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Environmental impact assessment in the JRC BIOMASS project

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European Commission

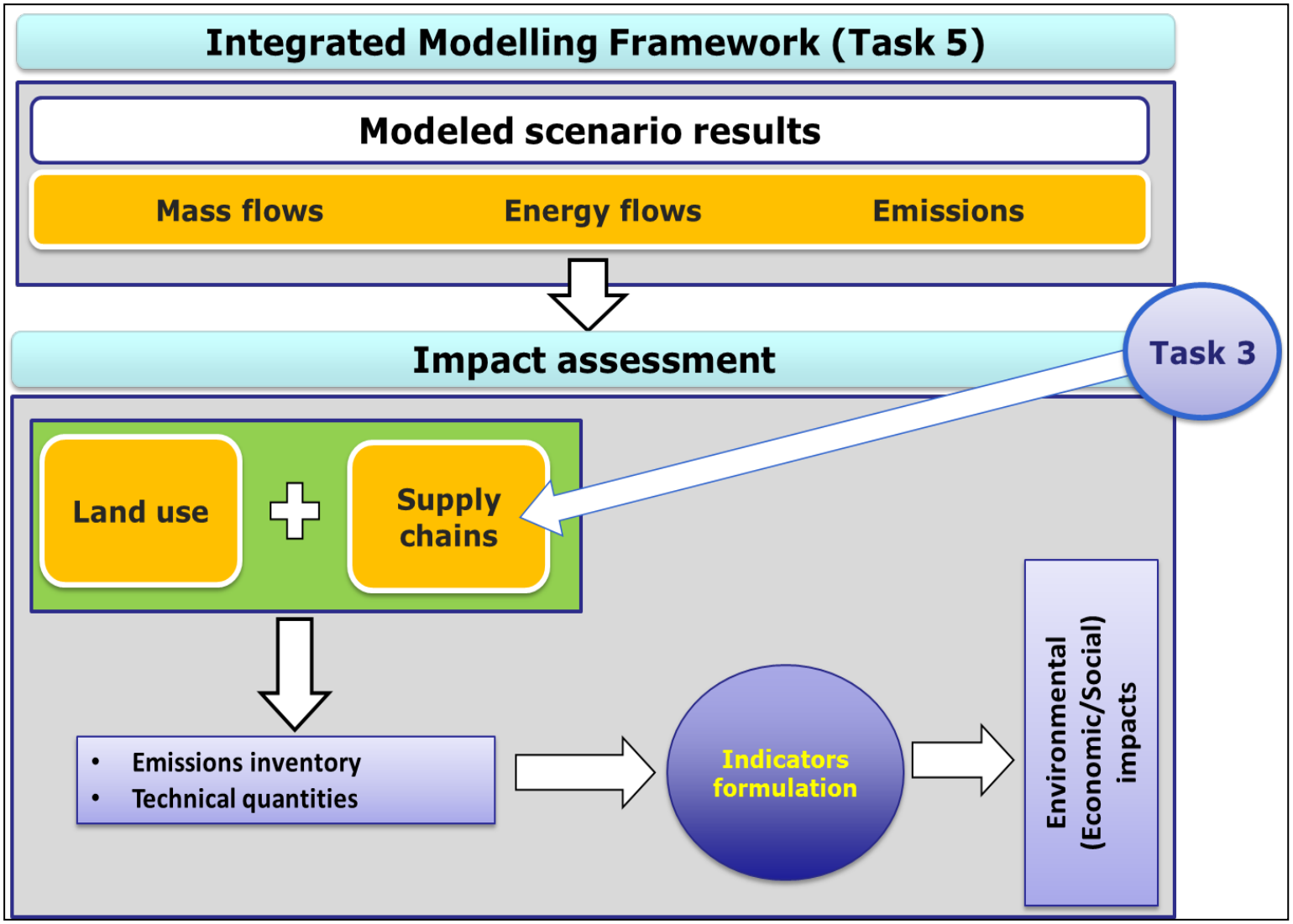
Environmental impacts in the BIOMASS project

Commodity-level

(Task 3)

System-level

(Task 5)



Two different LCA modelling principles

Because the scope of the analysis in the two tasks is different, we need two modelling principles.

The attributional life cycle model depicts its actual or forecasted specific or average supply-chain plus its use and end-of-life value chain. The existing or forecasted system is embedded into a static technosphere.	The consequential life cycle model depicts the generic supply-chain as it is theoretically expected in consequence of the analysed decision. The system interacts with the markets and those changes are depicted that an additional demand for the analysed system is expected to have in a dynamic technosphere that is reacting to this additional demand.

Task 3 is based on A-LCA modelling, while Task 5 follows more consequential principles.

