



***3rd Workshop of regional sub-sectoral
networking group on LNG markets***

**LNG prospects in Ukraine
and Eastern Partnership**

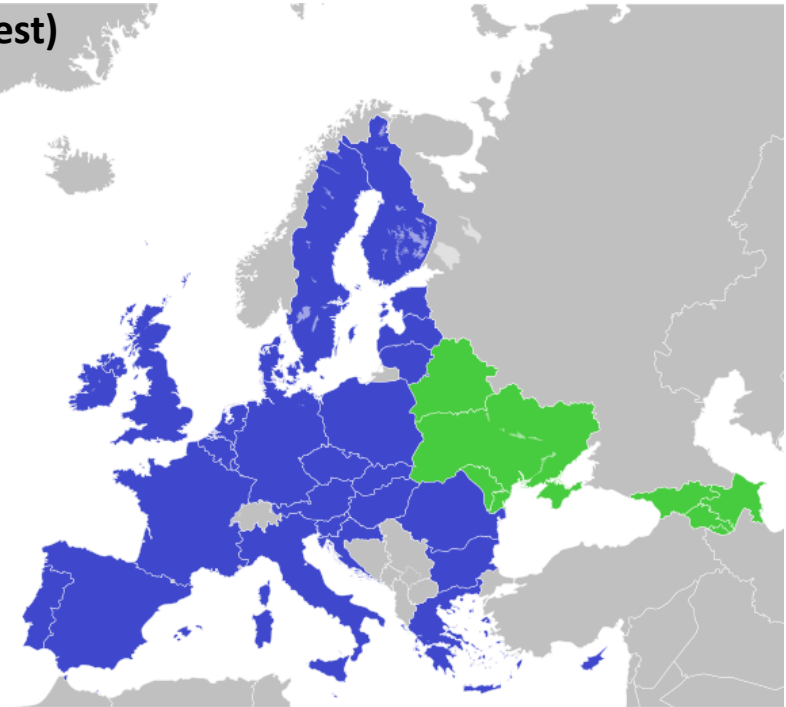
Laktionov Oleksandr,
Head of strategic projects and programs
Naftogaz of Ukraine

20 September 2019, Kyiv, Ukraine



Dependency on Russian gas in Eastern Partnership (EaP)

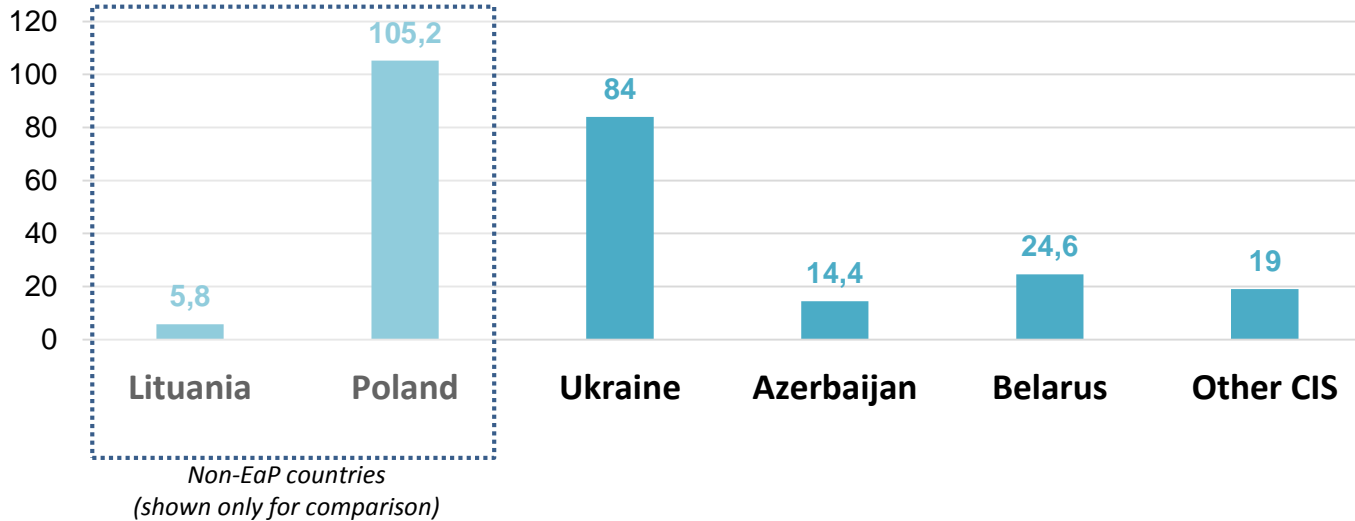
Country member of the Eastern Partnership	Russian gas supply (ave), bcm		Dependency on Russian gas (est)
	2017	2018	
Ukraine	0	0	0%
Georgia	~0,2	<0,05	< 5%
Azerbaijan	~0,4	1	< 5%
Armenia	~2	1,8	~80%
Moldova	~2,7	3	>95%
Belarus	~19	20	100%



