Renewables in the Energy Mix of Algeria, a pledge for food security

Saliha Haddoum, Hocine Bennour, and Toudert Ahmed Zaid

Abstract− This paper examines the renewables potential in the energy mix of Algeria with a special insight to bioenergy and food security. In recent years, and at global scale, bioenergy was seen as the leading renewable energy source. That contribution was particularly consistent with long-term climate targets. The 2015-updated version of the Algeria Renewable Energy Development Program foresees the introduction of biomass sector with a contribution of 1000 MW by 2030. This represents barely 5% of the country's renewable energy targets which amount to 22 000 MW, 93.5% of which are planned for solar and wind. In 2020, this objective has been reduced to 15,000 MW and the deadline extended to 2035. To date, despite the growing perception of a real desire to encourage clean energy projects, the renewable energy installed capacity is less than 500 MW without any contribution from the biomass sector. However, whatever the goals or the achievements, the need for renewable deployment is crucial for strategic purposes such as energy, water desalination and food security. The relationship between food security, sustainable development, and renewable energy is well demonstrated. Ensuring food security is closely linked with energy, hence with renewable energy sources in the middle and long terms, including biomass valorization. This paper presents a comprehensive outlook of the bioenergy sector, highlighting the barriers, which stand in the path of biomass recovery and use. Today, it appears clearly that a significant increase in renewable energy can only be achieved by higher solar power production.

***Keywords*− Biomass, Bioenergy, Energy mix, Energy and Food security.**

I. INTRODUCTION

.Globally, humanity consumes nearly 15 billion tons of oil equivalents. This represents approximately 1.8 tons per inhabitant. The current trend in energy consumption is indeed very worrying, with a rate of about 2% per year of growth [1], which means a doubling of this consumption every 35 years. Several elements clearly indicate that the current global energy system is not sustainable in the long term and that it must change. As energy sources are not evenly distributed worldwide, each nation has to optimize its own energy mix taking into account its potentials and possibilities. In the same time, climate change accelerating drastic effects on the planet is calling for an urgent need to transition towards renewables while geopolitics is thwarting trade and the way fossil energy is exchanged across regions. This makes the options even tougher for decision makers when it comes to energy planning. Sadly enough, because of a massive gas supplies disruption, instead of accelerating the pace towards cleaner energy sources, we are witnessing a comeback of coal in many parts of the world despite climate goals and environmental issues. It can be argued that the upheaval caused by the Ukrainian crisis in the international energy landscape has led to an unexpected lack of interest in the energy transition in many countries. The main reason oil and gas producers are obviously reluctant to turn their back on fossil fuels which provide external income, especially when the ongoing conflict which has led to the disruption of Russian gas supplies to Europe, has pushed prices up to pre-2014 levels. Almost everywhere in Europe, coal-fired power plants are back in service, to cope with the cut in the supply of Russian gas. It seems clear that the priority of the leaders of European countries dependent on Russian gas supplies does not seem to be in the energy transition, at least for the moment. In Germany for example, nearly a third of the electricity came from coal-fired power plants in the first half of 2022. In these countries, where the concept of energy transition was born and matured, the most urgent thing is to find new gas suppliers and manage to reduce the impact of rising energy prices on the way of life of their citizens. However, Algeria was counting on these countries to come and invest in the field of renewable energies to boost its energy transition. Oddly enough, the tender that was issued in March 2022 for the production of 100 MW solar electricity has not received much attention. It is also clear that, as one of the most fossil fuel-rich regions of the world, the Middle East and North Africa has not been at the forefront of the energy transition so far [2]. However, things are starting to move, with global zero-carbon targets pushing the region's countries towards developing their own carbon-neutrality targets and low-carbon fuel strategies. Egypt, for example, is aiming to provide the lowest-emissions natural gas and is emerging as an exporter of low-carbon LNG, electric power and green ammonia to Europe and beyond [2]. Other countries in the Gulf region have issued ambitious hydrogen strategies, and they are set to exploit abundant access to solar and wind power, natural gas reserves for blue hydrogen. Meanwhile, Algeria is aiming to make hydrogen a strategic vector of its energy transition program and its climate commitments. It is also keen to take advantage of its competitive advantages to supply the European hydrogen market with 10% of its needs by 2040 according to the media and officials declarations. Figure 1 shows the take-off of hydrogen production in the Middle East and North Africa from the 2030s. The production of hydrogen for energy purposes will be multiplied by ten in two decades, rising from less than 1 Mt in 2030 to nearly 10 Mt in 2050. Initially, it will consist almost entirely of blue hydrogen

