alternatives supported by Ecuador's FIT scheme. However, it is worth mentioning that by the time when this thesis was written, Ecuador's Electrification Master Plan for the period 2013-2022 was in progress[92] and the forecasting for RES-E alternatives will probably differ from the currently available 2009-2020 Electrification Master Plan. For instance, Ecuador's Strategic Sectors Coordinator Ministry (MICSE) published on January 2012 an investment catalogue where the geothermal RES-E alternatives presented on Annex 12 were included and their construction phase is expected to start in January 2015.

Regarding targets related with sustainable development, Ecuador's National Development Plan for the period 2009-2013 established as a goal to ensure that 97%,[93] 98%,[94] and 96%,[95] of national, urban, and rural households, respectively, have access to electricity by 2013. RES-E has the potential to contribute to these electricity coverage targets. However, besides these short-term goals, none other sustainability related targets are established in relation to the promotion of RES-E projects. This is a critical issue for monitoring and evaluating the *rationale* of promoting RES-E alternatives. As it was mentioned before, a sustainability evaluation of renewable energy policy is a novel field and some of these indicators will be proposed and analyzed further on section five in the specific context of Ecuador's electricity sector.

Progress reports:

According to Mendonça, *et al.* (2010), "evaluating and periodically reporting on the state and progress of FIT programmes is crucial for long-term success."[96] In Ecuador, prior the approval of each FIT revision, CONELEC prepares a report supporting the changes on the conditions of each FIT scheme revision. So far, such reports have been used internally and have not been openly published, for example, at CONELEC's web portal. However, according to article 19 of Ecuador's Organic Law of Transparency and Public Information Access, anyone who could be interested (*e.g.* potential investors and/or financiers) on such reports could motivate their requirement and formally ask for them to CONELEC's executive director. According to article 9 of this law, the applicant should receive a reply within the next 15 days.

4.2.2. Advanced FIT design options

In addition to the above described basic FIT design options, Mendonça, *et al.* (2010) also propose the advanced FIT design options systematized on Table 4-5:

[91] The necessity of medium and long-term RES-E targets was specially stressed out during the interview with Alfredo Mena, Executive Director at Energy Research Corporation (CIE), February 27, 2012.
[92] Interview with Paúl Vásquez, Planning Manager at CONELEC, February 23, 2012.
[93] *See* goal 4.3.4 of SENPLADES, *National Plan for Good Living 2009 - 2013.*
[94] *Ibid,* goal 4.3.5.
[95] *Ibid,* goal 4.3.6.
[96] *Supra* note 18, p. 36.

Table 4-5: Advanced FIT design options

Aim		Other 'novel' options
Better market integration	**Ensure economic efficiency and keep windfall profits to a minimum**	
• Premium FITs • Incentives for participation in the conventional energy market • Demand-oriented tariff differentiation • Tariff payment for combining technologies • Forecast obligation • Special tariff payment for grid services	• Location-specific design • Tariff payment for limited or total electricity generation • Tariff degression • Flexible tariff degression	• Increasing tariffs • Inflation-indexed tariffs • Additional tariff payment for innovative features • Exclusion for energy-intensive industries

Source: Mendonça, *et al,* (2010, p. 39)

From these, Ecuador has incorporated on its FIT design the forecast obligation for those generators that are subject to the centralized dispatch system. Regarding location-specific designs, Ecuador has implemented since its 2004 FIT revision a tariff differentiation depending if whether the beneficiary RES-E project is developed in Ecuador's continental territory or in the Galapagos Islands. In Ecuador's case, such differentiation is a special consideration for location-specific designs and does not respond to differences in, for example, the solar radiation or wind quality of the site, but to the fact that RES-E projects in the Galapagos Islands tend to have higher access and transport costs throughout all their stages, including construction, operation, maintenance, and decommissioning. Finally, regarding a tariff payment for limited electricity generation, as it was explained above, Ecuador's last FIT Regulation eliminated the 15 MW cap restriction. The other proposed advanced FIT design options presented in Table 4-6 could be evaluated for future revisions depending on how the conditions and specific objectives of the FIT scheme as a policy instrument evolve over time.

4.2.3. 'Bad' FIT design options

Mendonça, *et al.* (2010) suggest a list of 'not recommendable' FIT design options, which include: low tariff level, unnecessarily high tariff level, flat-rate tariff, maximum and minimum tariffs, exemptions from purchase obligation, bad financing mechanisms, bad tariff calculation methodologies, capacity caps, and legal status.[97] Table 4-6 describes Ecuador's FIT scheme in relation to each of these 'disadvantageous' design choices.

[97] *Supra* note 18, pp. 57 - 64.

Table 4-6: 'Bad' FIT design options

'Bad' FIT design options	Ecuador's FIT scheme
Low or unnecessarily high tariff level	Until Ecuador's 2002 FIT revision, tariffs for photovoltaic RES-E was set to 13,65 cent.USD/kWh, which could be considered a relatively 'low' tariff for this technology, especially back in 2002. However, this tariff was revised and increased in later regulations based on international experiences. As a reference for tariff levels, the Intergovernmental Panel on Climate Change (IPCC) on its 2011 Special Report on Renewable Energy Sources and Climate Change Mitigation presented in its Annex III some Recent Renewable Energy Cost and Performance Parameters with ranges of levelized costs of electricity for 19 RES-E technological choices.[98] These costs are presented on Annex 13.
Flat-rate tariff	Although the beneficiary technologies have increased over the different FIT scheme revisions in Ecuador, some technological choices are still too general (*e.g.* biomass/biogas). Such broad level of specificity could somehow be characterized as a type of a flat-rate tariff. As a reference, the IPCC proposed a well-elaborated breakdown of technologies that could also be evaluated for further revisions depending on the country's specific RES-E potentiality and promotion policy. See Annex 13.
Maximum and minimum tariffs	Ecuador's FIT scheme sets a fixed tariff for each technology and does not have maximum and/or minimum tariffs.
Exemptions from purchase obligation and capacity caps	If any exemption from purchase obligation is established in Ecuador's FIT scheme, it is related with a capacity cap for RES-E, which was formerly 2% and is currently 6% of the installed and operative capacity of the SNI. Hydroelectricity is not considered for such exemption. According to Mendonça, *et al.* (2010), "… today it will be much easier to argue against capacity caps, as the need for massive renewable energy deployment cannot be dismissed in the light of global climate change."[99]
Bad financing mechanisms	If the subsidized tariff charged to the final consumer is not enough to cover the required resources to finance the FIT, such gap is covered from a tariff deficit subsidy, which is financed with the government's budget.
Bad tariff calculation methodologies	Ecuador's FIT scheme is revised on the basis of international experiences, the price reality of Ecuador's electricity market, or other procedure that could be considered convenient by CONELEC.
Legal status	Ecuador's FIT scheme has been governed by CONELEC's regulations, which are hierarchical inferior than laws.

[98] Bruckner, T., H. Chum, A. Jäger-Waldau, Å. Killingtveit, L. Gutiérrez-Negrín, J. Nyboer, W. Musial, A. Verbruggen, R. Wiser, 2011: *Annex III: Cost Table. In IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation* [O. Edenhofer, R. Pichs-Madruga, Y. Sokona, K. Seyboth, P. Matschoss, S. Kadner, T. Zwickel, P. Eickemeier, G. Hansen, S. Schlömer, C. von Stechow (eds)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.

[99] *Supra* note 18, p. 64.

5. FINDINGS AND ANALYSIS

As explained above, a FIT scheme is a specific policy instrument intended to promote commercialization and further deployment of RES-E technologies. This section will explore: a) the effectiveness of Ecuador's FIT scheme in terms of encouraging RES-E, and b) their contribution to certain sustainability parameters. As long as it has been possible, goal attainment evaluation has been applied. In this sense, the only specifically established goals detected were: a) to reach a 6% participation of RES-E over the total installed capacity and b) to ensure that 97%, 98%, and 96% of national, urban, and rural households, respectively, have access to electricity by 2013. However, such targets has been set for the 2007-2013 National Development Plan, while the FIT scheme has been in force since 2000. For this reason, and as long as the gathered data allowed, goal free evaluation has been used for the previous periods, as well as for the remaining sustainability related objectives that Ecuador has not explicitly defined any specific targets in relation to RES-E.

5.1. Effectiveness of FIT to promote non-conventional RES-E in Ecuador

Ecuador's FIT effectiveness in terms of promoting non-conventional RES-E projects has been evaluated individually for each of the FIT scheme revisions since their characteristics have evolved as exposed on the previous chapter. In addition, the elements that have affected investor's security to attract, or not, RES-E investments, have been addressed as well.

5.1.1. Evolution of non-conventional RES-E along with FIT regulations

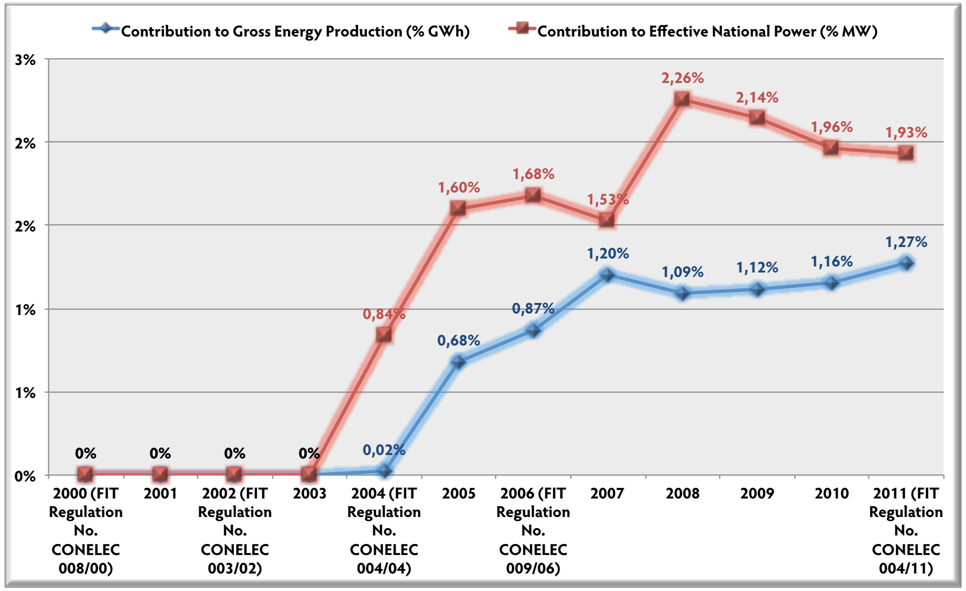
Despite of the existence of a FIT scheme to support non-conventional RES-E since 2000, none geothermal capacity has been implemented, while biomass (Figure 5-1), wind (Figure 5-2), and solar (Figure 5-3) RES-E alternatives have not showed a significant contribution in terms of electricity generation and share in Ecuador's electricity mix. By the time of writing this thesis, neither solar thermal nor marine current projects that are beneficiary of Ecuador's FIT scheme have been developed since these technologies were recently incorporated into Ecuador's FIT scheme on January 2012.

Currently existent biomass RES-E projects that are beneficiary of Ecuador's FIT scheme are showed on Table 5-1. These projects are subject to the 2002 FIT Regulation, so only the first 15 MW, totaling 45 MW, are beneficiary of this FIT scheme. These biomass RES-E projects are located on Ecuador's continental territory, while the remaining wind and solar RES-E projects have been developed so far only on the Galapagos Islands.