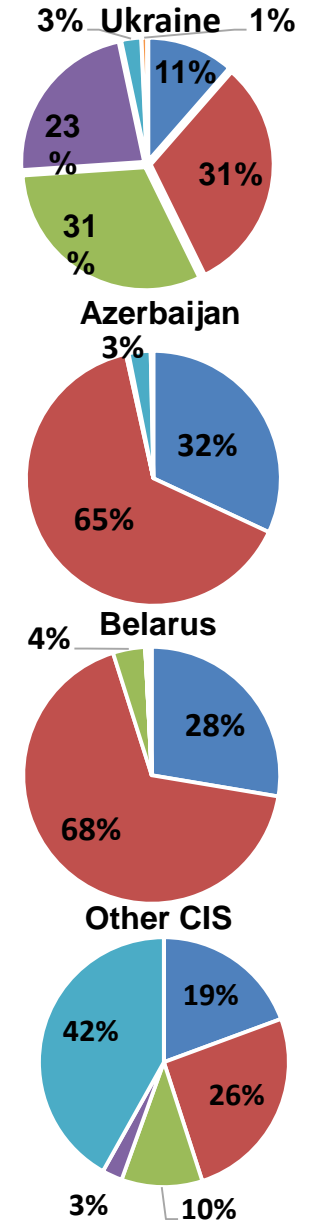
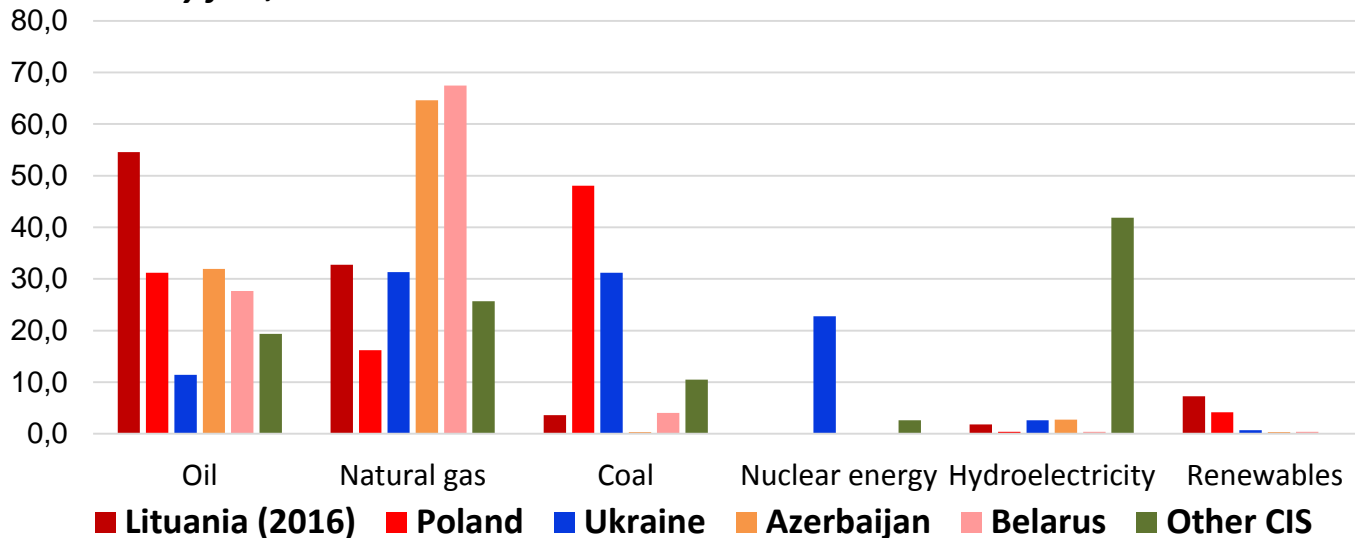
Energy independence has its price: world prices and competition or loyalty of the Russia, political pressure, war/occupation

Primary energy consumption in EaP countries (2018)

