MASTERPLAN FOR LNG ON RHINE-MAIN-DANUBE AXIS
BUILDING A PIONEER MARKET AND LNG ARTERY FOR EUROPE
RATIONALE FOR LNG IN IWT

• **Environmental drivers**
  - LNG as fuel reduces air emissions (-10-20% CO2, -80-90% NOx, almost zero PM & SOx)
  - Further CO2 reduction possible by “blending” (balance) with BIO-LNG

• **Economic drivers**
  - Price gap Gasoil - LNG and estimated price reduction for LNG due to massive production increase; favourable payback time of investment; significant reduction in fuel consumption; fuel cost savings result into higher profitability/lower transport costs
  - LNG as cargo will increase transport volumes and will offer energy cost savings to many industries along the Rhine-Main-Danube axis; reduces oil dependency and supports diversification of energy mix

• **Regulations**
  - **EU Directive on Deployment of Alternative Fuels Infrastructure** (approved April 2014) demands deployment of LNG fuelling infrastructure (in a sufficient number of maritime ports till 2025, inland ports till 2025, core road network till 2025 & common technical standards for CNG and LNG refuelling points by 2015
  - **Future air emission regulation**: “LNG most effective measure to reach Stage IV for medium and large inland vessels” (NAIADES 2/Panteia-NEA report)
  - **ECA/SECA regulation which** fosters built-up of LNG infrastructure in NW-Europe and development of Small Scale LNG Supply Chains
Global Liquefaction Capacity Margins Will Widen until the Mid 2020s

Global liquefaction capacity reached 404 BCMA in 2012.
- Global LNG trade volumes reached 328 BCMA, or approximately 81 percent of capacity.
- Global liquefaction capacity margin is expected to drop to 64 percent in 2020 before rising to 90 percent by 2040.

Source: Pace Global
Note: Nameplate Capacity ≠ Available Capacity (set at 85% of nameplate capacity)
DNV expects 1,000 vessels to be running on LNG by 2020 of which 400 will operate in Europe.
LNG EXPECTED TO ACCOUNT FOR CA. 25% OF OVERALL FUEL MIX BY 2030 IN NWE

Market forecast (WoodMacKenzie 2014)

Volume LNG bunker market North Western Europe [tpa]

Share LNG in total bunker market North Western Europe

LNG Masterplan: Status April 2015
LNG MASTERPLAN – KEY FIGURES

- **Programme**: TEN-T Multi-annual Call 2012
- **Timeframe**: 1 January 2013 - 31 December 2015
- **Est. investment**: approx. 120 mil. EUR
- **Budget (eligible costs)**: 80,5 mil. EUR  
  (out of which 69,2 mil. EUR are dedicated to pilot activities)
- **EU funding**: 40,25 mil. EUR
- **Beneficiaries**: 33 EU-funded organisations  
  (majority from private sector) and 1 Non-EU funded organisation
- **Special endorsement**: by several Ministries of Transport and CCNR
- **Non-funded partners**: more than 50 public/private organisations participating in IRG and AG

---

**Budget (mil. EUR)**

- **11,3**
  - Danube pilots
- **28**
  - Rhine pilots
- **41,2**
  - Studies & trials

**Beneficiaries**

- **19**
  - Public
- **12**
  - Private
- **1**
  - EEIG
- **1**
  - Member State
LNG MASTERPLAN – WORK STRUCTURE

Work plan

LNG Masterplan for Rhine-Main-Danube
Masterplan for introduction of LNG as fuel and as cargo for inland navigation

- Framework & Market Analysis
  - Status quo analysis & trends
  - LNG supply analysis
  - LNG demand analysis
  - Impact analysis: safety, ecology & socio-economic aspects

- Technologies & Operational Concepts
  - Engine technologies & concepts
  - LNG tank & equipment technologies
  - LNG bunkering
  - Technical evidence & safety and risk assessment

- Vessels & Terminal Solutions
  - Terminal concepts & cost assessment
  - Vessel concepts (new-build)
  - Vessel concepts (retrofit) & other vehicles & machinery
  - Financing models for terminal infrastructure & vessel investment

