LNG MASTERPLAN IN A NUTSHELL

COURSE OF PRESENTATION

• Pro Danube International
• LNG Properties
• LNG as fuel in European transport policy
• Main Project Deliverables
• Lessons learned – Recommendations - Conclusions
• Additional slides for discussion
Platform of private companies with strategic economic interest in better framework conditions and higher public investment in the Danube transport & logistics system

- Established autumn 2011 by companies & associations
- Non-profit association based in Vienna
- Network of currently more than 140 companies
- More than a lobbying organisation as it initiates and executes projects
- Service company: Pro Danube Management GmbH
- Coordinator of LNG Masterplan for Rhine-Main-Danube
- More info on: www.prodanube.eu

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PRIORITIES OF PDI

- **Engagement for better waterway maintenance & execution of TEN T bottleneck projects**
  - Push governments & administration for minimum standards in waterway maintenance (2,5 m fairway depth at LWRL)
  - Engage in permanent monitoring of infrastructure maintenance & proposing improvements
  - Promote quicker implementation of TEN T projects (2,5 m draught according UNECE/AGN)
  - Support waterway administrations to use EU programs in financial period 2014-2020

- **Promotion of investment in Danube ports**
  - Promote ports as hubs for regional development strategies & cross-border initiatives
  - Support public and private stakeholders in port development programs/projects

- **Support to modernisation of Danube fleet**
  - Promote & support implementation of LNG as fuel as well as cargo for Danube navigation
  - Propose & implement EU funded projects for higher efficiency of operations & environmental performance
  - Promote development of long-term public funding schemes for fleet renewal

- **Elimination of administrative barriers**
  - Identification of barriers and engagement in dialogue with administrations/policy makers to achieve elimination/reduction
  - Harmonizing administrative procedures - “Same River – Same Rules” initiative of PDI

- **Active involvement in EC initiatives & programs**
  - Special focus on EUSDR/PA1A
  - Facilitation of projects in Horizon 2020, TEN T/CEF, regional development programs

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PROPERTIES OF LNG

- **LNG is natural gas cooled down to minus 162 °C**; making it extremely compact: 3.5 times more compressed than CNG and 600 times more compact than natural gas.
- LNG consists largely of CH4-methane (> 90%) and for the rest of ethane, propane, butane and nitrogen, often mistaken for liquefied petroleum gas (LPG) which is a mixture of mainly propane and butane, liquid at environment temperature and moderate pressure (<1.5MPa).
- CO2 emission of fossil LNG compared to diesel is around 15% less, bio-LNG becomes improves CO2 performance significantly.
- Safety: LNG is a cryogenic substance: it is lighter than air, colorless, odorless, non-toxic, non-corrosive and non-flammable. Methane/air mixture only flammable in range of 5-15%.
- Some important factors (approximate):
  - 1 ton LNG = 2.2 m3 LNG (Density: 430-470 kg/m3) / 1 ton LNG = 15.2 MWh (GHV) / 1 m3 LNG = 580-600 m3 gas
  - 1MWh = 3.4121 MMBTu/29.307 kWh = 1 Therm / 10 Therm = 1 MMBTu
  - NG: Density 0.78 kg/m3 = 38 MJ/m3 whereas Petrol: Density 750 kg/m3 = 45.7MJ/m3
  - Prices bunker fuels NWE March 2015 in €/MWh: 26.15 HFO 3.5S / 26.70 IFO380 3.5S / 26.91 LSFO 1%S / 40.31 LSGO 0.1%S / MGO 40.70 / LPG 32.80/
  - Prices NG March 2015 in €/MWh: 21.55 TTF / 22.20 NBP / 8.66 HH
  - Prices LNG March 2015 in €/MWh: 24.8 SS reloads NEW (oil proxy) / 27.9 bunker fuel@16% Brent indexation
  - Prices LNG March/April 2016 in € / MWh: 11-12 TTF; 5-6 HH

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Clean Power for Transport: A European alternative fuels strategy
(COM(2013) 17 final)

- Europe is heavily dependent on imported oil for its mobility and transport: in 2010, oil counted for 94% of energy consumed in transport.
- A strategy for the transport sector to gradually replace oil with alternative fuels and build up the necessary infrastructure could bring savings on the oil import bill of €4.2 billion per year in 2020.
- Low-CO2 alternatives to oil are also indispensable for a gradual decarbonisation of transport, a key objective of the Europe 2020 strategy for smart, sustainable and inclusive growth.
- A coherent and stable overarching strategy with an investment-friendly regulatory framework needs to be put in place.

