Energy balance comparisons of organic and conventional farming systems and potentials for mitigation of fossil ressource use

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International Conference on Organic Farming Systems as a Driver for Change.
NJF seminar 461, 21-23 Aug 2013, Vingsted, Denmark.

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Program

- Introduction
- Methods for farm energy balance comparisons
- Key figures and examples
  - Plant production
  - Livestock production
  - Farming systems
  - Combined Food and Energy Systems
  - National scenarios
- Organic farming as a driver for change? – and for the transition to renewable resources?

Energy and nutrient cycling

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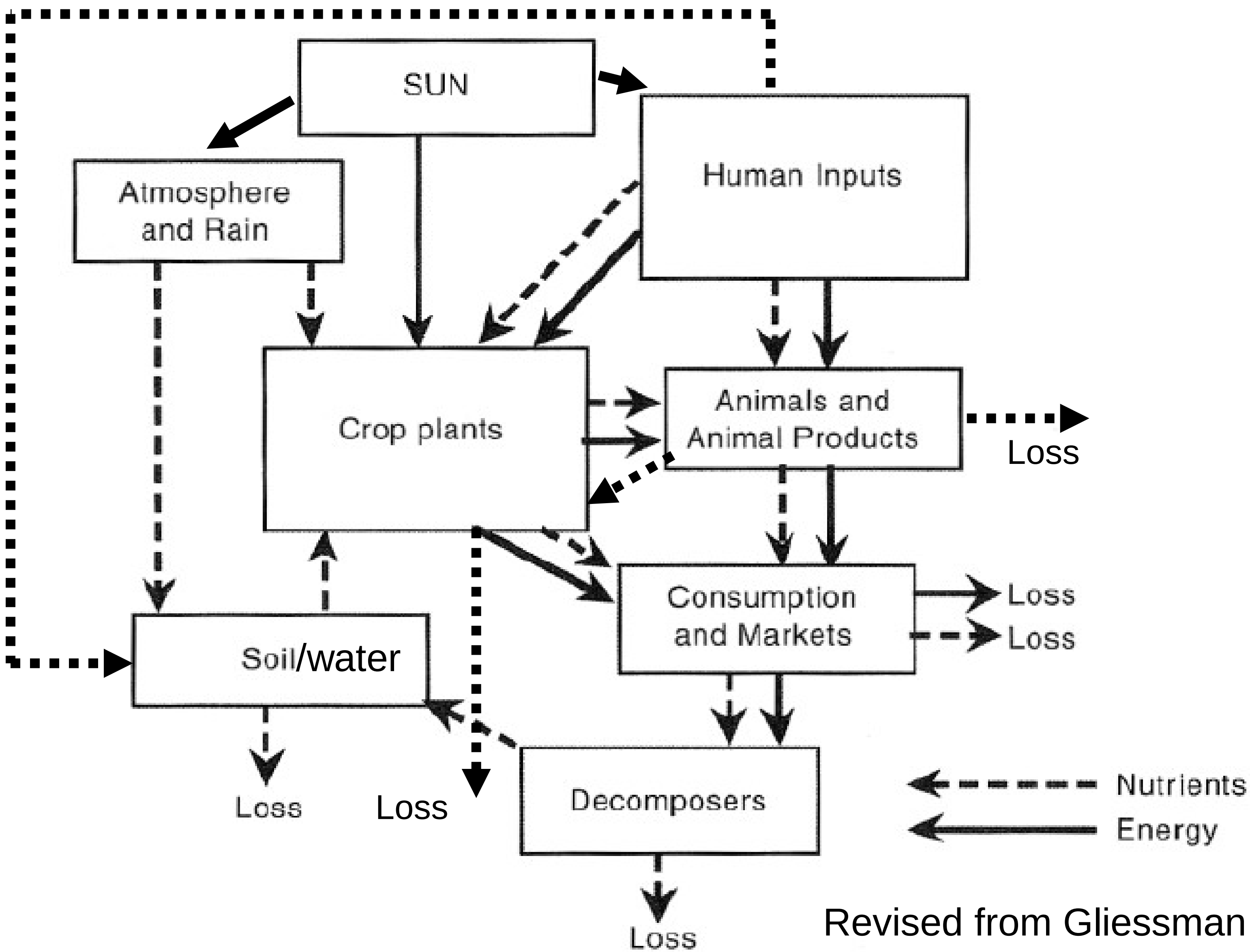
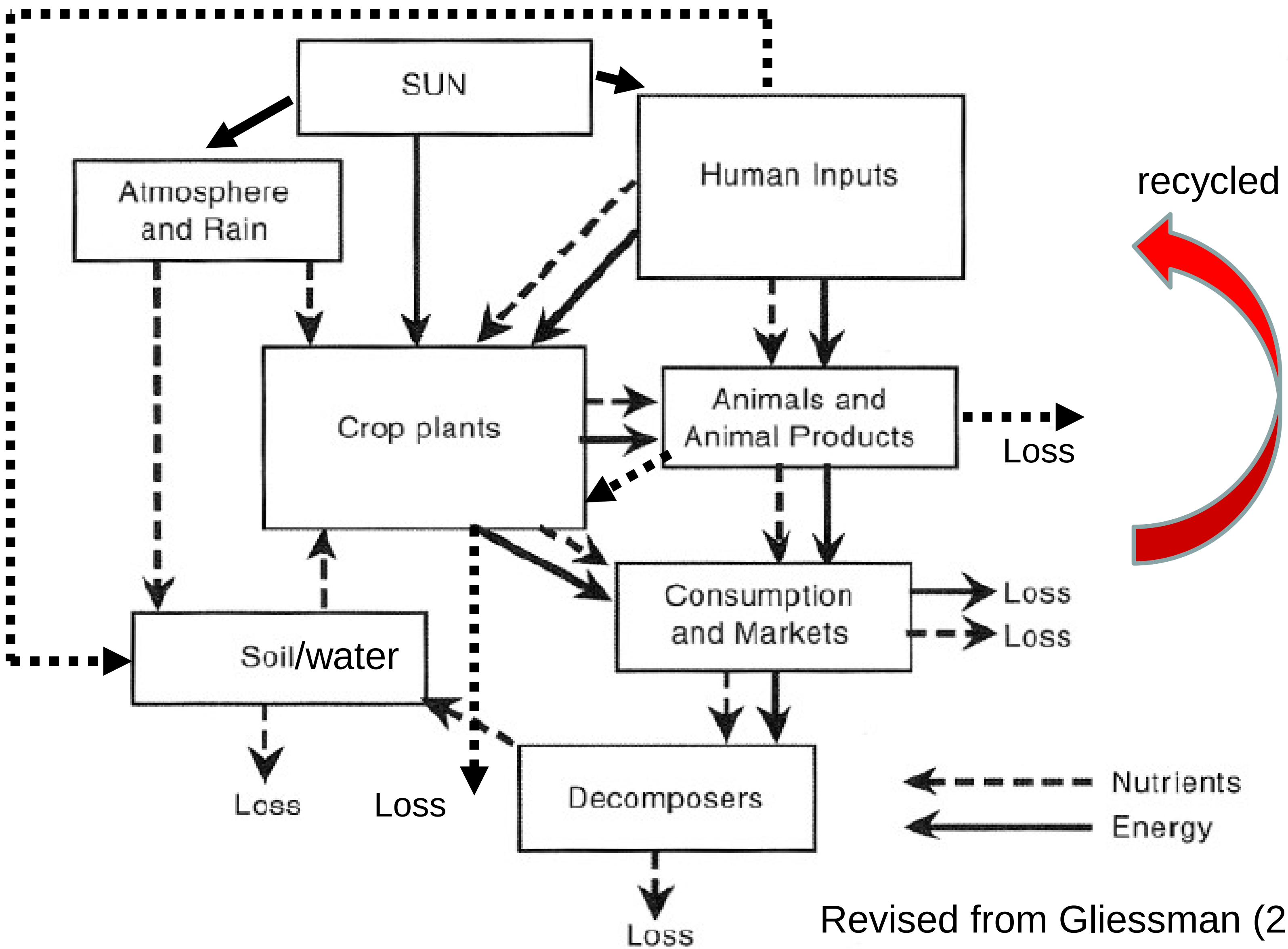


