TECHNISCHE UNIVERSITÄT WIEN

Valorizing flexible bioenergy

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Parallelsession 4D: Flexibilität

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Variable renewable electricity (VRE) production

IEA's "Six phases of system integration"

- Phase 1: No relevant impact on system integration
- Phase 2: Drawing on existing system flexibility
- Phase 3: Investing in flexibility
- Phase 4: Requiring adv. technologies to ensure reliability
- Phase 5: VRE surplus from days to weeks
- Phase 6: Seasonal or inter-annual surpluses of VRE

Source: https://www.iea.org/topics/system-integration-of-renewables

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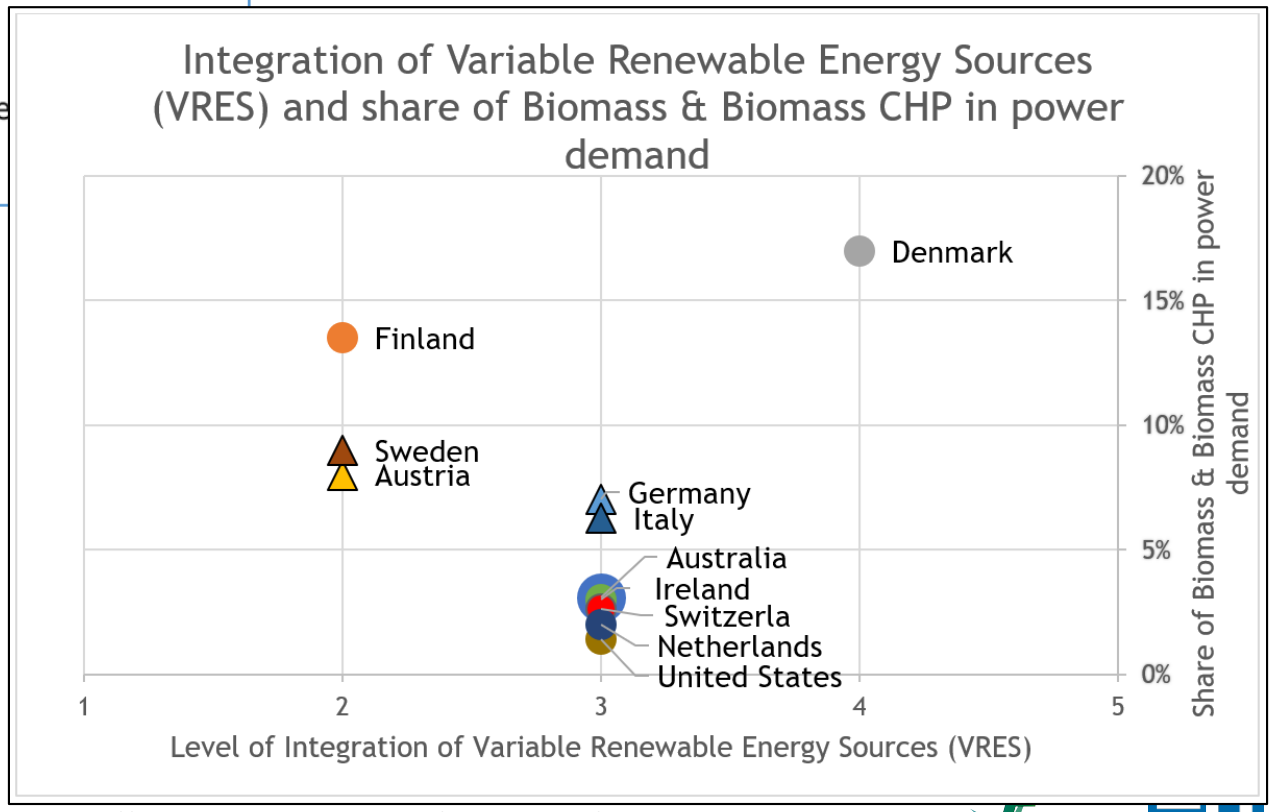
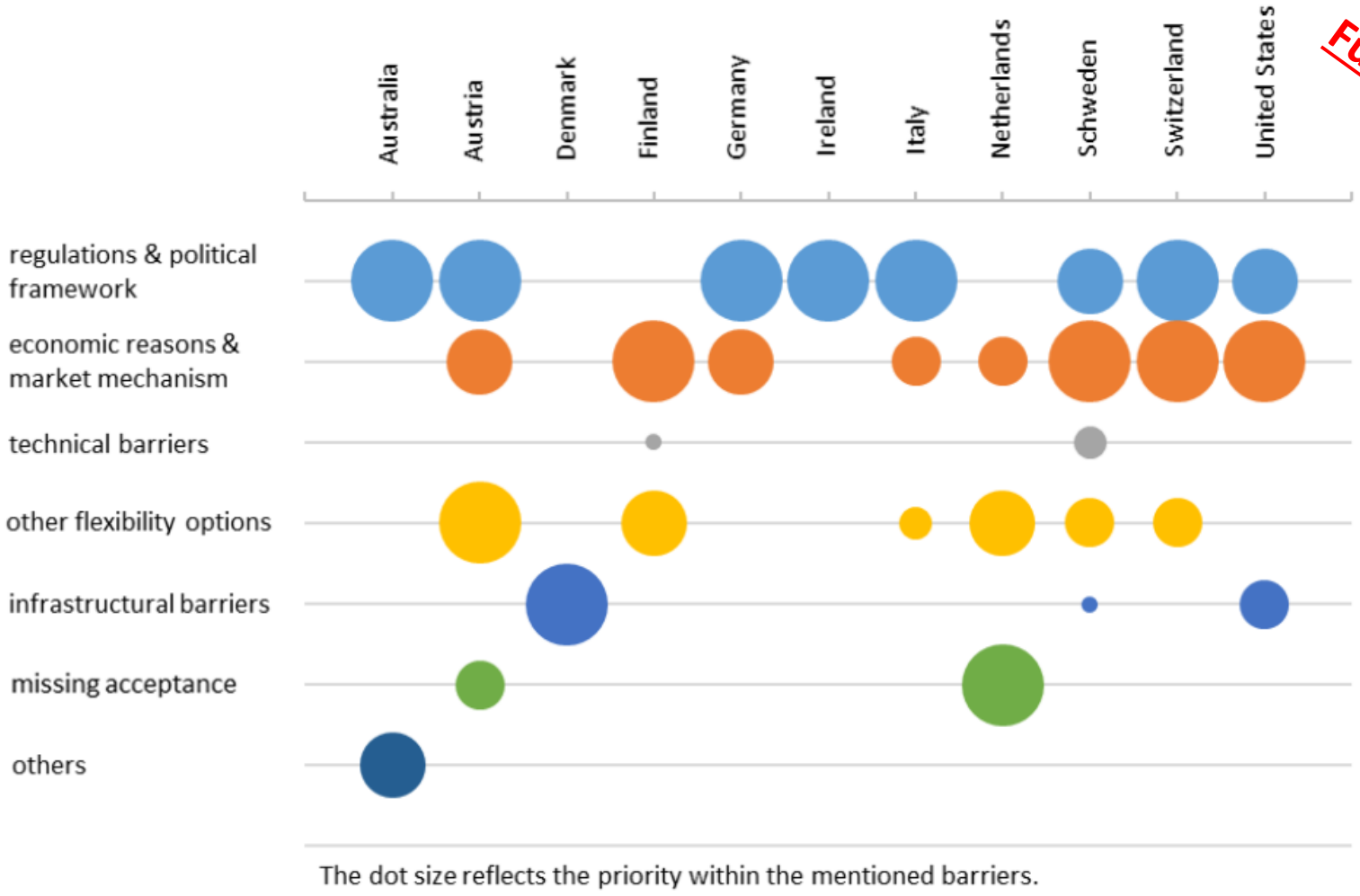


Source: https://task44.ieabioenergy.com/publications/bioenergexpectation-and-implementation-of-flexible-y-in-different-countries-2021/

Weighted barriers for the implementation of flexible bioenergy (country-specific)



