



**A new energy culture**

**sustainability and territories**



# Energy production and consumption in Croatia

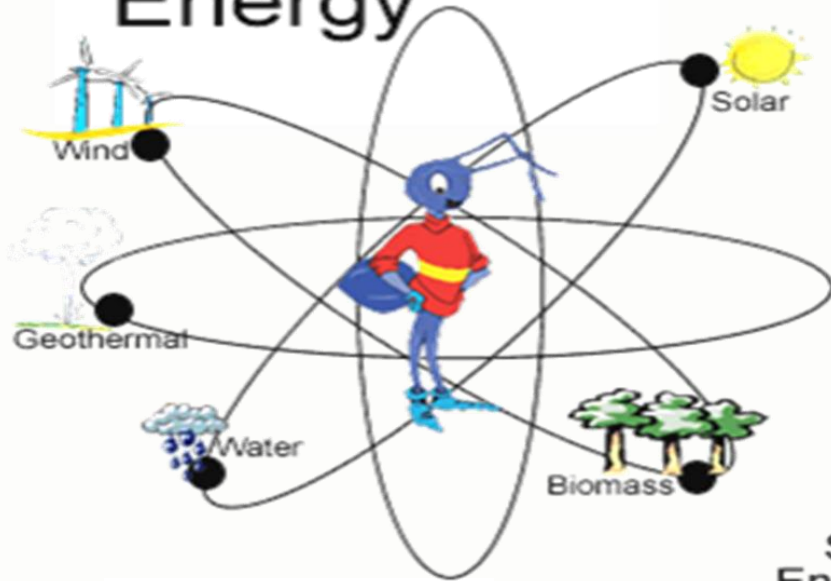
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**Faculty of Mining, Geology and Petroleum Engineering,**  
**University of Zagreb, Croatia**

# 5 fundamental sources of energy:

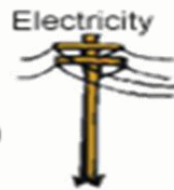
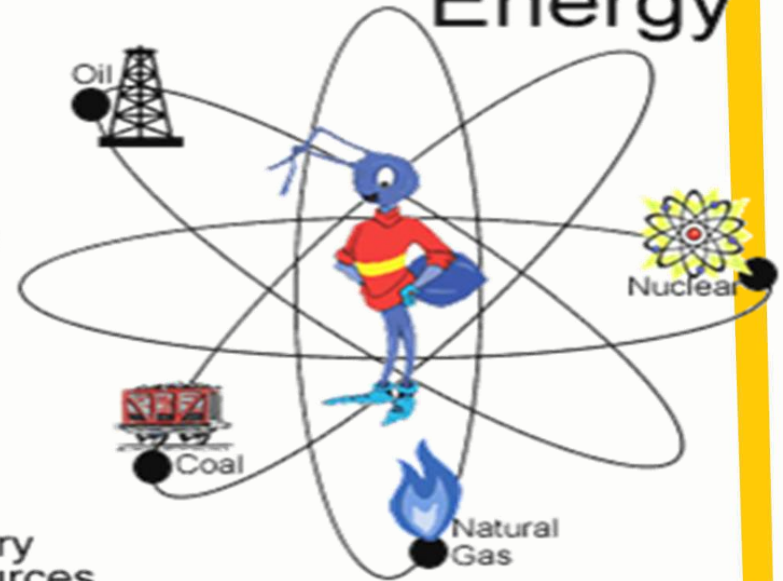
1. Nuclear fusion in the Sun (solar energy)
2. Gravity generated by the Earth & Moon.
3. Nuclear fission reactions.
4. Energy in the interior of the Earth.
5. Energy stored in chemical bonds.

# Renewable and non-renewable energy resources

## Renewable Energy



## Non-Renewable Energy



Secondary Energy Sources

## Global wind production

According World Energy Council (**World Energy Resources: 2013 Survey**)



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## Global solar capacity



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## Global geothermal production



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**Tonne of oil equivalent (TOE)** - Unit representing energy generated by burning one metric ton (1000 kilograms or 2204.68 pounds) or 7.4 barrels of oil, equivalent to the energy obtained from 1270 cubic meters of natural gas or 1.4 metric tons of coal that is, 41.87 gigajoules (GJ), 39.68 millionBtu (MMBtu), or 11.63 megawatt hours (MWh).

