Technology Roadmap

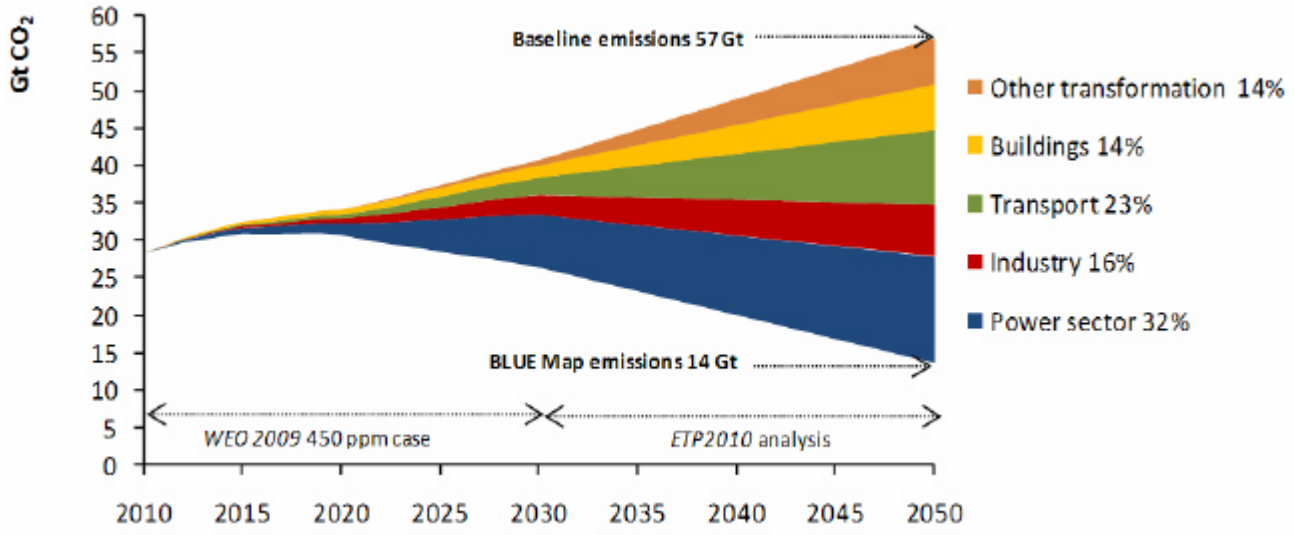
Biofuels for Transport

Adam Brown
International Energy Agency

IEA Bioenergy ExCo Workshop
10 May 2011
Helsinki

International Energy Agency

The IEA BLUE Map Scenario



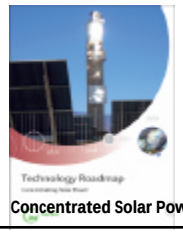
- **Baseline Scenario** – business-as-usual; no adoption of new energy and climate policies
- **BLUE Map Scenario** - energy-related CO_2-emissions halved by 2050 through CO_2-price and strong support policies
  - 23% of emission savings in the transport sector
    → 20% (2.1 Gt) of this through use of sustainable biofuels (mainly advanced biofuels)
- The BLUE Map Scenario serves as basis for all IEA Technology Roadmaps

IEA Technology Roadmaps

- Roadmaps are intended to:
  - Highlight pathway(s) to reach large scale use of low-carbon technologies, consistent with *Energy Technology Perspectives 2010*
  - Focus on the key steps over the next 5-10 years, as well as long-term milestones, including:
    - Identify barriers and obstacles and how to overcome these
    - Identify key conversion pathways
    - Key RD&D gaps and how to fill them while ensuring sustainability
    - Identify market requirements and policy needs
    - Define international collaboration needs

  For more information: www.iea.org/roadmaps

- IEA Technology Roadmap - Biofuels for Transport
  - Developed under consultation of industry, governmental and research institutions as well as NGOs
  - Workshop on feedstock availability and sustainability feeds also into the upcoming Technology Roadmap on **Bioenergy for Heat and Power** (available early 2012)



