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Scenario for the management and monitoring of the electricity sector Vulnerability to Climate risks in Burkina Faso

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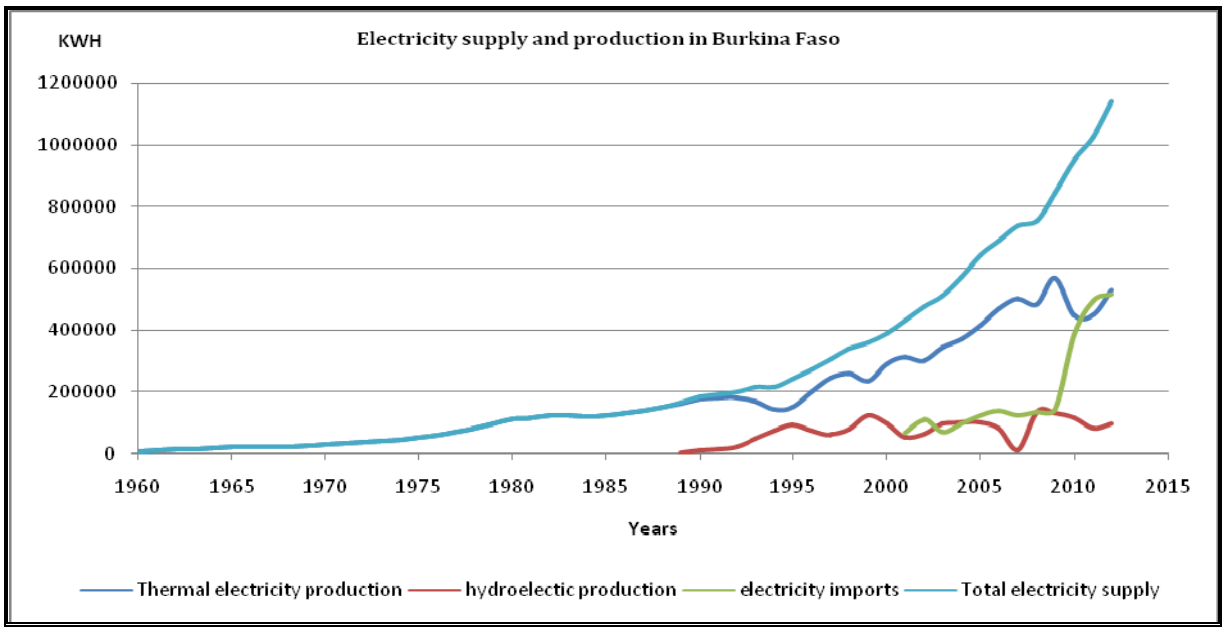
Abstract: For a country like Burkina Faso, the resilience of energy sector is an essential factor for the adaptation of socio-economic sectors to climate change. The basic option to build this resilience is to take into account climate risks into energy policies and strategies. In this paper, we analyze the current and future vulnerability of the electricity sector to climate risks and propose a scenario for its management and monitoring. The main factors of the resilience of the electricity sector to climate risks which are identified in this scenario are energy efficiency and renewable energy.

Keywords: electricity sector, climate change, scenario of resilience.

I. Introduction

Located in the heart of West Africa, Burkina Faso is a low income country facing a multitude of development deficits. The electricity sector is one of the sectors where these deficits are the most important. In this sector, the key development deficit is the low population access to electricity. Only 25% of the population has access to electricity (Burkina, 2011), with a lingering imbalance between urban centers (46%) and rural areas (2%).
The country's electricity supply is mainly devoted to the national electricity company (SONABEL), which is a public company. This supply is based on three main sources that are local thermal and hydropower generation and electricity imports from neighboring countries such as Ghana, Côte d'Ivoire and Togo. Figure (1) describes the contribution of each of these sources to the overall supply of electricity, for the period 1960-20012.



