



Biogas in Scandinavia

Skandinavisk Biogaskonference, Skive, 7. november 2017, Knud Boesgaard, FREMSYN

Setting the right perspective



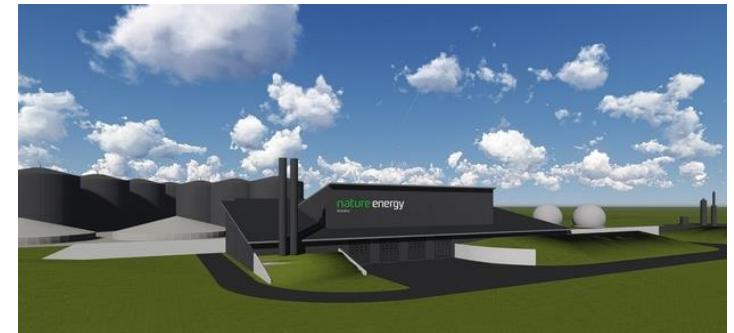
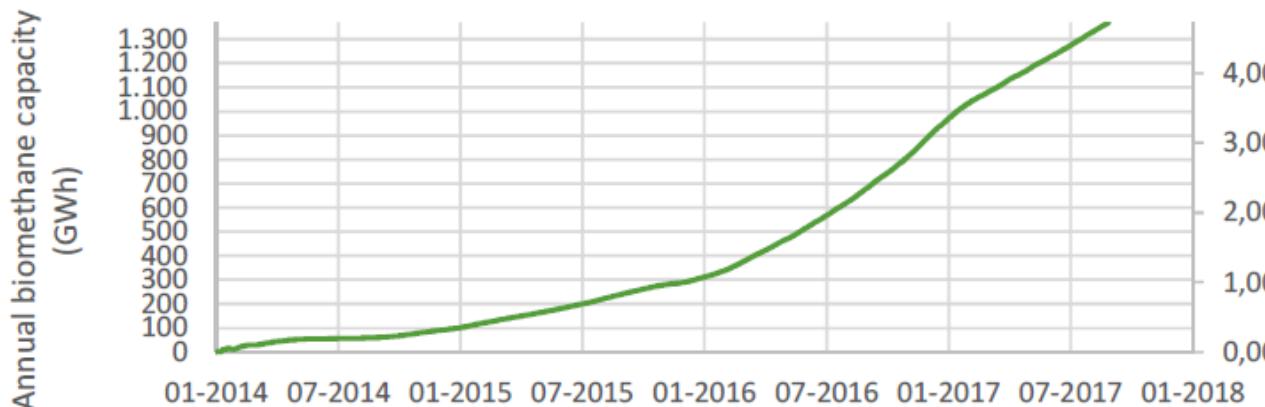
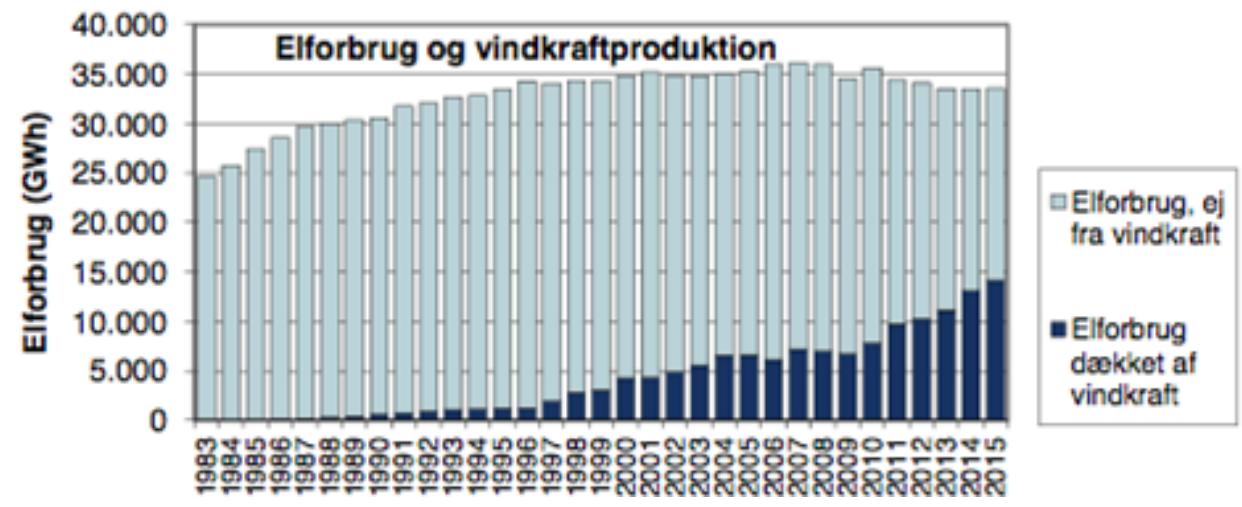
Gedsermøllen (1957)
24 m wingspan



Tvindmøllen (1975)
54 m wingspan



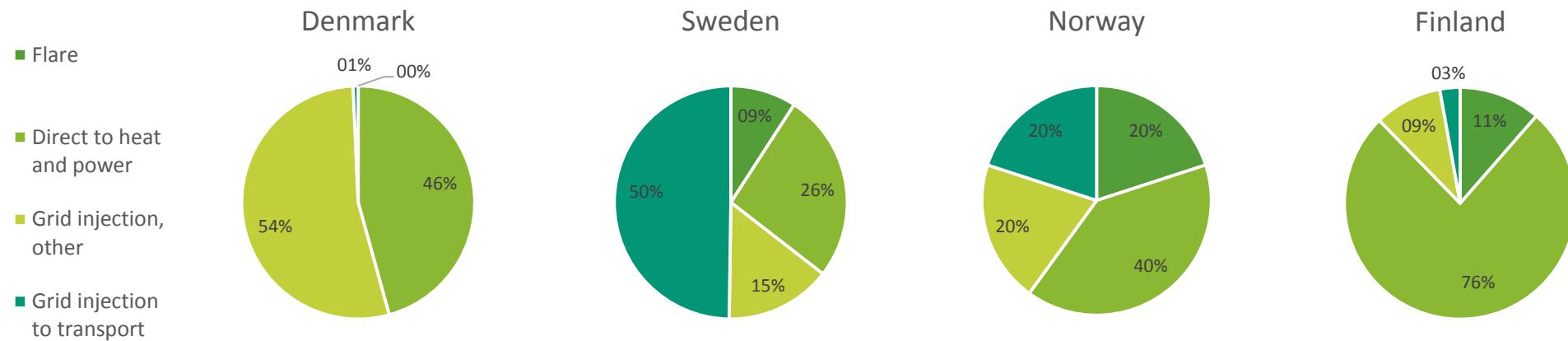
Vestas V164 (2017)
164 m wingspan



Nature Energy Korskro (2018)
710.000 tonnes of biomass

Biogas status in Scandinavia

	Denmark	Sweden	Norway	Finland
Number of biogas plants	165	282	40	84
Number of upgrading plants	12	61	9	10
Production Nm3	333,000,000 Nm3	202,000,000 NM3	80,000,000	80,000,000 Nm3
Production TWh	3,3 TWh	2,1TWh	0,8 TWh	0,8 TWh



