METHANE EMISSIONS ALONG THE GAS VALUE CHAIN

GREENHOUSE GASES

«CARBON FOOTPRINT» OF GAS INDUSTRY
METHANE EMISSIONS REGULATION IN RUSSIA

Greenhouse Gas

Toxic Gas

FEE ➔ KPI (Reduction in GHG Intensity CO$_2$-eq, %)

Methane emissions (thousand tonnes)

Environmental Report 97

Methane emissions to air (thousand tonnes)

The Power Within

Methane emissions, thousand tonnes

1,338.2

2016
STATE SYSTEM

PERMITTING

LIMITATIONS OF EMISSIONS FOR EVERY FACILITY BY STATE BODIES

Official reporting

FEE COLLECTION

5% FEDERAL BUDGET

40% REGIONAL BUDGET

55% MUNICIPAL BUDGET

SUPERVISION

ENVIRONMENTAL AND TAX AUTHORITIES
(EMISSIONS MONITORING AND PAYMENT CONTROL)

Source: Rosstat, 2016

State Environmental bulletins
http://www.gks.ru/wps/wcm/connect/rosstat_main/rosstat/ru/statistics/publications/catalog/5e9010042b5cc99b49bf307f3a3f8
METHANE EMISSIONS DETECTION, MEASUREMENT AND ELIMINATION

CONTINUOUS MONITORING OF NATURAL GAS CONCENTRATION ON COMPRESSOR STATIONS BY LASER TECHNOLOGIES

DISTANT PERIODIC MONITORING OF METHANE EMISSIONS WITH TOTAL QUANTITATIVE ASSESSMENT

LOCALIZATION OF LEAKAGES BY PORTABLE INSTRUMENTS

PERIODIC MONITORING OF NATURAL GAS EMISSIONS ON COMPRESSOR STATIONS BY HAND-HELD CONTROL DEVICES

INSPECTION

DISCOVERED LEAKAGE ELIMINATION
- Replacement of leaky facilities
- Bandaging
- Sealing of shut-off valves
### EVALUATING METHANE EMISSIONS AT GAZPROM FACILITIES WITH FOREIGN PARTNERS

<table>
<thead>
<tr>
<th>YEAR</th>
<th>PARTNERS</th>
<th>SUBJECT OF INVESTIGATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>1995</td>
<td>US EPA</td>
<td>1 compressor station; 1 compressor shop</td>
</tr>
<tr>
<td>1996-1997</td>
<td>Ruhrgas (Open Grid Europe)</td>
<td>3 complex gas treatment plants; 2 well clusters; 3 compressor stations; 6 compressor shops; 5,000 km of linear routes of mains</td>
</tr>
<tr>
<td>2002-2003</td>
<td>Ruhrgas (Open Grid Europe), Wuppertal Institute for Climate, Environment and Energy, Max Planck Institute for Chemistry</td>
<td>5 compressor stations; 10 compressor shops; 4,000 km of linear routes of mains</td>
</tr>
<tr>
<td>2004-2005</td>
<td>Sumitomo Corporation, Agra</td>
<td>1 compressor station; 3 compressor shops; 750 km of linear routes of mains; 5 pipeline branches; 5 gas distribution stations</td>
</tr>
<tr>
<td>2006, 2008</td>
<td>Sojitz Corporation</td>
<td>2 compressor stations; 4 compressor shops; 600 km of linear routes of mains; 100 valve nodes; 80 valve nodes of pipeline branches; 32 gas distribution stations, 4 gas measuring stations</td>
</tr>
<tr>
<td>2010</td>
<td>Global methane initiative, US EPA</td>
<td>162 km of gas main pipeline; 2 compressor shops; 41 valve nodes</td>
</tr>
<tr>
<td>2011</td>
<td>GDF-SUEZ (ENGIE)</td>
<td>1 compressor shop; 2 junction points</td>
</tr>
<tr>
<td>2013</td>
<td>Gasunie</td>
<td>1 shop; 10 valve nodes</td>
</tr>
</tbody>
</table>
Modern methods of determining the age and the source of methane (CH$_4$) are based on the registration of stable isotopes carbon-12 and carbon-13 and its natural ratio 98.92% and 1.08%.