Concentrated Solar Power

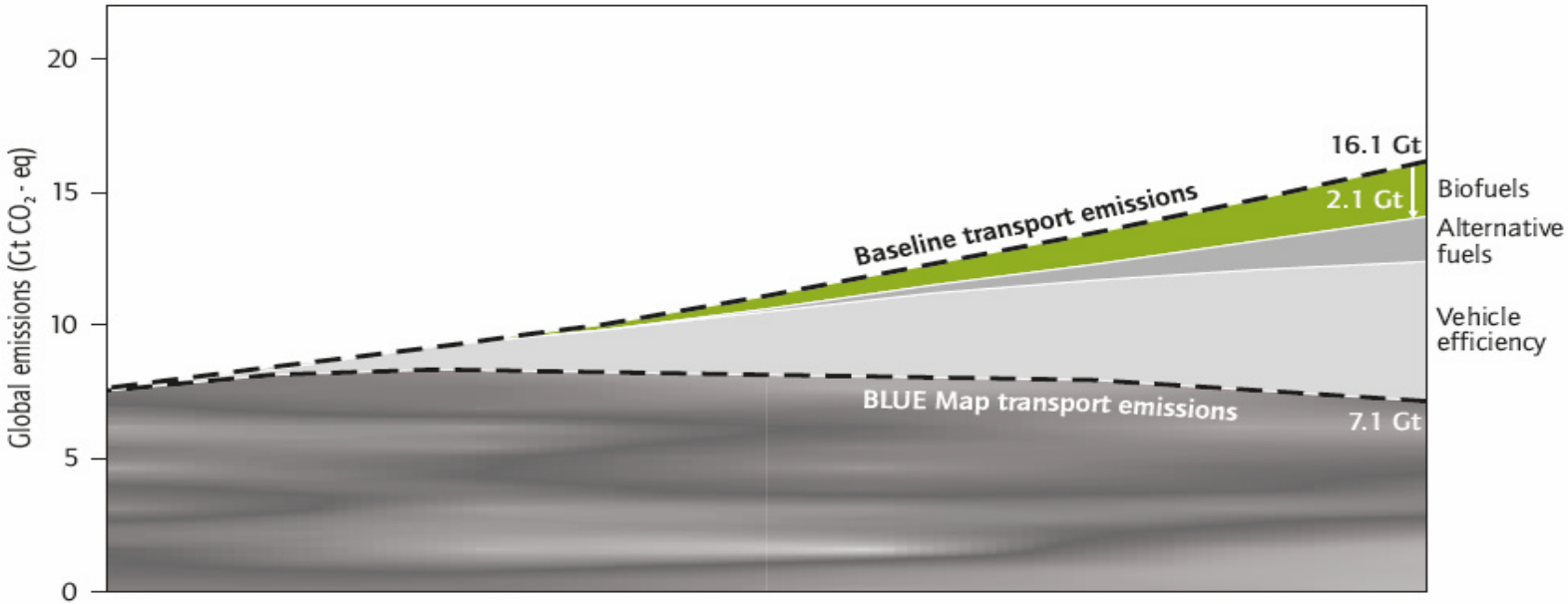
Electric & Plug-in Hybrid Vehicles

Smart Grids

Solar Photovoltaic Energy

Wind Energy

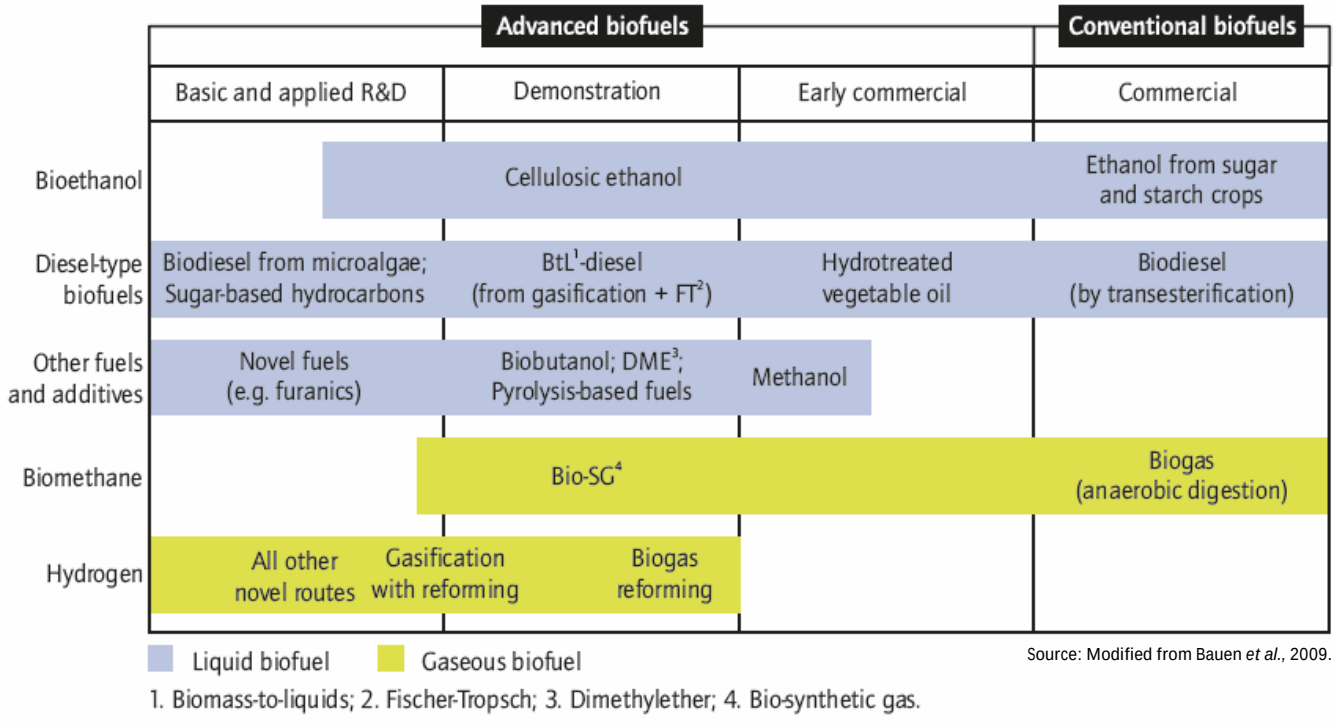
Biofuels Contribution to Emissions Reduction



Note: Modal shifts (not included) could contribute an additional 1.8 Gt CO_2-eq. of emission reductions.

