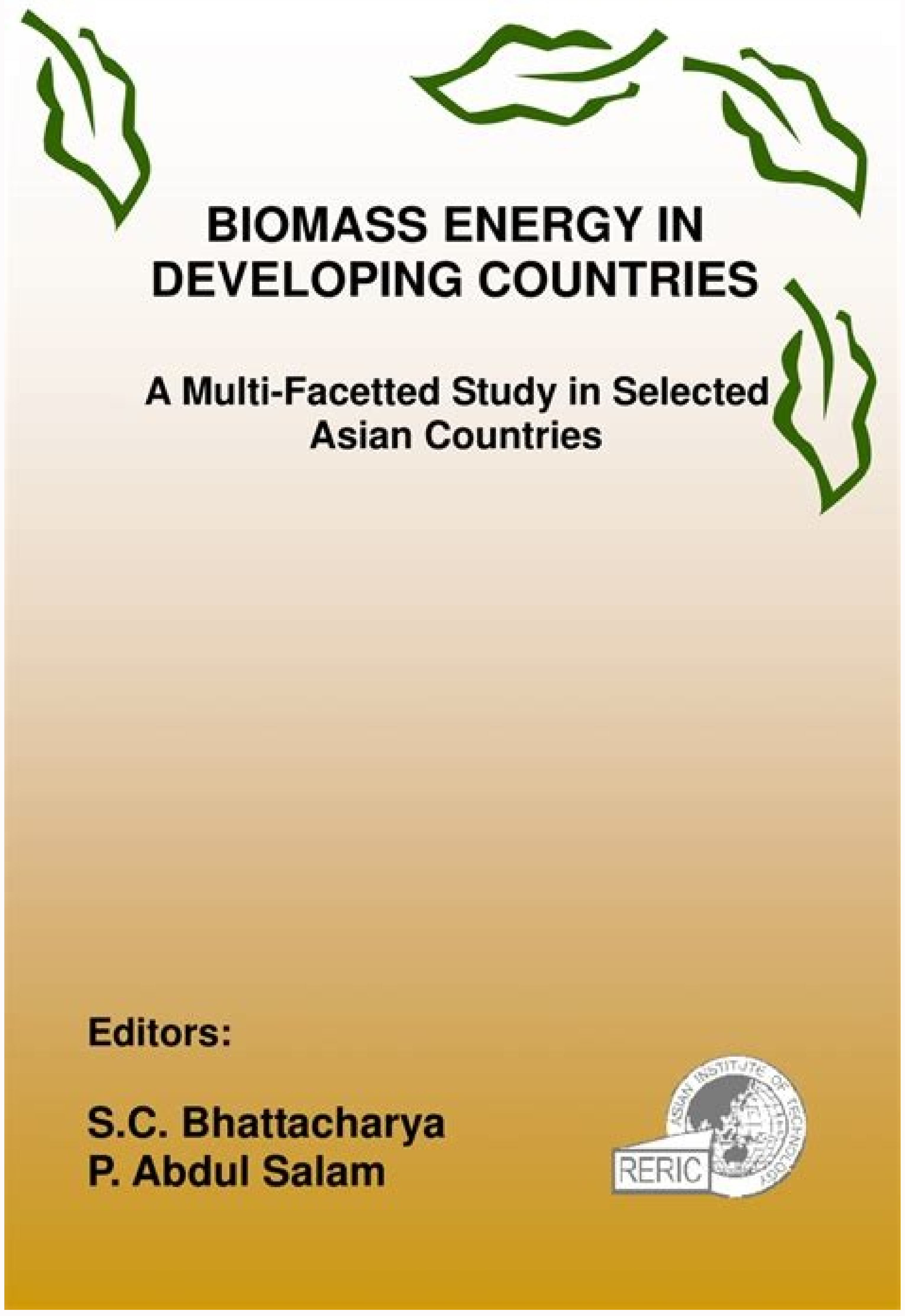
BIOMASS ENERGY IN
DEVELOPING COUNTRIES
A Multi-Facetted Study in Selected
Asian Countries
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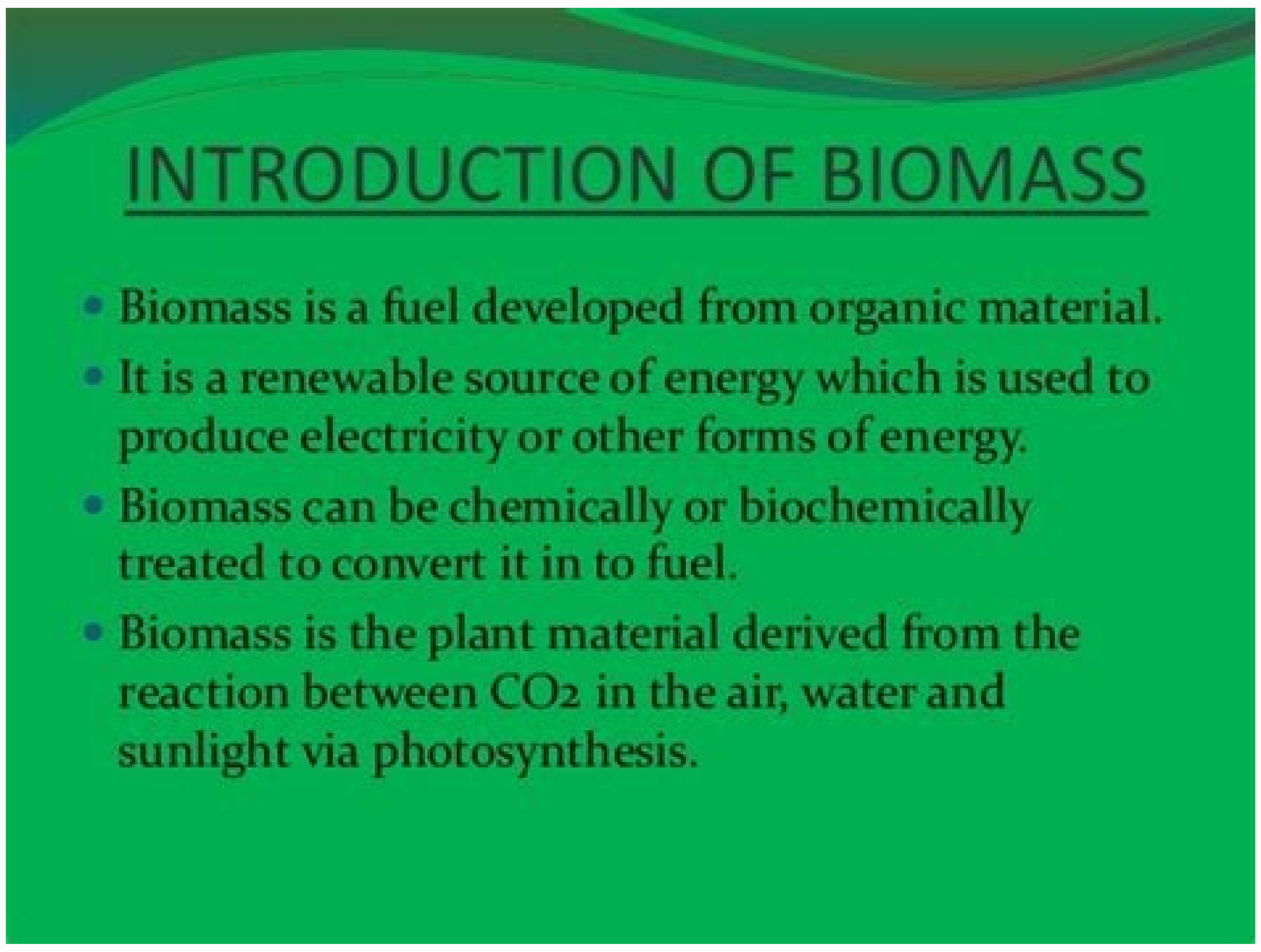
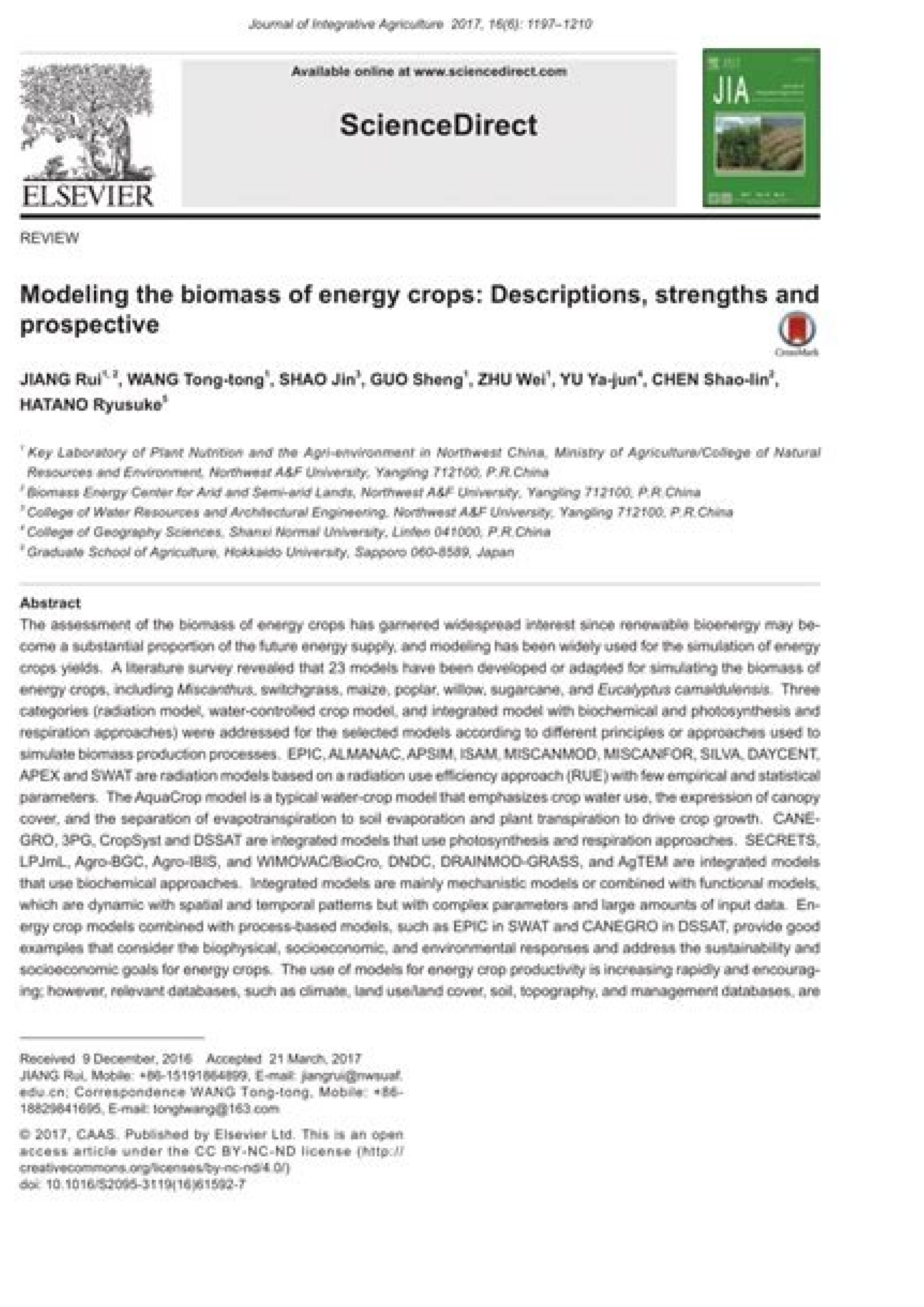

INTRODUCTION OF BIOMASS
Biomass is a fuel developed from organic material.
