METHANOL INSTITUTE

Methanol: Emerging Global Energy Markets

Gregory Dolan, CEO
Methanol Institute

16th Annual State of the Energy Industry Forum
23 January 2020 – Washington, DC

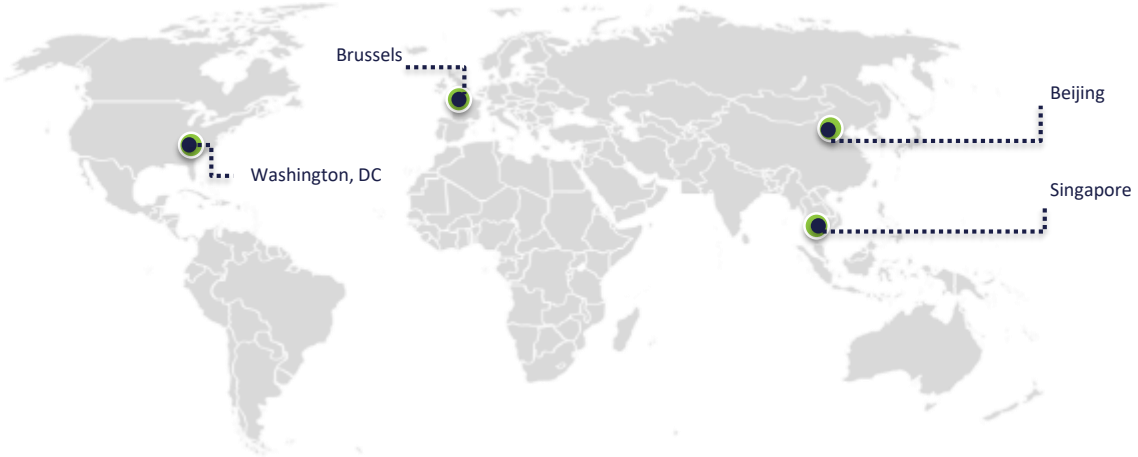
Singapore | Washington | Brussels | Beijing

Agenda

- About the Methanol Institute
- Methanol Overview
- Road Transport
- Marine Fuels
- China Heat Markets
- Hydrogen Carrier

MI History

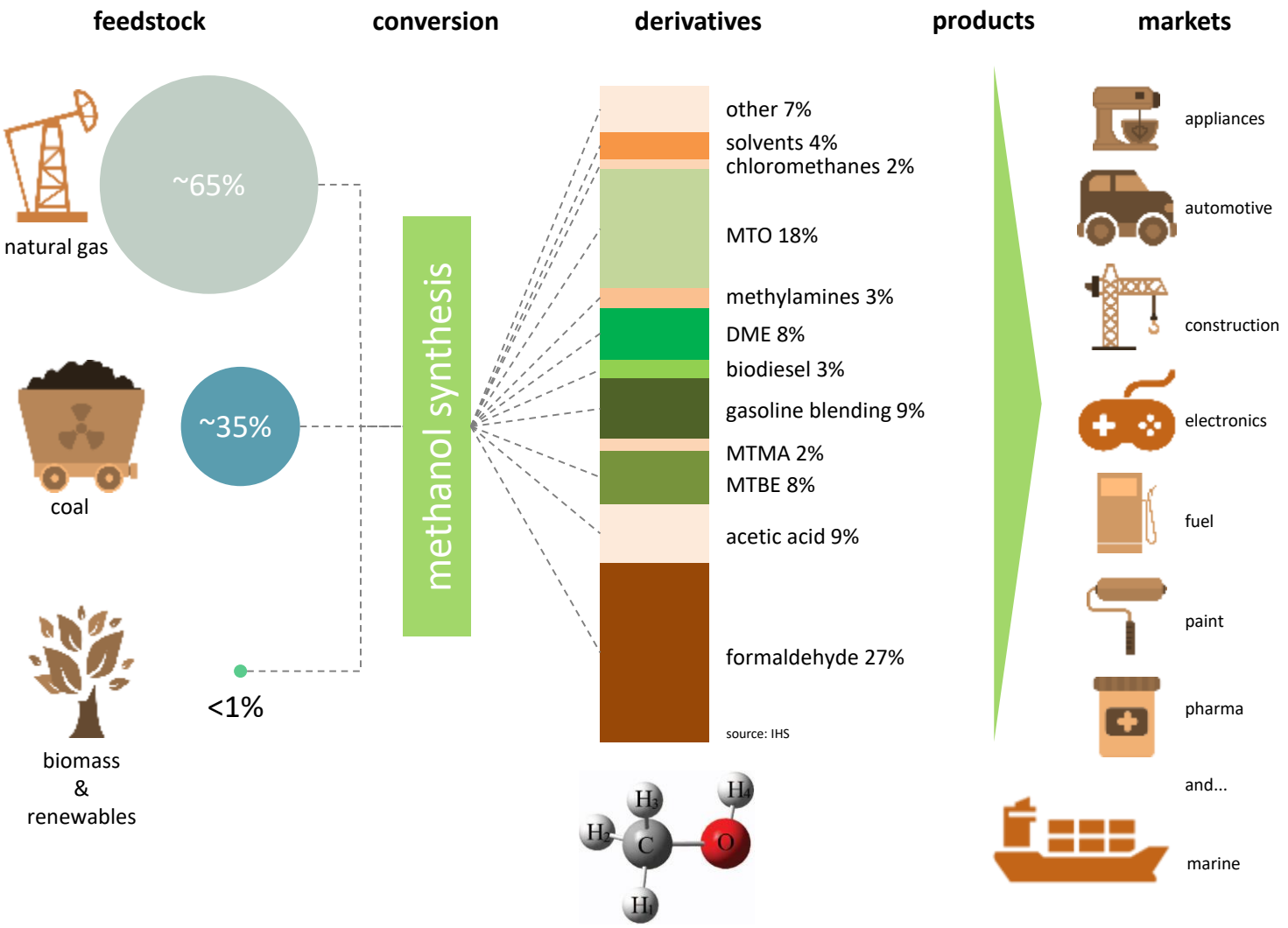
- The Methanol Institute (MI) was established in 1989
- Three decades later, MI is recognized as the trade association for the global methanol industry
- Facilitating methanol's expansion from our Singapore headquarters and regional offices in Washington DC, Brussels, and Beijing



