The Energy Complex: Technology, Innovation and Sustainability in Large Firms

Linkages between Actors in the Innovation System
Extended Workshop

June 14, 2012
Moscow

Thomas Gstraunthaler
Vitaly Lavrov
Elena Vetchinkina
### 10 largest Russian companies by net profit, 2010

<table>
<thead>
<tr>
<th>Ranking by indicator</th>
<th>Ranking in «Finance-500»</th>
<th>Company</th>
<th>Net profit in 2009, bln RUB</th>
<th>Dynamics, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>Gazprom</td>
<td>779,585</td>
<td>+5</td>
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<tr>
<td>2</td>
<td>2</td>
<td>Lukoil</td>
<td>222,411</td>
<td>-2</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>Rosneft</td>
<td>206,644</td>
<td>-25</td>
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<tr>
<td>4</td>
<td>5</td>
<td>TNK-BP International</td>
<td>157,759</td>
<td>+20</td>
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<tr>
<td>5</td>
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<td>Russian Railways</td>
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<tr>
<td>7</td>
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<td>Surgutneftegaz</td>
<td>113,874</td>
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<td>8</td>
<td>14</td>
<td>Norilsky Nickel</td>
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<tr>
<td>9</td>
<td>11</td>
<td>Tatneft</td>
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<tr>
<td>10</td>
<td>28</td>
<td>Megafon</td>
<td>45,289</td>
<td>+5</td>
</tr>
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</table>

Source: [http://www.finansmag.ru/96286](http://www.finansmag.ru/96286)
## Innovation activity in Russian extractive industry (1)

### Innovation activity of Russian organizations, mining operations, 2003-2009

<table>
<thead>
<tr>
<th></th>
<th>Share of organizations, performing innovation activity in the total no. of organizations, %</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>2003</td>
</tr>
<tr>
<td><strong>Total for the economy</strong></td>
<td>10,3</td>
</tr>
<tr>
<td><strong>Mining operations</strong></td>
<td></td>
</tr>
<tr>
<td>Extractions of fuel and energy natural resources</td>
<td>5,7</td>
</tr>
<tr>
<td>Extraction of natural resources, other than fuel and energy</td>
<td>7,3</td>
</tr>
<tr>
<td></td>
<td>4,5</td>
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</table>
## Volume of dispatched innovative goods, works and services, Mining operations, 2003-2009

<table>
<thead>
<tr>
<th></th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
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<tr>
<td><strong>Million rubbles</strong></td>
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<tr>
<td><strong>Total for the economy</strong></td>
<td>312692,0</td>
<td>433003,5</td>
<td>545540,0</td>
<td>714024,6</td>
<td>916131,6</td>
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<tr>
<td><strong>Mining operations</strong></td>
<td>67259,3</td>
<td>83763,1</td>
<td>81199,0</td>
<td>90969,2</td>
<td>110950,2</td>
<td>133553,9</td>
<td>122998,3</td>
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<tr>
<td><strong>Extractions of fuel and energy natural resources</strong></td>
<td>61296,7</td>
<td>82438,7</td>
<td>75521,7</td>
<td>85304,8</td>
<td>103476,6</td>
<td>109627,6</td>
<td>111636,8</td>
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<tr>
<td><strong>Extraction of natural resources, other than fuel and energy</strong></td>
<td>5962,6</td>
<td>1324,4</td>
<td>5677,3</td>
<td>5664,3</td>
<td>7473,6</td>
<td>23926,2</td>
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<tr>
<td><strong>In percent of the total volume of dispatched goods, performed works and services</strong></td>
<td></td>
<td></td>
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</tr>
<tr>
<td><strong>Total for the economy</strong></td>
<td>4,7</td>
<td>5,4</td>
<td>5,0</td>
<td>5,5</td>
<td>5,5</td>
<td>5,1</td>
<td>4,6</td>
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<tr>
<td><strong>Mining operations</strong></td>
<td>5,2</td>
<td>4,3</td>
<td>2,7</td>
<td>2,8</td>
<td>3,0</td>
<td>3,0</td>
<td>2,7</td>
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<tr>
<td><strong>Extractions of fuel and energy natural resources</strong></td>
<td>5,6</td>
<td>5,0</td>
<td>2,9</td>
<td>3,0</td>
<td>3,2</td>
<td>2,8</td>
<td>2,8</td>
</tr>
<tr>
<td><strong>Extraction of natural resources, other than fuel and energy</strong></td>
<td>2,9</td>
<td>0,5</td>
<td>1,6</td>
<td>1,5</td>
<td>1,6</td>
<td>4,2</td>
<td>2,2</td>
</tr>
</tbody>
</table>

