The Second European Climate Change Programme
Final Report
Working Group ECCP Review -
Topic Group Agriculture and Forestry

1. BACKGROUND

Agriculture and forestry have the potential to contribute positively to tackle climate change, for example through bio-energy production and carbon sequestration, respectively. Agriculture also faces particular challenges in mitigating its own emissions of methane (CH_4) and nitrous oxide (N_20) and in minimising soil carbon loss.

During the first European Climate Change Programme (ECCP I), the working group on agriculture identified and discussed about 60 measures having potential for GHG emissions mitigation.[1] The measures were evaluated according to their mitigation potential, socio-economic implications (costs, effects on farm income, labour), environmental side effects (e.g., biodiversity), and technical feasibility.

The ECCP I identified the most cost-effective measures with highest emission reduction potential which are: set-aside and efficient fertilizer application (e.g., spreader maintenance, precision farming techniques). The measures to reduce N_2O emissions are closely linked with measures of Action Plans under the Nitrates Directive. The highest potential was identified for bio-energy production from biomass, in particular biofuels and biogas (anaerobic fermentation).

GHG EMISSIONS

An overall reduction potential of 31 Mt CO_2eq. per year in GHG emissions was estimated. This corresponds to an identified mitigation potential of 19 Mt CO_2eq./year based on the CAP reform (Agenda 2000) and the effect of additional measures, which were estimated to be 12 Mt CO_2eq. This represented 7.4% of agricultural emissions in relation to the 1990 (baseline year) and about 9% of the total EU-15 reduction objective.

CARBON SEQUESTRATION

The ECCP I identified a potential reduction of 14Mt CO_2eq. by 2010 for the EU-15 for afforestation and reforestation, and of 19Mt CO_2eq. for forest management. For CO_2 sequestration (CO_2 sinks) in soils a potential of 60-70 Mt CO_2eq. in the EU-15 was estimated for the first commitment period, which is equivalent to 1.5-1.7% of the EU-15 anthropogenic CO_2 emissions.

BIO-ENERGY

ECCP I identified a technical potential for bio-energy from agriculture, forests and other residues of 200-600 Mt CO_2eq.

This report on the ECCP II reviews the results of the ECCP I taking account of the latest reports on Member States' implementation, updated scenarios and projections (including the effects of the 2003 CAP reform).

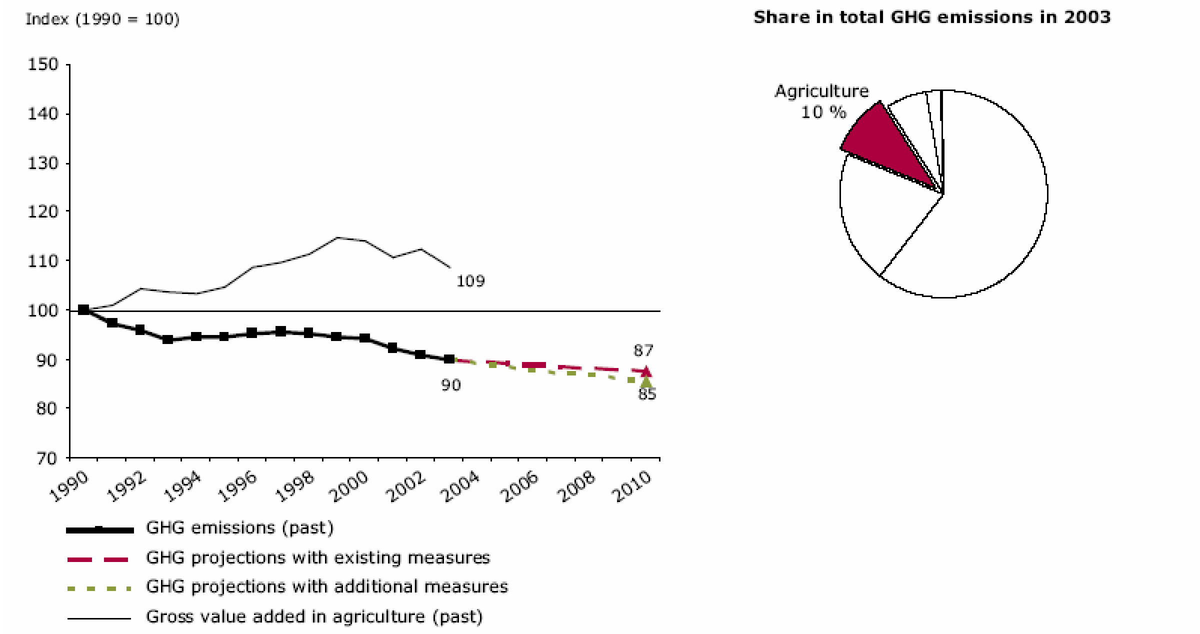
[1] See the following reports for the measures identified under the ECCP I by the working group on agriculture: http://ec.europa.eu/environment/climat/pdf/agriculture_report.pdf; http://ec.europa.eu/environment/climat/pdf/finalreport_agricsoils.pdf; http://ec.europa.eu/environment/climat/pdf/forest_sinks_final_report.pdf.

2. GHG EMISSIONS

2.1 TRENDS OF GHG EMISSIONS IN THE AGRICULTURAL SECTOR

Agriculture accounts for 9% of EU-25 and 10% of EU-15 greenhouse gas (GHG) emissions. The main gases emitted from agricultural activities are nitrous oxide (N_2O) from soils and fertiliser use management and methane (CH_4) from livestock digestion processes and manure management. Total EU-25 GHG emissions from agriculture decreased by 14% between 1990 and 2003[2]. The decreasing trends in livestock numbers, fertiliser use and the improvement in manure management systems are the main factors which explain this trend. GHG emissions in the EU declined by 10% over the same period, while the decline was much more pronounced in the 10 new Member States.

FIGURE 1: EU-15 PAST AND PROJECTED GREENHOUSE GAS EMISSIONS FROM AGRICULTURE AND GROSS VALUE ADDED



Note: GHG projections for the EU-15 are calculated on the basis of projections reported by 12 Member States. The percentage change 2003–2010 of the EU-12 is applied to EU-15. Sectoral emission projections with existing measures are missing for Germany, Luxembourg and Spain, sectoral emissions projections with additional measures are missing for Austria, Denmark, Germany, Ireland, Luxembourg, Spain, Sweden and the United Kingdom.

Source: EEA, Eurostat.