MEMBERS

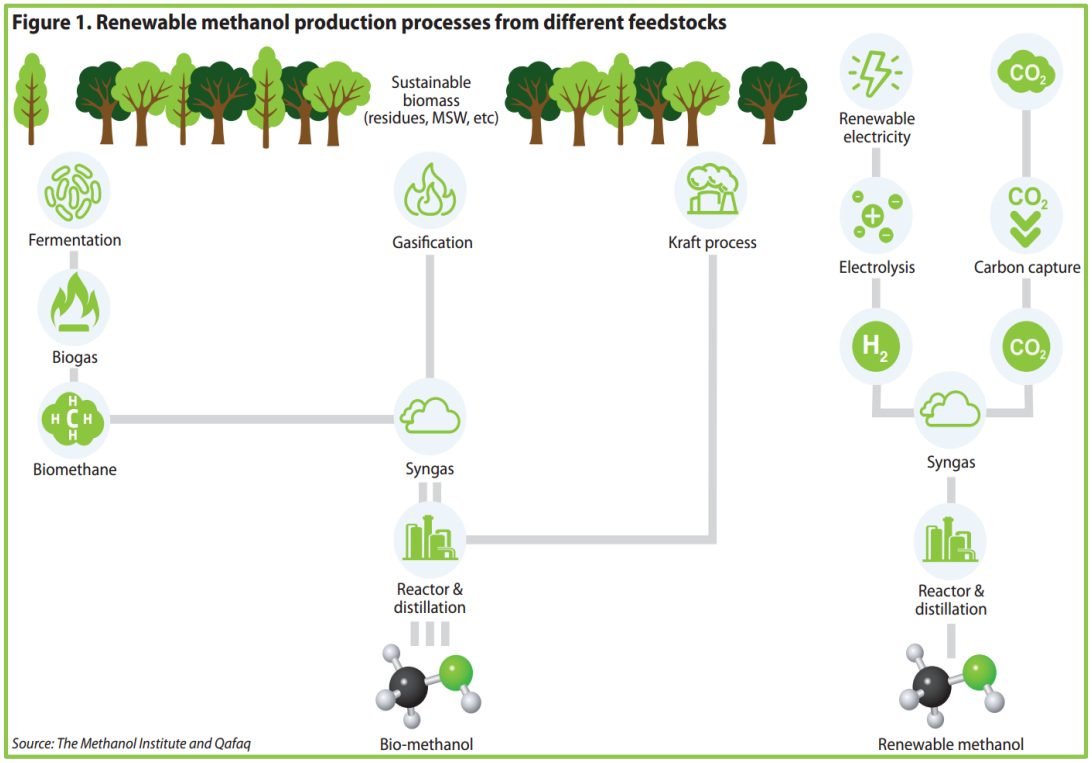
https://www.methanol.org/join-us/

Feedstocks and Markets



2019: Global Methanol Demand = 83 Million Metric Tons or 27.6 billion gallons

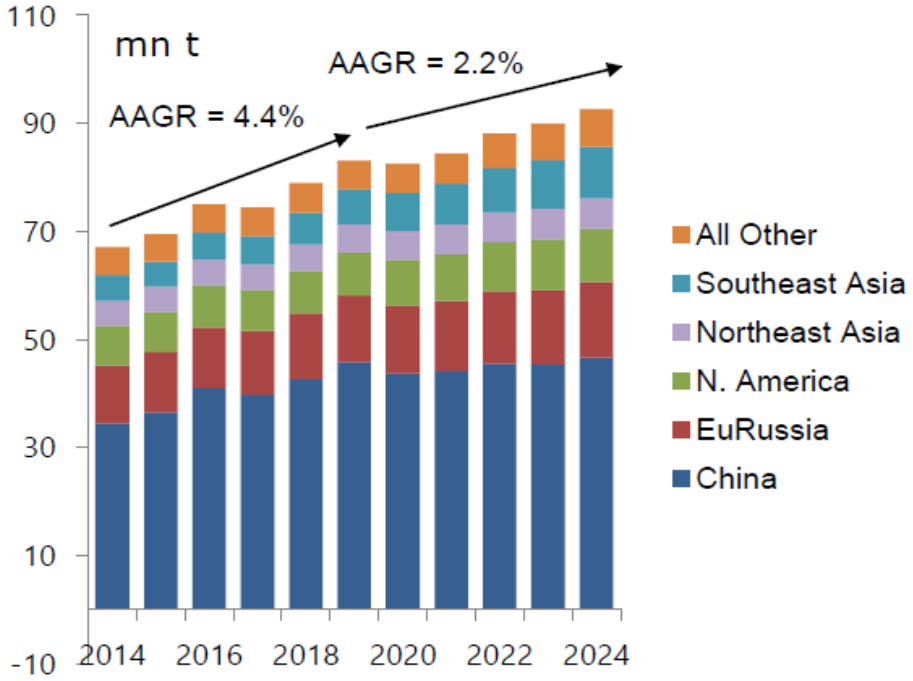
Methanol: Net Carbon-Neutral Pathways

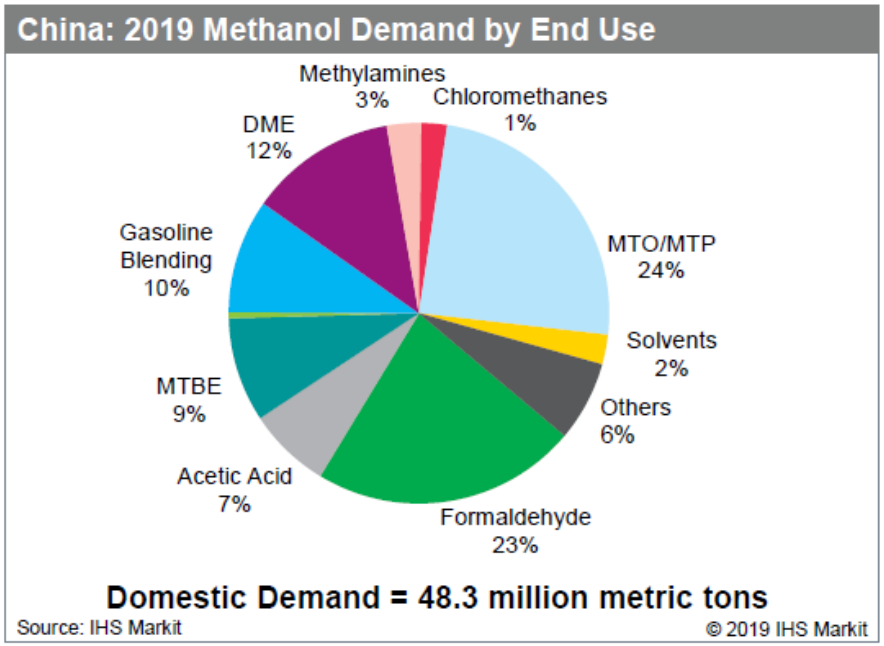


> *Renewable methanol is an ultra-low carbon chemical produced from sustainable biomass, often called bio-methanol, or from carbon dioxide and hydrogen produced from renewable electricity.*

Renewable Methanol Emission Reductions: CO2 by up to 95%; NOx by 80%; virtually eliminating SOx and Particulate Matter (PM)

China = More than Half of Global Methanol Demand – 16 Billion Gallons





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IHS Markit

US Methanol Production Resurgence

Timing	Name	Location	Ownership	Capacity '000t	Status
In Operation					
2010	Eastman, LYB, Praxair	Various	Various	860	
'11-'15	LYB, OCI, Methanex, Fairway	Various	Various	5,060	
2018	Natgasoline	Beaumont, TX	OCI/G2X	1,800	
2019	Alpont LLC	Toledo, OH	Interstate Chemical	85	
				7,805	
Under/Pending Construction					
2020	US Methanol - Liberty ONE	Institute, WVA	US Methanol	200	Under Re-assembly
	Koch - Methanol 1	St. James, LA	Koch/Yuhuang	1,650	Under Construction
2022	Methanex Geismar 3	Geismar, LA	Methanex	1,650	Approved
2023	South Louisiana Methanol	St. James, LA	Todd Energy/SABIC	2,000	FID 2019
2024	Theoretical			*2,800*	From List Below?
				8,300	
In Development					
TBD	*Lake Charles Clean Energy*	*Lake Charles, LA*	*Lake Charles Clean Energy*	*1,600*	*Planning Stages*
TBD	*Sandpiper*	*Texas City, TX*	*EAI*	*1,600*	*Under Study*
TBD	*Primus Green Energy*	*Marcellus Region*	*Primus*	*56*	*Under Study*
TBD	*Northwest Innovation Works*	*Kalama, WA*	*NW Innovation*	*3,600*	*Challenges*
TBD	*IGP*	*Plaquemines Parish, LA*	*IGP*	*7,200*	*Under Study*
TBD	*Nauticol Energy*	*Alberta, Canada*	*Nauticol Energy*	*3,000*	*Under Study*
TBD	*Nauticol Energy*	*Quebec, Canada*	*Nauticol Energy*	*1,500*	*Under Study*
TBD	*Big Lake Fuels/G2X Energy*	*Lake Charles, LA*	*G2X Energy/Proman*	*1,400*	*Under Study*
