SDU
LIFE CYCLE ENGINEERING

Recirkulering af affald- og biomasse

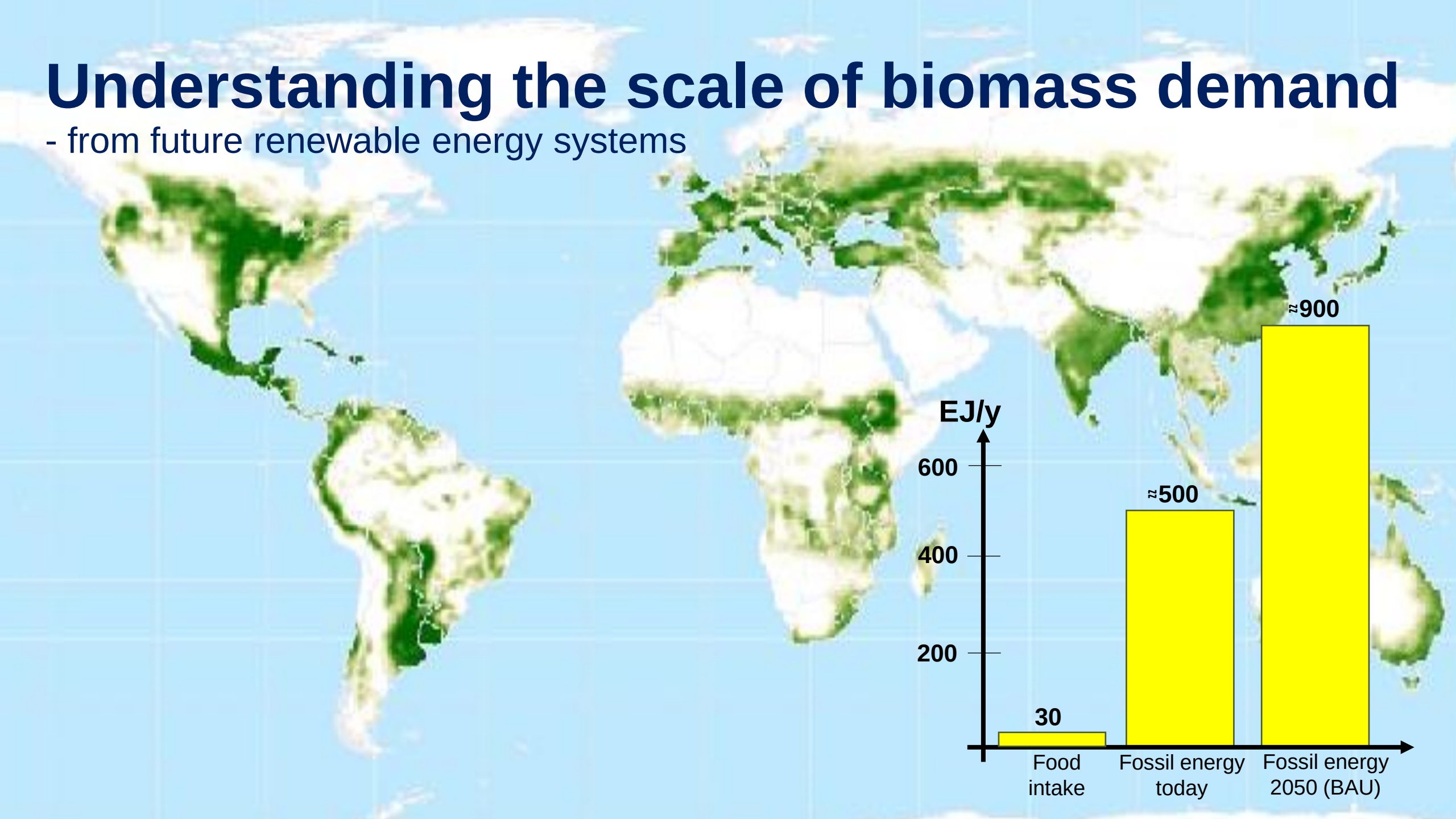
- biogasanlæggets betydning for fremtidens energi- og forsyningssikkerhed

Henrik Wenzel og Anders Winther Mortensen
www.sdu.dk/lifecycle

DIALOGMØDE I ØSTJYSK RECIRKULERINGS-INITIATIV
Åbyhøj, 8. oktober, 2019

Understanding the scale of biomass demand

- from future renewable energy systems



Global extra biomass potentials 2050

Biomass origin & study reference	Scale of availability
Wenzel et al. 2014	≈ 180 EJ/year
• Forestry pre-commercial thinnings & residues	≈10 EJ/year
• Yield increases from forestry intensification	≈ (?) 10 EJ/year
• Plantation on grassland with no or low ILUC	≈ 40 EJ/year
• Plantation on 'other land' (savanna, cerrado)	≈ 80 EJ/year
• Harvest from existing forest	≈ 40 EJ/year
• Plantation on forest land	…
Lauri et al., 2014 (- thinnings and yield increase)	≈165 EJ/year
International Energy Agency, 2017	≈145 EJ/year
Chum et al., 2011 (IPCC expert group consensus)	100 – 300 EJ/year

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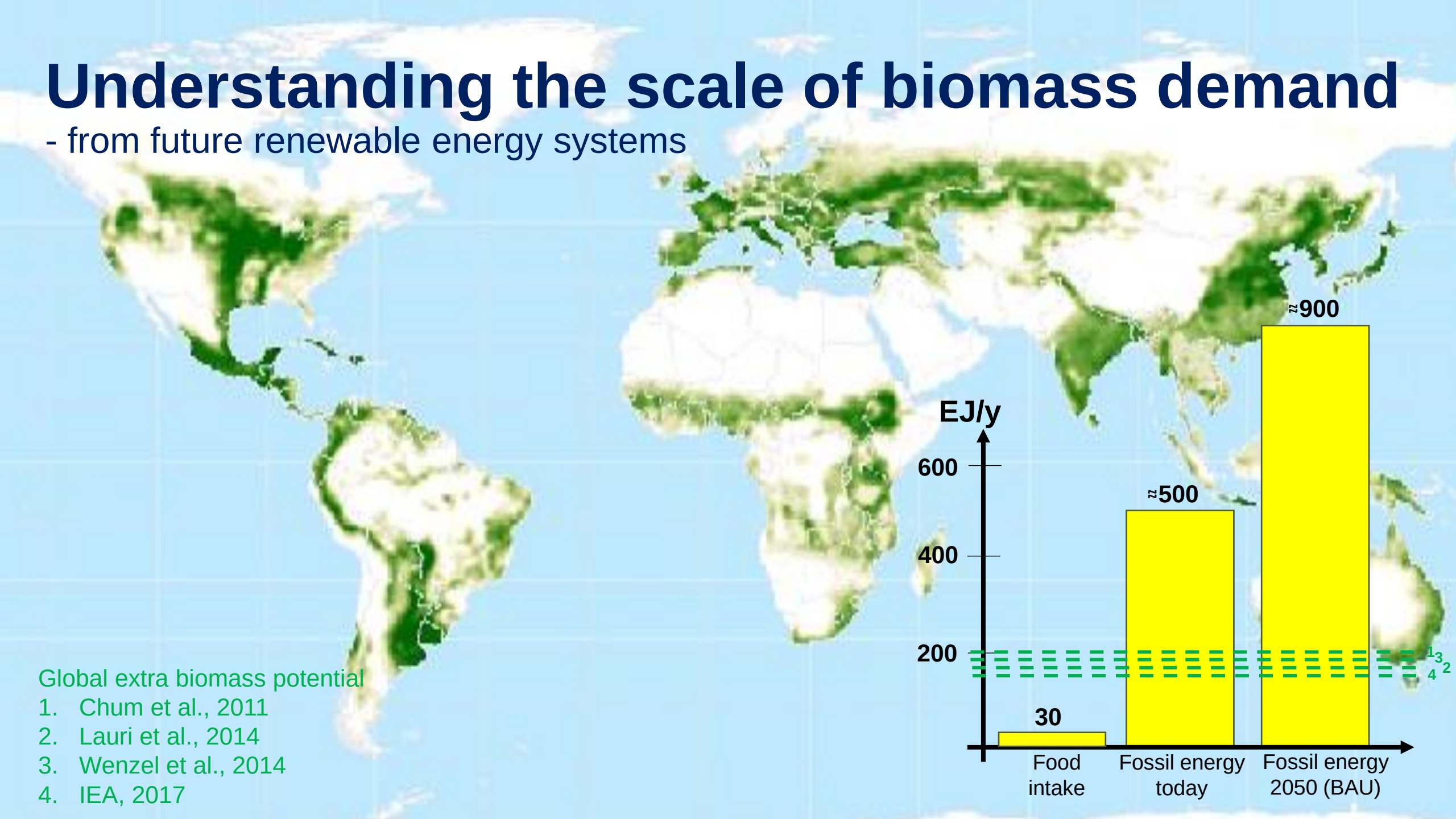

