CENTER FOR STRATEGIC RESEARCH NORTH WEST

Energy Foresight (vision of the future of energy)

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CSR «North-West» Foundation

October, 2010

Events that took place at world energy markets in 2008-2010 show that these markets are on the verge of their profound modification

1. Transformation of the natural gas market caused by: a) «gas war» between Russia and Ukraine; b) explosive growth of unconventional gas production in the USA; c) launch of significant volumes of liquefied natural gas on the world market, unification of American, European and Asian gas markets; d) growth of spot market gas volumes; e) reduction of market sector where there are long-term contract prices which are tied to the oil price.

2. Growth of volatility in prices for hydrocarbon fuels. Confirmation of the carbon-based fuels market cycle: in less than one year oil prices reached their peak and then fell almost 3.5-fold and grew nearly twofold again.

3. 5 years in a row in the U.S. and 9 years in the EU wind energy industry ranks second in the volume new generating capacities added. In 2009, 139.1 billion dollars were invested in the clean energy industry all over the world. In January 2009, 142 States signed an agreement to establish the International Renewable Energy Agency (IRENA).

4. Entrance of new players onto the energy market. In early 2010, the U.S. Federal Energy Regulatory Commission granted the Google Energy a license to purchase and resell electricity on the market.

5. In September 2010 the American Petroleum Institute and the National Association of Manufacturers (NAM)) asked a federal appeals court to put on hold the first nationwide regulations to limit greenhouse-gas emissions (from factories, coal mines, power plants and other facilities (GHG Rules).

1

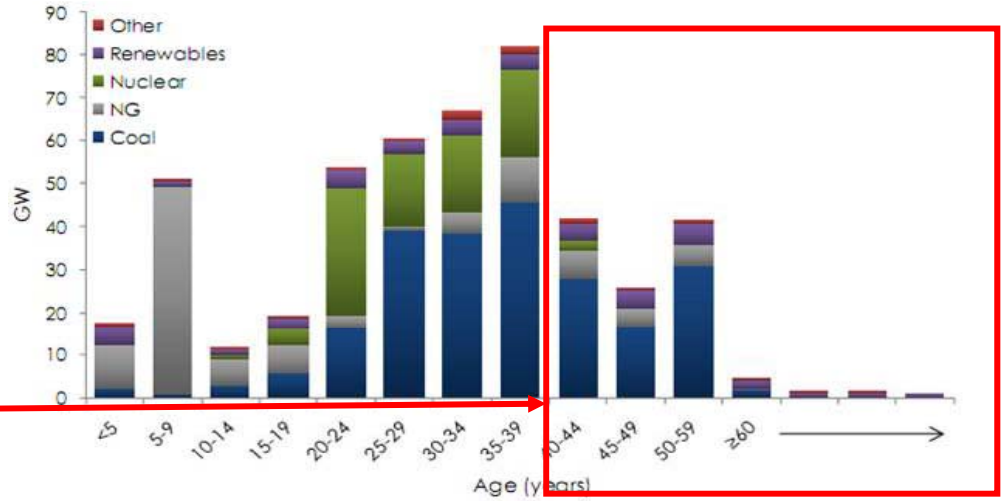
For global energy market players the uncertainty of their future has increased greatly.

The complication lies in the fact that all this is unfolding against a background of the beginning of a new large-scale investment cycle in the energy sector of industrially developed nations. Normal duration of such cycle is 40-60 years is determined operation life of main generating facilities and energy infrastructures.

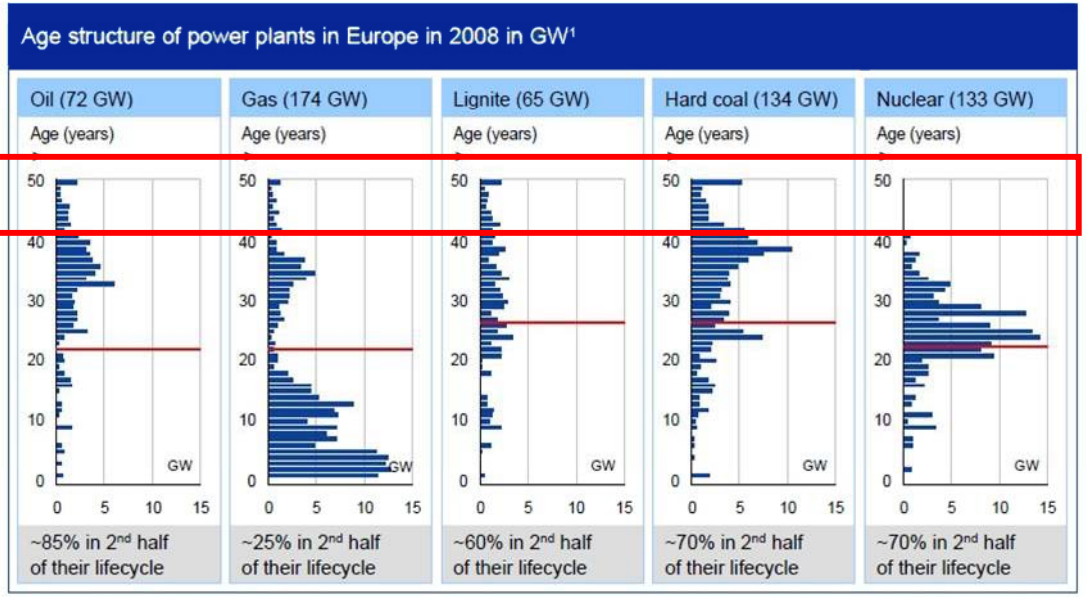
Presently, facilities with the age of over 40 years created within the framework of the previous large-scale investment cycle in 60s-80s of the 20th century will be removed from service. In the nest 10 years it will be a mass scale process.

