Sustainability issues related to straw used for energy in Denmark

- Outcome of a GBEP evaluation

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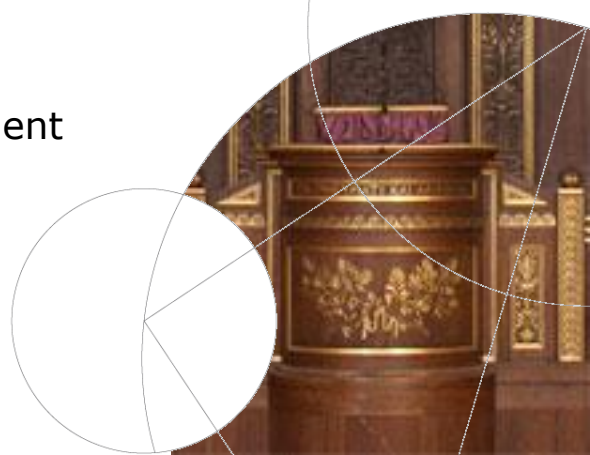

IEA Bioenergy Intertask study

IEA Bioenergy aims at supporting a development, where bioenergy contributes substantially to the future global renewable energy mix.

An inter-Task project has been commissioned to facilitate further mobilization of sustainable bioenergy supply chains in different operational environments.

The project should also inform the debate around bioenergy feedstocks and end-uses, and make suggestions to improve governance of biomass supply chains.

Supply chains:

- Agricultural residues for energy
- Forest biomass for energy
- Waste for biogas
- The Brazilian case, sugar cane
- Cellulosic energy crops

GBEP – Global Bioenergy Partnership

Established in 2007

A forum for voluntary cooperation between governments, intergovernmental organizations and other partners to support work on sustainability issues relating to bioenergy production, use and deployment.

GBEP Indicators

In June 2008 GBEP established a task force on sustainability to develop 'a set of global science based criteria and indicators regarding the sustainability of bioenergy'.

The task force developed a set of 24 indicators addressing the three pillars of sustainability as described in 1987 by the Brundtland Commission; the environment, social issues and economics.

PILLARS

GBEP's work on sustainability indicators was developed under the following three pillars, noting interlinkages between them:

Environmental	Social	Economic
THEMES GBEP considers the following themes relevant, and these guided the development of indicators under these pillars:		
Greenhouse gas emissions, Productive capacity of the land and ecosystems, Air quality, Water availability, use efficiency and quality, Biological diversity, Land-use change, including indirect effects.	Price and supply of a national food basket, Access to land, water and other natural resources, Labour conditions, Rural and social development, Access to energy, Human health and safety.	Resource availability and use efficiencies in bioenergy production, conversion, distribution and end use, Economic development, Economic viability and competitiveness of bioenergy, Access to technology and technological capabilities, Energy security/Diversification of sources and supply, Energy security/Infrastructure and logistics for distribution and use.
INDICATORS		
1. Lifecycle GHG emissions	9. Allocation and tenure of land for new bioenergy production	17. Productivity
2. Soil quality	10. Price and supply of a national food basket	18. Net energy balance
3. Harvest levels of wood resources	11. Change in income	19. Gross value added
4. Emissions of non-GHG air pollutants, including air toxics	12. Jobs in the bioenergy sector	20. Change in consumption of fossil fuels and traditional use of biomass
5. Water use and efficiency	13. Change in unpaid time spent by women and children collecting biomass	21. Training and requalification of the workforce
6. Water quality	14. Bioenergy used to expand access to modern energy services	22. Energy diversity
7. Biological diversity in the landscape	15. Change in mortality and burden of disease attributable to indoor smoke	23. Infrastructure and logistics for distribution of bioenergy
8. Land use and land-use change related to bioenergy feedstock production	16. Incidence of occupational injury, illness and fatalities	24. Capacity and flexibility of use of bioenergy

The Danish case

Scenarios:

1. Cereal straw for CHP
2. Cereal straw for ethanol

Baseline / Counterfactual:

- Straw left in the field

Why these and not others?

