METHANOL INSTITUTE

Methanol, from electrons to engines

Eelco Dekker, Chief EU Representative

Methanol Institute

Turin, June 6th, 2018

01 Who we are

A global industry association

- First formed in 1989, the Methanol Institute (MI) serves as the trade association for the global methanol industry.

- MI represents the world's leading methanol producers, distributors and technology companies from offices around the world

MI provides value to its members by:

- Ensuring safe handling of methanol and its derivatives
- Promoting methanol growth by furthering methanol as an essential chemical commodity and an emerging source of clean and renewable energy
- Influencing global regulatory and public policy initiatives that impact the methanol industry

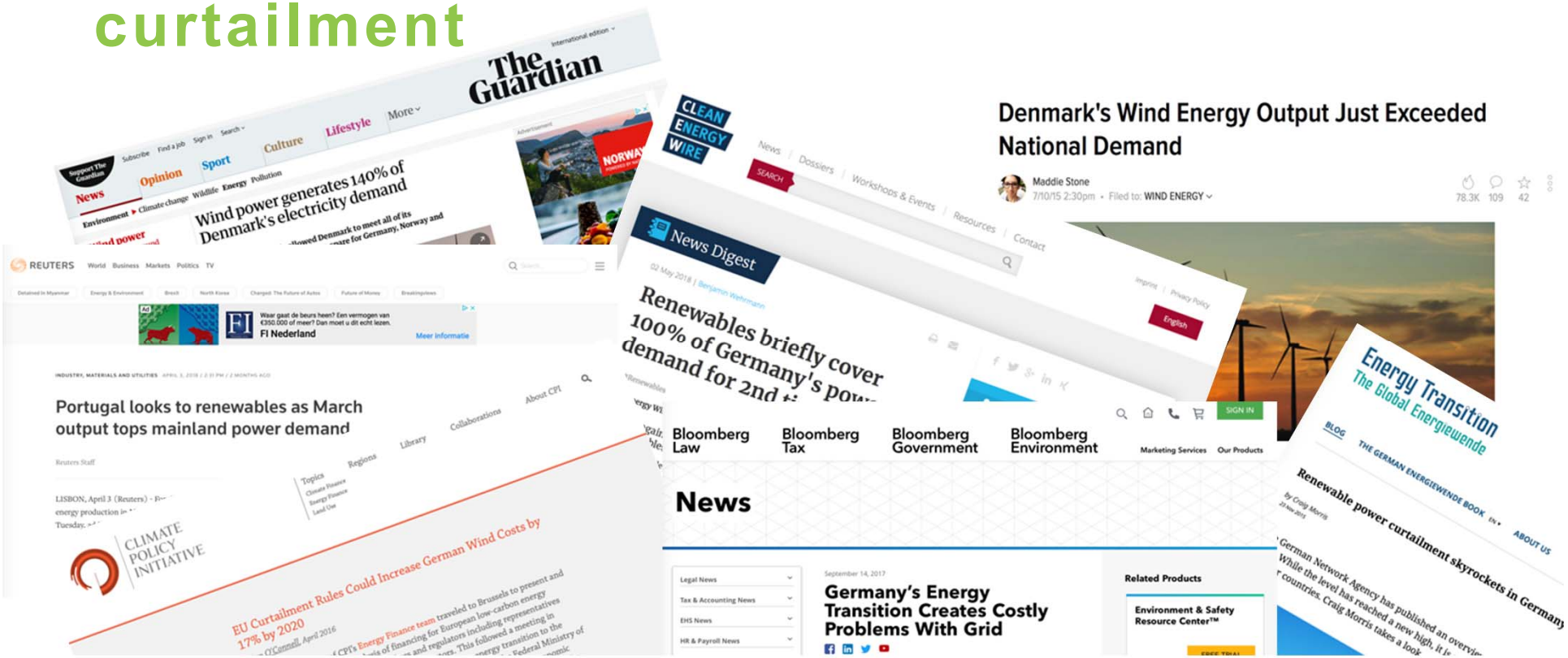
2018 members

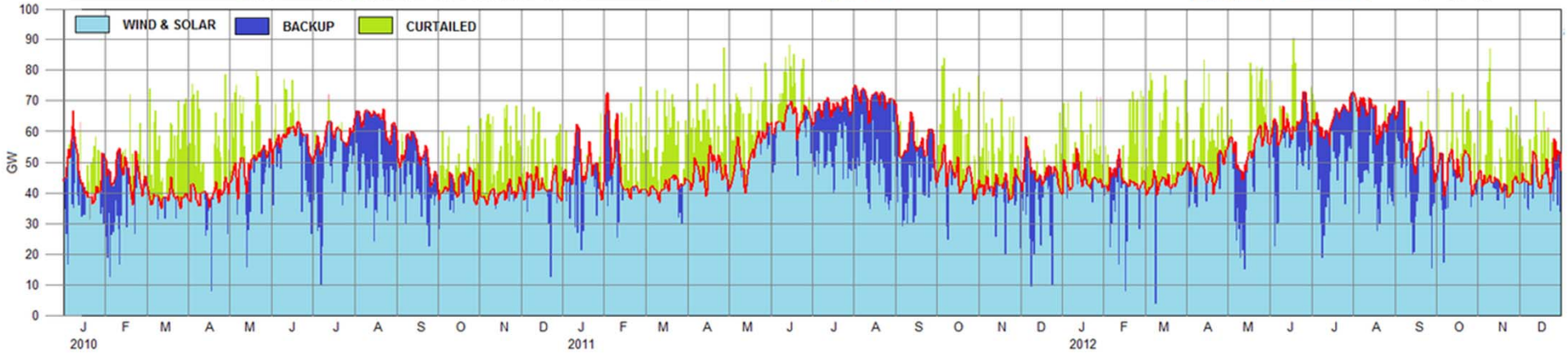
methanex the power of agility
MHTL METHANOL HOLDINGS (TRINIDAD) LTD.
سابك sabic
ATLANTIC METHANOL
Mitsubishi Gas Chemical America, Inc
MITSUI & CO.
OCI
Oman Methanol Company L.L.C.
PETRONAS
كفاك QAFAC
bp
شركة صلالة للميثانول ش.م.م. (المنطقة الحرة) Salalah Methanol Company L.L.C. (SFZ)
G2X ENERGY
JM Johnson Matthey Inspiring science, enhancing life
سبكيم Sipchem
Eni GROUP Ecofuel
Mitsubishi International Corporation
METAFRAX
CARBON RECYCLING INTERNATIONAL
MOL Mitsui O.S.K. Lines
FiTech
HELM
United Chemical Company
IMTT INTERNATIONAL-MATEX TANK TERMINALS
منتجات Muntajat
SCC SOUTHERN CHEMICAL CORPORATION
VITUSA PRODUCTS™ INCORPORATED
Double Green Bridge NW INNOVATION WORKS
azelis
NAKHODKA FERTILIZER PLANT
TRICON ENERGY
Enerkem
Billionmiles
HALDOR TOPSOE
CoogeeEnergy
CLARIANT
solvadis
FUEL FREEDOM FOUNDATION CHEAPER. CLEANER. AMERICAN MADE.

