T6 Methane Power

Agenda

- Background
- Distribution methane
- Engine
- Tanks and design
- LN
- Methane tractor calculator.

- Baggrund og Vision
- Distribution methan/Biomethan
- Motor
- Tanke og design
- LNG, Flydende gas
- Methane traktor calculator.
- Andre alternative brændstoffer

CNH Industrial
Segments and key features

CNH INDUSTRIAL

Agriculture

Second largest manufacturer of agricultural machinery

CASE IH AGRICULTURE

STEYR TRAKTOREN

NEW HOLLAND AGRICULTURE

Construction

A global player in the manufacturing of construction equipment

CASE CONSTRUCTION

NEW HOLLAND CONSTRUCTION

Financial Services

A global leader in equipment finance, supporting customers and dealers with tailor made solutions

CNH INDUSTRIAL CAPITAL

Powertrain

Global number one in highly regulated markets, producing more than half a million engines a year and market leader in alternative fuels powertrains

FPT POWERTRAIN TECHNOLOGIES

NEW HOLLAND AGRICULTURE

A HISTORY OF SUCCESSFUL ENTREPRENEURS

1842
CASE FOUNDED
BY JEROME CASE

1985
CASE ACQUIRES
INTERNATIONAL
HARVESTER

1996
Acquisition of STEYR
Landmaschinentechnik AG

1895
NEW HOLLAND
FOUNDED BY ABE
ZIMMERMAN

1986
Ford buys
New Holland,
becoming Ford
New Holland

1899
Fiat founded by
Giovanni Agnelli

1918
Fiat starts
mass production
of tractors

1991
FiatGeotech
purchases
Ford New
Holland

1999
Case IH
and New Holland
merge to form
CNH Global

2005
Fiat, Fiat-Kobelko, O&K,
New Holland and
Fiat Allis are united under the
New Holland Construction
brand

2022

1864
Conrad
Magirus starts
his company

1937
Lancia Veicoli Industriali
opens facility for
the production
of military trucks

1975
Fiat forms
IVECO merging
operations of
several truck
brands

1986
Acquisition
of ASTRA
by IVECO

2005
Fiat groups all automotive
and
industrial powertrain
activities together
to form FPT

2011
Fiat spins out
its non - auto
activities to
form Fiat Industrial

2013
CNH Industrial
is born with dual
listing on New York
and Milan Stock Exchanges

IVECO • GROUP

Background

New Holland Agriculture
Farming technology of tomorrow

CLEAN ENERGY LEADER

let's get it done.

The Clean Energy Leader® strategy

JULY 2006 /
THE BIRTH OF A NEW ERA
CLEAN ENERGY LEADER®
STRATEGY LAUNCHED

NOVEMBER 2007 /
100% BIODIESEL
ALL NEW HOLLAND ENGINES ARE
100% BIODIESEL COMPATIBLE

FEBRUARY 2009 / A ZERO EMISSION FUTURE
NH2™ HYDROGEN TRACTOR AND ENERGY
INDEPENDENT FARMSM WIN A SIMA GOLD
INNOVATION MEDAL

NOVEMBER 2011 /
INTELLIGENT VITICULTURE
ECOBRAUD AND
SUSTAINABLE VITICULTURE
WIN A SILVER MEDAL AT
AGRITECHNICA

SEPTEMBER 2012 /
A RENEWABLE
ALLIANCE
STRATEGIC PARTNERSHIP
WITH GROWTH ENERGY
TO PROMOTE ETHANOL
PRODUCTION IN THE USA

NOVEMBER 2013 /
THE NEW FRONTIER
1ST GENERATION T6
METHANE POWER
TRACTOR LAUNCHED

JUNE 2015 /
INNOVATION
THAT WORKS
2ND GENERATION
T6 METHANE POWER
TRACTOR PRESS
RIDE AND DRIVE

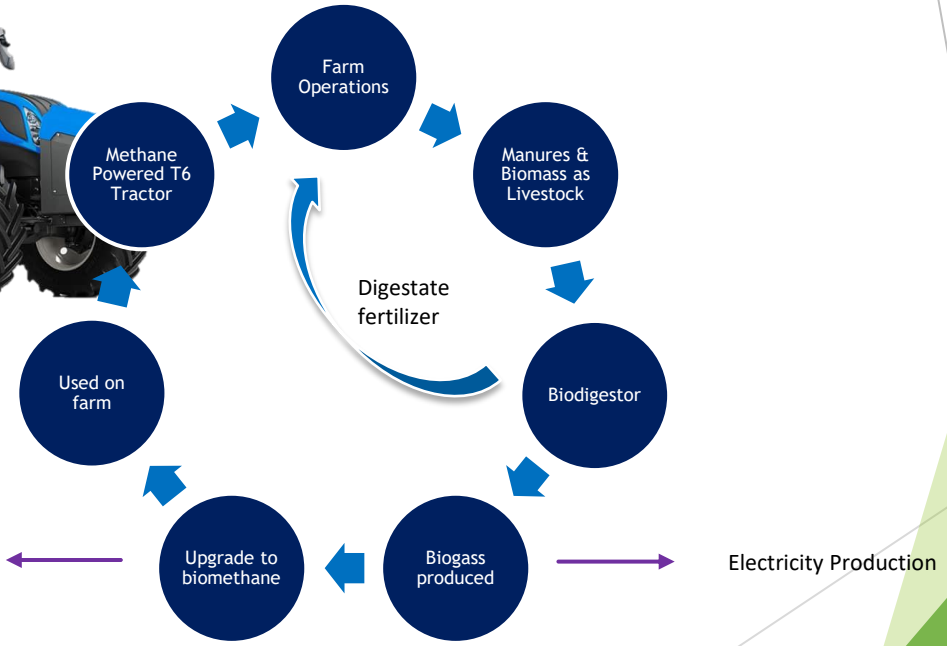
AUGUST 2016 / REDEFINING
THE AGRICULTURE
OF TOMORROW
NHDRIVE™ CONCEPT AUTONOMOUS TRACTOR,
UNVEILED AT FARM PROGRESS, USA.
IT PROVIDES A GLIMPSE INTO THE FUTURE
OF TRULY AUTONOMOUS FARMING.

AUGUST 2017 / METHANE POWERED
CONCEPT TRACTOR
LAUNCHED AT FARM
PROGRESS SHOW, USA,
REIMAGINES THE DESIGN
AND REVEALS A CONNECTED
AND SUSTAINABLE FUTURE

NOVEMBER 2019 /
T6 METHANE POWER
THE WORLD'S FIRST
PRODUCTION UNIT
UNVEILED AT THE
AGRITECHNICA
SHOW, GERMANY.

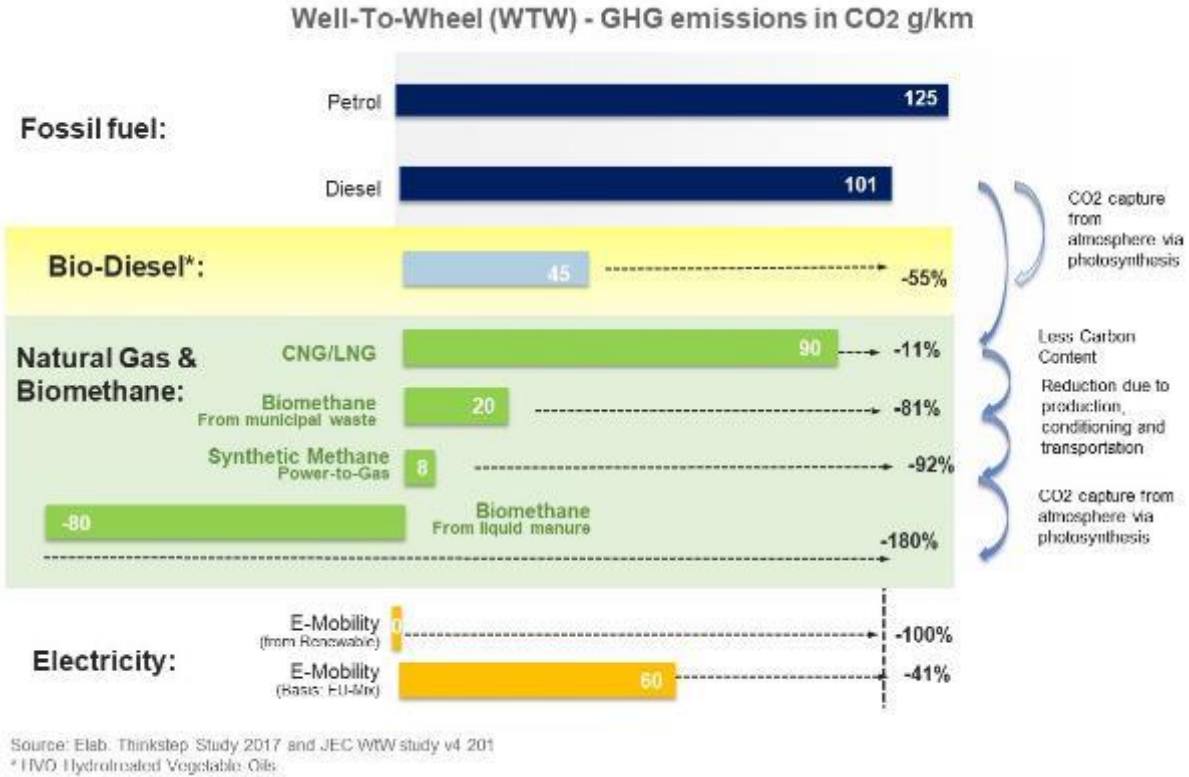
Create the farm of tomorrow - The Energy Independent Farm℠

