Chassis & Powertrain

CNG System Development & - Integration
Development and integration of top level system-solutions from the 'complete-vehicle' point of view.

We guarantee the customer the best compromise in costs, weight, technology and functional requirements all over the vehicle!
Competences

- Concept Development & System Definition
- Design & Geometrically Integration
- Validation Test Rig & On vehicle
- Functional Integration & Vehicle Dynamics
- Program Management & Consulting
- Prototyping
- Low Volume Production

From idea to serial production!
Chassis & Fuel-Storage

Components & Systems

- Axle- & Suspension Systems
- Brake- & Steering Systems
- Aggregate- & Powertrain Mountings
- Fuel Storage Systems (standard & alternative)
- Vehicle Stability Systems
- Active Chassis Systems
- Chassis Actuators
Components & Systems

- Engine Application & Calibration, Emissions
- Intake- & Exhaust Systems, Cooling Systems
- Automatic & Manual Transmission
- Axle & Transfer gearboxes, Torque-Vectoring
- Actuators & specialized powertrain
- Alternative fuels
- Hybrid & Electric Powertrain
# Hybrid & Electric Propulsion Systems

## Description
- Definition, Development and Validation of Powertrain Concepts
- Serial Development
- Prototypes & low volume production

## Features/Specifications
### Examples:
- **E-Axle Drive / Hybride**
  - Definition, Development of Concept
  - Prototyping, Validation
  - Co-axial Version (planetary gears)
  - Torque-vectoring optional

- **E-Axle Drive / Battery Vehicle**
  - Definition, Development of Concept
  - Prototyping, Validation
    - Co-axial Version (standard gears)
    - Offset Version

## Key Benefits
- Environment Friendly
- Comfort/Convenience
- Weight Reduction
- Fuel Economy

## Contact
- **Name:** DI Markus Rudolf  
  **Chief Engineer Chassis & Powertrain**
- **Phone:** +43 664 8840 2499
- **Email:** markus.rudolf@magnasteyr.com
ETS Electric Traction System

Description

coaxial single-speed gearbox for EVs
modular concept with optional parking brake mechanism
Low volume production

Features/Specifications

Axle drive:
• Power / torque range: up to 100KW / 300 Nm
• gear ratio range: i=5 to i=13
• optimized functionality (NVH, efficiency, weight, costs)

System development:
• Development, production and testing
• End Of Line test

Vehicle integration:
• Customer or MAGNA STEYR

Assembly and low volume production:
• Gearbox, engine and power electronics

Key Benefits

Cost Reduction
Comfort/Convenience
Fuel Economy

Contact

Name: DI Markus Rudolf  Chief Engineer Chassis & Powertrain
Phone: +43 664 8840 2499
Email: markus.rudolf@magnasteyr.com
# Vehicle Testing on 4WD Chassis Dyno

## Description
- 4WD chassis dyno for emission energy consumption
- functional and thermal development
- Passenger Cars and Light Duty
- Conformity of Production

## Features/Specifications

### Performance
- **Power**: 4x150/200 kW
- **Speed; max.**: 260 km/h
- **Wheel-base**: 1.8 – 4.2 m
- **track**: 0.9 – 2.3 m
- **axle load max.**: 2,500 kg
- **simulated vehicle mass**: 450 – 4500 kg
- **wind tunnel**: 200 kmh / 200,000 m³/h
- **climate range**: -35 – +55 °C
- **sun light; full spectrum**: 1,200 W/m²
- **2-line raw modal mass emission**
- Certified SULEV CVS emission test system
- 2,5 – 27 m³/min

### Key Benefits
- Cost Reduction
- Comfort/Convenience
- Vehicle Performance
- Fuel Economy

## Contact
- **Name**: Dr. Franz Kampelmühler
- **Head Application & Calibration Powertrain**
- **Phone**: +43 664 8840 2450
- **Email**: franz.kampelmuehler@magnasteyr.com
CNG vehicle targets

Efficient CO\textsuperscript{2} reduction:
- ~ 100 € per % CO\textsuperscript{2} reduction
- ~ 5 kg per % CO\textsuperscript{2} reduction
- Competing (EURO VI) Diesel and / or Hybrides

Integration to volume production:
- 100% assembled & pretested Fuel Storage Module
- No high pressure lines in vehicle assembly
- ‘simplified’ technology compared with hybrides & battery propulsion

