REPORT ON THE SYMPOSIUM 'BIOFUEL AND WOOD AS ENERGY SOURCES'

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'Biofuel is a hot potato,' comments Hans Clevers, president of the Royal Netherlands Academy of Arts and Sciences (KNAW), as he gives the opening address to the symposium on 'Biofuel and Wood as Energy Sources'. It is 10 April 2015 and the Tinbergen Room in The Trippenhuis in Amsterdam is filled to capacity. Some 200 scientists, students, representatives of industry and the service sector, NGOs, officials, ordinary members of the public, journalists and some policymakers are assembled to debate the advantages and disadvantages of biomass as an energy source. The reason is the KNAW position paper entitled 'Biofuel and wood as energy sources' that was published January 2015, which has provoked a real media storm.

Fundamental misconception

According to the three authors of the position paper, Academy members Martijn Katan, Louise Vet and Rudy Rabbinge, the Dutch and European rules on co-firing biomass are based on a fundamental misconception. The subsidised co-firing of wood does not lead to innovation and it is by no means certain that it helps to reduce CO_2 emissions. Meanwhile, the Dutch government will pay energy companies the difference in price between wood and coal during the next eight years. This will cost three billion euro of taxpayers' money. Almost 2,000 square kilometres of forest – mainly in Canada and the United States – will be cut down for this, resulting in a loss of biodiversity. According to the authors, the production of bio-ethanol and biodiesel for various forms of transport is not sensible either, as cars and aircrafts burn fuel much faster than plants can grow. What is more, biofuels displace food crops, with the result that natural land has to be cultivated for growing food, referred to in scientific jargon as indirect Land Use Changes, or iLUC. Cultivating marshland causes the release of methane, a powerful greenhouse gas. In addition, the cultivation, transport and processing of biofuels themselves also require a lot of fertiliser, pesticides and water, which means that part of any gain in terms of sustainability is lost again. And, finally, the three Academy members wrote that the firing of biomass prevents other, more valuable applications of biomass such as its use as a green oil in the production of chemicals or plastics.

Lack of subtlety

The position paper has generated a lot of reaction. The media were full of comments such as 'kindergarten level', 'total lack of subtlety' and an 'activist pamphlet, far below KNAW's standards'. The authors were accused of cherry-picking among hundreds of scientific publications and ignoring new developments in this area. The three scientists, who had published their position paper the day before the debate in the

Dutch parliament on the Netherlands Energy Agreement for Sustainable Growth, were accused of being politically motivated. It was said that their publication could reduce or even bring to an end, investments in biofuel research. But there was also praise: 'A clear scientific analysis which sets out both economic and ecological consequences'. 'It's good that the Academy has put this issue on the agenda. Better late than never!'

Being impartial

'As the Academy, we are the voice, the forum and the conscience of the scientific community', continues KNAW president Clevers. 'Every year we publish about six weighty detailed reports. But, in addition, we will more frequently be publishing shorter position papers on current issues, to ensure that the voice of science can be heard more clearly in public debate.' The Academy has a statutory role as a government adviser on complex social issues which are the subject of scientific debate. 'But we are always impartial', explaines Clevers. 'We maintain a strict scientific perspective in all our position papers and follow a thorough 'peer review' process.' Clevers points out that the position paper was a follow-up of the advisory report 'Current status of biofuels in the European Union', published in 2012 by the European Academies' Science Advisory Council (EASAC), which is formed by the national science academies of the EU Member States. He wishes those present a productive debate.

As a warm-up act, chair Stefan Wijers askes the symposium audience to write down on Post-It notes what they regard as the biggest misconceptions of proponents and opponents of the co-firing of wood in power stations. The upshot was that proponents were thought to be ignoring global dynamics, opting for short-term solutions, claiming that this was sustainable and driven by the profit motive. On the other hand, opponents were said to have too much faith in alternative solutions, to exaggerate the extent of the disappearance of the forests and indirect land use changes, to be blocking further innovation and to have little conception of the urgent need to mitigate the consequences of burning fossil fuels. A full overview of the collected misconceptions can be found at the symposium website: www.knaw.nl/biofuel.

