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**ENERGY TRANSITION POLICY AND FOREST PROTECTION IN THE REPUBLIC
OF MALI AND AZERBAIJAN: ANALYSIS OF POTENTIALITIES
AND ASSETS FOR SUSTAINABLE DEVELOPMENT**

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**ПОЛИТИКА ЭНЕРГЕТИЧЕСКОГО ПЕРЕХОДА И ОХРАНА ЛЕСОВ
В РЕСПУБЛИКЕ МАЛИ И АЗЕРБАЙДЖАНЕ: АНАЛИЗ ПОТЕНЦИАЛОВ
И АКТИВОВ ДЛЯ УСТОЙЧИВОГО РАЗВИТИЯ**

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Abstract. The energy transition is a challenge and an urgency for the world facing the scarcity of fossil fuels and their impacts in the ecosystems by climate change. Through this study, we wanted to assess the potential of new and renewable energies in the Republic of Mali and Azerbaijan in view of their promotion for the preservation of forest areas, in a world facing the challenges of global warming. The methodology was based on documentary collection and documentary exploitation and analysis of cartographic data, tables and other figures. The study revealed to us the high frequency of the potential of these so-called energies, especially solar in Mali and hydraulic, wind and solar in Azerbaijan and the commitment of the authorities of these States to promote the energy transition but also the dependence of these States on fossils such as: oil and gas. The Republic of Azerbaijan exports fossil fuels and Mali depends on imports. The transition to alternative energy resources will undeniably make it possible to reduce greenhouse gas emissions at the global level and to preserve forest ecosystems in both countries.

Аннотация. С помощью этого исследования мы хотели оценить потенциал новых и возобновляемых источников энергии в Республике Мали и Азербайджане на примере лесных массивов, сохраняемых в условиях глобального потепления в мире. Методика основывалась на документальном сборе и документальном использовании и анализе картографических данных, таблиц и других рисунков. Исследование показало нам высокую частоту потенциала этих энергий, особенно солнечной в Мали и гидравлической, ветровой и солнечной в Азербайджане, приверженность властей этих государств содействию энергетическому переходу, а также зависимость этих государств по ископаемым энергетическим ресурсам, таким как нефть и газ. Азербайджанская Республика экспортирует ископаемое топливо, а Мали зависит от импорта. Переход к альтернативным энергетическим ресурсам, несомненно, позволит сократить выбросы парниковых газов на глобальном уровне и сохранить лесные экосистемы в обеих странах.

Keywords: renewable energy, forest protection, sustainable development, Mali, Azerbaijan.

Ключевые слова: возобновляемая энергия, защита леса, устойчивое развитие, Мали, Азербайджан.

In 2012, in the world, there were 19% of EnR, 78.4% of fossils and 2.6% of nuclear. Of the 19% of renewables, just under half was linked to "traditional biomass", i.e. the combustion of wood or organic waste. "Modern" forms of renewables therefore represented around 10% of global final energy consumption (not counting the energy consumption of the energy sector).

Renewable primary energies are natural primary energy sources whose consumption does not limit their future use: They are replenished faster than they are used. These are permanent flows that can be discontinuous for short periods (e.g. variable sunshine over a day) but their consumption will not limit their future use. The permanent flows of primary energy come from four natural sources: the sun, the atmosphere, the hydrosphere and the internal earth (lithosphere, mantle and core). The biosphere, or non-fossil biomass, can be added, but it is only considered renewable if its regeneration is greater than consumption over a fixed period [6].

Fossil fuels, including petroleum, natural gas, and coal, are the dominant energy source for the region, accounting for 71% of energy supply [7].

According to UNEP, the large-scale penetration of renewable energy is a key intervention for greening the economy considering its: climate change mitigation potential; fossil energy-saving potential; ability to generate "green jobs" [3].

Since 2009, Azerbaijan has been a member of the International Renewable Energy Agency (IRENA). The country had established the State Agency for Alternative and Renewable Energy (SAARES). SAARES and the Ministry of Industry and Energy prepared the National Strategy on the Use of Alternative and Renewable Energy Sources for the Period 2012-20, including the Law on Renewable Energy Sources. In June 2012, SAARES was abolished, and in its place was launched the State Company of the Republic of Azerbaijan on alternative and renewable energy sources [4].

