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Development Scenarios for Drop-In and Non Drop-In Fuel Options

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Agenda

Reduce aviation‘s greenhouse gas (GHG) emissions

Use a suitable, renewably sourced fuel

Initial assessment - today

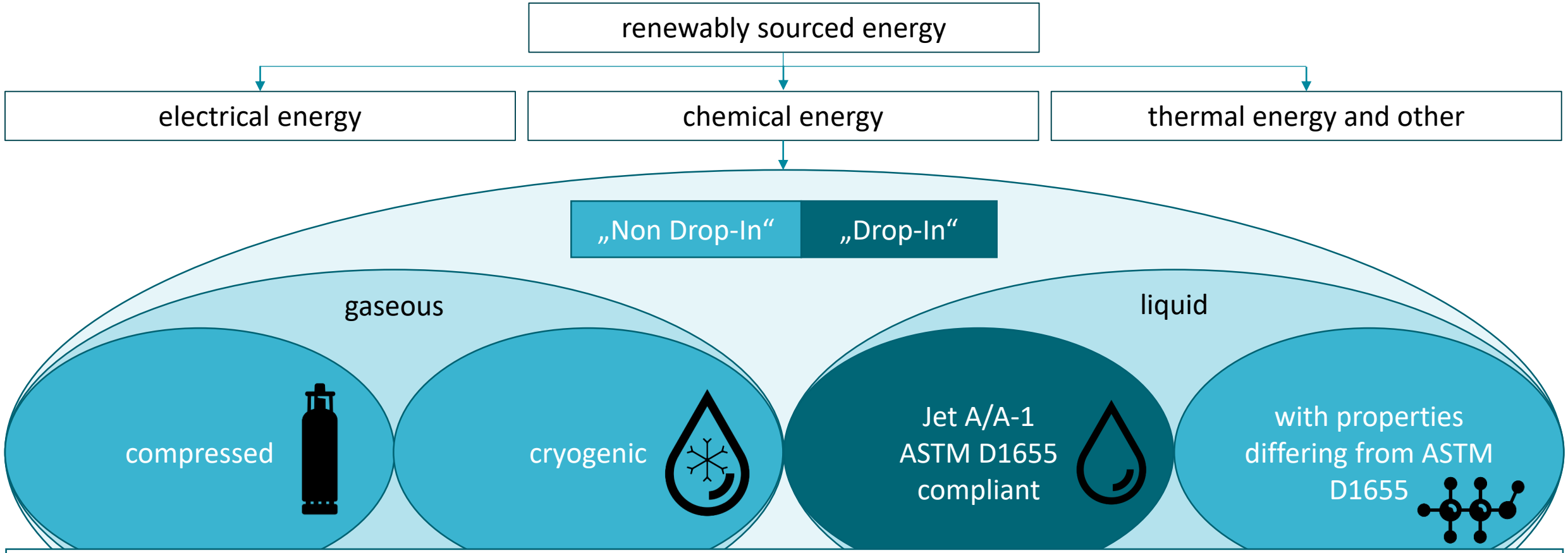
Possible future developments

Assessment – year 2050

Goal: Assessment of scenarios for the development of (Non) Drop-In Aviation Fuels

Initial assessment - today

Selection of fuel options



Selection criteria:

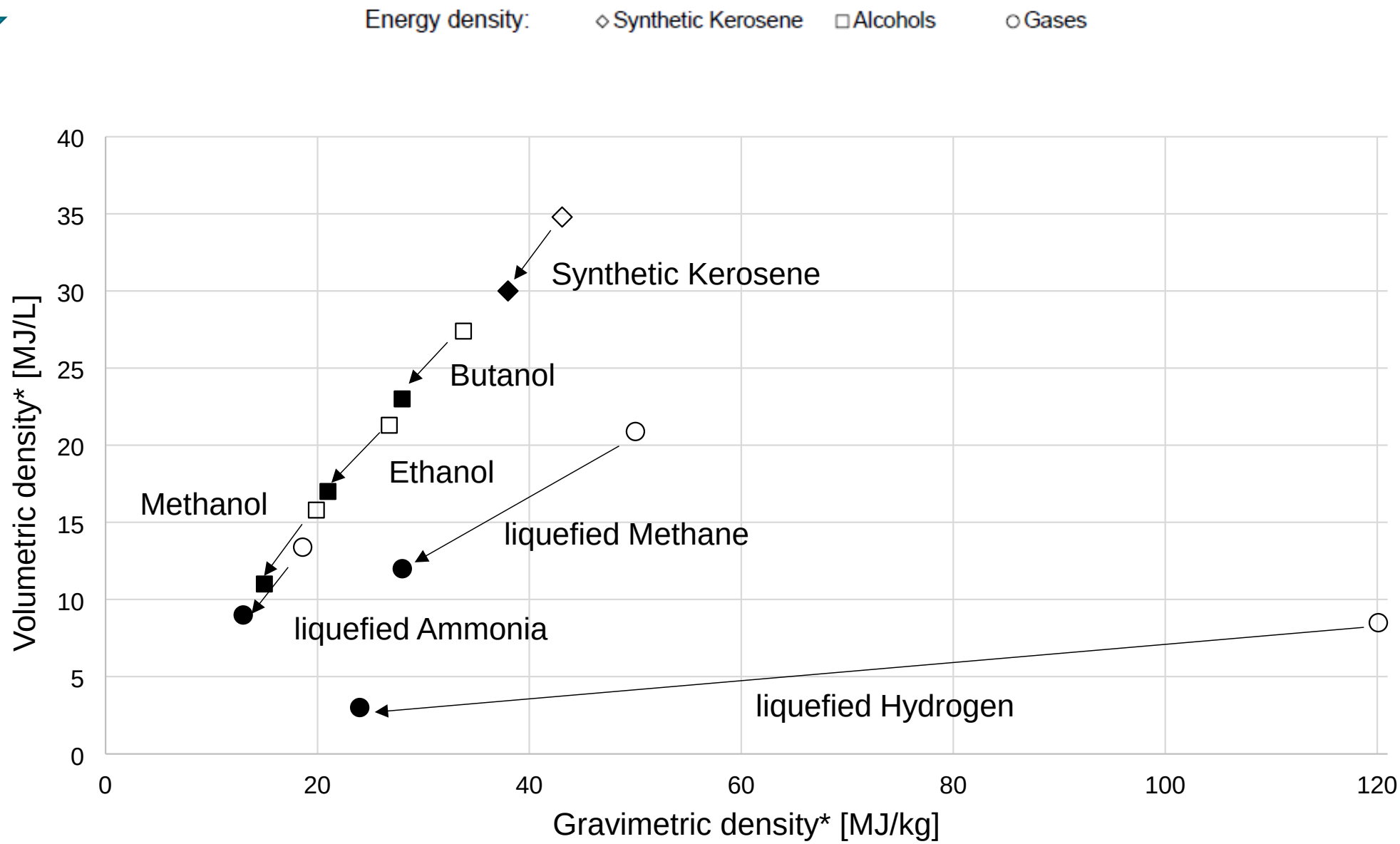
1. discussed as renewable aviation fuels
2. already produced at scale from renewable sources
3. potentially central role for defossilation of overall energy system