Supply-chain impacts





Silviculture + Logging + Transport + Processing + Commodity

= Total GHG emissions

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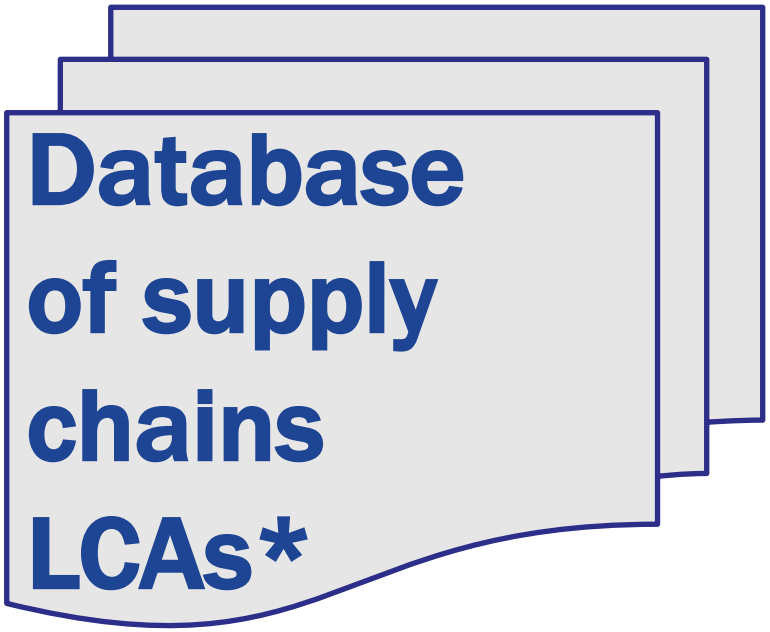
Task 3: Database

