



Faculty of Science



The +10 million tonnes study

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*W-E-F Nexus workshop
Pietermaritzburg
November 21-23 2016*



Will there be enough biomass for establishing a significant bio-refinery industry in Denmark?

- Will the production be sustainable?
 - Soil C, pesticides, nutrient leaching, biodiversity, eco system services etc..
- What about indirect land use change (iLUC)?
- What types of biomass can be available for which technologies?



THE + 10 MILLION TONNES STUDY

Increasing the sustainable production of biomass for biorefineries.

Updated Edition 2016



See the study at:

<http://biovalue.dk/media/TimioplanUKrevideret-1310-2016.pdf>

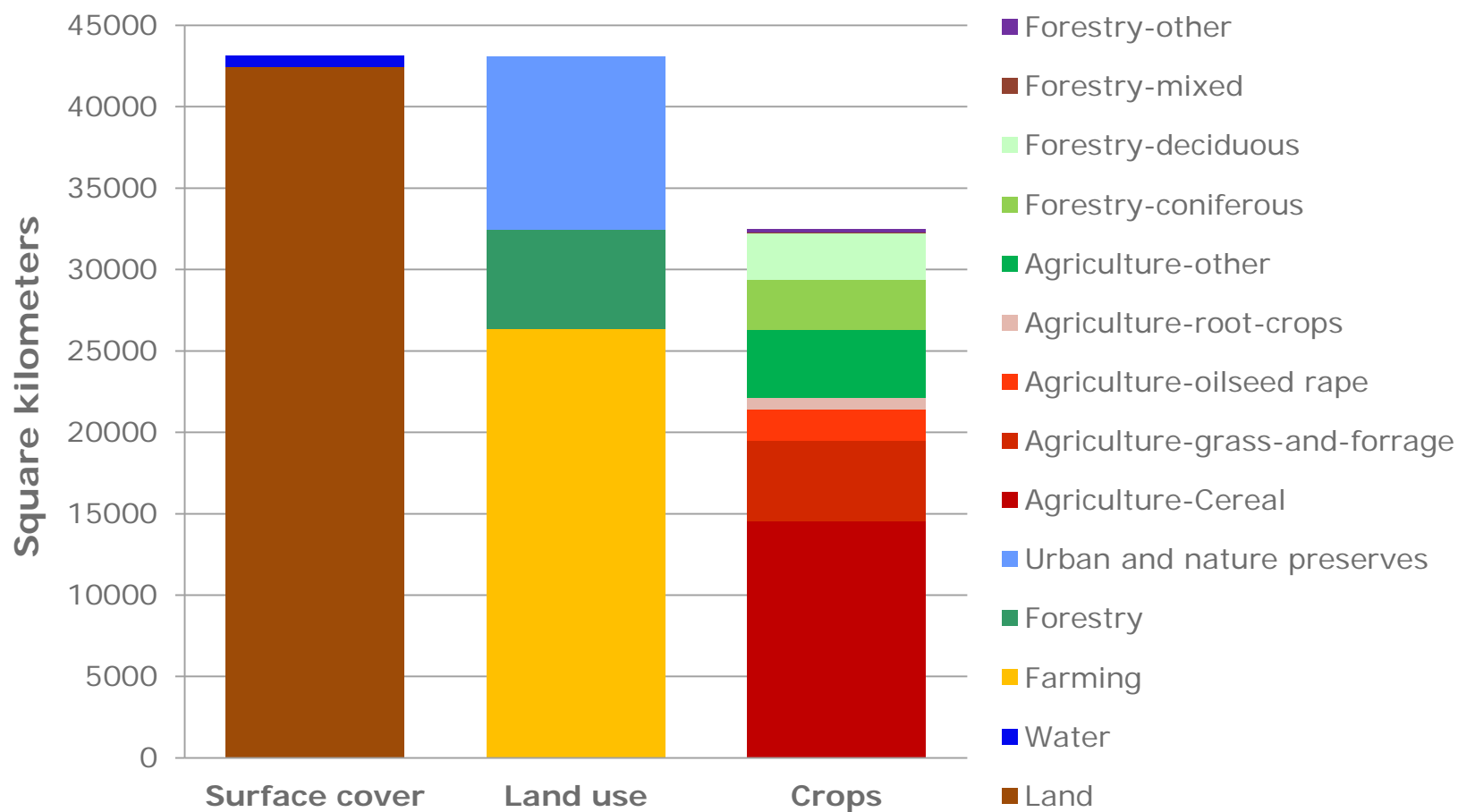


Prerequisites:

