

# First and next generation biofuels

**An overview of potentials and challenges for sustainable production and consumption**

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# Overview

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- **Background on biofuels**
- **1st generation biofuels**
  - Support policies
  - Market overview
  - Sustainability conflicts and challenges
  - Sustainability certification
- **2nd generation biofuels**
  - Potentials
  - Bottlenecks
- **3rd & 4th generation biofuels**
  - Prospects & problems
- **Outlook**
  - Potential links to and challenges for SCP

# Background on biofuels

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- **What are biofuels?**
  - any liquid, solid or gaseous fuels produced from organic matter
    - extensive range of organic materials used for biofuel production
    - many different feedstocks, conversion paths, etc.
- **Are/Were supposed to be the solution for a number of problems**
  - Climate warming
  - Energy insecurity
  - Rural poverty
  - Etc.

# What are 1st generation biofuels?

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- **Derived from sugar, starch, and vegetable oil (only from edible parts of crops)**
- **Two main types of 1st generation biofuels**
  - Bioethanol
    - Made from sugar cane, corn
  - Biodiesel
    - Made from palm oil, rapeseed
- **Rather low-tech production processes**
- **Already available on the market**
- **However: in most cases still more expensive than fossil fuels, therefore supported by biofuel policies in many countries**

# Biofuel support policies

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## – EU

- Renewable Energies Directive (RED) adopted in 2009
- Binding 10% target for 2020
- Tax exemptions and quotas for biofuels in many member states
- Special incentives for next generation biofuels (total tax exemptions, double counting towards the target, financing of R&D projects, etc.)