- Regulatory Framework & Masterplan
  - Provisions for harmonised European regulations
  - Education & training requirements
  - Assessment of concepts, trials & pilot deployments
  - Masterplan (strategy & recommendations)

- Pilot Deployment
  - LNG Terminals
  - LNG Tankers (LNG as cargo)
  - LNG propelled vessel (LNG as fuel)
  - LNG vehicles & machinery

Comments

- Identify supply options & quantify pioneer markets in the hinterland of inland ports
- Elaborate technical concepts for inland navigation sector by investigating & assessing of innovative engine, or LNG tank & equipment technologies
- Facilitate the creation of a harmonised European regulatory framework considering LNG as fuel and as cargo for inland navigation
- Deliver & assess technical concepts for new and retrofitted vessels & terminals & execute pilot deployments (investments) & looking into finances
- Develop a comprehensive strategy with a detailed roadmap for the implementation of LNG in line with the EU policies in transport, energy and environment → wide scale deployment

LNG Masterplan: Status April 2015
LNG IS FUEL AND ENERGY RESOURCE

LNG SUPPLY CHAINS TO INDUSTRIAL HEARTLANDS OF EUROPE

Rhine/Meuse-Main-Danube: LNG ARTERY FOR EUROPE
Inland navigation functions as pioneer consumer and facilitator

Co-financed by the European Union
Trans-European Transport Network (TEN-T)
## Beneficiaries (Project Partners)

<table>
<thead>
<tr>
<th>BENEFICIARIES (PROJECT PARTNERS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A3PS - Austrian Agency for Alt. Propulsion Systems</td>
</tr>
<tr>
<td>Erste Group Bank AG</td>
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<tr>
<td>EVN AG</td>
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<tr>
<td>FH ÖÖ Forschungs &amp; Entwicklungs GmbH</td>
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<tr>
<td>Pro Danube Management GmbH</td>
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<td>Schönerr Rechtsanwälte</td>
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<td>LINZ AG</td>
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<td>AT</td>
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<td>Gemeentelijk Havenbedrijf Antwerpen</td>
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<td>Bulmarket DM Ltd.</td>
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<td>Asociace NGV o.s.</td>
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<tr>
<td>DST Entwicklungszentrum für Schiffstechnik und Transportsysteme e.V.</td>
</tr>
<tr>
<td>Germanischer Lloyd SE</td>
</tr>
<tr>
<td>Universität Duisburg Essen</td>
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<tr>
<td>Port autonome de Strasbourg</td>
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<tr>
<td>Bernhard Schulte (Cyprus) Ltd</td>
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<td>Chemgas Barging S.ar.l</td>
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<td>DCL Barge B.V.</td>
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<td>Havenbedrijf Rotterdam N.V.</td>
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<td>Stichting STC-Group</td>
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<tr>
<td>Kooiman Marine B.V.</td>
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<tr>
<td>Veka Mariska BV</td>
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<tr>
<td>Bodewes Binnenvaart B.V.</td>
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<tr>
<td>National Company The Maritime Danube Ports Administration, Galati</td>
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<tr>
<td>Ceronav</td>
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<tr>
<td>Navrom S.A.</td>
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<tr>
<td>Transport Trade Services S.A.</td>
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<tr>
<td>University of Craiova</td>
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<tr>
<td>Danube LNG (EEIG)</td>
</tr>
<tr>
<td>Výskumný ústav dopravný, a. s.</td>
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<tr>
<td></td>
</tr>
<tr>
<td>Ministero delle Infrastrutture e dei Trasporti</td>
</tr>
</tbody>
</table>

