Responding to the growing climate urgency:

Biofuels and sustainability in turbulent times

Gothenburg 26th May 2008

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A centre with: SEI Stockholm Environment Institute

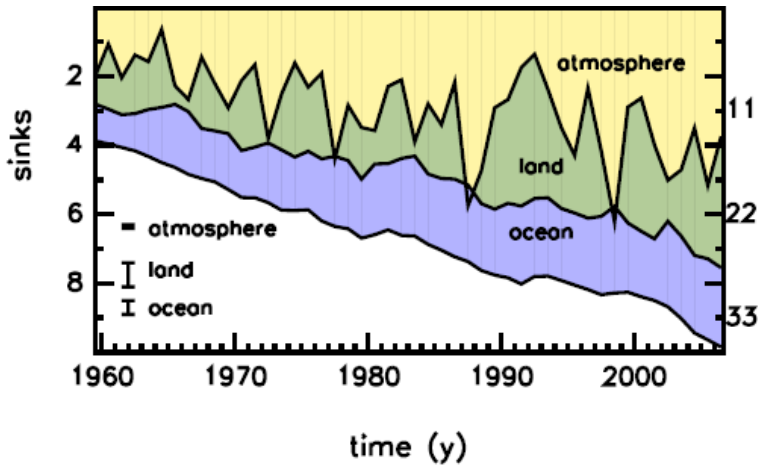
The Beijer Institute of Ecological Economics

Greenland Ice Sheet

IPCC AR 4: 0.18-0.59 m 2100

Hanssen 2007: “several meters“ 2100

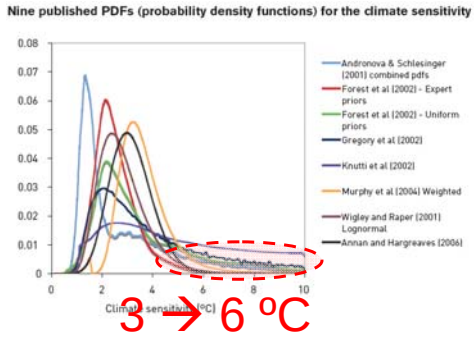
Carbon Cycle Feedbacks



“Together, these effects characterize a carbon cycle that is generating stronger-than-expected climate forcing sooner than expected.” (Canadell et al, 2007, *PNAS*)

Certain Uncertain uncertainty

Internalising surprise and fat-tail risks in governance and management

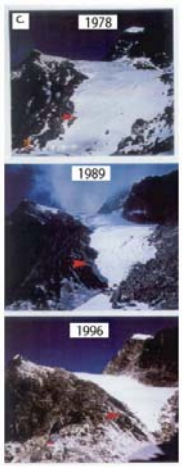


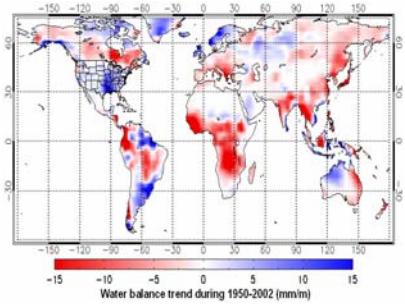
ref: Baer and Mastrandrea (2006)

"Humanity is facing double Wammies. Really big transformations triggered by 2 or more simultaneous shocks"
Professor Brian Walker

Anthropocene – already affecting us

Shorong Himal Glacier in Nepal (WWF, 2005)





Kilimanjaro 1970

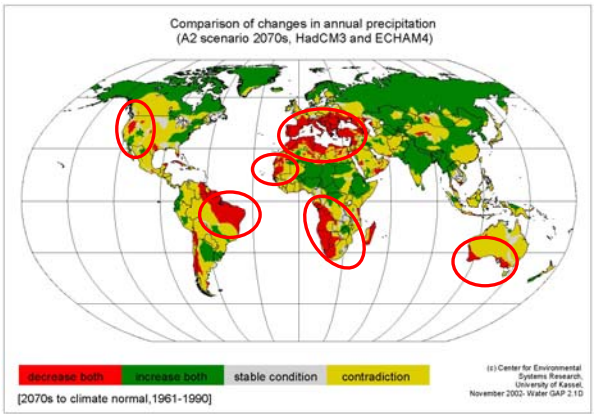
Kilimanjaro 2000

PAGES

Courtesy Will Steffen, 2006

e.g. Steffen et al. 2004. *Global Change and the Earth System: A Planet Under Pressure.*