02 Trends drive change

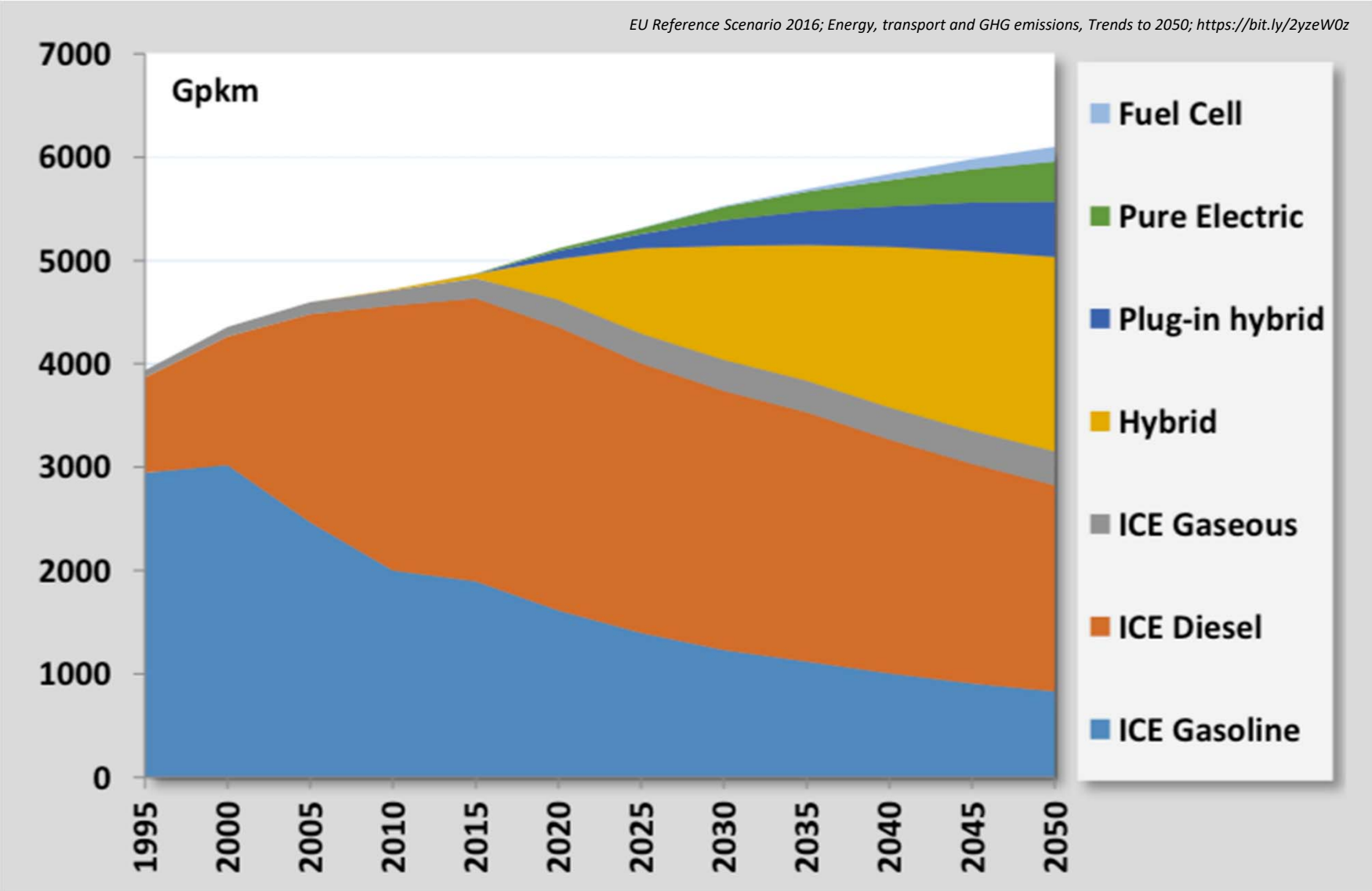

electric
drive

As renewable energy increases, so does curtailment





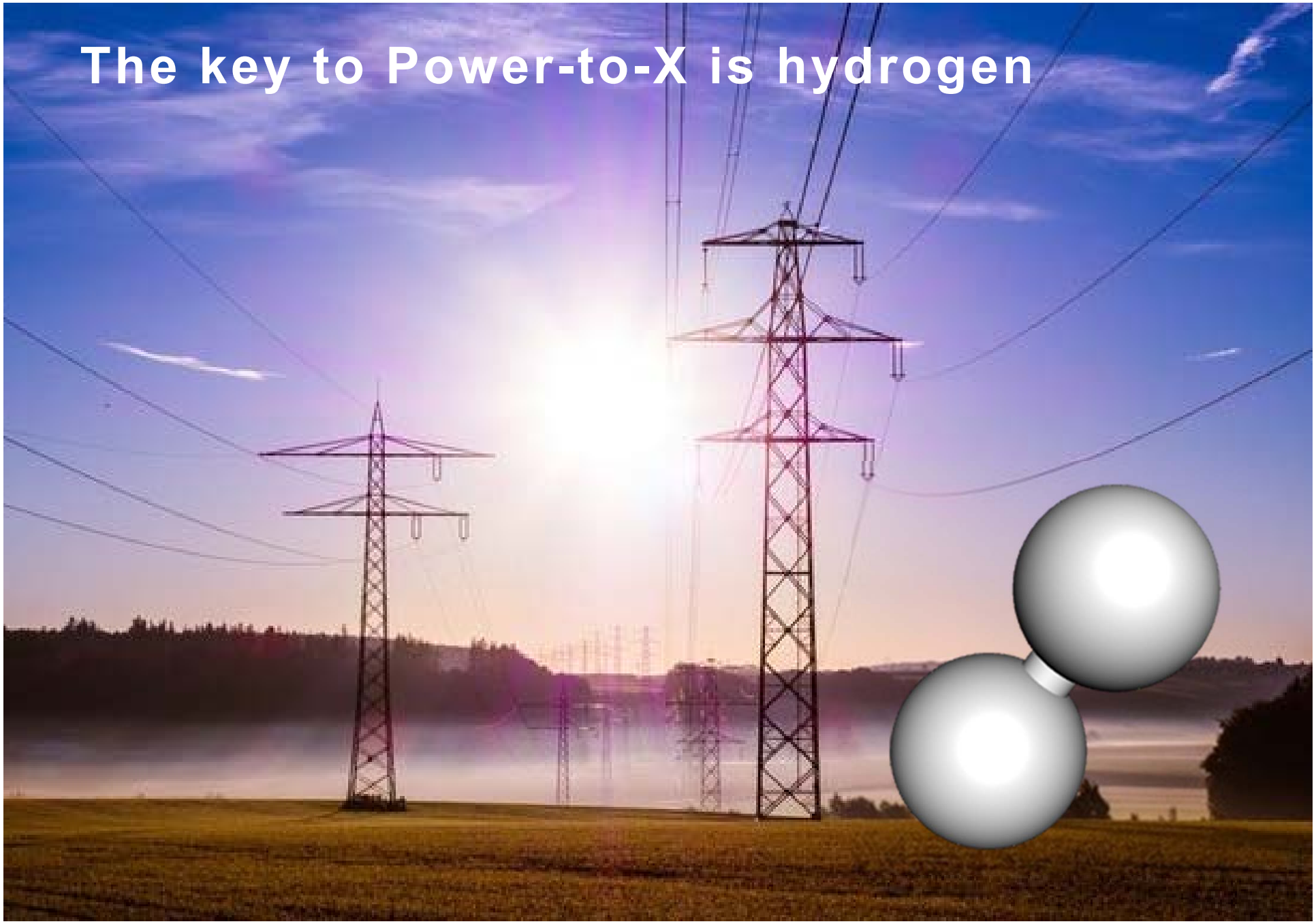
And combustion engines remain dominant




• Power to Methanol
• Methanol fuel

03 Converting electricity to fuel

The key to Power-to-X is hydrogen



PtX and CCU are similar but not the same

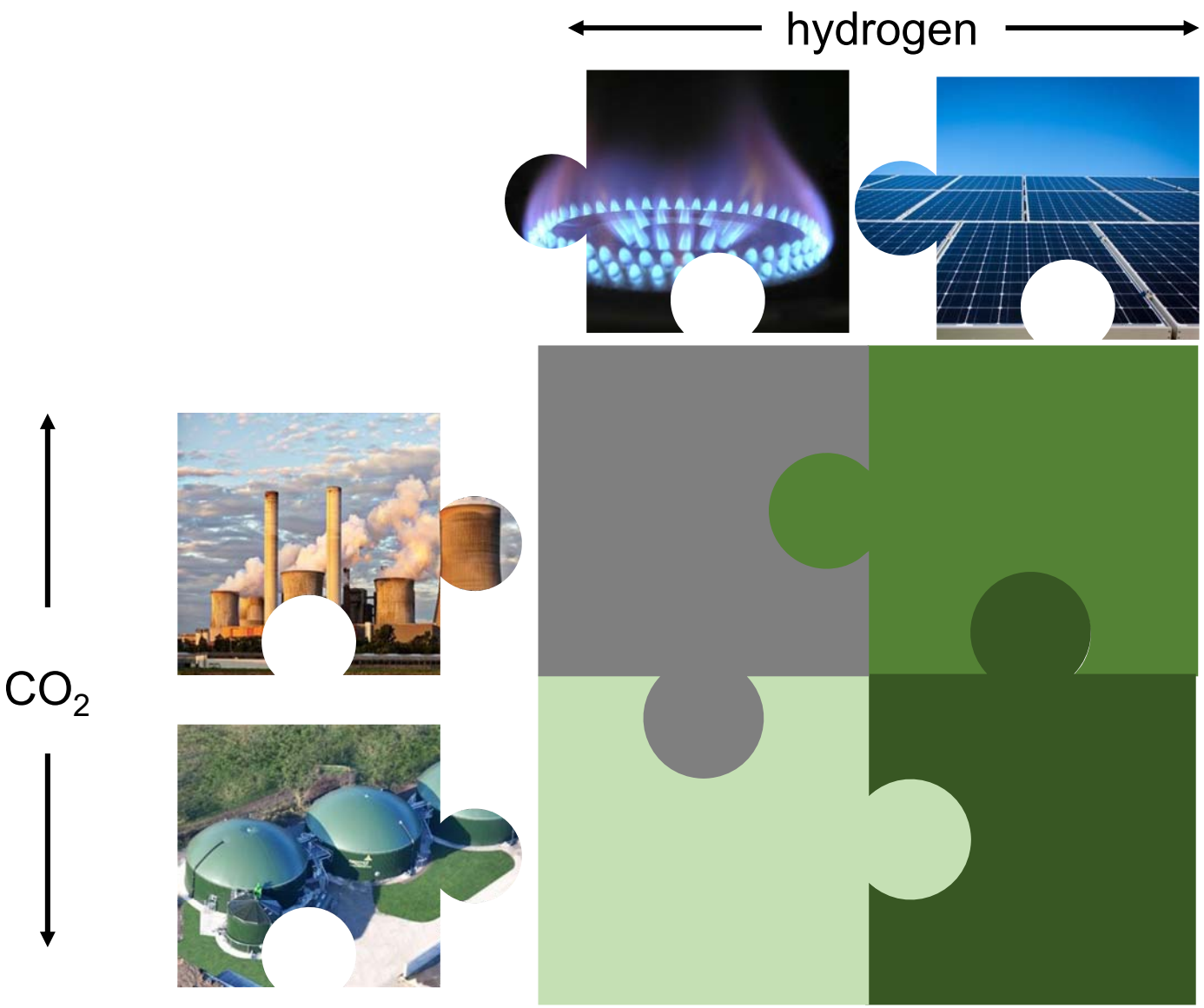
1 Convert electricity to hydrogen

electricity – electrolysis – hydrogen

2 Convert hydrogen to fuel

	gaseous	liquid
-	• hydrogen	
Nitrogen	• ammonia	
Carbon	• methane	• formic acid • methanol • butanol • FT diesel • gasoline • a.o.

