Learning diary

Course: Bioenergy markets and policy

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Lecture 1: Background

Reutilization of bioenergy due to several events in the 20th century after the Second World War

During the oil crisis of 1973 oil becomes much more expensive. In this time the oil price is not set by the market but it is a political decision by the oil producing countries. In 1979/1980 there is a second oil price shock and the price rises more and more.

Before 1980 the main heating resource was gas. However, after the mentioned oil crises policy in the energy sector changes. Due to reasons which will be mentioned below, some countries started to burn wood for heating again. This was the start for the bioenergy as we know it today. The difference to previous use of bioenergy is the high technological level, a better efficiency and planning which also considers sustainability aspects.

The oil crisis showed that the economies of the western world are highly dependent by oil and therefore vulnerable if the oil production is cut back. Mitigating strategies were diversifying the energy production and structure to gain more self-dependence in the energy production. In the case of Finland bioenergy is a good alternative because the large forests provide plenty of resources. In the 1990s ecological concern in the energy production have arisen which also fostered the development of bioenergy.

What is bioenergy?

Bioenergy is produced from biological material (biomass). There are different groups of bioenergy which are wood energy, agri energy and municipal by-products. Wood energy can be produced for example from fuel wood (solid), black liquor (liquid) or pyrolysis gases of above fuels (gas). Furthermore wood energy can be generated by pellets that are solid but behave like a liquid.

To classify energy as bioenergy it is important that the resources are renewable which means renewable in human-relevant time spans.

As mentioned above, nowadays bioenergy is characterized by technology, efficiency and planning.

Support of bioenergy production

From the point of view of a western country in the 1970s there were several good reason to support bioenergy production. A crucial factor is the self-dependence in the energy production if there are sufficient resources available. It reduces the dependency on oil and fosters energy sovereignty. Closely linked to this point is the diversion of the energy mix which decreases the vulnerability if one energy resource like oil is not available. Besides, environmental aspects play a crucial role when it comes to supporting bioenergy. Apart from the machinery which is used to process the trees, it is carbon neutral and there are less environmental hazards compared to oil production. Another main reason to support bioenergy are economic reasons. It strengthens the local economy and provides new jobs. Furthermore, it changes the socio-economic structure of the energy production to a more decentralized and therefore less vulnerable system.

However, there are quite good reasons to not support bioenergy production, too. First of all, the costs are higher than for energy from fossil fuels and the energy density is lower. Besides, there are environmental aspects like deforestation which argue against bioenergy. Another point is the food security which could be at risk in some countries if the biomass for bioenergy is produced in the agricultural sector. Lastly, the growth and the cost reduction that is expected could simply not apply.

All in all, the decision-making depends on policy and this is the reason why there is a different development in each country. From my perspective, the arguments to support bioenergy production are stronger and it is a good technology to strengthen.

Lectures 2/3: Policy

The role of policy

Policy can be described as a "deliberate system of principles to guide decisions and achieve rational outcomes". It is a way to achieve a certain goal like a five-percentage share of bioenergy in the total energy mix of a country. But why is it justified to interfere in the market with policy? The answer to this question are externalities. They are not directly reflected in the market prices and non-evitable by whom gets benefit or suffers from it. The result is market failure (inefficiently allocation of economic resources or improper allocation of property rights). For example, air pollution by producing energy from coal is a negative externality nobody pays for and this unfair condition is the reason why policy is allowed to interfere in the market.

Practical Examples: Main policies affecting the production and use of wood in Europe

The EU Policies related to Biomass are divided into Environmental Policy, Agricultural Policy and Energy Policy. The Common Agricultural Policy and Rural Development Policy of the EU aims at the competitiveness of the agricultural sector and the development of rural areas. Almost 50 percentage of the overall budget of the EU is spent in the agricultural sector and forestry measures with the goal of producing bioenergy can be financed directly from it.

