Universiteit Utrecht

[Faculty of Science]

Improved modeling & mitigation of iLUC

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Workshop:

Quantifying and managing land use effects of biofuels

Campinas, 20 September 2011

Copernicus Institute
Research Institute for Sustainable Development and Innovation

Overview

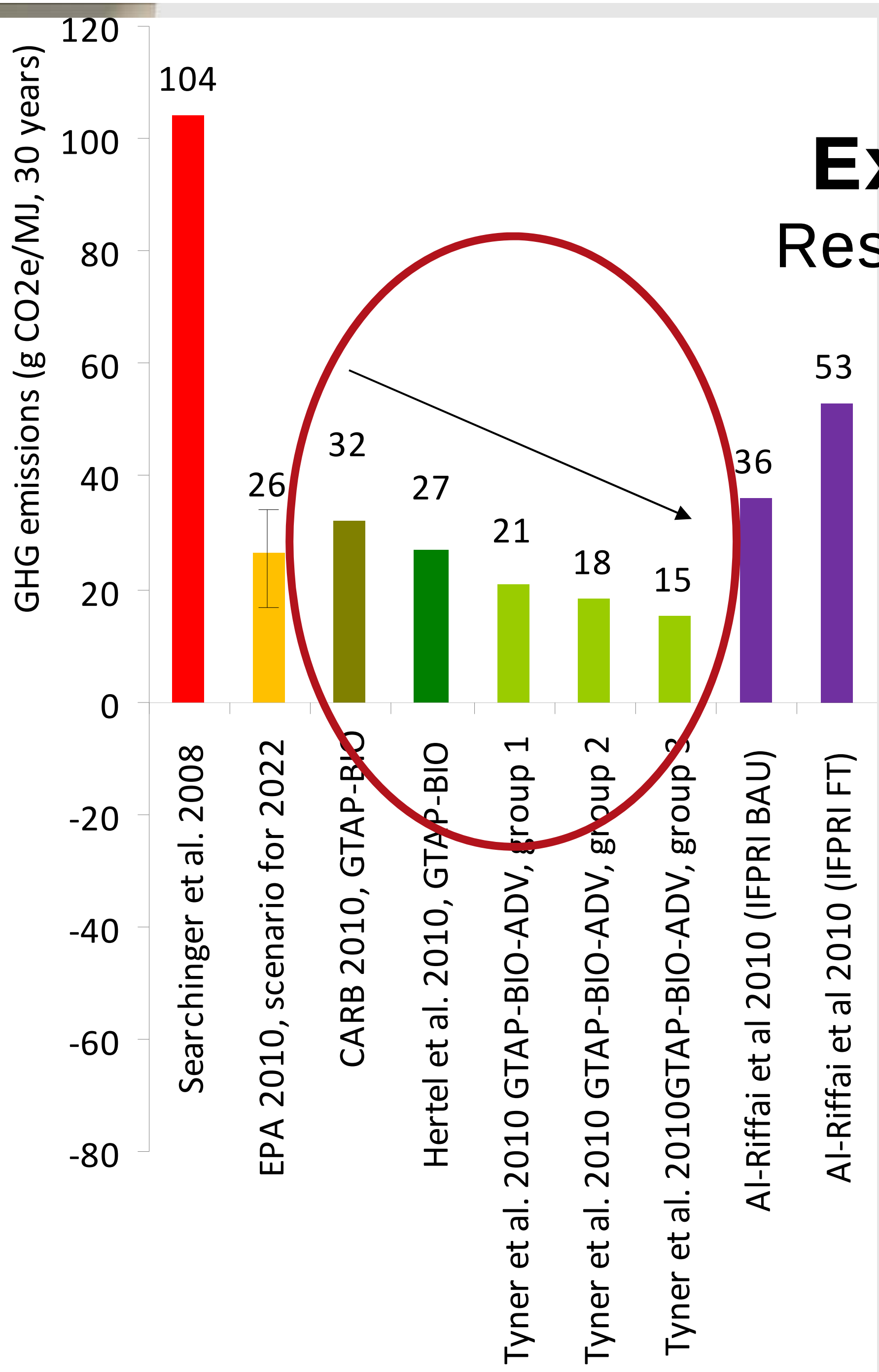
- Uncertainties & shortcomings of existing modeling efforts
- Further analysis
- Mitigation option

