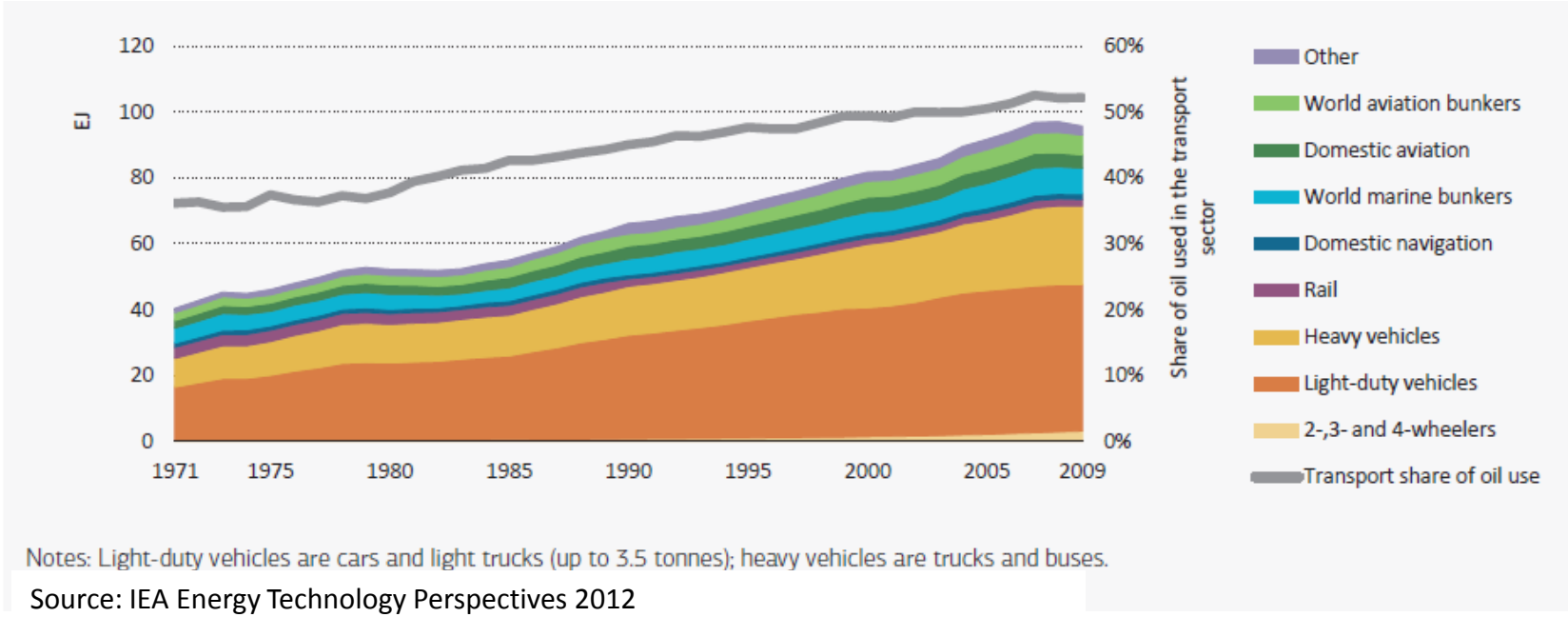
Renewable energy in transport

Source: http://worldwideed.staradvertiserblogs.com/2009/11/23/fun-day-monday-free-transport-from-naia-airport

World transport energy use is growing rapidly…

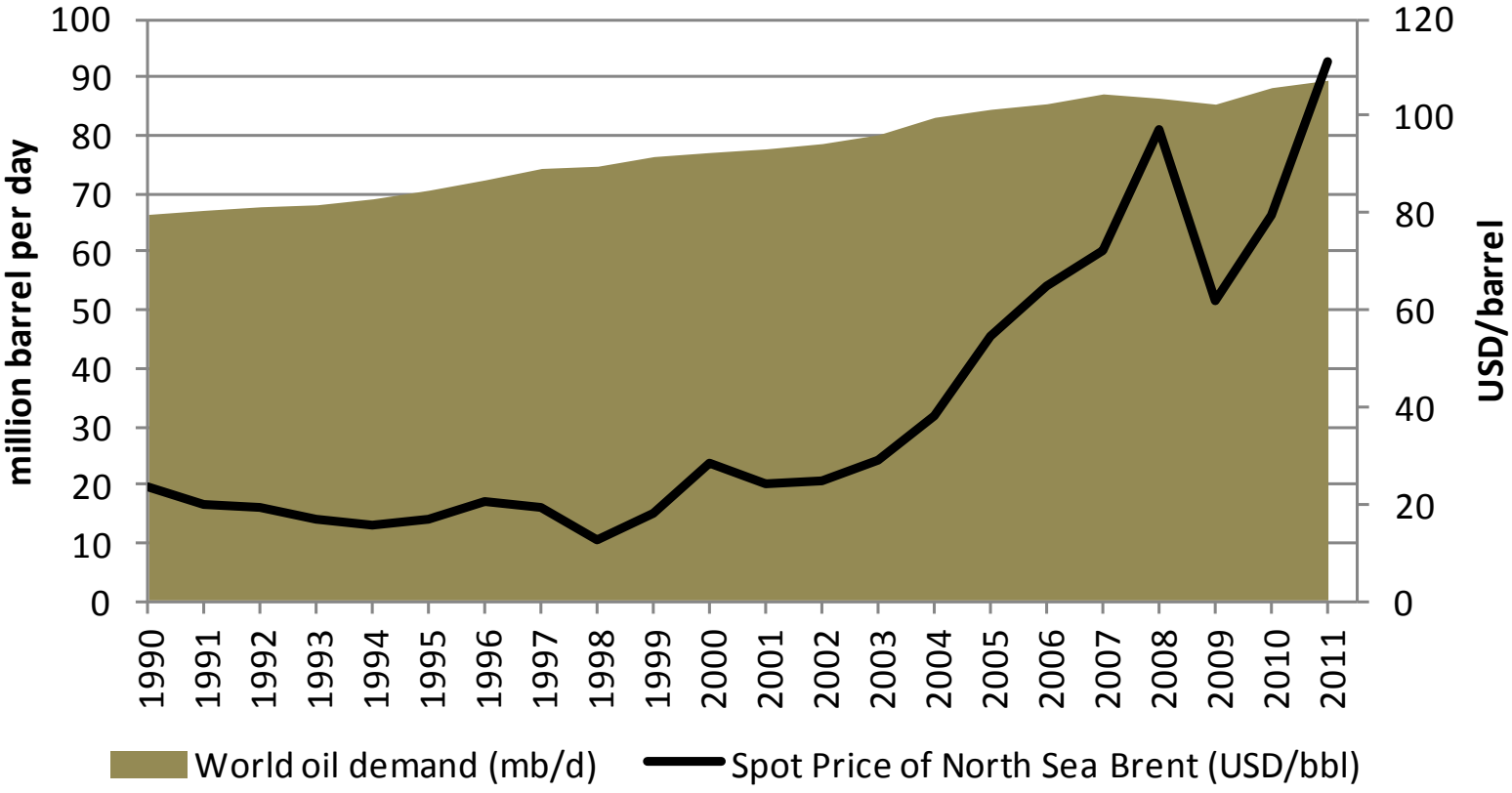


Notes: Light-duty vehicles are cars and light trucks (up to 3.5 tonnes); heavy vehicles are trucks and buses.