**LNG Masterplan: Status April 2015**
ADVISORY GROUP & INDUSTRY REFERENCE GROUP

Industry Reference Group

• Air Liquide Advanced Technologies (FR)
• Anthony Veder LNG Shipping B.V (NL)
• Batini Traverso Consulting Ltd. (UK)
• Bomin Linde LNG GmbH & Co. KG (DE)
• Bulgarian River Shipping JSCo (BG)
• Caterpillar Marine Power Systems (DE)
• Connect LNG AS (NO)
• Cryonorm Systems B.V. (NL)
• DNV Kema Nederland B.V. (NL)
• Energy Valley Foundation (NL)
• Ennovos Luxembourg S.A (LU)
• Ennshafen OÖ GmbH (AT)
• Galli and associates Marine and Port Consultants (UY)
• Gas-und Wärme Institut Essen e.V. (DE)
• Gaztransport & Technigas Sas (FR)
• GAZU GmbH
• ICS Danube Logistics SRL (MD)
• Inros Lackner SE (DE)
• LIQUIND (DE)
• LNG Europe B.V. (DE)
• Mercurius Shipping Group (NL)
• MOL Hungarian Oil and Gas Plc. (HU)
• MTU Friedrichhafen GmbH (DE)
• N.V. Nederlandse Gasunie (NL)
• National Company “Maritime Ports Administration” Constanta (RO)
• NAVMAR Inc. SRL (RO)
• Netherlands Organisation for Applied Scientific Research - TNO
• Odessagaz (UA)
• OMV Gas & Power GmbH (AT)
• Port of Amsterdam (NL)
• Pöyry Deutschland GmbH (DE)
• PMSC S.A. (CH)
• QaGroup Holding B.V. (NL)
• Remontowa LNG Systems Sp (PL)
• SEATECH Engineering Ltd. (PL)
• Shipyard ATG Giurgiu (RO)
• Steel Trans s.r.o. (SK)
• Stevas Shipping (BE)
• Stroje a Mechanizmy, a.s. (SK)
• TIS Group of marine terminals (UA)
• Vanzetti Engineering Srl
• via donau – Österreichische Wasserstraßen GmbH (AT)
• Wartsila Netherlands B.V. (NL)
• Westport Innovations Inc. (FR)
• Worldenergy (CH)

Advisory Group

• Bundesministerium für Verkehr, Innovation und Technologie (AT)
• Bundesverband Öffentlicher Binnenhäfen (BÖB)
• Bureau Veritas
• Central Commission for the Navigation on the Rhine (CCNR)
• Duisburger Hafen AG
• European Barge Unit (EBU)
• European Federation of Inland Ports (EFIP)
• European Transport Workers’ Federation
• European Skippers’ Organisation (ESO)
• Inland Navigation Europe (INE)
• International Sava River Basin Commission
• Lloyds Register EMEA
• Ministerie van Infrastructuur en Milieu (NL)
• Ministerstvo dopravy (CZ)
• Ministerstvo dopravy, vystavby a regionalneho rozvoja (SK)
• Ministerul Transporturilor (RO)
• Ministry of Transport, Information Technology and Communications (BG)
• Port Authority Osijek (HR)
• Port of Switzerland (CH)
• Romanian Inland Port Union (UPIR)
• Secretariat of Danube Commission (HU)
### OUTPUT FRAMEWORK & MARKET ANALYSIS

#### FRAMEWORK

**Status Quo Analysis & Trends (SuAc 1.1)**
- Stakeholder analysis & LNG small scale logistics analysis
- LNG in maritime (status /trends)
- LNG in inland navigation (status /trends)
- LNG in road transport (status/trends)
- Existing & future emission regulations (IWT)
- Gap analysis & trend assessment

Completed in Q1/2015 (D 1.1.1)

**Impact Analysis (SuAc 1.4)**
- Safety – summary of properties, hazards, safety regulations & incidents connected to LNG
- Ecology – current state & tendency of transport, its impact on enviro & enviro efficiency of transport (trends)
- Socio-economic aspects

Completed in Q4/2014 (D 1.4.1)

#### MARKET - Danube

**LNG Supply Analysis-Danube (SuAc 1.2)**
- Global Energy Market
- Specific European Energy Market
- Supply Chain Scenarios & SWOT analysis
- National Supply Analysis (AT, SK, DE, BG, RO)