... by countries, mlt.oe



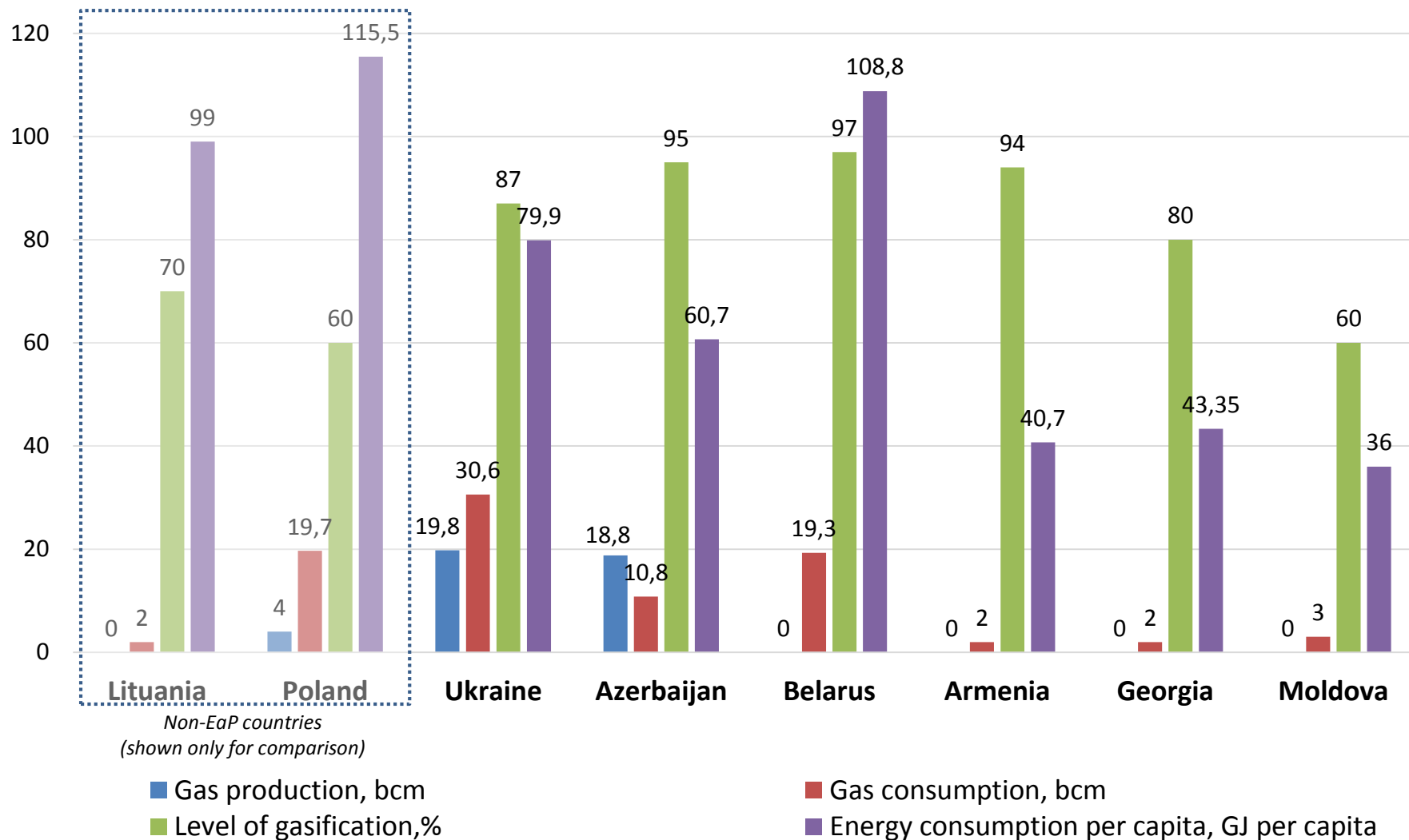
....by fuel, %



Source: BP Statistical review

Natural gas – main source of energy for economy each EaP countries

Some main «gas» characteristics by EaP countries

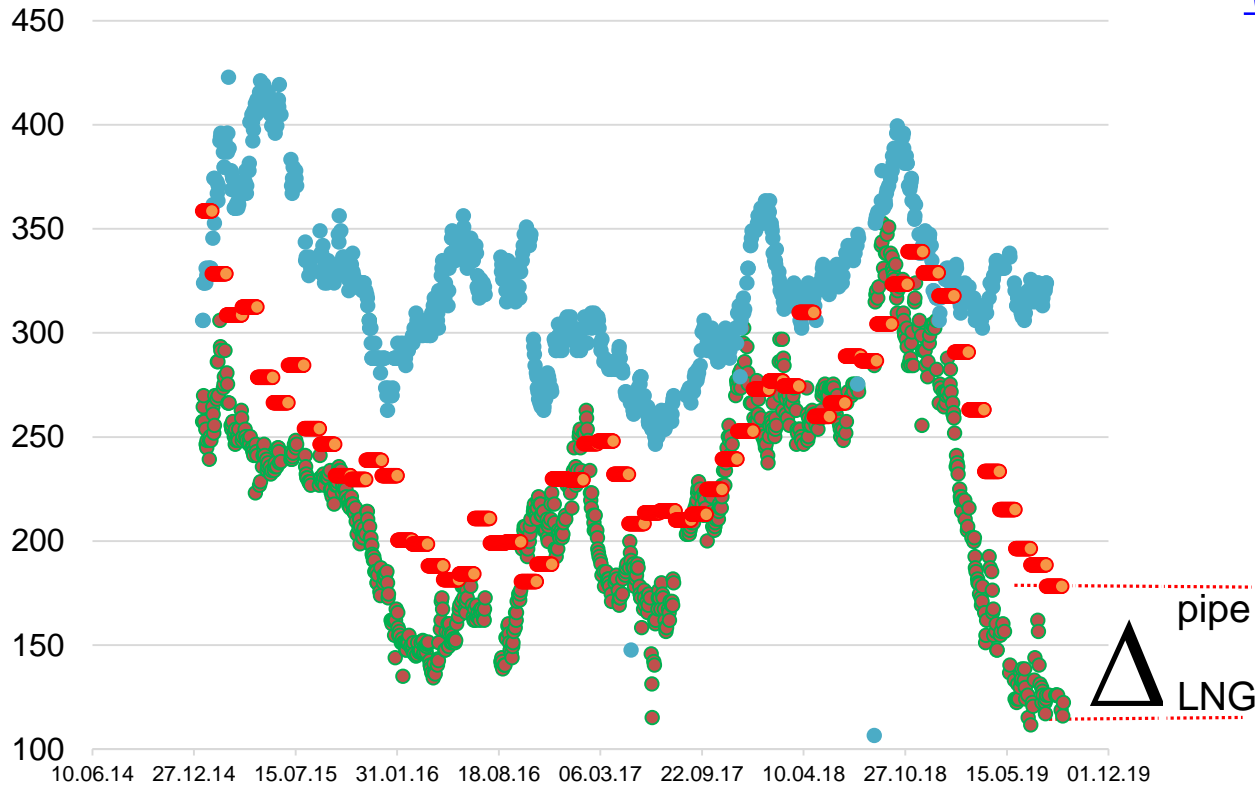


Source: BP Statistical review, open sources

So much different conditions for be wide open for LNG

Main parameters for choose LNG

Prices for pipe gas for Ukraine vs LNG in Europe, \$/tcm



- LNG Journal European Spot (USD/tcm) Indicator PRICE
- LNG Journal Asian Delivered Oil-Linked LNG Indicator (USD/tcm)
- Average import to UA natural gas price (USD/tcm)

Global Innovation Index (GII) 2019
(26 July 2019)

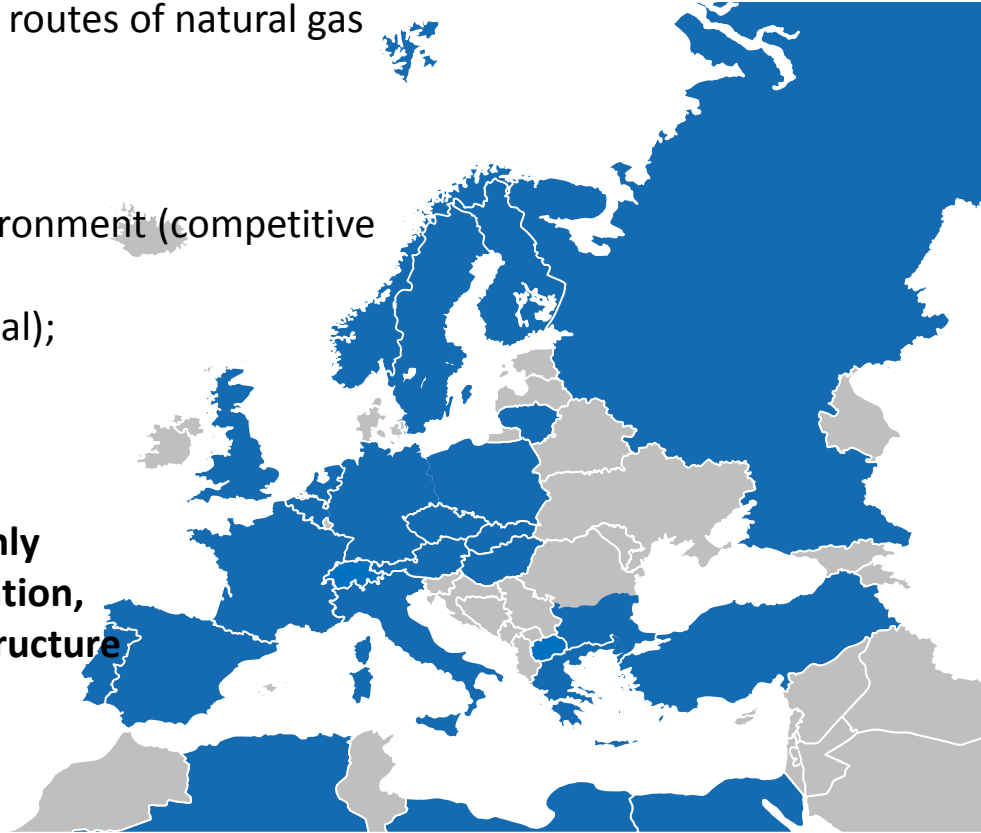
Country	Rank
Switzerland	1
Sweden	2
USA	3
Netherlands	4
UK	5
Finland	6
Denmark	7
Singapore	8
Germany	9...
Lithuania38
Poland	39
Russia	46
Ukraine	47
Georgia	48
Moldova	58
Armenia	64
Belarus	72
Azerbaijan	84
.....	129

.... stable LNG competitiveness and readiness to innovation in question

LNG utilization: main goals, sectors and geography

- Security of natural gas supply
- Diversification or alternative source and routes of natural gas supply/import;
- Retail LNG;
- Local regional gasification;
- Fuel for transport which friendly to environment (competitive with diesel and fuel oil):
 - road/auto (municipal, commercial);
 - water/sea transport;
 - rail
- Other (in particular source of cooling)

The positive dynamics of LNG prices mainly predetermine investment in local gasification, maritime, rail, road transport and infrastructure



The natural gas utilization on transport contributes to the improvement of air quality, namely by reducing emissions of NOx by up to 85% and CO2 by up to 30%.