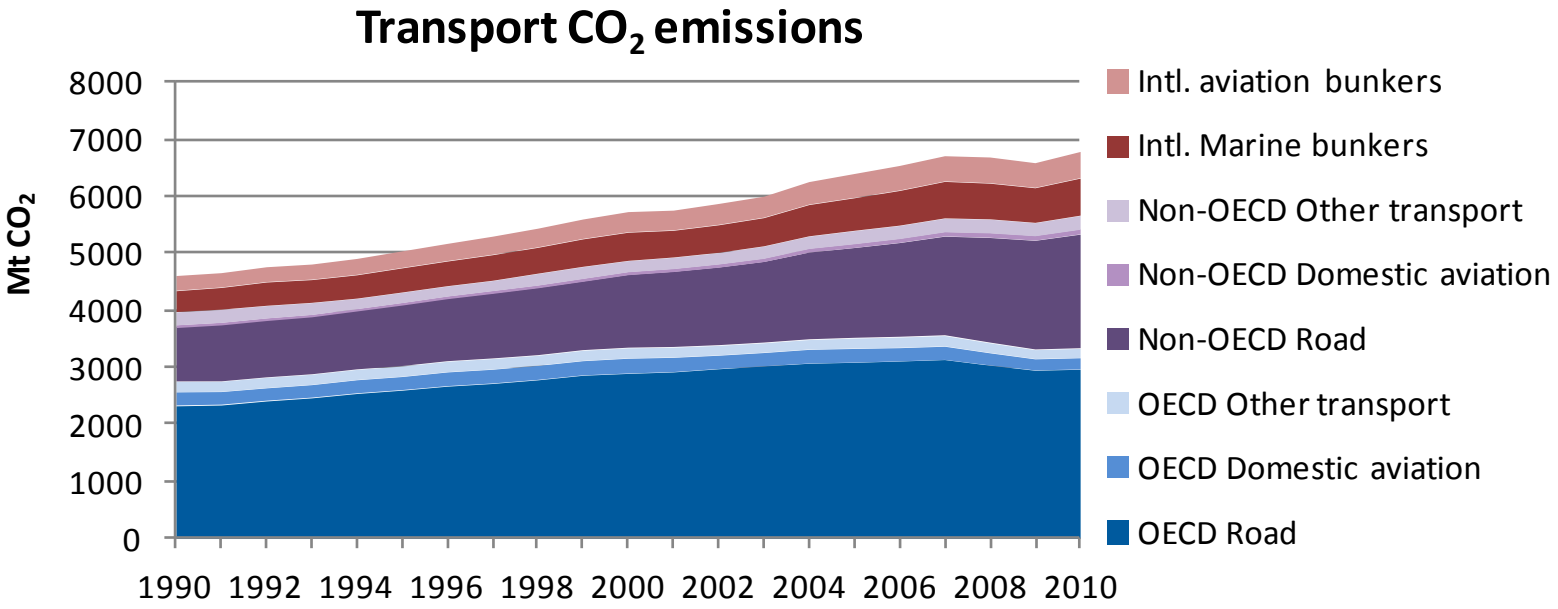
Source: IEA Energy Technology Perspectives 2012

- Demand for transport fuels is growing rapidly as car-ownership rates in emerging countries increase

…with strong impact on oil demand …



…and CO_2 emissions



CO_2 emissions from transport account for almost 25% of world energy-related CO_2 emissions


Never mind about "coming in peace"! TELL me you brought alternative energy technology!
8-15-08

Why biofuels?

- Oil prices are rising and increasingly volatile
  - → *The era of cheap oil is over!*
- Global transport fuel demand is growing rapidly
  - → 50% increase in transport energy demand by 2050 in a business-as-usual scenario
  - → Biofuels replace fossil fuels
    - → Improved energy security
    - → Reduced oil import bills
- Agricultural sector has been suffering from high production costs and relatively low commodity prices
  - → Biofuels can create **additional income** opportunities in **rural areas**
- Reduction of energy-related CO_2 emissions is needed to mitigate Climate Change
  - → biofuels can **reduce transport CO_2 emissions** compared to use of gasoline/diesel
  - → biofuels are the only low-carbon fuel suitable for **heavy transport** modes (planes, trucks, marine vessels)