The Directive 2002/91/EC on energy performance of buildings promotes the energy performance of buildings and fosters the use of renewable energies. So, the demand for energy wood is stimulated due to its broadly use for efficient heating technologies. Also, the Renewable Energies Directive (Directive 2009/28/EC) and the Biofuels Directive (Directive 2003/30/EC) fosters the utilization of bioenergy by forcing EU Member States to increase the use of wood via legally binding targets.
Furthermore, the EU Emission Trading Scheme (Directive 2003/87/EC), which is the core of EU climate change policy, fosters the substitution of fossil fuels with less carbon-intensive energy sources like biomass.

Policy Instruments

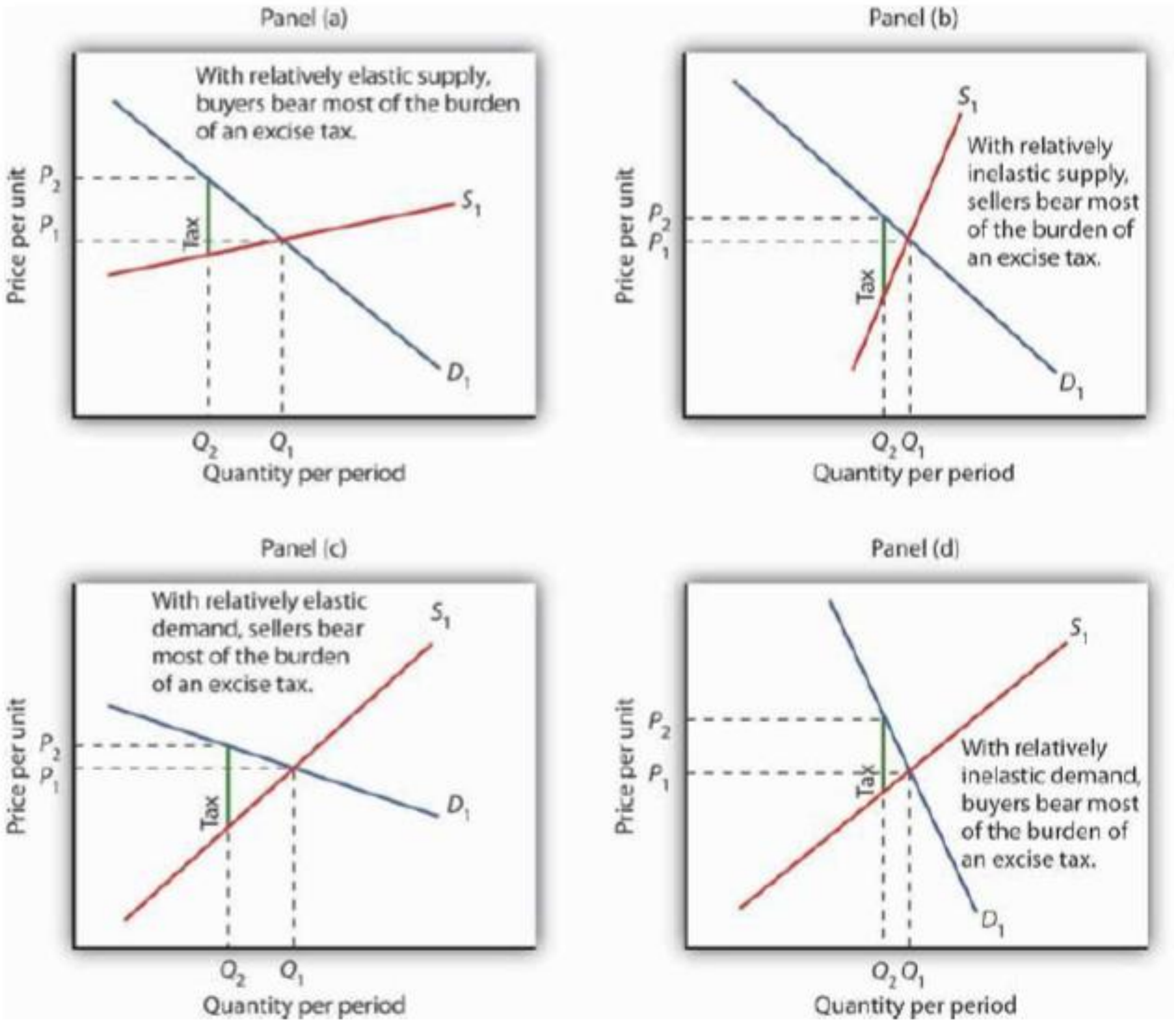
There are several different instruments to support the production of bioenergy, which will be mentioned here and the effects on the market will be analyzed in detail in the previous sections. Such instruments are capital subsidies (Sweden/Austria on district heating systems), tax incentives, energy tax policies (CO2 taxes in Finland, Denmark, Sweden, Norway, Netherlands, …), guaranteed markets (Obligations percentages on Renewables in Germany), regulations (Command and control), R+D, Eco-labelling, information/promotion campaigns, education, quotas or emissions trading. In Finland, there are financial instruments like a tax relief for all fuels used for electricity generation, a feed-in-tariff for wood fuel based small-scale CHP, an investment subsidy for biomass and an energy taxation for fossil fuels used for heat generation. In addition to these financial instruments, there are regulations like the obligation to distribute biofuels to the transport market.

