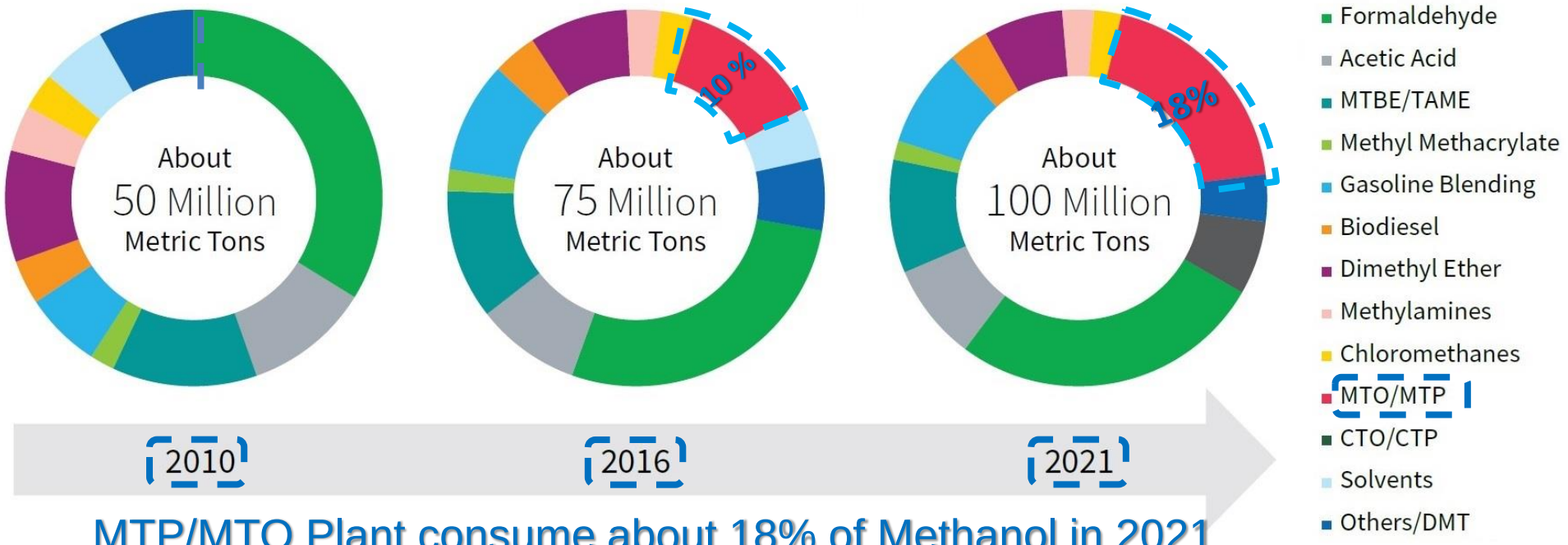
Methanol Value Chain

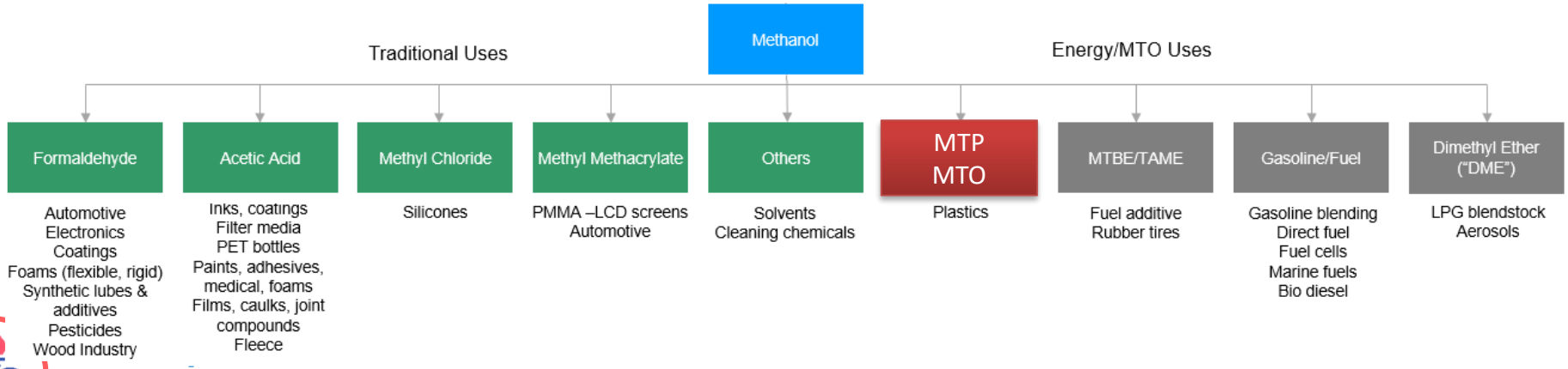
Present & Prospects

Methanol Demand by End-use

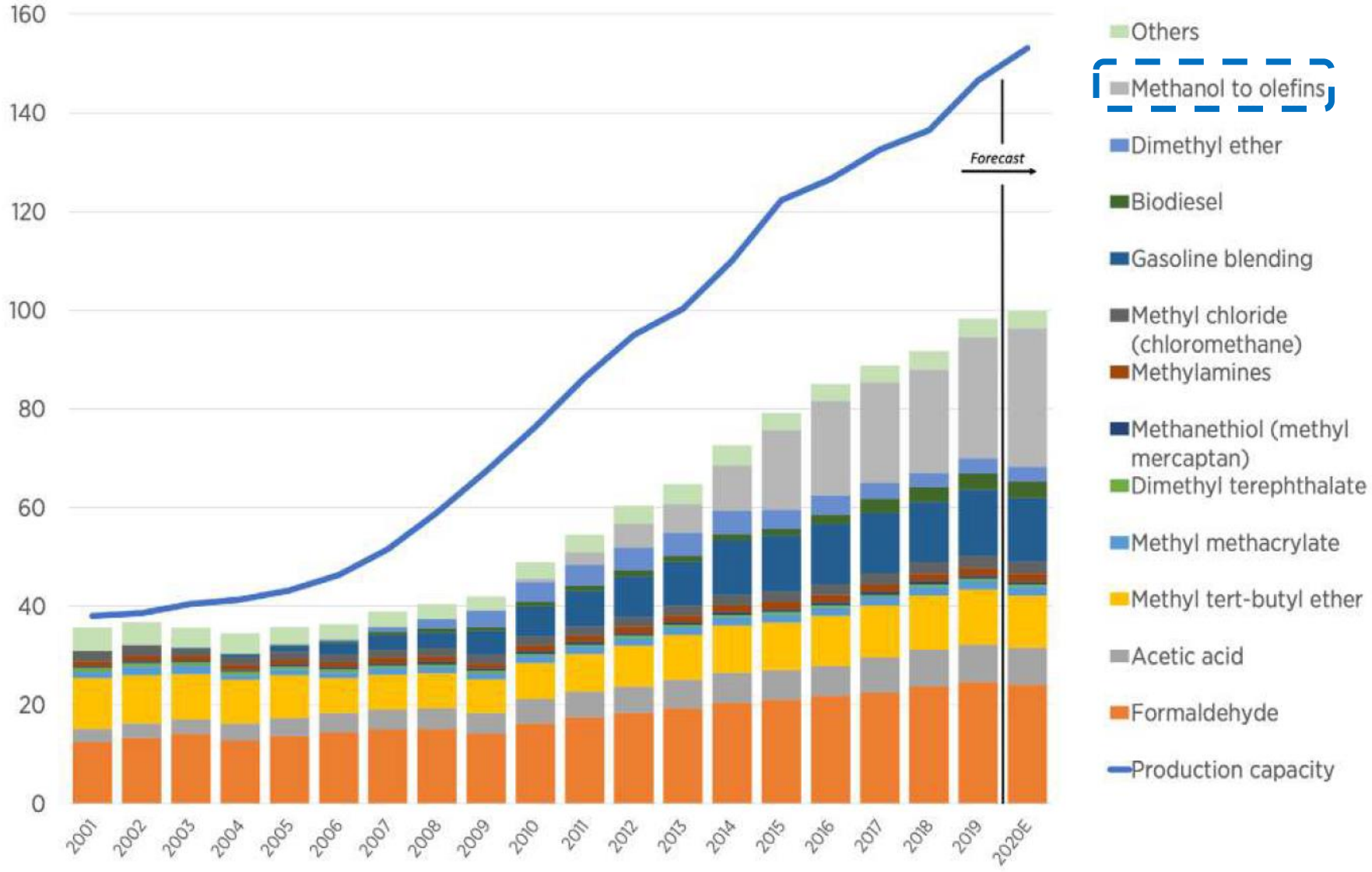
MTP/MTO



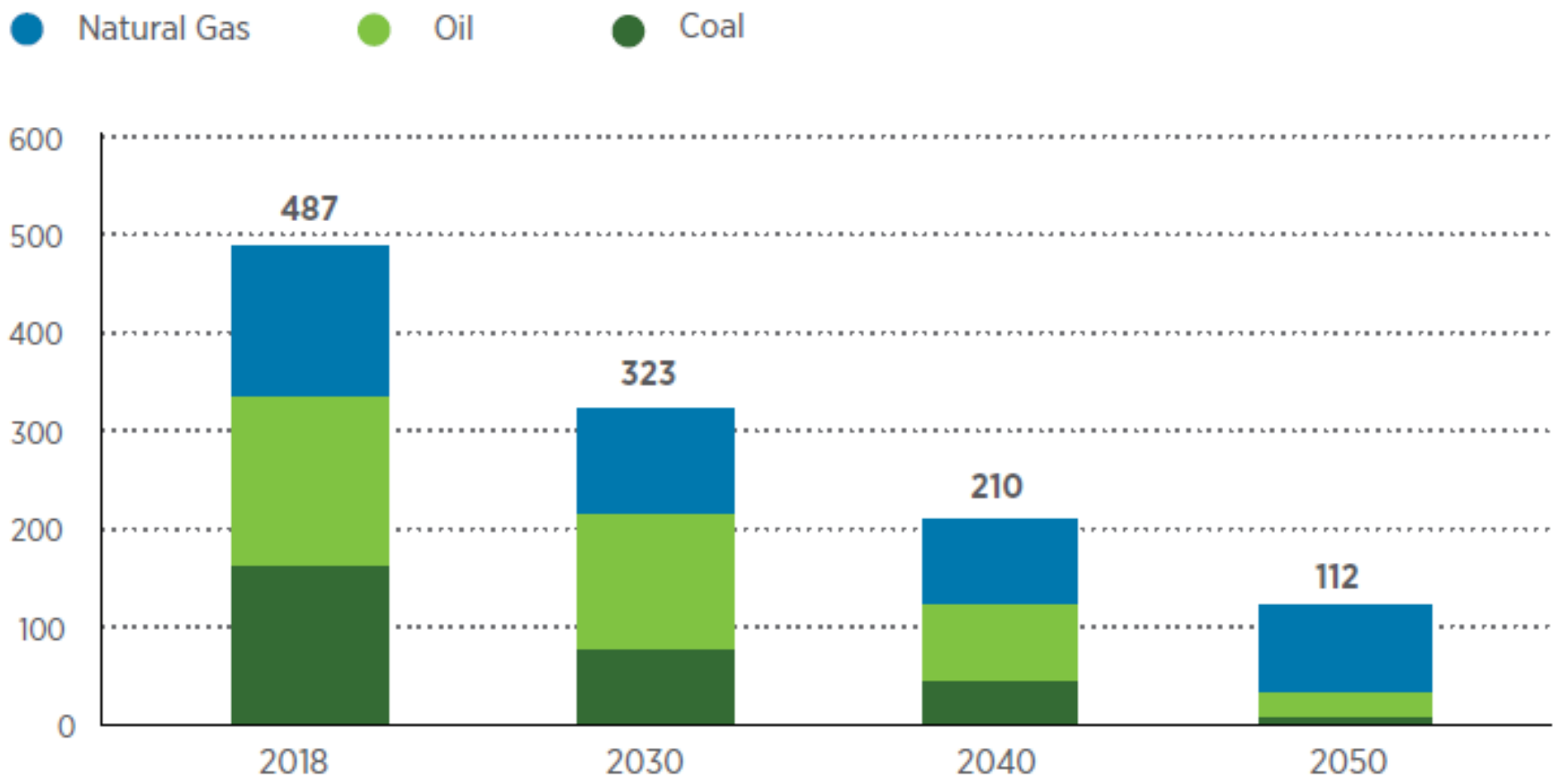
MTP/MTO Plant consume about 18% of Methanol in 2021 and the rate of expansion will continue in future.