Different shades of green

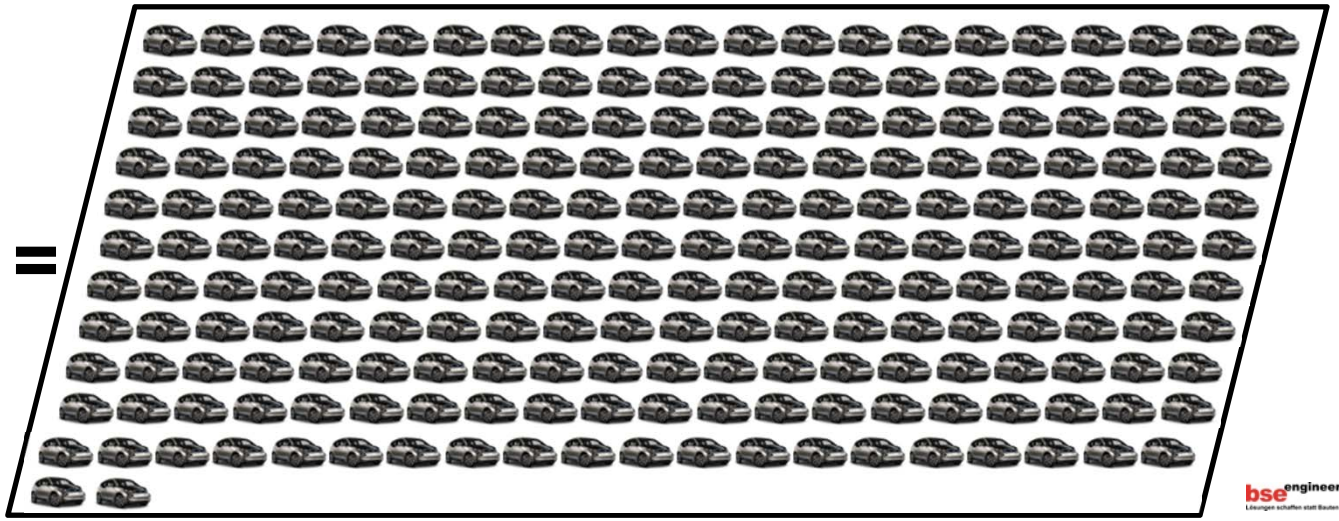


The practical side of energy storage

One cubic meter of e-Methanol contains the same amount of energy as the battery capacity of **222** BMW i3‘s*