Lectures 4/5/6: Economic instruments

The effects of taxes and subsidies on the market

The price of a commodity is determined on the market which is shaped by the demand and the supply of a commodity. The equilibrium of the demand and supply curves then sets the price. The demand and supply and therefore the price can be changed through different policy measures like subsidies or taxes.
The demand curve reflects the demand of a certain commodity which is mainly set by consumers. The shape of the demand curve reflects its elasticity, how it responds to changes in the axis. A perfectly inelastic demand curve is vertical, which means consumers will buy the commodity no matter the price and a perfectly elastic curve is horizontal. The supply curve is mainly determined by the producers who sell a commodity and its shape reflects the elasticity like the demand curve. When it comes to energy markets, the elasticity becomes very important.

An excise tax on a certain commodity increases the price for the consumer so that the demand will be lower. Due to this effect there also is a negative effect on the producer who suffers from less selling. With a normal demand and supply the tax is more or less equally paid by both, the consumers and the producers. However, if the two curves have a different elasticity also the burdens differ. With a relatively elastic supply or a relatively inelastic demand, buyers bear most of the burden of a tax. In contrast, with a relatively elastic demand or a relatively inelastic supply, sellers bear most of the burden.



A subsidy works like a tax but in the opposite direction. It decreases the price of a commodity for the buyer which increases the quantity and therefore the revenue of the seller. Also with subsidies, the elasticity of the demand and supply curve indicates who benefits most of it.

Yet it is not easy to estimate how large a tax or subsidy must be to remain the aimed results because it is hard to determine the exact demand and supply curves.

https://www.investopedia.com/exam-guide/cfa-level-1/microeconomics/tax-effects.asp

http://www.economicsonline.co.uk/Competitive_markets/Subsidies.html

Examples: Energy policy in Sweden in Austria

In Sweden, since 1980 (almost 100% oil) the resources used for heating diversified to lower the dependence on oil. In order to succeed different policy incentives were made. For instance, investments in biomass R+D especially in the beginning around 1980 were increased. Furthermore, heavy taxes on coal, heavy fuel oil and gas oil plants for district heating, but also for the industry were implemented. Due to these measures, the revenues from energy and environmental taxes rose from 1990 to 1999 by more than factor 3. Through the taxes, biomass plants were the cheapest alternative for district heating and among the cheapest alternative (almost equal with heavy fuel oil plants) for the industry. These taxations (mainly on CO2 and Sulphur) led to a strong increase of biomass use for district heating systems since the 1980s.

