NATIONAL RESEARCH UNIVERSITY

The Energy Complex:

Technology, Innovation and Sustainability in Large Firms

Linkages between Actors in the Innovation System
Extended Workshop

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Moscow

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Extractive industry companies in the Russian economy

10 largest Russian companies by net profit, 2010

Ranking by indicator	Ranking in «Finance-500»	Company	Net profit in 2009, bln RUB	Dynamics, %
1	1	Gazprom	779,585	+5
2	2	Lukoil	222,411	-2
3	3	Rosneft	206,644	-25
4	5	TNK-BP International	157,759	+20
5	4	Russian Railways	150,001	+102
6	12	Transneft	120,407	+71
7	7	Surgutneftegas	113,874	-21
8	14	Norilsky Nickel	82,480	
9	11	Tatneft	55,532	+477
10	28	Megafon	45,289	+5

Source: http://www.finansmag.ru/96286

Innovation activity in Russian extractive industry (1)

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

	Share of organizations, performing innovation activity in the total no. of organizations, %						
	2003	2004	2005	2006	2007	2008	2009
Total for the economy	**10,3**	**10,5**	**9,3**	**9,4**	**9,4**	**9,6**	**9,4**
Mining operations	**5,7**	**5,9**	**5,6**	**7,0**	**5,8**	**5,1**	**5,8**
Extractions of fuel and energy natural resources	7,3	7,4	5,7	8,0	6,6	5,6	7,0
Extraction of natural resources, other than fuel and energy	4,5	4,8	5,6	6,1	4,9	4,4	4,2

Innovation activity in Russian extractive industry (2)

Volume of dispatched innovative goods, works and services, Mining operations, 2003-2009

	2003	2004	2005	2006	2007	2008	2009
Million rubbles							
Total for the economy	**312692,0**	**433003,5**	**545540,0**	**714024,6**	**916131,6**	**1046960,0**	**877684,8**
Mining operations	**67259,3**	**83763,1**	**81199,0**	**90969,2**	**110950,2**	**133553,9**	**122998,3**
Extractions of fuel and energy natural resources	61296,7	82438,7	75521,7	85304,8	103476,6	109627,6	111636,8
Extraction of natural resources, other than fuel and energy	5962,6	1324,4	5677,3	5664,3	7473,6	23926,2	11361,5
In percent of the total volume of dispatched goods, performed works and services							
Total for the economy	**4,7**	**5,4**	**5,0**	**5,5**	**5,5**	**5,1**	**4,6**
Mining operations	**5,2**	**4,3**	**2,7**	**2,8**	**3,0**	**3,0**	**2,7**
Extractions of fuel and energy natural resources	5,6	5,0	2,9	3,0	3,2	2,8	2,8
Extraction of natural resources, other than fuel and energy	2,9	0,5	1,6	1,5	1,6	4,2	2,2

Source: http://www.gks.ru/wps/wcm/connect/rosstat/rosstatsite/main/enterprise/science/#

Technology Audit for Corporate Innovation Strategies

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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	Prospective Management	Feedback mechanisms
Resources	Goals and objectives-setting	Monitoring & control system
Production	Planning	Adjustment system
Output	Forecasting	

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***

Financial audit (“accounting”)

Technical expertise on equipment or a set of technologies

Commercialization and transfer potential on technology R&D results identification

= ***Notion updates***

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

…. > 2010 2011 …. >

Time horizon

Technology Audit contest within the corporate innovation strategies framework

Subject of analysis	The outcomes (tools)
Long-term development strategy	Key challenges and strategic guidelines

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

1 Production and innovations performance estimates	Key performance indicators (KPI)
2 New technologies employed by companies	Prospective technology absorption methods
3 Innovative and high-technology goods and services	Innovation products & services portfolio analysis
4 S&T and Innovation funding	Financing of S&T and innovation development
5 Business structure, business and production-technology processes	S&T and innovation management, process innovations

Principles for indicators design

System of indexes for technology auditing

Basic requirements

- Comprehensiveness
- Accessibility
- Relevance
- Data availability
- Objectiveness

Additional requirements

- Flexibility
- Firm- and Industry-customization
- Measurability
- Feasibility
- Comparability
- Non- redundance

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

The challenge for indicator system

A new system of indicators which suit all the requirements and to propose valuation methods for

Production performance | S&T and innovation development | 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, Technological advance)

System of indicators was harmonized with international experience

International standards, guidelines and recommendations

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

Best practice: Foreign companies

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

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

Technology Efficiency and Effectiveness of Production Process

- Fixed capital assets employment
- Expenditures for intermediate consumption
- Labor and human resources employment
- Production tec[illegible]ologies processi[illegible]

Structural, flexible and systematic model

Science and Technology and Innovation activities indexes

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

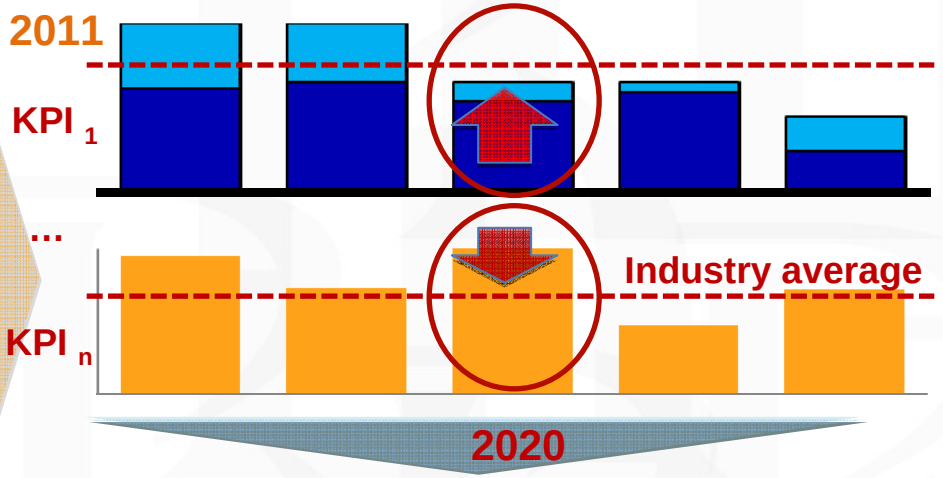
- Industry
- Type and range of operation activities
- etc.

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

Comparative analysis: Innovation & technologies, products & services

When the analysis of statistic indicators is not sufficient…

Scoring and indexing + **Expert statement**

Innovations and technology absorption matrix

•Projects •Innovation metrics •Maturity •Absorption and application rates •Implementation	Company 1	….	Company N
Innovation technology$_1$	X		
….			
Innovation technology$_N$			X

Product and services portfolio analysis

•Innovation and technology metrics •Maturity & technology readiness •Time of production stages	Company 1	….	Company N
Innovation product$_1$	X		
….			
Innovation product$_N$			X

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

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

Research and Technology Organizations (RTOs) in the primary sector: Providing Innovation to Russia's mines and corn fields

- 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

Green challenges for companies in the context of green economy

Green economy

UNEP, 2011, Towards a Green Economy

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*»

Green management

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

From theoretical goal settings at the general level

Our Common Future, 1989

- Identification of problems
- Reasoning of the ways to run sustainability
- Constitution: the necessity of new approaches

To tackling the real industrial targets

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

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)

Literature review

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

Literature review

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)

Theory

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).

Regulations to drive «green» changes in oil and gas industry companies' behavior

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
  - Venders
  - 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.)

Data, methodology, theory

Greening of production

Preferred method	Innovation	Modernization	
Drivers	Government regulation	Foreign Clients	Own Management
Specification	Legislative framework	International orientation	• Efficiency improvements • Safety concerns

Data, methodology, theory

Drivers of Environmental Management and Keywords

Regulators	Government (государство) Legislation (законодательство)
Management	Corporate governance/ management (корпоративное управление)
Customers	Consumers (клиенты) Corporate governance/ management (корпоративное управление)
Company's international orientation	International (международный)

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”.

Rosneft

“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

Rosneft

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”.