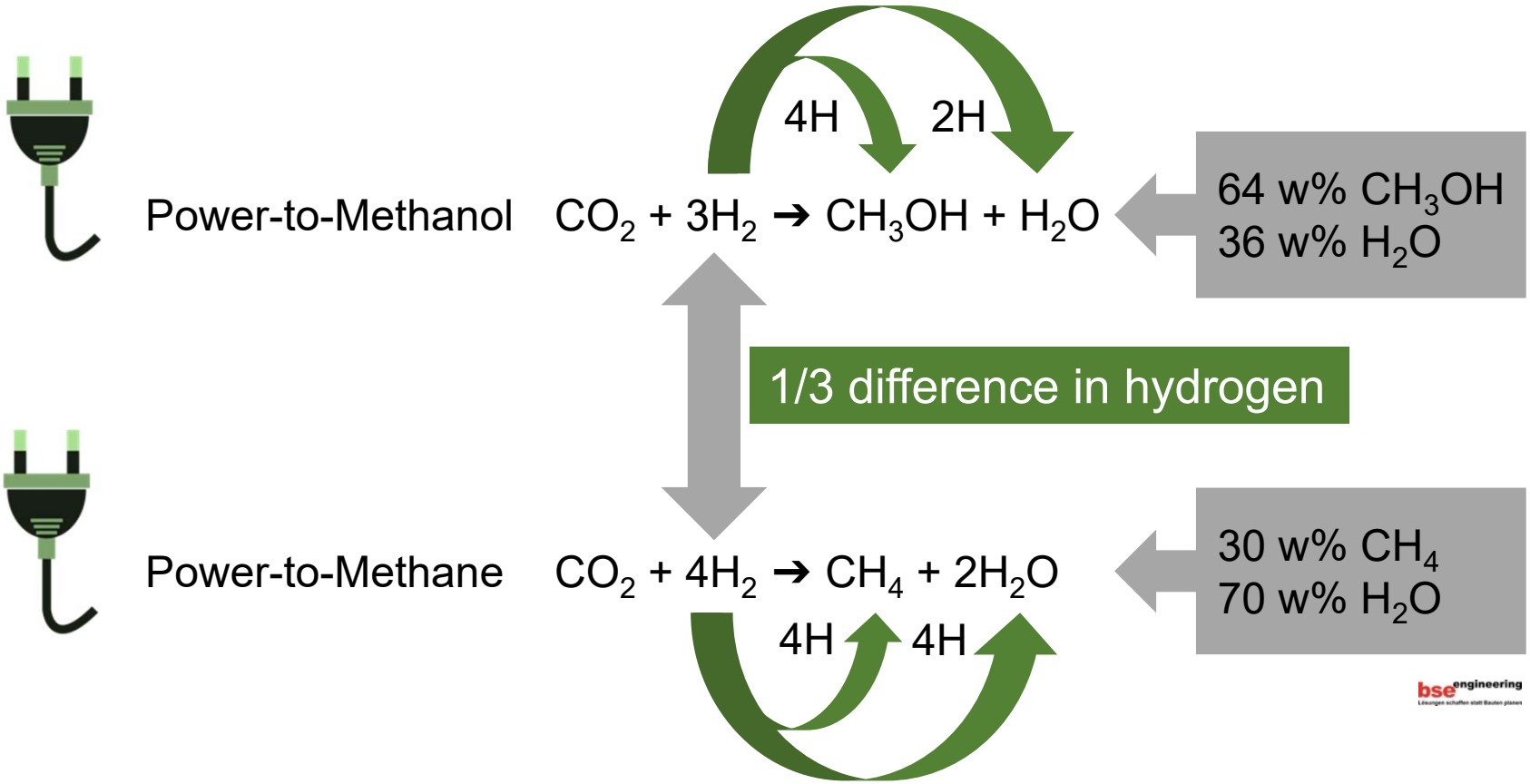
1 Nm³ CH_3OH

=



*Storage capacity BMW i3 = 21,6 kWh

Methanol process requires less hydrogen



Increasing carbon conversion yield

Gevo

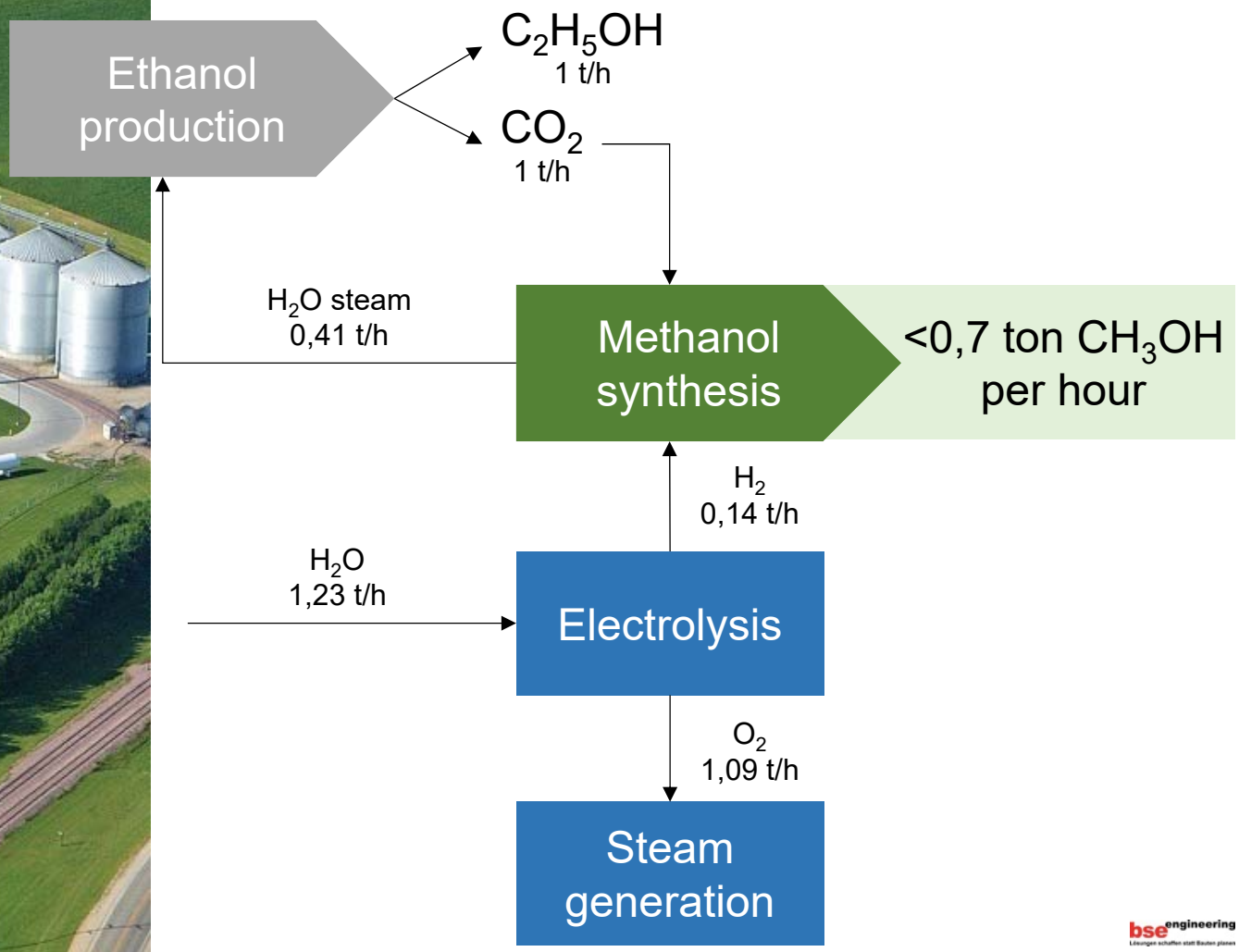
Ethanol production

C_2H_5OH
1 t/h

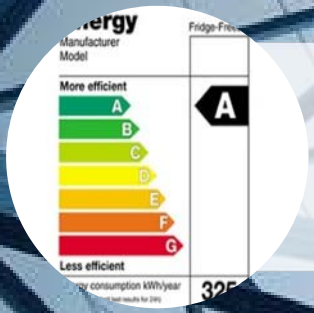