Under the IEA's conservative basic scenario (World Energy Outlook, 2009), about $ 26 trillion is needed to be invested through 2030 in world energy sector, 53% of it – in electric power industry. Under the ambitious «450 scenario» an additional investment of $10,5 trillion is needed globally in the energy sector: $4,5 trillion – in transportation; $ 2,5 trillion - in building efficiency, $1,7 trillion – in electric power plants; $1,1 trillion in industry; $0,5 trillion – in biofuel.

Age of U.S. Electric Power Fleet (Scaled to Utilization Rate)



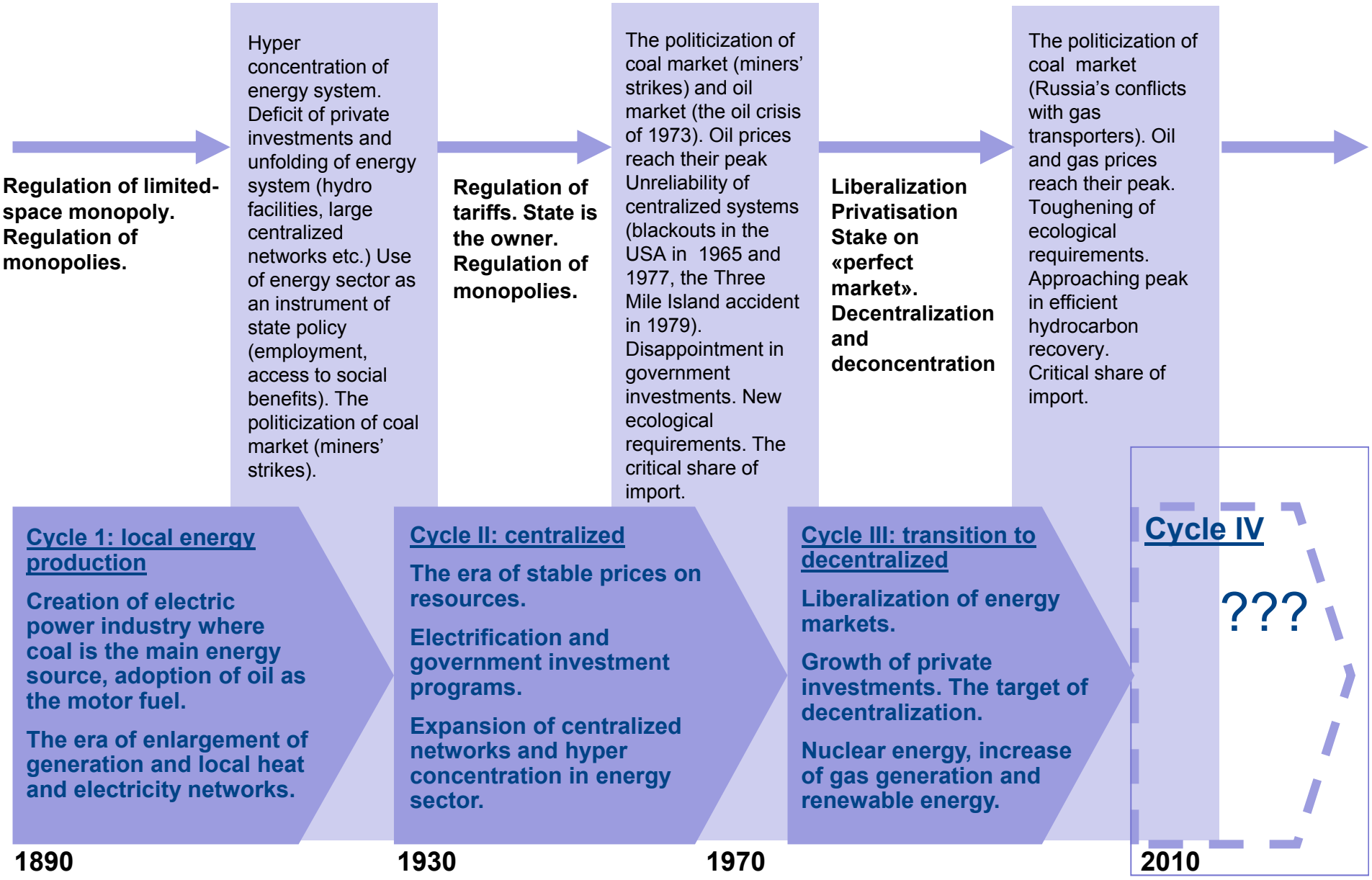
Source: Securing America's Future Energy



Sources: RWE

Hilf livetime

Industrially developed nations have gone through 3 cycles of the electricity era and are on the threshold of the 4th cycle.