Introduction

- iLUC exists
- But discussion on the magnitude and how best to deal with it
- Discussions stem from
  - spatial and temporal character of iLUC
  - Difficulties in monitoring iLUC
  - Large uncertainties in models
- Let's look at the example of corn ethanol

Example: Corn ethanol

Results from PE & CGE models



GTAP model: Downward trend with refinements

What led to the reduction?

- Updates in the global economic database used in GTAP (from 2001 to 2006)
- Inclusion of pastureland conversion
- Treatment of animal feed co-products
- Crop yields (both for agricultural crops and bioenergy crops) on existing agricultural land and newly converted land,
- The fraction of carbon that is stored in wood products

Tyner et al., 2010

Introduction

- But how certain are we about these results?
- Similar trends for other fuels?

→ What are uncertainties/shortcomings of existing modeling efforts and how can modeling be improved?

- But even if even lower, (most) iLUC is undesirable

→ How can we mitigate the (i)LUC and its effect?

Uncertainties

- Underlying datasets
  - Key feedback relations: price, innovation and policy ←→ productivity increases ← → land expansion
  - Elasticities
  - Yield on newly converted land
  - Learning
- Amount, location and type of land use change
- By-products from bioenergy
- Technology changes over time (2nd generation)
- Dynamic nature of iLUC

Shortcomings

- Comprehensive uncertainty analysis
- Focus on 1st generation biofuels
- No inclusion of sustainability criteria and land use policies
- Impacts from iLUC

Further analysis

- Address uncertainties and shortcomings
- Pro-active iLUC modeling
  - How can iLUC be minimized?
  - → Include scenarios with sustainability criteria
  - → Include perennial crop production
  - → Include scenarios with iLUC mitigation options (next slides)
- Investigate drivers of LUC
- Investigate all impacts of LUC

(i)LUC mitigation measures

- ILUC = LUC of another land-based activity

→ Must be seen in context of other land-based activities

- Mitigation measure:
  - Control extent of (undesirable) LUC
  - Control type of LUC

Controlling extent of LUC

- Using agricultural and forestry residues
- Increasing efficiency in agriculture, livestock and bioenergy production
- Increasing chain efficiencies
- Minimizing degradation and abandonment of agricultural land

Controlling type of LUC

- Sustainable land use planning (incl. monitoring)
- Appropriate zoning of land use and land cover; e.g. excluding high carbon stock and biodiversity areas
- Using degraded and marginal land
- Using unused or abandoned agricultural land

Use of biomass residues and wastes

- no iLUC and large GHG emission savings if residues and wastes are used that are otherwise disposed off

- **BUT:** negative effects if existing uses!

(Ecometrica, 2009)

Increase efficiency in agriculture

- Use of arable & pasture lands: only when surplus capacity is available or created via increased efficiency/output:
  - Livestock management
  - Co-products
  - Productivity increases of conventional crops
  - Inter- and multiple cropping systems
  - Multiple rotations
  - Biorefining of crops (e.g. grasses)

Example: Increasing livestock density Brazil

Lapola et al., 2010, PNAS:

Indirect land-use changes can overcome carbon savings from biofuels in Brazil

But: if livestock density is increased by 0.13 head per hectare (instead of 0.09 as in baseline) between 2003 and 2020, then iLUC could be avoided (Lapola et al. 2010)!