## – USA

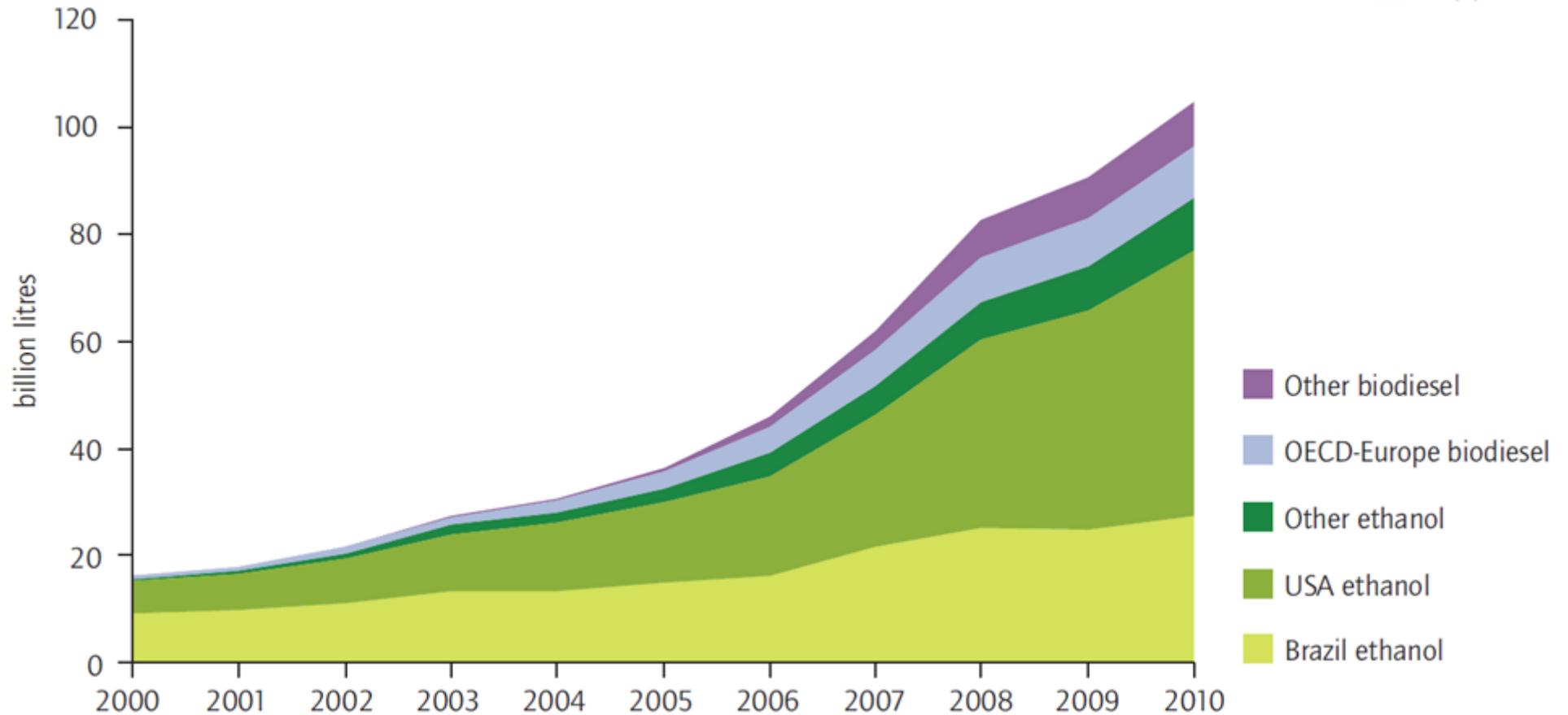
- Binding target for 2022
- Subsidies

## – Brazil

- Pró-Álcool programme in the 1970s

## – Many more...

# Market development



Source: IEA, 2010a.

# Conflicts and challenges of 1st generation biofuels

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## – **GHG balance**

- In theory: burning biofuels only emits the amount of CO<sub>2</sub> the plants have sequestered from the atmosphere before
- No scientific clarity concerning this aspect
- Ranging from “carbon negative” to “three times worse than fossil fuels” → always case-specific depending on system boundaries
  - Most delicate aspect: how to deal with [indirect land use change](#)?

## – **Land use competition and rising food prices**

- In theory: biofuels divert food crops to energy production
- Again no scientific clarity concerning this aspect
- However: Increased biofuel production will have an impact on land and food availability

## – **Impacts on biodiversity, soil and water**

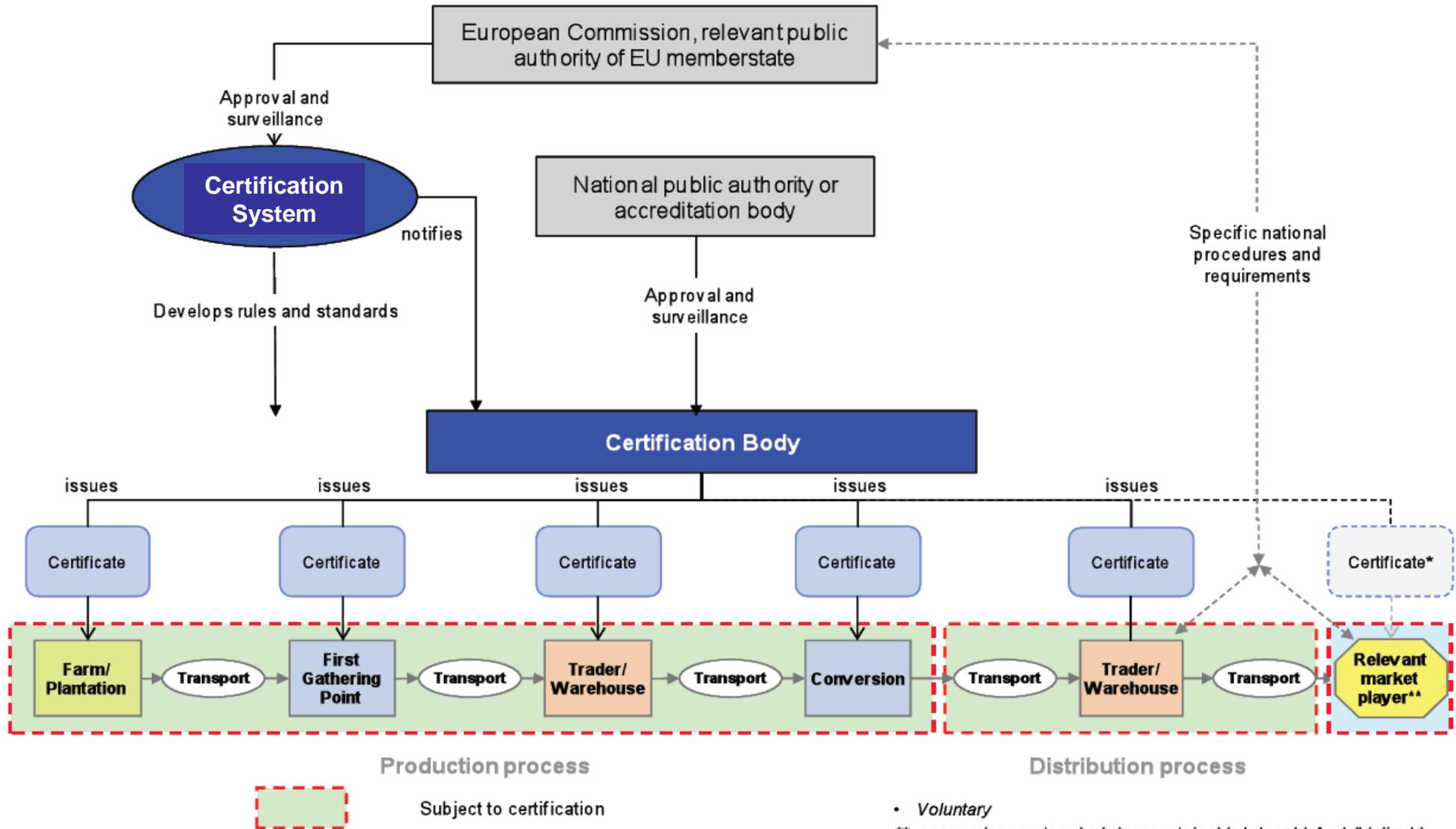
# EU RED sustainability criteria for biofuels

