



# International Gas Union WOC-2, Study Group 2.3

## ACHIEVEMENTS AND MODERN TENDENCIES IN THE FIELD OF UNDERGROUND GAS STORAGE SAFETY AND ECOLOGICAL STABILITY

*Dr. Gretta Akopova*  
*Dr. Sergei Khan,*  
*Dr. Nadezhda Vlasenko*

23<sup>rd</sup> World Gas Conference  
Amsterdam, 5-9 June, 2006



**Report of the International Gas Union  
WOC-2 (Underground Gas Storage)  
Study Group 2.3, Triennium 2003 - 2006**



# Table of contents

Enhancement  
of UGS  
Environmental  
Stability

Status of environmental regulations.  
What bodies regulate and monitor the environment?

Technologies and methods to reduce the impact of hazardous  
factors on the environment (UGS only)

Technologies and methods to reduce the impact of physical, mechanical  
and other factors on the environment (UGS only)

Enhancement of environmental reliability of UGS operation

Atmospheric air pollution, methods and means of control

Regulations for sewage water, brine, wastes of production  
and consumption

Norms of natural gas leakages from equipment

Norms of emissions from fuel-consuming facilities and control devices

Ecological, sanitary and other norms for pollutants monitoring  
at environmental objects

Miscellaneous: what reserves and means of enhancing  
UGS environmental reliability do companies possess, et ctr.)



# Objective

- creation of a “good ecological potential” for efficient exploitation of UGS facilities

## Tasks:

- retrieval and analysis of information aimed at ensuring of rational exploitation of UGS facilities;
- definition of normative and legal UGS exploitation support levels (legal and normative environmental protection documents);
- list of best technologies and means for creation of ecological stability in UGS operation;
- development of proposals and recommendations for enhancement of UGS environmental stability;
- determination of trends allowing companies to enhance the UGS operation efficiency

## Method of study:

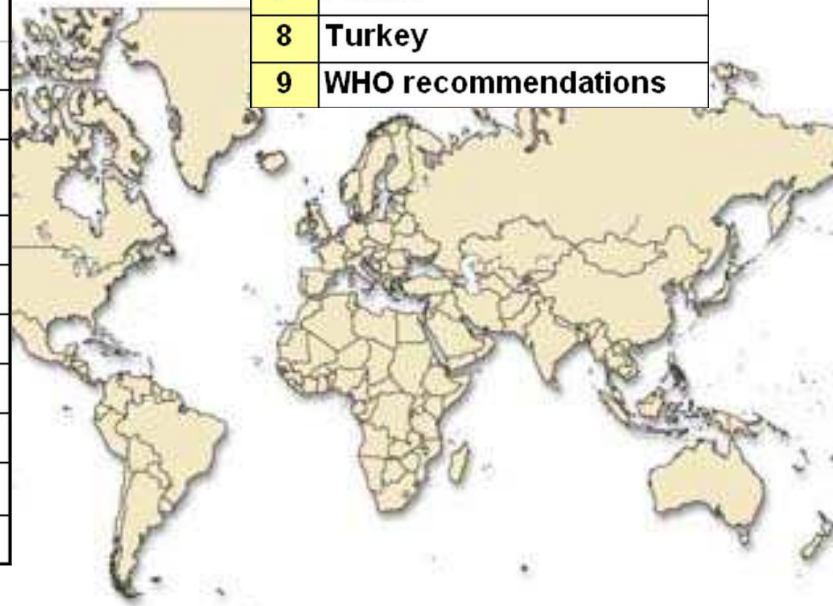
- search and analysis of information for database creation on technologies, methods and means of enhancement of UGS environmental stability.