Siberian gas fields have isotope ratio, which is would be unlikely to produce the shift observed Russian natural gas is not the source of methane growth in the atmosphere

Isotopic studies indicate that the methane rise is a result of increased emissions from biogenic sources, e.g., extension of wetland and expansion in the number of methane emissions sources in agriculture: ruminants and rice fields

https://www.repository.cam.ac.uk/bitstream/handle/1810/261156/Nisbet_et_al-2016-Global_Biogeochemical_Cycles-VoR.pdf?sequence=1&isAllowed=y

Taking samples: US National Oceanic and Atmospheric Administration (NOAA)
Isotopic analysis: Institute of Arctic and Alpine Research, Royal Holloway, University of London, University of Heidelberg
CHANGE OF EMISSIONS FACTORS
(from developing country to developed country)

Emissions calculation in inventories: scope of activity * emission factors (IPCC or national)

Russian GHG Inventory Submissions

national emission factors = further decrease of figures

- 53.7%
## IPCC Emission Factors

### Table 4.2.4

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-category</th>
<th>Emission source</th>
<th>IPCC Code</th>
<th>Value</th>
<th>Uncertainty (% of value)</th>
<th>CH$_4$</th>
<th>CO$_2$</th>
<th>Units of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas Production</strong></td>
<td>All</td>
<td>Fugitives</td>
<td>1.B.2.b.ii.2</td>
<td>3.8E-04 to 2.3E-03</td>
<td>±100%</td>
<td>1.4E-05 to 8.2E-05</td>
<td>±100%</td>
<td>Gg per 10$^6$ m$^3$ gas production</td>
</tr>
<tr>
<td></td>
<td>Flaring*</td>
<td>1.B.2.b.ii</td>
<td>7.6E-07</td>
<td>±25%</td>
<td>1.2E-03</td>
<td>1.2E-03</td>
<td>±25%</td>
<td>Gg per 10$^6$ m$^3$ gas production</td>
</tr>
<tr>
<td><strong>Sweet Gas Plants</strong></td>
<td>Fugitives</td>
<td>1.B.2.b.ii.3</td>
<td>4.8E-04 to 1.0E-04</td>
<td>±100%</td>
<td>1.5E-04 to 3.5E-04</td>
<td>±100%</td>
<td>Gg per 10$^6$ m$^3$ raw gas feed</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Flaring</td>
<td>1.B.2.b.ii</td>
<td>1.2E-06</td>
<td>±25%</td>
<td>1.8E-03</td>
<td>1.8E-03</td>
<td>±25%</td>
<td>Gg per 10$^6$ m$^3$ raw gas feed</td>
</tr>
<tr>
<td><strong>Sour Gas Plants</strong></td>
<td>Fugitives</td>
<td>1.B.2.b.ii.3</td>
<td>9.7E-05</td>
<td>±100%</td>
<td>7.9E-06</td>
<td>7.9E-06</td>
<td>±100%</td>
<td>Gg per 10$^6$ m$^3$ raw gas feed</td>
</tr>
<tr>
<td></td>
<td>Flaring</td>
<td>1.B.2.b.ii</td>
<td>2.4E-06</td>
<td>±25%</td>
<td>3.6E-03</td>
<td>3.6E-03</td>
<td>±25%</td>
<td>Gg per 10$^6$ m$^3$ raw gas feed</td>
</tr>
<tr>
<td><strong>Raw CO$_2$ Venting</strong></td>
<td>1.B.2.b.i</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>6.3E-02</td>
<td>-10 to -100%</td>
<td>6.3E-02</td>
<td>Gg per 10$^6$ m$^3$ raw gas feed</td>
</tr>
<tr>
<td><strong>Transmission &amp; Storage</strong></td>
<td>Transmission</td>
<td>Fugitives</td>
<td>1.B.2.b.ii.4</td>
<td>6.6E-05 to 4.8E-04</td>
<td>±100%</td>
<td>8.8E-07 to 5.8E-07</td>
<td>±100%</td>
<td>Gg per 10$^6$ m$^2$ of marketable gas</td>
</tr>
<tr>
<td></td>
<td>Vented</td>
<td>1.B.2.b.i</td>
<td>4.4E-05 to 3.2E-04</td>
<td>±75%</td>
<td>3.1E-06</td>
<td>3.1E-06</td>
<td>±75%</td>
<td>Gg per 10$^6$ m$^2$ of marketable gas</td>
</tr>
<tr>
<td></td>
<td>Storage</td>
<td>1.B.2.b.ii</td>
<td>2.5E-05</td>
<td>-20 to -50%</td>
<td>1.1E-07</td>
<td>1.1E-07</td>
<td>-20 to -50%</td>
<td>Gg per 10$^6$ m$^2$ of marketable gas</td>
</tr>
</tbody>
</table>
## IPCC EMISSION FACTORS

### Table 4.2.5

**Tier 1 Emission Factors for Fugitive Emissions (including Venting and Flaring) from Oil and Gas Operations in Developing Countries and Countries with Economies in Transition**