Biofuels

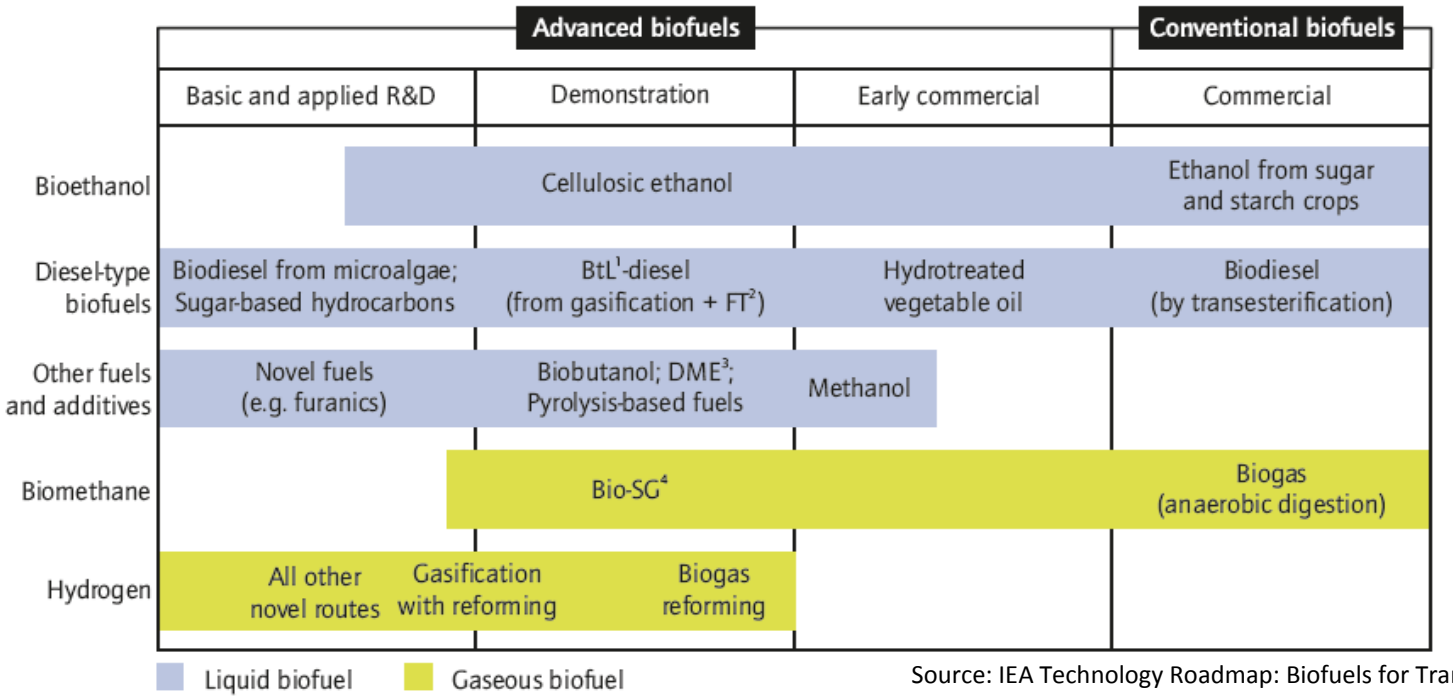
Some definitions

- **Biomass:**

  Any organic, *i.e.* decomposing, matter that is derived from plants or animals

- **Biofuels:**

  Liquid and gaseous fuels produced from biomass, used in the transport sector



Source: IEA Technology Roadmap: Biofuels for Transport

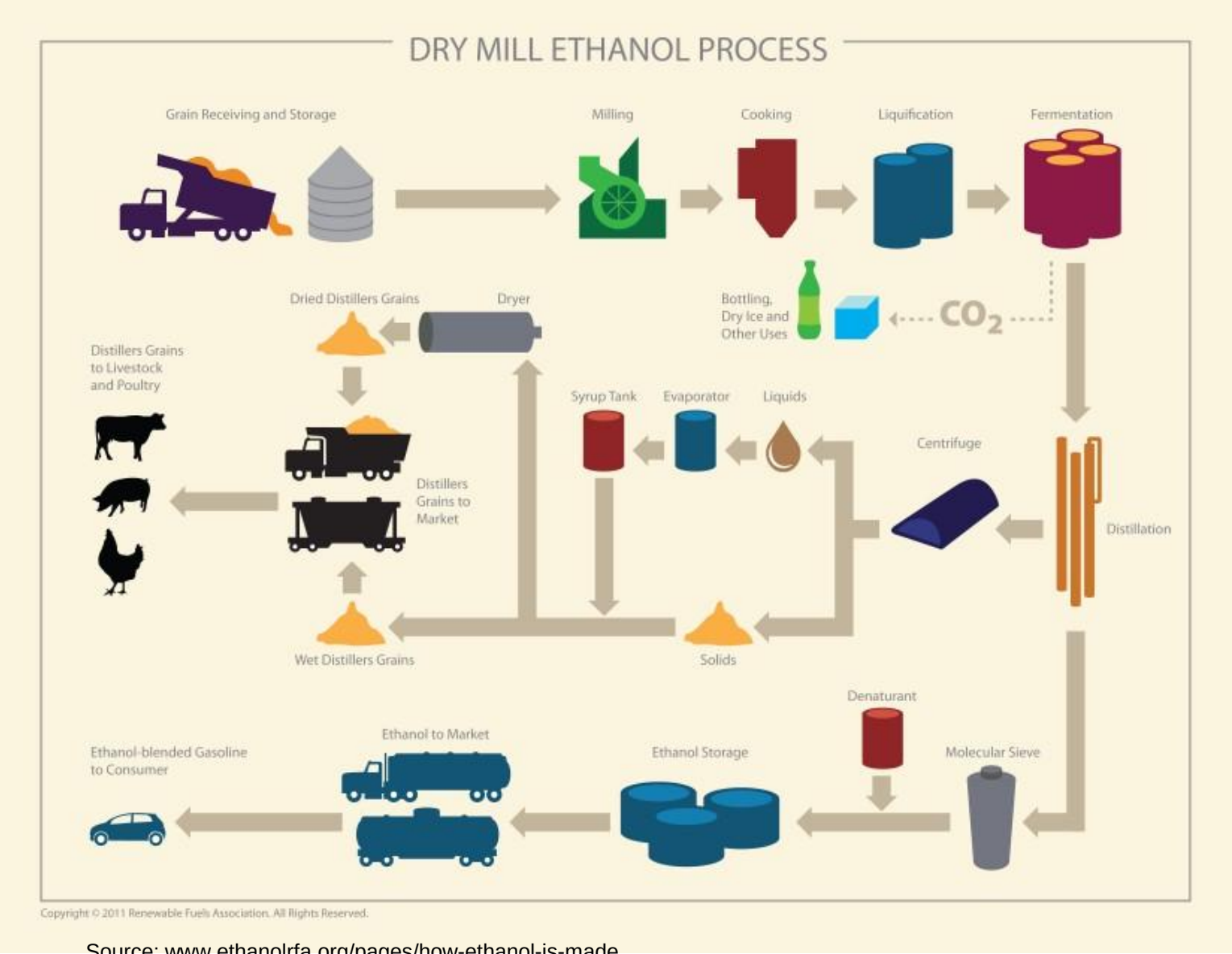
1. Biomass-to-liquids; 2. Fischer-Tropsch; 3. Dimethylether; 4. Bio-synthetic gas.

Conventional biofuels

- **Conventional biofuels (also referred to as 1st generation)**
  - Well-established technologies; commercial production
  - **Ethanol:** corn, sugarcane, wheat, sugarbeet, cassava
  - **Biodiesel:** rapeseed, soybean, oil palm, sunflower
  - **Biogas:** produced via anaerobic digestion of energy crops (*e.g.* maize silage) and wastes (*e.g.* organic waste, manure)

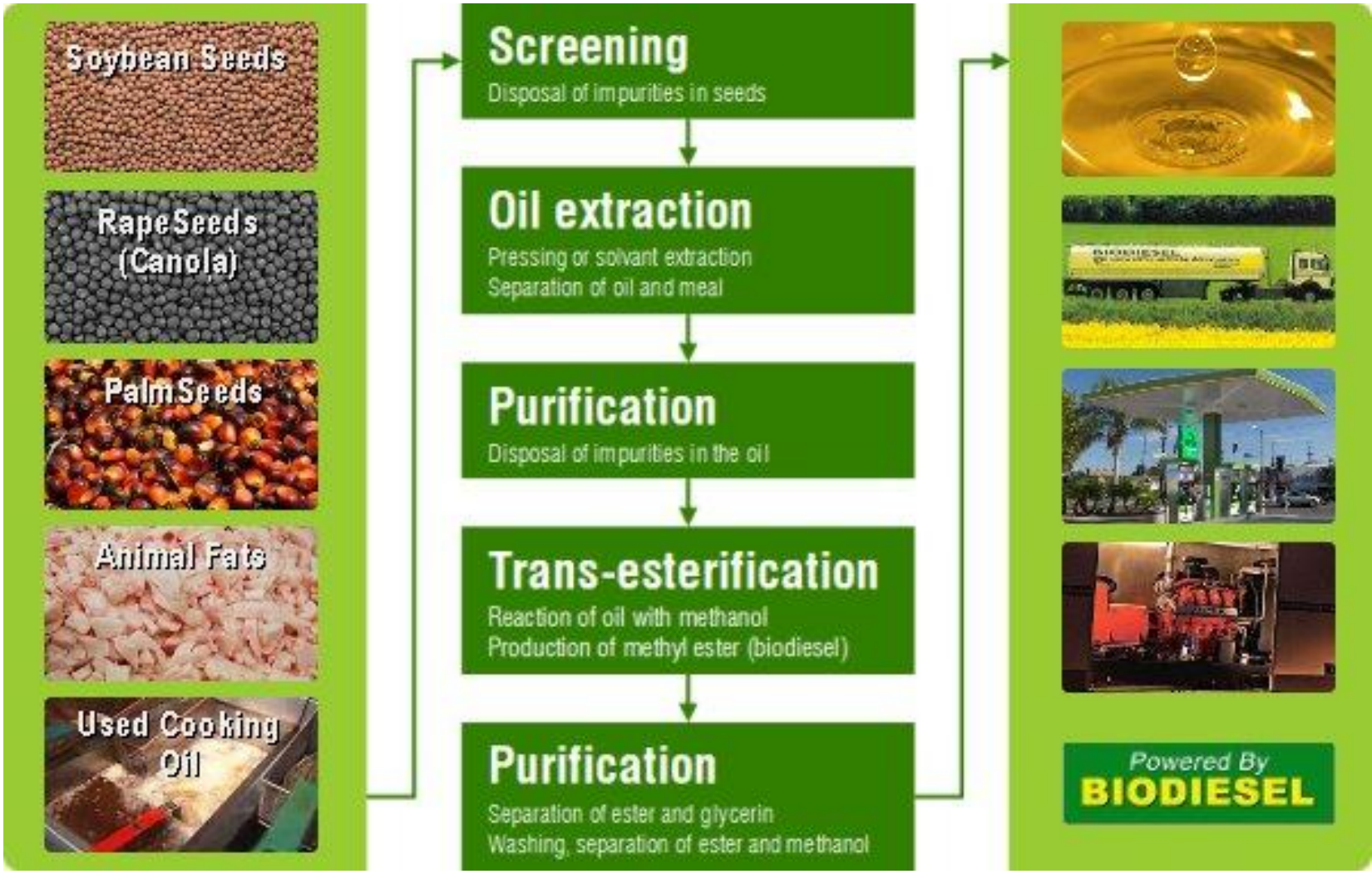
Courtesy: www.flashnewstoday.com; www.palmplantations.com.au; soilcrop.tamu.edu; www.reggie.net