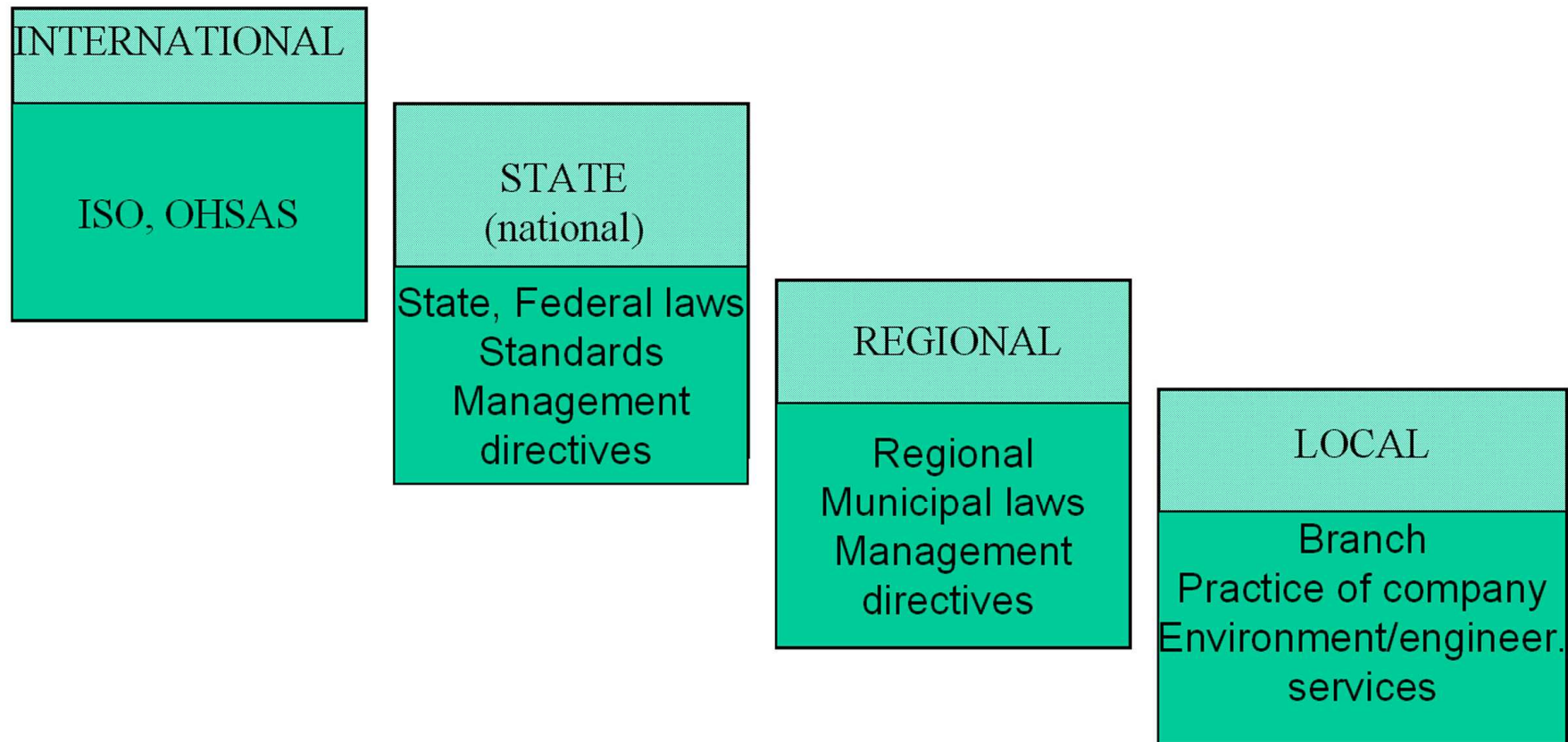
# List of countries which have conducted studies of the questionnaire «Enhancement of UGS environmental stability»

Data of surveys under the questionnaire			
No	Country	No of surv.	Company
1	Argentina	1	Repsol YPF
2	Croatia	1	INA-NAFTAPLIN
3	Czech Republic	1	RWE-Transgas Net,
4	Denmark	1	DONG
5	France	1	Gaz de France
6	Germany	3	VNG-VerbundnetzGas BEB Transport WINGAS GmbH
7	Italy	1	STOGIT S.p.A.
8	Japan	1 & addition	TEIKOKU OIL CO
9	Netherlands	1	Shell EPE
10	Romania	1	S.N.G.N. ROMGAZ S.A.
11	Russia	1	GAZPROM (VNIIGAZ)
12	Sweden	1	Sydskraft Gas AB
13	Spain	1	ENAGAS
14	Ukraine	1	UkrNIIGAZ
15	USA	3	DTE Energy

From other sources	
No	Country
1	Croatia
2	Czechia
3	Germany
4	Hungary
5	Netherlands
6	Norway
7	Poland
8	Turkey
9	WHO recommendations