Expected in Q2/2015 (D 1.2.2 - Danube)

**LNG Demand Analysis-Danube (SuAc 1.3)**
- Methodology (Feb 2014)
- National & regional results of demand studies (DE, AT, BG, CZ, SK, HU, IT, RO)
- Visibility events (AT Jul 2014, others)
- Evaluation workshop (to be in Q2/2015)

Completed in Q1/2015 (D 1.3.1.1 - Danube)

#### MARKET - Rhine

**Rhine region study**
(Port of Rotterdam, Antwerp, Mannheim, Strasbourg, Basel)

[Contracted June 2014: Pace, Buck, TNO]
- Literature review LNG in shipping (SuAc 1.1 - completed in Q4/2014)
- Supply chain analysis & assessment of options for the Rhine corridor - different sourcing options for LNG and the different supply chain options along the Rhine corridor (SuAc 1.2)
- Elaboration of dynamic model, development and deployment scenarios will be generated for the Rhine Ports Group (SuAc 1.3)
- Brochure “Facts & figures for LNG as fuel and cargo in inland navigation” (SuAc 1.4)

Expected in Q2/2015
LNG bunkering (D 2.3.1) addresses:
1. Overview of regulatory framework
2. LNG bunkering procedures

LNG (un)loading (D 2.3.2) addresses:
1. Difficulties between LNG vessel & shore connections & provides overview of regulatory framework
2. Standardised installations for LNG (un)loading
3. Standardisation scenarios & procedures for (un)loading LNG

Safety & Risk Assessment addresses:
1. Comparison of risk assessment tools used in the Rhine Ports (D 2.4.1)
2. Study on operational safety & nautical conditions with regard to LNG bunkering in the Rhine Corridor (D 2.4.2)
3. Risk comparison of different bunker scenarios (D 2.4.2)
4. Emergency & incident response study (D 2.4.4)

Rhine Ports’ studies
A. „LNG bunkering and LNG loading and unloading: technical evidence, safety and risk assessment leading to provisions for harmonised European regulations“ [DNV GL]
B. „Emergency & incident response“ [Falck/Gezaemnlijke Brandweer]
C. “Recommendations on Police Regulations” covering (i) overview of existing local & international police legislation, (ii) consultations to CCNR, (iii) recommendations on adjustment of Police Regulations [Claire Groenewegen]

Expected: Q2/2015

ICGR Group “International Coordination Group on Regulatory adjustments” was established … (Kick-off in Apr 2014)
1. To create a platform addressing the LNG related regulatory issues
2. To support the regulatory bodies with expertise on defined LNG related topics addressed by LNG Masterplan
3. To elaborate set of guidelines & recommendations based on input from studies delivering:
   … Study on bunkering regulations (D 4.1.2)
   … Study on port regulations (D 4.1.3)
   … Study on police regulations (D 4.1.4)
   … Report on guidelines & recommendations for emergency response organisations (D 4.1.5)

Official publication of “Emergency & incident response study & Guidelines & recommendations” on 15 April 2015 in Mannheim

Harmonised regulatory framework is of utmost importance for a safe & effective transport of LNG as well as for LNG bunkering.
Keeping LNG’s safety records high through Education & Training

**Questionnaire**
- Gather information
- Identify professional profile with respect to various staff categories

**Curricula**
- Elaborate common curricula on OL & ML based on the applicable legislation
- Include into the European framework of the PLATINA Tables of Competencies

**Training material**
- Develop training material for several stuff categories to ensure full coverage of a logistics chain involving LNG
- (crew, terminal & bunkering personnel, company & management personnel, inspectors, students)

**Pilot classes**
- Pilot training according to the developed E&T standards with the help of the elaborated E&T materials

**Simulators & e-Learning modules**
- Specification, pilot implementation & integration into the educational & training programme