Technology Audit for Corporate Innovation Strategies

Elena Vetchinkina
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June 14, LEI HSE
The strategic management system of organization: demands, functions and information flows

Information support, analysis and application system

Operational Management
- Resources
- Production
- Output

Prospective Management
- Goals and objectives-setting
- Planning
- Forecasting

Feedback mechanisms
- Monitoring & control system
- Adjustment system

Information support system

«Hard» data
- System of economic indexes
- System of specific indicators

«Soft» data

Analysis techniques
- Intra-company analysis
- Intra-branch analysis
- Normative analysis
The concept of technology audit

in the corporate innovation strategies framework

Precedent notions ≠ Notion updates

Financial audit ("accounting")

Technical expertise on equipment or a set of technologies

Commercialization and transfer potential on technology R&D results identification

Innovation and technology level assessment

Scope of innovation and technology-related activities for competitiveness enhancement analysis:
- Equipment and technologies absorption
- Goods and serviced produced, IP employed
- Organization structure and business processes

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Given the corporate innovation development programme guidelines, technology audit procedures comprise from the following pillars:

1. Production and innovations performance estimates
2. New technologies employed by companies
3. Innovative and high-technology goods and services
4. S&T and Innovation funding
5. Business structure, business and production-technology processes

The outcomes (tools):

- Key performance indicators (KPI)
- Prospective technology absorption methods
- Innovation products & services portfolio analysis
- Financing of S&T and innovation development
- S&T and innovation management, process innovations
### Principles for indicators design

#### System of indexes for technology auditing

<table>
<thead>
<tr>
<th>Basic requirements</th>
<th>Additional requirements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Comprehensiveness</td>
<td>Flexibility</td>
</tr>
<tr>
<td>Accessibility</td>
<td>Measurability</td>
</tr>
<tr>
<td>Relevance</td>
<td>Feasibility</td>
</tr>
<tr>
<td>Data availability</td>
<td>Comparability</td>
</tr>
<tr>
<td>Objectiveness</td>
<td>Non-redundance</td>
</tr>
</tbody>
</table>

#### System of indexes subject areas

- **Productivity**
- **Costs of production and Operating expenditures**
- **User properties**
- **Energy efficiency**
- **Health, safety and environment-efficiency**
- **Innovation development**
- **Intellectual property creation and transfer**
- **R&D, technology and innovation activities financing**
A new system of indicators which suit all the requirements and to propose valuation methods for

- International and regional organizations (including industry-specific)
- International, regional and national innovation offices

Market factors

Innovations and technologies embodied into the business processes, operating activities and matching goods and services manufacturing processes

Measuring the *competitiveness*:

\[ F = f(K, L, M, \text{Technological advance}) \]

System of indicators was harmonized with international experience

International standards, guidelines and recommendations

- Key performance indicators
- High-technologies and innovations
- IP objects
- New products and services
- Business structure and processed

Best practice: Foreign companies
System of statistical indexes for corporate innovation and technology level assessment

Innovation and technology level assessment

Production performance indexes

- Aggregate production performance
  - Turnover, sale volume and marketplace ratios
  - Profitability and manufacturing costs factors
  - Production (services) quality metrics

Science and Technology and Innovation activities indexes

- Technology Efficiency and Effectiveness of Production Process
  - Fixed capital assets employment
  - Expenditures for intermediate consumption
  - Labor and human resources employment
  - Production technologies process

- Research and Experimental Development Activities
  - Resources for research and development activities
  - Science and technology activities effectiveness and intensity

- Innovation Activities Effectiveness
  - Innovation activities
  - Expenditures for innovations
  - Innovation activities effectiveness and intensity
  - Cooperation ties and interaction with external sources of innovation

Internal and external audit

KPI + Benchmarking
Comparative analysis: production, technologies and innovation activities

Indexes for innovation and technology level assessment

Key performance indicators

Benchmarking

Companies selection criteria

Basic requirements

Industry

Type and range of operation activities

etc.

Operation activities measures matching

Financials

Production performance

etc.

Direct competitors

Best-practice companies

Companies comparison criteria

Industry average and threshold level

KPI target variables – strategy objectives
When the analysis of statistic indicators is not sufficient...