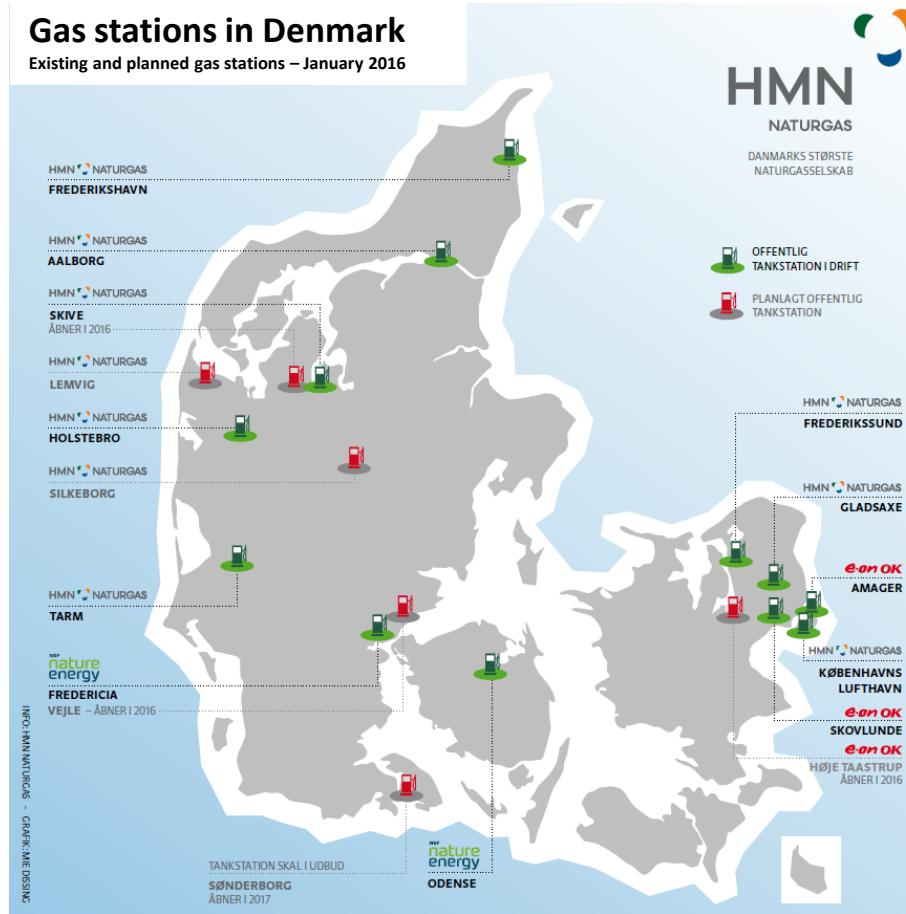
Biogas incentives

	Denmark	Sweden	Norway	Finland
Taxes	Full energy and CO2 tax on biomethane	40% company tax reduction for using NGVs Biomethane exempt from fuel taxes	Biomethane exempt from fuel taxes	CO2 tax exemption for biogas
Subsidies	Feed-in-premium: biomethane to power biomethane to grid	Fund for climate projects (163,5 million € in 2019-2020)	€1,65 / m3 manure Investment grant for biomethane plants	Feed-in-premium: biomethane to power
Other measures	Biotickets Minimum of 0,9% advanced biofuels in 2020	Target of 75% environmentally friendly vehicles in public sector Free parking	Pump law: large tank stations (more than 1000m3 capacity must sell one alternative fuel)	Investment subsidy Construction subsidy

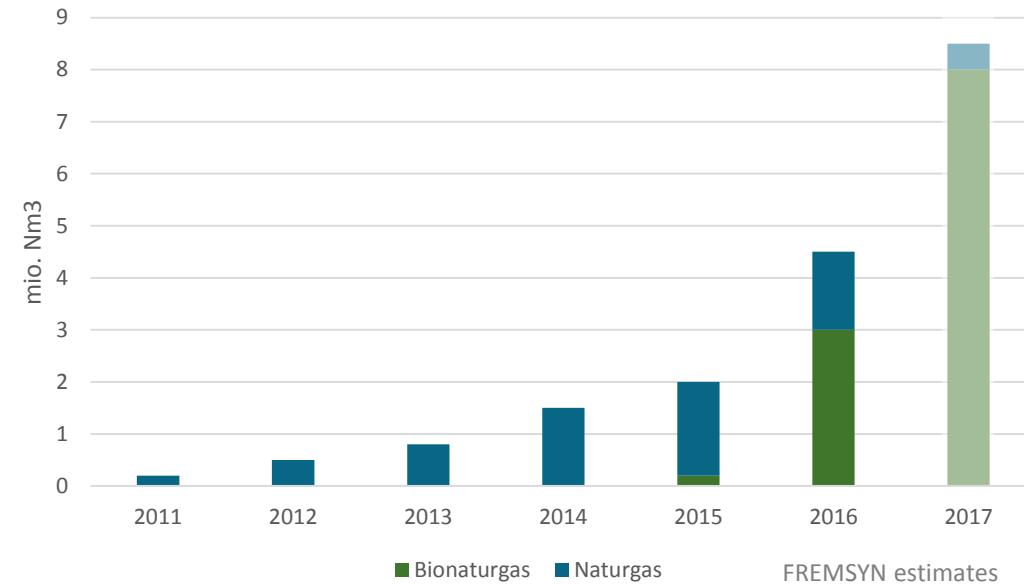
Status of NGV deployment

	NGV cars		NGV buses		NGV vans and trucks		Total NGV's		Filling stations
	#	%	#	%	#	%	#	%	#
Denmark	93	0,00%	73	0,54%	197	0,05%	363	0,01%	15
Norway	126	0,00%	624	3,84%	522	0,10%	1.282	0,04%	18
Sweden	42.675	0,90%	2.357	16,97%	8.079	1,31%	54.439	1,01%	218
Finland							2.375		29

Biogas for transport in Denmark



Development of gas consumption for transport in Denmark



Trends

- Transition to bio nature gas
- Sales of CBG almost exclusively runned by local offers in the municipalities

Interessefællesskabet for biogas til transport

*Interest community for biogas in transport

- Investigation of opportunities barriers for biogas in heavy transport
- Report series
- Send an e-mail to: knud@fremsyn.net

Lots of potential ...