CO_2
1 t/h

Increasing carbon conversion yield

Gevo



Power to methanol benefits



Energy efficiency

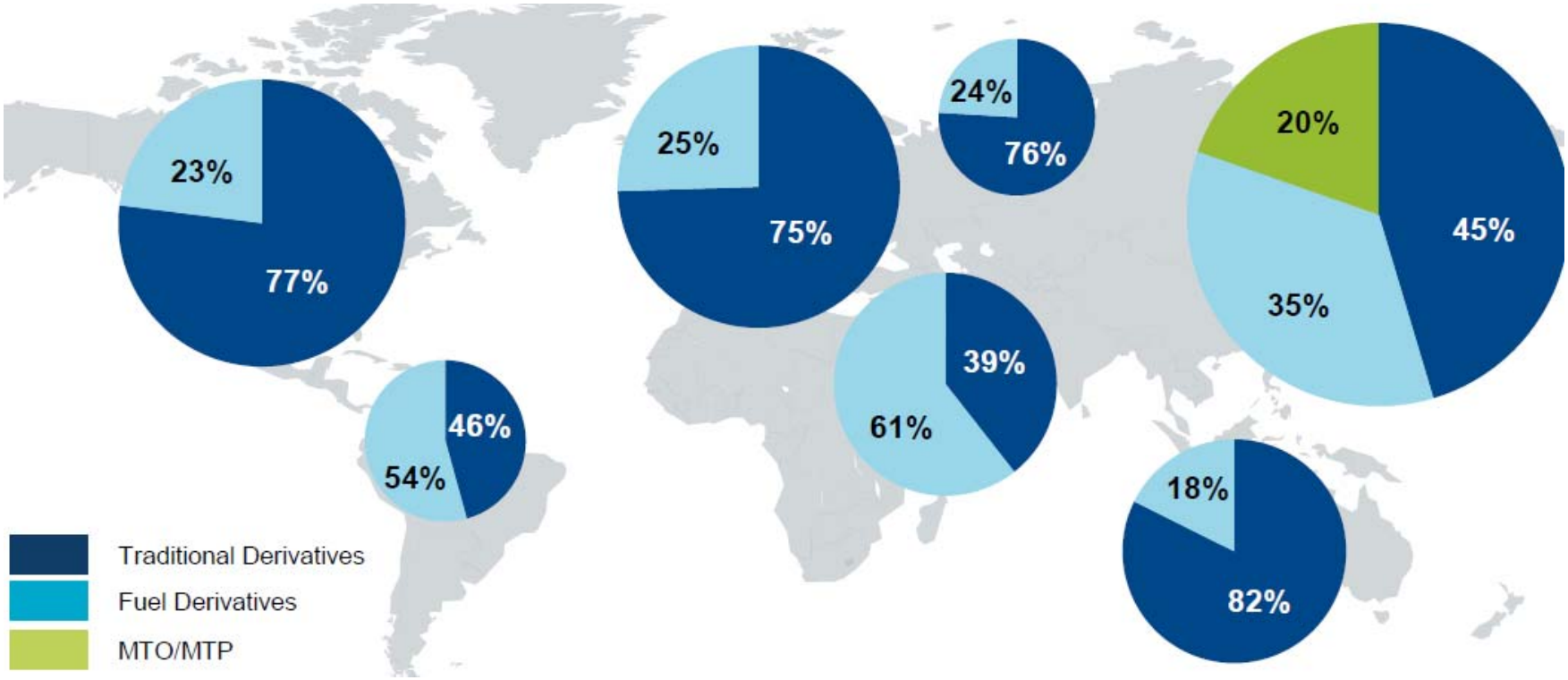
Carbon efficiency

Energy security

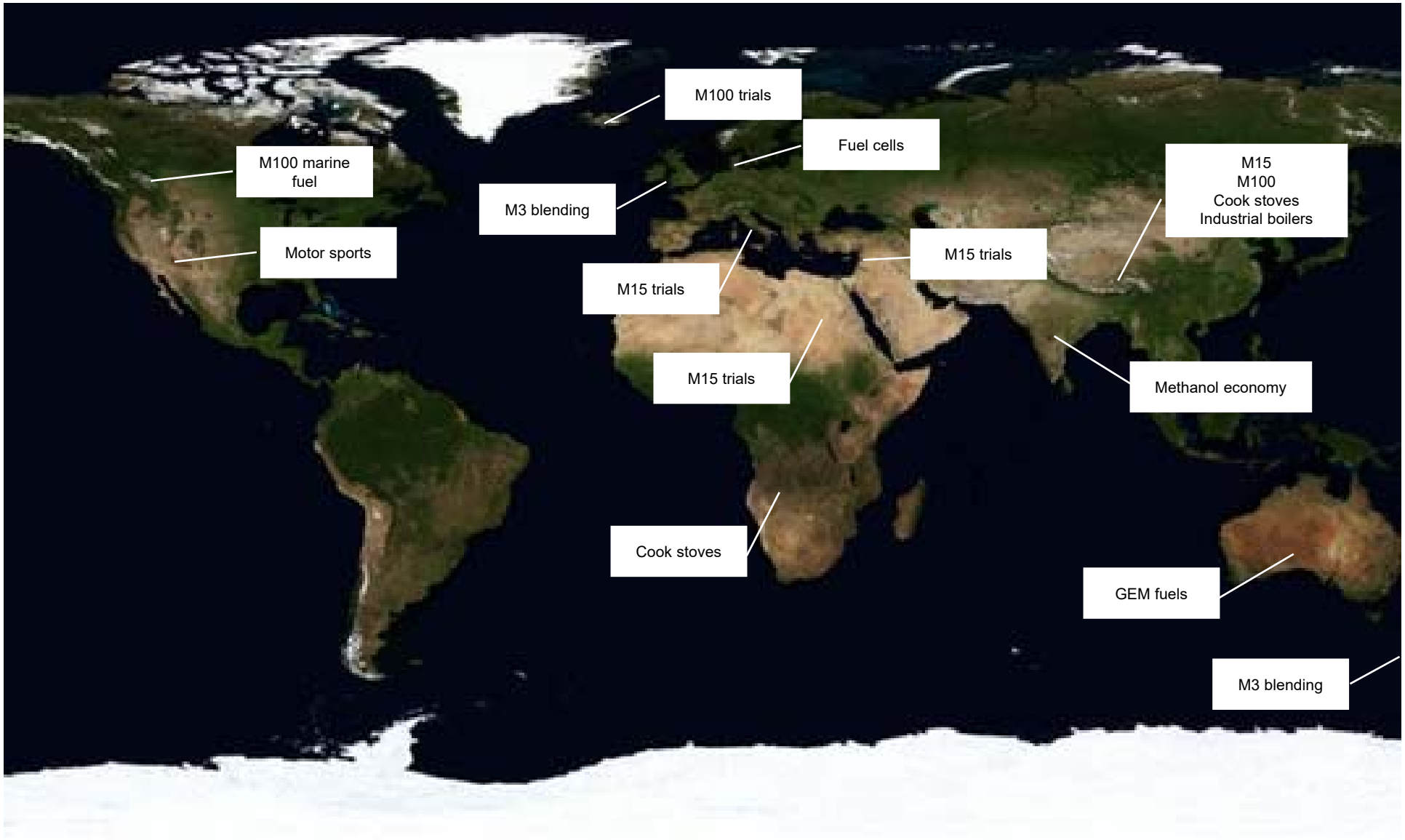
Additional option to EV

04 Methanol fuels