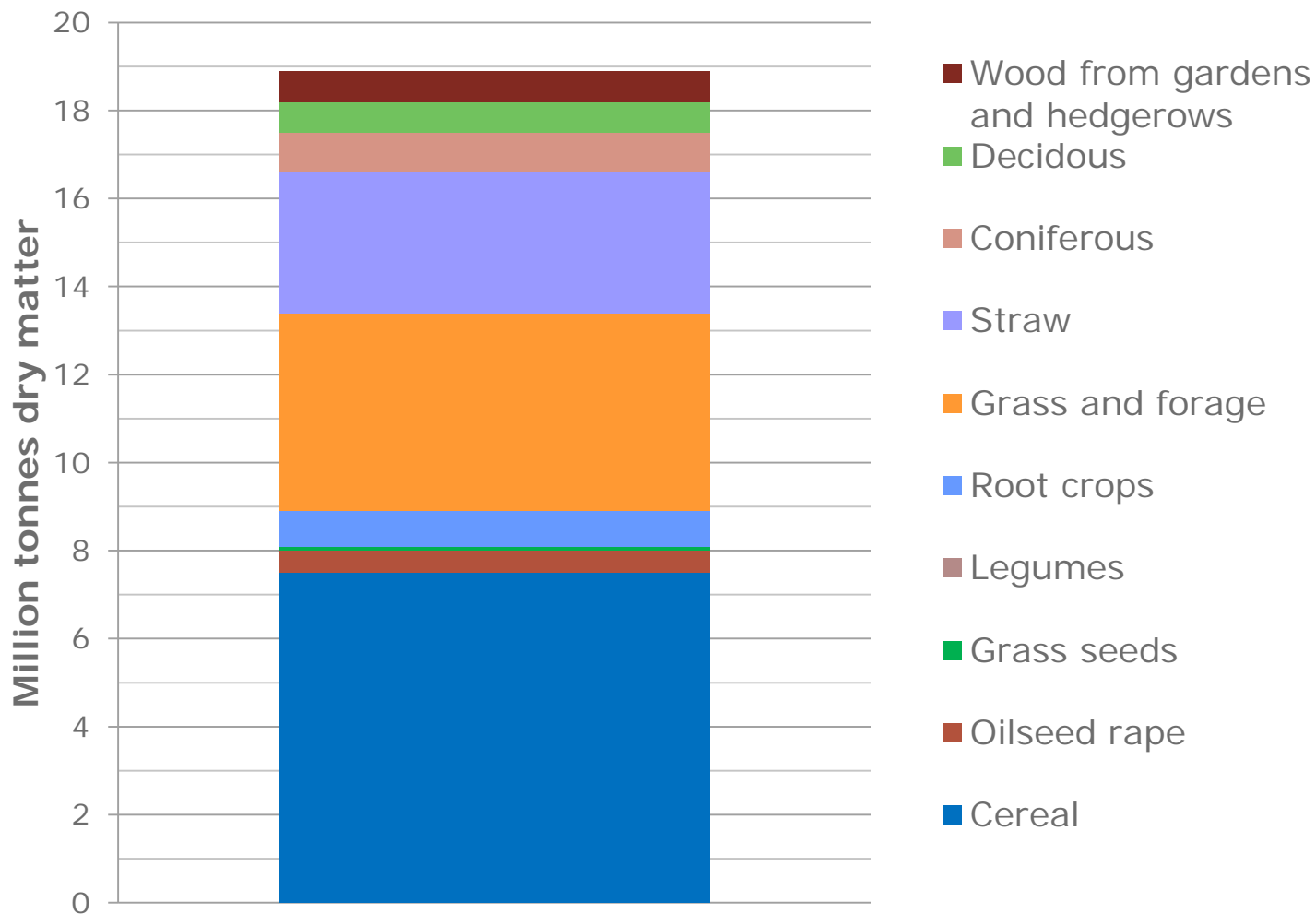
- **No reduction in Danish food and animal feed production**
- **No expansion of the agricultural area**
- **Must match the political desire for promotion of sustainability and a 'greener' society/economy**
- **Must not have negative environmental effects**
- **Be within the current regulatory framework**



Land use in Denmark



Biomass harvest in Denmark



Three Scenarios for 2020

Business as usual (BAU):

- No changes in crops or technologies
- Existing resources (straw, manure, oil seed rape oil etc.)