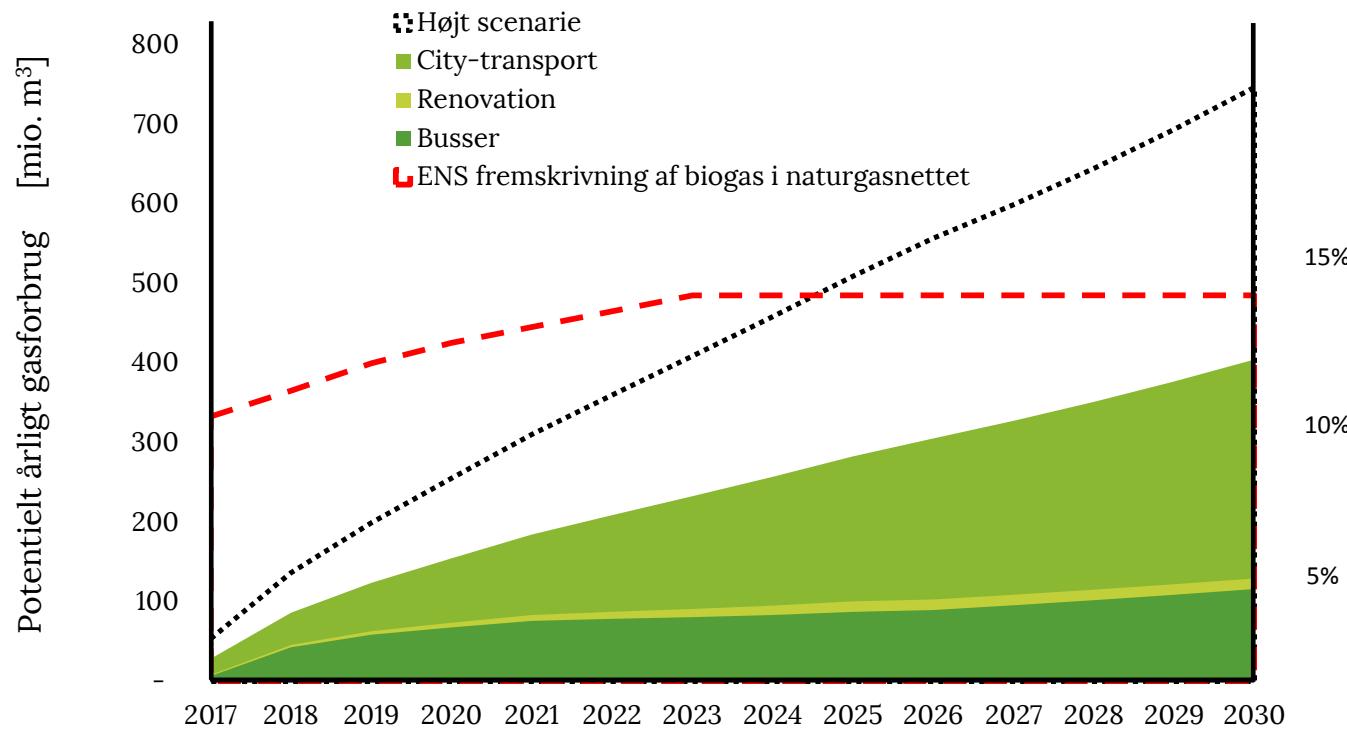
Cleaner than the alternatives ...



And it's cheaper ...



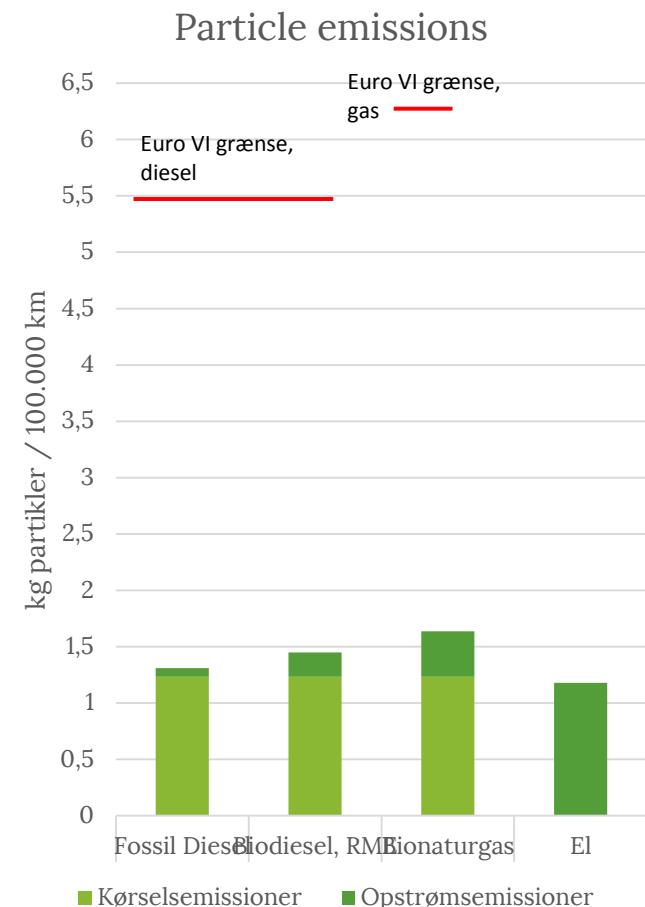
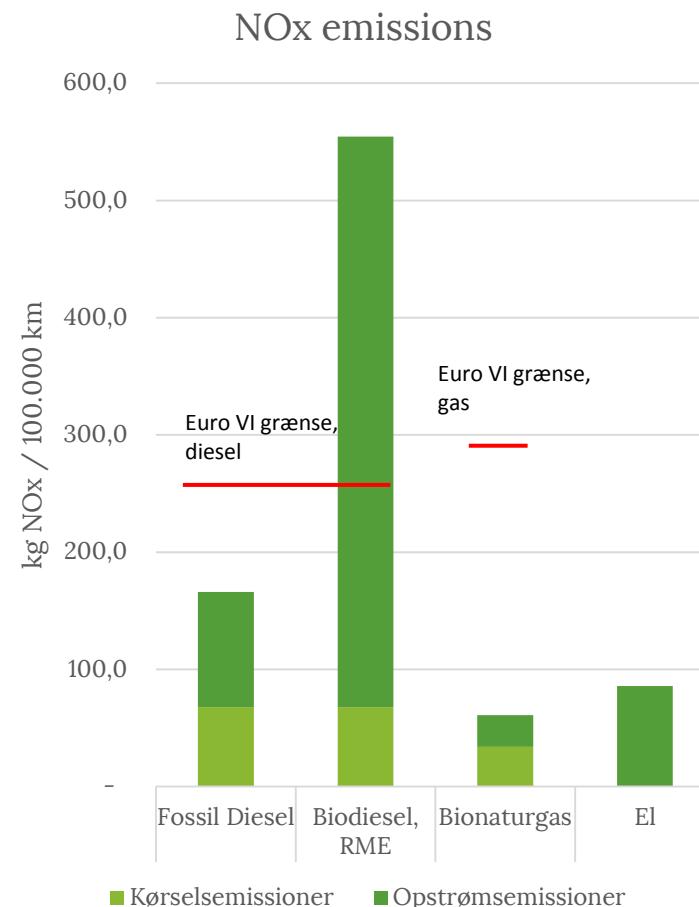
Danish biogas potential in transport



