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The potential of biogas in a 100% renewable energy system in Denmark

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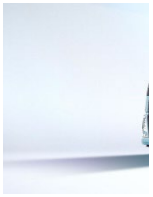
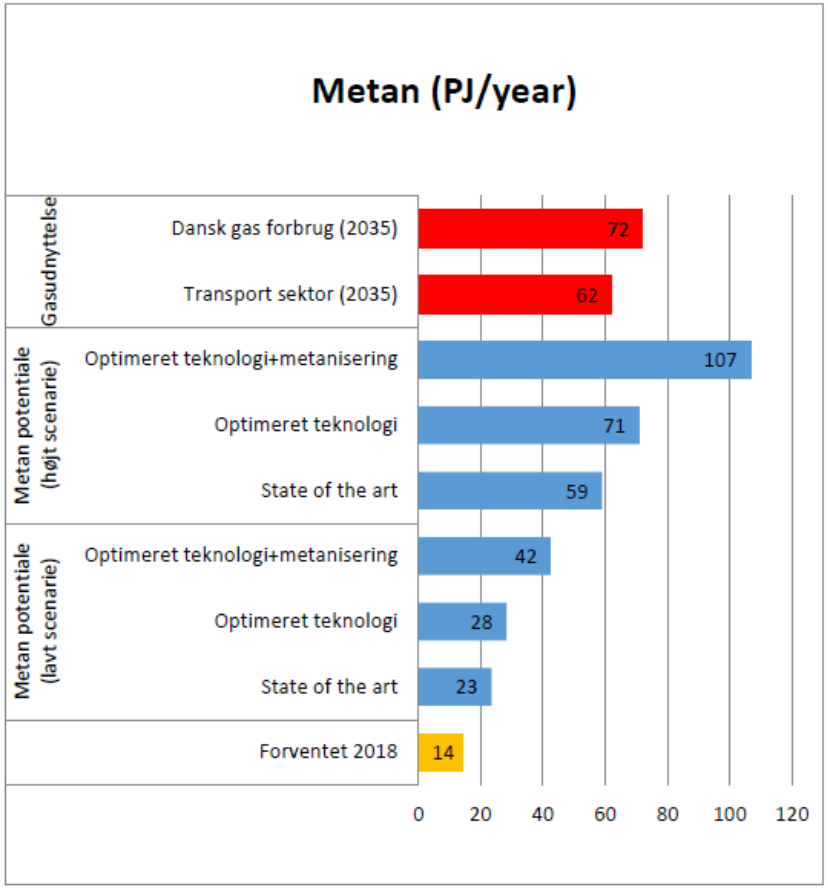
Applications for biogas

Power and district heat

Industry





Source: GASEnergi, Danish Gas Association, June 2018

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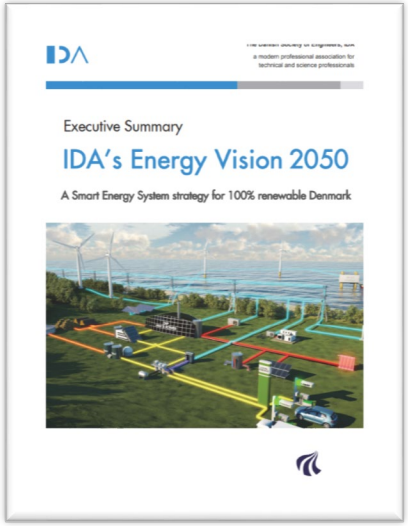
A reference model is set up for Denmark 2050

- 100% renewable
- No biogas
- Methane produced via biomass gasification and biomass hydrogenation
- Limited excess electricity
- Technical simulation
- Derived from IDA Energy Vision 2050
- EnergyPLAN use in the analysis



