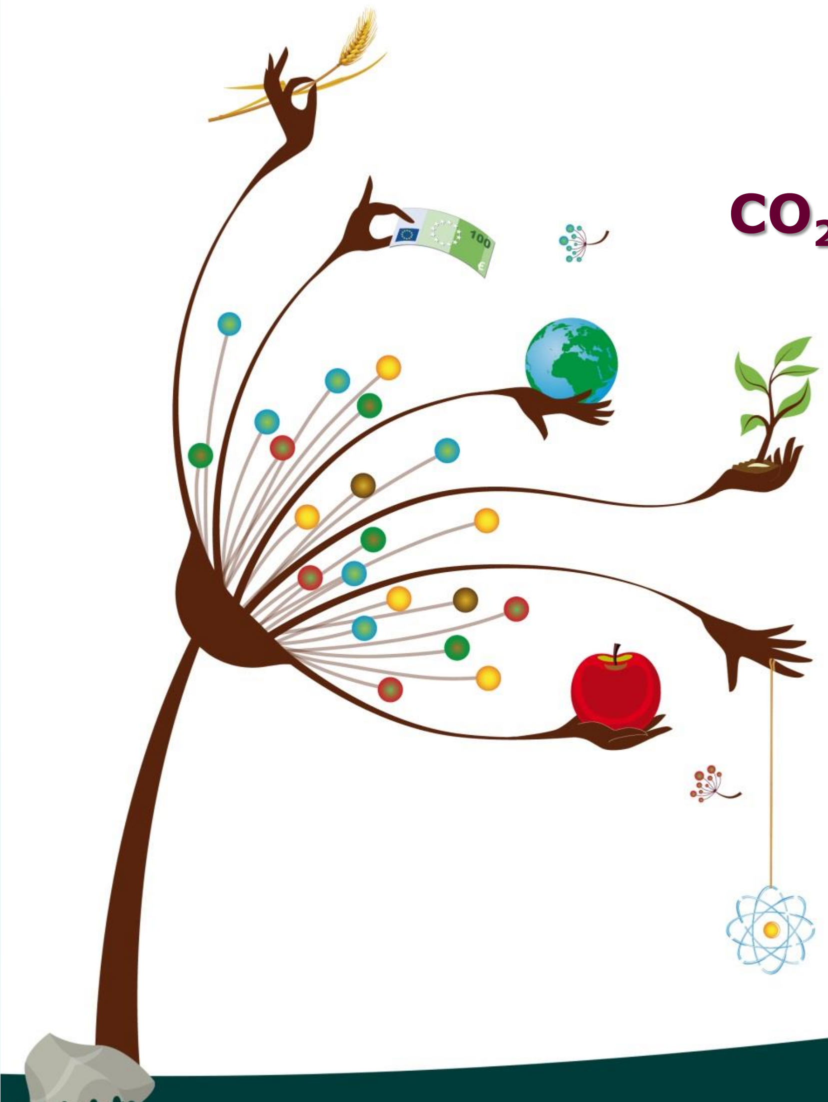

The European Commission's science and knowledge service

Joint Research Centre

CO_2 performance of forest bioenergy: What do we know?