Currently, 94 percent of electricity is produced using natural gas, the remaining 6 percent is produced at hydroelectric power stations and other power plants. At the same time, 55 percent of electrical energy is produced at three thermal power plants using natural gas. If one of these three power plants is under repair (or is shut down), there may be serious risks in the power supply. From this point of view, the diversification of sources of production of electric energy is an important task and its solution will minimize the risks of power supply.

The State Agency on Alternative and Renewable Energy Sources of the Republic of Azerbaijan was established by the Decree of the President of Azerbaijan dated February 1, 2013, to improve the management system in the field of alternative and renewable energy [4].

In Africa in general and Mali in particular, extreme economic poverty, conflicts, energy poverty in terms of new and renewable resources and extreme dependence on forest resources by populations who live mainly in rural areas, exploitation and development in forests mortgage any possibility of regenerating these endangered resources [10]. More than 80% of the population lives in rural areas. Urban and urban community depends on forest resources.

In March 2022, the government of Mali, explaining that "EDM (Énergie Du Mali) has been experiencing a financial imbalance for several years", approved in the Council of Ministers the Development Plan for the electricity sub-sector over the period 2022- 2026 of the structure. A plan which, he says, is based on a major investment program focused on the exploitation of renewable energy deposits and the construction of electricity transmission and distribution lines in order to limit dependence on fossil fuels (<https://qptr.ru/ekz4>).

According to the Minister of Energy, Mali has adopted a favorable framework for the development of renewable energies (openness to private investment, State guarantees, exemption of imported equipment) [9].

Although the richness of Azerbaijan in non-renewable energy such as: Gas and oil and the current energy poverty of Mali which import non-renewable energy and rich in natural resources non exploited yet, both countries tend to orient through the new renewable energy to preserve, protect the health of their biodiversity for sustainability.

Methods and materials

Documentary collection. At this stage, information has been collected via documents to learn more about renewable energy potential and the mechanisms put in place for their promotion with the aim of sustainable development in a world facing the challenge of climate change and the scarcity of energy so-called fossil fuels. We used articles, expert reports, scientists for literature and specific data on the energy policy of Mali and the Republic of Azerbaijan.

Data analysis. We used the maps, tables of other figures related to the consumption and potential of renewable energies in the two states for analysis.

Results and discussions

The impact of fuelwood consumption on forest formations is enormous and as proof, the supply of the Bamako District alone, which concentrates 12.46% of the total population in fuelwood for the year 2016 required 1,095,070.33 steres, i.e. a clearcut of 21,901.40 ha of a plant formation of the wooded savannah type. For the year 2017, from January to November, 1,103,121.66 cubic meters of wood were needed, i.e. 22,062.43 ha of the same type of plant formation [1].

On average, it was necessary to deforest the equivalent of about 22,000 ha to meet the fuelwood needs of the District of Bamako during the period 2016-2017. In a country exposed to climate change and where the degradation of land and natural resources is a real problem, the fuelwood resource cannot provide an adequate response to growing energy needs. The implementation of the various projects and programs resulted in the main indicators of the energy sector (situation in 2014) below (Table 1):

TABLE 1
 ENERGY SECTOR INDICATORS FOR MALI 2012-2016 (<https://goo-gl.me/S5baf>)

Variables	2012	2013	2014	2015	2016
Electricity access rate, %	31,7	32,4	34,9	35,7	38,2
Access rate to electricity in urban areas, %	64,1	66,8	70,7	79,5	88,6
Rate of access to electricity in rural areas,%	17,8	17,2	17,4	16,7	19,9
Average low voltage electricity tariff, EDM SA scope (urban centers), excluding VAT (in CFA)	100	105,2	105,6	105,4	104,2
Average price of electricity in the areas of AMADER operators (in CFA francs)	245 ≤ et ≤ 300				
EDM electricity production (GWh)	1 276	1 420	1 574	1 594	1 768
Rate of renewable energies excluding hydroelectricity in electricity production			7%	7%	No Available
Consumption of petroleum products per year (TOE)	911 839	972 928	1 024 000	1 056 864	1 373 533
Butane gas consumption (in tonnes)	13 279	12 010	12 228	12 982	14 530
Biomass consumption,%	78% du National energy balance 2014			71,6	73,2
Import of all Hydrocarbon consumption, %	17% balance sheet 2014			24,9	22,3
electricity consumption, %	5% balance sheet 2014			3,5	4,6

The electricity sub-sector contributes 1.91% of the GDP. Mali imports all of its fossil fuel needs. The petroleum sub-sector accounts for 26% of all 2010 imports and 22% in 2015, which makes it very sensitive to price volatility. This is the reason we must focus on new and renewable energies in accordance with the challenges [10].