TBD	*Celanese/Partner TBD*	*Bishop, TX*	*Celanese/JV*	*1,300*	*Under Study*
TBD	*Zeogas*	*Lake Charles, LA*	*Zeogas*	*1,600*	*Under Study*
				22,856	
Total existing, under construction, probable and in development				***38,961***	

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New U.S. Methanol Plants Offer Many Economic Benefits

Economic Impact of a Typical U.S. Methanol

Typical capacity
1.5 million tons / year

Capex
$1.1 billion

State and local taxes
$35 million

Annual natural gas used
45 billion cubic feet

Construction jobs
2,086

Direct and indirect jobs
592

Economic ripple effect
$1.5 billion

Average annual salary
$72,579

ADI Analytics
ENERGY INSIGHT AND CONSULTING

US-China Tariffs

MI Opposes Tariffs

- Reciprocal 25% tariffs on methanol in effect
- 23 August 2018 – MI Testified before U.S. Trade Representative
- Urged USTR to remove methanol from List 3 of 6,000 products of Chinese goods
- **Virtually no methanol trade from China to U.S.**
- U.S. net methanol exporter and China the world's largest market for methanol
- Tariffs threaten expansion of U.S. methanol production – risking billions $$ in investment and thousands of jobs
- ***SIMPLY PUT, CHINA DOESN'T WANT TO SELL US* THEIR *METHANOL, THEY WANT TO BUY* OUR *METHANOL***

China M100

- Dec 2018: MIIT completes acceptance of all methanol pilot demonstration programs
- ***March 2019: MIIT and 7 other ministries announce methanol policy paper for M100***
- MI issues press release and briefing report
- https://www.methanol.org/wp-content/uploads/2019/03/A-Brief-Review-of-Chinas-Methanol-Vehicle-Pilot-and-Policy-20-March-2019.pdf
- "Paper 61" encourages commercial introduction of M100 vehicles
- Approval of 32 product models from 9 methanol vehicle manufacturers

China Methanol Taxi Fleet

- China consumes 4.8 MMT or 1.6 billion gallons of methanol for road transport
- Currently over 20,000 methanol-fueled taxis operation for total of 125 million kilometers
- Neat methanol fuel or “M100” consumption for taxi is 13.5 litres/100 km, with energy consumption of 237.8 MJ