Our mission: Helping farmers around the world to become independant regarding energy by allowing the creation of a more sustainable agricultural world.

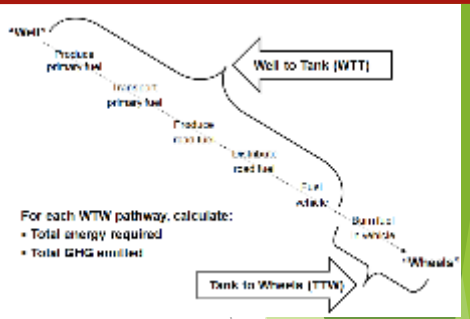


Environmental Impact View - Well to Wheel

Green-House-Gas Emissions by Source – On-Road



Well to Wheel



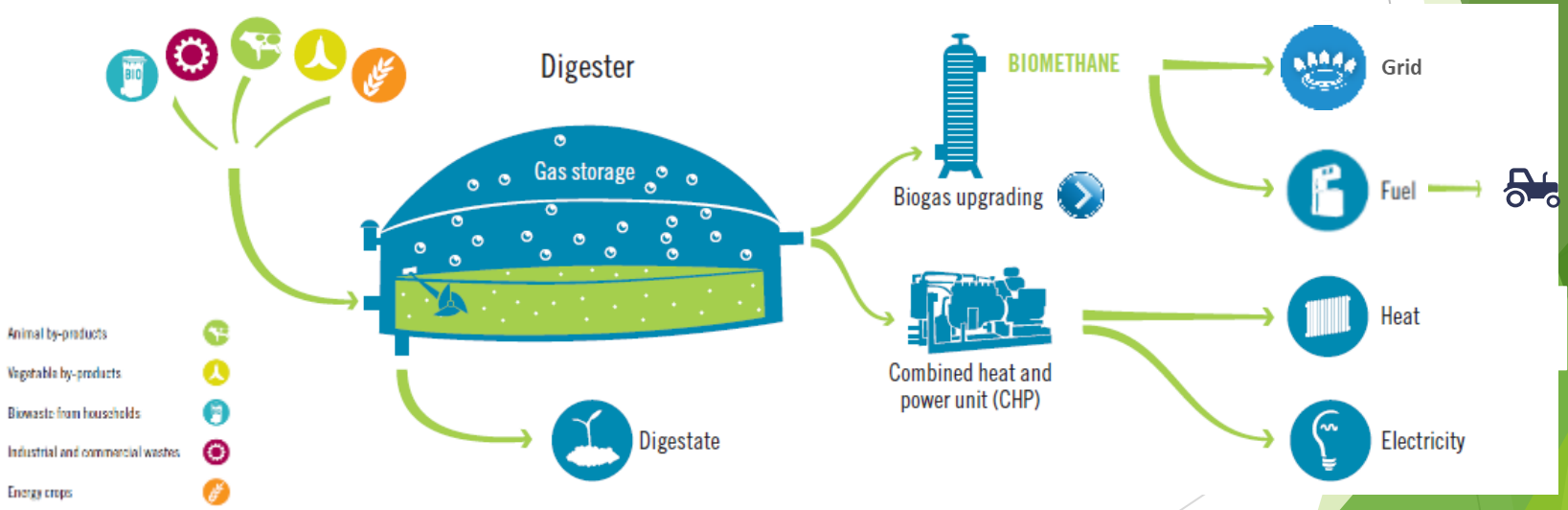
Natural Gas vs Diesel

- **Non-Renewable** Natural Gas has a significant reduction in CO_2 emissions vs Diesel (~11%)
- **Renewable** sources of Gas reduce CO_2 emissions even further vs Diesel
  - Between ~ 80% - 180% reduction depending on the source

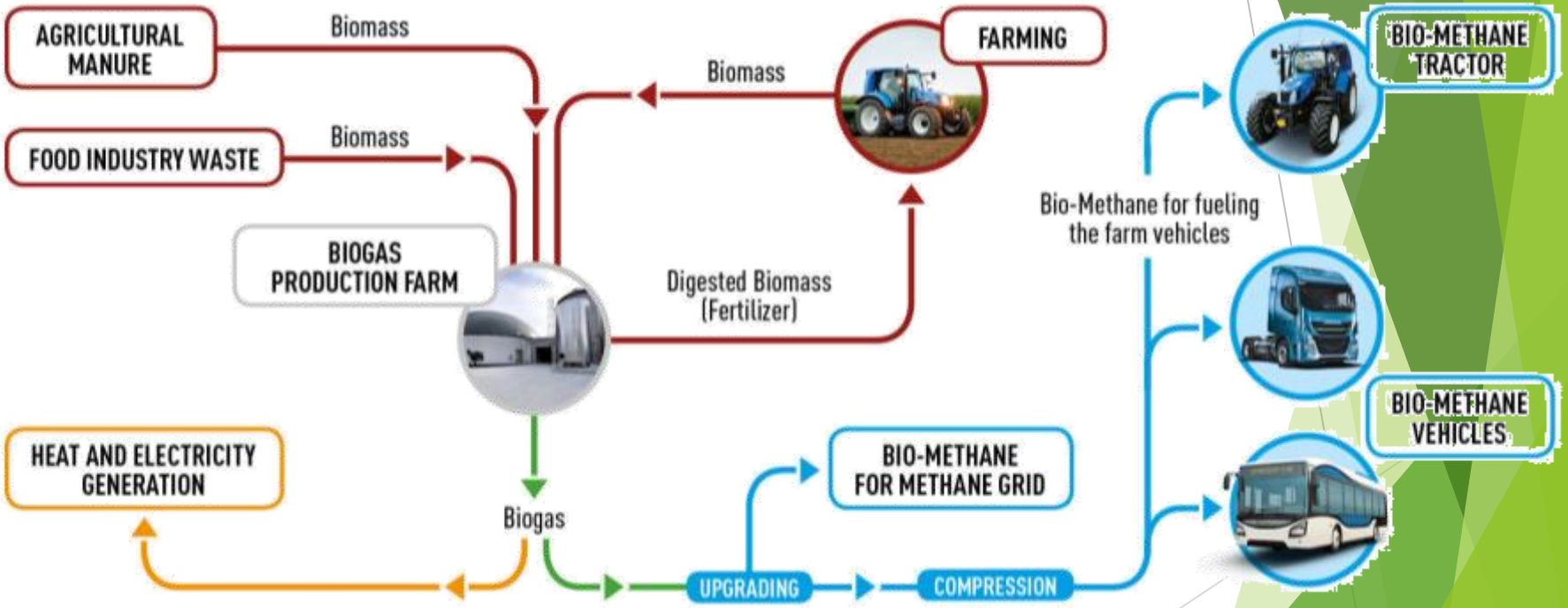
Renewable Gas

Sources & Utilization

- The raw output of an Anaerobic Digester (AD) is **Biogas**, which can either be used directly to generate **Electricity** & **Heat**, or upgraded to produce **Biomethane**
- **Biomethane** can then be injected into the **Grid** or used directly as **Fuel**
- The waste output of the Anaerobic Digester is known as **Digestate** which can be further recycled into various products