Given the scale of this scourge, the dependence of rural and urban communities on forest timber resources hypothesizes any effort to preserve forests, particularly that of Faya, which is very close to Bamako.

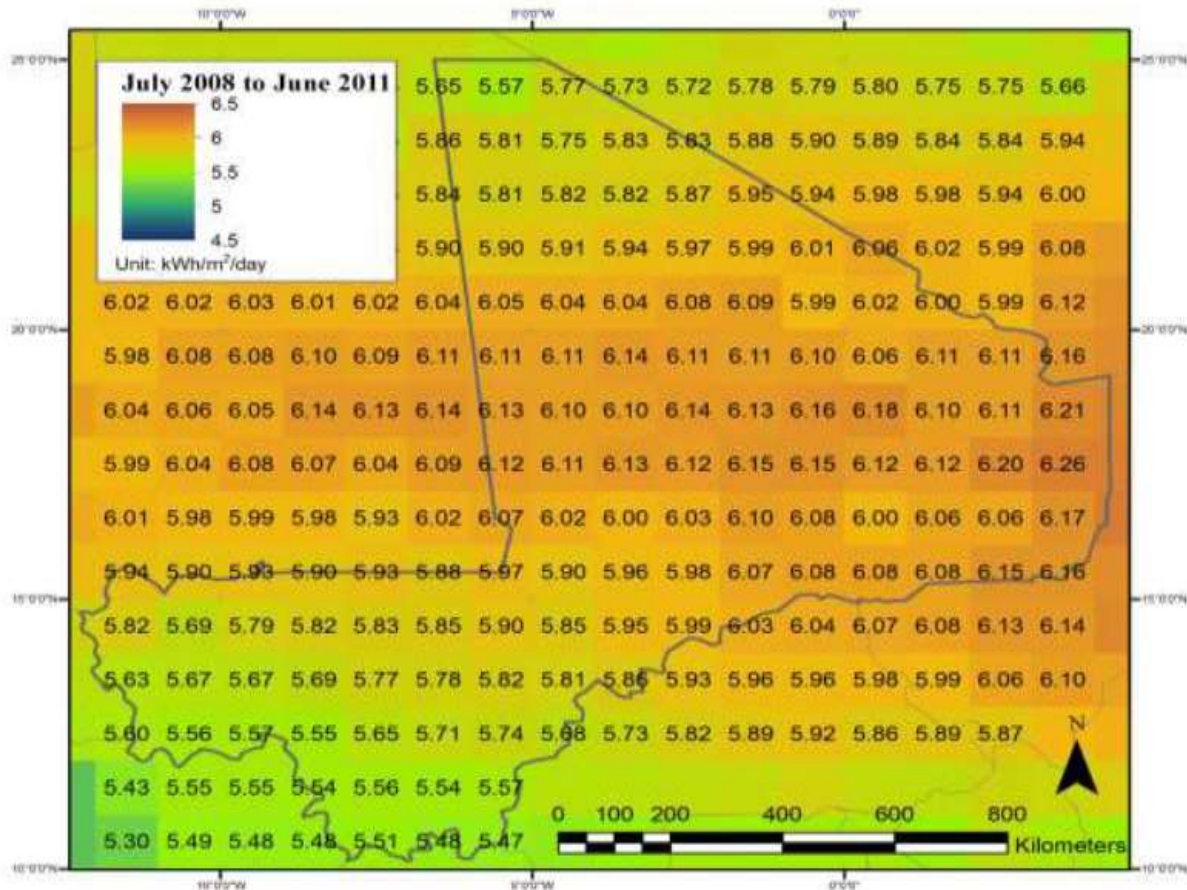


Figure 1. Potentiality of Solar energy in Mali (<https://goo-gl.me/S5baf>)

At level economic, the forests remain the main source of domestic energy through wood and charcoal used by almost all households in Mali, most without access to alternative energy (gas and electricity). The consumption of wood and charcoal is estimated at 459 kg per person per year [2]. This makes the exploitation of timber forest products the most important forest economic activity in terms of volume and income. It has generated approximately 1 146 584 211 F.CFA of average income per year from 2014 to 2017. In reality, these are only quantities under the control of the forestry services, and therefore lower than the actual quantities, it being understood that the said services lack the human and material resources to produce exhaustive statistics in this area. Solutions have been identified towards an energy transition to preserve forest resources. The concept of energy transition is defined as the transition from conventional energies to new and renewable energies that are less polluting, efficient, economical and controllable from an energy point of view. The energy transition will be of great contribution to the safeguarding of forest resources in Mali. According to the TCN-AEDD-MEADD study, entitled “Energy transition in the residential sector as a mitigation measure for greenhouse gas emissions in households” carried out in December 2016, the application of actions within the framework of the transition energy, in

particular the energy mix for cooking and heating, would among other things reduce by 40% the annual consumption of wood energy, or 49 7315 kg [8].