Grain ethanol production



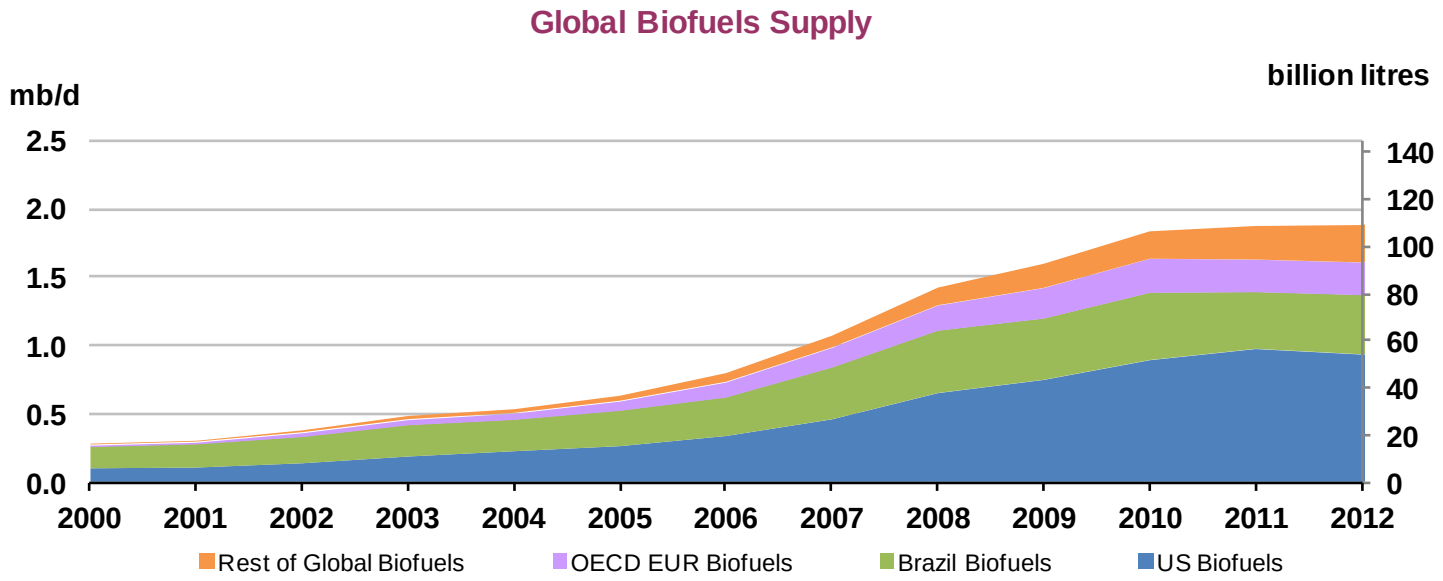
Source: www.ethanolrfa.org/pages/how-ethanol-is-made

FAME biodiesel production



Source: www.2g-cenergy.com/biodieselproduction.html

Biofuel production 2000-12



- Global biofuel production grew rapidly in the last decade
  - → Reached 110 billion litres in 2012
  - → 22% average annual growth 2000-10, but only 1.2% 2010-12
- Biofuels provide around 3% of total road transport fuel today
- Support policies main driver behind biofuel development
  - → more than 50 countries (including many developing countries) have now adopted blending mandates and targets

Advanced biofuels

- Currently in R&D, pilot or demonstration phase
- **Cellulosic-ethanol:** different types of lignocellulosic biomass
- **Biomass-to-liquids (BtL)-diesel:** different types of lignocellulosic biomass
- **Bio-synthetic gas (bio-SG):** biomethane produced from different types of biomass via gasification
- **Other novel technologies** in the R&D phase
  - Algae-biofuels
  - Sugar-based hydrocarbons

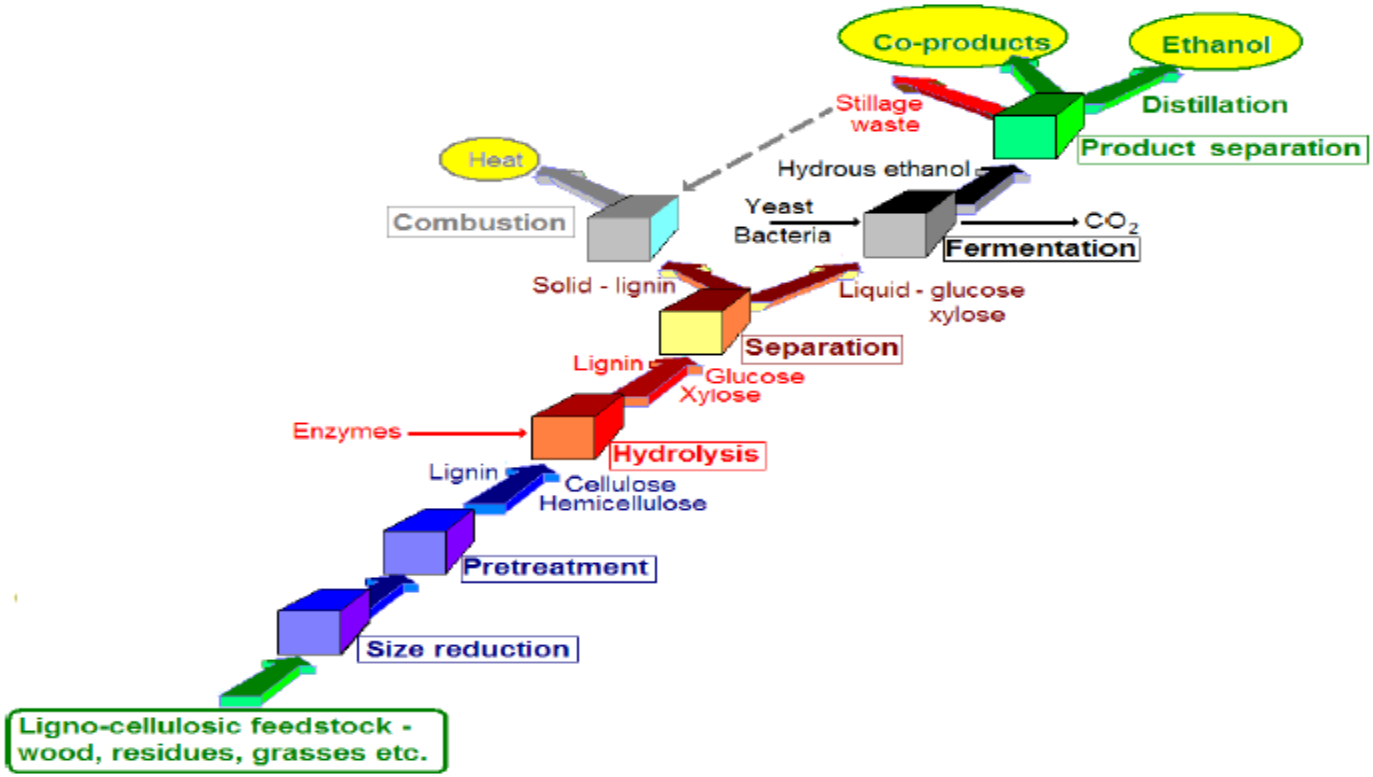
- Advanced biofuels promise:
  - high land-use efficiency
  - use of non-arable land
  - reduced fertiliser input through use of perennial crops
  - **Can they meet these expectations?**