Calculations for busses are based on numbers from The Danish Transport, Construction and Housing Authority
Numbers City-transport og renovation are based The Danish Energy Agency's "Rammevilkår for gas til tung transport"



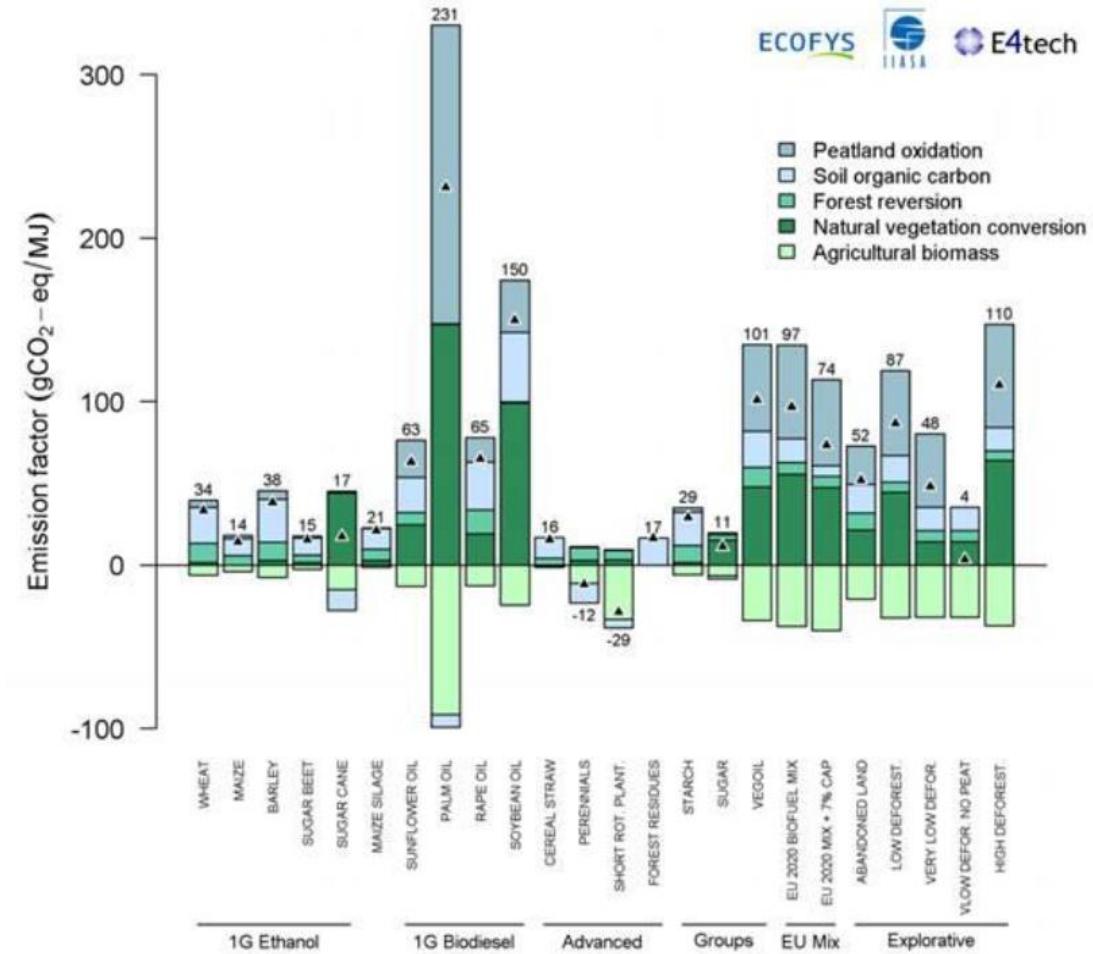
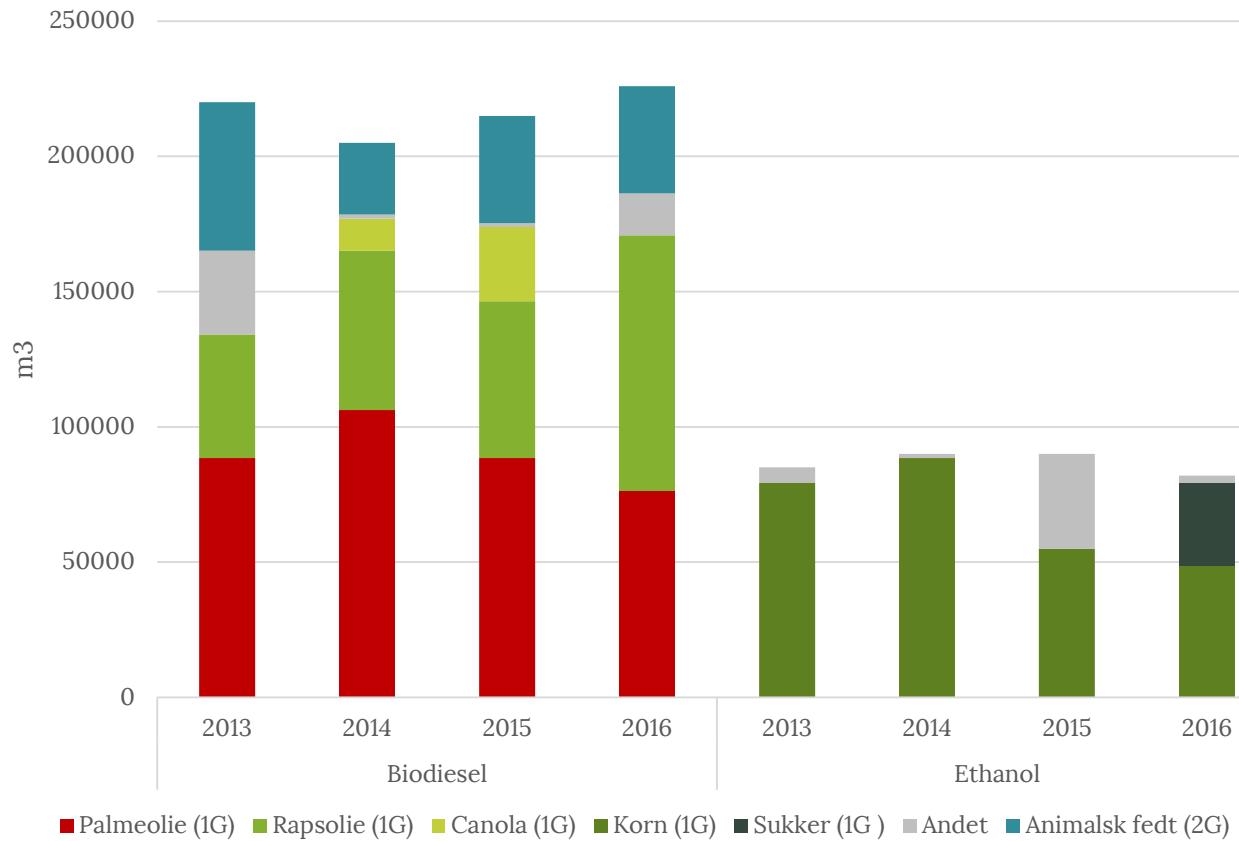
Emissions from biogas for transport



