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Advances in power-to-liquids for aviation

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Content



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Profile

2. Technology / projects
3. Sustainability / regulatory
4. Conclusions

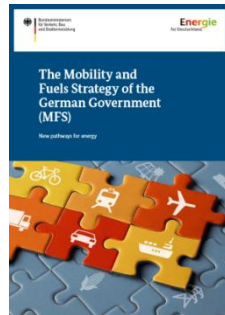
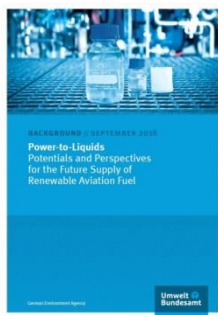
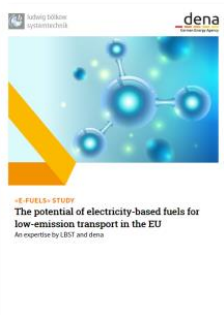


Profile

- Independent expert for sustainable energy and mobility for over 30 years
- Bridging technology, markets, and policy
- Renewable energies, fuels, infrastructure
- Technology-based strategy consulting, System and technology studies, Sustainability assessment
- Global and long term perspective
- Rigorous system approach – thinking outside the box
- Serving international clients in industry, finance, politics, and NGOs

References

- UBA – *Power-to-Liquids for Aviation*
- BMVI – *Aviation Competition*
- BMVI – *Integrated Energy Concept 2050*
- BMVI – *Mobility & Fuels Strategy*
- VDA – *E-Fuels Study*
- EC – *CertifHy – EU-wide green H₂ guarantee of origin scheme*



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Recent projects and technologies



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- Green Power 2 Jet (DE)
 - DOW/Stade, BP/Lingen, Airbus, et al.
 - Fischer-Tropsch
- KEROSyn100 (DE)
 - Raffinerie Heide, Lufthansa, et al.
 - Methanolroute
- Delfzijl DSL-01 (Groningen, NL)
 - KLM, SHV Energy, SkyNRG, et al.
 - Wastes/residues + hydrotreating with power-to-hydrogen (40 MW)
- E-Fuel 1 (Herøya, NO)
 - Nordic Blue Crude, Sunfire, Climeworks, et al.
 - 20 MW co-SOEL + Fischer-Tropsch

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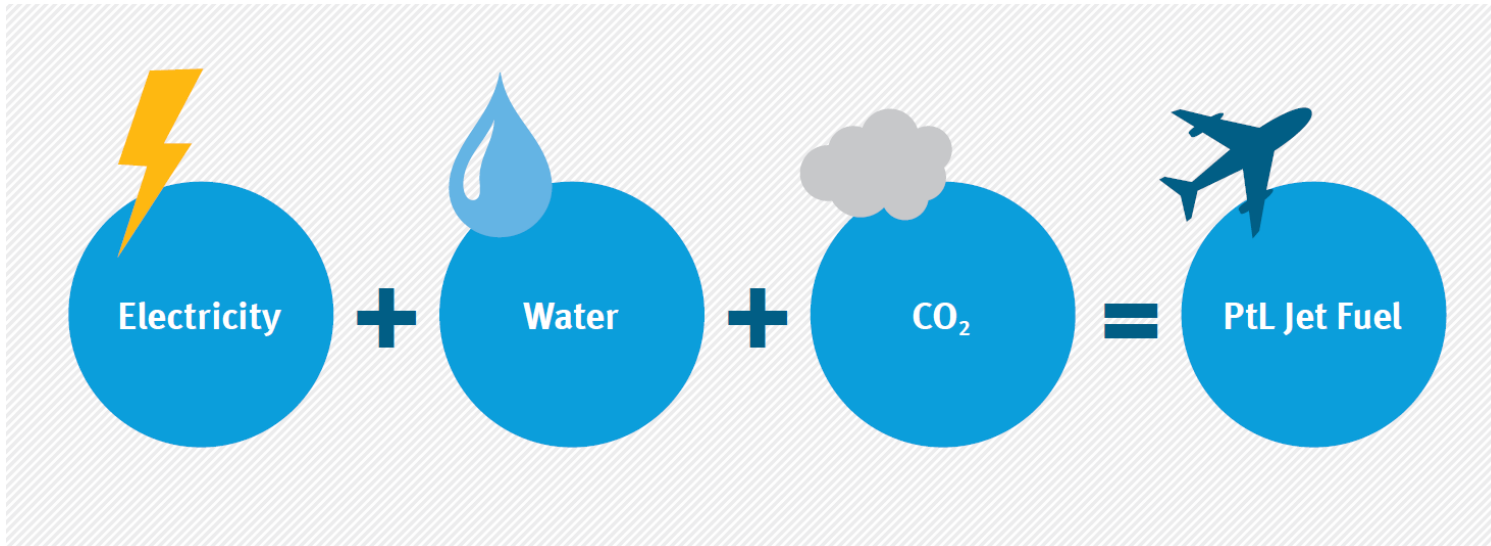
Sustainability / regulatory