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produced by reforming natural gas with carbon capture and storage CCS. Blue hydrogen will remain dominant throughout the forecast period. Gradually however, green hydrogen produced in electrolysis plants using solar electricity and yellow hydrogen, produced by electrolysis from grid electricity, are expected to take off in the 2040s [2].

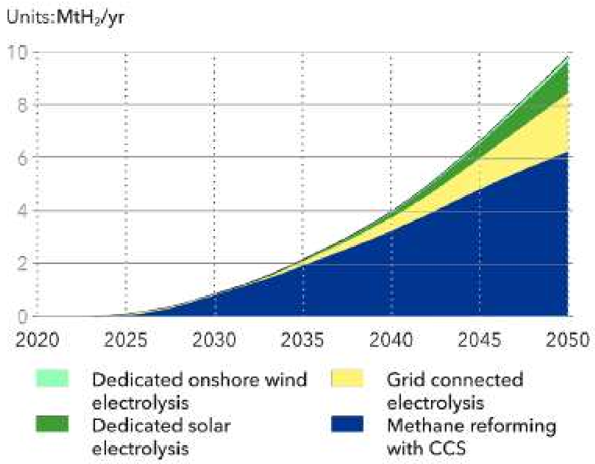

Fig.1: MENA Hydrogen production as energy carrier [2]

Indeed, the whole world is going through difficult economic times especially for those who have to import energy products. Algeria is an oil and gas exporting country and, in this respect, the recent increase in oil and gas prices should benefit its economy. It should namely accelerate its energy transition and help to win the double challenge of diverting its economy away from oil and gas while cushioning the social impact of the ongoing reforms and the ones to come.

II. ALGERIAN RENEWABLE ENERGY POTENTIAL

II. 1 SOLAR AND WIND ENERGY

Because of its geographical location, Algeria holds one of the highest solar potentials in the world, which is estimated at 13.9 TWh per year. The country receives annual sunshine exposure equivalent to 2,500 KWh/m2. Daily solar energy potential varies from 4.66 kWh/m2 in the north to 7.26 kWh/m2 in the south.

Algeria has also promising wind energy potential of about 35 TWh/year. Almost half of the country experience significant wind speed. The country's first wind farm is being built at Adrar with installed capacity of 10MW.

Despite this important renewable energy potential, renewable energy, production (in particular photovoltaic and wind power) still occupies a minor place in the production of primary energy [3]. With 23 solar and wind facilities all over the country, the total currently installed capacity barely amounts to 500 MW. Various barriers still stand in the path of renewable energy development. These barriers will be briefly mentioned in the last section.

II. 2 BIOENERGY POTENTIAL

Biomass resources include wood and wood wastes, agricultural crops and their waste byproducts, municipal solid wastes, animal wastes, and waste from food processing.

Worldwide, the majority of biomass energy is produced from wood and wood wastes, followed by municipal solid wastes, agricultural waste, and landfill gases. Biomass is the third largest renewable electricity-generating source. In this respect, it is worth questioning to what extent could bioenergy play a role in Algeria, knowing that the country is committed to reduce its greenhouse gas (GHG) emissions by 7% by 2020-2030. In addition to promoting sustainable agriculture, biomass growing, harvesting, storage and transportation, trading, and processing to end use for energy conversion purposes can enhance rural economic development, via the creation of additional jobs.