Global extra biomass potential

1. Chum et al., 2011
2. Lauri et al., 2014
3. Wenzel et al., 2014
4. IEA, 2017

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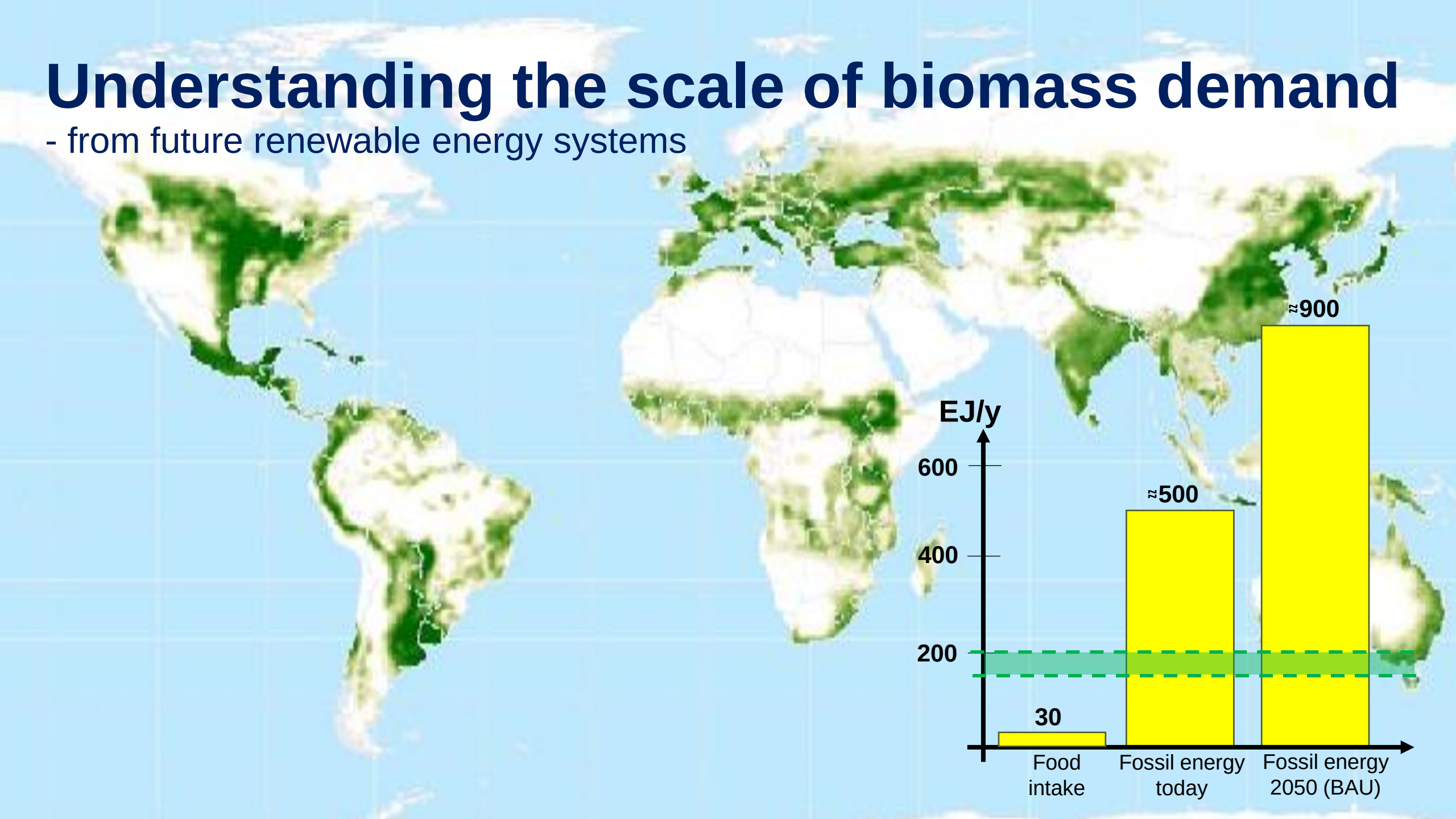

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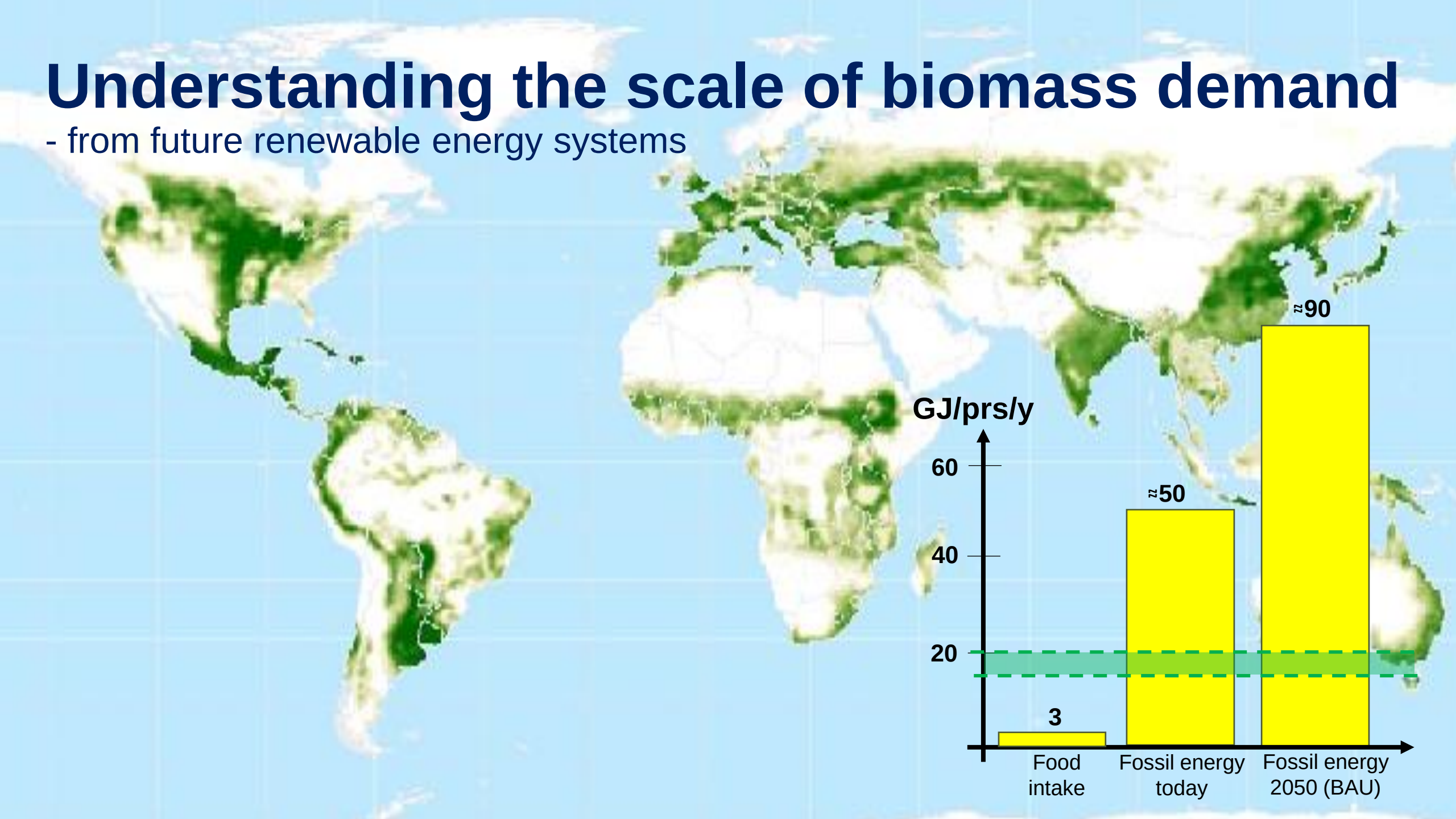
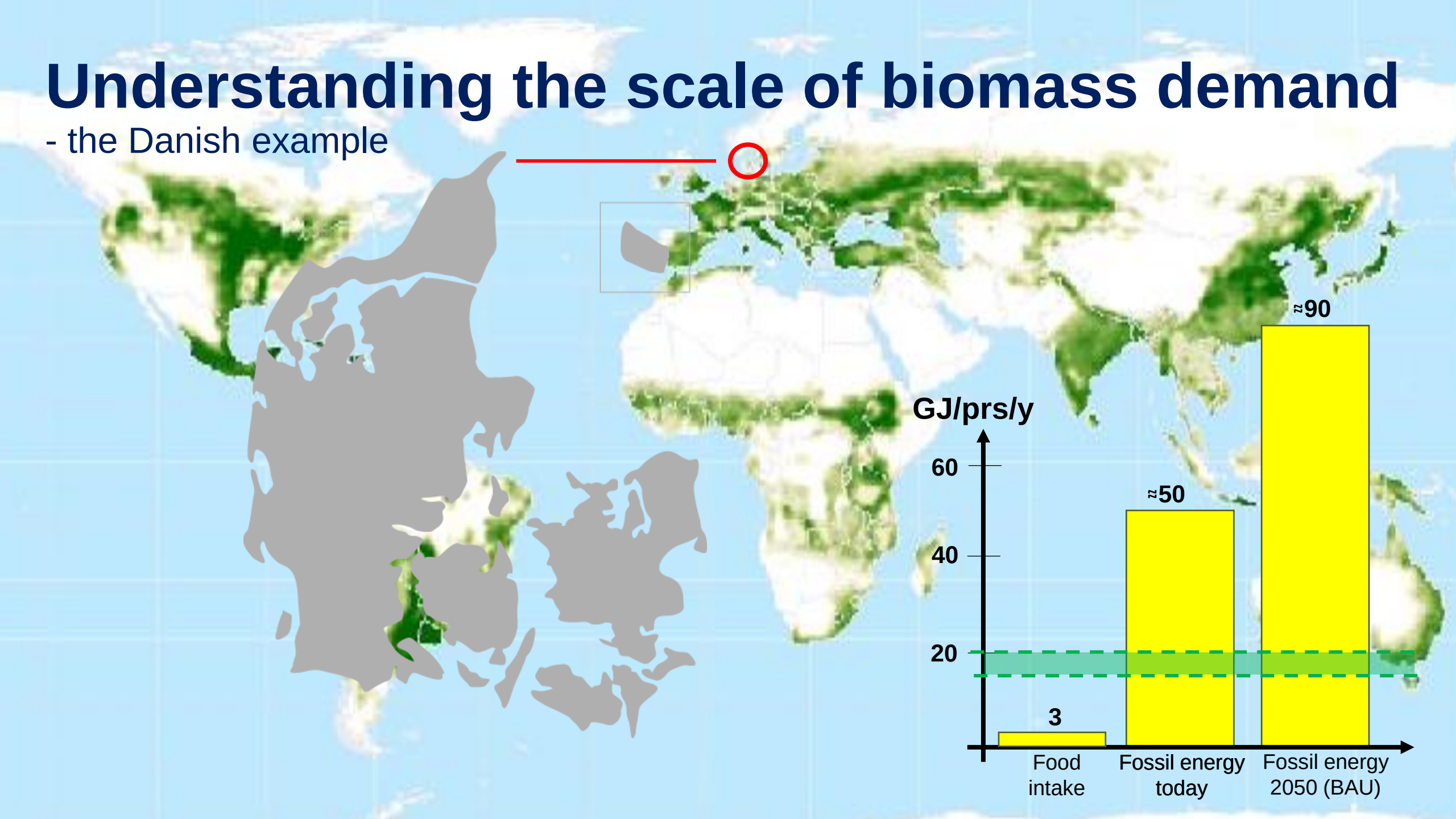


