



**Energy Systems:
Vulnerability – Adaptation – Resilience
(VAR)**

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Regional Focus: sub-Saharan Africa

Democratic Republic of Congo



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Executive Summary

This is the first time that work based on the assessment of the vulnerability and resilience of energy systems to climate change has been undertaken in the Democratic Republic of Congo (DRC), a country with abundant energy potential.

The task has been undertaken using the energy vulnerability and resilience indicators developed by HELIO International.

The study indicates the limits of Congo's energy systems, which are highly vulnerable.

Dependence on non-renewable energy, the current centralisation of the energy sector (under State monopoly), the unequal distribution throughout the territory of the country's (almost wholly unexploited) energy potential, the concentration of almost half of its hydropower at the Inga plant (in the west of the country), and the lack of diversity of energy production technologies all have adverse consequences for the population—already suffering from worrying levels of poverty—and for the country's economic development.

As if that were not enough, variations in annual rainfall—increasing each year and projected to rise above present levels by some 7–11 percent—will have further repercussions not only for agriculture but also for water resources and electricity generating.

This report presents a set of policies and measures that could reduce vulnerability and increase resilience of DRC's energy system. Included in these measures are, notably:

- the liberalisation of Congo's energy system;
- the implementation of projects that are integrating for rural areas and economically viable for regions;
- projects in which the energy component will involve micro or mini electricity power plants not exceeding 20 MW;
- provision of supply and strengthening of distribution of fuels in each province, district and locality;
- diversification and improvement in energy enterprise infrastructure, to increase resilience to variations in climate; and,
- research and development of use of biomass waste as an energy source, with a substantial budget; and creation of an energy map.

The aim is to mitigate the severest effects of climate change and to guarantee better living conditions for DRC's population.

About the Author



Born 17 July 1962 at Kabinda (DRC), Mr Séraphin Kasemuana M. obtained a diploma as an electrical engineering technician in 1990 from the *Institut Supérieur de Techniques Appliquées*, DRC and then qualified as an Electrical Engineer in 1997 (*Institut Supérieur de Techniques Appliquées*, DRC). He then took up the post of Head of the electrical machinery testing laboratory at the *Institut Supérieur de Techniques Appliquées* (1999–2001), as well as that of expert in charge of mining and precious metals contracts, within the cabinet to the Minister of Overseas

Trade for DRC (formerly Zaïre) in 1997.

Mr. Kasemunana became head of the Energy Systems Department at OMRU (world organisation of nations and religions) from 2003-2004. Currently M. Kasemuana is Director of Studies, lecturing in electrical grids and electrical circuitry analysis at the *Institut Supérieur de Techniques Appliquées*, where he also Deputy Head of Section in charge of undergraduate studies.

Séraphin Kasemuana has participated in both national and international conferences, the most recent being in Bamako (Mali), 30 October–1 November 2008 (on vulnerability, adaptation and resilience of energy systems) and the Climate, Energy and Ecosystem Conference, also held in Bamako, in May 2008.

Mr Kasemuana has published several works on various aspects of energy, notably on solar energy, hydroelectricity, and energy transmission and distribution systems. For the past five years his research has focused on energy, ecosystems and climate change, from which the following are selected publications:

- *Energie et éco développement en République démocratique du Congo.* www.helio-international.org/reports/pdfs/congo.fr
- *Renforcer la resilience des systèmes énergétiques et des écosystèmes en République Démocratique du Congo.* www.helio-international.or/RDC.fr.pdf

He has been the DRC observer-reporter for HELIO International since 2005.

Mr. Kasemunana is pursuing his research in the area of illegal connections to energy systems.

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List of Abbreviations

C.G.E.A.:	Commissariat Général à l’Energie Atomique
C.N.E.:	Commission Nationale de l’Energie
CRENK:	Centre Régional d’Etudes Nucléaires de Kinshasa
D.S.C.R.P.:	Document de la Stratégie de croissance et de Réduction de la Pauvreté
DPR:	Disease Prevalence Rate
DRC:	Democratic Republic of Congo
FAO:	Food and Agriculture Organisation
IGC:	Institut Géographique du Congo
J.V.L.:	Jules Van Lancker
O.E.C.D.:	Organisation for Economic Co-operation and Development
ONATRA:	Office National de Transport
PAN:	Programme d’Action National de Lutte contre la Dégradation des terres et la déforestation
PNRSAR:	Programme National de Relance du Secteur Agricole
R.V.F.:	Régie des Voies Fluviales
R.V.M.:	Régie des Voies Maritimes
REGIDESO:	Régie de distribution d’eau
S.N.S.A.:	Service National des Statistiques Agricoles
SNEL:	Société Nationale d’Electricité

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Country Overview

Geography and Climate¹

The Democratic Republic of Congo (DRC) is located at the heart of the continent of Africa. Straddling the equator, DRC lies between the 5°20' northern and 13°27' southern parallels. From west to east, the country lies between the 12° and 31°15' meridians.

DRC has borders with nine other countries: Republic of the Congo to the west, Central African Republic and Sudan to the north, Burundi, Rwanda, Tanzania and Uganda to the east and Angola and Zambia to the south.

The country's physical area is 2,345,000 km², making it Africa's third largest country after Sudan and Algeria. It has 37 km of Atlantic coastline. The country's dominating feature is the Congo River basin, extending over 3,831,400 km².

The Congo River, with a length of 4,700 km and average discharge of 40,000 m³/s, is Africa's major river and, after the Amazon River, is the second largest in the world. The Congo is a main artery for the country's communications.

This immense basin, covering all of the central part of the country, is a vast area of low lands that do not extend beyond 500 m in altitude; it is bordered by plateaux and mountain ranges to the east.

DRC's geographical position, its geomorphological diversity and vast physical area give it a wide range of climates encompassing equatorial, tropical and mountainous. Average rainfall is around 800 mm on the coast and more than 2000 mm in the Congo basin. Average annual temperature is between 24 and 26°C, with extremes of between 25 and 30°C in the basin and between 15 and 20°C in the uplands. Humidity shows consistently high mass mixing ratio values, more than 100 g/kg of dry air over three-quarters of the country. As a consequence, the relative humidity rarely falls below 70 percent anywhere in the country, even in the dry season.



¹ First national communication on climate change, 2000, pp 4-6.

Annual average insolation is five to six hours in the basin areas, rising to nine hours on the high plateaux. Rainfall patterns have changed significantly since the early 1990s, especially in the plateaux regions. Recent studies also indicate an average increase of 2.1°C over the past decade in both rainy and dry seasons, particularly in Kinshasa.

Demographics

DRC's population is estimated to be 64,930,719, with a growth rate of over 3.5 percent. Females represent 51 percent of the population and males, 49 percent. Seventy percent of the population lives in rural areas, with the majority practicing subsistence agriculture.

Excessive demographic pressure is due to both the high annual growth rate and to the proportion of economically inactive young people (59 percent of total population), with dependency² ratios and nutritional status that are disastrous.

Socio-economic Background

From 1990 to 1996 RDC experienced an acute financial crisis due to catastrophic financial management and the collapse of the main macro-economic balances. The result was galloping inflation and monetary depreciation, shrinking production, widespread unemployment and poverty.

Since 1997 D. R. Congo has been in political and social turmoil. Inadequate governance, chaotic economic management and the freezing of international cooperation had lead to widespread instability.

