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Energy and Biodiversity

life
Lasting Initiative For Earth

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Temporary Technical Commission for Energy:
Coordinator:
Amaro Olímpio Pereira Junior (Energy Planning Program, Management for Postgraduate Engineering Programs (COPPE), Federal University of Rio de Janeiro (UFRJ))

Team:
Luciano Basto Oliveira (Energy Planning Program COPPE/UFRJ)
Natália Pezzi Fachinelli (Energy Planning Program COPPE/UFRJ)
Eveline María Vásquez Arroyo (Energy Planning Program COPPE/UFRJ)
General Coordination: Regiane Borsato

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Permanent Technical Commission: André Ferretti (Boticário Group Foundation for Nature Protection); Daniel Fernandes (The Caatinga Association); Glaucia Seixas (Fundação Neotrópica); Liz Buck (Society for Wildlife Research and Environmental Education - SPVS); Mariano Cenamo (Institute for the Conservation and Sustainable Development of Amazonas - IDESAM); José Milton Andriguetto (Federal University of Paraná -UFPR); Niro Higuchi (National Institute of Amazonian Research - INPA); Rafael Loyola (Federal University of Goiás - UFG); Tamara Van Kaick (Federal Technological University of Paraná - UTFPR); Thomas Lewinsohn (University of Campinas - Unicamp); Marcus Vinicius Seixas Cadete (CRA); Newton Kaminski (Itaipu); Vanessa Vitoriano Silva (O Boticário); Veronica Theullen (OGX Group); Vinicius Burigo (Petrobras).
Contributors: Karen Barbosa (Petrobras); Ibsen Gusmão Camara; Maron Galliez (UFRJ), Anderson Braga Mendes (Itaipu).

Editing: Anke Manuela Salzmann, Regiane Borsato, Miriam Garcia e Marina Cioato.
Layout: LIFE Institute
Executive Director: Maria Alice Alexandre
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1. Introduction

The scenario for the creation of LIFE Certification was configured by the need to preserve biodiversity through maintaining natural heritage and intensifying the involvement of the private sector in environmental issues. Aiming to spread the commitment to conservation more fairly, the LIFE Certification Methodology establishes a minimum performance in biodiversity conservation which is in line with each organization's size and environmental impact.

In calculating an organization's impact, The LIFE Certification Methodology takes into account the following environmental aspects: (i) Generation of Waste; (ii) Emission of Greenhouse Gases; (iii) Use of Water; (iv) Energy Consumption; and, (vi) Occupation of Area. These are used to define the organization's Biodiversity Estimated Impact Value (BEIV).

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Due to the great importance of the relation between energy matrix and biodiversity conservation, and with a view to the continuous improvement of the calculation of BEIV, the LIFE Institute set up a Temporary Technical Commission for Energy (TTC – Energy) to refine the information and the practical evaluation of this relation.

The reduction of habitats and the alteration of the countryside, global warming, air quality, water availability and quality, siltation processes and soil quality are all impacts which directly or indirectly affect biodiverity and the sustaining of life on Earth.

Different sources of energy contribute in different degrees to the generation of these impacts, resulting in greater or lesser severity for biodiversity. This analysis depends on the evaluation of all the stages of the energy chain – from extraction through to its final use – considering the existent resources.

That is the work presented in this publication, which results in a single general matrix for evaluating and comparing the impact of different sources of energy. This result serves the LIFE Methodology as a reference for the evaluation of the impact of the use of the energy, and which shall be constantly improved.

An organization's decision to use one or another source of energy can represent greater care for biodiversity, and this is to be valued by LIFE Certification.

2. Objective of the work

The work aimed to develop a single general matrix for evaluating and comparing the impact from different sources of energy.

3. Methodology

The methodology adopted for this work had four stages:

- Conceptual structuring of a matrix for evaluating the impact of sources of energy
- Definition of the sources of energy and bibliographic survey of their impacts
- Evaluation of the impact of each source of energy in partial matrices
- Compilation of the results of the matrices for each source of energy in a single general matrix for evaluating and comparing energy sources' impacts

CONCEPTUAL STRUCTURING OF A MATRIX FOR THE EVALUATION OF IMPACT OF SOURCES OF ENERGY

The structuring of the matrix took place through defining the criteria to be applied for each source of energy.

Source of energy
the form in which the energy is found in nature (originating from natural processes of the transformation of primary sources).

The following were selected as criteria to be observed in the matrix:

Environmental component

Factors which make up the environment (soil, water, atmosphere, biota) – representing the place where the impact occurs;

Environmental aspect

An organization's activities, products or services that may be interacting with the environment;

Potential impact

Alteration of the environment resulting from an organization's activities, services or products;

Generating action

Action in each phase of the energy chain, responsible for generating the impact;

Phases of the energy chain

phases which include energy extraction, conversion, distribution/storage and final uses. The phases of the energy chain determine the extent of the impacts to be considered for each source.

Considering these criteria, a matrix was structured for comparing impacts, using the Leopold Matrix (1971) as a reference, because the use of bi-dimensional criteria – a characteristic of that matrix – facilitates quantification; and, therefore, the ordering of the environmental impacts from different sources.