- Domestic biomass, no import or export involved
- No co-product allocation issues

Other scenarios in this work package in the IEA Bioenergy Intertask study:

- Corn stover utilisation in Ontario, Canada and in Idaho, USA

Indicators

Subset of 14 indicators in all three pillars selected for analysis.

Disregarded indicators found irrelevant to the Danish context.

2 indicators subsequently disregarded due to lack of data.

Over representation of 'Environmental' and 'Economic' indicators.

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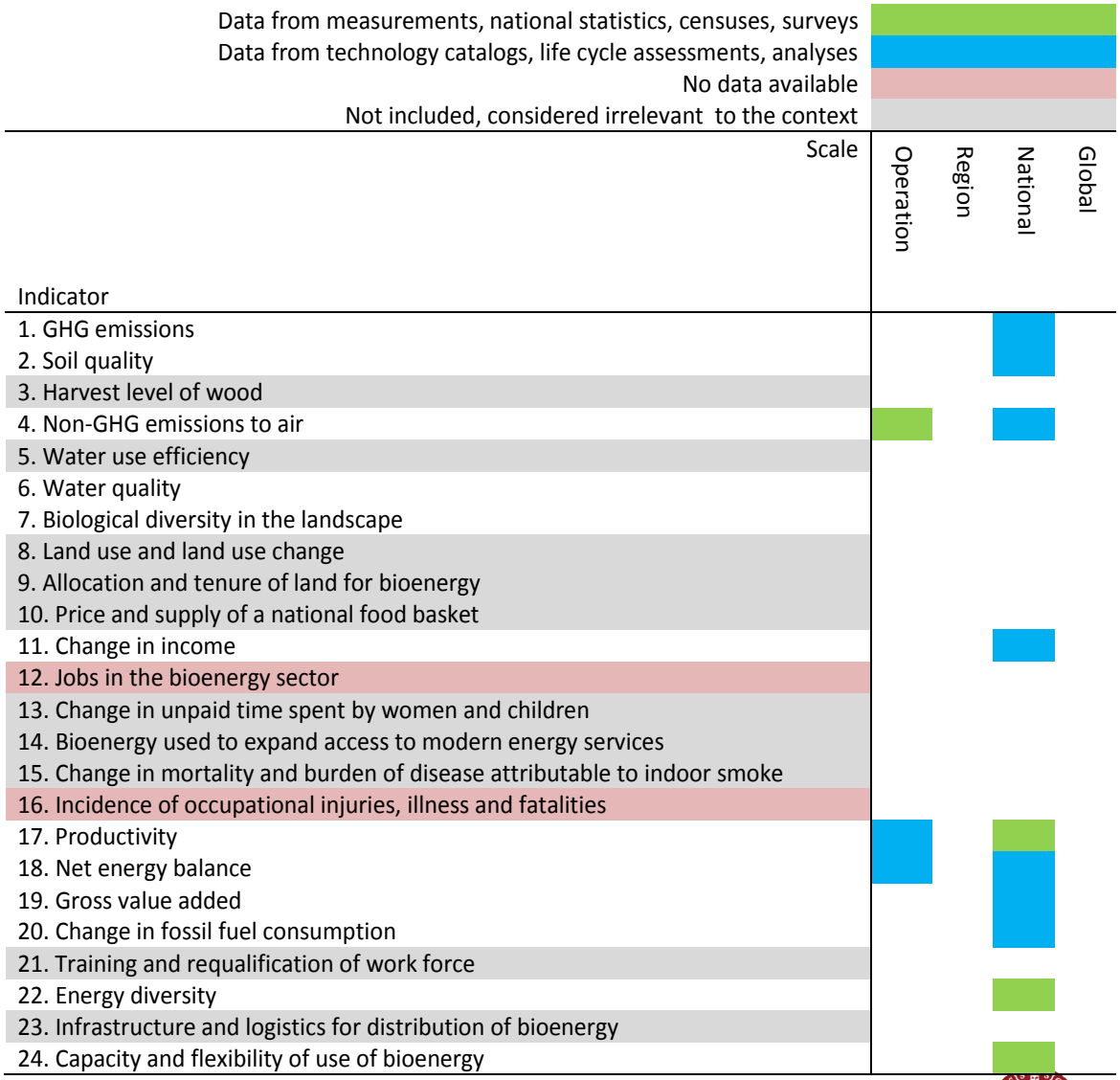
Data availability and quality