1. Income and salaries: prices in the country are unstable, salaries are derisory and paid irregularly, per capita GDP is decreasing continually. In 1990 the GDP was USD170; it has reduced by 47 percent to date).
2. Investments: a dramatic reduction in investment to less than 10 percent of GDP. The main cause of this is destruction of the production base and shrinkage of production, aggravated by destruction of plant during pillaging in 1991–1993. This has been compounded by the absence of private investors who are reluctant to conduct business in such an unsafe climate.
3. Social conditions: characterised by continuous deterioration and widespread poverty.

The 1984 census indicated a fertility rate of 6.7 children, slightly higher than the the overall average for Africa of 6.0 children. By 1995, the fertility rate had risen to 7.3 children.. Infant mortality remains high, at around 148 per thousand in 1994. It has since risen 20 percent, as a result of the war.

Environment: there is widespread destruction of the main ecosystems, i.e. forests, soils and water, caused by slash and burn agriculture, over-exploitation of forests

² Dependency ratio: relationship between the numbers of people in economically inactive age groups and those who are of active age.

(timber, firewood, charcoal), absence or lack of enforcement of laws and regulations, uncontrolled building, water pollution, mining, setting of bush fires, extensive livestock farming, population explosion, and an absence of a coherent national policy on waste management.

Literacy and education: school attendance and literacy levels are low, with a need for greater educational infrastructure and more teachers to improve.

Equity issues: the wide range of responsibilities and incomes among the population, and for women in particular, does not allow promotion of gender equality nor emancipation of women. The Republic's constitution establishes notional equality between men and women, but in reality the parity distribution is about 10 percent³.

Agriculture and livestock farming: the population is predominantly rural in spite of the country's rapid urbanisation over the past 20 years.

Around 80 percent of the total population lives in rural areas and is therefore dependent on agriculture. However, agriculture accounts for only around 30 percent of GDP⁴. The value of agricultural production, at constant prices, has risen in line with the 1.2 percent annual increase in per capita volume of agricultural production. With its vast expanses of grassy and woody savannah, DRC has enormous possibilities for livestock farming, varying between 30 and 40 million head of cattle with a livestock load of 1/6 to 1/12 throughout the year.

Meat production is growing annually by 1 percent; fishing (i.e. fish production) is growing at about 2.5 percent.

Use of natural resources in the form of land cultivation and forestry are the major socio-economic sectors, with more than 90 percent of the economically active population in rural areas engaged in agriculture, forestry and forestry-related activities.

Studies by the World Bank and DRC's Ministry of Agriculture estimate the physical area of DRC's agricultural land at 6 million hectares (ha). The area under subsistence farming was 8,431,049 ha in 1994 and has increased at an average rate of 6.9 percent, reaching worrying proportions. Moreover, according to the same studies, the land used for livestock farming in DRC is thought to occupy a total of 9 million ha. Currently this activity is often carried out in savannah areas and thus has little effect on the forest cover. However, the prolonged decline in the political and social situation has led to freezing of cooperation aid and cut off of investments, resulting in reduced production across all sectors, including livestock farming.

Health: there is little progress towards Millennium Development Goals. Ninety-seven percent of the Congolese population is exposed to endemic malaria. The prevalence of fever amongst children under five years of age is 42 percent, corresponding to a number of incidences of between six and ten illness per child per year. It is estimated that between 150,000 and 250,000 children below the age of five die each year from malaria. DRC is also one of the 22 countries in the world most affected by tuberculosis, with an annual prevalence of more than 160 cases per 100,000

³ DSCR, Kinshasa, July 2006, page 43.

⁴ DSCR, op cit. page 32.

inhabitants. Around 23.6 million people are exposed to onchocerciasis in DRC, amongst whom more than half are infected.⁵ Of the 300,000 to 500,000 cases of trypanosomiasis in Africa, half are in DRC (150,000 to 250,000 cases).

Health care coverage currently stands at 50.12 percent.

Energy policy: DRC's energy policy is based on:

1. alleviating poverty and illiteracy;
2. developing an 'extrovert' economy with projects that integrate rural areas and economically viable regions (and where the energy component of the project involves the design of micro or mini electricity power plants not exceeding 20 MW);
3. implementing major industrial projects that demand large amounts of electricity; and,
4. constructing hydroelectric plants at numerous sites throughout the country. (Initially, the focus will be on isolated grids which will later be interconnected.

Background Statistics

Table 1: Basic statistics

Basic statistics	Unit	Value	Year
Physical area of country	km ²	2,345,000	2007
Cultivated areas as % of total area of country	%	dna	
Arable land	ha	5,413,000	2002
Area under permanent cultivation for domestic use	ha	dna	
Area under permanent cultivation for export	ha	dna	
Population			
Total population	Inhabitants	64,930,719	2007
% of which is rural	%	70	2006
% of which is under 5 years old	%	48.1	2006
Population density	Inhabitants/km ²	27.6	2007
Economically active population	Inhabitants	27,300,000	2006
as % of economically active population	%	48%	2006
female (%)	%	51%	2006
male (%)	%	49%	2006

⁵ DSCR, op. cit., page 38

Basic statistics	Unit	Value	Year
Population economically active in the agricultural sector	Inhabitants		
as % of total economically active population	%	74.4%	2005
female (%)	%	60	2005
male (%)	%	40	2005
Economy and development			
Gross domestic product (GDP)	USD million/yr	80	2005
value added in agriculture (% of GDP)	%	30	2008
GDP per capita	USD/yr	143.5	2008
Balance of trade (USD)			
% change from 1990 to current year	%	6.1%	2006
Human Development Index (and ranking)	%	0.4116	2007
Human Poverty Index (and ranking)	%	71.34	2006
Environmental Sustainability Index		dna	
GHG emissions	Tons CO ₂ eq	415,586.54	2002
Access to potable water (less than 500 metres)	%	17%	2006
Infant mortality	%	18%	2005
Literacy			
as % of population	%	65.3	2001
female (%)	%	51.9	2001
male (%)	%	79.8	2001

dna: data not available. However, it should be pointed out that in DRC, it is the surplus which forms part of exports for a given field.

Key Vulnerabilities

Environmental

Coastal area: From the environmental point of view, DRC's coastal area is highly vulnerable, and is characterised by:

1. Erosion: in low-lying coastal areas (Moanda – Ville de Banana) the sea has encroached on more than 27 m of land over 26 years, i.e. at an annual rate of around 1.03 m/yr. The causes of this coastal erosion are both natural and human-induced.
2. Floods: floods are caused by high tides, river floods and precipitation. In the coastal region, many areas are located just a little above sea level, meaning that they are flooded in high-water periods.
3. Pollution: DRC's coastal waters are victim to pollution; contaminants, including heavy metals, sewage and solid waste, damage ecosystems.

⁶ Country ranking per HDI 2007:

http://hdrstats.undp.org/countries/country_fact_sheets/cty_fs_CIV.html

Agriculture – soils: Agriculture is one of the sectors of the economy most vulnerable to environmental degradation since it is directly dependent upon natural systems and resources. In addition to climate change, increasing population and migratory movements resulting from the repeated conflicts that have ravaged the country since 1996 are increasing pressure on the land, leading to deforestation and soil degradation. The latter phenomenon affects agriculture and forests directly by reducing yields. In comparison to current levels, annual rainfalls are anticipated to be seven percent higher by 2050, growing to eleven percent by 2100. There will also be increased evaporation because of higher temperatures.