It is a renewable source of energy which is used to produce electricity or other forms of energy.
Biomass can be chemically or biochemically treated to convert it in to fuel.
Biomass is the plant material derived from the reaction between CO2 in the air, water and sunlight via photosynthesis.



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REVIEW

Modeling the biomass of energy crops: Descriptions, strengths and prospective

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Abstract

The assessment of the biomass of energy crops has garnered widespread interest since renewable bioenergy may become a substantial proportion of the future energy supply, and modeling has been widely used for the simulation of energy crops yields. A literature survey revealed that 23 models have been developed or adapted for simulating the biomass of energy crops, including *Miscanthus*, switchgrass, maize, poplar, willow, sugarcane, and *Eucalyptus camaldulensis*. Three categories (radiation model, water-controlled crop model, and integrated model with biochemical and photosynthesis and respiration approaches) were addressed for the selected models according to different principles or approaches used to simulate biomass production processes. EPIC, ALMANAC, APSIM, ISAM, MISCANMOD, MISCANFOR, SILVA, DAYCENT, APEX and SWAT are radiation models based on a radiation use efficiency approach (RUE) with few empirical and statistical parameters. The AquaCrop model is a typical water-crop model that emphasizes crop water use, the expression of canopy cover, and the separation of evapotranspiration to soil evaporation and plant transpiration to drive crop growth. CANEGRO, 3PG, CropSyst and DSSAT are integrated models that use photosynthesis and respiration approaches. SECRETS, LPJmL, Agro-BGC, Agro-IBIS, and WIMOVAC/BioCro, DNDC, DRAINMOD-GRASS, and AgTEM are integrated models that use biochemical approaches. Integrated models are mainly mechanistic models or combined with functional models, which are dynamic with spatial and temporal patterns but with complex parameters and large amounts of input data. Energy crop models combined with process-based models, such as EPIC in SWAT and CANEGRO in DSSAT, provide good examples that consider the biophysical, socioeconomic, and environmental responses and address the sustainability and socioeconomic goals for energy crops. The use of models for energy crop productivity is increasing rapidly and encouraging; however, relevant databases, such as climate, land use/land cover, soil, topography, and management databases, are

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Gross potential of Biomass products for Energy Generation in Azad Jammu and Kashmir. A case study using Bio-IRENA Simulator

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Abstract—**Economic stability of a country is critically driven by the outlook of its energy sector. This study discusses the range of organic materals than can be used to produce energy in Azad Jammu and Kashmir. Gross potential of Forestry products, livestocks and agricultural crops are estimated using Bio-IRENA simulator. Complete cycle from biomass feedstock to energy end use is considered to evaluate the assistance of these products in CHPs (combined heat and power plants), electricity and transport sector of the country. The aim of this study is to understand the gross potential of energy generation through biomass. Although utilizing every single grain and plant in energy sector of the country is not feasible, this study shows that using only a small quantity can provide a sustainable future. The results of the simulator shows that forestry products alone can supply gross electricity of more than 150 TWh. Considering Pakistan's annual consumption of 452 kWh/capita, it can supply energy to more than 5% of our entire population. Livestock will not only provide energy but will also result in reducing the carbon emissions due to waste to a large extent. Similarly, agricultural products can be cultivated along marginal lands of AJK. This will also result in energy generation along with revitalization of soil.**

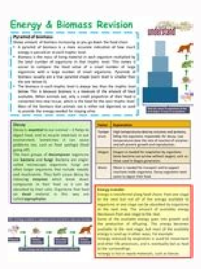
Index Terms—**Biomass, Bio-IRENA Simulator, Energy harvesting, Energy Modeling**

I. Introduction

Pakistan has been blessed with abundant water resources. Water is flowing down from Himalayas and Karakorum heights thus resulting in one of the best irrigation systems of the world. However, recent events and constantly changing demographics are expected to cause some serious water problems [1]. Moreover, with constant depletion of water resources and constantly increasing energy demand, situation is likely to get worse. Population of Pakistan according to latest census has increased to 207.1 Million and is expected to increase at a much higher rate in coming future [2]. With fossil fuels being depleted, energy that can be derived from biomass is more sustainable and electricity generation is considered one of its most important end use [3]. So, there is a need to devise a system that is more sustainable, and which can even provide energy at low water conditions.

A. Power Production in AJK

Even compared to renewables, hydro energy is the cheapest source of energy in Kashmir [3]. At current scenario, AJK produces supplies almost 1100 MW to the national grid and all of this is through hydro power plants. Currently, it is spread over an area of 13,297 km2 and has the population of 4045366. In spite of having such a large potential and supplying electricity almost 4 times than its own demand to the national grid, AJK is still suffering from energy shortfall. The total power capacity of AJK in 2016 is 9034 MW out of which 1141 MW is comissioned, 2092 MW under construction, and 5800 MW is under planning process. (Power Developmemt Department, Muzaffarabad). However, despite having such a large potential, the production through this area falls abruptly due to water droughts affecting the power sector of whole country. Moreover due to Indus water treaty between India and Pakistan, all the projects are based on run off river. Considering the poor relation among the neighbouring countries, this can also cause some serious problems in the coming future. Now the potential of biomass in Kashmir is very high [4]. A large population of this area relies on agriculture and forestry products to earn a living. The potential of biomass in this area can also help in the energy generation process by integrating them with hydel power plants or simply through waste to energy conversion plants.