Understanding the scale of biomass demand

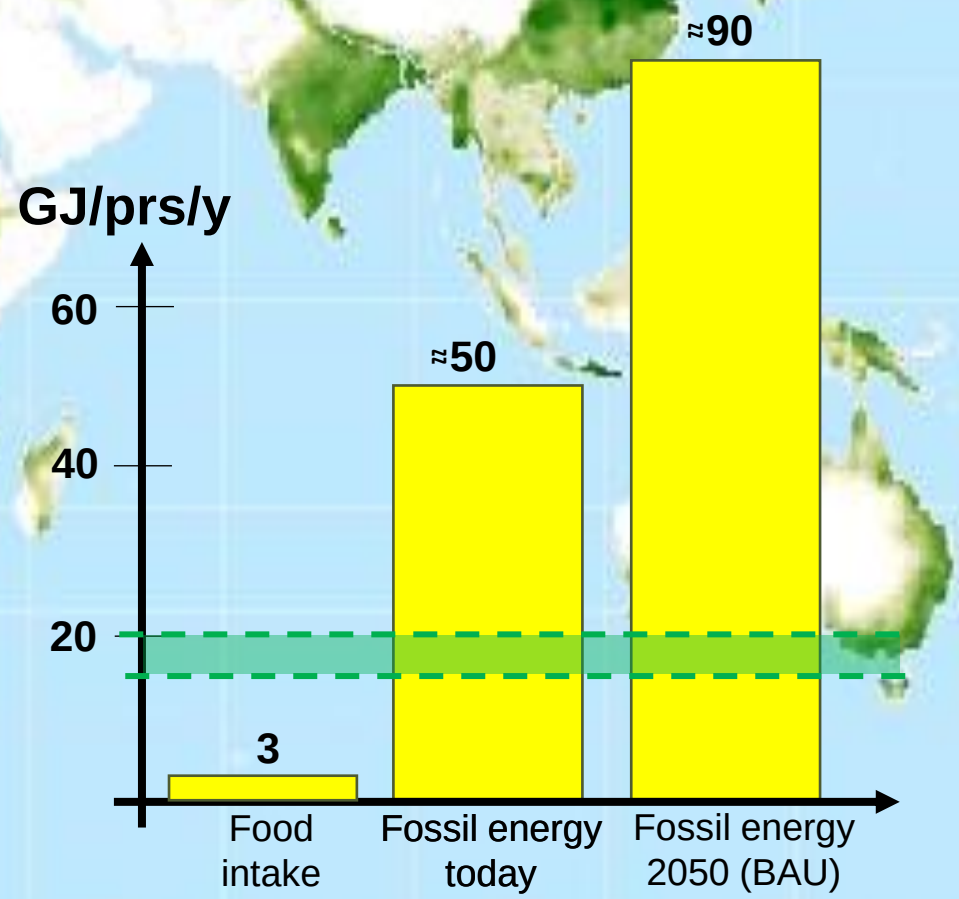
- the Danish example



Understanding the scale of biomass demand

- the Danish example

Study title (original title)	Reference
IDAs energiplan 2030	IDA (2006)
IDAs klimaplan 2030	IDA (2009)
IDAs Energi Vision 2050	IDA (2015)
Grøn energi – vejen mod et dansk energisystem uden fossile brændsler	The Climate Commission (2010)
Coherent Energy and Environmental System Analysis (CEESA)	AAU et al. (2011)
Energiscenarier mod 2020, 2035 og 2050	Danish Energy Agency (2014)
Carbon Footprint of bioenergy pathways for the future Danish energy system	SDU and COWI (2014)
Energi 2050 – et udviklingsspor for energisystemet	Energinet (2010)
Energikoncept 2030	Energinet (2015)
Systemperspektiv 2035	Energinet (2018)

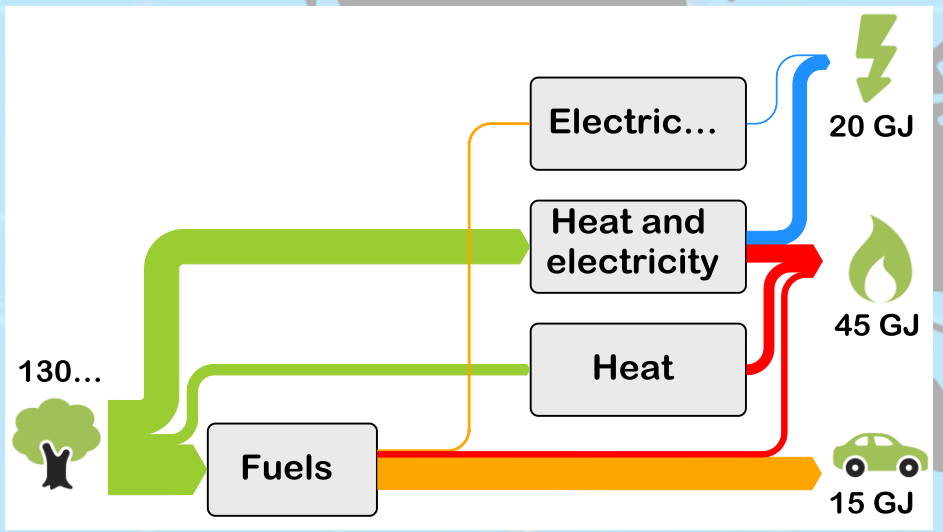


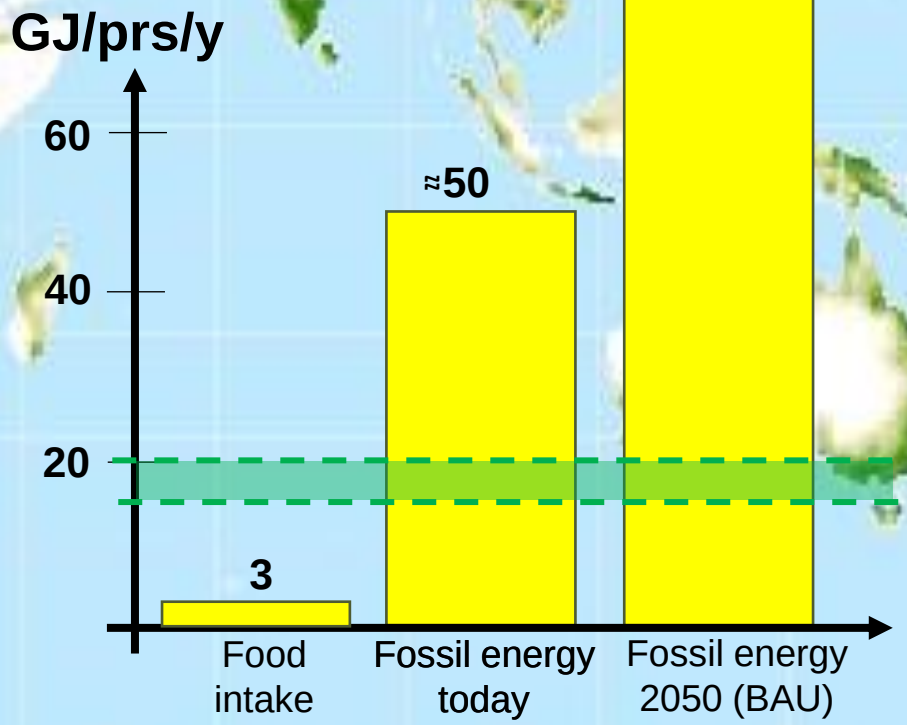
Understanding the scale of biomass demand

- the Danish example

130 GJ/prs/y – bio-energy scenario

Pure bioenergy





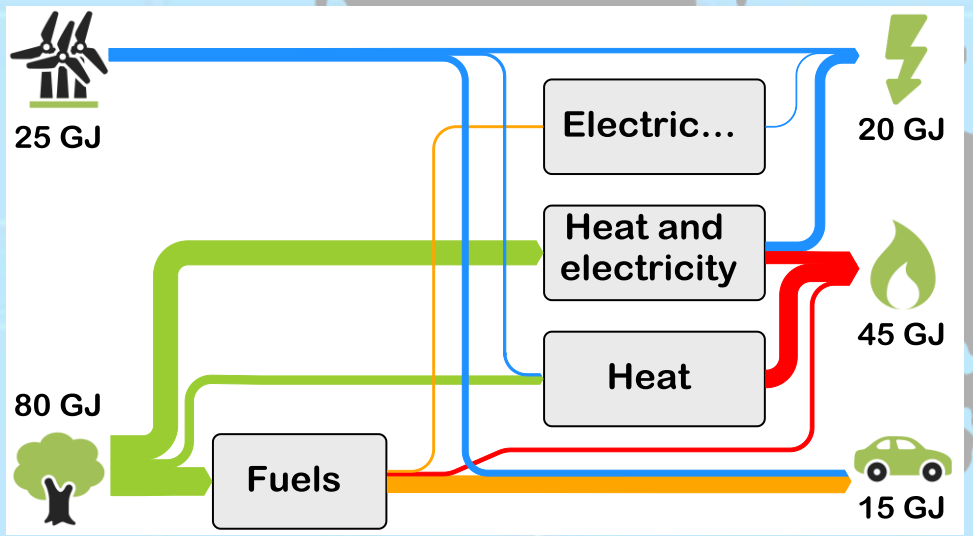
Understanding the scale of biomass demand