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**Table of competence**

<table>
<thead>
<tr>
<th>Column 1</th>
<th>Column 2</th>
<th>Column 3</th>
<th>Column 4</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>COMPETENCE</strong></td>
<td><strong>KNOWLEDGE, UNDERSTANDING AND PROFICIENCY</strong></td>
<td><strong>METHODS FOR DEMONSTRATING COMPETENCE</strong></td>
<td><strong>CRITERIA FOR EVALUATING COMPETENCE</strong></td>
</tr>
<tr>
<td>To describe the main physical properties of LNG</td>
<td>K, U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explain what is LNG</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Explain how LNG differs from other marine fuels</td>
<td></td>
<td></td>
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<tr>
<td>State the storage temperature</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>State the Flashpoint, Lower Explosion Limit, Upper Explosion Limit and auto-ignition temperature of LNG</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>To describe environmental properties of LNG</td>
<td>K, U</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recognize the environmental impact of an operational release of LNG as compared to a release of a similar quantity of CO₂</td>
<td></td>
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<tr>
<td>Describe the effects of fumes of methane in the combustion process</td>
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<tr>
<td>Describe the advantages/disadvantages to use LNG</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

LNG for bunkering personnel, CERONAV, 21-24 Jul 2014
150's certification for LNG as fuel, STC, October 2014

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Co-financed by the European Union
Trans-European Transport Network (TEN-T)
LNG Bunker Station for inland vessels in NW Europe by Port of Antwerp
Location selected, preliminary study, risk assessment & technical concept finalised, EIA screening completed in Feb 2015 & application for environmental permit submitted. Derogation from national legislation to produce CNG from LNG and not from local gas grid available. Tender for construction & for operation → on-going

Port of Mannheim & Switzerland (case study)

LNG terminal in Komarno in Slovakia by Danube LNG (feasibility study)
First drafts of terminal available (3 locations identified), incl. risk assessment, safety zone definition & project impact on the environment. Negotiations with City Council → on-going. Outcomes expected in Q4/2015 (incl. land-use planning documentation, EIA, HAZOP, CBA & planning permission)

LNG terminal in Ruse in Bulgaria by Bulmarket (pilot deployment)
Storage for LNG, bunkering for vessels, trucks, peak shaving unit, 4x250m³ Conceptual & preliminary design, together with planning permission → ready. Detailed Site Development Plan & HAZID → ready. Civil works started in Feb 2015. Pilot deployment expected: Q4/2015.

Port of Galati by APDM (pre-feasibility study)
Pre-feasibility study regarding the development of LNG terminals on the Romania Maritime Danube was finalised in Dec 2014 and included selection of location(s) & scale, assessment of investments for LNG facilities & equipment needed.

Port of Constanta by TTS (feasibility study & technical design)
<table>
<thead>
<tr>
<th>VESSELS – PILOT DEPLOYMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>DCL Barge B.V. (Danser Group)</strong></td>
</tr>
<tr>
<td>Retrofitted container vessel with LNG used as propulsion</td>
</tr>
<tr>
<td>Area of operation: Rhine - ARA to Basel</td>
</tr>
<tr>
<td>Delivered in June 2014</td>
</tr>
<tr>
<td><img src="image" alt="DCL Barge B.V." /></td>
</tr>
<tr>
<td><strong>Chemgas Barging B.V.</strong></td>
</tr>
<tr>
<td>Conventional tanker for transport of liquefied gases fuelled by LNG</td>
</tr>
<tr>
<td>Area of operation: Rhine - ARA to Basel</td>
</tr>
<tr>
<td>Delivered in September 2014</td>
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<tr>
<td><img src="image" alt="Chemgas Barging B.V." /></td>
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<tr>
<td><strong>Damen Shipyard Hardinxveld B.V. (previous Bodewes)</strong></td>
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<tr>
<td>LNG propelled chemical tanker “Ecoliner”</td>
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<tr>
<td>Area of operation: Rhine</td>
</tr>
<tr>
<td>Expected in Q3/2015 (hull launched February 2015)</td>
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<tr>
<td><img src="image" alt="Damen Shipyard Hardinxveld B.V." /></td>
</tr>
<tr>
<td><strong>Argos Bunkering B.V.</strong></td>
</tr>
<tr>
<td>MGO-LNG Bunker Vessel</td>
</tr>
<tr>
<td>Area of operation: Rhine</td>
</tr>
<tr>
<td>Expected Q2/2016 (on-hold)</td>
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<tr>
<td><img src="image" alt="Argos Bunkering B.V." /></td>
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<tr>
<td><strong>LNG E-motion</strong></td>
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<tr>
<td>LNG inland tanker</td>
</tr>
<tr>
<td>Area of operation: Rhine</td>
</tr>
<tr>
<td>Expected: Q2/2016 (on-hold)</td>
</tr>
<tr>
<td><img src="image" alt="LNG E-motion" /></td>
</tr>
</tbody>
</table>