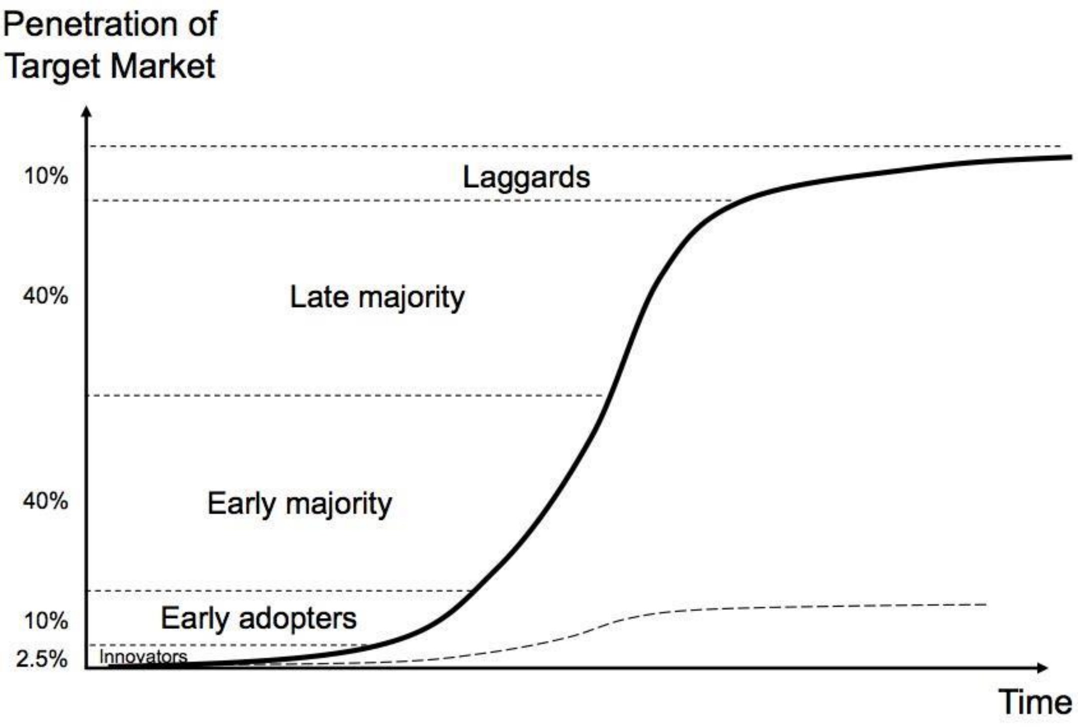
The development in Austria was almost simultaneous. Indeed, another policy incentive, capital grants, was implemented, but the installed capacity of biomass district heating systems increased very strong from the 1980s to the 2000s.

Lectures 6/7: Adoption dynamics

Reaching the goal

If a certain goal shall be reached, different people always have different perspectives on the topic. For a farmer, the most important determinant is the yield. Through different methods and a good management of the plantation, he wants to increase the efficiency (natural science). On the other side, a policy maker is more interested in the total area planted and the market share. Therefore, he wants to reach the highest profitability and focuses on policy incentives (social science). To reach a certain goal, these two approaches have to work hand in hand. However, there is yet another concept which is essential to reach a certain goal by creating a plan, which is *adoption*.

In the beginning of an innovation, there are the early adopters who first buy the innovation. After them, the early majority makes for a quite high market share before the late majority finally establishes the innovation in the market. At the end the laggards are the last group who buy the innovation.



But which determinants influence the adoption? The adaption of an innovation like for instance bioenergy from a biomass plantation is mainly influenced by market forces (demand, opportunity costs, alternatives), profitability, local perceptions plus attitudes and the yield. The latter is itself affected by local factors (weather, soil), the management and R+D in the field. The degree of adaption then determines the total area planted and will therefore set the market size. Often, in the beginning of the process, costs are much higher for the pioneers, but fall during the adaption process due to different factors (economy of scale, R+D) up to 50%. However, early innovators have the advantage of gaining experience by planting a new crop for instance, which is crucial for succeeding.

To sum up, all the previous discussed policy incentives aim at reaching a certain goal by an optimal adaption process. To reach this process, it is essential for the policy maker to also take into account the farmer's point of view (see slide 67).