Courtesy:
A. Eisentraut; www.biofuelstp.eu;
www.roulonspropre-roulonsnature.com

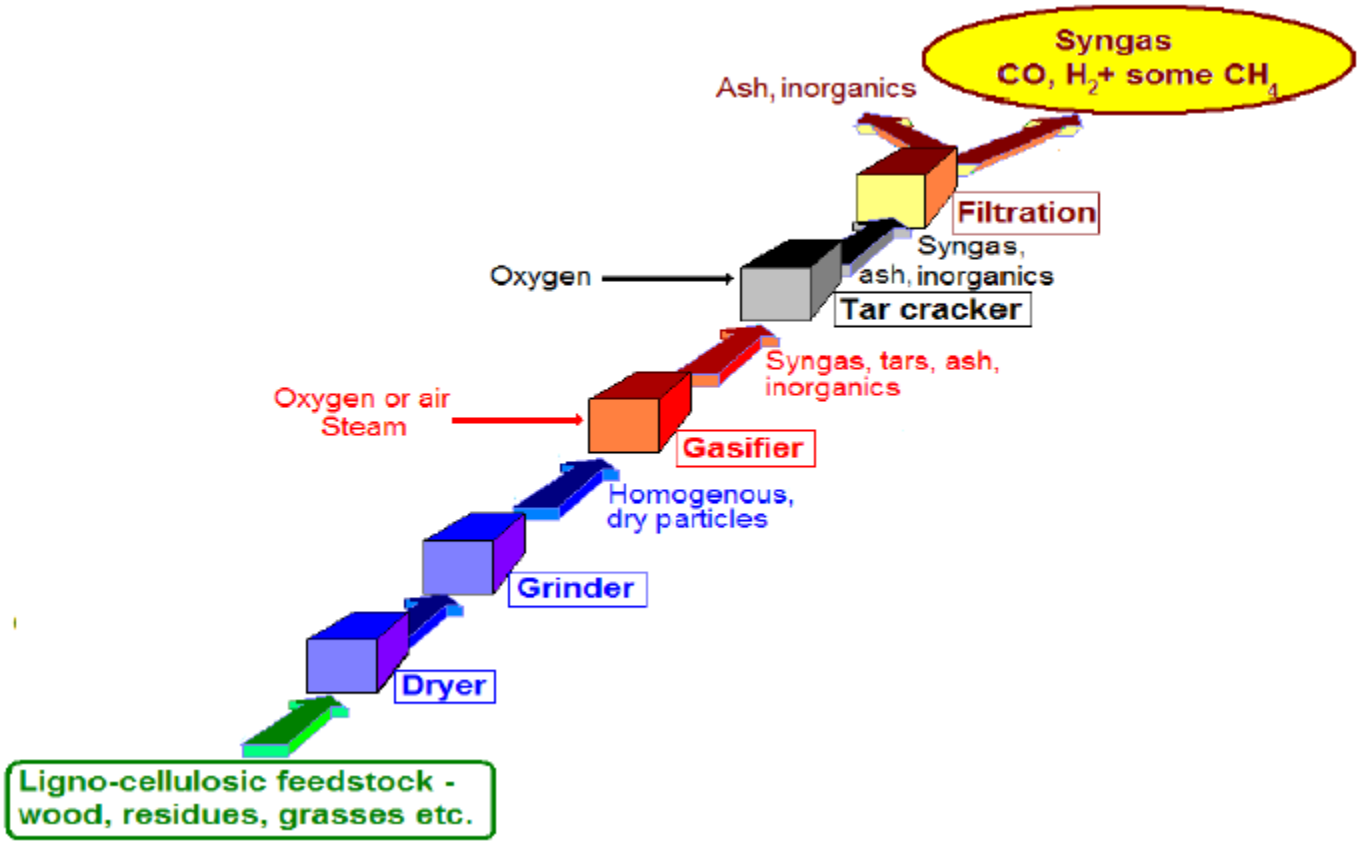
Cellulosic Ethanol



- Enzymatic or acidic hydrolysis of lignocellulosic biomass into sugars and subsequent fermentation to ethanol
- Relatively advanced process with several pilot and demo plants in place and first pre-commercial plants starting up
- Pretreatment process suitable for butanol, sugar-to-diesel and other advanced biofuel pathways