Performance & acceptance
- Driving performance competitive to diesel & hybride propulsion
- Driving range competitive to gasoline propulsion
- Sufficient number of vehicle variants
Energy Density of alternative propulsion

**Petrol**
- Total system: 31 [MJ/ltr.]
- Fuel/Energy carrier only: 27 [MJ/ltr.]
- 1 Liter Petrol ~ 32 MJ
- 1 kg Petrol ~ 43 MJ

**LPG**
- Total system: 28 [MJ/ltr.]
- Fuel/Energy carrier only: 25 [MJ/ltr.]
- 1 Liter LPG ~ 50 MJ
- 1 kg LPG ~ 46 MJ

**LNG**
- Total system: 16 [MJ/ltr.]
- Fuel/Energy carrier only: 19 [MJ/ltr.]
- 1 Liter LNG ~ 50 MJ
- 1 kg LNG ~ 46 MJ

**CNG**
- Total system: 11 [MJ/ltr.]
- Fuel/Energy carrier only: 12 [MJ/ltr.]
- 1 Liter CNG ~ 50 MJ
- 1 kg CNG ~ 46 MJ

**C-H₂**
- Total system: 9 [MJ/kg]
- Fuel/Energy carrier only: 7 [MJ/kg]
- 1 Liter C-H₂ ~ 120 MJ
- 1 kg C-H₂ ~ 120 MJ

**L-H₂**
- Total system: 7 [MJ/kg]
- Fuel/Energy carrier only: 4 [MJ/kg]
- 1 Liter L-H₂ ~ 120 MJ
- 1 kg L-H₂ ~ 120 MJ

**Li-Ion-Battery**
- Total system: 0.75 [MJ/kg]
- Fuel/Energy carrier only: 0.26 [MJ/kg]
- 1 Liter Li-Ion-Battery ~ 120 MJ
- 1 kg Li-Ion-Battery ~ 120 MJ

**Energy Density System**
- Total system
- Fuel/Energy carrier only

LPG ... Autogas (Propan/Butan) (8 bar / 293 K)
L-NG ... liquid natural / biogas (5 bar / 135 K)
C-NG ... compressed natural gas (200 bar / 293 K)
L-H₂ ... liquid hydrogen (5 bar / 26 K)
C-H₂ ... compressed hydrogen (700 bar / 293 K)
Li-Ion- ... Lithium-Ionen-Batterie Bat (293 K)
Efficient CO² reduction:

B-Segment: ~ 1.300 Kg vehicle weight
Efficient CO\textsuperscript{2} reduction:

B-Segment: ~ 1.300 Kg vehicle weight
CNG Fuel Management

Description

Definition, Development and Validation of Fuel Storage & Management Systems
All high-pressure devices integrated
Pretested for vehicle assembly

Features/Specifications

CNG Fuel Storage Module:
- MAGNA TYPE IV pressure vessels
- Generation II in-tank valves
- Integrated electronic pressure regulator
- Integrated Gasoline (emergency) storage
- Pressure Regulator Calibration
- Prototype Validation
- Vehicle Integration

Test vehicle for validation

Key Benefits

- Cost Reduction
- Fuel Economy
- Vehicle Performance

Contact

Name: DI Markus Rudolf  Chief Engineer Chassis & Powertrain
Phone: +43 664 8840 2499
Email: markus.rudolf@magnasteyr.com
Full Integrated high Pressure Storage system

100% assembled & pretested Fuel Storage Module
- High pressure components concentrated in the module
- Electronic Fuel Management
- Preassembled & high pressure tested (200 bar)
- Low Pressure components (10bar) in vehicle assembly
Full Integrated high Pressure Storage system

Demonstrator:
- TYP IV Composite-vessels by MAGNA STEYR
- 2nd generation in-tank valves
- Electronic Fuel Management
- Engine Power up to 115 kW

source: VENTREX
# CNG Integrated Rail

## Description

<table>
<thead>
<tr>
<th>Integrated Rail System</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNG / LPG injection system</td>
</tr>
<tr>
<td>Pretested for engine assembly</td>
</tr>
</tbody>
</table>