**Scoring and indexing** + **Expert statement**

**Innovations and technology absorption matrix**

**Product and services portfolio analysis**

- **Projects**
- **Innovation metrics**
- **Maturity**
- **Absorption and application rates**
- **Implementation**

<table>
<thead>
<tr>
<th>Innovation technology $y_1$</th>
<th>$\times$</th>
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<tbody>
<tr>
<td>$\ldots$</td>
<td></td>
</tr>
<tr>
<td>Innovation technology $y_N$</td>
<td>$\times$</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Innovation product $p_1$</th>
<th>$\times$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\ldots$</td>
<td></td>
</tr>
<tr>
<td>Innovation product $p_N$</td>
<td>$\times$</td>
</tr>
</tbody>
</table>

List of preferential technologies and projects that employs the best-practice and matches company’s project portfolio and peculiarities.
Results for innovation strategy development based on technology audit

Technology audit
- Key performance and innovation indicators
- Innovations and technology absorption matrix
- Product and services portfolio

Corporate Innovation Strategy Change

Strategy Management System and Instruments
- Innovation and S&T management
- Structure and business-processes
- Standards and regulations
- Scenarios and Integration Planning Roadmap

Cooperation and Partnership Programme
- Research centers and higher education institutes
- Small and medium innovation enterprises
- Technology platforms participation
Research and technology organizations in the primary sector

Thomas Gstraunthaler
Research and Technology Organizations (RTOs) in the primary sector: Providing Innovation to Russia’s mines and corn fields
• Cost structure of the RTO
• R&D head count
• Income-oriented variables
• Technology Transfer
• Quality control
• Own management priorities
• Memberships of groups and networks
• largely oriented towards own knowledge generation and derive much of their information from own literature resources and other customers
• The strong enterprise ownership in the field of mining could be explained through industry specific
• Radical innovation is not only influenced by the ownership and funding structure, but also by the recruitment strategy
• the use of third party quality control negatively related to TT revenues
• competitive funding plays a different role in both industries
Green growth for the oil and gas industry companies

Thomas Gstraunthaler
Elena Vetchinkina
UNEP defines a green economy as one that
«results in improved human well-being and social equity, while significantly reducing environmental risks and ecological scarcities»

Khanna and Anton, 2002, p. 539
«Organizational change within corporations and an internationally motivated effort at environmental self-regulation by adopting management practices that integrate the environment into production decisions identifying opportunities for pollution and waste reductions, and implementing plans to make continuous improvements in production methods and environmental performance»
Green challenges for companies of oil and gas industry

Our Common Future, 1989
- Identification of problems
- Reasoning of the ways to run sustainability
- Constitution: the necessity of new approaches

Gulf of Mexico Spill, 2010
- Paradigm shift: rapid adoption of green elements and practices to strategies and operation
- Long-term assessment
- Stewardship: alternative costs and NPV’s concept measurements

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Research questions

What are the driving forces for Russian Oil- and Gas-producers to adapt green production technologies?

How are they greening their production? Are there any practice variations visible in the Russian Oil- and Gas industry in going green?
Methodology

analysis of policies and practices of largest companies and their peers?

focus on Environmental Reports (e.g. Kemp, Arundel)

assessment of innovative changes over 3 years (2008-2010) at sectoral level

assessment of contextual factors / framework conditions – socio-economic conditions in Russia and government regulations over time (3 years)
10% of the contributions resource based theory,
11% institutional theory and
15% stakeholder theory.
32% of the papers used no theory at all and instead are
phenomena-driven or practice-orientated
From the perspective of corporate social responsibility (Fetzer, Aaron, 2010; Aras, Crowther, 2008)

Green innovation (in extractive industry) as a source for economic growth in a development perspective featuring specific cases of low-income (Auty, 2007) or developed countries (Alfsen, Greaker, 2007), underlining the need for sound natural resource management, standards and accounting (Auty, 2007; Muradian, Martinez-Alier, 2001)

Case studies from Russia’s regions (Yakovleva et al., 2000)
building competitive advantages through firm-level efficiency advantages, based on specific capabilities and assets. Focus rests on the existence of isolating mechanisms and fundamental determinants of firm performance (Teece, 1984; Wernerfelt, 1984).

Hard or impossible to imitate (Barney, 1991; Reed & DeFillippi, 1990).

Higher positive returns for shares of companies with advanced green management and reporting procedures (e.g. Ziegler et al., 2011).
### International companies

**Voluntary sustainability guidelines**
- Global Reporting Initiative
- etc.

**Voluntary International sustainability framework**
- UNEP, 2011, Towards a Green Economy
- etc.

**Legislation on managing risks**
- US Securities and Exchange commission
  - risk-monitoring and risk-securing functions
  - normalizing data flows
- etc.