Table 5-1: Private biomass RES-E producers

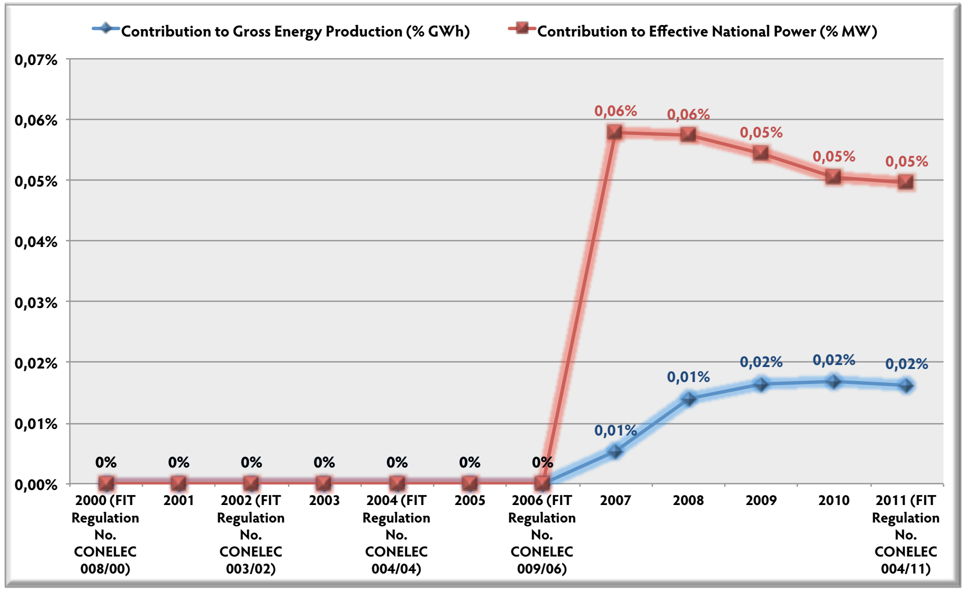
PRODUCER	INSTALLED CAPACITY (MW)	CONELEC'S CERTIFICATE DATE	OPERATIVE SINCE
SAN CARLOS	35,00	June 25, 2004	December 2004
ECUDOS (Lucega)	34,80	December 10, 2004	July 2005
ECOELECTRIC	36,50	December 10, 2004	June 2005

Data source: CENACE



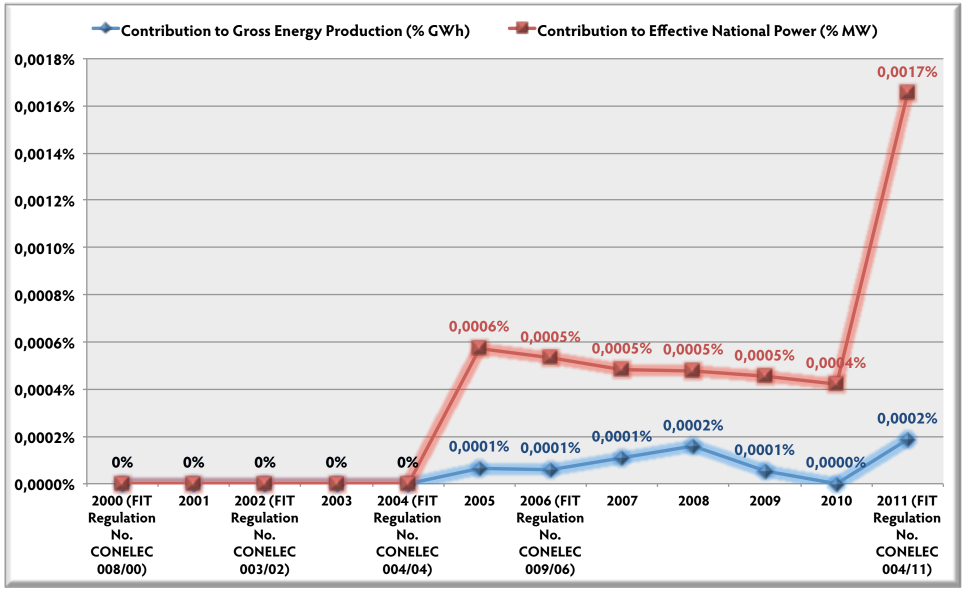
Data source: CONELEC

Figure 5-1: Evolution of Biomass Share in Ecuador's Electricity Mix



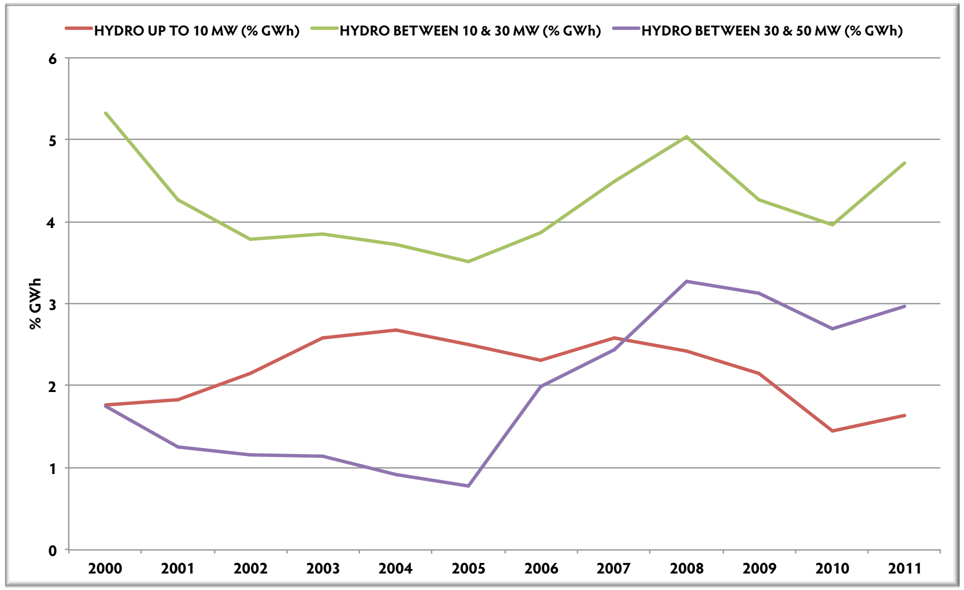
Data source: CONELEC

Figure 5-2: Evolution of Wind Share in Ecuador's Electricity Mix



Data source: CONELEC

Figure 5-3: Evolution of Solar Share in Ecuador's Electricity Mix



Data source: CONELEC

Figure 5-4: Evolution of Hydro (< 50 MW) Share in Ecuador's Electricity Mix

Ecuador's wind RES-E showed on Figure 5-2 corresponds to the 2.4 MW (3 x 800 kW) of Galapagos Island's San Cristobal wind project, which started its operations on October 2007. This project was developed by a special commercial trust named EOLICSA and the price conditions established on the 2006 FIT Regulation were reflected on the PPA subscribed between EOLICSA and Galapagos electricity utility, ELECGALAPAGOS. Regarding the solar RES-E presented on Figure 5-3, it mainly corresponds to photovoltaic systems installed on Floreana Island in the Galapagos Archipelago. These 18 kWp started operations on March 2005.[100] Finally, Figure 5-4 shows the evolution of the contribution of hydroelectricity over the gross electricity production (% GWh) according to the size specific division of the last FIT Regulation.[101] However, in terms of FIT policy effectiveness, it should be noted that these RES-E have not necessarily been beneficiary of the FIT scheme since, for instance, these projects may be already established and operating before the enforcement of the different FIT scheme revisions.

The FIT treatment for RES-E projects that are developed in the Galapagos Islands are particular because these isolated systems are not connected to the national interconnected grid and a unique electricity utility, ELECGALAPAGOS, is in charge of the electricity generation, transmission, distribution, and retail in the archipelago.[102] In this setting, the Renewable Energy for Galapagos project, ERGAL, is in charge of RES-E projects. The RES-E development in the Galapagos Islands has received considerable attention from the international community since its invaluable natural heritage.[103] This makes these projects *sui generis* because the driver to deploy RES-E in the Islands goes beyond the commercial attractiveness intended by the FIT scheme.[104]

Summing up solar, wind, and biomass capacity, they have all contributed to less than 2% of Ecuador's electricity mix by 2011. The current FIT scheme revision should be extremely effective in order to reach the proposed 6% targets by 2013.

5.1.2. Attracting RES-E investments

Ecuador's historical reputation of political and economic instability has blurred the potential effectiveness of its FIT scheme. To illustrate such instability, Ecuador has had 8 presidents since 1996.[105] Ecuador's former legal tender, the 'Sucre', was replaced in 2000 (year when the first FIT scheme started to be in force) by the United States dollar, which now is the official currency, due to an accelerated macroeconomic crisis with an uncontrollable depreciation phenomenon that reached its peak on 1999 when the Sucre lost 67% of its foreign exchange value.[106] Such instability raised the country's risk perception on these years as reflected on the volatility of Ecuador's Emerging Markets Bond Index (EMBI) showed on Annex 14. This index abnormally raised during 2009, which was an electoral year for Ecuador, evidencing EMBI's sensitivity to Ecuador's political uncertainty. Although current EMBIs are not as high as in the past crisis years, there is still much to do in terms of improving the country's overall business climate, which, according to the World Bank's Doing Business ranking, Ecuador is ranked 130 out of 183 countries in 2012, only above Bolivia and Venezuela from other

[100] *See* <www.ergal.org/cms.php?c=1300>, visited on April 10, 2012 at 10:42.
[101] *Note* that Regulations No. CONELEC 004/04 and 009/06 have a different division and recognized different preferential prices only for hydroelectricity up to 5 and 10 MW, respectively.
[102] *See* <www.ergal.org/cms.php?c=1292>, visited on April 10, 2012 at 10:01.
[103] ERGAL's investor structure showed on <www.ergal.org/cms.php?c=1282> is a proof of such attention.
[104] Interview with Luis Vintimilla, General Manager at EOLICSA, March 7, 2012.
[105] *See* Historia de los presidentes de Ecuador, <www.migranteecuatoriano.com/ecuador/presidentes-de-ecuador>, visited on 20 November 2011 at 11:38.
[106] Stephen Grimsley, *Dollarization in Ecuador*, <www.ecuadornumismatics.com/numisphily/dollarization/dollarization.html>, visited on 13 April 2012 at 18:59.

Latin American countries. The components of this ranking are exposed on Annex 15. [107] Independently of the methodology used by these indicators, in practice they may influence the investor's perception of a particular country.

Since the above-mentioned crisis, attracting investments in all industries, including electricity, has been a permanent challenge for Ecuador. In the particular case of the electricity sector, and also due to the previously explained payment risks, the few private non-renewable electricity generation utilities (*e.g.* Electroquil and Machala Power[108]) have struggled in terms of opportunely recovering their portfolio and have demanded payment guarantees, creating a negative signal to other potential investors, including RES-E. [109] From interviews conducted, it can be determined that such payment uncertainty has characterized Ecuador's electricity sector and has been one of the main reasons why the FIT scheme has not had the desired success in terms of promoting RES-E, regardless of the economic signal given through the establishment of preferential prices that have always existed since 2000. However, these unfavorable market conditions have changed over time and, as it is exposed on Annex 9, RES-E has now a special treatment in terms of their payment priority. This may not be a guarantee in itself, but still is a positive signal at least to minimize the involved payment risk. In addition, at the beginning of the FIT scheme back in 2000, private RES-E investments were not as supported as they are nowadays with the entire legal framework that has evolved and that was described on section 4.1. However, an updated electricity law compatible with these legal bodies that have emerged over time would be determinant in terms of providing legal certainty and investor's security for RES-E projects under a FIT scheme.

5.2. Contribution of non-conventional RES-E to selected sustainability issues

In addition to the above-evidenced weak effectiveness of Ecuador's FIT scheme in terms of promoting RES-E, one of the main findings of this research is that, in general, Ecuador's renewable energy policy lacks specific sustainability-associated renewable energy policy objectives and targets. At most, since its origins on 2000, the FIT scheme as a policy instrument has been conceived with the general objective of promoting RES-E for the specific technologies contained on each of its revisions. Explicit RES-E participation and electricity coverage goals were further established with the National Development Plan for the period 2007-2013. Irrespective of the weak effectiveness of Ecuador's FIT scheme evidenced on section 5.1.1 and the general lack of sustainability-associated renewable energy objectives and targets on Ecuador's policy design, this section has attempted a goal free evaluation explaining Ecuador's status in relation to the proposed set of potential sustainability related renewable energy policy objectives selected on section 2.2.

5.2.1. Energy security

In order to ensure energy security, Ecuador depends on fossil fuel based electricity generation and imports. RES-E deployment can contribute to reduce such dependency and provide 'clean' energy security.

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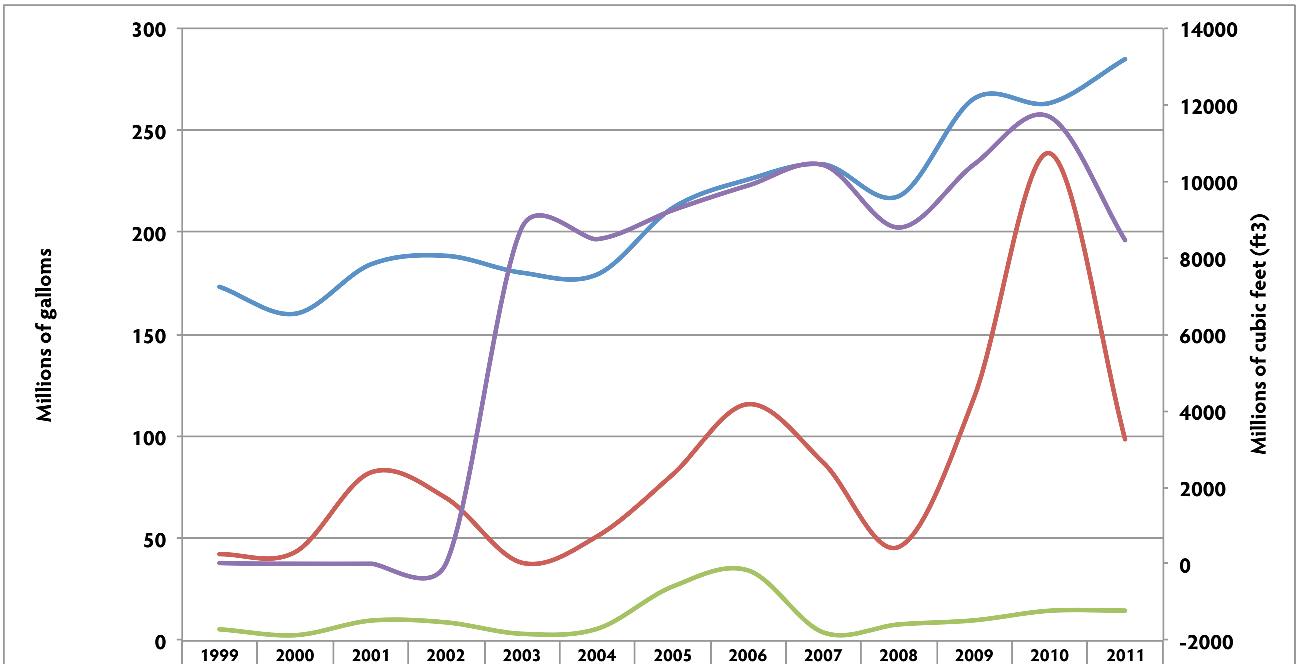
[107] World Bank and International Finance Corporation, *Doing Business in a More Transparent World, 2012,* <www.doingbusiness.org/~/media/FPDKM/Doing%20Business/Documents/Annual-Reports/English/DB12-FullReport.pdf>, visited on 14 April 2012 at 11:43.