Water resources: Given its geographical location, immense hydrographical basin of more than 3,822,000 km², and a series of bodies of water that cover more than 86,080 km² (Bultot, 1970), it is unlikely that DRC will experience freshwater shortages. Moreover DRC's green "ocean" of dense tropical vegetation receives around 30 percent of the annual precipitation for the entire African continent. Unfortunately, in the urban centres, water supply is neither free nor abundant, nor permanently available. This makes water a very vulnerable resource in terms of available quantity, exacerbated by increases in urban population that are accelerated by influxes of people from rural areas. The problem is further aggravated by serious pollution of the rivers from which drinking water is drawn.

Economic

DRC's economy is one of the least competitive in Africa⁷. According to the World Bank, in 2008, DRC occupied the 178th position in the world, i.e. next to last from the point of view of ease of doing business.

The country is an importer of oil, mainly in the form of crude oil and petroleum products. Since 1994, the largest share of the latter has been for fuels for automobiles and aircraft (53.6 percent) and diesel (39.8 percent). Other petroleum products are imported in small quantities including lamp oil (1.8 percent) and fuel oil (3.7 percent).

Exports are made up of fuel oil and Congolese oil (medium crude with low sulphur content usable by the petrochemical industry) which cannot be processed in any local refinery.

Level of debt: DRC has an average debt level of 8.6 percent; the acceptable norm is 3 percent. External debt is very high (USD12.6 billion – the equivalent of 200 percent of GDP at the end of 2004).⁸

Income: agriculture remains the most important sector of DRC's economy. It represented 57.9 percent of GDP in 1997; currently contributes only around 30 percent of GDP.⁹

The main crops exported are coffee, palm oil, rubber, cotton, sugar, tea and cocoa; food crops are mainly manioc, plantain, maize, groundnuts and rice. Unfortunately,

⁷ From the World Economic Forum on Africa, held 13–15 June 2007: Rankings 2007. www.weforum.org/en/initiatives/gcp/Africa

⁸ http://fr.wikipedia.org/wiki/Economie_de_la_R%C3%A9publique_D%C3%A9mocratique_du_Congo

⁹ DRC national communication, November 2000, Kinshasa, p. 33.

agricultural exports accounted for only around 10 percent of GDP in 2006, against 40 percent in 1960.

Once a flourishing sector, DRC's agricultural sector is now totally paralysed and experiencing a productivity rate so low that 73 percent of the Congolese population faces food insecurity.¹⁰

Imports of foodstuffs (staples) are increasing while exports of cash crops are falling.

Livestock farming is under-developed in DRC, partly because the country's terrain is not favourable to large cattle. DRC's dense forests offer no possibilities for grazing and trypanosomiasis, carried by the tsetse fly, is endemic to most of the lowland areas.

Energy imports: DRC is highly dependent on imports of oil and coal. The threat of loss of supply is real since the occurrence of armed conflict and civil unrest. The eastern part of the country faces a real problem of timely supply; the cost of imports and sales of goods and services is becoming exorbitant for both importers and consumers who operate under extremely difficult economic conditions.

Technical

Lack of diversification of power sources: in DRC, the energy sector remains highly dependent on ligneous fuels (wood, charcoal, plant residues, etc.). Eight-six percent of the country's energy needs are met via biomass. Procurement of this energy source is fast becoming a major factor in destruction of the forests.

Poor quality of infrastructure: the general situation of DRC's infrastructure is disastrous. The country is in a state of semi-isolation because, in addition to a very sparse communications network (0.074 km of links per km²)¹¹. Moreover it has a very tiny maritime coast (37 km of Atlantic coast).

- *REGIDESO, RVF* and *RVM* water authorities use obsolete infrastructure largely unsuited to modern technology.
- Electricity provision is abysmal with daily power cuts due to overloading and an old, worn out transmission and distribution system and equipment.
- Internet first made its appearance in 1995 via a few private initiatives (a few cyber cafés opened). However, a decade later, Internet in DRC remains a luxury for the majority of the population.

Social

Limited access to services and resources

- A large proportion of DRC's population consumes water in the form of rainwater collected directly or drawn from household wells, where there is a high risk of contamination, or from highly polluted rivers.
- Use by the Congolese of ligneous fuels (wood, charcoal, plant residues) supplements the low level of electrification
- Land has become subject to speculation, depending on the use to be made of it: housing, agricultural or other activity. Land is subject to several different forms

¹⁰ Source: FAO.

¹¹ DSCR, op. cit., 2006, page 34.

of tenure and ambiguity in application of the current law on land rights does not enable a clear distinction to be made between actual land owners and those managing the land. This has led to the immobilisation of thousands of hectares of agricultural land granted by the State (the land owner) to third parties. Development of these concessions has therefore remained hypothetical, a situation which has deprived local populations of fertile land, driving them to farm marginal areas.

Low and unequal levels of education: female education has the following characteristics:

1. Low levels of school attendance and of literacy.
2. The disastrous nutritional state of the population.
3. The wide gap in allocation of responsibilities and in incomes within the population in general, and for women in particular, does not allow promotion of gender equality nor emancipation of women.

Poverty: incidence of poverty is very high (71.34 percent) compared to other central African countries. Poverty is also very deep (32.23 percent) and severe (18.02 percent).¹²

Civic (governance and regulations)

Energy sector reforms: reform of the sector shows a high degree of vulnerability:

1. DRC's energy sector is currently highly centralised and characterised by a state monopoly.
2. DRC's has enormous energy potential that is unequally distributed over the country's territory and is almost wholly unexploited. DRC's energy potential is around 100,000 MW of exploitable capacity, of which almost half (44,000 MW) is concentrated at the Inga site alone.

Unbalanced governance and low public participation in decision making: in DRC decisions on investment, policy and implementation are made by political, economic and social managers. The population has no say in the decision making process; there are no consumer or user groups.

Unequal gender roles: women in DRC have only their physical capabilities with which to confront the harsh conditions of the labour market, the demanding role of wife and the crushing duties of motherhood. DRC's women low productivity is linked to difficulties that have in securing access to land, occupational training and credit. This lack of access is reinforced by a legal and institutional system which disempowers married women by requiring prior authority from their husbands. A minority of Congolese women (ten percent only) have the right to manage their own assets. In rural areas, despite women ensuring 75 percent of food production including storing and processing crops they themselves receive any income; by right any income goes directly to their husbands.

Corruption: Reports from the NGO 'Transparency International' give DRC a low score annually. In 2006 it was classified as the 6th most corrupt country in the world and the 3rd most corrupt in Africa.

¹² DSCR 2006, op. cit., page 22.

Measurement of Current Vulnerability

The country's current vulnerability is measured using general vulnerability indicators.

Environmental

Indicator 1: Change in rainfall patterns

Year	Average annual rainfall in mm
1990	1,298 ¹³
2006	1,200
Change in rainfall between 1990–2006: 0.75% decrease	

DRC has four climates:

- Equatorial: annual rainfall varies between 1,600 and 2,000 mm with a dry season lasting two months; the rest of the year constitutes the rainy season.
- Wet tropical: annual rainfall between 1,200 and 1,600 mm with dry season of between two and four months; the rest of the year constitutes the rainy season.
- Tropical climate with arid tendency: annual rainfall is generally between 1,000 and 1,200 mm. The dry season is greater than four months and can be as long as six months or more.
- Mountain climate: annual rainfall is more than 1,000 mm in the Katanga and 1,200 mm in the east and north-east.