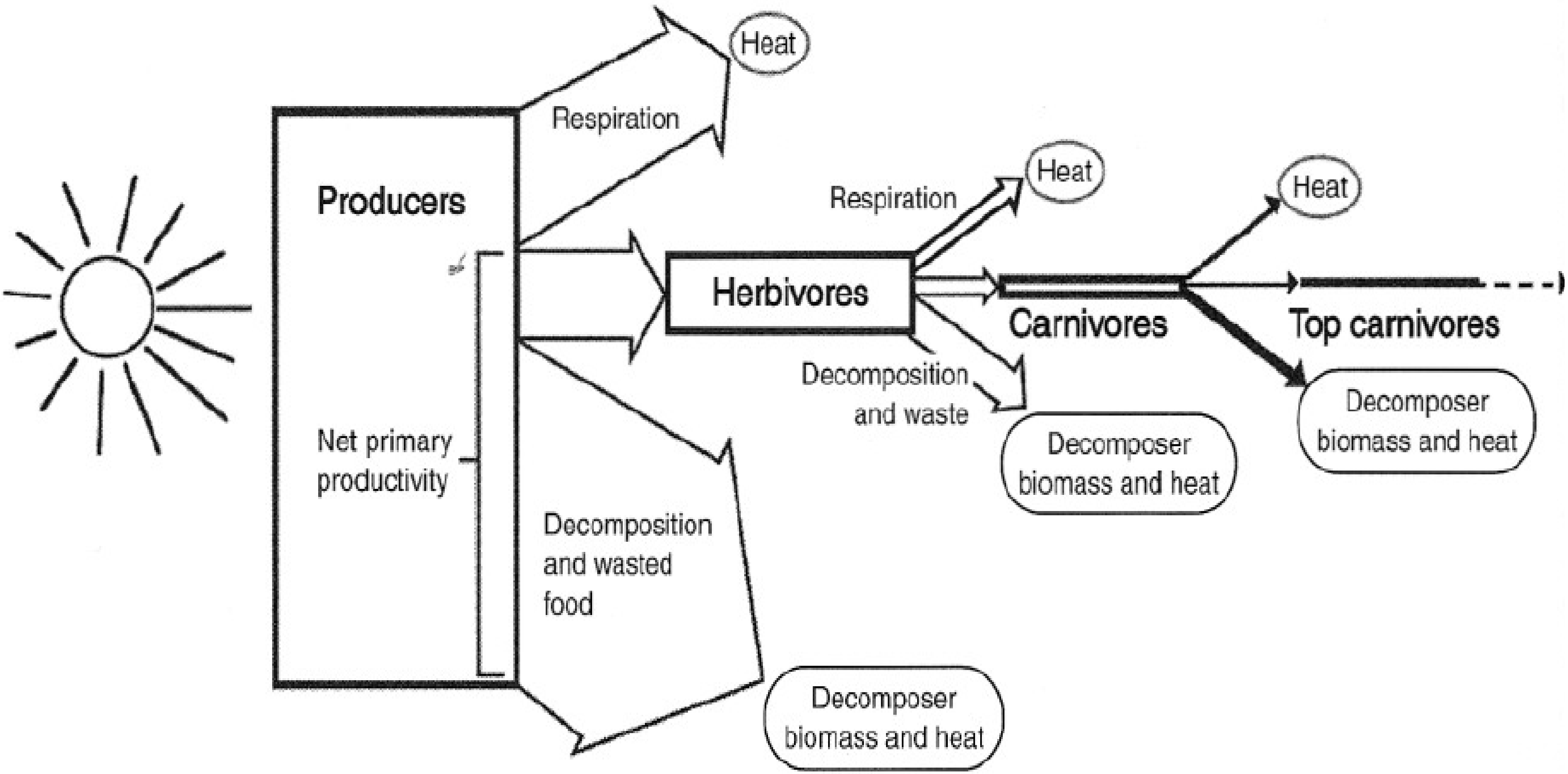
Revised from Gliessman (2006)