The following criteria were used for scoring each impact evaluated within the matrix:

Reversibility

Evaluates the capacity to return to the original environmental conditions after the action. The classification used was: Irreversible (IRR); Reversible (REV).

Magnitude

Evaluates the degree of de-characterization of the environmental component when submitted to the incidence of an impact. The classification adopted was: Large (LAR); Medium (MED); Small (SMA).

Severity

Information resulting from the combination of the analyses of Reversibility and Magnitude. The severity values were classified as:

- High (3): high/medium magnitude; irreversible or difficult to reverse
- Medium (2): high/medium magnitude; reversible
- Low (1): minimal magnitude, irrespective of its reversibility

The final score for impact was obtained by taking into account the combination of the value attributed to the "severity" criteria (1, 2, 3), with the quantity of phases of the energy chain which received this value, according to the hierarchy presented in Table 1.

Impact	Description
0	No phase
1 - 2	Severity 1 in one phase of the energy chain
3 - 4	Severity 1 in more than one phase of the energy chain
5 - 6	Severity 2 in one phase of the energy chain
7 - 8	Severity 2 in more than one phase of the energy chain
9 - 10	Severity 3 in one or more phases of the energy chain

The scoring of the impact always takes into account two possibilities for values for each possibility of combination, allowing subjective information to receive an appropriate final score, greater or lesser, depending on the specialists' final evaluation. This method makes it possible to differentiate the impact of sources of energy which would otherwise receive the same score.

The impacts in each phase of the energy chain were evaluated, for all of the aspects listed in each environmental component.

DEFINITION OF THE SOURCES OF ENERGY AND THE BIBLIOGRAPHIC REVIEW OF THEIR IMPACTS

LIFE Technical Guide 1 establishes an impact index for 14 sources of energy: Biofuels (Alcohol); Biofuels (Vegetal oils and Biodiesel); Biogas; Biomass (Firewood); Biomass (Waste); Coal; Wind; Natural Gas; Geothermal; Hydroelectric; Nuclear/fission; Crude oil and oil products; Solar; and Ocean Thermal Energy Conversion.

Reviewing the sources considered, it was defined that the energy source "Ocean Thermal Energy Conversion" should be altered to energy from seawater, as this includes a wider range of technologies which produce electricity from the seawater. The review also determined that the energy source "Non-Renewable Residues" should be included. It is commonly generated by productive processes which use fossil sources. This residues has significant calorific power and can be re-used as an energy carrier.

As a result, 15 sources of energy were defined for this work: Biofuels (Alcohol); Biofuels (Oils and Biodiesel); Biogas; Biomass (Firewood); Biomass (waste); Non-renewable Residues; Coal; Wind; Natural Gas; Geothermic; Hydroelectric; Nuclear/fission; Crude oil and oil products; Solar; and, Energy from Seawater.

Based on the determination of the phases of the energy chain, an extensive bibliographic review was undertaken, on the potential impacts related to each one of the sources of energy considered.

EVALUATION OF THE IMPACT OF EACH SOURCE OF ENERGY IN PARTIAL MATRICES

For each one of the 15 sources of energy, an impact value was established, based on the analysis of the entire process of generation of energy.

This individual analysis for each source of energy allowed the definition of the reversibility, the magnitude and the severity for all the potential impacts linked to different generative actions in the phases of extraction, processing, conversion, storage and final use of the energy source.

All the environmental aspects listed for each one of the environmental components of water, air, soil and biota were evaluated separately. The sum of the impact value for each environmental aspect listed in these components resulted in the energy source impact index.

As a result of this stage, 15 matrices and their respective impact indexes are presented in item 4.1, this matrix relating to each source of energy studied.

COMPILATION OF THE RESULTS OF THE MATRICES FOR EACH SOURCE OF ENERGY

The results from all 15 partial matrices were compiled into a single general matrix, making it possible to evaluate and compare the impacts of all the sources of energy studied.

The final consolidated matrix is presented in item 4.2 of this Technical Document.

4. Results

The partial matrices and the consolidated matrix for evaluation and comparison of the impacts from sources of energy are presented below.