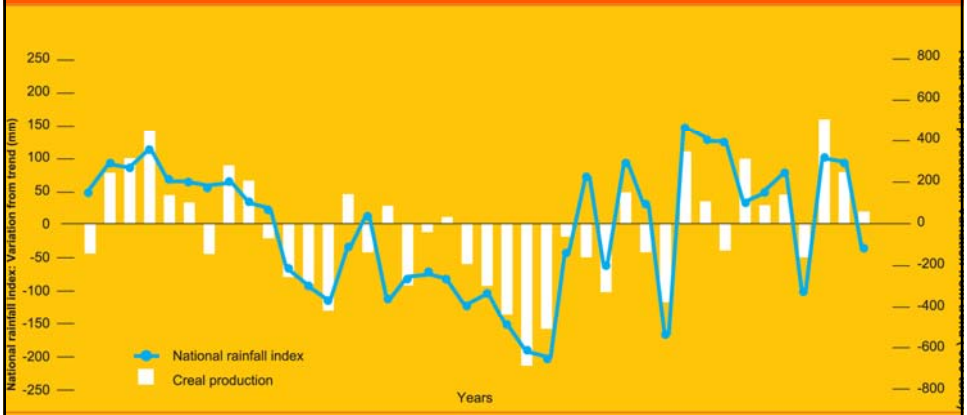
Global Water Hot-spots



Geographic patterns of climate change impacts on water resources are consistent between GCMs

Arnell 2004

Relationship between rainfall and cereal production in Burkina Faso



Yields are closely tied to rainfall. This can be seen by lining up the national rainfall index for Burkina Faso, where less than one percent of agricultural land is irrigated, with the total annual cereal production. In most cases, during drier than normal years, cereal yield took a corresponding plunge, whereas during wetter than normal years it received a boost. What can't be seen from this graph is when during the growing season rain shortfalls occurred—it is these short dry spells which greatly lower yields.

Climate urgency

and

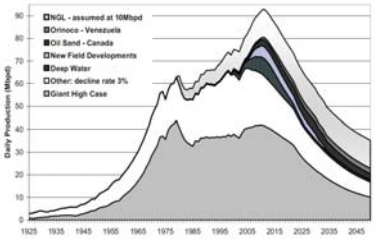
Global energy turbulence increases pressure