Energy Independent Farm™ system

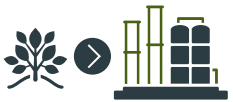


Methane gas requires high compression or liquefaction to be usable

Overview of gas usage opportunities

Methane Sources

- Grid quality: ~85% methane



- Biogas contains ~ 65% methane

- Need for purification to >85% methane content

- At outlet pressure: 1 day tractor use[1] = 360m³ (5 shipping containers)

Processing Required for use as Fuel

- High compression (250bar)
- 1 day = 1.4 m³ CNG*

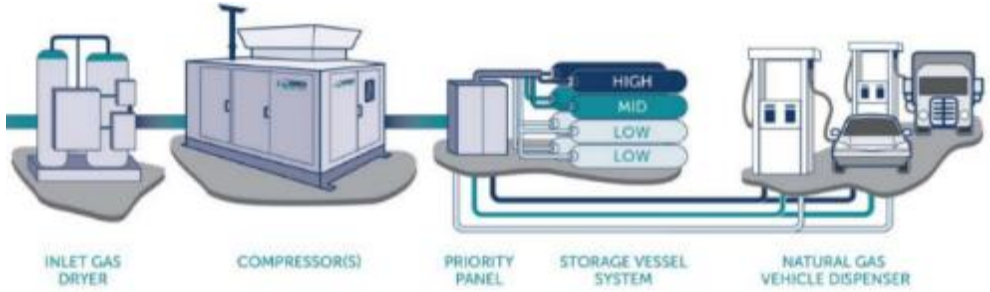
- Extremely low temperatures of less than -170°C and requirement to keep cooled
- 1 day = 0.6 m³ LNG*

1) 10h operating time = 360 m³

* Volume calculated using ideal gas law – PV=nRT

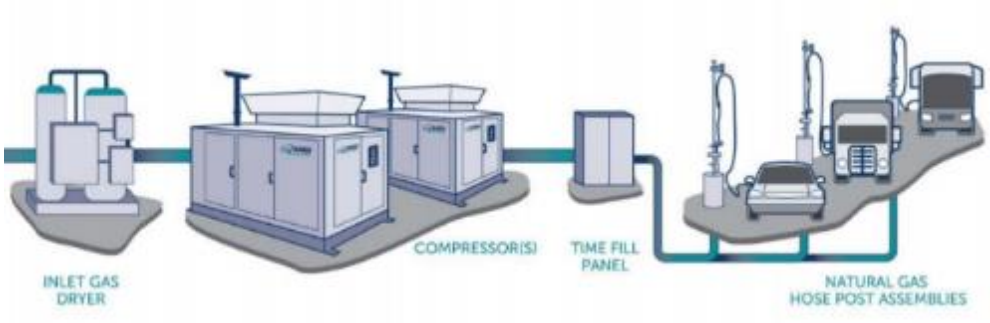
Infrastructure investment for CNG filling technology

Fast-fill station configuration (3-4 minutes)



$45-75k
Initial investment

Time-fill station configuration (~6 hours)



$35-50k
Initial investment

Source: Clean cities project; ANGI Engineering, Phoenix Energy, US Deprtment of Energy

Infrastructure

$65k system example

- $65k will buy a compressor and one bank of 15 tanks
  - Additional tanks ~$15k per bank of 15 cylinders
  - Compressor (example)
    - Coltri MCH-24 Compressor (250 Bar)
    - 13kg/hr (24 m3/hr)
  - Fast Fill Storage
    - SM15 Bank (1x from image)
    - 140kg of usable gas at 200bar
  - Usage of 140kg
    - 4x APH with out range extender
      - Tractor fill time 5 minutes
    - Storage bank refill time ~11hrs
- Notes
  - Additional banks can be added as it is a modular system
  - Additional vehicles can refuel a lower pressure

France Suppliers CNG fuelling stations

On farms : N°1 is Prodeval

- CN'Green = solution for AD plant with injectio
- 75 k€ (60k€ for the station / 15 k€ installation
- 18 Nm3/h (= 13,5 kg/h)
- Simulation with a gas price of 28€/MWh (up to 90€/MWh end of 2021)

PRODEVAL
INGÉNIERIE DES SOLUTIONS GAZ

Volume de GNC distribué = 39 tonnes / an soit l'équivalent de 150 kg/jour, 5 jr/semaine, 52 semaines/an

	Années 1 à 8	Années 8 à 15
Achat gaz naturel	0,398 €HT/kg de CNG	0,398 €HT/kg de CNG
Achat Garanties Origines	0,000 €HT/kg de CNG	0,000 €HT/kg de CNG
Electricité	0,032 €HT/kg de CNG	0,032 €HT/kg de CNG
Exploitation de l'installation	0,077 €HT/kg de CNG	0,077 €HT/kg de CNG
Maintenance préventive	0,066 €HT/kg de CNG	0,066 €HT/kg de CNG
Maintenance curative	0,000 €HT/kg de CNG	0,000 €HT/kg de CNG
Abonnement internet	0,000 €HT/kg de CNG	0,000 €HT/kg de CNG
Assurances équipement et responsabilité civile	0,051 €HT/kg de CNG	0,051 €HT/kg de CNG
Taxe foncière / Redevance occupation du terrain	0,000 €HT/kg de CNG	0,000 €HT/kg de CNG
Entretien site	0,000 €HT/kg de CNG	0,000 €HT/kg de CNG
Gardiennage site	0,000 €HT/kg de CNG	0,000 €HT/kg de CNG
TICPE	0,076 €HT/kg de CNG	0,076 €HT/kg de CNG
Dotation aux amortissements	0,240 €HT/kg de CNG	0,000 €HT/kg de CNG
Coût de l'endettement	0,017 €HT/kg de CNG	0,000 €HT/kg de CNG
Coût de revient du CNG	**0,957 €HTVA/kg de CNG**	**0,700 €HTVA/kg de CNG**

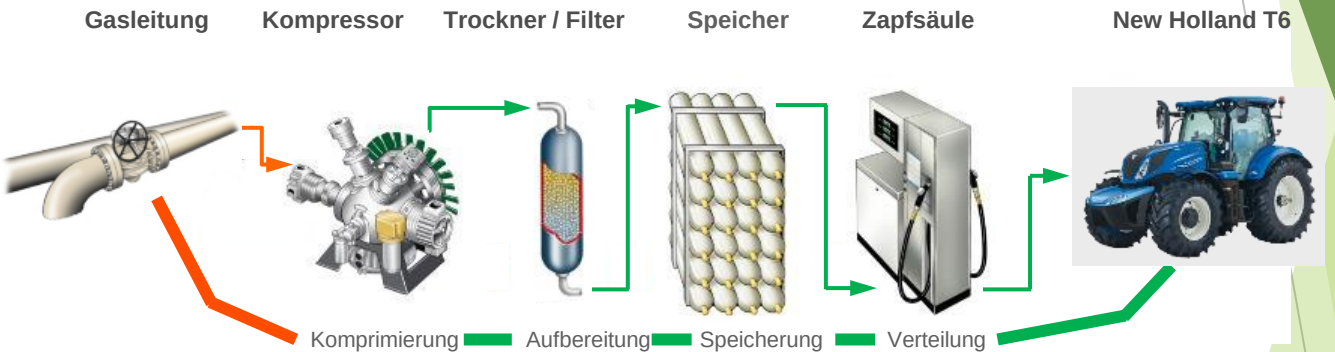
Composantes prix de revient du GNC (scénario à 39 tonnes/an)

Scenario 39 t / year
= 150 kg/day over 260 days

NEW HOLLAND AGRICULTURE

2. WAS MACHT BAUER KOMPRESSOREN ?

kompressoren ?