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This article deals with biomass as a source of renewable energy. For the use of the term in ecology, see Biomass (ecology). Biological material used as a renewable energy source Wood pellets Biomass is plant or animal material used as a fuel to produce electricity or heat. Examples include timber, energy crops, and waste from forests, yards, or farms.[1] Because biomass can technically be used as fuel directly (e.g. logs), some people use the terms biomass and biofuel interchangeably. In most cases, the word biomass simply denotes the biological raw material from which the fuel is made. The word biofuel is usually reserved for liquid or gaseous fuels, used for transport. The United States Energy Information Administration (EIA) follows this designation practice.[2] The IPCC (Intergovernmental Panel on Climate Change) defines bioenergy as a form of renewable energy[3]. In 2017, the International Energy Agency (IEA) described bioenergy as the most important source of renewable energy.[a] The IEA also argues that the current rate of bioenergy deployment is well below the levels required in low-carbon scenarios, and that Accelerated deployment is urgently needed.[b] Researchers have questioned whether the use of forest biomass to generate energy is carbon neutral.[4][5] balesWood and wood waste are the largest source of biomass energy today. Wood can be used as fuel directly or transformed into fuel for pellets or other forms of fuel. Other plants can also be used as fuel, e.g. maize, alternate grass, miscanthus and bamboo.[6] The main sources of residual energy are the residual waste of oil. agricultural waste, urban solid waste, industrial waste and landfill gases. Debugger sludge is another source of biomass. There are ongoing research on algae or biomass derived from algae.[7] Other biomass raw materials are enzymes or bacteria from various sources, cultivated in cell or hydroponic crops.[8] Biomass is also used to produce fibers and industrial chemicals. Based on the source of biomass, biofuel biofuelsclassified into three main categories: [9] First-generation biofuels are derived from food sources, such as sugar cane and corn starch. The sugars present in this biomass are fermented to produce bioethanol, an alcohol fuel that serves as an additive to gasoline, or in a fuel cell to produce electricity. Second-generation biofuels use non-food-based biomass sources, such as perennial energy crops (low consumption crops), and agricultural and municipal wastes. The supporters argue that there is a huge potential for second-generation biofuels. Third-generation biofuels refer to microalgae derivatives. Biomass Conversion Biomass Plant in Scotland. Improvement of raw biomass to higher-grade fuels can be achieved through different methods, widely classified as thermal, chemical or biochemical. Thermal conversions Thermal conversion processes use heat as a dominant mechanism to improve biomass in a better and more practical fuel. The basic alternatives are turrefaction, pyrolysis and gasification, they are separated mainly by the extent to which the chemical reactions involved are allowed to proceed (mainly controlled by the availability of oxygen and conversion temperature). [10] There are other less common, more experimental or patented thermal processes that can offer benefits, such as hydrothermal improvement. [11] Some have developed for use in high-moisture biomass, including watery legumes, and allow them to become more convenient forms. Conversion of chemicals A range of chemical processes can be used to convert biomass into other forms, such as to produce a more practical fuel to store, transport and use, or to exploit any property of theprocess. Many of these processes are largely based on similar coal-based processes, such as Fischer-Tropsch synthesis. [12] Biomass can be converted into multiple chemicals. [13] Biochemical Conversion As biomass is a natural material, many highly efficient biochemicalsThey have developed in nature to decompose the molecules from which biomass is composed, and many of these biochemical conversion processes can be exploited. In most cases, microorganisms are used to perform the conversion process: anaerobic digestion, fermentation and composting. [14] Glucose hydrolases are the enzymes involved in the degradation of the greater fraction of biomass, such as the polysacanides present in starch and lignocellulose. The thermostable variants are gaining rising roles as catalysts in biiorition applications, since recalcitrant biomass often needs thormic treatment for efficient degradation. [15] Electrochemical conversions Biomass can be converted directly into the electrical energy by electrochemical (electrocatalytic) oxidation of the material. This can be performed directly on a direct carbon fuel cell, [16] direct liquid fuel cells as a direct ethanol fuel cell, a direct methanol fuel cell, a celler Fuel of Direct Formic Fuel, an acidic acid fuel cell (vitamin C fuel cell), [17] and a microbial fuel cell. [18] The fuel can also be consumed indirectly through a system of fuel cells containing a reformer that converts the biomass into a mixture of CO and H_2 before consuming it in the fuel cell . [19] Carbon neutrality for GHG emissions of Forestry Biomass of Production and Transport of Wood Pellets (Hanssen et al., 2017). [20] IEA defines carbon neutrality and carbon negativity as here: «Carbon neutrality, or 'Net zero' means that any CO_2 released in the atmosphere of human activity is balanced by an equivalent amount that is Eliminate. Become negative carbon requires a company, sector or country for more co_2 of the atmosphere than it emits. »[21] the actual carbon intensity of biomass varies with production techniques and transport lengths. according to the ue, the typical savings of greenhouse gas emissions by replacing fossil fuels with wood pellets of forest waste is 77% when the transport distance is 0 to 500 km, also 77% when theThe distance is between 500 and 2500 km, 75% when the distance is between 2500 and 10,000 km, and 69% when the distance is above 10 000 km. When STEMOOD is used, the savings change only marginally, between 70 and 77%. When residues of the wood industry are used, the savings increase to between 79 and 87%. [C] Also, Hanssen et al. Argume that greenhouse gas emissions savings from wood pellets produced in Southeast USA UU and sent to the EU are between 65 and 75%, compared with fossil fuels. [D] estimate that Net Get emissions average wood pellets imported from the United States and burned. For electricity in the EU it amounts to approximately 0.2 kg of CO_2 equivalents per kWh, while the average emissions of the folish fuel mixture that are currently burned for electricity in the EU amount to 0.67 kg of CO_2- EQ per kWh (see table on the right). Marine transport emissions amount to 7% of fuel fuel emissions per kWh produced (equivalent to 93 kg of CO_2-EQ / T vs 1288 kg CO_2 / T). [22] IEA Bioenergy estimates that in a scenario where Canadian wood pellets are used to replace the use of carbon at a European carbon plant, specific emissions originated in the maritime transport of pellets, ranging from Vancouver to Rotterdam, equals approximately 2% of the total carbon of the plant. - Related emissions. [23] More CO_2 of wooden combustion that carbon combustion is combined in combustion installations with the same efficiency of heat conversion abelling, the oven drywood emits a little less CO_2 per unit of heat produced , in comparison with dry baked carbon. [E] However, many biomass combustion facilities are relatively small and inefficient, compared with carbon plants bigger. In addition, raw biomass can have a higher moisture content compared to some common carbon types. When this is the case, more from the inherent energy of the wood, it should be used only in the humidity of evaporation, compared to the carbon dryer, which means that the amount of CO_2 emitted per unit of heat produced will be greater. Carbon port in Russia. Some some groups (e.g. Chatham House) argue that "[...] the use of woody biomass for energy will release higher levels of emissions than coal."[24] How much "extra" CO_2 released depends on local factors. Some research groups estimate relatively low additional emissions. Yeah. Bioenergy, for example, estimates 10%.[25] The FutureMetrics bio-energy consulting group argues that wood pellets with 6% of humidity emit 22% less CO_2 for the same amount of heat produced, compared to sub-bituminose coal with 15% humidity, when both fuels are combusted in facilities with the same conversion efficiency (here 37%).[f] They also say that "[...] dry wood in the humidity content of the MC less than 20% have the same or less CO_2 emission by MMBTU [billionaires British thermal units] as most coal. Wood pellets at less than 10% of MC result in less CO_2 emissions than any coal under different circumstances. »[26] (The humidity content in wood pellets is usually less than 10%, as defined in ISO 17225-2:2014.)[27] However, when raw wood chips (45% of humidity content) are used instead, this wood biomass emits 9% more CO_2 than coal in general, for the same amount of heat produced. [26] According to Indiana Center for Coal Technology Research, coal-type anthracite usually contains less than 15% humidity, while bituminous contains 2-15%, sub-bituminoso 10–45%, and lignite 30–60%.[28] The most common type of coal in Europe is lignite. [29] Other research groups estimate relatively high additional emissions. The Manomet Centre for Conservation Sciences, for example, argues that for smaller-scale enterprises, with 32 per cent conversion efficiency for coal, and 20-25% for biomass, coal emissions are 31 per cent less than for carbonwood. The moisture content assumed for wooden chips is 45%, as above. The moisture content assumed for coal is not provided. [30] The IPCC (Intergovernmental Panel on Climate Change) put its estimates "extra CO_2" for biomass at approximately 16% extra for wood on coal inThey argue that focusing on gross emissions does not make sense, what counts is the net effect of emissions and absorption taken together: «Estimating only gross emissions, creates a distorted representation of human impacts in the carbon cycle of the Terrestrial sector. While the forest seal to obtain wood and lightening and the change of land use (deforestation) contribute to gross emissions, to quantify the impacts on the atmosphere it is necessary to estimate net emissions, that is, the balance of emissions Grups and the gross absorption of carbon from the atmosphere through forest growth [Ã Ã Ã Ã Ã âda] Â »[31] Wood pellet mill in Germany. Ã â € "[25] also argue that the wrong approach in emissions at the combustion point diffuses the distinction between fossil and biogenic carbon, and prevents adequate evaluation of camo The displacement of fossil fuels with biomass affects the Development of biomass. Ã â € »[32] The AIE BioenergÃƒ A concludes that the additional CO_2 of the [...] biomass" [...] is irrelevant if biomass comes from sustainable managed forests, [25] Â What © Are the forests managed in a sustainable way? The IPCC writes: «Sustainable forest management (MFS) is defined as« the administration and use of forests and forest lands in a way and a rhythm that maintains its biodiversity, productivity, regeneration capacity, vitality and its Potential to fulfill, now and in the future, ecological, economic and social functions relevant, at the local, national and global level, and not to cause damaging to other ecosystems. This definition of sustainable forest management was developed by the Ministerial Conference for the Protection of Forests in Europe and was subsequently adopted by the United Nations Organization for Agriculture and Food (FAO)]. Â «[33] In addition, the IPCC "Sustainable forest management can prevent deforestation, maintain and improve carbon sinks and can contribute to GHG emission reduction targets. Sustainable forest management generates socio-economic benefits, and provides fiber, wood and biomass to meet the growing needs of society." [34] In the context of CO_2 mitigation, the key measure on sustainability is the size of forest carbon. In a research paper for FAO, Reid Miner writes: "The central objective of all sustainable management programmes in production forests is to achieve a long-term balance between harvesting and re-relief. ["] The practical effect of maintaining a balance between harvesting and recessing is to maintain stable long-term carbon stocks in managed forests." [35] Globally, forest carbon stock has decreased by 0.9 per cent and tree cover. 