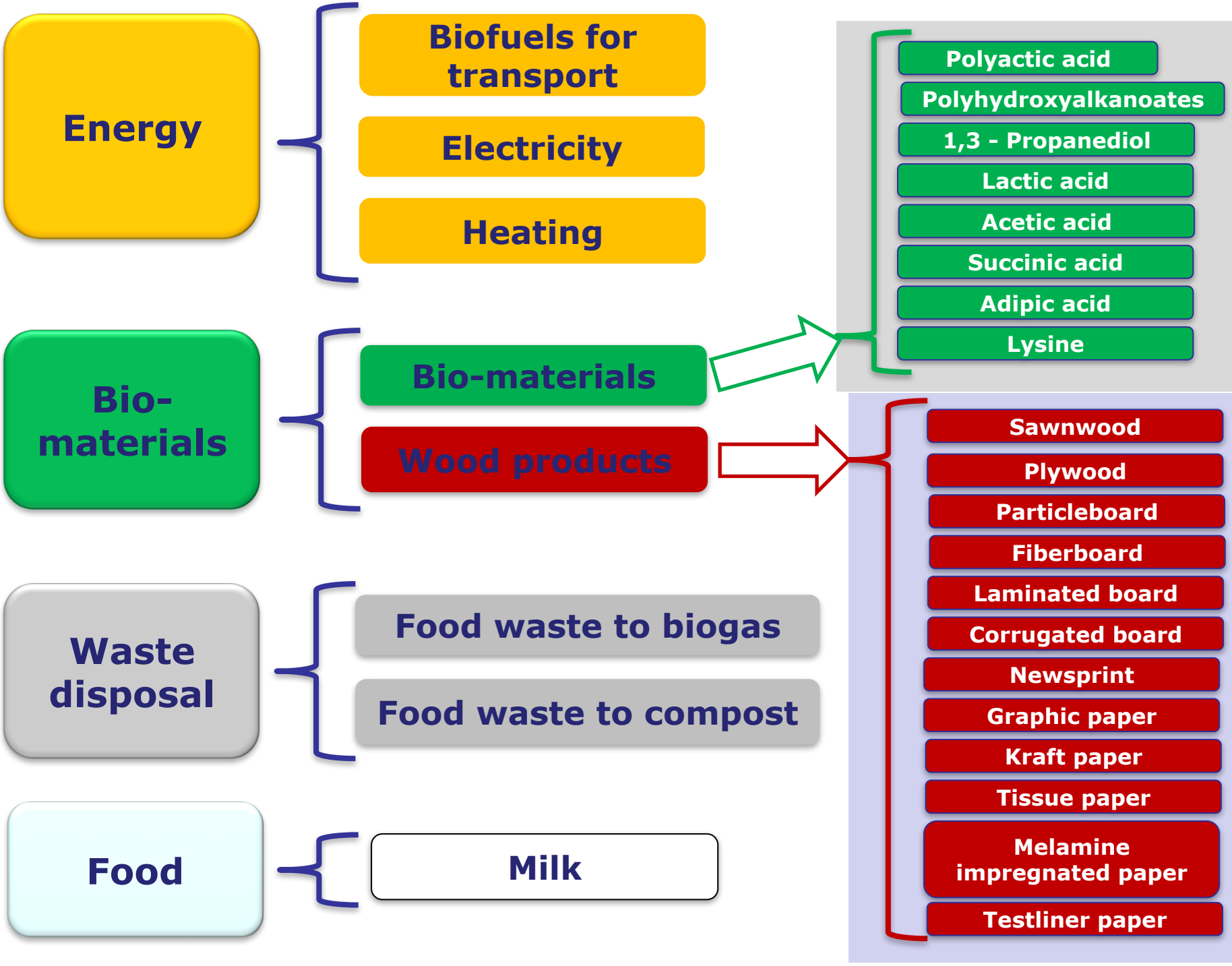
343 **PATHWAYS**

30 **FEEDSTOCKS**



100% **Coverage for GHG emissions**

≈15% **Coverage for Acidification, Particulate, Eutrophication, Ozone formation, Primary energy use**