TNK-BP

- 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

	Gazprom	Lukoil	Rosneft	Surgutneftegas	TNK-BP	Tatneft
Government and regulation	2	2	3	3	1	2
International orientation	1	1	1	2	2	1
Consumers	0	0	0	0	0	0
Own management	3	3	2	1	3	3

	government	own management	international orientation	customers
industry-wide driving forces	11	17	8	3

Green performance measurement concept for oil and gas companies

Indicator's Group	British Petroleum	Exxon Mobil	Shell	Rosneft	Lukoil	TNK-BP
Air emissions	X	X	X	X	X	X
Water spills	X	X	_	_	_	_
Other incidents	X	X	X	X	_	_
Flaring volumes	X	X	X	_	_	_
Energy efficiency	_	X	X	X	X	X
Resources use	_	_	X	X	X	X
Waste disposal	_	X	X	X	X	X
Losses	X	X	X	X	X	X
Fines	X	_	_	X	_	_
Green investments	X	X	_	X	X	X

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

British Petroleum	Exxon Mobil	Shell
Air emissions		
Greenhouse gas emissions (GHGs)		
Direct GHGs •Direct GHGs, mln tonnes (Mte) CO_2 •Direct CO_2, Mte •Direct methane, Mte **Indirect GHGs** •Indirect CO_2, Mte	• GHGs , absolute (direct equity, CO_2-equivalent emissions), Mte • GHGs, normalized (direct equity, CO2-equivalent emissions, excluding cogeneration…), Mte per 100 Mte of throughput or production: - Upstream - Downstream - Chemical	**Direct GHGs** •Total GHGs emissions, Mte CO2 equivalent •CO2 emissions, Mte •Methane (CH4) emissions, thousand tones (Tte) •Nitrous oxide (N2O) emissions, Tte
Acid gases and Volatile organic compounds (VOCs) and other emissions		
• Customer emissions, Mte CO2	**Acid gases and VOCs** •Sulfur dioxide (SO2) emitted, Mte •Nitrogen oxides (NOx) emitted, Mte •VOCs emitted, Mte •VOCs emitted, metric tons per 100 metric tons of throughput or production: - Upstream - Refining - Chemical	**Acid gases and VOCs** •SO2 emissions Tte •NOx emissions Tte •VOCs emissions, Tte **Ozone-depleting emissions** •CFCs/halons/trichloroethane, tonnes •Hydrochlorofluorocarbons (HCFCs), tonnes
Oil spills		
• Number of oil spills – to land and water, mln litres • Volume of oil spilled, mln litres	• Volume of spills (thousands of barrels) • Marine vessel spills (owned and long-term leased), number of hydrocarbon spills > 1 barrel • Other spills (not from marine vessels), number of oil, chemical, and drilling fluid spills > 1 barrel	• Number of oil spills to land and water • Volume of oil spilled, mln litres • Operational spills – volume, thousand tonnes - Nigeria - Rest of world • Operational spills – number - Nigeria - Rest of world
Other incidents		
–	• Other spills (oil, chemical, and drilling fluid spills), thousands of barrels	• Sabotage spills – volume, Tte • Sabotage spills – number • Hurricane spills – volume, Tte

Green performance measurements: indicators for world oil and gas leaders (2)

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

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.

Environmental Indicators BP
• Number of oil spills – to land and water
• Volume of oil spilled (million litres)
• Volume of oil unrecovered (million litres)
• Direct carbon dioxide (CO_2) (million tonnes (Mte))
• Indirect carbon dioxide (CO_2) (Mte)
• Direct methanee(Mte)
• Direct greenhouse gas (GHG) emissionse (Mte CO_2)
• Flaring (E&P) (thousand tonnes (kte) of hydrocarbons)
• Customer emissionsh (MteCO_2)
• Environmental and safety fines ($ million)
• Environmental expenditure ($ million)

Environmental Indicators, International

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;

Environmental Indicators Chevron
• GHG Emissions by Source - Millions of metric tons of CO2 equivalent
• Total GHG Emissions by Type - Millions of metric tons of CO2 equivalent
• Energy Efficiency Performance - Percentage improvement since 1992 baseline
• Air Emissions - Metric tons
• Air Emissions by Sector - Metric tons
• Average Oil Concentration in Discharges to Water - Parts per million
• Petroleum Spills - Volume in barrels
• Petroleum Spills - Number of spills
• Fines and Settlements

Environmental Indicators, International

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, International

Environmental Indicators Shell

- **Direct greenhouse gas emissions (GHGs)**
  - Total GHGs (million tonnes CO_2 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**

Gazprom

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.

Rosneft

Indicators	Description
Accepted program	The Energy Saving Program for 2009-2013
Goals	• The program, based on the as
•	specific energy consumption should be decreasing by approxim
Expenditures	Between 2009 and 2013, the expenditures on the program shoul
Cost-effectiveness	According to the Company's estimates, these expenditures will
Prior activities of the program	• introduction of economic ince
•	energy audits, implementation of measures on the saving of en
•	introduction of energy efficient equipment and energy saving te
•	installation of metering devices for electricity, heat, gas, water,
Complying with the Federal Law "On Energy Saving and the Impr	Yes
Number of subsidiaries participating	49
Saved electricity, GW*h	815
Saved heat, GCal	354 thousand
Saved fuel, tonnes	13 thousand
Total savings, GJ	9 million
Instruments reducing energy	oil production sector •
•	using more efficient pumps in reservoir pressure maintenance s
	refining and petrochemical sector •
total consumption of energy and energy	
resources, GJ	232 million

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

safety

- 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

balance

- stakeholders'-targeted
- to maintain the present upstream and downstream competitive advantages
- to launch new excellences
  - investments
  - capitalization
  - collaboration
  - in products (renewables)

strategy-linkage

- 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

ROSNEFT

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

LUKOIL

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

TNK-BP

- diversification
  - resources
  - Infrastructure
  - production capacities
- operational efficiency
- new energy capacities
- technologies

Green modes in terms of oil and gas companies strategies

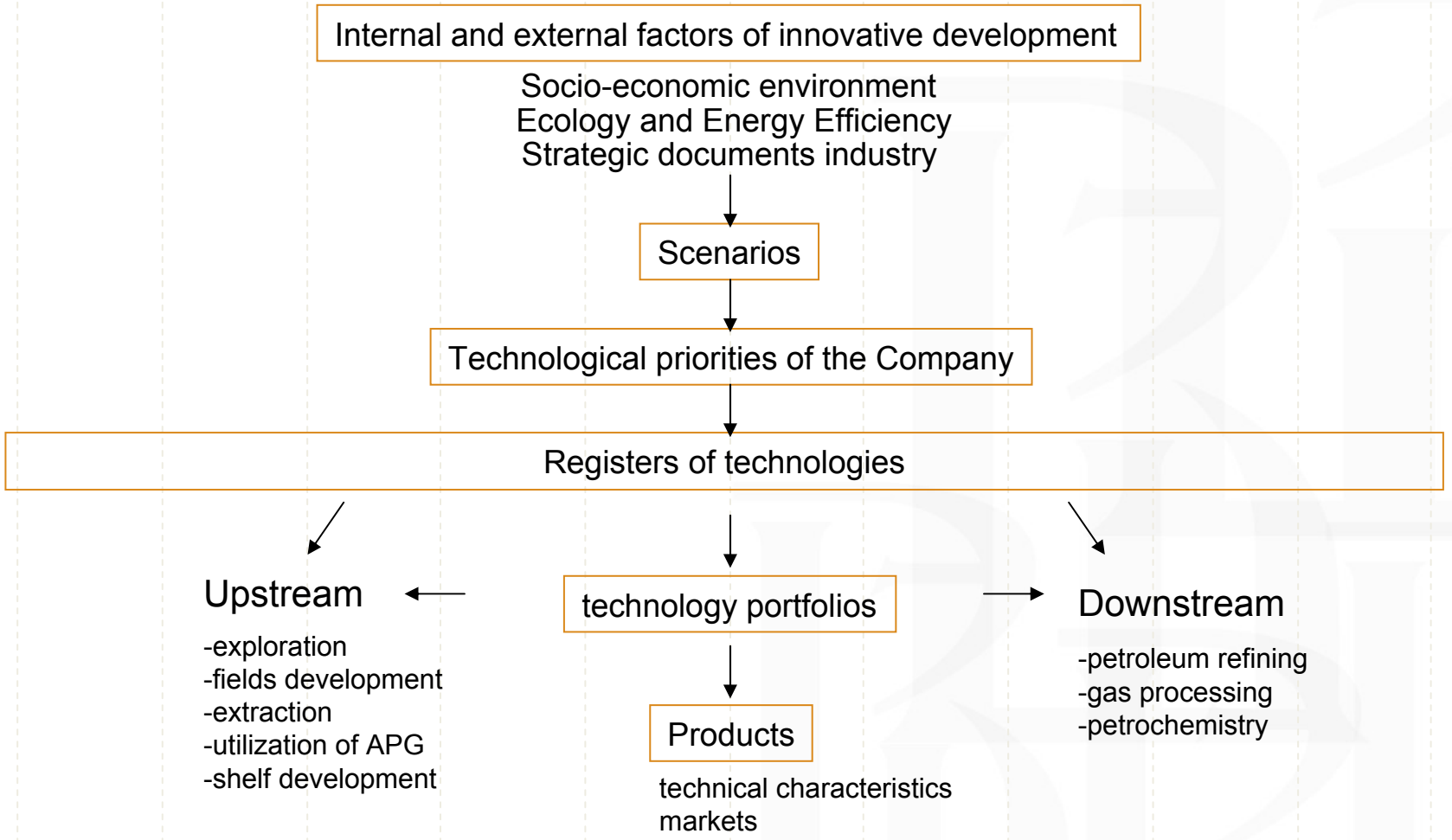
sophistication	maturity	diversification
reactivity	imitativeness	degree of changes
Initiation level	Realization level	etc.