As regards CH_4, emissions fell, mainly due to a drop in the number of cattle, and also, to a large extent as a result of the CAP reforms. The main trends reported by Member States regarding livestock numbers are: decreasing dairy cattle in all countries, decreasing non-dairy cattle and sheep in most countries, variable trends for swine and goats, slightly increasing numbers of poultry in most countries[3].

Changes in manure management systems have a large impact on CH_4 and N_2O emissions. Liquid systems tend to increase in importance for dairy cattle and swine, but decrease for non-dairy cattle.

The fertilizer consumption is decreasing at the same time that crop production is increasing. It is difficult to quantify to what extent this is a direct effect of the Common Agricultural Policy (CAP) measures, such as agri-environmental measures and the obligation to respect minimum environmental standards as a condition for eligibility for support under several rural

[2] The section is based on JRC (A. Leip) presentation in the 1st meeting of the WG ECCP I review-agriculture (31 January 2006).

[3] The avian flue could have some impact on this estimation.

development measures (good farming practices), and as well of the implementation of the nitrates directive, aimed at reducing water pollution caused by nitrates from agricultural sources. Further work may be required to understand the impacts of price volatility in the fertiliser market.

As regards to N_2O, between 1990 and 2003 emissions from agricultural soils fell mainly due to a decrease in the use of nitrogen mineral and organic fertilisers. This can be assumed to be to a large extent a consequence of both the reforms of the CAP and the implementation of the nitrates directive.

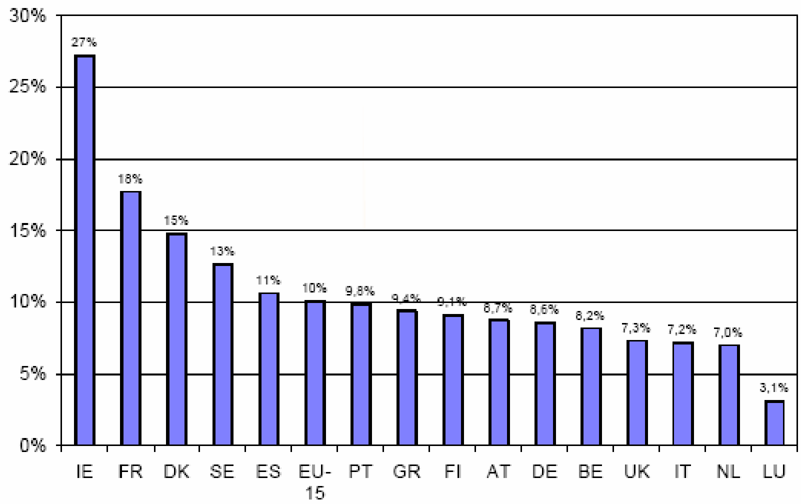
There are large uncertainties in emission factors and activity data regarding N_2O emissions from agricultural soils, and N_2O and CO_2 from organic soils. The standard IPCC emission coefficients are used in most cases (instead of national factors), which do not allow to capture the impact of some measures in the annual inventories (see point 22).

For 2010, emissions from agriculture are projected to further decrease (see figure 1). This is mainly due to the effect of the 2003 CAP reform[4] and the implementation of the nitrates directive (see section 4). However, the 2003 CAP Reforms also made the agricultural sector more responsive to the market, so projections are more vulnerable to farmer's reacting to non-policy signals that may increase emissions.

2.2 EMISSION REDUCTION MEASURES IMPLEMENTED IN MEMBER STATES

At national level, the contribution of agriculture to total emissions shows broadly similar situations (around 10%) (see figure below). Exceptions are Ireland (27%), France (18%) and Denmark (15%), which report higher shares than the EU-average. This is due, at least in part, to the relative importance in the national economy of the livestock breeding sectors in these countries.

FIGURE 2: AGRICULTURE: SHARE IN TOTAL NATIONAL GHG EMISSIONS



Source: IRENA project

Member States regularly report on policies and measures (PAM) implemented and their quantified estimated effects, including in the agricultural sector, to the United Nations Framework Convention on Climate Change (UNFCCC) and under the EC Monitoring Mechanism[5].

[4] EC Regulation 1782/2003.

[5] The section is based on results from the Monitoring Mechanism under Decision 280/2004 – presented by Anke Herold in the 1st meeting of the WG ECCP I review-agriculture (31 January 2006).

The status of information in the agriculture and forestry field is relatively weak compared to other sectors. Only 10 out of the EU-25 Member States reported quantified reduction effects of their policies and measures in the agriculture sector. There is no quantified data from Austria, Cyprus, Czech Republic, Estonia, Finland, France, Hungary, Ireland, Lithuania, Latvia, Luxembourg, Malta, Poland and Sweden. Luxembourg and Cyprus did not provide any information.

The decline of key emitting activities is very likely the main driver for the emission trends. The decrease in fertiliser use and the reduction in the application of manure have resulted in a reduction of N_2O emissions, while decreases in the number of cattle and increases in cattle productivity are curbing in emissions of CH_4. Both the decline in fertiliser use and the decline of animal numbers between 1990 and 2003 were partly due to the 1992 and 1999 reforms of the CAP, which entailed a shift of support from guaranteed prices to direct aid payments in the arable and the beef and veal sectors. Measures that are part of the rural development policy, such as the agri-environmental programmes (e.g. extensification, input reduction) are also reported to have contributed to this trend.

In addition, reduction in fertiliser use has also been achieved due to the implementation of environmental policies, such as the Nitrates Directive. Since 2000 an improved implementation of the nitrates directive can be detected from the emission trends in some countries. Promotion of good practice codes for the agricultural sector is a widespread measure for Member States to reduce N_2O and CH_4 emissions. Generally, the actual declining trend reported for cattle confirms the effect of measures to reduce livestock population. Therefore, it is likely that projected emissions reduction will be achieved.

The quantified reductions of N_2O emissions from soils by only six Member States amount to 50% of the emission reduction potential quantified by the ECCP I (10 Mt CO_2-eq year^{-1}). Denmark reports by far the largest effects of PAMs in relation to its emissions, followed by the Netherlands, Spain and Germany. The observed trend in N_2O emissions from soils supports the estimated reduction effect of PAMs for Denmark, Germany and the Netherlands.

However, in particular for Italy and Spain, additional efforts appear to be needed to achieve the reductions quantified for the PAMs.