4.2% between 1990 and 2020, according to FAO. [36] The IPCC states that there is a disagreement about whether the Global Forest is shrinking, and the contribution research that indicates that tree cover has increased 7.1% between 1982 and 2016. [H] IPCC writes: "While biomass carbon stocks above the soil are estimated at Being decreasing in the tropics, they are increasing globally due to the growing actions in temperate and boreal forests [- [37] Forest Forest France. Some research groups seem to want more of the sustainably managed forests, want to realize the full carbon storage potential of forests. For example, EASAC writes: "There is a real danger that the policy on emphasizing the use of forests in energy production rather than increasing forest stocks for carbon storage. [38] In addition, they argue that " [" Δ] It's the big forests,longer rotation and protected ancient growth forests that exhibit the highest carbon stocks. A great potential for future carbon absorption is lost. Besides, they're them. That there is a carbon loss of the soil due to harvest operations. [40] The investigation shows that the old trees absorb more CO_2 than the young trees, due to the largest leaf surface in complete growth trees. [41] However, the old forest (as a whole) will eventually stop absorbing CO_2 because the CO_2 emissions of dead trees cancel the CO_2 absorption of the remaining living trees. [I] The old forest (or forest posts) They are also vulnerable by natural disturbances that produce CO_2. The IPCC writes: Â «When the vegetation matures or when the vegetation and carbon deposit of the soil reach saturation, the annual disposal of CO_2 of the atmosphere decreases towards zero, while carbon reserves can be maintained (high confidence). However, the accumulated carbon in vegetation and soil is at risk of future peaks (or lavatory reversion) caused by disturbances such as floods, drones, fires or pest sprouts, or futures of poor management (high confidence). Â »[42] In summary, the IPCC writes that« [...] Landscapes with ancient forests have accumulated more carbon but its resistance to sink is decreasing, while landscapes with younger forests contain less Carbon, but they are very eliminating the CO_2 of the atmosphere. «Recent studies indicate that the effects of forest management shares in soil stocks [carbon] can be difficult to quantify and report effects have been variable and even contradictory (see Box 4.3a).» Because the «current scientific melting is not enough», the IPCC will not currently provide soil carbon emission factors for forest management. [44] Regarding the net climatic effect of the conversion of natural forests to the administered forests, the IPCC maintains that both modes can oscillate: «The Sustainable Order of the Forests applied to Landscapes to current non-managed forests can first reduce average forest carbon stocks and subsequently increase the rate referred to by atmosphere CO_2, since the net production of the ecosystems of forest posts is greater. higher. At intermediate ages (Kurz et al., 2013, Volkova et al., 2018, Tang et al., 2014). The net impact on the atmosphere depends on the magnitude of the reduction of carbon stocks, the fate of the biomass harvested (ie, use in biological (ie, shortly Ã â, ¬ "or long products Duration and for bioenergy, and therefore the displacement of the emissions associated with the intensity of GHG. Construction materials and fossil fuels), and the reef rate. Therefore, the SFM impacts on an indicator (for example , the low reduction in carbon populations in the wooded landscape) can be negative, while those in another indicator (for example, current forest productivity and CO_2 elimination rate of the atmosphere, avoid emissions of folossile fuels.) Be positive. The forest landscapes managed in a sustainable manner may have a lower carbon density of biomass than the unmanaged forest, but the youngest forests can have a growth rate more High, and, therefore, contribute with stronger carbon sinking than the oldest forests (Tropymow et al. 2008; Volkova et al. 2018; Poorter et al., 2016). Â »[33] In other words, there is compensation between the benefits of having a maximized forest carbon stock, which does not absorb more carbon and the benefits of having a portion of that" unlocked "carbon stock. , and instead working as a renewable fuel replacement tool. When it is placed to work, this carbon is constantly replacing the carbon in the fossil fuels used in, for example, the production of heat and the production of base load electricity, the sectors, where it is not economical or impossible to use sources of Energy intermittent like wind or solar energy. Being a renewable carbon source, the unlocked portion maintains cycling between forests and wood and wood pellets. For each cycle, replace more and more fossil-based alternatives, for example. Cemento and coal. FAO researcher Reid Miner argues that the "competence" between carbon of the closed and unlocked forests is gained by unlocked carbon: "long term, using sustainable forest biomass as a carbon-intensive substituteAnd fossil fuels provide greater permanent reductions in atmospheric CO_2 than preservation. Â"[45] Plantation forest in Hawaii. Summing up the above, IEA Bioenergy writes: "As the IPCC has pointed out in several reports, forests managed to produce sawnwood, bioenergy and other wood products can make a greater contribution to climate change mitigation than conservation forests alone, for three reasons. The strength of the sink decreases as the conservation forests approach maturity. Second, wood products displace GHG-intensive materials and fossil fuels. Third, forest carbon is vulnerable to loss through natural events, such as insect infestations or forest fires, as seen recently in many parts of the world, including Australia and California. Forest management can help increase the total amount of carbon sequestered in forest carbon products and wood products, reduce the risk of loss of sequestered carbon, and reduce the use of fossil fuels. "[46] The IPCC further suggests that making A Life Out of Forestry an incentive for sustainable forest practices: Â"[Ã¢ â¨¬ |] SFM [sustainable forest management] aimed at providing timber, fibre, biomass and non-timber resources can provide long-term livelihoods for communities, reduce the risk of forests conversion to non-forest uses (liquidity, crops, etc.), and maintain the productivity of the land, thus reducing the risks of land degradation [("[43]" [43], further: "By providing long-term livelihoods for communities, sustainable forest management can reduce the extent of forest conversion to non-forest uses (e.g., cropland or settlements) (high confidence)."[47] The National Programs of Forest Resources of the University Agree: «The investigation shows that the demand for Wood's demand helps KEE Praces in the forest and encourage investments in new and more productive forests, all which have important carbon benefits. [Ã ¢ â, ¬ |] Do not consider the effects of markets and investment in carbon impacts can distort distort Characterization of carbon impacts of forest biomass energy. Â »[48] Favero et al. Focus on the possible future increase in demand and argues: «The increase in bioenergy demand increases carbon forest stock thanks to forestry activities and more intensive management in relation to a non-bioenergy case [. ..] The greatest demand for biomass will increase the value of the wood, will encourage additional investments in forestry management and forestation, and will result in higher carbon forest reserves with time. »[49] Europe (including Russia) produced 54% of the wooden pellets in the world in 2019, and forest carbon in this area increased from 158.7 to 172.4 between 1990 and 2020. Likewise, North America produced 29% of the world pellets in 2019, while forest carbon increased from 136.6 to 140 GT in the same period. The stock of carbon decreased from 94.3 to 80.9 GT in Africa, 45.8 to 41.5 GT in southern and Southeast Asia combined, 33.4 to 33.1 GT in oceania, 5 to 4.1 GT in Central and 161.8 to 144.8 GT in South America. The production of wood pellets in these combined areas was 13.2% in 2019. [K] Chatham House responds to the previous argument as the following: Â «Fortuito carbon stock levels can remain equal or increase for reasons Totally not connected with the use of energy. Â »[50] Carbon return time Some research groups still argue that even if the European and North American forest carbon is increasing, it simply takes too long for the harvested trees to grow. EASAC, for example, argues that since the world is on track to go through the agreed target of 1.5 degrees of temperature increase already in a década or thoroughly burned wood, which resides in the atmosphere For many other decades before being reabsorbed, it makes it more difficult to achieve this goal. Therefore, they suggest that EU must adjust its sustainability criteria so thatonly renewable energy with carbon recovery times of less than 10 years is defined as sustainable,[l] e.g. wind power, solar power, biomass from wood waste and thinning of trees that would otherwise burn or decompose relatively quickly, and biomass from the collection of short rotations[51]. Chatham House agrees, and further argues that there may be tipping points along the temperature scale where warming accelerates.[m] Chatham House also argues that various types of roundwood (mainly pulpwood) are used in the production of pellets in the United States..[52] FutureMetrics argues that it makes no sense for foresters to sell sawn quality timber to pellet mills, as they get much more money from sawmills for this part of the tree. Foresters derive 80-90% of their income from sawn quality roundwood (the lower and thickest straight part of the stem), and only 10-15% from pulpy wood, defined as (a) the middle part of mature trees (the thinnest part of the stem that is often doubled). a little bit, in addition to branches) and b) thinning of trees (small trees and felling (young trees uprooted to increase the productivity of the whole felling).) This low-value biomass is mainly sold to pulp mills for the production of paper, but in some cases also to pellet factories for the production of pellets[53]. Pellets are typically made from sawmill residues in areas where there are sawmills, and pulpwood in areas where there are no sawmills.[n] Chatham House further argues that almost all available sawmill residues are already being used for pellet production, so it is not possible to use them to produce pellets. there is room for expansion. In order for the bioenergy sector to develop significantly in the future, a greater part of the harvested should be used for pellet factories However, the collection of octopus (trees' swell) eliminates the possibility that these trees grow old and thus maximize their carbon retention capacity.[54] Compared to pulp wood, sawn wastes have less net emissions: "Some types of biomass raw material can be carbon neutral, at least for a period of some years, including in particular:waste. These are waste from other forestry operations that do not involve additional harvests, and if otherwise it is burned as waste or it is left to rotate carbon at the atmosphere in any case. "[55] An important presupposition for the argument of Â« The growth of the tree is too slow "is the opinion that carbon accounting should begin when combusting trees of particular forests, harvested forests and not when the trees in those stands begin to grow. [or] It is within this framework of thought that is possible to argue that the combustion event creates a carbon debt that has to be paid through the growth of the harvested stands. [P] When instead of assuming that the accounting of the Carbon should begin when the trees begin to grow, it becomes impossible to argue that the carbon emitted constitutes debt. [Q] Futuremetrics, for example, argues that harvested carbon is not a debt but [...] n benefit that was gained for 30 years of management and growth [...]