INNOVATIVE TECHNOLOGY STRATEGY AND MODEL OF TECHNOLOGICAL DEVELOPMENT IN OIL AND GAS COMPANIES: METHODS AND PRACTICE

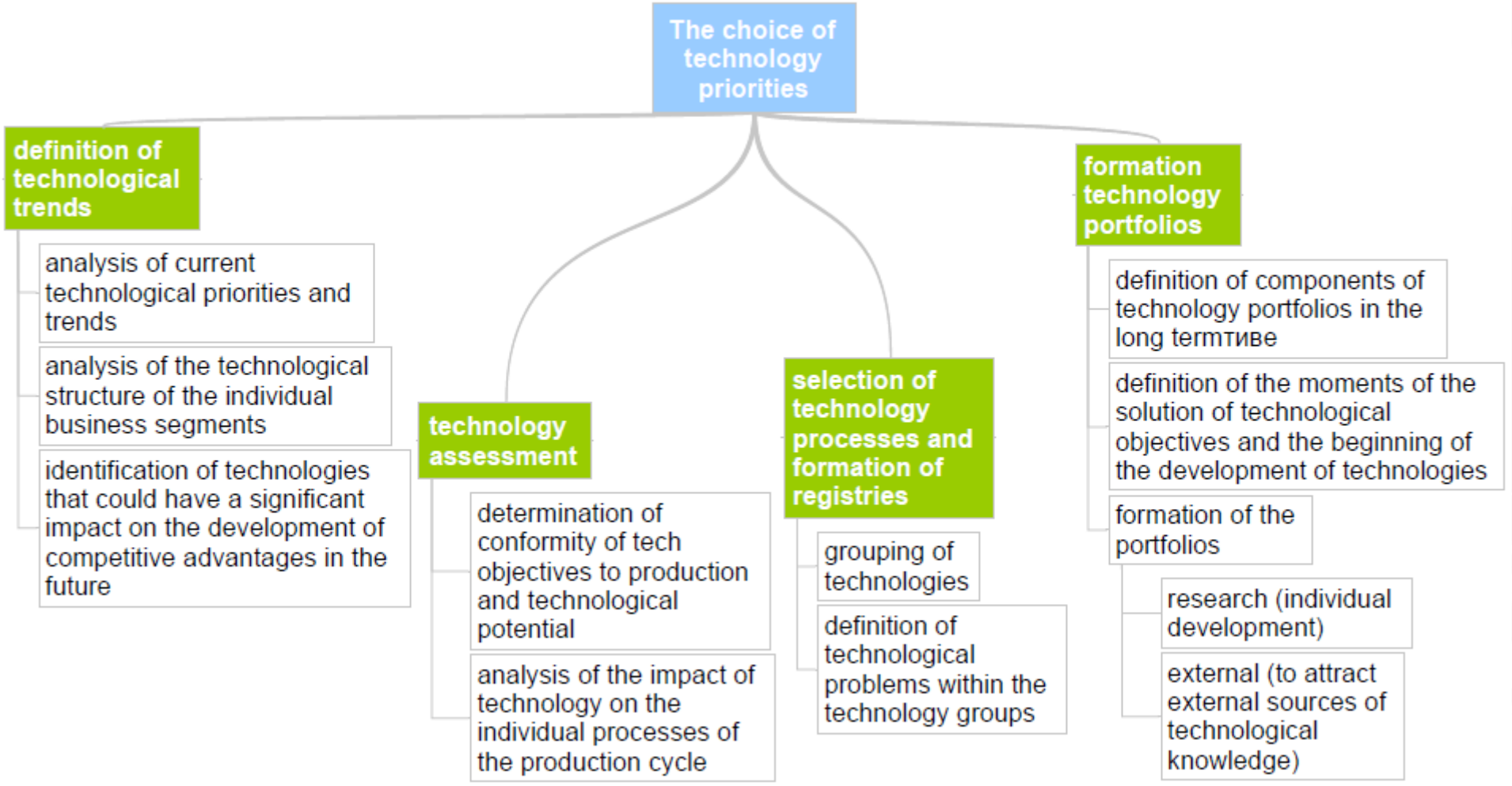
Vitaly Lavrov

June 14, LEI ISSEK

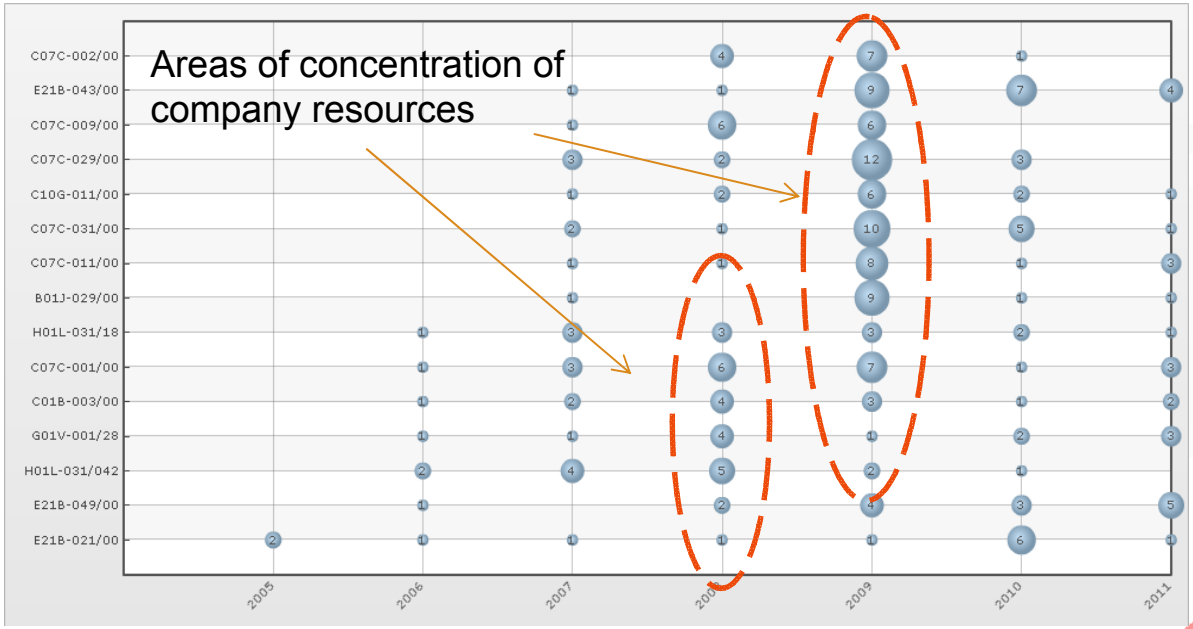
Structure


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
technology portfolios
Products
technical characteristics
markets
Downstream
-petroleum refining
-gas processing
-petrochemistry