The key factor in adaption processes are the costs for energy production. They depend on the profitability, the utilization of existing resources and risk spreading aspects. The risk is the difference between expected and real income and different factors are important to reduce risks. For instance, these are increased knowledge, cultivation technology, subsidies, contract design or portfolio thinking with the cultivation of different crops. When it comes to profit maximization, an increase in the price for willow has a larger impact than a higher yield due to rising costs for instance for fertilizers or transport. A crucial determinate for a successful adaption process is the cost reduction potential of a crop, which varies from crop to crop. Usually, future costs can be reduced by technology, plant

breeding and organizational development. These costs reductions occur in different areas like harvest or transport. In general, crops, that are already widely spread have a lower cost reduction potential than newly introduced crops, because there is already knowledge and infrastructure and so on.
https://en.wikipedia.org/wiki/Diffusion_of_innovations

The Swedish case: Cultivation of willow

To find out how certain instruments work, it is important to examine experiences in other regions or countries. One (negative) example is the cultivation of willow in Sweden. After the oil crisis, Sweden tried to become more independent from the oil by research and development and investments in bioenergy. In the 1990s different economic/policy incentives for biomass plantations (including willow) were established to foster bioenergy use. From 1991 to 1996 subsidies were implemented for farmers who change from cereal to other activities (especially willow production, 1330€/ha). In addition, the taxation on Sulphur and CO_2 in heat production was increased (biofuels exempted). Set-aside land was provided for willow cultivation and a market for wood fuel was created, which is why chips from forest residues could be delivered all year around. The plan was to create a market for willow that at some point would work without the subsidies and create a huge amount of energy from renewable biomass. Until 1995 the plan worked quite well and the consumption of wood biomass as well as the commercial plantations established increased very fast. Especially in the south and in the east of Sweden huge willow plantations were created. However, after the subsidies ran out, the market collapsed. But why so? One reason is that many farmers were only interested in the subsidies and after they planted the willow, they didn't care about their plantations anymore and didn't manage them well. This effect is very bad for policy makers, because these farmers don't contribute to developing the plantation techniques which is very important in the adaption process. After the market collapsed, the Swedish government tried to fix the mistake by implementing some lower subsidies again, but willow production didn't increase as strong as before. It is difficult to assume what the government did wrong, but the situation could have been completely different if the subsidies would have run some more years.

Furthermore, the success of such an adaption process depends highly on the farmers. Their main motives were less workload, subsidies and high expected revenues. A typical owner was about 50-65 years old or an institutional owner and had a large farm or forest land. During the cultivation engagement was very important, as satisfied owners were more engaged in their cultivation than dissatisfied owners. Besides, regularly meetings and interchange between owners contribute to a successful cultivation. Also, collaboration with local driving forces is essential because without local support the start of a cultivation is very difficult. Consequently, reasons for dissatisfaction were a poor organization around the harvest, a low harvest income and failure of harvesting in the favored year. May farmers reduced their plantations because of failed growth due to weeds, dry soil or a wrong plant variety. All these reasons occurred more often, if the farmers didn't engage that much in their cultivation.

Lecture 8: International markets

Pellets

Pellets have special attributes, because they are solid, but behave like a fluid. It is also possible to store them and they can be transported by tubes to a certain extend. Often, pellets are a by-product of saw mills, which is why pellet plants are usually located next to saw mills and the production is coupled. The energy density of pellets compared to oil is 1:3, so pellets have a higher volume than oil. However, there are pellets of different quality depending on the type of wood or biomass. A typical energy amount is about 18J/Kg.

Pellets market

Pellet trade takes place mainly with a country's neighbors because long distance transportation is expensive. Norway for instance exports huge loads of waste wood to Sweden because there is no pellet industry in Norway but in Sweden. When it comes to wood chips, Sweden, Denmark and Germany are the main importers and Russia and the Baltic countries the main exporters.

However, the market for pellets strongly depends on the heating plant. For instance, in central Europe, most of the heating plants are small scale or in domestic homes (55%), whereas in Finland and Sweden 70% are large scale heating plants with 50-500 MW.

Internationally important pellet trade flows are from Canada to Europe and lately also from the US to Europe. In Europe, most of the pellet exporters are located in Eastern Europe and Spain/Portugal and most of the importers in central Europe and Scandinavia (except for Finland which is an exporter). Although Sweden is a net importer, it is also the second largest pellet producer after Germany. The largest per capita consumers are Sweden and Denmark.