## Features/Specifications

### Sufficient Package Solution:
- Intake behind engine
- Limited package to firewall
- one-box design

### Ready for engine plant assembly
- Substitution of standard intake manifold & air-cleaner-box
- Minimized tooling
- Minimized interfaces to vehicle
- Minimized assembly time

## Key Benefits

- Cost Reduction
- Fuel Economy
- Vehicle Performance

## Contact

Name: DI Markus Rudolf  
Chief Engineer Chassis & Powertrain  
Phone: +43 664 8840 2499  
Email: markus.rudolf@magnasteyr.com
CNG 600 Concept Vehicle

Description

Concept Vehicle close to serial production
Natural gas monovalent
Driving range over 600 km

Features/Specifications

Daten:
- CO$^2$ emission ~ 120 g/km
- Driving range: 650 km
- Weight reduction: ~ 100 kg
- Increased storage volume: 175 l / 28 kg
- MAGNA STEYR TYPE IV CFK vessels

Key Benefits

- Cost Reduction
- Fuel Economy
- Comfort/Convenience
- Weight Reduction
- Environment Friendly

Contact

Name: DI Walter Schimpl
Leiter Konzepte Fahrwerk & Antrieb
Phone: +43 664 8840 3695
Email: walter.schimp@magnasteyr.com
Prototype Vehicle:
- TYPE IV carbon composite vessels
- Electronic Fuel Management
- 2\textsuperscript{nd} generation in-tank valves
- Engine Power up to 200 kW

Full Integrated high Pressure Storage system
Concept Vehicle

- **Power**
  - 4-inline turbocharged
  - 1,984 cm³
  - 240 hp (5,000 min⁻¹)
  - 420 Nm (3,000 min⁻¹)

- **Fuel Storage**
  - Methane: 14 kg
  - Energy: 196 kWh

- **Performance**:
  - 0-100 km/h < 4.0 s
  - $v_{\text{max}}$ 220 km/h
  - Range: 250 – 300 km
Natural gas power engine

natural gas versus gasoline

Environment Friendly  Vehicle Performance
Clean Heavy Duty low emission transport

Description

Acceptance Analysis
Real Life Vehicle validation
Type IV vessel & Innovative Fuel management
Test fleet operation, Business Case

Features/Specifications

- Subjective & Objective vehicle validation
  - Driver acceptance & ergonomics
  - Refuelling & vehicle performance
- On-Board real life evaluation of:
  - Emission, fuel consumption
- Type IV vessel & fuel management system:
  - New MAGNA STEYR type IV vessels
  - High Pressure components concentrated in Fuel storage module
  - 100% off-line tested high pressure module
- Test fleet operation with FRIKUS:
  - September 2009 – December 2010
- Official fleet operation since January 2011

Key Benefits

- Emission, fuel consumption
- Type IV vessel & fuel management system:
  - New MAGNA STEYR type IV vessels
  - High Pressure components concentrated in Fuel storage module
  - 100% off-line tested high pressure module
- Test fleet operation with FRIKUS:
  - September 2009 – December 2010
- Official fleet operation since January 2011

Contact

Public funding by:
Back-UP
**CO₂ Reduktion CNG**

Allgemeine Betrachtung:
- Chemische Eigenschaft

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>CNG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Energiedichte</strong></td>
<td>11,8 kWh/kg (8,9 kWh/l)</td>
<td>13,0 kWh/kg *)</td>
</tr>
<tr>
<td></td>
<td>95ROZ</td>
<td>130ROZ Equivalent</td>
</tr>
<tr>
<td><strong>CO₂ Ausstoß</strong></td>
<td>2.938 g/kg</td>
<td>2.750 g/kg</td>
</tr>
<tr>
<td></td>
<td>249 g/kWh</td>
<td>199 g/kWh</td>
</tr>
<tr>
<td><strong>Einsparungspotential</strong></td>
<td>ohne Berücksichtigung potentieller Effizienzsteigerung durch die höhere Klopffestigkeit von CNG</td>
<td><strong>20,1%</strong> CO₂ Einsparung bezogen auf den Energieinhalt</td>
</tr>
</tbody>
</table>