Energy and nutrient cycling



Revised from Gliessman (2006)

Energy flows in ecosystems



Gliessman (2006)

Energy yields in agroecosystems

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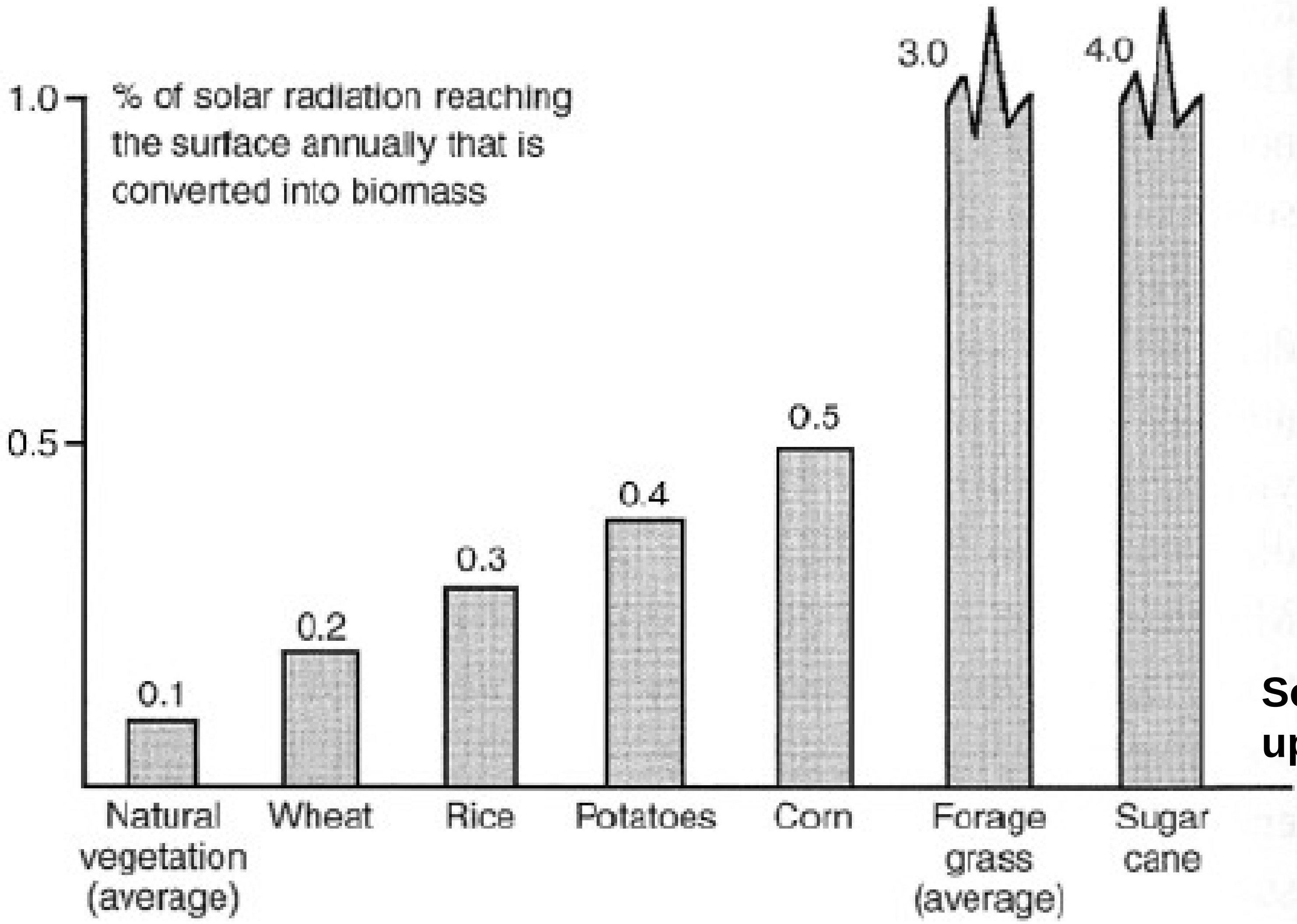