Variations in rainfall could increase in coming years.

According to data from the climate change model, the regions of DRC close to the equator will experience increases in rainfall of around 7.3 percent by 2050 and 13.5 percent by 2100, whereas the rainy season will become shorter moving away from the equator, where rainfall will be more abundant.¹⁴

Indicator 2: Variation in temperature

Year	Average temperature
1990 ¹⁵	24.8 °C
2006 ¹⁶	26.50 °C
Increase 1990–2006	% increase/decrease
1.7°C	+6%

Average annual temperature will vary between 24 and 26 °C, with extreme values of between 30 and 35°C in the Congo basin and between 15 and 20° C in the uplands. Depending on the climate zone, DRC's temperature profile is as follows:

¹³ DRC national communication, November 2000, p.95.

¹⁴ Rainfall and temperature projections were generated using Magic Schengen software

¹⁵ DRC national communication, op.cit, p.95.

¹⁶ PAN, op.cit, pp. 7–8.

- Equatorial: temperatures in the months of May and July can reach 27 and 25°C respectively.
- Wet tropical: temperatures in the months of March and July can be 28 and 21°C respectively.
- Tropical climate with arid tendency: temperatures in the months of March and July can be between 28 and 22°C to the west (Bas-Congo); temperatures for November and July between 24 and 26°C to the south-east (south Katanga).
- Mountain climate: temperatures in October and July vary between 25 and 20 °C.

According to the data generated for Indicator one, there will be a significant long-term increase (2050 to 2100), in temperatures in the west and east; dry seasons will be drier than at present. Such increases will mean that vegetation will be subject to physiological stress affecting mainly long-lasting food crops such as cassava.

Economic

Indicator 1: Access to electricity

Access to electricity in DRC is as shown in the table below:

Electrification level

	1990	2001	2007	Difference
Electrification (%)	5 ¹⁷	6 ¹⁸	6	1

RDC rates are very low in comparison with the sub-Saharan Africa average, which is 24.6 percent.

Indicator 2: Level of increased energy autonomy

The corresponding total of imports and consumption of non-renewable energy (oil and coal) is given in the table below, taken from the energy balance for non-OECD member countries.

Imports and consumption of non-renewable energy

	1990	2006
Total non-renewable energy imports (mtoe)	0.09	0.66
Total energy consumption (mtoe)	1.16	0.96

In 1990, the ratio was $(0.09/1.16) \times 100 = 7.8\%$

In 2006, the ratio was: $(0.66/0.96) \times 100 = 68.7\%$

Dependence on non-renewable forms of energy is extremely high. The ratio between exports of non-renewable energy and all exports is zero.

¹⁷ The 1990 data were taken from the Congo (formerly Zaïre) Central Bank's report, 1991.

¹⁸ CNE, DRC energy policy, 2007.

Technical

Indicator 1: Quantity of energy supplied by renewables

Quantity of hydroelectricity

	1990	2006
Hydroelectricity	99.56%	99.72%

- Total of heat and electricity from renewables: 0
- Projects for combined production are being implemented.

Hydroelectricity accounts for the largest proportion of renewable energy:

- In 1990: it accounted for 99.56 percent.
- In 2006: this share was 99.72 percent of all electricity generated from renewables.

Volume of renewable fuels in total consumption: none.

Indicator 2: Level of diversity of renewable energy sources and technologies

With the exception of hydropower, which generates electricity, other renewable sources are only present in the country in experimental form.

Social

Indicator 1: Distribution of waterborne diseases

DRC monitors 34 diseases, in two categories: diseases that could cause epidemics,¹⁹ and endemic diseases and health priorities. Amongst those that have a potential to cause epidemics, two waterborne diseases are the subject of particular attention as indicated below.

Changes in waterborne disease patterns²⁰

Disease	2003		2004		2005		2006		2007	
	Cases	Deaths								
Cholera	27,272	989	7,983	233	13,793	232	31,336	432	28,261	600
Bacillary dysentery	61,714	306	40,137	114	55,054	238	42,605	100	37,051	127

The number of cases of cholera has been increasing continually since 2004, whereas the epidemiological profile of bacillary dysentery shows peaks and troughs over the past five years. In 2007, incidence was lower than in 2006.

¹⁹ *Rapport épidémiologique des maladies à potentiel épidémique en RDC*. Ministry of Health, 2007, p. 7

²⁰ *Rapport épidémiologique des maladies*, op.cit. , pp 21–26

Indicator 2: Changes in employment

Employment pattern

	1958	2000
Percentage of population in employment	8%	2%
Percentage of economically active population in employment	18%	4%
Percentage of male population in employment	35%	8%

In 2000, two percent of the total population was employed, meaning that four percent of the economically active population and eight percent of the active male population, against eight percent, 18 percent and 35 percent respectively in 1958.

The socio-political crisis of the 1990s further precipitated this negative trend. Employment and professional training crisis is now one of the major causes of the country's extremely difficult social situation. The result is an aggravation of poverty and vulnerability of the population and high levels of urban unemployment.

As a result of the country's ongoing crisis, the economy is dominated by the informal sector which is characterised by extremely low wages and non-existent social protection. In the absence of any recent statistics on the country, it is difficult to give an official unemployment figure. However, in 2006 unemployment was very high, above 40 percent.²¹

Civic

Indicator 1: Farmers owning land or having access to land

Evolution of this indicator is shown in the table below.

Changes for farmers in DRC²²

	1990	2000	Difference	%
Agricultural households (no.)	4,744,900	6,450,052	1,705,152	26
Agricultural population (%)	25,225,658	34,218,912	8,993,254	26.3
Total population(inhab.)	37,400,000	57,295,962	19,895,962	34.7

The following results emerge from the table:

- In 1990: 67.4 percent of total population was involved in agriculture.
- In 2000: this figure was 59.7 percent.

There has therefore been a 7.7 percent reduction in the number of farmers, dictated not only by farmers' poor working conditions but also by the immobilisation of thousands

²¹ http://fr.wikipedia.org/wiki/Economie_de_la_République_Démocratique_du_Congo

²² SNSA: *Rapport annuel 1990 et 2000*.

of hectares of land given out by the Congolese state (owner of the lands) to third parties who are not able to exploit it.

Indicator 2: Public participation in the planning process

In the absence of any reliable statistics, and given the context in which the elections took place in 1990, it is difficult to have any meaningful figures especially as there was no population census at the last elections.

Current Energy Situation

Characteristics

Sine 1990 DRC's energy situation has been characterised by very high dependence on petroleum products and coal, with continuously falling production and increasing consumption. The ratio between imports and total energy consumption went from an energy vector of 0.085 in 1990 to 0.68 in 2006.²³ Seventy percent of imports are used in the transport sector.

Energy Consumption

Energy consumption is, unfortunately, dominated by traditional fuels (especially wood and its derivatives) which account for more than 85 percent of total use. Final energy consumption is estimated at around 8 mtoe²⁴.