Table 2 Taxi Fuel Cost Comparison of Taxi in Jin Zhong City			
	Gasoline	CNG	M100
Fuel Price RMB/L	5.51	3.5 RMB/m^3	1.8
Fuel Economy L/100km	8	8.8 m^3/100km	13.5
Fuel Cost Saving %	37.5	10.6	--

Note: the fuel price is based on the operation in November of 2015;

GEELY M100 Vehicles

- China's Geely Automotive Holdings is global leader in the commercialization of M100 vehicles
- Geely has two methanol engine and five methanol vehicle manufacturing bases, with an annual methanol vehicle production capacity of 300,000 - 500,000 cars
- Geely M100 taxi fleet hit 20,000 cars in June 2019, consuming 200,000 MT year

Italy M15/E5 Blending

- 21 November 2017: With Italian Prime Minister, the CEOs of Eni and Fiat Chrysler Automobile sign MOU for joint development of technology reducing CO2 of road transport vehicles
- Eni had developed an “A20” fuel blend of 15% methanol and 5% bioethanol
- New blend demonstrated in 5 FCA Fiat 500 vehicles in Eni’s Enjoy car-sharing fleet

Joint press release

Eni and FCA sign research agreement for joint projects to significantly reduce CO_2 emissions produced by road transport vehicles

https://www.eni.com/en_IT/media/2017/11/eni-and-fca-sign-research-agreement-for-joint-projects-to-significantly-reduce-co2-emissions-produced-by-road-transport-vehicles

A20: a New Methanol-based Alternative Fuel

15% MeOH

5% bio-EtOH

80% Gasoline

- Formula Cost Reduction
- "Transparent" to all the E10 car vehicles
- No-chemical corrosion problems
- No-phase separation (in the car tank and gas-station)

CUNA specification (NC 627-02 July 2018)

Property	Units	Limits MIN – MAX	
Research octane number, RON		100	
Motor octane number, MON		86	
Lead content	mg/l		5.0
Density (at 15 °C)	kg/m^3	720.0	775.0
Sulfur content	mg/kg		10.0
Manganese content	mg/l		2.0
Nitrogen content	ppm		100
Oxidation stability	minutes	360	
Existent gum content (solvent washed)	mg/100 ml		5
Water content	% (m/m)		0.2
Oxygen content	%(m/m)		10.0
Methanol	%(V/V)	12.0	16.0
Ethanol + other Alcohols (C3-C4)	%(V/V)	4.0	6.0
Ethers (5 or more C atoms) other oxygenates	Volume blending of these components is restricted to 10.0 % (m/m) maximum oxygen content including methanol oxygen.		

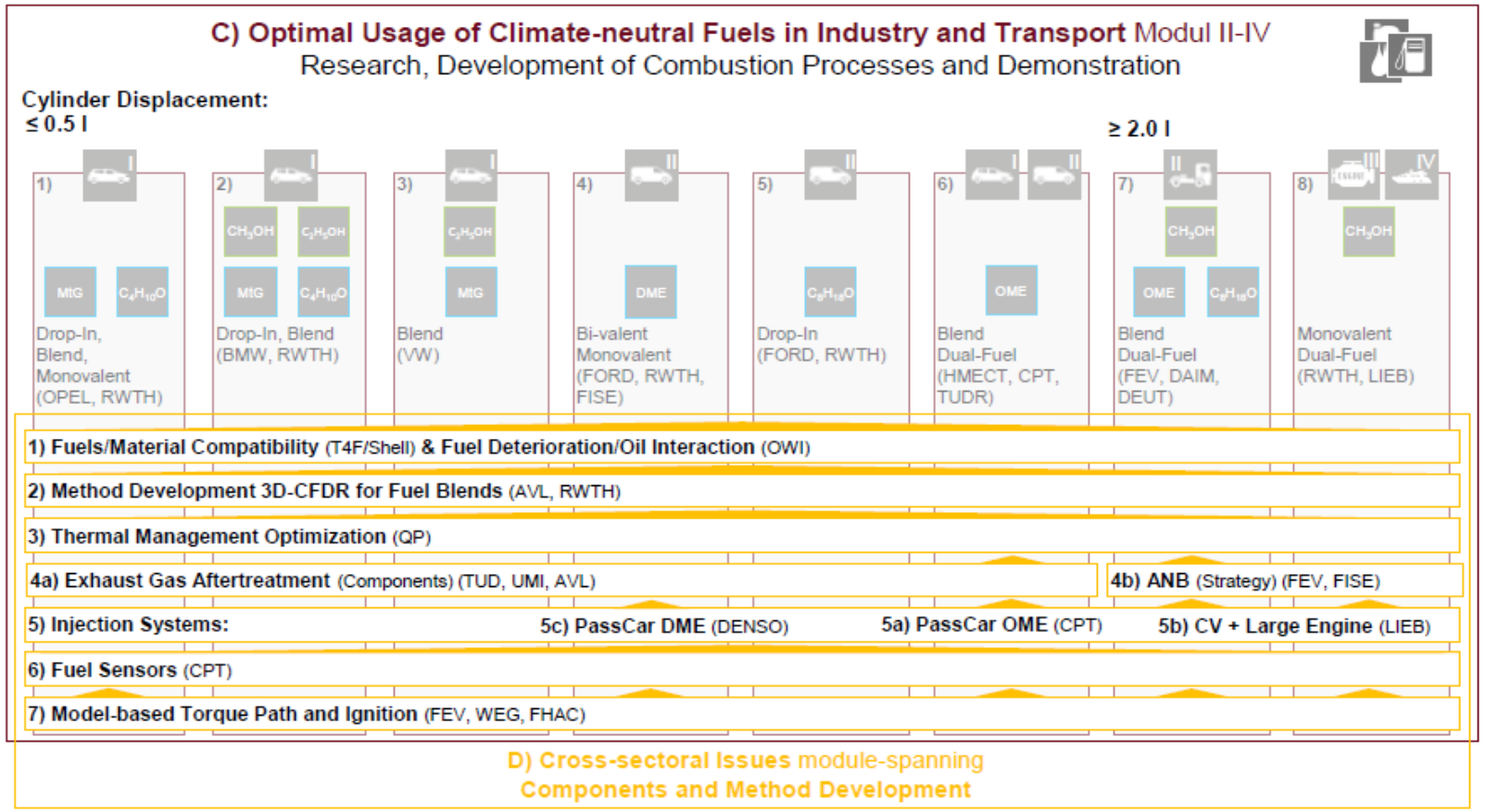
CUNA NC 627-02 include also the evaporative class parameters to prepare A20 grade for summer, winter and transition period