[108] *Note* that the Ecuadorian government on June 2011 acquired Machala Power. *See* El Comercio, *Machala Power a manos del Estado,* <www.elcomercio.com/negocios/EDC-Machala-Power-pasaron_0_496150546.html>, visited on 13 April 2012 at 21:19.

[109] Supra note 78.

Dependence on fossil fuels:

Although Ecuador is a crude oil exporter country, its current refineries have limited capacity and still imports processed petroleum products such as diesel, which is not only demanded for transportation, but is also required for electricity generation. Ecuador has currently diesel importing agreements with Venezuela, ENAP Chile, and ANCAP Uruguay.[110] As it can be recalled from Figure 1-1, non-renewable thermal electricity generation has had a significant role in Ecuador's electricity mix. Figure 5-5 shows the evolution of the consumption of the main fossil fuels used for electricity generation in Ecuador. The increasing tendency in the demand of these fossil fuels evidences that the incorporated RES-E have not been able to avoid Ecuador's dependency from fossil fuels. This dependency was especially clear when, for example, on 2009 and 2010 Ecuador faced an energy security crisis that led to scheduled blackouts across the country. Figure 5-5 reveals a prominent increase of fossil fuel's consumption on these years when the hydrological conditions were not favorable.



	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Fuel Oil	173,22	160,114	184,31	188,49	180,22	179,34	211,94	225,91	233,33	217,77	265,65	263,41	284,96
Diesel	41,83	43,32	82,3	69,7	38,04	50,97	81,23	115,76	87,09	45,76	119,27	238,81	98,55
NAFTA	5,69	2,66	9,81	8,93	3,34	5,78	26,5	34,44	4	7,94	9,95	14,64	14,71
Natural Gas	0	0	0	24,21	8782,3	8489,43	9244,61	9891,93	10426,63	8794,13	10448,6	11688,28	8464,07

Data source: CENACE

Figure 5-5: Evolution of Fossil Fuel's Consumption for Electricity Generation

Effectively promoting RES-E in order to create hedge against conventional fossil fuels price volatility is especially convenient for Ecuador's State budget since fossil fuels for electricity generation are highly subsidized. Moreover, from a social development perspective, if RES-E projects could substitute the use of these subsidized fossil fuels, more resources could be potentially liberalized and directed to other social priorities, like health and education, just as examples to magnify the involved opportunity costs of relying on non-renewable sources instead of RES-E. A summary of the evolution of the unitary

[110] PETROECUADOR EP, Informe Estadístico 2010, <www.eppetroecuador.ec/Internet1/CentroHome/centro/000812>, visited on16 April 2012 at 17:10, p. 117.

subsidized prices of the different fossil fuels used for electricity generation is presented on Annex 16.[111] Even with these subsidies, and without internalizing the resulting environmental impact, electricity generation based on diesel has been in some years more expensive than the current preferential prices for biomass/biogas, wind, and hydroelectricity. Annex 17 shows the evolution of Ecuador's non-renewable thermoelectricity average prices.

Dependence on electricity imports:

Also, the implementation of RES-E projects could potentially increase energy independence from foreign electricity imports. However, it should not be ignored that in the absence of local capacity and within the limits of the interconnection transmission lines[112] and foreign export capacity, energy imports are still an alternative to guarantee electricity supply. In the case of Ecuador, it is interconnected with Colombia and Peru. So far, the scarce incorporation of the RES-E projects promoted by the FIT scheme has not been enough to completely avoid electricity imports. The evolution of Ecuador's international transactions with its main electricity commercial partner, Colombia, with whom Ecuador has traditionally been a net importer of electricity, is shown on Annex 18. From Peru, Ecuador imported 174 GWh during the semester November 2009 - April 2010 when the lack of local generation (renewable or not) threatened Ecuador's capacity to guarantee electricity supply. According to CENACE, average prices of Ecuador's imports from Peru on these periods were of 24,55 cent.USD/kWh for 2009 and 28,66 cent.USD/kWh for 2010. As a reference, these prices are well above the preferential prices for geothermal, biomass/biogas, wind, and hydroelectricity technologies promoted on Ecuador's current FIT scheme.

5.2.2. Greenhouse gases emissions

One of the main attributes of renewable over non-renewable electricity is the difference in GHG emissions.[113] Indeed, in the context of climate change, the reduction of these emissions is a common argument to justify the promotion of renewable energy and its policy instruments, including FITs. By the time when this thesis was written, Ecuador had not established specific GHG emissions reduction targets from electricity generation. However, efforts have been launched, for example, to calculate an overall CO_2 emission factor among the different electricity generation plants incorporated to the SNI.[114] The evolution of such factor in ton CO_2/MWh for the period 2007-2010 is showed on Table 5-2.[115] Regardless of the absence of an emission reduction target from electricity generation, the level of this CO_2 emission factor throughout the years is explained by the participation of thermoelectric plants. This is another indicator of how the implemented RES-E projects have not been enough to counterbalance or reduce CO_2 emissions in the last years.

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[111] *Supra* note 65.

[112] Currently, the effective capacity of Ecuador's interconnection with Colombia is limited to 525 MW and with Peru to 110 MW.

[113] *Supra* note 2, *See* Figure 9.8: Estimates of lifecycle GHG emissions (g CO2eq/kWh) for broad categories of electricity generation technologies, plus some technologies integrated with CCS, p. 732.

[114] *Note* that not all RES-E is necessarily incorporated to the SNI.

[115] CENACE, *et al*, *Factor de emisión de CO2 del Sistema Nacional Interconectado del Ecuador al año 2011*, <www.cenace.org.ec/documentosgenerales/Factor_Emision_CO2_2011.pdf>, visited on 24 April 2012 at 11:40.

Table 5-2: Evolution of Ecuador's electricity generation CO_2 emission factor

Year	Overall emission factor (ton CO_2/MWh)
2008	0,7206
2009	0,7310
2010	0,7586

Data source: CENACE, *et al.*

5.2.3. Energy access

Renewable energy offers attractive technological alternatives to electrify uncovered areas. As revealed on Table 5-3, Ecuador still has room for improvement in term of electricity coverage even though this indicator has increased from 2001 to 2010 both in urban and rural areas.[116]

Table 5-3: Evolution of Electricity Coverage in Ecuador

Source	Date	Electricity Coverage (%)		
		National	Urban areas	Rural areas
INEC Census	November 2001	89,7	91,5	79,1
	November 2010	93,53	95,81	89,67
SENPLADES Goal	2013	97	98	96

Data sources: INEC and SENPLADES

However, it should be noted that in the case of rural electrification, the increase in electricity coverage from 2001 to 2010 could hardly be attributed exclusively to RES-E projects derived from the FIT scheme, which have had an overall weak deployment as evidenced on section 5.1.1. Instead, the increase in electricity coverage could be explained fundamentally by the rural electrification projects implemented by local public distribution utilities through the Rural Electrification Fund Programme, FERUM. For example, nearly 450 family size photovoltaic systems have been implemented with FERUM along the provinces of Sucumbíos, Loja, and Zamora Chinchipe.[117] By the time of writing this thesis, CONELEC was working on a draft FIT type regulation specific for distributed generation projects, which aims to be more effective in terms of promoting RES-E projects in this context.[118] According to Tester, *et al.* (2005), distributed generation can be defined as "… small-scale generation located near and connected to a load being served with or without grid interconnection."[119] Significant efforts should still be implemented in the remaining time to reach the established electricity coverage goals for 2013.

5.2.4. Job creation

Implementation of RES-E projects undoubtedly creates jobs along all their life cycle, including construction, operation, maintenance, and decommissioning. In Ecuador, unfortunately there is a lack of statistics of the particular direct and indirect jobs created by RES-E projects so far. For this reason,

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[116] CONELEC, *Cobertura Eléctrica,* <www.conelec.gob.ec/contenido.php?cd=1102&l=1>, visited on 24 April 2012 at 12:15.
[117] *Supra* note 6, p. 193.
[118] Interview with Iván Calero Freire and Fabián Calero Freire, Regulation Professionals at CONELEC, February 13, 2012.
[119] Tester Jefferson W, et al, *Sustainable Energy, Choosing Among Options*, The MIT Press, 2005, p. 678.

for the case of biomass[120] an approximation has been made based on Max Wei's, et al, estimation of job-years / GWh for different RES-E technologies presented on Annex 19.[121] Table 5-4 shows an example of the application of Wei's job-years / GWh factors to biomass. However, in this case it is important to consider that the job creation structure of RES-E may vary between industrialized and developing countries. For example, jobs related with technological development may be stronger in the former, while agricultural jobs related with biomass may be stronger in the latter in the absence of machinery.

Table 5-4: Estimation of Biomass Jobs in Ecuador

Year	Biomass production (GWh)	Jobs (Wei's 0,21 factor)
2005	103	22
2006	146	31
2007	219	46
2008	208	44
2009	217	46
2010	236	50
2011	264	55

Considering that for new RES-E, jobs are especially required for the construction phase. According to the Ministry of Electricity and Renewable Energy, the Ocaña hydroelectric project (26 MW) has generated approximately 461 direct and 2335 indirect jobs since March 2009 when its construction phase started.[122] In the case of Galapagos wind project (2.4 MW), the construction phase had a peak of 70 people working during the civil works for approximately six weeks. For the operation of this RES-E project, 2 full time engineers are required. For maintenance tasks, 4 to 5 workers assist for 2-3 days on a bimonthly basis.[123]

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[120] Wei's, et al, job - years / GWh factors are not applicable to wind and solar RES - E in Ecuador due to the low electricity production of these technologies.

[121] Max Wei, Shana Patadia, and Daniel M. Kammen, *Putting renewables and energy efficiency to work: How many jobs can the clean energy industry generate in the US?,* Energy Policy 38, 2010, pp. 919-931, <http://rael.berkeley.edu/sites/default/files/WeiPatadiaKammen_CleanEnergyJobs_EPolicy2010.pdf>, visited on 25 April 2012 at 10:51, p. 922.

[122] MEER, *Presidente Rafael Correa inaugura Central Hidroeléctrica Ocaña*, <www.meer.gob.ec/index.php?option=com_content&view=article&id=314:presidente-rafael-correa-inaugura-central-hidroelectrica-ocana-&catid=17:ultimas-noticias>, visited on 13 May 2012 at 11:00.

[123] Personal communication with Luis Vintimilla, General Manager at EOLICSA, May 14, 2012.

6. DISCUSSION AND RECOMMENDATIONS

From a holistic approach, the sections above did not limit the analysis to the FIT in terms of promoting RES-E, but went beyond by analyzing how these projects are related with specific sustainability components (See section 5). At first, it could sound unfair to blame the FIT scheme about the impact on sustainability since it is just meant to promote RES-E. However, following their causality chain, there is a tendency for these RES-E projects to have an important role on meeting sustainability objectives. For this reason, and considering all the elements described and analyzed so far, it is convenient to place Ecuador's FIT scheme in the 'big picture'. For this, the DPSIR structure has been used as a system analysis tool that can contribute to understand the intended, or not, *rationale* behind the implementation of a FIT scheme to promote RES-E and sustainable development in the Ecuadorian electricity sector context. Figure 6-1 illustrates the DPSIR elements for this case.