Increasing environmental requirements for fuel is one of the main drivers of LNG development, but after price

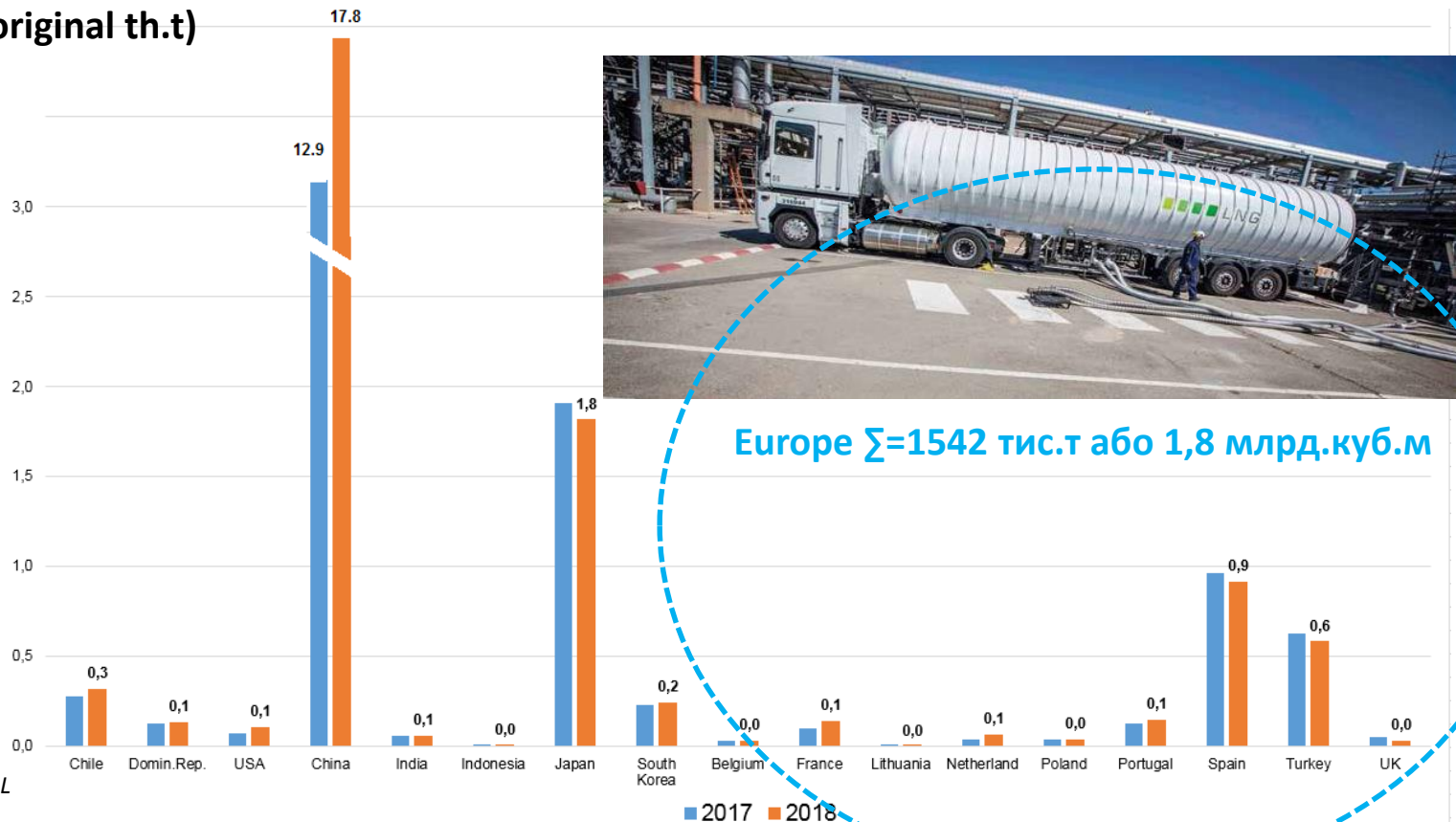
Retail LNG

The development of retail LNG is gaining momentum.

The uptake of **LNG as a fuel for ships** is accelerating, with more than 220 ships in service and under construction worldwide at the end of 2017.

The distribution of **LNG by trucks** is also growing. A number of receiving terminals have developed truck loading capabilities in order to support LNG distribution for retail applications, including transport, power and industrial uses.

TRUCK LOADING OF LNG FROM RECEIVING TERMINALS IN 2017-2018, bcm (converted from original th.t)



Source : GIIGNL

LNG utilization (additional options excl. regasification)

Poland



Lithuania



Turkey



Rest of the world



LNG utilization is extending in Europe, USA, Asia, but not in EaP

Local gasification with LNG

Gasification with LNG useful for:

- No access to grid gas Pre - gas grid development;
- Heating
- Temporary supplies
- Burning in production processes