*) Methananteil 95%
CO₂ Reduktion CNG

Berechnungsprogramm 'optiresource':
• komplette Wirkungsgradkette / Fahrzeug

17,3%  22,3%
CO₂ Reduktion
**CO₂ Reduktion CNG**

**VW Caddy 2.0 CNG**
- Saugmotor
- Benzin-Saugrohr-Einspritzung

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>CNG BIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leistung</td>
<td>102PS</td>
<td>109PS</td>
</tr>
<tr>
<td>CO₂ Emission</td>
<td>196g/km</td>
<td>157g/km</td>
</tr>
<tr>
<td>CO₂ Einsparungspotential</td>
<td>20.1%</td>
<td>20.9%</td>
</tr>
<tr>
<td></td>
<td>CO2 Einsparung gegenüber Benzin</td>
<td></td>
</tr>
</tbody>
</table>

Datenbasis: KBA 03/2008
**CO₂ Reduktion CNG**

**VW Passat 1.4 TSI CNG**
- Kompressor & Turbolader
- Benzin-Direkt-Einspritzung

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>CNG BIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leistung</td>
<td>150PS</td>
<td>150PS</td>
</tr>
<tr>
<td>CO₂ Emission</td>
<td>157g/km</td>
<td>119g/km</td>
</tr>
<tr>
<td>20,1% CO₂ Einsparungspotential</td>
<td></td>
<td>24,2% CO₂ Einsparung gegenüber Benzin</td>
</tr>
</tbody>
</table>

Datenbasis: Herstellerangabe
**CO₂ Reduktion CNG**

*Opel Zafira 1.6 CNG*
- Saugmotor
- Benzin-Saugrohr-Einspritzung

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>CNG BIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leistung</strong></td>
<td>77 kW 95ROZ</td>
<td>69 kW 130ROZ Äquivalent</td>
</tr>
<tr>
<td><strong>CO2 Emission</strong></td>
<td>169 g/km</td>
<td>138 g/km</td>
</tr>
<tr>
<td><strong>20,1% CO₂ Einsparungspotential</strong></td>
<td></td>
<td><strong>20,7% CO2 Einsparung gegenüber Benzin</strong></td>
</tr>
</tbody>
</table>

Datenbasis: KBA 03/2008
**CO₂ Reduktion CNG**

**Opel Zafira 1.6 turbo CNG**
- Turbolader
- Benzin-Saugrohr-Einspritzung

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>CNG BIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leistung</strong></td>
<td>110PS 95ROZ</td>
<td>150PS 130ROZ Äquivalent</td>
</tr>
<tr>
<td><strong>CO₂ Emission</strong></td>
<td>183g/km</td>
<td>144g/km</td>
</tr>
<tr>
<td><strong>20,1% CO₂ Einsparungspotential</strong></td>
<td></td>
<td><strong>21,3% CO₂ Einsparung gegenüber Benzin</strong></td>
</tr>
</tbody>
</table>

Datenbasis: Herstellerangabe
CO₂ Reduktion CNG

Mercedes E200 NGT
- Kompressormotor
- Benzin-Saugrohr-Einspritzung

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>CNG BIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leistung</td>
<td>135 kW</td>
<td>120 kW</td>
</tr>
<tr>
<td>CO₂ Emission</td>
<td>195g/km</td>
<td>168g/km</td>
</tr>
<tr>
<td>20,1% CO₂ Einsparungspotential</td>
<td></td>
<td>13,9 % CO₂ Einsparung gegenüber Benzin</td>
</tr>
</tbody>
</table>

Datenbasis: KBA 03/2008
**CO₂ Reduktion CNG**

**FORD S-Max 2.0**
- Saugmotor / ‘Nachrüstlösung‘
- Benzin-Saugrohr-Einspritzung

<table>
<thead>
<tr>
<th></th>
<th>Benzin</th>
<th>CNG BIVALENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Leistung</strong></td>
<td>145PS</td>
<td>143PS</td>
</tr>
<tr>
<td><strong>CO2 Emission</strong></td>
<td>194g/km</td>
<td>162g/km</td>
</tr>
<tr>
<td><strong>20,1% CO₂ Einsparungspotential</strong></td>
<td></td>
<td>16,5% CO₂ Einsparung gegenüber Benzin</td>
</tr>
</tbody>
</table>

*Datenbasis: Herstellerangabe*
Contact:

Dipl.- Ing Markus Rudolf
Chief Engineer Chassis & Powertrain
MAGNA STEYR Engineering Graz
markus.rudolf@magnasteyr.com
+43 664 8840 2499