### Russian companies

**Legislation**
- Law on Energy Saving and Energy Efficiency Improvement
  - energy cuts
  - energy audits
- Law on associated gas employment
  - fines
  - volumes of employment
  - timing

**Industrial strategies documentary**
- 2030 Energy complex strategy
- General Schemes on Oil and Gas Sector Development until 2020
- Russian Gas and Petrochemistry Development Plan until 2030

**Voluntary sustainability guidelines and International framework**
Key «green» drivers for oil and gas companies: factors to shape green metrics on strategies

**External Factors**
- Macro- and sectoral conditions
- Legislation
- Stakeholders consensus
  - Regulators
  - Policymakers
  - General public (society)
  - Shareholders
  - Vendors
  - Customers
  - Partners
  - Employees

**Internal factors**
- Companies’ priorities
- Business activities
- Operational structure
- Organizational structure
- Management culture
- Risk management
- Environmental footprint
- Compliance costs
- etc.
### Data, methodology, theory

#### Data sources
- Federal agency for state statistics (Rosstat)
- Largest companies’ reports (financial & environmental)
- National and international policy documents
- Russian rankings and other studies

#### Literature review
- Previous research about how and why companies are going green throughout different sectors & countries

#### Methodology
- Change of socio-technical systems, innovation theory, green growth paradigm
- A theory distinguishes between change from inside and change triggered by outside factors (market demand, etc.)
Greening of production

Preferred method

Innovation

Modernization

Drivers

Government regulation

Foreign clients

Own management

Specification

Legislative framework

International orientation

Efficiency improvements

Safety concerns
## Drivers of Environmental Management and Keywords

<table>
<thead>
<tr>
<th>Regulators</th>
<th>Government (государство)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Legislation (законодательство)</td>
</tr>
<tr>
<td>Management</td>
<td>Corporate governance/ management (корпоративное управление)</td>
</tr>
<tr>
<td>Customers</td>
<td>Consumers (клиенты)</td>
</tr>
<tr>
<td></td>
<td>Corporate governance/ management (корпоративное управление)</td>
</tr>
<tr>
<td>Company's international orientation</td>
<td>International (международный)</td>
</tr>
</tbody>
</table>
Rosneft

- 2009, “We will continue to work efficiently in the future for the good of the country and of our shareholders, adhering to the highest business standards with respect to production, the environment and society”.

- “Energy and fuel savings in 2010 thanks to our efficiency program were over 350,000 tonnes of conditional fuel, or 4% of total consumption. Progress in reducing fuel and energy use in production is continuously monitored”.

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“Protecting the unique natural environment of Krasnoyarsk Territory is of great concern to Rosneft, and the Company therefore has comprehensive measures in place for ecological protection at the Vankor field. All storage facilities and buildings as well as the pipeline are equipped with special systems for thermal stabilization of the ground which prevents the ground from thawing. This technology is being used for the first time in Russia.
Also in 2010, “to transform Rosneft from a national player, applying traditional technologies at traditional oilfields, into an international oil & gas leader with a diversified field portfolio including shelf reserves, and applying the latest technologies, including many of our own invention”.
Surgutneftegas

- 2008: “the company bets on the use of modern equipment and advanced technologies, support to forward-looking solutions and innovations”.

- 2009: “the accent is on development and usage of new environmentally friendly technologies and equipment, which is the result of innovation activity of Surgutneftegaz.

- 2010: “investments in environment protection activity amounted RUB 20 bln”, which resulted in high output indicators, such as “96% use of associated gas, which is the highest indicator value across the industry”.

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• 2008: Sustainable “despite the crisis, the company's investment plans and obligations remain the same”.
• 2009: “to be the leader in environmental and industrial safety”.
• In 2010, “environmental stewardship, the development of human capital and social responsibility remain key priorities for TNK-BP. In 2010, we continued to implement a range of measures designed to ensure the safety of our people and protect the environment. This has resulted in a substantial reduction in the number of lost-time accidents and oil spills”
### Data, methodology, theory

<table>
<thead>
<tr>
<th></th>
<th>Gazprom</th>
<th>Lukoil</th>
<th>Rosneft</th>
<th>Surgutneftegaz</th>
<th>TNK-BP</th>
<th>Tatneft</th>
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<table>
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<th>international orientation</th>
<th>customers</th>
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<tr>
<td>industry-wide driving forces</td>
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<td>17</td>
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## Green performance measurement concept for oil and gas companies

<table>
<thead>
<tr>
<th>Indicator’s Group</th>
<th>British Petroleum</th>
<th>Exxon Mobil</th>
<th>Shell</th>
<th>Rosneft</th>
<th>Lukoil</th>
<th>TNK-BP</th>
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<tbody>
<tr>
<td>Air emissions</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
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<td>Water spills</td>
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<tr>
<td>Other incidents</td>
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<td>_</td>
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<td>Fines</td>
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<td>X</td>
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<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

