Carbon impacts of biomass consumed in the EU

EU DG ENER project ENER/C1/427

Approach and key findings

Quantitative assessment (Tasks 2, 3 and 4)

- Focus on total GHG emission balanced of solid biomass for electricity and heating/cooling
- Assessment of different bioenergy energy scenarios
- Considering the full biomass/bioenergy life cycle and key GHGs
- Specified time horizons, notably 2030 and 2050

Supported by qualitative assessment (Task 1)

- Literature review on biogenic emissions of forest bioenergy

Qualitative assessment (biogenic carbon and forest bioenergy) Key points

Biogenic carbon and forest bioenergy

- Under Business as Usual, forest bioenergy is 'carbon-neutral' when it is produced as part of long-standing management of forest areas for wood production

- However, biogenic C emissions can occur when production from forests is increased significantly to meet requirements for wood
  - i.e. if 'mobilising the wood resource'

Biogenic carbon and forest bioenergy

- Forest growth > harvest does not always mean low/no CO_2 emissions
- Biogenic C emissions are 'finite' and take place over a fixed period (related to period over which the 'wood resource is mobilised')
- Climate policy should account for them
  - Care needed to define 'business as usual' and 'increases' relative to this

When biogenic C emissions are allowed for:

- Forest bioenergy use can lead to net GHG savings or increases depending on:
  - What time horizon you consider
  - What forest management is involved in producing the 'extra' wood
  - What types of wood (bits of tree) are used for bioenergy
  - What you do with the wood and which fuels are replaced

Quantitative assessment

Scenarios for biomass use in the EU

- **A: 'Reference':** Existing 2020 policy targets
- **B: 'Carry on/unconstrained use'** – highest use of biomass for energy, from all sources, no constraints
- **C1: 'Carry on/imported wood'** – emphasises (relatively unconstrained) imported forest bioenergy
- **C2: 'Carry on/domestic crops'** – emphasises energy crops/agricultural biomass in the EU region, application of biomass sustainability criteria
- **C3: 'Carry on/domestic wood'** – emphasises forest bioenergy supplied from the EU region, application of biomass sustainability criteria
- **D: 'Back off'** – Bioenergy de-prioritised post 2020.

Modelling approach

- **VTT-TIAM (VTT)**
  - A version of the TIMES Integrated Assessment Model (TIAM) of IEA-ETSAP
  - Technology-rich, bottom-up, partial market equilibrium model
  - Used to model energy markets in long term scenarios
  - Outputs include energy use, prices and GHG emissions (partial)
- **MITERRA-Europe (Alterra) and Roth-C**
  - Used to model agricutural biomass supply and associated changes in carbon stocks/sequestration/indirect GHG emissions
- **CARBINE (Forest Research)**
  - Large-scale forest sector carbon accounting model
  - Used to model forest biomass supply, changes in forest carbon stocks/sequestration/GHG emissions of forest operations
- **Bespoke pathway workbooks (North Energy Associates)**
  - Used to calculate indirect GHG emissions, from bioenergy and wood material use/counterfactuals, synthesis of final results.

Key assumptions (1)

- **Relate to updated PRIMES 2013 scenarios for future energy use in the EU**
  - Involves allowing for multiple, complex changes in energy supply, conversion and use over time
  - PRIMES Reference scenario for Scenario A
  - PRIMES EEMRES2030 scenario for decarbonisation scenarios
  - PRIMES scenarios include specified levels for renewable energy use and GHG emissions reductions in 2030 and 2050
  - Also other factors are specified, e.g. ETS carbon price
- **'Carry on' scenarios involve measures to stimulate bioenergy demand and supply e.g.**
  - Acceleration of the time to market of highly efficient bioenergy technologies
- **'Back off' scenario involves reduced contribution from bioenergy compared to Reference scenario after 2020**
  - Greater emphasis on other energy sources.

Key data sources

Agriculture, including soils and climate

- Common Agricultural Policy Regionalized Impact (CAPRI) model outputs
- MITERRA-Europe model outputs
- LUCAS Soil Survey
- WorldClim database.