Example: Yield projections Europe

Observed yield

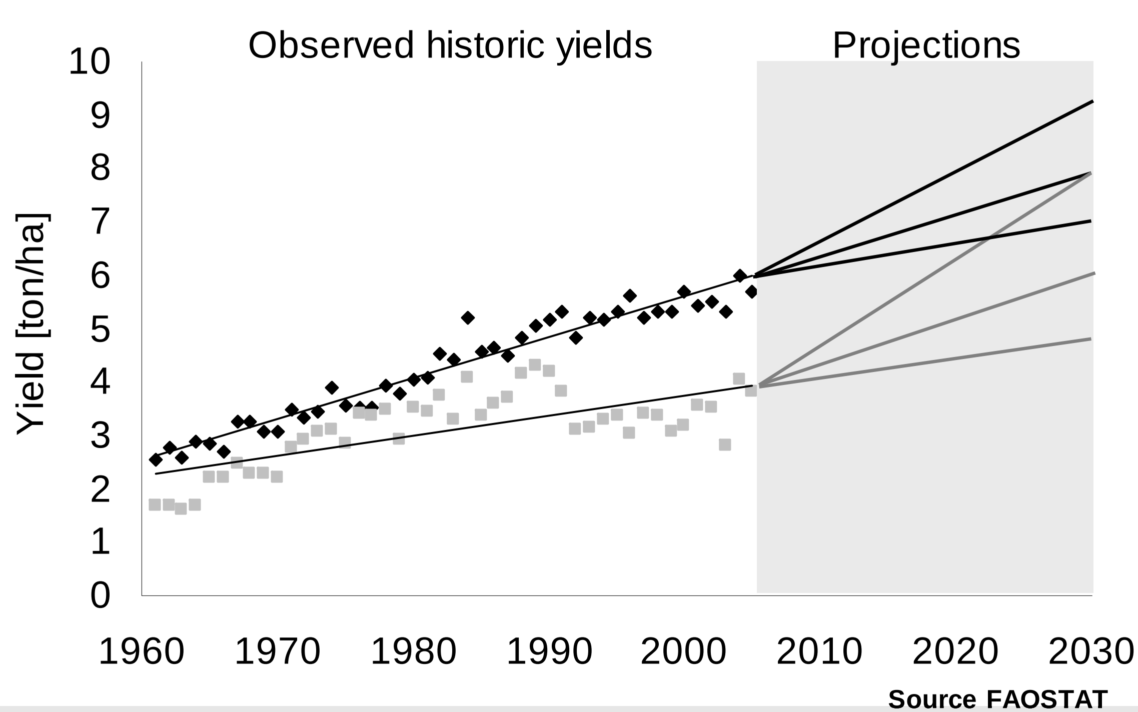
- CEEC and WEC

Linear extrapolation of historic trends

- Widening yield gap

Applied scenarios

- Low, baseline and high

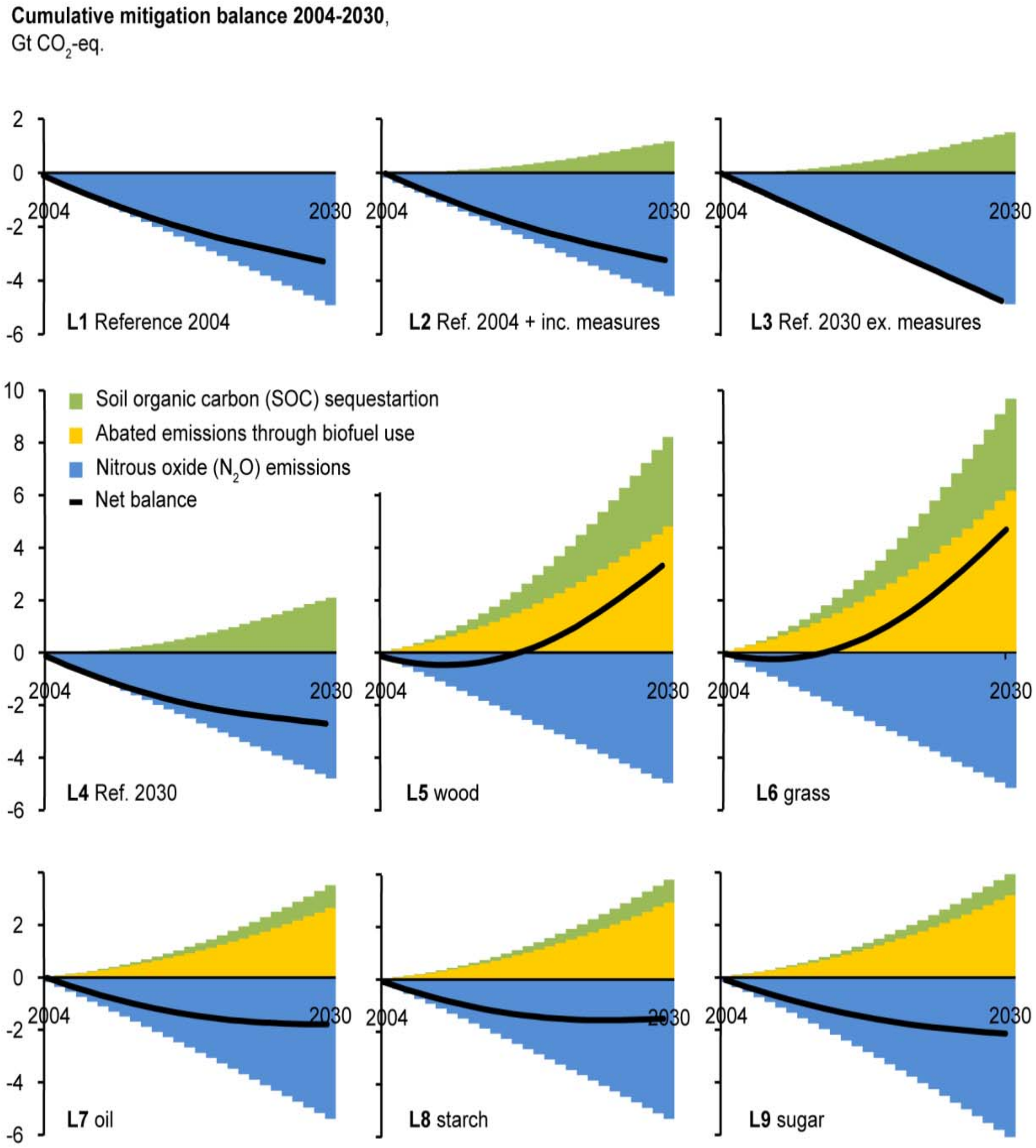


[Wit & Faaij, Biomass and Bioenergy, 2010]

Absolute productivity increases and relative growth rates for the period 1961-2007 and per decade

Wit, et al., RSER, 2011

		Absolute 1961-2007 kg ha^{-1} y^{-2} kg animal^{-1} y^{-1}	Relative **1961-2007**	'61-'69	'70-'79	'80-'89	'90-'99	'00-'07
					% y^{-1}			
France	Wheat	104	**3.6**	5.2	2.5	2.5	1.6	-0.9
	Rapeseed	40	**2.5**	1.4	0.3	-0.3	2.1	1.2