Most desired data:

- National coverage
- Measurements
- Official statistics
- Census data

Less desired data:

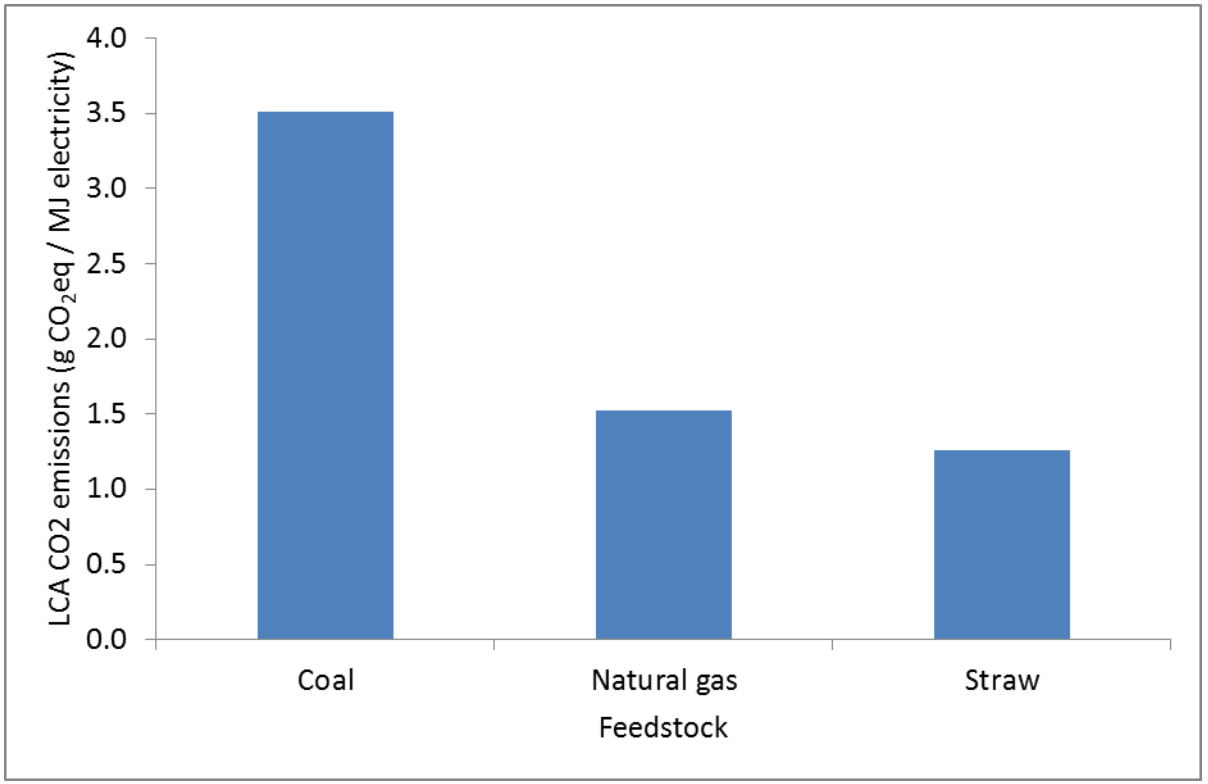
- Highly location specific data
- Data from foreign sources
- Global databases



Results – Environment – Indicator 1: Lifecycle GHG emissions

CHP based electricity production can reduce GHG emissions.