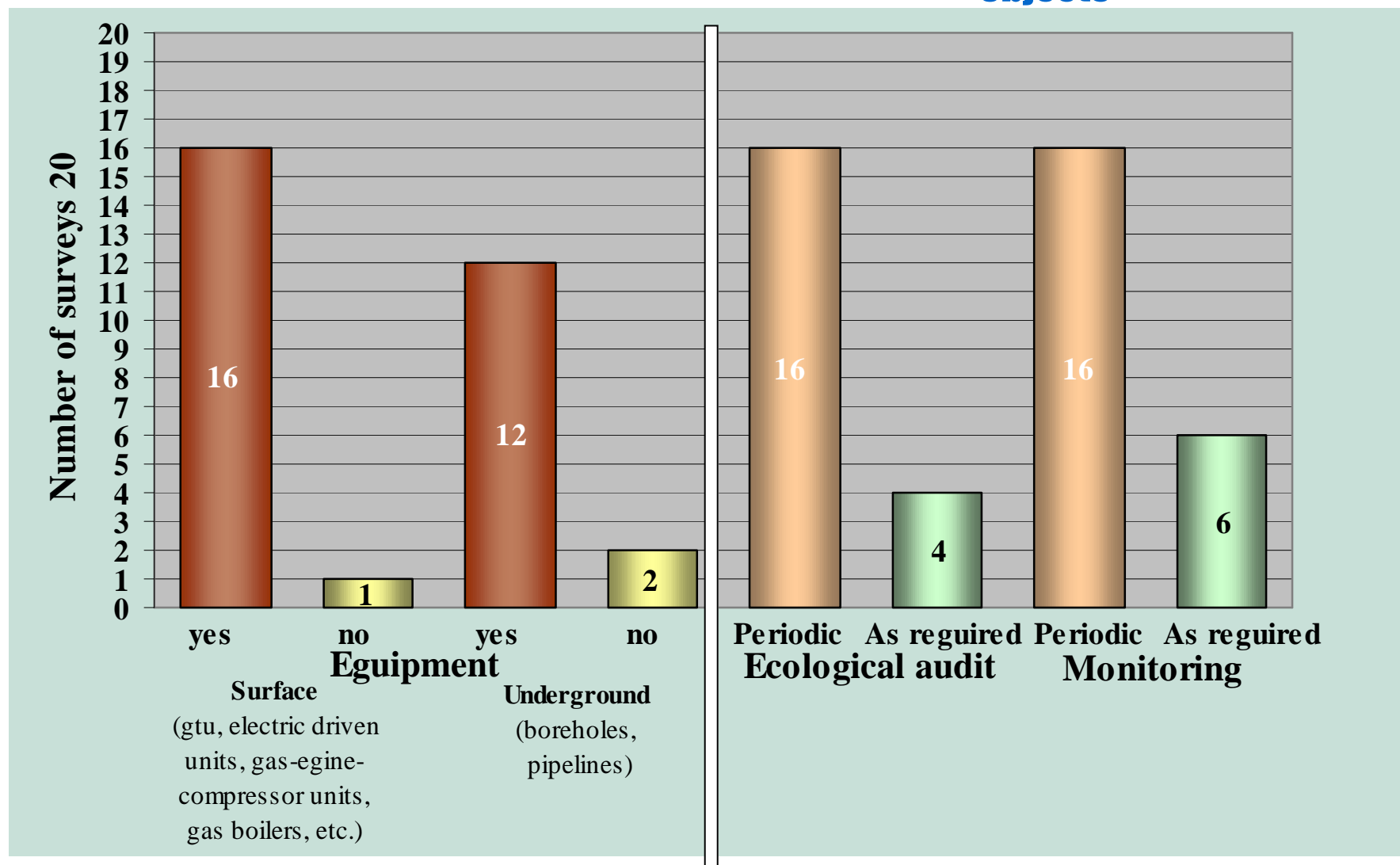


# Institute on legislative environmental activity of UGS



## Ecological standards for UGS equipment

## Frequency of conducting ecological audit and monitoring of processing facilities emissions and environmental objects



# Technologies and methods to reduce the impact of hazardous factors on the environment

Technology	Assessment (by five point mark)			
	Past	Present	Future	Average
Reduction of vented gas	4,7	5,0	5,0	4,90
Reduction of flared gas	4,7	4,7	4,7	4,70
Reduction of effluents	4,7	4,7	4,7	4,70
Water disposal	4,3	4,3	4,3	4,30
Noise reduction	3,4	3,4	3,4	3,40
UGS territory arrangement	2,6	3,0	3,2	2,93
Methods and means of reduction of physical and mechanical factors	2,8	2,6	2,8	2,73
Effluents and emissions measuring procedures	2,2	2,2	2,33	2,24
Technology and methods of natural gas burning	2,2	2,2	2,2	2,20
Reduction of emissions	2,0	2,2	2,0	2,06
Closed cycled systems	1,2	1,2	3,3	1,90



