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Hydrogen from power-to-gas for use in refineries



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- LBST
- Regulatory
- Hydrogen in refineries
- Conclusions

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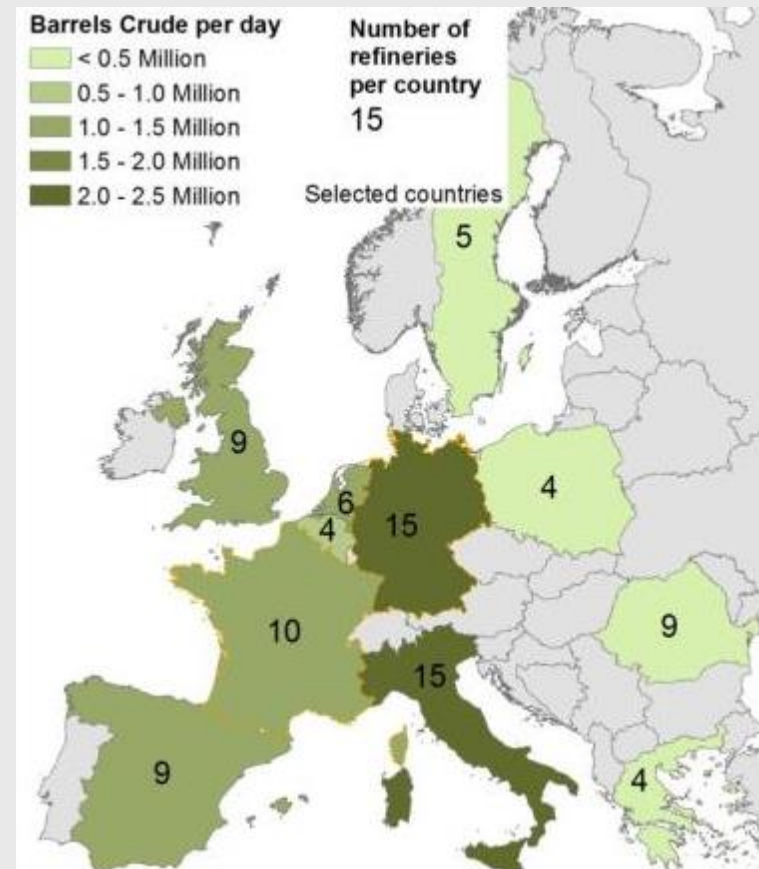


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Criteria	EU Fuel Quality Directive (FQD)	France Code de l'énergie	Germany BImSchG/V
Lifetime	2020	2020	2020
GHG targets	-2 % by 2015 -4 % by 2017 -6 % by 2020	-10 % by 2020	-3.5 % by 2015 -4 % by 2017 -6 % by 2020
Responsibility	Supplier	Energy tax responsible entity (usually the refinery)	Energy tax responsible entity (usually the refinery)
Options			
upstream:	Flaring/venting	Flaring/venting	–
refinery:	–	Refinery GHG emissions reduction	–
downstream:	Biofuels and alternative fuels from non-biological sources	Biofuels, electricity	Biofuels
Hydrogen	H ₂ eligible as transportation fuel (2015/652/EU, ANNEX I), <u>not</u> for use in refineries yet	H ₂ <u>not</u> yet eligible as transportation fuel. Reduction of refinery emissions through use of low carbon hydrogen is eligible	H ₂ <u>not</u> yet eligible; 'further renewable fuels' (e.g. PtG) and 'other measures' are subject to enforcement of a legal ordinance (§37d (2), point 13)
Infringement penalty	Subject to national implementation, which shall be 'effective, proportionate and dissuasive'	Not yet defined (application decrees to be published in 2017)	470 €/t CO _{2ea}