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## Green performance measurements: indicators for world oil and gas leaders (1)

### Air emissions

#### Greenhouse gas emissions (GHGs)

<table>
<thead>
<tr>
<th>British Petroleum</th>
<th>Exxon Mobil</th>
<th>Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Direct GHGs</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Direct GHGs, mln tonnes (Mte) CO₂</td>
<td>• GHGs, absolute (direct equity, CO₂-equivalent emissions), Mte</td>
<td>• Total GHGs emissions, Mte CO₂ equivalent</td>
</tr>
<tr>
<td>• Direct CO₂, Mte</td>
<td>• GHGs, normalized (direct equity, CO₂-equivalent emissions, excluding cogeneration…), Mte per 100 Mte of throughput or production:</td>
<td>• CO₂ emissions, Mte</td>
</tr>
<tr>
<td>• Direct methane, Mte</td>
<td>- Upstream</td>
<td>• Methane (CH₄) emissions, thousand tones (Tte)</td>
</tr>
<tr>
<td><strong>Indirect GHGs</strong></td>
<td>- Downstream</td>
<td>• Nitrous oxide (N₂O) emissions, Tte</td>
</tr>
<tr>
<td>• Indirect CO₂, Mte</td>
<td>- Chemical</td>
<td></td>
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</tbody>
</table>

#### Acid gases and Volatile organic compounds (VOCs) and other emissions

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<tr>
<th> </th>
<th>British Petroleum</th>
<th>Exxon Mobil</th>
<th>Shell</th>
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<tbody>
<tr>
<td>• Customer emissions, Mte CO₂</td>
<td><strong>Acid gases and VOCs</strong></td>
<td><strong>Acid gases and VOCs</strong></td>
<td><strong>Acid gases and VOCs</strong></td>
</tr>
<tr>
<td></td>
<td>• Sulfur dioxide (SO₂) emitted, Mte</td>
<td>• SO₂ emissions Tte</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Nitrogen oxides (NOₓ) emitted, Mte</td>
<td>• NOₓ emissions Tte</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• VOCs emitted, Mte</td>
<td>• VOCs emissions, Tte</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• VOCs emitted, metric tons per 100 metric tons of throughput or production:</td>
<td></td>
<td><strong>Ozone-depleting emissions</strong></td>
</tr>
<tr>
<td></td>
<td>- Upstream</td>
<td></td>
<td>• CFCs/halons/trichloroethane, tonnes</td>
</tr>
<tr>
<td></td>
<td>- Refining</td>
<td></td>
<td>• Hydrochlorofluorocarbons (HCFCs), tonnes</td>
</tr>
<tr>
<td></td>
<td>- Chemical</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Oil spills

<table>
<thead>
<tr>
<th> </th>
<th>British Petroleum</th>
<th>Exxon Mobil</th>
<th>Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number of oil spills – to land and water, mln litres</td>
<td>• Volume of spills (thousands of barrels)</td>
<td>• Number of oil spills to land and water</td>
<td></td>
</tr>
<tr>
<td>• Volume of oil spilled, mln litres</td>
<td>• Marine vessel spills (owned and long-term leased), number of hydrocarbon spills &gt; 1 barrel</td>
<td>• Volume of oil spilled, mln litres</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Other spills (not from marine vessels), number of oil, chemical, and drilling fluid spills &gt; 1 barrel</td>
<td>• Operational spills – volume, thousand tonnes</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Nigeria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Rest of world</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Operational spills – number</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Nigeria</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>- Rest of world</td>
<td></td>
</tr>
</tbody>
</table>

### Other incidents

<table>
<thead>
<tr>
<th> </th>
<th>British Petroleum</th>
<th>Exxon Mobil</th>
<th>Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Other spills (oil, chemical, and drilling fluid spills), thousands of barrels</td>
<td>• Sabotage spills – volume, Tte</td>
<td>• Sabotage spills – number</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hurricane spills – volume, Tte</td>
<td></td>
</tr>
</tbody>
</table>
Green performance measurements: indicators for world oil and gas leaders (2)