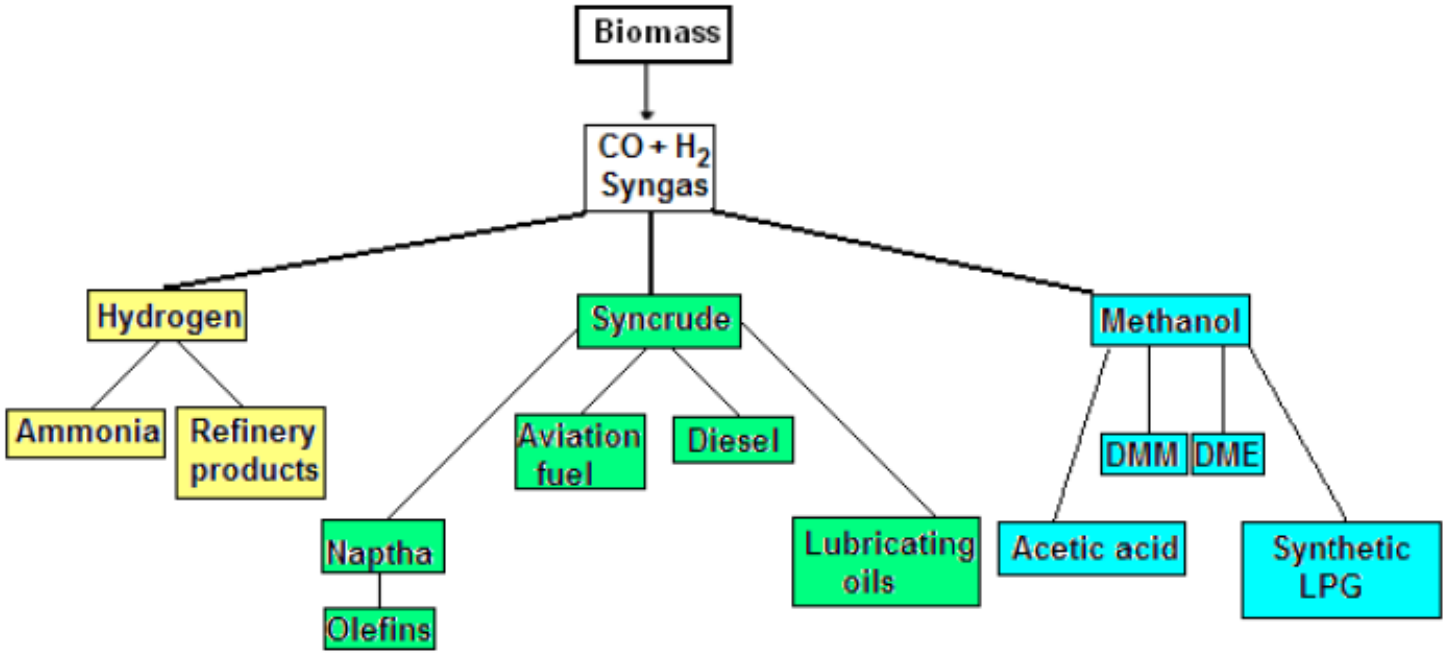
Thermo-Chemical Conversion

Biomass Gasification



- Thermo-chemical conversion of biomass into synthesis gas (CO, H2 + CH4)
- Feedstocks need to be dry and relatively homogenous to ensure highprocess efficiency

Biomass Gasification



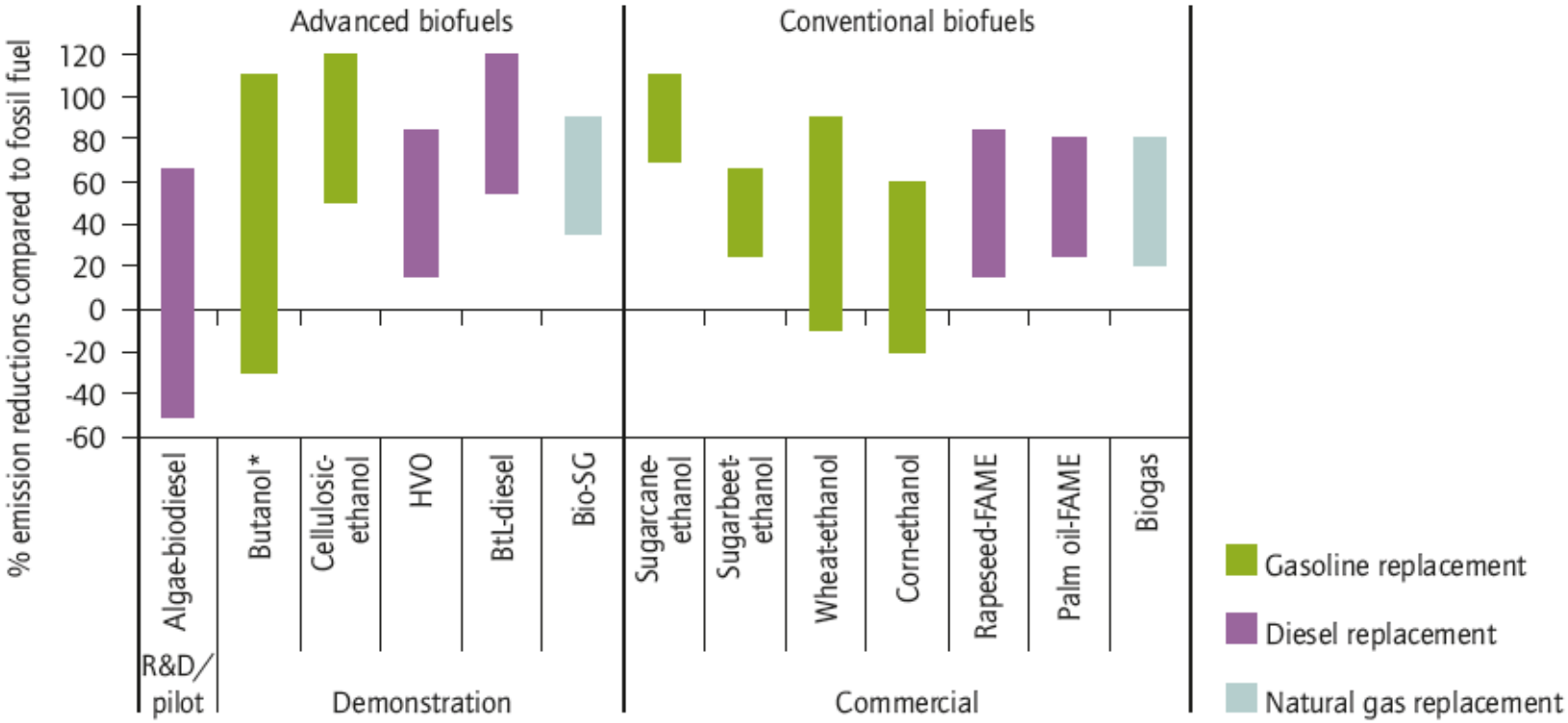
DMM = dimethoxy methane; DME = dimethyl ether

- A broad range of biofuels can be produced from the syngas
- Can potentially serve other sectors as well (*e.g.* chemical industry)
- Key is to produce clean, high quality syngas

The advanced biofuels industry is expanding

http://demoplants.bioenergy2020.eu

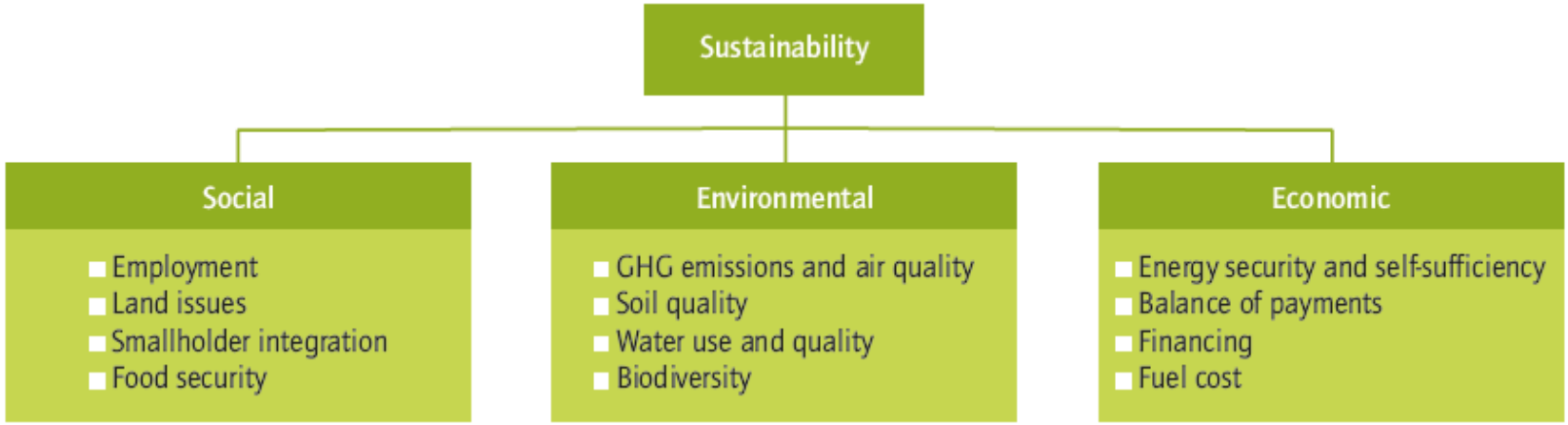
GHG-Reduction Potential of Biofuels



Note: The assessments exclude emissions from indirect land-use change. Emission savings of more than 100% are possible through use of co-products.
Source: IEA analysis based on UNEP and IEA review of 60 LCA studies, published in OECD, 2008; IEA, 2009; DBFZ, 2009.