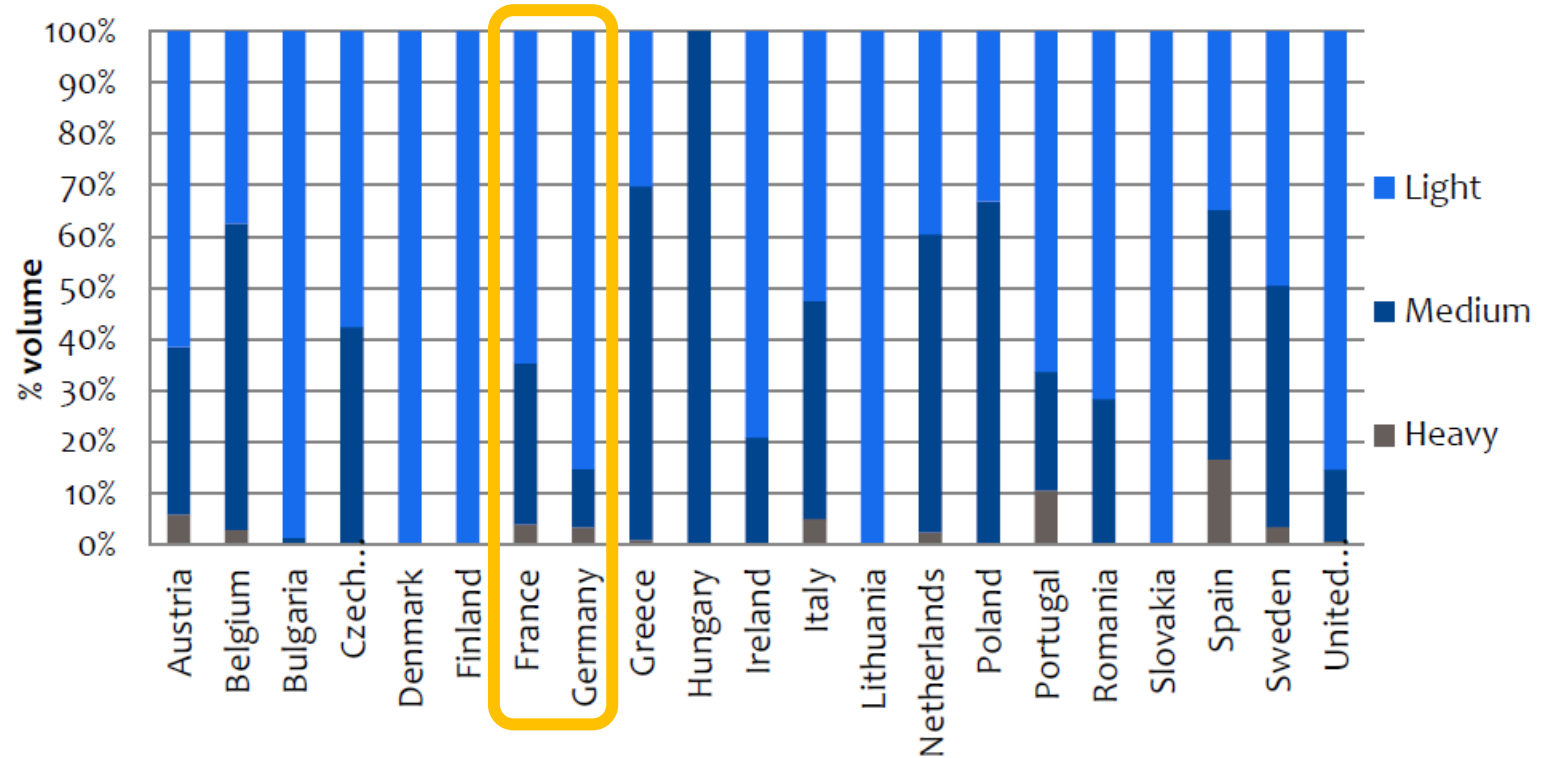
Major refinery locations in Europe:

1. Germany
2. Italy
3. UK
4. France
5. Spain
6. The Netherlands
7. ...

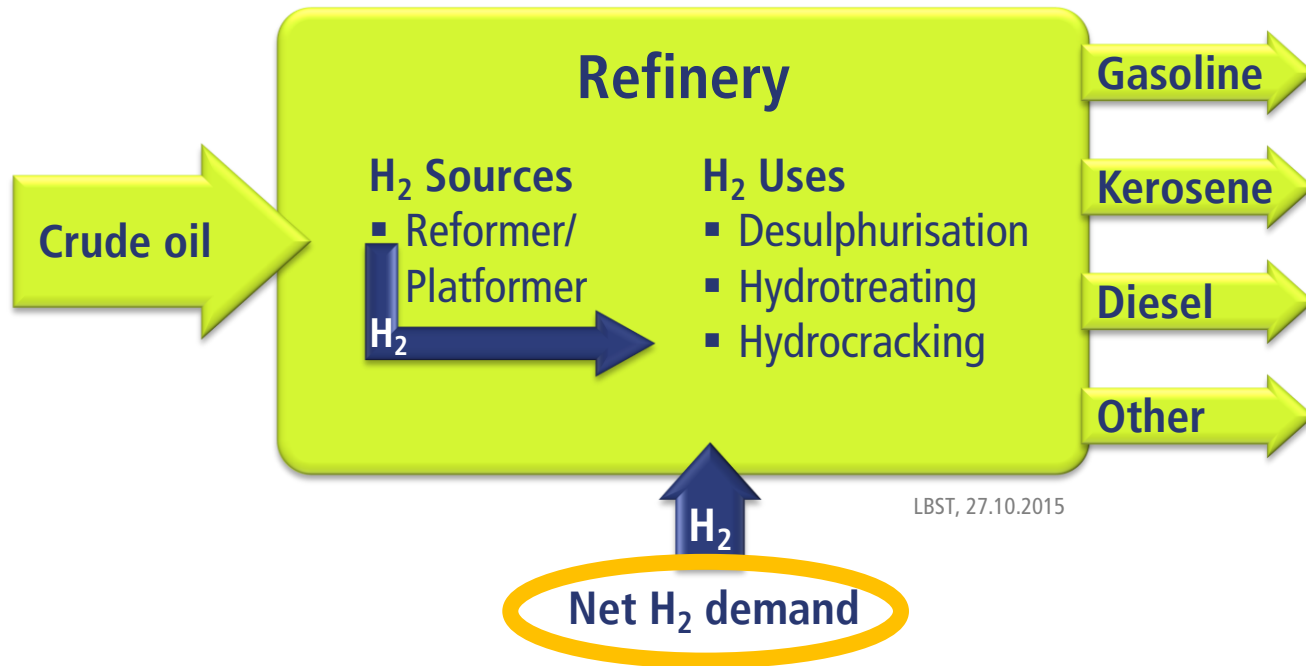