- Efficiency improvements are the most important low-cost measure to reduce transport emissions
- Biofuels can reduce global transport emissions by 2.1 Gt CO_2-eq. in 2050
- To achieve these reductions, all biofuels must provide considerable life-cycle GHG emission reductions

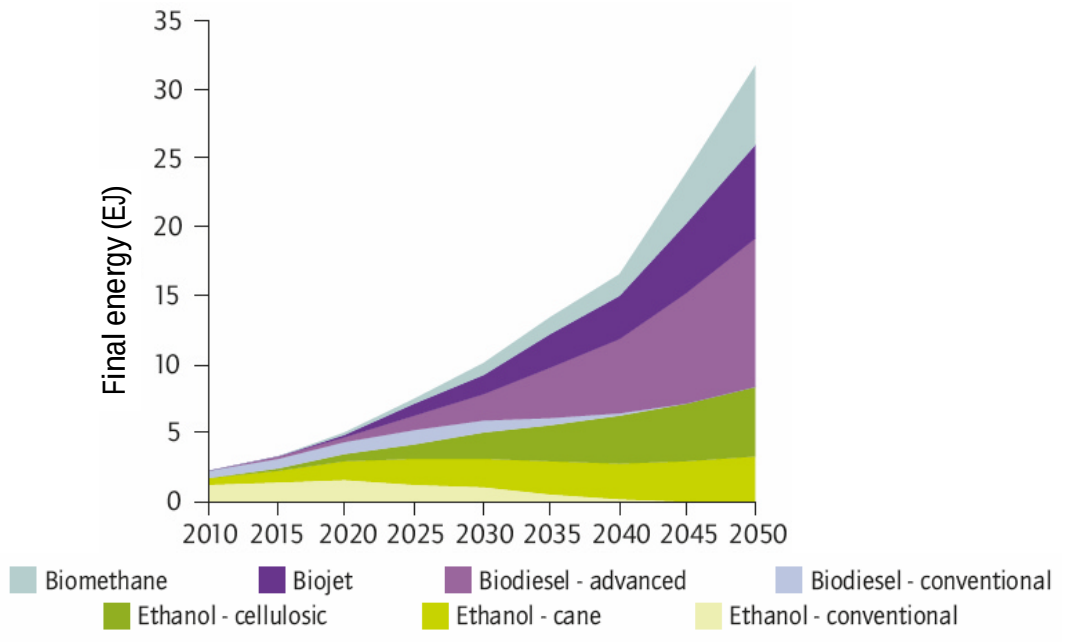
Overview on Biofuel Technologies



Source: Modified from Bauen *et al.*, 2009.

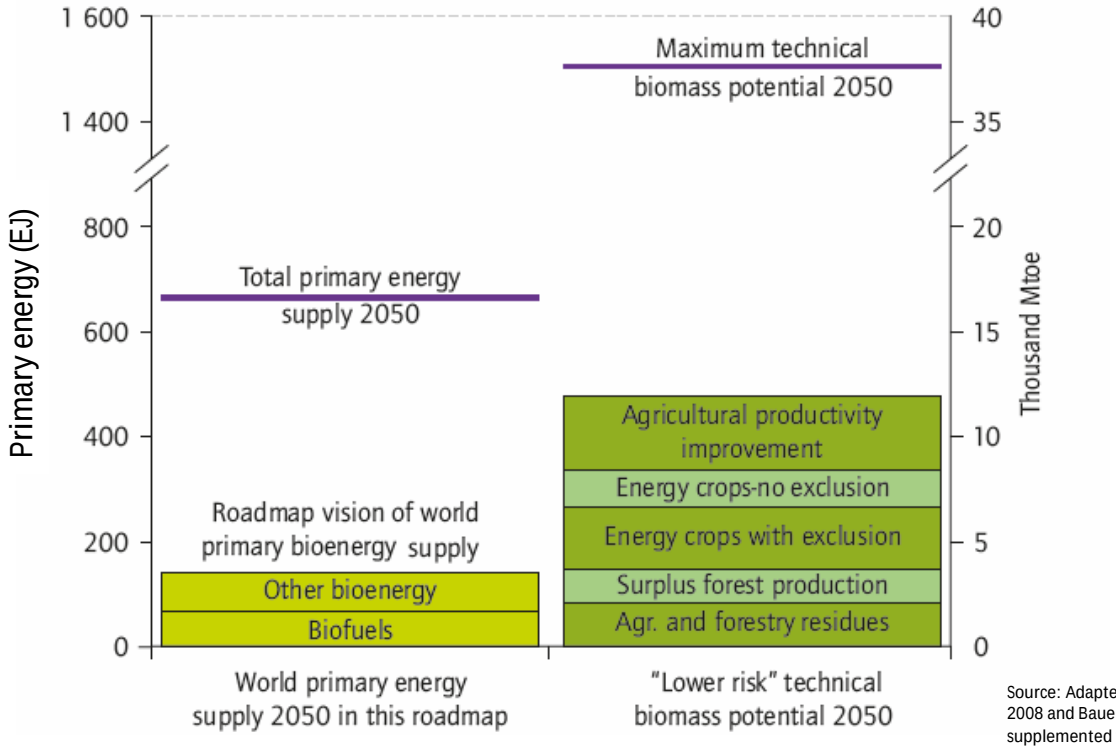
- A broad number of conversion routes exist
- More RD&D is needed to get advanced biofuels to commercial-scale to prove they can meet cost and GHG targets