Potential renewable fuel options – present state

	liquid					gaseous		
	„Drop-In“	„Non Drop-In“						
	Blend SK	Neat SK	Methanol	Ethanol	Butanol	Ammonia	Methane	Hydrogen
present production based on renewables [Mt]	< 0.2		< 1	**100**	-	-	0,1	-
sectors with present use	• aviation		• chemical • transport	• chemical • pharma-ceutical • transport	• chemical	• agriculture • chemical • pharma-ceutical	• energy • chemical	• energy • chemical
additional sectors with future use					• chemical • **transport**	• agriculture • chemical • pharma-ceutical • **energy (storage)**	• energy (storage) • chemical • **transport**	• energy (storage) • chemical • **production (e.g. steel)**

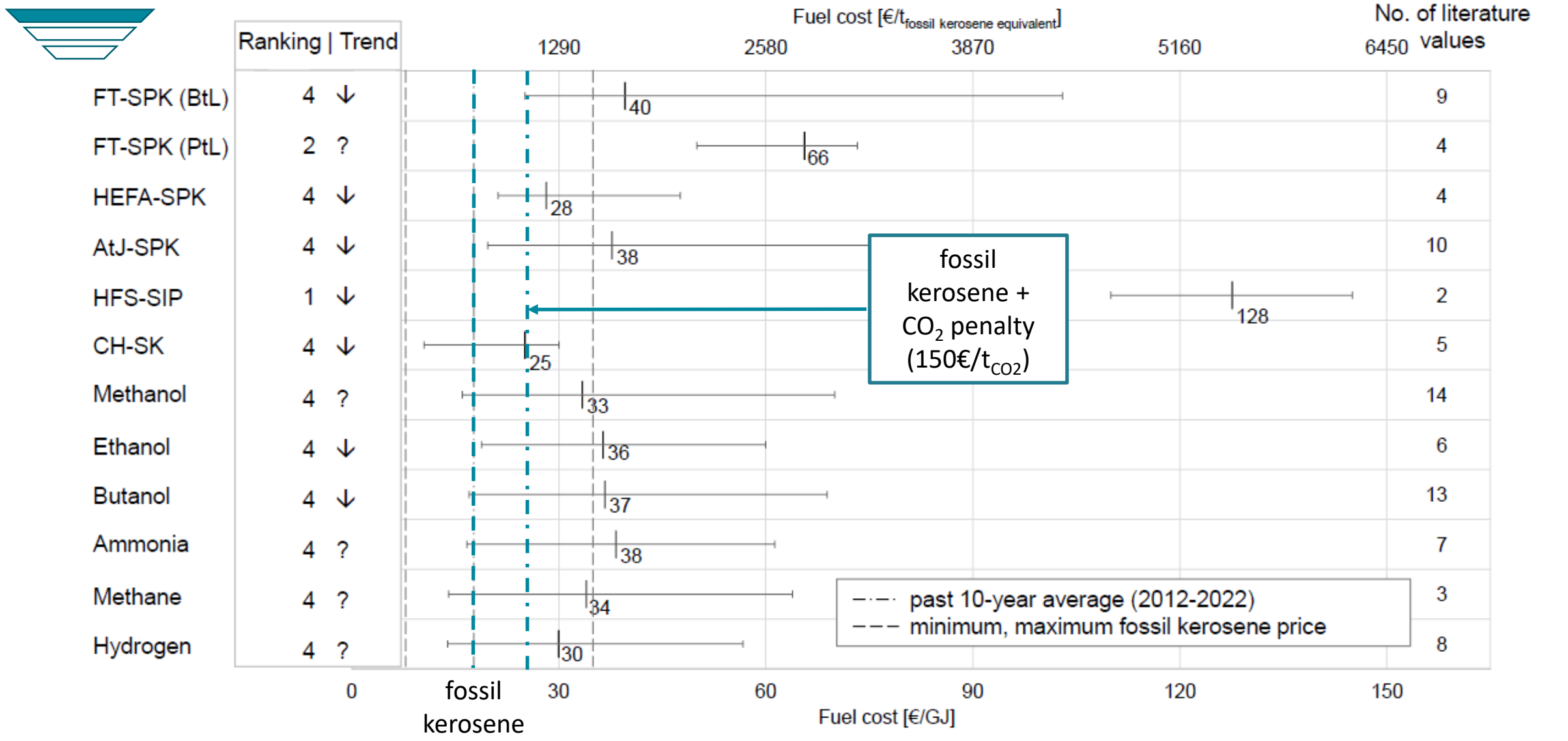
SK – synthetic kerosene

Static criteria – energy density

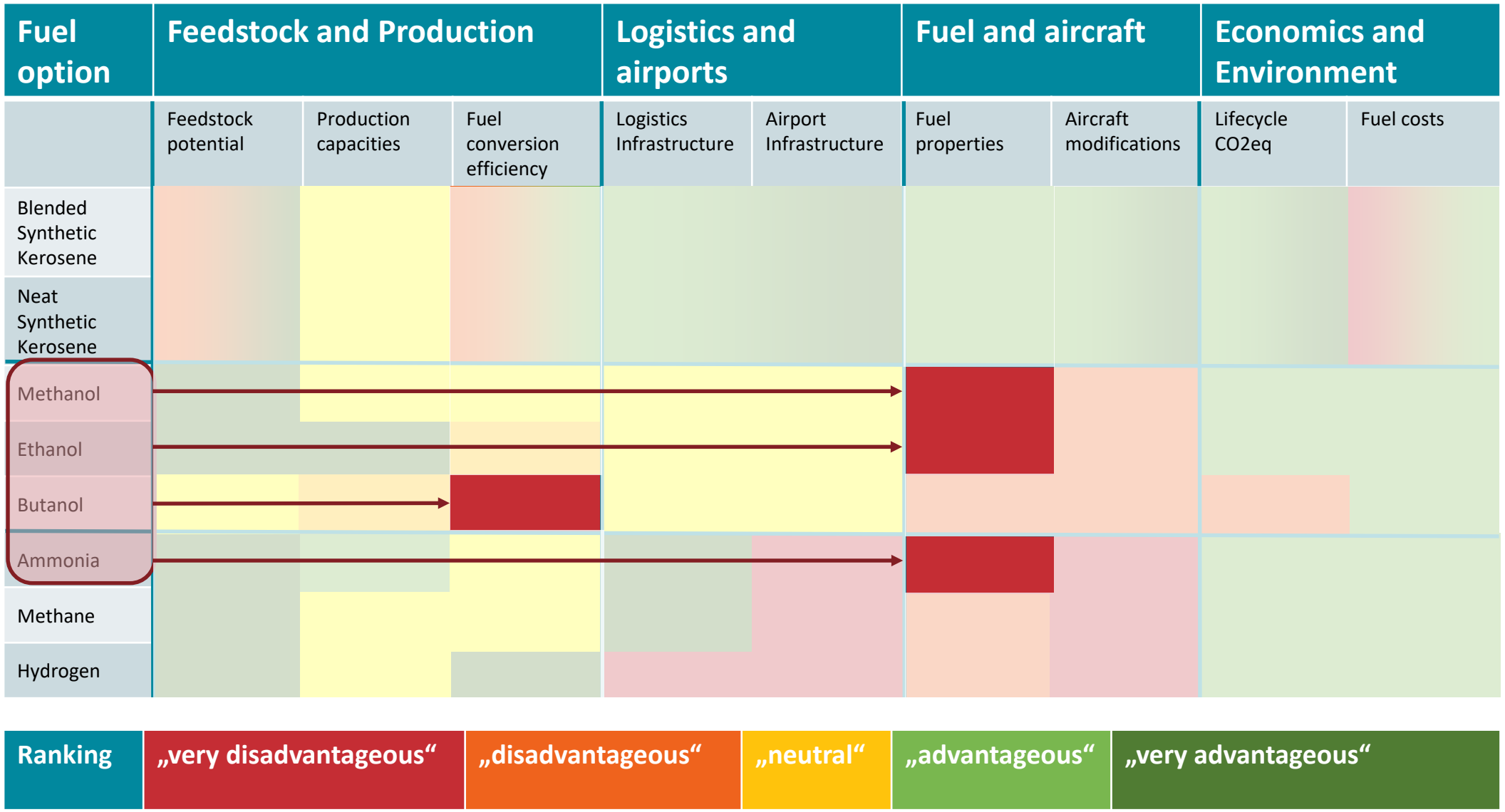


* based on lower heating value (LHV)