Impact Matrix: Crude oil and oil products

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy conversion / generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
CRUDE OIL AND OIL PRODUCTS	Water	Water use and/or consumption	Changes in water availability	Water consumption in the extraction of the energy source; processing; conversion and energy generation	IRR	SMA	1	IRR	LAR	3	IRR	SMA	1	--	--	0	--	--	0	9
		Effluents generation	Changes in water quality	Production of effluents in the process of drilling wells (off-shore and on-shore); in refining the petroleum and its derivatives and in the conversion and generation of energy	REV	MED	2	REV	LAR	2	REV	MED	2	--	--	0	--	--	0	8
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Greenhouse gas emissions in the exploration (principally on-shore); process of refining derivatives; fugitive emissions in transporting, handling, operation and combustion of the petroleum products and in the final use of the energy source	IRR	MED	3	IRR	MED	3	IRR	MED	3	--	--	0	IRR	LAR	3	10
		Atmospheric emissions	Changes in air quality	Atmospheric emissions (CO, SOx, CO2, NOx), hydrocarbons, particulate matter and fugitive emissions throughout the energy chain	IRR	SMA	1	IRR	MED	3	IRR	MED	3	IRR	SMA	1	IRR	MED	3	10
		Noise emissions	Changes in noise levels	Exploration of the energy source; construction and operation of the thermal power plant	REV	MED	2	REV	MED	2	REV	MED	2	--	--	0	--	--	0	7
	Soil	Movement of soil	Intensification of siltation processes	Indirect impact of the exploration actions (principally open air) and processes of infrastructure construction	IRR	SMA	1	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	4
			Intensification of erosive processes	Impact of exploration actions and construction of buildings	IRR	SMA	1	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	4
			Generation of induced earthquakes	Indirect construction actions: drilling and completion of wells	IRR	LAR	3	--	--	0	--	--	0	--	--	0	--	--	0	9
		Soil Occupation	Landscape and land use change	Exploitation of the energy source (especially open air); building sites; thermal power plant instalation	IRR	MED	3	REV	MED	2	REV	MED	2	IRR	SMA	1	--	--	0	9
		Solid waste generation	Changes in soil quality	Generation of waste during the exploitation of the energy source, processing, conversion and generation of energy, and final use	REV	MED	2	REV	MED	2	REV	SMA	1	0	0	0	REV	SMA	1	8
	Biota	Occupation of areas	Habitat alteration and/or reduction	Activity exploiting the energy source and implantation of infrastructure	IRR	SMA	1	IRR	SMA	1	IRR	SMA	1	IRR	SMA	1	--	--	0	4
		Effluents and solid waste generation; atmospheric emissions	Ecosystem structural and/or functional alteration	- Production of waste and emissions during the extraction of the energy source, processing, conversion and energy generation	REV	MED	2	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	6
																			IMPACT INDEX	88

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Natural Gas

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy conversion/ generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
NATURAL GAS	Water	Water use and/or consumption	Changes in water availability	Consumption of water during processing, transport and cooling of equipment	IRR	SMA	1	IRR	MED	3	IRR	SMA	1	--	--	0	--	--	0	9
		Effluents generation	Changes in water availability	Production of effluents in the process of drilling wells, treating and burning the gas	REV	MED	2	REV	LAR	2	REV	MED	2	--	--	0	--	--	0	7
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emissions from processes and fugitive emissions	IRR	MED	3	IRR	MED	3	IRR	MED	3	IRR	MED	3	IRR	MED	3	9
		Atmospheric emissions	Changes in air quality	Emissions into the air of nitrogen oxides (NOx) during gas burning	REV	SMA	1	REV	SMA	1	REV	MED	2	REV	SMA	1	REV	MED	2	7
		Noise emissions	Changes in noise levels	Construction actions and operation of installations	REV	LAR	2	REV	MED	2	REV	MED	2	--	--	0	--	--	0	7
	Soil	Movement of soil	Intensification of siltation processes	Construction actions	IRR	SMA	1	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	4
			Intensification of erosive processes	Installation of on- and off-shore infrastructure and pipelines	IRR	SMA	1	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	4
			Generation of induced earthquakes	Indirect impact of construction actions: drilling and completion of wells	IRR	LAR	3	--	--	0	--	--	0	--	--	0	--	--	0	9
		Soil Occupation	Landscape and land use change	Construction and operation of on- and off-shore gas-production installations; construction and operation of the thermal power plant, natural gas processing units and regasification terminals, and during implantation of pipelines	IRR	MED	3	REV	MED	2	REV	MED	2	IRR	SMA	1	--	--	0	9
		Solid waste generation	Changes in soil quality	Generation of waste which impacts soil quality	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
	Biota	Occupation of areas	Habitat alteration and/or reduction	On- and off-shore installations for its extraction; building sites; installation of thermal power plants, regasification terminals and natural gas processing units; implantation of pipelines and respectives rights-of-way. Exploratory activities and infra-structure implementation and operation	IRR	SMA	1	IRR	SMA	1	IRR	SMA	1	IRR	MED	3	--	--	0	8
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Production of waste and emissions during the extraction of the energy source, processing, conversion and generation of energy	REV	MED	2	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	6
																			IMPACT INDEX	84