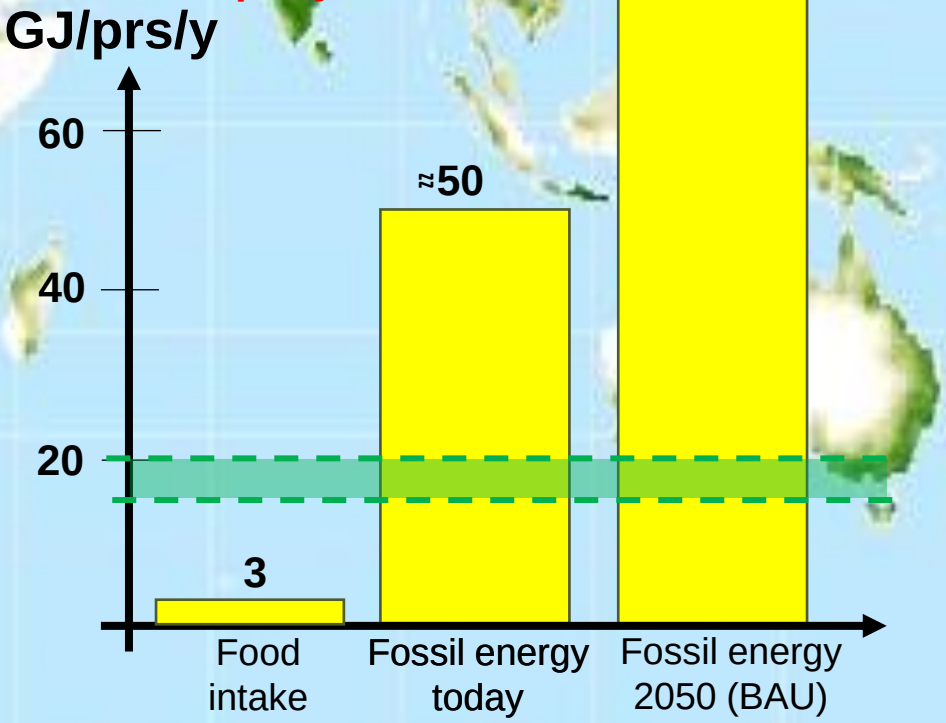
- the Danish example

130 GJ/prs/y – bio-energy scenario

80 GJ/prs/y – electrification scenario

Electrification





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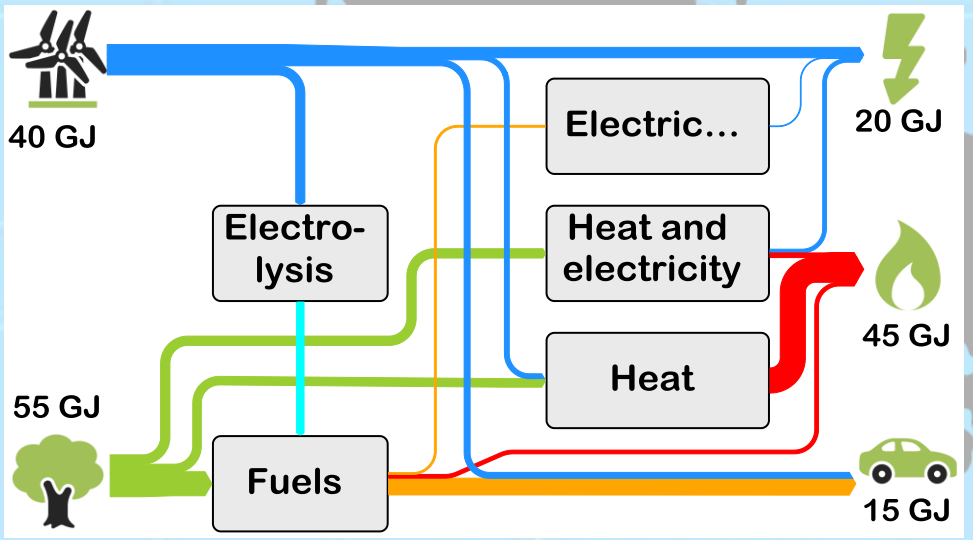
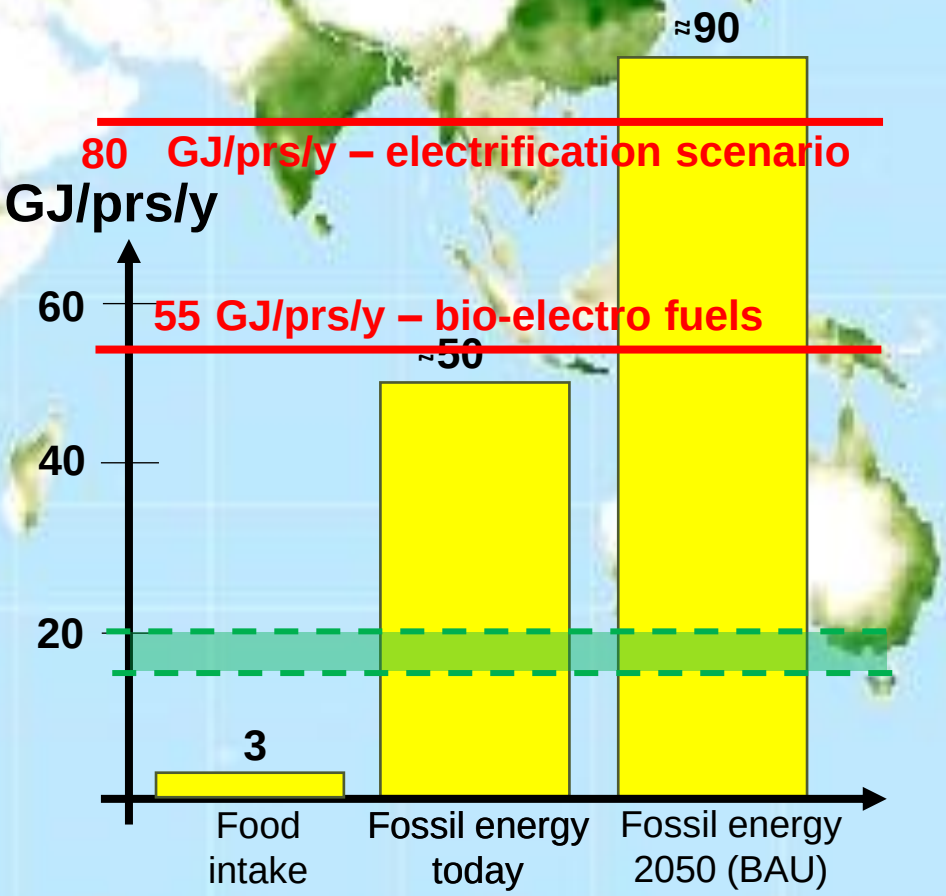
130 GJ/prs/y – bio-energy scenario

80 GJ/prs/y – electrification scenario

55 GJ/prs/y – bio-electro fuels

Bio-electrofuels





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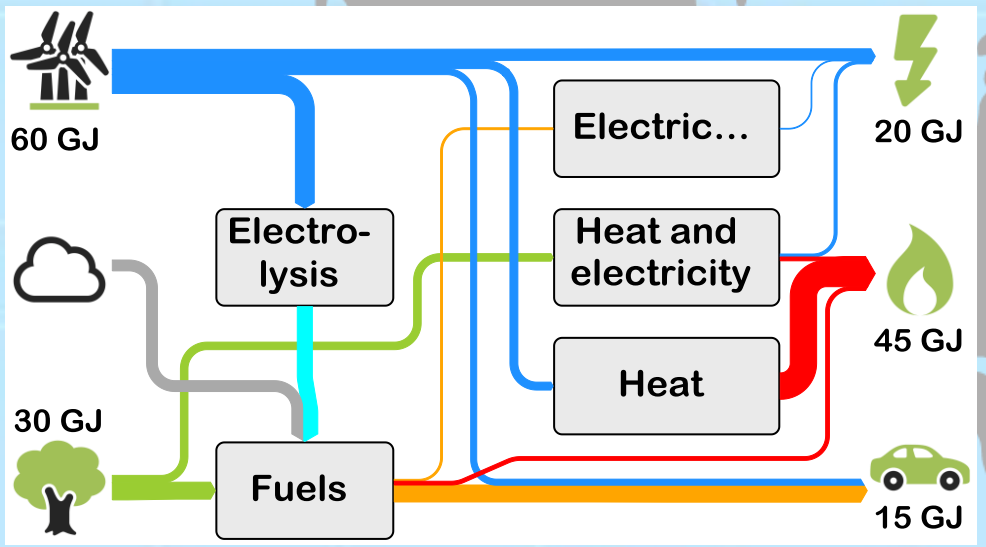
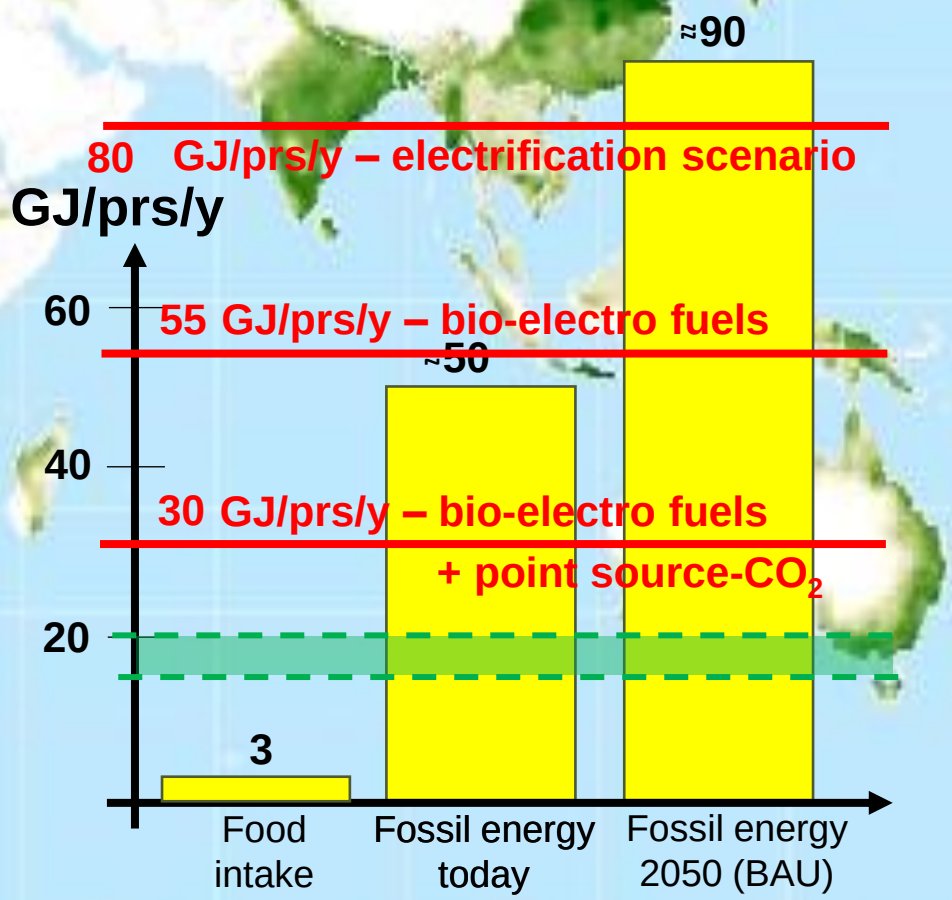
Bio-electrofuels + point source CO_2