4. Conclusions

Sustainability determinants of PtL



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Project-attributable

⇒ Electricity

⇒ CO₂

⇒ Water

Regional (social) politics

⇒ Land

⇒ Socio-economics

■ Renewability

- Energy source is subject to regional availability
- Most abundant at global scale: **wind, solar**

■ Additionality

- Additional renewable power plants for new electricity consumers
- Point taken, but how can this be granted anyway?
 - PtX ventures embedded in regional energy roadmaps
 - Power purchase agreement (PPA), Guarantees of Origin (GO)
 - Use of electricity that would otherwise not be used (grid congestion, lack of demand, remote potentials)
 - Grid connection ⇔ direct connection / off-grid

■ Suitability

- Provision of electricity system services (control power, voltage support, black-start support)

The level of ambition with regards to PtL sustainability criteria is a triangle of tension between

- production costs
- environmental performance
- social acceptance (reputational risk)

Current regulatory developments

- ICAO CORSIA (CO₂ compensation): risks falling too short in ambition
- RED II (EU Renewable Energy Directive 2020+): details are under development
- Clean Sky & Fuel Cell and Hydrogen Joint Undertaking: mapping of research and innovation needs in the field of hydrogen (electric) aircraft propulsion

RED II on electricity eligible for e-fuels production



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- RED II as per 12/2018 stipulates renewable electricity requirements
- Details to be laid out in RED II delegated acts (to be developed in the course of 2020)
- Sustainable aviation fuels embrace 1.2 multiplier

Electricity supply cases

- 1) Grid mix
- 2) Direct connection
- 3) 100% RES-E from grid

RED II requirements

- a) Renewable electricity
- b) No double counting
- c) Temporal & geographical correlation
- d) Additionality

	1	2	3
a	Methodology option 1, 2, ..., n	...	...
b	...	...	...
c	...	...	...
d	...	...	...

- Observers: DG ENER, DG MOVE, DG CLIMA



- Participants, e.g.
 - Hydrogenics, ITM, ...
 - Air Liquide, Air Products, Engie, Linde, ...
 - Shell, OMV, Q8, ...
 - EDF, Enertrag, Statkraft, Uniper, Verbund, ...
 - Hydrogen Europe, Wind Europe, ...
 - AGCS, AIB, GERG, i-REG, VREG, ...

⇒ www.CertifHy.eu

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Conclusions

Carry-on conclusions (1/2)



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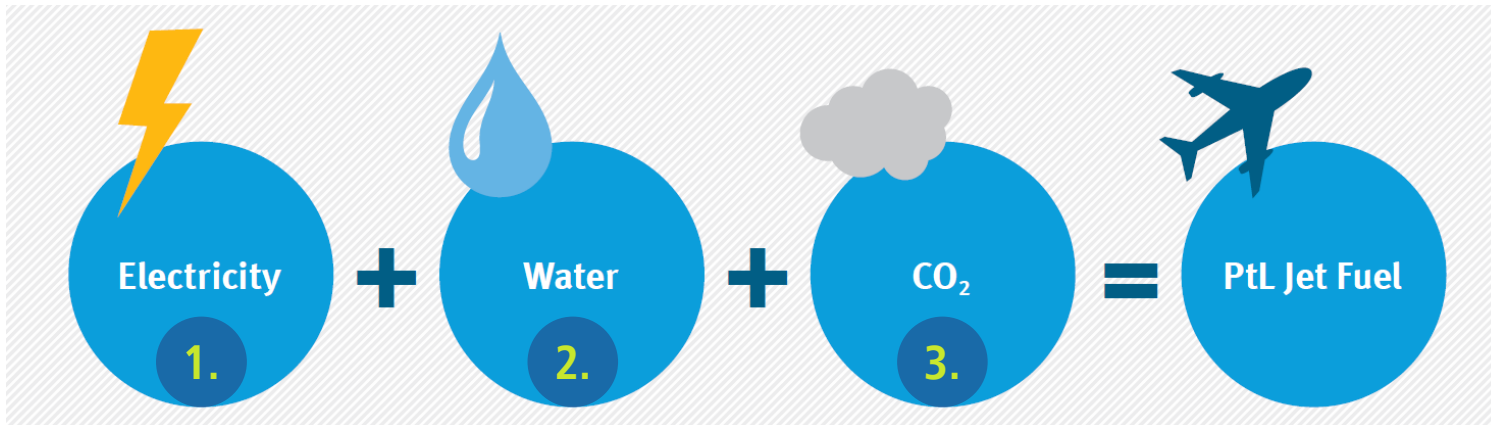
- Key technology components for PtL production are there.
 - First MW-scale projects have been announced.
 - Initially very high production costs, albeit for a small fuel share.
 - Costs decrease with increasing capacities deployed.
 - Production ventures require long-term off-take contracts for bankability.
- ⇒ Tangible regulatory/support framework needed

Carry-on conclusions (2/2)



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3 key environmental safeguards for PtL:



1. Additional renewable power plants (to avoid sector carbon leakage)
2. Sea water desalination (in regions prone to water supply stress)
3. Renewable CO₂ sources (to avoid lock-in risk with fossils)

⇒ Regulatory may allow for a host of options ⇒ Business case analysis!