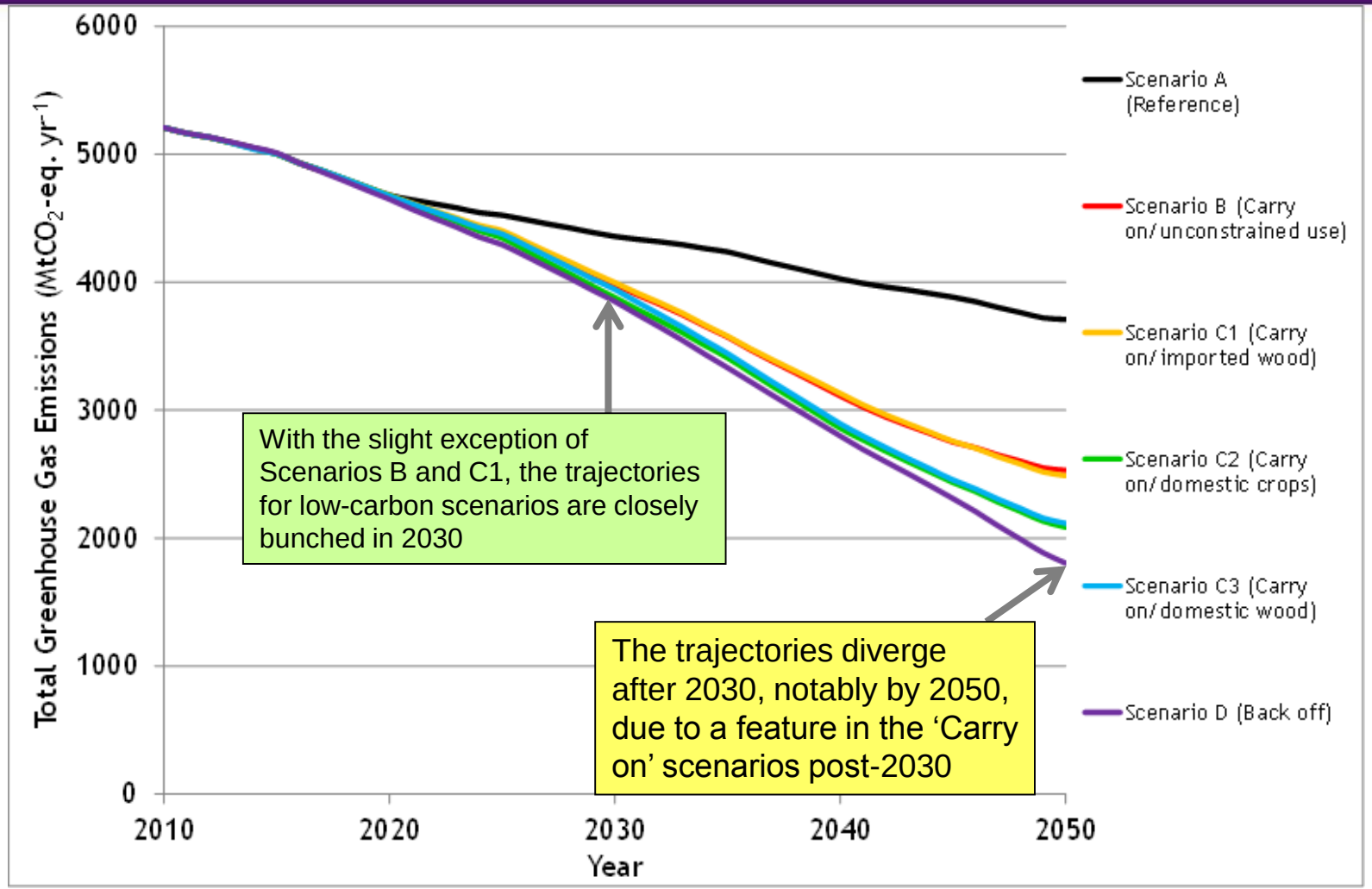
Forests, including soils, wood production

- UN-ECE forest database
- Canadian and USA National Forest Inventories
- Global Land Cover 2000
- Harmonized World Soil Database
- FAO Global Forest Resource Assessment 2010.

Pathway workbooks

- GEMIS database
- Relevant IPCC Guidance
- European Reference Life Cycle Database (ELCD).

Total annual GHG emissions



- Total annual GHG emissions decrease for all scenarios
- Bigger reductions for all 'low-carbon' scenarios
- Relatively small differences between 'low-carbon' scenarios.

Detailed analysis of results 2030

Positive results = emissions increases, negative = savings

Source	GHG contribution by scenario ($MtCO_2$-eq. yr^{-1})				
	B	**C1** wood imports	**C2** Domestic crops	**C3** Domestic wood	**D** Back off
CCS	-24	-24	-24	-24	-42
Energy efficiency	-89	-37	-85	-56	+72
Nuclear	-100	-135	-65	-86	-280
Other renewables	-3	-74	-31	-73	-290
Bioenergy (avoided emissions energy sector)	*-262*	*-223*	*-277*	*-247*	*+133*
Bioenergy (biogenic emissions)	*+101*	*+133*	*+4*	*+71*	*-101*
Bioenergy (net)	-161	-90	-273	-176	+32
Total	-378	-360	-478	-415	-508

Cost performance of scenarios

Scenario	Marginal energy system cost (% of GDP) for year		Marginal carbon price (€/tCO$_2$) for year		Average GHG reduction cost 2010-2050 (€/tCO$_2$)
	2030	2050	2030	2050	
B ('Carry on/ unconstrained use')	0.18%	0.90%	48	196	122
C1 ('Carry on/ imported wood')	0.19%	0.89%	43	147	125
C2 ('Carry on/ domestic crops')	0.18%	0.91%	43	160	96
C3 ('Carry on/ domestic wood')	0.20%	0.91%	38	138	100
D ('Back off')	0.63%	1.59%	53	310	183
	×3.4	×1.8	×1.2	×1.9	×1.7

Based on several measures of energy system costs:

- Scenario D ('Back off') achieves the greatest reductions in GHG emissions, but stands out as much more costly than the various 'Carry on' scenarios
- Amongst the various high-bioenergy 'Carry on' Scenarios, C2 ('domestic crops') and C3 ('domestic wood') are marginally favourable.

Detailed analysis of results 2030

- **Key conclusions:**
  - A significant increase in bioenergy use in the EU, considered as a whole, is likely to lead to a net decrease in GHG emissions being contributed by this particular type of energy source.
  - Bioenergy use can be de-prioritised, but this involves higher costs for the energy system.
  - But what about differences in types of bioenergy source?

Forest bioenergy sources

- **Further detailed analysis reveals that:**
  - *GHG emissions due to use of forest bioenergy sources are extremely variable (significant net increases to significant net decreases)*
  - Variations can be observed between scenarios and between forest biomass supplied from different geographical regions
  - *However,* these variations reflect underlying assumptions about:
    - Types of forest involved
    - Approaches to forest management
    - Interactions with non-energy wood uses
    - Type of fossil fuels replaced

Thank you