Energy cycles demonstrated high sensitivity of the sector to measures of state regulations and technological development, and also to accessibility of resource base.

1971 – permission for 100% oil recovery in Texas. Loss of opportunity to manage imports.

Transition to open pit coal extraction, rapid growth in labor productivity

Clean Air Act 1970-77, Public Utility Regulatory Policies Act of 1978 (PURPA).

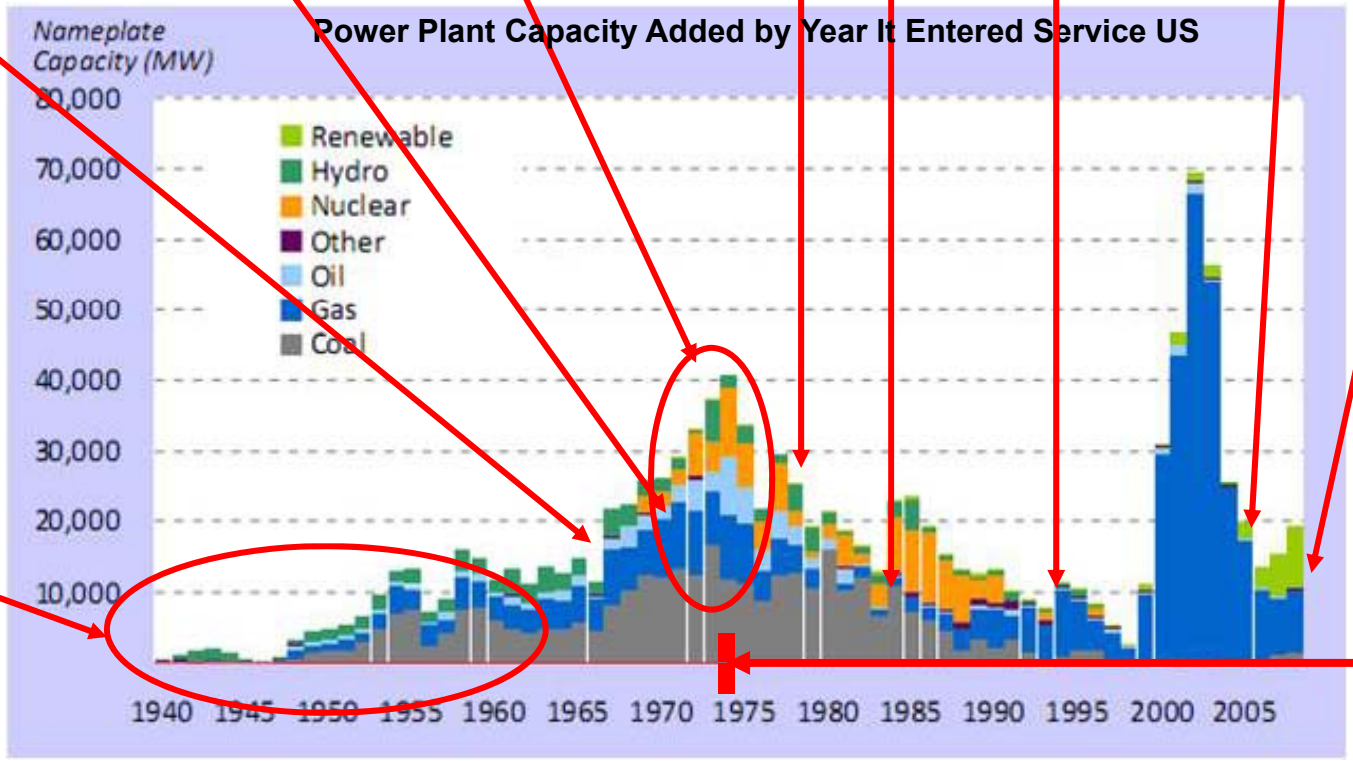
Oil crisis of 1973: increase of nuclear and gas generation.

Energy Policy Act of 1992 (EPACT).

Deployment of combined cycle plants

Programs of state support to renewable energy.

Shale gas Market.



Large scale programs

Capacity of centr. generation exceeds capacity of decentr. generators

Source : diagram
Ceres, et al., Benchmarking Air Emissions of the 100 Largest Electric Power Producers in the United States, June 2010

Starting a new investment cycle it is necessary to answer a question of whether it would reproduce existing model, of will this model change considerably? Evidently, the moment of transition from one cycle to another would require strengthening of state influence.