Taking up a lot of space

Guest speaker David MacKay immediately caught the attention of his audience. The well-known British physicist's first simple calculation concerned EU transport policy, which envisages an increasing use of biofuel. What would that look like in practice, if the biofuels were grown on the verge of the road? MacKay imagines a dual carriageway on which all the cars are driving at 100 kilometres per hour, maintaining a distance of 80 metres between them. The fuel consumption of modern European cars is about 8 litres per 100 km and a field of rapeseed produces on average 1,200 litres of biofuel per hectare per annum. According to MacKay's figures, the verges would have to be eight kilometres wide to supply the biofuel to run all the cars. 'This doesn't mean that biofuel is bad. But maybe European policymakers should be more aware of physical reality'.

MacKay is Regius Professor of Engineering at the University of Cambridge and was for five years the UK government's Chief Scientific Advisor to the Department of Energy and Climate Change. In 2008 he wrote the successful book 'Sustainable Energy - without the hot air', which can be downloaded free from the internet (www.withouthotair.com), in which he explains scientific discussions over zero-carbon energy for a wider audience. 'As a physicist, I love to do calculations on the back of an envelope, because they can give such clear insights', says MacKay. 'My book is full of these calculations.' He worked with a team at the Department of Energy and Climate Change that published an open-source energy calculator for the UK (http://2050-calculator-tool.decc.gov.uk) which allows the user to explore the trade-offs between different ways of using and supplying energy, so the user can choose 'a plan that adds up'. This UK calculator was followed by similar calculators for a further twenty countries and there is now a global calculator (www.globalcalculator.org) as well. These tools are extremely enlightening and help to fathom out the energy problem.

Global increase in energy demand

It is an interesting exercise to calculate energy consumption by unit area. MacKay calculates this by multiplying the energy consumption per person by the number of inhabitants per square kilometre. The resulting picture varies widely. The Netherlands stands out as a densely populated country with high energy consumption, about 2.5 watts per square metre. The energy consumption in the United Kingdom is about 1.25 watts per square metre. An increasing number of countries will follow this Western pattern as prosperity levels rise around the world. These power consumptions per unit can be compared with the power production per unit area of various renewables. Energy crops produce, on average, 0.5 watts per square metre. If the United Kingdom wanted to meet all of its current primary energy consumption by using biofuels, it would need 2.5 times its own land area to cultivate the crops.

Wind energy is slightly more space efficient, with wind farms producing an average of 2.5 W/m^2. Solar panels produce about 20 W/m^2 on average, but (thanks to the space between panels), solar parks produce less: solar parks in northern Europe produce about 5 W/m^2, solar panels in sunnier countries produce about 10 W/m^2 and concentrating solar power plants in the desert could produce some 15-20 W/m^2. Hydroelectric power generates about 0.05 W/m^2 in Scotland. Renewable energy sources generally are diffuse, and therefore one must expect any energy plan that generates significant power from renewables, to take up a large amount of space. Nuclear energy in contrast, generates about 1,000 W/m^2, but it has different drawbacks. Another constraint to remember when building an energy plan that adds up, is that supply and demand must be in balance at all times of the day, all year round. It is not only the supply of solar and wind energy that can fluctuate wildly, the demand for energy is constantly changing as well.

Energy efficiency

'Many people are wrong about energy efficiency and the scale of the measures needed for renewable energy sources to really make a difference in the fight against climate change', MacKay continues. 'If we want to get rid of fossil fuels, we have to keep all our other options open. If you reject one option, you will have to pull harder on the other levers. Leaving aside the supply side of energy, a lot can also be done to limit consumption. A bike consumes 80 times less energy than a car. Other examples include lightweight, low-energy, aerodynamic, efficient vehicles, improved home insulation, heat pumps and other new technologies. Allowing people to gain an insight into their own energy consumption has a major impact. Smart meters with attractive displays can have a major impact. Read your meters, it will change your life!'