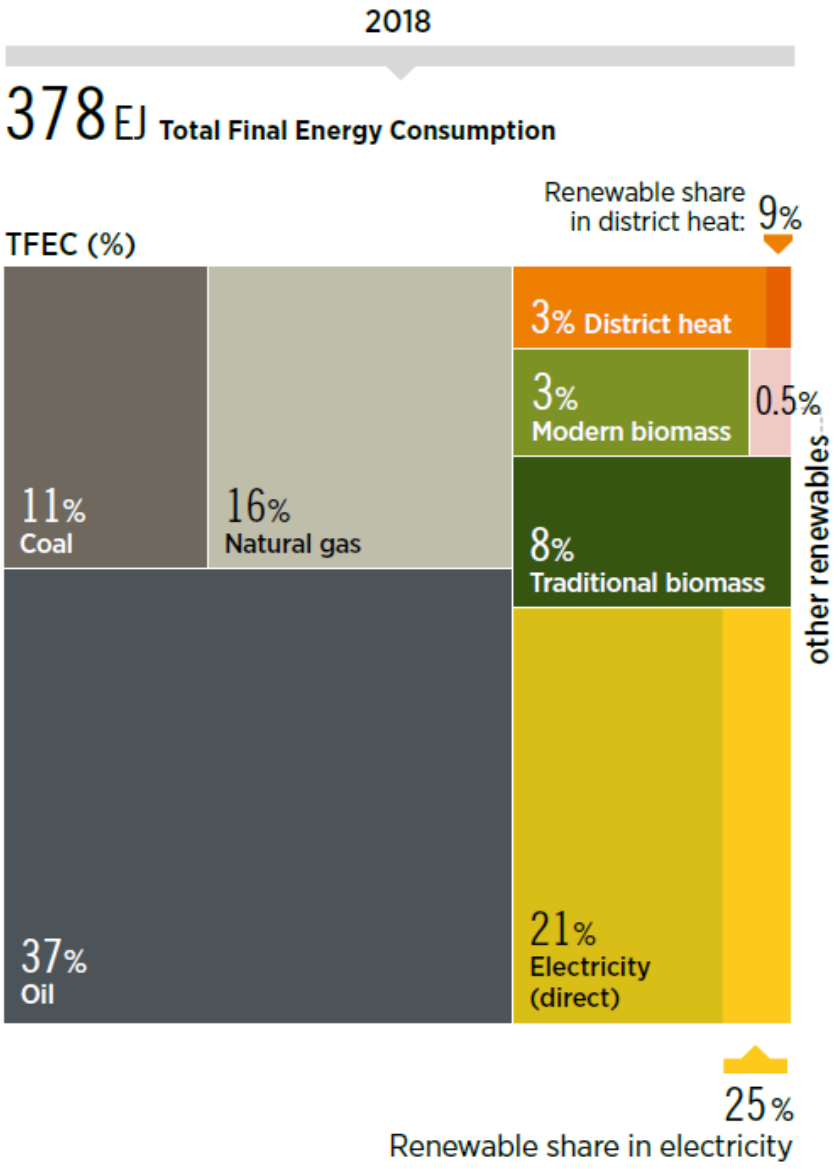
Methanol Demand by End-use

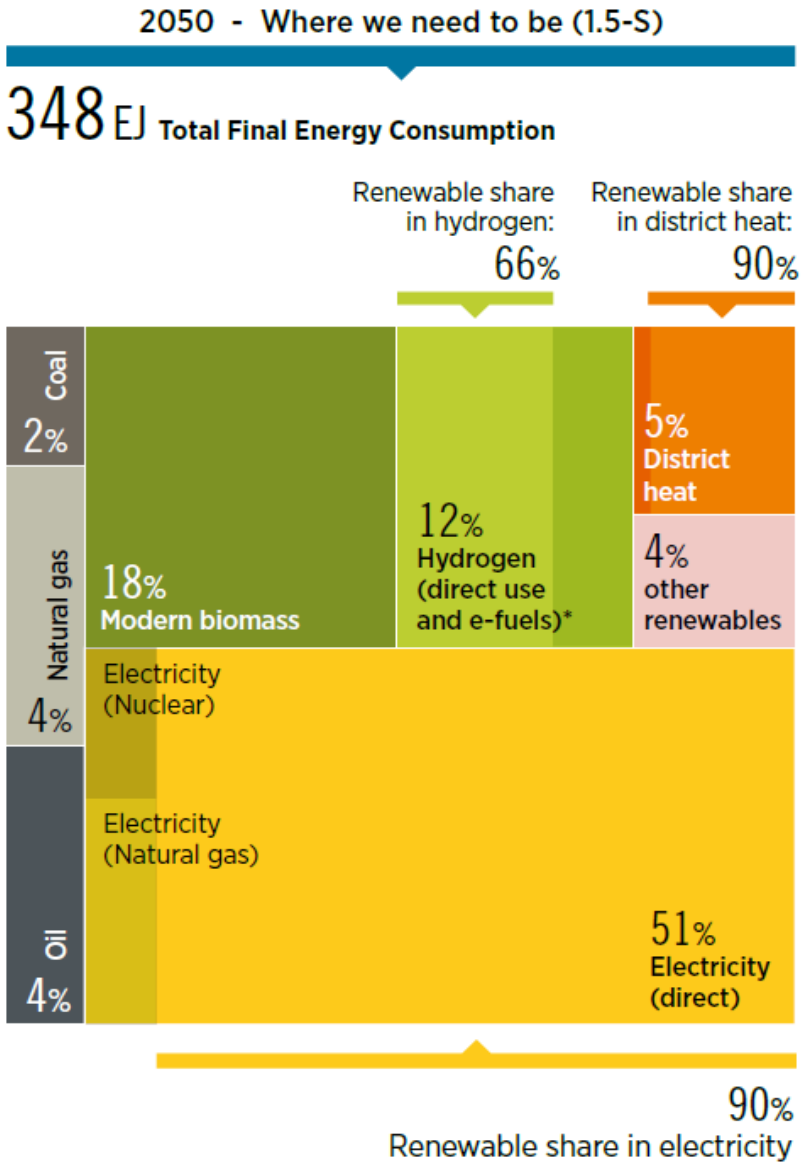


NG / Oil / Coal Consumption Perspective



Energy Source Perspective





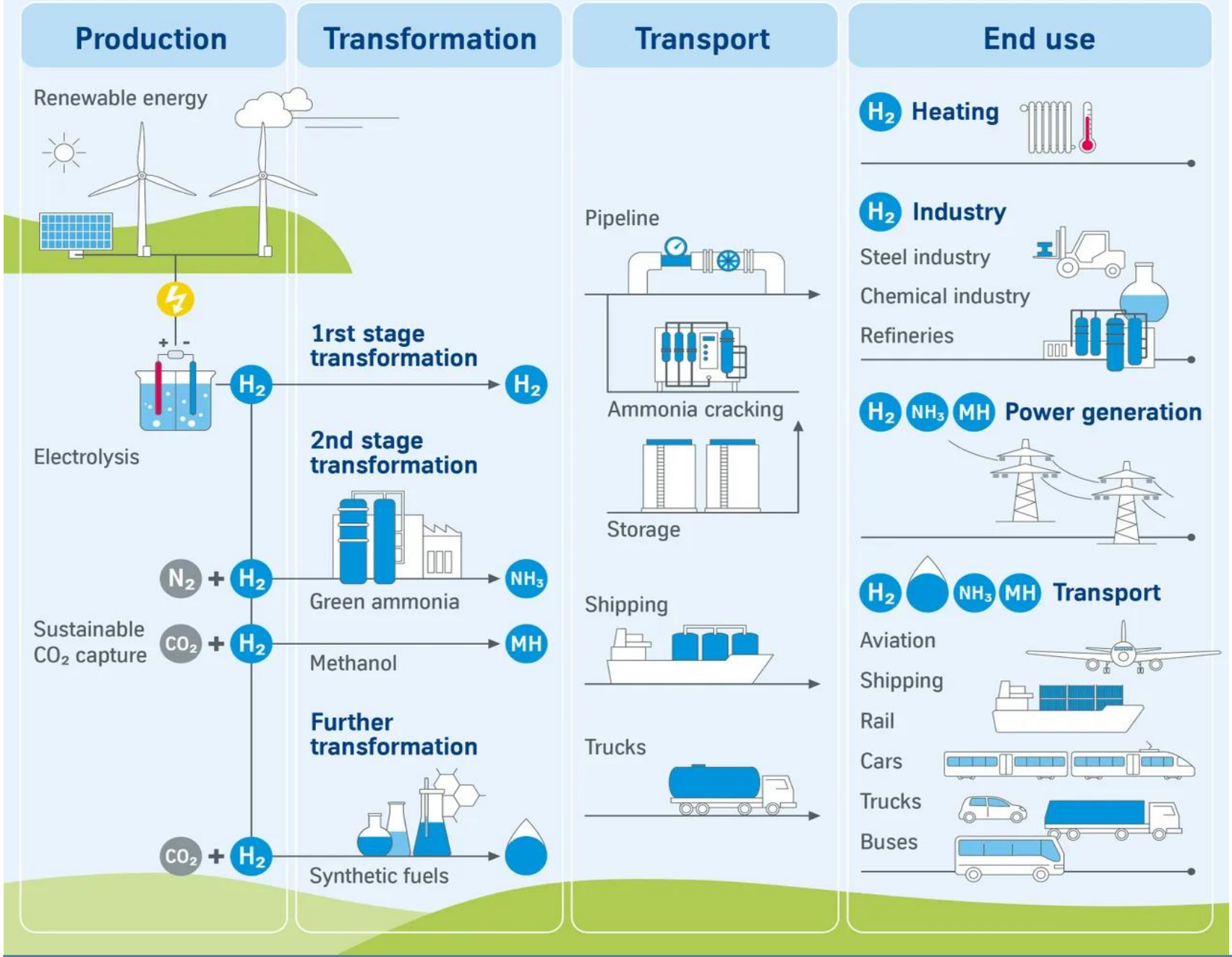
Future Investments/Jobs in Carbon Management B$/Y

End uses and district heat

		Annual average investments USD billion/yr: Historical 2017-19	1.5-S 2021-50
Renewables end uses and district heat	Biofuels - supply	2	87
	Renewables direct uses and district heat	31	84
Energy efficiency	Buildings	139	963
	Industry	45	354
	Transport	65	157
Electrification	Charging infrastructure for electric vehicles	2	131
	Heat pumps	12	102
Innovation	Hydrogen - electrolysers and infrastructure	0	116
	Hydrogen-based ammonia and methanol	0	45
	Bio-based ammonia	0	22
	Bio-based methanol	0	12
Carbon removals	Carbon removals (CCS, BECCS)	0	65

Energy transition component	Indicators Unit	Historical 2018	Where we need to be (1.5°C Scenario) 2030	 2050	Implications/Key actions
Energy transition strategy and components					