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<th>Mode</th>
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<td>Synthetlic fuels</td>
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CNG & LNG IN TRANSPORT & BIO-METHANE

- In EU 1,200,000 CNG vehicles (0.7% of EU vehicle fleet); industry aims to 5% of fleet by 2020
- 3,000 CNG refuelling stations, majority in DE & IT
- 15 million vehicles worldwide; strongest growth in Asia & South America
- Several hundreds EURO V & EURO VI LNG trucks & c100 LNG/L-CNG stations (UK, E, SE, NL)
- China: 240,000 LNG trucks & c.2,500 refuelling stations; USA: >25,000 LNG trucks
- In 2013 bio-methane produced in 14 European countries (230 upgrading plants), total capacity of 0.8 billion m³/year; grid injection in 11 European states
- over 300 CBG100 and 100 LBG stations in AT, CH, DE, DK, FI, FR, HU, IS, IT, NL, SE, UK
- blend of 85% LNG and 15% BLG results into minus 35% CO2 (UK example)
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 2030, 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

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MISSION & OBJECTIVES

MISSION
To facilitate the deployment of LNG as an eco-friendly alternative fuel and a new commodity for the inland navigation sector.

OBJECTIVES
1. Based on the input and recommendations from various project activities to elaborate strategy – action plan with measures – for LNG deployment in IWT
2. to test, operate and monitor LNG deployment pilots
LNG MASTERPLAN IN NUMBERS

**PARTNERS**
- 33 EU FUNDED
- 1 NON-EU FUNDED
- 13 Countries

**BUDGET**
- MEUR 34
- 50% FROM EU

**INDUSTRY**
- 52 MEMBERS
- 2 CONTINENTS

**TIME**
- 1.2013 - 12.2015
- 3 FULL YEARS OF COOPERATION

**ADVISERS**
- 21 BODIES
- AUTHORITIES
- BRANCH ORGANISATIONS

**COORDINATORS**
- PRO DANUBE
- PORT OF ROTTERDAM
FRAMEWORK & MARKET STUDIES

RHINE REGION
Several LNG sourcing options available. Demand in Lower Rhine dominated by maritime sector & in Upper Rhine by IWT, trucks and industry.

DANUBE REGION
Several sourcing options were investigated (North-West Europe, the Black Sea / Eastern Mediterranean or Caspian region. Demand is dominated by LNG as alternative energy source for industry – especially in countries with less developed gas transmission network (Bulgaria) and transport.

IMPACT ANALYSIS
Investigating general safety aspects, impact on ecology & socio-economic aspects.

Rhine/Meuse/Main-Danube: LNG ARTERY FOR EUROPE
Inland navigation functions as pioneer consumer and facilitator.
The Study discusses different engine types available for inland navigation. Load distribution, redundancy, exhaust and GHG emissions are considered. For use as auxiliary machinery, alternative engines, e.g. micro turbines and fuel cells, are discussed, too.

The Study provides an overview of different LNG tank systems, described the thermodynamic background and the behaviours of LNG in a closed system. An improved understanding why tank technology is of importance for implementation of LNG as fuel is provide to the reader.
SAFETY & OPERATIONAL ASPECTS

HOW TO ORGANISE LOCAL SAFETY REGULATIONS AND PROCEDURES

Studies give an insight into safety regulations & procedures into the small-scale LNG for inland waterways. They cover:

- Framework for LNG bunkering & (un-)loading
- Operational safety during LNG bunkering
- Nautical conditions and impact on bunkering
- Risk assessment of different bunker scenarios

CASE STUDY OF PORT OF ROTTERDAM

Study offers guidance to what seaports have to do when dealing with safe handling and bunkering of LNG with examples from the Port of Rotterdam.