Biomass optimised:

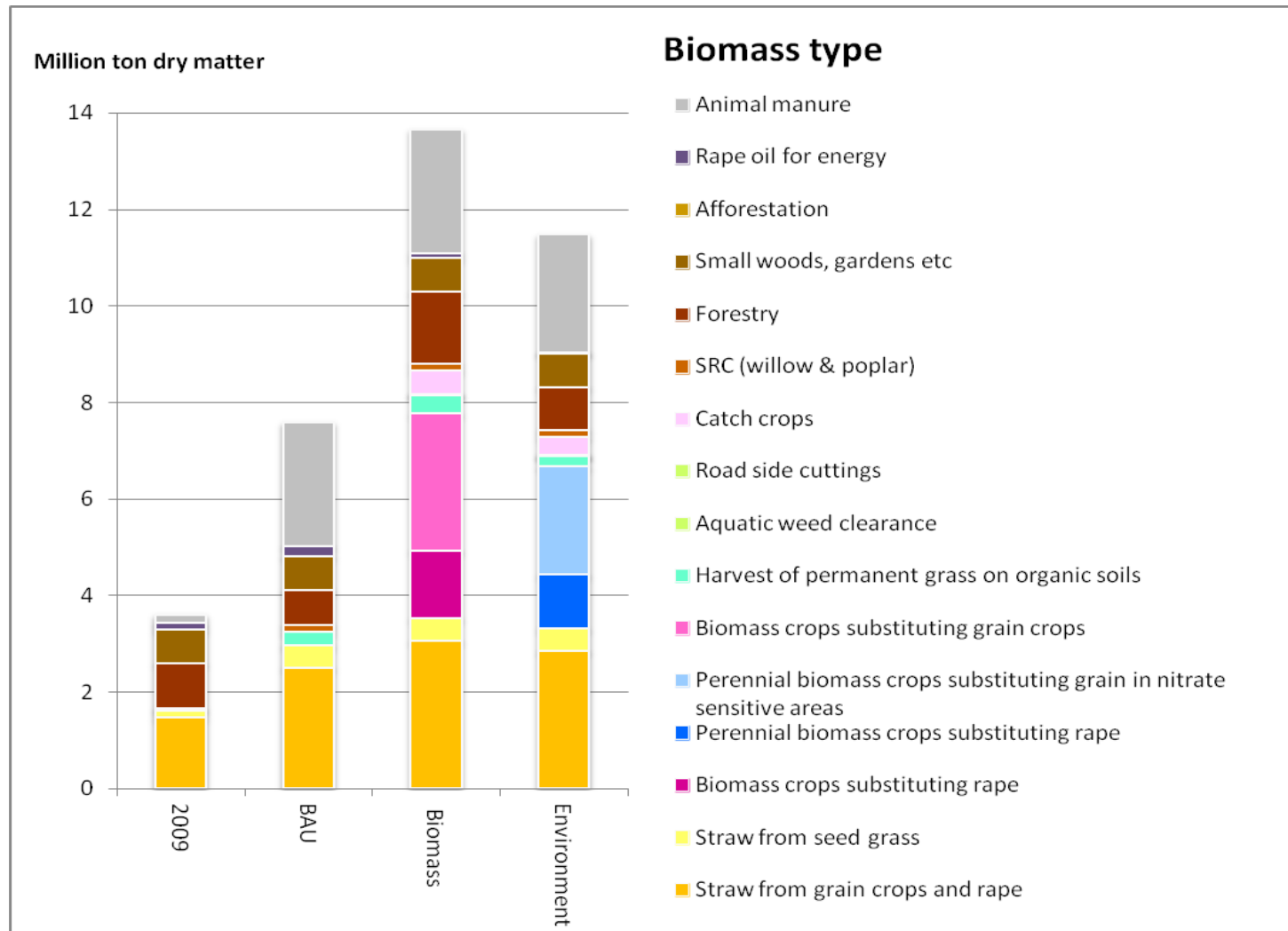
- Straw rich grain varieties
- Increased straw harvest
- Less grain and oil seed rape
 - > high productive biomass crops (beets 19 t ha⁻¹ DM)
- Fertilization of natural grasslands
- Road sides, aquatic weeds, catch crops etc.