Developing renewable energies and increasing access of rural and urban populations to electricity at a lower cost is becoming a leitmotif in Mali. Several important actions are being implemented to strengthen production capacities, network extension, and promotion of electrification in rural areas and development of renewable energy sources. Private investors in the fields of renewable energies have benefited from the tax exemption for solar equipment for several years. Some banks instead promote access solar power project developers to equipment through the terms of favorable payment, plus the banker Guarantee Fund which proves a real facilitation instrument of investment by sector private. Unfortunately, in spite of this potential of solar energy, the countries of the Sahel in general and Mali in particular do not take advantage of this mass of energy.

In 2021 in the Azerbaijan 87,7 percent of energy products with total production volume of 75,5 million tons of oil equivalent made primary energy products, 8,7 percent — oil products, 3,6 percent — heat and electricity. 53,8 percent of all primary energy products made crude oil (including gas condensate), 45,9 percent — natural gas, 0,3 percent — energy products produced on renewable energy sources.

Azerbaijan is a country exporting crude oil, natural gas and oil products. In 2021 volume of export in the country made 48,6 million tons of oil equivalent of which 59,5 percent — crude oil, 36,7 percent — natural gas, 3,5 percent — oil products, 0,3 percent — electricity.

In comparison with 2020 total energy supply increased for 5,8 % and made 17,6 million tons of oil equivalent. 20,7 % of total energy supply made transformation processes, 5,2 percent — losses, 5,3 percent – energy industries own use, 68,8 % - final consumption and etc. (Figure 1, 2). 44,6 % of final consumption for energy purposes was the share of households, 15,6% — industry and construction, 25,8 % — transport, 14,0% — other branches of economy (<https://qptr.ru/XORz>).

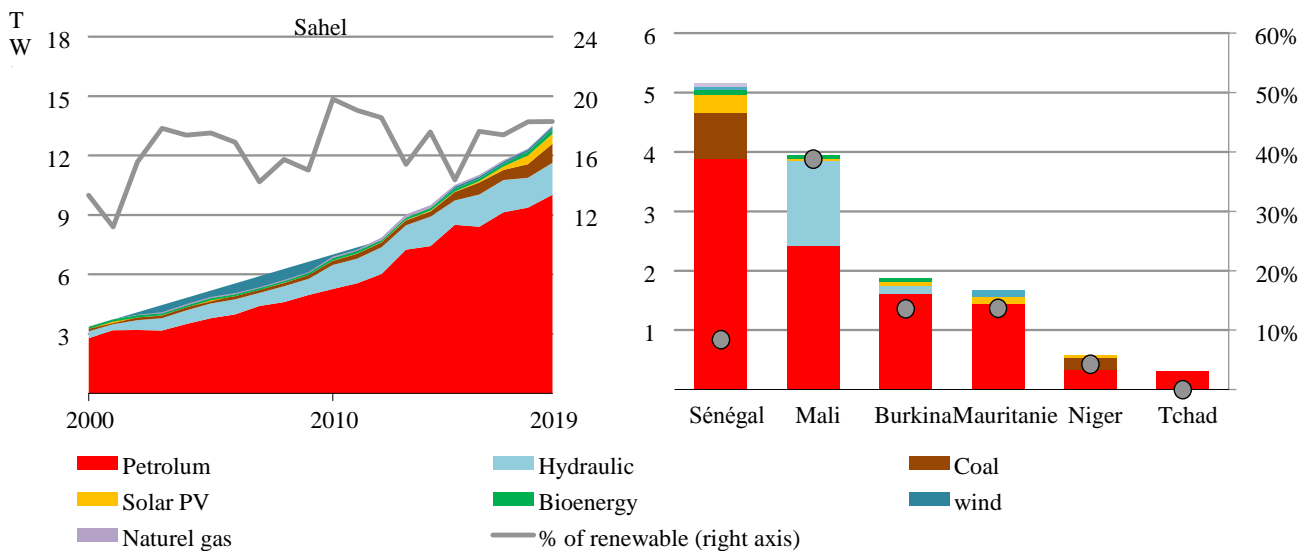


Figure 2. Electricity production by energy source and share of renewable energies in the Sahel, and by country in 2019 [5]