Energy PLAN
Advanced energy system analysis computer model

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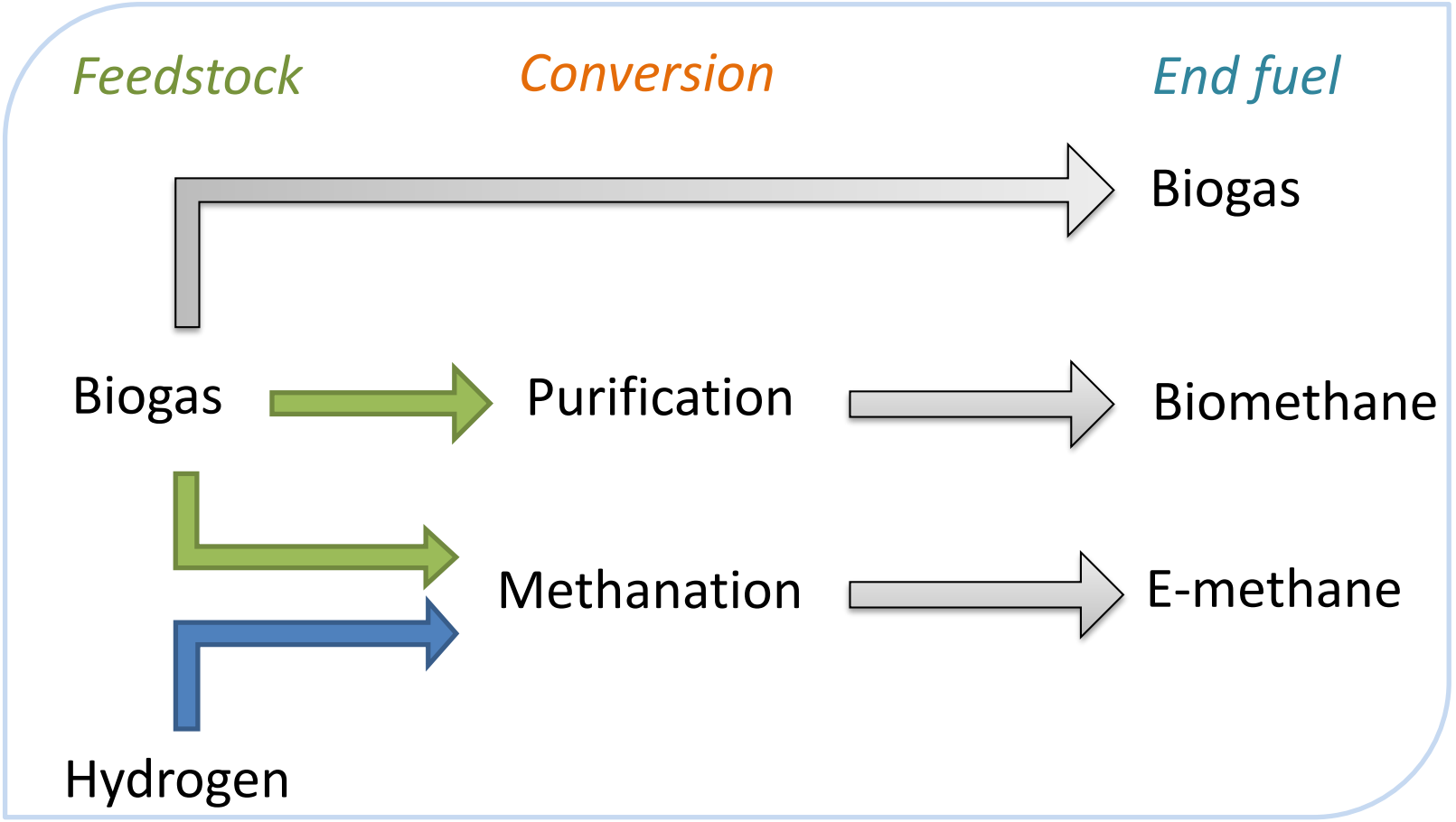
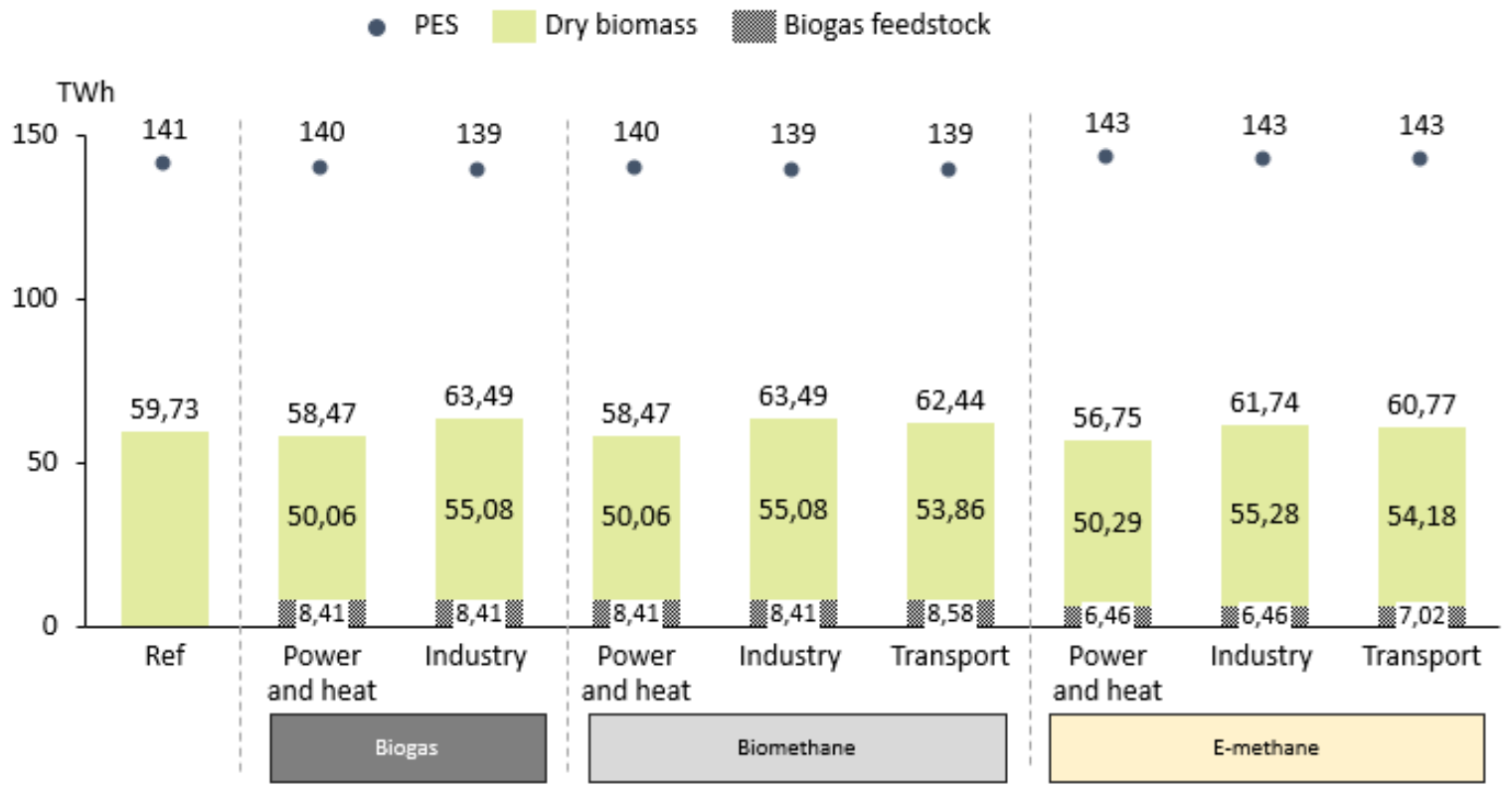
Biogas as a fuel and its derivatives