Energy calculator

In 2011, MacKay and his colleagues used the UK Energy Calculator 2050 to devise an overall strategic plan for UK energy policy, consistent with the UK's legal target to reduce greenhouse gases by 80% by 2050, compared with 1990 levels. The British government is legally required to evaluate how this reduction policy is progressing every five years and to state what it plans to do to achieve the objectives. The approach adopted by the UK was to electrify as much of its energy supply as possible over the next few years and then to generate as much of this electricity as possible using low-carbon methods. How did biomass fit into this policy? Until now, three-quarters of the country's energy system was not electrified and some sectors of the economy – such as transport – were simply hard to electrify. Biomass could play an important part in these sectors. But in view of the large amount of space required by energy crops, bio-energy has only been given a role as a scarce resource if no good alternatives were available, e.g. for freight traffic, air transport, shipping and some energy sectors which are hard to electrify. However, it was decided not to burn trees in power stations, except perhaps in Carbon Capture and Storage (CCS) plants, using wood from sustainably managed forests, in order to remove CO_2 from the atmosphere. In principle, biomass will cease to be used for heating purposes in the long term.

Cumulative emissions

MacKay stresses that climate change is proportional to the total cumulative anthropogenic emissions of greenhouse gases, which accumulate in the atmosphere year after year. There is no point in reducing greenhouse gases a little bit. Unless we reduce the annual emissions of greenhouse gases to zero, the greenhouse effect will continue to increase. If we were to look at the approximately 500 gigatonnes of anthropogenic $C0_2$ emissions since 1850, we would find that 320 gigatonnes originated from fossil fuels and cement and 180 gigatonnes were released by land use changes, such as clearing forests for agricultural purposes. The aim of burning wood and other biofuels as an alternative to coal is potentially at odds with the aim of reforestation to counteract the greenhouse effect.

MacKay initiated a study into the impact of the lifecycle of electricity produced from biomass in 2020. This resulted in an open-source biomass emission calculator published by the British government in July 2014 (the Bioenergy Emissions and Counterfactual Model (BEAC Model)). Harvesting roundwood from American or Canadian forests and shipping it to the United Kingdom uses quite a lot of energy and, most significantly, may result in high carbon emissions in the deforested landscape in North America. A forest of 100-year-old trees stores about 260 tonnes of carbon per hectare. The Stephenson-MacKay study involved the numerical calculation of the impact on carbon dioxide emissions of all kinds of scenarios where timber was harvested. The calculations for burning wood did not, by any means, appear to be favourable in all scenarios. Only the burning of wood residues which would otherwise be burned by the roadside in North America and the intensification of wood production in order to achieve a larger harvest and/or a shorter rotation cycle would be a sensible way of reducing greenhouse gas emissions. The researchers concluded that the burning of wood waste which would otherwise be left to rot in mixed North American forests would not be a sensible way of combating the greenhouse effect.

MacKay concludes that policymakers should distance themselves from the term 'renewable resource' as the starting point for climate policy. It is not about whether resources are renewable but what their impact will be on carbon dioxide emissions.

MacKay concludes by presenting a set of possible policy responses to improve the current disatisfactory European biomass policies:

- Abolish the renewable target – focus on measuring carbon, and on policies for valuing carbon, everywhere
- Focus on Research and Development for efficiently turning biomass into useful fuels
- Stop subsidising wood-to-electricity either immediately or by 2027 (except, in the future, wood-to-carbon-capture-and-storage may be crucial, in the climate-change end-game)
- Enhance the definition of 'sustainably-sourced' wood so that carbon stocks in the landscape are taken into account
- Don't use pellets derived from roundwood, only use residues (However MacKay pointed out that the Stevenson-MacKay report identifies some 'good' scenarios that would be excluded by this constraint; moreover, most residues that would otherwise decay in forest are not low-carbon!)
- Monitor supply chains to check that most wood from a region is going to high-value uses.