In Europe, there are four core areas of pellet production: Central Europe (Bavaria, Austria, neighboring areas of France, Switzerland, Italy), Scandinavia (Southern Sweden), Finland and Baltic. These four regions account for 30-50% of Europe's total pellet production. However, each of these four markets has been developed with different policy incentives.

The price of the pellets depends highly on the living area, the closer to production sites, the lower the price. This is mainly due to the high transportation costs.

The main barriers for pellet heating systems are raw material supply with sawdust (localized production, new feedstocks, import restrictions), logistics, sustainability concerns (food vs. wood, rising price, land), fuel quality (lack of certification, standards and quality control), lacking financial policy support (e.g. subsidies or taxes) and unfair competition to fossil fuels (VAT tariffs).

Case study: pellet markets in Northern Europe (Sweden and Finland)

Sweden is the biggest consumer as well as producer of wood pellets in the world. Different factors affecting the development of the pellet industry to become a leader have been identified: Good availability of raw materials, a taxation system that favors biofuels and extended district heating networks. There exist a total of about 100 pellet plants producing about 1,4 million tons of pellets in 2007.

In Finland, recently the domestic consumption has started to increase, but markets have been export-oriented from the beginning. There are 25 pellet plants with a production of 330.000 tons of pellets existing in 2007. The development has been slower than in Sweden, especially on the consumption side, but recently subsidies are also available and should foster the small-scale use of pellet stoves in Finland as well.

Small-scale pellet producers are typically producing pellets as a by-product, whereas middle and large-scale producers are mainly concentrating on pellet production. In both countries, there are still significant capacities concerning increasing the production and consumption.

The main challenge for the coming years will be the supply and development of raw materials. It is crucial to secure pellet supply and ensure price stability to build trust in this still young technology.

Lecture 9: Governance

Governance:

Governance means setting rules that in many cases are not yet incorporated in governmental policy. This can encompass coordination mechanisms that are outside the authorities of states. In governance processes in bioenergy social acceptance is a key factor. It is essential for the political legitimacy of bioenergy supporting schemes and the whole bioenergy industry

https://en.wikipedia.org/wiki/Governance

Role of ENGOs

ENGOs are Environmental Non-Governmental Organizations which are formed by members of the public. These Organizations have no government connections and are concerned with environmental issues. They use research, campaigns and advocacy as an attempt to influence political decisions of an

"elite". ENGOs have a huge impact when it comes to policy incentives and they provide input to environmental policy (lobbying) but their role is also monitoring and reviewing environmental legislation. Furthermore, they guarantee effective dialogues and have an advisory role, create environmental awareness and education and sometimes even provide technical services.
Recently ENGOs act more globally with offices all over the world like companies. The internet plays an important role for the ENGOS, on the one hand they can interconnect and on the other hand they increase the potential impact of their campaigns via different internet platforms.

Stakeholders:
Stakeholders are people who are directly involved in the project, affected by it, or dependent on the resources concerned. They often play a crucial role in governance processes.
https://en.wikipedia.org/wiki/Stakeholder_(corporate)

Lecture 10: Bioenergy regions

Translation loops of bioenergy policy and materialization
The design of EU bioenergy policy can be illustrated in translation loops. The EU establishes mandatory governance like rules and standards (e.g. fixed targets of renewable energy per country) and voluntary governance like soft incentives (e.g. recommends, ideas). The next step on the national level is the empty governance space, where the countries establish measures to achieve the goals set. In the following on the local level, the regional translation is the step before production. It is the most important part, because it determines if the goals can be reached. However, on this level there are problems like missing identification or bureaucracy. At the end of the cycle there will be contestation and feedback from the EU about the production.