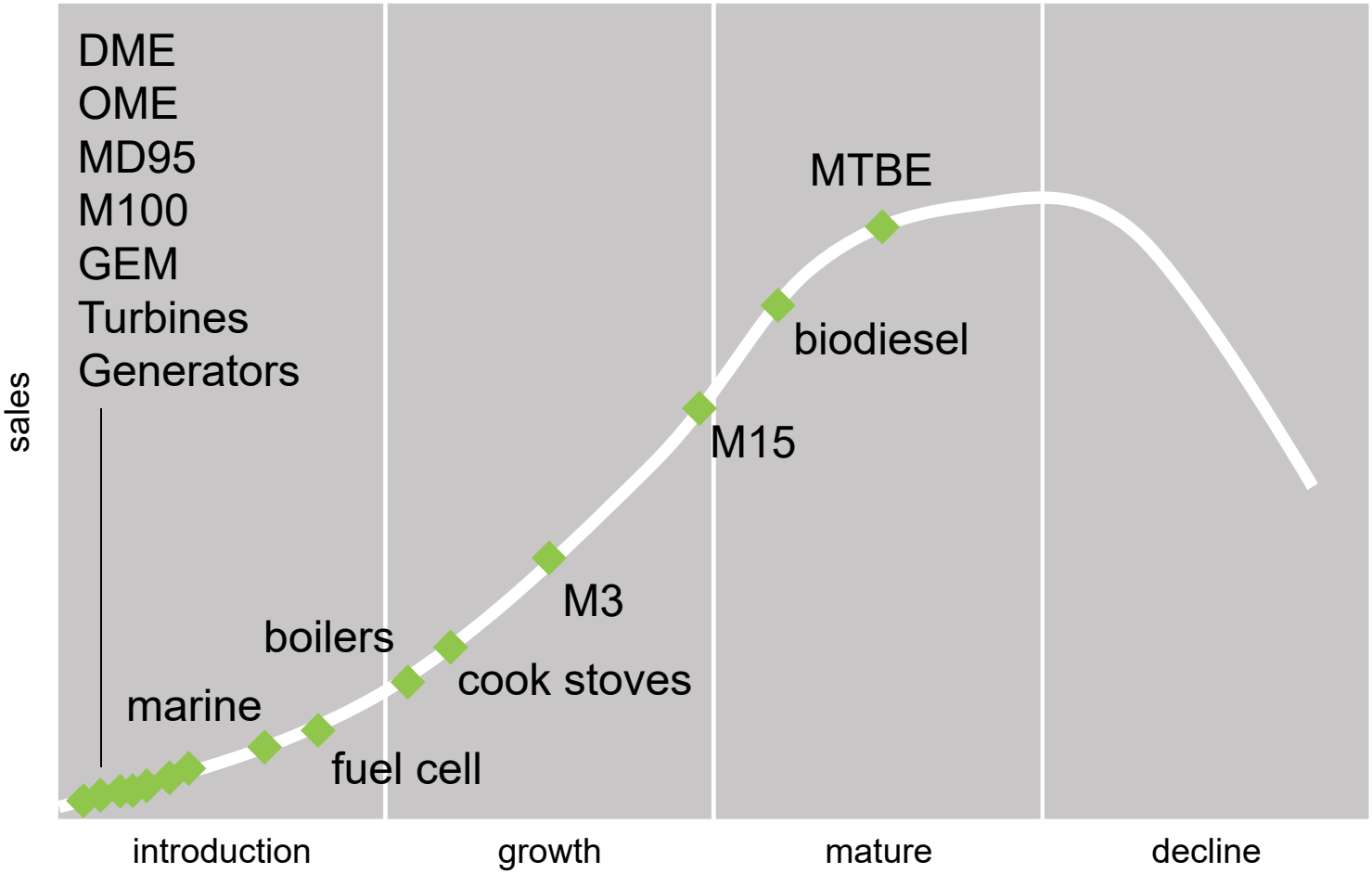
Oil displacement drives growth



Source: IHS


M100 trials
Fuel cells
M100 marine fuel
M3 blending
M15
M100
Cook stoves
Industrial boilers
Motor sports
M15 trials
M15 trials
M15 trials
Methanol economy
Cook stoves
GEM fuels
M3 blending