Solar cells: up to 10-20%

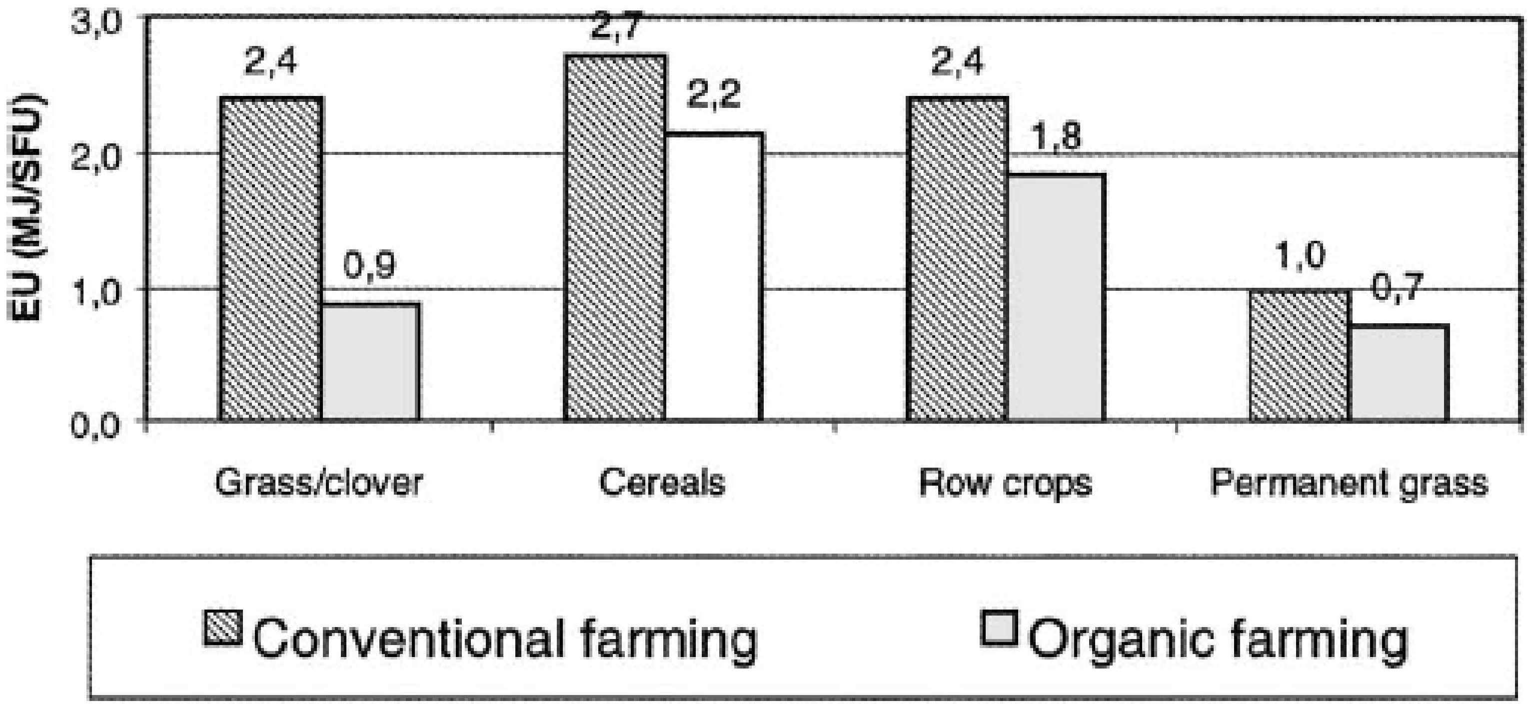
Gliessman (2006)

Direct and indirect industrial (fossil) fossil energy inputs

Direct energy		Indirect energy
Diesel for farm operations (EU_{diesel})	Other direct energy (EU_{other})	($EU_{indirect}$)
1. Tillage and sowing	1. Lubrication	1. Machinery & buildings
2. Fertilising and liming	2. Field irrigation	2. Other external inputs (nitrogen, phosphorous, potassium, lime and pesticides)
3. Plant protection	3. Drying	
4. Harvesting and baling	4. Heating	
5. Transport	5. Ventilation	
6. Loading and handling	6. Milking	