The review of the implemented PAMs by Member States showed that there is also scope to improve the monitoring methodologies. Most Member States use IPCC default emission factors for the calculation of N_2O emissions from the application of mineral and organic fertilizers. The emissions data only reflect changes in the amounts of fertilisers applied, but not the changes in the application techniques or fertilizer formulations. Thus, a number of PAMs reported for the agriculture sector, which are likely to reduce the emissions, will not influence the emission data in the annual inventory. On the other hand, intensification of livestock production leads to an increase of emissions per animal, which is also not represented in all Member States inventories. Monitoring methods and default parameters for the inventories and PAMs should be improved through the appropriate methodological development.

2.3 OUTLOOK OF GHG EMISSIONS AND THE ROLE OF THE CAP

Several scenarios[6] suggest a significant decline of agricultural non-CO_2 GHG emissions between 1990 and 2010/2015 across the EU-25, mainly as a consequence of reformed CAP support, declining cattle numbers due to productivity increases in milk and beef production and more efficient application of fertilizers.

These scenarios explore the likely implications of changes in agricultural production based on the:

1. Implementation of the EU CAP reform of 1999 (Agenda 2000) and the EU Nitrates Directive of 1991 (as used for the analyses of the EU Clean Air for Europe–CAFE programme) (scenario 1)
2. Implementation of the 2003 mid-term reform of the CAP and anticipated impacts on fertilizer use of the reform of the EU sugar sector agreed in 2005 (scenario 2)
3. Agricultural projections provided by the EU Member States to IIASA for the preparations of the revision of the EU National Emission Ceilings (NEC) Directive in 2005 (scenario 3).

For the first scenario, an 11-13% decline of emissions from the whole EU-25 is estimated for the period from 1990 to 2010, depending on the calculation methodology. The changes in livestock numbers and fertilizer use implied by the 2003 reform of the CAP and the recent sugar reform (scenario 2) would reduce non-CO_2 GHG emissions further by approximately 4%. Based on the national projections of livestock numbers and fertilizer use as provided in 2005 by the Member States for the NEC revision (scenario 3), agricultural non-CO_2 GHG gases are estimated to decline by approximately 16% up to 2010.

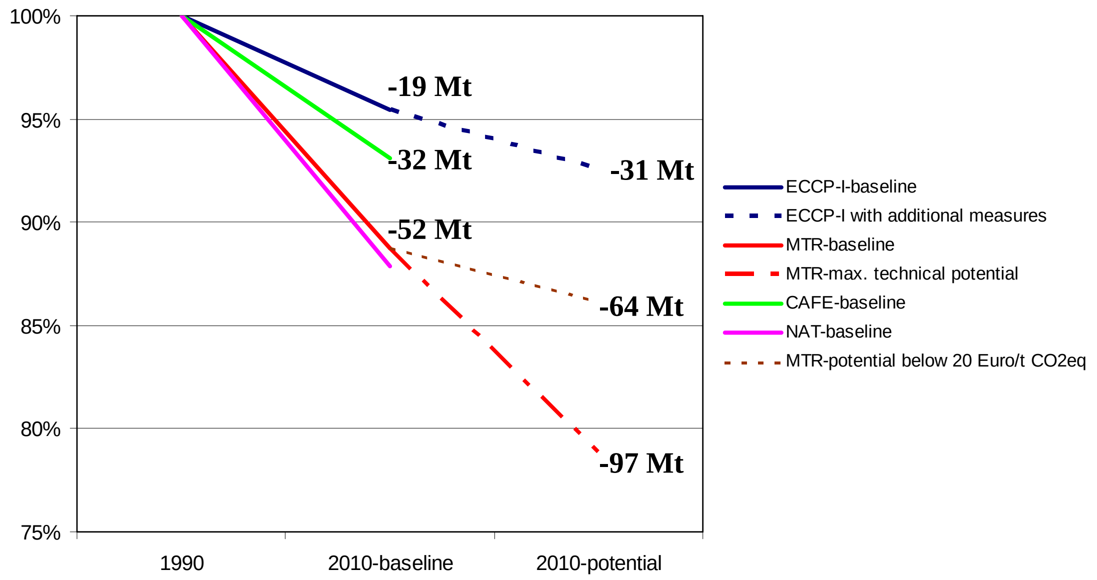
However, these trends vary significantly between Member States. Emissions from the EU-15 Member States are calculated to decline by between 7 to 13% depending on the agricultural scenario and calculation method. For the new Member States (NMS-10), reductions between 32 and 35% are estimated.

Figure 3 shows that for EU-15, in comparison to the ECCP-I estimations, the 2003 CAP reform projections lead to larger reductions by 2010, i.e., up to 14% reduction against about 7% estimated previously (see point 4), compared to the 1990 level. This is consistent with trends that are derived from the most recent MS reports (National Communications), which show a reduction of GHG emissions from agriculture by about 12-13% between 1990 and 2003.

It is estimated that GHG emissions could be further reduced by about 12 Mt CO_2eq in the EU-15 for costs below 20 €/t CO_2eq. with the implementation of certain measures. These include a full introduction of farm-scale anaerobic digesters (biogas). Thereby, agricultural GHG emissions would probably decline by about 14% compared to 1990, which is fairly consistent with extrapolated historical emission trends and the country-specific additional measures as reported in the National Communications. Biogas production from manure (and by-products) is one of the most promising measures for the future. However, the potential of biogas production depends on accompanied measures from other sectors, such as feed-in tariffs for electricity.

[6] The emission scenarios have been developed with IIASA's through the Greenhouse and Air pollution Interactions and Synergies (GAINS) model (www.iiasa.ac.at/gains).

FIGURE 3: COMPARISON OF THE BASELINES AND POTENTIAL REDUCTIONS ESTIMATED WITHIN ECCP-I AND THE CURRENT GAINS SCENARIOS (REDUCTION RELATIVE TO 1990, MT CO_2EQ.) FOR EU15



Source: IIASA (2006): Emission scenarios for methane and nitrous oxides from the agricultural sector in the EU-25, Background document prepared for the Topic Group Agriculture and Forestry under the ECCP-I Review.

Additional measures, exhausting the full technical potential (at higher costs) would bring reductions of additional 33 Mt CO_2eq. The model GAINS estimates a technical potential for reductions of GHG from agriculture in the EU-15 of about 22% compared to the 1990 emissions (or 97 Mt CO_2eq.) (see figure 3). However, this is a technical potential (no cost constraint factors were included in the model), which may differ from the economic viability.