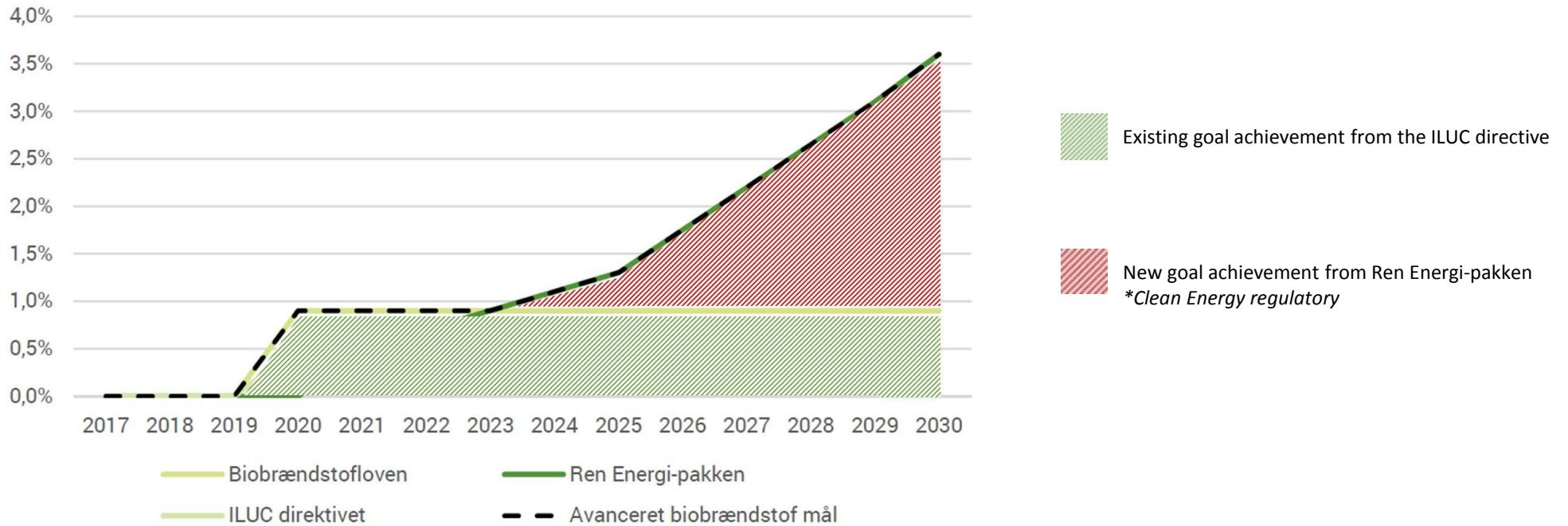
Modelkørsler

Kørselsemissioner fra leverandøroplysninger

Biofuels in Denmark



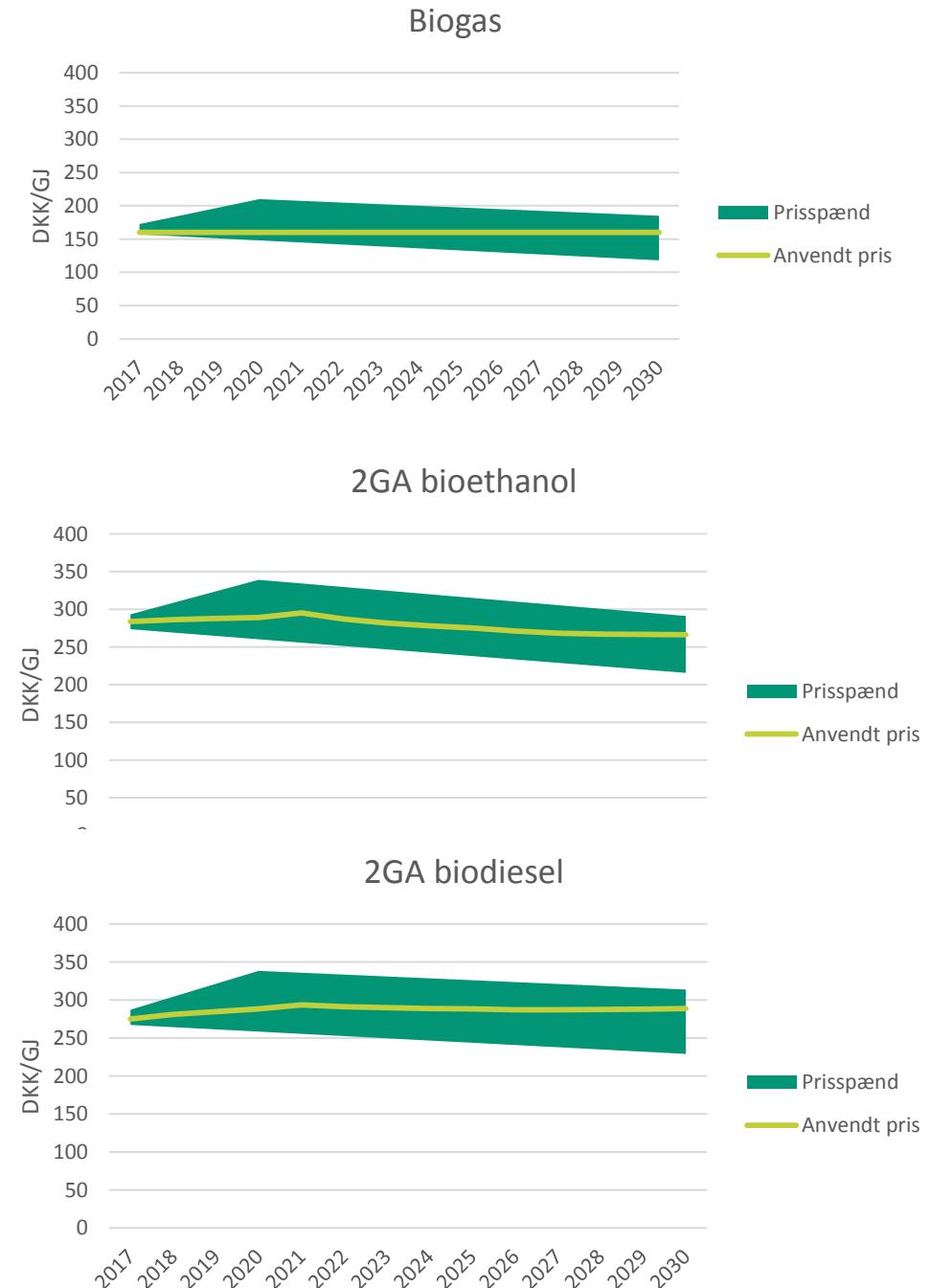
2GA biofuels in the next RE Directive



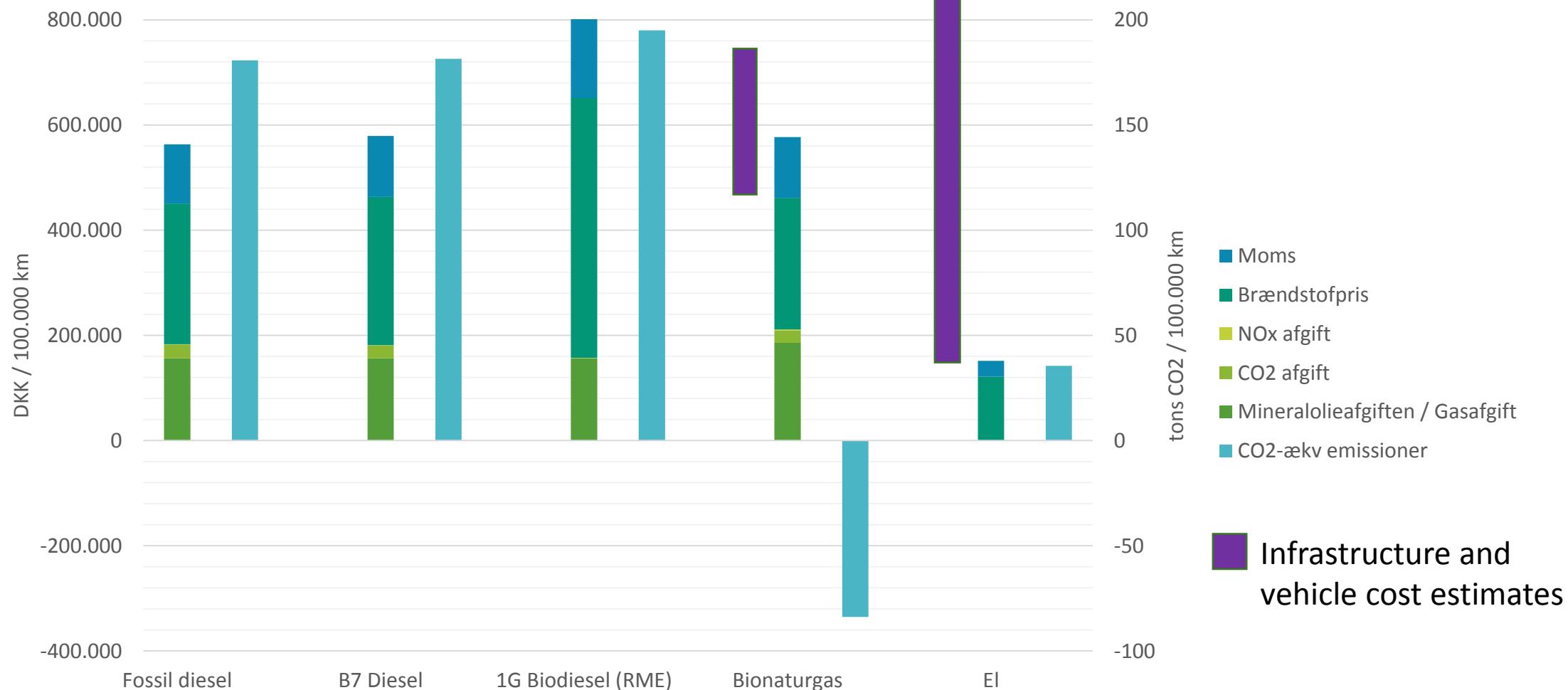
- From 2020, Denmark introduces a requirement for advanced biofuels of 0.5%
- The EU Commission currently discuss raising this requirement to 3.5% by 2030
- Økonominotatet (the financial note) examines the socioeconomic and state-financial effects of 3 alternatives to fulfillment of the requirement; Bio nature gas, Advanced Bioethanol and Advanced Biodiesel

Socio-economics in 2GA

Socio-economic net present value 2017 - 2030	Biogas	Bioethanol	Biodiesel
Fuel gains	+953	-1.192	-1.688
Infrastructure costs	-602	0	0
Additional costs for gas vehicles	-308	0	0
Externality gains	+834	+64	+372
Cross border trade	+435	+306	+118
Tax distortion	+136	+92	+8
Total socio-economic gains	+1448	-731	-1189
Total government revenue, present value million. kr.	+513	+345	+29



100,000 km in a bus



Scandinavian policy developments

Denmark	Sweden	Norway	Finland
EV's are heavily favoured over NGV's.	Public fleets are dominantly biomethane when possible	Oslo has a target of 100% renewable energy in public transport	Focus on double counting towards 2GA in Renewable energy directive
Increasing taxes on NGV cars	Regions Skåne, Halland and Västra Götaland actively promoting biomethane for NGV's.	Expects to implement toll-roads, where toll is based on CO2 and NOx emissions	Positive attitude towards biogas in heavy transport
Tax system doesn't differ between natural gas and biomethane	70% of gas for transport is biogas	Green vehicle strategy review in 2017	
No environmental requirements for public transportation		New green vehicle strategy in 2018	
No strategy for alternative fuels		16% of gas for transport is biogas	
100% of gas to transport is biogas due to bioticket system			