. Â »[56] Other researchers, however argue that« [...] what is important for climate policy is to understand The difference in the future atmospheric levels of GHG, with and without changing to the biomass energy lightening. The previous growth of the forest is relevant for the political question [...]. Â »[57] Greenhouse gas parity times for wood-pellet electricity of different raw materials (Hanssen et al., 2017). [58] Some researchers limit their carbon accounting to certain forest positions, ignoring the carbon absorption that occurs in the rest of the forest. [R] In opposition to this financial forest accounting, other researchers include the entire forest when they do Your carbon accounting. Futuremetrics, for example, argues that the entire forest continuously absorbs CO2 and therefore immediately compensates for relatively small amounts of that is combined in biomass plants from today's day. [S] In the same way, IEA bioenergy criticizes the EASAC for ignoring the carbon absorption of the forests as a whole, signal that there is no net loss of carbon if the The IPCC argues similarly: "While the individual forest tracks may be sources or sinks, the forest carbon balance is determined by the sum of the net balance of all the tracks".[59] The IPCC also states that the only universally applicable approach to carbon accounting is that which accounts for both emissions and carbon removals (carbon absorptions). option) for the entire landscape (see below). When the total is calculated, natural disturbances such as fires and insect infestations are subtracted, and human influence remains.[u] In this way, entire landscape functions as an indicator for the specific calculation of human GHG emissions: "In the AFOLU sector [Agriculture, Forestry and Other Earth Use], soil management is used as the best approximation of human influence and the So, the estimates of emissions and removals in managed lands are used as a substitute for anthropogenic emissions and removals from the anthropogenic effects that are managed by the preponderating volumes. This allows consistency, comparability and transparency in the estimate. The IPCC recognizes that this approach is the only universal application to estimate anthropogenic emissions and removals in the AFOLU sector (IPCC 2006, IPCC 2010). «[60] Hanssen et al. point out that when comparing the continuous production of wood pellets with a possible change in policy in which the forest is protected, most researchers estimate a 20â «50 years of carbon parity (refund) time interval for burnt wood pellets. But when the continuous production of pellets is compared to the most realistic alternative hypothesis of 1.) instead of using all the biomass harvested to produce paper, pasta or wooden boards, 2.) the practice of the(leaving small trees alone, taking advantage of more growth potential but at the same time reducing the growth potential of large large and 3.) leave the forest residue alone, so it decomposes in the forest over time, instead of being burned almost immediately in power plants, the result is that the carbon recovery times (parity) for wood pellets drop to 0-21 years in All demand scenarios (see table at the right). The estimate is based on the landscape rather than the practice of carbon accounting of the individual forest stand. [61] Researchers of short-term vs. long-term climate benefits on both sides agree that in the short term, emissions may increase compared to a non-bioenergy scenario. IPCC, for example, states that forest carbon avoidance strategies always provide a short-term mitigation benefit, but argue that the long-term benefits of sustainable forest activities are larger: [59] relative to a baseline, the largest short-term gains are always achieved by a through mitigation activities aimed at the avoidance of emissions [â˜]. But once an emission has been avoided, the carbon stocks in that forest will simply be maintained or slightly increased. [Âé â˜]] In the long term, the sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual yield of wood, fiber or forest energy, will generate the greatest benefit of sustained mitigation". Âé â˜ "IPCC 2007 similarly, addressing the issue of climate implications for the Modern bioenergy in general, the IPCC states:Â"Life-cycle GHG emissions of modern bioenergy alternatives are generally lower than those of fossil fuels [â˜]. Â"[62] As a result, most IPCC GHG mitigation pathways include a substantial deployment of bioenergy technologies. [63] The ways of limited or do not lead to further climate change or shifting the burden of bioenergy mitigation to other sectors. [V] In addition, it increases the cost of mitigation. [W] IEA Bioenergy also prioritizes long-term benefits: Â"concern about near-term emissions is not a strong argument for stopping investments that contribute to the reduction of net emissions beyond 2030, either Scaling up of battery manufacturing to support the electrification of car fleets, the development of railway infrastructure, or the development of biomass supply systems and innovation to provide bio-based products that displace fossil fuels, cement and other GHG-intensive products. We affirm that it is essential to focus on the global emissions path needed to achieve climate stabilization, recognizing possible trade-offs between short-term and long-term emission reduction targets. A strong focus on short-term carbon balances may result in decisions that make it harder to achieve long-term climate goals. "[32] IEA states that "[...] the current rate of bioenergy implementation is well below the levels required in low-carbon scenarios. Accelerated deployment is urgently needed to increase the contribution of sustainable bioenergy across all sectors [...].Â"[64] They recommend a five-fold increase in the sustainable supply of bioenergy feedstock. [x] The National Association of University Forest Resources Programs agrees, and argues that a 100-year timeframe is recommended to produce a realistic assessment of cumulative emissions: "Comparisons between forest biomass emissions and fossil fuel emissions at the time of fuel combustion and, subsequently, during Short periods do not represent long-term carbon accumulation in the atmosphere and may significantly distort or ignore the comparative effects of carbon over time. [...] The most common timeframe for measuring greenhouse gas impacts is 100 years, as illustrated by the widespread use of the 100-year global warming potentials. This timeframe provides a more accurate accounting of cumulative emissions than shorter intervals. "[65] Carbon for Energy Crops Miscanthus X Giganteus, Germany. As with forests, it is the total amount of emissions and equivalent CO2 emissions that determines whether an energy crop project is positive carbon, neutral carbon or negative carbon. If the emissions during Processing, transport and fuel are higher than what is absorbed, both above and below the ground during the growth of crops, the project is carbon positive. Similarly, if the total removal over time is higher than the total emissions, the project is carbon negative. Many first-generation biomass projects are carbon-positive (have a positive life cycle cost), especially if emissions caused by direct or indirect land-use change are included in the GHG cost calculation. However, the IPCC status that indirect land-use change effects are highly uncertain, however. [Y] Some projects have higher total GHG emissions than some fossil-based alternatives. [Z] [AA] [AB] Transportation fuels may be worse than solid fuels in this regard. [AC] During plant growth, ranging from a few months to decades, CO2 is re-absorbed by new plants. [66] While regular forest supports have carbon rotation times that span many decades, short rotational forest supports (SRF) have a rotation time of 8-20 years, and short rotational clutch (SRC) has a rotation time of 8-20 years.) is 2 â¬ "4 years. [67] Perennial herbs such as Miscanthus or Napier Herb have a rotation time of 4, 12 months. In addition to absorbing CO2 and storing it as carbon in their soil tissue, biomass crops also sequester carbon beneath the soil, in roots and soil. [AD] Typically, perennial crops sequester more carbon than annual crops because the accumulation of roots is allowed to continue undisturbed for many years. In addition, perennial crops avoid the annual tillage procedures (ploughing, digging) associated with annual crops. The tillage helps the populations of microbes in the break down available carbon, producing CO2. [EA] [AF] Soil organic carbon has been found to be higher below crisis crops than under crop soils, especially at depths below 30 cm (12 Â° en). [68] A meta-study of 138 individual studies, conducted by Harris et al., revealed that second-generation perennial herbs (Miscanthus and Switchgrass) planted on arable land in the tent average five times more carbon in the soil Short-rotating coppice or short-rotating forest plantations (poplar and willow).[ag] McAlmont et al. comparing several individual European reports on carbon sequestration Miscanthus x giganteus, and found accumulation rates ranging from 0.42 to 3.8 tonnes per hectare per year. year,[ah] with an average accumulation rate of 1.84 tonnes (0.74 tonnes per acre per year),[ai] or 25% of the total carbon harvested per year.[aj] When used as a fuel, the greenhouse gas (GHG) savings are large, even without considering the GHG effect of carbon sequestration, the poor fuel carbon has a GHG cost of 0.4-1.6 grams of CO2-equivalents per megajoule, compared to 33 grams of carbon, 22 for liquefied natural gas, 16 for North Sea gas, and 4 for wood chips imported from Britain. Similarly, Whitaker et al. argue that a miscanthus crop with a yield of 10 tonnes per hectare per year sequesters enough carbon below the ground than the crop that most offsets emissions from agriculture, processing and transportation. The graph on the right shows two negative ways of producing CO2 spur, represented by the gram of CO2-equivalents per megajoule. The bars are sequential and move up and down, as atmospheric CO2 is estimated to increase and decrease. Grey/blue bars represent emissions related to agriculture, processing and transport, green bars represent soil carbon change and yellow diamonds represent total final emissions. [al] Relation between top yield (diagonal lines), soil organic carbon (X-axis) and soil potential for successful/unsuccessful carbon sequestration (Y-axis). Basically, the higher the yield, the more land can be used as a GHG mitigation tool (including relatively rich in carbon). Successful kidnapping depends on planting sites, as the best soils for kidnapping are those that are currently low in carbon. The varied[am] For the United Kingdom, success is expected in the conquest of arable land over most of England and Wales, with unsuccessful sequestration expected in parts of Scotland, due to already carbon-rich (forest-existing) soils with lower yields. Already carbon-rich soils include peat and mature forest. Milner et al. further argue that the most successful carbon sequestration in the United Kingdom occurs below improved pasture.[an] However, Harris et al. notes that since the carbon content of grasslands varies considerably, the success rate of land use also changes from pasture to grassland.enne.