Dynamic criteria – fuel provision cost

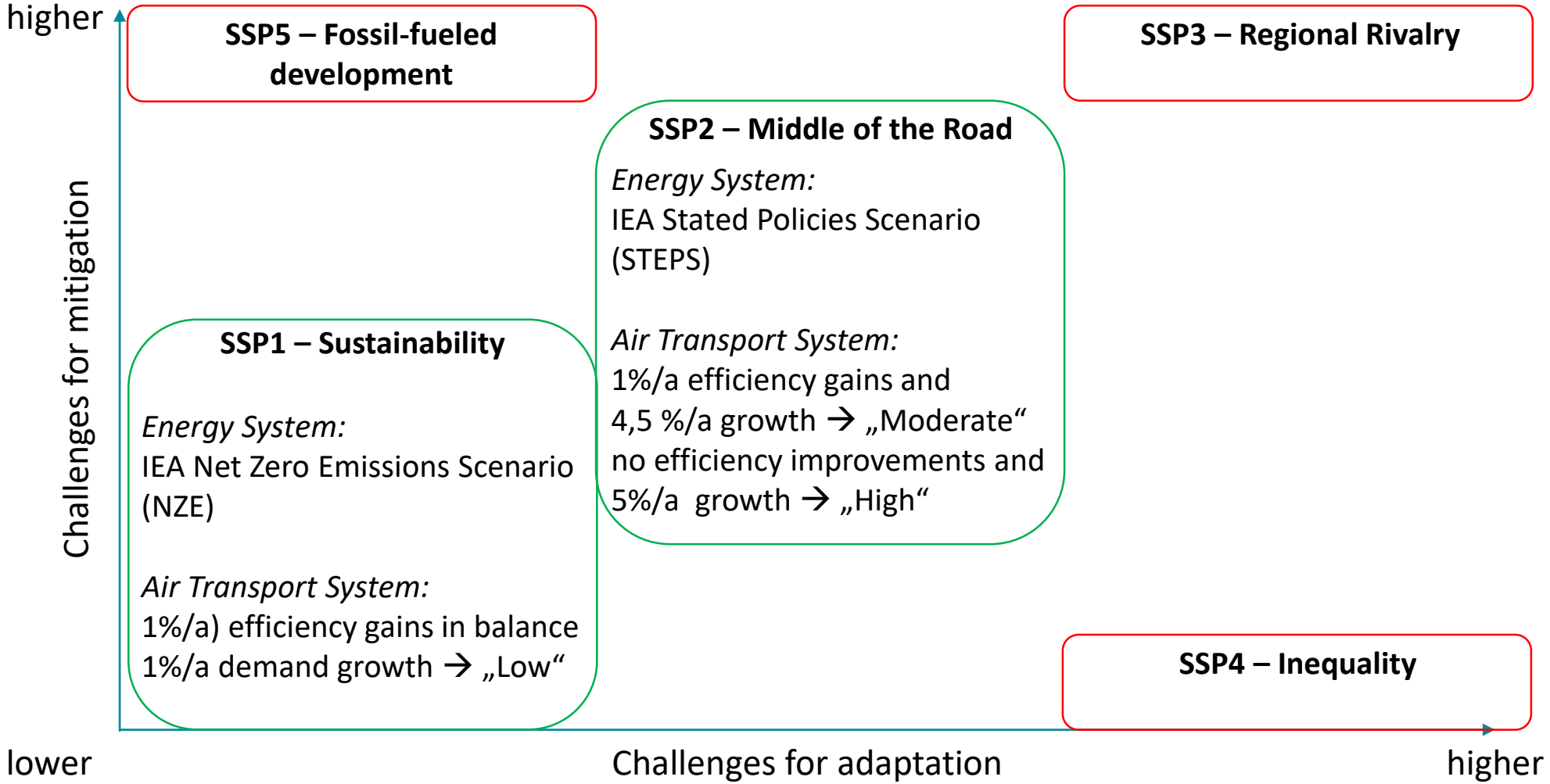


Potential renewable fuel options – present state



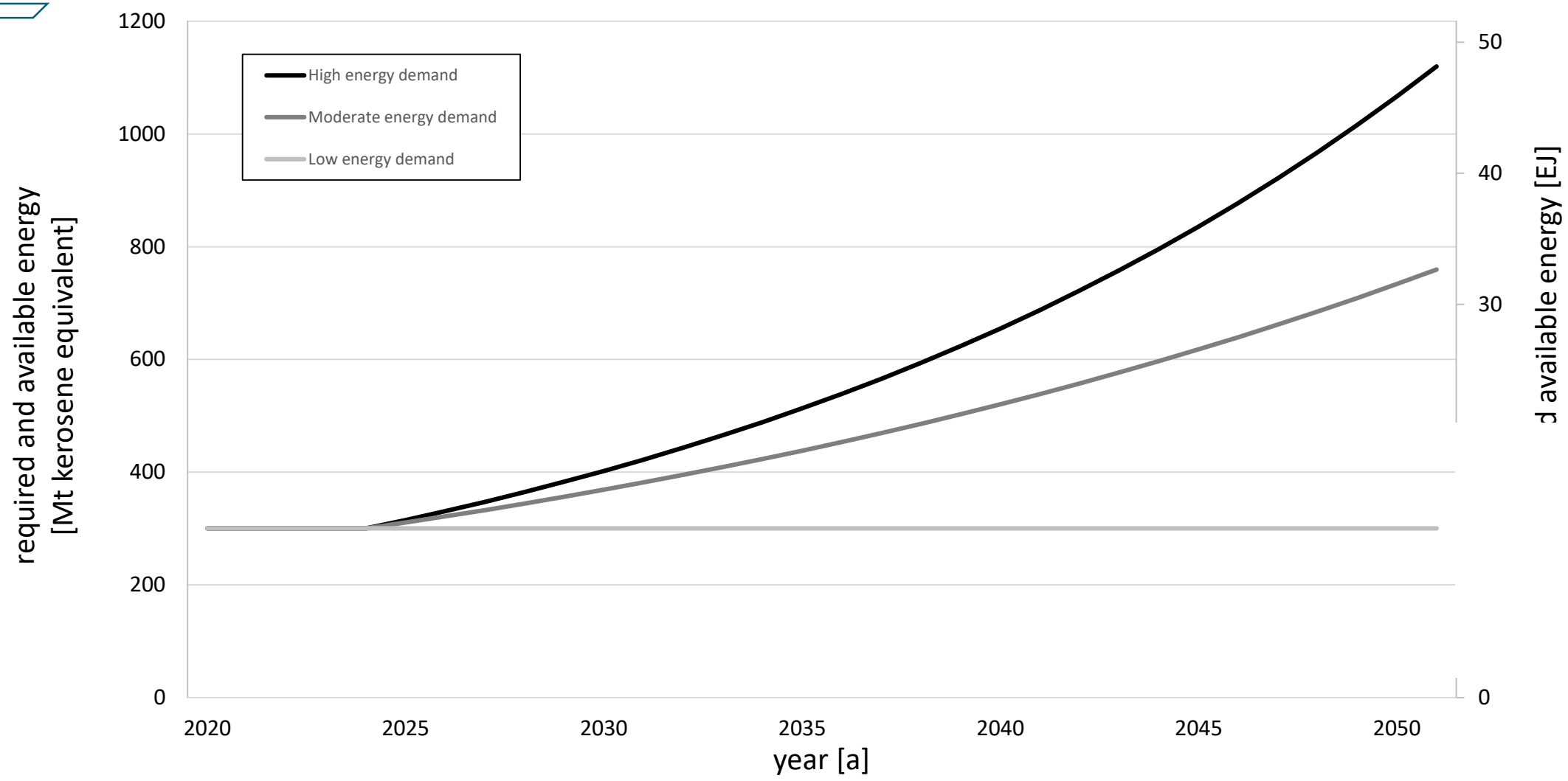
Future Developments

