Chapter 17
Summary: The Contribution of Bioenergy to Energy Access and Energy Security

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Abstract Energy is a key factor for the general historic human development and today's society. With the exploitation of natural gas and crude oil in the mid-nineteenth century, human development experienced a techno-economic boom. The access to modern forms of energy, based mainly on fossil fuels, has led to technical, social, and economic growth and development on the globe. Still, today's modern society is mainly based on fossil fuels. In contrast, the main energy source of many developing countries depends on biomass, often used in a non-sustainable form, as wood is used from sensitive environments with no opportunity for regrowth. Depleting resources of fossil-based fuels and non-sustainable bioenergy requires new solutions and approaches in the production and use of energy in order to ensure energy access and security. This chapter provides a short overview on the contribution of bioenergy to energy access and security and relates the results to socio-economic aspects addressed in the other chapters of this book.

Keywords Energy access · Energy security · Fossil fuels · Energy mix

17.1 Introduction

With the exploitation of natural gas and crude oil in the mid-nineteenth century, human development experienced a techno-economic boom. The access to modern forms of energy, based mainly on fossil fuels, has led to technical, social, and economic growth and development on the globe. Still, today's modern society is mainly based on fossil fuels. In contrast, many developing countries heavily depend on biomass as energy, often used in a non-sustainable form, as wood is used from sensitive environments with no opportunity for regrowth. For instance, wood-based fuels (charcoal and firewood) provide more than 70–80 % of the total energy consumption in sub-Saharan Africa (Sawe 2012; Denruyter et al. 2010).

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Depleting resources of fossil-based fuels and non-sustainable bioenergy requires new solutions and approaches for the production and use of energy in order to ensure energy access and security. Besides other renewable energies, such as solar and wind energy, biomass will be a core energy source in the future energy mix. Bioenergy has received enormous attention in the past few years due to its contribution to address three of the world's great challenges—energy security, climate change, and poverty reduction (FAO/GBEP 2008).

On the other hand, bioenergy is constantly accused of having negative socio-economic impacts, besides negative environmental impacts. In doing so, arguments are often based on local examples and then generalized to the whole bioenergy sector. This needs to be avoided and local impacts have to be always addressed case-specific. As bioenergy is produced locally, many positive and negative impacts also occur locally. Furthermore, it is important to evaluate the impacts in a holistic way and always in comparison with other indicators, especially those that go beyond the local level.

Thereby, it has to be considered that energy security and access are among the main drivers for bioenergy development and thus influencing the overall socio-economic performance of bioenergy value chains.

17.2 Energy Security

Energy security is the continuous supply and availability of energy sources at an affordable price. It can be applied to several levels and timeframes:

- **Short-term energy security**: energy security on a daily basis to satisfy current energy demand
- **Long-term energy security**: energy security within the next decades and even beyond the fossil fuel age
- **National energy security**: energy security in a country; this depends on local resources and imports

17.2.1 Energy Security of Today's Energy Mix

As economic growth is based on the continuous supply and availability of energy sources, energy security is of utmost strategic importance for governments. Several conflicts and wars between countries occurred due to such strategic interests.

The need to increase energy security was the main objective underpinning the establishment of the International Energy Agency (IEA) with particular emphasis on crude oil security (OECD/IEA 2013a). Oil security remains a cornerstone of the IEA, with each member required to hold oil stocks equivalent to at least 90 days of net imports and to maintain emergency measures for responding collectively to disruptions in oil supply of a magnitude likely to cause economic harm to its members.

At the same time, the IEA recognizes the broader needs of ensuring energy security and is progressively taking a more comprehensive approach to the security of supplies, including natural gas supplies and power generation (ibid.).

In contrast to this short-term energy security, long-term energy security has to be considered as well. Fossil fuels are fuels formed by long-term decomposition of organic material that were produced typically millions of years ago. The availability of fossil fuels, including crude oil, natural gas, and coal, is depleting, as they are extracted by humans at a by far higher speed than they are reproduced. An important indicator for the availability of crude oil is "Peak Oil" which is the point in time when the maximum rate of crude oil extraction is reached, after which the rate of production is expected to enter terminal decline.

Due to the depleting fossil sources and the associated increasing energy prices, new approaches in energy supply and consumption are needed. The two main cornerstones are energy efficiency and renewable energies.

17.2.2 The Contribution of Bioenergy to Energy Security

Today, bioenergy contributes with about 10 % of the world's total primary energy supply (47.2 EJ of bioenergy out of a total of 479 EJ in 2005, i.e., 9.85 %) (OECD/IEA 2013a). Thereof, 97 % are solid biofuels which are mainly used in the residential sector (71 %) in developing and emerging countries (ibid.). Thus, bioenergy already today contributes to short-term energy security.

However, solid biomass can be classified into renewable wood from sustainable managed forests and into nonrenewable wood from land where trees/shrubs do not regrow (Rutz and Janssen 2012). Furthermore, the produced biomass has to have a positive energy balance to be renewable. Renewable biomass is an important contributor to long-term energy security.

The limiting factor of fossil fuels is its depleting resources. In contrast, the limiting factor for renewable biomass production is land availability. This limitation applies to biomass production for different uses such as for food, feed, fibre, and biomaterials. In a bio-based economy, the different uses of biomass, including energy, coexist and benefit from synergies as multiple products can be derived. An example for such synergy is the increased agricultural efficiency due to, e.g., diversified crop rotation and intercropping. Furthermore, synergies are created during harvesting and during the conversion process as all coproducts are efficiently used. As all production and conversion processes require large amounts of energy, bioenergy is an important factor that contributes not only to energy security, but also to food security, and the supply of bio-products.