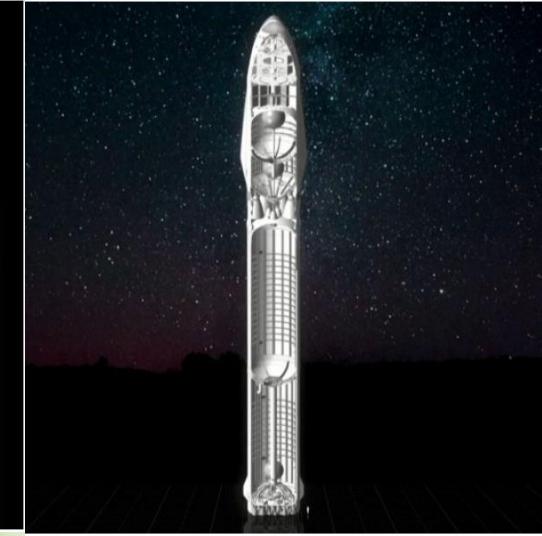
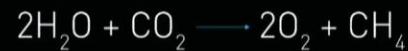
Cycle	Full-flow staged combustion
Oxidizer	Subcooled liquid oxygen
Fuel	Subcooled liquid methane
Chamber Pressure	300 bar
Throttle Capability	20% to 100% thrust
Sea-Level Nozzle	
Expansion Ratio:	40
Thrust [SL]:	3,050 kN
Isp [SL]:	334 s
Vacuum Nozzle	
Expansion Ratio:	200
Thrust:	3,500 kN
Isp:	382 s

First ship will have small propellant plant, which will be expanded over time

Effectively unlimited supplies of carbon dioxide and water on Mars

5 million cubic km ice

25 trillion metric tons CO₂



Thank you for your time!

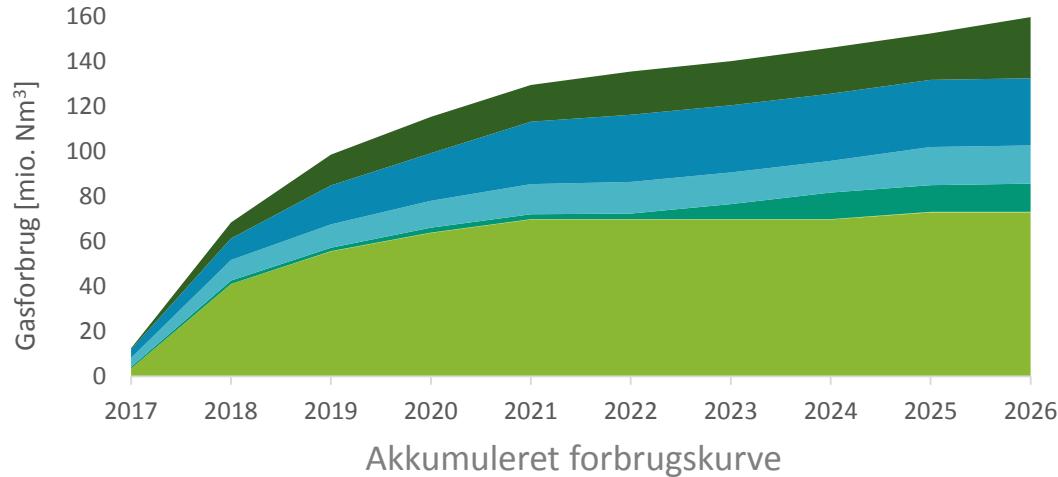
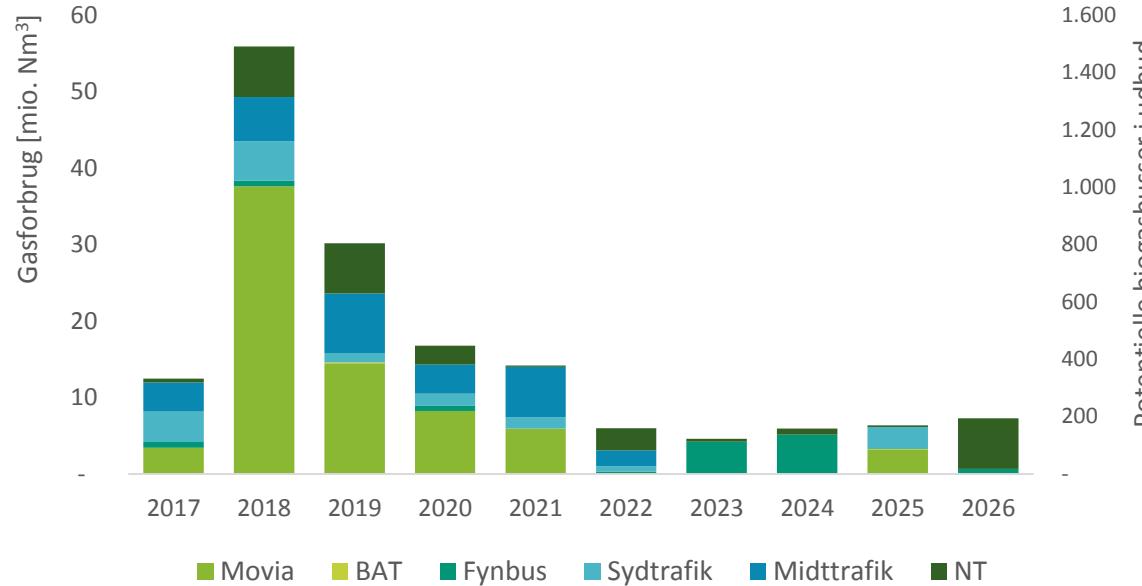
Knud Boesgaard
knud@fremsyn.net
+45 6171 8811



Potential for biogas in busses



Biogas potential in traffic companies' supplies



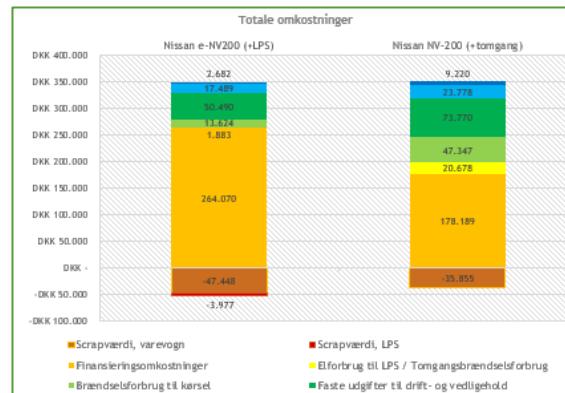
Project developing

- Development of consortias
- Applications
- Implementation and reporting



Fleet analysis

- Consumption Needs
- TCO (Total Cost of Ownership)
- Assisting and support of implementation