- Most biofuels can reduce GHG-emissions compared to gasoline/diesel
- However, uncertainty on the impact of land-use change on GHG balance remains
- All biofuels should provide at least 50% life-cycle GHG emission reductions by 2020

Sustainability of biofuels is an important issue

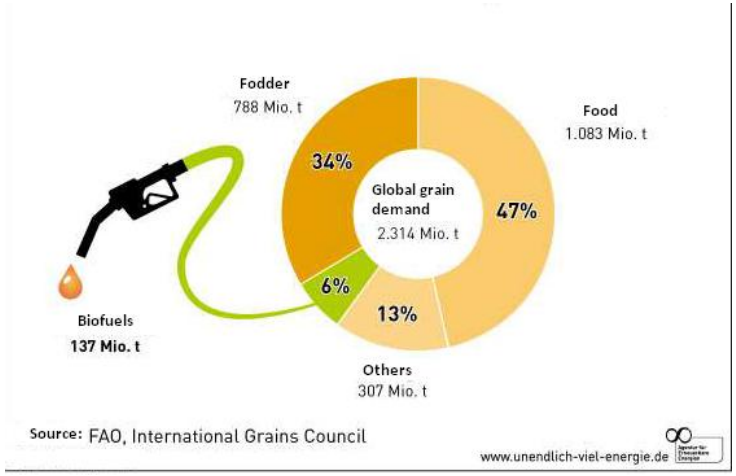


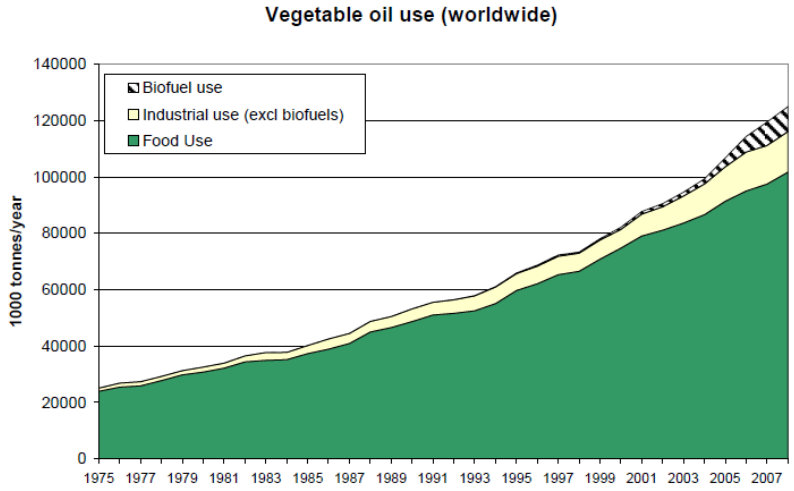
- Biofuels' **impact on food security** remains important topic that needs to be addressed
- **Environmental sustainability** continues to be questioned
  - → Deforestation; Indirect land-use change emissions; biodiversity impact; water consumption
- **Social aspects** are critical in particular in developing countries
- **Economic impact** of biofuels support measures needs to be monitored

Possible solutions:

- Sustainability relevant to whole agricultural sector → holistic policy approach needed
- GBEP sustainability indicators as basis for solid certification schemes for biofuels

Biofuels' place in the agricultural sector





- Biofuels are cultivated on 30 Mha of land toady, less than 1% of all agricultural land globally
- 6% of world grain production and <10% of world vegetable oil production is used for biofuels

→ Biofuel production is not the key driver for agricultural commodity prices

→Weather, oil prices, population growth (i.e. growth in demand), speculation and exchange rates are the strongest drivers

Electric vehicles & Plug-in hybrids can make a difference

Source: http://dicodelauto.yakarouler.com/autolib%E2%80%99-le-bilan-apres-6-mois/

Key requirement for emission reductions is use of **low-carbon electricity**


Source: http://www.ecochunk.com/2015/2012/08/27/sunstation-to-charge-your-electric-car-with-renewable-solar-energy/

Electric mobility - more than cars

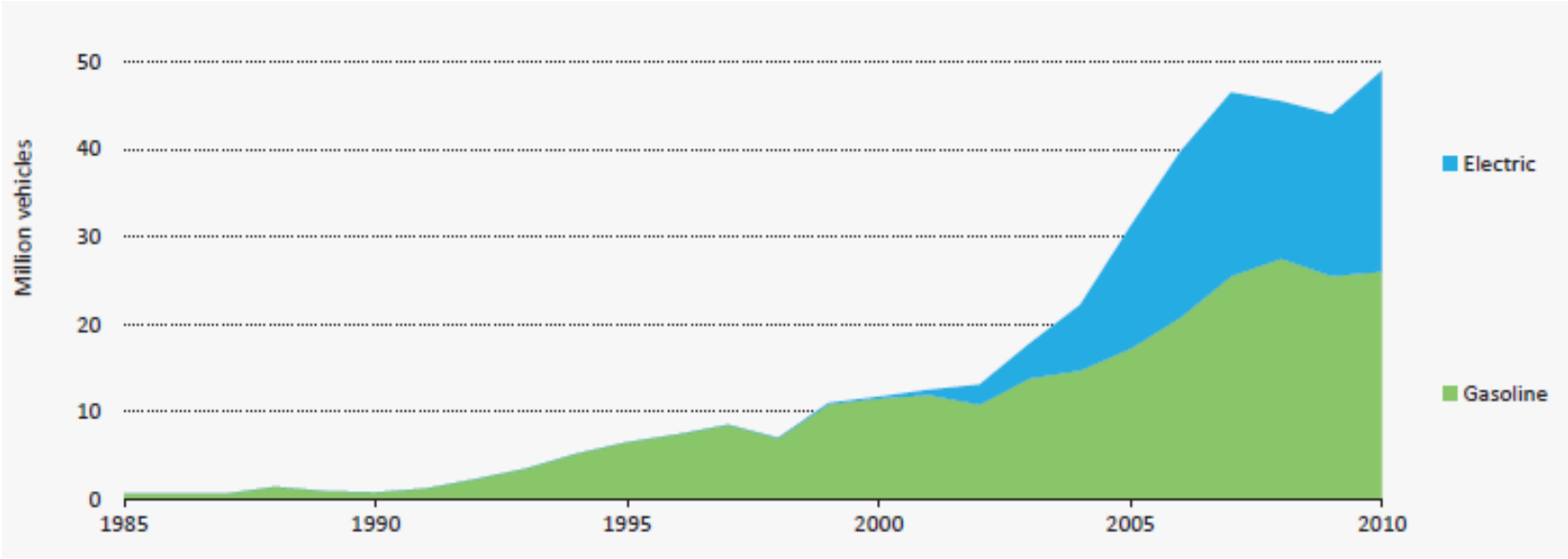
www.iloveebikes.com/

http://inhabitat.com/honda-unveils-all-new-electric-scooter-the-ev-neo/

http://green.autoblog.com/2010/03/07/solarbullet-campaign-shoots-for-high-speed-solar-train/