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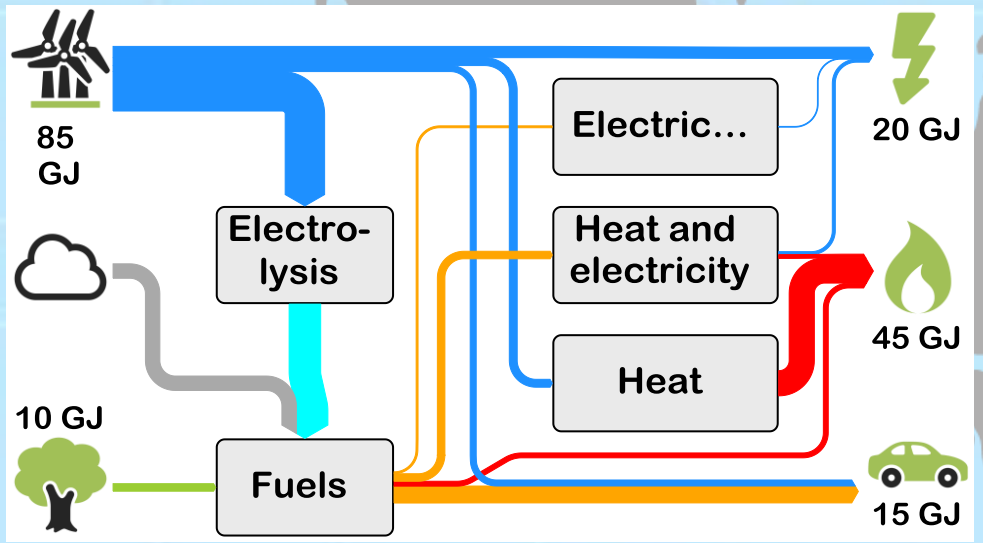
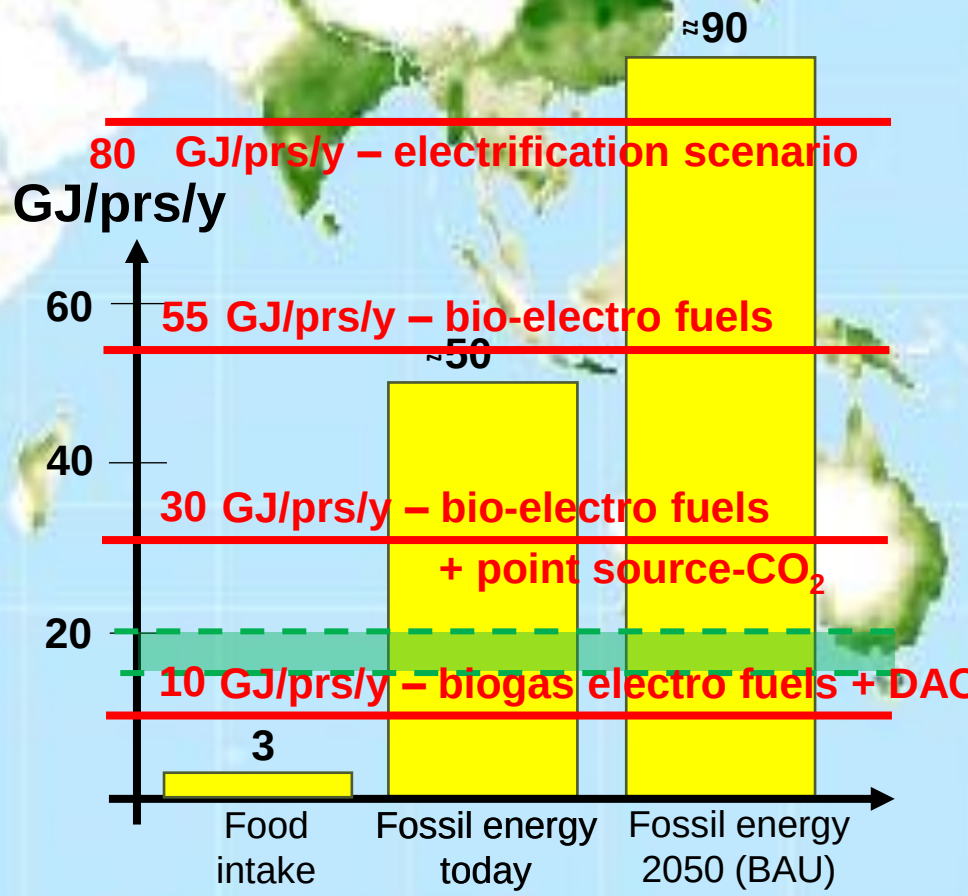
80 GJ/prs/y – electrification scenario

Biogas-electrofuels incl. DAC





Understanding the scale of biomass demand

- the Danish example

130 GJ/prs/y – bio-energy scenario

Plastic 2050:
1,2 Gtons/y*

80 GJ/prs/y – electrification scenario

GJ/prs/y

60

55 GJ/prs/y – bio-electro fuels

~50

40

30 GJ/prs/y – bio-electro fuels
+ point source-CO_2

20

10 GJ/prs/y – biogas electro fuels + DAC

3

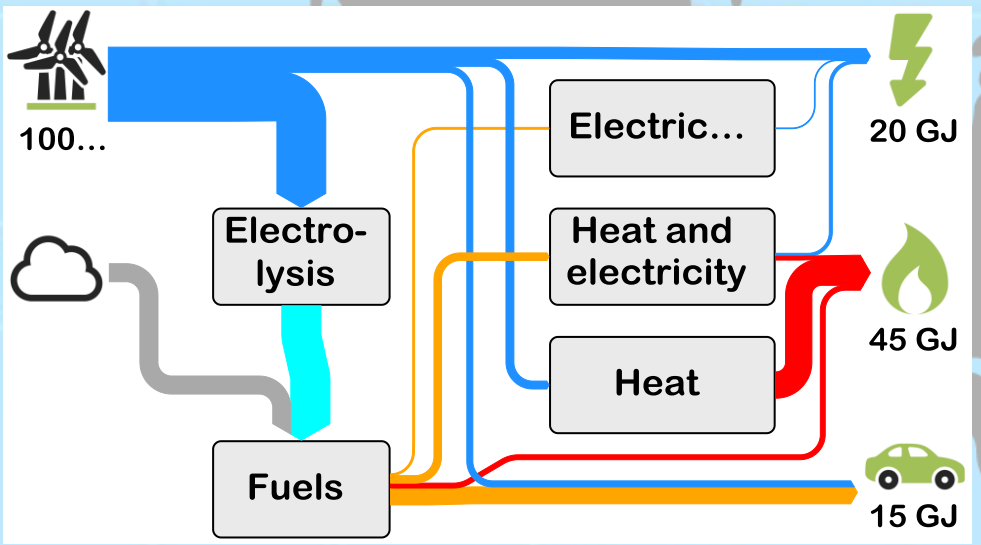
0 GJ/prs/y – electro fuels + DAC

Food intake

Fossil energy today

Fossil energy 2050 (BAU)

