Greenhouse Gas Balance of Natural Gas: New Measurements For the Import Process Chain Of Russian Natural Gas to Europe

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Overview

- Background and Target of the Survey
- New Measurement Campaign
  - Field Measurements in Russia
  - Operational Data Obtained from Gazprom
- Overview over GHG emissions
- Actual and future development

Background of the Survey

- GHG emissions of the natural gas life cycle
  - Undoubted **advantages** in direct CO_2 emissions (low emission factor, high efficiency)
  - **Disadvantage**: CH_4 is a potent greenhouse gas
    --> Leakages along the process chain may lead directly to significant GHG emissions
- Discussion emerged:
  Is switch to natural gas a climate mitigation option?
  - Lignite based East German energy system came under pressure by gas fired CHP
  - Some studies stating extreme emissions of Russian gas export system are in the public debate in Germany
  - Other countries have comparable debates (E.g. Belgium)

Measurements (2003) at the Russian Natural Gas Export System

Measurements of CH_4 Emissions in Russia

- Earlier measurements in Russia
  - 1996/97 by Gazprom&Ruhrgas; 1995 by Gazprom&US EPA (not published)
  - Critics on representativeness, transparency and, on uncertainty ranges
  - Made by gas industry without independent know-how
- New measurements and analyses were made in 2003 and 2004
  - On behalf of Gazprom and E.ON Ruhrgas
  - By Wuppertal Institute together with Max Planck Institute, Mainz and VNIIGAZ Institute, Moscow
  - According to international standards for greenhouse gas inventories (US EPA, IPCC)
  - With bigger sample size and more representative
  - Transparently documented

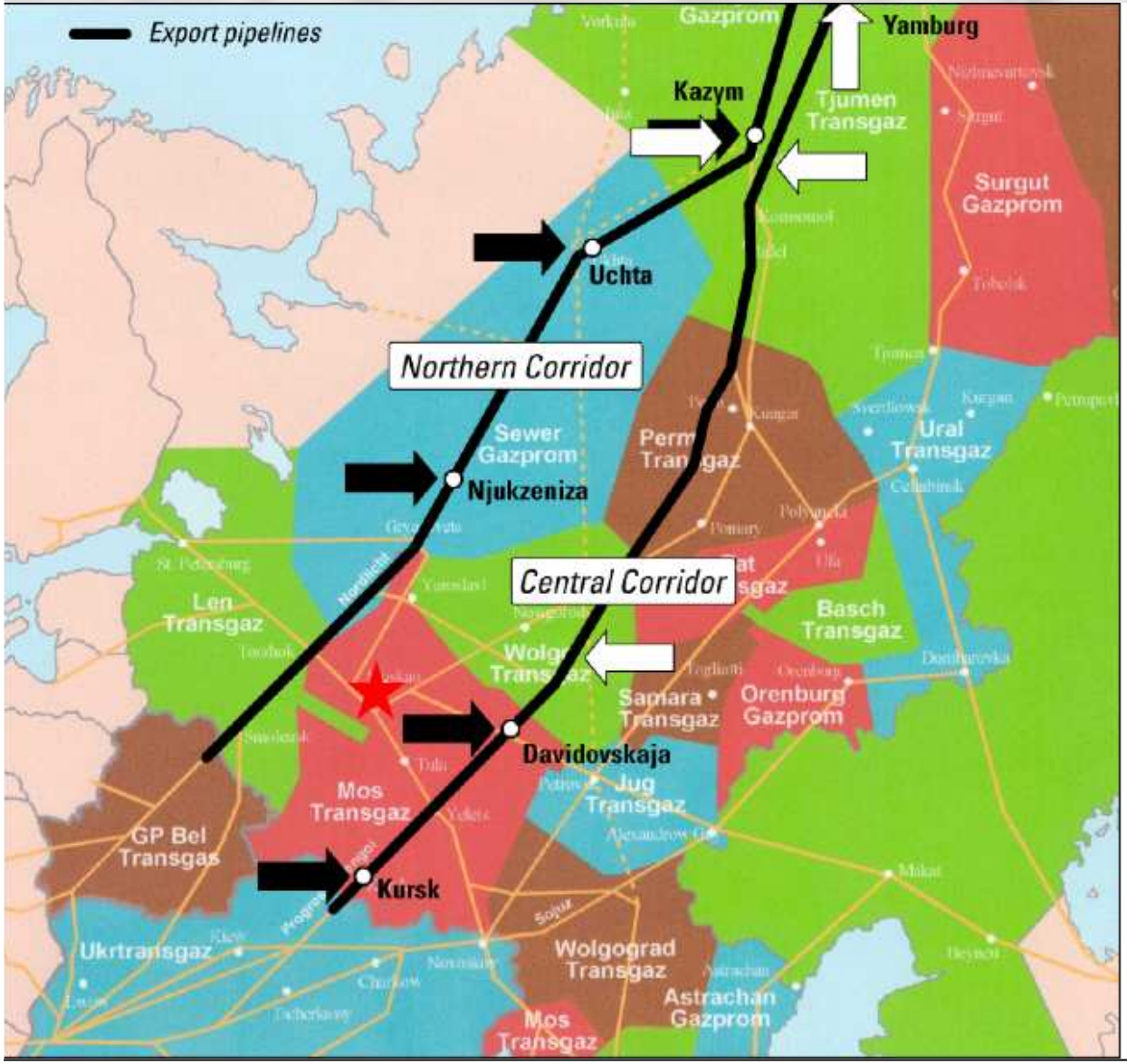
Focus: Export corridors as most relevant part of the gas transmission system