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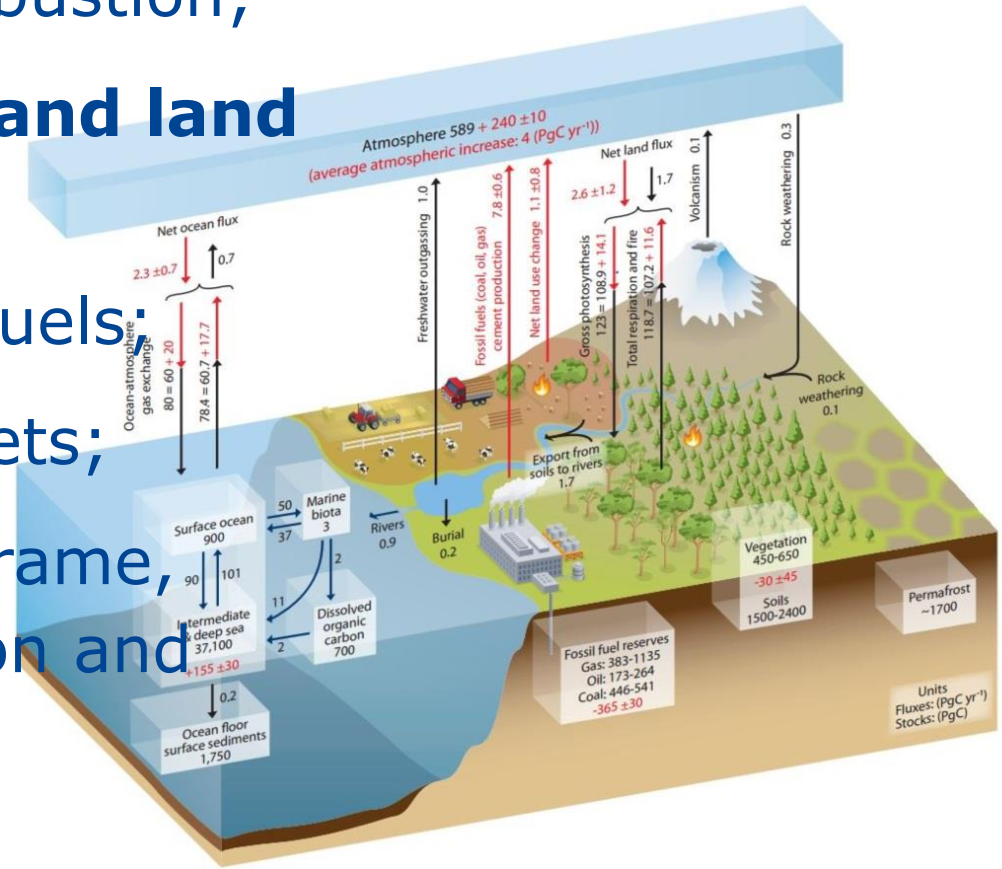
European Commission

How to ensure GHG emissions reductions from forest bioenergy compared to using fossil fuels?

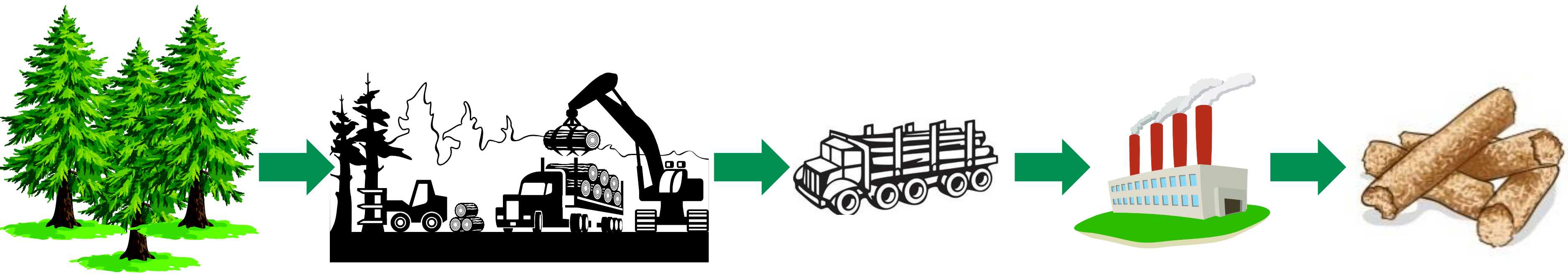
Bioenergy and climate change

Bioenergy systems can influence directly and indirectly local and global climate through a complex interaction of perturbations including:

- **CO_2** from biomass combustion;
- Influence on **land use and land management**;
- **Substitution** of fossil fuels;
- Impacts on wood markets;
- **Time** dimension: timeframe, dynamics of perturbation and climate response