<table>
<thead>
<tr>
<th>British Petroleum</th>
<th>Exxon Mobil</th>
<th>Shell</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Flaring volumes</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Flaring, Tte (kte) of hydrocarbons</td>
<td>• Hydrocarbon flaring (worldwide activities), Mte</td>
<td>• Flaring, Tte (kte) of hydrocarbons</td>
</tr>
<tr>
<td></td>
<td>• Flaring (Upstream), Mte CO2 equivalent</td>
<td></td>
</tr>
<tr>
<td><strong>Energy efficiency</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Energy intensity, normalized versus Global Energy Management System (GEMS) base year</td>
<td>• Energy intensity, normalized versus GEMS base year</td>
</tr>
<tr>
<td></td>
<td>- refining</td>
<td>- refining</td>
</tr>
<tr>
<td></td>
<td>- chemical steam cracking</td>
<td>- chemicals</td>
</tr>
<tr>
<td></td>
<td>- oil sands</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Cogeneration capacity, gigawatts</td>
<td></td>
</tr>
<tr>
<td><strong>Resources use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Fresh water use, mln cubic metres</td>
</tr>
<tr>
<td><strong>Waste disposal</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hazardous, Tte</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Non-hazardous, Tte</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Total waste, Tte</td>
</tr>
<tr>
<td></td>
<td>• Total waste, Tte</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Total hazardous waste disposed from operations, Mte</td>
<td></td>
</tr>
<tr>
<td><strong>Losses</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Volume of oil unrecovered, mln litres</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Hydrocarbons spilled (oil spilled), thousands of barrels</td>
</tr>
<tr>
<td></td>
<td>• Total number of losses of primary containment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Number of oil spills – loss of primary containment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Volume of oil unrecovered, mln litres</td>
<td></td>
</tr>
<tr>
<td><strong>Fines</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Environmental and safety fines, $ million</td>
<td></td>
</tr>
<tr>
<td><strong>Green Investments</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Environmental expenditures, $ million</td>
<td>• Environmental expenditures, billions of dollars</td>
</tr>
</tbody>
</table>
Environmental Indicators, International

We are determined that BP will be a safer, more risk-aware business. We will deliver on our commitments from the Gulf Coast incident and work hard to earn back the trust in our operations. We will rebuild value for our shareholders by re-establishing our competitive position within the sector by playing our part in meeting the world’s growing demand for energy, as well as participating in the transition to a low-carbon economy.

<table>
<thead>
<tr>
<th>Environmental Indicators BP</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number of oil spills – to land and water</td>
</tr>
<tr>
<td>• Volume of oil spilled (million litres)</td>
</tr>
<tr>
<td>• Volume of oil unrecovered (million litres)</td>
</tr>
<tr>
<td>• Direct carbon dioxide (CO₂) (million tonnes (Mt))</td>
</tr>
<tr>
<td>• Indirect carbon dioxide (CO₂) (Mt)</td>
</tr>
<tr>
<td>• Direct methane (Mt)</td>
</tr>
<tr>
<td>• Direct greenhouse gas (GHG) emissions (Mt CO₂)</td>
</tr>
<tr>
<td>• Flaring (E&amp;P) (thousand tonnes (kte) of hydrocarbons)</td>
</tr>
<tr>
<td>• Customer emissions (Mt CO₂)</td>
</tr>
<tr>
<td>• Environmental and safety fines ($ million)</td>
</tr>
<tr>
<td>• Environmental expenditure ($ million)</td>
</tr>
</tbody>
</table>
earn the admiration of all our stakeholders — investors, customers, host governments, local communities and our employees — not only for the goals we achieve but how we achieve them;

<table>
<thead>
<tr>
<th>Environmental Indicators Chevron</th>
</tr>
</thead>
<tbody>
<tr>
<td>• GHG Emissions by Source - Millions of metric tons of CO2 equivalent</td>
</tr>
<tr>
<td>• Total GHG Emissions by Type - Millions of metric tons of CO2 equivalent</td>
</tr>
<tr>
<td>• Energy Efficiency Performance - Percentage improvement since 1992 baseline</td>
</tr>
<tr>
<td>• Air Emissions - Metric tons</td>
</tr>
<tr>
<td>• Air Emissions by Sector - Metric tons</td>
</tr>
<tr>
<td>• Average Oil Concentration in Discharges to Water - Parts per million</td>
</tr>
<tr>
<td>• Petroleum Spills - Volume in barrels</td>
</tr>
<tr>
<td>• Petroleum Spills - Number of spills</td>
</tr>
<tr>
<td>• Fines and Settlements</td>
</tr>
</tbody>
</table>
Sustainable development for Shell means considering both short- and long-term interests and integrating economic, environmental and social considerations into our decision making. Sustainable development helps govern the way we develop new projects and run our facilities, how we manage our supply chains, and how we share benefits where we operate. It also helps us to make better products for our customers.
Environmental Indicators Shell