Biogas utilization scenarios

	Biogas	Biomethane	E-methane
Power plants	Replacing **methane** from **biomass gasification**		
Industry	Replacing **methane** from **biomass hydrogenation**		
Transport	x	Replacing **liquid fuel** from **biomass hydrogenation**	

PES and biomass consumption



Energy system costs

*Biomass price 6 €/GJ

Marginal system cost difference [M€]		Biogas		Biomethane			E-methane			
		Power plants	Industry	Power plants	Industry	Transport	Power plants	Industry	Transport	Low
Biogas feedstock prices [€/GJ]	0	-133	-174	-107	-147	-171	51	8	-20	
	4.5	3	-38	29	-12	-33	155	112	87	
	5.2	24	-16	50	10	-11	171	128	104	
	5.9	46	5	72	31	11	188	145	121	
Displacing		Gasified biomass	Gasified biomass + H_2	Gasified biomass	Gasified biomass + H_2	Liquid bio-electrofuels	Gasified biomass	Gasified biomass + H_2	Liquid bio-electrofuels	High

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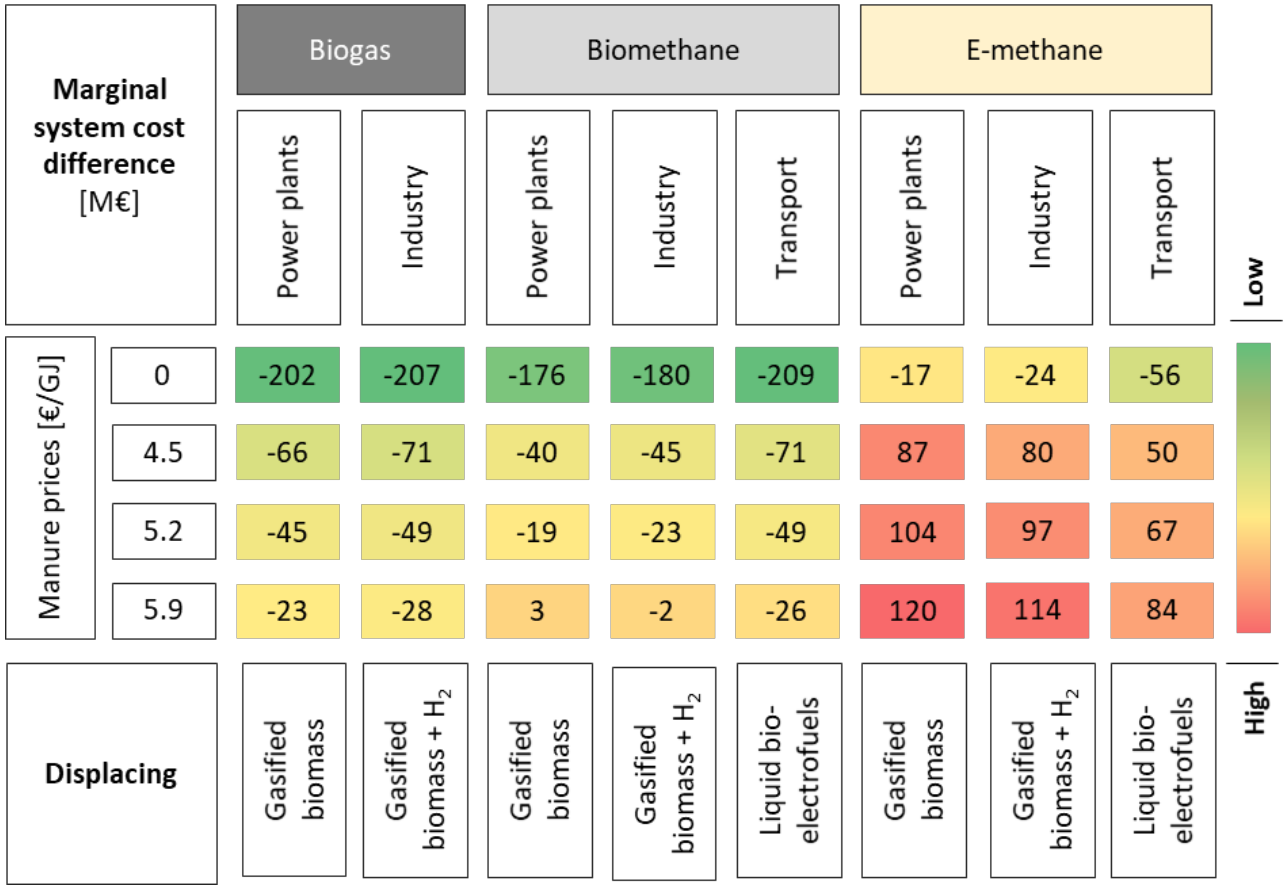
Energy system costs