ELECTRIFICATION IN END-USE SECTORS (DIRECT)	**Share of electricity in TFEC** (%)	1 %	9 %	49 %	• Promote the rapid electrification of road transport. • Support battery and charging research and development (R&D), considering both mobility and grid needs.
RENEWABLES (DIRECT USES)	**Biofuels share in transport TFEC** (%)	3 %	13 %	24 %	• Broaden and scale up the sustainable production and use of biofuels.
HYDROGEN AND ITS DERIVATIVES	**Clean hydrogen share in transport TFEC** (%)	<0.1 %	0.7 %	12 %	• Explore hydrogen as a potential transport fuel for road, aviation and shipping. • Introduce and scale up the use of alternative fuels though measures to support early demand.
	Ammonia, methanol, synthetic fuels share in transport TFEC (%)	<0.1 %	0.4 %	8 %	

TFEC: Total Final Energy Consumption

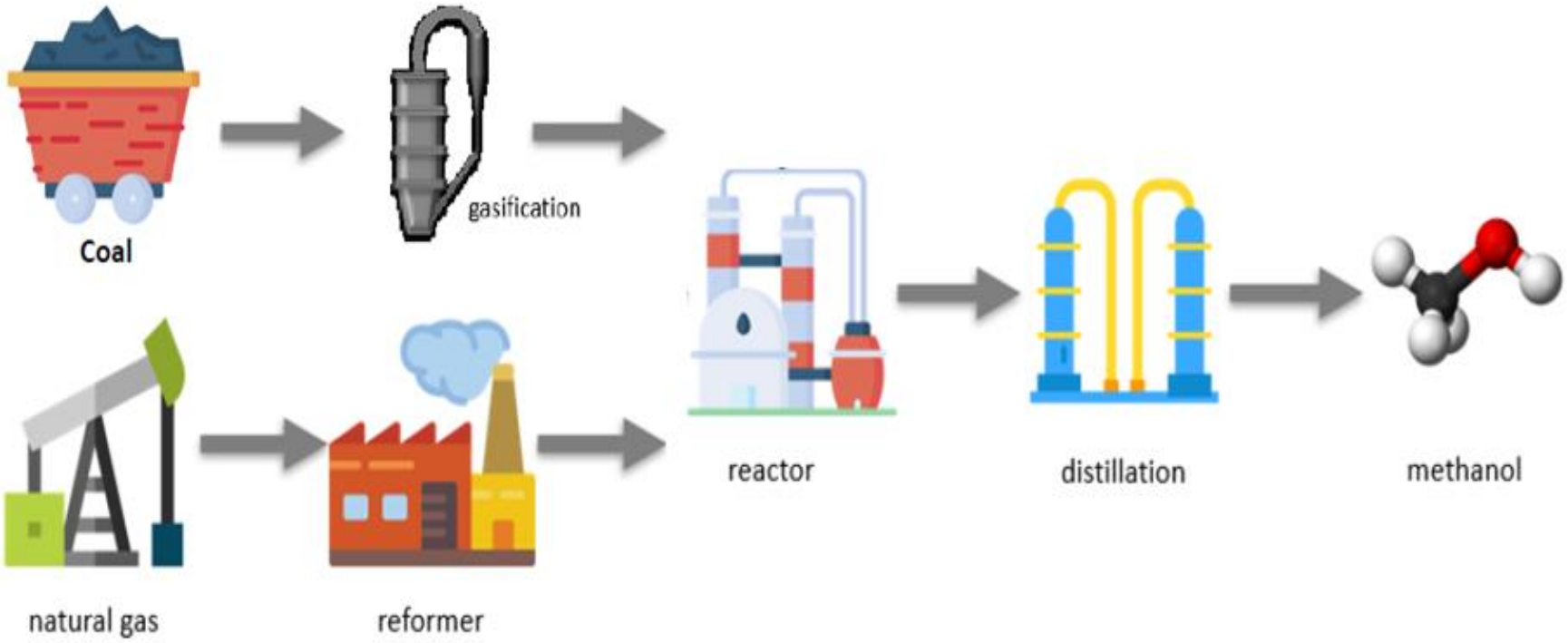

Production
Transformation
Transport
End use
Renewable energy
Electrolysis
1rst stage transformation
2nd stage transformation
Green ammonia
Sustainable CO_2 capture
Methanol
Further transformation
Synthetic fuels
Pipeline
Ammonia cracking
Storage
Shipping
Trucks
Heating
Industry
Steel industry
Chemical industry
Refineries
Power generation
Transport
Aviation
Shipping
Rail
Cars
Trucks
Buses