INCIDENT RESPONSE STUDY

Study gives an overview of incident scenarios and guidance for incident response. It zooms in on preparedness as well as training and education for incident response forces.
EDUCATION & TRAINING

CURRICULA & LESSONS MATERIAL
The newly developed curricula and lessons material for inland waterways personnel focus on transportation, transfer, bunkering and use of LNG as fuel.

PILOT CLASSES
More than 200 „students“ participated in pilot classes in the Netherlands, Austria, Bulgaria and Romania covering competencies like crew members, terminal, bunkering and management personnel and authorities.

SIMULATORS & E-LEARNING TOOLS
The simulators and training facilities were extended or developed, when necessary, in the project providing a practical way to obtain necessary competencies for handling LNG in a safe way. The e-learning modules are offered prior to the training to get familiarised with the topic.
FINANCES

TOTAL COST OF OWNERSHIP MODEL
To support the decision process for the conversion of inland vessels, the Total Cost of Ownership (TCO) model was elaborated. It addresses private funding (business case) as well as public funding (economic & social effects) and compares TCO of a LNG dual-fuel refit with conventional gasoil operation.

FINANCING OF INFRASTRUCTURE
Erste Group Bank investigated from a commercial key factors on which lenders will focus when evaluating financing opportunities of LNG structures and drafted a set of guidelines and recommendations for such projects.

REGULATORY, LEGAL & CONTRACTUAL IMPACT ON LNG SUPPLY CHAIN
The study done by Schönherr, a law firm, assists project partners in identifying legal difficulties of their concepts and provides guidelines how to diminish them.
In its findings the LNG Masterplan project concludes that in order to create a viable business case the LNG inland terminals shall function as satellites for hinterland ensuring that LNG reaches its end-users like the public or heavy duty transport sector or industry stakeholders.

**LNG FOR ROAD TRANSPORT**

The trials with public buses showed that use of LNG in transport contributes much to emission savings. Having travelled 5,108 km in Slovakia, 43.58 kg of NOx, 1.47 kg of PM and 0.04 kg of SO2 were saved.

**PORT EQUIPMENT**

Port of Antwerp analysed the technical, economic and ecological aspects of drive train mechanisms for port equipment in the port of Antwerp. Investigated alternatives: stage IV diesel engines, CNG, LNG and electric TCO of gas turbine LNG-driven straddle carrier is likely to be significantly lower as compared to diesel hybrid.
TERMINAL CONCEPTS

RHINE REGION
- LNG bunker station in Port of Antwerp
- LNG infrastructure in Port of Mannheim
- LNG infrastructure in Port of Switzerland

DANUBE REGION
- LNG small scale terminal in Constanta (RO)
- LNG small scale terminal in Galati (RO)
- LNG small scale terminal in Ruse (BG)
- LNG floating terminal in Komarno (SK)

Rhine/Meuse/Main-Danube: LNG ARTERY FOR EUROPE
Inland navigation functions as pioneer consumer and facilitator
ELABORATION OF TECHNICAL DESIGN AND OBTAINING PERMITS

LNG BUNKER STATION IN THE PORT OF ANTWERP

Capacity: 400 m³ of LNG  
Facilities: storage of LNG and CNG, bunkering inland ships with LNG, fuelling road transport with LNG & CNG  
Investment & operation: by concessionaire  
Start of operations: by January 2019

FEASIBILITY STUDIES CHECKING THE OPTIONS

LNG INFRASTRUCTURE IN THE PORT OF MANNHEIM

Capacity: 500 m³ of LNG  
Facilities: LNG storage, truck fuelling, vessel bunkering  
Estimated investment: 6-7 MEUR  
Operational costs/year: 250,000 EUR  
Interested investors are welcome

LNG INFRASTRUCTURE IN THE PORT OF SWITZERLAND

Capacity: 1,000 m³ of LNG  
Facilities: LNG storage, truck fuelling, vessel bunkering  
Estimated investment: 6-7 MEUR  
Operational costs/year: 250,000 EUR
LNG FLOATING TERMINAL IN KOMARNO (SLOVAKIA)
Size: 126 x 24 m (L x W). Draught: 2 m
Capacity: 12 x 350 m³ of LNG
Facilities: LNG storage, vessel bunkering, facilities for other services, e.g. ship waste reception facilities, potable water, etc.