Gaseingang
Niederdruck

Gasausgang
Hochdruck

Bulk fuel transport comparison

Transport capacity & cost has a significant variation by fuel type

44 Ton Bulk Haulage

- **Diesel**
  - 38,000 litres (31,616 kg)
  - 1,500 hours tractor usage
- **CNG (250-300 Bar compressed)**
  - 5,000 kg
  - 262 hours tractor usage
  - 5.7x to match Diesel
- **LNG (insulated cryogenic tank -163 ºc)**
  - 21,000 kg
  - 1,100 hours tractor usage
  - 1.4x to match Diesel

Increasing complexity and cost of storage

Technical criteria for natural gas of an FPT engine

Natural Gas must meet the expectations of Law EN 16732-2 "Natural gas and biomethane for use in transport and biomethane for injection in the natural gas network – Part 2: Automotive fuels specification“

Natural gas used in FPT engines must meet the following technical criteria:

- $CH_4 > 85\%$ v/v
- NMHC< 13% v/v
- Inert (CO_2, N_2) < 14% v/v
- $H_2 < 5\%$ v/v
- Water < 55mg/Nm3 - MN (Methane Number) > 70 (AVL method)
- H_2S < 10ppm
- Total sulphur < 10mg/Nm3 (ISO 6326-5)
- Siloxanes < 5mg/Nm3

Prototypes and development in methane supply

Methane powered Tractor Prototype

- Prototype 1, F1C engine from the Iveco Daily
- Proof of concept

Main specifications

Name: **T6.140 Methane Power**
Engine family: **139hp 4-cylinder F1C**
100% **Methane Powered**
10L Petrol Back-up

Methane powered Tractor Prototype

- The methane prototype has been extensively tested in Europe and Brazil

(Germany, France, Italy, UK, Spain, Denmark, Czech Republic, Belgium, Netherlands, Luxemburg)

- Engine derived from the Iveco Eurocargo

METHANE POWER TRACTOR

Main specifications

Name: **T6.180 Methane Power**
Engine family: **179hp 6-cylinder NEF**
100% **Methane Powered**

Prototypes at work

Methane Power

Prototypes at work

Methane Power

Methane Concept

The Methane Concept has been all around the world, multiple fairs and events in Europe including Agritechnica, SIMA and EIMA. It has been to Agrishow in Brazil and to the Farm Progress show in the USA. It also went to the Obihiro show in Japan.

FPT NEF NG 67 Engine

FPT the best of the best

The Cursor 16 for agriculture and construction applications

The 460 hp Cursor 13, the most powerful natural gas engine on the market

The Cursor X engine concept: Multi-power, Modular, Multi-application and Mindful

CLEAN DIESEL

Best in class advanced solutions in almost all segments:

- 13 registered in-house patents on Stage V and Selective Catalytic Reduction (SCR) technologies
- SCR, a highly efficient system that can achieve a reduction of up to 98%
- Currently meeting Stage V and Euro VI Step D requirements
- Ongoing research to further increase efficiency and reduce CO_2 emissions
- Featuring improved Total Cost of Ownership (TCO) with longer maintenance intervals

NATURAL GAS

- Natural Gas is a key step towards future zero CO_2 emission propulsions
- Biomethane solutions for all the segments
- Research on alternative fuels/ biofuels for the lowest possible CO_2 emissions

ELECTRIFICATION

Dedicated e-powertrain organization focused on the execution of projects:

- New e-axles, diesel-hybrid and gas-hybrid powertrains
- Fully electric propulsions as long-term solutions for zero-emission vehicles, mainly for urban missions
- Hydrogen fuel-cell propulsion as a solution for long distance missions

Methane power Tractor Range & Main Specifications

New Holland T6.180 Methane Power

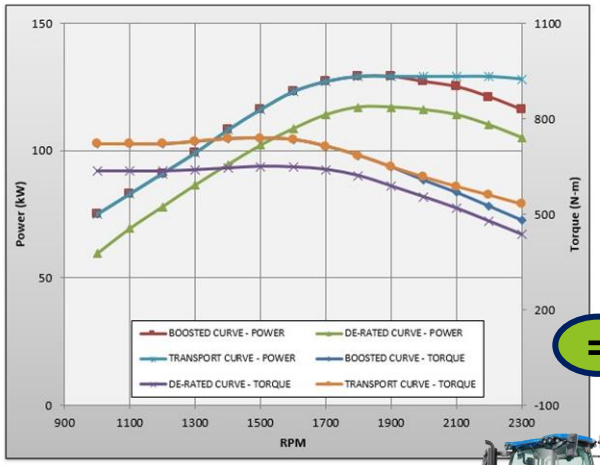
Name:	Methane Power
Engine:	FPT 6-Cylinder
Model:	T6.180
Engine power:	179hp / 132 KW
Torque:	740 Nm
Methane tank capacity:	190 l
Transmission:	ElectroCommand

Methane Power tractor Vs Diesel Key Elements

Standard Diesel tractor vs Methane Power

Same	Power 180 hp
Same	Torque 740 Nm
Same	Durability
Same	Service intervals
Same	Productivity
Same	Performance
Running costs	Saving 30%

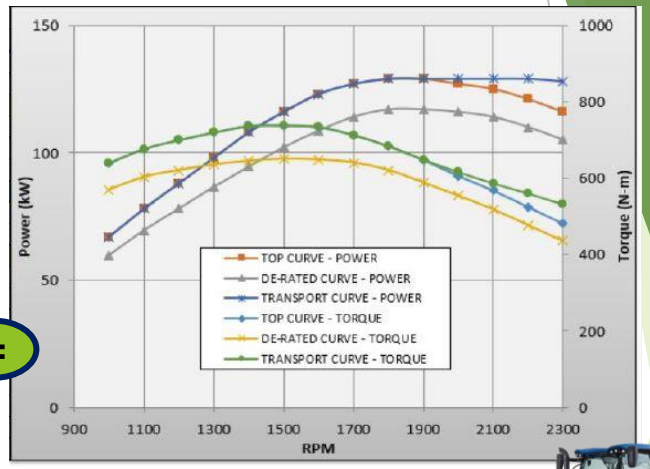
Same power and performances as a diesel tractor



***T6.180 Methane Power**

STAGE V

=



***T6.180 Diesel**

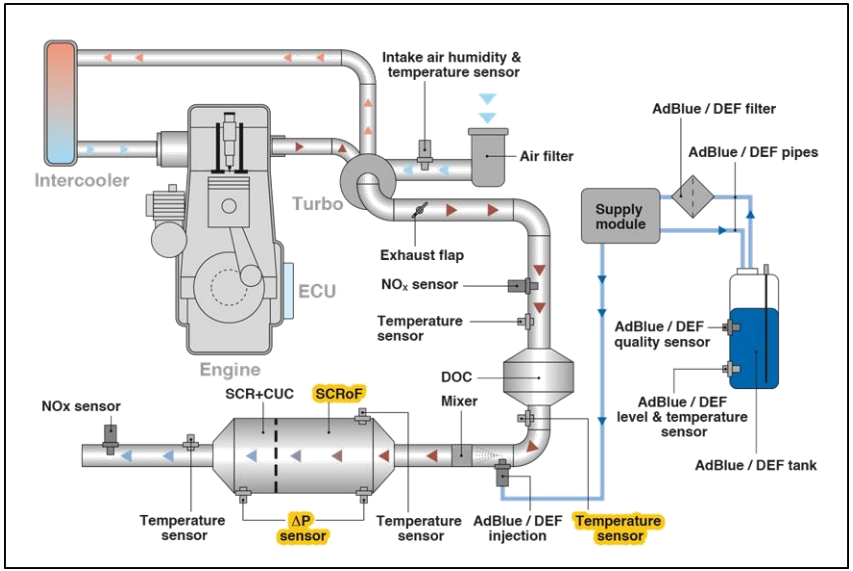
STAGE V

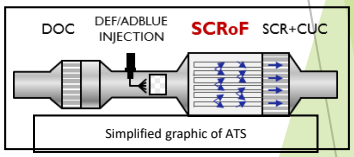
We were really looking for creating a more **sustainable** tractor without impacting farmers **performance.**

Structural comparison between a gas engine and a diesel engine

Tracteur à gaz

Tracteur Diesel (stage V)



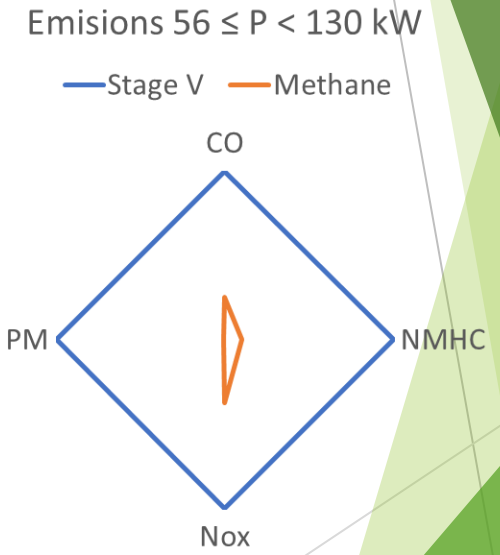


Comparison of emissions between a Diesel engine / Gas engine

By developing a methane engine, we have the opportunity to develop agricultural production more in line with current environmental issues.