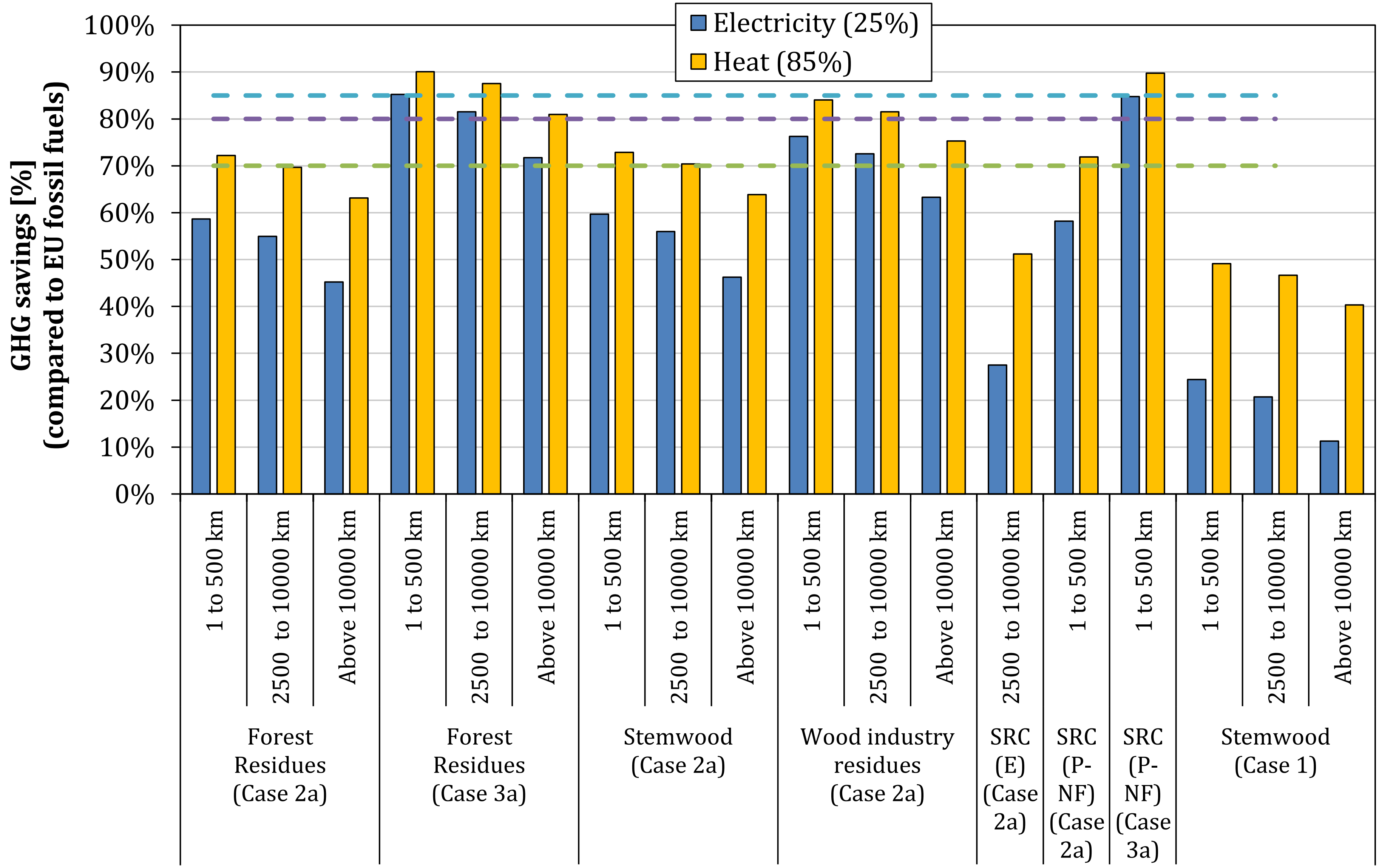
Regulatory purposes: Supply-chain emissions



Silviculture + Logging + Transport + Processing + Commodity

= Total GHG emissions

- For **regulatory purposes**, simplified life-cycle methodologies helpful to **benchmark** various pathways on a common scale so to exclude the pathways which are inefficient or with highest impacts



Source: > Renewable Energy Directive – Recast (COM(2016) 767), Annex VI;
> JRC (2017)

Supply-chain emissions do not include:

- **biogenic-C flows** and impacts on other markets
- Many of other bioenergy-climate interactions (albedo, evapotranspiration, other near-term climate forcers…)

Assessment of mitigation strategies

Goal: assess the GHG performance of different mitigation strategies.