Questions?



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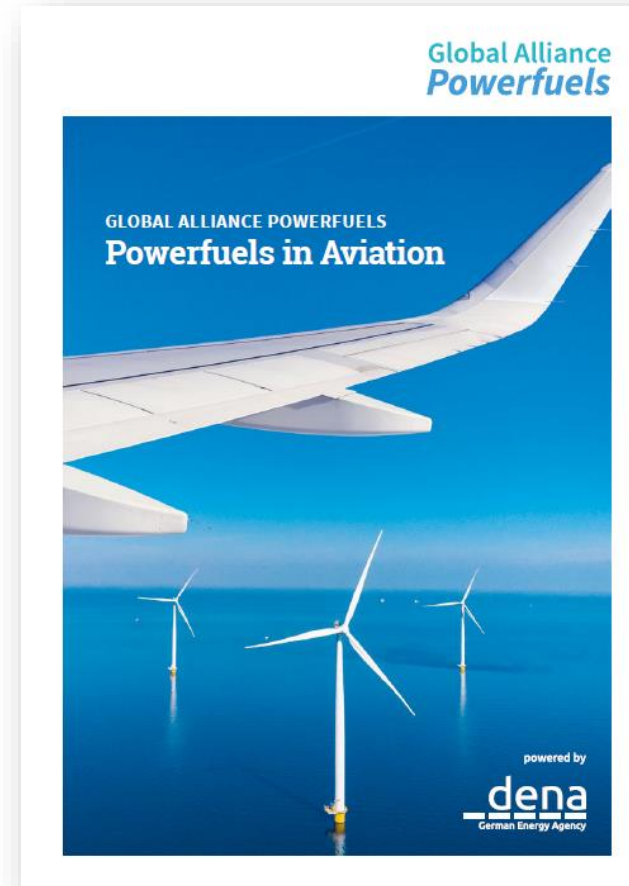
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Recommended reading



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Global Alliance Powerfuels
Powerfuels in Aviation
dena (ed.), Berlin, September 2019



=> https://www.dena.de/fileadmin/dena/Publikationen/PDFs/2019/Powerfuels_in_Aviation_GAP.pdf

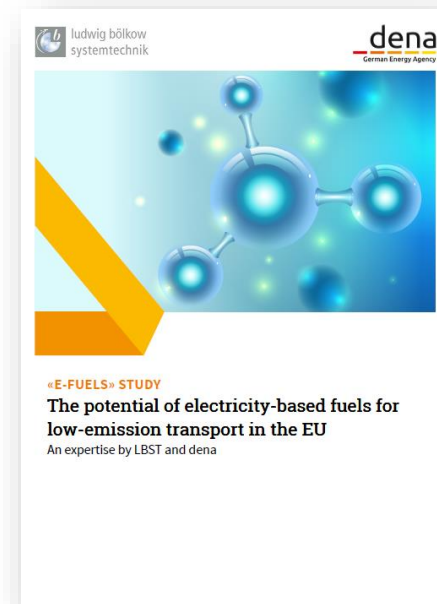
P. Schmidt, W. Weindorf, W. Zittel, T. Raksha, J. Zerhusen (LBST),
S. Siegemund, M. Trommler, O. Kolb, V. Zinnecker (dena)

«E-Fuels» Study – The potential of electricity-based fuels for low emission transport in the EU

Commissioned by Verband der Automobilindustrie e.V. (VDA), November 2017

- Transport energy scenarios comprising renewable electricity, BtX and PtX fuels
- Energy efforts, fuel demand, renewable power needs
- Fuel costs, cumulated investments
- Cost sensitivity analysis: PtCH₄ and PtL imports

=> http://www.lbst.de/ressources/docs2017/E-Fuels%20Study_VDA_11-17.pdf



Study | Power-to-Liquids for Aviation



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- Commissioned by German Environment Agency (UBA)
- Joint expertise of LBST and Bauhaus Luftfahrt e.V.
- Topics:
 - Technology readiness and development potentials
 - Techno-economics
 - Environmental performance (efficiency, greenhouse gases, land and water demand)
- Publications: flyer, background paper, presentation
- Link:
 - <http://bit.ly/2cowOyf>
 - <https://www.umweltbundesamt.de/en/publikationen/power-to-liquids-potentials-perspectives-for-the>
- Recommended citation:
Schmidt, P.; Weindorf, W. (Ludwig-Bölkow-Systemtechnik GmbH – LBST); Roth, A.; Batteiger, V.; Riegel, F. (Bauhaus Luftfahrt e.V.): Power-to-Liquids – Potentials and Perspectives for the Future Supply of Renewable Aviation Fuel; German Environment Agency (ed.), Background // September 2016, ISSN: 2363-829X