- The long distance transport system:
  - 153 000 km pipelines
  - 324 compressor stations
  - 4 000 compressors with 41 000 MW installed
- Export pipeline corridors:

Corridor	Length in Russia	Pipeline installed	Compressor stations	MW Installed (% of total)
Northern	3 075 km	12 000 km	23	5 442 MW (13%)
Central	3 376 km	22 000 km	30	14 544 MW (35%)
Survey	*>600 km*	*2 380 km*	*5*	*540 MW (1,3%)*

- Representative sample of sizes and ages of machines /pipelines covered

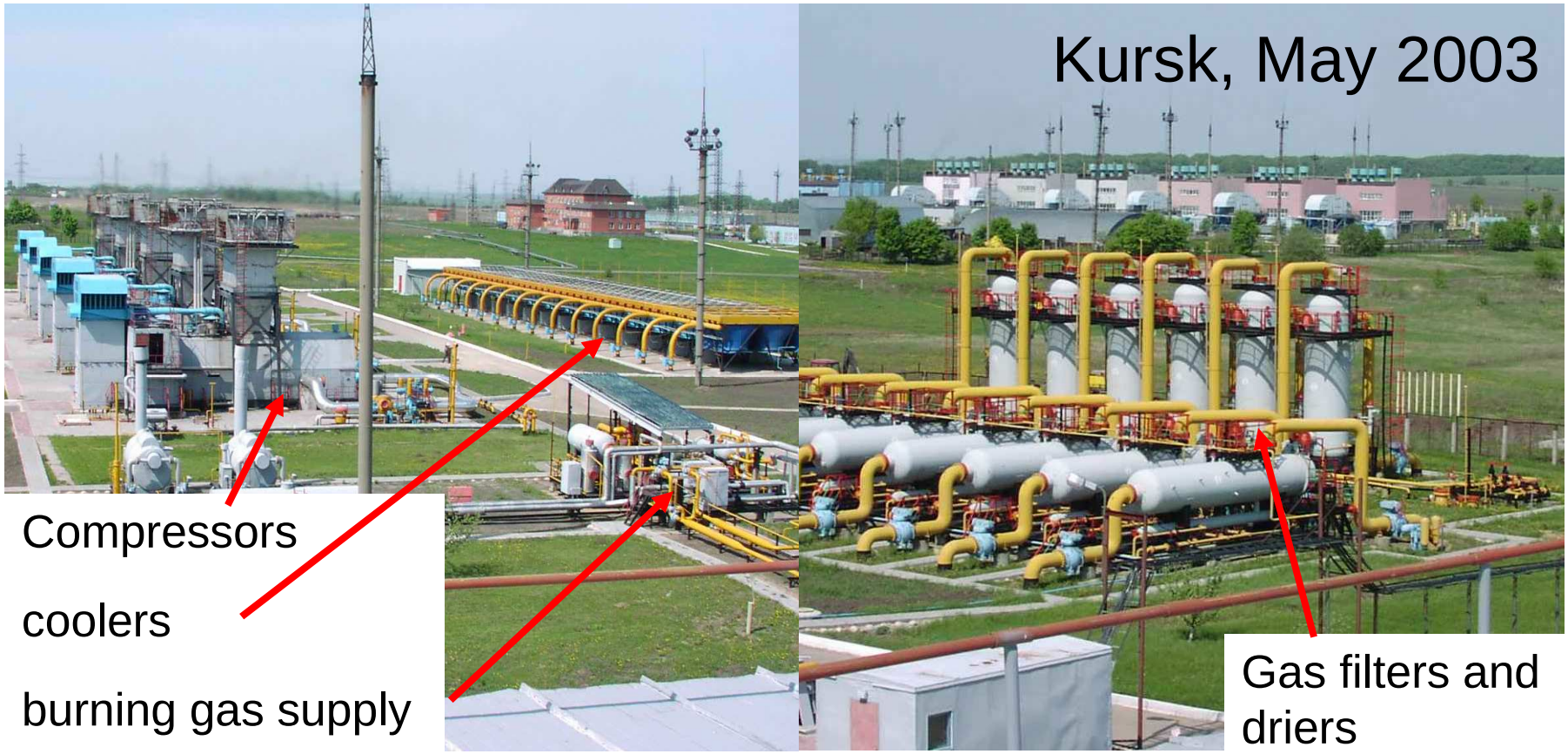
Russian Gas Export Mains and Location of Measurements