Different stage of the life cycle



Three main segments for methanol fuels

Gasoline blends

Diesel substitution

Hydrogen carrier

Methanol fuel benefits

High octane

Lower emissions

Existing infrastructure

Renewable pathways

Comparing apples to apples

	METHANOL	DIESEL	GASOLINE
Hazard pictograms (CPL)			
Signal word: (CPL)	Danger	Danger	Danger
Hazard statements (CPL)	H225 Highly flammable liquid and vapour. H301 Toxic if swallowed. H311 Toxic in contact with skin. H331 Toxic if inhaled. H370 Causes damage to organs.	H226: Flammable liquid and vapour. H304: May be fatal if swallowed and enters airways. H315: Causes skin irritation. H332: Harmful if inhaled. H351: Suspected of causing cancer. H373: May cause damage to organs through prolonged or repeated exposure. H411: Toxic to aquatic life with long lasting effects	H224: Extremely flammable liquid and vapour. H304: May be fatal if swallowed and enters airways H315: Causes skin irritation H340: May cause genetic defects H350: May cause cancer H361: Suspected of damaging fertility or the unborn child H336: May cause drowsiness or dizziness H411: Toxic to aquatic life with long lasting effects
Precautionary statements (CLP)	P210 - Keep away from heat. - No smoking P280 - Wear protective gloves, protective clothing, eye protection, face protection P304+P340 - IF INHALED: remove victim to fresh air and keep at rest in a position comfortable for breathing P303+P361+P353 - IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower P301+P310 - IF SWALLOWED: Immediately call a POISON CENTRE or doctor P403+P235 - Store in a well-ventilated place. Keep cool	P201: Obtain special instructions before use P210: Keep away from heat/sparks/open flames/hot surfaces – No smoking P240: Ground/bond container and receiving equipment P241: Use explosion-proof electrical/ventilation/ lightning equipment P242: Use only non-sparing tools P243: Take precautionary measures against static discharge P260: Do not breathe dust/fume/gas/vapours/spray P264: Wash hands thoroughly after handling P270: Do not eat, drink or smoke when using this product P273: Avoid release to the environment P280: Wear protective gloves/clothing/eye protection P301+P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician P302+P352: IF ON SKIN: Wash with plenty of soap and water P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower P304+P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing P308+P313: IF exposed or concerned: Get medical advice/attention P312: Call a POISON CENTER or doctor/physician if you feel unwell P331: Do NOT induce vomiting P332+P313: If skin irritation occurs: Get medical advice/attention P370+P378: In case of fire: Use water spray or foam for extinction P391: Collect spillage P403+P233: Store in a well-ventilated place. Keep container tightly closed P403+P235: Store in a well-ventilated place. Keep cool P405: Store locked up P501: Dispose of contents/container in accordance with local/regional/national/international regulation	P201: Obtain special instructions before use P202: Do not handle until all safety precautions have been read and understood P210: Keep away from heat/sparks/open flames/hot surfaces - No smoking P233: Keep container tightly closed P240: Ground/bond container and receiving equipment P241: Use explosion-proof electrical/ventilation/ lightning equipment P242: Use only non-sparing tools P243: Take precautionary measures against static discharge P261: Do not breath fume/gas/mist/vapours/spray P264: Wash hands thoroughly after handling P271: Use only outdoors or in a well-ventilated area P273: Avoid release to the environment P280: Wear protective gloves/clothing/eye protection P301+P310: IF SWALLOWED: Immediately call a POISON CENTER or doctor/physician P302+P352: IF ON SKIN: Wash with plenty of soap and water P303+P361+P353: IF ON SKIN (or hair): Remove/Take off immediately all contaminated clothing. Rinse skin with water/shower P304+P340: IF INHALED: Remove victim to fresh air and keep at rest in a position comfortable for breathing P308+P313: IF exposed or concerned: Get medical advice/attention P312: Call a POISON CENTER or doctor/physician if you feel unwell P331: Do NOT induce vomiting P332+P313: If skin irritation occurs: Get medical advice/attention P370+P378: In case of fire: Use water spray or foam for extinction P391: Collect spillage P403+P235: Store in a well-ventilated place. Keep cool P405: Store locked up P501: Dispose of contents/container in accordance with local/regional/national/international regulation

Less dangerous than gasoline

U.S. ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF MOBILE SOURCES

EPA 400-F-92-010

Methanol Fuels and Fire Safety

Vehicle Fire Risk

In 1986, there were 500,000 vehicle fires and 1,400 vehicle fire fatalities in the United States. Gasoline was the first material to ignite in 180,000 of these fires and many of the other fires ultimately involved gasoline.

Gasoline-ignited fires in 1986 involving cars, buses, or trucks resulted in 760 deaths, 4,100 serious injuries, and $215 million in property damage.

Projections indicate that casualties would drop dramatically if methanol were substituted for gasoline as the country's primary automotive fuel. Looking just at vehicle fires in which gasoline is the first material to ignite, a switch to methanol could save an estimated 720 lives, prevent nearly 3,900 serious injuries, and eliminate property losses of millions of dollars a year.

Methanol's fire safety advantage over gasoline stems from several physical and chemical properties (see figures on page 3):

- **LOWER VOLATILITY (Figure 1)**
  Methanol does not evaporate or form vapor as readily as gasoline does. Under the same conditions, exposed gasoline will emit two to four times more vapor than will exposed methanol.
- **HIGHER FLAMMABILITY REQUIREMENT (Figure 2)**
  Methanol vapor must be four times more concentrated in air than gasoline vapor for ignition to occur.
- **LOWER VAPOR DENSITY**
  Gasoline vapor is two to five times denser than air, so it tends to travel along the ground to ignition sources. Methanol vapor is only slightly denser than air and disperses more rapidly to non-combustible concentrations.
- **LOWER HEAT RELEASE RATE**
  Methanol burns 25 percent as fast as gasoline and methanol fires release heat at only one-eighth the rate of gasoline fires.

These properties together make methanol inherently more difficult to ignite than gasoline and less likely to cause deadly or damaging fires if it does ignite. Methanol is the fuel of choice for Indianapolis-type race cars, in part because of its superior fire safety characteristics.