# Has the company received (or will receive) any economic benefits after improving environmental situation at UGS?

Improving of an ecological situation has direct or indirect influence on economic efficiency of UGS facilities in the following directions:

- Development of legislative and normative-methodical basis on the environmental protection and technological aspects;
- Capitalization increasing (equity value, information receiving);
- Yield increasing (reduction of payments);
- More precise calculations of pollutants concentration ( $\text{NO}_x$ ,  $\text{CH}_4$ ) and the sizes of a sanitary-protective area of facility;
- Creation of modern UGS facility image



# Atmospheric air pollution, methods and means of control

Monitoring of pollutants in the atmospheric air		Technical means of control			Systems for continuous monitoring CO, CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> , etc.
Industrial zones (working area)	Outside the industrial zone (settlement)	Stationary	Mobile	Remote	
When legal requirements; Facility's rules; -Continuous measurement at emission sources (chimney and heaters); - Stack testing of emissions and air modeling; - Gas detectors; - Gas analyzers; - CEMS	Air quality control and air modeling - Gas analyzers; - CEMS	Legal requirements; By facility's rules; -Continuous; -Oxidation catalysts; -Low emission; -Combustion/oxidation; -Catalyst/thermal; (WINTERGAZ type, ASH type); - Cleaner burning engines;	When legal requirements; By facility's rules; -Measurements 1 per year; -SEWERIN type Chemiluminescent gas analyzers	In future	When legal requirements; CO, CO <sub>2</sub> , NO <sub>x</sub> , SO <sub>2</sub> CEMS



# Norms of natural gas leakages from equipment

Equipment	mg/sec
(experimental data)	- Less then 1,5 % of all connections With diffuse emission measurements;
locking and regulating reinforcement	1,83 - 5,83
flange connections	0,08 - 0,20
safety valves	24,45 – 37,78
compressors shaft sealing	31,95 – 33,34
pump gland sealing	38,89