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Coal

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy conversion/ generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
COAL	Water	**Water use and/or consumption**	Changes in water availability	Water consumption in extracting the energy source, processing, conversion, generation of the energy and its storage	IRR	MED	3	IRR	SMA	1	IRR	SMA	1	IRR	SMA	1	--	--	0	9
		Effluents generation	Changes in water quality	Production of effluents in the process of exploitation of the energy source (open air and subterranean), in processing, conversion and energy generation	REV	MED	2	REV	SMA	1	REV	MED	2	--	--	0	--	--	0	8
	Air	**Greenhouse gas emissions**	Contribution to increase in climate warming	Emissions throughout the energy chain: during exploitation (principally methane) and combustion processes	IRR	MED	3	IRR	MED	3	IRR	LAR	3	REV	SMA	1	IRR	LAR	3	10
		Atmospheric emissions	Changes in air quality	Emission of gases and particulate matter; fugitive emissions throughout the energy chain	IRR	SMA	1	IRR	MED	3	IRR	LAR	2	IRR	SMA	1	IRR	LAR	2	10
		Noise emissions	Changes in noise levels	Exploitation of the energy source; thermal power plant construction and operation	REV	MED	2	REV	MED	2	REV	MED	2	--	--	0	--	--	0	7
	Soil	**Movement of soil**	Intensification of siltation processes	Indirect impact of exploitation actions (principally open-air) and construction of infrastructure	IRR	LAR	3	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	9
			Intensification of erosive processes	Actions in exploitation and in the construction of buildings	IRR	LAR	3	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	9
			Generation of induced earthquakes	Exploitation actions, both subterranean and open-air, and construction of buildings	IRR	LAR	3	--	--	0	--	--	0	--	--	0	--	--	0	9
		Soil Occupation	Landscape and land use change	Exploitation of the energy source (especially open-air); building sites; installations of thermal power plants	IRR	LAR	3	REV	MED	2	REV	MED	2	IRR	SMA	1	--	--	0	10
		Solid waste generation	Changes in soil quality	Generation of waste during the exploitation of the energy source and during energy processing, conversion, generation and storage	IRR	MED	3	IRR	MED	3	IRR	SMA	1	IRR	SMA	1	--	--	0	10
	Biota	**Occupation of areas**	Habitat alteration and/or reduction	Activity exploiting the energy source and implanting infrastructure	IRR	MED	3	IRR	MED	3	IRR	SMA	1	IRR	MED	1	--	--	0	10
		Generation of effluents and solid waste; atmospheric emissions	Ecosystems structural and/or functional alteration	Production of waste and emissions during energy source extraction, processing, conversion and generation	REV	LAR	3	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	9
																			IMPACT INDEX	110

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matix: Nuclear

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
NUCLEAR	Water	Water use and/or consumption	Change in water availability	Consumption of water in the extraction of the energy source, energy processing, conversion and generation, and storage	IRR	MED	3	IRR	SMA	1	IRR	MED	3	IRR	SMA	1	--	--	0	10
		Effluents Generation	Changes in water quality	Production of effluents in the processes of exploitation of the energy source (open air and subterranean), in energy processing, conversion and generation	REV	MED	2	REV	SMA	1	REV	MED	1	--	--	0	--	--	0	6
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emissions generated during the processing of the energy source	--	--	0	IRR	SMA	1	--	--	0	--	--	0	--	--	0	1
		Atmospheric emissions	Changes in air quality	Very low combustion emissions, however, there is the possibility of emissions of radioactive gases during mining and processing	IRR	SMA	1	IRR	SMA	1	--	--	0	--	--	0	--	--	0	3
		Noise emissions	Changes in noise levels	Exploitation of the energy source, processing and in the construction and operation of the nuclear power plant	REV	MED	2	REV	MED	2	REV	MED	2	--	--	0	--	--	0	7
	Soil	Movement of soil	Intensification of siltation processes	Exploitation actions (principally open-air) and process of infrastructure construction	IRR	LAR	3	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	9
			Intensification of erosive processes	Exploitation actions and construction of buildings	IRR	LAR	3	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	9
			Generation of induced earthquakes	Exploitation actions, either subterranean or open air, and construction of buildings	IRR	LAR	3	--	--	0	--	--	0	--	--	0	--	--	0	9
		Soil Occupation	Landscape and land use change	Exploitation of the energy source (especially open-air); building sites; nuclear power plant instalations and storage of the energy source	IRR	LAR	3	REV	MED	2	REV	MED	2	IRR	SMA	1	--	--	0	10
		Solid waste generation	Changes in soil quality	Waste generation E14during the exploitation of the energy source, processing, conversion and generation of energy	IRR	MED	3	IRR	LAR	3	IRR	LAR	3	--	--	0	--	--	0	10
	Biota	Occupation of areas	Habitat alteration and/or reduction	Activity exploiting the energy source and implantation of infrastructure	IRR	MED	3	IRR	SMA	1	IRR	SMA	1	IRR	SMA	1	--	--	0	9
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration of the	Production of waste and emissions during the extraction of the energy source, energy processing, conversion and generation	REV	MED	2	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	5
																			IMPACT INDEX	88

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Biomass (Firewood)