More research

From the audience, KNAW researcher Ronald de Vries asks what the British academic expects from the research into converting biomass more efficiently into more high-value applications, because such conversions are still in their infancy. MacKay also believes that such research requires greater attention, for example for the production of biofuels for the aviation sector. Cathelijne Stoof of Wageningen University asks for a further explanation of the redefinition of the term 'renewable resource'. According to MacKay, people should henceforth take into consideration what, for example, the carbon impact is of shipping the wood approximately 9,000 nautical miles from Vancouver to the UK, how much gas is used to dry the wood, etc. You will only know whether the use of bioenergy is actually sustainable if you took account of the entire carbon cycle. Sustainable uses should be based on a carbon criterion. Academy member Martijn Katan, joint initiator of the symposium, wants to know what the link is between carbon storage underground and the use of biomass above ground. Does it matter if you store the carbon in Mexico and burn the trees in Japan? According to Mackay, it does not matter, because the atmosphere is one large system.

Carbon debt

The next guest speaker to address the symposium was Martin Junginger of the University of Utrecht. According to Junginger, the Netherlands has a problem, because we only used 4.5% renewable energy in 2013, whereas the mandatory target for 2020 was 14%. Biomass currently accounts for about 70% of the current use of renewable energy and this share was set to increase. In recent years, some of the coal burning in power stations has already been replaced by co-firing wood pellets from Canada and, in particular, the US. According to the 2013 Dutch Social and Economic Council energy agreement, the proportion of wood pellets used would have to increase from 1.5 to 3.5 tonnes to take account of criteria for sustainable forest management, indirect Land Use Changes (iLUC) and the carbon debt.

Is use of wood for as a source of fuel carbon-neutral? Trees absorb CO_2 as they grow and this CO_2 is released again when the tree dies and rots, or when the wood is burned. The idea behind the use of bio-energy is that burning wood in a power station saves fossil fuels. One remaining discrepancy is that forests absorb CO_2 very slowly, while they release it very quickly when burned. However trees do not keep growing forever. The older the forest, the smaller the amount of CO_2 they absorb and the greater the risk of disease, epidemics, storm damage and forest fires. Forest fires are a very important factor in releasing CO_2.

Forest dieback

Ironically, it is precisely because of climate change that not all of the forests in the world still act as a carbon sink. This is because, as forests age and mature, they capture less CO_2. Eventually, a tree would die and the stored CO_2 will be released again. In British Columbia in Canada, millions of hectares of coniferous forests have been seriously affected by bark beetles which are natural inhabitants of the forest but have started to become a pest now that winters are becoming milder. In large expanses of the affected forests, between half and 90% of the trees have died and are rotting. The affected trees can no longer be used for commercial purposes and are being felled and burned on a massive scale to prevent spontaneous forest fires. These forests have now become a net source of CO_2 emissions. If the trees have to be burned anyway, said Junginger, it would be better if they were burned in a power station than in the open air. Currently most wood pellets that are being exported to Europe are from the southeast of the US. There are extensive coniferous forest plantations in that area, with a rotation cycle of 25-35 years. About 25% of the wood (mainly 'thin wood' and small trees) on these plantations is used for paper and pulp but now also as a source of bio-energy. Most of the wood is used in the construction industry though.

Transport uses energy

According to some critics, hauling wood all around the world uses up more energy than it produces. Junginger sees things differently. 'Of course, energy is used in processing the wood, possibly using shell to dry it and then transporting it to Europe. Yet the total chain analysis shows that, overall, the carbon emissions resulting from burning woody biomass are 80-90% lower than from burning coal. The fact that – unlike, for example, wind and solar energy – biomass can be transported and stored is actually an advantage. Junginger does not think that its use as a biofuel would result in deforestation, quite the contrary. 'If the demand for wood increases, more forests will be planted. In any case, 10-20% of the forest area in the US will be lost by 2060 as a result of continuing urbanisation.'

Reference point

Another question is, what should now be used as a reference point? European policymakers begin their CO_2 calculations as soon as the timber is harvested and then conclude that co-firing wood results in a carbon debt. However, US foresters take as their reference point the point at which the forest is planted, which means that the carbon debt has already been paid off when the forest is cleared.