The reason for the differences in the analysed scenarios and the ECCP-I estimations is the 2003 CAP Reform and the decrease in application of fertilizers and/or better timing of application of fertilizers.

The following key measures of the 2003 CAP reform and of the new Rural Development Policy are expected to lead to a further decline in GHG emissions:

- **Decoupling.** Single Farm Payment decoupled from production replacing most of the direct payments under different CMO with the effect of reducing incentives towards intensive production (e.g., extensification, decreased livestock number, reduced fertiliser use, etc.)
- **Cross-compliance.** Full granting of income support made conditional to the respect of statutory management requirements, including those stemming from 5 environmental Directives, minimum standards of Good agricultural and environmental conditions (GAEC) and the obligation to maintain land under permanent pasture. This is a further incentive to comply with environmental legislation, e.g., Nitrates Directive (reduced fertiliser use and improved practices). The GAEC have to include, inter alia, provisions related to maintenance of soil organic matter levels (e.g., crop rotation, arable stubble management), the protection of soils against erosion, and the maintenance of carbon sinks for instance through the requirement to maintain permanent pasture.
- **Set aside.** The maintenance of individual historical set-aside obligation (10%) is expected to contribute to carbon sequestration, in particular for the long term non-rotational set-aside. In addition, non-food crops can continue to be grown on set-aside land, including energy crops for the production of biofuels. Also a carbon credit aid (45€/ha) was set up to promote the cultivation of energy crops.

- **Modulation.** Mechanism to strengthen the rural development policy (second pillar of the CAP). Modulation reduces direct payments (by 3% in 2005, 4% in 2006 and 5% in the years 2007 to 2012) on a compulsory community-wide basis, and shifts the funds saved into rural development, increasing the possibility to stimulate the adoption of environmentally friendly production techniques.

The **new rural development regulation** for the period 2007-2013[7] would provide further opportunities to strengthen the contribution of the CAP to combating climate change, which is one of the key priority areas defined in the Community strategic guidelines for Rural Development[8]. Axis 2 (improving the environment and the countryside) of the new regulation could have a crucial role to meet this objective, through the implementation of the agri-environment measures which is the core instrument to stimulate the adoption of measures with mitigation potential. However, there is a range of measures available under all 3 axes that can make a contribution (e.g., energy savings, renewable energy production, afforestation, agroforestry, forest-environment payments).

This new rural development regulation opens a whole range of options to enhance the environmental performance and the GHG mitigation at farm level. For instance: support for modernisation of farms can lead to energy savings (e.g., energy-efficient equipment and buildings) and more efficient fertilizer use and management (spreader, storage) or investments linked to processing and marketing products, development of new products, processes, technologies (e.g., renewable energies). Moreover, the new rural development regulation fosters the cooperation between farmers and the industry for promoting the introduction of new technologies and innovation (e.g., renewable energies) for instance to overcome logistical problems related to bio-energy use.

The rural development regulation also foresees support for diversification and the construction of biogas installations on the farm, biomass plants for local production of renewable energy (biofuels, electricity and heating) as well as the creation and development of micro-enterprises (beneficiaries from the non-agricultural sector) for instance for the building of renewable energy infrastructure (e.g., wind parks).

It appears to be vital that Member States use the policy instruments of the CAP that are now available to them in the best possible way to concretely contribute to environmental objectives, including combating climate change.

3. CARBON SEQUESTRATION

3.1 CARBON SEQUESTRATION POTENTIAL

Over the period from 1990 to 2004, a positive trend can be identified in the net removal of CO_2 (23 Mt CO_2 sink), which represents a 50% increase. Forest land is the most important category for net removals as opposed to grassland and cropland, which did not significantly change since 190. There is a common pattern for most Member States of a decrease in agricultural land and an increase in wooded land. This trend in the forest carbon sink is expected to continue in the future, at a higher rate.

Forests remain the main net carbon sink in Europe. Europe is the only large region in the world where the sink capacity is greater than the risk of destruction. Provided that the vulnerability of increased forest carbon stocks (e.g. forest fires and pests) is carefully managed, forest management can be regarded as a relatively safe mitigation measure in Europe[9]. Because of the dynamics of forest growth, these will not contribute up to 2010 but can contribute highly beyond. There is also scope for afforestation of agricultural land across

---

[7] Council Regulation (EC) 1698/2005 of 20 September 2005 on support for rural development by the European Agricultural Fund for Rural Development (EAFRD).

[8] Council Decision 2006/144/EC of 20 February 2006.

[9] Based on results from the research (6th Framework Programme) project CarboEurope (http://www.carboeurope.org).

the EU, as was found out under ECCP I. The realisation of the biological potential for sequestering carbon can, however, be constraint by economic viability factors (e.g., timber market). In this respect, it has also to be considered the "leakage" effect of the substitution of EU wood production by imports (and their transport), which will lead to a reduced carbon sink potential in forests outside the EU.

Croplands as major land use in Europe represent a considerable potential for sequestration and reduction of GHG emissions. However, there is a large uncertainty associated with Europe's GHG fluxes from soils. Theoretically carbon sequestration potentials are very large, but due to biological/physical, economical and social/political constraints a realistic figure for the potential actually represents 10 to 20% of the biological potential[10]. There are no realistic assessments for carbon sequestration of grasslands in Europe, although their management is considered the critical factor to perform a role as carbon sink.

Beyond that, some recent scientific studies suggest that European soils may currently represent a source rather than a sink of carbon. Considerable carbon losses from soils in the UK have been found[11].

In most EU countries effective incentives are lacking to encourage soil carbon sequestration. Carbon sequestration between 1990 and 2000 was small or negative in the EU-15 and all case study countries. For all countries except Belgium, carbon sequestration is predicted to be negligible or negative by 2010, based on extrapolated trends, and is small even in Belgium[12].

Previous estimates in ECCP I have focused on the potential for carbon sequestration and have shown quite significant potentials. The ECCP II review in this sector, which examines the sequestration likely to occur by 2010, suggests that the potentials will not be realized in the EU. Without incentives for carbon sequestration in the future, cropland carbon sequestration under Article 3.4 of the Kyoto Protocol will not be an option. Considerable additional uncertainty has to be taken into account as the potential for soil sequestration can also be wiped out by future climate change impacts.