Comparison of emissions with a traditional engine:

- **CO**
  - ✓ Reduction of 75%
- **NMHC**
  - ✓ Reduction of 90%
- **PM**
  - ✓ Reduction of 98%
- **NOx**
  - ✓ Reduction of 62%
- **CO_2**
  - ✓ Reduction of 10%-15% (not in the Phase 5 legislation)



Methane Power tractor

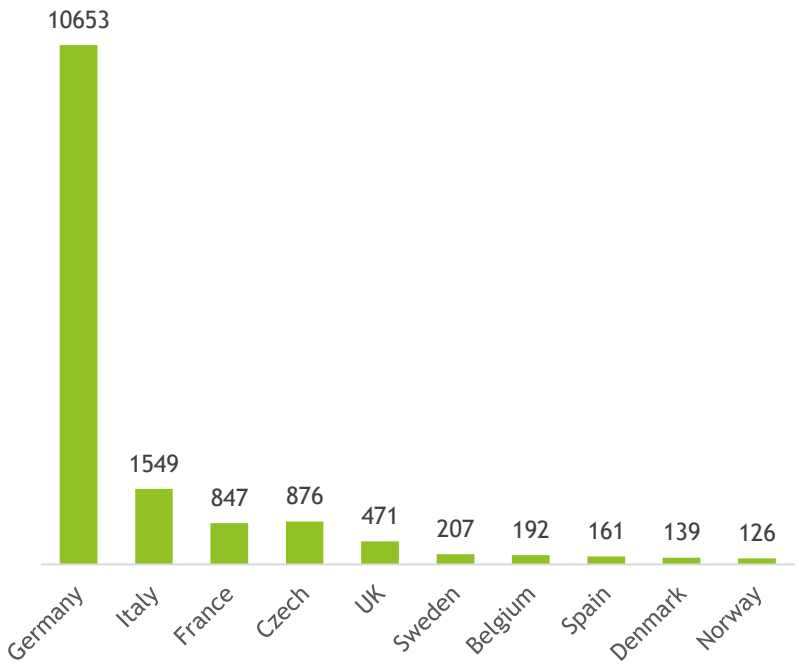
Standard Diesel tractor vs Methane Power

Methane Power tractor

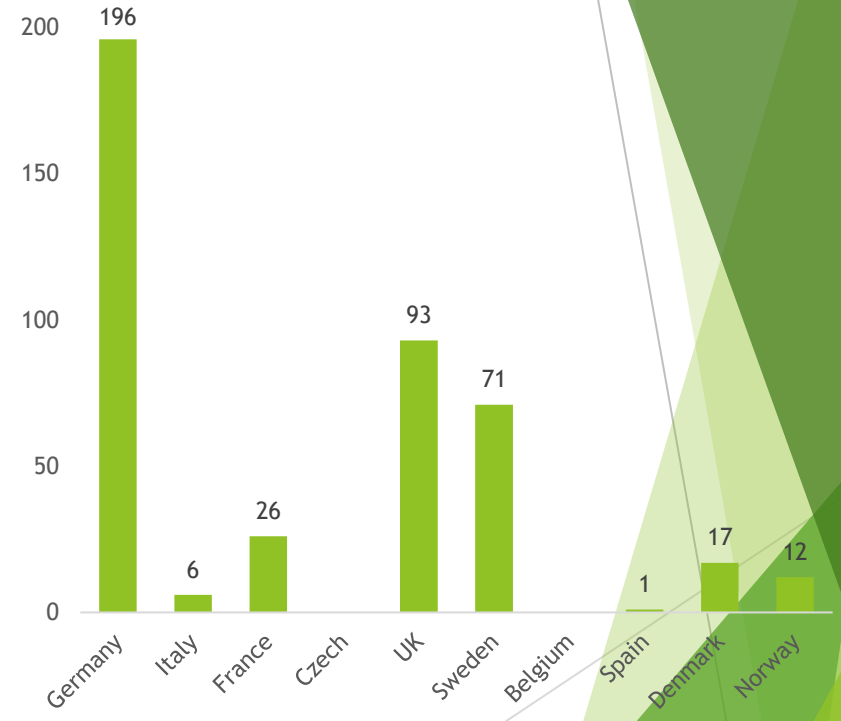
Standard Diesel tractor vs Methane Power

On-Farm BioGas & Biomethane Plants

Europe 2017

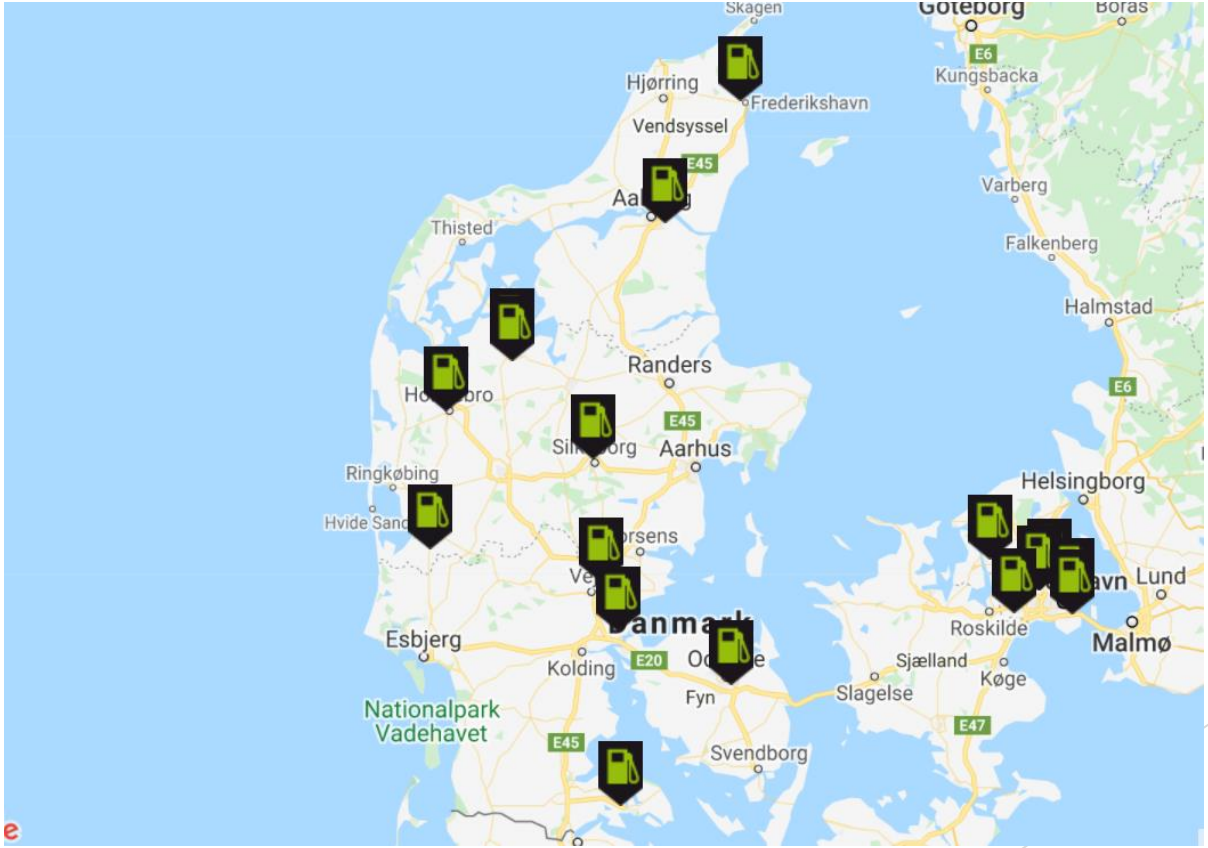


Number of biogas plants by Country



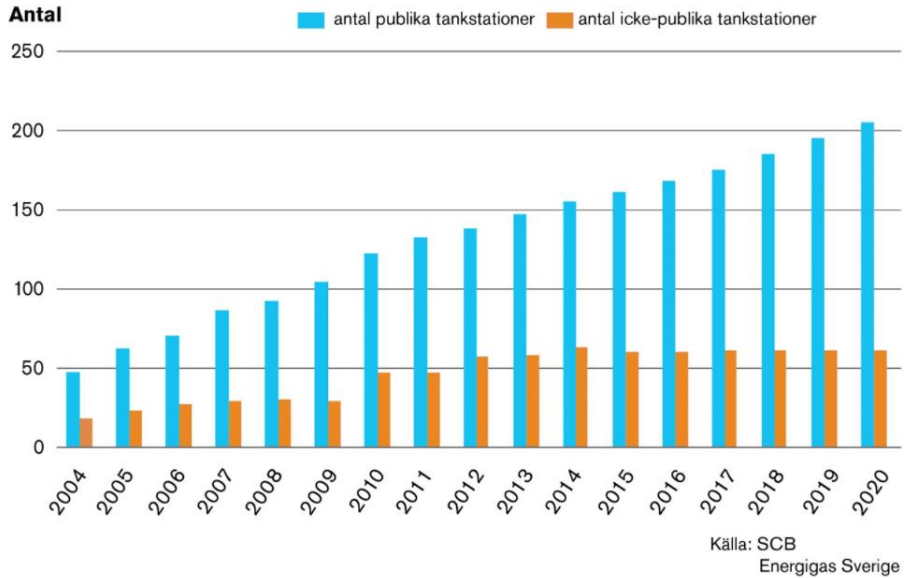
Number of biomethane plants by Country

CNG Tank stations in DK.