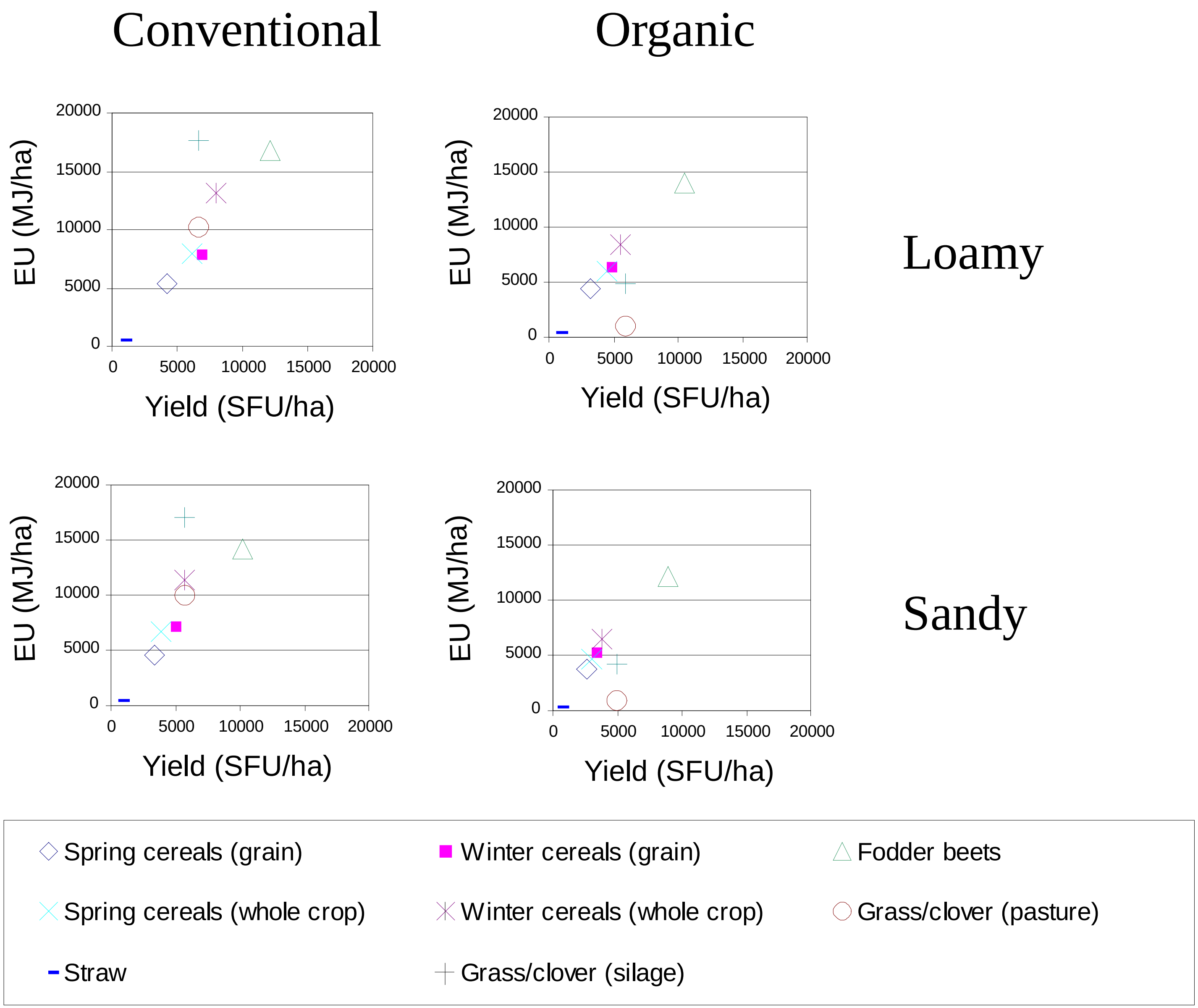
Source: Dalgaard et al. 2001

Average crop production energy efficiency in Denmark

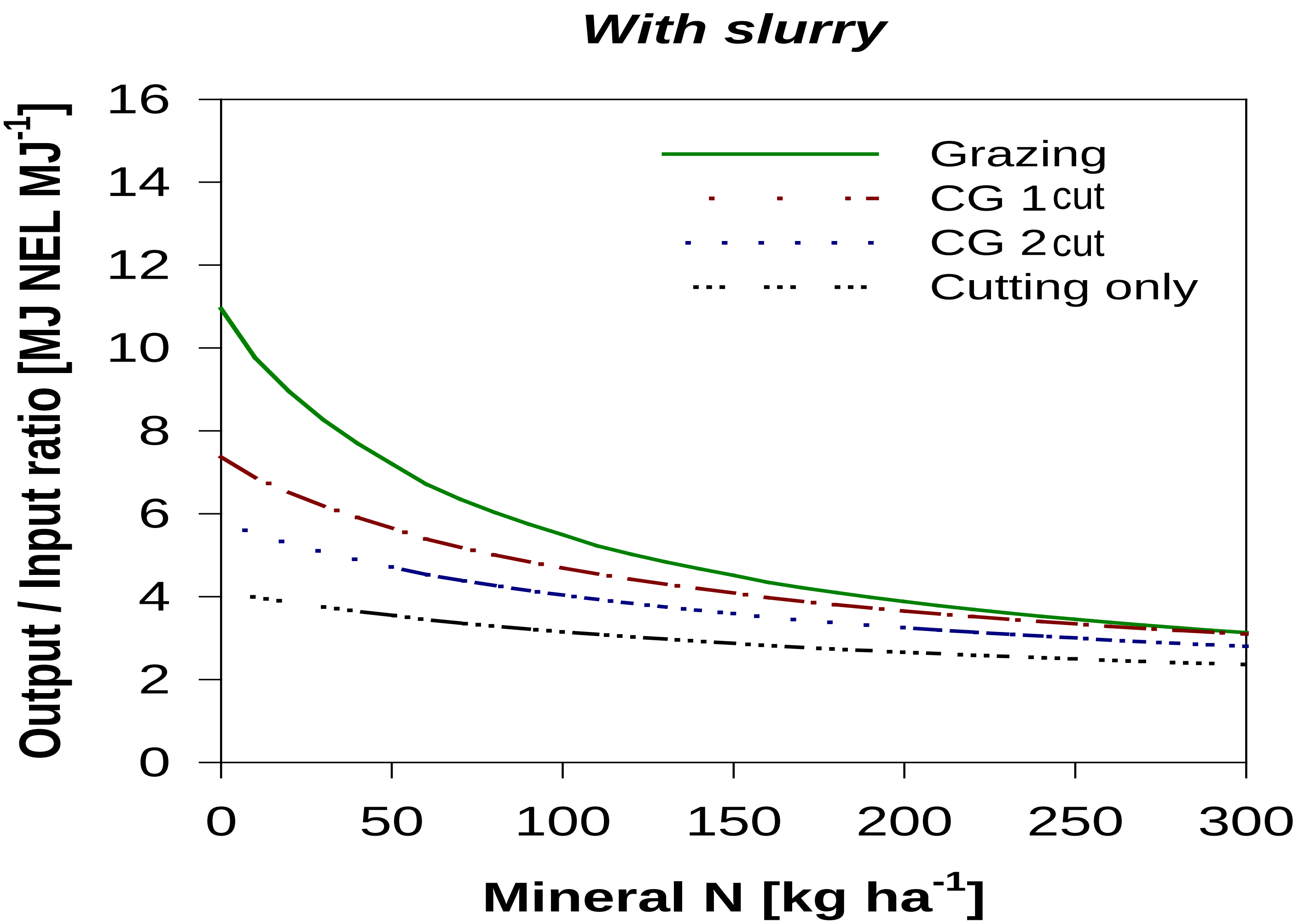


NB: 1 SFU equals the fodder value in 1 kg of barley

Forage production (non-irrigated)