Comparison of these two figures shows an energy loss rate of around 37 percent; 25 percent of that is from the carbonisation of wood. The remaining 12 percent is due to the low thermodynamic efficiency of equipment converting the thermal energy from charcoal, use of petroleum products and coal, and transmission losses on the electricity grid. The *Commission Nationale de l'Energie (CNE – national energy commission)* provides a breakdown of energy consumption per sector. The residential sector consumes 57 percent, followed by losses inherent to the conversion process (37 percent), industry is in third place (2.8 percent), followed by transport in the fourth position (2.5 percent) and finally, agriculture, fishing and forestry (0.1 percent).

Energy Demand and Contribution of the Global Energy System

Energy demand is met, for the most part, from fuelwood. Development of demand for and consumption of wood are linked closely to the population increase.

According to *CNE*, net electricity generating has increased by 15 percent in 10 years, whereas the current population growth rate should have induced a minimum increase of 41 percent. The energy balance emerging from this is negative. Breakdown of energy demand is given by the *CNE*.

²² Kasemuana, S. *Energie et écodéveloppement en République Démocratique du Congo*. Available on www.helio-international.org/reports/pdf/congo-fr.pdf, p.21.

²⁴ Communication nationale, 2000.

Table 2: Energy demand²⁵

Source	1994	2007
Wood	90.0	85%
Electricity	5.0	6%
Petroleum products	4.8	8%
Coal	0.2	0.1%

This shows increased electricity production reducing consumption of wood; the remaining percentage is due to energy losses.

Given the minimum increase rate required for the population growth cited above, if the demand was fully met, actual energy consumption would be roughly 20 mtoe. According to the business-as-usual model if production were to increase at its current rate i.e., 1.5 percent, this demand would be reached in 60 years, indicating the need for effective action to address this energy gap.

Energy Policies and Major Objectives

²⁶

DRC's energy policy aims to achieve the following overarching objectives:

1. Bringing electricity supply to the entire territory.
2. Responding to the social need for a healthy potable water supply.
3. Ensuring the country a regular supply of petroleum products.

The development programme includes the following actions to be implemented by 2030:

- The development of hydroelectricity and promotion of renewables other than hydro via projects for electrification of DRC's regions. Hundreds of sites have been identified throughout the country amongst which 55 could be developed in the mid term at a cost of USD647.3 million. The cost of preliminary and feasibility studies for the other sites is USD1.3 million.
- Start of an intense, two-part rural electrification programme.
- Research and development backed up by preliminary and end-use studies as well as pilot and demonstration centres.
- Development work on lowest cost electrical energy supply installations.
- Development of the Inga site.
- Institutional development, especially via creation of an independent regulating agency and an energy management unit, as well as implementation of a well designed energy price policy.

²⁵ CNE. (2008). *Etat des lieux du secteur énergétique*.

²⁶ CNE. (2003). *Définition de la politique énergétique en RDC*. pp. 16–21.

Projects

DRC has initiated projects in the energy sector.

In the short term: there are priority electrification projects for urban and rural areas, using micro-hydro plants that can be implemented quickly. These projects are in line with the Ministry of Energy's programme, on the basis of studies for electrification of DRC's regions (developed by *CNE*).

In the medium and long terms: development of the Inga site (major interconnection lines – Africa's energy highway). DRC is developing a dynamic policy for energy exports from the Inga facility through implementation of interconnection projects oriented in three major directions, i.e.:²⁷

- Northern axis: DRC– North Africa (Libya – Egypt)
- Western axis: DRC – Gabon – Cameroon – Nigeria
- Southern axis: DRC – Angola – Namibia – South Africa.

This major project will constitute an important source of finance to pursue DRC's electrification projects.

Electrification of 347 centres via micro-hydro plants, established over 20 years, aimed essentially at improving the current electrification level.

Energy Systems

Hydroelectricity

DRC remains one of the few countries in the world with large hydroelectric resources. The exploitable potential is estimated at 774 GWh, i.e. 66 percent of central Africa's potential, 35 percent of the whole of the continent's potential and eight percent of the world's annual potential. This corresponds to a minimum exploitable power capacity of 88,400 MW. Annual production would be around 6,000 GWh, i.e. only 0.77 percent of the exploitable potential; consumption would be around 5,000 GWh.

Hydroelectricity provides more than 96 percent of all of the electricity generated in DRC. Concentration of more than half of the exploitable capacity is at the Hyd'Inga facility, in the west of the country. The long distance between this site and users has had a negative impact on electrification of villages and towns across the country. DRC's physical area (four times that of France) would require thousands of kilometres of electricity lines from Inga to reach users.

Solar

DRC is in a very high level sun belt where values are between 3,250 and 6,000 Watt-peak/m²/s. This makes installation of photovoltaic systems viable in many parts of the country, as well as use of thermal solar systems. Power could be used for pumping water, guaranteed lighting, pumping irrigation and other aspects of agriculture and the heating or drying of some foods (as operating costs are low). Unfortunately, there are only 836 existing solar systems with a total power of 83,160 Wp. These systems are located in: Equateur (167), Katanga (159), Nord-Kivu (170), the two Kasai provinces

²⁷ *CNE: Etats des lieux du secteur énergétique du RDC*. November 2005, pp. 19-21.

(170), Bas-Congo (170). There is also the 148 Caritas network systems with a total power of 6,310 Wp. This is insignificant in terms of the country's additional energy needs.

Wind

There are some areas in DRC where the windspeed is equal to or greater than 5 km/h, (for example measured wind speeds are: 5.5 km/h at Matadi, 6 km/h at Gimbi and 6.6 km/h at Kalemie and Goma). However wind energy is not used in DRC, with the exception of a few pilot facilities, or in isolated cases where the energy is used to supply pumps and/or lighting.

Geothermal

There is a definite geothermal potential in the east of the country consisting of active geothermal sites and volcanoes, but this is hardly exploited. The hot springs identified are as follows:

Table 3: Hot springs in east DRC

Geothermal sources	Temperature (°C)	Flow rate	Number of springs
NYANGEZI	37 to 50	11 l/s	12
KATANGA	30 to 63	162 l/s	15
RWINDI	75 to 90	75 l/s	33

These energy systems have some advantages:

1. Support for replanting schemes.
2. Increased amounts of biomass for energy and fodder.
3. Substitute for wood and charcoal.
4. Soil fertilisation.
5. Better soil protection.
6. Reduced pressure on vegetation.

Nuclear Energy

There are three high-concentration uranium deposits in the south of Katanga (Shinkolobwe, Kalongwe and Lwambo). Assessment of the reserves is about 1,800 tonnes. These deposits are not mined.

The only national use of nuclear energy is by the *Commissariat Général à l'énergie atomique* (CGEA – atomic energy commission), which has a multi-discipline and varied mission. Current CGEA activities focus on the following sectors:

1. Research.
2. Monitoring and regulation.
3. Industry.

Biomass

Fuelwood: DRC has around 125 million hectares of forest, of which:

- 120,000,000 ha are equatorial forest.

- 5,000,000 ha are gallery, marshland and high-altitude forests.

The wood potential is 12.5 billion m³ i.e., 100 m³ of wood per hectare, and annual production is 2 m³/ha. Firewood and charcoal account, on average, for 80 percent of the primary energy consumed in DRC. Unfortunately, these fuels waste precious and limited local wood resources, as well as generating considerable quantities of pollutants that affect users' health.