Measurements 1996 / 97
Ruhrgas AG and Gazprom
- 2 compressor stations
- 1 pipeline section
- Production and processing at Yamburg

Measurements 2003
Wuppertal Institute and Max-Planck-Institute
- 5 compressor stations
- 2380 km of pipelines

Measurements at all potentially emitting component of the compressor stations



And at the Pipeline routes

- 25 valve nodes in the pipelines were investigated
- Approx. 2 380 km of pipeline surveyed by helicopter overflight


Davidovskaya, May 2003


Kazym, October 2003

The Measurements

Coverage:

- unplanned emissions (leakages) and
- planned releases (from machine vents, fuel gas plants, compressor seal oil system)

Programme on site:

- **Step 1:**
  Screening and identification of elevated methane levels (leaks)
- **Step 2:**
  Measuring of places with significant concentration
- **Integrated quality mangement**

Step 1: Screening of complete shops & pipeline intersections

Screening of fittings at seperator

Screening at pipeline intersection

Screening of Pipelines by Helicopter and Laser Detector

Detector indication on paper strip

Laser detector

Step 2: Measuring

- Valves & flanges via flux method
- Vents direct volumetric

Measurements at Vent Stacks:

Njukzeniza
June 2003

Davidovskaja, May 2003

Quality Assurance & Quality Control

- **Standardised measurements**
- **Documentation**:
  - ***Before:*** **Project manual** (agreed standards; procedures; regulations) as guideline for measurement teams
  - ***During:*** **Day logs** (measurement; site; team; number; method; meter; temperature, wind, air pressure, results)
  - ***After:*** **Technical report** prepared **at every station** and signed by all partners
- **Independent monitoring** of measurements by expert of MPI
- **Database** with all measurements **completed on-site**
  - Direct on-site check
  - Check of subsequent statistical analyses for completeness and errors
- **Archiving** of all relevant documents at WI

Operational Data

Obtained from Gazprom/VNIIGAZ for extrapolation of results

- Comprehensive data set of both export corridors was provided
  - To determine all operation related emissions and
  - Emissions due to breakdowns
- Detailed information given for every machine hall & pipeline section of both corridors (machines, running hours, fuel gas usage, maintenance, etc.)
- Parallel collection of data at 5 surveyed stations to complete and verify given data

⇒ **Typical emission factors for all operation related emissions could be calculated**