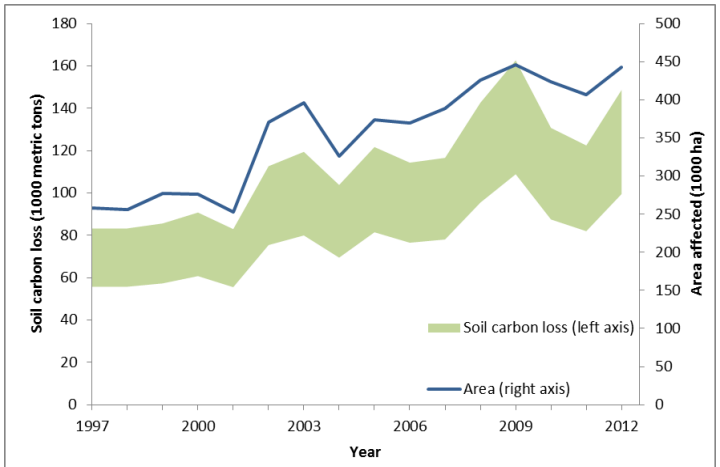
The benefit depends on what resource is displaced

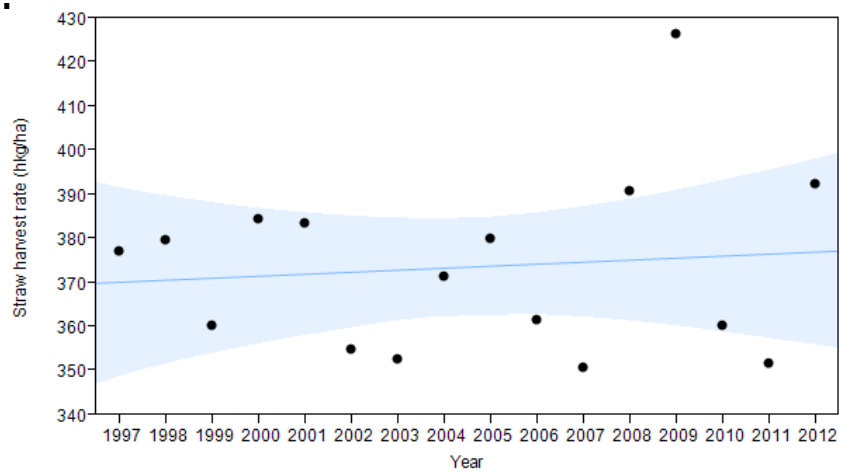


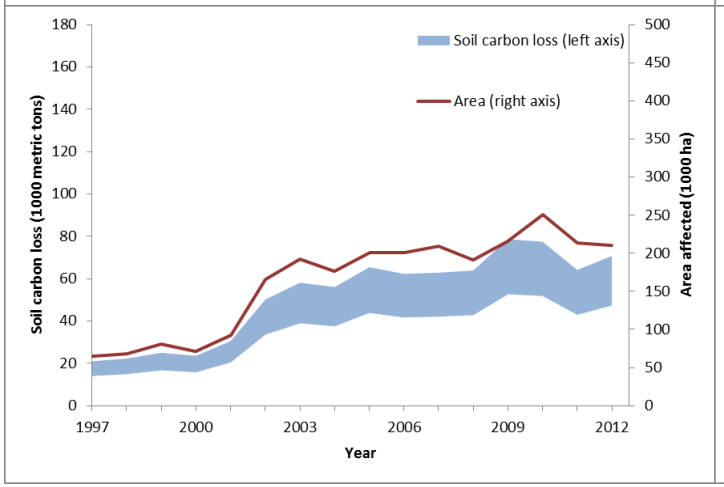
Results – Environment – Indicator 2: Soil quality