Potential farm management measures for enhancement of the role of cultivated soils as carbon sink include: zero or reduced tillage systems, organic farming, and permanent revegetation of set-aside areas. The main measures that may be enhancing carbon stocks on croplands is organic farming, although the magnitude of this effect is highly uncertain[13]. These measures are already implemented driven by environmental (e.g., soil, nutrient management, quality of air) and agricultural (e.g., cross-compliance, including the protection of permanent pasture, and agri-environment programmes) policies. It has, however, to be considered that any measure for sequestration need to be implemented for over 20 years to get beneficial carbon accrual in climate change terms and meet the Kyoto Protocol rules. Cost-analyses would be needed to examine the real potential, in which the costs for monitoring are included. Stability in policy incentives, if these measures are assessed as

---

[10] Smith, P. 2004. Carbon sequestration in croplands: the potential in Europe and the global context. *European Journal of Agronomy* **20**: 229-236.

[11] Bellamy, P.H., P.J. Loveland, R.I. Bradley, R.M. Lark and G.J.D. Kirk (2005): Carbon losses from all soils across England and Wales 1978-2003, Nature 437, 245-248. Carbon was lost from soils at an annual rate of 6g carbon per kg of soil on average (measured in the UK but representative for Europe). For soils with more than 100g per kg carbon, the rate of loss was even greater (>20g per kg per year). Bogs and upland heaths in particular have changed considerably between the first and second sampling. This accounts to a net rate of change in the UK of 13Mt carbon per year. Currently further research is ongoing on the issue of carbon loss from soils in Europe.

[12] Smith, J.U., Smith, P., Wattenbach, M., Zaehle, S., Hiederer, R., Jones, R.J.A., Montanarella, L., Rounsevell, M.D.A., Reginster, I., Ewert, F., 2005. Projected changes in mineral soil carbon of European croplands and grasslands, 1990-2080. *Global Change Biology* **11,** 2141–2152.

[13] Smith, P., Andrén, O., Karlsson, T., Perälä, P., Regina, K., Rounsevell, M. & van Wesemael, B. 2005. Carbon sequestration potential in European croplands has been overestimated. Global Change Biology 11, 2153-2163. Evidence of the effects of organic farming to enhance carbon stocks can be found in 'Current trends of soil organic carbon in English arable soil' King, Bradley and Harrison Soil Use and Management Volume 21, Number 2, June 2005, pp. 189-195(7).

beneficial, would be necessary as, for instance, half of any carbon stored can be lost in the first year of tillage. The effectiveness of the relevant measures would need to be assessed at regional or low spatial level.

Drained peatlands under agricultural use are hotspots of CO_2 emissions and often also N_2O emissions (in terms of CO2-eq., emissions are typically ten times higher than from mineral agricultural soils). Anthropogenic emissions from agricultural peatlands in EU-25 are estimated at >40 Mt CO2-eq. Thus, re-establishing peatland dynamics could lead to an additional long-term carbon sink. Peatland conservation programmes have been already developed in some MS (e.g., the Netherlands).

3.2 CARBON SEQUESTRATION MEASURES IMPLEMENTED IN MEMBER STATES[14]

Several MS report that afforestation and reforestation are part of the national policy or strategy towards Kyoto. However the quantitative effects so far reported remain uncertain, or incomplete (missing reporting) because several MS report quantitative effects estimated together with forest management or forest conservation. Some MS however report that afforestation/reforestation programmes do not fulfill expectations and areas planted are below targets (Denmark, Belgium).

The effects estimated under the ECCP I for afforestation and reforestation may still match current estimates from member states, assuming comprehensive estimates by those MS, which did not yet report quantitatively the mitigation effect of afforestation /reforestation.

Some Member States have elected to include Forest Management under Article 3.4 of the Kyoto Protocol in their emission reductions. Currently the UK, France, Sweden and Portugal, have reported a positive decision which would result (using Forest Management up to the Kyoto Cap) in a total of 7.53 Mt CO_2eq. for forest management. A positive election of Member States where decisions on Forest Management are pending, may add an additional 10.5 Mt CO_2eq., which would result in 18.03 Mt CO_2eq., slightly below the ECCP I estimate of 19 Mt CO_2eq.

The state of implementation in Member States of ECCP I measures identified on carbon sequestration from soil measures is sobering. It is often not addressed by MS in reporting on policies and measures. Soil effects are only accountable under the Kyoto Protocol when cropland management is elected (so far only in Portugal). Inventory methods used by MS mostly do not differentiate between the various cropland management practices and the total effect and long-term effect remain very uncertain. The figures provided by MS do not allow the conclusion that the LULUCF sector would make any contributions to the ECCP I objectives in carbon sequestration – thus some 60-70 Mt CO_2eq. identified in the ECCP I will not materialise for the first commitment period.

4. BIO-ENERGY FOR CARBON SUBSTITUTION

4.1 CARBON SUBSTITUTION POTENTIAL

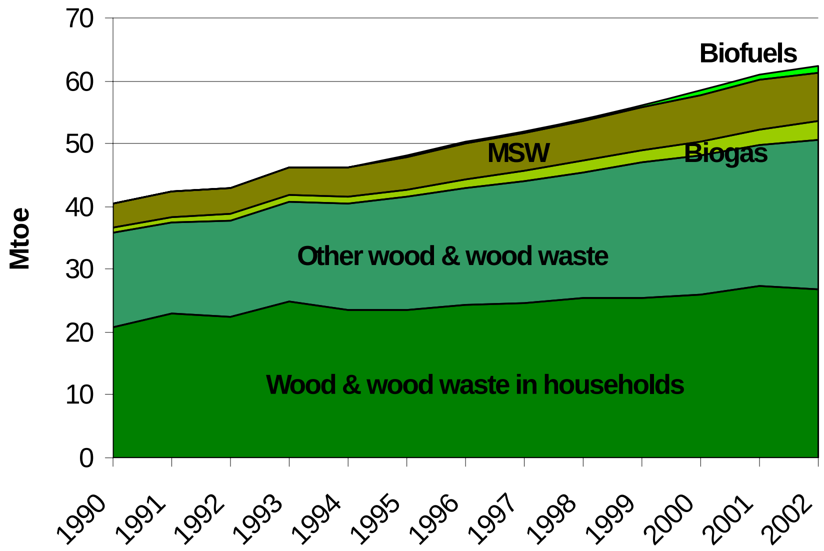
ECCP I identified a technical potential of bio-energy from agriculture, forests and waste of 200-600 Mt CO_2eq. Biomass is a source of renewable energy which is quoted in all sectors (electricity, heat, transport). The key technologies for conversion of biomass are by combustion, pyrolysis, and gasification. Waste modification can be completed by auto-claving and anaerobic digestion. Biomass can be used by heat or power only, by combined heat and power as well as for the production of biofuels and biomaterials.