IEA Biofuel Roadmap: Vision



- Global biofuel supply grows from 2.5 EJ today to 32 EJ in 2050
  - Biofuels share in total transport fuel increases from 2% today, to 27% in 2050
- In the longer-term, diesel/kerosene-type biofuels are particularly important to decarbonise heavy transport modes
- Large-scale deployment of advanced biofuels will be vital to meet the roadmap targets

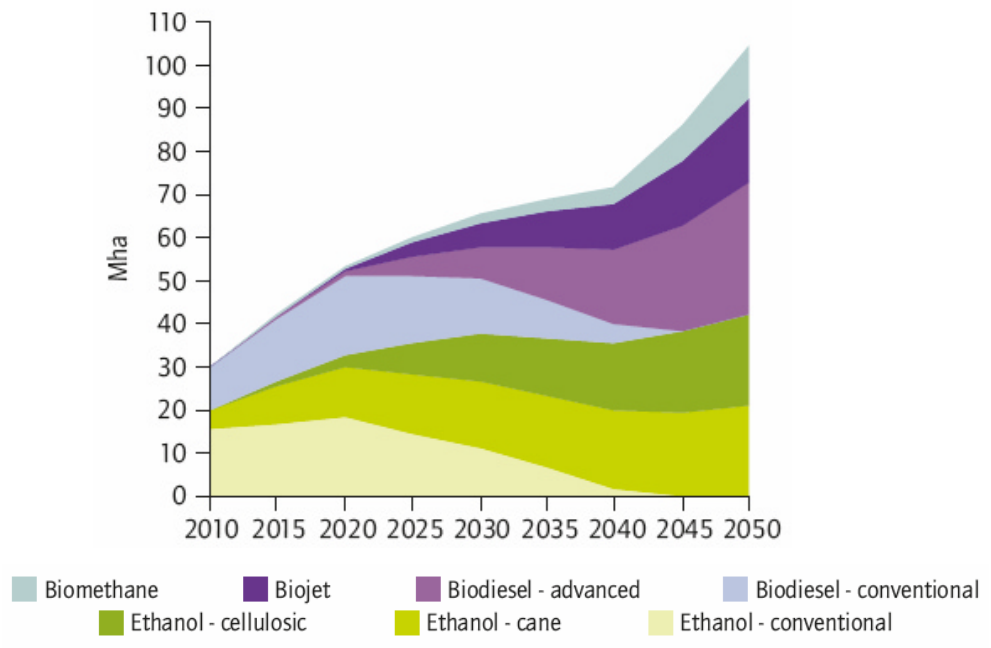
Global Biomass Potential



Source: Adapted from Dornburg et al., 2008 and Bauen et al., 2009, and supplemented with data from IEA, 2010c.

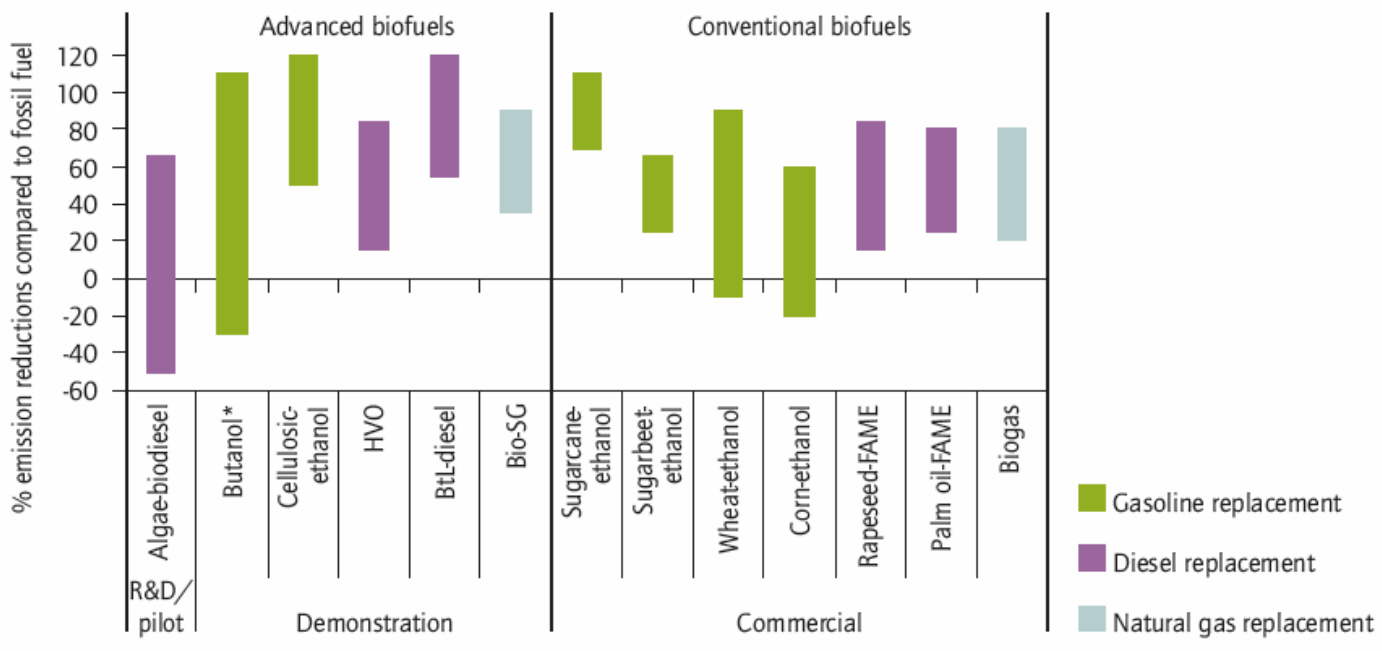
- A considerable potential of "low risk" biomass sources has been assessed
- Biomass for biofuel production (65 EJ) could come entirely from residues, wastes, and sustainably grown energy crops