Poland



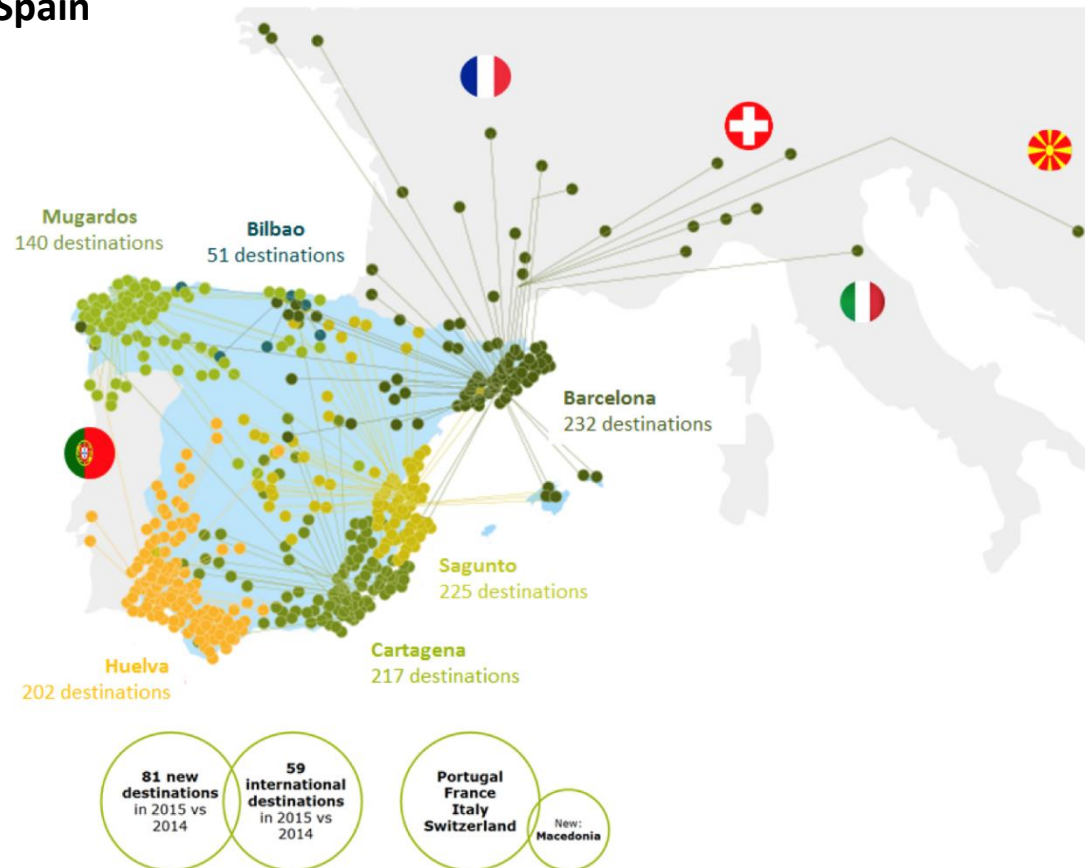
Lithuania



Turkey



Spain



Destinations of LNG truck loadings by LNG regasification terminal in 2015

Source: Enagas

Spain is the biggest consumer LNG in Europe

CNG vs LNG on road transport

The value of LNG as an environmentally friendly fuel is increasing (including compared to LPG and CNG).

The use of LNG is expanding, both in the road and water segment, and is gradually pushing CNG out of the market.



**Use in private cars and transport, buses
(up to heavy trucks)**

**Heavy trucks,
Vessels, barges, trans-ocean liners**

LNG demand for maritime transport in Northern Europe by 2020 may be 2-4 mln.t/year. Strong growth is expected in 2020, which will require the development of appropriate infrastructure, including the LNG fueled vessels fleet.

Road transport will be the driver for the development and extending of utilization of LNG in the short and medium term

LNG on municipal transport

Some countries with wide utilization LNG on municipal transport (buses):

- USA
- China
- UK
- Spain
- Italy
- Poland (2015)
- Slovakia (2015)
- Bulgaria (2015)
- India (2016)
- Hungary (2017)

Spread prices LNG vs diesel

Country / Company	Price LNG (€/kg)	Price diesel (€/l)	Delta ³⁾ LNG vs Diesel (% of diesel price)
Belgium / Drive system	0,98	1,29	54
Italy / Eni	0,98	1,52	46
The Netherlands / LNG24	1,22	1,36	64
Portugal / Galp	1,23	1,29	68
Spain / GasNaturalFenosa	1,0	1,18	61
Sweden / FordonsGas	1,62 ¹⁾	1,40	83
UK / Gasrec, Chive	1,2 ²⁾	1,65	52

- 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)

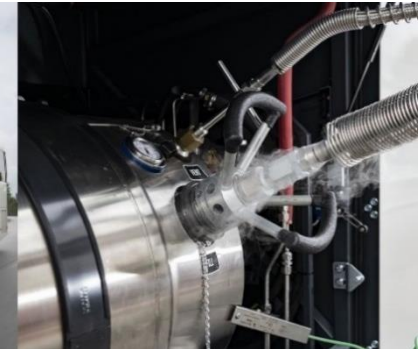
Source: LNG Blue Corridors, NGVA Europe



Scania introduces world's first gas-fuelled long-distance coach

5 September 2018

<https://www.scania.com/group/en/scania-introduces-worlds-first-gas-fuelled-long-distance-coach/>



LNG become more popular fuel on municipal transport due to price and ecological friendly

LNG on commercial transport and heavy trucks

A range of heavy trucks with gas engine manufactured in the EU

Trademark	Engine	Capacity (horsepower)	Mileage for refueling
Iveco Stralis CNG	Cursor 8	271/300/330	450
Iveco Stralis LNG	Cursor 8	330	1000
Daimler Econic CNG	M900 LAG	279	450
Daimler Econic LNG	M900 LAG	279	1000
Scania CNG	9-liters	270/305	450
Volvo Daul Fuel CNG	7-liters	460	450
Volvo Daul Fuel LNG	7-liters/13-liters	460	1000

Some manufacturers of transport with engines fed by natural gas

Scania (2010),
 Volvo (2011),
 IVECO (2012),
 FOTON
 TATA
 MAN
 Ikarus
 Solbus
 Daimler Trucks,
 Skoda, Mercedes,
 Volkswagen, Opel, Ford, Fiat, Seat, Renault and others
 Ukrainian: KpA3, Bogdan, LAZ (CNG only).