Local thermal power generation and electricity imports are currently the main sources of electricity supply in Burkina Faso. Hydropower generation, mainly due to precipitation patterns in Burkina Faso, is not well developed.
In order to create the conditions for a secure and efficient electricity supply, the government of Burkina Faso has integrated into the national strategy of growth and sustainable development (Burkina Faso, 2011) a series of options to develop the electricity sector. These options are: a) the establishment of an institutional framework and regulatory and fiscal measures that allow the mobilization of actors and financial resources; b) securing the country's supply and reducing energy costs; c) the extension of electricity networks to rural areas; d) mobilization of national energy potential and its development and e) improving the efficiency of energy consumption.
However, these efforts, which will shape the future of the electricity sector in the short, medium and long terms, will have the desired effects if they fully incorporate environmental and change risks. The temperature rise of the earth, increased frequency and intensity of extreme weather events and altered precipitation patterns are aspects of expected changes in climate and the environment that are likely to affect significantly electricity supply and demand (IPCC, 2007b **;** T.K. Mideksa et al, 2010).
In this paper, a conceptual resilience to climate risks model will be completed to produce a scenario for the management and monitoring of the electricity sector vulnerability to disaster risk and climate change. This model, which is illustrated in figure (2), is one of the results of research conducted in our institute (IAVS) in the field of disaster risk management (M. BADOLO et al, 2011). The model has two main components. Each component is divided into specific sets of solutions.

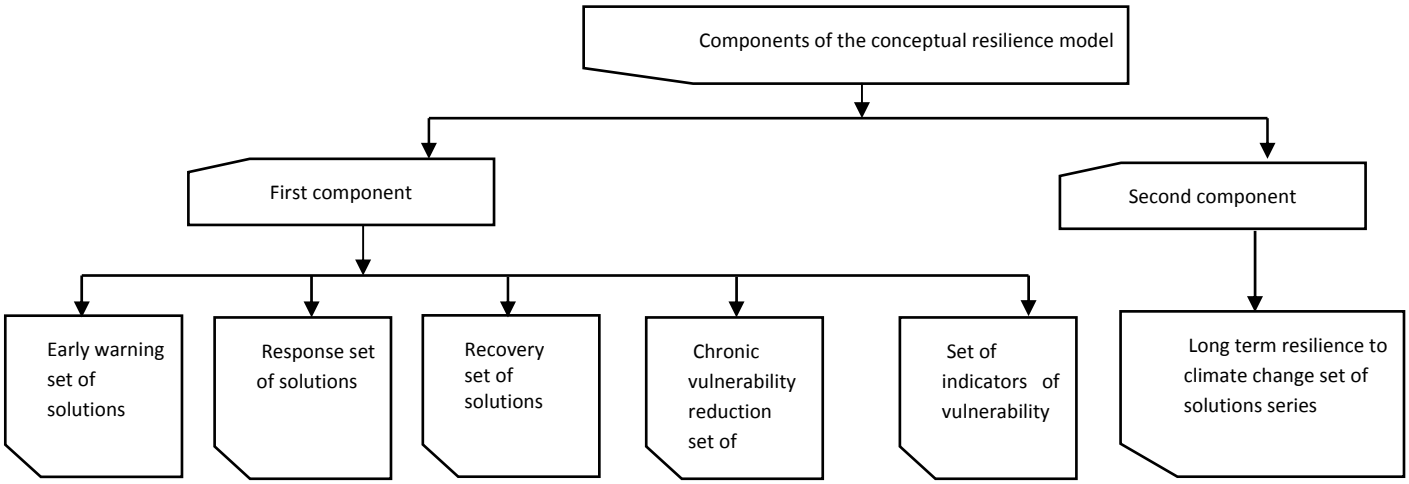


Figure (2): Illustration of the conceptual resilience model

II. Data and Methodology

1. Climate risk and climate change scenarios

In Burkina Faso, climate risks that affect significantly electricity supply and demand are droughts, floods and strong winds. It is on the basis of these three risks that the vulnerability of the electricity sector to climate risks will be evaluated.

In order to take into account the uncertainties associated with future climate in Burkina Faso, particularly uncertainties in precipitation, three qualitative climate change scenarios will be used to identify the potential challenges related to climate change for electricity sector. These scenarios are:

Scenario S1: it anticipates, compared to the current climate, a future drier and warmer climate. It is characterized primarily by a significant increase in temperature and permanent drought.

Scenario S2: it projects, compared to the current climate, a future highly variable climate. It is characterized by an increase in temperature and in the frequency and intensity of climatic shocks (droughts, heat waves, floods).

Scenario S3: it anticipates, compared to the current climate, a future wetter and warmer climate.