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
BIOMASS (FIREWOOD)	Water	Water use and/or consumption	Change in water availability	Vegetation growth of the forest. Water consumption during energy conversion and generation	IRR	SMA	1	--	--	0	IRR	SMA	1	--	--	0	--	--	0	3
		Effluents generation	Changes in water quality	Effluents production during energy conversion and generation	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Pressure on native forests can cause de-forestation, indirectly causing GHG. - Production of coal contributes to an increase in greenhouse gases through the process of carbonization. Burning of the firewood and the production of charcoal	IRR	MED	3	IRR	SMA	1	IRR	SMA	1	--	--	0	IRR	SMA	1	9
		Atmospheric emissions	Changes in air quality	Burning of firewood and the production of charcoal. Production of charcoal contributes to an increase in greenhouse gases through the process of carbonization	--	--	0	REV	MED	2	REV	MED	2	--	--	0	IRR	SMA	1	7
		Noise emissions	Changes in noise levels	Use of equipment (such as chainsaws), transport of vehicles and people during the extraction of the energy source. Operation of the thermal power plant	REV	SMA	1	--	--	0	REV	SMA	1	--	--	0	--	--	0	3
	Soil	Movement of soil	Intensification of siltation processes	Deforestation actions	IRR	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	2
			Intensification of erosive processes	Impoverishment and erosion of the soil when the forests are exploited indiscriminately	IRR	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	2
		Soil Occupation	Landscape and land use change	Changes in the prior use of the soil. Indirect impacts: displacement of the agriculture and livestock farming to areas of native vegetation	REV	MED	2	--	--	0	REV	MED	2	--	--	0	--	--	0	7
		Solid waste generation	Changes in soil quality	Ash production during the phase of energy generation	--	--	0	--	--	0	IRR	SMA	1	--	--	0	IRR	SMA	1	3
	Biota	Occupation of areas	Habitat alteration and/or reduction	Deforestation actions cause reduction of arboreal diversity. Direct or indirect advance on areas with native vegetation and forest and/or endemic fauna	IRR	MED	3	--	--	0	--	--	0	--	--	0	--	--	0	9
		Effluents and solid waste generation; atmospheric emissions	Ecosystem structural and/or functional alteration	Production of waste and emissions during energy conversion and generation, and the final use of the energy source	--	--	0	--	--	0	IRR	SMA	1	--	--	0	IRR	SMA	1	3
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Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Biomass (Waste)

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACTO
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
BIOMASS (WASTE)	Water	Water use and/or consumption	Change in water availability	Consumption of water in the energy conversion and generation	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	1
		Effluents Genereation	Changes in water quality	Production of effluents in the process of energy conversion and generation	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emissions created by the machines and trucks for collecitng and transporting the waste biomass, if they use petroleum devivatives. Burning of the biomass in heat generation processes and final use	IRR	MED	1	--	--	0	IRR	SMA	1	--	--	0	IRR	SMA	1	3
		Atmospheric emissions	Changes in air quality	Burning of biomass in heat generation processes and final use emits particulate matter, CO and Nox	--	--	0	--	--	0	REV	MED	2	--	--	0	REV	SMA	1	5
		Noise emissions	Changes in noise levels	Operation of the thermal power plant	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Soil	Movement of soil	Intensification of siltation processes	Indiscriminate removal of waste from the soil	REV	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	1
			Intensification of erosive processes	Indiscriminate removal of waste from the soil	REV	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	1
		Soil Occupation	Landscape and land use change	Construction and operation of the power plant	--	--	0	--	--	0	REV	MED	2	--	--	0	--	--	0	5
		Solid waste Generation	Changes in soil quality	Production of ash in the phase of generation of energy	--	--	0	--	--	0	REV	SMA	1	--	--	0	REV	SMA	1	3
	Biota	Occupation of areas	Habitat alteration and/or reduction	The removal of agricultural waste from the soil interferes in the fauna and microfauna associated with the agriculture	REV	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	1
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Burning of the biomass in processes of heat generation and final use	--	--	0	--	--	0	REV	SMA	1	--	--	0	REV	SMA	1	3
																			IMPACT INDEX	25

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Hydroelectric

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy conversion/ generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
HYDROELECTRIC	Water	Water use and/or consumption	Changes in water availability	Use of large quantities of water during energy conversion and generation, as well as evaporation in the case of large reservoirs. - Rivers course and hydrological cycle alteration	--	--	0	--	--	0	IRR	LAR	3	--	--	0	--	--	0	9
		Effluents generation	Changes in water quality	Production of effluents during energy conversion and generation	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	1
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emissions generated by the degradation of the biomass flooded in reservoirs	--	--	0	--	--	0	--	--	0	IRR	SMA	1	--	--	0	1
		Atmospheric emissions	Changes in air quality	Emissions generated by the degradation of biomass flooded in reservoirs. During the energy conversion and generation there is production of particulate matter due to the transport of materials and persons	--	--	0	--	--	0	IRR	SMA	1	IRR	SMA	1	--	--	0	3
		Noise emissions	Changes in noise levels	During the phases of construction (movement of people and vehicles, detonation of rocks) and of operation (turbine)	--	--	0	--	--	0	REV	SMA	1	REV	SMA	1	--	--	0	3
	Soil	Movement of soil	Intensification of siltation processes	Construction actions and functioning of the reservoirs	--	--	0	--	--	0	IRR	LAR	3	IRR	LAR	3	--	--	0	10
			Intensification of erosive processes	Erosion processes upstream and downstream of the dam, with loss of soil and vegetation	--	--	0	--	--	0	--	--	0	IRR	LAR	3	--	--	0	9
			Generation of induced earthquakes	Detonations to fragment rocks and filling of the reservoir may cause artificial seismic activity	--	--	0	--	--	0	--	--	0	IRR	SMA	1	--	--	0	2
		Soil Occupation	Landscape and land use change	Transfers or diversion of rivers; displacement of the original population, urban and rural infrastructure; filling of the reservoir	--	--	0	--	--	0	IRR	LAR	3	IRR	LAR	3	--	--	0	10
		Solid waste generation	Changes in soil quality	Production of waste during the operating of the hydroelectric facilities	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Biota	Occupation of areas	Habitat alteration and/or reduction	Interference in natural cycles, in the reproduction and dispersal of fish and other aquatic animals, in addition to deforestation	--	--	0	--	--	0	IRR	LAR	3	--	--	0	--	--	0	9
		Effluents and solid waste generation; atmospheric emissions	Ecosystem structural and/or functional alteration	Production of waste during the conversion and energy generation.	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
																			IMPACT INDEX	59