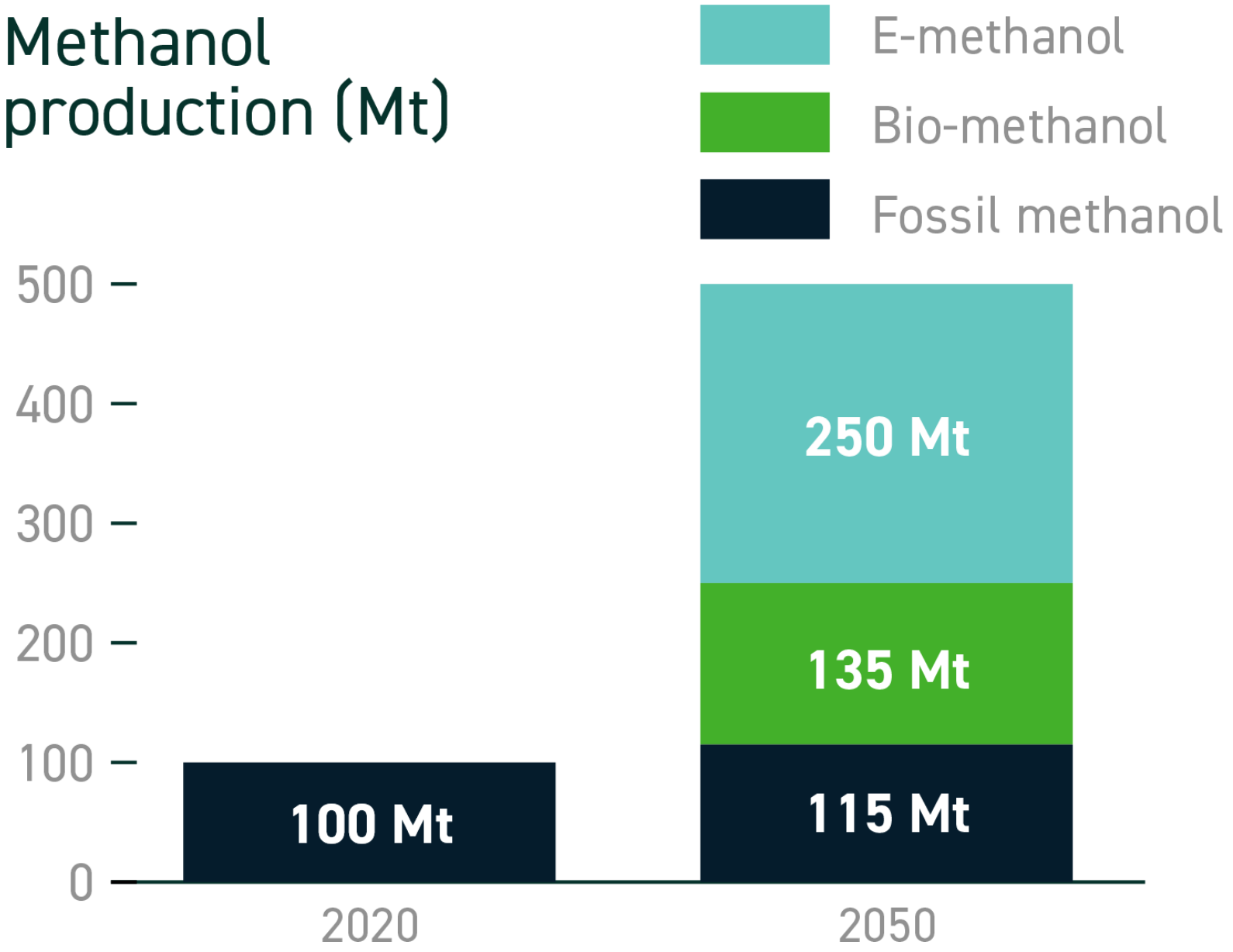
Methanol: A Unique Renewable Fuel

Fuel type	Lower heating value [MJ/kg]	Volumetric energy density [GJ/m³]	Storage pressure [bar]	Storage temperature [°C]
Marine gas oil	42.7	36.6	1	20
Liquefied natural gas	50	23.4	1	-162
Methanol	19.9	15.8	1	20
Liquid ammonia	18.6	12.7	1/10	-34/20
Liquid hydrogen	120	8.5	1	-253
Compressed hydrogen	120	7.5	700	20

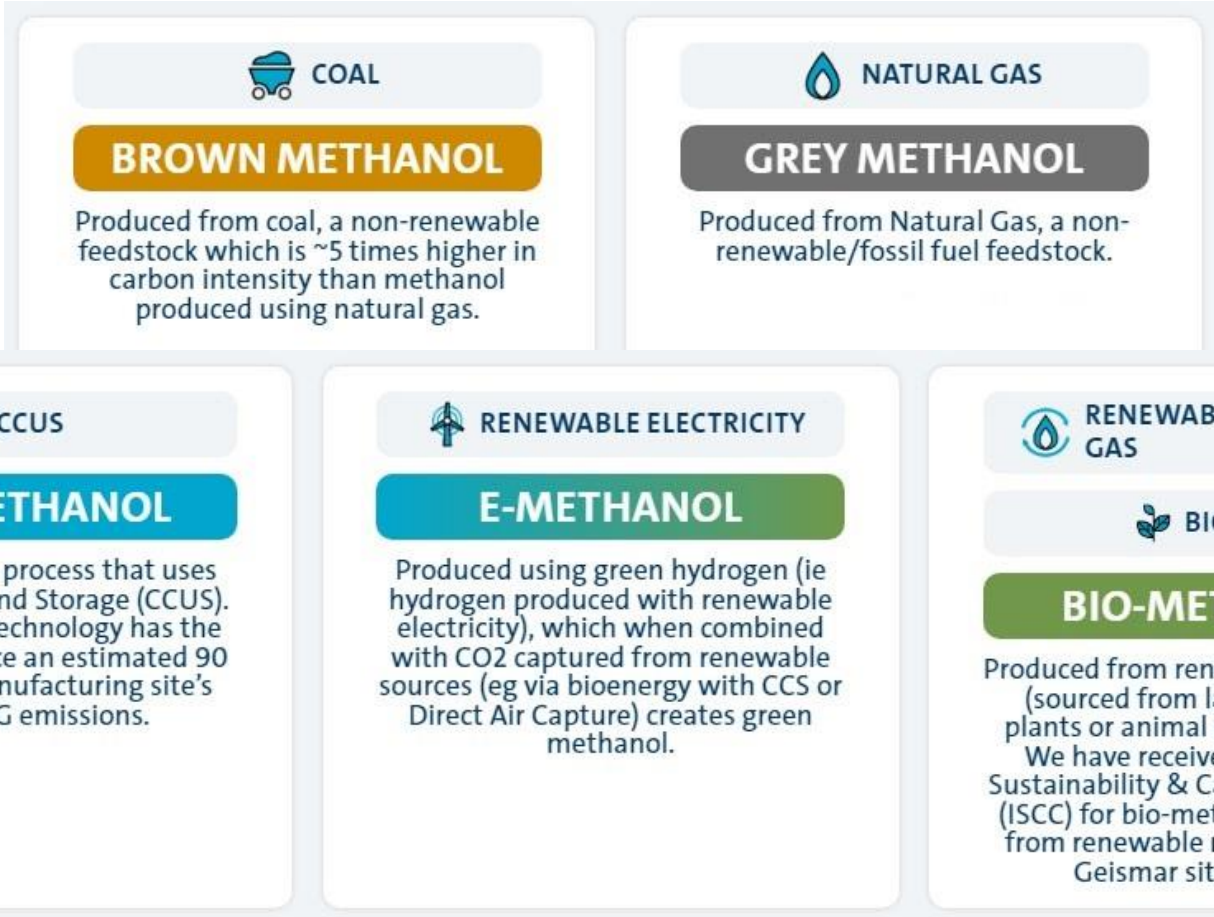
Renewables

Methanol Synthesis Routes from Hydrocarbons




Methanol production (Mt)
E-methanol
Bio-methanol
Fossil methanol
500
400
300
200
100
0
100 Mt
250 Mt
135 Mt
115 Mt
2020
2050