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- **Counting towards target resp. eligibility for subsidies bound to sustainability criteria**
  - 35% GHG emission reduction
  - No feedstock from peatland and other land with high carbon stocks
  - No feedstock from land with a high biodiversity value
- **No inclusion of indirect land use changes**
  - Discussions on how to integrate going on at the moment
- **No social criteria are included**
  - Only reporting duty
- **Voluntary certification systems can be recognized as part of the RED of the EU if they can ensure the proper evaluation of the sustainability criteria**

# Sustainability certification of biofuels



• *Voluntary*

\*\* *economic operator who brings sustainable biofuels/bio liquids into the market, e.g. cogeneration plants, mineral oil companies etc.*

## Sustainability certification of biofuels (cont.)

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- **Several voluntary biofuels certification systems have emerged in recent years**  
Role Model: Forest product certification (FSC)
- **EU RED builds on these voluntary initiatives**  
Biofuels certification is a politically instituted market
- **Most of them applied to the EU for recognition**
  - 7 of them have been recognized by the EU in July 2011
    1. Roundtable on Responsible Soy (RTRS)
    2. Roundtable on Sustainable Biofuels (RSB)
    3. Bonsucro
    4. International Sustainability and Carbon Certification (ISCC)
    5. Greenergy
    6. 2BSvs
    7. Abengoa RED Bioenergy Sustainability Assurance (RBSA)
  - Approx. 20 more will follow

## Sustainability certification of biofuels (cont.)

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- **Most of these schemes exceed the provisions of the EU sustainability requirements**
  - Not only environmental criteria, but also social criteria
    - Food security
    - Working conditions
    - Etc.
  - However, the issue of biotechnological processes/GM crops is far for the most part neglected
    - Exception: [RSB](#)
- **Most of them are just now starting to become operational**  
So far only little of the biofuel produced has been certified
- **However, under the current regime, certification of biofuels will play a major role**

Most of the biofuel used in the EU will be certified

# Sustainability certification for biofuels (cont.)

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## Challenges for Certification of 1st generation biofuels

- Broad range of feedstock for biofuel production
  - How to define the right criteria?
  - How to deal e.g. with biotechnology/GM crops?
- Measurement problems
  - e.g. inclusion of iLUC
- System boundaries
  - What are the limits to certification?
- Acceptance in industry and civil society
  - Demand for certified products?
  - “Greenwashing” of unsustainable production?
- Awareness regarding consumers
  - How to raise consumers’ awareness for sustainable biofuels?
- Democratic legitimacy of voluntary certification schemes
  - How to organize equal participation of stakeholders?
  - How to control and hold to account?