Land Requirements



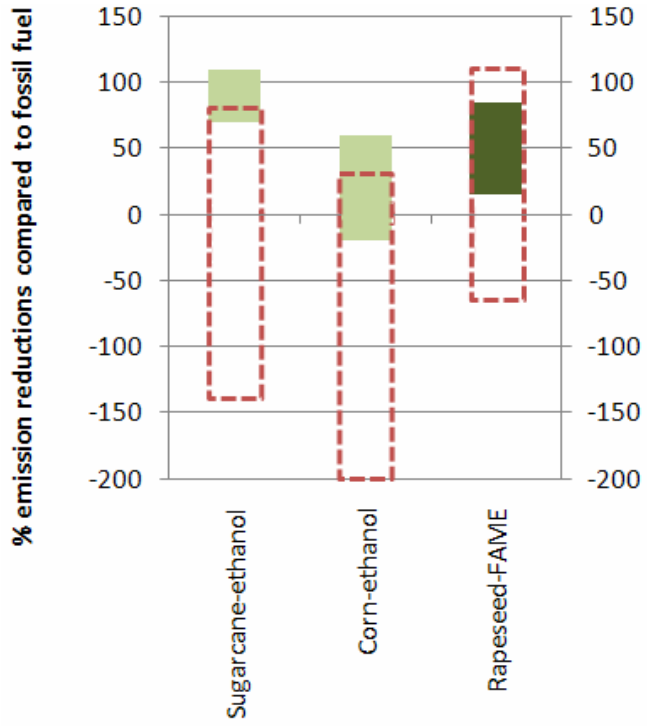
- Land required to produce biofuels grows from 30 Mha today to 100 Mha in 2050
- In addition, 1 billion tons of residues will be needed (mainly for advanced biofuels)
- Sound policies are required to ensure biofuel production does not compete for land with increasing food demand

GHG-Reduction Potential of Biofuels



- Most biofuels can reduce GHG-emissions compared to gasoline/diesel
- To achieve GHG reductions, biofuels must be produced in an efficient way
- However, uncertainty on the impact of land-use change on GHG balance remains

Impact of Emissions from Land-Use Change



Source: Based on IEA and UNEP analysis and Berndes *et al.*, 2010

- There is a considerable uncertainty on the exact amount of GHG emissions from land-use change
- In the worst case, the impact of land use change can off-set GHG emission reductions
- Land-use changes (direct and indirect) caused by biofuel production must be avoided

Measures to Reduce Risk of (i)LUC

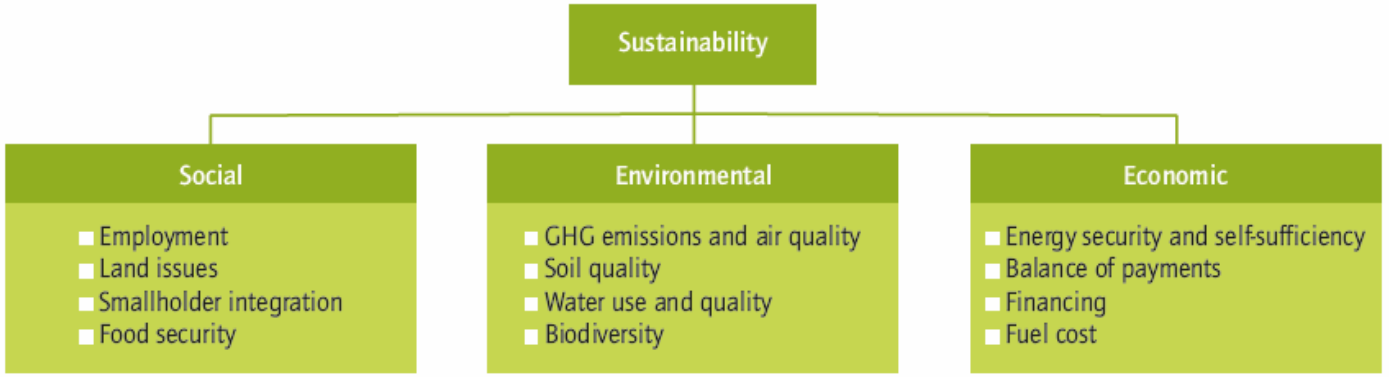
- Producer side:
  - Efficiency improvements of land-use and biomass conversion
    → yield-improvements and new, high-yielding feedstocks
  - Focus on wastes and residues as feedstock
  - Cascade utilisation of biomass
  - Co-production of energy and food crops (*e.g.* Integrated Food and Energy Systems)