	Sugarbeet	1024	**3.1**	3.6	0.2	2.4	1.0	2.8
	Cattle	2.8	**1.6**	0.5	1.2	0.9	-0.1	0.9
Netherlands	Wheat	110	**2.7**	0.7	3.8	1.4	0.5	-0.6
	Rapeseed	25	**1.0**	-0.6	-1.8	-0.1	0.6	0.2
	Sugarbeet	489	**1.2**	2.6	0.1	1.4	-1.9	2.5
	Cattle	1.1	**0.6**	0.7	0.9	2.1	-0.9	-1.0
Poland	Wheat	39	**1.8**	3.6	2.3	4.1	-0.6	1.6
	Rapeseed	21	**1.4**	1.7	0.4	-0.4	-0.6	4.0
	Sugarbeet	319	**1.2**	3.5	-0.5	2.6	1.0	3.7
	Cattle	2.5	**2.7**	3.6	6.1	4.9	0.6	10.1
Ukraine *(USSR)* [a]	Wheat	*n.a.*	*n.a.*	5.1	1.0	3.6	-4.5	-0.2
	Rapeseed	*n.a.*	*n.a.*	3.5	-2.7	-0.4	-7.4	9.4
	Sugarbeet	*n.a.*	*n.a.*	9.0	0.3	5.0	-3.2	11.3
	Cattle	*n.a.*	*n.a.*	6.3	2.1	2.1	-4.9	1.2