Derivation of aviation energy demand scenarios



[1, 2]

Global aviation energy demand vs fuel option‘s availability



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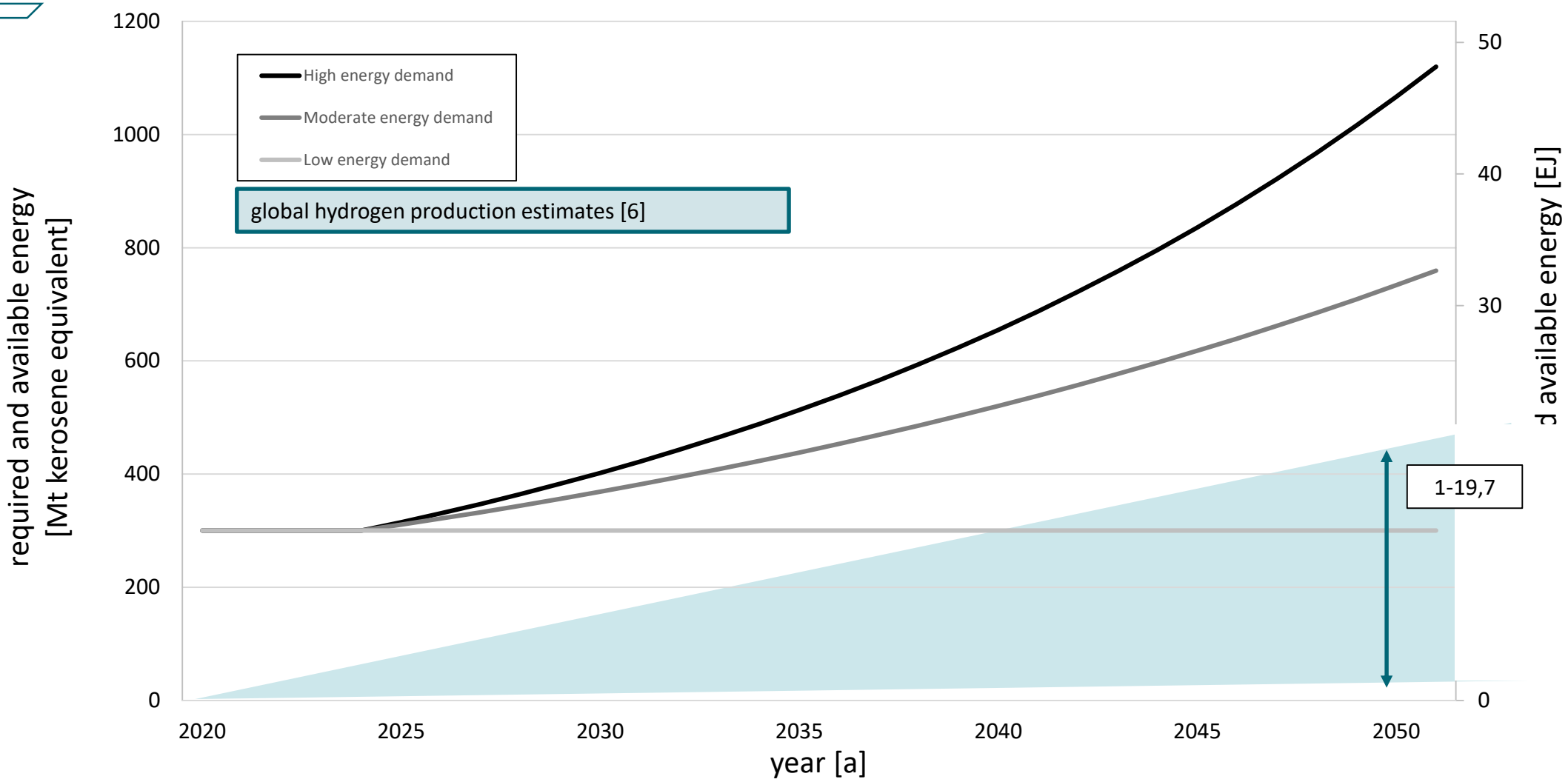