Pure electrofuels



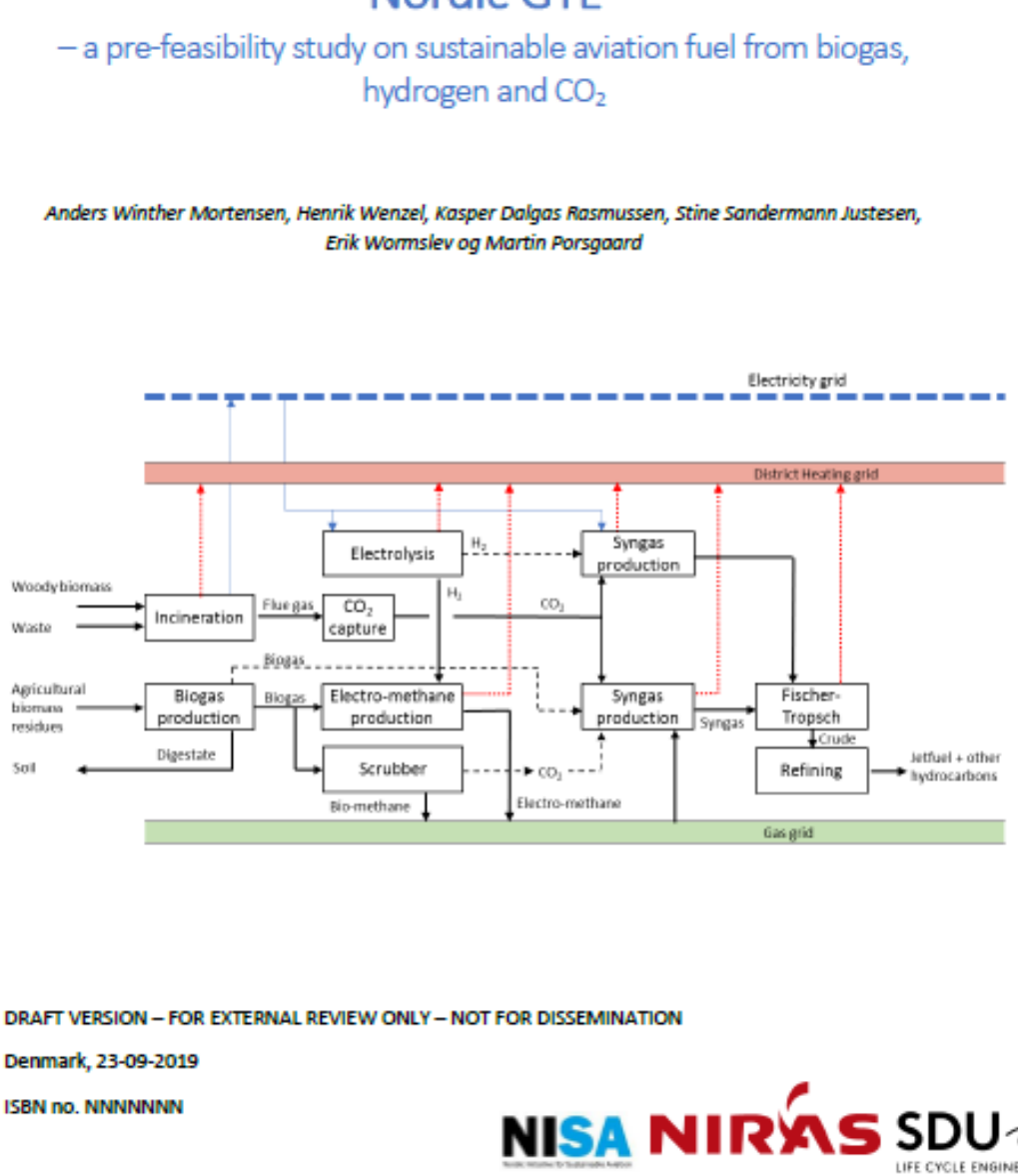
* Ellen MacArthur Foundation. *The New Plastics Economy - Rethinking the Future of Plastics & Catalysing Action*; 2017

Sustainability criteria for any hydrocarbon supply pathway

Money: cost, image value, front runner value
Technique: Area efficiency, biomass efficiency or carbon efficiency of hydrocarbon supply
Robustness, flexibility, readiness, supply security, sufficiency, …
Environment: carbon footprint, biodiversity, soil quality

Nordic GTL

- Afklaring af bæredygtig løsning til fremtidens flybrændstof mm.
- Baseret på biogas, CO_2 og brint
- Samarbejde mellem SDU, NISA og NIRAS
- Finansieret af Brancheforeningen Dansk Luftfart, Nordic Energy Research, Dansk Energi, Københavns Lufthavn, SAS, Nature Energy, ARC
- Pre-feasibility rapport færdig og sendt i høring
- Klar om 2 uger



Nordic GTL

– a pre-feasibility study on sustainable aviation fuel from biogas, hydrogen and CO_2

Anders Winther Mortensen, Henrik Wenzel, Kasper Dalgas Rasmussen, Stine Sandermann Justesen, Erik Wormslev og Martin Porsgaard