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Biofuels (Alcohol)

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
BIOFUELS (ALCOHOL)	Water	Water use and/or consumption	Changes in water availability	Water consumption for crop irrigation and energy processing	IRR	LAR	3	IRR	SMA	1	--	--	0	--	--	0	--	--	0	9
		Effluents Generation	Changes in water quality	Effluents generation in the production of ethanol	REV	SMA	1	REV	MED	2	--	--	0	--	--	0	--	--	0	5
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	GHG emissions in the final use	--	--	0	--	--	0	--	--	0	--	--	0	IRR	SMA	1	2
		Atmospheric emissions	Changes in air quality	Combustion gases emissions during the final use of the energy source	--	--	0	--	--	0	--	--	0	--	--	0	REV	MED	2	5
		Noise emissions	Changes in noise levels	Noise production during energy source processing	--	--	0	REV	SMA	1	--	--	0	--	--	0	--	--	0	1
	Soil	Movement of soil	Intensification of siltation processes	Agricultural management of the farmland	REV	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	2
			Intensification of erosive processes	Agricultural management of the farmland	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
		Soil occupation	Landscape and land use change	Agricultural management of the farmland	REV	LAR	3	--	--	0	--	--	0	--	--	0	--	--	0	9
		Solid waste generation	Changes in soil quality	Solid waste generation during the energy source processing	--	--	0	REV	SMA	1	--	--	0	--	--	0	--	--	0	1
	Biota	Occupation of areas	Habitat alteration and/or reduction	Agricultural management of the farmland	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Agricultural management of the farmland	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	--	--	0	3
																			IMPACT INDEX	47

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Biofuels (Oils and Biodiesel)

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
BIOFUELS (OILS AND BIODIESEL)	Water	Water use and/or consumption	Change in water availability	Consumption of water for irrigating farmlandand processing the energy source	IRR	LAR	3	IRR	SMA	1	--	--	0	--	--	0	--	--	0	9
		Effluents Generation	Changes in water quality	Effluents generation E6in the production of biodiesel	--	--	0	REV	MED	2	--	--	0	--	--	0	--	--	0	5
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emissions of GHG during the final use of the energy source	--	--	0	--	--	0	--	--	0	--	--	0	IRR	SMA	1	2
		Atmospheric emissions	Changes in air quality	Emissions of combustion gases during the final use of the energy source	--	--	0	--	--	0	--	--	0	--	--	0	REV	MED	2	5
		Noise emissions	Changes in noise levels	Production of noise during the processing of the energy source	--	--	0	REV	SMA	1	--	--	0	--	--	0	--	--	0	1
	Soil	Movement of soil	Intensification of siltation processes	Agricultural management of the farmland	REV	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	2
			Intensification of erosive processes	Agricultural management of the farmland	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
		Soil occupation	Landscape and land use change	Agricultural management of the farmland	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
		Solid waste generation	Changes in soil quality	Solid waste generation during the processing of the energy source	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
	Biota	Occupation of areas	Habitat alteration and/or reduction	Agricultural management of the farmland	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Agricultural management of the farmland	REV	SMA	1	REV	SMA	1	--	--	0	--	--	0	--	--	0	3
																			IMPACT INDEX	47

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Biogas

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
BIOGAS	Water	Water use and/or consumption	Change in water availability	Consumption of water in energy conversion and generation	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	2
		Effluents generation	Changes in water quality	Effluents generation during energy conversion and generation	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emission of GHG during energy extraction, conversion and generation, and the final use of the energy source	IRR	SMA	1	--	--	0	IRR	SMA	1	--	--	0	IRR	SMA	1	3
		Atmospheric emissions	Changes in air quality	Emissions of combustion gases during the extraction, conversion and generation of energy, and the final use of the energy source	REV	SMA	1	--	--	0	REV	SMA	1	--	--	0	REV	SMA	1	3
		Noise emissions	Changes in noise levels	Production of noises during the processing of the energy source	--	--	0	REV	SMA	1	--	--	0	--	--	0	--	--	0	1
	Soil	Movement of soil																		
		Soil occupation	Landscape and land use change	Installation of digesters for its production; building sites; thermal power plant installations	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	2
		Solid waste generation	Changes in soil quality	Waste generation during energy conversion and generation	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Biota	Occupation of areas																		
		Effluents and solid waste generation; atmospheric emissions																		
																			IMPACT INDEX	13