Source: LBST with data [E3M et al. 2015]

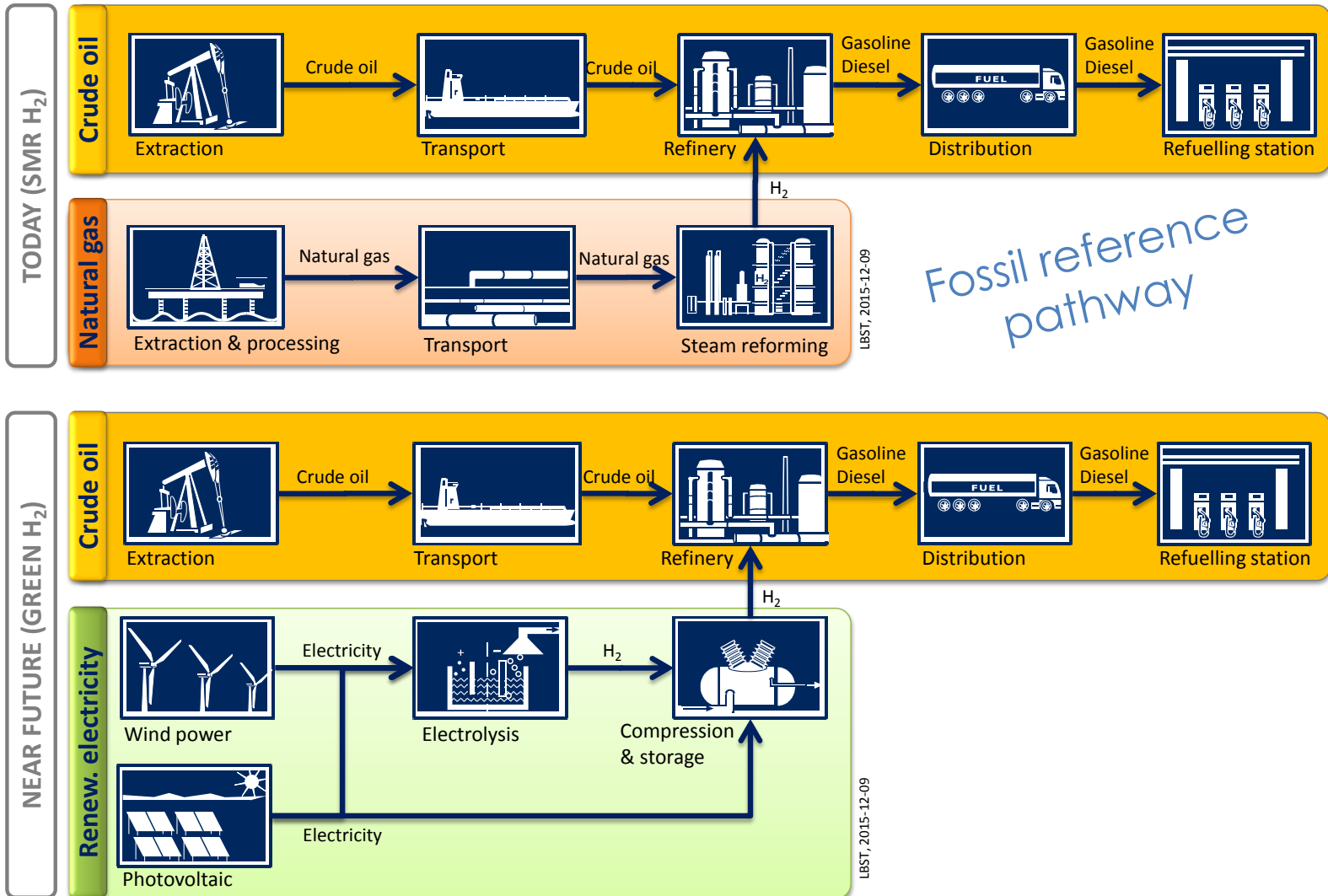
Crude oil qualities in European refineries