Clover Grass production



Dalgaard, Kelm et al. (2003)

Dairy farming systems

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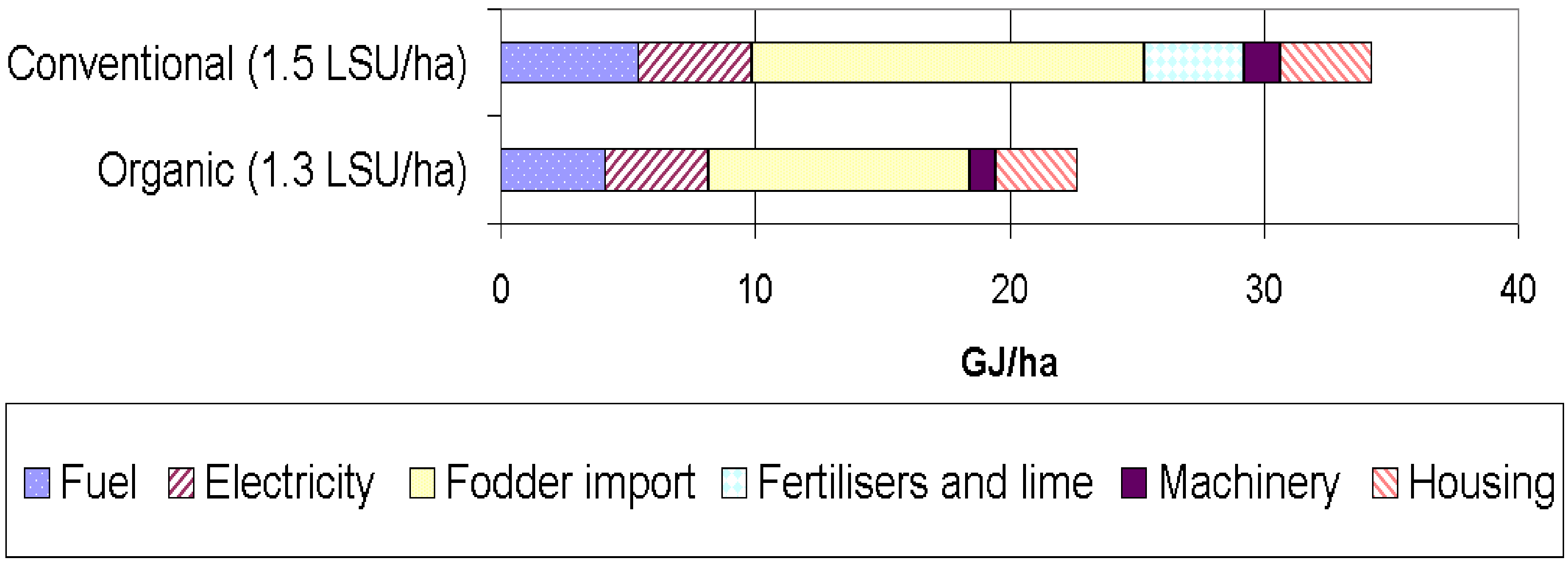
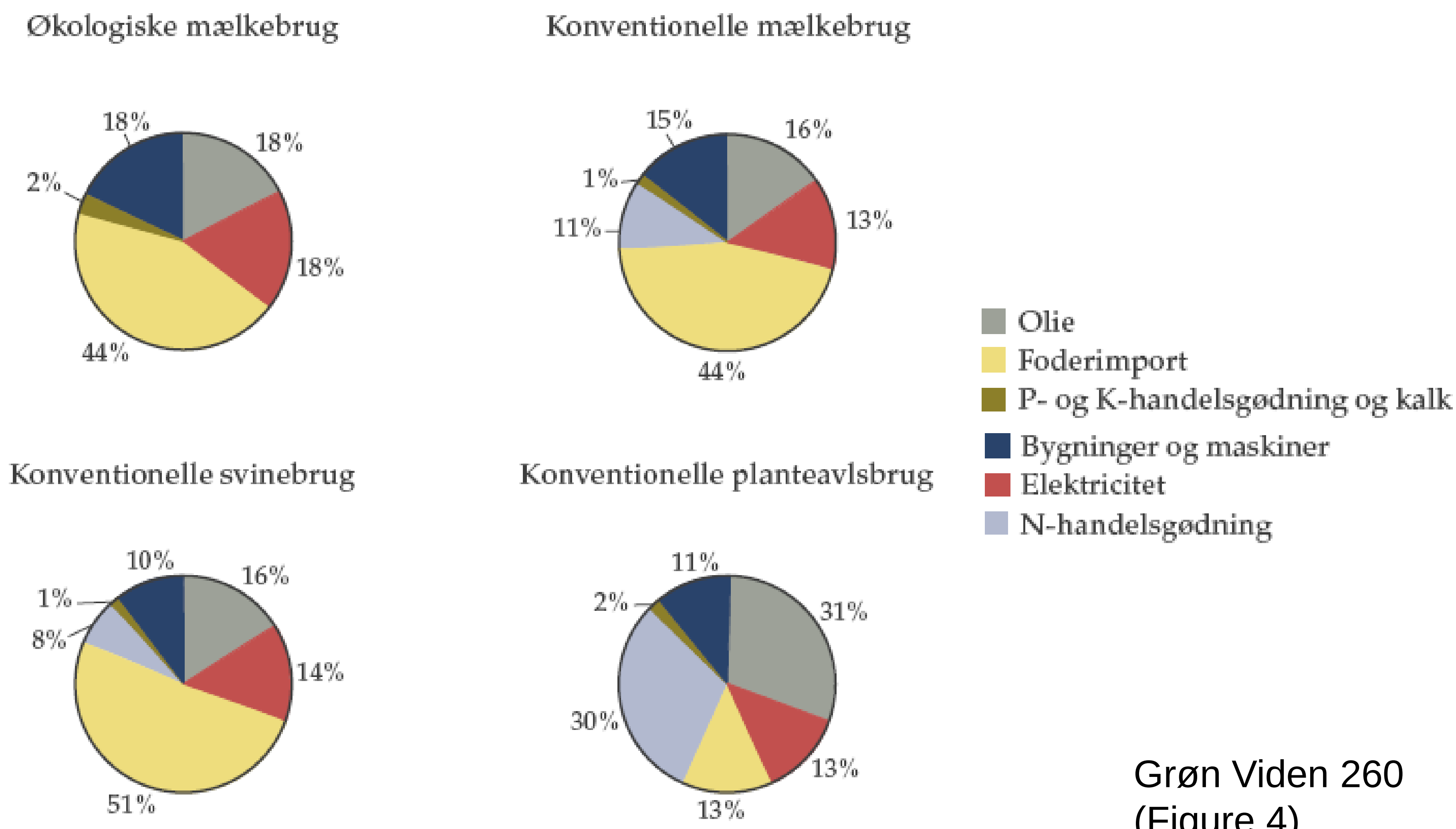