LNG Masterplan: Status April 2015
## VESSELS – CONCEPTS

<table>
<thead>
<tr>
<th><strong>Rhine</strong></th>
<th><strong>Danube</strong></th>
</tr>
</thead>
</table>
| LNG inland tanker of Chemgas Holding  
(*downscaled to preparatory works*)  
*for both Danube & Rhine* | Preparatory works & technical studies looking into solutions for LNG tank insulations & management of boil-off. |
| LNG pusher of Kooiman Marine  
(*downscaled to study*) | Technical concept & HAZID finalised, CCNR & ADN approvals received. |
| LNG coastal carrier / bunker vessel of Bernhard Schulte  
(*downscaled to study*) | Technical concept & HAZID finalised, approvals available. |
| Danube river-sea tanker for transport of LNG of Danube LNG  
(*study*) | Technical concept under elaboration.  
Expected in Q2/2015. |
| River based unloading, floating pier for LNG port terminal of Danube LNG  
(*study*) | Technical concept under elaboration.  
Expected in Q2/2015. |
| River barge for the transport of LNG of Danube LNG  
(*study*) | Technical concept under elaboration.  
Expected in Q2/2015. |
| Retrofitting of vessels/pushers of NAVROM to LNG propelled – feasibility study  
(*downscaled to study*)  
*new study of technical design for new build pusher* | Feasibility study finalised. It showed that the retrofitting of old Navrom pushers is economically not viable / technologically, in some cases almost not possible. |
| Retrofitting of pushers of SPaP fleet to LNG fuel  
– Danube LNG  
(*study*) | Technical concept & economic evaluation under elaboration.  
Expected in Q2/2015. |
DCL Barge B.V. (Danser Group)

Type of vessel: Retrofitted container vessel with LNG used as propulsion
Operational area: ARA ports – Basel
In operation: from June 2014
Chemgas Barging S.a.r.l.

**Type of vessel:** Conventional type-G tanker for the transport of liquefied gases with LNG used as propulsion

**Operational area:** ARA ports – Basel

**In operation:** from September 2014
**PILOT DEPLOYMENTS – EXPECTED**

**DAMEN**

- **Type of vessel:** LNG propelled chemical tanker
- **Operational area:** Rhine
- **Expected:** Q3/2015

**Argos Bunkering B.V.**

- **Type of vessel:** MGO-LNG Bunker Vessel
- **Operational area:** ARA
- **Expected:** Q2/2016

**LNG E-motion**

- **Type of vessel:** LNG inland tanker
- **Operational area:** Rhine
- **Expected:** Q2/2016

LNG Masterplan: Status April 2015
Bulmarket DM
Terminal for storage of LNG and filling vessels & trucks with LNG
Location: Ruse, Bulgaria (Port Bulmarket 2)
Expected: Q4/2015
LNG BUNKER STATION IN ANTWERP (DEPLOYMENT)

Port of Antwerp Authority

LNG bunker station for inland vessels

Location: Port of Antwerp

Expected: Q2/2016

General Specifications:
- Total LNG storage capacity below 200 ton LNG.
- Bunkering: up to 200 m³/hour and 10 bar.
- Filling station LNG: 2 x 150 l/min at 10 bar
- Filling station CNG: 2 x 70 Kg/min
Danube LNG
Case study for the small scale LNG terminal, incl. bunker station
Location: Komarno, Slovakia
Expected: Q4/2015