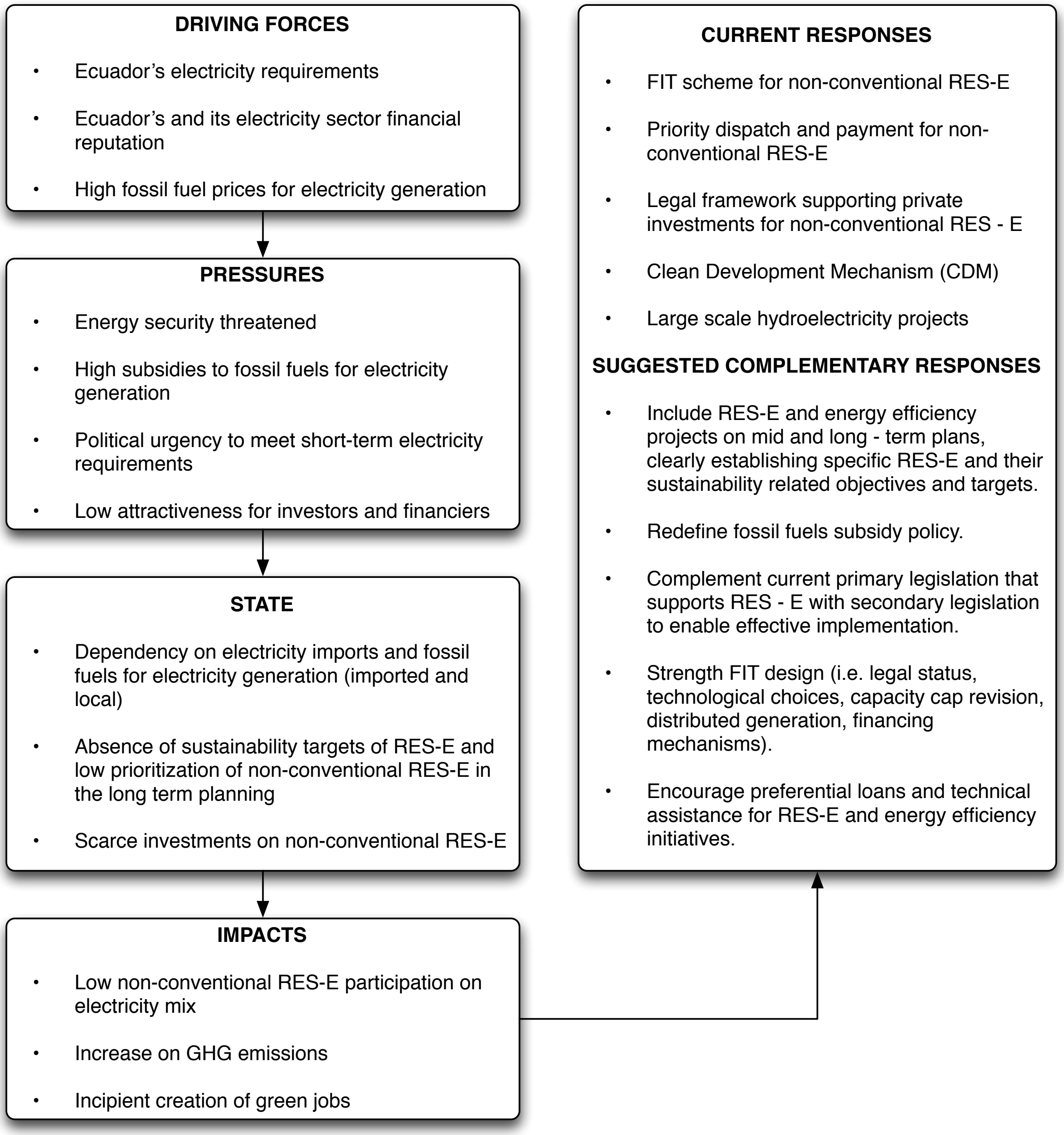

Figure 6-1: FITs as a response in Ecuador's electricity system DPSIR

The FIT is a single policy tool to promote RES-E that, from a systemic perspective, cannot address alone the different driving forces, pressure, state, and/or impacts presented on the DPSIR from Figure 6-1. For example, in order to cleanly satisfy Ecuador's electricity requirements, demand side measures like energy efficiency initiatives[124] should complement supply side responses like the FIT scheme. In other words, regardless of the theoretical effectiveness of a well-designed FIT scheme to deploy RES-E, it does not mean that it cannot be complemented with another policy tools to support such deployment. With all the findings derived from chapters 4 and 5 and the responses resulted from the DPSIR, this section is intended for the discussion of: a) the relevant improvements to the current FIT scheme design, and b) the suggested complementary policies to FITs and strategies to promote RES-E and sustainability. Finally, recommendations for further research will be advised.

6.1. Proposal of improvements to the current FIT scheme

In terms of design, Ecuador's FIT scheme has improved with each of its revisions. However, there are still some adjustments that could be considered for future revisions. First of all, the FIT scheme regulation, and if possible together with CEPSE's priority payment for non-conventional RES-E, should be enacted as part of the forthcoming Electricity Regime Law. This hierarchical superior legal status would increase the legal certainty of the FIT scheme, providing a positive signal to potential RES-E financiers and investors.

Second, there is room for improvement in terms of the specificity of the beneficiary technologies and their conditions. For example, although Ecuador's last FIT revision distinguishes between solar thermal and photovoltaic alternatives, specific signals could be given to different sizes of freestanding and roof-mounted alternatives as in the cases of Germany or Spain's FIT schemes. Regarding biomass, the last revision distinguished between different sizes. However, biomass RES-E is also sensitive to the sources and inputs used, and its selection should respond to Ecuador's particular potentialities (*e.g.* Jatropha curcas). As a reference, the Spanish FIT scheme differentiates between different sizes of biomass RES-E from energy crops, agricultural waste, forestry material, and biogas from landfill, liquid biomass, and others.[125] Also, and considering the current status of each of the beneficiary technologies, FITs could be specific not only for new plants, but also for modernized, revitalized, or renewed plants as in the case of hydroelectricity in Germany.[126] Regarding wind energy, the current FIT scheme differentiates whether the wind RES-E projects are developed on the Galapagos Islands or in the continental territory. Both are on shore alternatives but off shore options could also be explored for further revisions since Ecuador's coast faces to the Pacific Ocean. Moreover, once a wind potentiality map is available, the possibility to incorporate specific tariffs according to their location to promote wind RES-E on certain sites, and/or avoid windfall profits on other places, is an interesting alternative to be analyzed. The same location specific analysis could be done for solar technologies according to Ecuador's radiation maps. Regarding ocean energy, Ecuador gave a positive signal to incorporate marine currents on its last FIT revision. However, other ocean energy alternatives such as wave, tidal, and/or osmotic energy could be also incorporated on further revisions. Even though these are novel alternatives in the Latin American context and would require further research, promoting them could give Ecuador the chance to continue opening opportunities

[124] Though important from a systemic perspective, Ecuador has energy efficiency measures mainly led by the Ministry of Electricity and Renewable Energy that, as the CDM, have not been analyzed in this document due to the scope of this thesis.

[125] Boletín Oficial del Estado, No. 126, May 26, *Real Decreto 661/2007, de 25 de mayo, por el que se regula la actividad de producción de energía eléctrica en régimen especial,* <www.boe.es/boe/dias/2007/05/26/pdfs/A22846-22886.pdf>, visited on 13 May 2012 at 16:51.

[126] *Supra* note 18, p. 82.

with the international scientific community and venture capitals in order to be a regional pioneer on promoting these RES-E alternatives. Finally, another aspect to be considered is that the FIT scheme could have the ability to differentiate between tariffs for peak and off peak hours for technologies with storage capacity like biomass, hydroelectricity, or geothermal. This differentiation could be enhanced with the further implementation of smart grids and would be effective to displace the use of non-renewable electricity at some critical hours. These are specific examples of how the FIT scheme has the potential to make a real contribution to the transformation of Ecuador's electricity mix.

Third, further alternatives to improve the current financing mechanism of Ecuador's FIT scheme should be analyzed and discussed between the relevant stakeholders. This is highly recommendable since Ecuador's tariff deficit, a State subsidy for the electricity sector, could seriously get compromised in the case of an eventual deployment of RES-E, where the resources recovered from the already subsidized tariff would not be enough to cover the preferential prices derived from the FIT scheme. In this sense, and to minimize, or at least transparent, Ecuador's tariff deficit subsidy, the idea of creating an independent trust in benefit of the RES-E generators could be a valid alternative for this purpose. In terms of funding, it should be considered that the use of RES-E over non-renewable electricity already generates 'hidden incomes' that unfortunately are not reflected in the electricity tariff. Such revenues could be derived mainly from the monetary recognition of the avoided environmental costs and subsidies to fossil fuels for electricity generation. The omission of these flows in the tariff could mislead policy makers about the sometimes not accounted, but real, benefits of promoting RES-E and its sustainability through a FIT scheme. Indeed, one of the criticisms to FITs is that it is not the most efficient mechanism to promote RES-E in terms of costs. This is an expected outcome if the FIT preferential prices are compared with 'underestimated' costs of electricity. Overall, this proposal would require further research, especially in terms of crystalizing an effective funding mechanism for this trust, particularly with respect to the valuation and recognition of environmental costs. Regarding funding from savings from fossil fuels, and considering that in Ecuador the State is in charge of importing and commercializing these fossil fuels for electricity generation, it is likely that the involved public institutions would be interested in supporting this initiative. In this sense, even if the State feeds the trust, a progress would still be achieved in terms of transparency by clearly identifying the sources and destiny of these transfers. These public resources could even be justified if this initiative is considered to have the potential to be a referent in pro of an active implementation of the sustainability principles appealed on Ecuador's legal framework presented on section 4.1. Finally, this proposed trust would give an additional positive signal to potential financiers and investors, stimulating sustainability through the deployment of RES-E.

Fourth, if RES-E aspires to have an important role on Ecuador's electricity mix, the capacity cap of the 6% of preferential dispatch for non-conventional RES-E (excluding hydroelectricity) over the installed and operative capacity of the SNI should be revised. At first, the existence of such capacity cap could probably be motivated by the impact of FITs over the system's levelized cost of electricity and eventual increase in the tariff's deficit. However, this argument is not so strong considering, again, that Ecuador's electricity mix is highly supplied by non-renewable sources, which have greater environmental costs (that are not considered on the tariff) and are subject to costly imported and subsidized fossil fuels. Another possible argument in support of such capacity cap could be that it is intended to give a scarcity signal as the 6% 'quota' gets filled. In principle, this could influence the competitive behavior between the potential financiers and investors pushing the investment decision and probably accelerating the process. However, before reaching the 6% borderline, the risk of not being included into this cap could also discourage some other potential investors. For all these reasons, and supposing an electricity Master Plan with a serious intention to incorporate RES-E in the long term planning (see DPSIR), these capacity caps must be increased, or even eliminated from the

FIT scheme. In this sense, the current FIT Regulation leaves an open window to revise this cap under the condition that a subsidy or tariff compensation policies are dictated by the State for the promotion of non-conventional RES-E. The proposed trust described on the previous paragraph could also act as a specific tariff compensation mechanism in order to revise the current cap.

Recalling section 5.2.5, job creation is an important beneficial aspect of promoting RES-E from a sustainability perspective. In this case, the possibility of attaching the preferential prices to local content conditions as an incentive to stimulate the local economy could be analyzed for further revisions. However, the legal feasibility of such proposal should be carefully assessed so that it do not interfere with the principles of the World Trade Organization (WTO). Finally, the verification mechanisms for this initiative should also be considered.

Lastly, but not least important, in order to take full advantage of the potentiality of non conventional RES-E in terms of energy security, a FIT scheme for distributed generation (including off-grid) would be highly desirable. This will directly contribute to the technical reliability of the electricity system and will increase energy security, a fundamental aspect of energy from a sustainability approach. Regarding energy security, it is true that it could also be achieved with, for example, electricity from fossil fuel sources. For this reason, the establishment of energy security as a sustainability objective should go further and make a shift to 'clean' energy security.

6.2. Complementary strategies and policies to FITs to promote sustainability through RES-E

First, RES-E technologies supported by Ecuador's FIT scheme should be incorporated not only in the short term planning, but fundamentally into the mid and long term electricity expansion plans. This planning should go beyond vague policy statements in pro of RES-E, but instead also establish clear policy and sustainability objectives with well-defined indicators and targets, including qualitative and quantitative monitoring and reporting mechanisms. As a reference, and on the basis of the objectives recalled from section 5, Annex 20 shows a scheme with some examples of specific targets that could be evaluated over time for Ecuador and that are suggested as a starting point for this task. The values of the targets for these indicators will depend on the desired vision derived from the required, and therefore suggested, long term planning elaboration. It is important to weigh the efforts required for the data gathering of the defined indicators. In this sense, it would be efficient (and minimize potential transaction costs) if some of these indicators could be synchronized with those sustainability related indicators already asked to project developers by, for example, the United Nations Framework Convention on Climate Change (UNFCCC) when RES-E projects apply to be part of the CDM. Similarly, development banks like the World Bank (WB), the Inter American Development Bank (IADB) or the Development Bank of Latin America, CAF, also evaluate sustainability indicators when considering financing RES-E projects.

If the current FIT scheme aims to deploy RES-E, Ecuador's fossil fuels subsidy policy must be redefined. Otherwise, encouraging cheap fossil fuels is a contradictory policy against the FIT mission. Electricity generation is dispatched with the principles of marginal costs. However, such marginal costs consider subsidized prices of fossil fuels for electricity generation. Therefore, a dispatch mechanism that considers real (non subsidized) fossil fuel costs would be desirable to reflect the actual price of electricity. This way, the differences between the preferential prices promoted by the FIT scheme and the real prices of non-renewable electricity will be more transparent. Additionally, at a local level the diesel subsidy encourages the use of inefficient and pollutant diesel generators, discouraging the use of, for example, environmentally friendly solar RES-E alternatives for rural electrification. Other subsidies like the one to liquefied petroleum gas (LPG), which is used to heat water (and sometimes swimming pools), discourage the promotion of solar thermal alternatives supported by the FIT scheme.