- **Direct greenhouse gas emissions (GHGs)**
  - Total GHGs (million tonnes CO₂ equivalent)

- **Flaring**

- **Energy intensity**
  - Upstream excluding Oil Sands (gigajoules per tonne production)
  - Oil Sands (gigajoules per tonne production)
  - Refineries: Refinery Energy Index
  - Chemical plants: Chemicals Energy Index

- **Acid gases and VOCs**

- **Ozone-depleting emissions**

- **Spills and discharges**
  - Sabotage spills – volume (thousand tonnes)
  - Sabotage spills – number
  - Operational spills – volume (thousand tonnes)
    - § Nigeria
    - § Rest of world
  - Operational spills – number
    - § Nigeria
    - § Rest of world
  - Hurricane spills – volume (thousand tonnes)
  - Oil in effluents to surface environment (thousand tonnes)

- **Fresh water use**
  - Fresh water use (million cubic metres)

- **Waste disposal**
GOALS AND COMMITMENTS

Guaranteeing compliance with all standards set by the Russian Federation legislation and international legal acts related to environmental protection, as well as observing the principles of the Russian Federation Ecological Doctrine.

Enhancing energy efficiency of production processes at all stages.
## Indicators Description

<table>
<thead>
<tr>
<th>Indicators</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted program</td>
<td>The Energy Saving Program for 2009-2013</td>
</tr>
<tr>
<td>Goals</td>
<td>• The program, based on the as</td>
</tr>
<tr>
<td></td>
<td>• specific energy consumption should be decreasing by approxim</td>
</tr>
<tr>
<td>Expenditures</td>
<td>Between 2009 and 2013, the expenditures on the program shoul</td>
</tr>
<tr>
<td>Cost-effectiveness</td>
<td>According to the Company’s estimates, these expenditures will</td>
</tr>
<tr>
<td>Prior activities of the program</td>
<td>• introduction of economic inc</td>
</tr>
<tr>
<td></td>
<td>• energy audits, implementation of measures on the saving of en</td>
</tr>
<tr>
<td></td>
<td>• introduction of energy efficient equipment and energy saving to</td>
</tr>
<tr>
<td></td>
<td>• installation of metering devices for electricity, heat, gas, water,</td>
</tr>
</tbody>
</table>

### Prior activities of the program

- Introduction of energy efficient equipment and energy saving technologies
- Installation of metering devices for electricity, heat, gas, and water
- Use of more efficient pumps in reservoir pressure maintenance and refining and petrochemical sector

### Total consumption of energy and energy resources, GJ

- 232 million

### Number of subsidiaries participating

- 49
Green behavior of leading oil and gas companies in terms of strategies, operations and organization

- to maintain the present upstream and downstream competitive advantages
- to launch new excellences
  - in exploration basins
  - in markets
  - in products (renewables)
  - in collaboration
  - special organizational unit
- stakeholders’-targeted
- to maintain the present upstream and downstream competitive advantages
- to launch new excellences
  - investments
  - capitalization
  - collaboration
  - in products (renewables)
- performance in the near term (safety, communities and environment)
- growth in the medium term
- project initiatives in the long term
Green behavior of leading Russian oil and gas companies in terms of strategies, operations and organization

- transparency
- resource sustainability
- energy efficiency
- ecological safety
- associated gas employment
- infrastructure and production facilities modernization

- resource sustainability
- investment in new technologies
- operational effectiveness (upstream and downstream)
- energy cuts
- operational expenses cuts
- renewables

- diversification
- resources
- Infrastructure
- production capacities
- operational efficiency
- new energy capacities
- technologies
Green modes in terms of oil and gas companies strategies

- sophistication
- maturity
- diversification
- reactivity
- imitativeness
- degree of changes
- Initiation level
- Realization level
- etc.
INNOVATIVE TECHNOLOGY STRATEGY AND MODEL OF TECHNOLOGICAL DEVELOPMENT IN OIL AND GAS COMPANIES: METHODS AND PRACTICE

Vitaly Lavrov

June 14, LEI ISSEK
Internal and external factors of innovative development

Socio-economic environment
Ecology and Energy Efficiency
Strategic documents industry

Scenarios

Technological priorities of the Company

Registers of technologies

Upstream
- exploration
- fields development
- extraction
- utilization of APG
- shelf development

Downstream
- petroleum refining
- gas processing
- petrochemistry

technology portfolios

Products
- technical characteristics
- markets
The choice of technology priorities