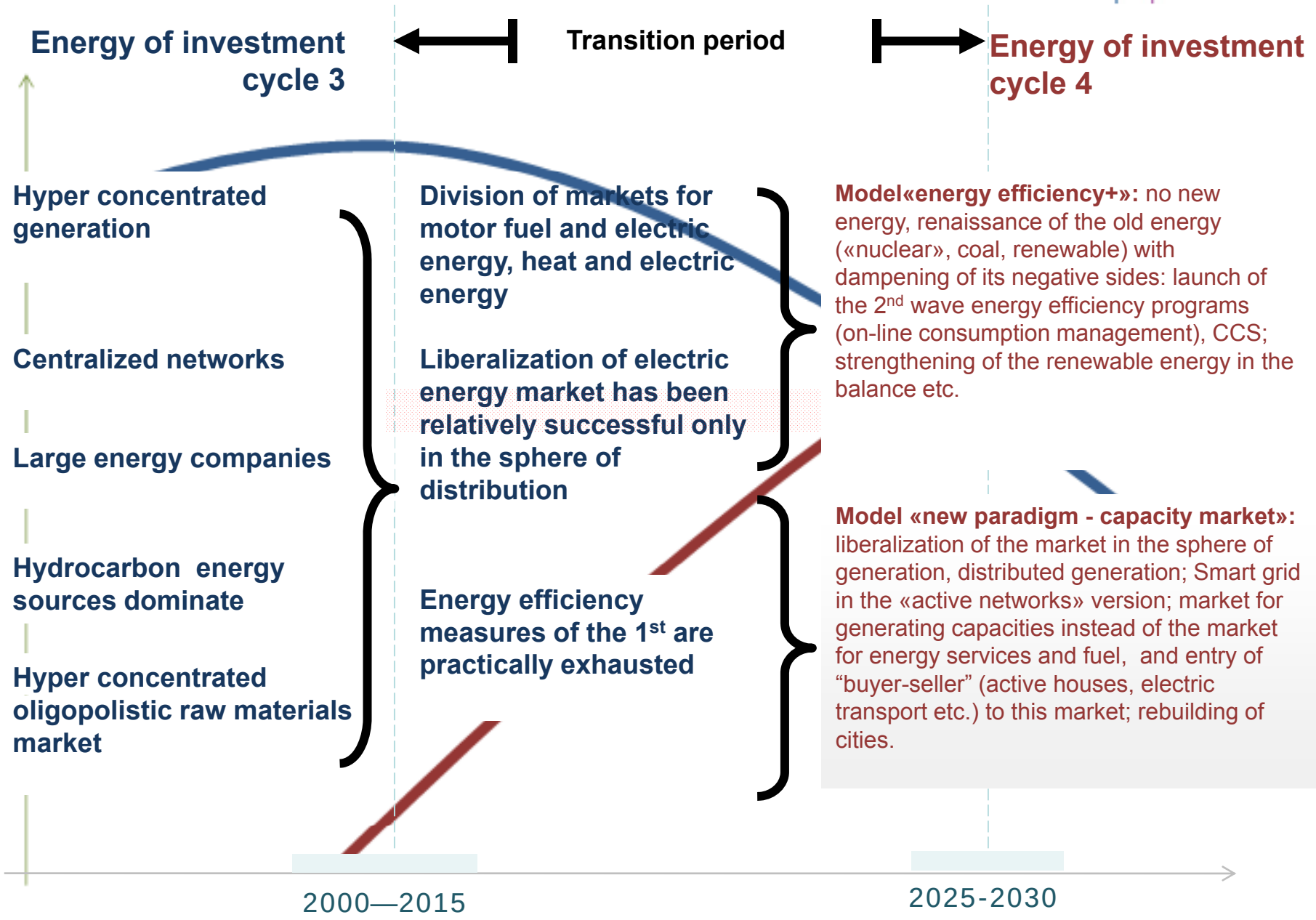
	Investment cycle 3	Investment cycle 4
Situation in which the new cycle is started	«Oil crisis» in conditions of critical dependence on import. Excess of generating facilities. «Weariness» from state management of the sector. Local ecological problems, accidents	Fluctuation of oil and gas market in the condition of critical dependence upon import. Deficit of generating facilities. Liberalization of the market is realistic only in the sphere of distribution (20-25% in electricity prices). Global «Climatic consensus».
Tasks solved during the cycle	1. Reduction of dependence upon oil. 2. Reduction of critical dependence upon import. 3. Ecological security of energy sector. 4. Growth of efficient use of resources.	1. Attraction of large investments in the sector. 2. Stability of fuel and energy balance. 3. Conformity to «climatic consensus». 4. Readiness to “post carbon energy” (peaks in coal, oil and gas production after 2050).
«Ideal solutions»	1. Liberalization of market (privatization of state-owned assets). 2. Energy efficiency. 3. Investments in renewable energy.	1. To continue liberalization, extending it to (distributed) generation??? 2. Completion of energy sector electrification??? Its informatization??? Blurring distinctions between «Consumer and producer»??? 3. CO2, quotas, hydro carbon tax??
Regulatory policy	Packet of reforms in energy (90es – first experiences in UK, USA; now - over 100 states; 1-2 «energy packets» EU). Rejection of state tariff regulation, creation of Independent marker regulators	Next packet of reforms, aimed at creation of distribution networks, protection of «consumer-producer», at the launch of new markets (energy storage, CCS, information storage and management etc.???

2

Main models and development scenarios of energy in the next investment cycle.

Most likely, the new investment cycle in energy may be based on two different target models and has three main development scenarios.

