

Fluidized bed methanol to gasoline (MTG):

A reliable and cost-effective
solution for production
of renewable gasoline

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Agenda

- Market needs
- MTG feedstocks and chemistry
- ExxonMobil MTG development history
- Process overviews:
MTG fixed bed and MTG fluid bed
- Advantages of fluid bed MTG



NEEDS*

CO₂ emissions
mitigation



Innovation

Speed of change
Evolving regulations



Proven and/or
scalable technology

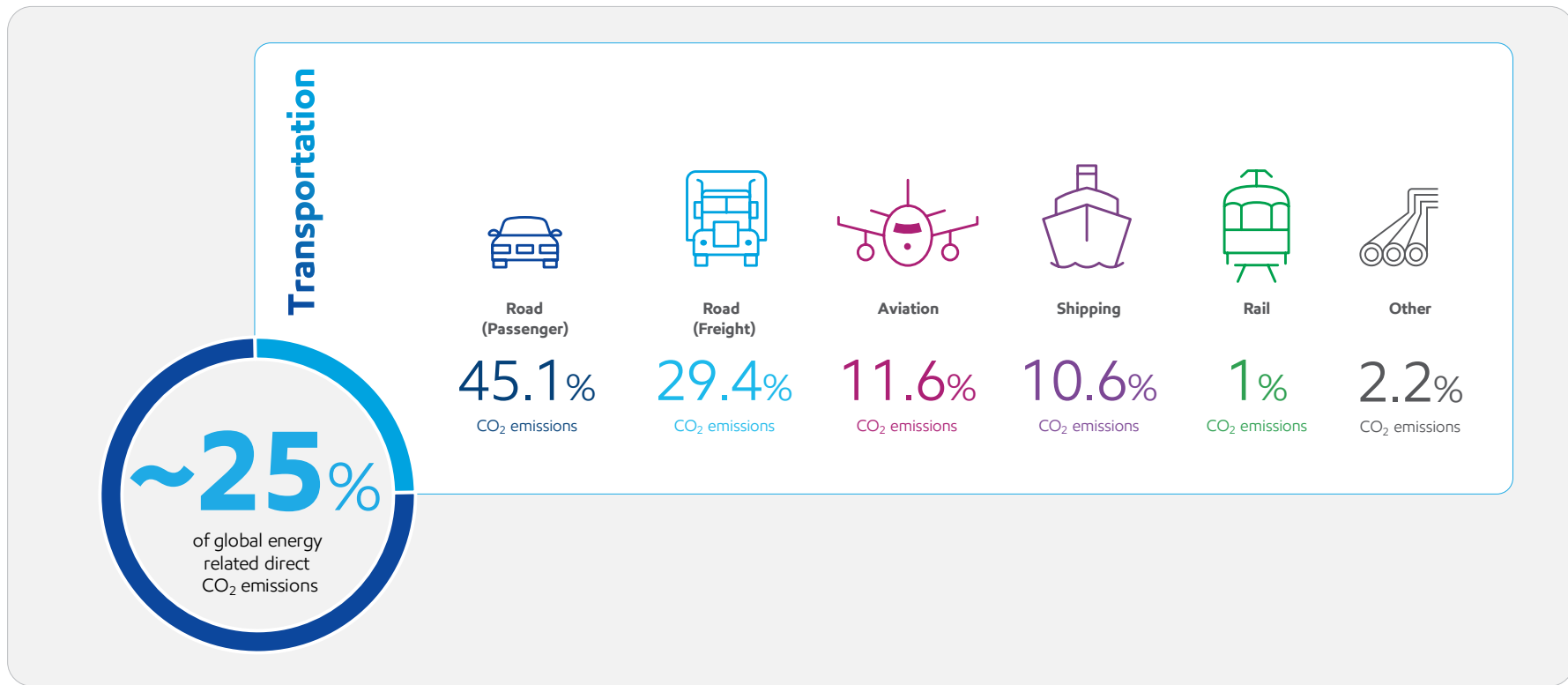
Affordability



Lower system cost

POTENTIAL
SOLUTIONS

Transport sector emissions



Technologies that can enable renewable fuels

*Advancing
the development
and use of
technologies for
lower-emission
fuels*