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Solar

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	FASES DA CADEIA ENERGÉTICA															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
SOLAR ENERGY	Water	Water use and/or consumption	Changes in water availability	Consumption of water in energy conversion and generation	--	--	0	--	--	0	IRR	MED	2	--	--	0	--	--	0	5
		Effluents generation	Changes in water quality	Effluents generation during energy conversion and generation	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	The generation of electrical energy based on solar sources does not generate GHG emissions. Where panels are installed in areas where vegetation is removed, one considers CO2 emissions	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
		Atmospheric emissions																		
		Noise emissions	Changes in noise levels	Generation of noise during energy generation	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
	Soil	Movement of soil	Intensification of siltation processes	Power plant construction actions	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
			Intensification of erosive processes	Erosion of the place where the power plant installations are built	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
		Soil occupation	Landscape and land use change	Need for extensive areas in order to function	--	--	0	--	--	0	REV	SMA	2	--	--	0	--	--	0	6
		Solid waste generation	Changes in soil quality	Generation of used batteries and photovoltaic solar panels	--	--	0	--	--	0	REV	SMA	2	--	--	0	--	--	0	6
	Biota	Occupation of areas	Habitat alteration and/or reduction	Need for extensive areas in order to function	--	--	0	--	--	0	REV	SMA	2	--	--	0	--	--	0	5
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Instalation and operation of photovoltaic panels	--	--	0	--	--	0	REV	SMA	2	--	--	0	--	--	0	5
																			IMPACT INDEX	32

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Wind

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy conversion/ generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
WIND	Water	Water use and/or consumption																		
		Effluents generation																		
	Air	Greenhouse gas emissions																		
		Atmospheric emissions																		
		Noise emissions	Changes in noise levels	Emission of noise in the operation of the wind farm	--	--	0	--	--	0	REV	MED	2	--	--	0	--	--	0	6
	Soil	Movement of soil																		
			Intensification of erosive processes	Construction actions for installation of the wind farm	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	1
		Soil Occupation	Landscape and land use change	Functioning of the wind turbines	--	--	0	--	--	0	REV	LAR	3	--	--	0	--	--	0	9
		Solid waste generation																		
	Biota	Areas occupation	Habitat alteration and/or reduction	The functioning of the wind turbines causes changes in the migration routes of birds and bats	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	2
		Effluents and solid waste generation; atmospheric emissions																		
																			IMPACT INDEX	18

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Geothermal

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
GEOTHERMICAL	Water	Water use and/or consumption	Changes in water availability	Consumption of water in energy conversion and generation	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	1
		Effluents Generation	Changes in water quality	Effluents generation during the extraction, conversion of the energy source, and energy generation	REV	SMA	1	--	--	0	REV	MED	2	--	--	0	--	--	0	6
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emission of GHG during the extraction of the energy source	IRR	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	1
		Atmospheric emissions	Changes in air quality	Emission of CO2, NH3 and H2S during the extraction of the energy source	IRR	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	2
		Noise emissions	Changes in noise levels	Emission of noise in the extraction activity and in the generation of the electric energy	REV	SMA	1	--	--	0	REV	SMA	1	--	--	0	--	--	0	4
	Soil	Movement of soil	Intensification of siltation processes	Drilling the wells	IRR	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	1
			Intensification of erosive processes	Erosion of the area where the exploitation of the source takes place	IRR	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	1
			Generation of induced earthquakes	Drilling the wells	IRR	MED	3	--	--	0	--	--	0	--	--	0	--	--	0	9
		Soil Occupation	Landscape and land use change	Drilling the wells; conversion and generation of the energy	IRR	MED	3	--	--	0	REV	MED	2	--	--	0	--	--	0	9
		Solid waste Generation	Changes in soil quality	Waste generation during the extraction of the energy source	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
	Biota	Occupation of areas	Habitat alteration and/or reduction	Areas where drilling takes place for extraction of the energy source	REV	MED	2	--	--	0	--	--	0	--	--	0	--	--	0	5
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Atmospheric emissions and emissions of particulate matter, as well as solid waste generation during the extraction of the energy source	REV	SMA	1	--	--	0	--	--	0	--	--	0	--	--	0	1
																			IMPACT INDEX	45

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Seawater

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
SEAWATER	Water	Water use and/or consumption																		
		Effluents Generation																		
	Air	Greenhouse gas emissions																		
		Atmospheric emissions																		
		Noise emissions	Changes in noise levels	Generation of noise during energy conversion and generation	--	--	1	--	--	0	REV	SMA	1	--	--	0	--	--	0	2
	Soil	Movement of soil																		
		Soil Occupation	Landscape and land use change	Implantation of infrastructure for energy conversion	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
		Solid waste Generation																		
	Biota	Occupation of areas	Habitat alteration and/or reduction	Implantation of infrastructure for energy conversion	--	--	0	--	--	0	REV	MED	2	--	--	0	--	--	0	5
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Generation of noise during energy conversion and generation	--	---	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
																			IMPACT INDEX	9