CNG Tanks stations in SE

Tankstationer för fordonsgas



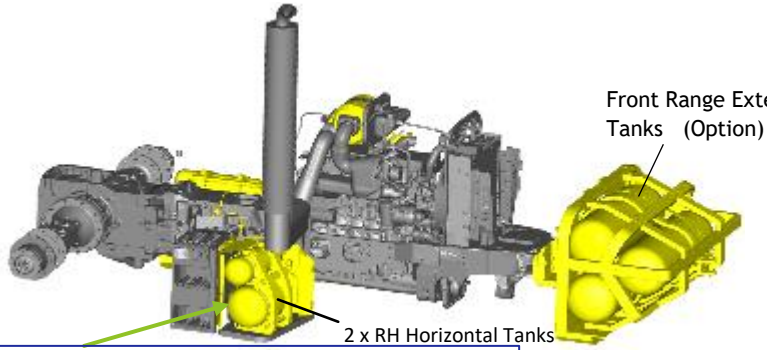
Fuelling satiations in Europe

https://www.ngva.eu/stations-map/

T6 Methane Tanks & Refueling Process

T6 Methane Tanks Available

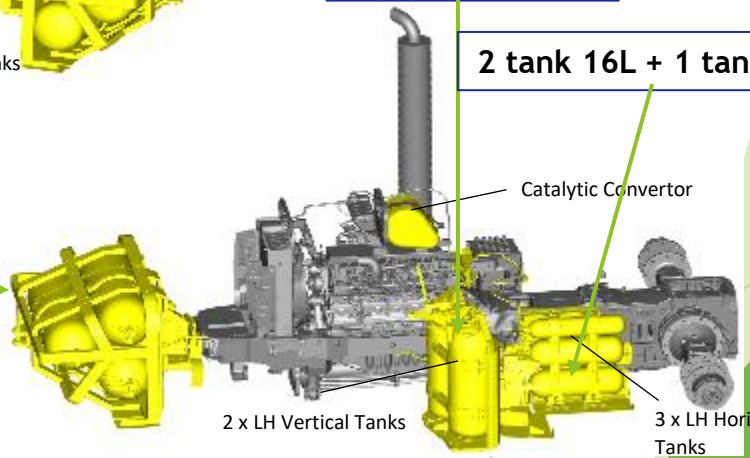
Total capacity: 190L Standard Laterals tanks + 270L Range Extender



1 tank of 14L + 1 tank 29L

2 tanks of 50L each

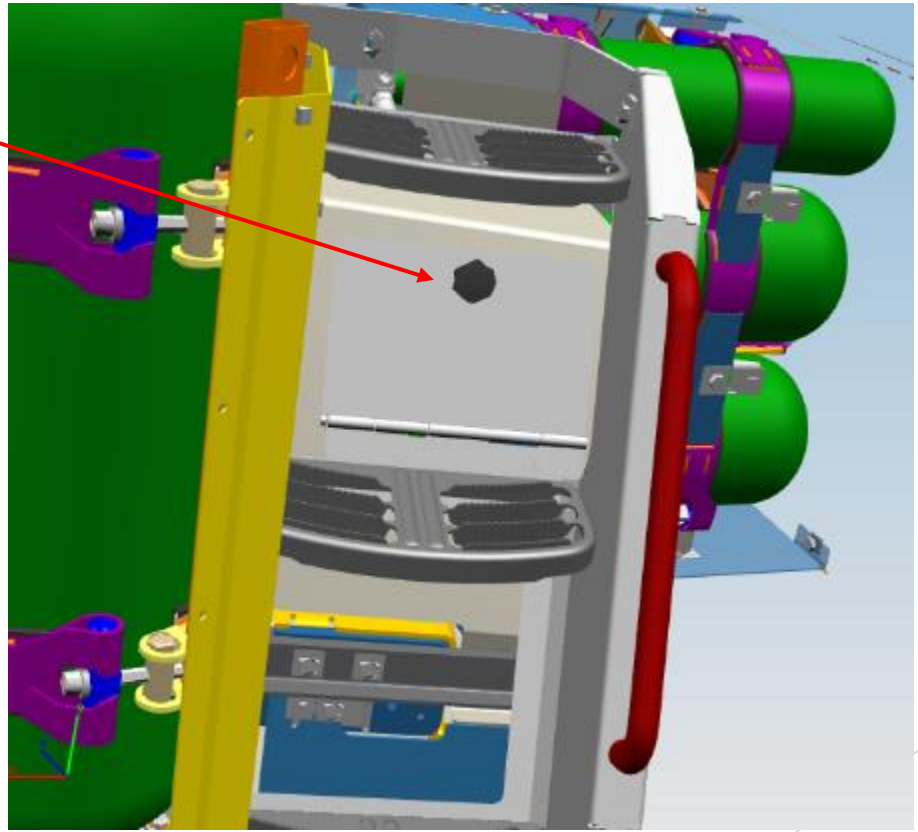
2 tank 16L + 1 tank 8L



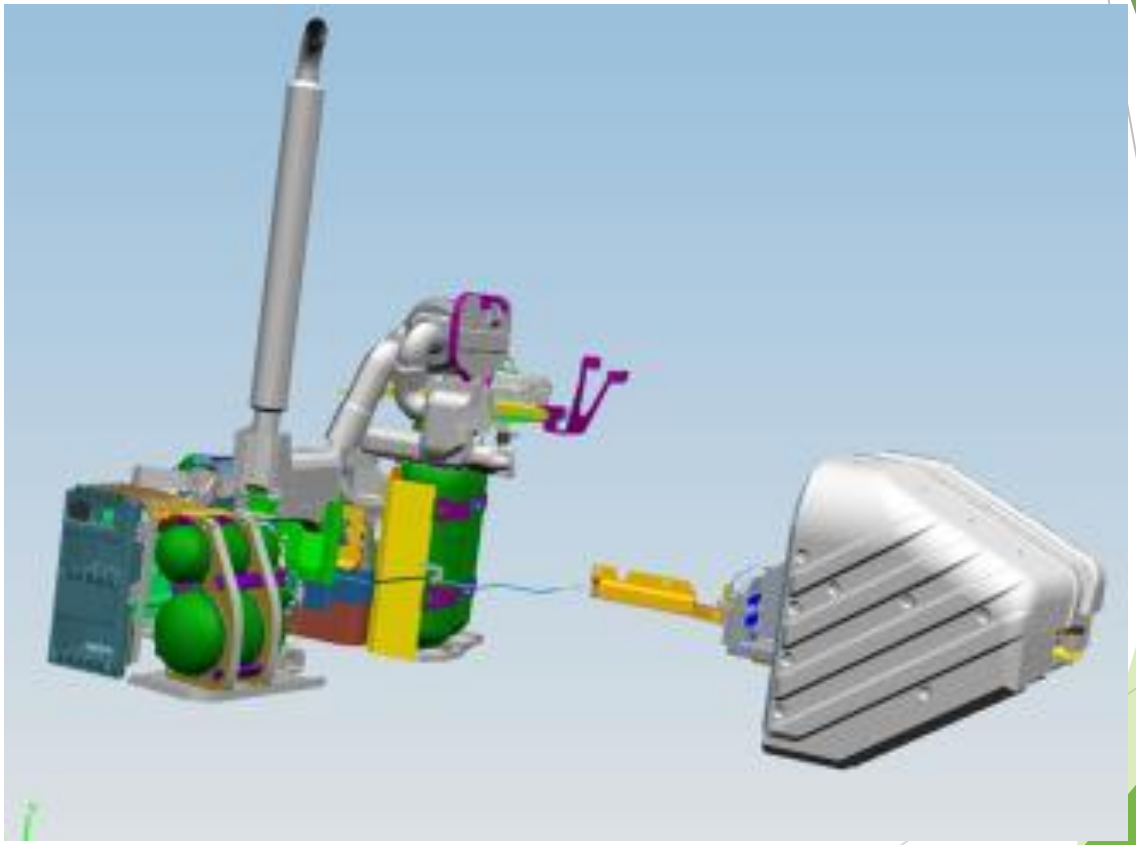
Range Extender:
3 tanks of 90L each

Controls and Refueling Point

New position for fill point and fuel pressure gauge.