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Licensing (C&L)**

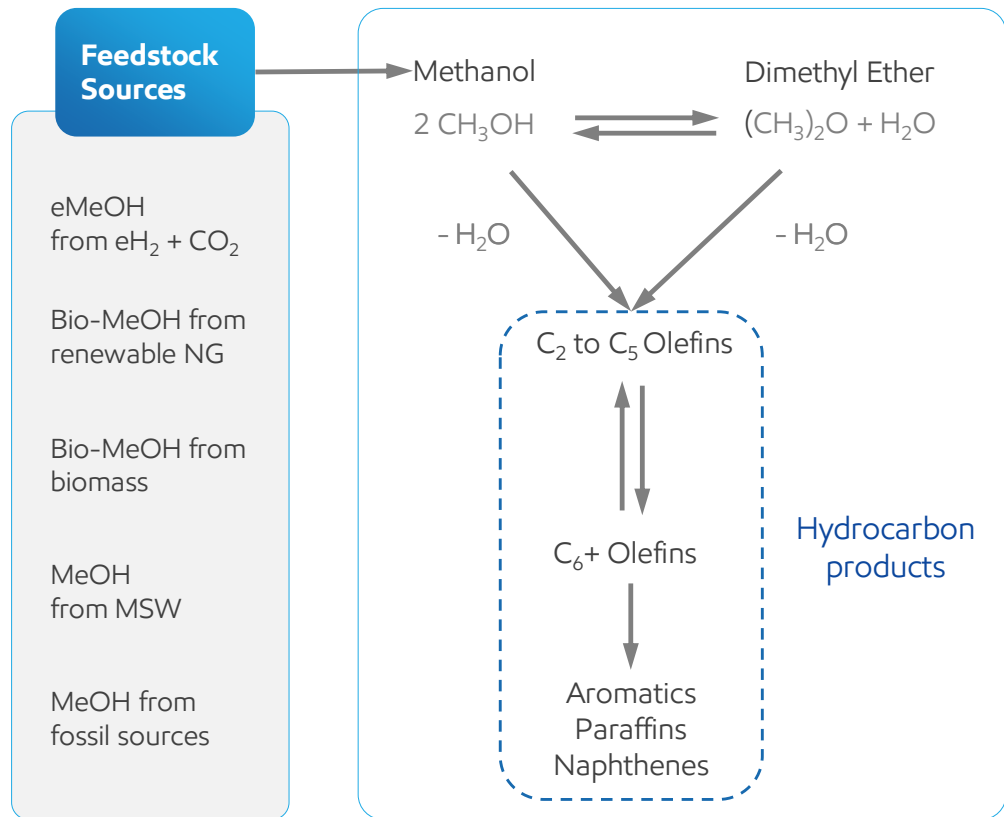
Renewable (distillate) fuel technologies:

- Bio-Isomerization Dewaxing (**BIDW™**) catalysts
- ExxonMobil Renewable Diesel Process (**EMRD™**)
- Flexibility to tailor the amount of jet fuel vs. diesel

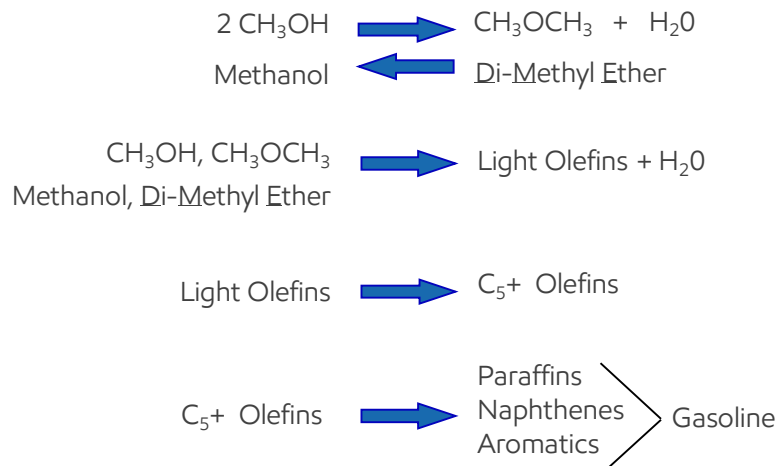
Renewable methanol to gasoline technologies:

- Fluid bed Methanol To Gasoline (FL-MTG)

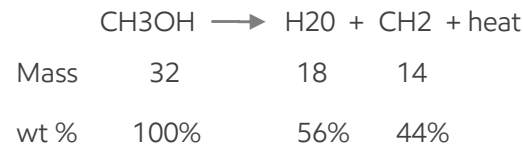
Methanol feedstocks and chemistry



MTG Reactions



Theoretical Chemistry



ExxonMobil MTG development history

Early 1970s

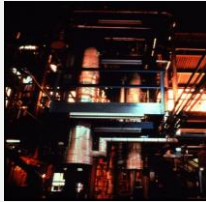
Bench Scale



- ZSM-5 Zeolite catalyst discovered
- ZSM-5 catalyst limits synthesis reactions to gasoline range hydrocarbons