- Policy side:
  - Adopt land-use zoning and land-use management schemes
  - Introduce sound sustainability criteria for biofuels
  - Promote use of residues and wastes as feedstock, and biofuel production on unused land
  - Support improvement of current iLUC models

- In the long-term, all agricultural and forestry products should be certified, and an overall sustainable land-use management should be adopted

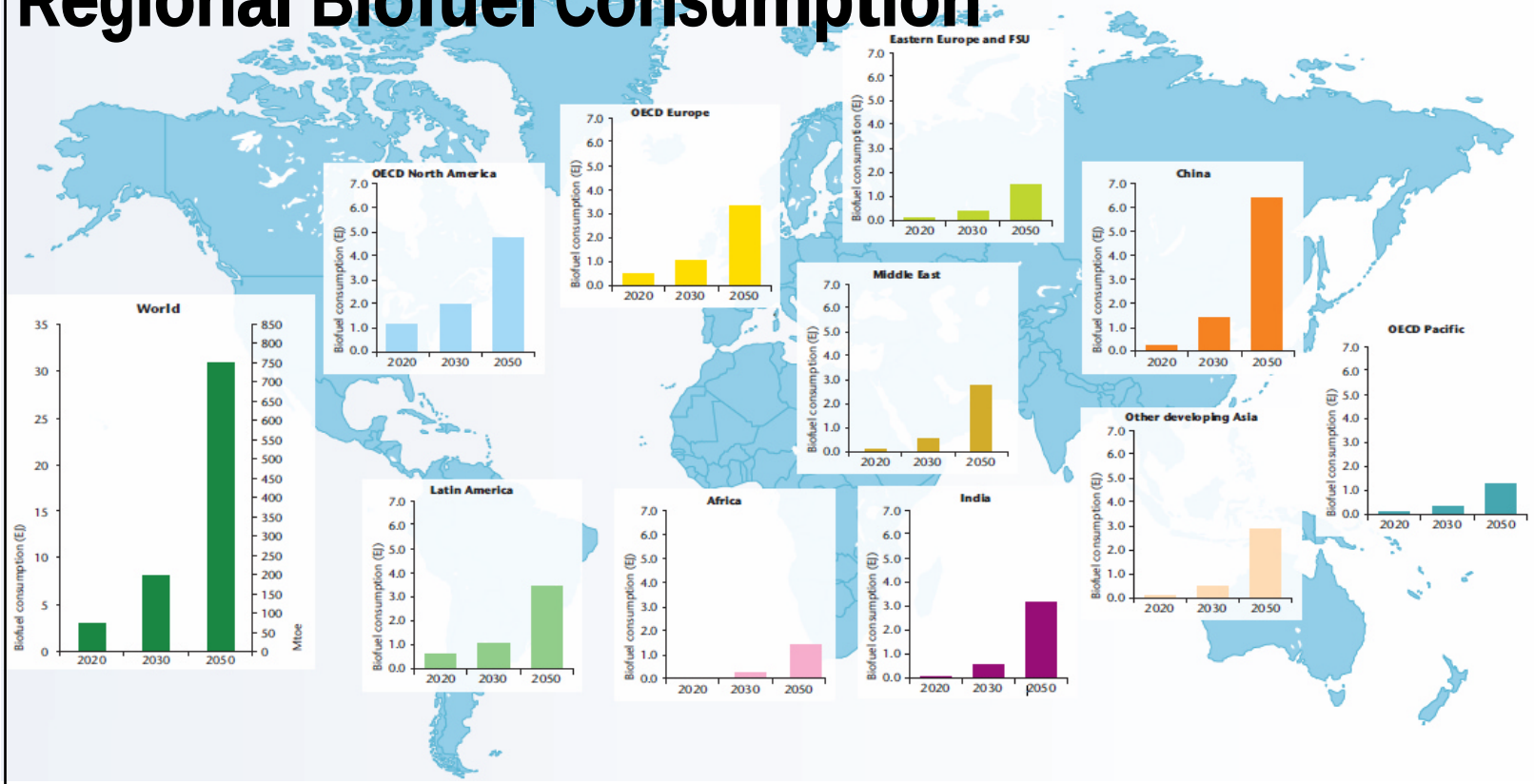
Courtesy:
A. Eisentraut; www.biofuelstp.eu