Currently a primary biomass potential of at least 180 Mtoe (combining waste, forest and agriculture) is estimated to be technically available without creating any additional pressure

[14] The section is based on results from the Monitoring Mechanism under Decision 280/2004 – presented by Anke Herold in the 2nd meeting of the WG ECCP I review-agriculture (2 March 2006).

on soil and water resources and biodiversity, rising to a potential in the order of 300 Mtoe by 2030[15]. There exist synergies between nature protection/extensification and bio-energy feedstock production, which remains so far largely unexplored, thus creating a need for assessment of high-yield, low-environmental impact crop systems and different biofuel technologies. An additional bio-energy potential may become available at the expense of other environmental objectives, as well as of domestic food production, if bio-energy crops are becoming more competitive with rising fossil fuel and carbon prices. However, this will require a discussion on the interaction between food self-sufficiency and bio-energy production, and other environmental objectives.

FIGURE 4: EU-25 BIOMASS FOR ENERGY USE 1990 - 2002



Source: EU Commission, DG Transport and Energy, based on EUROSTAT data.

The EU has set up indicative targets for renewable energy of 12% of gross energy consumption by 2010 (6% in 2003, of which 2/3 is bioenergy), electricity from renewable energies to 21% in 2010 (12.8% in 2003, biomass accounting for around 15%), and a 5.75% target for bio-fuels in 2010 (currently 1.4%). There are no targets for heating, but the preparation of a renewable heat directive has long been planned.

The key policy instruments to address biomass production, demand and supply are: research, indicative targets, tax reductions and exemptions (directive on energy taxation), technical standards, fuel quality[16]. Extending biomass use to produce energy (bio energy) will both help reduce greenhouse gas emissions and meet the European renewable energy targets.

The EC Biomass Action Plan (BAP) was adopted in December 2005. Its objectives are to set out measures to increase the development of bio-energy from wood, waste and agricultural crops by creating market-based incentives and removing barriers. It identified 20 measures to increase biomass use in electricity, heat and transport. Concerning heating and electricity sectors, the BAP measures are: legislation on renewable energy in heating, renewal of district heating, standardization of biomass fuels, explore how to develop spot market in pellets and chips, encourage Member States to establish national action plans, encourage research and development.

[15] EEA, 2006: How much bioenergy can Europe produce without harming the environment? EEA Report, forthcoming. Preliminary results published in EEA, 2005: How much biomass can Europe use without harming the environment? EEA briefing 2/2005.

[16] CEN/TC335.

The EU Strategy for Biofuels was adopted in February 2006. Its objectives are to further promote biofuels and ensure that their production and use is globally positive for the environment, prepare for the large-scale use of biofuels by improving their cost-competitiveness, research into "second generation" biofuels, scale-up demonstration projects and explore the opportunities for developing countries. The EU Biofuels Strategy has seven policy axes, as aiming to stimulate demand for biofuels, capture the environmental benefits, develop the production and distribution of biofuels, expand feedstock supplies, enhance trade opportunities, support developing countries and support research and development.

The 2003 CAP reform can contribute to the overall EU targets on renewable energy by encouraging farmers to respond to the demand for bio-fuels. For the EU-25 a use of bio-energy crops of 1.4 Mha is estimated. Life cycle analysis indicators will be important tools for monitoring and addressing the effects of any targets, environmental impacts and impacts on agricultural markets especially where bio-energy sources compete for resources or where the biomass has different uses.

Biomass is the main driver for renewable energies growth; the renewable target of 12% is basically led by bio-energy. A communication from the Commission published in 2004 on the share of renewable energy in the EU identified that the shortfall compared to the 12% target is caused by the sluggish growth of renewable energy markets for heating and cooling. The biomass use today is 69 Mtoe, whereas 150 Mtoe would be needed for the EU-25.

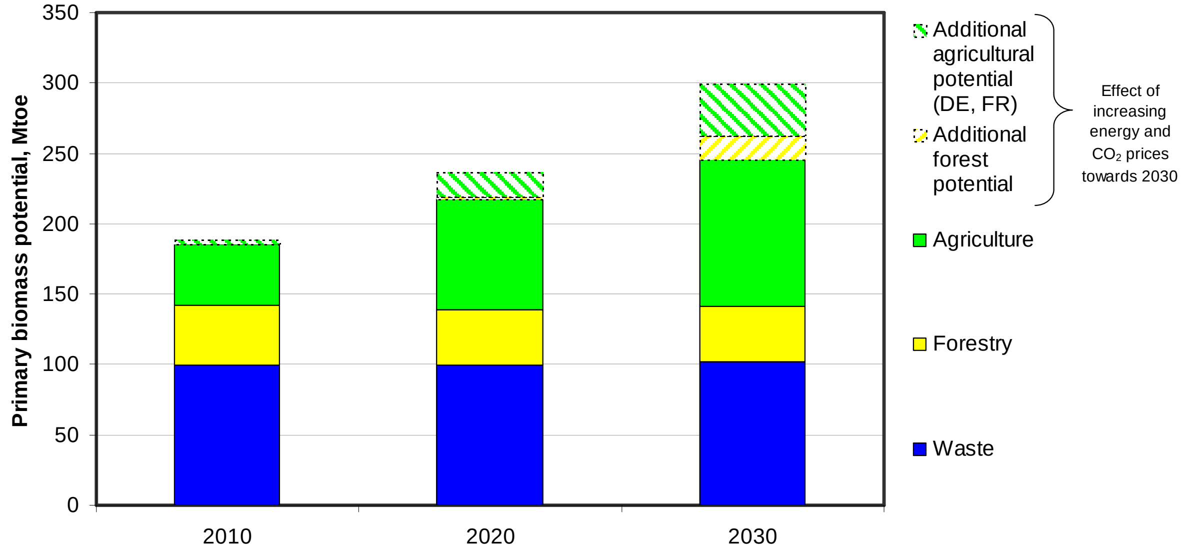
However, biomass production may create additional environmental pressures, such as on water and soil quality, water quantity, biodiversity and climate change emissions. Increased agricultural biomass production might particularly increase pressure on farmland and agricultural sectors, thus causing intensification and enlarged field sizes. There may be incentives to transform extensively used grassland into arable land for growing bio-energy crops. Ploughing permanent grass land will release large amounts of soil carbon and adversely affect biodiversity. However, the importance of permanent pastures is already clearly acknowledged in the mid-term reform of the CAP, which aims to retain permanent grassland[17].