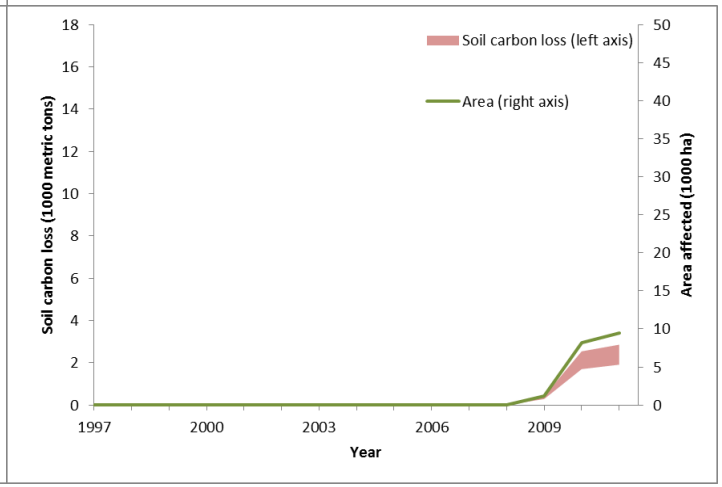
Intensification: Harvest more straw per ha.

Expansion: Harvest straw on more ha.









Results – Economic – Indicator 17: Productivity

Straw to CHP:

Increased overall productivity.

η_{total} = 0.73 in 2000

η_{total} = 0.79 in 2012

Has electricity productivity decreased lately?