Full report here

Country-specific presentation of the categorised barriers.
The larger the coloured circle, the more relevant the barrier is. The different colours represent the barrier categories
Source: Thrän et al. 2021.
https://task44.ieabioenergy.com/wp-content/uploads/sites/12/2021/04/IEA-Task-44-report-Expectation-and-implementation-of-flexible-bioenergy-in-different-countries.pdf

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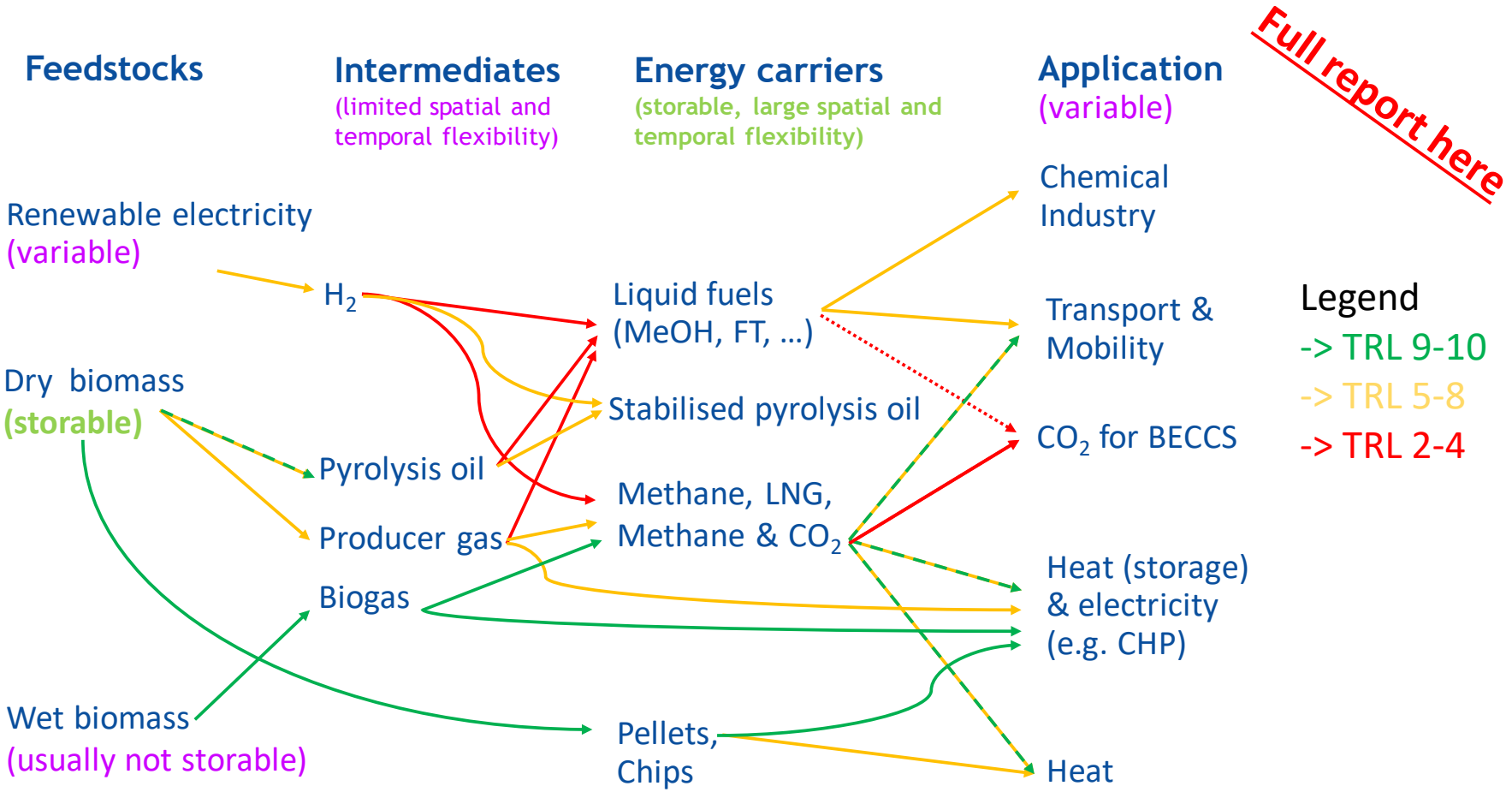
Bioenergy provides flexibility throughout supply chains