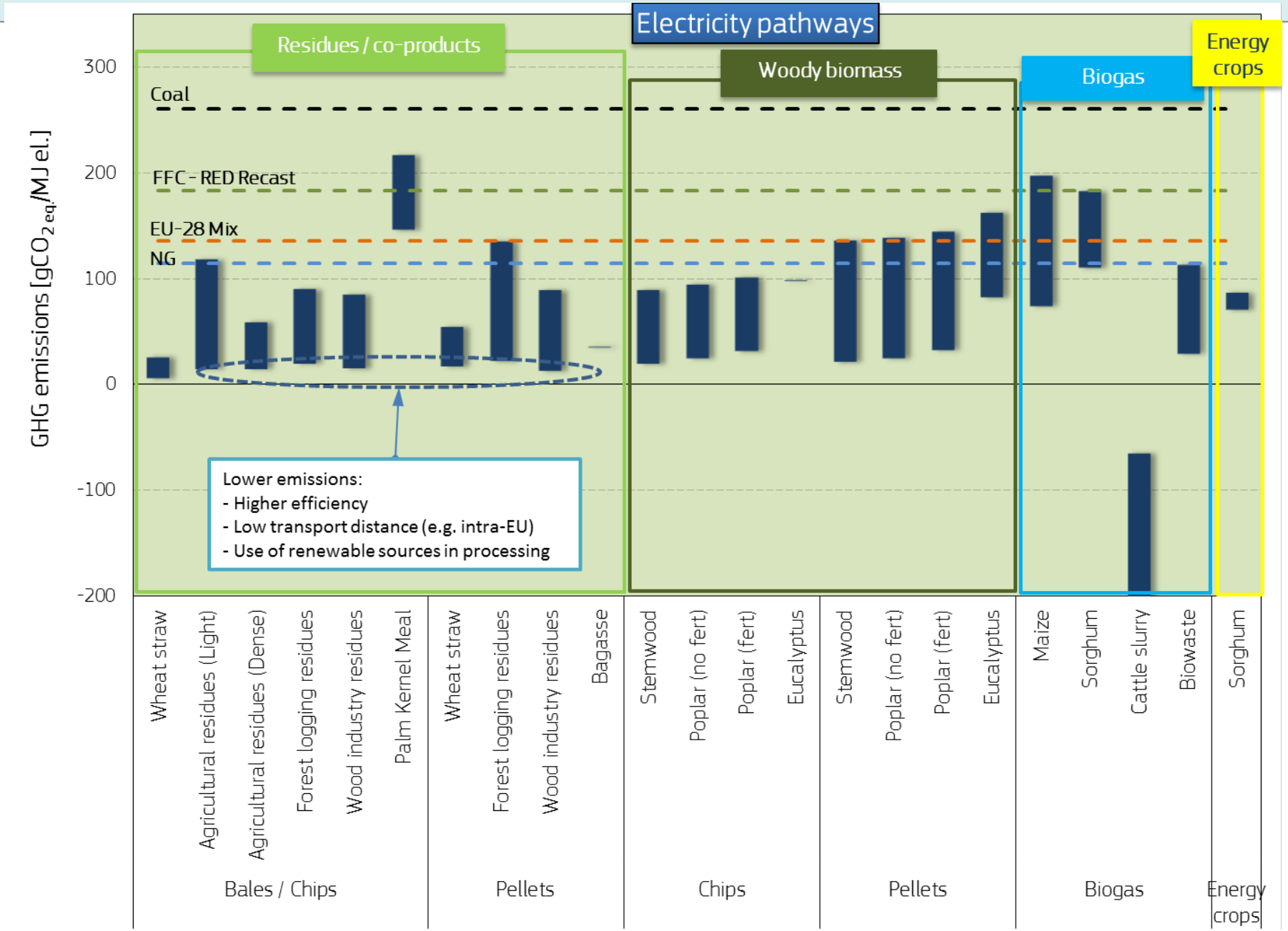

Energy
Biofuels for transport
Electricity
Heating
Bio-materials
Bio-materials
Wood products
Polyactic acid
Polyhydroxyalkanoates
1,3 - Propanediol
Lactic acid
Acetic acid
Succinic acid
Adipic acid
Lysine
Sawnwood
Plywood
Particleboard
Fiberboard
Laminated board
Corrugated board
Newsprint
Graphic paper
Kraft paper
Tissue paper
Melamine impregnated paper
Testliner paper
Waste disposal
Food waste to biogas
Food waste to compost
Food
Milk

Task 3: Supply chains results

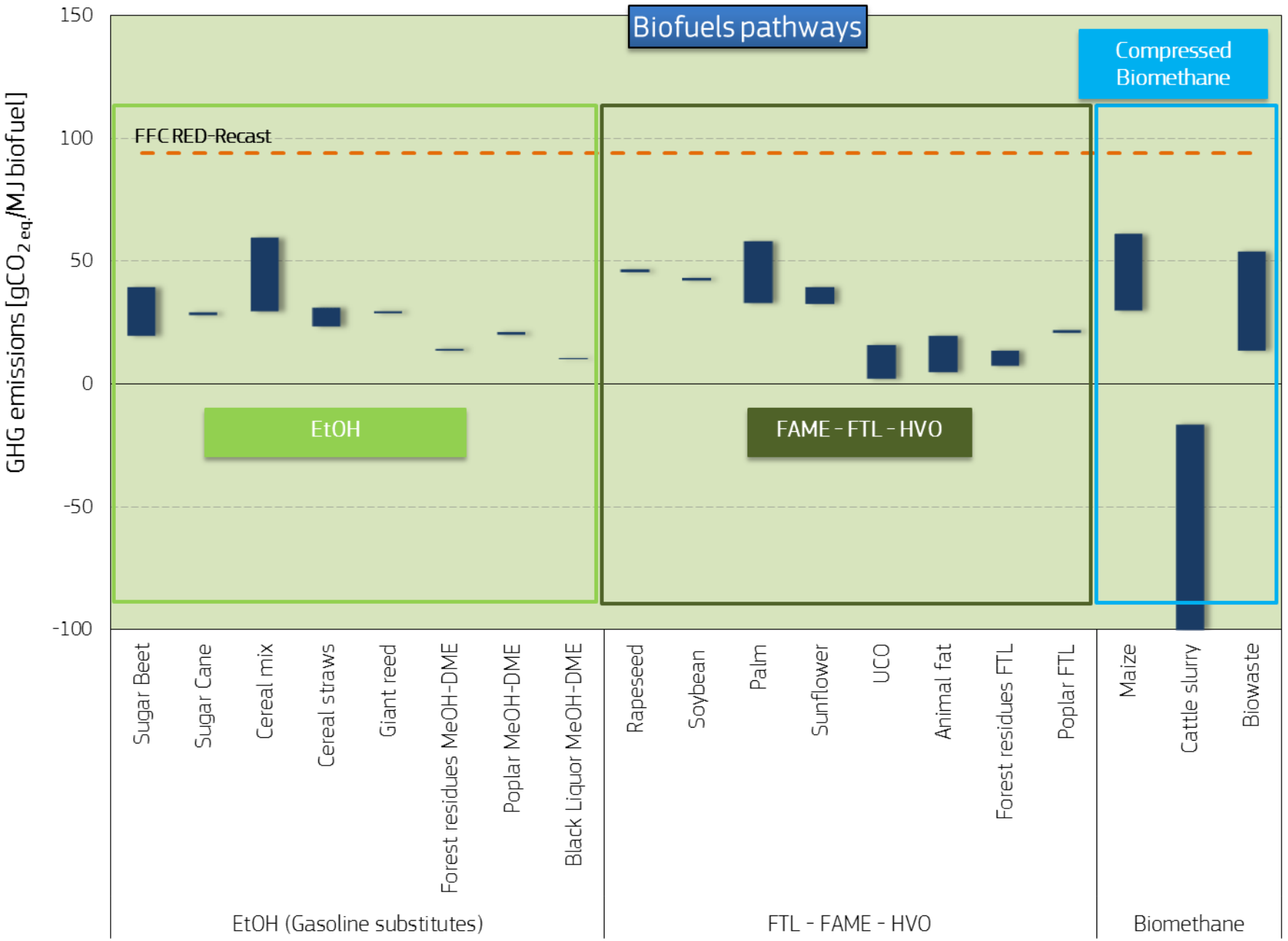
Nota bene:

- These values represent only SUPPLY CHAINS impact.
  - ❑ NO market-mediated impacts
  - ❑ NO biogenic-C emission and
  - ❑ NO counterfactual consideration
- See next section on Advanced A-LCA for an integration of these issues in LCA of bioenergy pathways

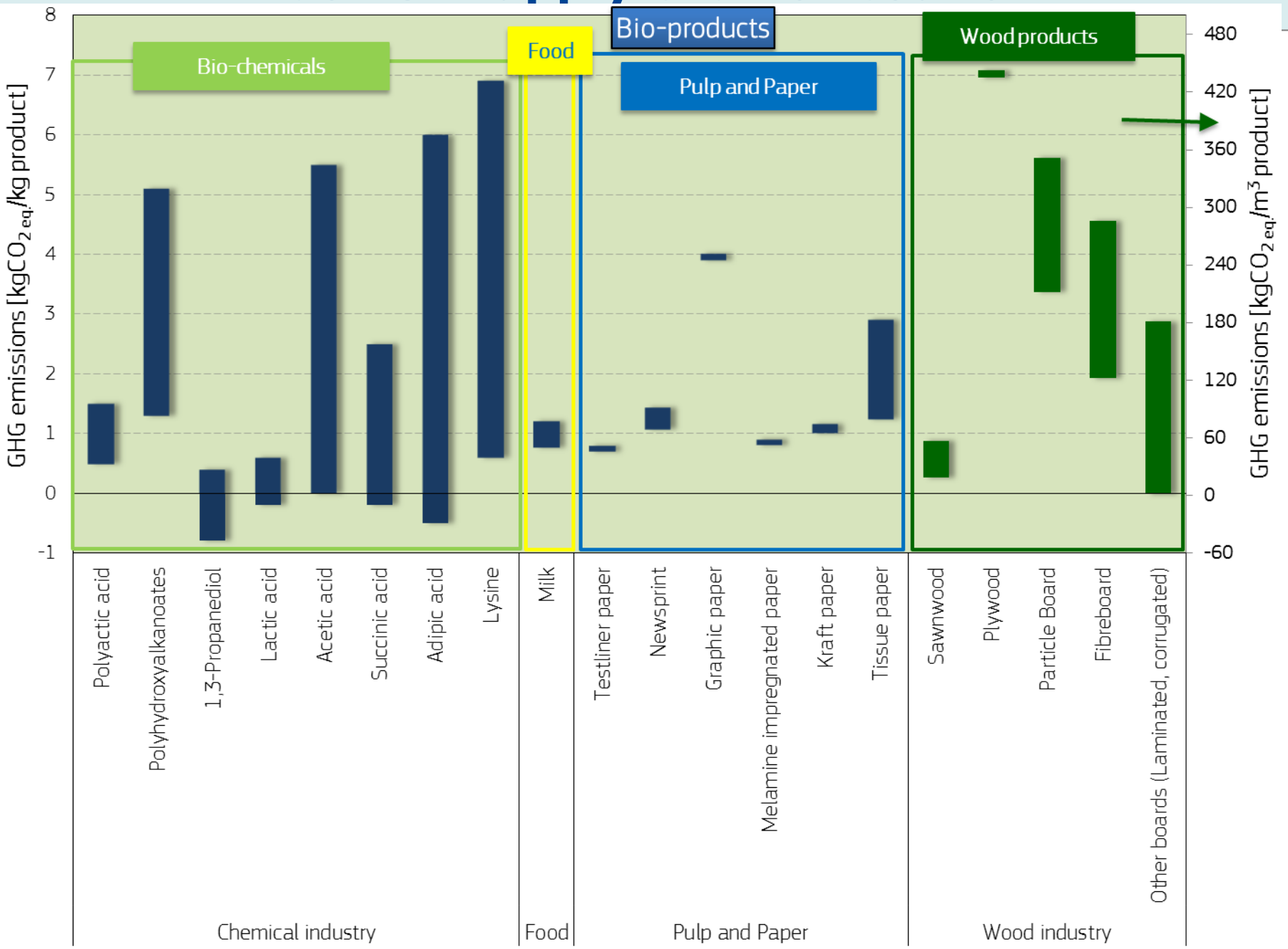
Task 3: Supply chains results



Task 3: Supply chains results



Task 3: Supply chains results



An "Advanced" approach to attributional-LCA?