ATS Reviewed System

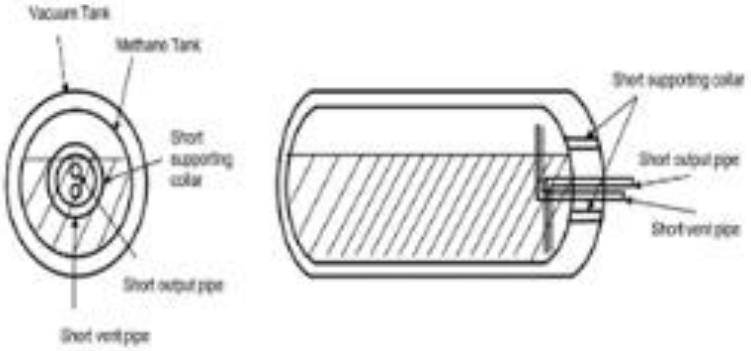


LNG – Liquified Natural Gas

LNG Tank option comparison

Key Challenges to using LNG as a vehicle fuel

- Tank design needs to minimise heat gain to fuel – Current designs are all “thermos flask” based



- Heat transfer path through thermal bridges limits storage time to **5 days**
- Fuel kept below **-163ºC**

Conventional “Chart” type

Iveco part no. 5802217070

103Kg LNG

Dimensions of tank (660mmX 1220mm) do not fit within tractor envelope.

Potential customers and solutions

Fuel consumption

- The fuel consumption estimation is based on simulations from Field test, Modena Engineering and bench testing from FPT.
- The Modena simulation is based on the duty cycles from the DLG testing

		DLG simulation	66%	75%	Fuel/hr
Usage - Farm	Diesel	25	0.66		16.50
	Methane	19	0.66		12.54
Usage - Municipality	Diesel	25	0.66	0.75	12.38
	Methane	19	0.66	0.75	9.41

Vehicle autonomy

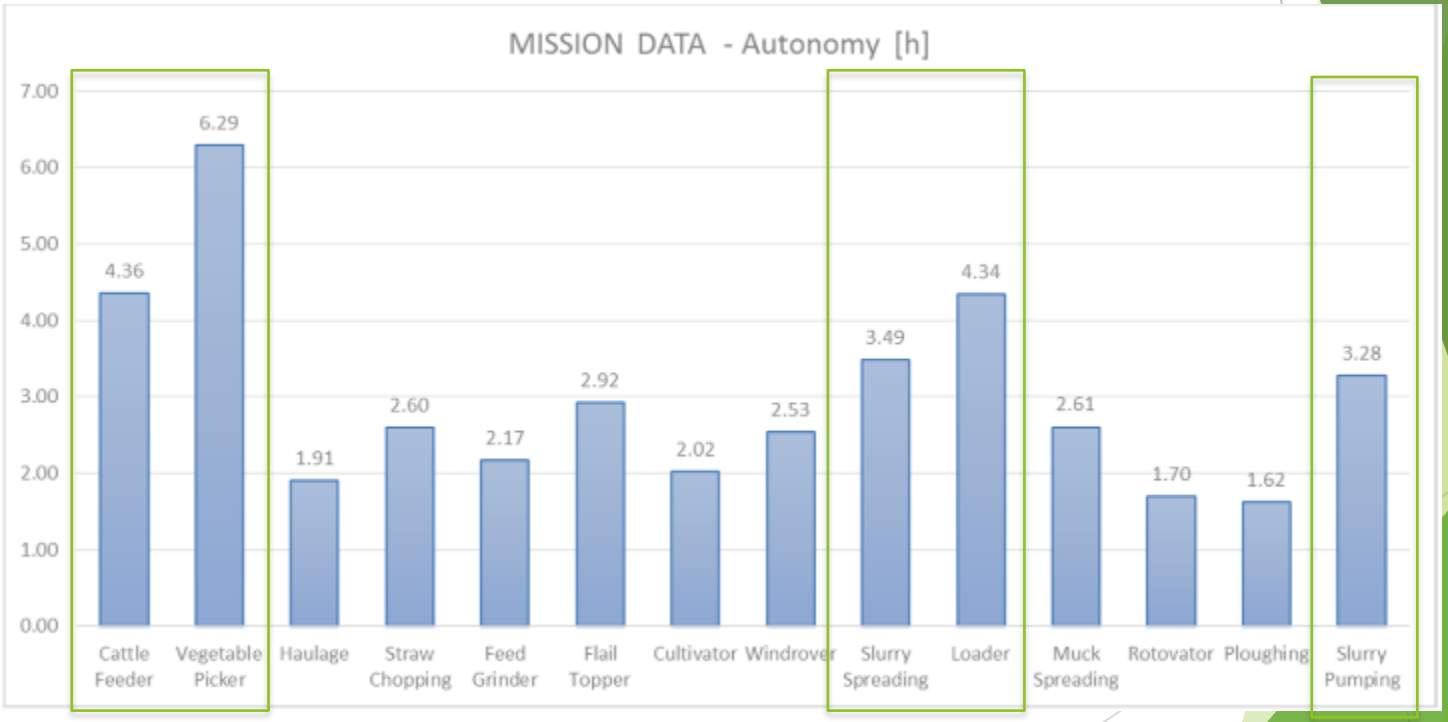
		DLG simulation	66%	75%	Fuel/hr
Usage - Farm	Diesel	25	66%		16.50
	Methane	19	66%		12.50
Usage - Municipality	Diesel	25	66%	75%	12.40
	Methane	19	66%	75%	9.40

Autonomy	185	185+270	Fuel Litres
	32	79	Fuel KG's
Usage - Farm	2.6	6.3	Hrs
Usage - Municipality	3.4	8.4	Hrs

Virtual analysis autonomy simulations

Based on measured Diesel values

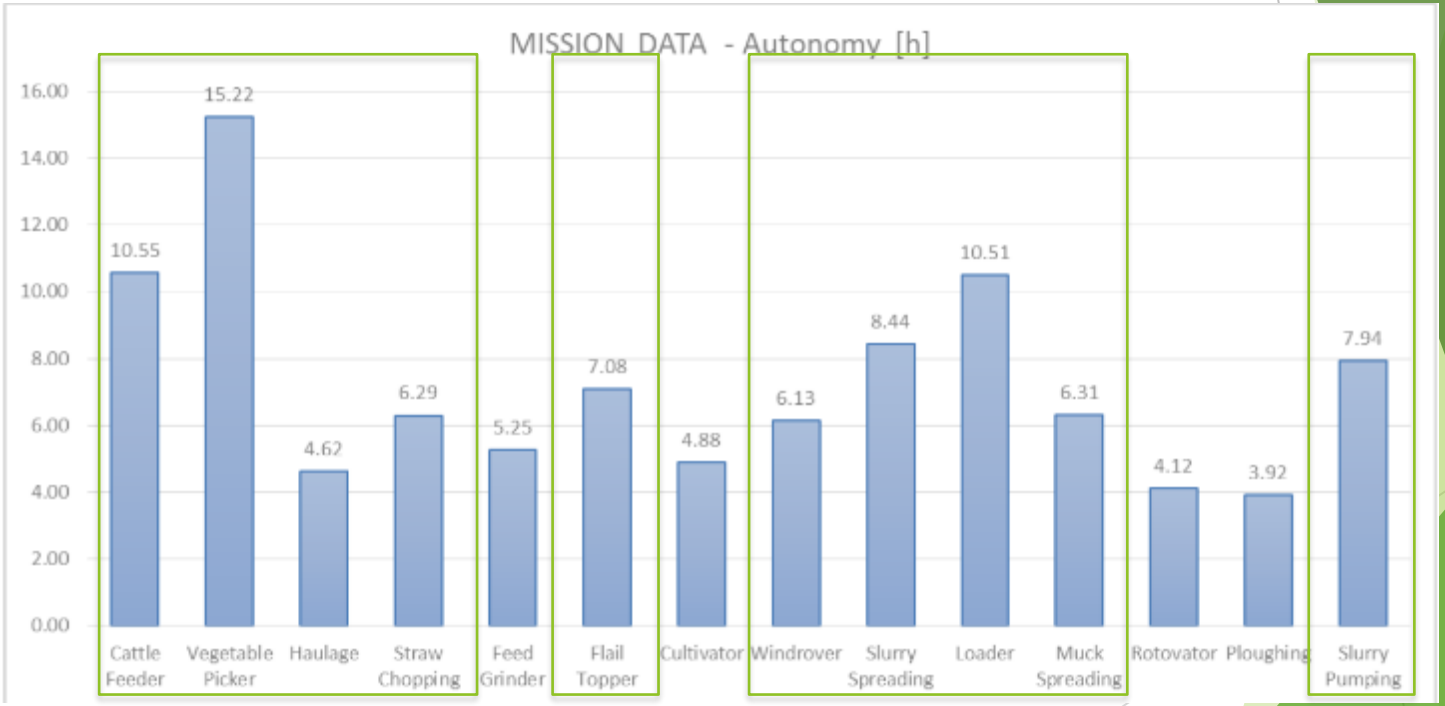
EUROPE STANDARD = **190 L**; MaxPressure = **200 bar**; MinPressure = **22 bar**