# What are 2nd generation biofuels?



- Derived from all forms of lignocellulosic biomass and residues

Biofuel group	Specific biofuel	Production process
Bioethanol	Cellulosic ethanol	Advanced enzymatic hydrolysis and fermentation*
Synthetic biofuels	Biomass-to-liquids (BTL) Fischer-Tropsch (FT) diesel synthetic diesel Biomethanol Heavier alcohols (butanol and mixed) Dimethyl ether (DME)	Gasification and synthesis**
Methane	Bio-synthetic natural gas (SNG)	Gasification and synthesis**
Bio-hydrogen	Hydrogen	Gasification and synthesis** or biological* processes.

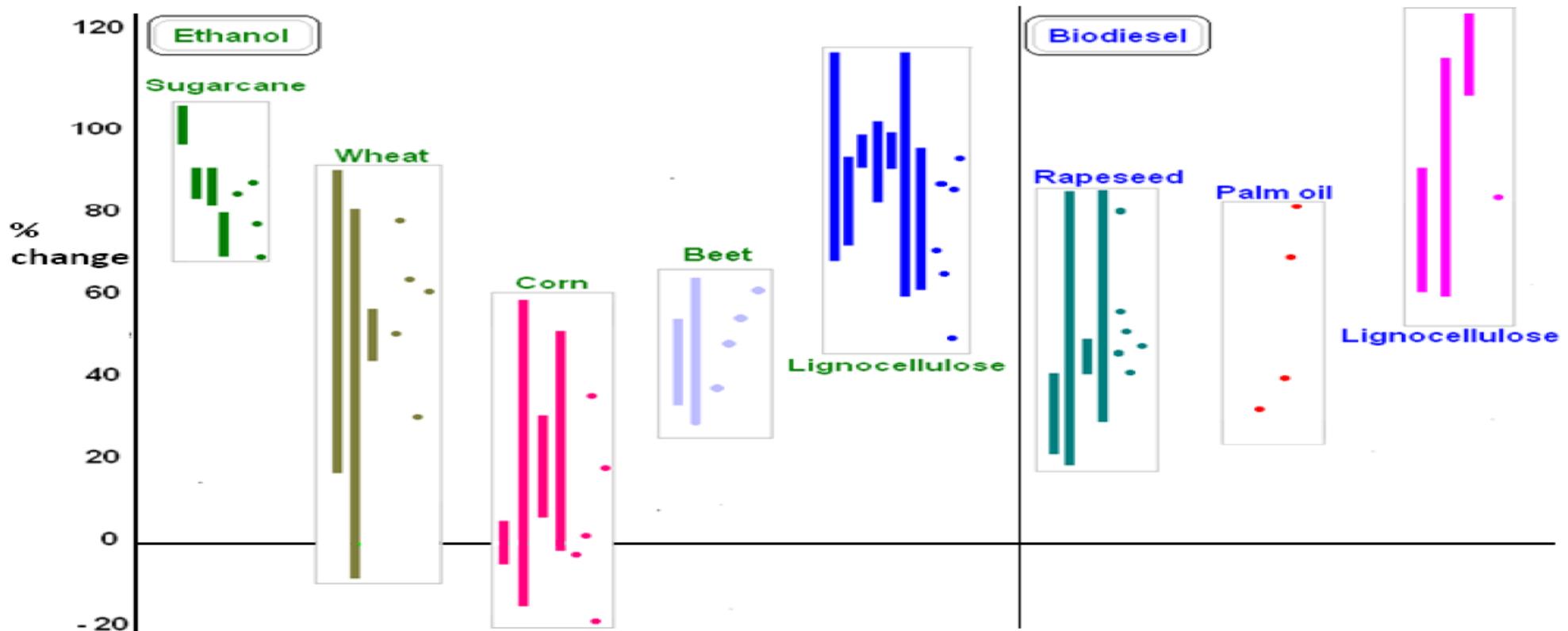
\*Bio-chemical route; \*\*Thermo-chemical route

- More and whole crops can be used to produce fuel (in principle)
- Only refers to processing technology

# Potentials of 2nd generation biofuels



- Promise to (at least partly) solve the problems related to 1st generation biofuels
- For example: better GHG balance