Environmentally optimised:

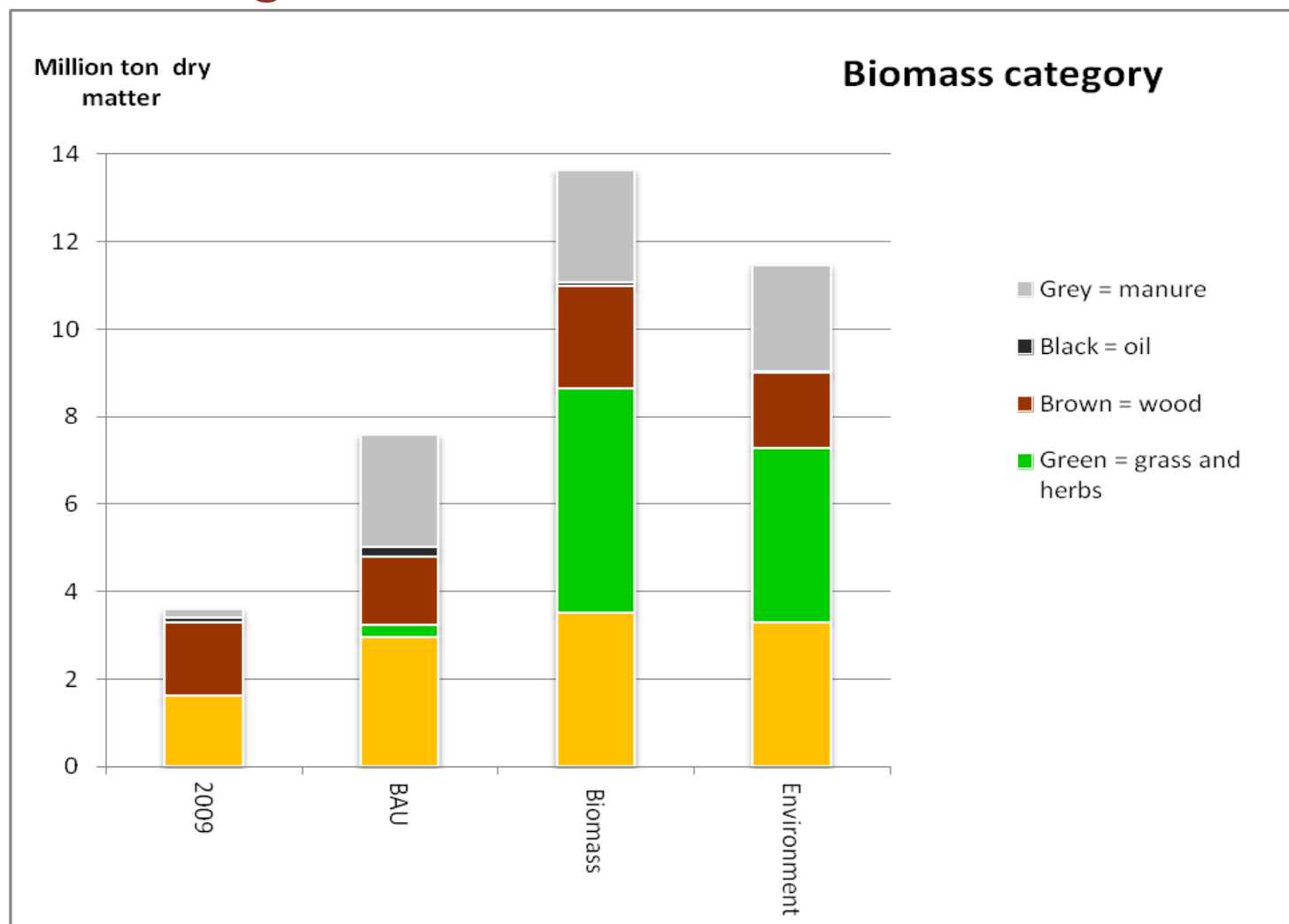
- No straw removal from land with critical low carbon content
- Perennial biomass crops (grass 15 t ha⁻¹ DM)
- No grain crop production in nitrate sensitive areas
- No fertilization of natural grasslands
- Increased afforestation



Danish agriculture and forestry can deliver 3-4 times more biomass for biorefineries in 2020