# Norms for emissions from fuel consuming equipment according to surveys

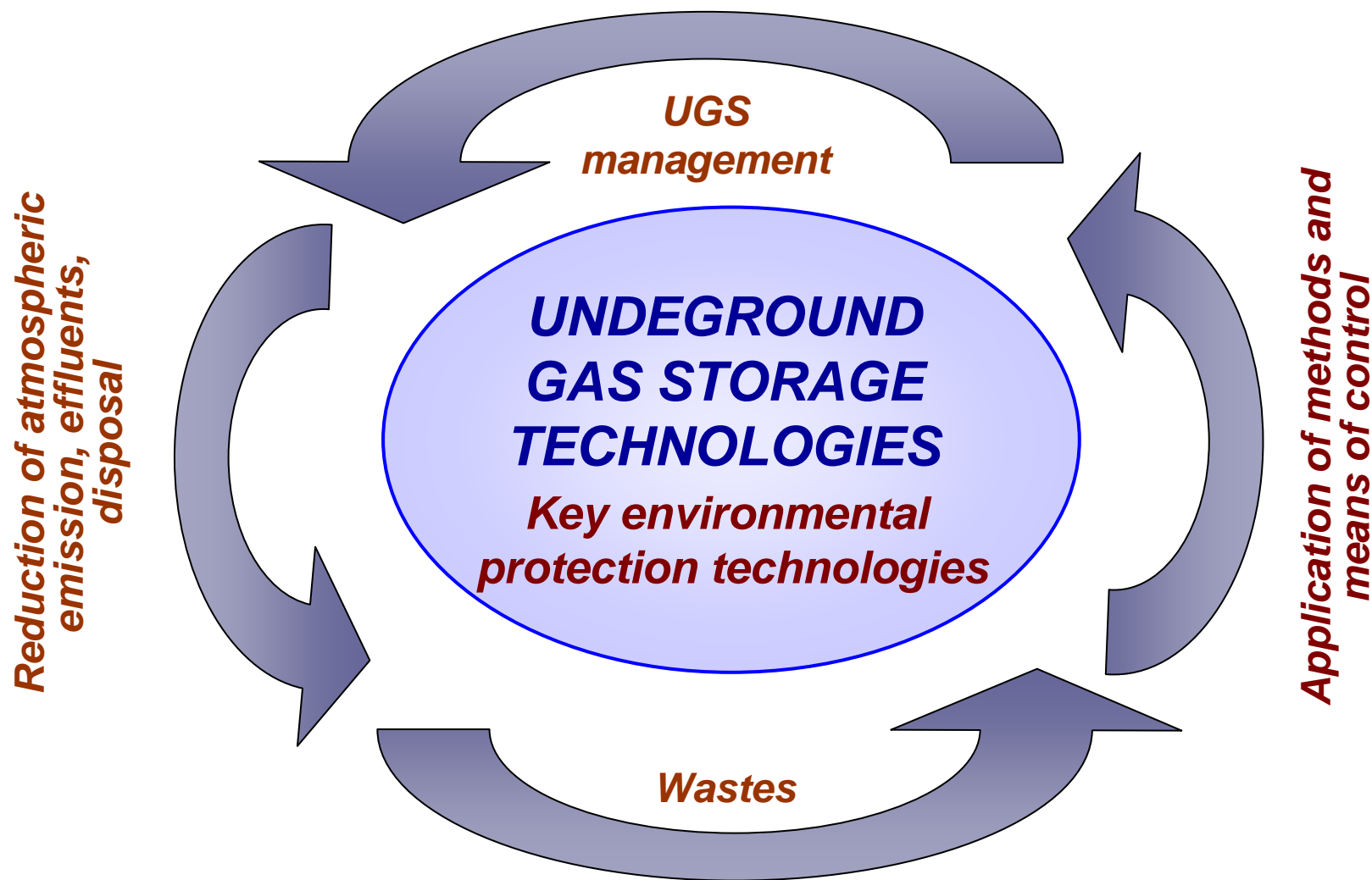
- 1. Gas turbine units** with indicated capacity in the range 2.6-30 MW:  
emissions of **nitrogen oxides** vary in great limits – from 20 to 500 mg/m<sup>3</sup>;  
emissions of **carbon oxide** – from 25 to 470 mg/m<sup>3</sup>
- 2. Gas Engine Compressor** with capacity from 0.7 to 5.5 MW:  
emissions of **nitrogen oxides** – 460-3500 mg/m<sup>3</sup>  
emissions of **carbon oxide** – 200 – 2000 mg/m<sup>3</sup>
- 3. Boiler units** with capacity from 0.12 to 10 MW:  
emissions of **nitrogen oxides** – from 42 to 785 mg/m<sup>3</sup>  
emissions of **carbon oxide** – 58 – 100 mg/m<sup>3</sup>
- 4. Fire vaporizers:** emissions of **nitrogen oxides**  
**58 – 200 mg/m<sup>3</sup>**  
emissions of **carbon oxide** - 75 mg/m<sup>3</sup>
- 5. Flares** with capacity 1 MW: emissions of **nitrogen oxides** - **1940 mg/m<sup>3</sup>**