There are two models: old and new architecture of energy system



In fact, the «new paradigm» model in the logic of continuation of the energy market reforms, extension of reforms to the sphere of generation and efficient integration of renewable energy sources in this sphere has no alternative.

The main point of the «new paradigm» model is that a consumer has the opportunity to manage not only consumption but also production of the energy. Applied «consuming-producing» technologies should be configured in such a way that all (or considerable part) of produced could be (preserved) stored and could be used (and not only by its producer). Among the examples of such technologies are:

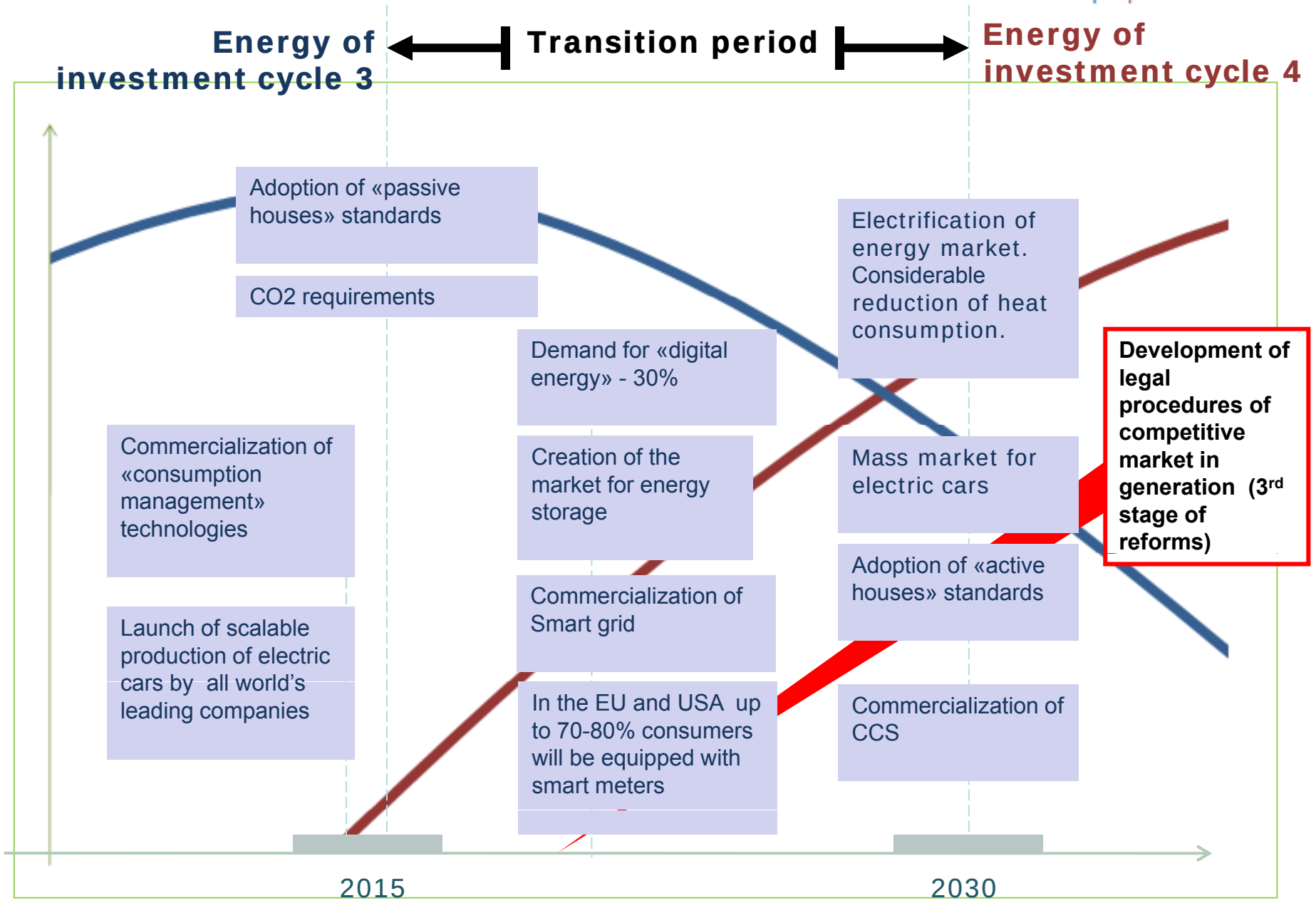
1. Electric cars connected to the so called «active network» (V2Grid), capable of not only supplying but also of receiving electric energy, stored in the “distributed battery” of electric car fleet, for example, to cover peak demands in electricity.

2. «Active houses», which not only save but also generate their own resources and can supply them to grids.