German C3 Mobility

- C3 Mobility for Closed Carbon Cycle
- Joint public/private partnership with German Ministry of the Economy and Energy and German automotive industry
- Two-year, € 24 million program

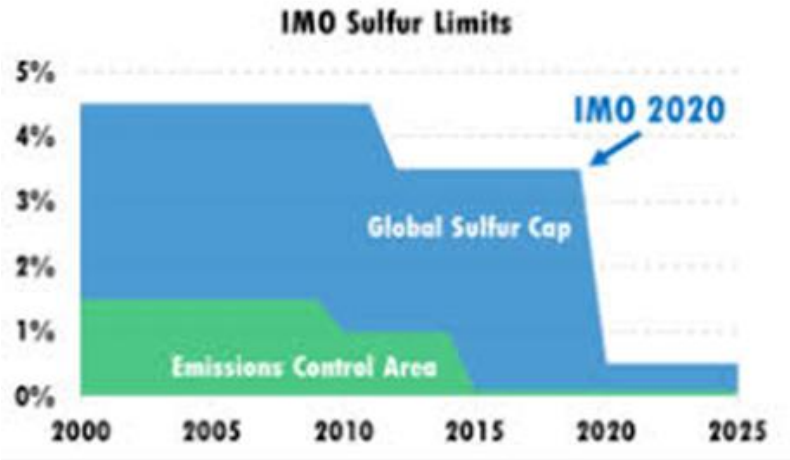
German C3 Mobility

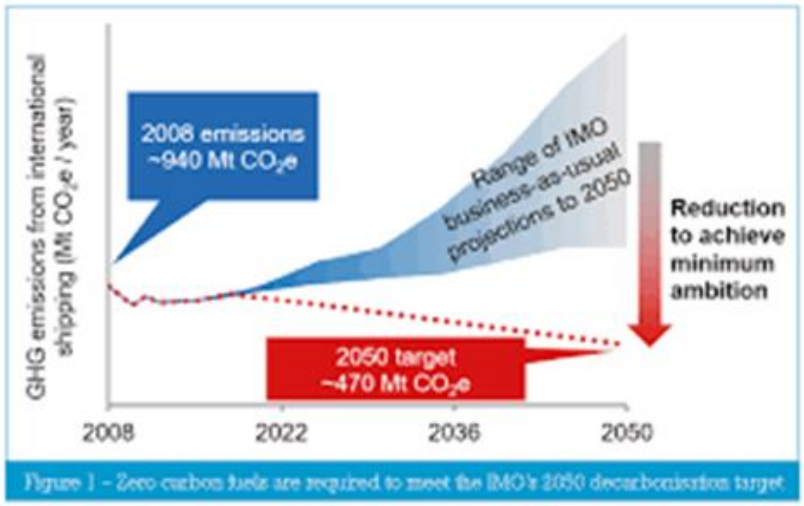
Project Structure
Usage of Climate-neutral Fuels



Emissions Regulations Driving Marine Fuel Market

- The International Maritime Organization has adopted emission regulations transforming the shipping industry
- In 2020, global SOx reductions took effect
- By 2050, greenhouse gas emissions must be cut in half





Methanol Vessels on the Water

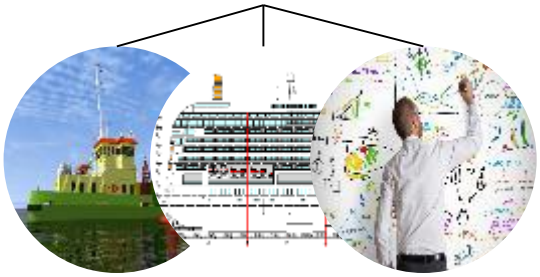
DUAL FUEL

9x - *+2*	1x	1x	1x
chemical tankers	ROPAX ferry	Pilot boat	dry bulk
MOL, WL, Marinvest	Stena Line	MI/SMA ScandiNaos	Jiang Long
2 stroke MAN	4 stroke Wärtsila	high speed Scania, Weichai	DMCC Yuchai
new build	retrofit	retrofit	new build

FUEL CELL

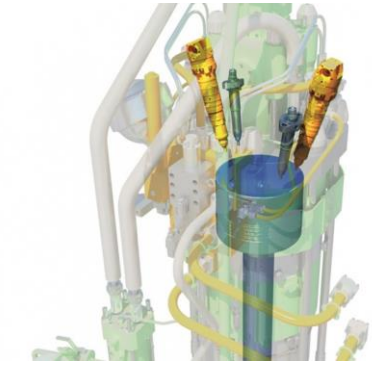
2x	1x
Tourist Boat propulsion	Ferry hotel load
Innogy HTWG Konstanz	Viking Line
SerEnergy fuel cells	
retrofit	retrofit

PROJECT and R&D



Cruise ships, fishing boat, barge, dredge, a.o.
SUMMETH/MARTEC, Lean Ships, Methaship, Billion Miles, FiTech, India, PCG Product Vessel, NTU Test Port of Rotterdam Barge, **Green Maritime Methanol, FastWater**
SI hybrid, dual fuel, fuel cells
new build & retrofit