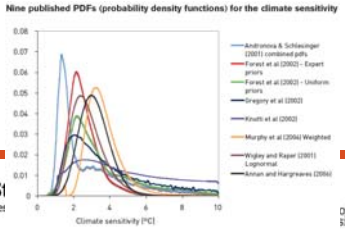
on

tranformation of transport sector

550 ppm

450 ppm

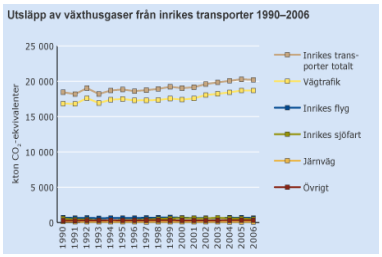


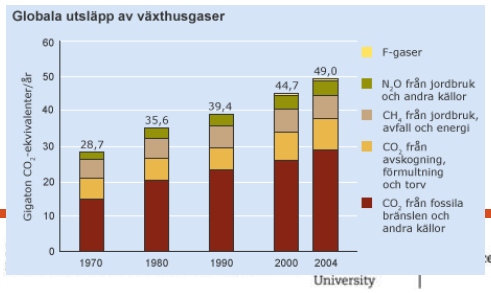


350 ppm

GHG emissions

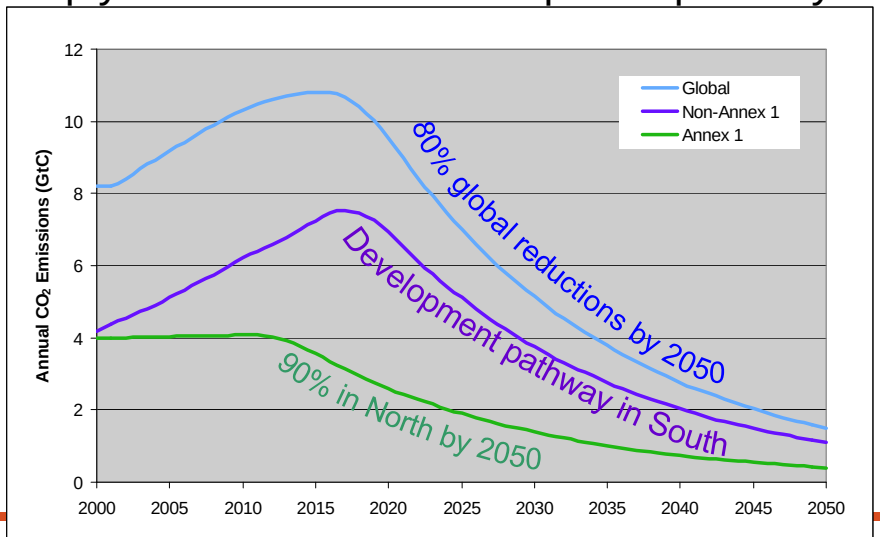
Global sources and domestic transport in Sweden





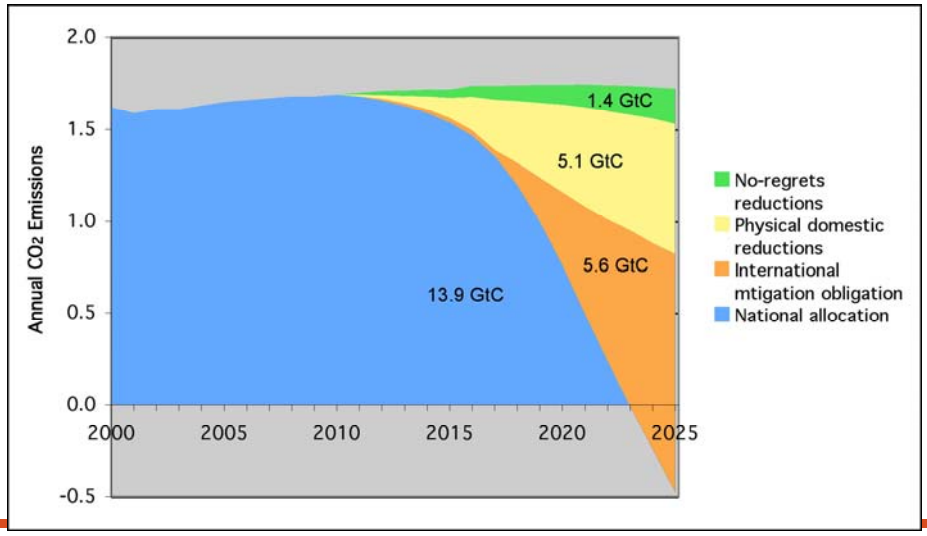
Källa: Sweden's National Inventory Report 2008, submitted under the United Nations Framework Convention on Climate Change

What does an "Emergency Climate Program" imply for the South's development pathway?



What kind of climate regime can enable this to happen…?