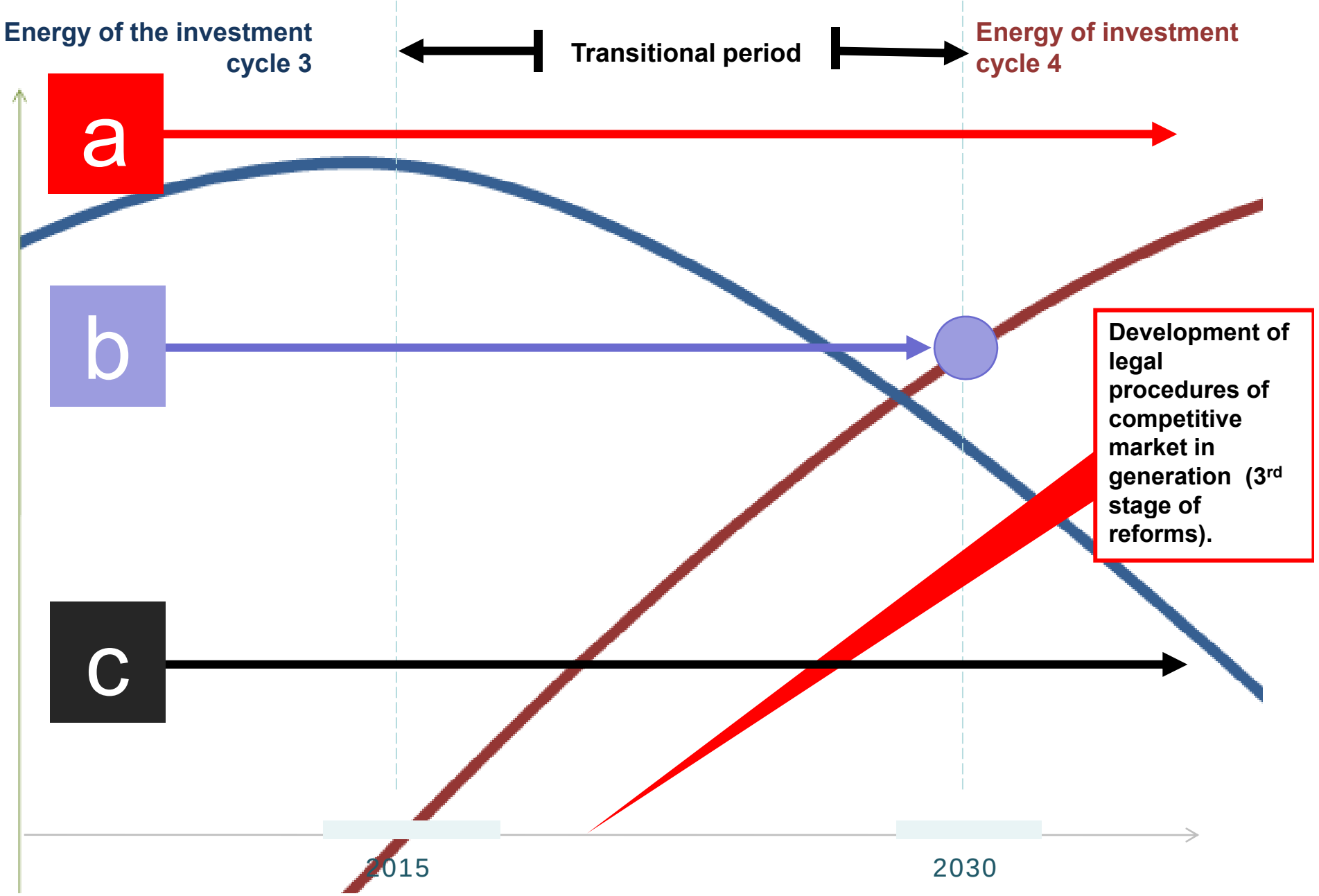
3. Smart grid in «active version» which integrates various entities acting as «consumers-suppliers» of energy and similar resources.

4. Scalable technologies for production of energy from locally available resources and various technologies for energy storage.

There are two models: old and new architecture of energy system



The speed of transition to the «new energy» can be different, this is the main point of development scenarios implemented in this sphere.



a

Gas pause.

Creation of the «ideal mixture»(«gas – renewable sources» or nuclear energy based, where gas generation and nuclear energy plant act as peak suppliers, demand for energy storage market is weak) or large (continental) network connection. Private investors are efficient.

Conditions for implementation: competitive and mobile gas market; production would peak after 2050; scalable varied solutions of gas generation; gas efficiently competes with renewable, coal and nuclear sources.

Risks: total dependence on one resource.

b

Balanced scenario:

2 energy sectors to be formed by 2030 – traditional («energy efficiency+») and the «new paradigm sector». Both are efficiently integrated into the Smart grid. High probability of formation of the independent energy storage market in different versions, including «distributed battery» in electric cars.

Conditions for implementation: toughening of CO2 emissions regulations, available and competitive gas market, scaling of renewable sources, their economic efficiency compared to other sources of energy.

Risks: resource shortage at the private market, necessary for restructuring of power grids, and also for development of renewable generation.

C

Status-quo scenario.

2 energy sectors to be formed by 2030 - traditional («energy efficiency+») and «new paradigm sector», but both are loosely integrated. «New paradigm» is provided only through government financing.