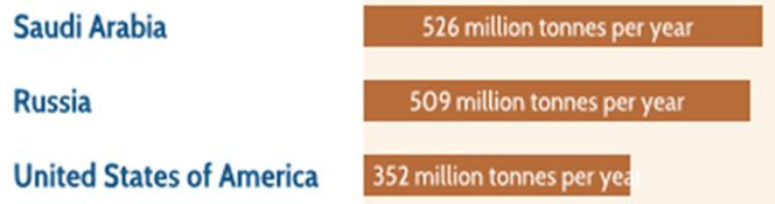
**The megatonne of oil equivalent (Mtoe)**, equal to  $4.1868 \times 10^{16}$  J, is used as the general unit to describe the energy content of all fuels.

## Global hydropower production



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## Global oil production



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According World Energy Council (**World Energy Resources: 2013 Survey**)

## Global gas production



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## Global coal production



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## Global nuclear production



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# Crude oil and natural gas use

## Crude oil products

virtually everything in the modern world is either made from oil derivatives, or uses oil-based energy to produce and transport it



## Natural gas use



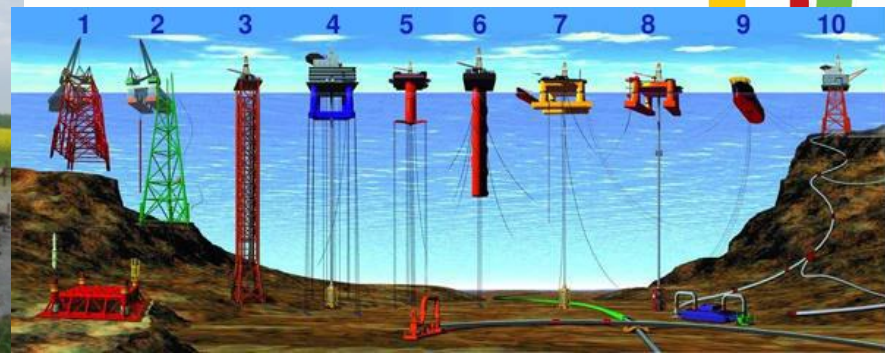
# Oil and gas production and processing

Gas producing well



Oil producing well

Offshore producing platforms



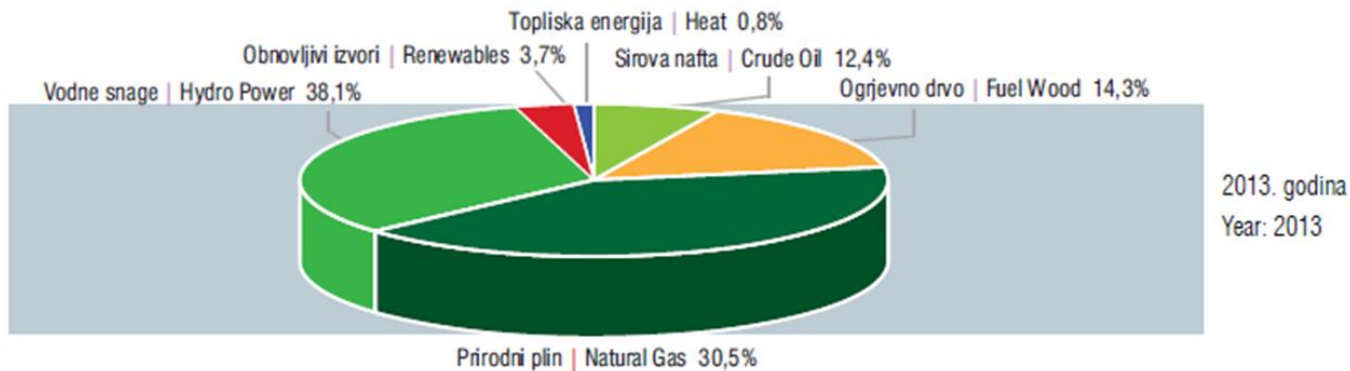
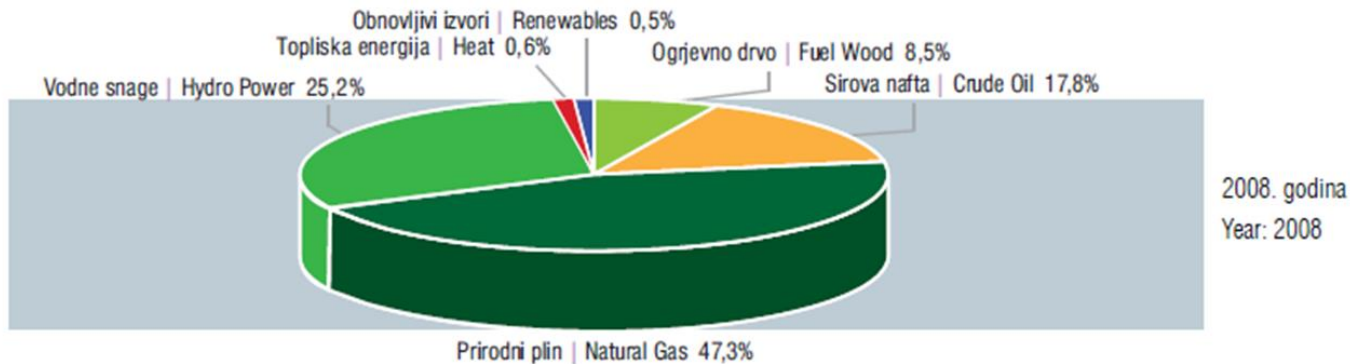
Oil processing plant