MAN Duel-fuel Engine Configuration



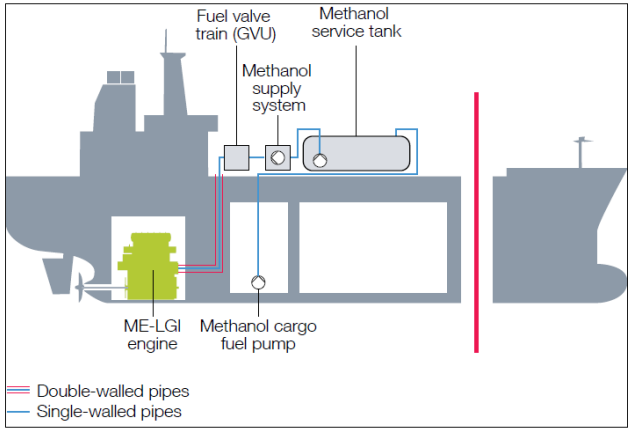
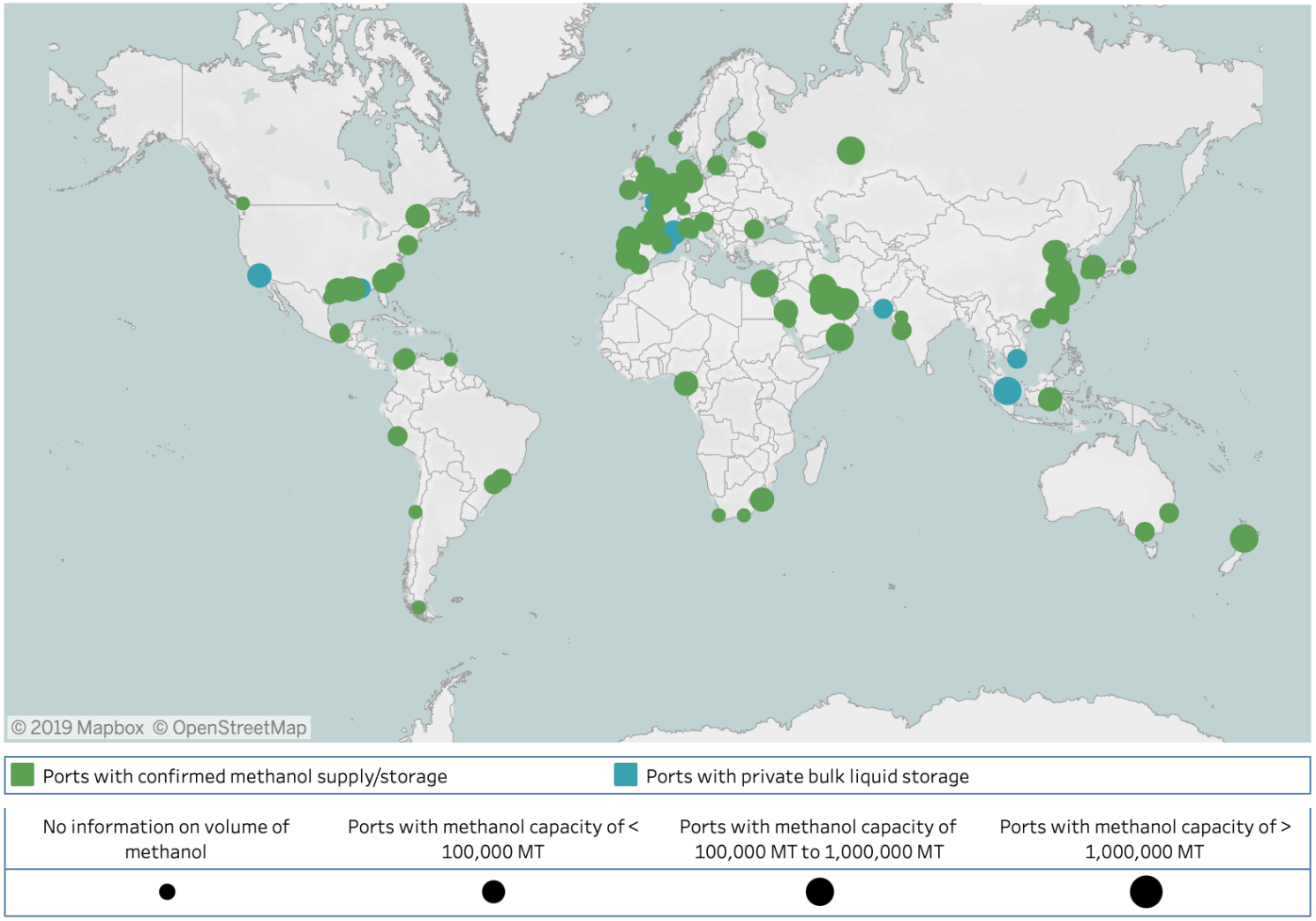


Fig. 4: ME-LGI system overview

"We developed the ME-LGIM engine in response to interest from the shipping world in alternatives to heavy fuel oil. With the growing demand for cleaner marine fuels, methanol is a sulphur-free alternative that meets the industry's increasingly stringent emission regulations." **René Sejer Laursen, Promotion Manager at MAN Energy Solutions**