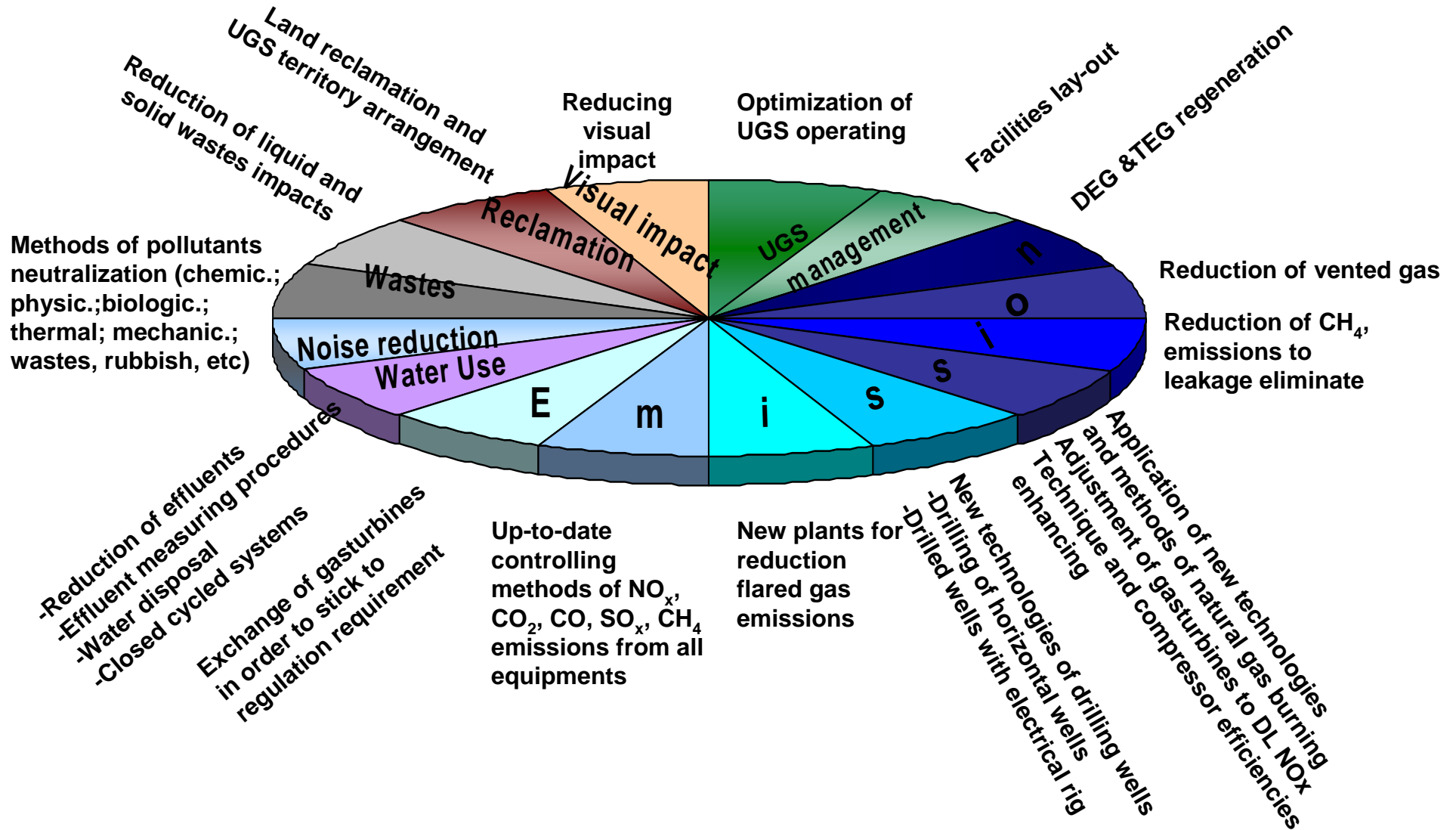
# Do you apply charges (tariffs) for NO<sub>x</sub>, CO, CO<sub>2</sub>, SO<sub>2</sub> emissions?

Country	Matter, euro per one tone				
	NO <sub>2</sub>	CO	CO <sub>2</sub>	SO <sub>2</sub>	CH <sub>4</sub>
Croatia	25,6 X (192 kn/t + corrective factor)			25,6 X (192 kn/t + corrective factor)	
Denmark			0,03 (tax: 0,2 DKK/m <sup>3</sup> X1960)		0,3 (2,04 DKK/m <sup>3</sup> )
France	45 (not for all sites)		Directive quotas CO <sub>2</sub> since 01/01/05	38 (not for all sites)	
Germany			No or a little bit. But more, in case we consume more than in the past. Then we have to buy certificates		
Russia	1,8 (62,4 ruble)	0,02 (0,7 rubl.)	No	1,4 (48 ruble)	1,4
Ukraine	12,7 (80 grn.)	0,5 (3 grn.)		12,7 (80 grn.)	0,5
USA	NO <sub>x</sub> 28 (35 \$)			28 (35 \$)	

# The main trends of environment protection technologies development



# The most important technologies and methods of enhancing UGS environmental stability



# Conclusions

The carried out analysis of legislative base, normative materials and technical decisions can be named comprehensive. The obtained result can be considered representative both by the number of respondents taking part in study and by geographical coverage of the world's countries operating UGS in gas industry.

The analysis data show the similarity of approach to environmental protection in different countries.

This systematized technologies set or separate technologies can successfully be applied on UGS in the further prospect. Technologies allow supporting the status of underground gas storages as the most reliable in the world.

The companies follow to the specified technical and environmental protection norms during all UGS life cycle, in spite of their distinctions in the different countries.



# What resume and guidance to action on the enhancement of the UGS ecological stability does the world community receive according to the study?

Following to key technological decisions results to:

- Reduction of emissions, effluence, waste of production and consumption
- Enhancing of ecological safety
- Ecologically focused technologies
- Extension to sustainable development of underground gas storages
- Further development of research in lines of energy- and resource-efficient and environmental protection in the next WOC triennium

internet: [www.vniigaz.ru](http://www.vniigaz.ru)

e-mail: [vniigaz@vniigaz.gazprom.ru](mailto:vniigaz@vniigaz.gazprom.ru)

phone: (+7 495) 355-92-06