Biogas: the potential from plant and animal wastes able to produce biogas is immense. Once produced, biogas can be used as a fuel for domestic uses (cooking, lighting, etc.) or to power suitably adapted generators to provide electricity.

In DRC, biogas is only at the experimental stage, mainly in Nord-Kivu and Sud-Kivu. Barriers to its development are:

1. the high cost of digesters in relation to people' incomes; and,
2. the lack of training of users and of maintenance technicians.

There are estimated methane reserves of 50 billion m³ at Lake Lac Kivu.

Biofuels: DRC's potential for production of biofuels is enormous. Unfortunately, experiments started at the molasses distillery set up at Kiliba, in the east of the country, and intended to be extended to the other sugar refineries, suffered the effects of the war. The work stopped and there is no indication of them recommencing.

Energy System Vulnerability

Vulnerability Indicator	Calculation
Coal	
1. Number of mine plants located at less than 1 metre above sea level and within an area that could be flooded by a flood with a current recurrence period of 100 years	4 ²⁸
Oil and gas	
1. Share of offshore oil and gas installations likely to be hit by a storm of more than 70 m/s gusts within the next 20 years (%)	0
2. Share/number of refineries likely to be hit by a storm of more than 70 m/s gusts within the next 20 years	0
<i>DRC's oil is refined overseas and its gas production facilities are not developed.</i>	
All fossil fuels	

²⁸ Mining land registry *Rapport annuel 2007*.

Vulnerability Indicator	Calculation
<p>1. Number of thermal (coal, oil and gas) power plants located at less than 1 metre above sea level and within the area that would be flooded by a flood with a current recurrence period of 100 years</p> <p><i>Most of the thermal plants are oil-fired and are located in places that, for the moment, are not threatened by flooding.</i></p>	
<p>2. Additional information: Expected number of droughts that lead to a capacity decrease of thermal power plants by more than 10% within the next 30 years</p> <p><i>No such study has been made to date.</i></p>	
Nuclear	
<p>1. Number of nuclear power plants located at less than 1 metre above sea level and within the area that would be flooded by a flood with a current recurrence period of 100 years</p> <p><i>DRC has no nuclear power plants. There are two research reactors at the Centre Régional d'Etudes Nucléaires (CRENK – regional nuclear study centre) in Kinshasa, the technical branch of the CGEA, one reactor is shutdown, the other is active and is used for research.</i></p>	There are no nuclear power plants in DRC
<p>2. Number of incidents/accidents since the plant was built</p>	No incidents reported at CRENK centre, apart from erosion which threatens the centre
Hydro	
<p>1. Expected precipitation change over the next 20–50 years (%) and/or probability of floods in each watershed</p> <p><i>These variations will have repercussions for water resources and electricity and will affect agriculture.</i></p>	7–11% of current values
<p>2. Number of multiple-use dams in the country today</p> <p>a. Volume of water (m³) of each dam</p> <p><i>The dams are used either to generate electricity (in the case of SNEL, the national electricity company) or for water supply distribution (REGIDESO); the agricultural irrigation function is not used.</i></p>	No multi-use dam
Transmission and distribution indicators	
<p>1. Length of transmission lines²⁸</p>	5,182.5 km in 1997 5,182. km in 2007
<p>1.b. Length of distribution lines</p>	34,374 in 2000 35,734 in 2007

²⁸ SNEL (2007). *Statistiques d'incidents du Réseau SNEL*.

²⁹ SNEL. *Rapport annuel 2007*.

Vulnerability Indicator	Calculation																											
<p>1.c. Possible transnational lines:</p> <p><i>DRC– southern Africa lines.</i></p> <ul style="list-style-type: none"> ▪ <i>In the short term, a second 200 kV line between two sub-stations at Karavia and Luano should be installed to bring capacity to 500 MW.</i> ▪ <i>In the mid term, the HVDC INGA – KOLWEZI lines and converters should be reinforced and a 330 kV link built between Kolwezi and Luano via Kolwezi, in Zambia, for expected 1,000 MW flow from the SNEL system to the west African interconnected system.</i> ▪ <i>Project for building of a high-voltage line from Kwilu, in DRC, to several towns in northern Angola.</i> ▪ <i>Study of a link between Pointe-Noire in Congo (Brazzaville) and the isolated Cabinda area in Angola (north of Congo River). This could be the first step towards the West African Power Pool (WAPP) via a DRC – Congo – Gabon – Cameroon – Nigeria link.</i> <p><i>DRC – North Africa lines:</i></p> <ul style="list-style-type: none"> ▪ <i>Lines to the north include the 5,300 km between DRC and Egypt that will also provide supply to Central African Republic, Sudan and Chad, through which it passes.</i> 																												
<p>2. Number of electricity power cuts</p> <p><i>These statistics concern all three sectors (west, south and east) but in 2007, the western sector was seen to be particularly affected (302 cuts). The table below shows the pattern of incidents.</i></p> <table border="1" data-bbox="289 1016 1089 1455"> <thead> <tr> <th rowspan="2"></th> <th rowspan="2">2006</th> <th rowspan="2">2007</th> <th colspan="2">Difference 30</th> </tr> <tr> <th>Actual</th> <th>%</th> </tr> </thead> <tbody> <tr> <td>Number of medium voltage (MV) incidents</td> <td>28,658.0</td> <td>61,945.0</td> <td>332,887</td> <td>116.15</td> </tr> <tr> <td>Average duration per MV incident (min)</td> <td>57</td> <td>23.6</td> <td>-33.45</td> <td>-58.68</td> </tr> <tr> <td>Number of low voltage (LV) incidents</td> <td>76,384.0</td> <td>1,553,717.0</td> <td>1,477,333</td> <td>1,934.09</td> </tr> <tr> <td>Average duration per LV incident (min)</td> <td>109.2</td> <td>173.2</td> <td>4.02</td> <td>58.63</td> </tr> </tbody> </table> <p><i>In view of the results for the city of Kinshasa, which represents almost 70 percent of the country, it can be seen that the grid is very vulnerable and that 70 percent of the incidents are attributable to equipment failures, 20 percent to weather conditions and 10 percent to rationing.</i></p>		2006	2007	Difference 30		Actual	%	Number of medium voltage (MV) incidents	28,658.0	61,945.0	332,887	116.15	Average duration per MV incident (min)	57	23.6	-33.45	-58.68	Number of low voltage (LV) incidents	76,384.0	1,553,717.0	1,477,333	1,934.09	Average duration per LV incident (min)	109.2	173.2	4.02	58.63	<p>788 in 2006 846 in 2007²⁸</p>
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<p>3. Percentage of energy supply requiring regional transport over 50 km</p> <p><i>Transport is of raw materials.</i></p>	<p>0%</p>																											

³⁰ Annual technical activities management report from *Direction de distribution de Kinshasa* (DDK – Kinshasa distribution authority), 2007.