Virtual analysis autonomy simulations

Based on measured Diesel values

EUROPE RANGE EXTENDER = **460 L**; MaxPressure = **200 bar**; MinPressure = **22 bar**



Fuel cost

	Wholesale Gas kwh	Per KG	Electricity cost per KG to compress	Methane Fuel Cost	"Farm Diesel"	Road Diesel, less VAT
Belgium	€0.02	€0.17	€0.05	€0.22	€0.59	€1.19
United Kingdom	€0.03	€0.20	€0.06	€0.26	€0.57	€1.23
Germany	€0.03	€0.22	€0.05	€0.28	€0.59	€1.06
Italy	€0.03	€0.24	€0.06	€0.30	€0.60	€1.22
France	€0.04	€0.27	€0.05	€0.32	€0.61	€1.22
Netherlands	€0.04	€0.27	€0.04	€0.32	€0.62	€1.13
Average	€0.03	€0.23	€0.05	€0.28	€0.60	€1.17

	Whole sale Gas price in (fossil gas, from the grid)									
Market	Wholesale Gas kwh	Per KG	Electricity cost per KG to compress	Methane Fuel Cost	"Farm Diesel"	Road Diesel, less VAT	Farm Diesel vs Gas	Farm Diesel vs Gas rank	Road Diesel vs Gas	Road Diesel vs Gas rank
Turkey	0.021	0.15	0.044	0.193						
Georgia	0.023	0.16	0.038	0.200						
Belgium	0.024	0.17	0.052	0.220	0.59	1.19	0.37	6	0.97	1
Ukraine	0.026	0.18	0.042	0.224						
Moldova	0.027	0.19	0.049	0.236						
United Kingdom	0.028	0.20	0.064	0.263	0.57	1.23	0.31	19	0.97	2
Hungary	0.029	0.20	0.055	0.258	0.63	0.98	0.37	5	0.73	16
Czechia	0.029	0.21	0.049	0.255						
Croatia	0.030	0.21	0.057	0.268	0.65	1.06	0.38	4	0.80	11
Greece	0.030	0.21	0.051	0.262	0.63	1.11	0.43	3	0.85	7
Bulgaria	0.031	0.22	0.056	0.273	0.60	0.93	0.33	11	0.66	23
Spain	0.031	0.22	0.070	0.287	0.63	1.01	0.35	9	0.73	17
Romania	0.032	0.22	0.053	0.276	0.62	1.02	0.35	10	0.75	14
Germany	0.032	0.22	0.055	0.279	0.59	1.06	0.31	18	0.78	12
Latvia	0.032	0.22	0.054	0.278	0.61	0.99	0.33	12	0.71	19
North Macedonia	0.032	0.23	0.044	0.272						
Portugal	0.033	0.23	0.056	0.285	0.65	1.13	0.36	7	0.85	8
Austria	0.033	0.23	0.052	0.281	0.60	1.01	0.32	13	0.73	16
EU-28	0.033	0.23	0.056	0.287						
Lithuania	0.033	0.23	0.053	0.284	0.60	0.95	0.32	16	0.66	22
Luxembourg	0.033	0.24	0.052	0.288	0.61	0.94	0.32	15	0.65	24
Euro area	0.034	0.24	0.056	0.293						
Denmark	0.034	0.24	0.041	0.278	0.71	1.14	0.43	2	0.86	6
Slovenia	0.034	0.24	0.051	0.290	0.55	1.02	0.26	23	0.73	15
Italy	0.034	0.24	0.061	0.302	0.60	1.22	0.30	21	0.92	3
Slovakia	0.034	0.24	0.059	0.300	0.65	1.05	0.35	8	0.75	13
Ireland	0.034	0.24	0.085	0.326	0.58	0.99	0.25	24	0.67	21
Estonia	0.034	0.24	0.049	0.291	0.61	1.10	0.32	14	0.81	9
Poland	0.035	0.24	0.051	0.296	0.61	0.95	0.31	17	0.65	25
Bosnia and Herzegovina	0.037	0.26	0.042	0.300						
France	0.036	0.27	0.052	0.319	0.61	1.22	0.29	22	0.90	4
Netherlands	0.039	0.27	0.044	0.316	0.62	1.13	0.30	20	0.81	10
Serbia	0.039	0.27	0.049	0.324						
Sweden	0.040	0.28	0.047	0.327	0.77	1.22	0.44	1	0.89	5
Finland	0.063	0.44	0.041	0.483	0.70	1.16	0.22	25	0.68	20
Liechtenstein	:	#VALUE!	#VALUE!	#VALUE!			0	0	0	0

Target customers

- Vegetable producers
  - Emissions reduction targets
    - Supermarket/consumer influence
  - Large fleets
  - High hour usage
- Biogas producers
  - Fuel availability
  - Emissions reduction targets
- Municipal contractors
  - Emissions reduction targets
  - Grid gas availability
  - Access to public fuel stations





Biogastraktorn nu i verkligheten

Han blir först med biogas i traktortanken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What is next?

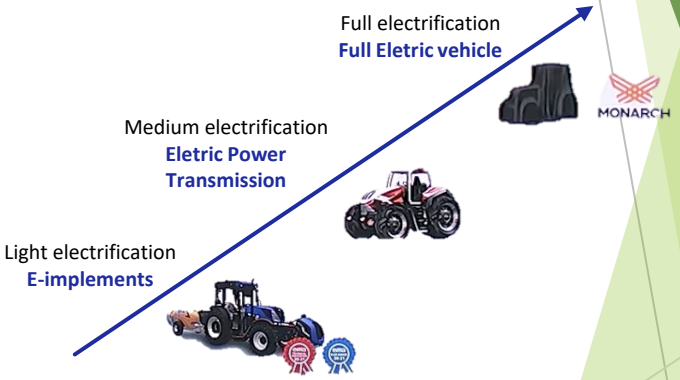
Alternative fuels

New T6 Methane tractor already launched

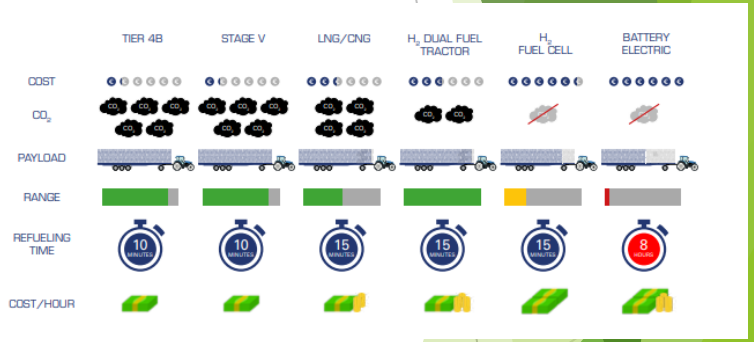
Technology applied to other product platforms

Electrification

Committed to bringing our customers electric technologies within the plan horizon



Hydrogen today



Thank you for listening

Backup