[ao] The graph below shows the estimated yield needed to achieve CO2 negativity for different levels of carbon saturation of the existing soil. The higher the yield, the more likely CO2 negativity becomes. Environmental Impact Biodiversity and Pollution Gasparatos et al. reviews current research on the side effects of all types of renewable energy production, and argues that there is generally a conflict between "[...] site-specific conservation objectives and national energy/climate policies changes Mitigation priorities [...]". The authors argue that, for example, biodiversity should be considered as an equally "[...] legitimate goal of the Green Economy as the reduction of GHG emissions. "[69] Oil palm and sugarcane are examples of crops that have been linked to biodiversity reduction. [70] Other problems include soil and water contamination from the use of fertilizers/pesticides[71] and the release of environmental pollutants, mainly from the burning of waste in the open field. [72] The authors note that the extent of environmental impact "[...] varies considerably between different bioenergy options. "[70] For the of the impact, they recommend "[...] adopt pastics of bioenergy ecological production, for example by limiting the expansion of monoculture plantations, adopting wildlife-friendly production practices, installing contamination control mechanisms, contamination, carry out continuous monitoring of the landscape. "[73] They also recommend "[...] multifunctional bioenergy landscapes".[73] Other measures include "[...] careful selection of raw materials, as different raw materials may have radically different environmental exchanges. For example, U.S. studies have shown that second-generation raw materials grown on unfertilized land could provide benefits to biodiversity compared to annual monoculture crops such as maize and soybeans that make extensive use of agrochemicals. "[73] Miscanthus and switchgrass are examples of such crops.[74] Air Quality The traditional use of wood in stoves and open fires produces pollutants, which can lead to serious health and environmental consequences. However, a shift to modern bioenergy contributes to improved livelihoods and can reduce land degradation and impacts on ecosystem services.[ap] According to the IPCC, there is strong evidence that modern bioenergy has "big positive impacts" on air quality. [75] When burned in industrial facilities, most pollutants from woody biomass are reduced by 97-99% compared to open burning. [76] A study of the giant brown brush that periodically covers large areas in South Asia found that two-thirds of it had been produced primarily by residential cooking and agricultural burning, and one-third by burning fossil fuels. [77] Consequences of Low Density of Surface Energy Production While bioenergy is often agreed to have a net impact on global greenhouse gas emissions, increasing demand for biomass can create significant social and environmental pressure at the locations where biomass is produced. [78][79] The impact is mainly with the low surface energy density of the biomass (see below). The low surface energy density has the effect that much larger areas of land are needed to produce the same amount of energy, compared to for example fossil fuels. In some cases, large areas of natural forests have been recorded(e.g., in Romania[80] and Siberia[81]), and the remaining forest has been burned to cover illegal operations. [82] Feasibility assessments to replace coal in German power plants with biomass of shrub harvested in Namibia, which undergoes the invasion of bushes in more than 30 million hectares, have caused protests from environmental organizations. The organizations argue that trees and bushes store carbon, and that burning releases more CO2 in front of the burning coal. [83] Namibian researchers argue that the invasion of bushes causes lower income for farmers, lower biodiversity, lower groundwater levels and wildlife displacement. [84] Protests against forest exports for biomass also happened in Sweden[85] and Canada.[86] In Mississippi, a company that produces wood pellets for UK power plants was fined $2.5m for excessive contamination of volatile organic compounds for several years. [87] The long-distance transport of biomass has been criticized as waste and unsustainable. [88] Biomass surface energy production densities compared to other renewables In calculating land use requirements for different types of energy production, it is essential to know the relevant surface energy production densities. Vaclav Smil estimates that the average energy densities of the life cycle surface for the production of biomass, wind, hydro and solar energy are 0.30 W/m2, 1 W/m2, 3 W/m2 and 5 W/m2, respectively (power in the form of heat for biomass, and electricity for wind, hydro and solar). [89] The surface density of the life cycle includes the land used by all supporting infrastructures, manufacturing, mining/arming and dismantling. Van Zalk et al. Estimates 0.08 W/m2 for biomass, 0.14 W/m2 for hydro, 1.84 W/m2 for wind, and 6.63 W/m2 for energy (average values, excluding any renewables, exceeding 10 W/m2). Fossil gas has the highest surface density at 482 W/m2 while nuclear power at 240 W/m2 is the only high-density, low-carbon energy source. [90] The average human energy consumption on ice-free land is W/m2 (combined heat and electricity),[91] although it increases to 20 W/m2 in urban and industrial areas.[92] Plants with low yields have lower surface power density compared to plants with high yields. In addition, when plants are used only partially, surface density falls even further. This is the case with the production of liquid fuels. For example, ethanol is often manufactured from the sugar content of cane or corn starch, while biodiesel is manufactured from the content of cabbage and soy oil. Smil estimates the following densities for liquid fuels: U.S. wheat fields Etanol Winter Trigo (USA) 0.08 W/m2 [93] Maize 0.26 W/m2 (network 10 t/ha) [94] Trigo (Germany) 0.30 W/m2 [93] Miscanthus x gigantic 0.40 W/m2 (reignment 15 t/ha) [95] Sugar crank 0.50 W/m2 (wet 80 t/ha yield) [96] Fuel for Reaction planes Soja 0.06 W/m2 [96] Jatrofa (small land) 0.20 W/m2 [96] Palm oil 0.65 W/m2 [96] Bidden cabbage seed 0.12 W/m2 (middle of the EU) [97] Colza seed [98] Eucalyptus Planning in India. Solid biomass combustion is more energy efficient than liquid combustion, as the whole plant is used. For example, maize plantations that produce solid biomass for combustion generate more than double energy per square metre compared to corn plantations that produce ethanol, when yield is the same: 10 t/ha generate 0.60 W/m2 and 0.26 W/m2 respectively.[99] The dry biomass of the oven in general, including wood, miscanthus[100] and napier[101] herb, has a calorie content of approximately 18 GJ/t.[102] When calculating the production of energy per square meter, each t/ha of production of dry biomass increases the production of energy ofplanting at 0.06 W/m2.[aq] As a result, Smil estimates the following: Large-scale plantations with pines, acacias, poplars and willows in temperate regions 0.30 «0.90 W/m2 (reference 5 «15 t/ha) [103] Large plantations of eucalyptus, acacia, leucaena, pinus and dalbergia in enand subtropical regions 1.20 "1.50 W/m2 (yield 20, 25 t/ha) [103] In Brazil, the average yield for eucalyptus is 21 t/ha (1.26 W/m2), but in Africa, India and Southeast Asia, the typical eucalyptus yields are below 10 t/ha (0.6 w / m2). [104] FAO (United Nations Agriculture and Agriculture Organization of the United Nations) estimates that yields from forest plantations range from 1 to 25 m3 per hectare per year globally, equivalent to 0.02 "0.7 W/m2 (0.4-2.2 t/ha): [ar] Pine (Russia) 0.0 "0.1 w / m2 (0.4-w/m2 (0.4- 2 t/ha or 1.5 m3) [AR] Eucalyptus (Argentina, Brazil, Chile and Uruguay) 0.5 â¬" 0.7 W/m2 (7.8-12.2 t/ha or 25 m3) [AR] Alamo (France, Italy) 0.2 "0.5 w/m2 (2.7-4" 8.4 t/ha or 25 m3) [ar] Smil Estimates that Natural temperate mixed forests produce on average 1.5, 2 dry tons per hectare (2, 2.5 m3, equivalent to 0.1 w/m2), ranging from 0.9 m3 in Greece to 6 m3 in France). [105] IPCC provides annual average biomass growth data for natural forests globally. Net growth varies between 0.1 and 9.3 dry tons per hectare per year, with most natural forests producing between 1 and 4 tons, and with the global average at 2.3 tons. The average net growth for plantation forests varies between 0.4 and 25 tons, and most plantations producing between 5 and 15 tons, and with the global average at 9.1 tons. [106] As mentioned above, Smil estimates that the global average for wind, hydro and solar power generation is 1 w/m2, 3 w/m2 and 5 w/m2 respectively. To match these surface power densities, plantation yields must reach 17 t/ha, 50 t/ha and 83 t/ha for wind, hydroelectric and solar respectively. This seems achievable for tropical plantations previously (rendement 20, 25 t/ha) and for elephant pastures, for example. Miscanthus (10, 40 t / ha), and Napier (15, 80 t / ha), but unlikely for forests and many other types of biomass crops. To match the global average for biofuels (0.3 w/m2), plantations must produce 5 tons of dry mass per hectare per year. When instead, using Van Zalk estimates to stopEOLIC AND SOLAR (0.14, 1.84 and 6.63 W / M2 respectively), plantation yields should reach 2 T / ha, 31 t / ha and 111 t / ha to compete. However, only the first two of those yields seem achievable. The yields must be adjusted to compensate for the amount of humidity in biomass (high humidity to reach the ignition point is generally wasted power). The moisture of the biomass straw or the balloons varies with the humidity of the surrounding air and eventual measures of present, while the pellets have a standardized moisture content (defined by ISO) less than 10% (wooden pellets) [as] and less than 15% (other pellets). [AT] Also, for wind, hydro and solar, the transmission loans of the energy line amount to approximately 8% worldwide and must be accounted for. [AU] China 346 EspaÃ ± a 9 378 Spain 9 9 378 China 9 418 China 9 320 España VÃ © Renewable Energy Biofuels Biogas Geothermal Hydroelectric Power Tide Power Wave Energy Wind energy Country thematics Marketing and Policy Trends vte Renewable Energy Portal Energy Ecology Biochar Biofacto (biology) Biomass (ecology) Gasification Biomass heating system Biomass to liquid Bioproducts Biorefinement European Association of Biomass Carbon dioxide Although these developments are remarkable, they also stand out what remains the most important source of renewable energy today – bioenergy." IEA 2017a. ^ "Bioenergy is the main source of renewable energy today. IEA modeling also indicates that modern bioenergy is an essential component of the future global low-carbon energy system if global climate change commitments are to be met, playing a particularly important role in assisting in decarbonizing sectors such as aviation, maritime transport and long-distance road transport. However, the current rate of bioenergy deployment is far below the required levels in low-carbon scenarios. An accelerated deployment is urgently needed to increase the contribution of sustainable bioenergy in all sectors, particularly in the transport sector where consumption is required to triple in 2030." The estimates are for the "medial house" considered (case 2a); a pellet mill that uses wood for heat processing, but source the electricity of the network. Estimates (for pellets based on forest waste) reduce to 50-58% when usedfossils for heat processing (case 1,) but increase to 84-92% when the electricity comes from a chp biomass power plant (case 3a.) see EUR-Lex 2018, p. annex vi. ^ " Reduction of the gei emissions of wood-pellets wood-pelletsIn comparison with the electricity of the EU's phonuses network are 71% (for small residues of round wood and harvest), 69% (for commercial weight loss) or 65% (for mill residues), such as It is shown in more detail in Fig. S3. The GHG reduction percentage of wood-pellets of mill residues was [...] 