Then:

- Supply chain emissions +
- Biogenic-C flows
- the emissions caused by various strategies should be evaluated against one (or multiple) baselines (biomass alternative uses to bioenergy)

Assessment of mitigation strategies

GHG performance can be assessed:

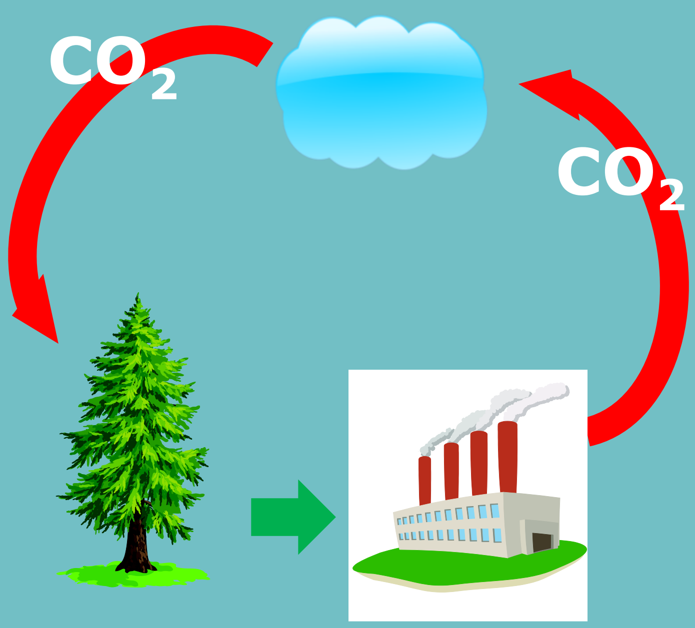
- on a "**commodity**" level (e.g. for a single bioenergy pathway)
- on a "**system**" level (economy-wide and global scale) with a modelling framework

EC Impact Assessment on bioenergy sustainability (SWD(2016)418) includes both analyses