Different biomass types for different conversion technologies

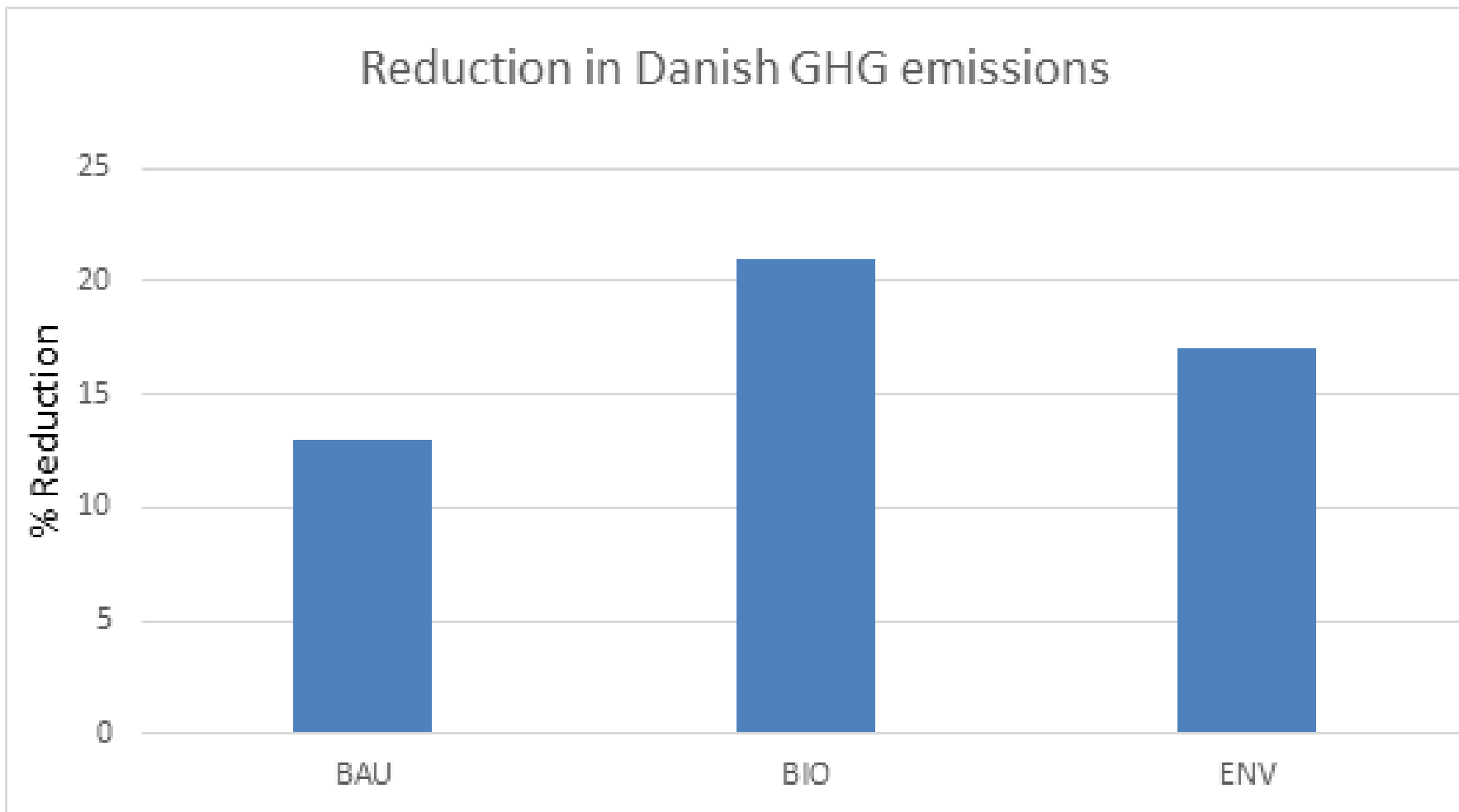


Increased biomass utilisation can reduce nitrate leaching

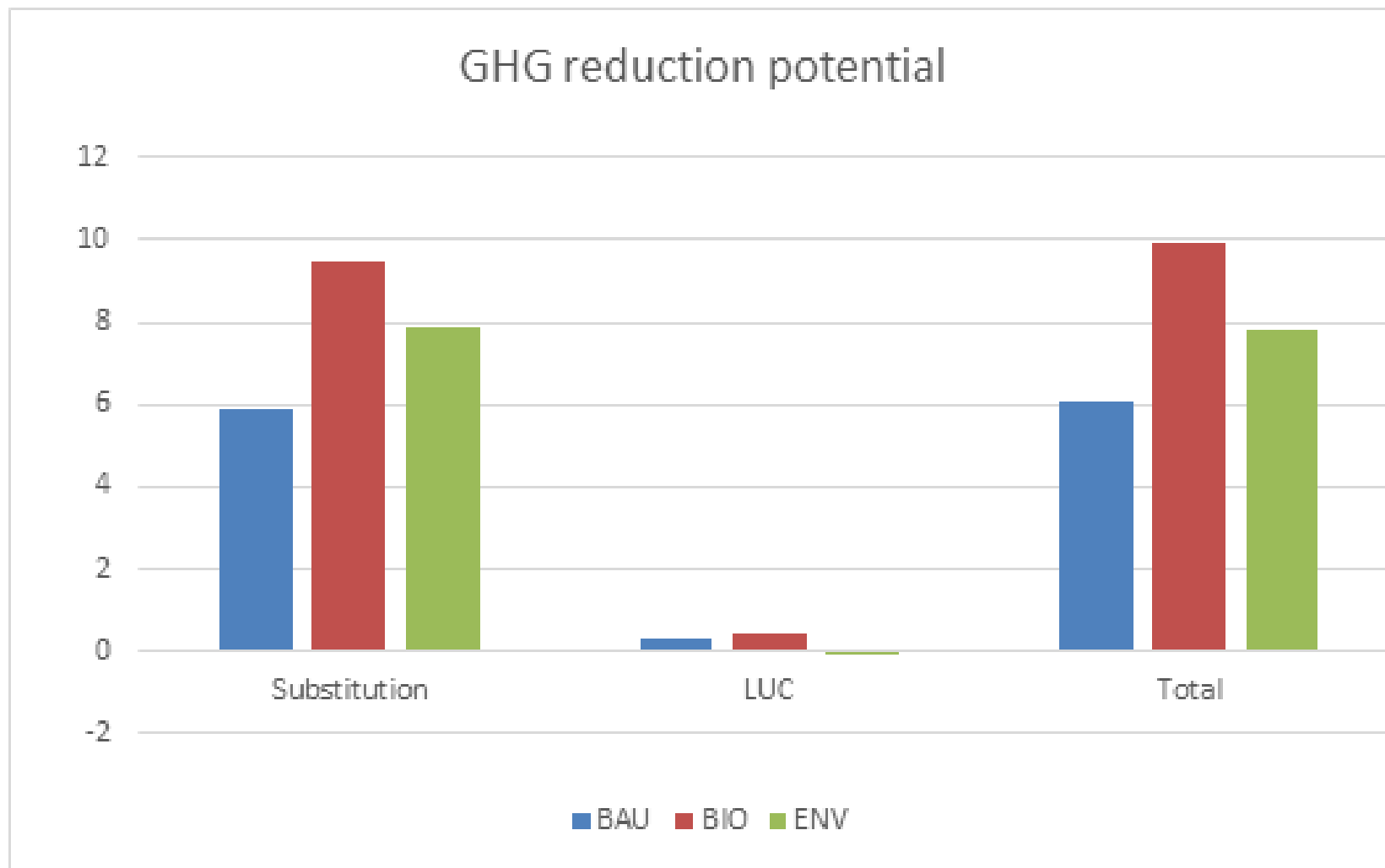
	Change in nitrate leaching for Denmark (ton N y ⁻¹)		
	BAU	Biomass	Environment
Animal manure	-5.752	-5.752	-5.487
SRC	-248	-248	-248
New biomass crops substituting oil rapeseed		-3.142	-6.085
New biomass crops substituting grain crops		775	-5.040
Afforestation	-847	-847	-2.005
Additional catch crops			-4.598
Total	-6.846	-9.214	-23.463