US Obligations under a GDRs Framework

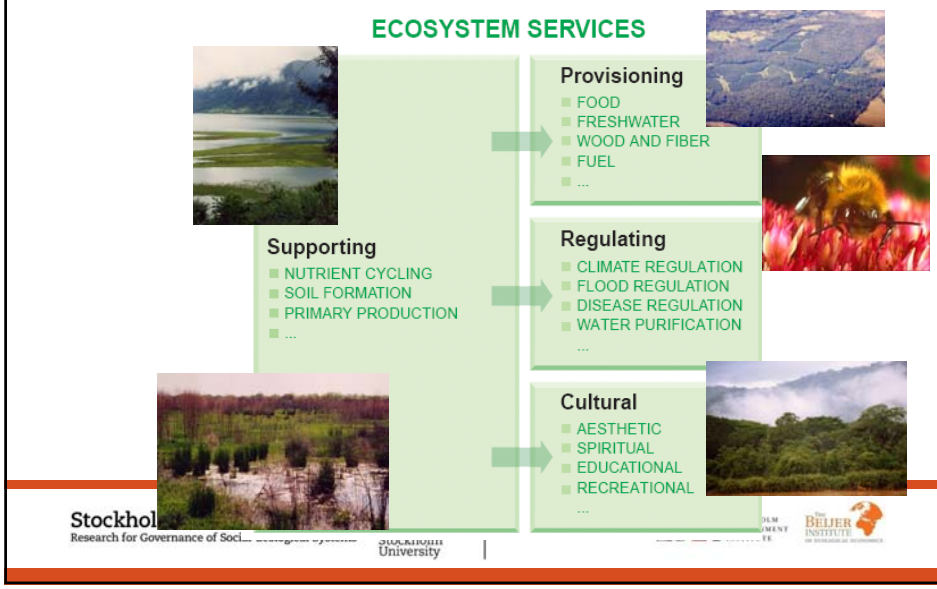


Physical domestic reductions as 90% by 2050, but US obligations are much greater. Must be met internationally.

Ecosystem Services, Resilience & Livelihoods

Ecosystem Services

The welfare nature produces for humanity



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Millennium Ecosystem Assessment

Key messages

- 60 % of analysed ecosystem services degraded over the past 50 years
- Agriculture the major driver behind ecosystem change

- A new Green revolution required
- Continued expansion of agriculture not an option

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Biofuels in the sustainability transition

Global Energy Mix

Global Energy consumption	~470 EJ/yr (6Xsince WW2)
Energy demand > 50 % to	700 EJ by 2030
Renewable Energy	~13 % (62 EJ) in 2004
Modern Bioenergy	**~2 % (8 EJ)**
Biodiesel	**0.28 EJ (7.2 Mt, 2006)**
Ethanol	**0.67 EJ (40 billion litres, 2006)**

World Energy Outlook 2006 – transport biofuels expected to reach 4 EJ by 2030 (12 % growth rate → 2015, 7 % growth rate → 2030)

”Whatever scenario materialises, bio-energy is expected to play a substantial role in the energy mix in 2030, providing around 70 EJ per year compared to 49 EJ in 2004; for modern bio-energy, range from 15 – 18 I EJ in 2004. **This rec amounts of biomas**

Louise Fresco, 2007

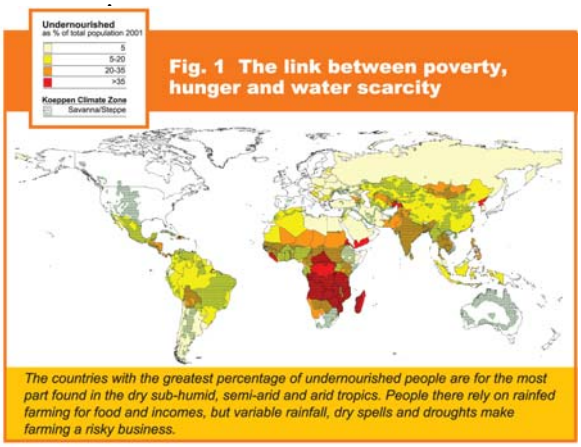
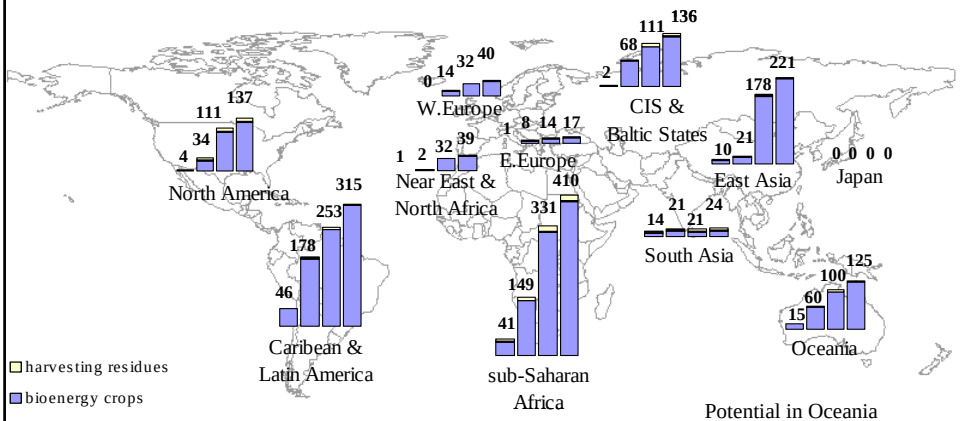


Fig. 1 The link between poverty, hunger and water scarcity

The countries with the greatest percentage of undernourished people are for the most part found in the dry sub-humid, semi-arid and arid tropics. People there rely on rainfed farming for food and incomes, but variable rainfall, dry spells and droughts make farming a risky business.