2. Methodology

The methodology used to produce the set of information needed to complete the conceptual model of resilience is illustrated in figure (3). This methodology, known as the ClimProspect model (M.BADOLO et al, 2011), allows in practice to develop three different sets of solutions which are the set of indicators of vulnerability, the set of solutions to reduce vulnerability to climate risks and the long-term resilience to climate change set of solutions. The first and second sets of solutions are used to develop the six sets of solutions of the first component of the conceptual model.

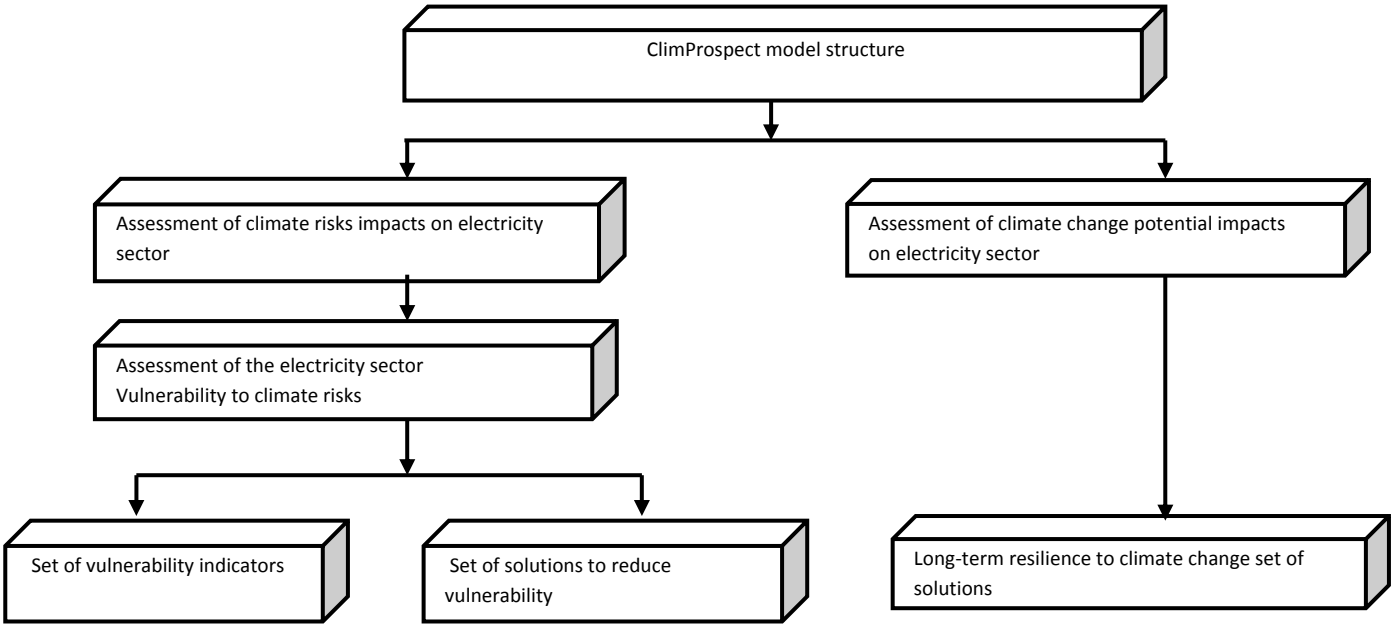


Figure (3): Methodological approach

The main effects of the three identified climate risks on the supply and demand of electricity and the socio-economic consequences of these effects are described in the Table (I). In Burkina Faso, drought is the most significant climate risk for electricity sector. By affecting both electricity supply and demand, droughts increase the imbalance between electricity supply and demand. Droughts reduce the supply of electricity by reducing the generation of hydroelectricity. By cons, they increase the demand for electricity due to rising temperatures. Droughts contribute to the deterioration of the financial situation of SONABEL, since they induce an increase in the thermal power generation and electricity imports. These effects of droughts indicate that a future drier and warmer climate will pose significant challenges for the electricity sector.