Will fulfil the demands of the EU Water Framework Directive

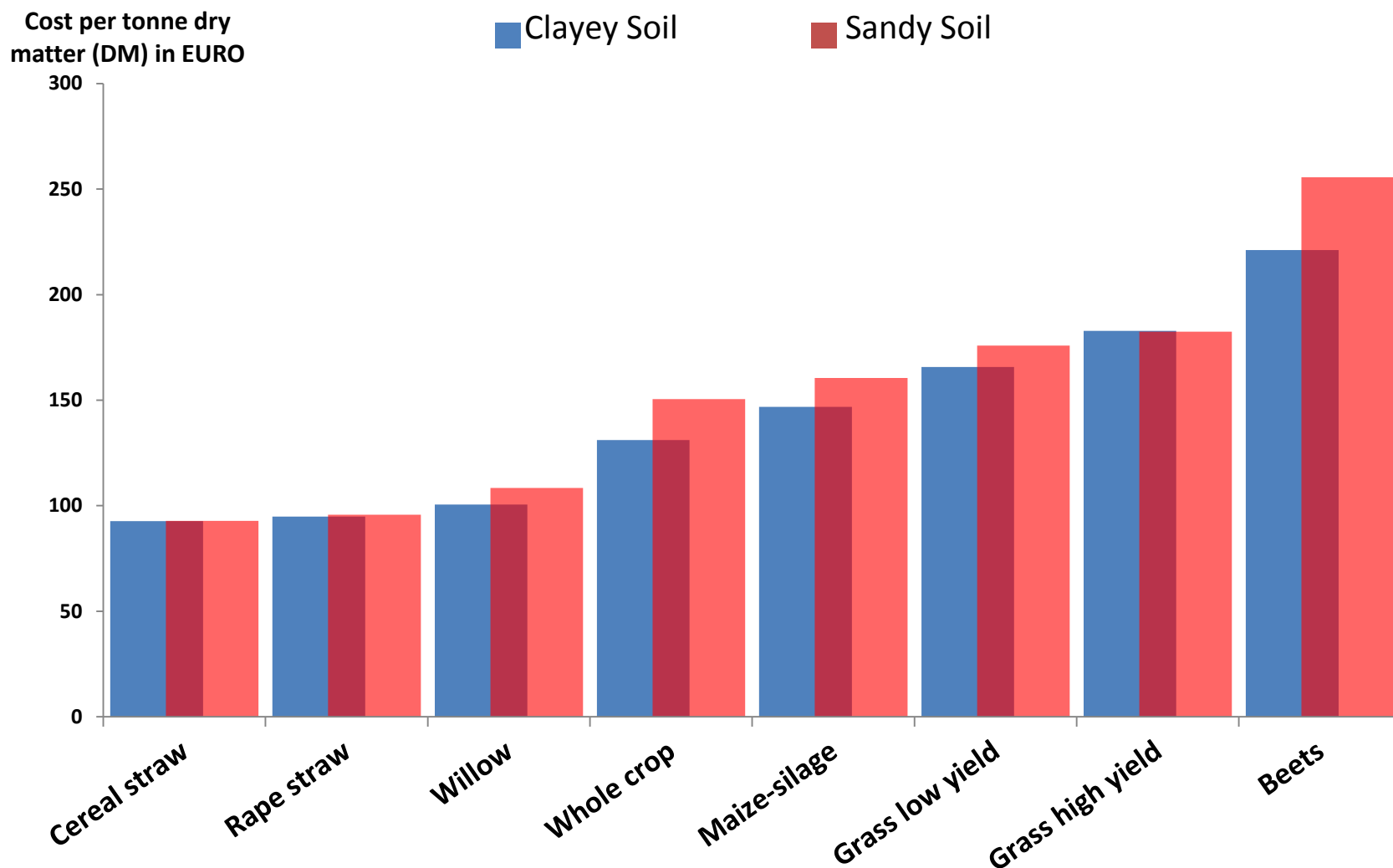
Energy system scenarios were defined to analyse the effect on TOTAL Danish GreenHouse Gas emissions



The scenario effects on fossil fuel substitution and on Land Use Change (mio. T CO₂ eq.)



Average cost of supplying one tonne drymatter from field to biorefineries in different soil types areas



Gylling et al., 2016



Employment effects - persons

Sector	BAU	Biomass	Environment
Agriculture, fisheries, extraction of raw materials	5978	8897	5448
Industry	1842	3558	2623
Energy and water supply	399	857	663
Building and construction	421	863	653
Trade, hotel and catering	823	1455	1020
Transport, postal service and telecommunications	879	1842	1401
Financial and business services	1607	2865	2016
Public and personal services	246	420	276
Associations, culture and refuse disposal	112	208	149
Total	12306	20965	14249

Place and date



What is needed to double productivity and halve environmental impact from Danish agriculture?