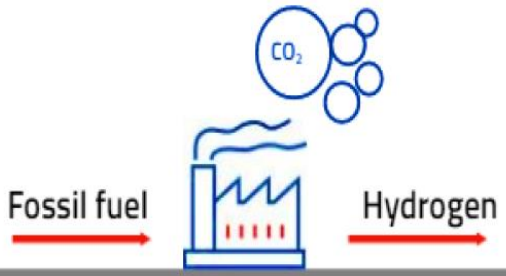
Types of Methanol



Types of Hydrogen

Grey hydrogen

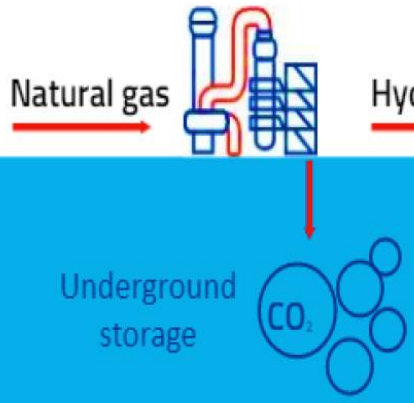
Steam methane reforming (SMR) of natural gas



- Steam methane reforming of natural gas
- 95% of all current H_2 production
- 9-10 kg of CO_2 emissions for each kg of H_2
- SMR: TRL 9

Blue hydrogen

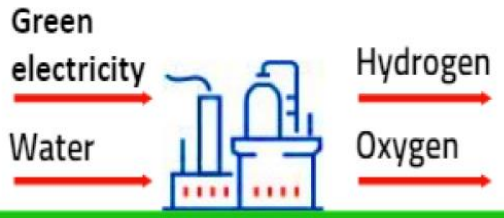
SMR with carbon capture and storage (CCS)



- Not yet practiced, but significant attention lately
- CC(U)S: TRL 8

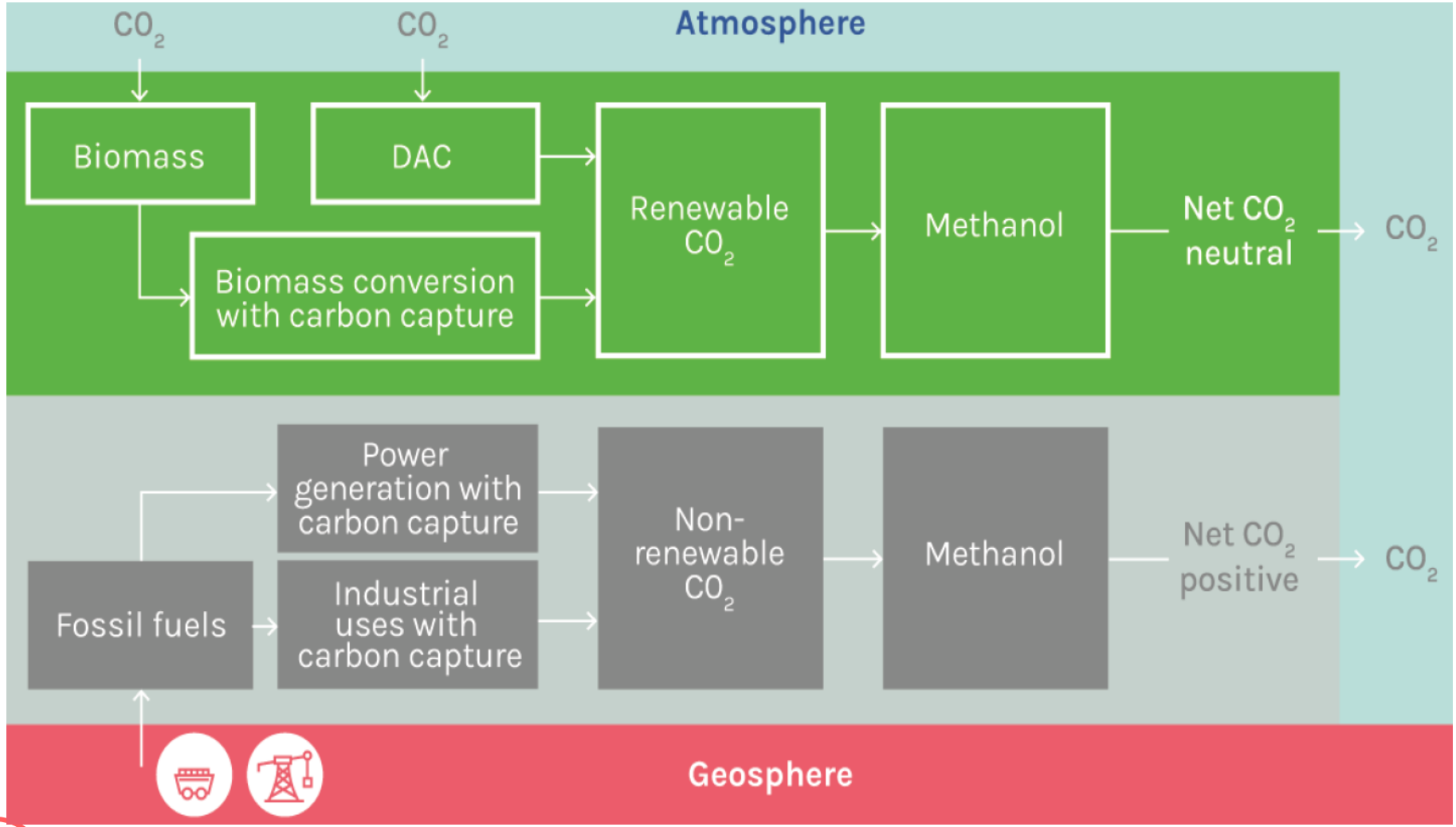
Green hydrogen

water electrolysis (AEM/PEM)

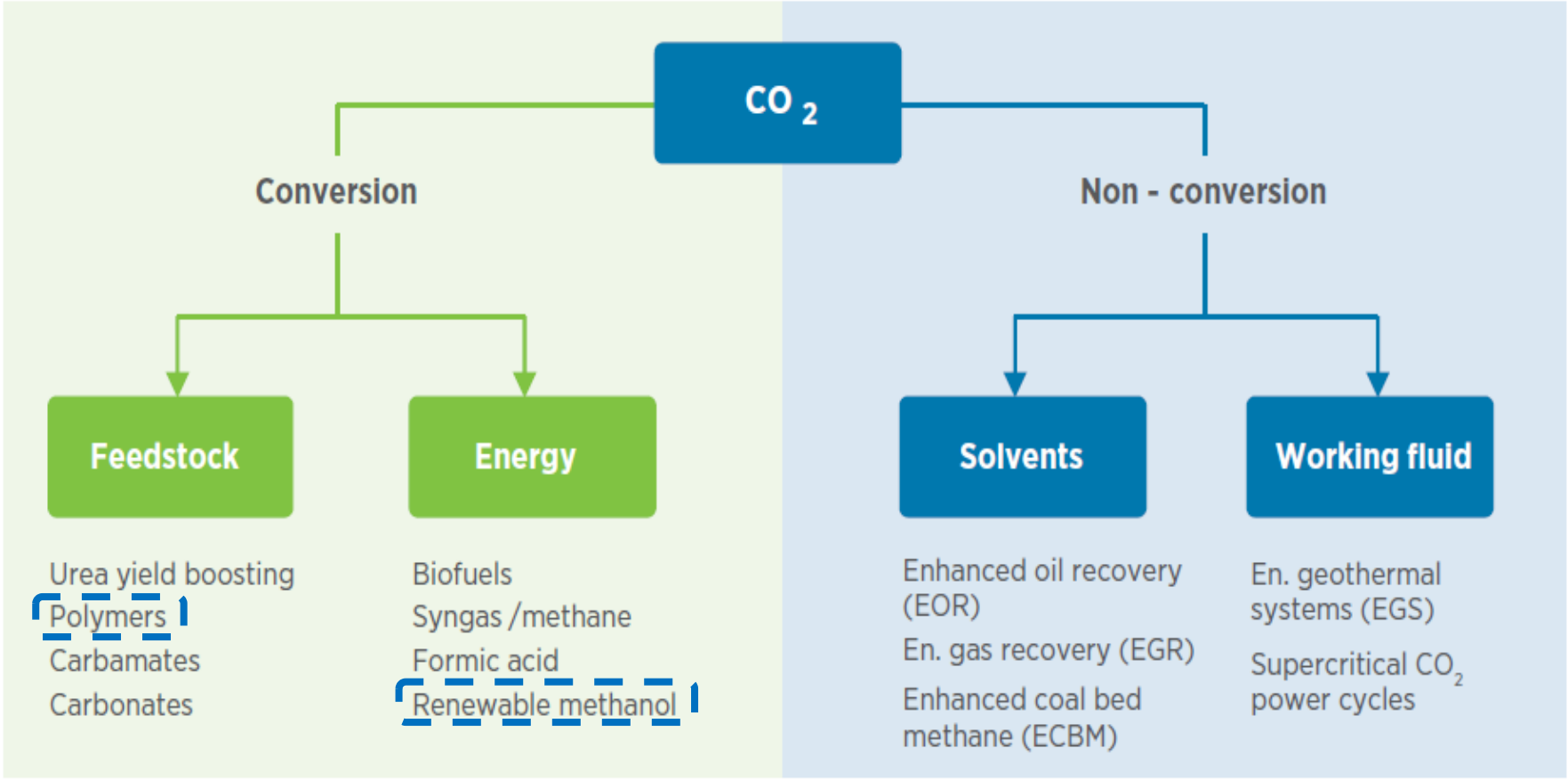


- Water electrolysis is a derivative of proven chlorine electrolysis, with decades of experience