The choice of technology priorities

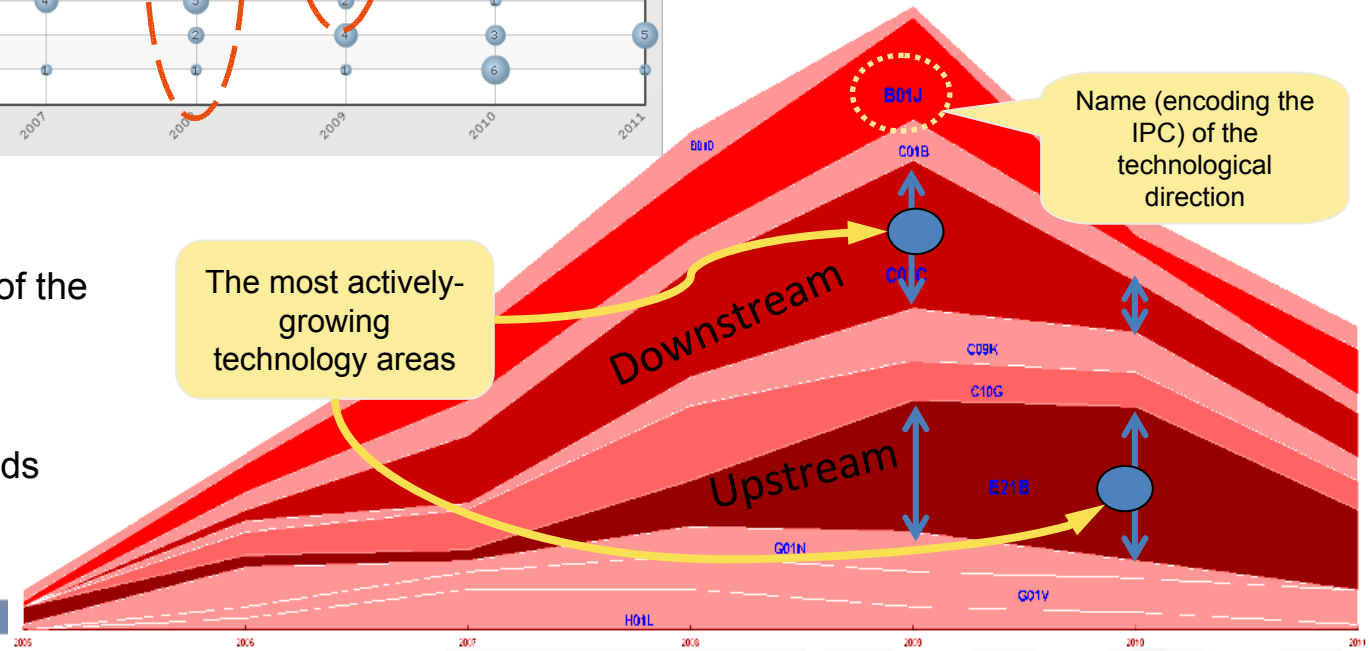


Analysis of the technological priorities of the leading companies



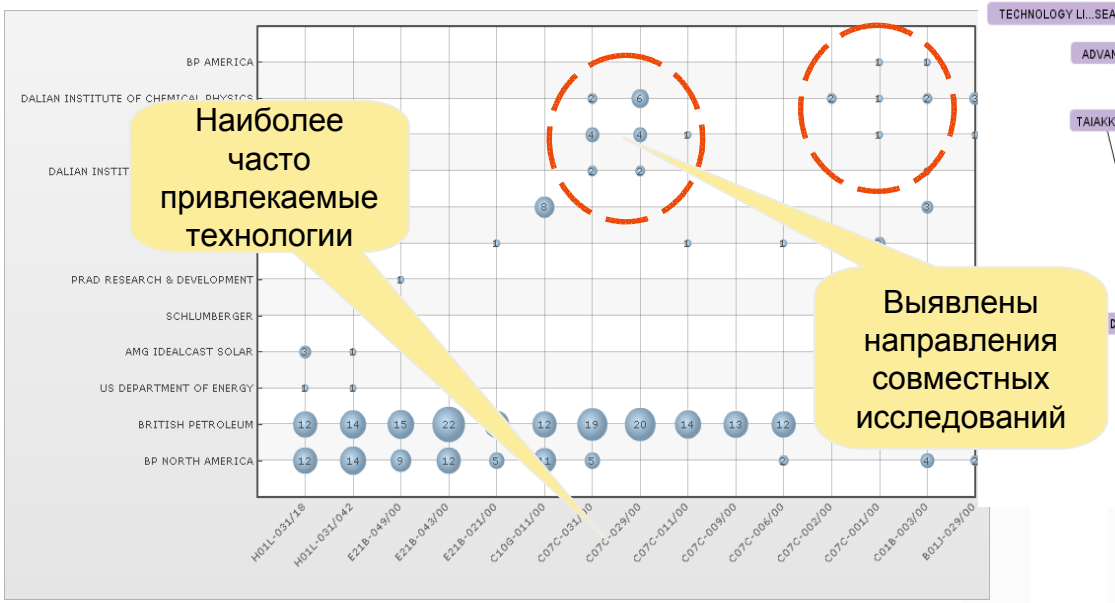
- analysis of technological priorities of the largest oil and gas companies (BP, RD Shell, ExxonMobil and others) over the past five years
- determination of dynamics of changes in key areas of research

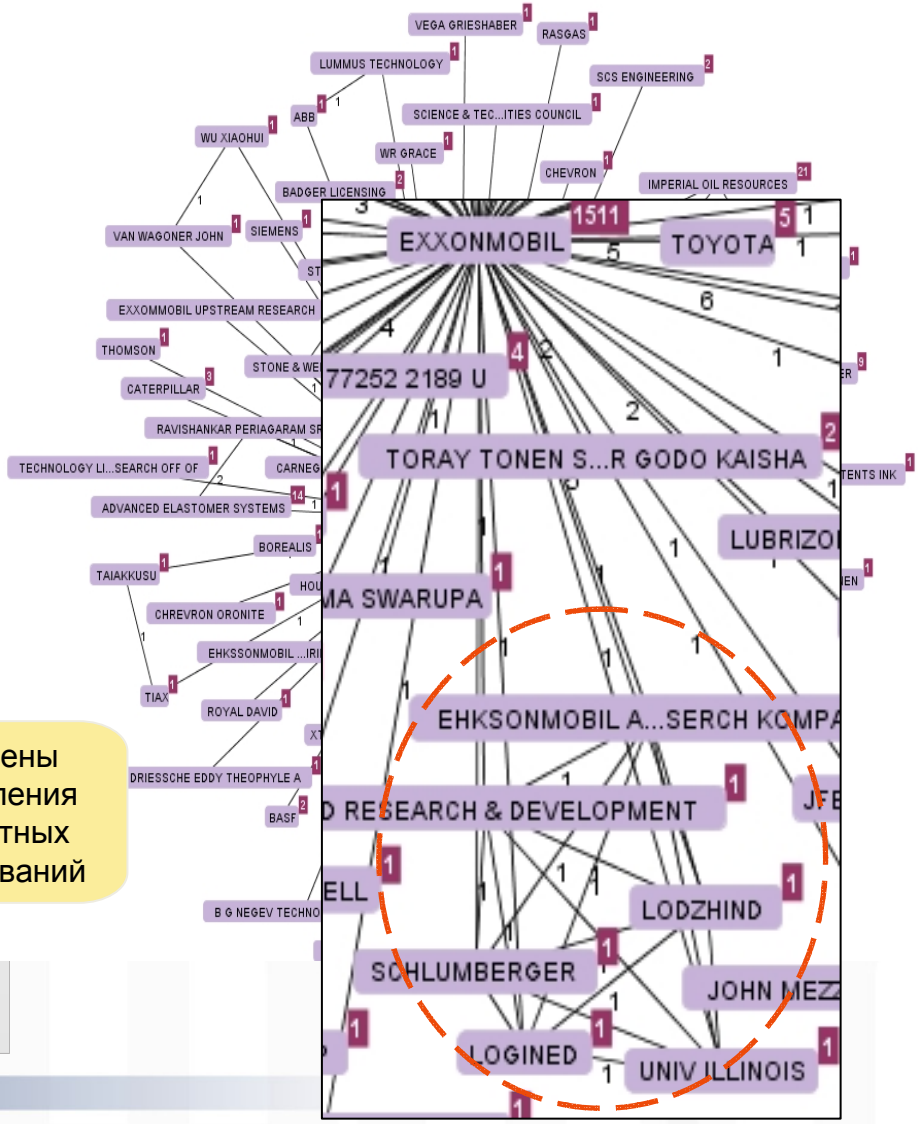
- identification of models of technological development of the leading companies
- identification of the most important technological trends based on patent analysis



Analysis of cooperation in research and development

- 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

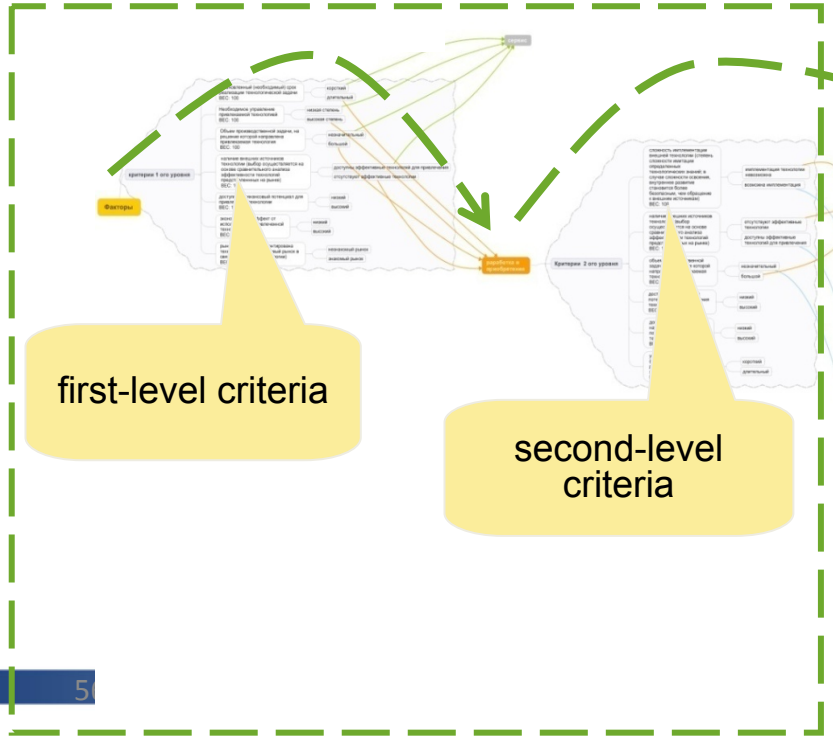
Upstream

•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)