Late 1970s

4 BPD Pilot Unit



- Mobil studied Fixed Bed and Fluid Bed MTG options at 4 BPD MeOH pilot plant scale

Early 1980s

100 BPD Demo Unit



- 100 BPD Fluid Bed MTG Unit was built in Germany
- Considered "Technically Ready"

1985 - 2016

Fixed Bed Commercial Scale



New Zealand, 1985-1997|

- 14.5 KBD MTG

JAMG-1, China, S/U 2009

- 2.5 KBD MTG

JAMG-2, China, 2016,

- 12.5 KBD X 2

2014 - 2017

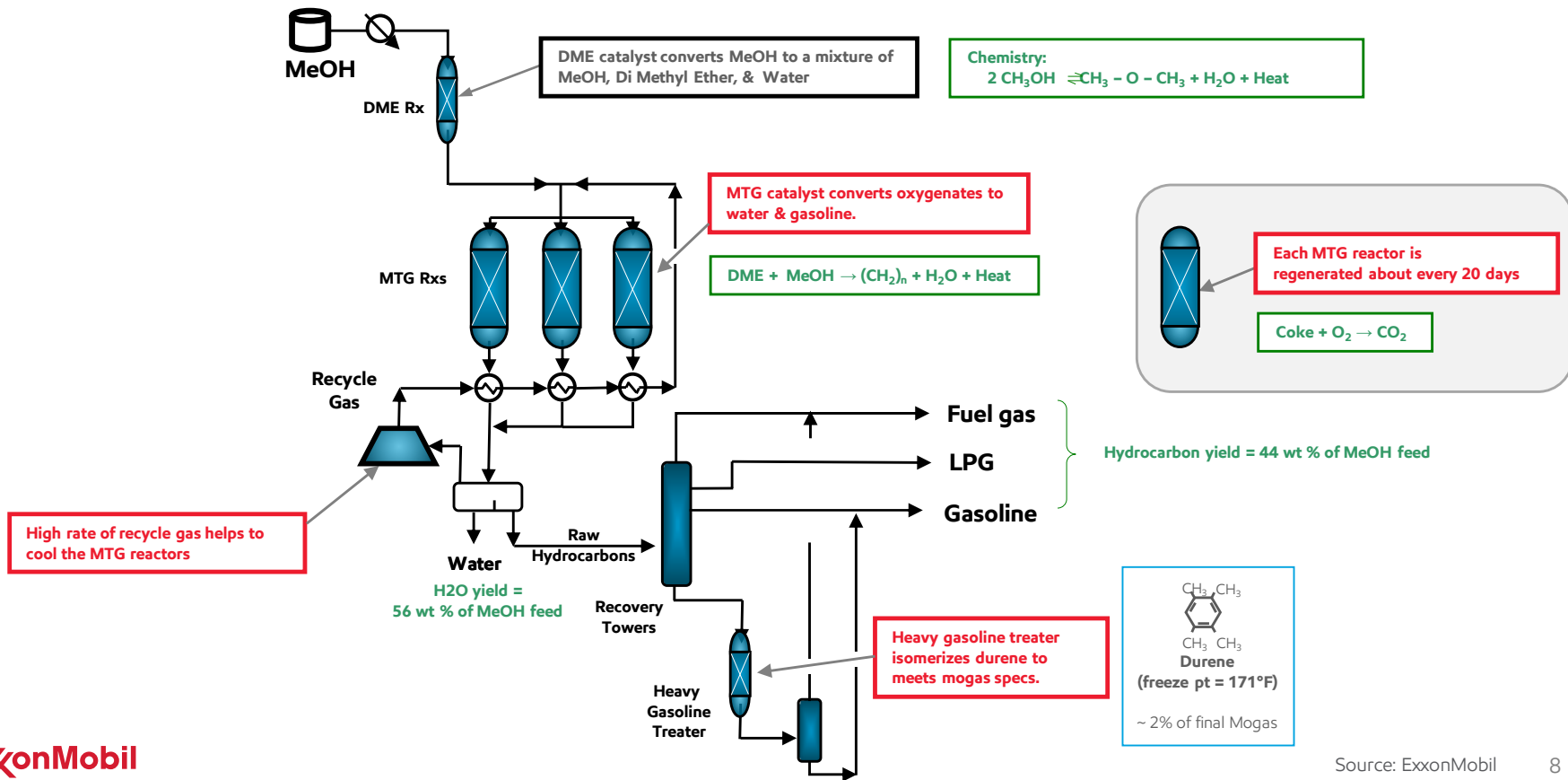
Fluid bed Path to Commercialization



- ExxonMobil and SEG Fluid Bed CDA, 2014 -2017
- Considered "Technically Ready"