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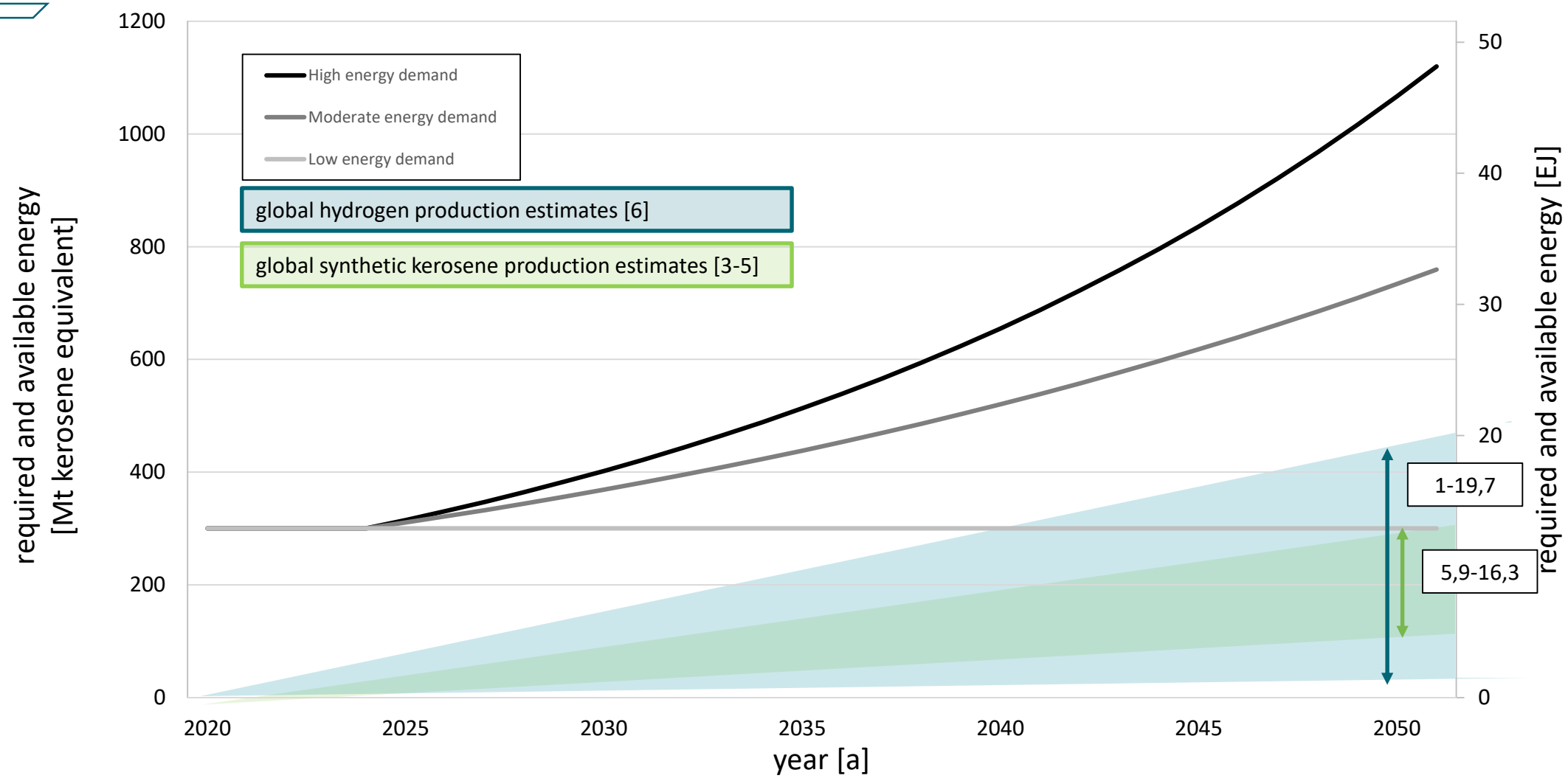