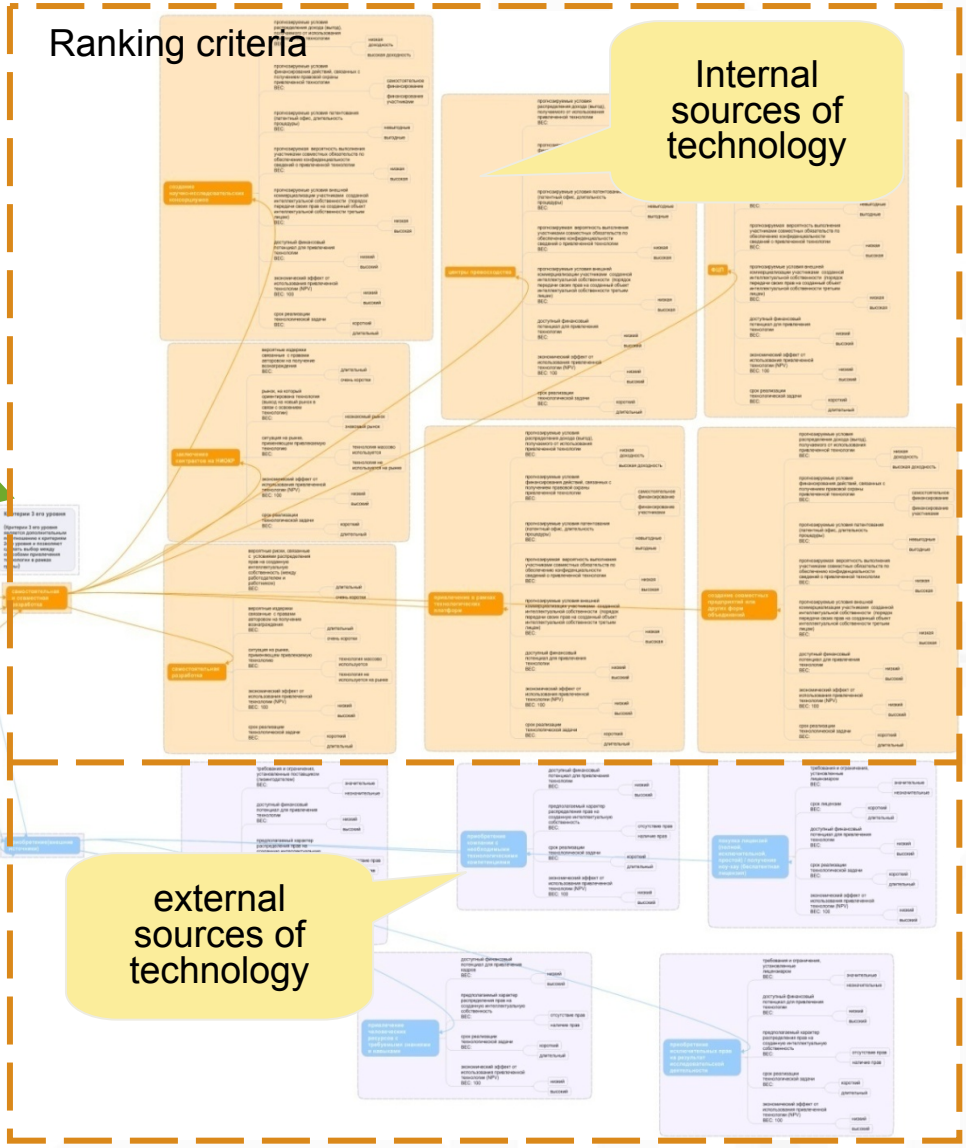
The criteria system for technology attraction

- proposed methodology for determining the optimal ways of technology attraction
- proposed a method of constructing technology attraction schemes

The filter criteria



Ranking criteria



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.

Involving service company

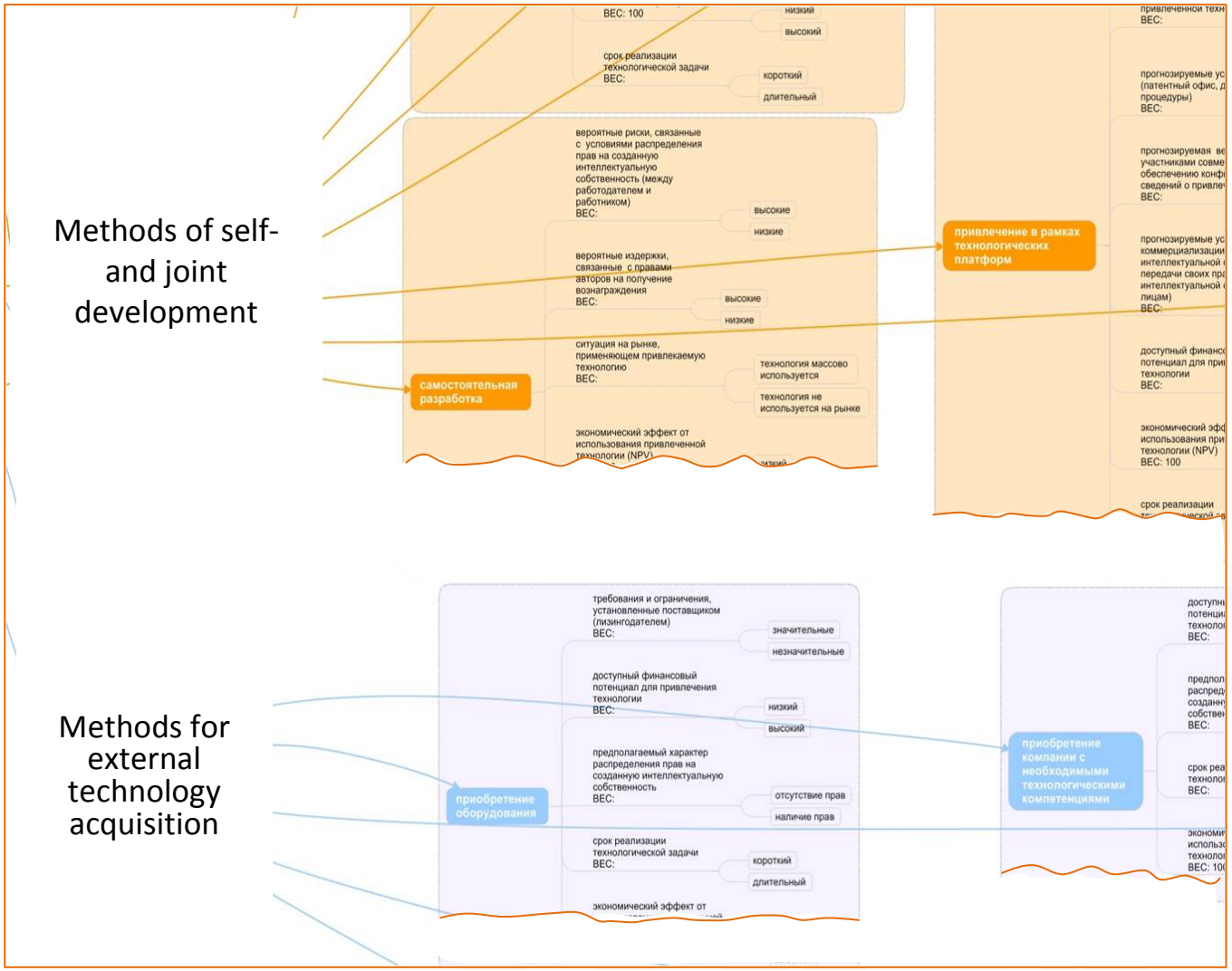
Development and technology acquisition

Second-level criteria

* 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

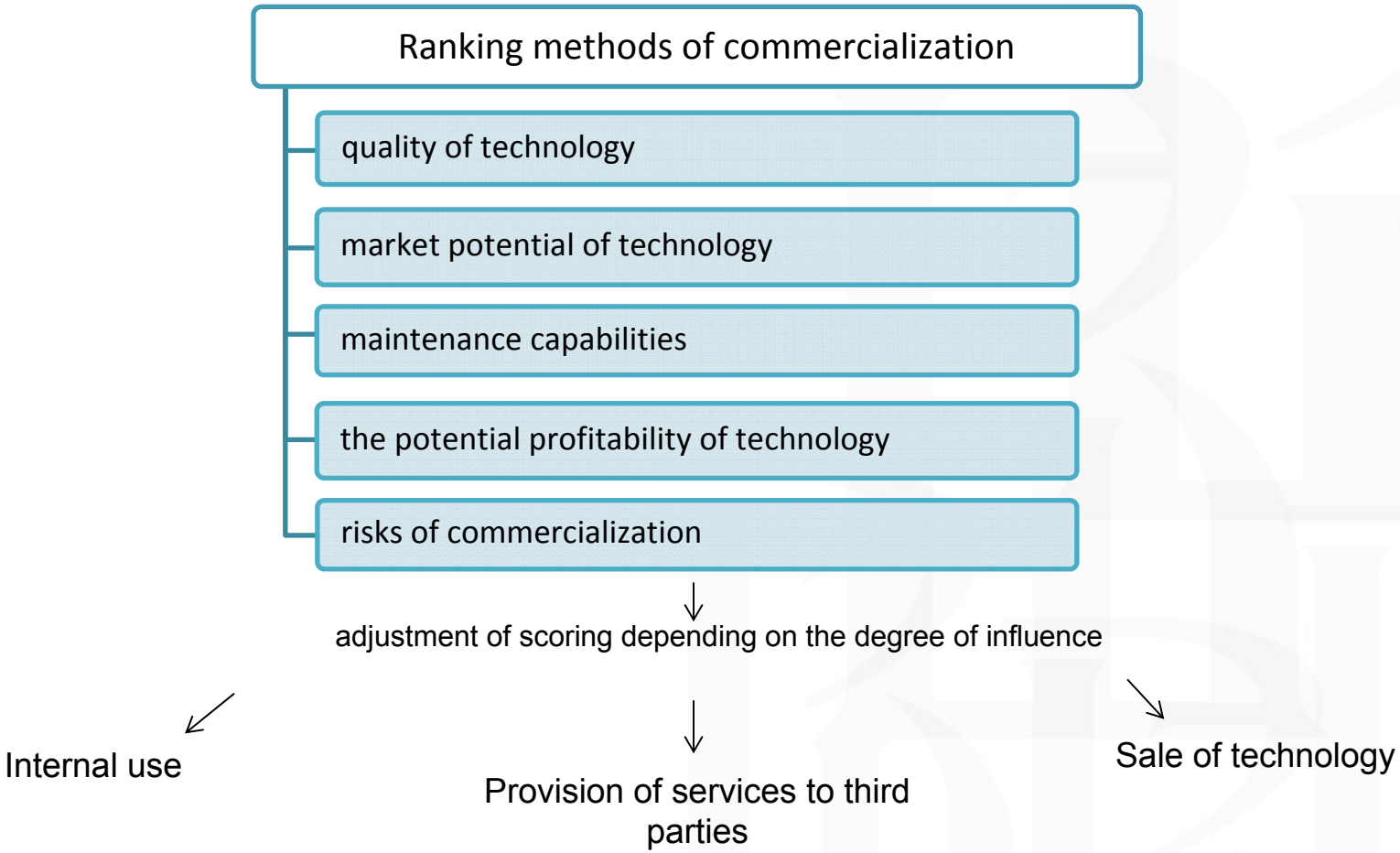
The system of selection criteria for ways to attract technology (3) Ranking criteria