Preliminary results in assessing how much biomass can be used for energy generation without causing such additional pressures suggest that there is sufficient biomass potential in the EU-25 to support ambitious renewable energy targets in an environmentally responsible way. The potential increased pressure on farmland could be minimized if environmental criteria were taken into account for bio-energy production. A recent study developed a number of criteria and calculated the environmentally-compatible potential on that basis.[18] The conclusions are that achieving maximum gains and minimising the potential threat of bioenergy production requires careful planning from EU to local level to develop an appropriate policy framework. It will be important to ensure a balanced approach between domestic production and imports. Development and use of sustainability standards and certification schemes may help to achieve this.

[17] Council Regulation (EC) N° 1782/2003 (Article 5.2) and Commission Regulation (EC) N° 796/2004 (Article 3.2).

[18] In the study, it was assumed that some 30% of the utilised agricultural area is expected to be used for environmentally oriented farming in 2030 and 3% of intensively used farmland should be set aside for nature conservation. This would safeguard against the loss of current extensive farmland categories, and will prevent bio-energy production counteracting a further introduction of organic farming.

FIGURE 5: ENVIRONMENTALLY-COMPATIBLE BIO ENERGY POTENTIAL, EU-25



Source: EEA, 2006: How much bioenergy can Europe produce without harming the environment? EEA Report, forthcoming. Preliminary results published in EEA, 2005: How much biomass can Europe use without harming the environment? EEA briefing 2/2005.

The environmental pressures on farmland and agricultural sectors can be minimised by growing the "right" kind of crops, i.e. environmentally friendly bio-energy crops. A ranking of bio-energy crops according to their specific environmental performance may be a first step towards identifying high-yield, low-impact crops (multi-year crops and perennial crops are overall more favourable), and setting the crop-specific pressure into the context of specific regional environmental characteristics. It is important to note that bio-energy crops can be different from conventional food and fodder crops that are optimised for the nutrient contents, and not their energy value. Moreover, the potential for achieving co-benefits between nature protection and bio-energy feedstock production has to be further explored.

It can be expected that in the coming decades, some land would be released from food and fodder production as a result of a further liberalisation of agricultural markets, and might be dedicated to bio-energy production, taking into account the above constraints. With regards to the targets for biomass for transport, (bio-ethanol and bio-diesel), projections indicate that this will increase in the EU strong demand for arable land.

Regarding forestry biomass, the following environmental considerations can be noted: forest residues provide the ecosystem with nutrients, reduce the risk of erosion, regulate water flows and are beneficial to biodiversity. Their use off-site as a source of biomass has therefore to be carefully considered in relation to these benefits. Moreover, the objective of increasing the use of forestry biomass for bioenergy should be assessed alongside the policy goal of enhancing carbon sequestration in forests.

The maximum technical potential for energy from forests in EU-25 exceeds 500 Mm^3 a year. However, only about 30% of this technical potential (140 M m^3) could be harvested annually for energy. In Europe, 75% of final fellings and 45% of thinnings can be harvested for energy, either with mechanised or manual cutting. However, there are large differences between countries and regions in EU in the availability, quality and costs of the forest biomass. Research needs to be carried out to identify how to mobilise the potential. Although the biomass is readily available and there is proven power plant technology, secure and cost competitive supply of feed stock is a key constraint. Detailed project by project biomass resource and supply chain analysis (machines and logistics) is one of the keys to success. The potential for unintended consequences in other timber markets has also to be considered.

4.2 CARBON SUBSTITUTION MEASURES IMPLEMENTED IN MEMBER STATES

The measures reported by Member States on biomass give a rather patchy picture far below the range of potentials identified in the ECCP I (200-600 Mt CO2 eq.). In particular the quantification of the projected effect is hardly possible because Member States only partly quantify these measures.

Belgium reported a wood energy plan for the recovery of energy from wood; Denmark reported a biomass agreement on the use of wood chips as fuel with an objective of 0.2-0.4 million tonnes wood chips per year used in primary CHP production. France reported the development of biomass energy from forests and the extension of the wood energy plan 2000-2006 until 2010 including a range of promotion measures (quantitative effect estimates as part of renewable strategy). Poland is planning the use of timber for energy generation and the development of new technologies for growing and harvesting vegetal biomass designed for being used as a renewable energy source and raw material for industry. Slovenia reported incentives for crops for biodiesel production. Sweden starts up grants for energy forests and UK has an energy crops scheme to support planting of short rotation coppice and miscanthus for heat and electricity production with a reduction effect of 0.15 Mt CO_2eq. in 2010.

Several Member States aim to create a market for biomass and biofuels. Such measures usually target other sectors, but no direct intervention in agriculture. For instance Germany's Renewable Energy Sources Act establishes new feed-in tariffs for electricity generation from biomass from small plants and a market incentive programme for renewables offers grants for investments or credits in biomass plants.

Compared to previous (under ECCP I) and current estimates of the effects of the various options, there could be double counting effects from biomass use due to Directive RES-electricity, Biofuels Directive, and further measures of RES regarding heating (mainly biomass, some solar thermal), anaerobic digestion of manure, potential of bio-energy from agriculture, forests and other residues.

5. CONCLUSIONS AND RECOMMENDATIONS

Measures identified under ECCP I remain valid. However, previous (ECCP I) estimates have to be considerably reviewed in view of the state of implementation of policies and measures. In particular, estimated carbon sink potentials in agriculture and forestry appear to be too optimistic.

The GHG emission trends currently observed are for the most part due to the side-effects of structural changes or CAP or the implementation of water protection legislation, and not to specific climate change measures in the agricultural policy area. This also makes it difficult for some Member States to quantify the effects.

Agriculture and forestry have additional opportunities to further contribute to climate change mitigation by reducing GHG emissions, by enhancing carbon sequestration and by producing renewable energies. Unlike other industries, controlling emissions in these sectors is not a matter of handling 'end of pipe' activities. Sustainable agriculture and forestry is required to deliver a range of other environmental outcomes (e.g., preservation of water resources and quality), and remain a viable competitive sector, bringing economic and social benefits. It is also uniquely affected, in general and in its ability to reduce emissions, by the impacts on climate change. Climate change has been acknowledged as one of the priorities for EU agricultural and rural development policy. The issue for the coming years is about using the possibilities and options to contribute to climate change mitigation and tackling challenges to enhance the resilience of the sector against and adapt to the adverse impacts of climate change.[19]

To effectively contribute to the environmental objectives of the CAP, particularly the objectives to combat climate change, it is of crucial importance that Member States implement the respective policies and measures now available to them in an efficient and comprehensive manner.