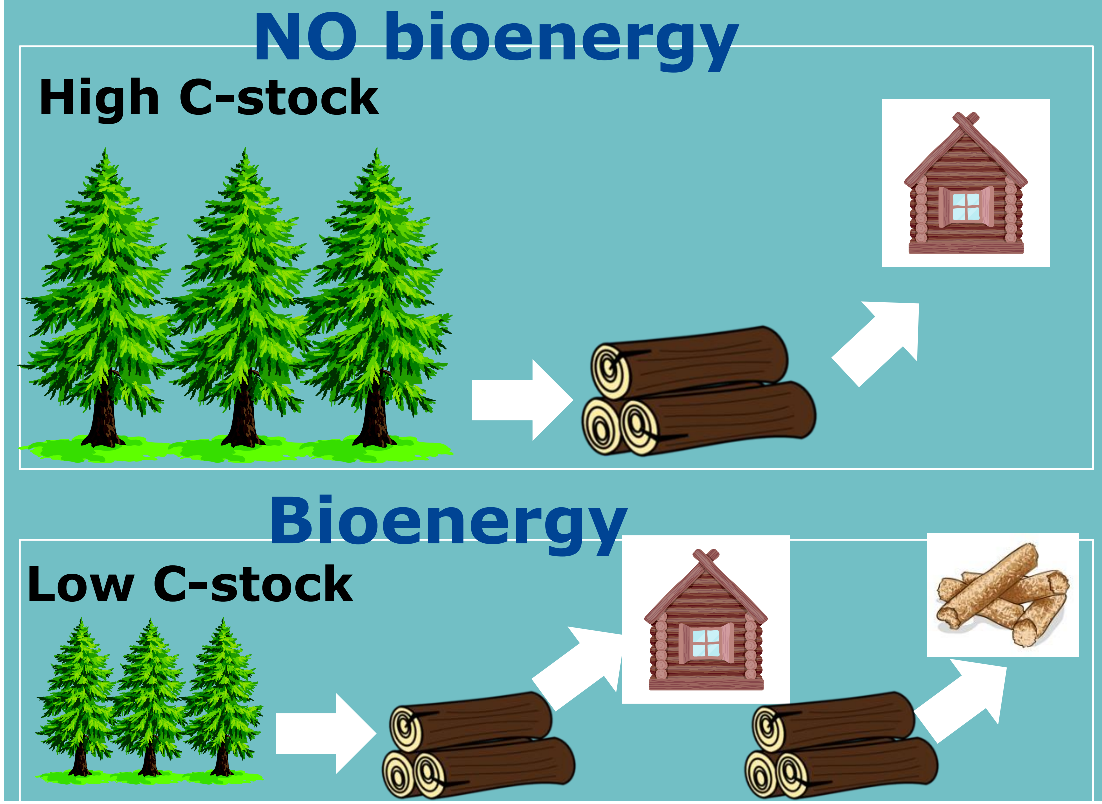
Biogenic Carbon

In the current debate, the word **"Biogenic-C"** has different interpretations:

A) Cycle of absorption during tree growth and release during combustion



B) <u>Relative</u> difference in carbon stocks and flows between bioenergy vs. no-bioenergy scenario.



Key messages *commodity* level analysis

- Contribution of biogenic carbon (in terms of difference with respect to alternative uses of the biomass) to emissions from forest bioenergy goes from negligible to very significant levels.
- Forest bioenergy can have positive or negative results compared to fossil fuels.

Annex 7, EC Impact Assessment on bioenergy sustainability

Key messages *commodity* level analysis

- GHG performance of forest bioenergy pathways depends on:
  - Type of feedstock
  - Type and change in forest management (past, present and forecasted)
  - Time horizon
  - Alternative uses of biomass
  - Fossil fuel substituted
  - End-use efficiency
  - Effects on other markets

Annex 7, EC Impact Assessment on bioenergy sustainability

Type of feedstock	CO_2 emission reduction efficiency					
	Short term (10 years)		Medium term (50 years)		Long term (centuries)	
	coal	natural gas	coal	natural gas	coal	natural gas
Temperate stemwood (energy dedicated harvest)	---	---	+/-	-	++	+
Boreal stemwood (energy dedicated harvest)	---	---	-	- -	+	+
Harvest residues	+/-	+/-	+	+	++	++
Thinning wood	+/-	+/-	+	+	++	++
Landscape care wood	+/-	+/-	+	+	++	++
Salvage logging wood	+/-	+/-	+	+	++	++
New plantation on marginal agricultural land (if not causing iLUC)	+++	+++	+++	+++	+++	+++
Forest substitution with fast growth plantation	-	-	++	+	+++	+++
Indirect wood (industrial residues, waste wood etc)	+++	+++	+++	+++	+++	+++

Source: JRC (2013)

Key messages *commodity* level analysis

While the results vary, certain trends in GHG performance can be observed for specific feedstocks or practices*:

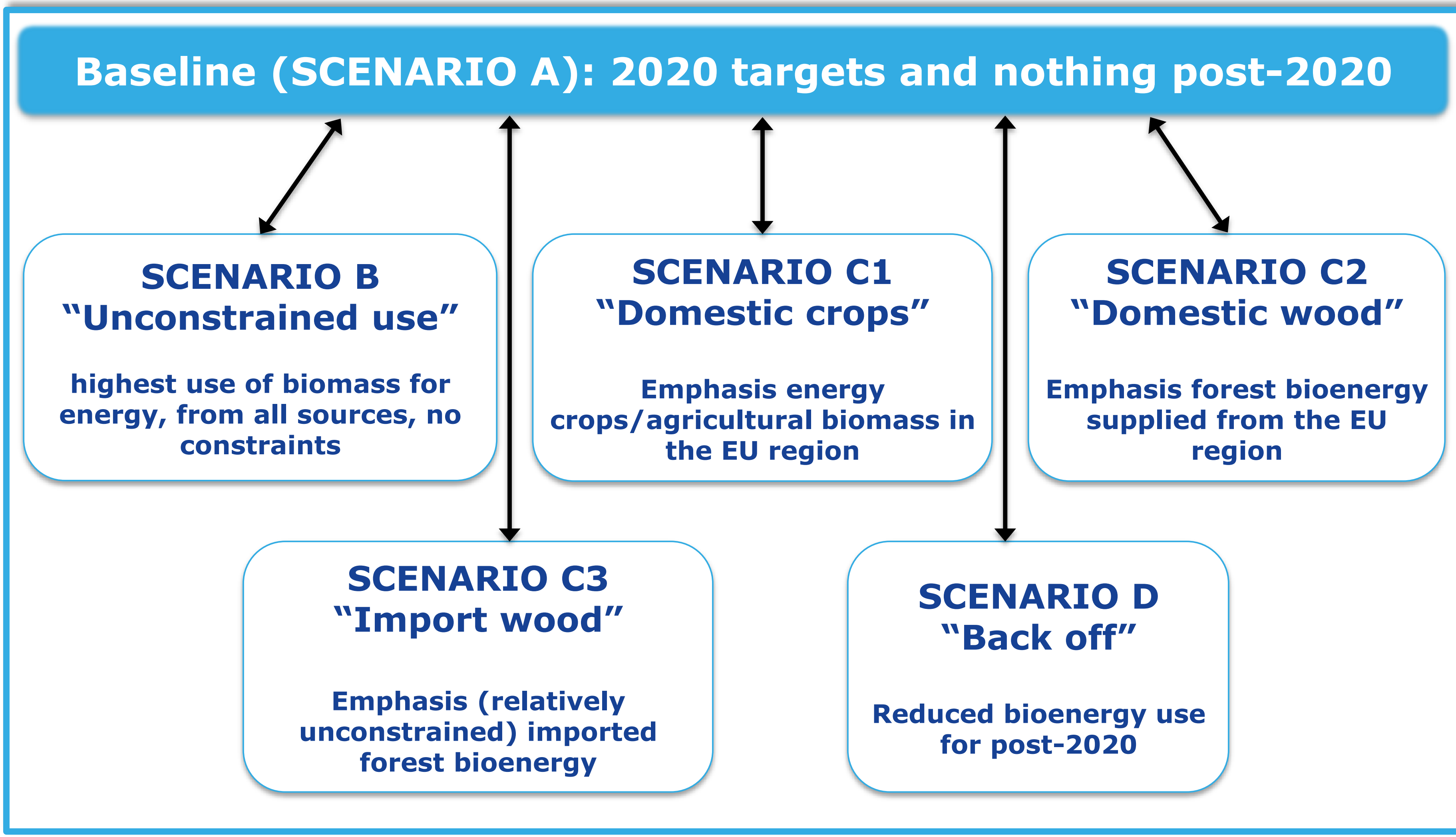
- Logging residues (except stumps and coarse deadwood)
- Waste wood
- Industrial residues (if not diverted from material uses)
- Salvage wood
- Wood from afforested areas
- Pre-commercial thinnings

- Sawnwood
- Stumps
- Coarse deadwood

- Small stemwood (incl. pulpwood)

* More details available in JRC (2013) and Matthews et al. (2014)

System level analysis: an example



Source: Matthews et al. (2015). *Carbon impacts of biomass consumed in EU.*

Key findings (1)

1) All scenarios achieve **GHG reductions,**
   Thanks to and Despite the use of bioenergy
2) The GHG benefits achieved depend on:
   - **Type of bioenergy used**
   - **Scale of deployment**
3) Contribution of Forest bioenergy to total GHG emissions can be of net mitigation or net emissions

Source: Matthews et al. (2015). *Carbon impacts of biomass consumed in EU. – Annex 8 EC Impact Assessment on bioenergy sustainability*

Key findings (2)

Contribution of increased forest bioenergy to the overall GHG performance compared to BASELINE

Scenarios	2030	2050
B ('unconstrained use')	Caution	Avoid
C1 ('imported wood')	Avoid	Avoid
C2 ('domestic crops')	Prefer	Caution
C3 ('domestic wood')	Caution	Caution
D ('Back off')	Caution	Caution
All scenarios (considering positive approaches* to forest management and wood use)	Prefer	Prefer

Examples of "Positive approaches":

- *Ensuring the conservation and enhancement of forest carbon stocks (and sequestration) as a complement to additional forest bioenergy supply;*
- *Favouring co-production of material wood products in conjunction with additional forest bioenergy*

* More details available in Matthews et al. (2015)

Key findings (3)

4) **Forest management choices and strategies** have an important role in mitigating bioenergy GHG impacts

- Assumption that harvest levels are below the growth rate of the forest in all scenarios;
- Thus, maintaining harvest levels below growth rate is **necessary but not sufficient** to ensure GHG benefits from forest bioenergy.