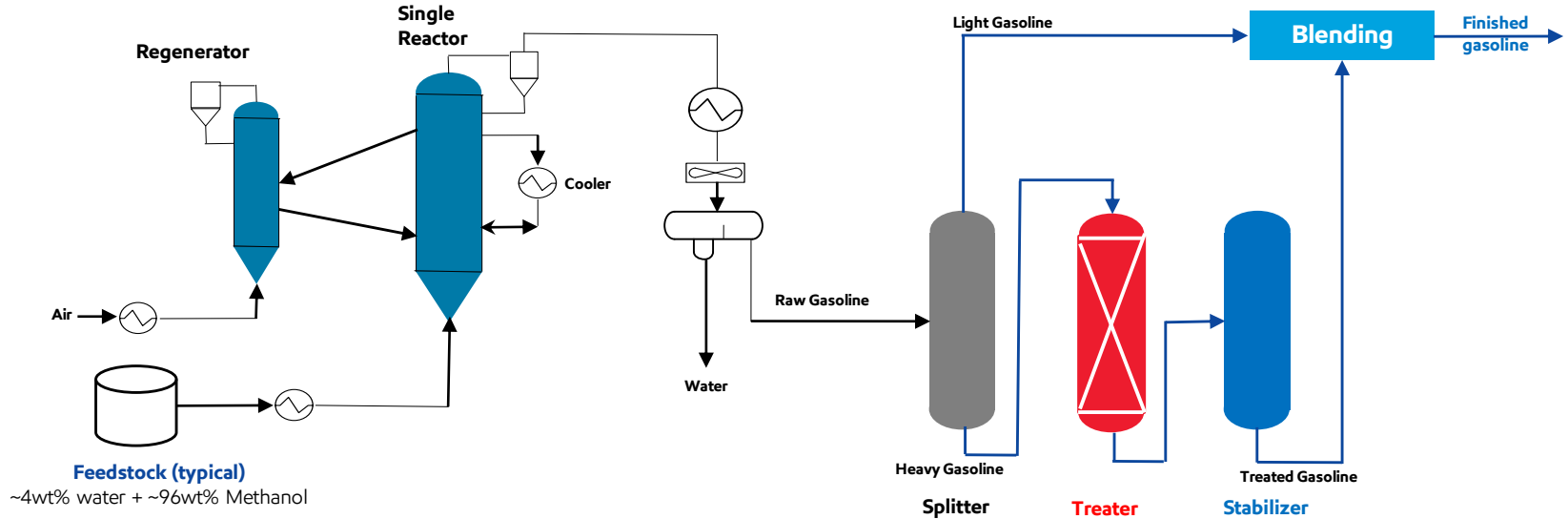
Process Overview – Fixed Bed MTG

(older design, for reference)



Process Overview – Fluid Bed MTG

(offered by ExxonMobil)



Property of MTG gasoline

Typical values

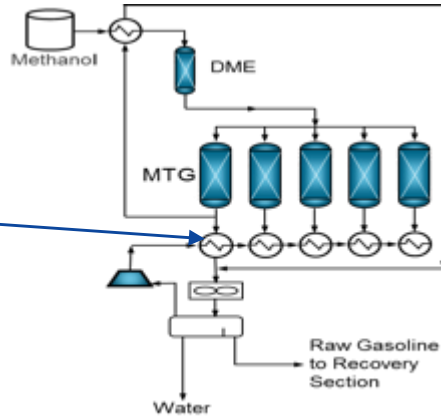
Octane number, RON	92 – 95
Octane number, MON	82 – 85
Aromatics, vol%	25 – 35
Olefins, vol%	10 – 14
Benzene, vol%	≤ 0.3
Durene, wt%	≤ 2
Sulfur, mg/Kg	≤ 10
Final boiling point (FBP), deg C	200 – 210