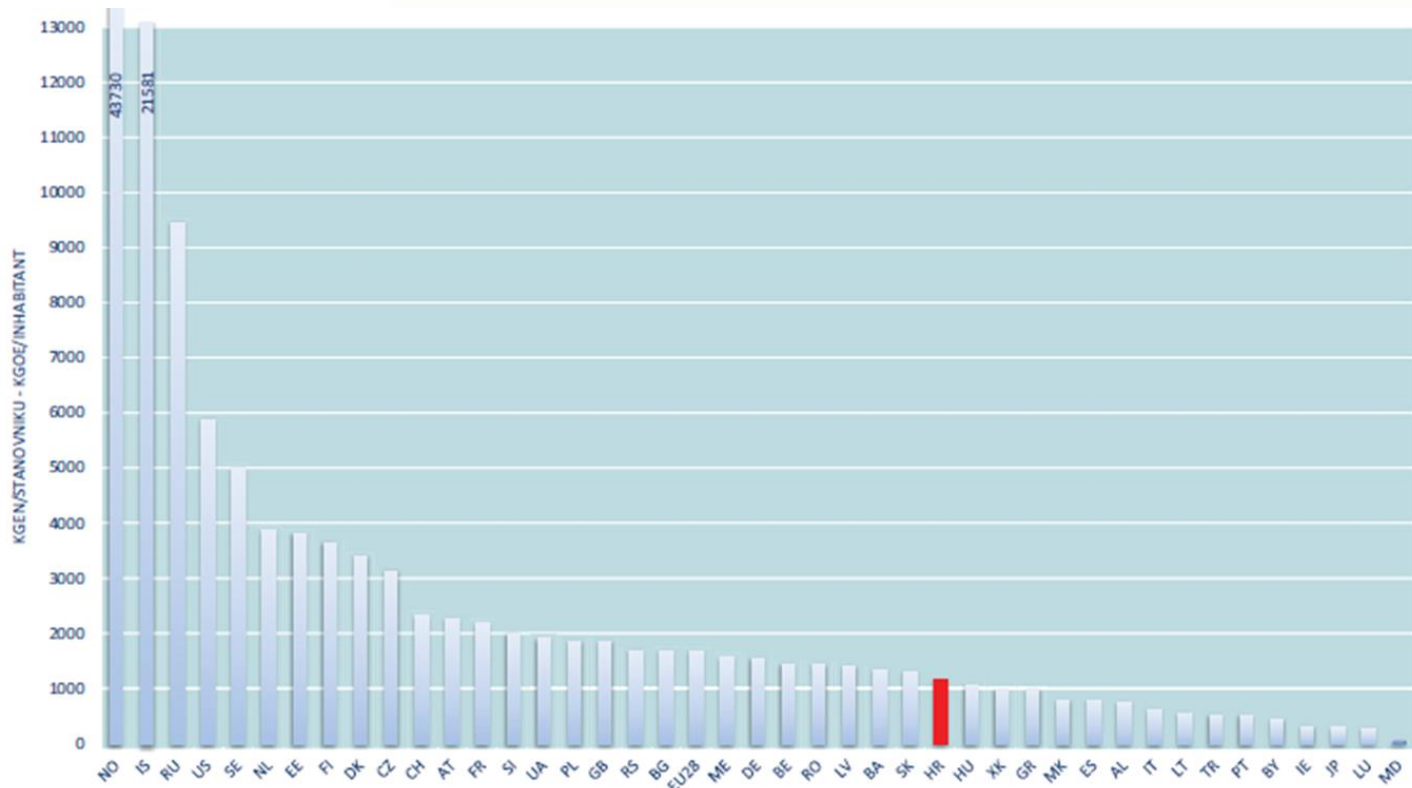
Gas processing plant



# Shares of individual energy forms in total primary energy production in Croatia



# Total primary energy production in Croatia per capita



# Oil and gas production in Croatia

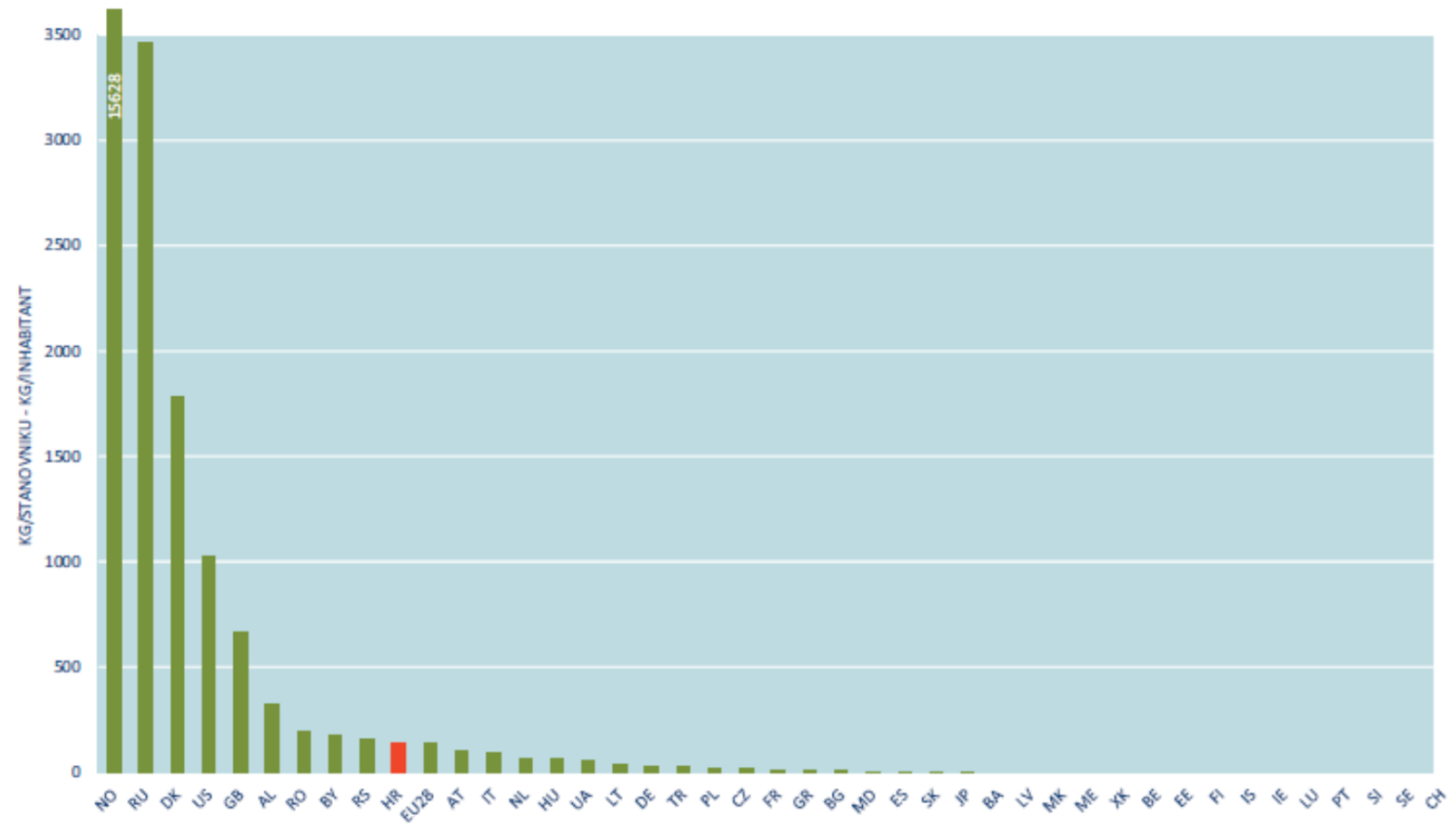
Nafta i kondenzat Oil and Condensate	2004.	2005.	2006.	2007.	2008.	2009.	2010.	2011.	2012.	2013.
Rezerve (1 000 m <sup>3</sup> ) Reserves (1 000 m <sup>3</sup> )	11 794,0	9 330,9	9 690,1	11 719,1	11 472,5	10 823,6	10 481,6	11 554,0	11 531,6	13 471,1
Proizvodnja (1 000 t) Production (1 000 t)	1 001,0	946,0	917,4	879,1	835,4	776,2	714,2	669,6	632,9	611,3