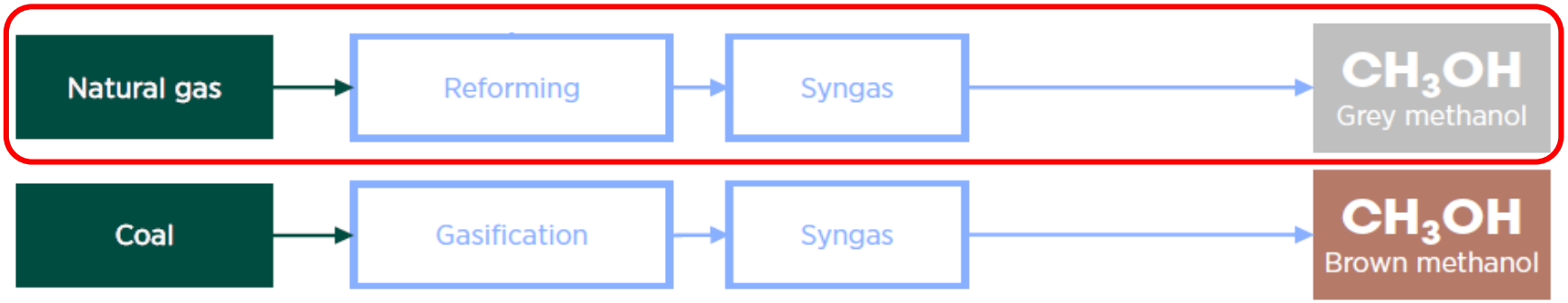
Types of CO_2


CO_2
CO_2
Atmosphere
Biomass
DAC
Biomass conversion with carbon capture
Renewable CO_2
Methanol
Net CO_2 neutral
CO_2
Power generation with carbon capture
Fossil fuels
Industrial uses with carbon capture
Non-renewable CO_2
Methanol
Net CO_2 positive
CO_2
Geosphere

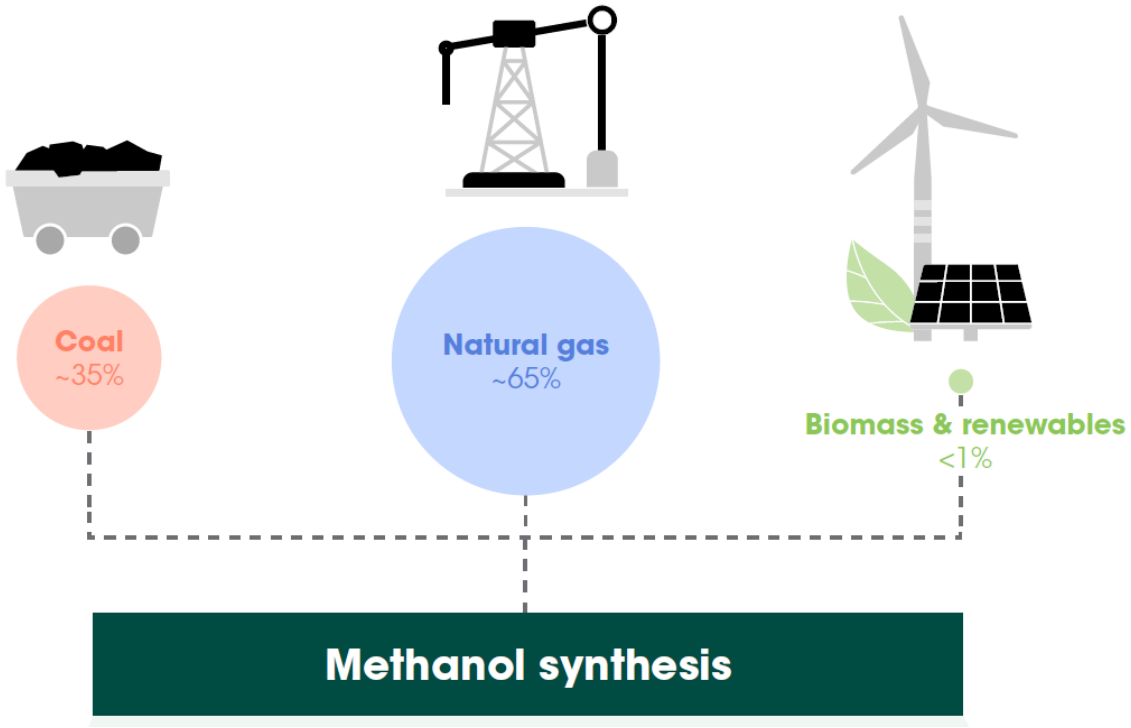
Utilizing of Absorbed CO_2



Methanol Synthesis Routes



Methanol Feedstocks



COAL

BROWN METHANOL

Produced from coal, a non-renewable feedstock which is ~5 times higher in carbon intensity than methanol produced using natural gas.

NATURAL GAS

GREY METHANOL

Produced from Natural Gas, a non-renewable/fossil fuel feedstock.

CCUS

BLUE METHANOL

Produced from a process that uses Carbon Capture and Storage (CCUS). Carbon capture technology has the potential to reduce an estimated 90 per cent of a manufacturing site's scope 1 GHG emissions.

RENEWABLE ELECTRICITY

E-METHANOL

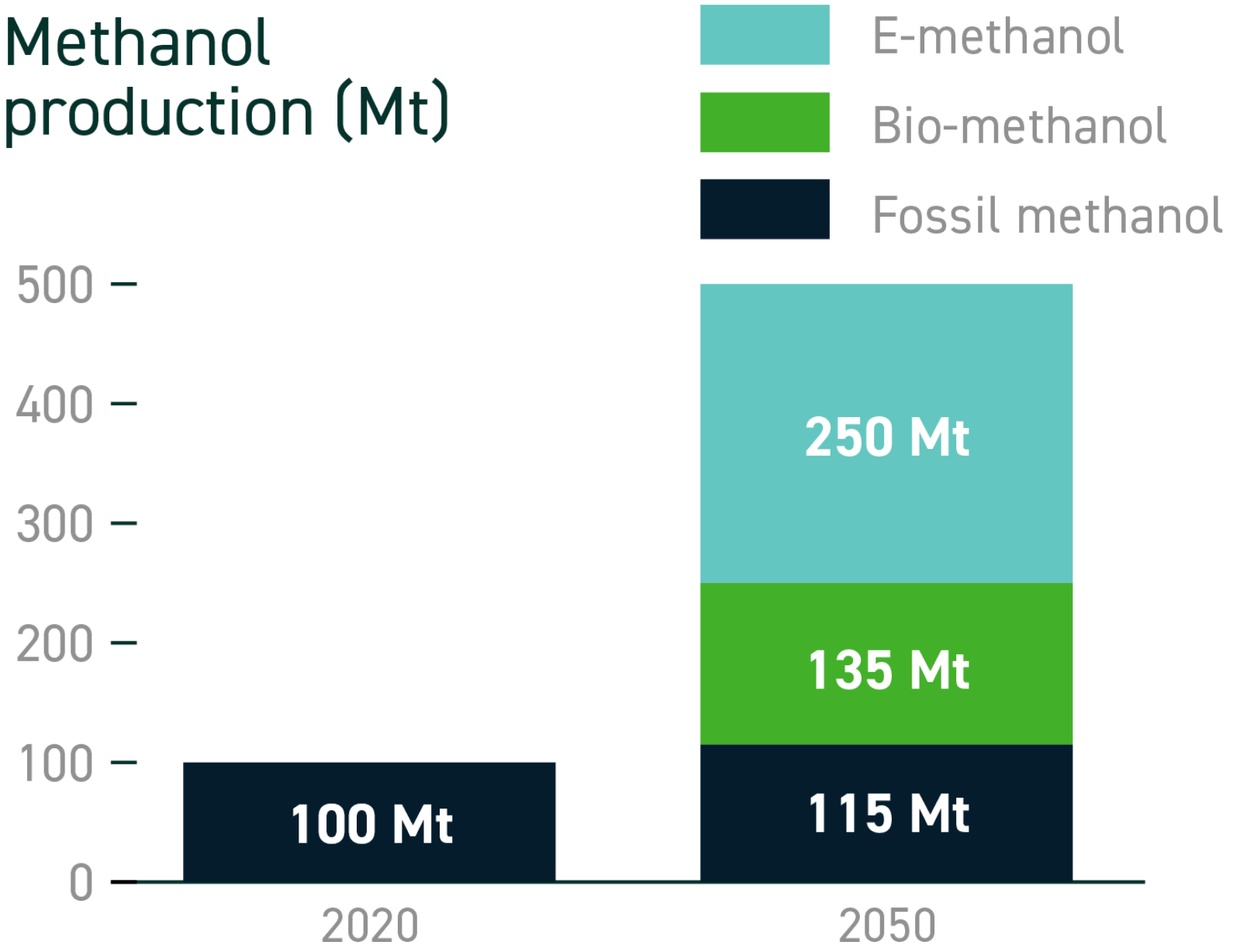
Produced using green hydrogen (ie hydrogen produced with renewable electricity), which when combined with CO2 captured from renewable sources (eg via bioenergy with CCS or Direct Air Capture) creates green methanol.