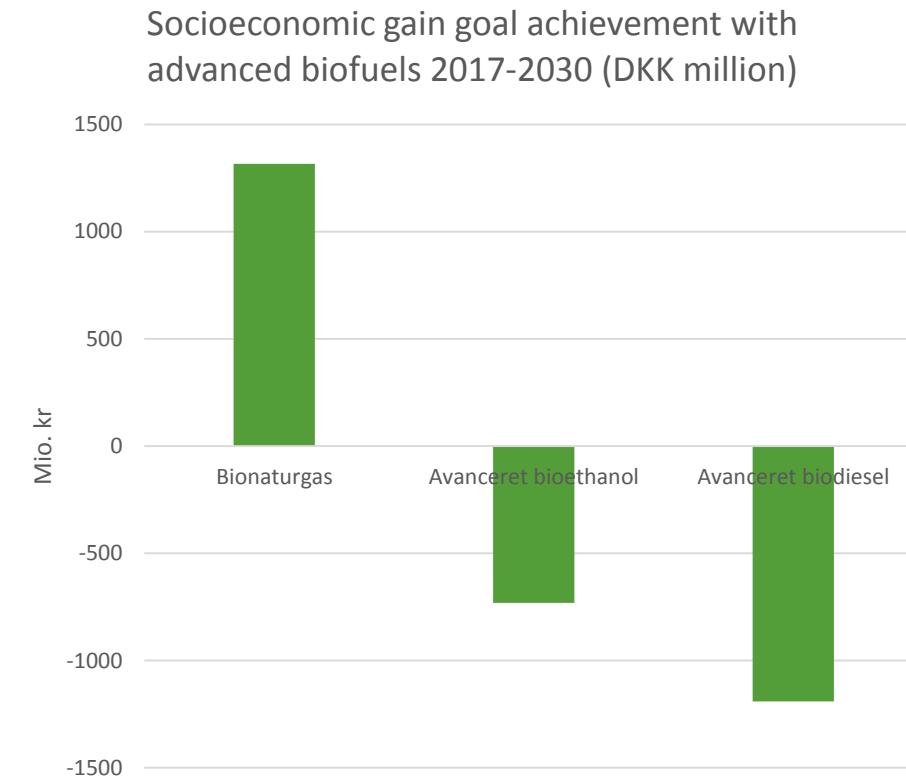
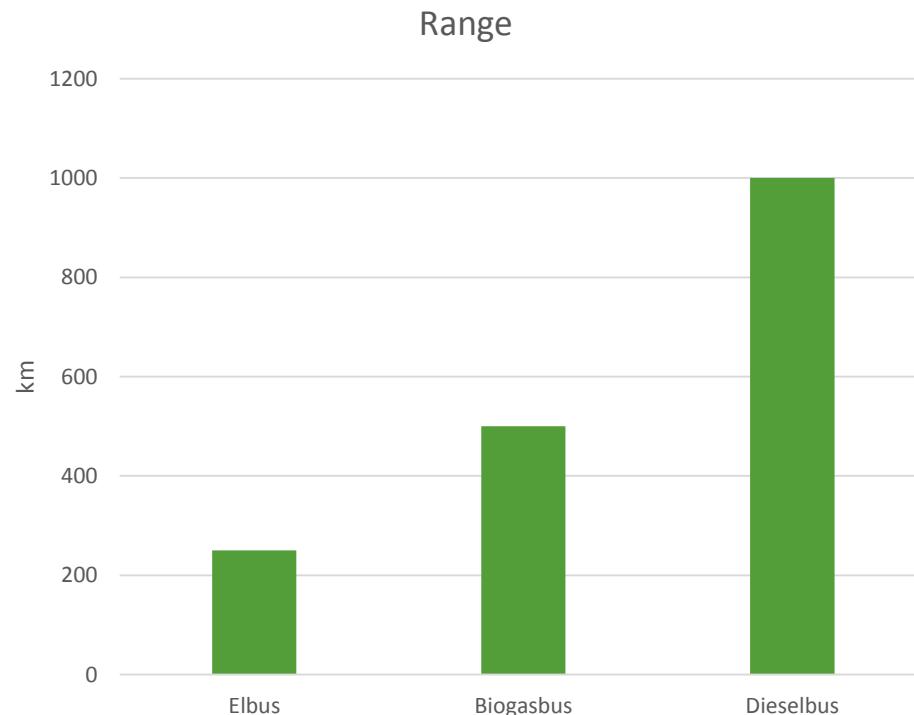


Environmental and climate analysis

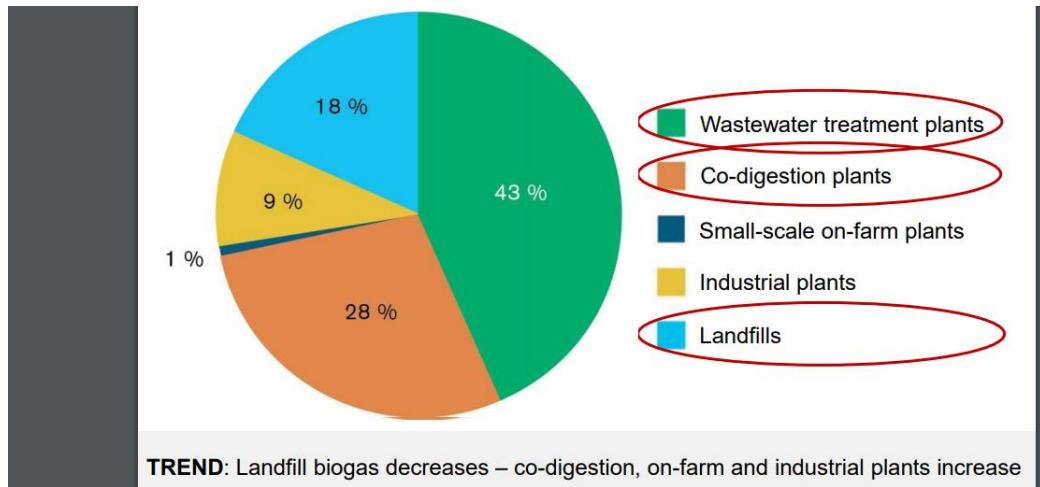
- Climate scenarios
- Emission inventories
- Socioeconomic calculations



Technoeconomic parameters



Biogas in Scandinavia



EBA has XX biogas plants

Finland:

<https://wiki.uef.fi/display/BIOMAP/Piia+Ikonen%2C+biogas+in+Finland>

<http://www.cbg100.net/news/finnish-biogas-statistics-2015/>