The vast majority of literature that references Ecuador's FIT scheme omits its first revisions and mistakenly believes that this country had a FIT scheme since 2005.[127] This evidences the historical little knowledge among the international community, which includes potential project developers and investors, about Ecuador's FIT scheme. If so, this lack of knowledge is another reason for the incipient effectiveness of Ecuador's FIT scheme. Therefore, it is not enough to just have a FIT scheme to promote RES-E investments. This FIT scheme should be complemented with a strategy to communicate Ecuador's renewable energy policy, including its FIT scheme, in both national and international settings. Aggressive lobbying with local and foreign potential investors and financiers will help to take the most of the current FIT scheme. Today, a progressive step has been done with the translation to English of some of the relevant regulatory framework presented on section 4.1. Specifically, Ecuador's 2008 Constitution, Ecuador's Code of Production, a summarized report of Ecuador's National Development Plan 2009 – 2013, and MICSE's 2012 investments catalogue for strategic projects have been already translated to English and are currently available online. Further translations to other languages of the remaining and relevant regulatory framework like the FIT regulation in itself would be highly recommended. Due to the complexity of Ecuador's electricity sector structure and rules, it is important to accurately explain to potential investors about practical information, which is not necessarily written on the regulations, regarding the investment process and access to the FIT scheme. Benefits of RES-E should be also communicated to the citizens and other important stakeholders, such as electricity utilities in order to achieve a collective support (and understanding) of FITs and RES-E in the context of sustainable development. Finally, it is highly recommendable to provide open access to the previous and forthcoming FIT revision reports. This would give transparency and trust to the FIT scheme and the interested stakeholders could even give useful feedback to improve the FIT scheme as a whole and be more effective accomplishing its objectives.

Currently, the FIT as a policy instrument to promote non-conventional RES-E is not widespread among every country in Latin America. As revealed on Annex 21, according to the Global Status Report on Renewables 2011 from the Renewable Energy Policy Network for the 21st century (REN21), the countries in Latin America with a FIT scheme or a premium payment for RES-E are: Argentina, Costa Rica, Dominican Republic, Ecuador, Honduras, Nicaragua, Panama, and Peru.[128] In principle, having a FIT scheme gives these countries, including Ecuador, a competitive advantage over the remaining countries in terms of attracting RES-E investments. However, since FITs have generally demonstrated to be effective around the world in terms of deploying RES-E, such advantage could just be temporary because it is probable that the other Latin American countries would soon consider the design and implementation of their own FIT scheme to promote RES-E. If a well-designed FIT scheme turns into the common practice among Latin American countries, it would not be a competitive advantage anymore, but an essential tool to avoid being in competitive disadvantage. If Ecuador wants to crystalize a transition in favor of non-conventional RES-E, this is another reason why it cannot rely only on its FIT as a single policy instrument in order to be attractive, but focus on the design and implementation of complementary policies and strategies as the ones suggested above.

Finally, tax incentives, preferential loans, and technical assistance are also valid strategies to complement FITs on its aim to develop RES-E projects. Currently, these initiatives are somehow available for RES-E projects in Ecuador but still they could always be reinforced. Specifically, RES-E projects have tax incentives in the terms described on section 4.1.2. With respect to preferential

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[127] For example, *see* REN21 Renewable Energy Policy Network for the 21st Century, *Renewables 2011, Global Status Report*, <www.ren21.net/Portals/97/documents/GSR/REN21_GSR2011.pdf>, visited on December 4, 2011 at 17:45, p. 84.
[128] *Ibid*, pp. 52 - 54.

loans and technical assistance, electricity generation (including RES-E) is one of the financeable activities for the National Finance Corporation (CFN), Ecuador's public development bank.[129]

6.3. Further research

There is still plenty of space for research focused on a better understanding of the socio-economic, environmental, and political relations involved on deploying RES-E, especially in the context of developing countries. Such understanding will contribute not only to orientate energy policy design and objectives to the right causes, but will also provide better knowledge for effective implementation of such policies. As Jayant Sathaye, *et al.* (2011) concluded on their chapter on 'Renewable Energy in the Context of Sustainable Development' of the IPCC Special Report on Renewable Energy Sources and Climate Change Mitigation,

> knowledge regarding the interrelations between SD and RE in particular is still very limited. Finding answers to the question of how to achieve effective, economically efficient and socially acceptable transformations of the energy system will require a much closer integration of insights from social, natural and economic sciences (*e.g.,* through risk analysis approaches) in order to reflect the different dimensions of sustainability. So far, the knowledge base is often limited to very narrow views from specific branches of research, which do not fully account for the complexity of the issue.[130]

For the specific case of Ecuador, further studies are required to determine the real value of electricity including environmental costs and subsidies (*e.g.* to imported fossil fuels for electricity generation), which are not reflected in the tariff and could mislead about the benefits of promoting RES – E and sustainability through a FIT scheme or with any other policy instrument. Applied legal research could also contribute to RES-E and sustainability, especially regarding legal certainty aspects, which are fundamental to attract RES-E investments. Nowadays, Ecuador has a well-oriented primary legislation that supports RES-E and sustainability in general terms, starting from its recent Constitution. However, further studies for the development of secondary legislation to support the effective enforcement of this currently available primary legal framework would be desirable. Finally, studies regarding Ecuador's RES-E potentiality should be constantly updated considering the technological advances around RES-E. Further FIT scheme revisions should consider these results, especially to define the beneficiary technologies and level of the preferential prices.

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[129] CFN, *Actividades financiables*, <www.cfn.fin.ec/index.php?option=com_content&view=article&id=597&Itemid=807>, visited on May 11, 2012 at 08:54.
[130] *Supra* note 2, p. 768.

7. CONCLUDING REMARKS

Ecuador's FIT scheme, implemented since 2000, has not had the desired effectiveness in terms of promoting non-conventional RES-E. The share of projects that have been adhered to the FIT scheme in Ecuador's electricity mix has been under 2% compared to the 2013 objective of 6%. This research has confirmed that such ineffectiveness could not be entirely attributed to the FIT design *per se*, which has evolved throughout its different revisions. Actually, scarce investments have been mainly explained by a reputation of payment uncertainty in Ecuador's electricity sector. Therefore, no matter how attractive the FIT signal could be, the desired investments have not been crystalized due to an overall legal uncertainty. To this, it should be added that the FIT scheme has had to deal with contradictory policies such as Ecuador's subsidies to fossil fuels. Additionally, electricity expansion plans have not considered all the technologies promoted on the FIT scheme, putting in doubt the long-term intentions of promoting non-conventional RES-E in Ecuador.

This research has also identified positive initiatives to promote RES-E. Specifically, RES-E has now a special treatment in terms of their payment priority. Additionally, the current legal framework supports private RES-E more explicitly than in previous years. But still, an updated electricity law compatible with these legal bodies that have emerged over time would be determinant in terms of providing legal certainty and investor's security for RES-E projects under a FIT scheme. Besides this legal status, other potential improvements have arisen from the FIT scheme design examination, including technological choices, capacity cap revision, financing mechanisms, and communication strategies.

Regarding sustainability derived from RES-E, it can be determined that Ecuador lacks of specific long-term objectives and targets, a missing issue that have undermined the effectiveness of the FIT from a sustainability standpoint. Nevertheless, the analysis of the selected sustainability objectives has been useful to reinforce the necessity of promoting RES-E. From this analysis, it can be concluded that the incipient deployment of RES-E has limited the capacity of providing 'clean' energy security, especially in uncovered areas. Also, the scarce incorporation of non-conventional RES-E projects has not been enough to displace the use of fossil fuels and dependency from electricity imports. Similarly, the few-implemented RES-E projects have not been enough to counterbalance or reduce CO_2 emissions in the last years. Finally, although Ecuador has not officially reported on the jobs created by RES-E, the magnitude of job creation is directly related with the level of RES-E deployment.

The DPSIR framework has proven to be a useful tool not only to understand, discuss and locate all the analyzed elements, including the FIT scheme, into the complexity of Ecuador's electricity sector, but also to elaborate well-targeted recommendations. In this sense, it can be concluded that if Ecuador wants to crystalize a transition in favor of non-conventional RES-E, it cannot rely exclusively on its FIT scheme as a single policy instrument. Additionally, it should focus on the design and implementation of complementary policies and strategies to effectively contribute to the immense challenge of transforming Ecuador's electricity mix and promote sustainable development.

Finally, from the FIT design analysis, to the selection of sustainability objectives and indicators, and the recommended policies and strategies, this research has been a clear reflection of the context-specific nature of sustainability challenges related to energy systems.

8. ANNEXES

Annex 1: List of interviewees by date

Interviewees	Position	Interview Date
Geovanny Pardo Salazar	Sectorial Management Control Undersecretary for Ecuador's Ministry of Electricity and Renewable Energy.	February 2, 2012
Fabián Calero Freire and Iván Calero Freire	Professionals at CONELEC's Regulation Department.	February 13, 2012
Rafael Drouet	Former CEO of Electroquil and Lecturer at ESPOL University.	February 13, 2012
Gabriel Salazar Yépez	Independent project developer and consultant.	February 14, 2012
Paola Andino	Chief of the Environmental Control Department at CONELEC.	February 17, 2012
Javier González	Professional at CONELEC's Environmental Control Department.	February 17, 2012
Elizabeth Lokey	Author of the book: "Renewable Energy Project Development Under the Clean Development Mechanism, A Guide for Latin America"	February 21, 2012
Paúl Vásquez	Chief of the Planning Department at CONELEC.	February 23, 2012
Alfredo Mena	Executive Director at Energy Research Corporation.	February 27, 2012
David Jacobs	Renewable Energy Director at IFOK GmbH.	March 1, 2012
Christian Marín Romo	Renovaenergía S.A. Independent project developer and consultant.	March 2, 2012
Carlos Julio Arosemena	Independent project developer and consultant.	March 5, 2012
Ryan Dick	President at Radical Energy Inc. Solar Energy Project Development & Investment.	March 7, 2012
Luis Vintimilla.	General Manager at EOLICSA.	March 7, 2012
Santiago Sánchez	General Manager at Enerpro. Independent project developer and consultant.	March 8, 2012
Aswin W. Linsenmeyer	Chief Technology Officer at SUNSET Energietechnik GmbH	March 13, 2012
Mauricio Solano	Consultant and project developer at Trama Tecnoambiental.	March 14, 2012

Annex 2: Questions for interviewees

1. Local authority
2. Potential investor / project developer
3. Analyst
4. Scholar

Questions	Targeted interviewee
From your experience, what are key considerations in designing FITs in developing countries? Learned lessons / best practices?	2, 4
How can a FIT scheme be complemented to promote RES-E in developing countries?	2, 4
What indicators can be used to evaluate the effectiveness of a FIT scheme? And for the sustainability of the RES-E projects promoted by the FIT scheme?	2,4
What policy and/or regulatory mechanisms exist to promote electricity generation from renewable energy sources (RES-E) in Ecuador?	1, 2, 3
What is the vision regarding electricity generation projects from renewable energy sources (RES-E) in Ecuador and what is its *rationale*?	1, 3
What qualitative and quantitiative objectives do the current feed-in tariff (FIT) scheme for RES-E has on Ecuador? How has the FIT scheme for RES-E contributed (or not) to achieve these objectives?	1, 3
How have the different environmental regulations and targets evolved over time in Ecuador's electricity sector? How FITs have contributed (or not) to reach such targets (if any) and accomplish the regulations?	1, 3
How has the Ecuadorian feed-in tariff (FIT) scheme been promoted both at a local and international arena?	1, 3
Why do you think that Ecuador could be attractive for RES-E investors?	1, 2, 3
How FITs for RES-E are financed (Tariff, tariff deficit (state budget), CDM?)	1, 3
What criteria were utilized to choose the technologies that will be subject of FITs in the regulation?	1, 3
What criteria were utilized to define the revision periods of FITs for RES-E in Ecuador?	1, 3
What criteria were utilized to limit the RES-E under the FIT scheme to the 6% limit of the installed and operative capacity of the National Interconnected System generators?	1, 3
How has been the evolution of renewable energy investments for rural electrification and what is planned for the future regarding this matter?	1, 3