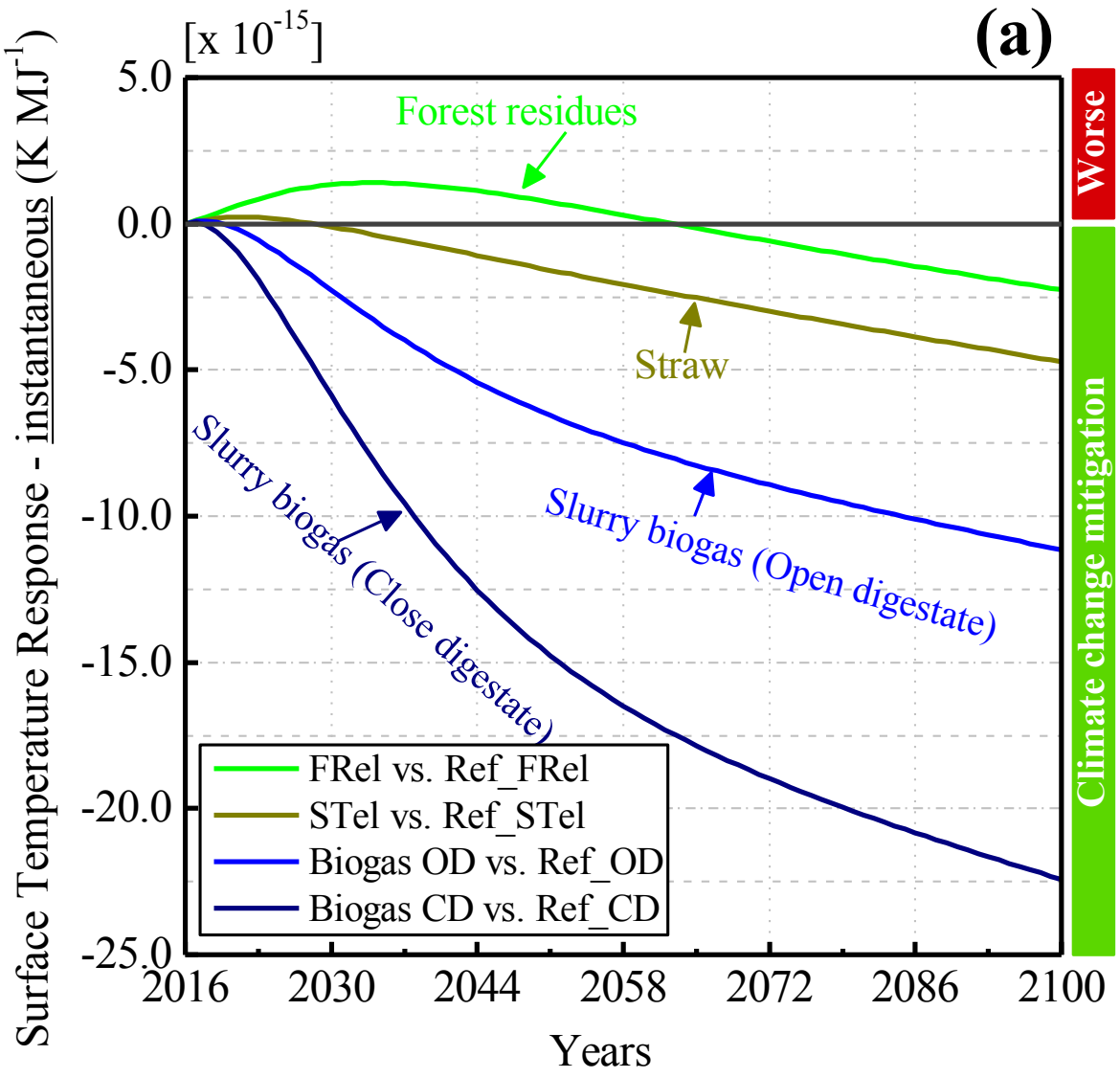
Consequential thinking and advanced tools applied to A-LCA studies.

Our definition of "Advanced A-LCA":

- Multiple systems and storylines are compared including alternative uses of biomass (**multiple "counterfactuals"**);
- Climate change is evaluated with normalized-cumulative metric (GWP(100)) and with absolute, time-explicit, end point metric (AGTP);
- Impact on climate change accounts also for **Near Term Climate Forcers (NTCF)** and for **biogeophysical forcers;**
- **Advanced tools** are used where possible, for instance:
  - Forest management and ecosystem models (**e.g. CBM, EFISCEN, G4M)**
  - Agricultural cropping system models (e.g. Cropsyst**, Century, DNDC)**
  - Energy system models (e.g. **JRC EU-TIMES, PRIMES, POLES)**

This analysis can provide relevant information on feedstocks, systems, configurations and management practices that carry potential environmental risks, highlighting particular red flags that will need to be looked at carefully (especially at local scale)

Example: Climate change mitigation potential of power generation from forest residues