Preferred location: West bank of the basin in the port of Komarno

Optional locations under investigation
Transcontinental logistics centre – a port in the area of ‘Veľký Harčáš’

Near the confluence of Danube & Vah

LNG Masterplan: Status April 2015
Maritime Danube Ports Administration – APDM Galati
Pre-feasibility study and a preliminary technical concept for a LNG terminal in the maritime Danube area
Location: Port of Galati, Romania
Subcontractor: Actia Forum SP
Initial storage capacity: 4,000 cbm (design capacity up to 8,000 cbm)
Completed: Q4/2014

Recommendations technical concept: Semi-pressurised tanks with an initial capacity of 4,000 cbm
Transport Trade Services S.A.
Feasibility study and a general technical design for a small-scale LNG terminal
Location: Port of Constanta, Romania
Subcontractor: PANTEIA & Tebodin Netherlands B.V.
Initial storage capacity: (to be outcome of the study)
Expected: Q3/2015
LNG BUS TRIALS IN SLOVAKIA

LNG Buses in Poland

• City of Warsaw (18 meters long):
  - 25 LNG buses were put into operation 1.1.2015
  - 10 LNG buses were put into operation 02.12.2015
  - By the end of 2016 plans to buy add. 130 LNG buses

• City of Olsztyn (12-meters):
  - 11 LNG buses to come into operation 1.10.2015
  - By the end of 2016 plans to buy add. 50 LNG buses

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Price difference between LNG and diesel

<table>
<thead>
<tr>
<th>Country / Company</th>
<th>Price LNG (€/kg)</th>
<th>Price diesel (€/l)</th>
<th>Delta 3) LNG vs Diesel (% of diesel price)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Belgium / Drive system</td>
<td>0,98</td>
<td>1,29</td>
<td>54</td>
</tr>
<tr>
<td>Italy / Eni</td>
<td>0,98</td>
<td>1,52</td>
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</tr>
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<td>The Netherlands / LNG24</td>
<td>1,22</td>
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<td>Portugal / Gaip</td>
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<td>Spain / GasNaturalFenosa</td>
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<td>Sweden / FordsGas</td>
<td>1,62 1)</td>
<td>1,40</td>
<td>83</td>
</tr>
<tr>
<td>UK / Gasrec, Chive</td>
<td>1,2 2)</td>
<td>1,65</td>
<td>52</td>
</tr>
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</table>

1) 50 % Liquefied Biomethane
2) Gasrec offers a mixture with biomethane
3) The delta is calculated taking into account the difference in energy content (1 kg LNG = 1,34 l diesel)

Source: LNG Blue Corridors, NGVA Europe

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LNG trial organized by Danube LNG, 02/2015
**LNG as fuel (vessels not transporting dangerous goods)**

Regulated by RVIR / RheinSchUO of CCNR & Directive 2006/87/EC laying down technical requirements for inland waterway vessels

- LNG Amendment of the RVIR / RheinSchUO is expected to come into force mid-2016

**LNG as cargo & LNG powered vessel transporting dangerous cargo**


Transportation of LNG in tank vessels *(using “conventional” isolated pressure tanks in accordance with ADN 2015)* is part of the new version of ADN 2015 *(in force from 1 Jan 2015)*

- Hazard Identification study (HAZID), previously necessary for obtaining derogation, is no longer required for these tank vessels transporting LNG

**BUT** vessels powered by LNG and LNG tankers using boil-off and transporting dangerous goods, incl. LNG, will still require a derogation → it is expected that the regulations for the use of LNG for propulsion will be included in ADN as from 2017

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*LNG Masterplan: Status April 2015*
SOME OPTIONS FOR SUPPLYING DANUBE

LNG Station implemented or investigated in the EU co-funded LNG Masterplan Rhine-Main-Danube