A recent study assessed the Algerian potential energy recovery from various wastes to ca.1700 GWh [4]. Based on this comprehensive study, the potential of biomass feedstocks in Algeria is summarized in Table 1.

As can be seen, urban wastes are the prominent fermentable resource. Considering all the investigated biomass feedstock resources, an electricity potential of ca. 1700 GWh can be reached from waste recovery that could meet the energy needs of over one million inhabitants [4]. This –theoretical - value represents less than 0.3% of the total energy consumption, so the biomass contribution to the energy mix seems quite negligible.

Table. I
BIOMASS FEEDSTOCK POTENTIAL FROM VARIOUS WASTES [4]

Biomass resources	Annual biogas potential	Power generation potential (GWh)
Urban wastes		
Organic fraction of household wastes	974 million of m^3	1646 (a)
Sewage from waste-water treatment plants	22.9 million of m^3	38.72 (a)
Industrial & agribusiness wastes		
Amurca from olive oil industry	10.5 million of m^3	17.74 (b)
Pomace from olive oil industry	---	215.50 (b)
Whey from dairy industry	2.35 million of m^3	3.97 (b)
Total	1009.76 million m^3	1706.43

Sources : (a) Ministère de l'Aménagement du Territoire et de l'Environnement (2013)
(b) FAO Statistics (2015).

One can argue that biomass potential is very limited in the Mediterranean region, which is characterized, by semi-arid climate conditions and where recurrent wildfires are continuing to threaten the already limited biomass resources. Nonetheless, the use of biomass for energy recovery is considered one of the priorities of the post-Kyoto development policies. Indeed, it represents an instrument to curb the climate changes and to reduce the environmental impacts that are linked to the use of fossil energy sources. This is why bioenergy development should target specific goals such as mitigating environmental issues.

III. BIOMASS FEEDSTOCKS RECOVERY

Throughout human history biomass in all its forms has been the most important source of all our basic needs (food, feed, fuel, feedstock, fiber and fertilizer). Forests have had a decisive influence on world civilizations, which flourished as long as forests and food producing areas backed up towns and cities. Today, biomass energy continues to be the main source of energy in many developing nations, particularly in its traditional forms, providing on average 35% of the energy needs of three-quarters of the world's population [5]. Despite the importance of bioenergy, there is surprisingly little reliable information on the consumption and supply of biomass. This serious lack of information is preventing policy makers and planners from formulating satisfactory sustainable energy policies. These multiple uses of biomass include not only energy but also food, fodder, building materials and more. Biomass is rarely, if ever, planted specifically for fuel: wood that is burned is often what is left over from some other process. Biomass energy should therefore always be looked at in the context of the other benefits that biomass provides, and never just from the point of view of a single sector. Having this in mind, we have listed the different problems and barriers that stand in the path of biomass energy valorization in Algeria.

III.1 Household wastes

The biodegradable organic fraction of wastes is recognized as a renewable energy source. The energy recovery of waste requires sorting operations upstream of the sector. A pilot project for the selective sorting of household waste at source was launched in Oran in 2015 as part of the framework of cooperation between Algeria and the World Organization R20. The role of the R20 "Regions of Climate Action" is to help governments implement low-carbon projects and to communicate best practices and policies in the area of renewable energy. This pilot project should therefore examine the possibilities of energy recovery from urban waste. Meanwhile less than 7% of household wastes are recycled for the recovery of metal and plastic according to the National Waste Agency (NWA). This is very low in view of the 4,000 businesses involved in the waste management sector. 13 million tons of household waste were generated in 2018, including 50% organic waste and 13% plastic. This figure is expected to exceed 20 million tons in 2035, according to a recent study carried out by the Ministry of the Environment. 34 million tons of waste of all categories are generated each year representing a potential market of nearly 90 billion Dinars [6]. To our knowledge, there is no data available on the energy recovery of household waste.