- 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



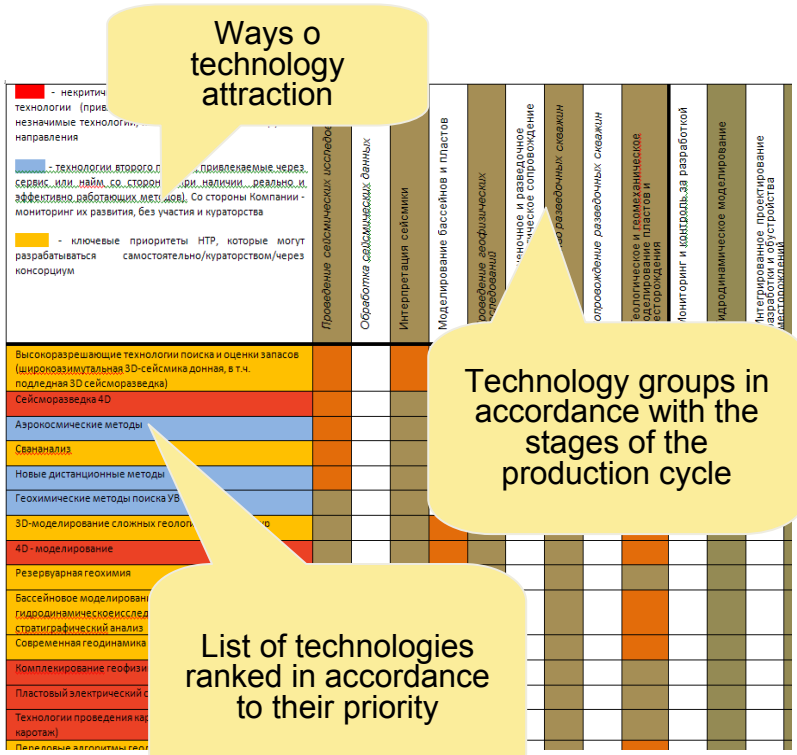
Technology commercialization

System of criteria for selecting the direction of technology use



Registry of technologies on the block «Upstream»

The grouping of technologies



The scenario possible implementation of technology

2 Текущий технологический портфель и инновационный сценарий его развития (ОАО «НК «Роснефть»)	3 Год внедрения/ Применяется	Год
	2010	
	2010	
Технологии вовлечения в разработку керогена (органика, содержащаяся в породе в связанном состоянии)	2020	
Технологии монетизации газа и повышения уровня использования попутного нефтяного газа		
	2010	
	2010	
Технологии очистки попутного нефтяного газа от сероводорода ультрафиолетовым излучением	15	
Технология совместного транспорта нефти и газа на основе создания устойчивых нефтегидратных см	15	
Технологии мембранного выделения гелия		
Технология по готовки попутного нефтяного основе мембр ого разделения		
Подготовка с использованием техн сверхзвуков епарации, создание опы установки лучения газового конденсата на основе си етилового эфира (GTL), технологии по иженного	2020	

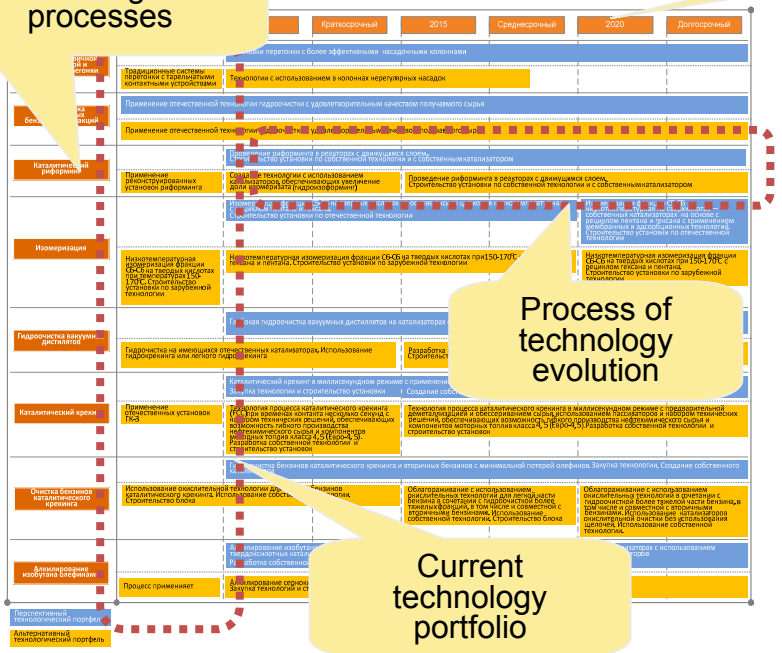
Ability to create technology portfolios in the segments of exploration, development and production and scenarios of their development

Technology portfolios

Timeline of technology usage

technological processes

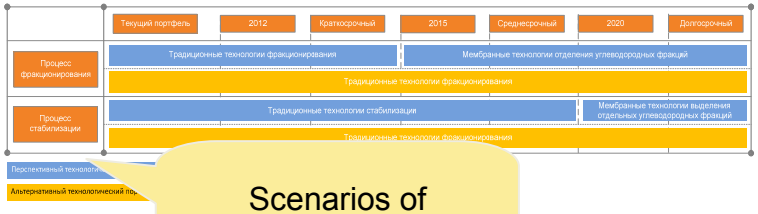
gasoline



Process of technology evolution

Current technology portfolio

stable gas condensate



Scenarios of technology portfolios

Timeline of technology development

Timeline

The recommended period R&D initiation

Технологии	2011	2012	2013	2015	2
Изомеризация фракции С5-С6 низкотемпературная на сверхкислотах – собственных катализаторах на основе с рециклом пентана и гексана с применением мембран… …тановки по отечественной технологии					
Низкотемпературная изомеризация фракции С6-С6 …льство установки по зарубежной технологии					
Низкотемпературная изомеризация фракции С6-С6 Строительство установки по зарубежной технологии					
гидроочистка вакуумных дистиллятов					
Глубокая гидроочистка вакуумных дистиллятов на катализаторах с оптимальной пористой структурой					
Глубокая гидроочистка вакуумных дистиллятов на катализаторах без носителя при более низких давлениях					
Гидроочистка на имеющихся отечественных катализаторах, Использование гидрокрекинга или легкого гидрокрекинга					
Легкий гидрокрекинг. Строительство установок					
Глубокая гидроочистка вакуумных дистиллятов на собственных катализато…ах с оптимальной пористой структурой					
каталитический крекинг					
Каталитический крекинг в миллисекундном режиме с применением высокоу…ойчивых к металлам и термопаростабильных катализаторов. Закупка технологии и строительство ус…новки					
Каталитический крекинг в миллисекундном режиме с применением высокоус…чивых к металлам и термопаростабильных катализаторов. Закупка технологии и строительство уста…ки. Создание собственного катализатора					
Технология процесса каталитического крекинга (FCC)при временах контакта нес…ко секунд с набором технических решений, обеспечивающих возможность гибкого производства нефт…ического сырья и компонентов моторных топлив класса 4, 5 (Евро-4, 5). Разработка собственной тех…гии и строительство установок					
Технология процесса каталитического крекинга в …иллисекундном режиме с предв…льной деметаллизацией и обессериванием сырья, использованием пассиват…в и набором технических реше…беспечивающих возможность гибкого производства нефтехимического …ырья и компонентов моторн…ив класса 4, 5 (Евро-4, 5). Разработка собственной технологии и строительство …новок					
очистка бензинов каталитического крекинга					
Гидроочистка бензинов каталитического крекинга и вторичн…ензины с минимальной …й олефинов. Закупка технологии. Создание собственного катализатора					
Использование окислительной технологии для очистки бензинов …литического крекин… Использование собственной технологии. Строительство блока					
Облагораживание с использованием окислительных технологий для л… части бензина …ии с гидроочисткой более тяжелых фракций, в том числе и совместной с вто…ми бензинам… Использование собственной технологии. Строительство блока					
Облагораживание с использованием окислительных технологий в сочетани… …роочистко… …елой части бензина, в том числе и совместной с вторичными бензинами Использование … …тов … …ой очистки					

technological objectives

The analysis characteristics of product
Forecast and comparison with the world‘s values