Izvor | Source: Ministarstvo gospodarstva | Ministry of Economy

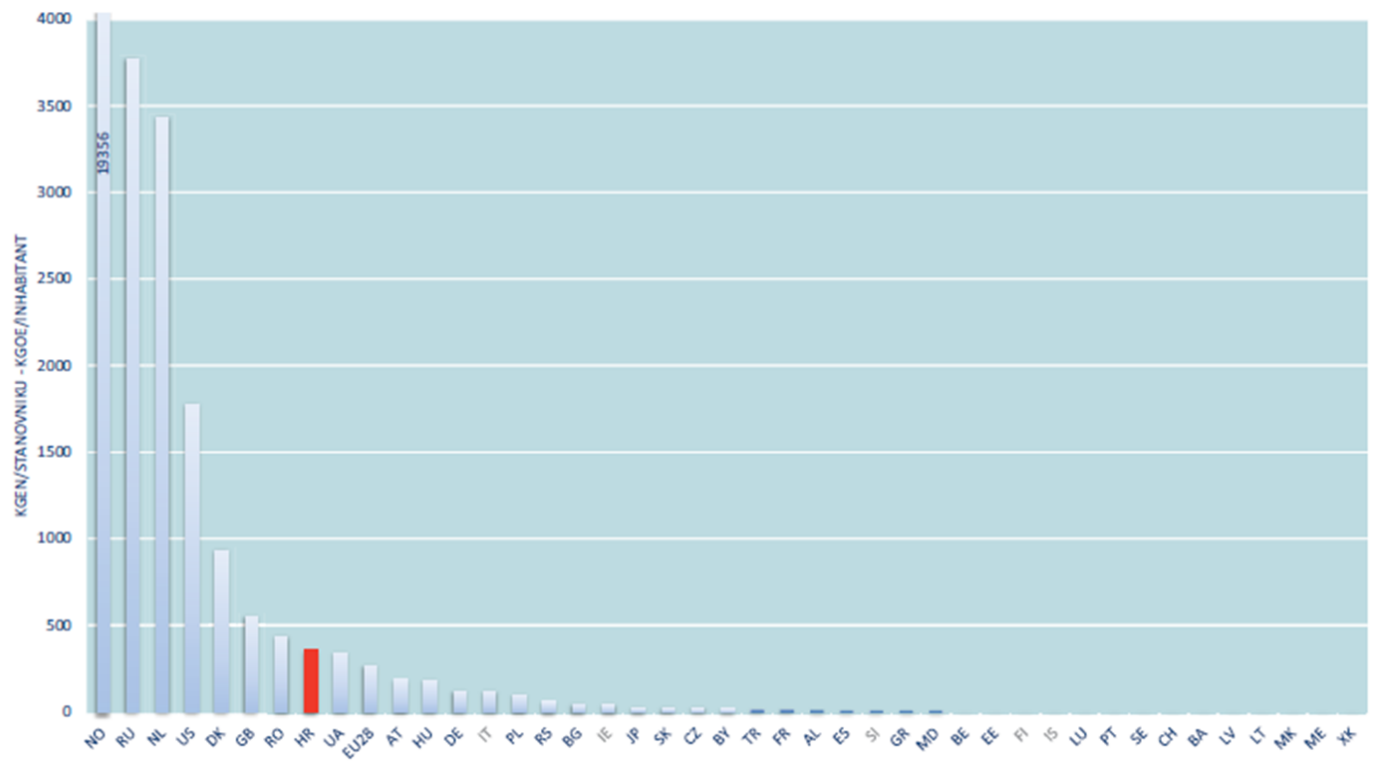
Prirodni plin Natural Gas	1990.	1995.	2000.	2005.	2010.	2011.	2012.	2013.
Rezerve Reserves (in billion cubic meter)	48 475,3	38 878,8	29 204,5	30 358,6	31 587,1	23 959,9	24 214,3	21 386,6
Proizvodnja Production	1 982,3	1 966,4	1 658,5	2 283,4	2 727,2	2 471,5	2 013,1	1 856,1