According to Junginger, the co-firing of wood could still be a sensible option over the next ten years to replace coal in power stations. 'We will have to focus on achieving better, more productive forest management in the United States. The debate should not centre on carbon alone, as we also want to achieve environmental targets and socio-economic sustainability'.

Junginger is delighted that the Dutch utility companies and NGOs signed an agreement in March 2015 to the effect that, as from 2016, biomass has to be 10% FSC (or equivalent) certified and, from 2023 onwards, 100%. A fund will be created to certify international forestry to FSC standards. With regard to carbon debt criteria, wood from production forests can no longer be used if these were natural or semi-natural forests after 2008. And there would have to be written evidence that CO_2 stored in forests was being maintained or increased. A comprehensive list of criteria can be found on the website of Netherlands Enterprise Agency.

Debate

During the debate, forest management advisor Leffert Oldenkamp comments that Junginger's estimate of the amount of carbon captured was too optimistic. Much of the carbon, for example in the leaves, is only captured very briefly and will be quickly released again. In order to recapture in the forest the additional CO_2 released during the burning of wood, we would have to improve our forestry methods to make the forests grow faster. Junginger agrees that we have to actively invest in higher production and faster growth, for example through the use of fertilisers. Boudewijn Klaversteijn of Fairchair proposes that we could use charcoal from clean biomass to improve the land of poor African farmers and at the same time store CO_2 in the ground. Junginger thinks that is a good idea, for example by applying pyrolysis and using the resulting charcoal as soil improver and the resulting oil for energy and materials. KNAW researcher Ronald de Vries wants to know what the long-term prospects are. If we wanted to achieve more valuable applications for biomass in future, would wood still be the preferred option or should we be looking for other energy crops with a shorter rotation cycle and higher carbon absorption capacity? Junginger replies that the two are not mutually exclusive. If forest plantations are already in existence somewhere, there is nothing wrong with continuing to use them. And energy crops are a good option on degraded land.

Dialogue

Once the question-and-answer session is over, David MacKay and Martin Junginger enter into a debate. According to Junginger, their positions are not so far apart. However, he does ask MacKay what he thinks about the burning of residues in North American forests and about harvesting dead trees to prevent forest fires. MacKay's view is that there is nothing wrong with this, especially if it had been established that forest fires will break out sooner or later. The two experts also agree that it would be better in the long term to develop more valuable applications for biomass – such as high-value fuel for the shipping industry – instead of co-firing it in power stations. Their third point of agreement is the need to improve sustainability criteria and FSC certificates. However, MacKay does point out that it will be difficult and expensive to actually measure the amount of carbon in the landscape. At this point, Tim Searchinger of Princeton University and the World Resource Institute comments that the co-firing of wood often uses forests originally intended for pulp and this often means in practice that pulp production moves to other places, for example Indonesia. This is a very bad thing for the world's climate. David MacKay believes that a price should be charged for CO_2 worldwide.

Huge amount of space required

The American researcher Tim Searchinger, associated with both Princeton University and the World Resources Institute, is highly critical of the use of biomass for co-firing in power stations. In his presentation, Searchinger explains that the increasing world population would, according to virtually all projections, require an increase in agricultural land just to produce food and feed. The large amount of space required to cultivate bio-energy crops would result in undesirable land use changes and would therefore actually contribute to the greenhouse effect.

Human beings have already put three-quarters of all the vegetated land on earth to use, to grow food or to harvest timber. In order to supply the world's future demand for food, according to FAO projections in diets and an expected population of 9.6 billion in 2050, annual crop production would have to increase from 9.5 ExaCalories to 16 ExaCalories in 2050, an increase of roughly 70%. FAO projections also imply increases in beef production by 90% and dairy production by 80% compared to 2006. Even if crop and pasture yields manage to grow at the same rate over the next 40 years as in the past 40 years, the result will be hundreds of millions of hectares of land clearing even without growth of bioenergy. One prominent recently estimated the need at 660 million hectares of additional arable land by 2050 and 430 million hectares of additional pasture, assuming crop and pasture yields grow at the same rate as previous trends. In the meantime, urbanisation will probably swallow up a further 100 million hectares of agricultural land by 2050 and the demand for timber and paper will increase by at least 70%. These developments mean there is unlikely to be surplus agricultural land in the world to grow biofuels.