Figure 1. Average energy use per area in the organic and conventional dairy farm sector of Denmark (Dalgaard et al., 2003). 1 LSU equals one dairy cow of large race.

Farm energy account examples



Grøn Viden 260
(Figure 4)

Combined Food Energy Systems

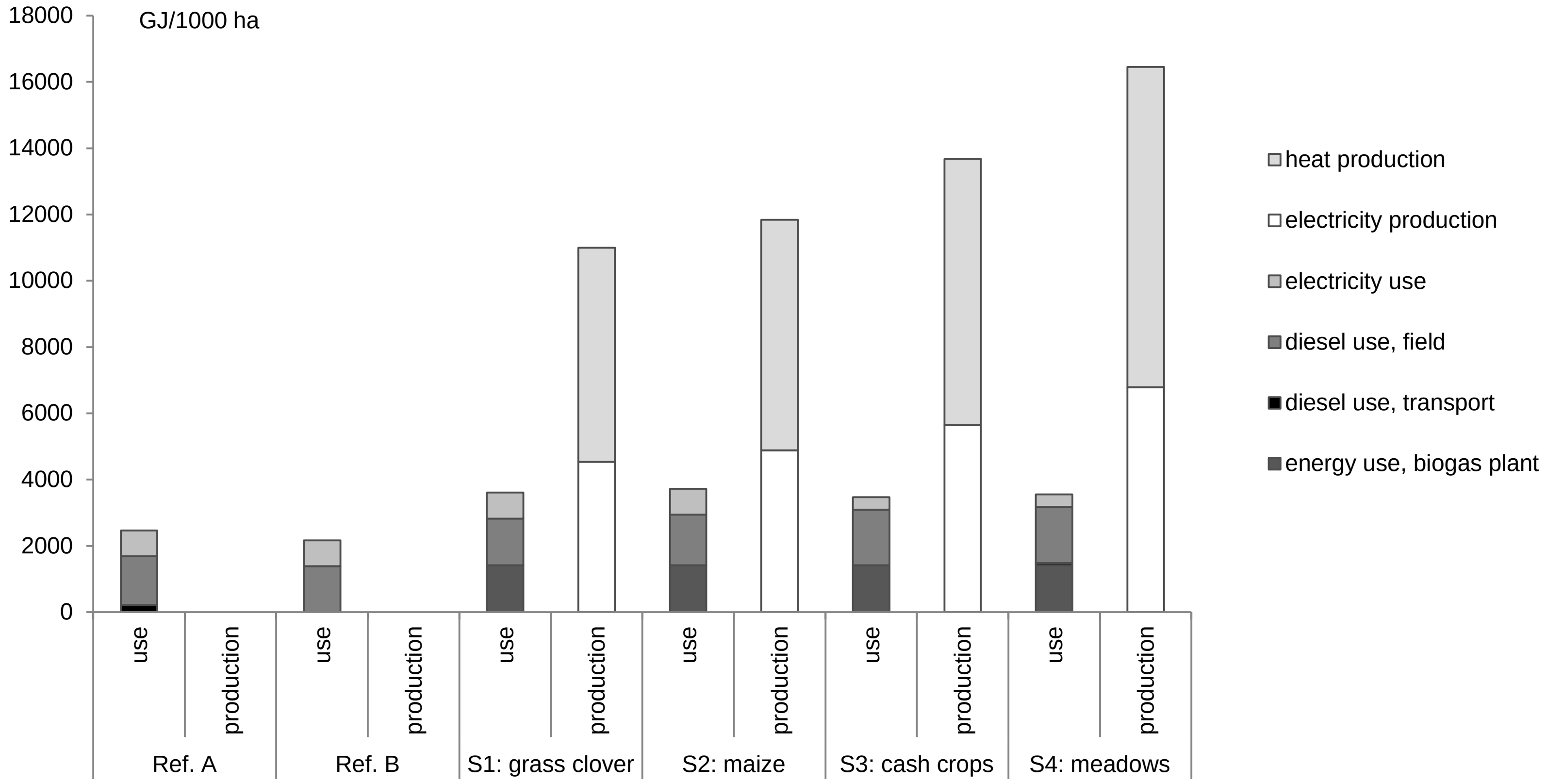


Figure 2. Comparison of energy use versus energy production on organic model dairy farms without biogas (Ref. A with slurry import, and Ref. B without slurry import), and three scenarios for conversion to organic farming with biogas production based on Grass Clover (S1), Maize (S2), increased cash crop production with maize for biogas, and reduced livestock production (S3), and biogas production based on imported meadow grass (S4). (Pugesgaard et al., 2013). *) Diesel use for transport includes solely external import of slurry and organic matter.