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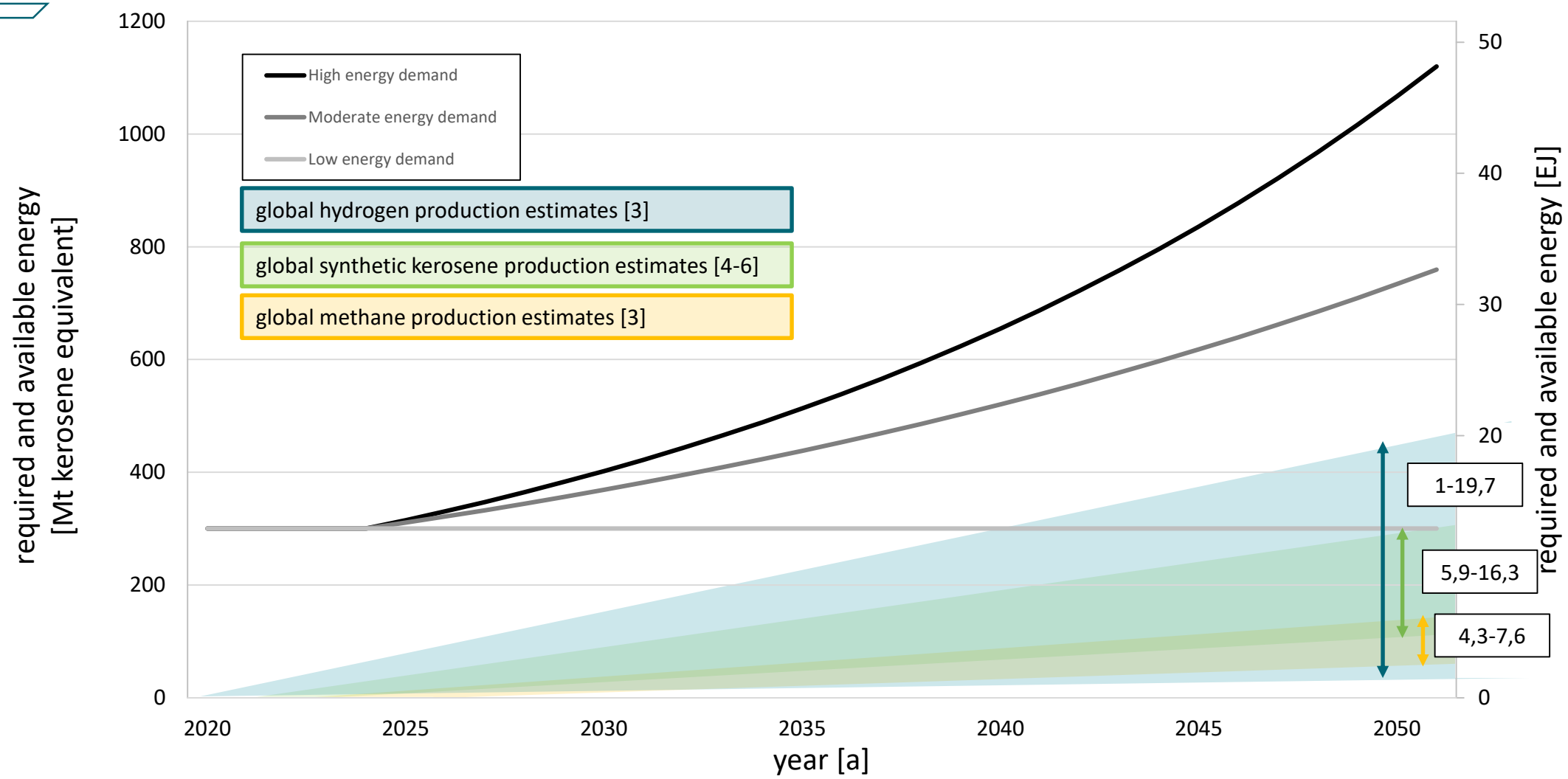