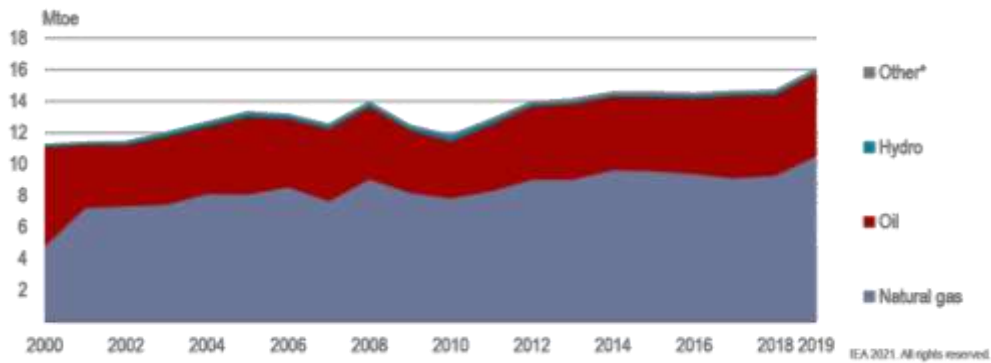


Figure 3. Total energy supply in Azerbaijan, 2000-2019 (<https://goo-gl.me/kmouc>)

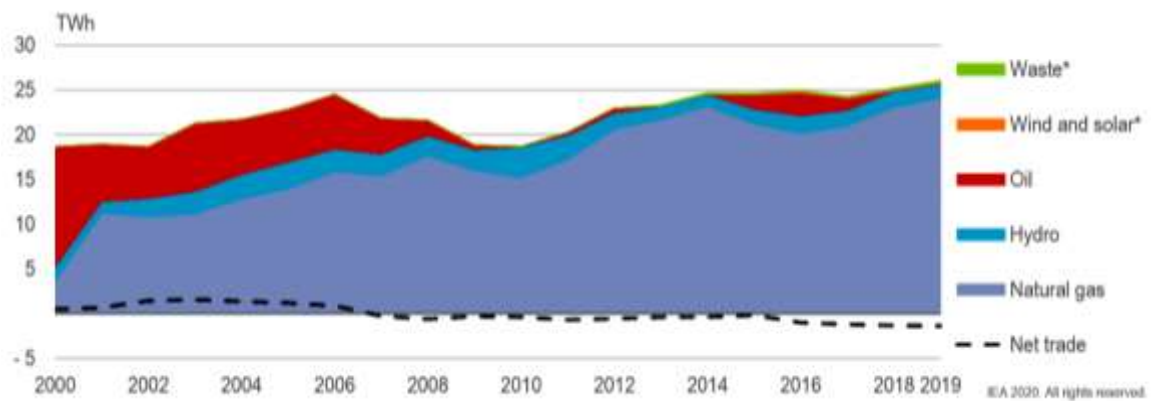


Figure 4. Electricity generation by source in Azerbaijan, 2000-2019 (<https://goo-gl.me/kmouc>)

Based on the analysis of indicators of electricity and gas consumption by the population of the administrative districts included in the object of study for 2015-2021, it can be said that with an increase in the population by 5-6%, electricity consumption either increased or decreased slightly, but gas consumption increased by 58 -81%, and in the Oguz region more than doubled (Table 2-4).

Table 2

DEMOGRAPHIC INDICATORS OF THE ADMINISTRATIVE DISTRICTS INCLUDED
 IN THE OBJECT OF STUDY (<https://area.gov.az/en/page/haqqimizda>)

Indicators	Goychay		Agdash		Gabala		Oghuz	
	2015	2021	2015	2021	2015	2021	2015	2021
Population (thousand people)	117,1	123,0	106,7	112,6	103,0	109	43,1	45,2
Natural growth, people	1357	480	1217	495	1449	711	505	194

Table 3

ELECTRICITY CONSUMED BY THE POPULATION BY ADMINISTRATIVE-TERRITORIAL
 UNITS OF THE COUNTRY (<https://area.gov.az/en/page/haqqimizda>)