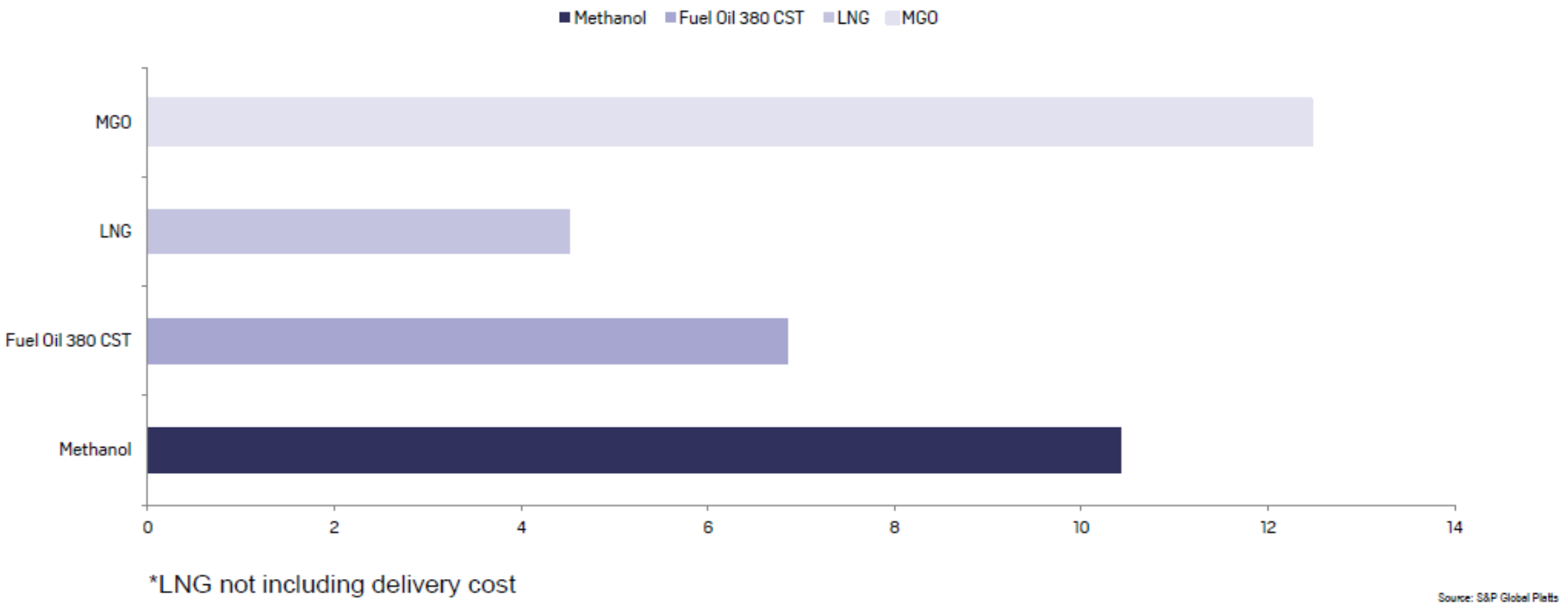
https://marine.man-es.com/two-stroke/2-stroke-engines/me-lgim

Methanol Available in Over 100 Ports Today



https://public.tableau.com/profile/quantzig#!/vizhome/MethanolAvailabilityDataTopGlobalMaritimePorts/MethanolFuelAvailabilityatPorts

Methanol Discount to Marine Gas Oil



(Price per unit of energy volumetrically – October 2019)

S&P Global Platts

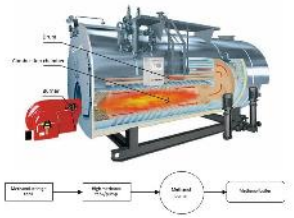
Methanol Bunkering Easy and Clean

- Liquid at atmospheric pressure
- Available in many ports around the world and along rivers
- Low infrastucture cost
- Flexible, modular system
- Environmentaly friendly as it’s **biodegradable**

China: Methanol Industrial Boilers

- Industrial boilers are widely used for heating and industrial stream
- Many cities in China prohibiting use of coal and diesel fuels
- Capacity ranged from 1 to 20 ton/hour
- One steam ton capacity consumes 110 kg of methanol, and runs 24/7
- Methanol fuel is used neat or as blend with diesel fuel
- Standards developed with MI and Methanex support
- ***Estimated more than 1000 units, consuming over 2 MMTs methanol in 2018***
- ***Growing to 5 MMT in 5 years***

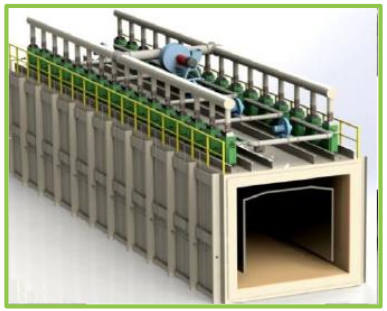
https://www.methanol.org/energy/boiler-cookstoves/

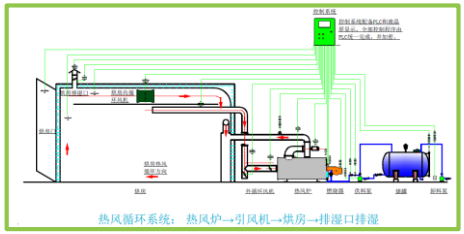


China: Methanol Cook Stoves

- **Different types methanol cook stoves:** Single heating, stir fry, steaming
- Widely used in restaurants, central kitchens, mainly cost-driven
- Simple storage and transportation, filling the gap of pipeline NG supply
- Fuel: 100% methanol to methanol blends usually with water
- ***Market for Cooking Application over 5 MMTs in China in 2018***
- ***Growing to 7-8 MMT in 5 years***

China: Glass/Ceramic Kilns and Tobacco Drying





- **China also developing other new markets for the use of methanol:**
  - **Glass/ceramic kilns –** China produced 60% of world's glass products; methanol uses less air intake and produces cleaner flue gas for superior finish
  - **Tobacco drying –** One in every 3 cigarettes smoked in the world are smoked in China

China: Household Heating

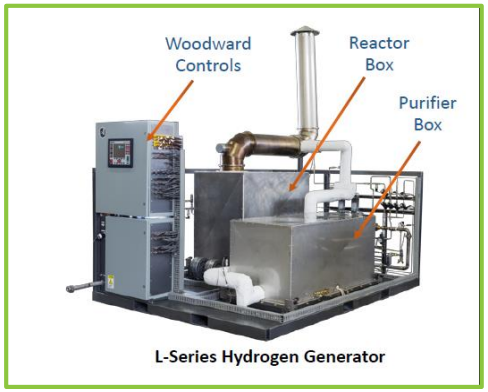
- **Beginning in 2018, China using methanol for home heating**
- Shanxi Province methanol used in 30,000 households in 10 counties, with Jinzong City adding 50,000 households in 2020
- Small heaters for individual families and centralized 2-4 ton steam boilers for larger buildings
- Cities promoting methanol as replacement for coal with government support of 6,000 RMP to furnace providers, free heaters for families and fuel subsidies