*Biomass price 8 €/GJ



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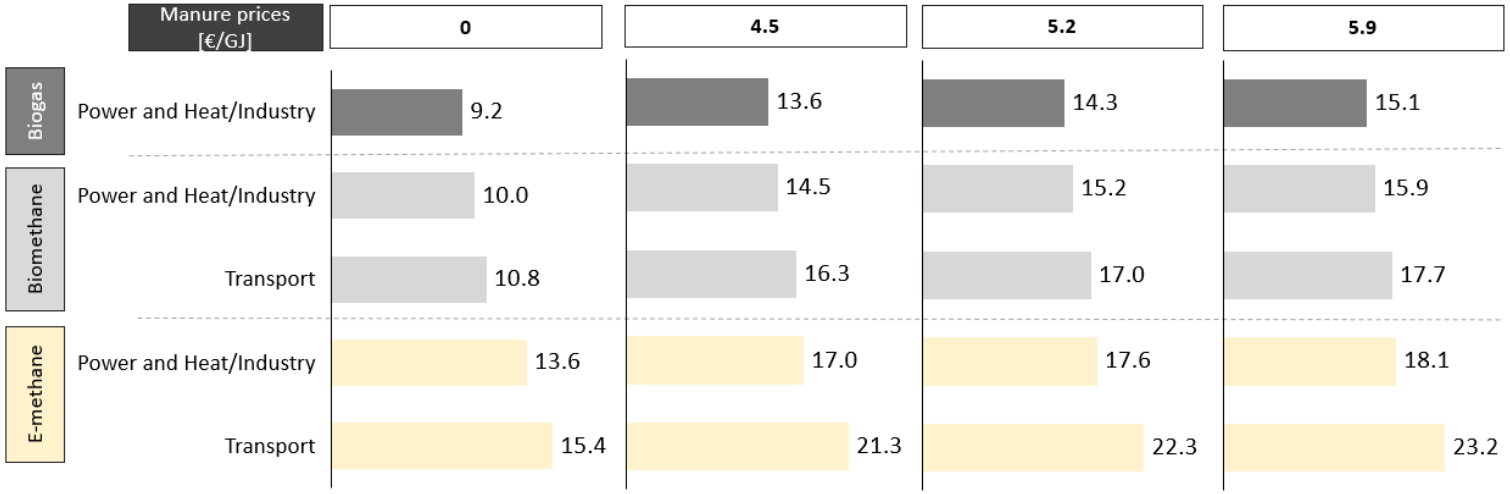
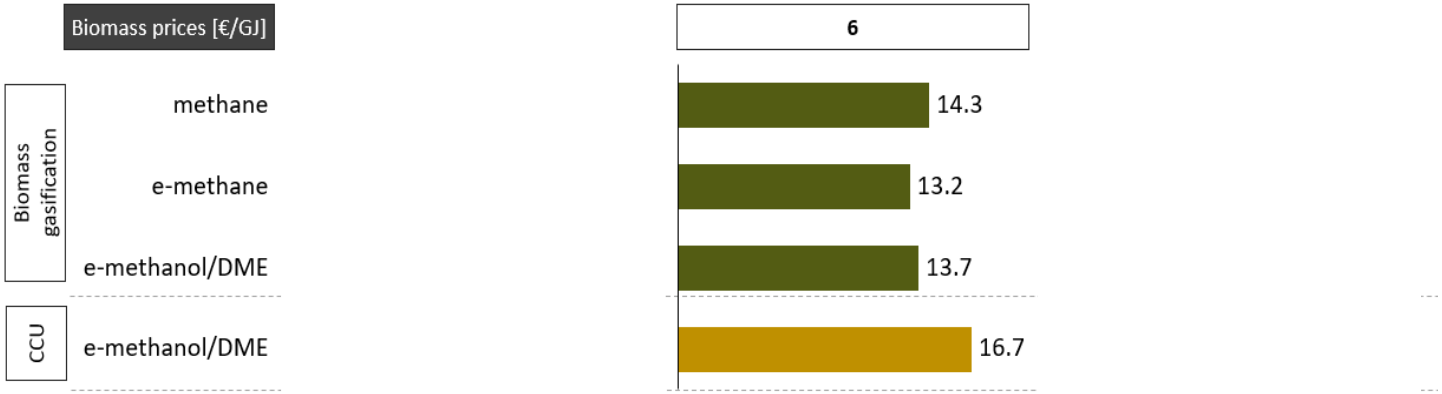
Gaseous fuel costs