Source: Matthews et al. (2015). *Carbon impacts of biomass consumed in EU. – Annex 8 EC Impact Assessment on bioenergy sustainability*

Key findings (4)

5) The projected levels of forest bioenergy supply approach an upper limit for sustainable-yield supply from 2030 onwards in the EU

6) The cost of the energy systems modelled is lower in scenarios with more bioenergy (excluding costs in other sectors, e.g. in forest sector)

Source: Matthews et al. (2015). *Carbon impacts of biomass consumed in EU. – Annex 8 EC Impact Assessment on bioenergy sustainability*

Conclusions (1)

- When biogenic C flows are considered, the assumption of ‘**carbon neutrality**’ of forest bioenergy is **not generally valid**
- CO_2 reduction obtained by forest bioenergy depends on: time horizon, type of feedstock, biomass alternative uses, fossil alternatives.
- The use of wood residues provide GHG benefits in most cases.
- The use of sawnwood, stumps, coarse deadwood will **not** provide carbon benefits in policy-relevant time horizons. The performance of pulpwood needs to be assessed case-by-case.

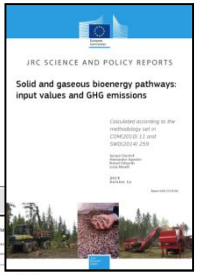
Conclusions (2)

- Majority of the forest bioenergy currently in EU can be considered to deliver GHG benefits even when taking into account biogenic emissions.
- Forest bioenergy impact in future strategies for GHG emissions reduction depends on the scale of demand and consumption.
- Forest management strategies (past, present and future) largely define forest bioenergy GHG performance.

A bit of homework…

Methodology, supply chains and biogenic-C

EC Impact assessment on bioenergy sustainability. SWD(2016) 418.
https://ec.europa.eu/energy/sites/ener/files/documents/1_en_impact_assessment_part4_v4_418.pdf



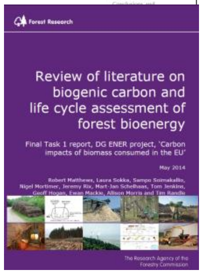
JRC 2017, JRC Database of input data and GHG emissions for solid and gaseous biomass for power and heat. Version 2 (in press): http://bookshop.europa.eu/en/solid-and-gaseous-bioenergy-pathways-pbLDNA27215

Giuntoli et al., *Domestic heating from forest logging residues: environmental risks and benefits*, **Journal of Cleaner Production 99 (2015) 206 – 216.**

Giuntoli et al., *Climate change impacts of power generation from residual biomass*, **Biomass and Bioenergy 89 (2016) 146 – 158.**

Commodity level analysis

JRC 2013, Carbon accounting of forest bioenergy: https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/carbon-accounting-forest-bioenergy-conclusions-and-recommendations-critical-literature

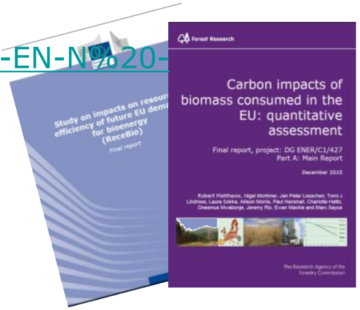


Matthews et al. (2014), Review of literature on biogenic carbon and life cycle assessment of forest bioenergy: http://ec.europa.eu/energy/sites/ener/files/2014_biomass_forest_research_report_.pdf

System level analysis

Matthews et al. (2015), Carbon impact of biomass consumed in EU: https://ec.europa.eu/energy/sites/ener/files/documents/EU%20Carbon%20Impacts%20of%20Biomass%20Consumed%20in%20the%20EU%20final.pdf

Study on impacts on resource efficiency of future EU demand for bioenergy - ReceBio (2016): http://ec.europa.eu/environment/enveco/resource_efficiency/pdf/bioenergy/KH-02-16-505-EN-N%20-%20final%20report.pdf



THANK YOU

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