METHANOL A HYDROGEN CARRIER FOR FUEL CELLS

- Blue World Technologies *(Denmark)*
- Palcan *(China)*
- Horizon Energy Systems *(Singapore)*
- Oneberry *(Singapore)*
- Altergy *(USA)*
- Serenegy *(Denmark)*
- SFC Energy *(Germany)*
- Toshiba *(Japan)*
- Ultracell *(USA)*

Practical Solution for Battery and Fuel Cell Vehicles

- Reformed Methanol Fuels Cells (RMFC) as range extender for battery electric vehicles
- Increasing range of battery powered vehicles from 300 to 1000 kilometers
- If you really need hydrogen, reform methanol at the fueling station



Denmark's Blue World Technologies and China's Palcan

MANUFACTURING PLANTS: 50,000 UNITS/YEAR – 5-15 kw RMFC

Blue World

Launch Reception: Blue World Technologies presenting plans for large-scale manufacturing facility

Blue World Technologies today presents plans for the world's largest methanol fuel cell factory located at the Port of Aalborg ready for global export of clean energy technology. Methanol fuel cell components will be produced in high volume enabling electric vehicles to have a 1000km range with 3 minutes refuelling time.

Blue World technology is newly founded but has ambitious goals from the start by targeting the most potential markets in form of automotive and electric mobility. The challenge is daunting, but also the possibility to really make a difference in the world.

Today the mayor of Aalborg; Mr. Thomas Kastrup Larsen is attending the launch reception of Blue World Technologies on the Port of Aalborg. Furthermore, plans for the world largest methanol fuel cell manufacturing facility will be presented.

1 - Blue World Technologies - fuel cell factory visualisation

Volume production of methanol fuel cells

Blue World Technologies will establish a state-of-the-art manufacturing plant for a unique fuel cell technology platform utilizing methanol as a fuel. The plant will be highly specialized in the production of materials and components for the fuel cell and stack which can be compared to the engine block of a car. The overall effort will require several hundreds of new employees for both development and operations. The factory will be built and have initial manufacturing activity during 2019.

Palcan

Our Development Plan Ⅱ

"Build a 50,000 sets of fuel cell module production base (2018)"

►Industrial Base: Cixi, Zhejiang province
►Total investment of 100 million
►Achieve 50,000 sets of fuel cell module production capacity.

►Market target：Electric logistics vehicle, mobile charging vehicle, communication backup power supply, civil-military integration.

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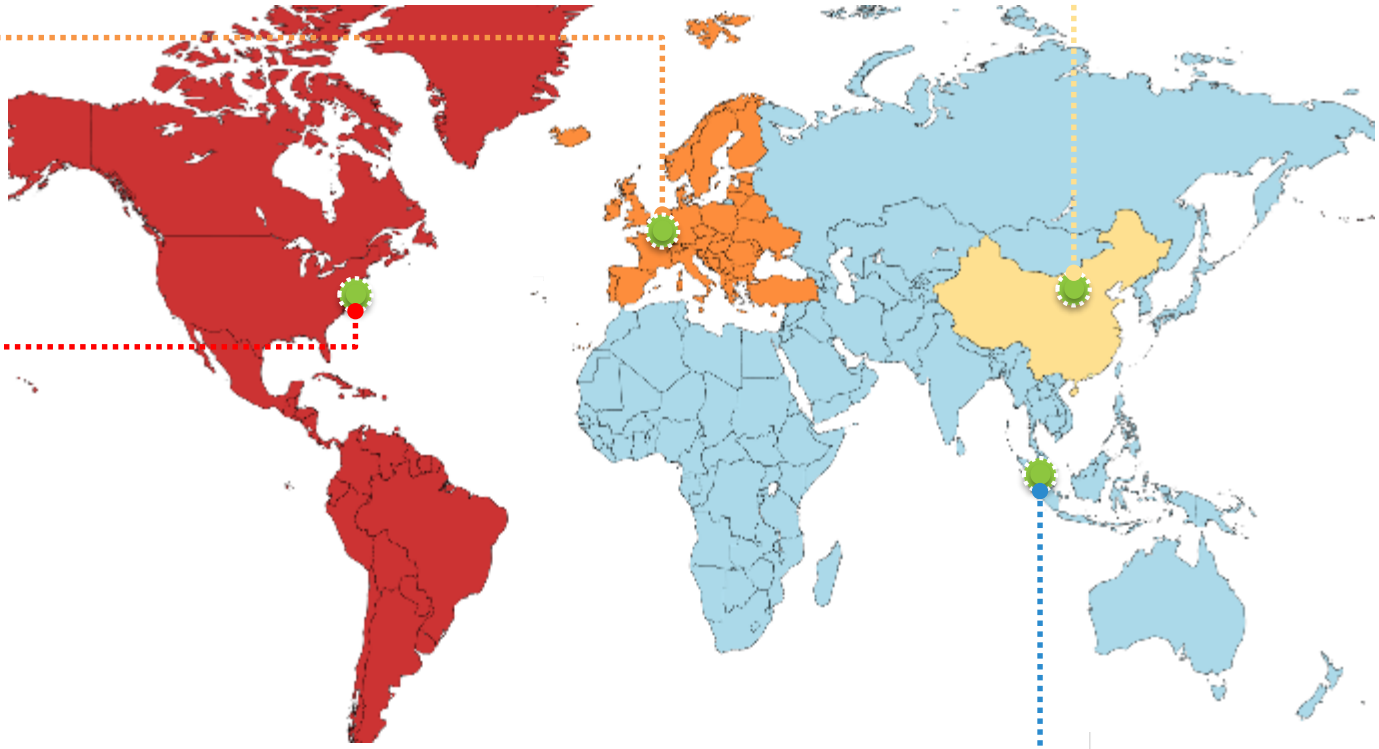

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