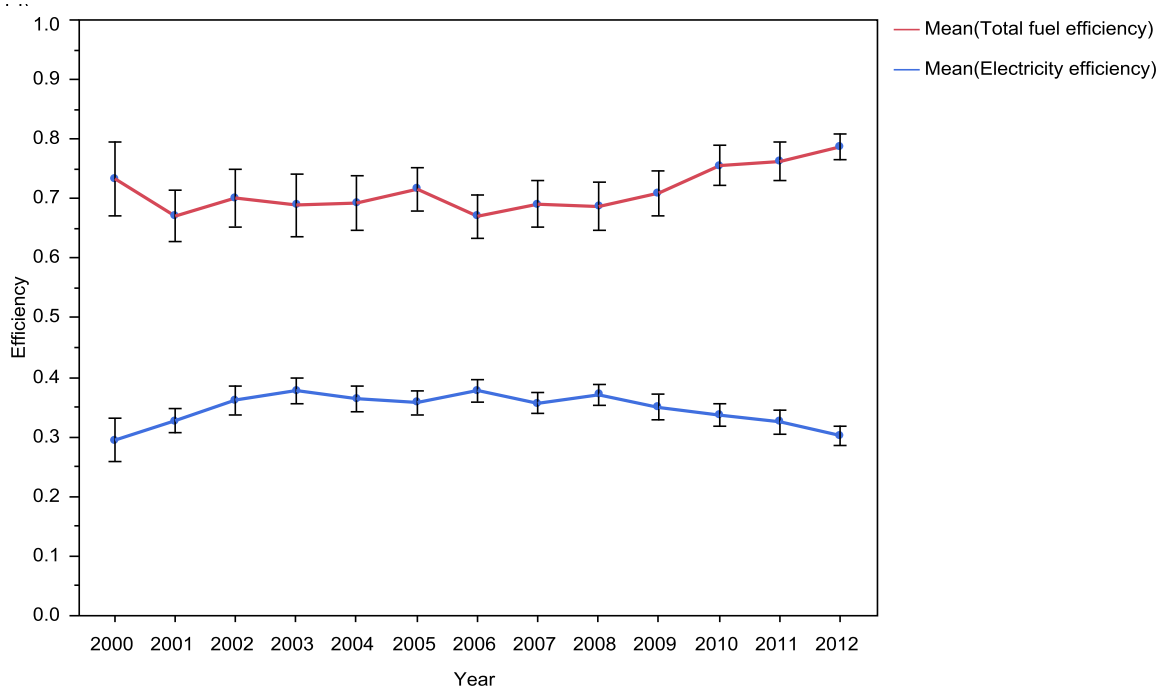
$\eta_{electricity}$ = 0.29 in 2000

$\eta_{electricity}$ = 0.30 in 2012

but

$\eta_{electricity}$ = 0.38 in 2006

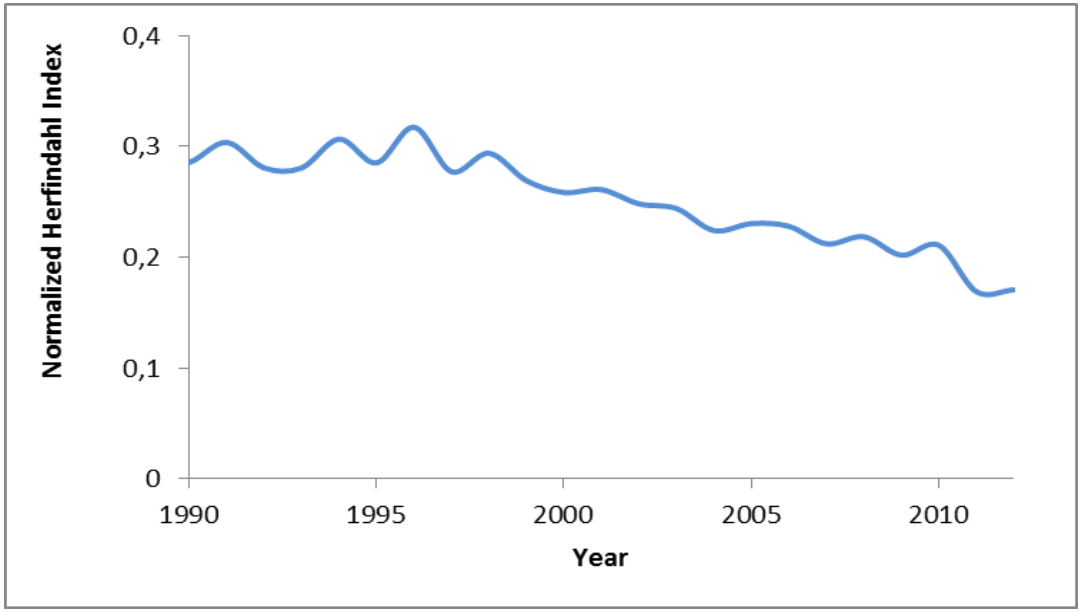
From a thermodynamic point of view the highest possible $\eta_{electricity}$ is desirable.



Results – Economic – Indicator 22: Energy diversity

Is diversity good or bad?

- Complicates energy infrastructure
- Reduces reliance on one/few energy resources
- Increase robustness and flexibility



Diversity index:

- Normalised Herfindahl Index (HHI*):