Bio-energy production potential in 2050 for different scenarios (EJ/year) (scenarios of different farming system mixes, animal production mixes)



Potential in Oceania is 4-6 times projected primary energy use

Source: E. Smeets, A. Faaij, I. Lewandowski – March 2004
A quickscan of global bio-energy potentials to 2050: analysis of the regional availability of biomass resources for export in relation to underlying factors, Copernicus Institute - Utrecht University, NWS-E-2004-109.

A systems perspective on Biofuels

Sobering up in a polarised ethanol debate

- Energy balance
- Ecosystem effects
- Trade-offs food-energy
- Social implications
- Long-term social-ecological resilience

Energy Balance

Pimentel & Patzek 2005 (29 % deficit)

Versus

Shapouri 2004 et al. (34 % positiv)

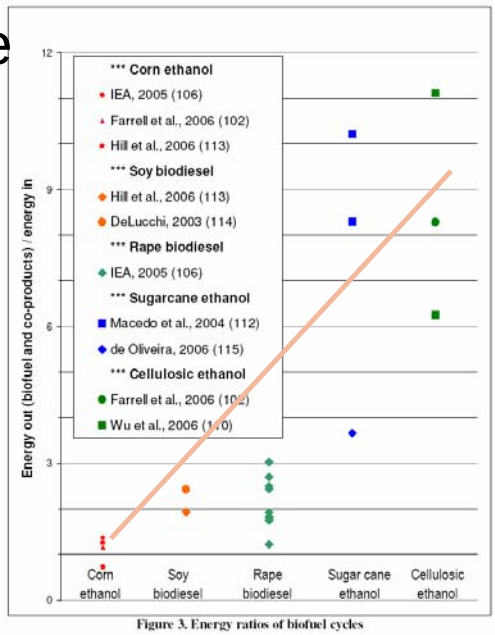


Figure 3. Energy ratios of biofuel cycles

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Land Use Change

Searchinger et al (Science 7 February 2008)

Maize based Ethanol:
From - 20 % to + 93 %

Biomass based (switchgrass) Ethanol:
From – 70 % to + 50 %

Maize Ethanol: 1.8 t/ha/yr CO2eq

Upfront emissions: Grasslands or Savannahs 75-305 t CO2eq
Forests 604 – 1146 t CO2eq

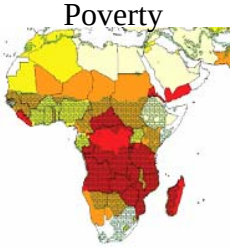
Brazilian Sugarcane (86 % GHG emission reductions):
4 yrs payback from grazing land
45 yrs payback from forests

A Regional Security Hot-Spot

And a bioresource challenge

Millions of Environmental Refugees?

Vulnerability & Poverty



Water Demand

Climate Risk

or, a transformation towards a bioresource economy?

Environmental consquences

GHG Emissions

	GHG reductions relative to petrol/diesel vehicle	Hectares required to fuel one car (ha/car)	
Ethanol (Maize)	14%	1.1	Farrell et al., 2006
Ethanol (Cellulosic)	88%	0.7	Farrell et al., 2006
Ethanol (Sugarcane)	91%	0.6	Macedo et al. 2004
Biodiesel (Soya)	40%	4.3	Hill et al., 2006
Biodiesel (Rape)	50%	2.0	IEA, 2005