III.2 Farm and agricultural wastes

Sustainable farming is at the heart of all food security policies. Indeed, sustainable farm projects are flourishing all over the world. Achieving energy autonomy of farms is one of the conditions to achieve food security. Growers may use methods to promote soil health, minimize water use, and lower pollution levels on the farm and, more importantly, need reliable sources of energy. Hence, in order to secure the farm energy autonomy, biofuels need to be produced locally. It is also possible to convert all kinds of agricultural and animal wastes by methanation. A biogas unit can perfectly fit into the agricultural value chain and offer many environmental benefits. Indeed, digestate, a by-product of biogas, is a green manure that can be used advantageously in place of chemical fertilizers. Biogas can fuel a micro cogeneration unit, and the surplus of produced electricity can eventually be injected into the grid. However, major constraints and limitations prevent the deployment of methanation projects in Algeria where farm sizes are generally too small for cogeneration projects to be cost-effective. Of the 967,800 farms in all categories, 52.3 % have sizes under 5 hectares and only 1.9 % have sizes of at least 50 hectares [7]. Meanwhile, without government support mechanisms such as long-term investment guarantees and the introduction of Feed-in-Tariffs similar to those provided for solar and Wind, it is financially difficult to implement cogeneration or anaerobic digestion projects. Nevertheless, it is generally accepted that Algeria has the profile as well as the conditions to develop its agricultural sector including: land, fertilizers, ability to increase mechanized agriculture and to develop the industrial sector, natural resources to sustain mechanized agriculture, human resources and a need to generate employment.

III.3 Forest wastes

There is an increasing understanding that only bioenergy that is supplied and used in a sustainable manner has a place in a low carbon energy future [8]. The use of woody biomass for energy purposes is a controversial subject in Algeria which has only low forest resources. Algeria total forest area is relatively small 4 118 940 ha which represents around 16.47 % of the north region area [9]. As desertification is likely to intensify with climate change, Algeria is engaged in a vast reforestation project to counteract the creeping phenomena. According to the Forest General Direction, around 80,000 hectares have been planted since 2000 in the highland regions and in the southern and northern regions of the country. The National Reforestation Plan (NRP) was planned to cover 1.2 million hectares by 2020. At present, the forest heritage in Algeria represents 11% of the total land area . The NRP aims to increase this rate to 13% by 2029 [10]. Three million hectares of land suitable for forestry or subject to erosion or desertification are to be planted in order to achieve a rate of afforestation of 24% in the next twenty years. The NRP is an important project aimed at addressing desertification. But fire forests which destroy thousands of ha each year are seriously undermining this plan. Increased efforts are needed to combat forest fires and support forest law enforcement. The damages caused by the fires in summer 2017, 2021 and 2022 were on an exceptional scale, and occurred within a general context of escalation of this type of disaster.

Afforestation and reforestation projects can produce biomass that, once harvested, can be used for generation of heat and electricity. Associated with the NRP, the cultivation of short rotation crops on degraded land, would sequester carbon, regenerate degraded soils, empower local communities to develop sustainable agro-forestry practices and provide an alternate livelihood potential. However, all these objectives need to be supported and framed by sound policies including all stakeholders. Obviously, our forests are poorly managed and we all know that a forest, which is treated as a sanctuary, is a poorly maintained forest, in which trees struggle to grow and are more vulnerable to stresses such as fires. It is only to be hoped that the objectives of reforestation will be met in order to increase the plant cover, and to slow down the advancing desert in the perspective of an acceleration of global warming. Today, not all the indicators encourage energy recovery from woody biomass and even the sustainable management of our forests seems beyond our reach.