Annex 3: Importance of energy to achieve the Millennium Development Goals

Goal	IMPORTANCE OF ENERGY TO ACHIEVING THE GOALS Some Direct and Indirect Contributions
1) Extreme poverty and hunger ■ To halve, between 1990 and 2015, the proportion of the world's people whose income is less than one dollar per day. ■ To halve, between 1990 and 2015, the proportion of people who suffer from hunger.	■ Access to affordable energy services from gaseous and liquid fuels and electricity enables enterprise development. ■ Lighting permits income generation beyond daylight hours. ■ Machinery increases productivity. ■ Local energy supplies can often be provided by small scale, locally owned businesses creating employment in local energy service provision and maintenance, fuel crops, etc. ■ Privatisation of energy services can help free up government funds for social welfare investment. ■ Clean, efficient fuels reduce the large share of household income spent on cooking, lighting, and keeping warm (equity issue – poor people pay proportionately more for basic services). ■ The majority (95 percent) of staple foods need cooking before they can be eaten and need water for cooking. ■ Post-harvest losses are reduced through better preservation (for example, drying and smoking) and chilling/freezing ■ Energy for irrigation helps increase food production and access to nutrition.
2) Universal primary education ■ To ensure that, by 2015, children everywhere will be able to complete a full course of primary schooling.	■ Energy can help create a more child friendly environment (access to clean water, sanitation, lighting, and space heating/cooling), thus improving attendance at school and reducing drop out rates. ■ Lighting in schools helps retain teachers, especially if their accommodation has electricity ■ Electricity enables access to educational media and communications in schools and at home that increase education opportunities and allow distance learning ■ Access to energy provides the opportunity to use equipment for teaching (overhead projector, computer, printer, photocopier, science equipment). ■ Modern energy systems and efficient building design reduces heating/ cooling costs and thus school fees, enabling poorer families greater access to education.
3) Gender equality and women's empowerment ■ Ensuring that girls and boys have equal access to primary and secondary education, preferably by 2005, and to all levels of education no later than 2015.	■ Availability of modern energy services frees girls' and young women's time from survival activities (gathering firewood, fetching water, cooking inefficiently, crop processing by hand, manual farming work). ■ Clean cooking fuels and equipment reduces exposure to indoor air pollution and improves health. ■ Good quality lighting permits home study and allows evening classes. ■ Street lighting improves women's safety. ■ Affordable and reliable energy services offer scope for women's enterprises.
4) Child mortality ■ To reduce by two thirds, between 1990 and 2015, the death rate for children under the age of five years.	■ Indoor air pollution contributes to respiratory infections that account for up to 20 percent of the 11 million deaths in children each year (WHO 2000, based on 1999 data). ■ Gathering and preparing traditional fuels exposes young children to health risks and reduces time spent on child care. ■ Provision of nutritious cooked food, space heating, and boiled water contributes towards better health. ■ Electricity enables pumped clean water and purification.
5) Maternal health ■ To reduce by three quarters, between 1990 and 2015, the rate of maternal mortality.	■ Energy services are needed to provide access to better medical facilities for maternal care, including medicine refrigeration, equipment sterilisation, and operating theatres. ■ Excessive workload and heavy manual labour (carrying heavy loads of fuelwood and water) may affect a pregnant woman's general health and well being.
6) HIV/AIDS, malaria and other major diseases. By 2015, to have halted and begun to reverse: ■ the spread of HIV/AIDS ■ the scourge of malaria ■ the scourge of other major diseases that afflict humanity.	■ Electricity in health centres enables night availability, helps retain qualified staff, and allows equipment use (for example, sterilisation, medicine refrigeration). ■ Energy for refrigeration allows vaccination and medicine storage for the prevention and treatment of diseases and infections. ■ Safe disposal of used hypodermic syringes by incineration prevents re-use and the potential further spread of HIV/AIDS. ■ Energy is needed to develop, manufacture, and distribute drugs, medicines, and vaccinations. ■ Electricity enables access to health education media through information and communications technologies (ICT).
7) Environmental sustainability ■ To stop the unsustainable exploitation of natural resources; and ■ To halve, between 1990 and 2015, the proportion of people who are unable to reach or to afford safe drinking water.	■ Increased agricultural productivity is enabled through the use of machinery and irrigation, which in turn reduces the need to expand quantity of land under cultivation, reducing pressure on ecosystem conversion. ■ Traditional fuel use contributes to erosion, reduced soil fertility, and desertification. Fuel substitution, improved efficiency, and energy crops can make exploitation of natural resources more sustainable. ■ Using cleaner, more efficient fuels will reduce greenhouse gas emissions, which are a major contributor to climate change. ■ Clean energy production can encourage better natural resource management, including improved water quality. ■ Energy can be used to purify water or pump clean ground water locally, reducing time spent collecting it and reducing drudgery.

Source: DFID 2002, cited in UNDP World Energy Assessment: Overview 2004 Update.

Annex 4: Economic, political, social and environmental advantages of FITs

Economic	Create green - collar jobs
	Create domestic manufacturing and export industry
	Drive economic development
	Create hedge against conventional fuel price volatility
	Enable businesses, urban or rural, to develop new revenue streams
	Help to establish supply chains for renewable technologies
	Provide investor security
	Create stable conditions for market growth
	Drive down production costs of green electricity
	Develop and expand export opportunities in the renewable energy sector
	Simple, transparent policy structure helps encourage new start-ups and innovators
Political	Increase the stakeholder base supporting renewable energy policies
	Demonstrate commitment to renewable energy deployment
	Create mechanism for achieving renewable energy and emissions-reduction targets
	Increase understanding of potential citizen, community and business roles in environmental protection
	Increase energy security and energy independence
	Promote a more decentralized and resilient electricity system
Social	Encourage citizen and community engagement in activities protecting climate and environment
	Empower citizens and communities
	Increase resilience of communities
	Make renewable energy a common part of the landscape and cityscape
	Increased public support for renewables through direct stake and increased exposure to renewables
Environmental	Reduce carbon emissions
	Reduce pollution
	Encourage energy efficiency measures
	Reduce dependence on fossil fuels

Source: Mendonça, *et al,* (2010, p. xxvii)

Annex 5: Economic, political, social and environmental challenges facing FITs

Economic	Controlling costs of law if take-up is significant
	Lack of support from donors for FITs in developing countries
	Preventing 'gaming'
	Balancing investor confidence with cost control
	Price rises in raw materials for manufacturing technologies
	Securing supply chains for manufacturing
	Near-term upward pressure on electricity prices (if costlier resources such as solar PV are included in large amounts)
	Setting the prices accurately and keeping them cost - efficient over time
	Tracking technological change can be challenging, particularly in emerging technologies
	Minimizing any negative economic effects of marginally higher electricity prices (*e.g.* Sheltering electricity-intensive industries and low income residents from full impact of FIT cost impacts)
Political	Opposition from vested interests
	Low government priorization of renewable energy
	Priorization of large centralized supply, such as nuclear and 'clean' coal
	Pressure to design 'low impact' (ineffective) FITs
	Combining with existing schemes
	Transition from existing schemes without investment disruption
	Ensuring planning system does not hamper development
	Opposition to higher electricity prices
	Permitting and other barriers
Social	Competition for best sites can lead to 'NIMBYism'
	Opposition to cost rises in fuel bills (especially for those in fuel poverty)
	Creating investment vehicles for average citizens to participate (*e.g.* Low interest loans, etc.)
	Maximizing local participation and ownership, rather than solely corporate and utility ownership
	Sheltering low-income residents from near-term impacts on electricity prices
	Cost sharing across customer classes, and geographic areas
	New transmission lines can generate opposition to projects
Environmental	Limitations of available sites for installations
	Air quality concerns in the case of biomass combustion systems
	Marine impacts in the case of tidal, wave and offshore wind
	Species-specific concerns (bats, birds, etc)
	Land-use issues and conflicts
	New transmission lines can create opposition
	Sound and 'strobe' impacts (specially for wind turbines)

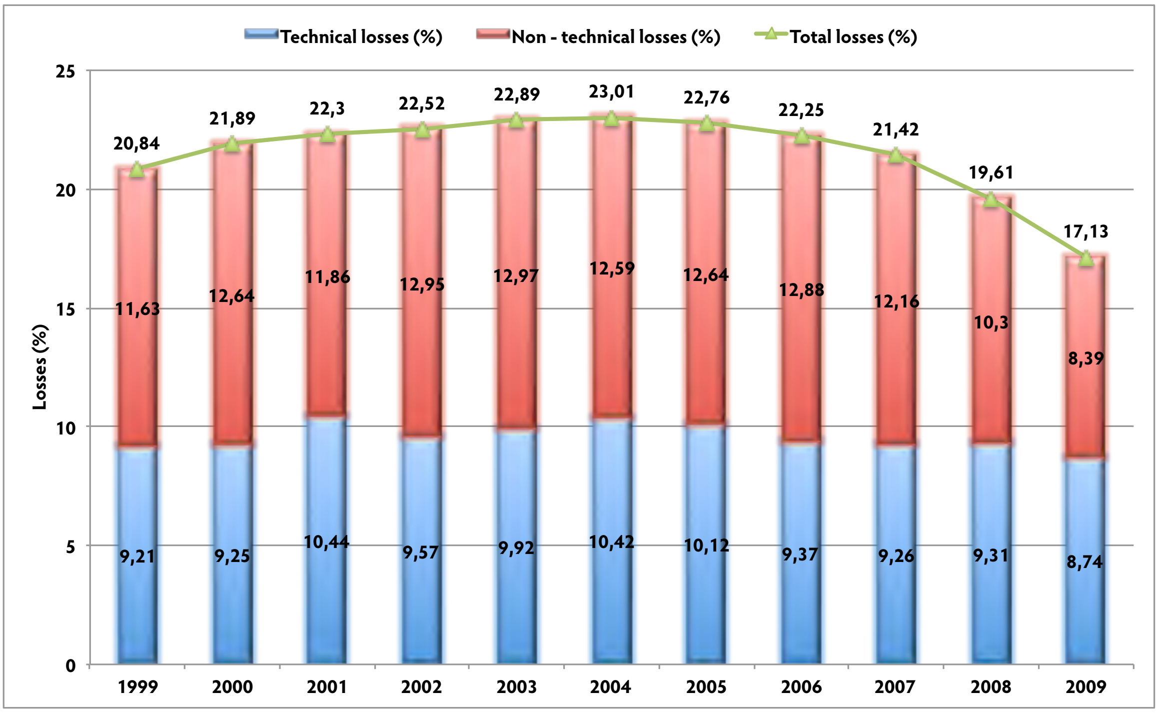
Source: Mendonça, *et al,* (2010, p. xxviii)

Annex 6: Ecuador's authorization periods for non-conventional RES-E projects

Non - conventional RES-E Technology	Years
Wind	25
Photovoltaic	20
Biomass/Biogas	15
Geothermal	30
Hydro 0-0,5 MW	20
Hydro 0,5-5 MW	30
Hydro 5-50 MW	40

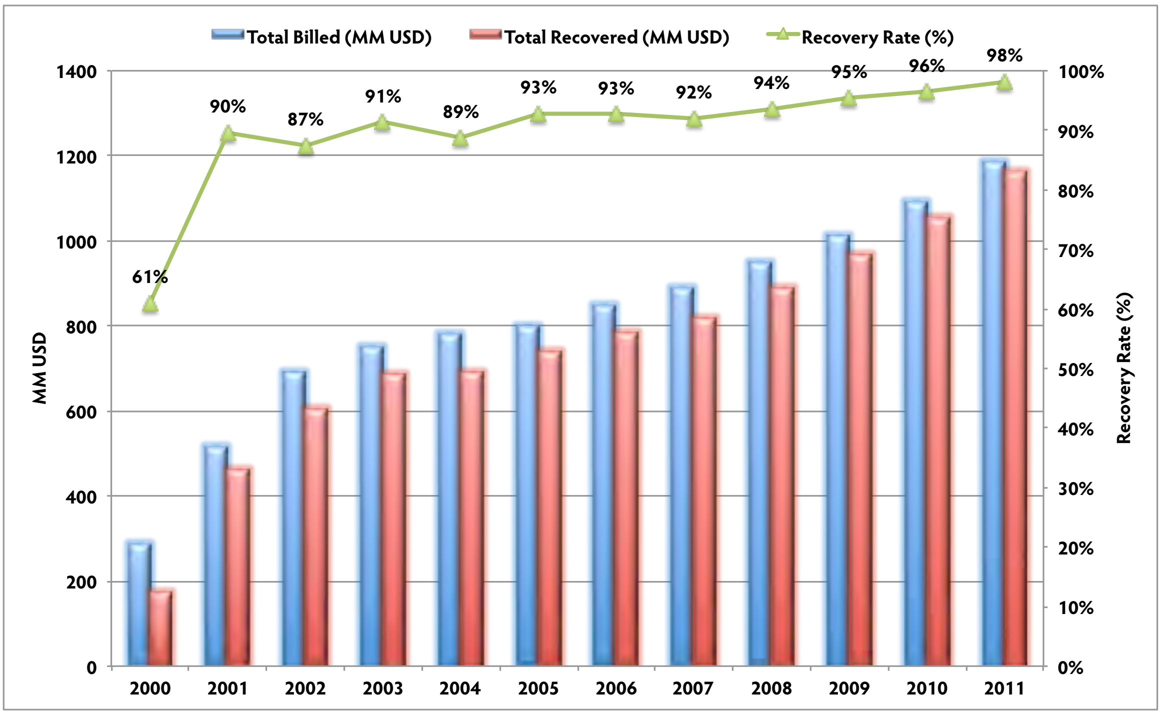
Data source: CONELEC

Annex 7: Evolution of technical and non-technical losses in Ecuador's electricity distribution system



Data source: CONELEC

Annex 8: Evolution of billing and recovery rates of Ecuador's electricity distribution utilities



