• Scale & scope
• (Impact) investment opportunity
• Case study - aviation
Sustainable bioenergy has an important role to play in the future energy mix that provides access to modern energy services for all.

Sustainable bioenergy can increase the share of renewables in view of using the variety of locally available energy sources and needs to mitigate climate change.

Integrated assessments of bioenergy systems are essential.

Monitoring of bioenergy systems needs to be improved.

The public perception can impede or accelerate realization of sustainability objectives via bioenergy.

Institutional and policy frameworks as well as capacity building are critical for sustainable bioenergy.
Ch6 Recommendations

1. To promote cross-sector data and information gathering, for informing innovative design and continuous monitoring of bioenergy systems.

2. To promote integrated assessment of social, economic, environmental aspects of bioenergy systems, adopting a landscape approach of natural resources management (land, water, etc.) to enhance productivity (bioenergy, food, feed, feedstocks, timber), environmental services (hydrology, biodiversity, carbon) and economic value, as a key reference framework informing innovation.

3. To promote innovative bioenergy technologies, considering the whole production chain: feedstock production, conversion and final use, in different scales and contexts.

4. Policies need to consider short- and long-term costs and benefits to avoid negative social and environmental impacts, while offering safe investment conditions.

5. To develop financing schemes and business models, especially to enable communities to benefit from small-scale bioenergy projects.

6. To enhance institutional frameworks and capacity building for improved governance, human resources, knowledge generation, innovation and extension in bioenergy systems.
GHG balance & climate

- Fossil, cement, steel:
  - 33.4 bn T/yr

- Land use change:
  - 3.4 bn T/yr

- Atmosphere:
  - 18.4 bn T/yr

- Land:
  - 9.5 bn T/yr

- Oceans:
  - 8.8 bn T/yr
Some say scientists can't agree on Earth's temperature changes.

Here's what “disagreement” looks like.
Projected sea-level rise and northern-hemisphere summer heat events in a 2°C world and a 4°C world

- Increased sea-level rise from 70 cm to more than a meter
- Increased frequency of extreme and unprecedented heat events
- ... and 75% of the poor in dev (agro) countries are hit first
Atmospheric $\text{CO}_2$ is now higher than it’s been for 650,000 years and increasing rapidly. This graph, based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements, provides evidence that atmospheric $\text{CO}_2$ has increased since the Industrial Revolution. (Source: NOAA)
High rate of change

1. So we have a time window of a few decades!
2. Linked climate and **economic** impacts
3. 80% of GHG emissions already locked in existing capital stock
4. 2°C goal: less than 1/3 of proven fossil reserves can be consumed before 2050 (significant capital loss)
5. 70-95 bn US$ in global annual adaptation costs
6. Impact investment - required: $1...2 trillion in next decade (@10-30% profit).
7. Pension funds: US $20 trillion, NL (EUR) 1 trillion
‘decades’: process / agro / logistics are slow industries

Example: Brazilian ethanol learning curve:
4x cost reduction in 30 yrs / 20 x volume increase

Bridging finance from discovery to deploy

1. **Accelerate** BBE-growth by
2. Sharing costs
3. Sharing resources
4. Sharing facilities
5. Reducing risk at any stage of innovation process, across regional borders
NRW and NL are #1 and #2 in Europe

Gas fields

Stationary sources

CO2/ha/yr

... in GHG emissions!
(so we have carbon to be recycled)
two sides of the coin in NW EU

GDP € 512 bn (#20 in 2010)
chemicals €13bn / 3% of GDP
   €47bn sales / 20% export
energy €30bn sales
imports 150 MT oil/ gas / 30% EU
emissions 224 MT CO$_2$e/yr

GDP € 2500 (#5)
chemicals €46bn / 8% of NRW GDP
   €145bn sales / 20% export
energy €33bn of GDP
chemical €109bn exports / €87bn imports (12%)
emissions 827 MT CO2e/yr
Aviation: no alternatives then TOI and jet biofuels

- **Carbon neutral growth**
- **KLM 1% biofuels in ’15**
- **50% GHG emission wrt ‘05**

CO2 emissions (kton/year) in NL at 3% net growth of aviation fuels consumption

- **improved technology, operations, infrastructure**
- **aviation biofuels**

From “Visie Duurzame Luchtvaart”. SER Report Van der Wielen et al. June 2014. adopting NL to ATAG ambitions
Introducing aviation biofuels (NL-numbers)

Fuel-pool composition in (kton/year) at 3% net growth of fuels consumption

- **150 kton/yr**
  - 1G: - 35% GHG

- **4 mio ton/yr**
- **7 mio ton/yr**
  - 2G: - 80% GHG

- **6 (12) bn $** estimates
- **4 (8)**
- **2 (4)**

- **0.7 mio ton/yr**

- **Carbon neutral growth**

- **“KLM gaat vliegen op frituurvet”**

- **doubling jet fuel towards 90% biojet**
Implementing the Bioport concept
mass yield matters: products are sold per tonne

**global production (MT/year)**
- fuels: 2000 (jet 300)
- cement: 3000 (600 MT CO₂)
- food: 4000 (50% waste)
- glass: 120
- plastics: 280 (big 5: 200)
- steel: 120 (200 MT CO₂)

**Substitutes**
- biomass
- CH₂O₀.₅
- CO₂
- sugars, lactic
- ethanol

**Drop-ins**
- natural gas

**Drop-outs?**
- crude oil
- fuels (energy dense) & polymers (PE, PP, PS, PVC)

energy density increases

mass composition biobased and fossil feedstocks and products
SAVE THE DATE!

ECO-BIO conference 2016:
“Challenges in Building a Sustainable Biobased Economy”

Tentative date: 6-9 March 2016

World Trade Centre
Rotterdam, The Netherlands

Chair:
Bram Brouwer
BioDetection Systems
VU University Amsterdam

Chair:
Luuk van der Wielen
Delft University of Technology
BE-Basic Foundation

More information: info@be-basic.org
Technology roadmap and (direct) economic impact (’08)

Internat HighTech
Chem’s, fuels & materials

- added value €/ton

200
100
10
0

€ 2-3 bn/yr 2020
€ 5-7 bn/yr 2030

National LowTech
EU & electricity focus
todays technology

- domestic production

€ 1-2 bn/yr 2010
€ 2-3 bn/yr 2030

- CO2e Mton/yr

56 (25 %)
30
8 (4 %)
0

target € 20 bn/yr
(incl indirect: 4-5% GDP)

NL: chemistry 2010: € 13 bn GDP (3%) / € 47 bn sales / 20% export ; energy € 30 bn sales
Contact us

B(E)-Basic Foundation
T +31 15 – 2782363
E info@be-basic.org
W www.be-basic.org

or

L.A.M.vanderWielen@tudelft.nl