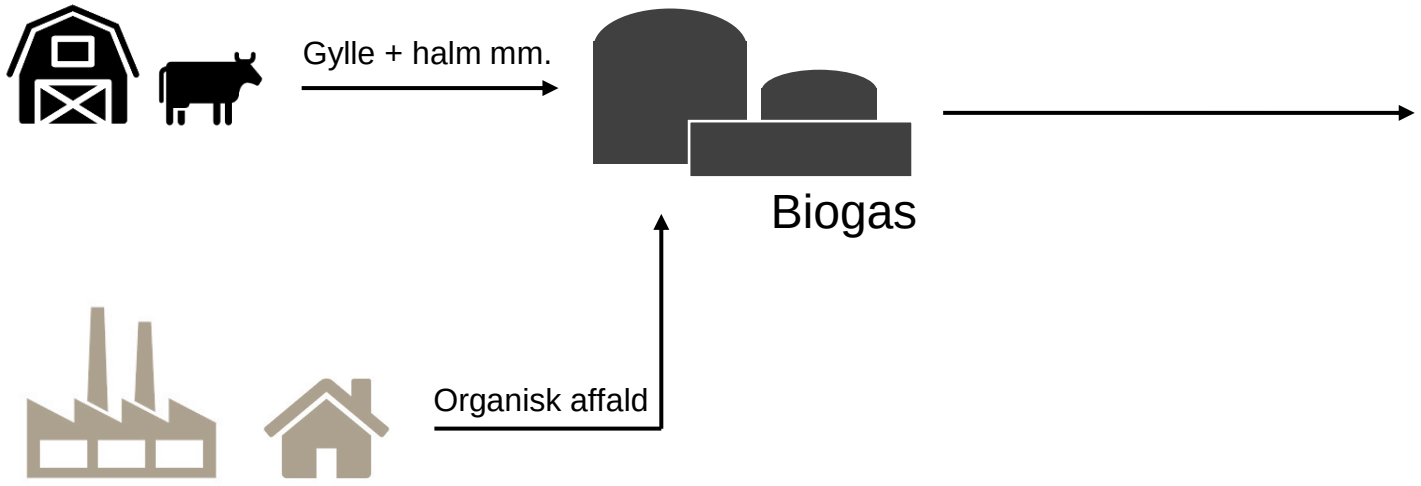
DRAFT VERSION – FOR EXTERNAL REVIEW ONLY – NOT FOR DISSEMINATION

Denmark, 23-09-2019

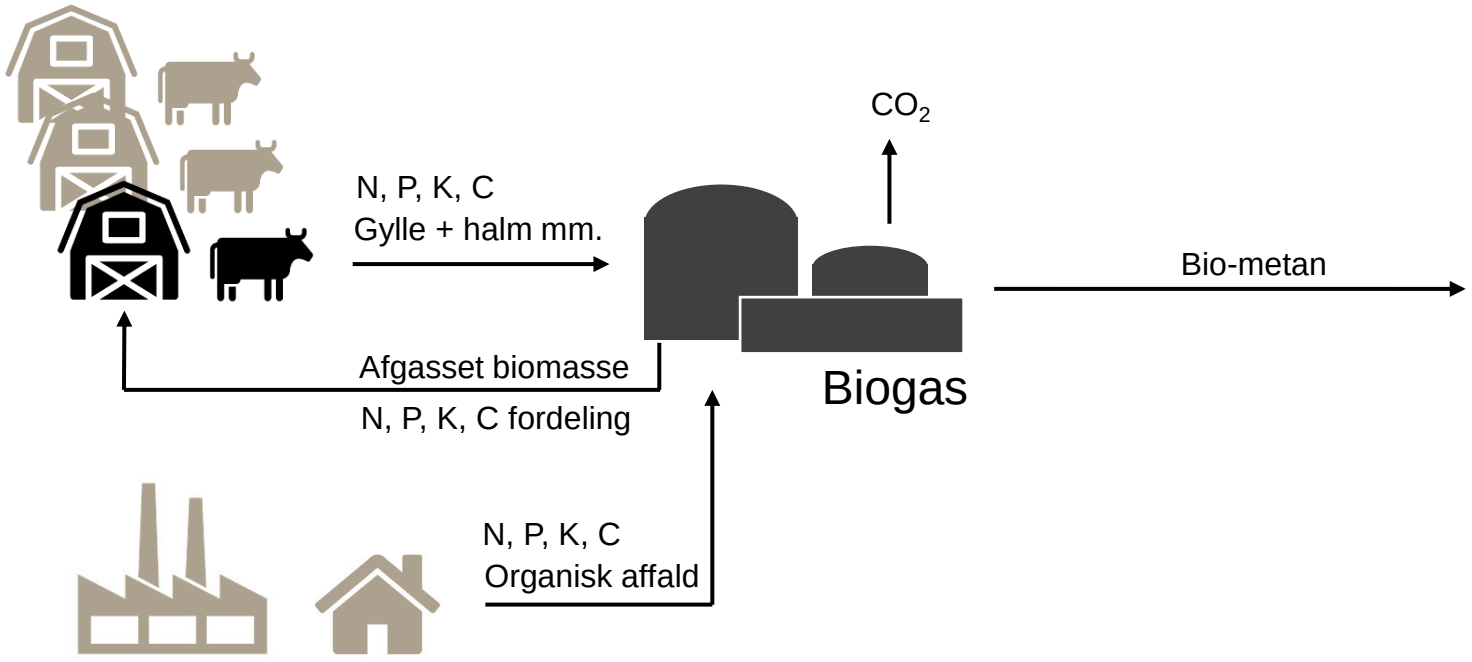
ISBN no. NNNNNNN

NISA NIRAS SDU LIFE CYCLE ENGINEERING

Nordic GTL 2022
- bio-metan til brændstof



Nordic GTL 2022
- bio-metan til brændstof



Nordic GTL 2022
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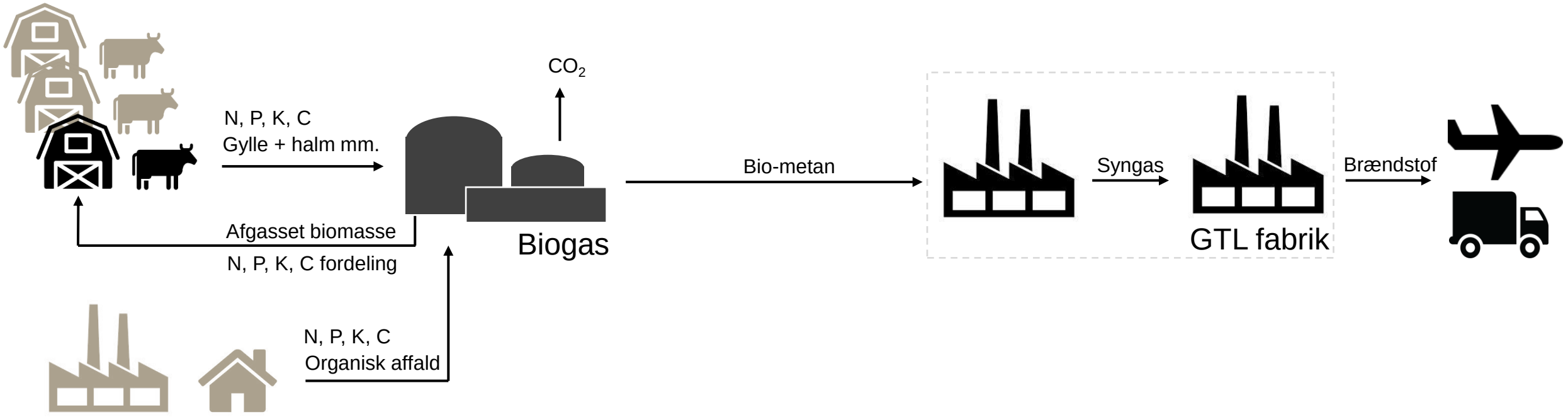
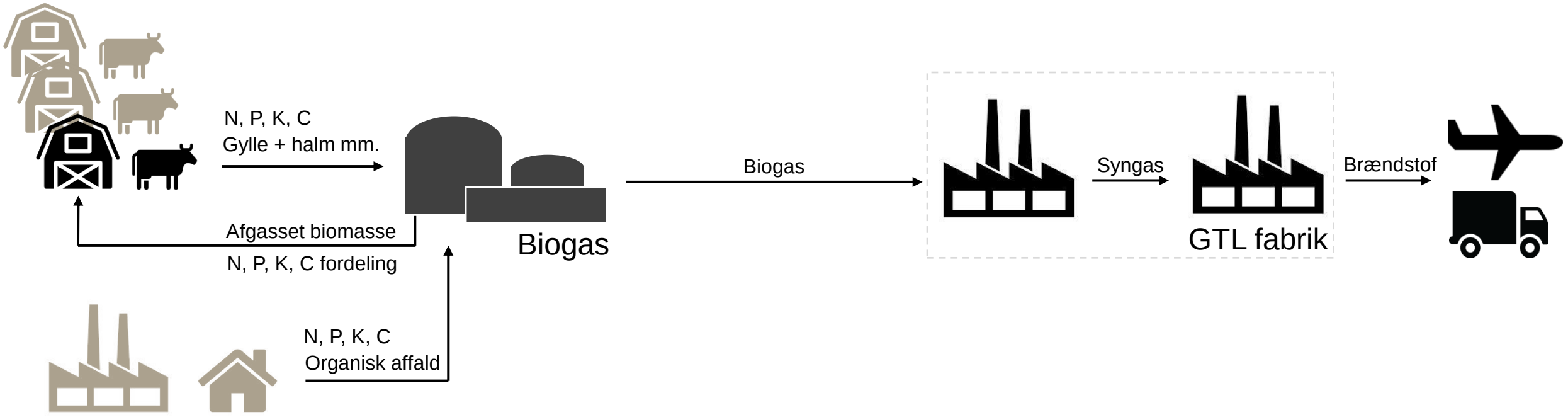
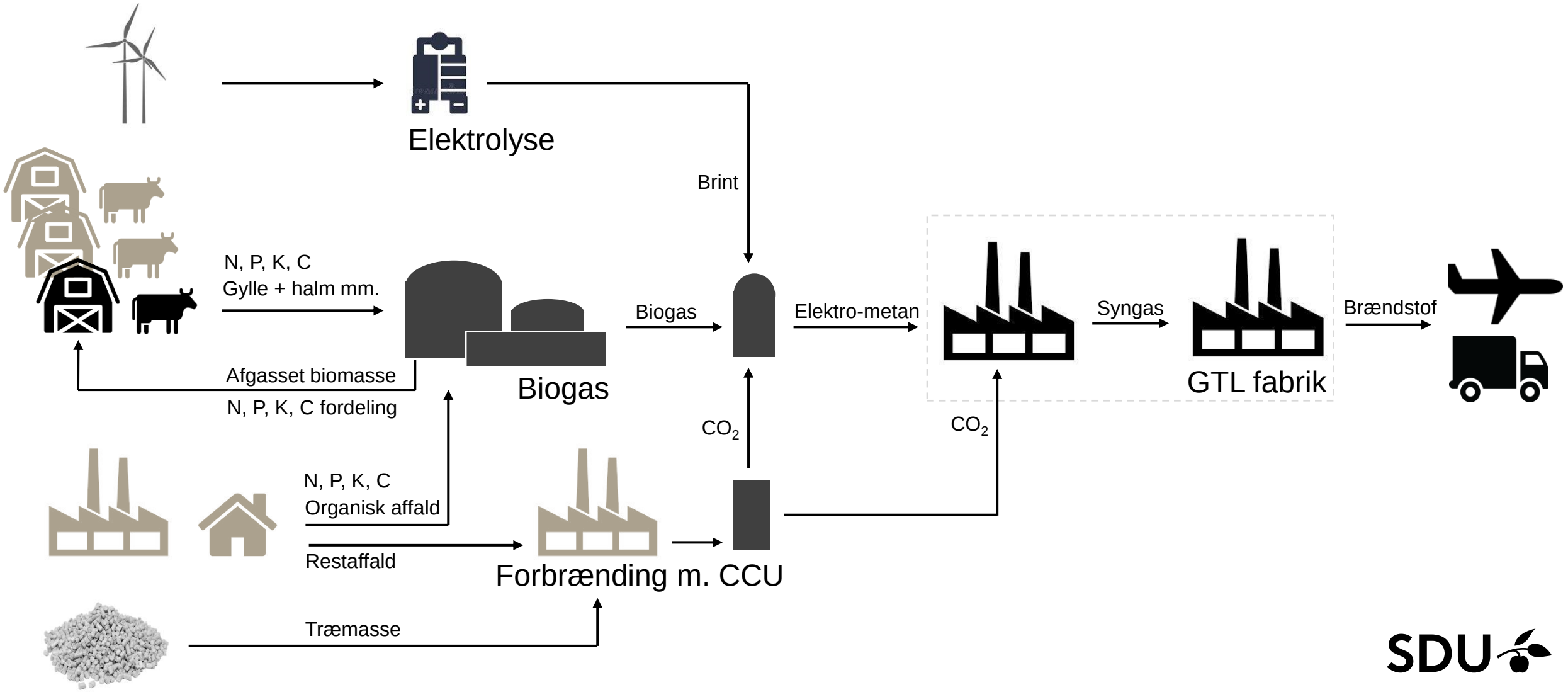


Nordic GTL 2022
- biogas direkte til brændstof



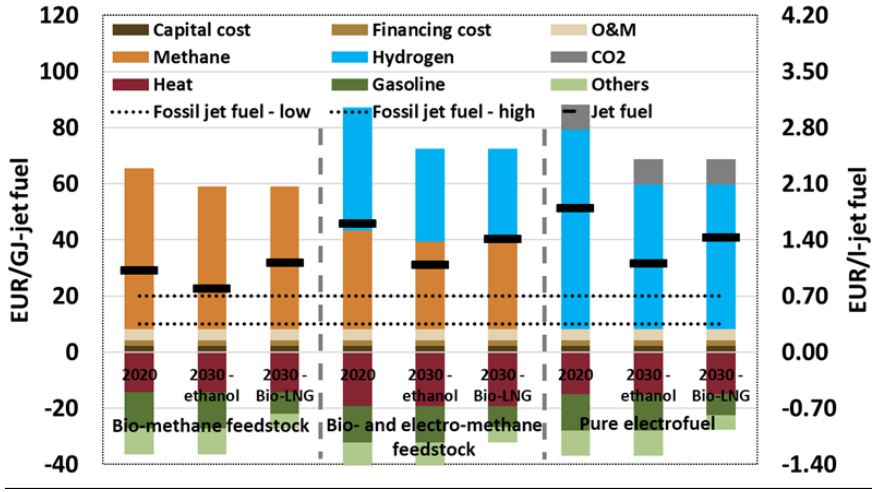
Nordic GTL 2025

- elektro-metan + CO_2 til brændstof



Nordic GTL 2030

- CO_2 og brint/el direkte til brændstof

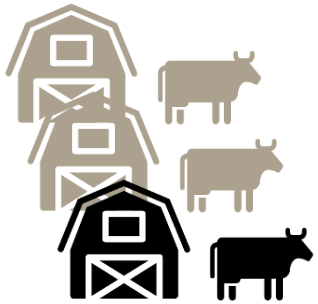


Elektrolyse

Brint

CO_2

CO_2



N, P, K, C
Gylle + halm mm.