LNG TERMINAL IN GALATI (ROMANIA)
Capacity: 4,000 m³ in semi-pressurised tanks with option to increase up to 8,000 m³
Facilities: LNG storage, truck fuelling, vessel bunkering
Estimated investment: 17 MEUR

SMALL SCALE LNG TERMINAL IN CONSTANTA (ROMANIA)
Capacity: 5,000 m³
Facilities: LNG storage, (un-) loading of (smaller) seagoing vessels, fuelling of inland vessels and trucks
LNG TERMINAL IN RUSE (BULGARIA)
Bulmarket DM Ltd.

**Location:** on the river Danube in the port area in Ruse, on the grounds of former heavy machinery building factory, on an area of 1,000 m²

**Capacity:** 4 vertical tanks of 250 m³ of LNG (total 1,000 m³)

**Facilities:** storage, vessel (un-) loading facility, truck-loading station, truck & vessel fuelling station

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**LNG-FUELED RETROFITTED CONTAINER VESSEL – EIGER**
DCL Barge B.V. (Danser Group)

- **Size:** 105 x 11.45 m (L x W). Draught (max): 3.55 m
- **Propulsion:** 2 dual-fuel Wärtsilä 6L20DF, 900 kW
- **Bunker capacity (LNG):** 60 m³ (gross)
- **LNG tank:** Vacuum-insulated double-wall pressurised tank IMO type C

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**LNG-FUELED TYPE C TANKER – ECOLINER**
Damen Shipyard Hardinxveld B.V.

- **Size:** 110 x 11.4 m (L x W). Draught: 3.4 m
- **Propulsion:** 4x Scania SGI-16M gas engine
- **Bunker capacity (LNG):** 2 x 26 m³
- **LNG tank:** Double walled vacuum-insulated cryogenic tank: Specifics: Air lubrication system, Van der Velden Flex® tunnel to reduce the resistance in shallow waters

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**LNG-FUELED TYPE G TANKER – SIROCCO**
Chemgas Barging S.a.r.l.

- **Size:** 110 x 11.4 m (L x W). Draught: 3.15 m
- **Propulsion:** single 8L20DF Wärtsilä main engine
- **Bunker capacity (LNG):** 88 m³ (gross)
- **LNG tank:** Single wall independent vacuum-insulated pressure tank with design pressure of 10 bar

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**LNG-FUELED RETROFITTED CONTAINER VESSEL – EIGER**
DCL Barge B.V. (Danser Group)

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**LNG-FUELED TYPE C TANKER – ECOLINER**
Damen Shipyard Hardinxveld B.V.

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**LNG-FUELED TYPE G TANKER – SIROCCO**
Chemgas Barging S.a.r.l.

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Trans-European Transport Network (TEN-T)
**VESSEL CONCEPTS**

**LNG/GASOIL BUNKER VESSEL**
- **Size:** 110 m x 13.5 m (L x W)
- **Propulsion:** 3 x gas generators and 1 diesel generator (backup)
- **Tanks:** 4 x 380 m³ of gasoil, 2 x 935 m³ of LNG

**LNG-FUELLED PUSH BOAT**
- **Size:** 40 x 18 m (L x W)
- **Propulsion:** 4 x 1,060 kW Wärtsilä 6L20DF
- **Bunker capacity:** 165 m³ (gross) of LNG & 80 m³ of gasoil
- **LNG tank:** double-shelled vacuum insulated type C (vertical design)

**LNG DANUBE RIVER-SEA TANKER & RIVER BARGE**
- **Size:** 130 x 16.6 m (L x W)
- **Propulsion:** dual-fuel (using boil-off)
- **Tanks (cargo):** 10 x 348.5 m³ of LNG
- **Barge tanks (cargo):** 3 x 348.5 m³ or 6 x 348.5 m³

**LNG-FUELLED GAS SUPPLY SHIP**
- **Size:** 110 x 18 m (L x W)
- **Propulsion:** 4 x Wärtsilä DF generators
- **Bunker capacity:** 165 m³ (gross) of LNG & 80 m³ of gasoil
- **LNG tank:** range from 3,500 m³ to 13,000 m³

**RETROFITTING**
Dual-fuel propulsion with vacuum-insulated LNG tanks with a capacity of 2 x 49 m³ for the type TR 1000 and of 4 x 6.75 m³ for the type TR Muflon 1100 is considered as a viable option.
Facilitate sufficient LNG fuelling infrastructure (enforcement of DAFI, provision of adequate locations, efficient & fast permitting procedure, incl. environmental), provide infrastructure for intermodal LNG logistics.