Liquid fuel costs in reference



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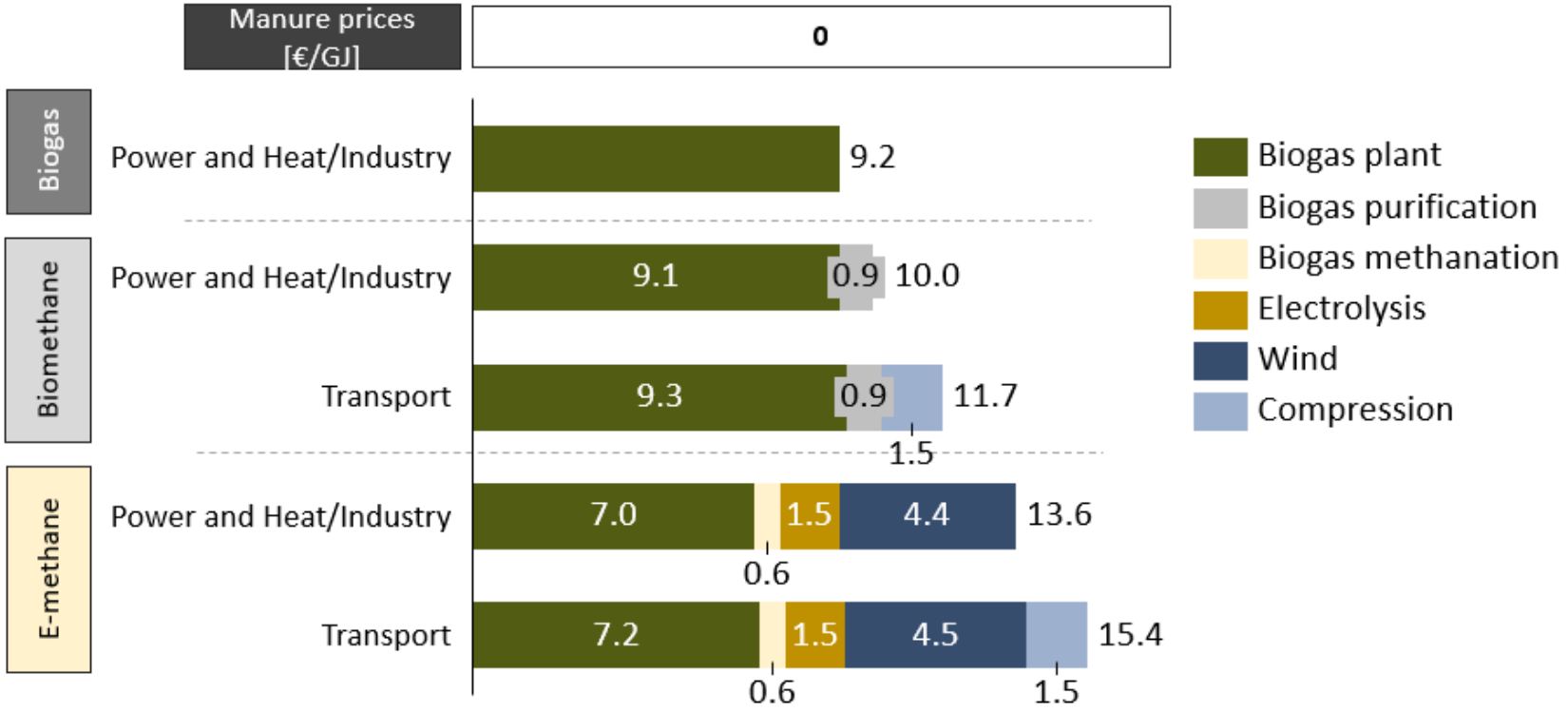
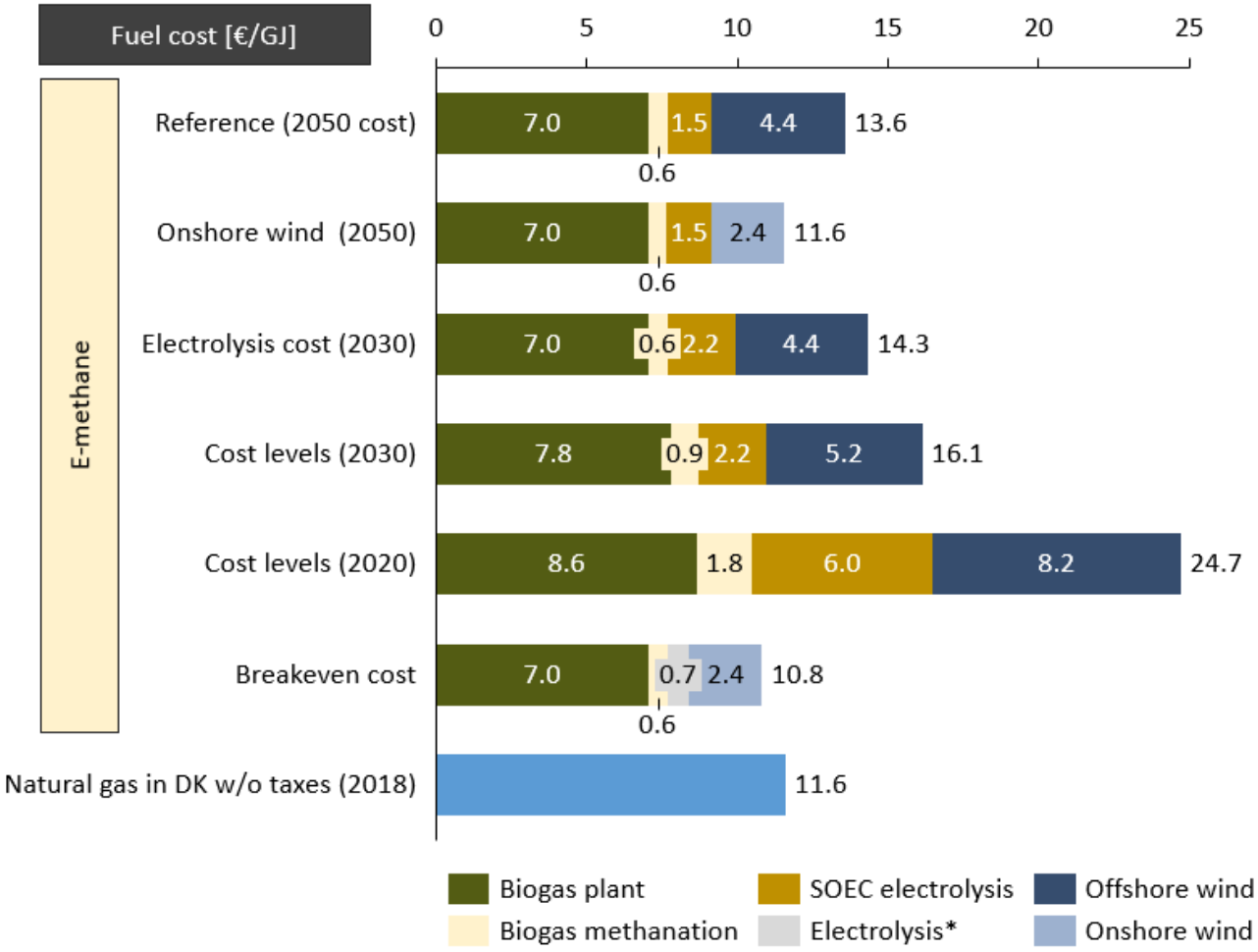
Cost breakdown



Cost development



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- If biogas
  - Power and heat/industry show high cost reductions
  - Power and heat/industry more appropriate if biogas is suitable
  - Fuel distribution could be an issue/imply a higher cost
- If biomethane
  - Versatility + low cost for all analyzed sectors
  - Transport seems the most suitable but high competition with electrification
  - More resilient to feedstock price changes
- If e-methane
  - Feasible in transport sector only
  - It competes with liquid fuels (cheaper) and electric vehicles

Conclusions

- More emphasis on gasification technologies
- Biogas as end-fuel is preferred independent of sector used and high biomass prices
- Biomethane should be used where biogas cannot (power and heat/industry)
- E-fuels have a role, but P2G does not present economic feasibility compared to alternatives.
- Biogas potential might suffer from change in dietary habits.

Thank you!

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