Example: Bioenergy regions in Germany as translation loops
Different EU plans and directives like the EC Biomass action Plan (2005), the Renewable Energy Roadmap (2007) or the Renewable Energy Directive (2009) with goals like sustainable development or secure low-carbon energy supply were translated differently in each country. In Germany measures like the national biomass action plan (NREAP) (2009), the German Government Energy Concept (2010) or the renewable energy directive (EEG) (2009, 2012, 2014) were established. The target relating to bioenergy was to increase the production within sustainable limits, climate protection, security of supply economic development (particularly rural) and network creation. One of the local translations are the "Bioenergy Regions", where selected regions are supported to integrate bioenergy. By doing so, they act as translation loops. However, these regions don't have the same aims as the EU. For

them, the creation of networks of regional actors (entrepreneurs, consumers, etc.), local energy transition, rural development and the creation of added value in the regions is of highest interest. This shows that economic growth and networks are more important to them than sustainability aspects. Also, during the production stage, the regional processes differ due to different legal forms of the operator, different approaches or a different socio-economic environment. Often the translation processes have a totally different outcome than expected and favored by the EU. One example for this is the production of knowledge on negative side effects. There were cases where neighbors introduced threatened species in stream next to a biogas plant to stop it.

Lecture 11/12: EU policies

The main policies are command and control or market-based policy tools (subsidies, taxes, emissions trading). Command and control policies are traditional and less flexible, because specific actions need to be done by polluter to reduce emissions. Often there is no distinction between different companies and no incentive for firms to innovate. Market-based environmental policies however offer greater flexibility for firms and are appropriate to reduce GHG emissions. Environmental objectives can be achieved at lower overall cost and there are incentives to develop and deploy lower emitting technologies (firms) and also to use these technologies (users).

Carbon markets and climate actions:

To reduce carbon emissions, the EU introduced the European Union Emissions Trading System (EU ETS). It is a flexible, market-based mechanism to cut back GHG emissions. Currently it is in its 3rd phase till 2020 and consistent with the reduction targets included in the Kyoto Protocol. It sets a cap on emissions and requiring entity to keep a permit for each ton of emitting CO2. Like this, a market for tradable allowances for emissions among the EU member states is created. If one entity doesn’t have a permit for their emissions, it has to buy one or cut back emissions, if another entity has too much permits, it can sell them (trading to other entities).
However, the problem with the EU ETS in the past was that it is not efficient, because there were too many permits on the market and therefore the price of one permit was too low. That’s why firms had no incentives to cut back emissions.

Conference of Parties (COP):

In total, there are 195 UNFCCC signatories which are parties. The first COP came into force 1994 in Rio de Janeiro with the aim of cutting back GHG emissions in the atmosphere. Important COPs were the COP 3 in Kyoto which led to the Kyoto Protocol and the COP 21 in Paris that led to the Paris Agreement in 2015. It had the aim to achieve a legally binding and universal agreement on climate change with the goal of keeping global warming below 2°C. Until December 2016, 194 members had signed the treaty of which 127 have already ratified it.

Policy and status of EU bioenergy:

The main objectives EU Energy policy are secure energy supply, environmental protection and the promotion of competition.

An important EU policy on bioenergy was the "climate and energy package" which set the 20-20-20 targets (20% reduction of GHG emissions, 20% share of renewable energy in the energy consumption, 20% improvement in the energy efficiency). However, experts are skeptical that the EU will achieve all of the 20-20-20 targets, especially the energy efficiency target.

Another important policy is the Renewable Energies (RES) Directive, the Directive 2009/28/EC. It aims at promoting energy from all renewable sources and sets mandatory national targets for the overall share of energy from renewable sources in gross final consumption of energy and for the share of energy from renewable sources in transport. Each state however, is independently allowed to define the renewable sources consumed and the promotion measures to achieve the targets (starting-points and targets for each country can be seen in the table below).

Furthermore, in 2007, EU member states set their national targets for a 5,75% share of biofuels in Europe in 2010 (see case of Germany in the upper part).