Increase awareness on socio-economic benefits of LNG, inform on safety requirements and standards for LNG infrastructure & operations, ensure implementation of Action Plan.

Minimise methane slip of engine & along LNG supply chain, facilitate production & use of advanced gas engines, manage boil-off on inland vessels, reduce bunkering time to comparable values with traditional fuels, facilitate retrofitting of vessels, reduce unit costs of LNG equipment, initiate continuous research on required safety levels for LNG equipment & operations.

Provide air emission limits in line with technological development, implement / create regulatory framework for LNG as fuel / cargo, provide guidelines for mobile LNG fuel tanks, provide guidelines for harmonised port regulations, spatial planning, risk assessment, LNG bunker stations & vessels, ensure safe & efficient LNG bunkering & (un-)loading.

Provide user oriented information, ensure fair & sustainable competition in LNG market, create economies of scales, provide public support for vessel operators & for LNG infrastructure build-up and extension.

Provide regulatory framework together with competencies required in handling of LNG for various personnel, facilitate EU-wide acceptance of E&T related to LNG, improve availability of and access to E&T, improve quality of LNG-related education through dedicated learning tools, ensure recognition & certification of E&T institutes, endure capacity of emergency responses.
IMPLEMENTATION OF LNG MASTERPLAN - FOUR MAYOR INSTRUMENTS PROPOSED

- Coordination of Implementation LNG Action Plan (Governance & Technical Measures)
- Program Support Action (PSA) 2016-2018
- Awareness & Promotion Campaign of LNG Platforms plus Market Sides Measures
- Interreg Europe /PSA 2016-2018
- IWT Lead Project for LNG innovations
- Horizon 2020 Open Call /Call 2017
- Deployment Projects
- CEF Pilot Projects National Programs Interreg Program EFSI Blending
HOW TO REALIZE A SMALL SCALE LNG TERMINAL IN THE DANUBE REGION?

- **MULTI-CLIENT STRATEGY**
  - Unite pioneer consumers searching clean & cost-effective energy (gas distributors, industry, off-pipeline energy user) & users of alternative fuel

- **SYNERGIES**
  - Generates economies of scale, reduces start-up losses and contributes to base load supply

- **PUBLIC COMMITMENTS**
  - Win commitment of public administrations
  - Ensure smooth admission / permitting process / administrative efficiency
  - Integrate public transport/utility operators/port operators/ vessel operators as pioneer consumers

- **PUBLIC FUNDING**
  - Seek public (EU) funding to level initial market risk and to compensate high investments
  - CEF/TEN, Operational Program Large Infrastructure, Cross-Border Cooperation Program, etc. offer funding opportunities

- **AWARENESS**
  - Invest into awareness and provision of know-how on LNG
  - Helps to reduce NIMBY risk and let you gain policy/administration support

- **BIO-LNG**
  - Integrate/facilitate supply of Bio-LNG
  - Ensures local/regional supply of low volumes in ramp-up phase
  - Improves CO2 performance and strengthens political support

- **MULTI-SOURCING**
  - LNG for Danube will come from multiple sources
  - Import from LNG terminals in Turkey & Greece, in future KRK/Croatia, Liquefaction of bio-methane & local stranded resources,
  - Multi-modal supply from NW/SW-Europe