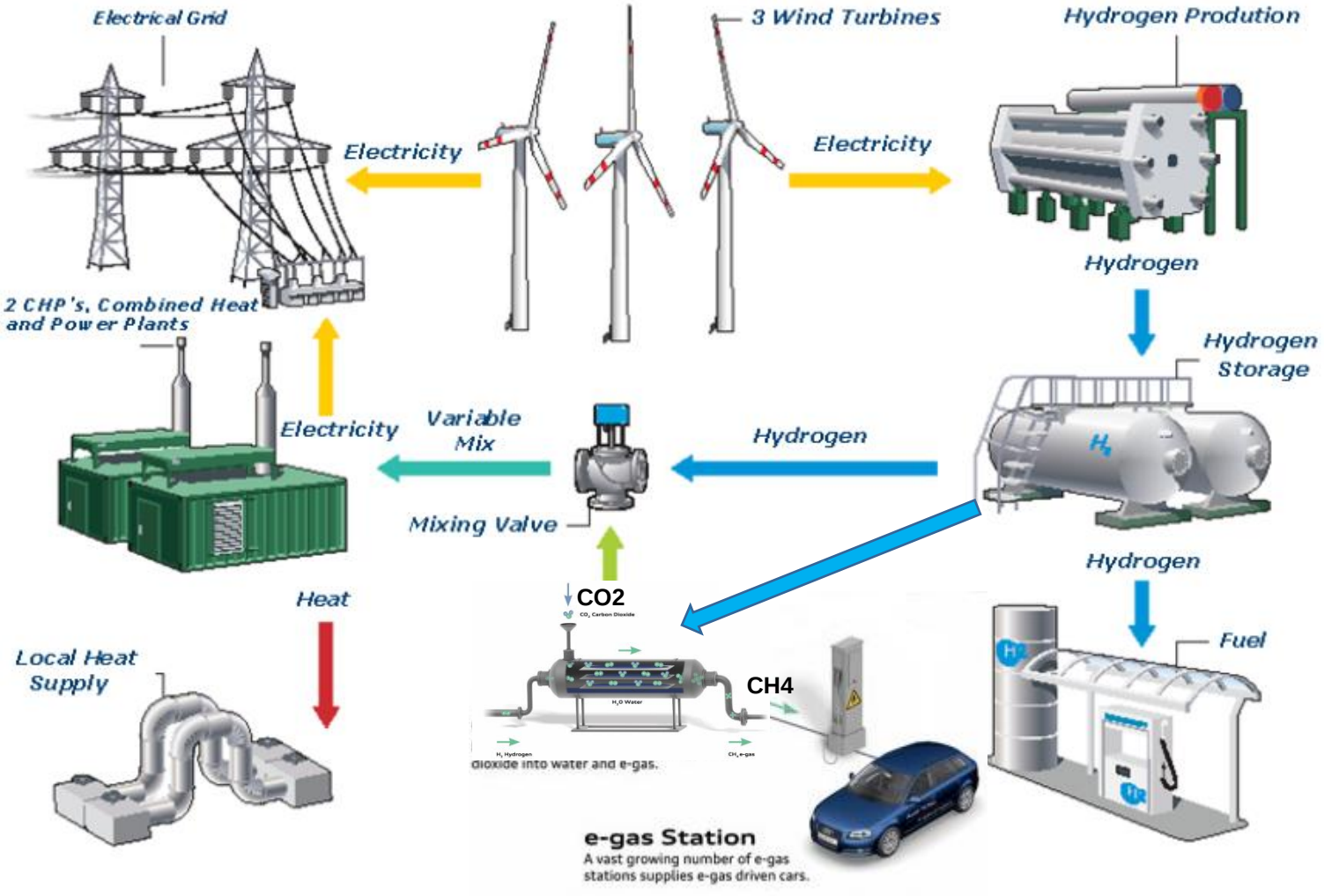
Electric scooters in China

Sales of electric 2-wheelers in China match gasoline-powered scooters after just a decade in the market



Source: IEA Energy Technology Perspectives 2012

Hydrogen might also play a role as vehicle fuel in the future

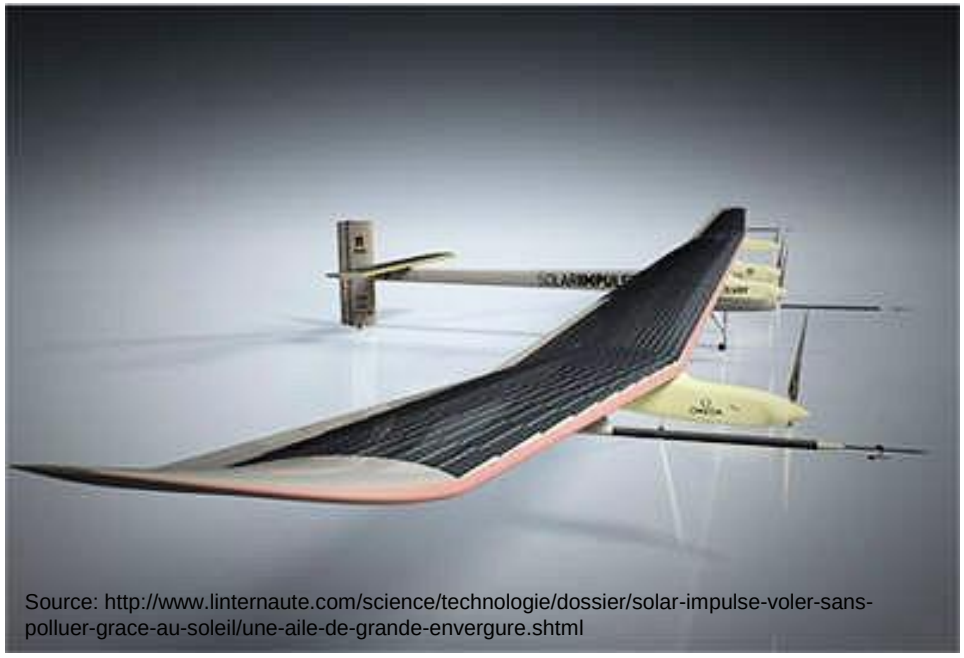


Source: Enertrag.com

Alternative fuel options for heavy and long-distance transport are limited

High energy density of fuels is key criterion for planes, marine vessels and long-haul trucks

→ Electrification and use of hydrogen are no realistic options at the moment

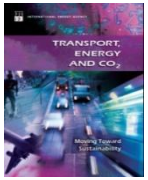


Source: http://www.linternaute.com/science/technologie/dossier/solar-impulse-voler-sans-polluer-grace-au-soleil/une-aile-de-grande-envergure.shtml


Thank you for
your attention!
20buckssaysyoullrememberme.tumblr.com

Further reading

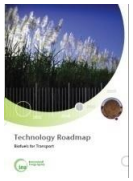
- **Transport, energy and CO_2 - Moving towards sustainability** (2009)
  Horizon 2050, all energy sources relevant to transport
  www.iea.org



- **From 1st- to 2nd-Generation Biofuel Technologies** (2009)
  Current state of the art of 2nd-generation biofuel industry

- **Sustainable Production of Second-Generation Biofuels** (2010)
  Potential for biofuels form agricultural and forestry residues
  Both publications available at ***www.iea.org***

- **IEA Technology Roadmap – Biofuels for Transport** (2011)
  Focus on global biofuel deployment to 2050
  www.iea.org/roadmaps



- Contact: Anselm.Eisentraut@iea.org