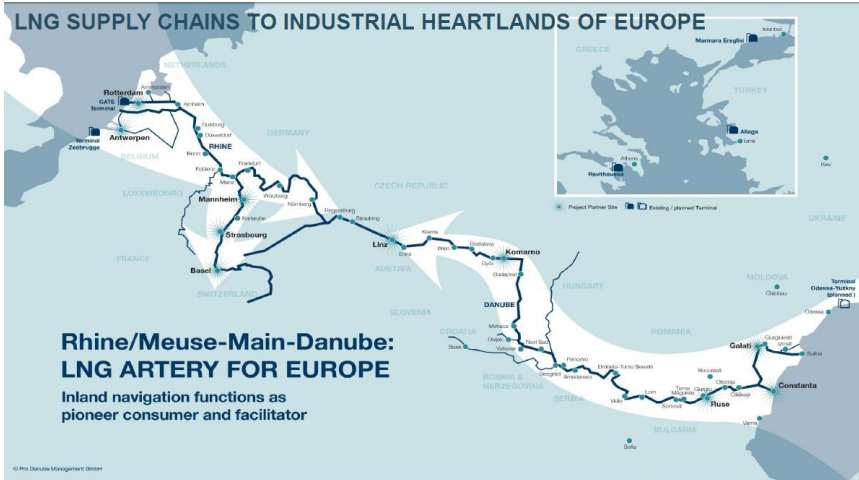


The number of natural gas transport producers and units in use is steadily increasing

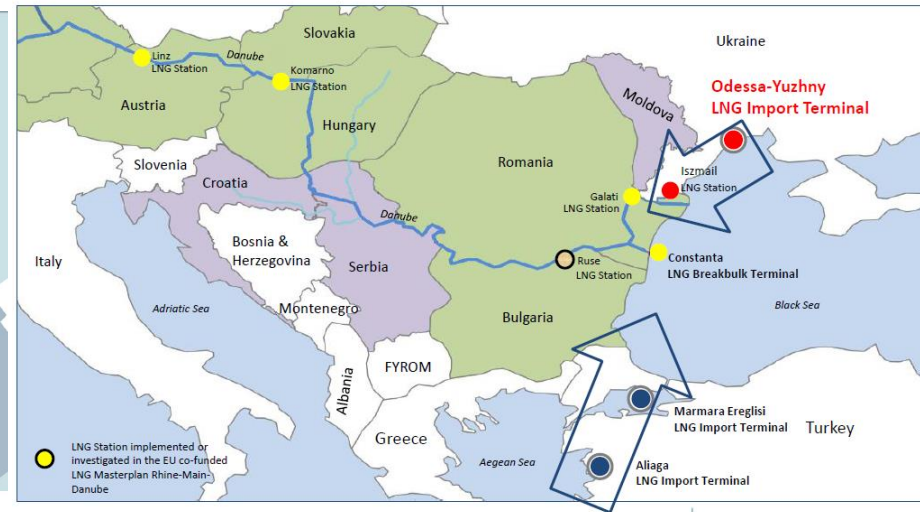
LNG initiatives on sea/water transport in Europe



SOME OPTIONS FOR SUPPLYING DANUBE



LNG Masterplan: Status April 2015



LNG Masterplan: Status April 2015



LNG Masterplan for Rhine-Main-Danube

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



LNG-FUELLED RETROFITTED CONTAINER VESSEL – EIGER DCL Barge B.V. (Danser Group)
Size: 105 x 11.45 m (L x M), 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



LNG-fuelled type G tanker SIROCCO Chemgas Barging S.a.r.l.
Size: 110x 11.4 m (L x W), Draught: 3.15 m
Propulsion: single 6L20DF Wärtsilä main engine
Bunker capacity (LNG): 88 m³ (gross)
LNG tank: Single wall independent vacuum-insulated pressure tank with design pressure of 10 bar



LNG-FUELLED TYPE C TANKER – ECOLINER Damen Shipyards Hardinxveld B.V.
Size: 110x 11.4 m (L x W), Draught: 3.4 m
Propulsion: 4x Scania 501-16M 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



Breakthrough LNG Deployment in Inland Waterway Transport



Source: Batelia & D-ZIB Workshop Natural gas for inland shipping Keynote: Options to use Natural Gas in IWT. Manfred Seitz, General Manager, Strasbourg, 21st of June 2017

https://batelia.eu/wp-content/uploads/sites/3/2016/02/LNG-WS-VNF-Strasbourg-21-June-2017_final.pdf