Izvor | Source: Ministarstvo gospodarstva, rada i poduzetništva | Ministry of economy, labour and entrepreneurship, EIHP

# Crude oil production in Croatia per capita



# Natural gas production in Croatia per capita

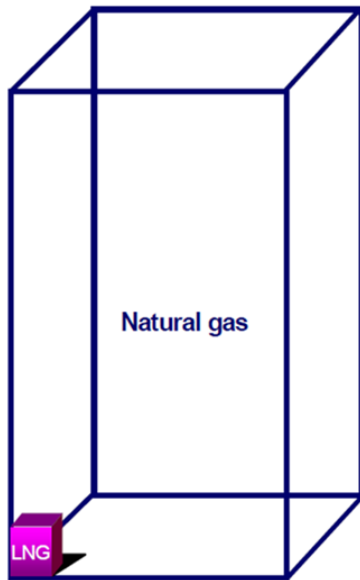


# Oil and gas transportation



# Liquefied natural gas - LNG

## Physical properties LNG Density



1 m<sup>3</sup> LNG corresponds  
to 600 Sm<sup>3</sup> natural gas

S = Standard state, 15°C, 1 atm

At temperatures above -110 °C  
LNG vapour is lighter than air

LNG is lighter than water  
LNG Density: 450 kg/m<sup>3</sup>  
Water density: 1000 kg/m<sup>3</sup>

# Natural gas liquefaction plants

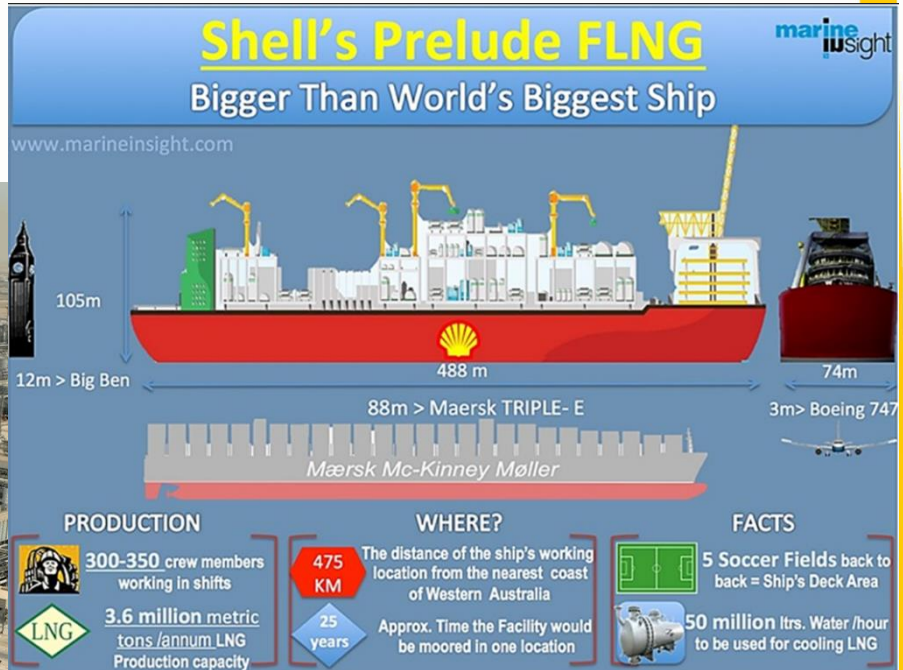



On-shore liquefaction plant

**Shell's Prelude FLNG** marine insight

Bigger Than World's Biggest Ship

www.marineinsight.com



PRODUCTION	WHERE?	FACTS
 <p>300-350 crew members working in shifts</p> <p>3.6 million metric tons / annum LNG Production capacity</p>	<p>475 KM</p> <p>The distance of the ship's working location from the nearest coast of Western Australia</p> <p>25 years</p> <p>Approx. Time the Facility would be moored in one location</p>	<p>5 Soccer Fields back to back = Ship's Deck Area</p> <p>50 million ltrs. Water /hour to be used for cooling LNG</p>