Administrative-territorial units	2015	2016	2017	2018	2019	2020	2021
Azerbaijan	2750,7	3186,9	2826,5	3055,4	3316,9	3786,3	4005,0
Agdash	23,9	29,9	27,8	28,6	33,0	39,4	43,4
Goychay	31,9	37,8	35,5	36,7	44,5	50,6	53,9
Gabala	25,9	29,5	29,7	29,5	33,2	39,8	41,0
Oghuz	7,5	9,4	9,8	10,1	12,5	15,1	15,6

Table 4

CONSUMPTION OF NATURAL GAS BY THE POPULATION BY ADMINISTRATIVE-TERRITORIAL UNITS OF THE COUNTRY (<https://area.gov.az/en/page/haqqimizda>)

Administrative-territorial units	2015	2016	2017	2018	2019	2020	2021
Azerbaijan	7937,9	8071,5	7134,6	6699,3	6418,0	7118,0	6960,3
Agdash	65,7	67,5	62,2	59,9	58,3	60,5	59,9
Goychay	69,4	70,3	65,4	69,4	65,1	69,2	68,3
Gabala	59,6	64,8	61,8	62,6	59,2	64,7	63,2
Oghuz	21,1	21,1	18,8	14,4	14,5	16,2	15,3

Since 2004, the government of Azerbaijan has begun to pay more attention to the development of renewable energy. This is also confirmed by the entry of Azerbaijan into the International Renewable Energy Agency (IRENA) in June 2009, the creation of the State Agency for Alternative and Renewable Energy Sources (SAARES) in July 2009, and the adoption of the State Program on the Use of Alternative and Renewable Energy Sources for 2004-2013 years. Subsequently, the SAARES developed a National Strategy on the use of renewable energy sources for 2012-2020 and a “Law on Renewable Energy Sources” (2012) was prepared (<https://qptr.ru/Urww>).

Azerbaijan's renewable energy potential, which are economically viable and technically feasible, is estimated at 27,000 MW, including 3,000 MW of wind energy, 23,000 MW of solar energy, 380 MW of bioenergy potential and 520 MW of mountain river potential. Estimates put the renewable energy potential of Azerbaijan at 37,000 MW — around ten thousand of which was unveiled after the liberation of the country's territories from Armenian occupation in 2020 (<https://qptr.ru/rkpH>).

The share of renewable energy sources (RES) in Azerbaijan's total energy supply (TES) has been stable – but low – since the 1990s. The portion of RES in electricity generation was higher during 2008-2019, ranging from 7% to 18% of total generation. Hydropower accounted for 59% of total renewable energy supply in 2019, with the remainder coming mainly from municipal waste and bioenergy (Figure 5).



Figure 5. Renewable energy production in Azerbaijan's TES, 2000-2019 (<https://google.me/kmouc>)

According to the Ministry of Energy, Azerbaijan's technical solar power potential is around 23 000 MW. The country has 2 400 to 3 200 hours of sunshine per year and its annual solar intensity is

estimated at 1 500 kilowatt hours per square meter (kWh/m²) to 2 000 kWh/m²; both values are high compared with other countries. The best resources are in the central river valleys and in the north and northwest of the country. With growth in agriculture, forestry, industry and services creating opportunities for heat and electricity generation from biomass and waste, the MoE estimates technical potential of 380 MW. We believe that in settlements located in the territory of the Ajinohur arid forests, solar energy and bioenergy can be used to heat houses and generate electricity (<https://qpтр.ru/rkpH>).

Conclusion

In Mali, the energy sector is still dominated by biomass. In a country exposed to climate change and where the degradation of land and natural resources is a real problem, firewood resources cannot provide an adequate response to growing energy needs. The energy transition is very necessary given it's very sunny and hot with good hydraulic potentialities, this transition will be profitable for the biodiversity and the communities.

The Government's policies on energy and actions in favor of investments will be very weak in terms of the promotion and popularization of new and renewable energies, the only guarantee of responding to the present concerns of the fight against change in preserving Mali's forest resources. The creation of socio-professional schools and training, non-taxation on the import of equipment for new technologies of new energies, rural electrification, the promotion of modern ecological cooking methods, the creation of income-generating activities for rural populations in addition to agroforestry and participatory management are among other means and tools to preserve Malian biodiversity. In spite of the abundance of fossil fuels, the Republic of Azerbaijan has already project to involve the transition energy for the sustainability. Many frameworks and actions have been adopted in this way.

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