Biogas

Biogas

Elektro-metan

Syngas

GTL fabrik

Brændstof

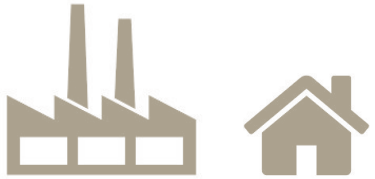
Afgasset biomasse

N, P, K, C fordeling

CO_2

CO_2

Syngas



N, P, K, C
Organisk affald

Restaffald

Forbrænding m. CCU

CO_2

Co-elektrolyse

Træmasse

CO_2

SDU

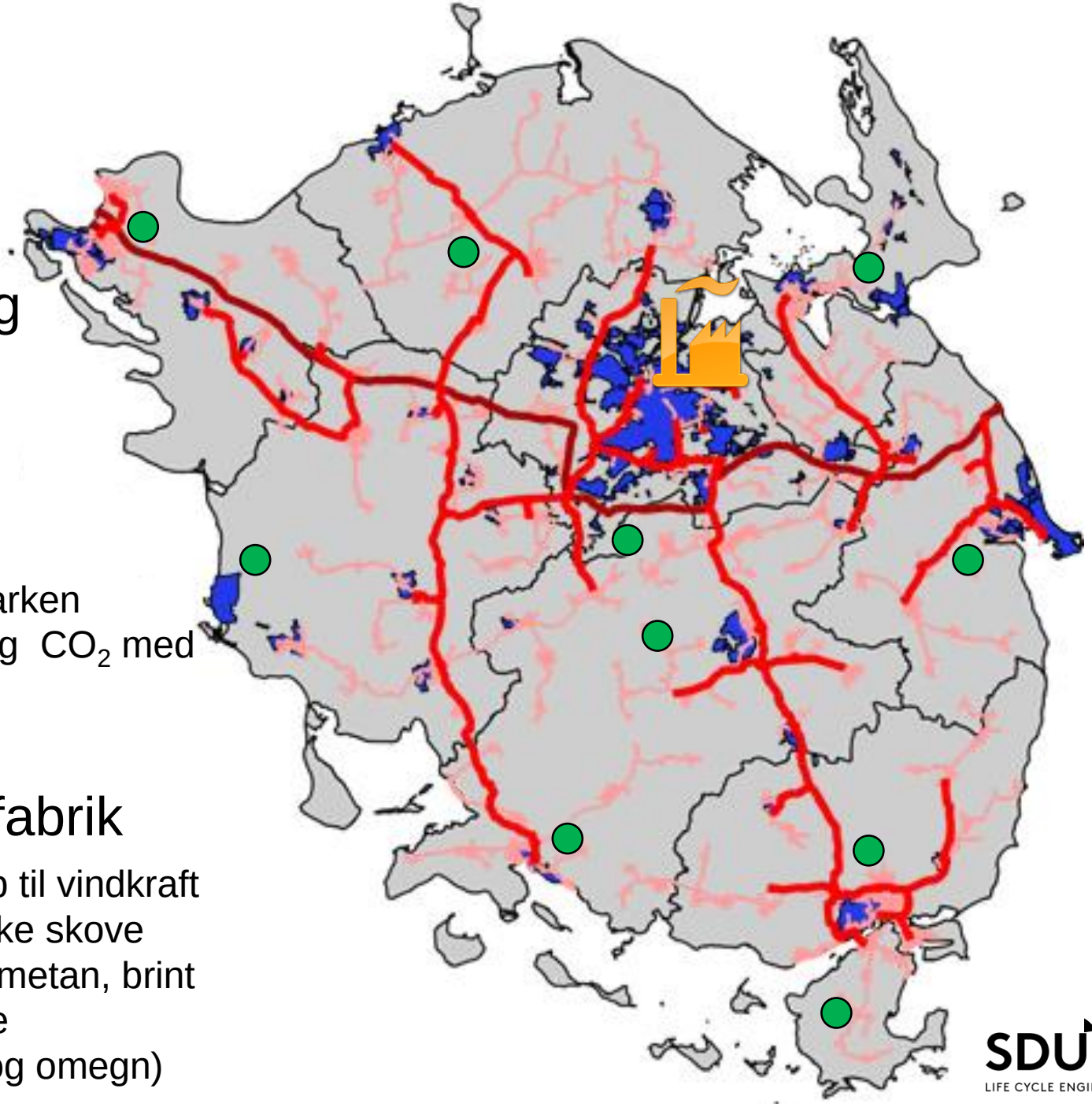
Nordic GTL 2030
- Geografisk eksempel: Fyn

Decentral biogas m. metanisering

- Ca. 10 biogasanlæg fordelt i landskabet
- Behandler al fynsk gylle og halm
- Behandler KOD og anden organisk affald fra husholdning, detailhandel og industri
- Fordeler N, P og K optimalt i landbruget
- Giver svært nedbrydeligt kulstof tilbage til marken
- Metaniserer biogas-CO_2 og anden tilgængelig CO_2 med brint
- Leverer fjernvarme til de fynske købstæder

Central gasturbine og brændstoffabrik

- Central gasturbine som stand-by & back-up til vindkraft
- Biomasse CHP med overskudstræ fra fynske skove
- Central brændstof fabrik med feedstock af metan, brint og CO_2 fra affaldsforbrænding og biomasse
- Procesvarme til Fjernvarme Fyn (Odense og omegn)



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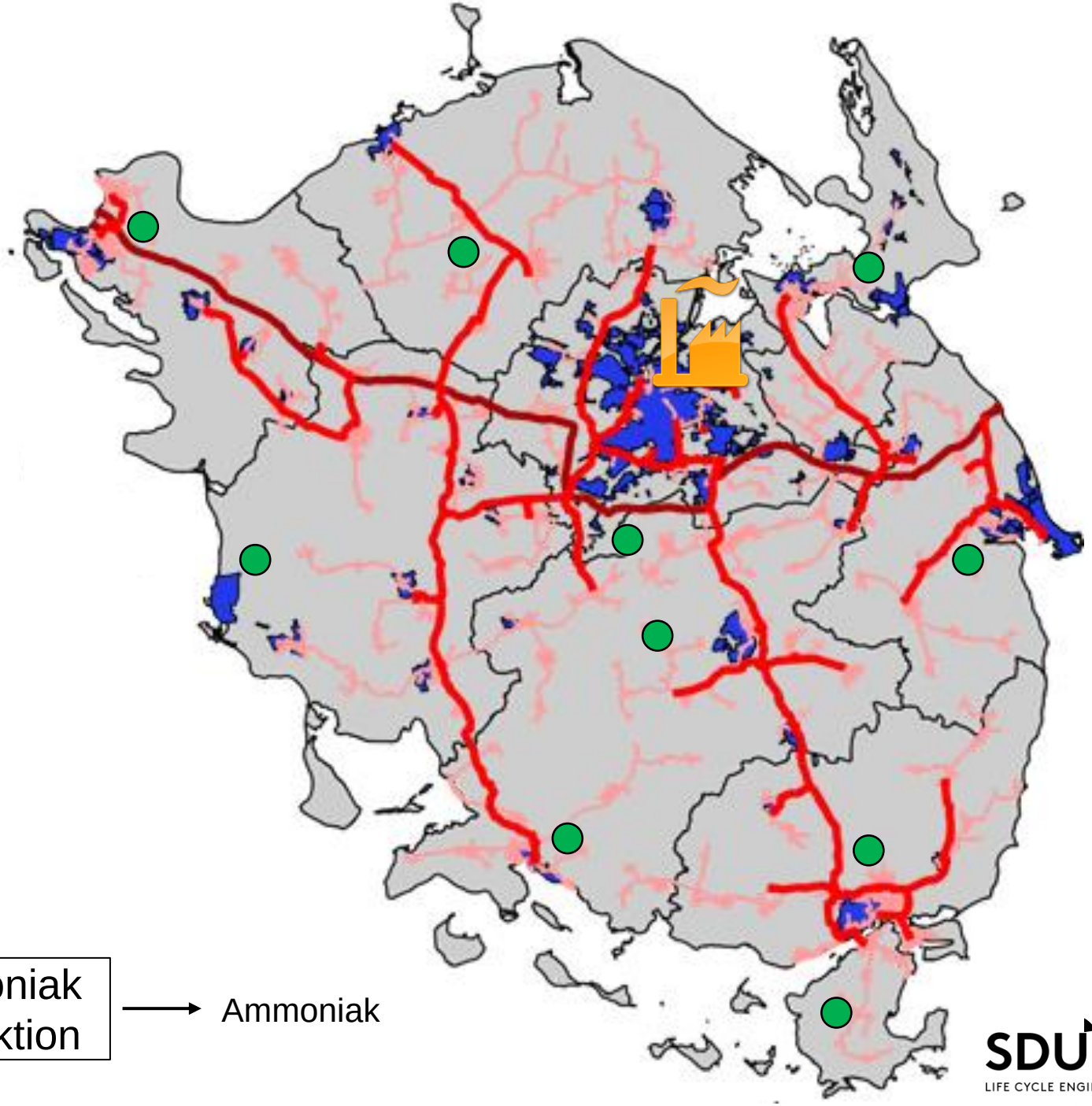
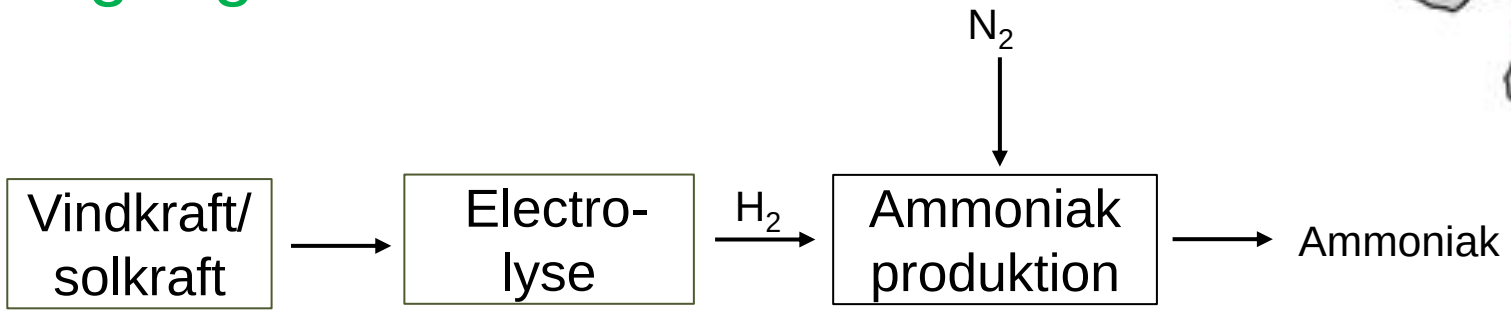
Diskussion



PS: kunne man evt. bruge noget grøn ammoniak?



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