Significantly simplified process with lower CAPEX

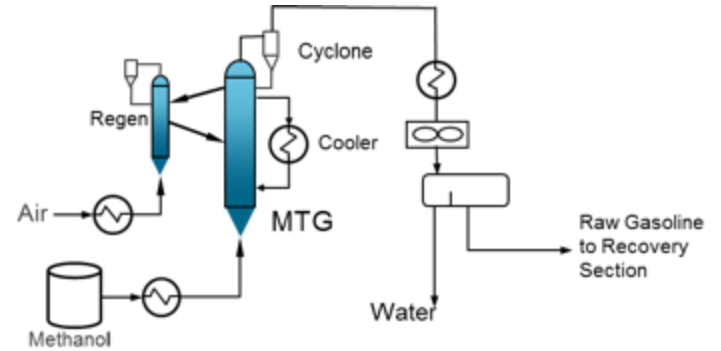
Recycle Gas
Heat Exchangers
(for a 14.5 kbd unit)



Fixed bed



Fluid bed



Higher operation reliability with lower Operating Costs

	Fixed bed	Fluid bed	Fluid bed benefit
Operating pressure	~300psi	~70psi	Less energy consumption
Catalyst age monitoring	Requires rigorous programming and operation expertise to manage each reactor's catalyst age / cycle length	Continuously add make-up small amount of catalyst to maintain activity	Easier catalyst management
Gasoline yields & quality control	<ul style="list-style-type: none"> • Very complicated at managing the variability of product yields & quality by monitoring sequencing / regeneration of each reactor • Difficult to maintain the steady state yields & quality 	Stable product quality due to the steady state mode	Easier production process control
Heat integration	Require very large heat exchangers for recycle gas quench due to low gas/gas heat transfer	High pressure steam generation	More efficient quench
Stream factor	~91%	Expected to be similar to FCC unit	Higher availability

Fluid Bed MTG Advantages

Compared to fixed bed MTG, fluid bed MTG demonstrates following advantages:



**Lower
CAPEX**

Single reactor/regenerator
Significant reduction in equipment/piping



**Lower
Operating Cost**

Less recycle gas
Better heat integration
Lower power consumption



**Higher operation
reliability**

More efficient quench
Less switching of reactors
Lower operating pressure

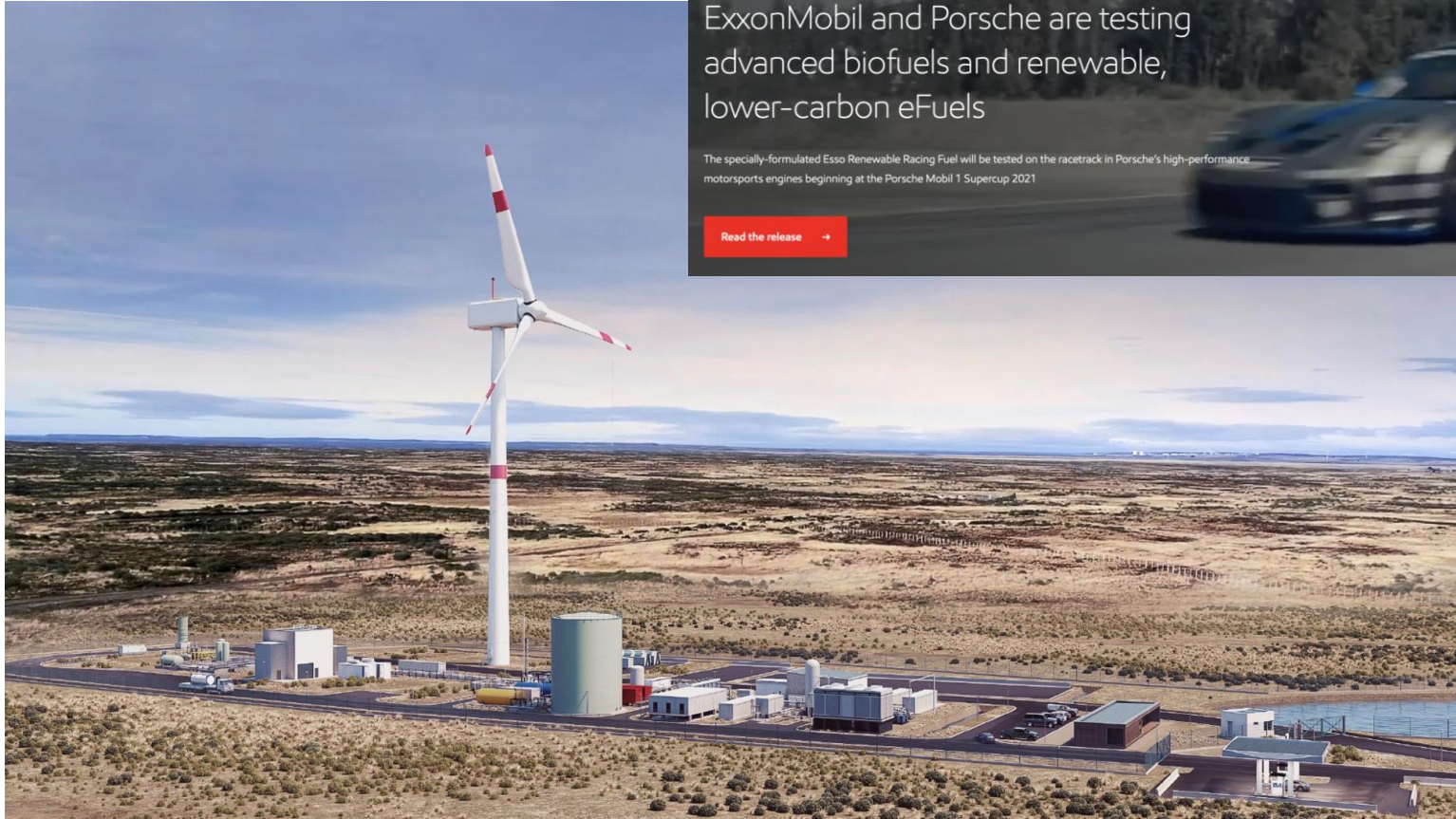


**Steady product
yields & quality**

Steady state operation mode
Catalyst maintained in steady active state

Scalable Methanol to Fuels Conversion Technology

Haru Oni Project in Chile



EMERGING VEHICLE AND FUEL TECHNOLOGY

ExxonMobil and Porsche are testing advanced biofuels and renewable, lower-carbon eFuels

The specially-formulated Esso Renewable Racing Fuel will be tested on the racetrack in Porsche's high-performance motorsports engines beginning at the Porsche Mobil 1 Supercup 2021

[Read the release](#) →

Positioning for a lower carbon energy future

ExxonMobil is advancing sustainable, effective solutions that address the world's growing demand for energy and the risks of climate change

MTG process technology

EMRD™ process technology

BIDW™ catalyst solutions

Our approach includes:



PROVIDING PRODUCTS TO
HELP CUSTOMERS REDUCE
THEIR EMISSIONS



DEVELOPING AND
DEPLOYING SCALABLE
TECHNOLOGY SOLUTIONS

Thank you!

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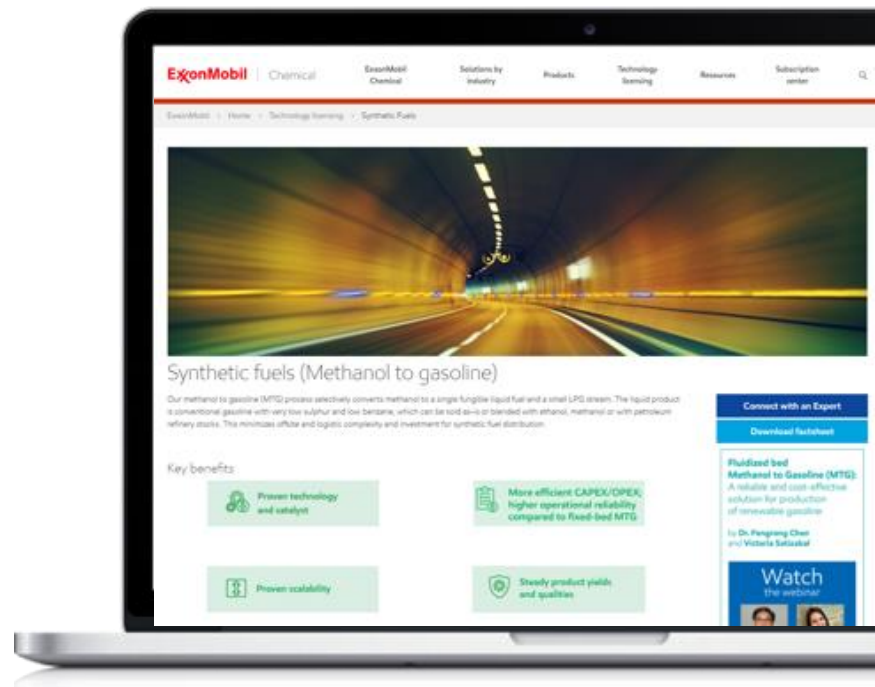
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