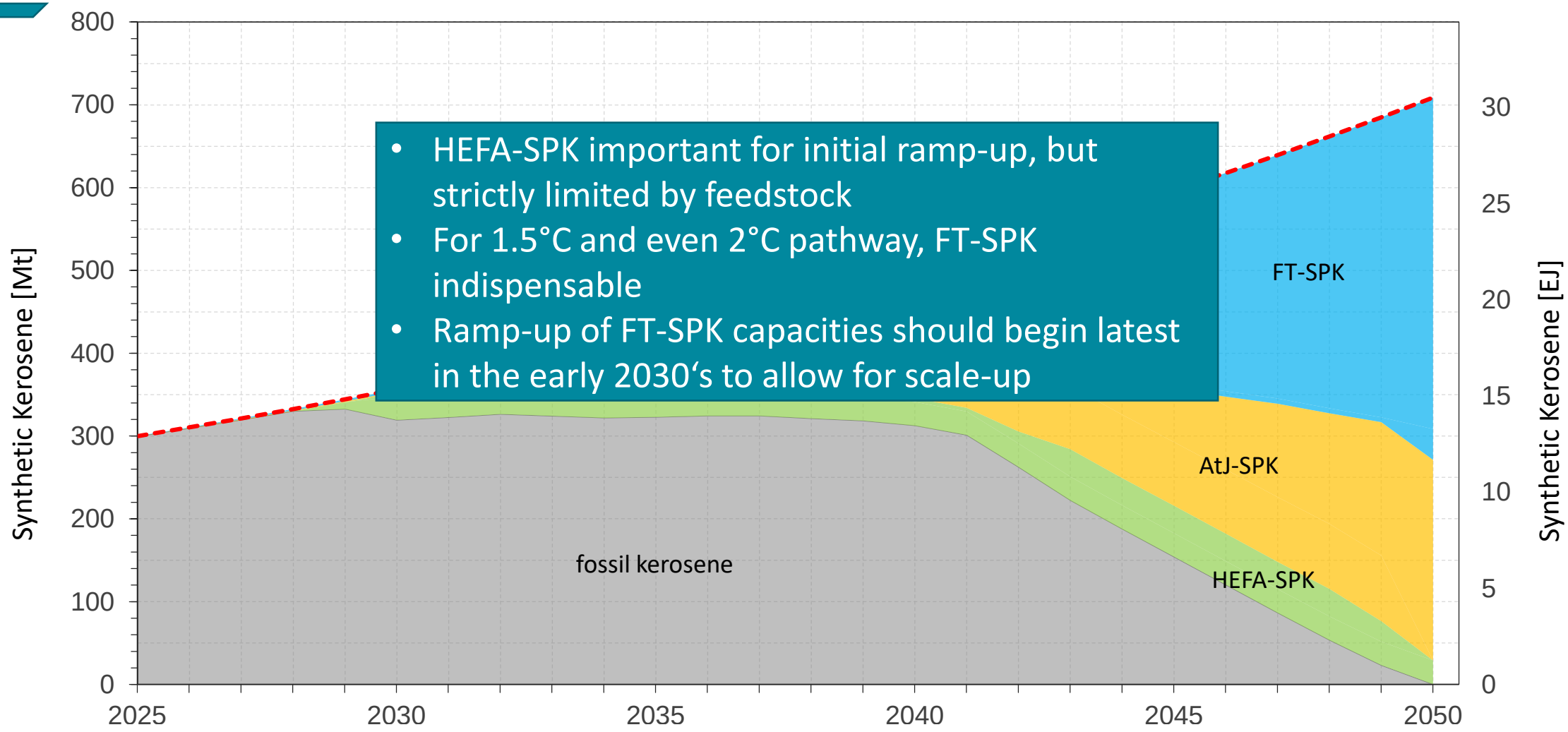
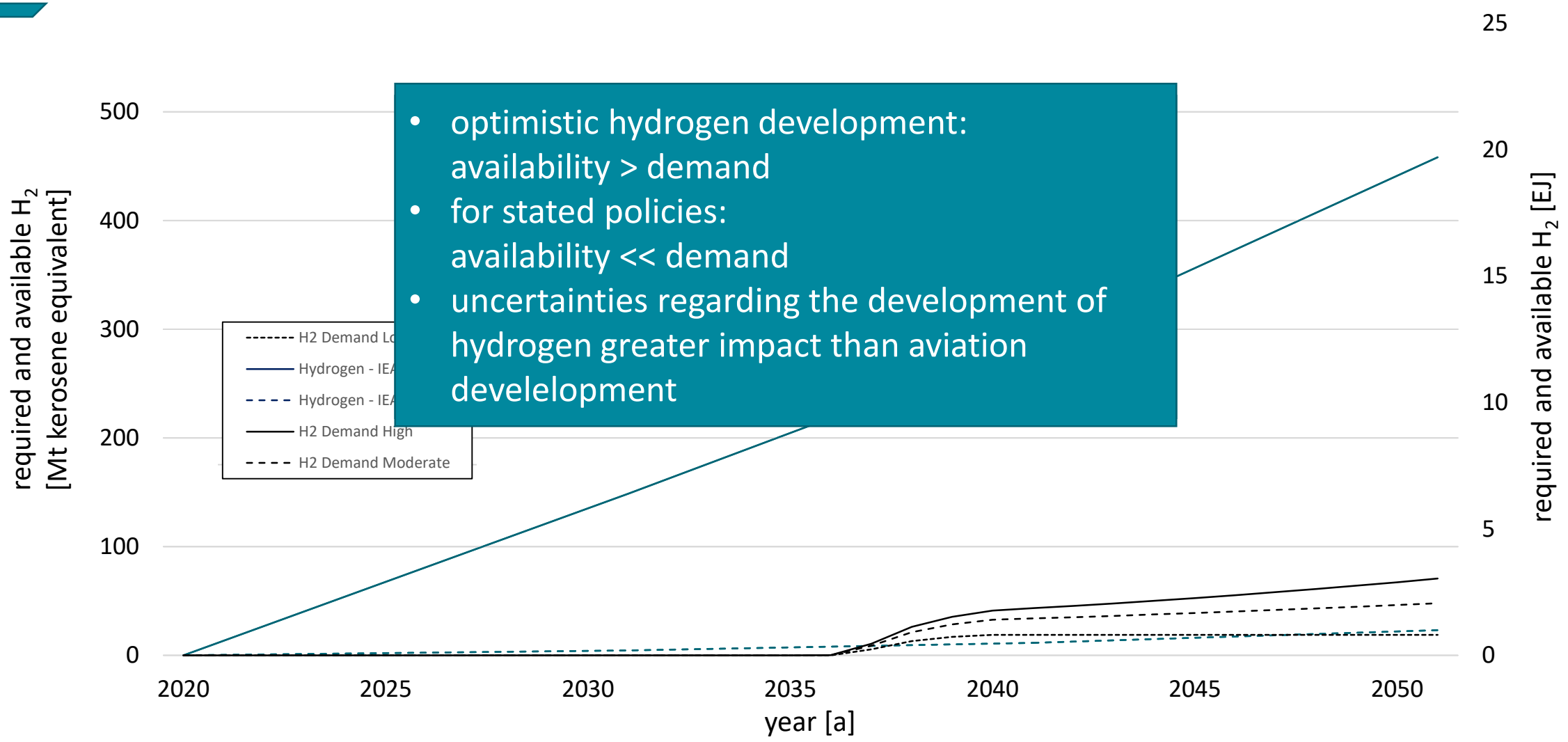