Table (I): Direct and indirect impacts of climate risks on electricity sector in Burkina Faso

climate risks	Effects on electricity supply	Effects on electricity demand	Socio-economic impacts
droughts	Decrease in hydroelectric generation; recurring cuts of the electricity supply; increase in thermal power generation	Changes in electricity demand ; Increasing imbalance between supply and demand for electricity	Disruption of economic and social activity; loss of income for SMEs and informal enterprises; deterioration of the financial situation of SONABEL
floods	Deterioration or destruction of infrastructures for hydroelectricity generation; disruption of electricity service to users		
Strong winds	Deterioration or destruction of electrical network; disruption or cuts of the electricity supply to consumers		

The impacts of climate risks in the electricity sector in Burkina Faso actually reveal the vulnerability of this sector to climatic risks. Several factors contribute to this vulnerability. The most important of these factors are low use of weather forecasts for planning and managing electricity supply and demand, deficiencies in the integration of energy efficiency in the electricity sector development policies, low integration of renewable energyin the overall electricity supply, the preponderance of fossil fuels in electricity supply , lack of early

warning for the electricity sector, deficiencies in the integration of disaster risk in the design and construction of infrastructure for production and transport of electrical energy, deficits in the integration of droughts in the annual planning of hydrocarbons controls, absence of mechanisms of response to disruptions in SMEs.

IV. Potential effects of climate change on electricity sector

The results of scientific research show that climate change will have significant effects on the supply and demand of electricity in the world. (T.K. Mideksa et al, 2010). To identify these effects in the context of Burkina Faso, the method of prediction by analogy was used to assess the impacts of the three scenarios S1, S2 and S3 on the supply and demand for electricity.

The main effects of climate change such as anticipated by the S1 scenario would be a significant reduction of water resources for hydropower, a substantial increase in the cost of thermal power generation and considerable increase in electricity demand of economic and residential sectors. The major impacts of climate change such as anticipated by the S2 scenario would be frequent variations in electricity supply and demand and a substantial increase in the cost of construction and maintenance of infrastructures for electricity production and transport. More water resources for hydropower generation and increased electricity demand are the main opportunity and challenge that could be related to a climate such as that described by the scenario S3.

V. Specification of the scenario components

Table (II) describes the package of solutions identified for each component of the scenario. These solutions are suggested by the factors of vulnerability of the electricity sector to climate risks and the expected impacts of climate change. To implement the proposed solutions, it will be necessary to develop specific partnerships at the national and international level, promote the development of platforms for energy efficiency and renewable energy and create appropriate framework for dialogue on the development of the energy sector.

Tableau (II) : Specification of the scenario components

Components of the scenario	Description of solutions
Early warning	An early warning system for electricity sector; a national system for the dissemination of early warnings
Response	Specific clauses related to droughts in the imports of electricity contracts; access to electricity generators facilities for SMEs and informal sector
Recovery	Access to renewable energy technologies facilities for SMEs; financial facilities for SMEs and informal sector for recovery actions; Incentives for energy efficiency measures in the SMEs and informal sector
Chronic vulnerability	Information campaigns on energy efficiency and renewable energy solutions; Set of solutions for promoting energy efficiency and renewable energy in residential and economic sectors; Operational mechanisms for the integration of seasonal forecasts in the planning of SONABEL's activities ; Operational mechanisms for the integration of climate risk in the management of electricity ;supply and demand ; Operational strategies for integration of renewable energy in SONABEL electricity supply ; intensification and improving import electrics strategies
Indicators of vulnerability	Percentage of enterprises that have not deployed energy efficiency solutions; percentage of electricity demand in urban areas that cannot be met by renewable energy technologies; percentage of SME that cannot access to renewable energy technologies ; percentage of financial recovery needs of SMEs that cannot be covered by recovery mechanisms established; percentage needs SONABEL in additional orders hydrocarbons drought cannot be covered by the annual budget
Long term resilience	Scientific research and innovation programs in the field of renewable energy; development of a local expertise and industry in the field of renewable energy technologies; development of instruments and tools for promoting energy efficiency; significant integration of renewable energy in electricity supply in Burkina Faso ; promotion of energy conservation

VI. Conclusion

The development, in Burkina Faso, of an efficient electricity sector can no longer be considered without taking into account climate change risks, which will affect both electricity supply and demand. The scenario proposed in this paper provides a set of information which is guidelines for the development of an operational framework for the integration of disaster and climate change risks into electricity sector development strategies. The vulnerability analysis shows that energy efficiency, renewable energy and energy conservation are, in the context of this study, the main factors that must be considered for the resilience and development of the electricity sector.

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