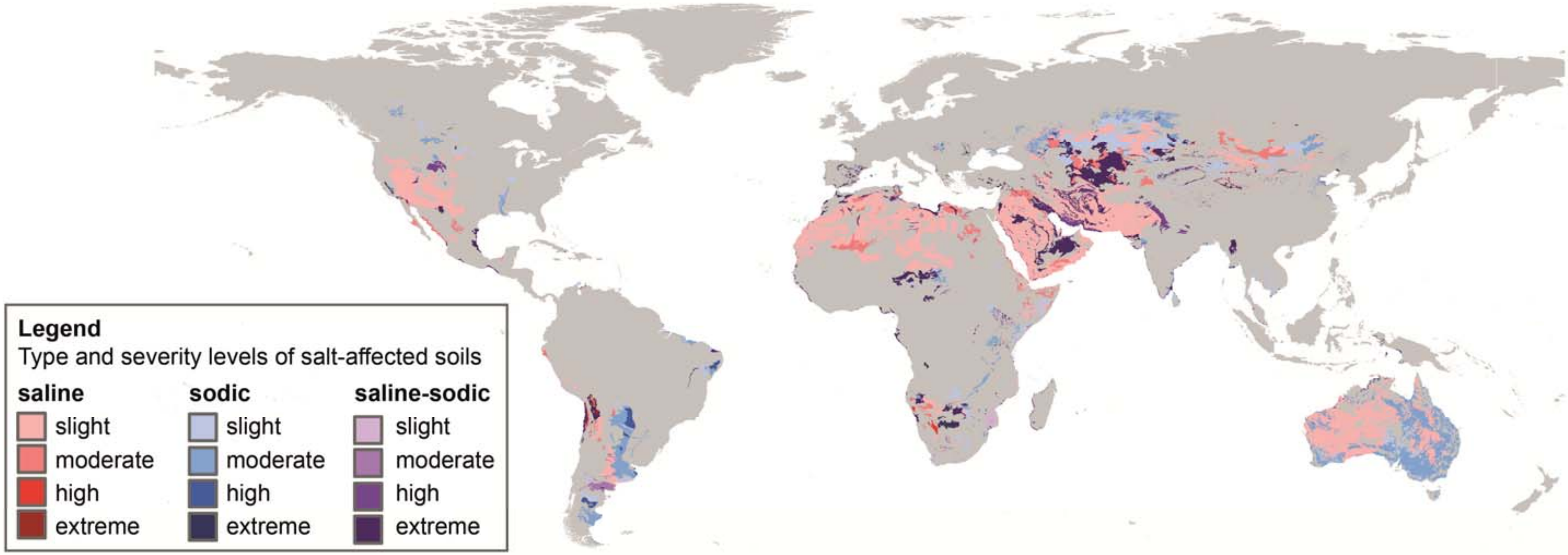
Example:
GHG balance of combined agricultural intensification + bioenergy production in Europe + Ukraine

[Wit et al., forthcoming]