The CEF - Connecting Europe Facility will play a key role in the further implementation of the initiatives. The «Horizon 2020» program should provide a dedicated program for LNG research

Regulation for LNG development

Directive 2014/94/EU of the European Parliament and of the Council of 22 October 2014 on the deployment of alternative fuels infrastructure

<https://publications.europa.eu/en/publication-detail/-/publication/d414289b-5e6b-11e4-9cbe-01aa75ed71a1/language-en>

EU Strategy for liquefied natural gas and gas storage (2016)

<https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/eu-strategy-liquefied-natural-gas-and-gas-storage>

IMO Sulphur 2020 (IMO regulations to reduce sulphur oxides (SO_x) emissions from ships to 2020)

<http://www.imo.org/en/mediacentre/hottopics/pages/sulphur-2020.aspx>

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

Regulated by ADN 2015 (European Agreement concerning the International Carriage of Dangerous Goods by Inland Waterways) & Directive 2008/68/EC on the inland transport of dangerous goods

- 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 à it is expected that the regulations for the use of LNG for propulsion will be included in ADN as from 2017

Potential interest EaP for LNG (personal assumptions)

Option/Country	Belarus	Ukraine	Moldova	Georgia	Azerbaijan	Armenia
Infrastructure for security of natural gas supply	●	●	●	●	●	●
Diversification or alternative source and routes of natural gas supply/import	●	●	●	●		●
Retail LNG		●				
Local regional gasification	●	●	●	●	●	
Fuel for transport which friendly to environment (competitive vs diesel/fuel oil)						
road/auto (municipal, commercial)	●	●	●	●		●
water/sea transport		●		●		
rail	●	●		●		●
Potential source of LNG supply, incl.						
LNG terminal/plant		●		●		
Cross-border supply	●	●	●			
Own production on the well		●			●	

Legend: ● - «yes»
● - «may be»

Ukraine is almost the only EaP country that is potentially interested in developing LNG

Current status LNG-project in Ukraine

- There is a need for import and further diversification of gas supplies
- The State Enterprise "National Project" LNG Terminal“ was created in 2010 for the realization of the LNG project
- There were 2 feasibility studies for the LNG terminal (onshore and FSRU) developed
- There is interest from domestic companies and potential foreign investors in the implementation of the LNG project: financing, construction, supply and solve Bosphorus pass issues (but needed State guaranties)
- In August 2017 est. a Working Group for resume consideration on the construction of a LNG terminal in Ukraine and to develop options for LNG supplies to Ukraine

LNG terminal benchmarks

Type and name LNG terminal	Commissioned projects		Valuation for Ukraine		
	Onshore «Świnoujście»	FSRU «Independence»	Onshore	FSRU	FSRU
Project executive	«Polskie LNG» (Gaz System)	«Klaypedos Nafta»	SE «LNG-terminal» (MEDT)	SE «LNG-terminal» (MEDT)	«TIS ltd», Odessagas
Place, year of commission	PL, Świnoujście, 2016	LT, Klaypeda, 2014	UA, Odessa, on entry of Yuzhny port	UA, Odessa, Yuzhny port, MNT Pivdenniy (JSC Ukrtransnafta)	UA, Odessa, Yuzhny port
Developer Feasibility study	SNC Lavalin (Canada)	BMGS (Latvia)	Socoin (Fenosa, Spain)	ILF Polska	n/a
Regasification capacity, bcm	5/7.5	4	10	5	5
Storage tanks	320 (2*160)/+1*160	170 (size FSRU vessel)	540 (3*180)	180 (size FSRU vessel)	(size FSRU vessel)
Additional facilities	-	Charter FSRU-vessel (owner Hoegh LNG)	-	Charter FSRU-vessel (owner Excelebrate Energy)	Charter FSRU-vessel (owner n/a)
Construction period, years	>5	<3	3	9m - 4	4m-16 m
CAPEX, mln. €	>950	~890 (200+690)	954.2	726.5 (36.5+690)	n/a (49+n/a)



Sources: Analysis of the Department of Strategic Planning and Control

Developments and goals (LNG)





Possible routes & sources

- Lithuania (Klaipeda)
- Poland (Swinoujscie)
- Greece (Revithoussa)
- Turkey (Marmara Eriglisi)

Projected

- Greece (Kavala, Alexandroupoulos)
- Croatia (Krk Island)
- Ukraine (near Odesa)

Legend

-  LNG terminals (existing)
-  LNG terminal (Projected, proposed and under construction)

$< 3 \text{bcm}</math> Potential of gas supply by corridors$

A lot of options to connect with several regional markets and energy corridors to receive natural gas and LNG both

Thank you very much for your attention!



Please find more information:

Official sites: www.naftogaz.com

<http://naftogaz-europe.com>

Annual report <http://www.naftogaz.com/files/Zvity/Annual-Report-2018-engl.pdf>

Movie «Energize Ukraine» <https://www.youtube.com/watch?v=oqJHh341PHY&t=1s>

Address: 6, B.Khmelnyskoho Str., Kyiv, 01601, Ukraine

e-mail: laktionov@naftogaz.com