Searchinger stresses that even relatively modest bioenergy targets would cause large competition with land and food production. The European Union now wants to obtain 10% of transport fuel from biomass by 2020. 'Suppose that we wanted to obtain 10% of our transport fuel from biomass around the world by 2050, this would require a quantity of energy crops equivalent to 30% of today's world crop production,' explains Searchinger. 'And that would supply 2% of world energy demand on a net basis. It's an extraordinarily inefficient use of land,' the American expert concludes.

Broader bioenergy targets, which include uses of wood for electricity, would cause much larger competition with food, natural ecosystems and carbon storage. All the plants presently harvested by people – all the crops, timber, harvested crop residues and grass eaten by livestock - contain a maximum of 230 exajoules of energy if burned perfectly and could supply only 20% of likely global energy demand by 2050. Bioenergy targets for 20% of global energy would therefore require a doubling of plant harvests.

Double counting

Searchinger also explains that a double counting error explains most of the analyses that claim that bioenergy reduces greenhouse gas emissions. When people burn bioenergy, either as liquid biofuels or as trees in power plants, the cars and power plants continue to emit carbon. Bioenergy can only reduce greenhouse gas emissions if in some way there is an offset of this carbon somewhere else. People often think the offset occurs through plant growth, which absorbs carbon. But the world's land is already growing plants, which absorb carbon, and which is being used by people for food or timber or to replenish carbon stored in vegetation and soils. The only way bioenergy can offset greenhouse gas emissions through plant growth is if it leads to additional plant growth. Alternatively, bioenergy can offset emissions by eliminating the decomposition of wastes. Other biomass only comes at the expense of carbon storage in plants and soils, so it does not reduce the total carbon in the air, or at the expense of food or timber use. 'When researchers factor in the CO_2 captured during the production of bio-energy crops as an additional gain, they are in fact double counting the carbon gain through plant growth, but that is of course not correct,' says Searchinger

Not surprisingly all large estimates of bioenergy potential, count land or plants that are already being used. Categories include: abandoned agricultural land, on which nearly always forests or grasslands regrow and store carbon which is critical to holding down the amount of the world's net deforestation; wetter grazing lands that are already being used for food production; and wet tropical savannahs, which store a lot of carbon that would be lost if they are used for bioenergy. Another example of double counting occurs when researchers claim they can use the wood that is accumulating in many of the world's forests as they regrow from prior harvests or because they are stimulated by increased carbon dioxide in the atmosphere. If these trees are used – even if the amount of carbon in the forest remains the same – the use of bioenergy eliminates the forest carbon sink, which is holding down climate change. All in all, according to Searchinger, bioenergy - whether from food crops, energy crops or forests - is a very inefficient form of land use, as they require enormous amounts of land and water to achieve a modest energy yield. Typically only 0.1% to 0.2% of the energy in the sun's rays is transformed into useable energy. Moreover, this land is not available, owing to our increasing demand for food, timber and carbon storage. Searchinger also explains it is really not necessary to focus so massively on biomass to solve our energy problem. Solar energy is at least 100 times more efficient and unlike biomass production, solar energy can use unfertile, unproductive land.

Debate

Henk Lekkerkerker of the University of Utrecht wonders whether large companies like Shell and DuPont had really lost the plot when they were investing so heavily in ethanol production from corn stover (maize waste). According to Searchinger, corn stover could be one of the few favourable exceptions, but it does not have much energy potential. Manure fermentation could also be useful, if nothing else was being done with the manure. Carlo Hamelinck of Ecofys wonders whether we could also regard biofuels as an investment that could pay for itself over 20 years. Searchinger confirms that bioenergy will typically eventually generate greenhouse gas reductions over a long enough time but said that time was money. And no-one will invest in technologies that only pays for themselves after 20 years.