Biofuel potential from cropland

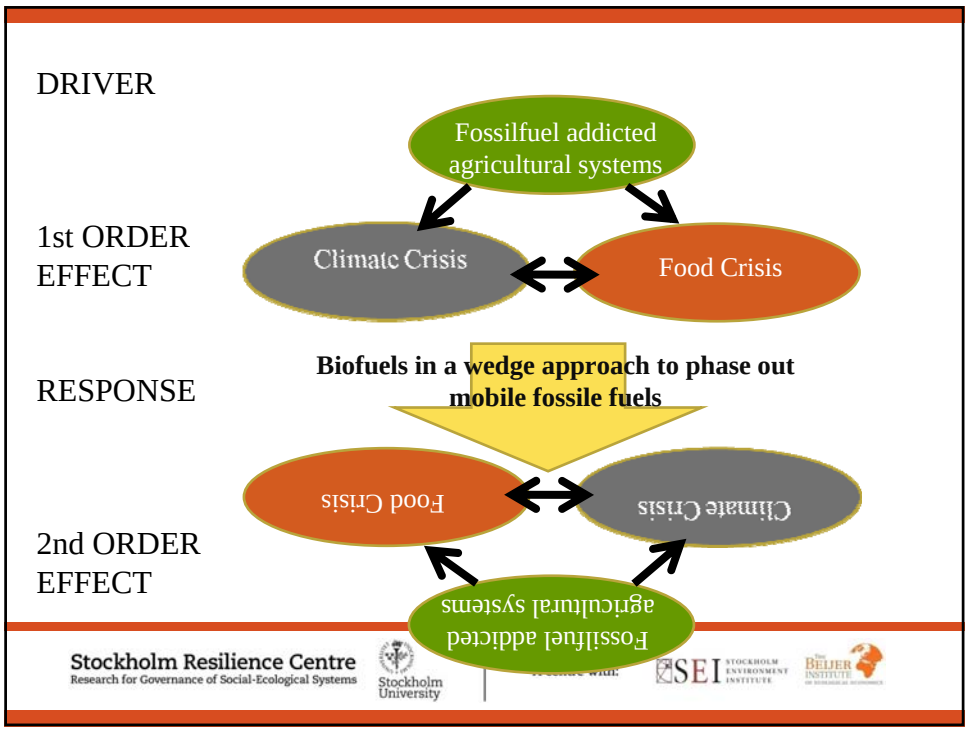
Globally we use ~0.25 ha/person for food production

Biofuels require from 0.5 – 2 ha/average car

Fueling all average person cars would at require at least 3 X current cropland….

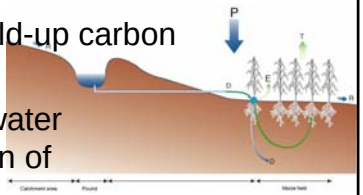
Indicates need for multiple strategies, and use of marginal lands.

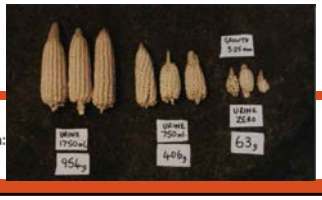
Field, Campbell and Lobell (2007) suggest the aggregate sustainable resource to ~5 % of current energy demand



Getting it right…

1. Original conversion
   - i. Minimize loss of cosystem services
   - ii. Minimize pulse of carbon loss
   - iii. Minimize risk for land use food trade-offs
2. New sources of energy for traction and fertilisation
3. New land management practices to build-up carbon in soil (not loose)
4. New water management practices for water productivity improvement and reduction of downstream trade-offs
5. Efficient biomass resource system





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Transforming Agriculture from Source to Sink

Improved land management practices in Agriculture has the potentialt to sequester 0.4 – 1.2 Gt C/år

(Rathan Lal, Science 2004)

Conclusions

- The climate challenge more dramatic than we previously thought – and moving quickly, in the wrong direction….
- Bioethanol not a panacea, but can be one among many ”wedges” in the social, economic and physical transition to zero carbon societies
- Bioenergy can be produced in a sustainable way that generates net energy gains, with larger positive environmental effects than fossil fuels, are economically competitive and accessible in large volumes without threatening food production (Fresco, 2007)
- Dangerous to focus blindly on carbon-budgets. Focus should shift towards securing ecosystem services, land-use change, and livelihood challenges
- Key challenge – to minimize trade-offs with ecosystem services and poverty reduction
- Largest untapped potential – Africa – where bioresource investments can combine poverty alleviation and macro-economic development
- Complexity – infinite outcome combinations – requires that biofuel investments are assessed from case to case based on a broad integrated assessment