- There is a trade-off between crude oil cost and quality
- In Europe, a wide range of crude oil qualities is processed
- French and German refiners source rather better qualities
- Average crude oil quality [EXERGIA et al. 2015]:
 - France: 36.0 API gravity, 0.7 wt.-% sulphur
 - Germany: 37.3 API gravity, 0.5 wt.-% sulphur



- Calculation: Net hydrogen demand = process sources – process uses
- Desulphurisation is a sensitive parameter to net hydrogen demand
- By tendency,
 - crude oil quality is further deteriorating → increasing sulphur content
 - demand for heavy fuel fractions is decreasing → maritime emission areas

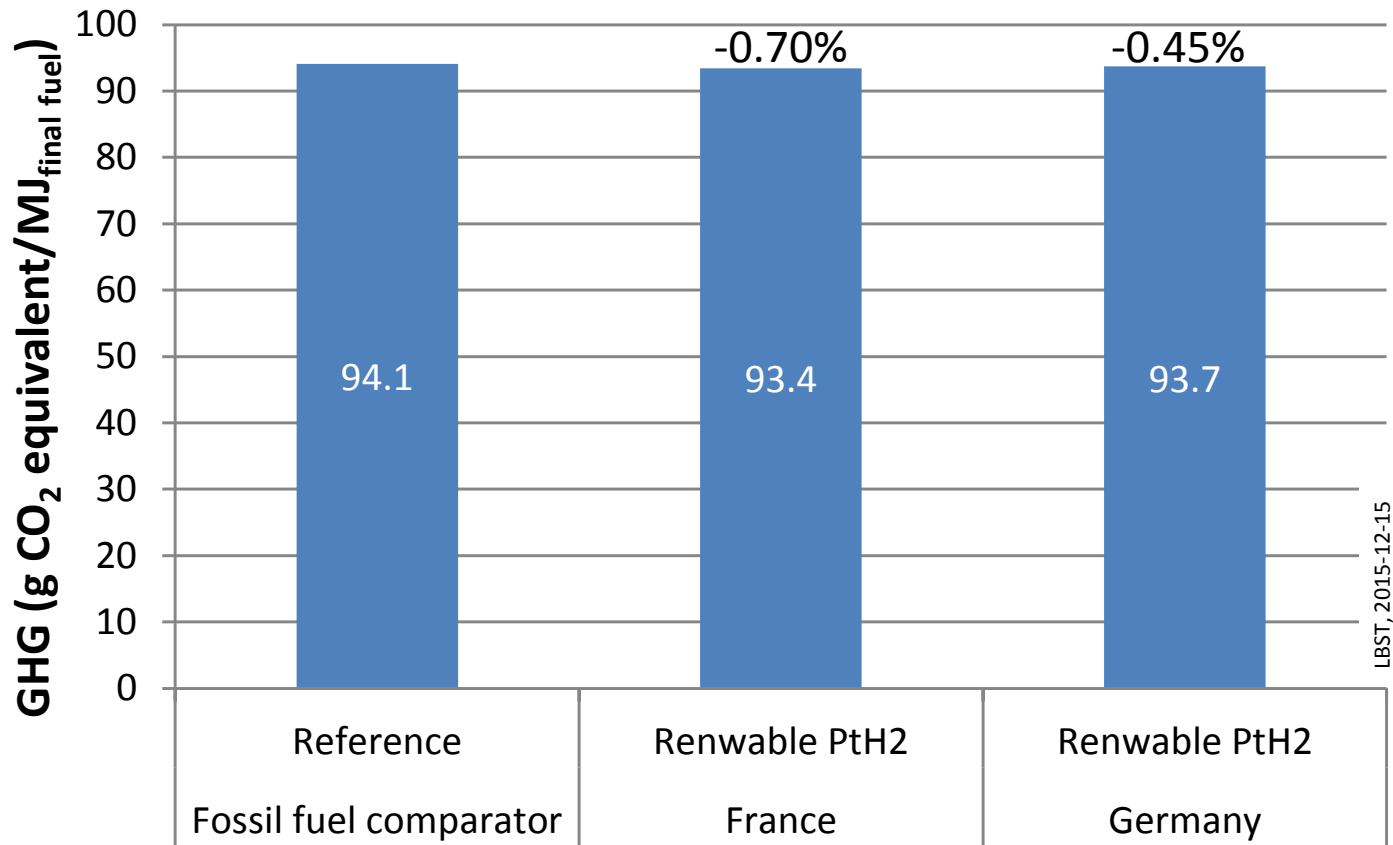




Scenario

Refinery net H₂ demand supplied from 100% green H₂

Greenhouse gas emissions 'well-to-tank' France and Germany [g CO_{2eq}/MJ_{final fuel}]



- FQD minimum target is -6% GHG emissions by 2020

	France	Germany
GHG mitigation of refinery emissions	1.33 Mt CO _{2eq} /a	1.50 Mt CO _{2eq} /a
	14.1 %	7.2 %
	331 €/t CO _{2eq}	339 €/t CO _{2eq}

→ Economic option for German refineries against 470 €/t CO_{2eq}

To give an impression about the quantities, this is equivalent to annual GHG emission of C segment cars in the order of

Gasoline car @ 7.0l/100km	575,000	648,000
Diesel car @ 5.5l/100km	658,000	740,000

→ Tangible action for refinery corporate social responsibility (CSR)

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- Green H₂ in refineries is an attractive GHG mitigation option
 - Introduction of green H₂ in an established bulk H₂ application
 - Volume production of H₂ reduces electrolyser costs
 - Electrolysers 'valley of death' is bridged by all fuel users
- Deployment of power-to-hydrogen for refineries is a strategic move entailing long-term benefits for all hydrogen uses.

- Establish regulatory grounds for accountability at EU level
 - Open FQD for greenhouse gas mitigation options in refineries
 - Sustainability criteria and certification for renewable/green hydrogen
- Fast-track implementation rather at national level, e.g.
 - In Germany through legal ordinance BImSchG § 37d (2)
 - In France through ordinances currently under development
 - Other EU Member States?
- Avoid regulatory pitfalls, like
 - Carbon leakage: RES-E deployment targets to reflect increasing demand
 - Double counting/residual mix between companies, sectors, geographies
 - Interventions 'behind-the-fence': Fees/taxes on RES-E own generation & consumption raises the bar for early markets

Vanhoudt, W., Barth, F. (Hinicio), Schmidt, P., Weindorf, W. (LBST), et al.: Power-to-gas – Short term and long term opportunities to leverage synergies between the electricity and transport sectors through power-to-hydrogen; Brussels/Munich, 19 February 2016

- Application A: Hydrogen from power-to-gas for use in refineries
- Application B: Semi-centralised power-to-hydrogen business cases