- Other aspect: less land use competition (in principle)

# Problems concerning 2nd generation biofuels

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- **2nd generation biofuels are not yet market-ready**
- **Were originally supposed to be market-ready about now**
- **Forecasts seem to be overly optimistic**
- **Several setbacks regarding the step from pilot projects/demonstration plants to a larger-scale production**
  - Lower yields when using residues of different crops
  - Problems regarding the processing technologies
  - Upscalability questionable
  - Latest example: bankruptcy of Choren Industries in Germany

# 3rd & 4th generation biofuels

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- **Definitional ambiguity about what 3rd & 4th generation biofuels are**
- **All based on biotechnological processes or GM crops**
- **Some examples**
  - Algae fuels
    - Based on photosynthesis of algae in photobioreactors
  - Fuels based on genetically optimized feedstocks
    - Designed to capture large amounts of carbon to efficiently make fuels (e.g. oilier crops)
  - Solar-to-fuel technologies
    - Based on artificial photosynthetic devices
- **Prospects and problems**
  - Many R&D projects on 3rd & 4th generation biofuels at the moment
  - So far, however, 3rd & 4th generation are not close to commercialization
  - Problems: Cost, environmental balance, yields, etc.

# Concluding questions

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## **What are the prospects for a sustainable consumption of biofuels?**

Which role for the consumer?

What can be learned from the recent E10 conflict in Germany?

What role can certification play in this context?

## **What would be the challenges to SCP that emerge from the usage of 2nd, 3rd, 4th generation biofuels production?**

More or less the same than for 1st generation biofuels?

Questions of land use, GHG emissions, water use will still be a major concern

What role can certification, which is so far very much geared to 1st generation biofuels, play in this context?

Will there be new ones? Which ones?

Regarding biotechnological production processes? Or GMOs?

# Thank you for your attention.



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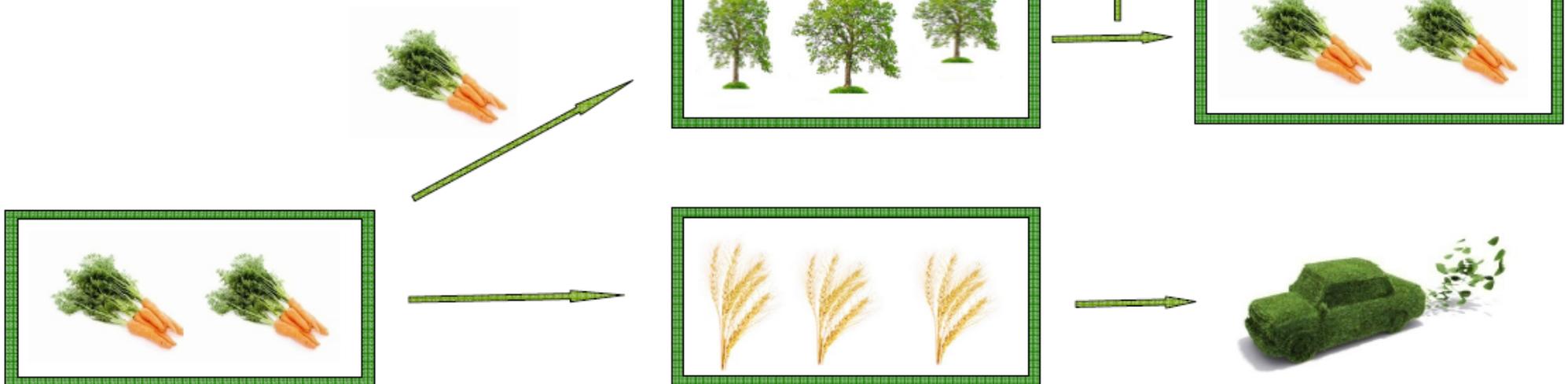
# Excursus: indirect land use change (ILUC)



## iLUC – indirect land use change

The cultivation of agricultural products on arable and pasture land can induce a replacement of the previous crops in other regions and areas.