Vulnerability Indicator	Calculation																																				
Biomass																																					
<p>1. Proportion of biomass used for energy purposes (%) in total biomass production: <i>These different sources (agricultural and forestry wastes) are not yet used for energy.</i></p> <p><i>It should, however, be noted that an experiment was carried out at Kolofua in the Cataractes sub-region, Bas-Congo Province, with J.V.L., using palm nuts; this was short-lived given the high cost.</i></p>	0%																																				
<p>2. Expected precipitation change over next 20–50 years (%)³¹.</p> <table border="1" data-bbox="272 646 1117 1373"> <thead> <tr> <th></th> <th>1990</th> <th>2100</th> <th>%</th> </tr> </thead> <tbody> <tr> <td>Precipitation (mm) at longitudes 12.5° (Bas Congo) Latitudes – 2.5</td> <td>1,031</td> <td>1,802</td> <td>42.8%</td> </tr> <tr> <td>Precipitation (mm) at longitudes 12.5° (Kinshasa) Latitudes – 2.5°</td> <td>1,530</td> <td>1,652</td> <td>7.3%</td> </tr> <tr> <td>Precipitation (mm) at longitudes 17.5° (Bandundu) Latitudes – 2.5°</td> <td>1,440</td> <td>1,622</td> <td>11.2%</td> </tr> <tr> <td>Precipitation (mm) at longitudes 22.5° (Kasai) Latitudes – 2.5°</td> <td>1,571</td> <td>1,889</td> <td>16.8%</td> </tr> <tr> <td>Precipitation (mm) at longitudes 22.5° (Kasai) Latitudes – 7.5°</td> <td>1,466</td> <td>1,538</td> <td>4.6%</td> </tr> <tr> <td>Precipitation (mm) at longitudes 27.5° (Maniema) Latitudes – 2.5°</td> <td>925</td> <td>1,056</td> <td>12.5%</td> </tr> <tr> <td>Precipitation (mm) at longitudes 27.5° (Katanga) Latitudes – 7.5°</td> <td>1,165</td> <td>1,252</td> <td>6.9%</td> </tr> <tr> <td>Precipitation (mm) at longitudes 27.5° (Maniema) Latitudes – 12.5</td> <td>1,262</td> <td>1,147</td> <td>9.1%</td> </tr> </tbody> </table> <p><i>Increased precipitation will add to run-off in urban areas in particular, resulting in less charging of groundwater, silting up of rivers causing flooding and obstruction of dams.</i></p>		1990	2100	%	Precipitation (mm) at longitudes 12.5° (Bas Congo) Latitudes – 2.5	1,031	1,802	42.8%	Precipitation (mm) at longitudes 12.5° (Kinshasa) Latitudes – 2.5°	1,530	1,652	7.3%	Precipitation (mm) at longitudes 17.5° (Bandundu) Latitudes – 2.5°	1,440	1,622	11.2%	Precipitation (mm) at longitudes 22.5° (Kasai) Latitudes – 2.5°	1,571	1,889	16.8%	Precipitation (mm) at longitudes 22.5° (Kasai) Latitudes – 7.5°	1,466	1,538	4.6%	Precipitation (mm) at longitudes 27.5° (Maniema) Latitudes – 2.5°	925	1,056	12.5%	Precipitation (mm) at longitudes 27.5° (Katanga) Latitudes – 7.5°	1,165	1,252	6.9%	Precipitation (mm) at longitudes 27.5° (Maniema) Latitudes – 12.5	1,262	1,147	9.1%	
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Wind																																					
<p>1. Number of wind turbines less than 1 metre above sea level: <i>DRC does not yet have any wind turbines: at the studies and trials stage.</i></p>	0																																				
<p>2. Projected change of average windspeed in the next 20 years based on regional climate models (%)</p> <p><i>Windspeeds relevant in this context currently vary from 5 to 6.5 km/h and could reach high levels in the next 20 years if present results remain unchanged.</i></p>	Data not available at present.																																				

Vulnerability Indicator	Calculation																											
Solar																												
<p>1. Capacity of solar installations already in place (m²):</p> <p><i>At present, the country has 836 solar PV installations with a capacity of 73,160 Wp and 6,310 Wp for FNMA under a public-private partnership and with private investment. These installations have a capacity of 1,000 Wh/m².</i></p>																												
<p>2. Expected temperature increase (°C) in the next 20 years</p> <table border="1" data-bbox="289 575 1016 1276"> <thead> <tr> <th></th> <th>1990</th> <th>2050</th> </tr> </thead> <tbody> <tr> <td>Temperature (°C) at longitudes 12,5° (Bas Congo) Latitudes – 2.5°</td> <td>25.2</td> <td>28.4</td> </tr> <tr> <td>Temperature (°C) at longitudes 12,5° (Kinshasa) Latitudes – 2.5°</td> <td>25.0</td> <td>27.5</td> </tr> <tr> <td>Temperature (°C) at longitudes 17,5° (Bandundu) Latitudes – 2.5°</td> <td>24.9</td> <td>27.7</td> </tr> <tr> <td>Temperature (°C) at longitudes 22,5° (Kasaï) Latitudes – 2.5°</td> <td>23.7</td> <td>26.4</td> </tr> <tr> <td>Temperature (°C) at longitudes 22,5° (Kasaï) Latitudes – 7.5°</td> <td>23.9</td> <td>26.9</td> </tr> <tr> <td>Temperature (°C) at longitudes 27,5° (Maniema) Latitudes – 2.5°</td> <td>30.2</td> <td>33.0</td> </tr> <tr> <td>Temperature (°C) at longitudes 27,5° (Katanga) Latitudes – 7.5°</td> <td>25.2</td> <td>28.2</td> </tr> <tr> <td>Temperature (°C) at longitudes 27,5° (Maniema) Latitudes – 12.5°</td> <td>20.4</td> <td>23.7</td> </tr> </tbody> </table> <p><i>At latitudes -2,5° ,a temperature increase of 2.5 to 3.2 °C; at latitudes -7.5° ,an increase of 2.8 to 3.0 °C, at latitudes -12.5° ,an increase of 3.3 °C.</i></p>		1990	2050	Temperature (°C) at longitudes 12,5° (Bas Congo) Latitudes – 2.5°	25.2	28.4	Temperature (°C) at longitudes 12,5° (Kinshasa) Latitudes – 2.5°	25.0	27.5	Temperature (°C) at longitudes 17,5° (Bandundu) Latitudes – 2.5°	24.9	27.7	Temperature (°C) at longitudes 22,5° (Kasaï) Latitudes – 2.5°	23.7	26.4	Temperature (°C) at longitudes 22,5° (Kasaï) Latitudes – 7.5°	23.9	26.9	Temperature (°C) at longitudes 27,5° (Maniema) Latitudes – 2.5°	30.2	33.0	Temperature (°C) at longitudes 27,5° (Katanga) Latitudes – 7.5°	25.2	28.2	Temperature (°C) at longitudes 27,5° (Maniema) Latitudes – 12.5°	20.4	23.7	<p>Latitudes around -2.5° a temperature increase of 2.5 to 3.2 °C;</p> <p>Latitudes -7.5°, a temperature increase of 2.8 to 3.0°C</p> <p>Latitudes -12.5°, an increase of 3.3 °C.</p>
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Energy System Resilience