<table>
<thead>
<tr>
<th>Category</th>
<th>Sub-category</th>
<th>Emission source</th>
<th>IPCC Code</th>
<th>$\text{CH}_4$</th>
<th>CO$_2$</th>
<th>Units of measure</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Value</td>
<td>Value</td>
<td>Value</td>
<td>Value</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Uncertainty (% of Value)</td>
<td>Uncertainty (% of Value)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gas Production</td>
<td>All</td>
<td>Fugitives$^4$</td>
<td>1.B.2.b.i.i.2</td>
<td>3.8E-04 to 2.4E-02</td>
<td>-40 to +250%</td>
<td>1.4E-05 to 1.8E-04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flaring$^4$</td>
<td>1.B.2.b.i.i</td>
<td>7.6E-07 to 1.0E-06</td>
<td>±75%</td>
<td>1.2E-03 to 1.6E-03</td>
</tr>
<tr>
<td>Gas Processing</td>
<td>Sweet Gas Plants</td>
<td>Fugitives$^4$</td>
<td>1.B.2.b.i.i.3</td>
<td>4.8E-04 to 1.1E-03</td>
<td>-40 to +250%</td>
<td>1.5E-04 to 3.5E-04</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flaring$^4$</td>
<td>1.B.2.b.i.i</td>
<td>1.2E-06 to 1.6E-06</td>
<td>±75%</td>
<td>1.8E-03 to 2.5E-03</td>
</tr>
<tr>
<td></td>
<td>Sour Gas Plants</td>
<td>Fugitives$^4$</td>
<td>1.B.2.b.i.i.3</td>
<td>9.7E-05 to 2.2E-04</td>
<td>-40 to +250%</td>
<td>7.9E-06 to 1.8E-05</td>
</tr>
<tr>
<td>Gas Transmission &amp; Storage</td>
<td>Transmission</td>
<td>Fugitives$^5$</td>
<td>1.B.2.b.i.i.4</td>
<td>16.6E-05 to 1.1E-03</td>
<td>-40 to +250%</td>
<td>8.8E-07 to 2.0E-06</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Venting$^5$</td>
<td>1.B.2.b.i</td>
<td>4.4E-05 to 7.4E-04</td>
<td>-40 to +250%</td>
<td>3.1E-06 to 7.3E-05</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Storage</td>
<td>1.B.2.b.i.i.4</td>
<td>2.3E-05 to 5.8E-05</td>
<td>-20 to +500%</td>
<td>1.1E-07 to 2.6E-07</td>
</tr>
</tbody>
</table>
The development of country-specific emission factors and parameters for greenhouse gas inventory in the Russian oil and gas sector was initiated under the support of

- Ministry of Energy of the Russian Federation (contract 16/0411.3070390019.241/02/170 of 21-09-2016)
- Federal Service for Hydrometeorology and Environment Monitoring of the Russian Federation
Data from oil and gas fields and infrastructure operated by main oil and gas companies were used.

CO₂ and CH₄ emission factors were developed for leakage and flaring of associated petrol gas and leakage on natural gas for their production and transport operations.

The representative average parameters for associated petrol and natural gas were developed along with the national emission factors.

The work was performed in accordance with general IPCC requirements and procedures [IPCC, 2006].
### COUNTRY-SPECIFIC EMISSION FACTORS DEVELOPED

<table>
<thead>
<tr>
<th>Emission category in gas sector</th>
<th>Emission type</th>
<th>Emission factor value and its uncertainty</th>
<th>Units</th>
</tr>
</thead>
<tbody>
<tr>
<td>NG production and processing (well testing and servicing is included)</td>
<td>Leakage and venting</td>
<td>$2.13 \times 10^{-4} \pm 50%$</td>
<td>$3.92 \times 10^{-6} \pm 50%$</td>
</tr>
<tr>
<td></td>
<td>Flaring</td>
<td>$1.12 \times 10^{-7} \pm 50%$</td>
<td>$1.95 \times 10^{-4} \pm 50%$</td>
</tr>
<tr>
<td>NG transport</td>
<td>Leakage and venting</td>
<td>$1.93 \times 10^{-3} \pm 50%$</td>
<td>$1.68 \times 10^{-5} \pm 50%$</td>
</tr>
<tr>
<td>NG underground storage</td>
<td>Leakage and venting</td>
<td>$3.73 \times 10^{-4} \pm 50%$</td>
<td>$2.11 \times 10^{-6} \pm 50%$</td>
</tr>
</tbody>
</table>

GHG inventory with national emissions factors enabled for:

- Enhancing accuracy of estimates of fugitive emissions;
- **First estimates** lower than those with IPCC defaults (left graphs) by:
  - 20.1 per cent for gas sector (top right graph);
  - 38.2 per cent for oil sector (bottom left graph)
- 4.8 times reduced national inventory uncertainty
CARBON FOOTPRINT OF NATURAL GAS CONSUMED IN CENTRAL EU

GHG INTENSITY STUDY ON NATURAL GAS

DELIVERY UPDATED BEST DATA TO PUBLIC

FINISHING VERIFICATION OF GAZPROM GHG EMISSIONS
THANK YOU FOR YOUR ATTENTION!

V INTERNATIONAL CONFERENCE
“ENVIRONMENTAL SAFETY IN THE GAS INDUSTRY”
Moscow, December 5-6, 2017
contact: M_Plotnikova@vniigaz.gazprom.ru