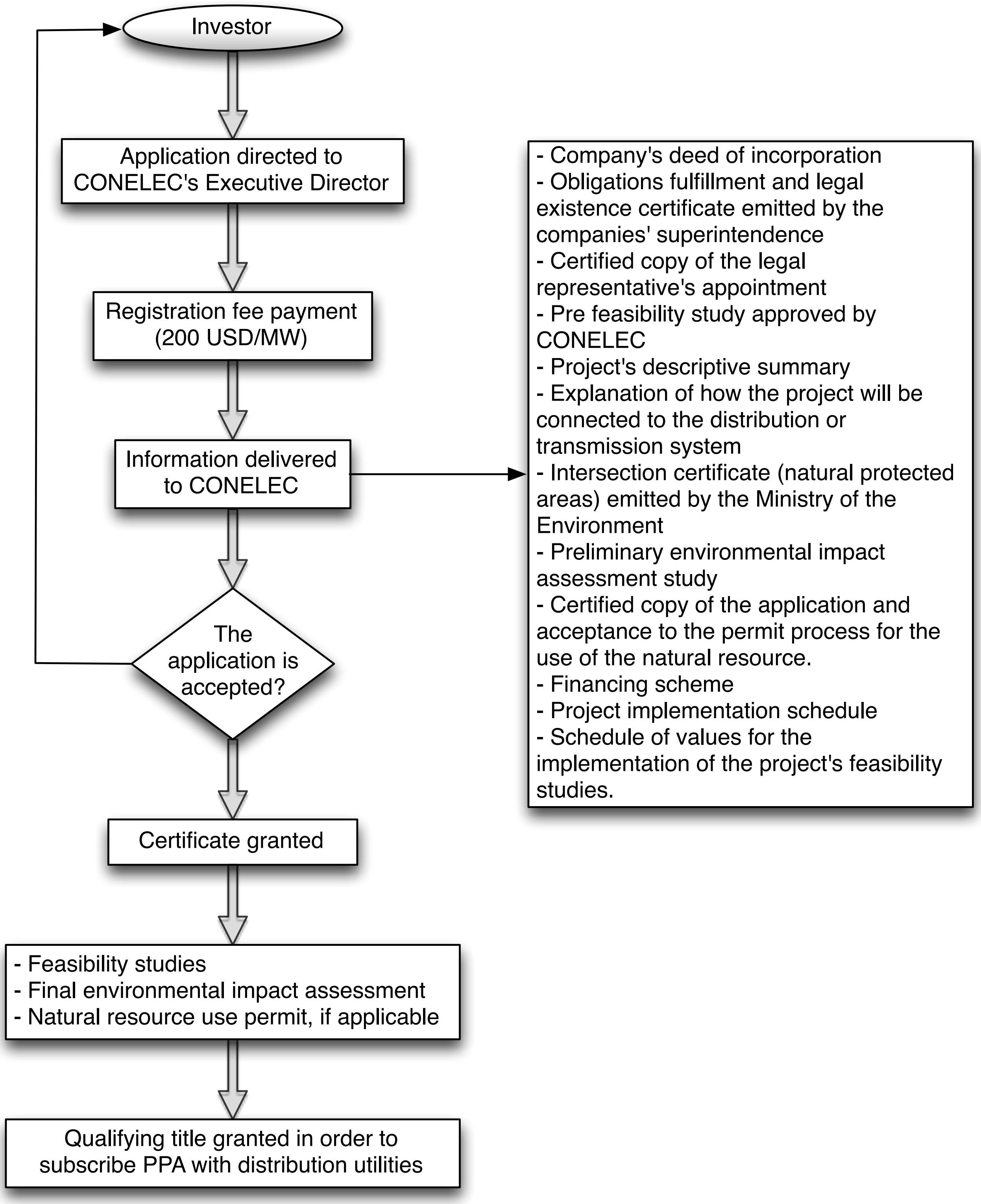
Data source: CONELEC

Annex 9: Payment priority scheme for electricity distribution utilities

Hierarchy	Payment Beneficiary	Description
0	Third parties	Collected values that do not correspond neither to the distribution, nor to the energy sales to final consumers.
0	Distribution	Collected values that do not correspond neither to the energy sales to final consumers, nor to the public lighting.
0	Distribution	Distribution aggregate value.
1	Transmission	Transmission administrative, operative, and maintenance costs.
2A	Generation	Energy imports.
2B	**Generation**	**Non-conventional RES-E according to FIT scheme.**
2C	Petrocomercial Generation	Variable costs of private owned generation with PPAs
2D	Generation	Fixed costs of private owned generation with PPAs
2E	Petrocomercial Generation	Variable costs of public owned thermal generation with PPAs
2F	Generation	Public owned generation administrative, operative, and maintenance costs.
2G	Generation	Variable costs of public owned hydroelectricity generation.
3A	Transmission	Transmission assets replacement fund.
3B	Generation	Public owned generation assets replacement fund.
4	Generation	Private owned generation in the spot market.
5	Distribution	Remaining distribution balance.
6	Generation, transmission, and distribution	Remaining generation, transmission, and distribution balance.

Data source: CENACE

Annex 10: Administrative procedures for non-conventional RES-E projects



Source: CONELEC

Annex 11: RES-E projects on CONELEC's Electrification Master Plan 2009 - 2020

Estimated entrance date	Project	Company / Institution	Ownership	Type of RES-E	Capacity (MW)
January 2011	Baba	Hidrolitoral S. A.	Public	Hydroelectricity	42
Januuary 2011	San José de Minas	San José de Minas S.A.	Private	Hydroelectricity	6
July 2011	Ocaña	Elecaustro S.A.	Public	Hydroelectricity	26
July 2011	Villonaco	Villonaco Wind Power S.A.	Private	Wind	15
January 2012	Chorrillos	Hidrozamora C.E.M.	Public	Hydroelectricity	4
January 2012	Ducal Wind Farm	Tradeflin S.A.	Private	Wind	5,2
March 2012	San José del Tambo	Hidrotambo S.A.	Private	Hydroelectricity	8
April 2012	Río Luis	Energyhdine S.A. (National Army)	Public	Hydroelectricity	15,5
July 2012	Topo	Pemaf Cía. Ltda.	Private	Hydroelectricity	22,8
August 2012	Mazar-Dudas	Hidroazogues S.A.	Public	Hydroelectricity	20,9
December 2012	Sigchos	Triolo S.R.L.	Private	Hydroelectricity	17,4
December 2012	Apaquí	Current Energy of Ecuador S.A.	Private	Hydroelectricity	36
January 2013	Angamarca Sinde	Hidronación S.A.	Public	Hydroelectricity	29,1
January 2013	Victoria	Hidrovictoria S.A.	Private	Hydroelectricity	10
January 2013	Pilaló 3	Qualitec Comercio e Industria Cía. Ltda.	Private	Hydroelectricity	9,3
September 2014	Quijos	Empresa Eléctrica Quito S.A.	Public	Hydroelectricity	50
September 2014	Baeza	Empresa Eléctrica Quito S.A.	Public	Hydroelectricity	50

Source: CONELEC

Annex 12: Geothermal RES-E projects on MICSE's Investment Catalogue 2012

Geothermal Project	Location / Province	Contracting Mode Alternatives
Chacana	Napo	Direct investment Bidding with financing Contract with international public companies Strategic alliances
Chachimbiro	Imbabura	Strategic alliances International bidding Contract with international public companies
Chalpatán	Carchi	Direct investment Bidding with financing Contract with international public companies Strategic alliances
Tufiño - Chiles - Cerro Negro	Carchi - Nariño	Direct investment Bidding with financing

Source: MICSE (2012)

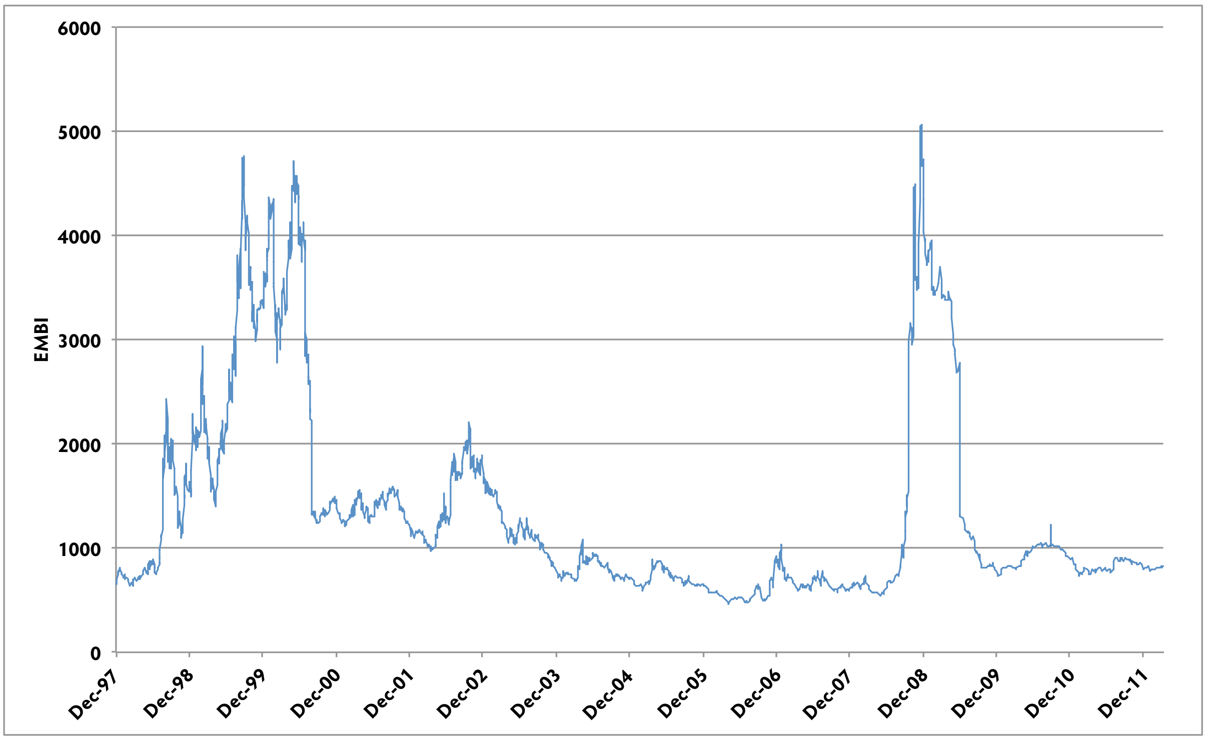
Annex 13: IPCC's ranges of levelized costs of electricity by RES-E technology

Resource	Technology	LCOE (US¢/kWh) Discount rate		
		3%	7%	10%
Bioenergy	Dedicated Biopower CFB	6.1-13	6.9-15	7.9-16
	Dedicated Biopower Stoker	5.6-13	6.7-15	7.7-16
	Dedicated Biopower (Stoker CHP)	5.1-13	6.3-15	7.3-17
	Co-firing: Co-feed	2.0-5.9	2.2-6.2	2.3-6.4
	Co-firing: Separate Feed	2.3-6.3	2.6-6.7	2.9-7.1
	CHP (ORC)	8.6-26	12-32	15-37
	CHP (Steam Turbine)	6.2-18	8.3-22	10-26
	CHP (Gasification ICE)	2.1-11	3.0-13	3.8-14
Direct Solar Energy	PV (Residential Rooftop)	12-53	18-71	23-86
	PV (Commercial Rooftop)	11-52	17-69	22-83
	PV (Utility Scale, Fixed Tilt)	8.4-33	13-43	16-52
	PV (Utility Scale, One-Axis)	7.4-39	11-52	15-62
	CSP	11-19	16-25	20-31
Geothermal Energy	Geothermal Energy (Condensing-Flash Plants)	3.1-8.4	3.8-11	4.5-13
	Geothermal Energy (Binary-Cycle Plants)	3.3-11	4.1-14	4.9-17
Hydropower	All	1.1-7.8	1.8-11	2.4-15
Ocean Energy	Tidal	12-16	18-24	23-32
Wind Energy	Wind Energy (Onshore, Large Turbines)	3.5-10	4.4-14	5.2-17
	Wind Energy (Off- Shore, Large Turbines)	7.5-15	9.7-19	12-23

Source: IPCC (2012)

For more details on the assumptions behind these levelized costs, see supra note 98, pp. 1004 - 1007.