Thereby, especially the agricultural sector depends on carbon-based fuels due to their heavy machinery. The only alternative to fossil-based heavy-duty machineries fuels, is the use of liquid or gaseous biofuels, as it is not foreseeable that these heavy-duty machineries can operate with other sources such as hydrogen or electricity in the short to medium term. Biofuels are available today and could be immediately used in the agricultural sector.

Besides agricultural machinery, also the process energy for the conversion of biomass to various products can be derived from biomass. Examples include the use of bagasse in the sugar and ethanol industry, the use of straw as process energy for different purposes, or the use of empty fruit bunches (EFB) in the palm oil industry. Still today, these resources are often not used, but wasted.

In conclusion, bioenergy cannot *ensure* energy security alone, but it can significantly contribute to important sectors such as agriculture, which is also relevant for the security of other supplies like food or bio-products.

17.3 Access to Energy

Modern energy services are crucial to human well-being and to a country's economic development. Therefore, access to modern energy is essential for the provision of clean water, sanitation, and healthcare and for the provision of reliable and efficient lighting, heating, cooking, mechanic power, transport, and telecommunications services. As the World Energy Outlook 2012 shows, 1.3 billion people are without access to electricity and 2.6 billion people rely on traditional use of biomass for cooking, which causes harmful indoor air pollution (OECD/IEA 2013b). These people are mainly in either developing Asia or sub-Saharan Africa, and in rural areas. According to United Nations Development Programme (UNDP)/World Health Organization (WHO) (2009), 2 million deaths annually are associated with indoor burning of solid fuels in unventilated kitchens and 1.5 billion people are still living in darkness, over 80 % of them in South Asia or sub-Saharan Africa.

The World Energy Outlook (WEO) defines modern energy access as "a household having reliable and affordable access to clean cooking facilities, a first connection to electricity and then an increasing level of electricity consumption over time to reach the regional average" (OECD/IEA 2013c). The lack of access to modern energy services is also called energy poverty (OECD/IEA 2013d). The lack of access to modern energy services is a serious hindrance to economic and social development, and must be overcome if the Millennium Development Goals (MDG) are to be achieved (ibid.).

In addition to energy access at the household level, energy access for businesses and the public sector, that are crucial to economic and social development, need to be included in this definition. Besides the local availability of energy (grid connection; local markets for modern fuels) consumers also need to have financial power to purchase energy at the given prices.

The simplest form of access to energy in developing countries is the use of firewood for cooking and heating. This, however, as mentioned in Chap. 17.2, is often based on nonrenewable wood. Therefore, alternatives are needed to substitute this traditional use of biomass. Alternatives include the use of LPG, kerosene, natural gas, or electricity. Usually, LPG or kerosene is used as they are cheaper than, e.g., electricity. However, all these fuels are prone to steep price increases in the short- to long-term. An alternative could be the use of modern bioenergy. This includes

biogas, bioethanol, plant oil, and biodiesel. These fuels can be either directly burned for cooking or lighting purposes or converted to electricity. However, modern bioenergy markets are still largely artificial markets that need policy and financial support. They are usually still not competitive with traditional and fossil fuels, as often the fossil fuels are highly subsidized. In many cases, a shift in the support scheme from subsidies for fossil fuels to renewable fuels would be sufficient to establish new bioenergy markets. The main barriers for this are often the existing phlegmatic schemes.

The advantage of modern bioenergy is that it can be produced locally, in comparison to fossil fuels that will be always imported to the local markets. The main challenge is to stimulate the market and to educate people in order to develop local supply chains.

In the overall debate about sustainability of bioenergy it has to be acknowledged that energy security and access are among the main drivers for bioenergy development, besides its potential to mitigate climate change. This has to be considered when assessing and evaluating the multitude of other socio-economic and environmental impacts of bioenergy, that are presented in this book and investigated in the Global-Bio-Pact project. It is without doubt that in the short-term, but especially in the long-term, bioenergy will be a crucial energy source that cannot be neglected. A main contribution of bioenergy will be to ensure the functioning of the overall agricultural system through the provision of energy and thereby also to ensure crucial other socio-economic aspects like food security.

17.4 Conclusion

In summary, bioenergy has the large potential to improve short- and long-term energy security. It thereby has also positive impacts on other sectors, such as the food sector, as bioenergy is the only carbon-based alternative to carbon-based fossil fuels which are urgently needed in the heavy-duty machinery of the agricultural sector. Due to its contribution to the security of supply in the food and product sectors, the application of bioenergy generates multiple socio-economic benefits. However, the sustainability of the value chains, especially local environmental and socio-economic impacts have to be considered.

In order to ensure overall long-term energy security worldwide, the sustainable production of bioenergy, as one measure parallel to the application of energy efficiency and other renewable energies, has to be supported. The main advantage is that technologies for bioenergy production and use are readily available and could be immediately applied. In doing so, also the technologies and thereby the efficiency will be continuously improved. The challenge is to convince decision makers about bioenergy in the energy sector that is mainly dominated by the power of fossil fuel-based companies.

Thereby, bioenergy will also contribute to improve energy access, if produced in a sustainable way. It has to be recognized, however, that different scales of bioenergy

systems and value chains need to be addressed differently, as the framework conditions and impacts differ (Rutz and Janssen 2012). Especially, smaller-scale systems have the opportunity to improve energy access for the poor in rural areas. This, however, needs to be supported and framed by education, awareness raising, suitable policies, and the stimulation of economic activities which allow income generation.

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