75%. "Hanssen et al., 2017, Pags 1415 to 1416. ^ ASE EPA 2020, PE. 1. The emission factors are based on the highest heating value (HHV) of the different fuels. The HHV value reflects the actual chemical energy stored in the fuel, without taking into account the content of Humidity. The smallest of fuel heating (LHV) is the energy that remains after which the necessary amount of energy has been spent to vaporize the moisture of the fuel (so that the fuel can reach the ignition point). ^ See Futuremetrics 2015A, p. 1-2. CHATHAM HOUSE Notes that modern ChP plants (combined Heat and power) achieve much higher efficiencies, above 80%, both for folossile fuels and for biomass. Chatham House 2017 , p. 16. ^ Individual emission rates are: Wood 112 000 kg CO2EQ per TJ, ANT Racita 98 300, 94 600 cooking carbon, another 94 600 bituminous, sub-bituminous 96 100, Ignífugo 101 000. IPCC 2006a, Pags. 2.16 to 22.17. ^ «Productivity trends shown by several remote control studies (see the previous section) are greatly compatible with the mapping of the forest cover and the change using a series of satellite data of thick resolution of 34 years OS (NOAA AVHRR) (Song et al., 2018). This study, based on a theme classification of satellite data, suggests that (i) global coverage of Canopy of trees increased by 2.24 million km2 between 1982 and 2016 (corresponding to + 7.1%) but with regional differences that contribute to a net loss in tropics and a net profit in higher, and (ii) bare soil fraction decreased by 1.16 million km2 (decorating at 3.1%), mainly in Asia. Other datasets of tree or land cover show opposing global net trends (Li et al. 2018b), but highIn terms of net loss in tropics and large net profits in temperate and boreal areas (Li et al., 2018, Song et al., 2018, Hansen et al., 2013). »IPCC 2019A, p. 367. ^ Stephenson et al. Continue: Â «Second, our findings are equally compatible with the well-known reduction of productivity related to the scale of forest posts even aging. We highlight the fact that the increase in the rate of individual growth does not automatically produce an increase in the productivity of the supports because the mortality of the trees can promote the reduction of the density of population That is, although the large trees in the larger supports, even aged can be growing more quickly, such stands have less trees. The dynamics of the wooded population, especially mortality, can be an important contributor to the decrease in productivity at the scale of forest base. Stephenson et al. 2014, p. 92. ^ According to FAO, the roof of trees in Australia is increasing, but the stored carbon is only provided for oceania as a whole. FAO 2020, p. 136. ^ Wood chips, used mainly in the paper industry, have similar data; Europe (including Russia) produced 33% and Northern America 22%, while forest carbon increased in both areas. In Western, Central and Eastern Asia, 18% occurred, and forest carbon in these areas increased from 31.3 to 43.3 GT. The production of wood shavings in the areas of the world were the stored carbon is decreasing, it was 26.9% in 2019. For the production data of wood pellets and wooden chips, see FAOSTAT 2020. For data on carbon stocks, see FAO 2020, pâ €. 52, Table 43. «The potentially very long reimbursement periods for forest biomass pose important issues given the aspiration of the UNFCCC to limit heating to Â ° C above the pre-industrial levels for â € significantly the risks and impacts of climate change â €. As for the current trends, this can be exceeded by approximately one dÃ © each. Taking advantage of the forest biomass for the EU renewable energy, with its initial increase associated in the levels of atmospheric carbon dixtion, the risk of The goal of 1.5 ° c if the refund periods are longer than this. The European Commission should consider the extent to which the use of large-scale forest biomass energy is compatible with the WCUCC objectives and whether a maximum recovery period permission must be established in its sustainability criteria. Â »EASAC 2017, P. 34.« Some have argued that the length of the carbon recovery period does not matter whenever all emissions are finally absorbed. This ignores the potential impact on the short term at the points of the climate tips (a concept for which there is some evidence) and the world's ability to fulfill the objective established in the 2015 Paris Agreement to limit the increase of The temperature at 1.5 ° C above the pre-industrial levels, which require greenhouse gas emissions to the maximum in the short term. This suggests that only the energy of the biomass with the most short carbon recovery periods should be eligible for financial and regulatory support. Â »EASAC 2017, Q., 4.« In many places, the residues of sawmills of structural-timber production are abundant and supply a large part of the raw material needed to produce wood pellets. In other places, there are not enough residue of sawmill. In those places, pellet mills, like pulp factories, use the non-Sawlog portions of the tree. Â »Futuremetrics 2017, P. ^« The collection immediately reduces carbon stock of foot forests compared with less (or not) harvest (Bellassen and Luyssaert, 2014; SievÃ¤nen et al., 2014) and It can delay from decades to centuries until the rerecimiento restores carbon stock at its previous level, especially if the Oldgrowth forests are harvested. Â »EASAC 2017, P. 21. Â ©« Following this argument, carbon dixture (and other greenhouse gases) released by burning biomass for energy, together with its associated life cycle emissions, creates what is called a "cannon debt". â˜¢ â˜¢, i.e. the additional emissions caused by biomass burn instead of the fossil fuels it replaces, plus the absorption of emissions lost from the of forests. Over time, the reef of the harvested forest eliminates this carbon from the atmosphere, reducing carbon debt. The period until carbon parity is achieved (that is, the point where cumulative net emissions of biomass use are equivalent to those of a fossil fuel plant that generate the same amount of energy) is generally referred to as the "period of Cannon Reward ". After this point, as the replenishment continues, the biomass may begin to produce "carbon dividends" in the form of higher atmospheric greenhouse gase levels of what would have happened if they had been used Fuel fuel. Eventually, carbon levels in the forest return to the level where they would have been left without ahead. (Some of the literature use the term "Canbon reward period" to describe this longer period, but is used more commonly to mean time for parity with fossil fuels; this meaning is used in this document). Â »Chatham House 2017, P. 27. Â« There is no such thing as a carbon debt if the carbon stock that is maintained in the forest [is] not reduced. "Futuremetrics 2017, P. ^ Â« It has eager that carbon balances should not be evaluated at the support level, since at the level of carbon carbon level in a stand can be compensated by growth in a stand elsewhere. For scientific analysis of the Impact on the climate change, however, it is necessary to compare the effects of several bioenergy harvest options against a baseline of the bioenergy harvest (or other counterpart scenarios) for the same forest area. Said studies They provide information on the impacts of changes at the support level, which can then be integrated with other factors (economic, regulators and social) that can influence effects at the level of »EASAC 2017, P. 23. ^« It is important to realize that our CHP plant of 3650 tons per year does not receive 3650 tons in a delivery and does not release 3650 tons of wood carbon in a package. In fact, the forest products industry can beas a manufacturing system just in time. For our cogeneration plant, 10 daily tons are harvested in a sustainable manner and delivered from our FSC certified FSC or SFI of 3650 acres. So the carbon released to the atmosphere that day comes from 10 tons of wood. The atmosphere â € œyeâ »new carbon. But that same day, in our 3650-acre plot, 10 new tons of wood grow and hijack the amount of carbon that is just released from .futuremetrics 2011b, p. 2. «The forests are generally managed as a series of standards of different ages, harvested at different times, to produce a constant supply of wood products. When considered a plot level, long rotation forests take many years to grow again after harvesting, and the statement of EASAC indicates that this is a time lapse between forest carbon liberation and Your reabsorption of the atmosphere. However, throughout the forest farm or landscape, temporary fluctuations are balanced since other stands continue to grow and hijacking carbon, causing the time interval less relevant as EASAC indicates. If the annual harvest does not exceed the annual growth of the forest, there is no net reduction in forest carbon ". IEA Bioenergy 2019: «The use of forest biomass for climate change mitigation: response to Easac» IEA bioenergy declarations, p. 2. «The natural disturbance component is subtracted from the total estimation of emissions and removals. Ã, Â »VÃ © ASE IPCC 2019J, P., 2.72. Ã, 'The 2006 IPCC guidelines are designed to help estimate and notify national emission inventories and anthropogenous absorptions of greenhouse gases. For the Afolu sector, anthropogenic emissions and absorption by greenhouse gases sinks are defined as all those that occur in «managed land. are those in which human interventions and practices have been applied to perform productive, ecological or social functions. [...] This approach, i.e., the use of land managed as For anthropogenic effects, it was adopted in the GPG "LULUCF" and maintained in the present guidelines. The fundamental reason for this approach is that the predominance of anthropogenic effects occurs in managed lands. By definition, all direct human effects on greenhouse gas emissions and removals are produced only on managed lands. While it is recognized that no area on Earth ' s surface is entirely free from human influence (e.g., fertilization by CO2), many indirect human influences on greenhouse gases (e.g., greater deposition of N, accidental fires) will predominantly manifest in managed lands, where human activities are concentrated. Finally, although local and short-term variability of emissions and removals due to natural causes can be considerable (e.g., fire emissions, see note 1), the natural "context" of greenhouse gas emissions and removals by sinks tends to average over time and space. This makes emissions and removals of greenhouse gases from managed lands the predominant result of human activity. Guidelines and methods for estimating greenhouse gas emissions and removals for the AFOLU sector now include: â¢ CO2 emissions and removals resulting from changes in biomass, dead organic matter and mineral soil reserves, for all managed land; â¢ CO2 emissions and non-CO2 emissions from fires in all managed land; â¢ N2O emissions from cropsfor the methodological development of CH4 emissions from land flooded in an Application 3); Ã ¢ Ã emissions from CH4 from livestock (enterprise fermentation); â € ¢ Emissions of CH4 and N2O from the management systems of the Estión; and â € ¢ Variation of C stock associated with wood products. VÃ © ASE IPCC 2006B, p. 1.5 ^ «For example, limit the deployment of a mitigation mitigation response either lead to increased climate change or additional mitigation in other sectors. Several studies have examined the limitation of bioenergy and BECCs. Some of these studies show higher emissions (Reilly et al. 2012). Other studies meet the same climate objective, but reduce emissions elsewhere by reducing energy demand (Grubler et al. 2018; Van Vuuren et al. 2018), increasing fossil carbon capture and storage (CCS), nuclear power, energy efficiency and/or renewable energy (Van Vuuren et al. 2018; Rose et al. 2014; Calvin et al. 2014; Van Vuurenerg et al. The studies have also examined the limitations of RDCs, including reforestation, forestry and bioenergy and BECCS (Kriegler et al. 2018a,b). These studies find that limiting RDC may increase mitigation costs, increase food prices, and even prevent limiting warming to less than 1.5Â°C above pre-industrial levels (Kriegler et al. 2018a,b; Muratori et al. 2016).