refined petroleum products

Продукт	Наименование характеристики (ключевое потребительское свойство продукта)	Значение показателя				
		2012		2015		2
		Компании -лидеры	НК Роснефть	Компании -лидеры	НК Роснефть	Компании -лидеры
- бензин	Массовая доля серы, не более	10	50	10	10	5
	Объемная доля бензола, не более	1	1	0.5	1	0.5
	Объемная доля углеводородов, ароматических	10-30	35-45		30-35	
	Олефиновых	5-14	18	5-14	14	2-5
	Октановое число: по исследовательскому методу	95	92-95	95	95	95
	по моторному методу	85	83-85	85	85	85
	Доля бензинов Класса 4	40	50	5	45	0
	Класса 5	55	5	80	45	50
	Класса выше 5	5	0	5	10	50
- дизельное топливо	Массовая доля серы, ppm	2-15	50-350	2-10	10-50	2-10
	Массовая доля полициклических ароматических углеводородов	0.1-5	11-24	0.1-2	5-11	0.1-2
	Массовая доля ароматических	5-20	-	5-10	20	5-10

gas processing products

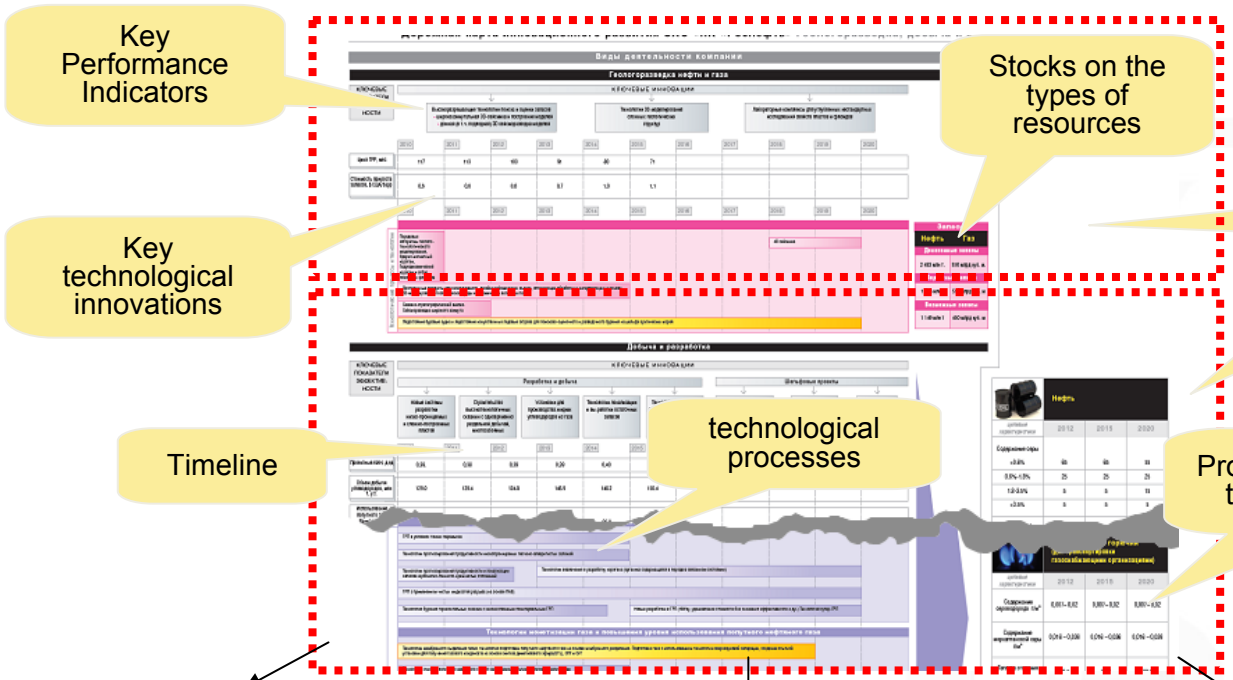
Продукт	Наименование характеристики (ключевое потребительское свойство продукта)	Значение показателя					
		2012		2015		2020	
		Компании-лидеры	НК Роснефть	Компании-лидеры	НК Роснефть	Компании-лидеры	Н Р
	меркаптановой серы г/м³						
	Теплота сгорания низшая, МДж/м3	34-40	32.5	34-40	32.5	34-40	3
- конденсат газовый нестабильный	Массовая доля ароматических у/в	<10 10-20 >20	<10 10-20 >20	<10 10-20 >20	<10 10-20 >20	<10 10-20 >20	< 1 >
	Массовая доля н-парафинов (200-320°С)	25 18-25 14-18 <14	25 18-25 14-18 <14	25 18-25 14-18 <14	25 18-25 14-18 <14	25 18-25 14-18 <14	2 1 1 <1
	Массовая доля серы	0.05 0.051-0.8 >0.8	0.05 0.051-0.8 >0.8	0.05 0.051-0.8 >0.8	0.05 0.051-0.8 >0.8	0.05 0.051-0.8 >0.8	0 0 >(
	Температура выкипания	<250 250-320 320<	<250 250-320 320<	<250 250-320 320<	<250 250-320 320<	<250 250-320 320<	< 2 3
- конденсат газовый стабильный	Давление насыщенных паров, мм	500-700	500-700	500-700	500-700	500-700	5(
	Температура начала кипения, °С	30	30	30	30	30	3(
	Доля воды, %	0.03-0.5	0.03-0.5	0.03-0.5	0.03-0.5	0.03-0.5	0.
- широкая фракция легких углеводородов	%C1-C2	3-5	3-8	3-8	3-8	3-8	3-
	% C3	15	18	18	18	18	1
	%C4-C5	40-45	40-45	40-45	40-45	40-45	4(

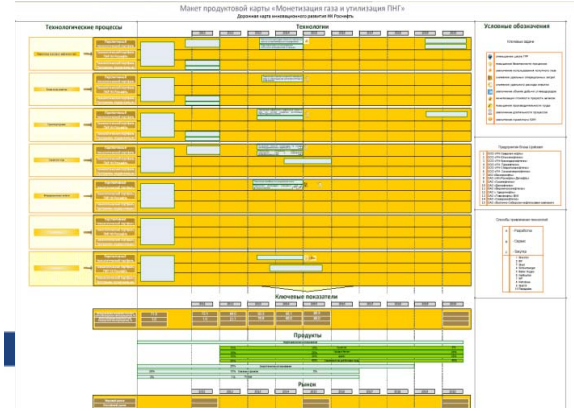
Formation of scenarios of characteristics of product portfolios until 2020

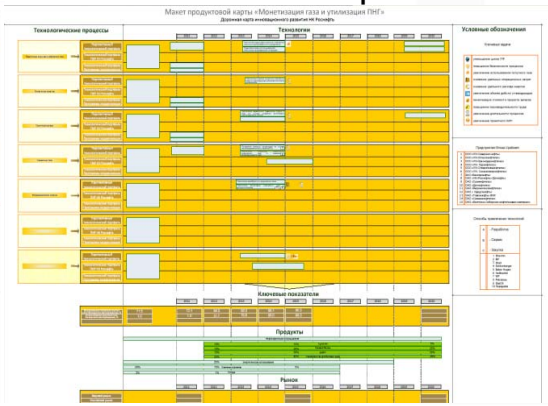
petrochemistry products

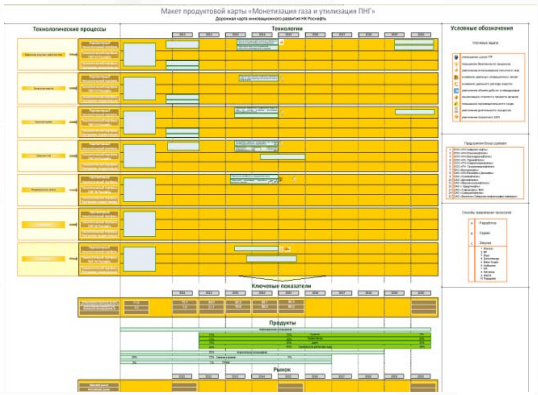
Продукт	Наименование характеристики (ключевое потребительское свойство продукта)	Значение показателя					
		2012		2015		2020	
		Компании-лидеры	НК Роснефть	Компании-лидеры	НК Роснефть	Компании-лидеры	НК Росне
	не менее этилена						
	не более пропилена	0.001	0.005	0.001	0.001	0.001	0.001
	метана и этана	0.1	0.1	0.1	0.1	0.1	0.1
	ацетилена	0.0005	0.001	0.0005	0.0005	0.0005	0.0005
	диенов	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	водорода	0.001	0.001	0.001	0.001	0.001	0.001
	CO	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	CO_2	0.0005	0.001	0.0005	0.0005	0.0005	0.0005
	O_2	0.0002	0.002	0.0002	0.0002	0.0002	0.0002
	Серы, мг/м³	1	1	1	1	1	1
- пропилен	Объемная доля,% пропилена не менее	99.8	99-99.8	99.8	99.8	99.8	99.8
	не более этилена	0.005	0.005-0.01	0.005	0.005	0.005	0.005
	ацетиленовых углеводородов	0.0005	0.001-0.005	0.0005	0.0005	0.0005	0.0005
	углеводородов С4	0.002	0.002-0.05	0.002	0.002	0.002	0.002
	диенов	0.0005	0.001-0.015	0.0005	0.0005	0.0005	0.0005
	этана и пропана	0.2	0.2-0.7	0.2	0.2	0.2	0.2
	водорода	0.0005	0.001	0.0005	0.0005	0.0005	0.0005
	CO	0.0005	0.0005	0.0005	0.0005	0.0005	0.0005
	CO_2	0.001	0.001	0.001	0.001	0.001	0.001