IV. The challenge of Food security

The links between energy and agriculture have been accentuated since the advent of oil. During the oil era, traditional agriculture has gradually become mechanized and is now very dependent on fossil fuels. With depletion of these nonrenewable resources, and escalating climate changes, food security is threatened on a global scale. According to the United Nations (UN) report, more than 836 million people in the world live in extreme poverty. Sustainable agriculture can offer a solution to increase production efficiency and meet the demand of the world's population [11]. According to FAO, agriculture and food supply chain are extremely dependent on fossil energy and contribute to 24% of the total global greenhouse gas (GHG) emissions. Figure 2 [12] shows the share of agriculture in global GHG emissions. These account for nearly one-third of annual GHG emissions [13]. Hence, sustainable agriculture practices and a shift to renewables can address both the climate change and the depleting fossil energy sources. Indeed, Global increases in population, increasing impacts of climate change, and threats to food, water and energy security have placed a renewed focus on the implementation of sustainability concepts. Solar energy is already widely used in agriculture as a substitute for conventional fossil fuels [14]. Agrivoltaic systems, in the form of photovoltaic (PV) modules installed on agricultural land, which optimally distribute sunlight to crops, maximize food and energy yields within reasonable limits have been already tested successfully in Japan [15].

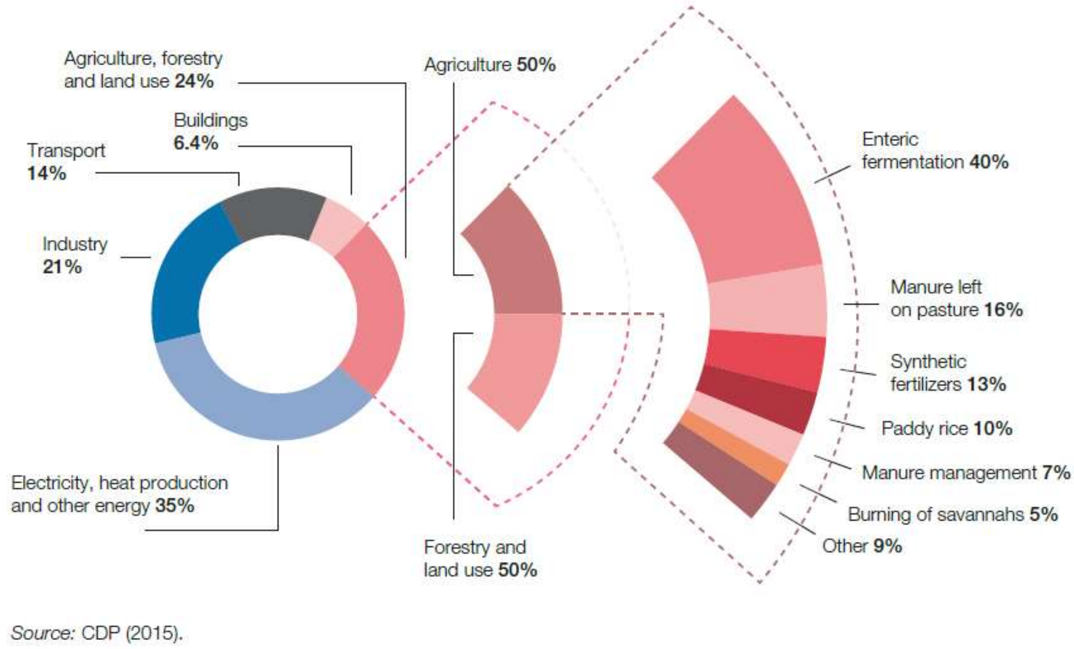

Fig.2: The share of agriculture in global GHG emissions [14]