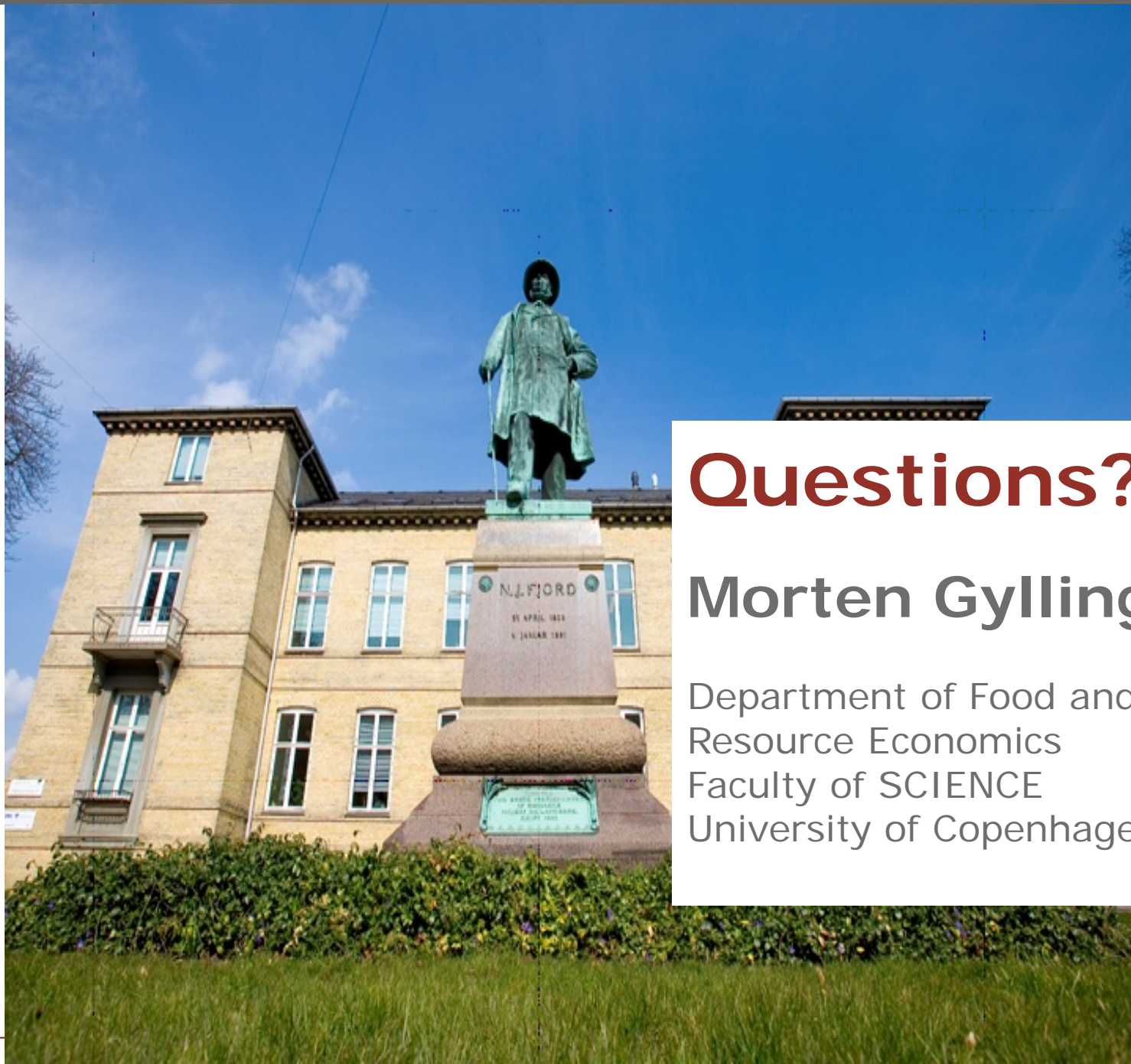
New crop production paradigm

- Annual crops -> perennial crops
- Improved application of cover crops
- Harvest green crops (maximum biomass & protein)
- Green biorefinery to produce food, feed, bioenergy & materials

Research and development

- Increase productivity of grasses and legumes
- Breeding for biorefinery quality (extractable protein, low ANF content)
- Biorefinery processes – protein extraction etc.
- Demonstration of new concepts (high production low emission crops, animal feeding, logistics & conversion)
- Optimized integration with bioenergy technologies (biogas, HTL, ethanol....)





Questions?

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