The integrated roadmap structure (summary and process maps)
Upstream

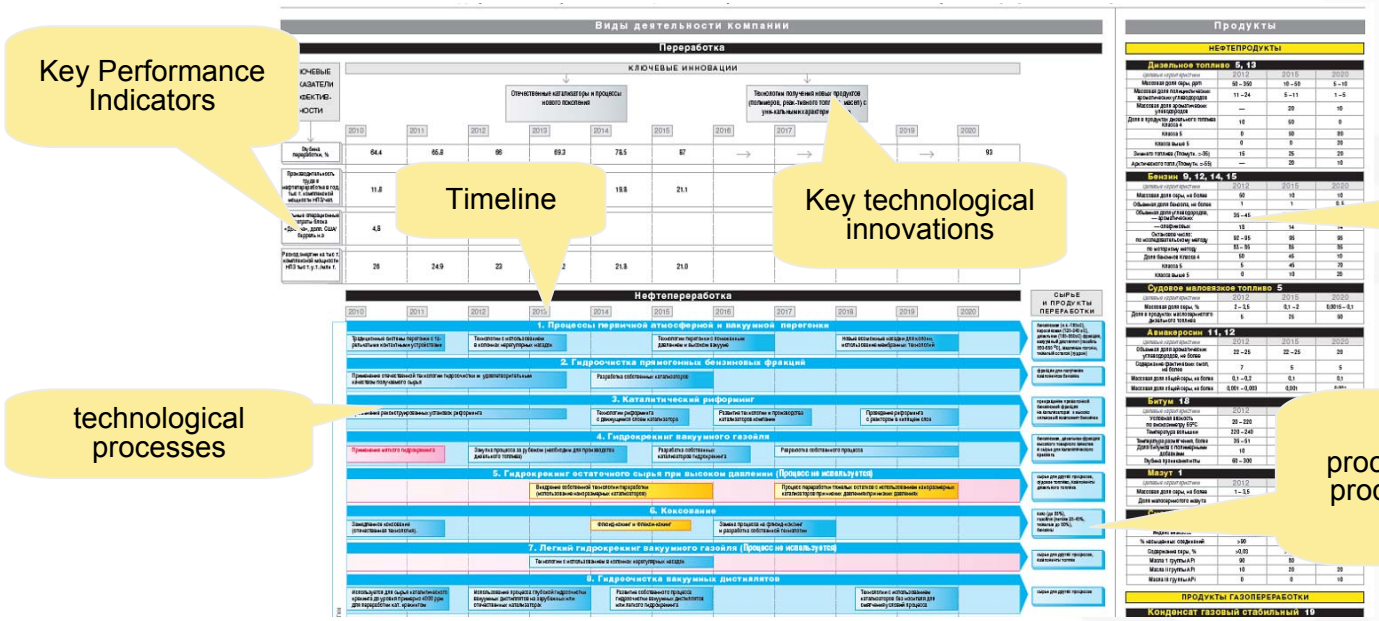




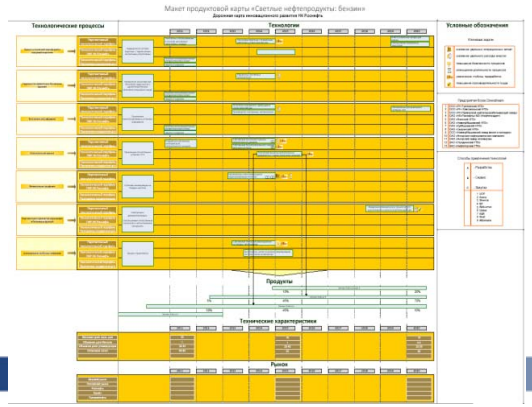


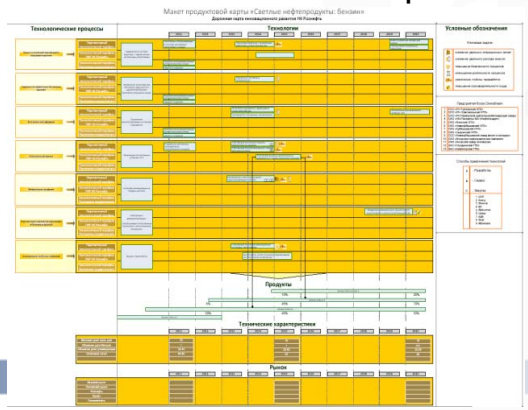


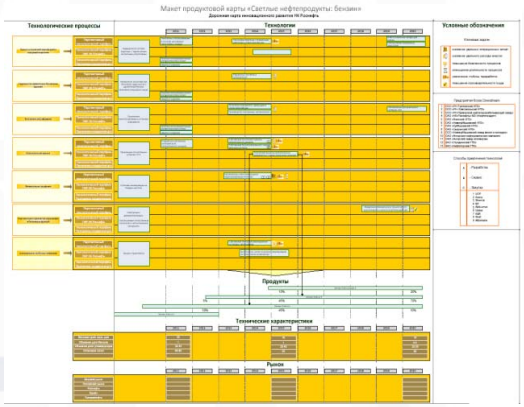
The integrated roadmap structure (summary and process maps) Downstream



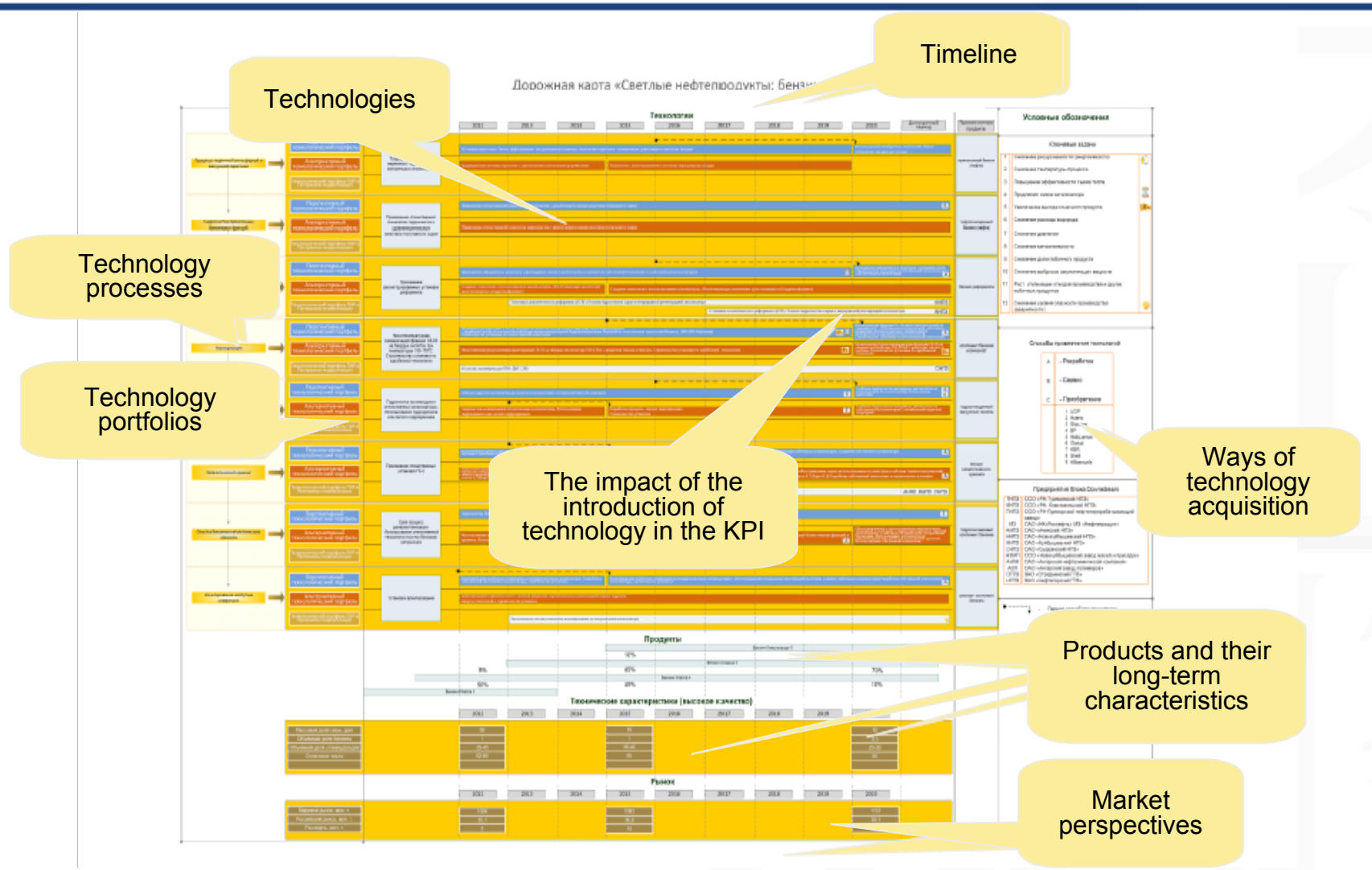
Product roadmaps







Product / Technology Roadmap



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