⇒ **Measured emissions could be extrapolated**

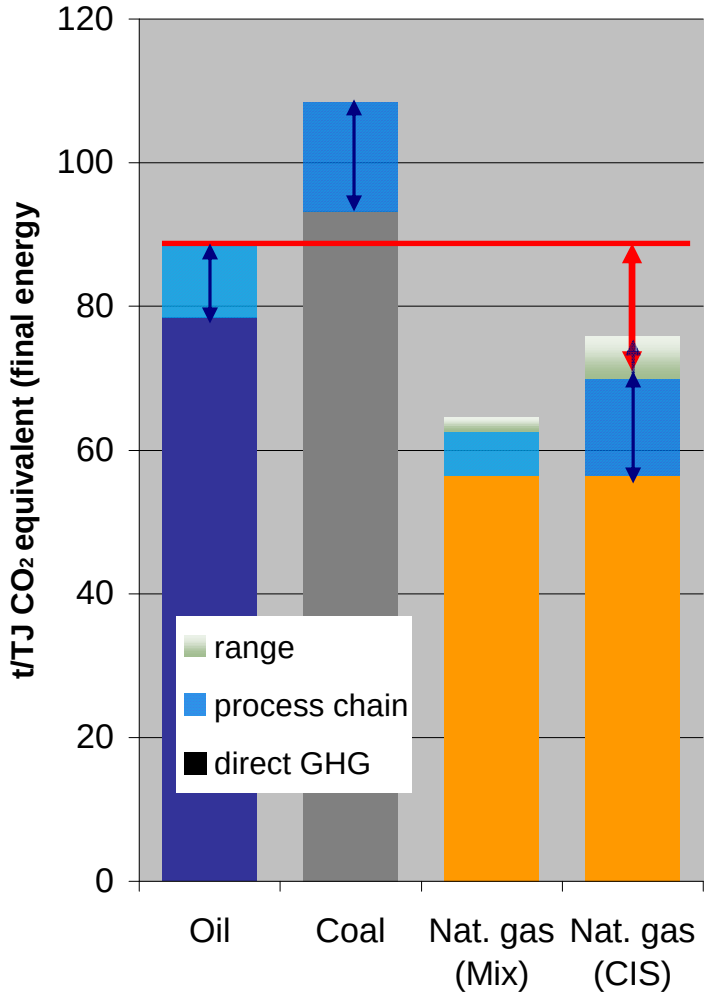
Results

Results (full process chain including production&processing)

- **Approx. 1 % of natural gas is emitted** (from production site in Yamburg to German border) (range: 0.6 to 2.4 %)
- **Two third** of GHG result from **transport energy** demand (CO_2)
- **Main sources** for CH_4-emissions:
  - Leakages at machines
  - CH_4-emissions at production and processing
  - Repairs and maintenance works at pipelines and stations
  - Breakdowns and leakages at pipelines are less than 2 % of total GHG emission
- A first **extrapolation** of our results to the complete Russian natural gas industry shows an emission range comparable to the US situation
  - Russia: 1.4 % losses (Range: 1.0 – 2.5 %) / USA: 1.5 % (1.0 – 2.0 %)
  - Russia benefits from a younger system and bigger size of wells, pipelines etc.

Resulting GHG emission balance of natural gas (for the German market)

- Indirect GHG emissions of natural gas are comparable to those of competing energy carriers
- Total GHG emissions of 100% Russian natural gas used in Germany are about 18% better than those of oil (final energy)
- This balance is even improved when higher efficiency of gas fired appliances are taken into account



Future challenges

- Huge potentials for GHG emission reduction remain (despite the efforts already made by Gazprom)
  - In existing infrastructure (CH_4-loss reduction & energy saving)
  - Re- and new investment (fields and pipelines) offers huge potential for introduction of low emission equipment
- Potential threats (that might increase emissions in the future):
  - Ageing of pipelines and equipment
  - The decline of existing fields and the development of new gas fields under more severe conditions
- **The favourable current GHG emission situation could be even improved but there are also challenges**

Conclusion

- Natural gas is the **fossil** fuel with the lowest greenhouse gas emissions by far
- Natural gas is a readily available option for reducing greenhouse gas emissions
- It can supplement the climate mitigation policy of substantially increasing energy efficiency and switching to renewable energy sources
- However, challenges remain to gas industry
  - In order to maintain this position and
  - To further improve the process chain emissions
- Industry can meet the challenges
  - By emphazising GHG mitigation in investment and operation
  - By conducting mitigation projects e.g. as Joint Implementation projects

We would like to thank all colleagues from E.ON Ruhrgas, Gazprom, VNIIGaz-Institute, Max-Planck Institute, Mostransgaz, Severgazprom and Tjumentransgaz and from the five compressor stations for their support with organization and conduction of the measurements. Without their great commitment the measurement campaign presented here would not have been possible.

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Thank you for your attention!

Further Information:

www.wupperinst.org

Download of the report:

www.wupperinst.org/download/1203-report-en

Available also in Russian and German language.

The new quality of our results:

- **More extensive and representative measurements than before**
  - Conducted by **independent** scientific institutes
  - Measurements based on **internationally accepted methods** (according to international standards of IPCC / US EPA)
  - With integrated **quality assurance**
  - **Transparency** of calculation and results
- **Transparent extrapolation**
  - Based on detailed Gazprom data on machines and equipment
  - Extrapolation by type of device (according to US-methodology)
  - Error analysis by Monte Carlo Model (defining confidence intervals)
- **Results based on representative measurements and surveys**