Sustainability of Biofuels



- Sound policies are needed to ensure biofuels are produced sustainably
- Adopt sound, internationally aligned sustainability certification for biofuels
  - Certification schemes should be based on international sustainability criteria (as developed *e.g.* by the Global Bioenergy Partnership, GBEP)
- However, most sustainability issues are relevant to the whole agricultural/ forestry sector
- In the long-term, all agricultural and forestry products should be certified, and an overall sustainable land-use management should be aimed for

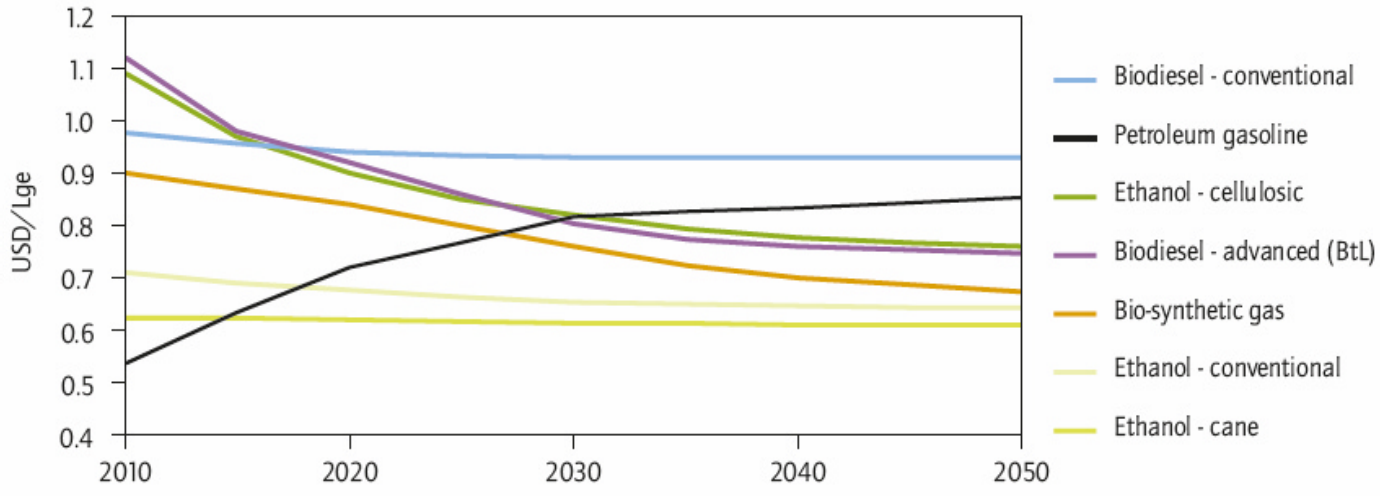
Regional Biofuel Consumption



- Biofuel use will increase in all regions
- Biofuel demand is strongest in OECD countries until 2020
- In 2050, non-OECD countries account for 70% of total biofuel consumption
- Trade will be vital to supply biomass and fuels to regions with strong demand

Biofuel Production Costs 2010-50

Low-cost scenario

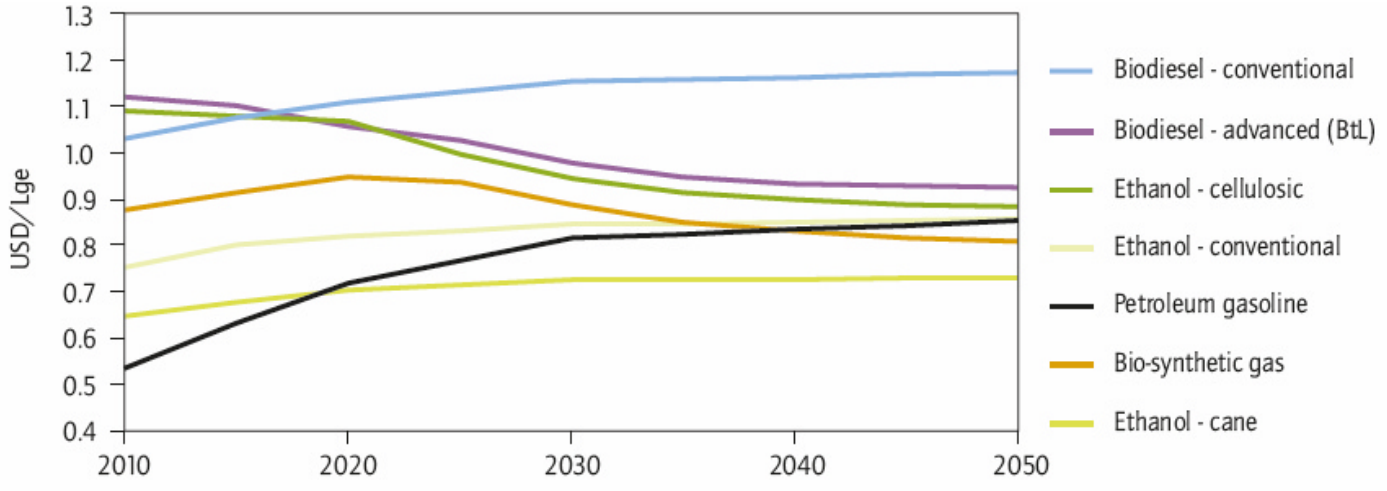


Production costs shown as untaxed retail price

- Most conventional biofuels could become competitive with fossil fuels around 2015-20 in an optimistic scenario
- Advanced biofuels could become competitive around 2030.
- Total expenditure on biofuels in 2010-50 is around USD 11 trillion (*i.e.* 11% of total fuel costs)