TABLE 6-1
HAZARD SUMMARY[a]

	M100	Gasoline
Flammability		
Ease of Occurrence		
Open & Restricted Areas	4	9
Enclosed Spaces	8 (2-4) [b]	2
Relative Hazard if Fire		
Fire Severity	3	10
Ease of Extinguishing	7	10
Flame Visibility	8	1
Toxicity		
Inhalation-Low Conc.		
Toxicity	3	10
Ease of Occurrence	10	10
Inhalation - High Conc.		
Toxicity	10	10
Ease of Occurrence	3	4
Skin Contact.		
Toxicity	9	8
Ease of Occurrence	3	3
Ingestion		
Toxicity	10	10
Ease of Occurrence	8(2) [c]	3

Table adapted from Machiele, 1998; [a] 1-No concern. 2 to 3 = Low Level concern. 4 to 6 = moderate concern. 7 to 8 = high-level concern. 9 to 10 = extreme hazard. [b] Numbers in parenthesis reflect hazard reductions resulting from design changes. [C] Number in parenthesis incorporates the lowered likelihood of ingestion due to the presence of additives.

Source: Malcolm Pirnie, Inc. , Technical Memorandum

Methanol has lower fire risk

Methanol

evaporates slowly

needs lots of vapour to burn

confined fire zone;
fires less likely

Gasoline

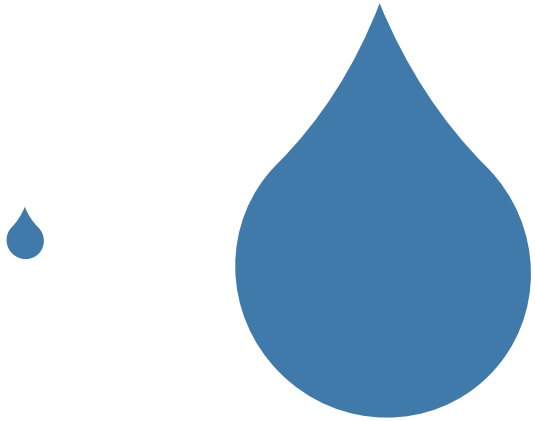
evaporates fast

needs little vapour to burn

broad fire zone;
fires more likely

Putting things in perspective

LC50 - Lethal dosis fish



Gasoline [1]
8,2 mg/l

Diesel [2]
65 mg/l

Methanol
15.400 mg/l

Sources:
[1] Petrobras/Statoil ASA, Safety Data Sheet, ECHA registration dossier Gasoline
[2] ECHA, European Chemical Agency, registration dossier Diesel
[3] ECHA, European Chemical Agency, registration dossier Methanol

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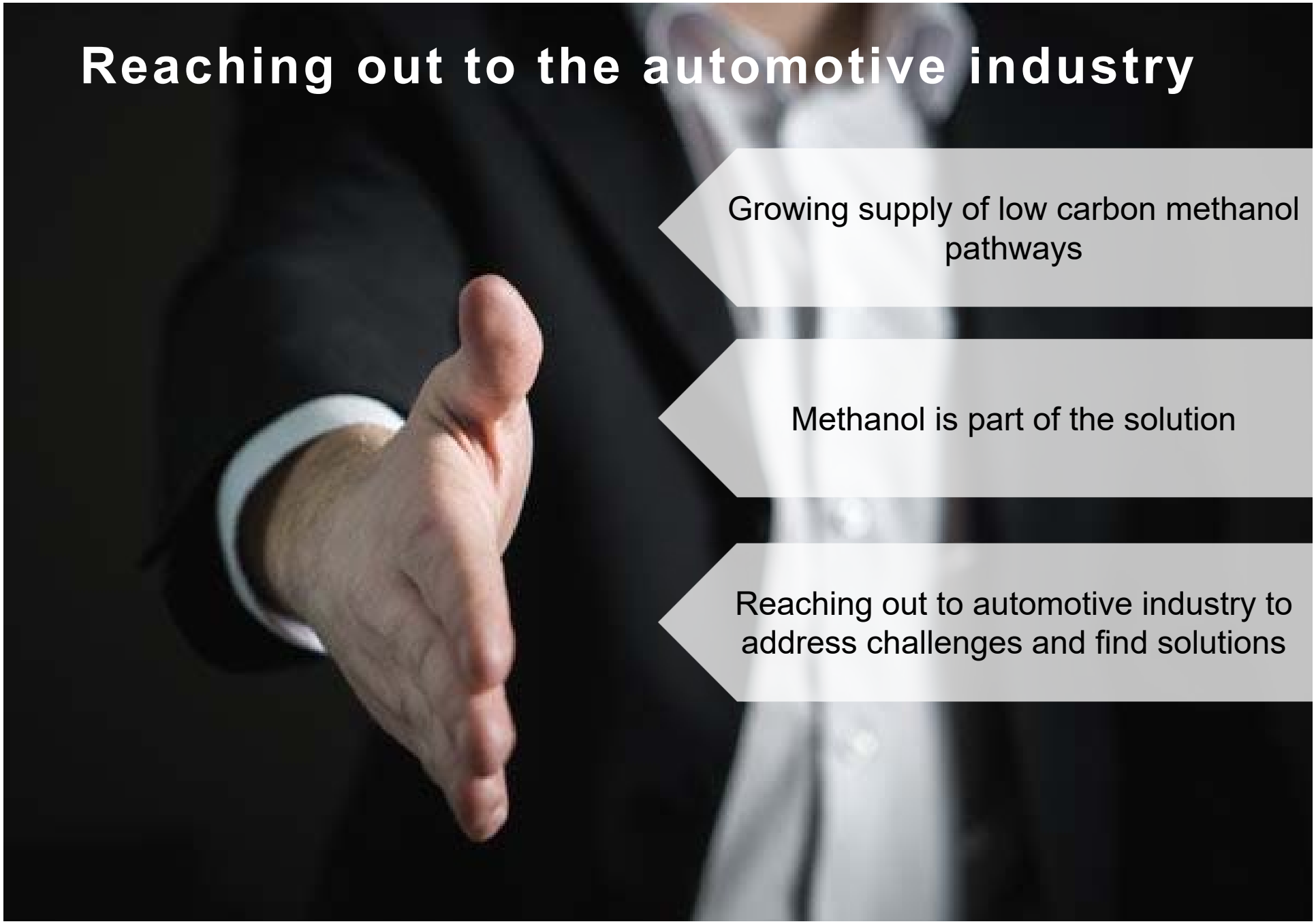
05 Moving forward

Reaching out to the automotive industry



Growing supply of low carbon methanol pathways

Methanol is part of the solution

Reaching out to automotive industry to address challenges and find solutions

06 Contacts

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Back up

PtX and CCU are similar but not the same