RENEWABLE NATURAL GAS

BIOMASS

BIO-METHANOL

Produced from renewable natural gas (sourced from landfills, sewage plants or animal manure farms) -> We have received International Sustainability & Carbon Certification (ISCC) for bio-methanol production from renewable natural gas at our Geismar site in the U.S.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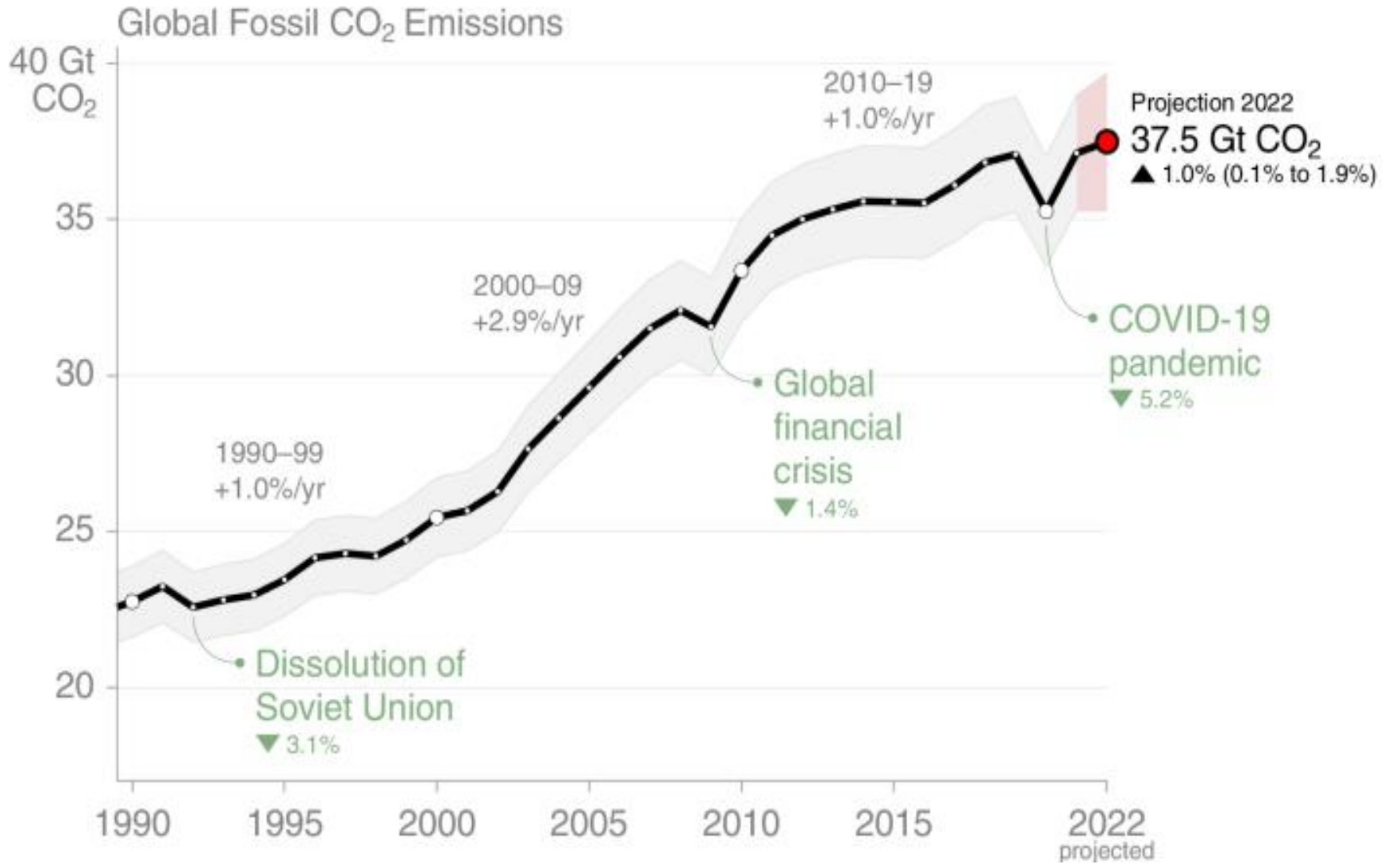
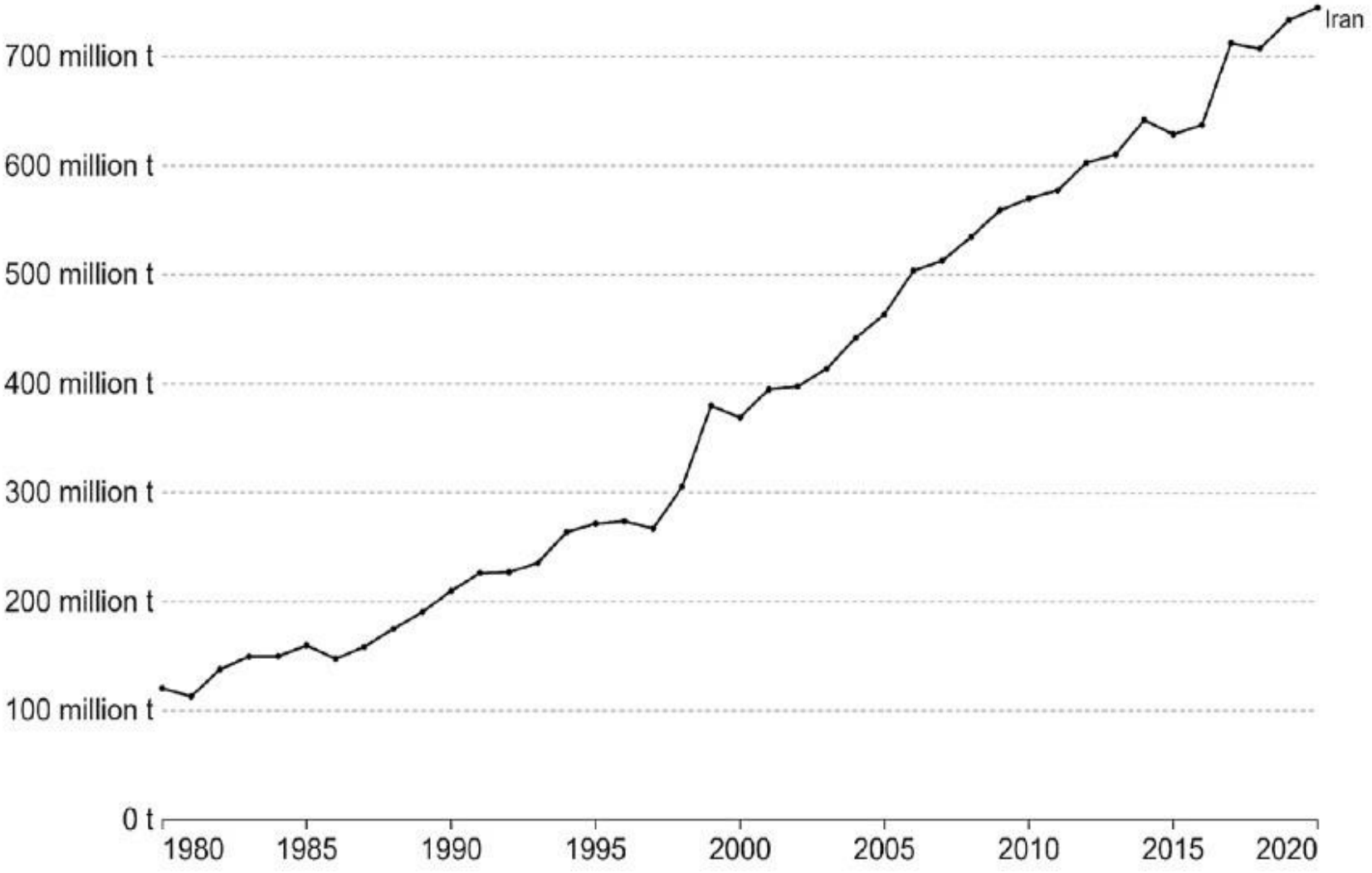
E-methanol
Bio-methanol
Fossil methanol
500
400
300
200
100
0
250 Mt
135 Mt
115 Mt
100 Mt
2020
2050