Biofuel Production Costs 2010-50

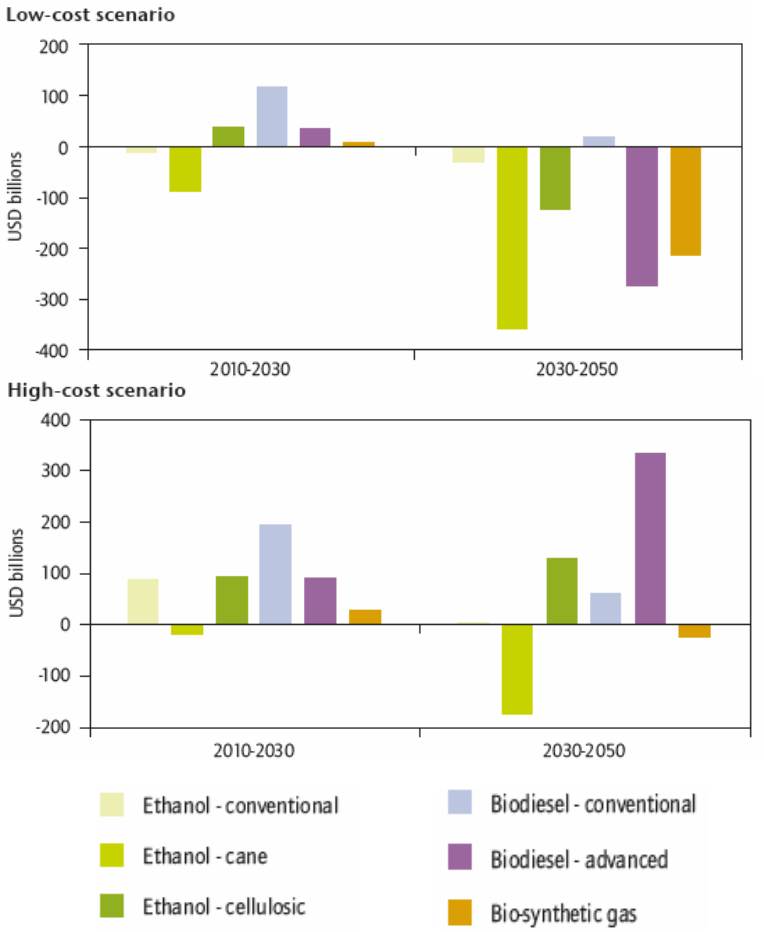
High-cost scenario



Production costs shown as untaxed retail price

- With a stronger impact of oil prices on feedstock and capital costs, some biofuels might remain slightly more expensive than gasoline/diesel
- The cost difference is less than USD 0.10 after 2040
  - → CO_2 price of USD 50/t would be sufficient to set off the cost difference
- Total expenditure on biofuels is around USD 13 trillion (*i.e.* 12% of total fuel costs)

Incremental Costs of Biofuels



- Additional expenditure on biofuels is around:
  - USD 810 billion in the high-cost scenario
  - USD 890 billion of fuel cost savings in the low-cost scenario

- Incremental costs compared to use of fossil fuels are in the range **of +/-1%** of total fuel cost spending in the next 40 years

Barriers and challenges

- **Economic barriers**
  - Production costs often not competitive with fossil fuels
    - → Feedstock price volatility is problematic
  - High capital costs
    - → Key challenge for advanced biofuels
  - High risk related to investments in “unproven” technology

- **Non-economic barriers**
  - Uncertainty about sustainability of biofuels
    - → can discourage investments
  - Infrastructure compatibility of certain fuels
  - Consumer acceptance
  - Trade barriers
  - Lack of capacities

- **Economic incentives should be adjusted over time and aim at encouraging the full competitiveness of biofuels!**

Key policy actions

- **Stability:**
  - Create a long-term policy framework for biofuels.
- **Innovation and RD&D**
  - Provide sustained funding, in particular for advanced biofuels RD&D.
  - Support research efforts on land availability mapping and biomass potential analysis.
- **Sustainability:**
  - Adopt sound, internationally aligned sustainability certification for biofuels.
  - Link economic incentives to sustainability performance of biofuels.
  - Incentivise use of wastes and residues.
- **International Collaboration:**
  - Engage in international collaboration on capacity building and technology transfer.
  - Promote the alignment of biofuel and other related policies (agriculture, forestry, rural development).

- IEA Technology Roadmap - Biofuels for Transport
  Available: *www.iea.org/roadmaps*

- Contact:
  biofuelroadmap@iea.org

- Forthcoming:
  IEA Technology Roadmap – Bioenergy for Heat and Power
  Available early 2012