LNG Masterplan: Status April 2015

Co-financed by the European Union
Trans-European Transport Network (TEN-T)
SOME LESSONS LEARNED

- LNG equipment costs were often underestimated (increases up to 20-30%)
- “Technologies” are there but still a lot of technical challenges (BOG, etc.)
- Retrofitting makes sense with certain types of vessel (e.g. container vessels, tankers, new vessels)
- LNG supply to Danube region is complex but offers high market potentials
- LNG hubs in hinterland need multi-client strategy to generate base load for cost-effective supply (road sector, off-road, peak shavers, off pipe clients, etc)
- Structural weakness of the IWT segment requires new financing instruments (“engine power/ molecules contracts”)
- Price gap LNG – diesel for barge operator should be higher than 15%
- “Integrators “ along the LNG value chain can speed up business by creating platforms projects with (potential) customers (breaking chicken – egg situation by creating commitment)
- Public co-funding in start-up phase is essential to make a business case for LNG hubs and vessel investment to compensate high LNG logistics costs as well as high LNG equipment costs
- Public/Politicians/Authorities tend to overestimate safety risks of LNG – more information needed
CONCLUSIONS

• LNG is the most relevant alternative fuel for inland navigation offering high environmental and economic benefits. Use of LNG supports major EU transport, environment and energy policy objectives.

• Only inland vessels can deliver high volumes of LNG cost-effectively from seaside import terminals to the economic heartlands of Europe. The barging sector, therefore, is pioneer consumer of LNG and enabler of LNG supply.

• Inland terminals will functions as satellites to the hinterland enabling to reach other pioneer markets like public transport and heavy duty transport sector.

• Rhine/Meuse-Main-Danube axis will serve as main European LNG artery contributing to a more balanced European energy mix.

• LNG Masterplan breaks up the chicken and egg situation and prepares sector for wide-scale deployment in follow-up EU projects. Public financial support is essential as well as supply chain approach involving end-consumers.

• European LNG technology industry cluster will support implementation and facilitates economic growth and job creation.

• CEF - Connecting Europe Facility will have to play a key role for further implementation; Horizon 2020 shall provide a dedicated LNG research agenda.
### Beneficiaries (project partners)

<table>
<thead>
<tr>
<th>A3PS - Austrian Agency for Alternative Propulsion Systems (Austria)</th>
<th>ERSTE (Austria)</th>
<th>EVN (Austria)</th>
<th>LOGISTIKUM Steyr University of Applied Sciences Upper Austria</th>
<th>pro DANUBE Management GmbH</th>
<th>Gemeentelijk Havenbedrijf Antwerp (Belgium)</th>
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<tr>
<td>Bulmarket GmbH (Bulgaria)</td>
<td>AENP (Czech Republic)</td>
<td>DST (Germany)</td>
<td>Germanischer Lloyd SE (Germany)</td>
<td>Universität Duisburg-Essen (Germany)</td>
<td>Port autonome de Strasbourg (France)</td>
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<td>Koeman Marine B.V. (Netherlands)</td>
<td>LNG-E-Motion B.V. (Netherlands)</td>
<td>Compagnia Nazionale Adriatica Portuale (Italy)</td>
<td>Murtine S.A. Galati (Romania)</td>
<td>Compagnia di Navigazione Finl. Romana NAROM S.A. Galati (Romania)</td>
<td>Transport Trade Services S.A. (Romania)</td>
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<td>University of Craiova (Romania)</td>
<td>Danube LNG, EEX (Slovak Republic)</td>
<td>Vukymjú (Slovak Republic)</td>
<td>Stadtische Rhein-Hafengesellschaft Mannheim mbH (Germany)</td>
<td>LINZ AG für Energie, Telekommunikation, Verkehr und Kommunale Energi (Austria)</td>
<td>Ministero delle Infrastrutture e dei Trasporti (Italy)</td>
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<td>Schönherr Rechtanwälte GmbH (Austria)</td>
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<td>Bernhard Schulte (Cyprus) Ltd.</td>
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