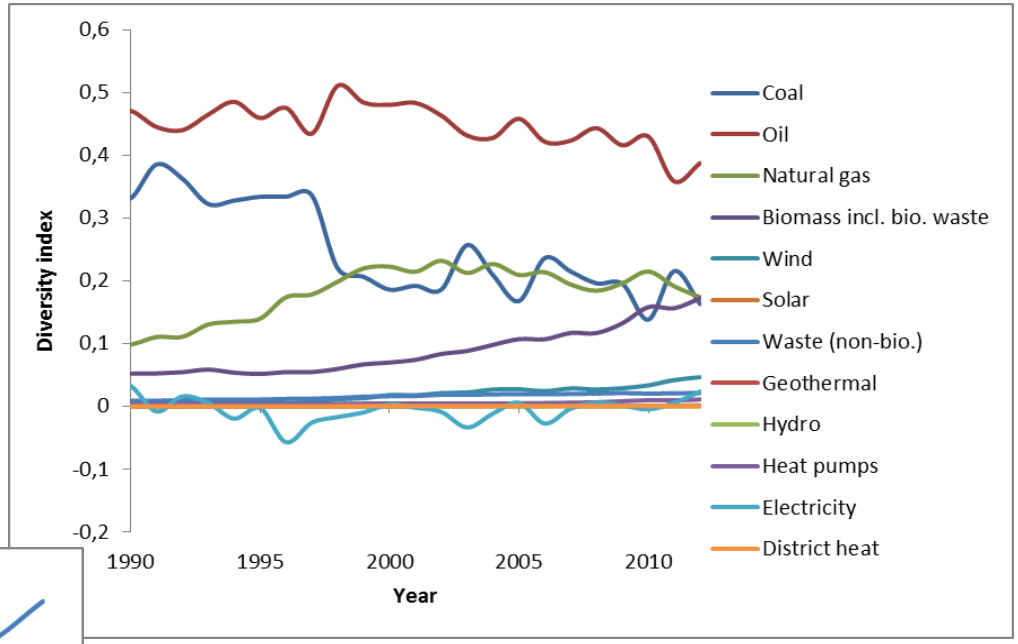
$$HHI^* = \frac{\sum_{i=1}^{N} MS_i^2 - \frac{1}{N}}{1 - \frac{1}{N}}$$

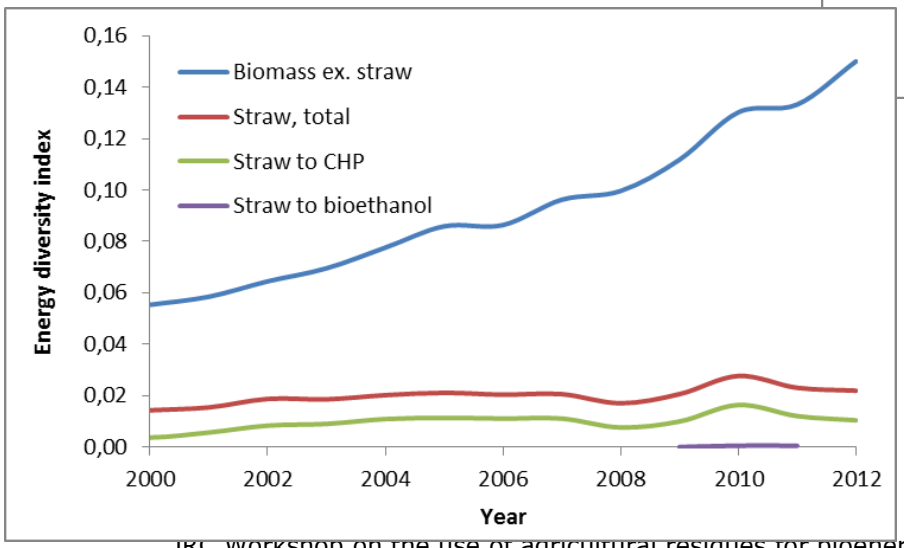
- The Danish energy supply has become more diverse over time.

Results – Economic – Indicator 22: Energy diversity

Contributions to diversity:

- less coal,
- more natural gas,
- more biomass and waste,
- more wind.





Straw use also contributes to diversity

Summary

Outlook on straw for bioenergy

- Challenges
    - Soil carbon

- Opportunities
    - GHG emission reduction
    - Rural economy generation

Outlook on the GBEP framework.

- Challenges
    - National boundaries, do not consider imported or exported biomass
    - Time dimension, a single value may be irrelevant, but a development trend could be
    - Impact allocation in multiple output systems, where bioenergy is only one of more outputs.

More information

IEA Bioenergy: www.ieabioenergy.com

Task 43 -
Biomass feedstocks for energy markets: www.ieabioenergytask43.org

GBEP: www.globalbioenergy.org