→ Download

http://www.fondation-tuck.fr/jcms/r_16975/fr/hinicio-sa





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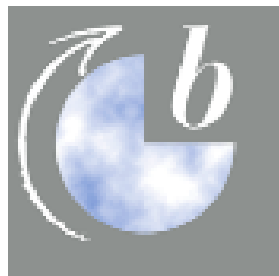
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ANNEX

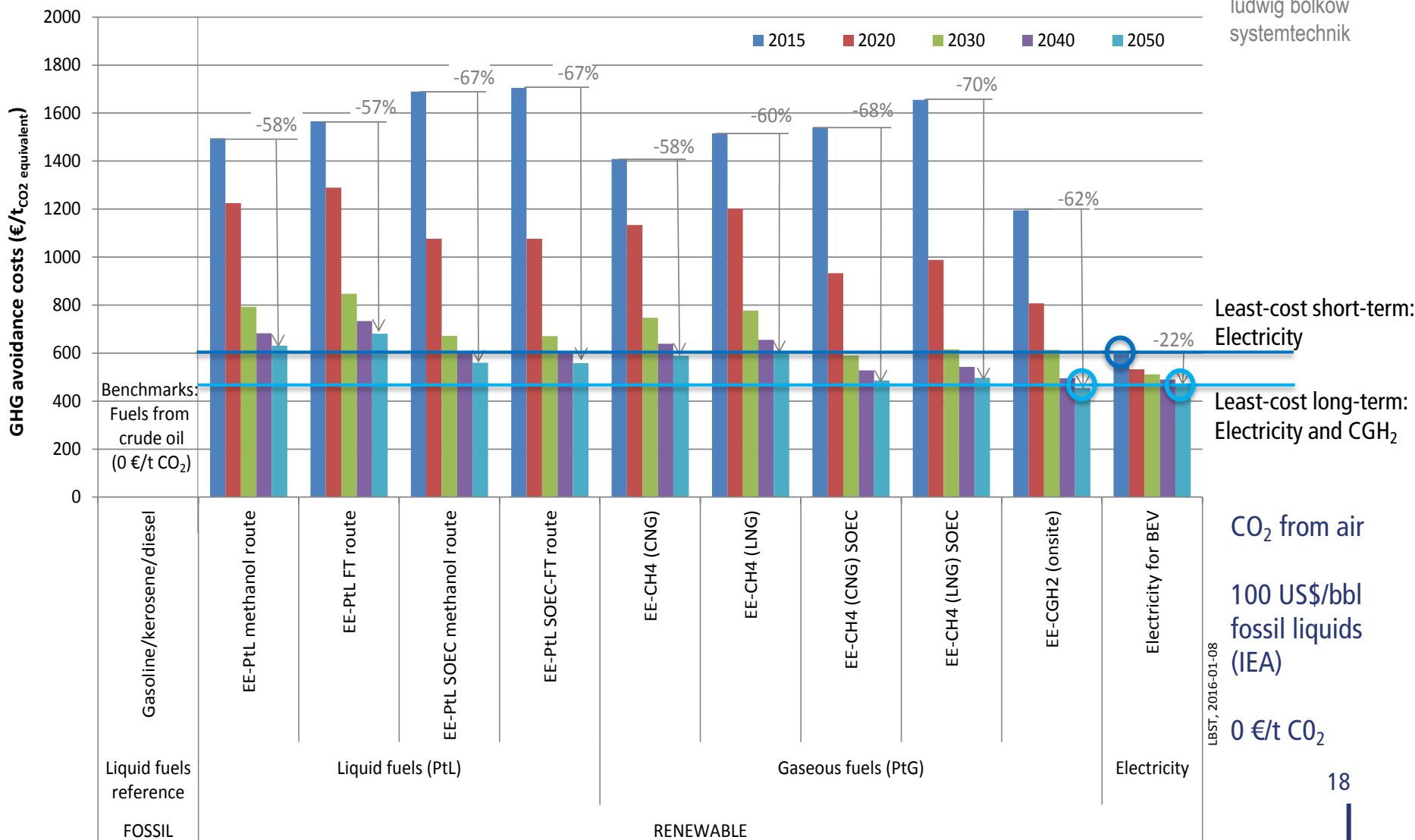


L B S T

CO₂ avoidance costs well-to-tank [€/t CO_{2eq}] for PtX in EU



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systemtechnik



16 March 2016