First offshore liquefaction plant



# Oil and gas transportation in Croatia

## Oil pipeline (JANAF)

Trasa Route	Promjer Diameter (")	Duljina Length (km)
Omišalj-Sisak	36	180
Omišalj-Urinj	20	7,2
Sisak-Virje-Gola (hrvatsko-mađarska granica / Croatian-Hungarian border)	28	109
Virje-Lendava	12	73
Sisak-Slavonski Brod	28	156
Slavonski Brod - Bosanski Brod (BiH / Bosnia and Herzegovina)	26	13
Slavonski Brod-Sotin (hrvatsko-srpska granica / Croatian-Serbian border)	26	84

Izvor | Source: JANAF

## Gas pipelines

DN (mm)	800	700	600	500	450	400	350	300	250	200	150	<150	Ukupno Total
Duljina (km) Length (km)	81	53	175	862	95	126	62	525	76	165	337	105	2 662

Izvor | Source: PLINACRO

Transportni plinovodi Transportation gas pipelines	Međunarodni International	Magistralni Main transmission lines	Regionalni Regional	Spojni Local linking lines	Ukupno Total
Duljina (km) Length (km)	42	1 607	647	366	2 662

Izvor | Source: PLINACRO

# Primary energy production and consumption in Croatia

## Primary energy production

	2008.	2009.	2010.	2011.	2012.	2013.	2013./12.	2008.-13.
	PJ						%	
Ogrjevno drvo i biomasa Fuel Wood and Biomass	17,01	17,97	19,96	26,74	29,17	29,62	1,5	11,7
Sirova nafta Crude Oil	35,42	33,07	30,69	28,37	25,62	25,71	0,4	-6,2
Prirodni plin Natural Gas	94,05	93,50	93,88	85,02	69,19	63,11	-8,8	-7,7
Vodne snage Hydro Power	50,19	65,77	79,71	42,59	45,45	78,88	73,6	9,5
Toplinska energija Heat	1,25	1,48	1,76	1,68	1,71	1,74	1,5	6,8
Obnovljivi izvori Renewables	1,01	1,30	2,63	2,97	5,66	7,70	36,1	50,0
<b>UKUPNO TOTAL</b>	<b>198,93</b>	<b>213,09</b>	<b>228,62</b>	<b>187,36</b>	<b>176,79</b>	<b>206,76</b>	<b>17,0</b>	<b>0,8</b>

## Primary energy consumption

	2008.	2009.	2010.	2011.	2012.	2013.	2013./12.	2008.-13.
	PJ						%	
Ugljen i koks Coal and Coke	34,65	24,66	30,92	31,66	28,37	32,18	13,4	-1,5
Drvo i biomasa Biomass	13,80	14,42	16,05	19,23	20,88	19,84	-5,0	7,5
Tekuća goriva Liquid Fuels	180,15	178,04	152,54	149,30	134,17	128,37	-4,3	-6,6
Prirodni plin Natural Gas	110,22	102,15	111,37	108,60	101,78	95,54	-6,1	-2,8
Vodne snage Hydro Power	50,19	65,77	79,71	42,59	45,45	78,88	73,6	9,5
Električna energija Electricity	23,68	20,46	17,15	27,71	27,46	16,17	-41,1	-7,3
Toplinska energija Heat	1,25	1,48	1,76	1,68	1,71	1,74	1,5	6,8
Obnovljivi izvori Renewables	0,95	1,39	2,24	2,83	5,72	7,80	36,4	52,3
<b>UKUPNO TOTAL</b>	<b>414,90</b>	<b>408,37</b>	<b>411,73</b>	<b>383,59</b>	<b>365,54</b>	<b>380,51</b>	<b>4,1</b>	<b>-1,7</b>

**Thank you!**