- Definition of technological trends
  - Analysis of current technological priorities and trends
  - Analysis of the technological structure of the individual business segments
  - Identification of technologies that could have a significant impact on the development of competitive advantages in the future

- Technology assessment
  - Determination of conformity of technology objectives to production and technological potential
  - Analysis of the impact of technology on the individual processes of the production cycle

- Selection of technology processes and formation of registries
  - Grouping of technologies
  - Definition of technological problems within the technology groups

- Formation of technology portfolios
  - Definition of components of technology portfolios in the long term
  - Definition of the moments of the solution of technological objectives and the beginning of the development of technologies
  - Formation of the portfolios
  - Research (individual development)
  - External (to attract external sources of technological knowledge)
Analysis of the technological priorities of the leading companies

- Analysis of technological priorities of the largest oil and gas companies (BP, RD Shell, ExxonMobil and others) over the past five years
- Determination of dynamics of changes in key areas of research

- Identification of models of technological development of the leading companies
- Identification of the most important technological trends based on patent analysis

Areas of concentration of company resources

The most actively-growing technology areas

Name (encoding the IPC) of the technological direction
• analysis of cooperative ties oil and gas companies over the past 5 years in attraction of new technologies
• estimation of the degree of integration of the major oil companies in joint research and development
• Identification of possible areas of technological development from domestic sources
**Key technology trends in Upstream and Downstream sectors**

**Downstream**
- processes of catalysis
  - catalytic cracking of hydrocarbon oils in the absence of hydrogen
  - catalysts containing molecular sieves
- fuel and the use of additives for fuels
- lubricants
- synthetic natural gas
- liquefied petroleum gas
- acyclic or carbocyclic compounds

**Upstream**
- methods and apparatus for controlling the flow of produced fluid or gas in wells (to wells) drilling soil and rock and geophysics
- enhanced extraction methods for obtaining hydrocarbons
- horizontal deviated well
- methods of enhanced oil recovery (priority is the integration of gas, thermal and chemical EOR, transient flooding)
The criteria system for technology attraction

- proposed methodology for determining the optimal ways of technology attraction
- proposed a method of constructing technology attraction schemes
The system of selection criteria for ways to attract technology (2)

Filter criteria

First-level criteria:
- Required period of implementation of the technological problems
- The place of technological problems in the Company's strategic priorities
- Extent of future use of technology in the Company
- Availability of technology on the market
- Economic benefits from the use of technology attracted (NPV)
- Etc.

* Within the range of values of each factor is fixed by the critical value of the criterion, which allows you to directly identify the source of attraction of this technology on a distinguished road.

Involving service company

Development and technology acquisition

Second-level criteria
• A system for the selection of specific tools to attract technology

• Selection of the ways to self-development or purchase of technology is carried out by assessing the feasibility of technology acquisition with the use of groups of criteria
Technology commercialization

System of criteria for selecting the direction of technology use

Ranking methods of commercialization

- quality of technology
- market potential of technology
- maintenance capabilities
- the potential profitability of technology
- risks of commercialization

Adjustment of scoring depending on the degree of influence

Internal use
-Provision of services to third parties
-Sale of technology
Registry of technologies on the block «Upstream»

The grouping of technologies

The scenario possible implementation of technology

Ways of technology attraction

Technology groups in accordance with the stages of the production cycle

List of technologies ranked in accordance to their priority

Ability to create technology portfolios in the segments of exploration, development and production and scenarios of their development
Technology portfolios

Timeline of technology usage

Timeline of technology development

technological processes

Timeline

gasoline

Technological objectives

Process of technology evolution

Current technology portfolio

Timeline

stable gas condensate

Scenarios of technology portfolios
The analysis characteristics of product Forecast and comparison with the world’s values

refined petroleum products

gas processing products

Formation of scenarios of characteristics of product portfolios until 2020

petrochemistry products
The integrated roadmap structure (summary and process maps)

Upstream

- Key Performance Indicators
- Key technological innovations
- Timeline
- Exploration
- Fields development
- Extraction
- Blocks:
  - "Exploration"
  - "Production and Development"
- Stocks on the types of resources
- Products and their long-term characteristics
- + utilization of associated gas
- + shelf development
The integrated roadmap structure (summary and process maps)

Downstream

Key Performance Indicators

Timeline

Key technological innovations

Products and their long-term characteristics

Raw materials for processing, semi-finished products of technological processes

Technological processes

Product roadmaps
The impact of the introduction of technology in the KPI

Technology processes

Technology portfolios

Products and their long-term characteristics

Ways of technology acquisition

Market perspectives

Timeline
Thank you for your attention!

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www.hse.ru

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