Annex 14: Evolution of Ecuador's EMBI (Country Risk)



Data source: JP Morgan

Annex 15: Ecuador's Doing Business Ranking 2011 - 2012

TOPIC RANKINGS	DB 2012 Rank	DB 2011 Rank
Ease of Doing Business	**130**	**131**
Starting a Business	164	160
Dealing with Construction Permits	91	84
Getting Electricity	128	126
Registering Property	75	75
Getting Credit	78	75
Protecting Investors	133	131
Paying Taxes	88	88
Trading Across Borders	123	126
Enforcing Contracts	100	101
Resolving Insolvency	139	138

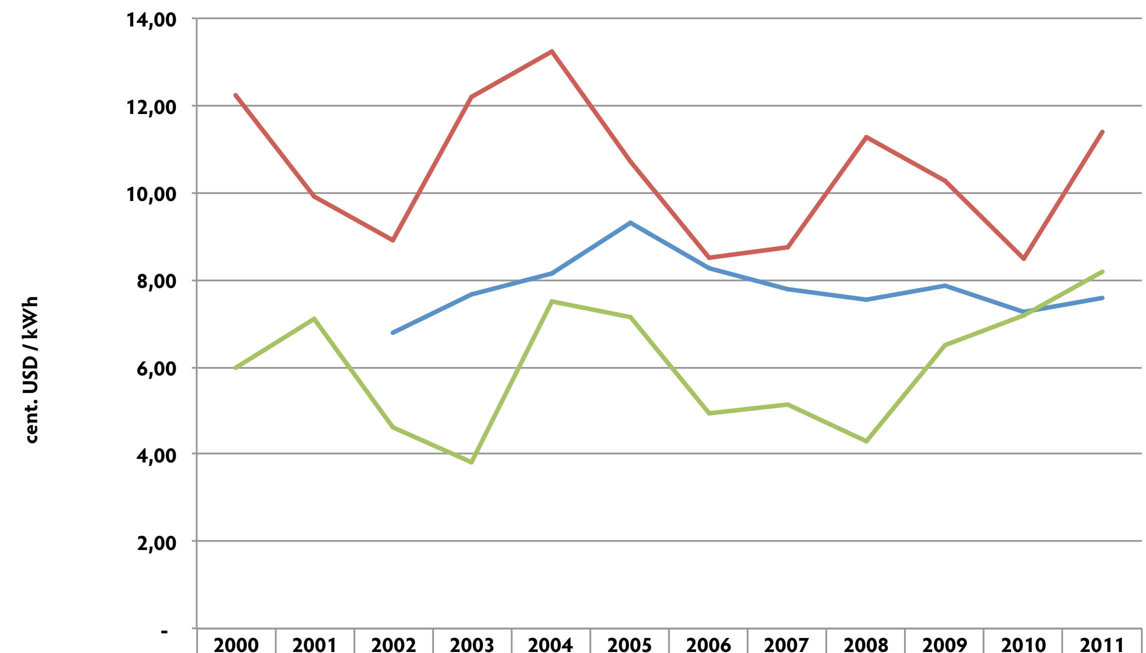
Source: WB & IFC (www. doingbusiness.org/rankings)

Annex 16: Evolution of Ecuador's fossil fuel prices for electricity generation

Year	Diesel (USD/gallon)	Fuel Oil (USD/gallon)	Petroleum Naphtha (USD/gallon)	Natural Gas (USD/ 1000 feet^3)	Esmeraldas 'residuo' (USD/gallon)	Sushufindi 'residuo' (USD/gallon)	La Libertad Fuel Oil (USD/gallon)
2000	1,023978	0,5843089					
2001	0,7529086	0,4717214	0, 4215549				
2002	0,6780181	0,5045722	0,6908561	2,6092768			
2003	0,9612877	0,71192	0,8346714	4,1523833	0,465552	0,346256	
2004	1,3416927	0,6162484	1,0895644	3,57415	0,4757186	0,2874739	
2005	1,3717203	0,7541586	1,0774883	4,3966454	0,4915525	0,3421087	
2006	0,9187181	0,706288	0,7479293	4,1231121	0,4196858	0,3923961	
2007	0,9187181	0,708288	0,7479293	4,1119145	0,4196858	0,3923961	
2008	0,9187181	0,5376	0,7479293	4,1044494	0,4458022	0,411193	0,548358
2009	0,9187181	0,5376	0,7479293	4,1559179	0,4458022	0,3923961	
2010	0,9187181	0,5376	0,7479293	4,1085213	0,4458022	0,3923961	
2011	0,9187181	0,5376	0,7479293	4,272072	0,4458022	0,3923961	

Source: CENACE

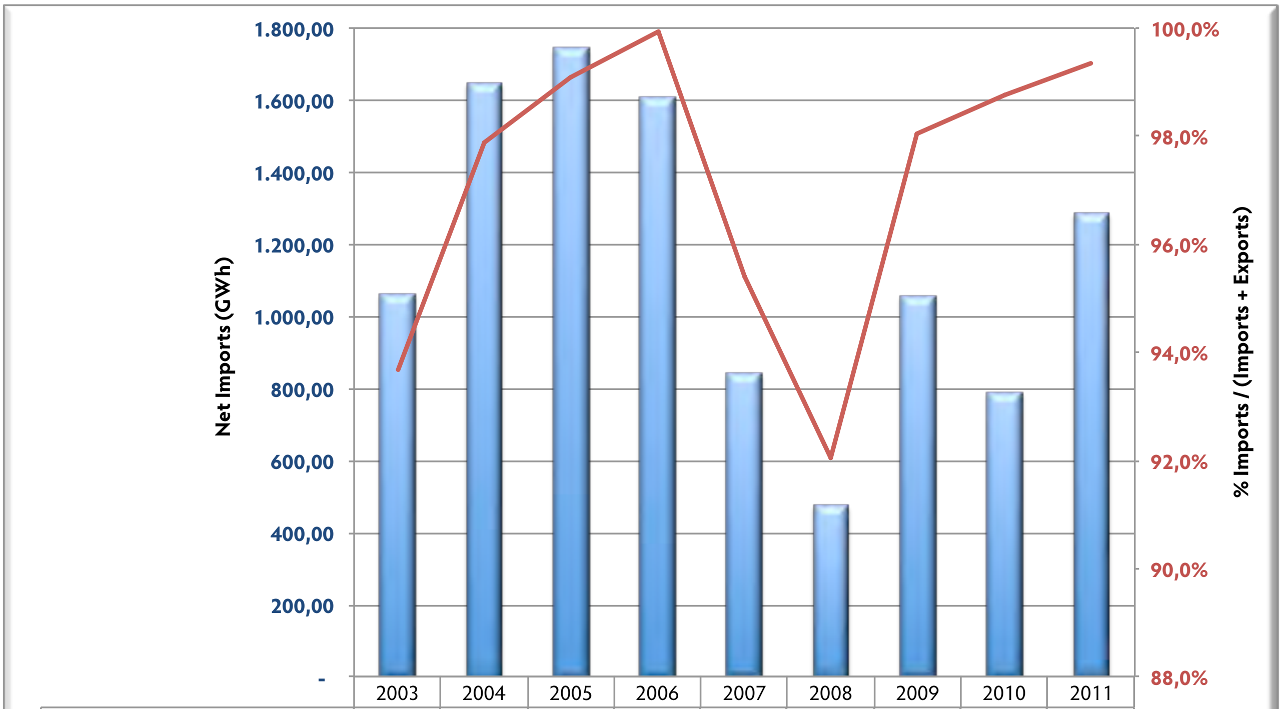
Annex 17: Evolution of Ecuador's non-renewable thermoelectricity average prices



	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Thermoelectric (gas)			6,79	7,69	8,14	9,29	8,27	7,78	7,54	7,88	7,27	7,60
Thermoelectric (diesel)	12,25	9,93	8,91	12,19	13,23	10,71	8,50	8,76	11,27	10,25	8,49	11,41
Thermoelectric (other)	6,00	7,10	4,61	3,80	7,49	7,15	4,96	5,14	4,30	6,51	7,18	8,20

Data source: CENACE

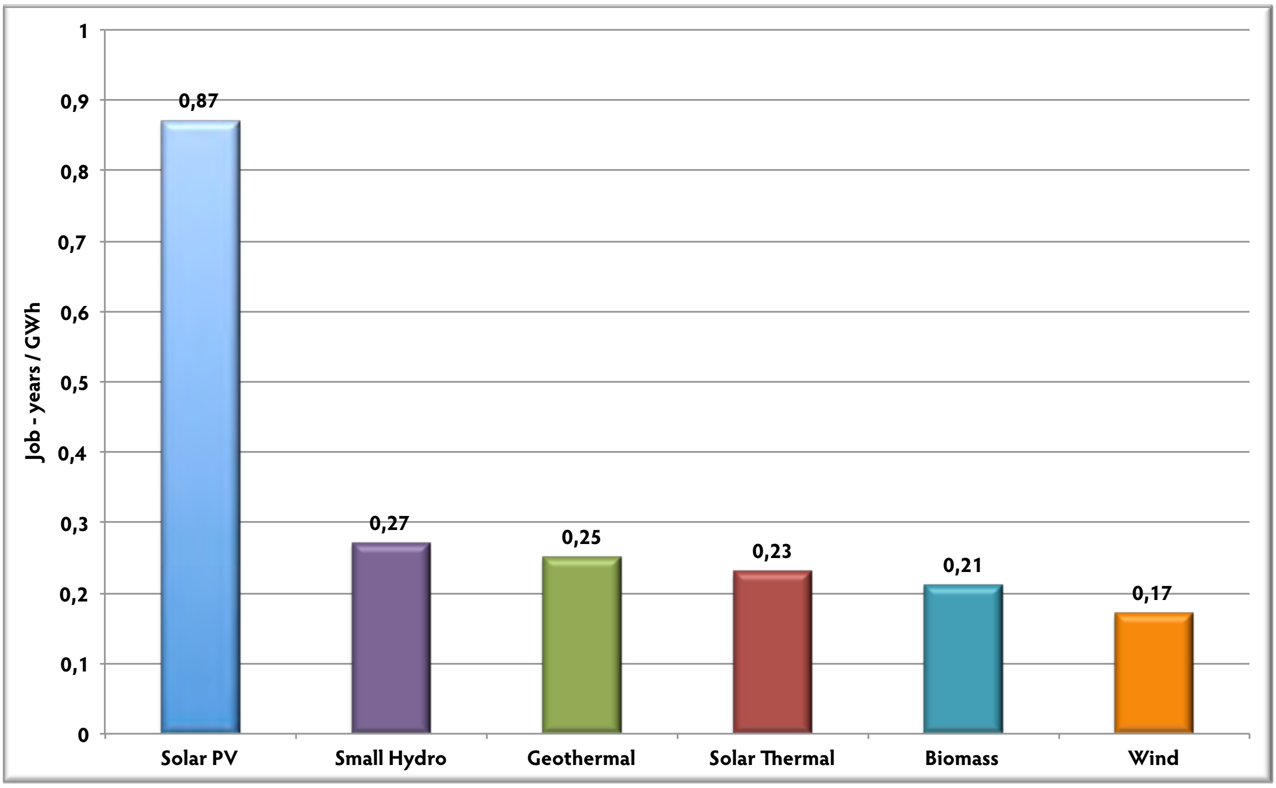
Annex 18: Evolution of International Transactions of Electricity (Ecuador-Colombia)



	2003	2004	2005	2006	2007	2008	2009	2010	2011
Net imports (GWh)	1.061,52	1.645,97	1.741,80	1.607,51	838,20	472,24	1.055,96	787,94	1.286,37
% Imports / (Imports + Exports)	93,7%	97,9%	99,1%	99,9%	95,4%	92,1%	98,0%	98,8%	99,4%

Data source: CENACE

Annex 19: Job-years / GWh for renewable energy technologies



Source: Wei, *et al*, 2010.

Annex 20: Examples of targets for Ecuador's RES-E planning

Objectives	Indicators		Yearly targets 2015	2020	2025	2030
Attract RES-E investments	Capital investment by technology (MM USD)	Marine current				
		Photovoltaic				
		Solar thermal				
		Geothermal				
		Biomass/Biogas				
		Wind				
		Small Hydro				
	Contribution of RES-E technologies over total electricity generation (% GWh).	Marine current				
		Photovoltaic				
		Solar thermal				
		Geothermal				
		Biomass/Biogas				
		Wind				
		Small Hydro				
	Contribution of RES-E technologies over total installed capacity (% MW)	Marine current				
		Photovoltaic				
		Solar thermal				
		Geothermal				
		Biomass/Biogas				
		Wind				
		Small Hydro				
Provide energy security	Scheduled blackouts due to generation scarcity (hours)					
	Fossil fuel consumption (galons)	Diesel				
		Fuel Oil				
		Petroleum Naphtha				
		'Residuo'				
		Natural Gas (ft^3)				
	Electricity imports on electricity matrix (%GWh)	Colombia				
		Perú				
Decrease GHG emissions from electricity generation	GHG emissions (tons)	Thermal (non-renewable)				
		RES-E				
Promote energy access	Electricity coverage (%)	Urban				
		Rural				
Stimulate job creation	Number of direct and indirect jobs created by RES-E technology	Marine current				
		Photovoltaic				
		Solar thermal				
		Geothermal				
		Biomass/Biogas				
		Wind				
		Small Hydro				

Annex 21: Renewable Energy Support Policies in Latin America

Income level	Country	Regulatory Policies				Fiscal Incentives				Public Financing	
		Feed - in tariff (including premium payment)	Electric utility quota obligation / RPS	Net metering	Biofuels obligation / mandate	Capital subsidy, grant, or rebate	Investment or production tax credits	Reductions in sales, energy, CO2, VAT, or other taxes	Energy production payment	Public investment, loans, or grants	Public competitive bidding
High	Trinidad & Tobago					✔	✔	✔			
Upper - middle	Argentina	✔			✔	✔	✔	✔	✔	✔	✔
	Brasil				✔			✔		✔	✔
	Chile		✔			✔		✔		✔	
	Colombia				✔	✔					
	Costa Rica	✔			✔						
	Dominican Republic	✔				✔	✔	✔			
	Mexico			✔			✔			✔	✔
	Panama	✔							✔		✔
	Peru	✔			✔		✔	✔	✔		✔
	Uruguay		✔		✔			✔			✔
Lower - middle	Bolivia							✔			
	Ecuador	✔									
	El Salvador						✔	✔	✔	✔	✔
	Guatemala			✔			✔	✔			✔
	Honduras	✔					✔	✔			✔
	Nicaragua	✔					✔	✔			

Source: REN21 (Renewables 2011 Global Status Report)

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