Amjith and Bavanish [16] studied the potential of wind energy systems and biomass-based hybrid configurations with wind and their various design factors. They found that biomass-based hybrid energy systems could be a cost-effective and environmentally friendly alternative for off-grid rural and agricultural electrification. However, it is good to remember that the complexity of bioenergy value chains requires considerable information requirements on policy makers, when attempting to steer bioenergy use to achieve targeted goals [17]. Careful evaluation of policies is necessary before implementation. In Algeria, both arable land and water resources are limited rendering more challenging the food security objectives. Water stress is expected to be further exacerbated by climate change. Thus, more coordinated planning and action will be needed between the water and energy sectors to prevent a further worsening of the water deficit. Integrated thinking on energy and water is thus essential to mitigate future stresses [18]. There is no doubt that, from a food security prospect, solar energy will play a key role in water pumping, seawater desalination and wastewater, all of which require high-energy consumption. Indeed, the authorities are already relying on the desalination of seawater to alleviate this stress and many desalination plants are planned or under construction along the Algerian coastline. The main aim of these desalination plants is to safeguard drinking water supplies to various regions, which are severely hit by drought. However, as long as fossil energy continues to be used for this purpose, the sustainability of the process is at risk, and greenhouse gas emissions are obviously significant because desalination is energy-intensive. Water recycling should be seriously considered only for irrigation purposes. Agriculture is tightly linked with food security, and in this prospect, solar energy will play a key role for ensuring sustainability. Poor irrigation practices and mismanagement of inputs are also a concern in the agriculture sector. Indeed, the adoption of sustainable farming practices is also essential to meeting the challenge of food security. Today more than ever, energy security is at the heart of all issues. Algeria has set up an important legal arsenal and various attractive mechanisms for the promotion of renewable energies and energy efficiency at all levels. A detailed battery of legislative texts can be found in the GIZ report issued in July 2022 [19]. The fact remains that many legal texts have not been applied in the field. According to the results of a survey, cited in another report issued in 2020 [20], one of the main barriers in the energy market is the monopolistic regime, in which natural gas - as primary energy - has a price well below the international price and an uncompetitive cost of renewable energy. Other barriers were briefly discussed in a previous paper [18]

V. CONCLUSION

Global increases in population, increasing impacts of climate change, and threats to food, water and energy security have placed a renewed focus on the implementation of sustainability concepts. The use of biomass for energy recovery is considered one of the priorities of the post-Kyoto development policies. Indeed, it represents an instrument to curb the climate changes and to reduce the environmental impacts that are linked to the use of fossil energy sources. One can argue that biomass potential is very limited in the Mediterranean region, which is characterized, by semi-arid climate conditions and where recurrent wildfires are continuing to threaten the already limited biomass resources. The lack of relevant data concerning biomass potential itself, the reliance on fossil energy sources, and a poor market acceptance due to the heavily subsidized fossil energy products are also among the most significant barriers to bioenergy deployment. With the increasing demand for food and the advent of mechanization in agriculture, energy must be supplied at a higher level. With the depletion of fossil resources, the agricultural sector, with its wide variety of energy applications and resources, is expected to be one of the main users of renewable energy systems. The current situation of rising oil and gas prices offers real opportunities of ensuring an energy transition thanks to the development of photovoltaic solar energy. It is also time to seize this opportunity to initiate and/or accelerate the necessary reforms and ensure food security and a sustainable energy future. According to the APS, the state aims to achieve self-sufficiency, reduce imports, particularly of cereals and pulses, and expand the agricultural area from 8,000 hectares to 2.4 million hectares, particularly on highlands and in the southern regions. The new areas must be efficiently irrigated using renewable energies with the aim of achieving yields of around 70 quintals per hectare. According to the same source, SONELGAZ has already adopted a special farm linkage plan with a budget of more than 25 billion Algerian dinars aimed at accelerating agricultural development and increasing the country's agricultural production. Given the importance of this process, out of 45,878 farms, the number of connected farms reached 20,233, with an achievement rate of 44%. Thus the use of renewable energy, which was marginal until now, is expected to gradually increase as long as the agricultural sector is supported in its transition to solar and wind power by providing sources of financing supported by the State in the form of granting loans dedicated to this matter at a low interest rate and long repayment term. In the period 2020-2021, we saw the importance of government leadership in responding to the coronavirus crisis. Now this leadership is also needed to achieve both energy and economy transitions in our country.

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