- Advanced tools (Century) to assess SOC change due to straw removal in EU-28 countries

- Mitigation potential: Impact of Bioenergy – Impact of Reference
- Reference = EU27 power generation Mix

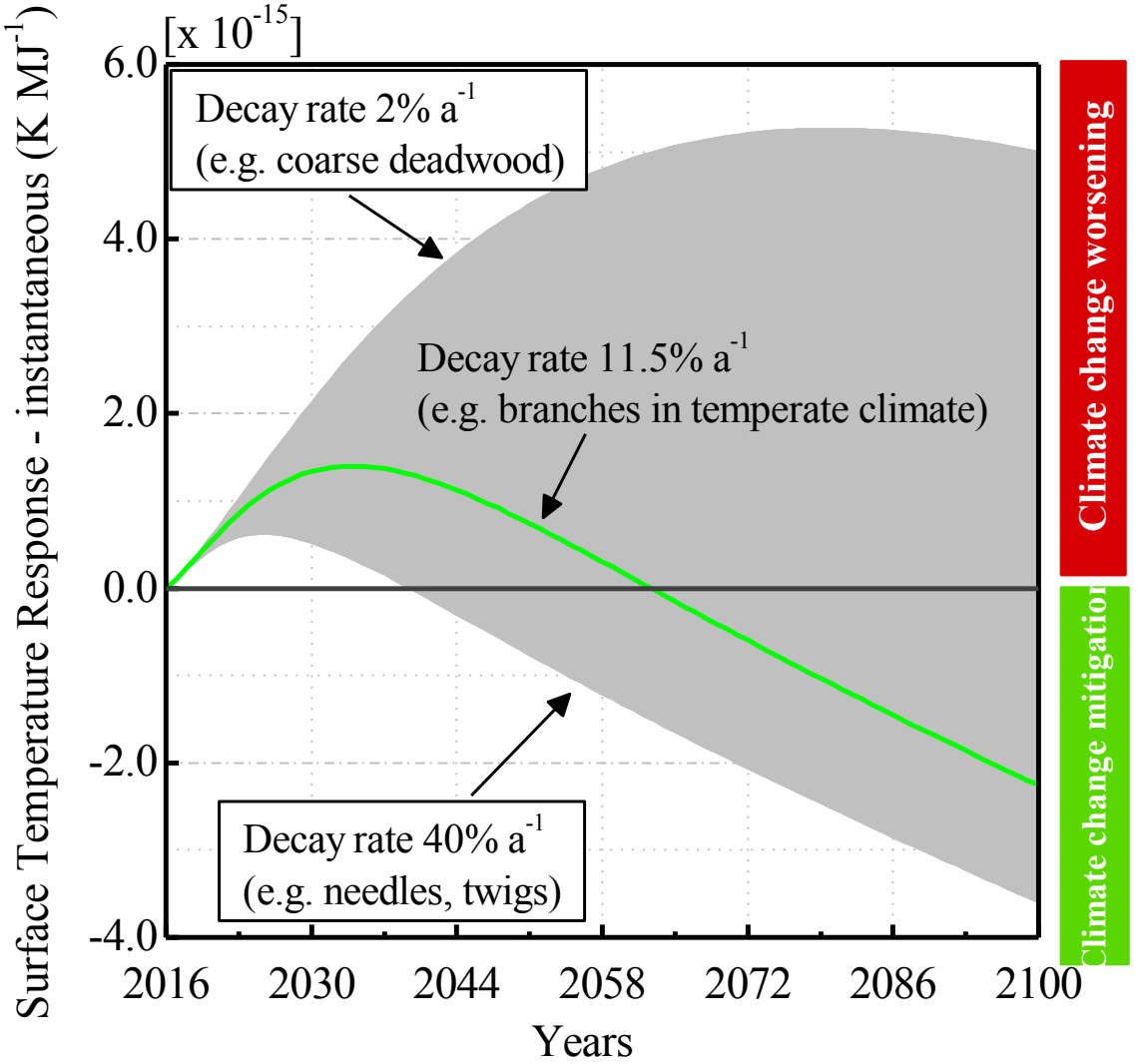
- Results obtained applying AGTP model formulations from IPCC AR5, 2013.

- Including WMGHG (CO_2, CH_4, N_2O) and NTCF (NOx, CO, NMVOC, SO_2, BC, OC).

N.B: results based on 1 MJ el. per year

Source: Giuntoli et al., Biomass and Bioenergy (2016), 89:146

Example: Climate change mitigation potential of power generation from forest residues



- **Negative** values: potential CC mitigation
- **Positive** Values: potential CC worsening

Sensitivity to decay rate of residues when left on forest floor

- Mitigation potential: Impact of Bioenergy – Impact of Reference
- Reference = EU27 power generation Mix

- Results obtained applying AGTP model formulations from IPCC AR5, 2013.
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Source: Giuntoli et al., Biomass and Bioenergy (2016), 89:146

Task 5: System level analysis

Nota bene:

- The list of indicators is preliminary.
- Relative impacts among different scenarios / storylines.