But still profitable in future

André Faaij, professor of Energy System Analysis at the University of Groningen, explains in his presentation how biomass could form part of sustainable development without undesirable indirect land use changes. His presentation How biobased economy can be part of sustainable development (without iLUC) and why we can't do without it is available at the symposium website.

Dialogue

Once the question-and-answer session with André Faaij is over, Tim Searchinger and André Faaij enter into a debate. Searchinger starts things off by stating that he does not think we should be anticipating an enormous increase in agricultural yields sufficient to reduce agricultural area while meeting food needs. As an example, he says, Africans would have to cultivate a further 125 million hectares of land just to provide for their own food production even if their yields grow at the high rates predicted by FAO, leaving aside any land required for biomass production. We should first wait and see whether it is indeed possible to produce so much more food from so much less land, before we withdraw so much land from agricultural use and clear so many forests in order to produce biomass. Second, Searchinger does not think it is right merely to be optimistic about future progress in agriculture. In reality, a lot of land is still being developed to expand agriculture. In Brazil, the best agricultural land is being used to grow sugar cane for ethanol production and bio-energy crops are also driving out other crops in the US. According to Searchinger, the idea that we need urgent action is a reason against bioenergy. After all, burning wood and other biomass would only increase the CO_2 content of the atmosphere in the short term. He again points to the misconception leading to double counting in carbon calculations. Besides, solar energy is also undergoing very rapid technological advances, so why should we only have to be optimistic about future falls in the price of biomass?

Faaij once again underlines the many advantages of using degraded land for biomass production. He has high expectations of more effective farming methods, including from a socio-economic perspective. He wants all the parties involved, to cooperate constructively. He believes that agriculture would have to become more sustainable and efficient in any case and regarded biomass as a fantastic opportunity to add economic value to agriculture and to set agricultural progress in motion. On the other hand, according to Searchinger, stimulating demand would not close the current gap between the supply of and demand for agricultural products, quite the contrary. The increasing cultivation of biomass would drive food prices up. Biomass is often cultivated on the best land, at the expense of badly needed food production. Solar energy has much better prospects. Faaij believes that we simply have to dive in and set to work with biomass. 'We know what we want to achieve and what the constraints are', he continues. 'So let's get down to work and concentrate on finding effective solutions. Time is scarce'.

Final debate

In the final debate, the participants are allowed to give their views on a number of arguments. First up is the question of whether support is needed for first-generation biofuels to facilitate the energy transition to more environmentally friendly forms of biomass. Proponents think it is important to acquire experience of new technologies, which improve each year, even though biomass competes with food production. Opponents consider further research unnecessary, as we can already produce good-quality biodiesel. Biodiesel has been used in vehicles as long ago as the First World War. Others point to the enormous amount of land required for biomass production. The problem of hunger in the world is not a production issue but a distribution issue. We should dispense with fossil fuels and introduce a carbon tax. Ecosystems are, by their nature, the best carbon storage systems. Moreover, the increasing consumption of meat in the world will increase the demand for agricultural land even more.

The second question is whether wood for power plants is derived 100% from waste or from woods harvested under stringent sustainability criteria. None of the participants believes that, on a global scale, all the wood is derived from sustainable sources. Opponents of the co-firing of biomass dismiss the proposed sustainability criteria as 'fairy tales'. No-one is monitoring these criteria in practice. The market for co-firing biomass is not transparent and waste transporters are not open about their prices.

Third, attendees are asked what message they would give to politicians regarding the usefulness of subsidies for co-firing wood and mandates to use biofuel. According to the majority of participants, they should stop subsidising the co-firing of wood in coal-fired power stations because by doing so we are in fact subsidising and maintaining the coal industry. These subsidies will not help to build an infrastructure for a future cascade of valuable and not so valuable applications for biomass. In countries like Indonesia, sustainable biomass production is a complete illusion as there is little or no regulation in practice. We should not cultivate biomass on degraded land but restore ecosystems because they are the best form of carbon storage. And if the entire population of the world wants to eat just like Europeans do now by 2050, there will certainly not be enough agricultural land.

All in all, it was an exciting, informative and illuminating afternoon.

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