World CO_2 Emissions

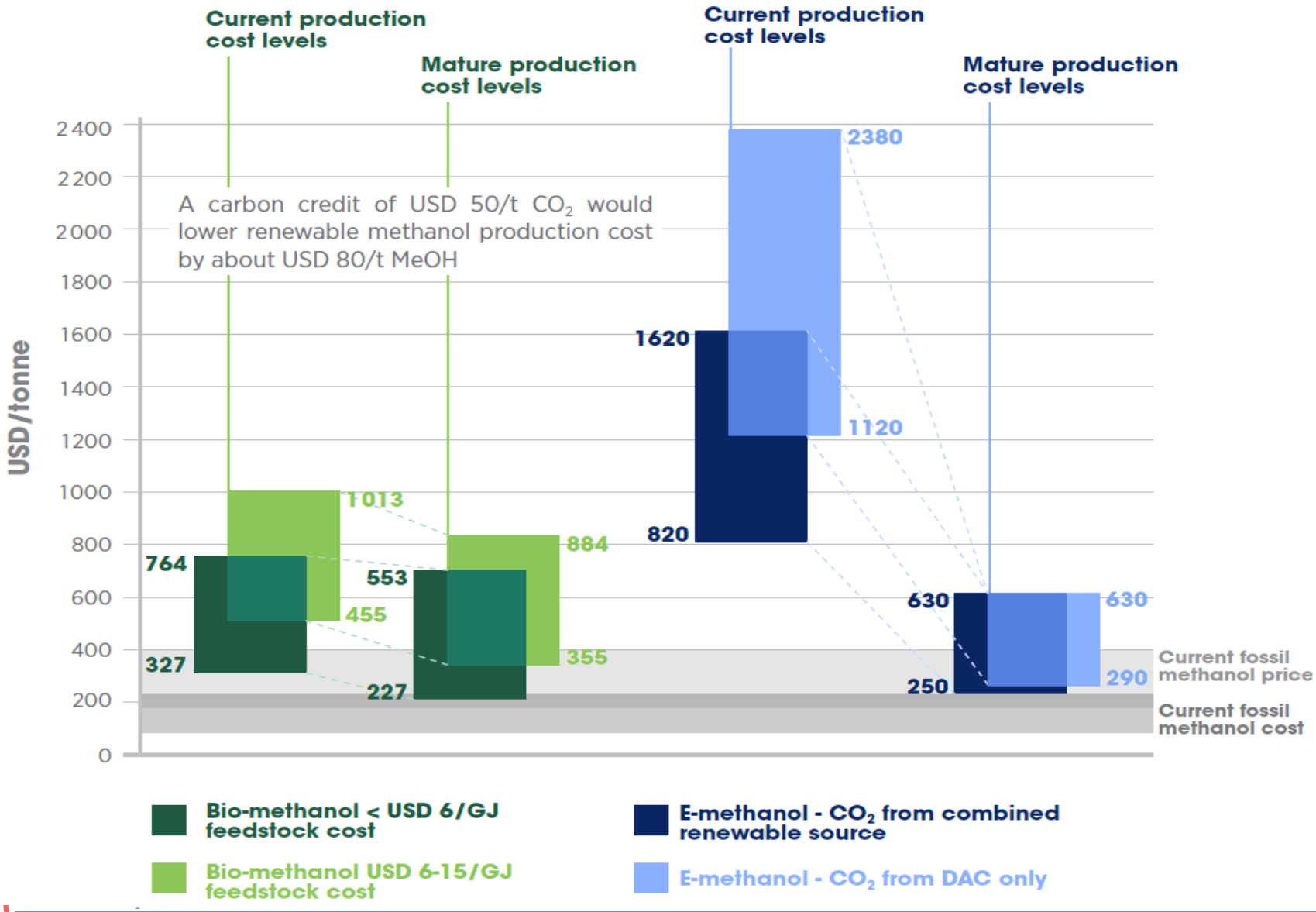


Annual CO_2 emissions

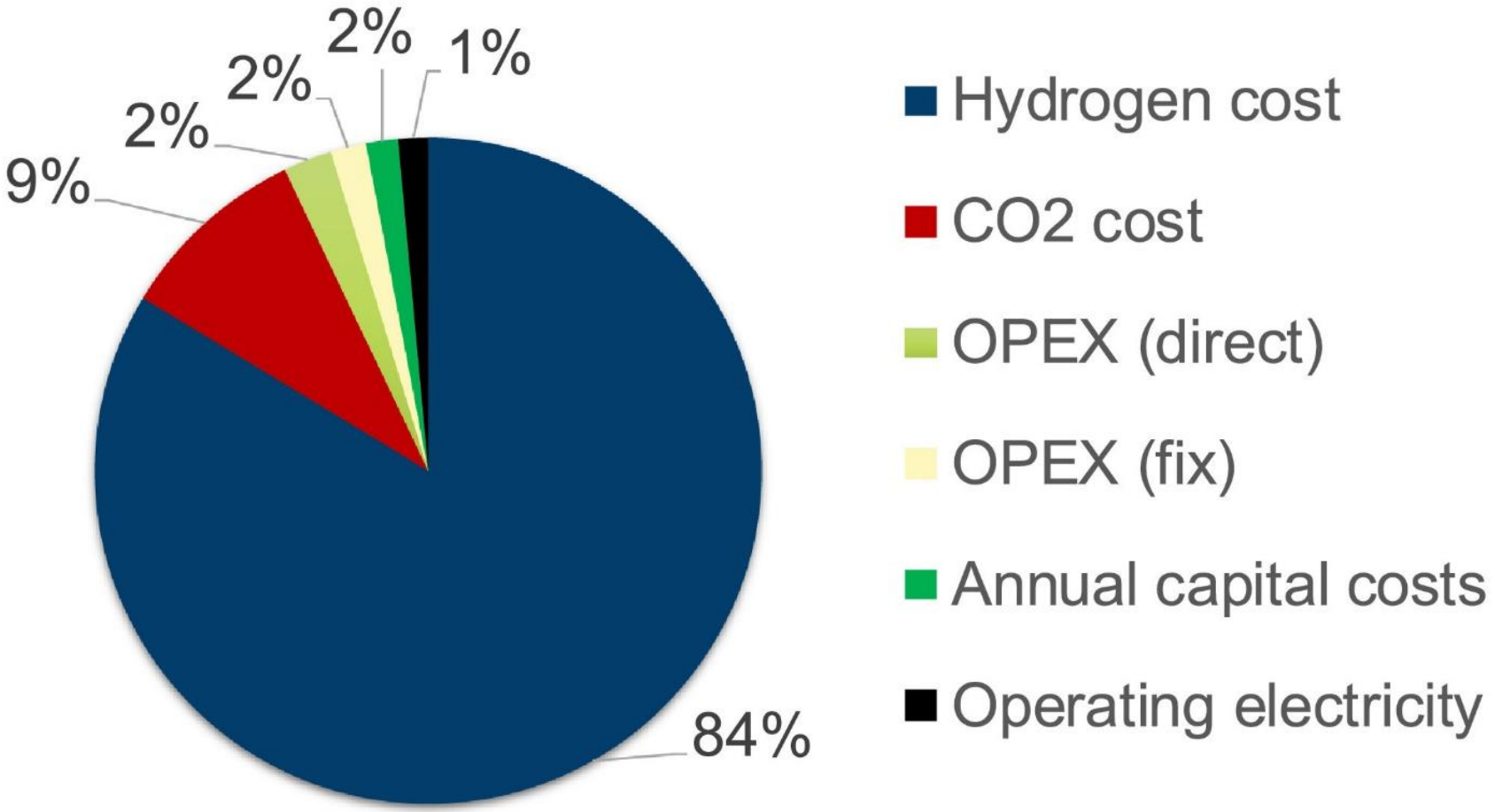
Carbon dioxide (CO_2) emissions from the burning of fossil fuels for energy and cement production. Land use change is not included.



Capital/Production Costs Outlook



Renewable E-Methanol Investment



Conclusion

- The production and consumption of Methanol will be five times the current level in the next 25-30 years.
- Production of plastics via Methanol using MTP/MTO processes continues to increase.
- The use of Methanol as a clean fuel will become one of the biggest uses of Methanol in the near future.
- The cost of Methanol production by renewable methods will decrease significantly in future and become competitive with current methods.
- Methanol synthesized from fossil fuels will be fined In the future and restrictions will be imposed on its purchase and sale. Therefore, a medium-term method can be the converting of Methanol into a value chain product.

Your kind attention is appreciated