TRLs are estimated on the case studies and installations as well as R&D needs, experiences and expectations and business cases collected for the report.

https://task44.ieabioenergy.com/publications/technologies-for-flexible-bioenergy-2021/

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Hypothesis and research question

1. We will need all available sustainable flexibility options **to enable further integration of VREs**.

2. Technology options exist, with partly **high TRLs** but only in niche applications.

3. Regulatory and economic barriers are high for flexible bioenergy options

4. → understanding of potential **benefits** of flexible bioenergy must be low.

5. What are the potential benefits of flexible bioenergy and **how can they be valorized**?

Some selected parameters & metrics:

Power grid
Ramp-rate capacity
Provision capacity (power & energy)
Ramp duration
Functions to describe frequency constraints
--> for positive & negative power services

+ Economic parameters (cost, prices, supply & demand potentials), environmental and socio-economic parameters

Some selected parameters & metrics:

Feedstock →	Intermediary →	Power grid and/or	other services
Biomass supply chain !!		Ramp-rate capacity	**Bioeconomy**
		Provision capacity (power & energy)	
		Ramp duration	
		Functions to describe frequency constraints	
		--> for positive & negative power services	

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Some selected parameters & metrics:

Feedstock →	**Intermediary →**	**Power grid and/or**	**Bioeconomy services**
Seasonal occurrence	Energy density	Ramp-rate capacity	CHP-parameters
Spatial availability	Bio- stability	Provision capacity (power & energy)	Chemicals properties
Residues' main product props.	Structural stability	Ramp duration	Applicability for ind. heat
Ecosystem services impact	Self-ignition risk	Functions to describe frequency constraints	Applicability for BECCUS
Quality fluctuations	Existing infrastructure	--> for positive & negative power services	Nutrients

+ Economic parameters (cost, prices, supply & demand potentials), environmental and socio-economic parameters

Valorizing flexible bioenergy – in theory & in practice

Feedstock	**Intermediary**	**Power grid**	**Bioeconomy services**
• Geospatial and seasonal maps on residues potentials • Seasonal cost-supply curves	• Commodity markets • Price signals triggering storing options	• Transactive control (TC) schemes or • Rolling horizon predictive scheduling	• Multi-carrier markets • Exergo-economic evaluation

↑ in theory ↑

Valorizing flexible bioenergy – in theory & in practice

Feedstock	Intermediary	Power grid	Bioeconomy services
↓ in practice↓			
• Highly limited data on availability, costs/prices • Only a view residues markets for selected feedstocks	• Immature commodity markets for a view densified energy carriers • Storage not acknowledged	• Larger producer/consumers • Short-term flex services • View pilots for smaller/decentralized prosumers • No long-term	• Almost no heat markets • Same for biobased chemicals • different qualities of carriers, processes and services

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Conclusions and recommendations

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- BUT (A) **niche applications with high TRL** exist and (B) as does the theoretical background for further integration **into energy system models** → quantify the added-value of flexible bioenergy!

Flexible Bioenergy

Flexibility can be defined from different perspectives, such as from system, process or component level perspective. Bioenergy and system integration covers multiple different dimensions of flexibility, including temporal and spatial flexibility, feedstock flexibility, operational flexibility, flexibility in the use of bioenergy and end-product flexibility. Task 44 has defined flexible bioenergy as following:

"Flexible bioenergy is defined as a bioenergy system than can provide multiple services and benefits to the energy system under varying operating conditions and/or loads.

https://task44.ieabioenergy.com/flexible-bioenergy/

Schipfer, F., Kranzl, L., Olsson, O., Lamers, P., 2020.
The European wood pellets for heating market - Price developments, trade and market efficiency. Energy 212, 118636. https://doi.org/10.1016/j.energy.2020.118636

Schipfer, F., Kranzl, L., 2019. Techno-economic evaluation of biomass-to-end-use chains based on densified bioenergy carriers (dBECs). Applied Energy 239, 715–724. https://doi.org/10.1016/j.apenergy.2019.01.219

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Thank you for your attention!

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