National scenarios

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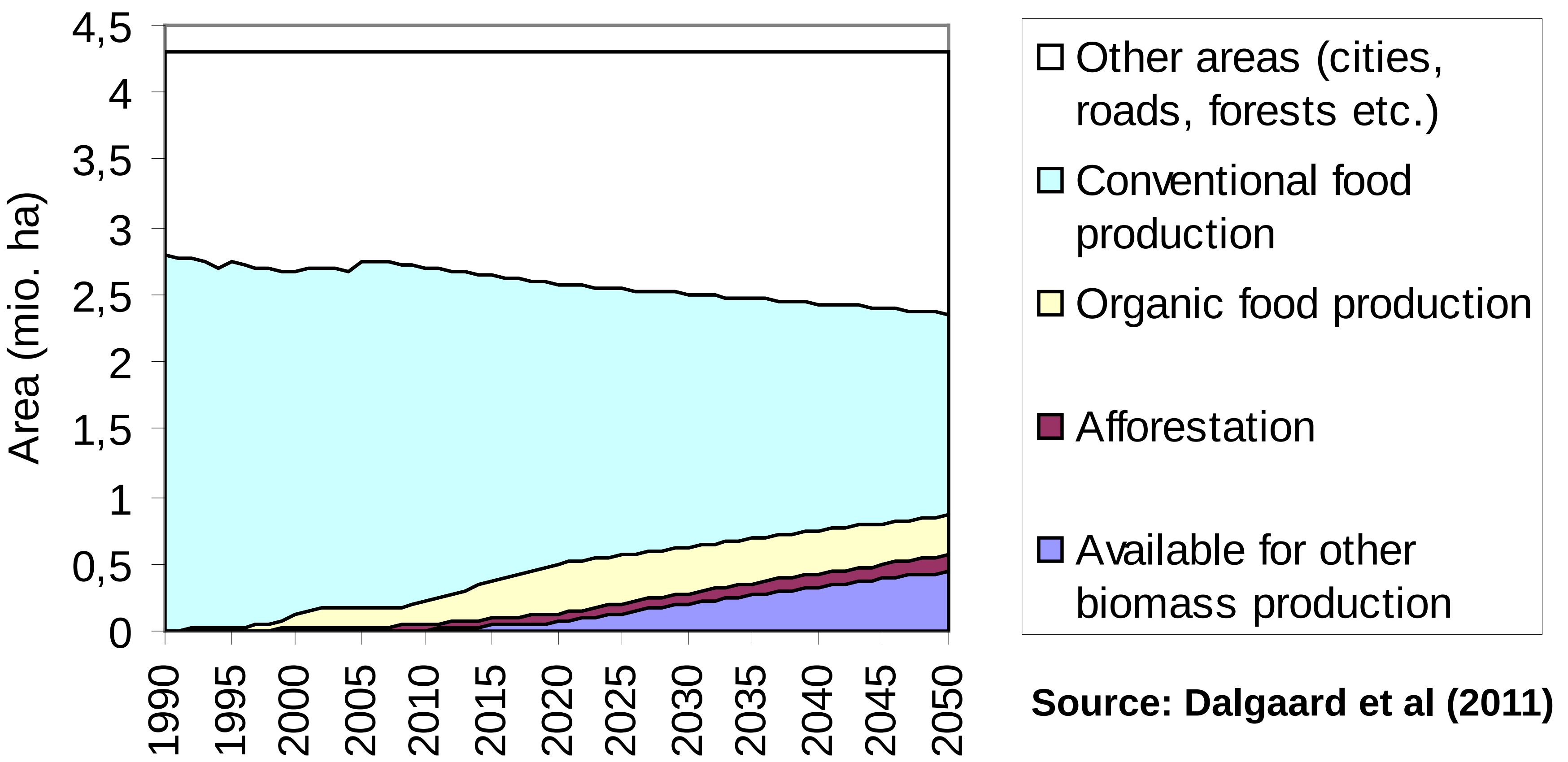
Projected land use changes



Source: Dalgaard et al (2011)

Agriculture as a net energy producer!

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(PJ)	2010	2050	
		Low Yield	High yield
Direct energy consumption:			
Fuel	-20	-19	-19
Electricity	-6	-5	-5
Indirect energy consumption:			
Fertilisers og pesticides	-10	-8	-8
Machinery	-4	-4	-4
Buildings	-6	-5	-5
Feed import	-19	-16	-16
Bioenergy production:			
Straw for CHP	19	40	40
Afforestation		2	2
Energy crops for CHP	1	37	109
Biogas	3	28	28
Biofuels	2	3	3
Energy balance	-41	53	124

Potential extra bioenergy from Danish organic farming

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	Net energy (PJ)
1) Biogas energy from livestock manure	1,10
2) Biogas energy from grass/clover	0,73
3) Rape oil energy from existing fields	0,02
4) Rape oil from new rape fields	0,19
5) Alder coppice on grass/set-aside areas	3,02
6) Alder coppice on permanent grasslands	1,81
Total	6,87

Jørgensen og Dalgaard (2004)

Vision

Source: Økologisk Landsforening

For the future generations

The snows in the Andes is melting, and in 40 years there may not be enough water for the Altiplano population and agriculture.