Assessment 2050

Scenarios for synthetic kerosene



Scenarios for hydrogen



- optimistic hydrogen development: availability > demand
- for stated policies: availability << demand
- uncertainties regarding the development of hydrogen greater impact than aviation develelopment

[7]

Conclusions

Renewable Fuel Options – 2050

Socio-Economic Preconditions

SSP1
- improved resource efficiency
- reduced overall energy use

SSP2
- sustainable development goals are slowly achieved
- overall intensity of resource and energy use declines

Air Transport System‘s Preconditions

Hydrogen
- global logistics infrastructure
- provision at several airports
- development of a hydrogen aircraft

Synthetic Kerosene
- use without fossil blending component

Key Lever

1. development of aviation‘s energy demand more important than availability of renewables

2. ramp-up of production capacities

3. willingness to cover the cost of the energy transition

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Questions and Discussion

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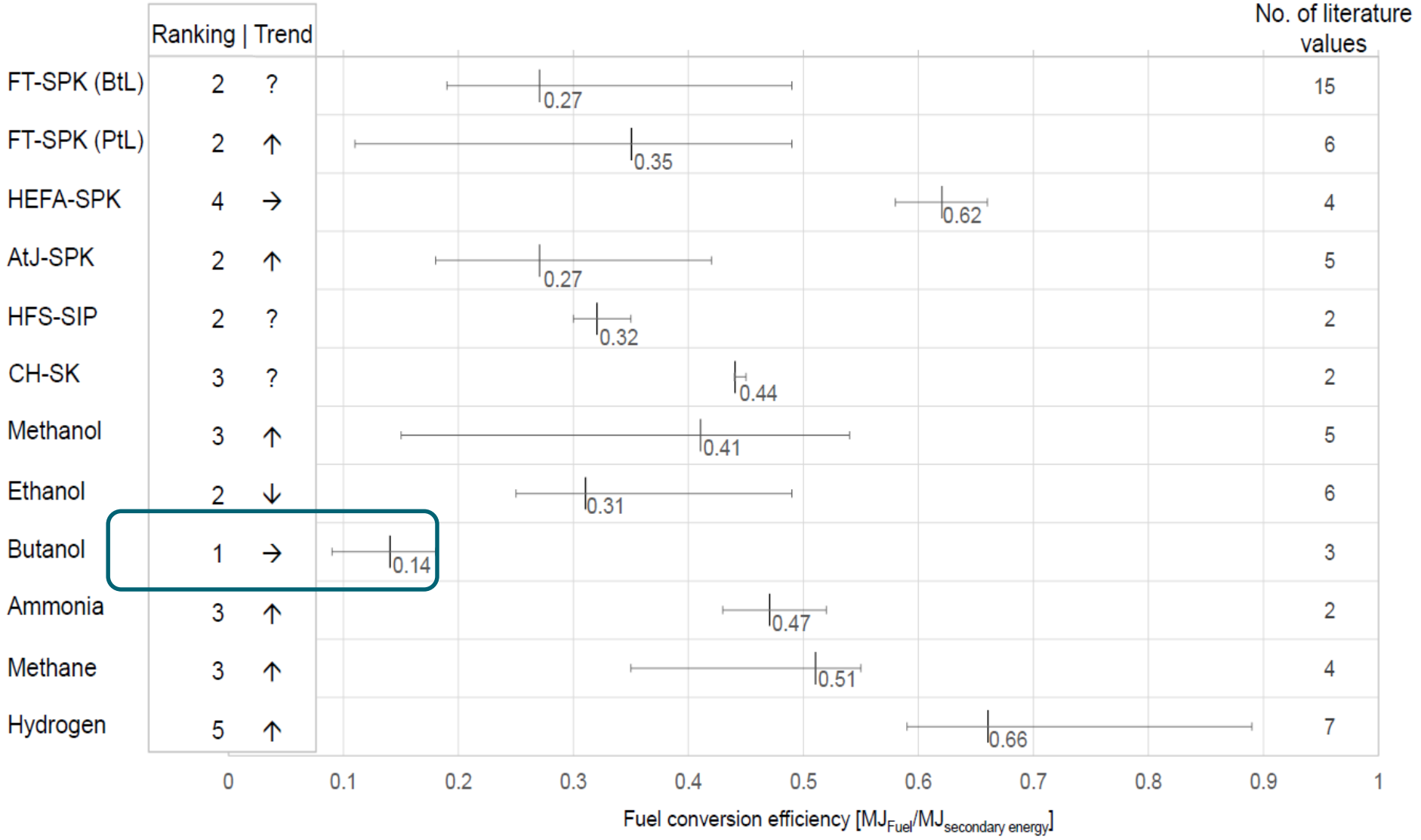
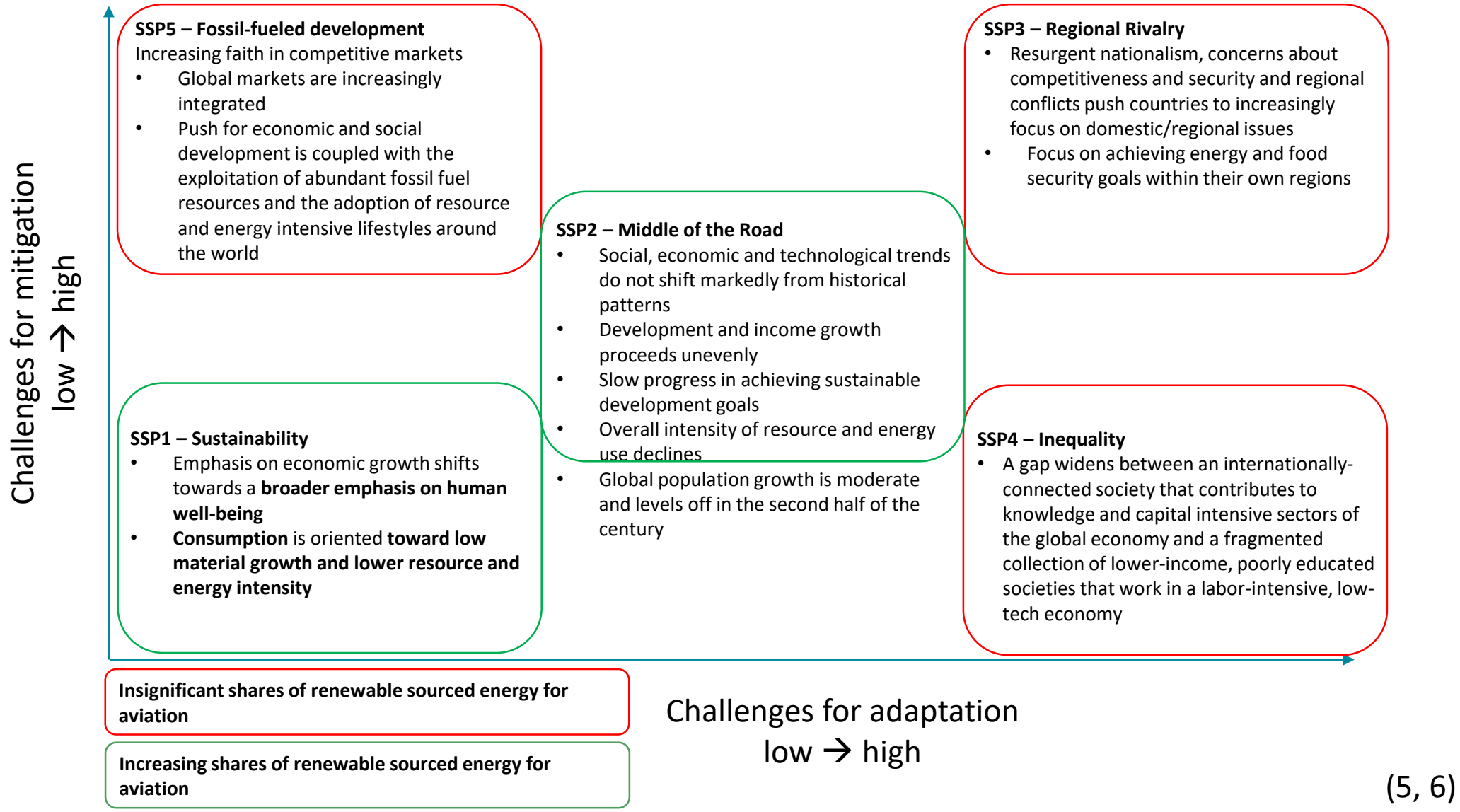
Static criteria – fuel conversion efficiency



Motivation – aviation energy demand scenarios



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Matching Socioeconomic and Energy Scenarios

Socio-economic scenario	Scenario for energy availability	Scenario for energy required
SSP1 – Sustainability • Emphasis on economic growth shifts towards a **broader emphasis on human well-being** • **Consumption** is oriented **toward low material growth and lower resource and energy intensity**	**IEA Net Zero Emissions Scenario (NZE)** • Net-zero emissions in 2050 • key energy related UN SDGs are met • **1,5° goal is achieved with 50% probability**	**Low** • low demand growth and energy efficiency improvements balance each other → constant aviation energy required
SSP2 – Middle of the Road • Social, economic and technological **trends do not shift markedly from historical patterns** • Slow progress in achieving sustainable development goals • Overall **intensity of resource and energy use declines**	**IEA Stated Policies Scenario (STEPS)** • Trends based on existing and policies under development • Development without any additional major steer from policy → economic growth outpaces energy efficiency improvements → aviation energy demand increases	**Moderate** • 4,5 %/a demand growth • 1,0 %/a fuel efficiency improvements **High** • 5 %/a demand growth • fuel efficiency diminish (0 %/a)

UN SDG. United Nations Sustainable Development Goal