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

Impact matrix: Non-Renewable Residues

ENERGY SOURCE	COMPONENT	ENVIRONMENTAL ASPECT	POTENTIAL IMPACT	CAUSATIVE ACTION	PHASES OF ENERGY CHAIN															IMPACT
					Extraction of energy source			Processing of energy source			Energy Conversion/ Generation			Storage/distribution of the energy and/or energy source			Final use of the energy source			
					Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	Reversibility	Magnitude	Severity	
NON-RENEWABLE RESIDUES	Water	Water use and/or consumption	Changes in water availability	Consumption of water in energy conversion and generation	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	1
		Effluents Generation	Changes in water quality	Effluents generation during the energy conversion and generation	--	--	0	--	--	0	REV	MED	2	--	--	0	--	--	0	5
	Air	Greenhouse gas emissions	Contribution to increase in climate warming	Emission of GHG during energy extraction, conversion, generation and the final use of the energy source	--	--	0	--	--	0	IRR	MED	3	IRR	MED	3	IRR	MED	3	10
		Atmospheric emissions	Changes in air quality	Emission of combustion gases during energy extraction, conversion, generation and final use of the energy source	--	--	0	--	--	0	REV	MED	2	REV	SMA	1	REV	MED	2	7
		Noise emissions	Changes in noise levels	Construction and operation in the conversion and energy generation	--	--	0	--	--	0	REV	MED	2	--	--	0	--	--	0	5
	Soil	Movement of soil	Intensification of siltation processes	Construction actions	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
			Intensification of erosive processes	Installation of on- and off-shore infrastructure and pipelines	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
		Soil Occupation	Landscape and land use change	Construction and operation of the thermal power plant	--	--	0	--	--	0	REV	MED	2	--	--	0	--	--	0	5
		Solid waste generation																		
	Biota	Occupation of areas	Habitat alteration and/or reduction	Installation of thermal power plant	--	--	0	--	--	0	IRR	SMA	1	--	--	0	--	--	0	2
		Effluents and solid waste generation; atmospheric emissions	Ecosystems structural and/or functional alteration	Effluents generation and atmospheric emissions during energy conversion and generation	--	--	0	--	--	0	REV	SMA	1	--	--	0	--	--	0	1
																			IMPACT INDEX	38

Reversibility: REV (Reversible), IRR (Irreversible)
Magnitude: SMA (Small), MED (Medium), LAR (Large)

IMPACT MATRIX: SOURCES OF ENERGY

Based on the impact matrices constructed for each source of energy, a comparative matrix was produced, listing the impact index for all 15 sources of energy evaluated. (Table 2).

Table 2: Comparative matrix for the impacts

IMPACT													
COMPONENT	**Water**		**Air**			**Soil**					**Biota**		**IMPACT INDEX**
ENVIRONMENTAL FACTOR	Use and/or consumption of water	Effluents generation	Greenhouse Gas emissions	Atmospheric emissions	Noise emissions	Movement of the soil			Soil occupation	Solid waste generation	Occupation of area	Effluent and solid waste generation; atmospheric emissions	
POTENTIAL IMPACT	Changes in water availability	Changes in water quality	Contribution to increase in climate warming	Changes in air quality	Changes in noise levels	Intensification of siltation processes	Intensification of erosive processes	Generation of induced earthquakes	Landscape and land use change	Changes in soil quality	Habitat alteration and/or reduction	Ecosystems structural and/or functional alteration	
ENERGY SOURCE													
Biofuels (Ethanol)	9	5	2	5	1	2	5	n.s	9	1	5	3	47
Biofuels (Oils and Biodiesel)	9	5	2	5	1	2	3	n.s	5	5	5	3	47
Biogas	2	1	3	3	1	n.s	n.s	n.s	2	1	n.s	n.s	13
Biomass (Firewood)	3	1	9	7	3	2	2	n.s	7	3	9	3	49
Biomass (Waste)	1	1	3	5	1	1	1	n.s	5	3	1	3	25
Coal	9	8	10	10	7	9	9	9	10	10	10	9	110
Seawater	n.s	n.s	n.s	n.s	2	n.s	n.s	n.s	1	n.s	5	1	9
Wind	n.s	n.s	n.s	n.s	6	n.s	1	n.s	9	n.s	2	0	18
Natural Gas	9	7	9	9	7	4	4	9	9	5	8	6	84
Geothermic	1	6	1	2	4	1	1	9	9	5	5	1	45
Hydroelectric	9	1	1	3	3	10	9	2	10	1	9	1	59
Non-Renewable Waste	1	5	10	7	5	1	1	n.s	5	n.s	2	1	38
Nuclear	10	6	1	3	7	9	9	9	10	10	9	5	88
Crude oil and oil products	9	8	10	10	7	4	4	9	9	8	4	6	88
Solar	5	1	1	n.s	1	1	1	n.s	6	6	5	5	32

n.s = not significant

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