Use marginal & degraded land

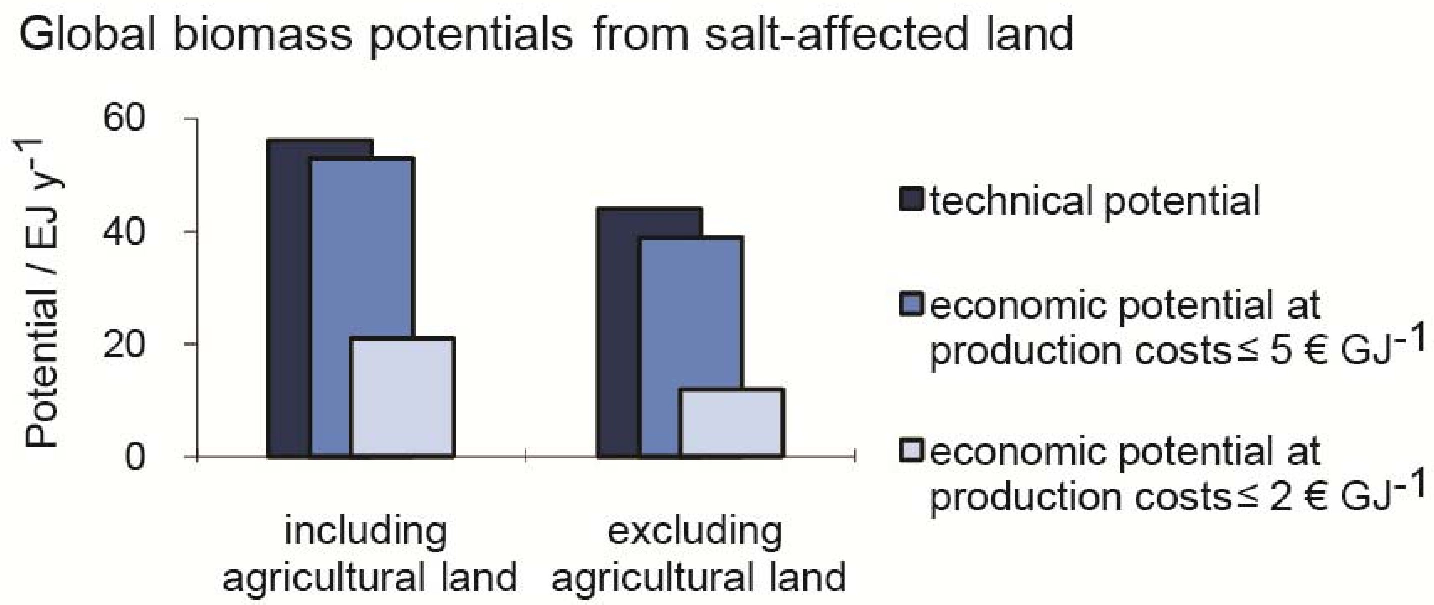
- Set-aside agricultural land
- Perennials on marginal land
- Degraded land (restoration functions/ ecosystem services)

Example: Salt-affected soils



[Wicke et al., Energy and Environmental Science, 2011]

Example: Salt-affected soils



[Wicke et al., Energy and Environmental Science, 2011]

Conclusions

- There is no question about the existence of iLUC but the magnitude and how best to deal with it is uncertain
- Modeling efforts have been improving, but still uncertainties & shortcomings exist and require more improvements
  - E.g. inclusion of perennial crops and sustainability scenarios, reducing key uncertainties, conducting sensitivity analysis, using models in pro-active manner
- iLUC can be mitigated!
  - E.g. using resides and waste, using degraded and marginal land, increasing crop production, improving chain efficiencies

Project: Knowledge infrastructure for sustainable biomass pathways

- **Project partners**
  - Copernicus Institute, LEI, PBL
- **Combining existing models**
  - MAGNET (former LEITAP)
  - IMAGE, IMAGE TIMER
  - bottom-up analysis of technological learning in biomass/bioenergy/agricultural production

Determine sustainable pathways

- **Funding:** Dutch Ministry of Economic Affairs, Agriculture and Innovation; European Climate Foundation; David & Lucile Packard Foundation
- **Timing:** 5 year project (2010 - 2015)

Thank you for your attention!

For more information:

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