Adaptation Indicator	Calculation
<p>1. Implementation indicators</p> <p>1b. Domestic capital formation (USD million per year)</p> <p><i>Ongoing research to find reliable data.</i></p>	Data not available
<p>2. Domestic investment in renewable energy (USD million per year)</p> <p><i>The figure given is for investment in renewable energy excluding hydroelectricity. Unfortunately implementation has not followed.</i></p>	USD1,185,621.80 ³³
<p>3. Number of electrical engineers graduating annually as a percentage of the total population</p> <p><i>In 2006, there were 550 qualified electrical engineers for a population of 60,000,000.</i></p>	9%
<p>4. Availability of hazard maps for floods/droughts</p> <p><i>The coastal area is most vulnerable to floods, caused by high tides and also by high river water levels and high precipitation. The northern part of Bandundu (Inongo territory) is very exposed to severe drought, leading to epidemics.</i></p>	Yes
<p>5. Existence and enforcement of power plants siting and construction guidelines taking climate change into consideration</p> <p><i>The plan does not yet exist but it is being prepared.</i></p>	No
<p>6. Existence of emergency plans to react to meteorological extreme events and availability of local emergency repair teams</p> <p><i>This plan is being prepared and there are no local emergency response teams at present. The collapse of a 220 kV HV pylon in the west of the country that deprived the entire capital of its electricity supply until the Direction générale (general management department) in Kinshasa could intervene illustrates the importance of such teams.</i></p>	0
<p>7. Domestic availability of insurance schemes</p> <p><i>Amongst the forms of insurance cover available from the sole insurance company (Sonas) there is insurance relating to forestry and mining³⁴, fully comprehensive cover has been introduced recently.</i></p>	0
<p>8. Existence of citizens' users groups in the energy governance structure (enforcement of participatory decision-making)</p> <p><i>There is only one NGO in the country, known as Ligue des Consommateurs du Sud-Kivu (Sud-Kivu consumers league), currently involved in legal proceedings with SNEC concerning overbilling.</i></p>	0

³³ Ministry for National Budget: Law No. 07/009 of 31 December 2007'.

³⁴ Range of insurance policies proposed by SONAS: www.sonasrdc.com.

Adaptation Indicator	Calculation
Coal, oil and gas, uranium and nuclear power plant	
<p>1. Existence and use of a siting map for mines and power plants taking into account projected storms, floods and drought areas</p> <p><i>The maps exist; DRC geographical institute determines these areas. The maps are unfortunately under-used.</i></p>	Yes
<p>2. Implementation of national regulations for thermal power plant siting at sites with sufficient cooling water availability over the next 50 years</p> <p><i>No regulations of this type.</i></p>	No
Hydro	
<p>1. Existence of a national plan for optimised operation of hydro plants under projected flow regimes for systems</p> <p><i>No such programme exists. The Ministry for Energy is preparing an electricity code.</i></p>	No
<p>2. Number of dams equipped with desilting gates and/or number of upstream land use management and water catchment plans for each hydro installation</p> <p><i>In 1990, 18 dams were equipped with desilting gates³⁵. In 2007, this number had decreased to 16 dams, an 11 percent decrease.</i></p>	16 dams
Biomass	
<p>1. Research, development and dissemination budget for heat and drought resistant crops, biofuels, agricultural* waste for energy and vulnerability of forest (USD million per year)</p> <p><i>Research is ongoing but, in the field, research in this area is very far from the forefront.</i></p> <p><i>* does not include municipal waste – this is usually considered in mitigation plans</i></p>	Data not available currently
<p>2. In-country utilisation of biomass fuels not traditionally used by private enterprises and cooperatives (% of total fuels)</p> <p><i>No use made. Biomass fuels not usually used by enterprises are left in the natural environment. The experiment in the village of Kolofua was short-lived.</i></p>	0
<p>3. % of households using improved woodstoves out of total number of households using woodstoves</p> <p><i>This technique is not very common in Congolese households. At the studies stage, although the technique should be used widely nationally to save on wood and conserve the forests.</i></p>	0

³⁵ SNEL. (2002). *Répertoire des aménagements hydro-électriques de la RDC.*

Adaptation Indicator	Calculation
Wind	
1. Existence and enforcement of national regulations requiring storm proofing of wind power plants to withstand highest anticipated windspeed <i>These regulations are included in the electrification code currently being drafted.</i>	These regulations will be issued in the near future
Solar	
1. Existence of a siting map that details projected changes in cloud cover <i>Such maps do not exist. However, variations in cloud cover are observed in the mountains in the eastern and central parts of the basin, which could be a handicap for solar installations.</i>	0
2. Existence and enforcement of national regulation requiring storm proof concentrating solar power plants (CSP) to withstand the highest anticipated windspeed. <i>There is not such regulation.</i>	0

Conclusions and Recommendations

Climate change is a challenge that is facing the whole world.

In DRC, changes in climate have added to social problems already characterised by a continual decline in living conditions, resulting in overall poverty. Incidence of poverty is currently 71.34 percent.

Economic instability, the freezing of international aid, and the absence of a policy on demographics that is coherent and appropriate to local conditions have had a negative effect on the country's overall social development.

This study has shown the limits of DRC's currently highly vulnerable energy system:

- High dependence on non-renewable energy that has gone from 7.8 to 68.7 percent in less than 20 years.
- At present, the Congolese State has a total monopoly in the energy sector.
- DRC's enormous energy potential, distributed unevenly throughout the territory, is virtually untapped.
- Around half of the hydroelectric power is concentrated at a single facility, at Inga.

- The expected rainfall changes of between 7 and 11 percent will be greater than at present and, combined with weak infrastructure, will impact not only agriculture and increase flooding in prone areas but will also effect water and electricity resources.

Faced with this situation, the following policies and recommendations are made to help reduce energy system vulnerability and increase overall resilience:

1. Carefully managed removal of the monopoly over DRC's electricity system. Setting up of specialist Congolese SMEs would permit, amongst other things, development of decentralised energy systems involving building of micro and mini generating plants not exceeding 20 MW, and the creation of new jobs.
2. Supply and better distribution of fuels in each province, district and locality would help to ensure local energy supplies.
3. Investment in specifically designed and diversified use of biomass, especially use of improved stoves burning firewood, wood chips or charcoal, as well as improved carbonisation techniques, would reduce consumption of biomass and allow people to adapt to the changes made necessary by type and quantity of biomass.
4. Intensification of use of renewables—especially of the solar, wind and geothermal potential—would help to reduce the country's high dependence on biomass.
5. Diversification and improvement of energy company infrastructure, to increase resilience to climate variations. The power failures observed regularly are, to a large extent, the result of the poor condition of infrastructure. To achieve this, DRC will need to:
 - a. Intensify research and development into both dissemination and varieties of crops that are resistant to heat and drought as well as use of plant residues as a source of energy. This must be supported by preliminary and feasibility studies and pilot demonstration schemes, with a substantial budget, if the challenge of climate change is to be met.
 - b. Accelerate introduction of an electricity code, currently being prepared, and which must encompass expected climate change. The code must contain, amongst other things, regulations on construction of solar, wind and hydroelectric systems, allowing for meteorological conditions (wind, rain, sun, cloud cover). Drawing up of an energy map is therefore essential.
6. Creation of the conditions for access to easily affordable and sustainable energy. This can only come about if DRC improves its present infrastructure and diversifies its energy producing technologies, which will reduce dependence on non-renewable energy.

7. Involvement of citizens in making of decisions on energy services and participation of rural communities that are close to realities in the field, to allow identification of energy solutions appropriate to situations and needs which may change under the impacts of climate change.

In this way, we will create better living conditions for DRC's people and mitigate the impacts of climate change.

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Annex One: DRC's hydroelectric potential and sites