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<table>
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<th>Recommendation</th>
<th>Description</th>
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<td>1.</td>
<td>Develop and implement a <strong>National Strategy for Alternative Fuel with LNG</strong> as key element (like many other EU States are currently doing)</td>
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<td>2.</td>
<td>Take preparatory steps to LNG fueling infrastructure parallel to EU Directive on Deployment of Alternative Fuels Infrastructure (DAFI)</td>
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<td>Stimulate engagement and commitment of public administrations to develop public-private partnership structures to optimize EU funding</td>
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<td>Engage in EU activities for regulatory framework of LNG as fuel (technical provisions for vehicles, standardization and harmonization of fueling, storage, safety, etc. regulations and administrative procedures)</td>
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<td>Set-up a National Platform for LNG to unite public and private stakeholders for innovation and deployment projects (following the Dutch model)</td>
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<td>6.</td>
<td>Stimulate investment in LNG fueling infrastructure as well as in LNG-fueled vehicles operated by public organizations (e.g. public transit &amp; public utility operators) and make use of EU Programs 2014-2020</td>
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<td>7.</td>
<td>Secure LNG supply as part of national economic, transport &amp; energy strategies</td>
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<td>8.</td>
<td>Use national potentials and foreign policy to overcome supply problems in start up phase</td>
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CONCLUSIONS

- LNG is the **most promising alternative fuel for inland navigation** offering high environmental and economic benefits
- Use of LNG supports major EU transport, environment and energy policy objectives
- **Bio-LNG will improve CO2** performance significantly
- **Best possible bridge** for a strongly decarbonised inland shipping (e.g. fuel cell)
- Inland vessels can deliver high volumes of LNG cost-effectively from seaside import terminals to economic heartlands of Europe
- Barging sector, therefore, is pioneer consumer of LNG and enabler of LNG supply supporting a more diversified European energy supply
- Rhine/Meuse-Main-Danube axis will serve as **European main LNG artery**
- LNG Masterplan prepares sector for successful follow-up EU projects, but:
  - **Implementation of comprehensive strategy and favourable framework conditions (market & policy) are needed for wide-scale deployment**
  - **LNG is not a self-running case nor the solution to all evil in inland shipping**
Download Main Deliverables
http://lngmasterplan.eu/download/deliverables

LNG Booklet Online

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Additional slides for discussion
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)
LNG AS FUEL FOR TRUCKS

• OEM trucks Euro VI available from Iveco and Scania, Euro V also from Volvo and Mercedes for HP up to 330 PS
• 70% less NOx and 96% less PM than the Euro VI limit
• Less noise: when cold 1 Diesel truck = noise of 4 NG trucks
• TCO savings versus Diesel Euro VI (>125.000 km p.a.) despite higher capex
• Similar/same torque & drivability as diesel truck
• HHP segment needs research & development; efficient engines expected 2016/2017

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LNG bus trial organized by Danube LNG, 02/2015

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
LNG BUS TRIALS IN SLOVAKIA

Results

- 5,108 km driving with LNG
- 29.8 kg/100 km average consumption (compared to 33 l/100 km in case of diesel buses)

Saved

- 43.58 kg of Nox
- 1.47 kg of PM
- 0.04 kg of SO2

LNG vs CNG

- LNG consumption in kg by LNG bus was up to 19% less than the consumption of CNG bus in kg.

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<th>Pollutant</th>
<th>Specific emissions (g/km)</th>
<th>Annual emissions (kg/year)</th>
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<td>Diesel</td>
<td>LNG</td>
<td>Diesel</td>
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<tr>
<td>NOx</td>
<td>91.686</td>
<td>15.104</td>
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<tr>
<td>PM</td>
<td>0.262</td>
<td>0.013</td>
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<td>SO2</td>
<td>0.007</td>
<td>0.000</td>
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SUPPLYING DANUBE = MULTI SOURCE STRATEGY

- Intermodal supply W/SW-Europe
- LNG Import Black Sea/?FSRU Constanta
- Liquefaction of remote supply
- Liquefaction of bio-methane

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SPP GOING TO SUPPLY LNG

LNG Project

Project puzzle

LNG supply for buses

Basic scenario

Future

LNG filling stations for trucks

Košice

Žilina

Bratislava

Zvolen

Liquefaction

logistics

logistics

Bunkering in the Port of Bratislava

Floating Terminal

export

AUT

SK

HU

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LNG Project

Project visualization

LNG filling station localization on main road and river hubs with cross border interconnectivity