(e.g. Fritsche et al. 2011)



# Principle 11 of RSB: Use of Technology, Input, and Management of Waste

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**The use of technologies in biofuel operations shall seek to maximize production efficiency and social and environmental performance, and minimize the risk of damages to the environment and people.**

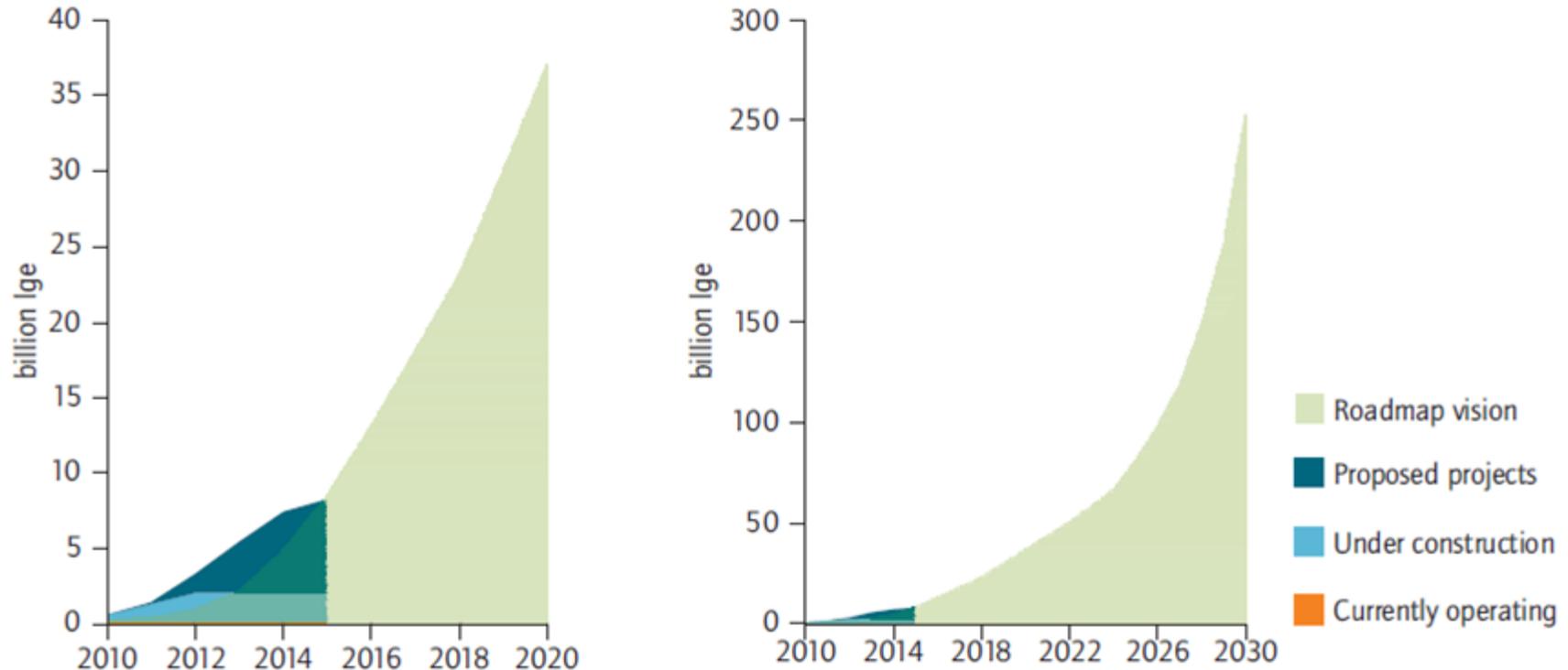
- Criterion 11.a: Information on the use of technologies in biofuel operations shall be fully available, unless limited by national law or international agreements on intellectual property.
- Criterion 11.b: The technologies used in biofuel operations including genetically modified: plants, micro-organisms, and algae, shall minimize the risk of damages to environment and people, and improve environmental and/or social performance over the long term.
- Criterion 11.c: Micro-organisms used in biofuel operations which may represent a risk to the environment or people shall be adequately contained to prevent release into the environment.

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# Forecast on 2nd generation biofuels



- Most projections for 2nd generation developments look like this



Note: A load factor of 70% is assumed for fully operational plants. Actual production volumes may be well below nameplate capacity within the first years of production.

Source: Based on IEA analysis in IEA, 2010a; IEA, 2010c; IEA 2010f.