DESCRIPTIVE INDICATORS

Indicators of DRIVERS

- GDP trend
- Population trend
- Overall level of consumption and production: Biomass flows through sectors.

Indicators of PRESSURES

Land Use change

(pressures on) Biodiversity

- Conversion / production on Protected areas → world database on protected areas / NATURA 2000 areas
- Conversion / production on intact forest landscapes
- Conversion / production on peatlands
- Conversion / production on areas of high biodiversity value (including grassland and forests).

(pressures on) Climate Change

- Conversion/intensification of production on high carbon stock forests
- Conversion/intensification of production on wetlands
- Conversion/intensification of production on peatlands (histosoils)
- Conversion of abandoned / marginal / fallow land;
- Conversion of grassland to cropland
- Conversion of forest to cropland
- Deforestation / Afforestation
- C-stocks in forests, wood products (and landfills)

Land management intensification

- Intensification of agricultural management:
  - Index on agricultural inputs: e.g. Total mineral fertilization
  - Agricultural residues management: increased removal of residues
  - Area with conventional / conservation agriculture.
- Intensification of forest management:
  - Rotation times
  - Area under mineral fertilization

Soil quality

- Biomass extraction on steep slopes
- Share of residues removed
- Extraction of biomass from soils defined as stony

Water use and quality

- Biomass cultivation with irrigation in areas with high level of water scarcity

ILCD Indicators and models at Midpoint

- Climate Change
- Ozone Depletion
- Ecotoxicity for aquatic fresh water
- Human Toxicity - cancer effects
- Human Toxicity – non-cancer effects
- Particulate Matter/Respiratory Inorganics
- Ionising Radiation – human health effects
- Photochemical Ozone Formation
- Acidification
- Eutrophication – terrestrial / aquatic
- Resource Depletion – water
- Resource Depletion – mineral, fossil
- Land Use

DESCRIPTIVE INDICATORS

Indicators of IMPACTS

ILCD Indicators and models at Endpoint	Impacts on resource efficiency / Natural resources
	• Land take / Urbanization • Recycling rate / cascading indexes • Carbon intensity of economy → GDP (or Value Added)/kg CO_2 • Energy intensity of economy → GDP (or Value added)/MJ primary energy • Freshwater extraction / consumption • (Human appropriation of net primary production) • (Transnational land acquisition)

PERFORMANCE INDICATORS

Carbon stocks and GHG emissions	EU 2030 targets
• LULUCF → aggregation of various C-stock data to comply with accounting rules defined at EU level. • GHG emissions from livestock sector • GHG emissions from energy sector • Potential leakages (emissions outside EU borders associated with imported biomass and with indirect effects)	• GHG emission reduction as compared to EU targets for 2030. • Energy efficiency: Primary energy consumption reduction • RES share in final energy consumption • RES share electricity generation • RES in transport

SOCIO-ECONOMIC INDICATORS (proposals)

- Price and supply of national food basket
- Definition of an index to account for displacement of biomass between sectors: e.g. as proxy, stemwood/sawnlogs to bioenergy; agricultural land converted to energy crop.
- Definition of a cascaded index of wood
- Energy security indexes: e.g. domestic biomass for bioenergy over imported biomass for bioenergy; domestic primary energy supply over imported primary energy.
- Food security: domestic food/feed production over import.
- Jobs created: estimate of jobs created per unit of residue delivered to the plant; employment indices in feedstock collection and in plant construction and operation
- Processing efficiencies by technology and feedstock
- Production costs
- Gross Value Added (GVA) at factor cost and contribution to gross domestic product (GDP)
- Average production cost (APC) and share of cost of wood-based materials
- Imports and exports of wood and products derived from wood, and net trade
- Use of renewable and non-renewable materials, classified by virgin and recycled material
- Labour productivity
- Share of forests certified for Sustainable Management
- Consumption of wood per capita

Impact assessment: conclusions and outlook

- LCAs of supply chains: we know how to do it
  - ✓ We will continue to expand the database (e.g. algal biofuels, waste-derived products, bio-plastics)
- Consequential thinking in attributional LCA: we are improving methodological understanding
  - ✓ More and more studies following these approaches for strategic assessment
- Impact assessment of large-scale models: we are learning how to do it
  - ✓ Good examples available in the literature;
  - ✓ Important integration of multiple expertise and modelers.
- Social and economic dimensions to be addressed in the future.

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