Â" IPCC 2019e, p. 638. ^ "Bioenergy has an essential and important role to play in a low-carbon energy system. For example, modern bioenergy in global final energy consumption is expected to increase fourfold by 2060 under the 2Â°C scenario of the IEA (2DS), which seeks to limit global average temperatures from rising more than 2Â°C by 2100 to avoid some of the worst effects of climate change. It plays a particularly important role in the transport sector, where it helps to decarbonise long-distance transport (aircraft, sea freight and long-distance), with a tenfold increase in final energy demand from 3 EJ today to almost 30 EJ. Bioenergy is responsible for almost 20% of the additional carbon savings needed in 2DS compared to an emissions trajectory based on existing satisfaction andPolitics But the current deployment rate of Bioenergy is well below these 2DS levels. In the transport sector, the consumption of biofuels must triple from here to 2030, and two thirds of that consumption must come from advanced biofuels. That means increasing the current production of advanced biofuels at least 50 times to keep the pace of 2DS requirements for 2030. In scenarios with more ambitious carbon reduction targets, such as the latter scenario of the 2 degree (B2DS) of the AIE, the bioenergy linked to the capture and storage of carbon is also necessary. [...] The roadmap also signals the need to multiply the sustainable supply of bioenergistic raw materials, much of which can be obtained by mobilizing the potential for waste and waste. "IEA 2017A . ^ «In some cases, bioenergy from specific crops is responsible for GHG emissions resulting from the indirect change of land use (ILUC), that is, bioenergy activity can lead to the displacement of agricultural activities or Forest to other places, driven by effects mediated by the market. Other mitigation options can also cause ILUC. Worldwide, indirect effects are not relevant because all emissions from land use are direct. ILUC emissions can be more important for crushing raw materials, such as corn, wheat and soybeans, which for advanced biofuels derived from lignocellulous materials (Chum et al., 2011, Wicke et al., 2012 ; Valin et al., 2015; Ahlgren and Di Lucia, 2014). The estimates of ILUC emissions are intrinsically uncertain, widely debated in the scientific community and depend to a large extent on modeling hypothesis, such as the elasticities of supply and demand, productivity estimates, the incorporation or exclusion of the scale of biofuel deployment (Rajagopal and Plevin 2013; Finkbeiner 2014; Kim et al., 2014; 2014; Zilberman, 2017). In some cases, the effects of iLUC are estimated to result in emission reductions. For example, the effects mediated by the bioenergy market in North America showed the potential for increasing carbon stocks Conversion of pastos o tierra marginal a Forestland (Cintas et al. 2017; Duden et al. 2017; Dale et al. 2017; Baker et al. 2019). There is a wide range of variability in ILUC values for different types of biofuels, from "75" 55 Gco2 MJ, 1 (Ahlgren and Di Lucia 2014; Valin et al. 2015; Plevin et al. 2015; Taheripour and Tyner 2013; Bento and Klotz 2014). There is low confidence in the attribution of ILUC emissions to bioenergy. Â"IPCC 2019i, p. 194. ^"The environmental costs and benefits of bioenergy have been the subject of significant debate, particularly for first generation biofuels produced from food. (e.g. grain and oil seeds). Studies have reported life-cycle GHG savings ranging from an 86% reduction to a 93% increase in GHG emissions compared to fossil fuels (SexBer et al., 2008; Davis et al., 2009; Liska et al., 2009; Whitaker et al., 2010). In addition, concerns have been raised that N2O emissions from biofuel feedstock cultivation may have been underestimated (Crutzen et al., 2008; Smith & Sexinger, 2012) and that expansion The cultivation of feedstock on agricultural land may displace food production on land with high carbon actions. carbon or high conservation value (i.e., ILUC) that creates a carbon debt that could take decades to pay (Fargione et al., 2008). Other studies have shown that direct nitrogen â¬ E Related The missions of crop annual raw materials can be mitigated through optimized management practices (Davis et al., 2013) or that recovery times are less significant than proposed (Mello et al., 2014). However, there are still significant concerns about the impacts of ILUC, despite the development of policies aimed at reducing the risk of ILUC occurring. (Ahlgren & Di Lucia, Del Grosso et al., 2014). "Whitaker et al. 2018, p. 151. ^ "The impact of the growing bioenergy and the cultivation of biofuels raw materials has been of particular concern, with some suggesting that the balance of greenhouse gases (GHG) of the food crops used for ethanol and biodiesel are not better or yr orthan fossil fuels (Fargione et al., 2008; Searchinger et al., 2008). This is controversial, as the allocation of GHG emissions to the management and use of co-products can have a great effect on the total carbon footprint of the resulting bioenergy products (Whitaker et al., 2010; Davis et al., 2013). The possible consequences of the change in land use (CUTS) for bioenergy in GHG balance through the displacement of food crops or the "indirect" change of land use (CUTS) are also an important consideration (Searchinger et al., 2008). Milner et al. 2016, pp. 317â»318. ↑ "While the initial premise with respect to bioenergy was that the recently captured carbon of the atmosphere in plants would produce an immediate reduction in GHG emissions from fossil fuel use, the reality proved to be less simple. Studies suggest that GHG emissions from energy crop production and land-use change could exceed any CO2 mitigation (Searchinger et al., 2008; Lange, 2011). The production of nitrous oxide (N2O), with its powerful atmospheric heating potential (PCA), could be an important factor in offsetting CO2 gains (Crutzen et al., 2008), as well as the possible acidification and eutrofization of the surrounding environment (Kim and Dale, 2005). However, not all biomass raw materials are the same, and most critical bioenergy production studies refer to biofuels produced from annual food crops at a high cost of fertilizers, sometimes using lands detached from natural ecosystems or in direct competition with food production (Naik et al., 2010). Perennial dedicated energy crops, produced in lower-quality existing agricultural land, offer a sustainable alternative with significant emissions savingsGreenhouse gases and carbon sequestration in the soil when they occur with proper management (Crutzen et al., 2008; Hastings et al., 2008, 2012; Cherubini et al., 2009; Dondini et al., 2009a; Don et al., 2012; Zatta et al., 2014; Richter et al., 2010 al., 2015). McCalmont et al. 2017, p. 490. ↑ "There have been significant reductions in GHG emissionsIn many ACV studies in a range of bioenergy technologies and scales (Thornley et al., 2009, 2015). The most important reductions have been observed in cases of heating and electricity. However, other studies (especially on transport fuels) have indicated otherwise, that is, bioenergy systems can increase GHG emissions (Smith & Searchinger, 2012) or not reach gei-saving thresholds every time It's strict. There are several factors that drive this variability in calculated savings, but we know that when no significant reductions are achieved or is informed of a broad variability, there is often uncertainty in data or variations in the ACV methodology applied (Rowe et al. 2011). For example, it has been shown that the uncertainty of data on changes in soil carbon reserves after land use significantly influences GHG intensity of biofuels production routes (Figure 3), while the Impact of radiing forced to the shorter of the black carbon particles from the biomass and biofuels combustible also represents a significant uncertainty of the data (Bond et al. (Bond, 2013). Â »Whitaker ET AL. 2018, pp. 156Â i157. Â † 'The soil carbon reserves are a balance between the decomposition rate of the organic matter and the contribution of organic matter each year by vegetation, animal estate or any other organic contribution. , can result in short-term organic carbon carbon loss, decomposed or by stimulated populations of soil microbes (Cheng, 2009; Kuzyakov, 2010). The annual disturbance of herbal crops is repeated after year, which results in a reduction in SOC levels. Perennial agricultural systems, like The They have time to replace their rare lusts due to disturbances that can lead to higher carbon content on the steady state (Gelfand et al., 2011, Zenone et al., 2013). »McCalmont et al. 2017, p., 493. â † «Tillage breaks the aggregates of the soil that, among other functions, is believed to inhibit soil bacteria, fungi and other others to consume and decompose SOM (Grandy and Neff 2008). The aggregates reduce microbial access to organic matter by restricting physical access to organic compounds stabilized in minerals, as well as reducing the availability of oxygen (Cotrufo et al. 2015; Lehmann and Kleber 2015). When the aggregates of the soil break with the farm in the conversion of native ecosystems to agriculture, the microbial consumption of SOC and the subsequent CO2 breathing increase dramatically, reducing soil carbon stocks (Grandy and Robertson 2006; Grandy and Neff 2008). IPCC 2019a, p. 393. ↑ « A systematic review and meta-analysis was used to assess the current state of knowledge and quantify the effects of land-use change (CUTS) to the second generation (2G), non-food bioenergy crops on organic soil carbon emissions (SOC) and greenhouse gases (GHGs) relevant to temperate agriculture. After the analysis of 138 original studies, the transitions of herbaceous crops to short crops (SRC, alamo or willows) or perennial pastures (mainly Miscanthus or alternating herb) resulted in an increase of the SOC (+5,0± 7.8% and +25.7 ± 6.7% respectively). Harris, Spake & Taylor 2015, p. 27. ^ Only three crop comparisons showed lower SOC reserves in Miscanthus, and these suggested insignificant losses between 0.1 and 0.26 Mg haã¯1 yearã¯1.» McCalmont et al. 2017, p. 493. ↑ «The correlation between the age of plantation and the SOC can be seen in Fig. 6, [...] the trend line suggests a net accumulation rate of 1.84 Mg C haãÂ1 year. with levelsto those of pastures in equilibrium. "McCalmont et al. 2017, p.E, 496. â † 'Given the maximum average performance of the EU of 22 tons of dry matter per hectare to year (approximately 15 tons during the spring harvest). VÃ © Aerson and others, 2014, Pg. 79). 15 15. It is also explicitly cited as the average performance of spring in German, see felten & emmerling 2012, P.Ã 662. 48% carbon content; see kahle et al. 2001, table 3, page 176. ^ "our work shows that the establishment of crops, performance and collection method affect the c. cost of solid miscanto fuel that for the collection of bullets is 0.4 g of co2 eq. c mjã'1 for the establishment of the rhizome and 0.74 g co2 eq. c mjã'1 for the establishment of the seed plug. if the harvested biomass is sworn and accumulated, then emissions increase to 1.2 and 1.6 g of co2 eq. c mjã'1, respectively. the requirements of energy for the collection and the shipyard. from this study that were used to estimate gei emissions are in line with the findings of meehan et al. (2013.) these estimates of gei emissions for the fuel of mycatos themselves confirm the findings of other life cycle evaluation studies (lca) (e.g., styles and jones, 2008) and spatial estimates of gei savings using fuel in mythese mycatos (hastenne). and soil tillage over 20 ye ar cycle of life that annual crops (heaton et al. 2004, 2008; Clifton-Brown et al. 2008; gelfand et al. 2013; mccalmont et al. 2015a; milner et al., 2015. in this analysis, we do not consider the gei flow of the soil, which was shown to kidnap on average in the united kingdom, 0.5 g of c per mj de mccalmont et al. (2015a). changes in soc resulting from miscantho cultivation depend on the previous use of the soil and the associated soc. if high carbon soils such as peatland, permanent grasslands, and mature forests are avoided, and only grasslands and rotational with mineral soil are used for miscanthus, the average increase of SOC for the first rotation of 20-year crops in the United Kingdom is 1⁄4 1- 1.4 mg C haã'1 yã'1 (Milner et al., 2015). Despite ignoring this additional benefit, these cost estimates of GHGGVery favourably with coal (33 g CO2 eq. C MJÃ€â¬1), northern marine gas (16), liquefied natural gas (22) and wood chips imported from the United States (4). In addition, although the cost of producing Miscanthus C. is only

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