Area/ Member State	2005	2006	2007	2008	2009	2010	2011	Target 2020	Need to be increased 2020/2011, percentage points
EU27	8.5	9.0	9.7	10.4	11.6	12.5	13.0	20	7.0
Austria	23.8	25.3	27.2	28.3	30.2	30.6	30.9	34	3.1
Belgium	2.3	2.6	2.9	3.2	4.4	4.9	4.1	13	8.9
Bulgaria	9.2	9.4	9.0	9.5	11.7	13.7	13.8	16	2.2
Cyprus	2.6	2.8	3.5	4.5	5.0	5.4	5.4	13	7.6
Czech Republic	6.1	6.5	7.4	7.6	8.5	9.2	9.4	13	3.6
Denmark	16.0	16.4	17.8	18.6	20.0	22.0	23.1	30	6.9
Estonia	17.5	16.1	17.1	18.9	23.0	24.6	25.9	25	-0.9
Finland	28.6	29.8	29.4	30.7	30.4	31.4	31.8	38	6.2
France	9.5	9.6	10.2	11.3	12.3	12.8	11.5	23	11.5
Germany	6.0	7.0	8.3	8.4	9.2	10.7	12.3	18	5.7
Greece	7.2	7.4	8.4	8.3	8.5	9.8	11.6	18	6.4
Hungary	4.5	5.0	5.9	6.5	8.0	8.6	9.1	13	3.9
Ireland	2.8	3.1	3.6	4.0	5.2	5.6	6.7	16	9.3
Italy	5.1	5.5	5.5	6.9	8.6	9.8	11.5	17	5.5
Latvia	32.3	31.1	29.6	29.8	34.3	32.5	33.1	40	6.9
Lithuania	17.0	17.0	16.7	18.0	20.0	19.8	20.3	23	2.7
Luxembourg	1.4	1.5	1.7	1.8	1.9	2.9	2.9	11	8.1
Malta	0.0	0.0	0.0	0.0	0.0	0.2	0.4	10	9.6
Netherlands	2.1	2.3	3.0	3.2	4.0	3.7	4.3	14	9.7
Poland	7.0	7.0	7.0	7.9	8.8	9.3	10.4	15	4.6
Portugal	19.8	20.9	22.0	23.0	24.6	24.4	24.9	31	6.1
Romania	17.6	17.1	18.4	20.3	22.3	23.4	21.4	24	2.6
Slovakia	6.6	6.9	8.2	8.1	9.7	9.4	9.7	14	4.3
Slovenia	16.0	15.6	15.6	15.0	19.0	19.6	18.8	25	6.2
Spain	8.4	9.1	9.7	10.8	13.0	13.8	15.1	20	4.9
Sweden	40.4	42.4	43.9	45.0	47.7	47.9	46.8	49	2.2
United Kingdom	1.4	1.6	1.8	2.4	3.0	3.3	3.8	15	11.2

Lecture 13: Future trends

The International Energy Agency (IEA) wrote in their World Energy Outlook-2017, that there are four main trends which will influence the world energy system.

First, there is the rapid deployment and falling costs of clean energy technologies. In 2016, growth in solar PV capacity was larger than for any other form of energy generation. Since 2010, costs of new solar PV have come down by 70%, wind by 25% and battery costs by 40%. Drivers of growth are solar PV and Wind, mostly because of the rapid development in China. Between 2017 and 2022, it is expected that the global renewable electricity capacity will expand by 43%.

Second, the growing electrification of energy takes place. This means in particular the transformation to electricity-based technologies in heating and transportation.

Furthermore, there is a (surprising) trend of the resilience of shale gas and tight oil in the United States. The US will probably export more energy and gas becomes the second largest fuel in the global mix after oil.

In the case of policy, it is striking that governments move away from feed-in tariffs to quota systems with green certifications or other form of auctions. Reasons are for instance high costs for the subsidies and that the renewable technologies are competitive now due to falling prices.

The share of renewables in heat consumption is forecasted to increase slowly. The most important renewable source of heating is bioenergy, followed by renewable electricity for heat. For this development, the European Union plays a central role due to the binding targets of the Renewable

Moreover, resource conflicts, geopolitics, wars and/or catastrophes like Fukushima can have big impacts, although they cannot be forecasted. I think, bioenergy will constantly and slightly increase also in the future. The growth will not be tremendous due to the land-use conflict as long as the world population increases and exhaustible resources like oil are affordable.