GHG EMISSIONS

With the current measures, the most recent projections show a decline of agricultural GHG emissions (CH_4 and N_2O) of around 15% by 2010 compared to 1990, for the whole EU-25. For EU-15, in comparison to the ECCP-I estimations, the 2003 CAP reform projections lead to larger reductions by 2010, i.e., up to 14% reduction against 7% estimated previously, compared to 1990 level. This trend is mainly a consequence of successive reforms of the CAP since 1992, declining cattle numbers and more efficient application of fertilizers. However, these estimated trends are different between Member States.

The 2003 CAP reform, with the introduction of a decoupled income support to farmers and cross-compliance, is by far the most important policy action and the main driver for the declining GHG emissions trend. Moreover, it should not be overlooked that further positive contributions can be expected from improvements in the implementation of the Nitrates Directive in some old and new Member States.

The new rural development regulation for the period 2007-2013 will provide further opportunities to strengthen the contribution of the CAP to combating climate change, which is one of the key priority areas defined in the Community strategic guidelines for Rural Development.

Among the measures that could help further reduce agricultural GHG emissions in the future, the production of biogas (installation of farm-scale, or centralised and farm supplied anaerobic digesters) appears among the most promising, though the economic viability need careful assessment.

CARBON SEQUESTRATION IN FOREST AND AGRICULTURAL SOILS

The reporting and accounting systems as implemented in the Member States show estimates of measurable carbon sequestration effects which are much more conservative than the potential estimated previously (ECCP I estimates).

The forestry goals (ECCP I estimates) are likely to be achieved, both for afforestation and reforestation (Kyoto Protocol Art. 3.3) and forest management activities (Kyoto Protocol Art. 3.4, which is capped by the Kyoto inventories rules).

The review of the implemented policies by Member States showed that there is scope to improve the monitoring methodologies and the reporting of policies regarding the agricultural sector.

The figures provided by MS do not allow the assessment whether the LULUCF sector would make any contributions to the ECCP I objectives in terms of carbon sequestration. In the view of the obligation for Member States to report projections regarding LULUCF to the UNFCCC, the inventories need to be improved and a future common methodology needs to be drawn up.

Cropland management options for carbon sequestration (Kyoto Protocol Art. 3.4) were not selected by Member States so far and will not account for the first commitment period of the

[19] Climate change adaptation needs in the agricultural and forestry sector are being considered in more detail in the ongoing ECCP II working group on adaptation; http://forum.europa.eu.int/Public/irc/env/eccp_2/library?l=/impacts_adaptation&vm=detailed&sb=Title.

Kyoto Protocol. However, in the long term (post 2012) there is still a considerably high potential, even if constrained by high uncertainty and potentially high monitoring costs. Despite the difficulty and the incertitude surrounding the potential for sequestering carbon of cropland management measures, these are important from a soil conservation perspective, particularly in the view of the risk of carbon losses.

Considerable carbon losses from all types of soils have recently been measured in the UK. If these findings will be confirmed across the EU, this would be a serious concern that would require further action. The UK is urgently taking forward these findings. Further research to clarify this issue and the role of different measures in addressing potential soil carbon loss is needed.

Drained peatlands under agricultural use are hotspots of CO_2 emissions and often also N_2O emissions. Thus, re-establishing peatland dynamics could lead to an additional long-term carbon sink.

Cross-compliance (CAP reform) include minimum standards of Good agricultural and environmental conditions related to the maintenance of soil organic matter levels (crop rotation, arable stubble management), the protection of soils against erosion, and the maintenance of carbon sinks (e.g., protection of permanent pasture). Agri-environmental measures provide support for measures which go beyond the mandatory management practices (e.g., conservation agriculture).

The forthcoming soil thematic strategy and Soil Framework Directive will provide an EU framework for Member States to better monitoring and protect their soils, such as their carbon sink effect and organic matter content. Soil conservation is beneficial not only for carbon sequestration but also for other environment-related targets like protecting biodiversity and stabilizing eco-systems.

BIO-ENERGY

Extending biomass use to produce bioenergy will both help reduce greenhouse gas emissions and meet European renewable energy targets. Renewable energy needs to be promoted also in view of increasing the security of fuel supply because of its potential benefits for employment especially in rural areas.

The measures reported by Member States give a rather uneven picture far below the range of potentials identified in the ECCP I. It needs to be noted that the decline in GHG due to the cultivation of bioenergy crops will not be accounted to the agricultural sector but the energy sector.

Biomass production may create additional environmental pressures, such as on biodiversity, soil and water resources. However, recent preliminary estimations suggest that there is sufficient biomass potential in the EU-25 to support ambitious renewable energy targets in an environmentally responsible way. Achieving maximum gains and minimising the potential threat of bioenergy production would require the evaluation of possible impacts on the environment and careful planning from EU to local level. In this respect, more research is needed to identify high-yield, low impact crops that can be optimised for their energy value. In Southern Europe, this will have to take into account the trade-offs between irrigation and yields. As regards the objective of increasing the use of forest biomass for bioenergy, this should be assessed alongside the policy goal of enhancing carbon sequestration in forests.

The recent EC Biomass Action Plan (December 2005) aims at setting out measures to increase the development of biomass energy from wood, waste and agricultural crops creating market-based incentives and removing barriers. The objectives of the EU Strategy for Biofuels (February 2006) are to further promote biofuels for transport through a set of measures in different policy areas.

The CAP can contribute to the overall EU targets on renewable energy by encouraging farmers to respond to the demand for biofuels. The new rural development policy for the period 2007-2013 offers a range of measures that can support the development of raw materials for renewable energy and processing capacities.

In order to win enhanced public acceptance and further the penetration of biofuels, careful planning along the entire supply chain to minimise logistical problems will be required (e.g., energy crops production practice, logistic optimization of inputs and outputs, conversion plant size and location, need to overlay maps of heat need, electricity need and availability of biomass).

In condensing power plants the current coal-fired energy conversion efficiency for biomass lies between 25% and 35%. This should be replaced by more efficient decentralised combined heat and power, where total efficiency exceeds 80%.