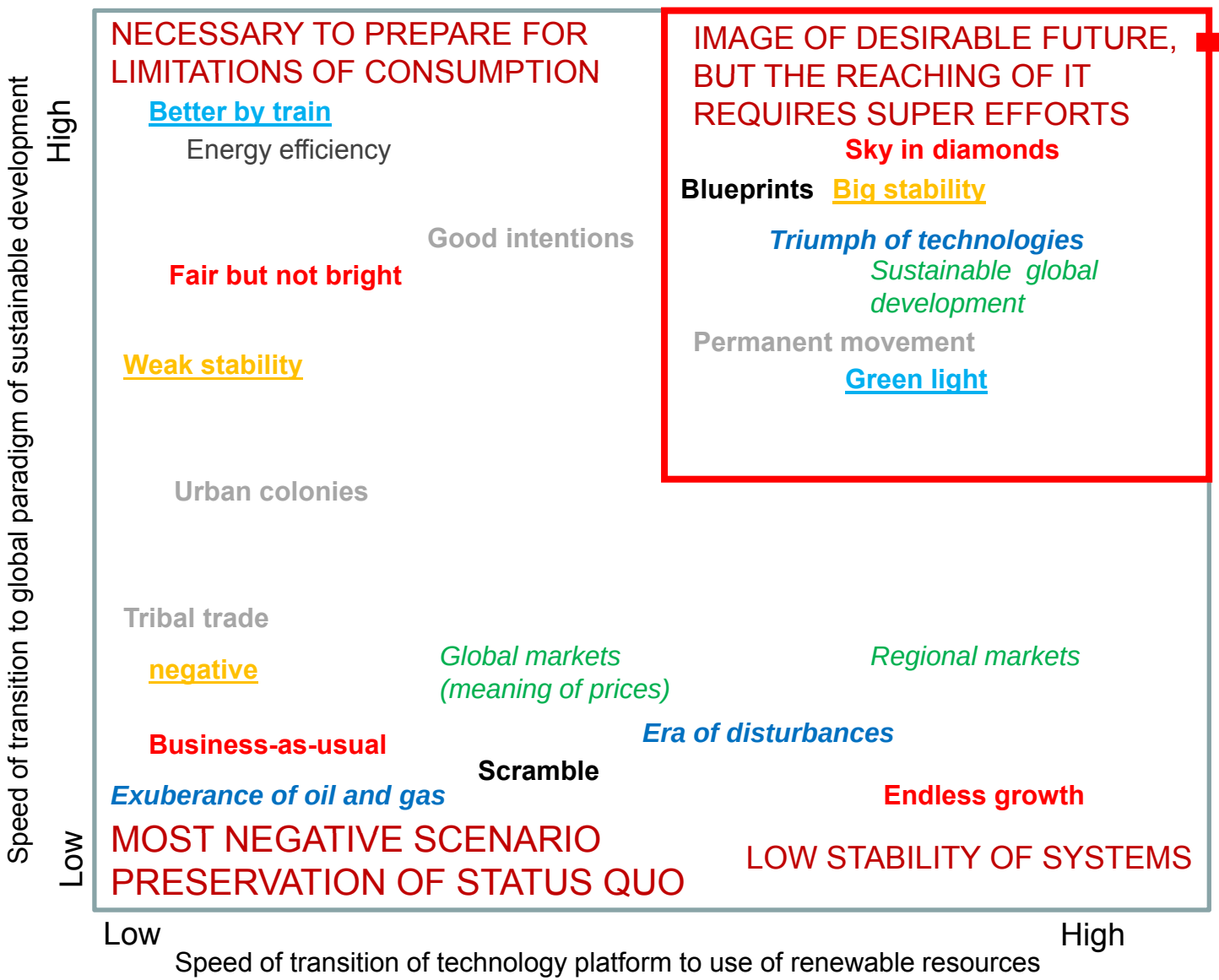
Conditions for implementation: soft CO2 emissions regulations, hydrocarbon production would peak after 2050.

Risks: production would peak earlier; return to tough regulation of market and state participation.

3

Russia is at the beginning of the new investment cycle in energy sector.

There is a number of proofs that for centers of market the vision of desirable future of energy lies in realization of the "New paradigm" model. This is expressed in scenarios of foresights conducted in the period of 2000es.



Requirements

- Technologic readiness of renewable resources
- Distributed generation and grids
- Free market
- International agreements on CO_2

Analyzed scenarios:

International Energy Agency

UK Department of Trade and Industry

European Energy Scenario for EU-25

Resource use scenarios for Europe in 2020

Intelligent Infrastructure Futures Scenarios Toward 2055, UK

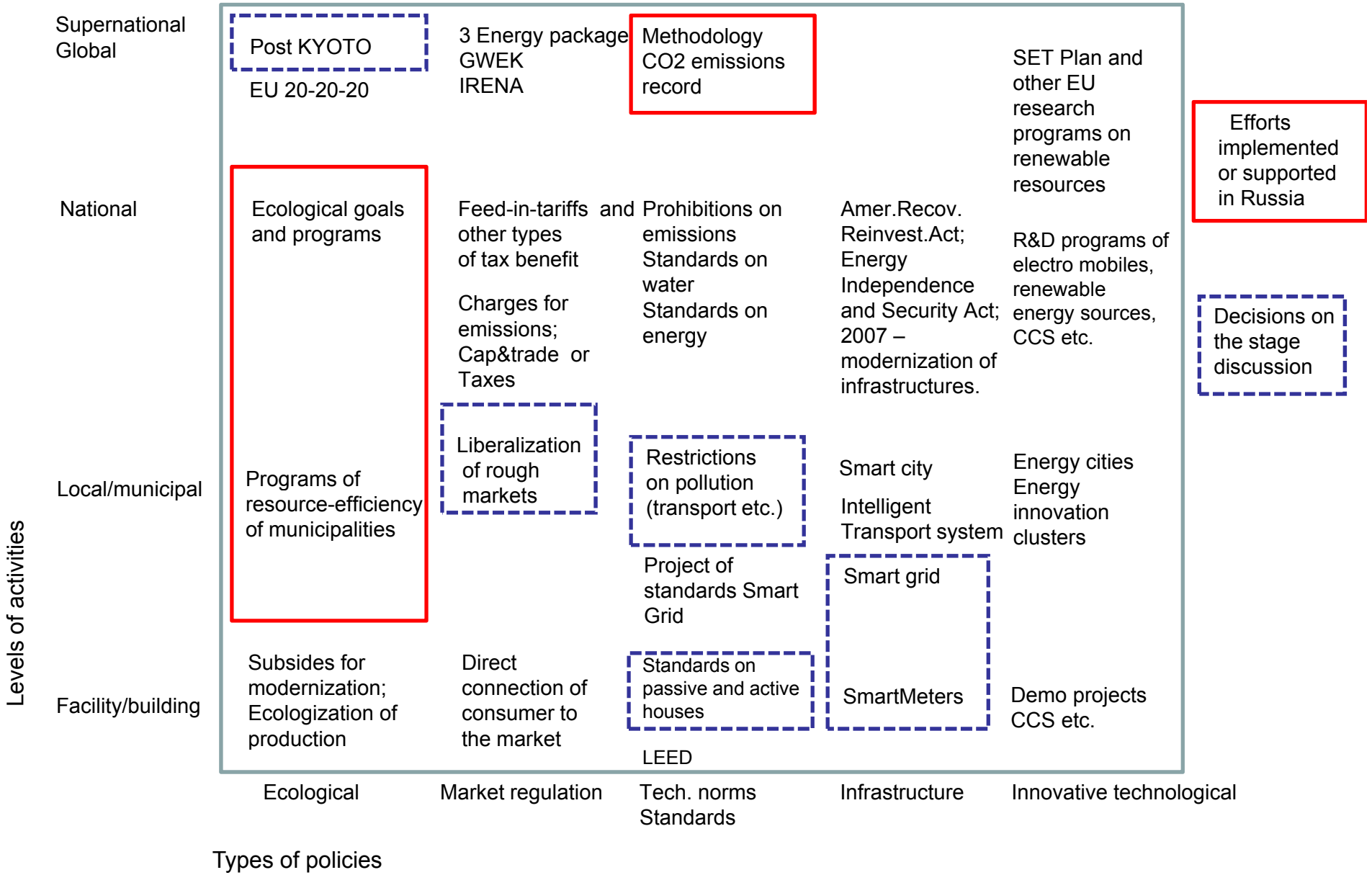
U.S. Energy Scenarios for the 21st Century

The Future of APEC

Megacities: A Foresight Approach

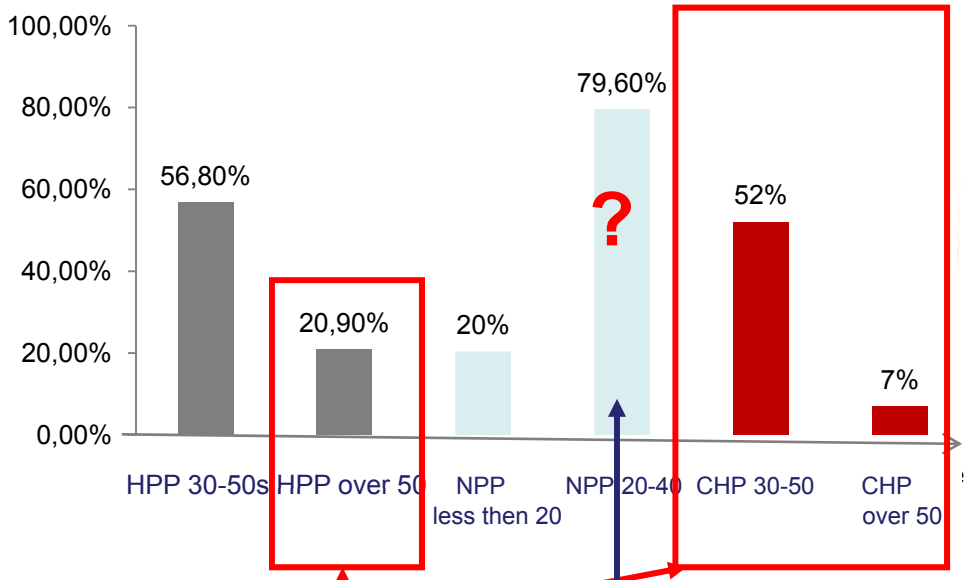
Energy scenarios of Shell concern till 2050

Main stream of energy policies (agenda).

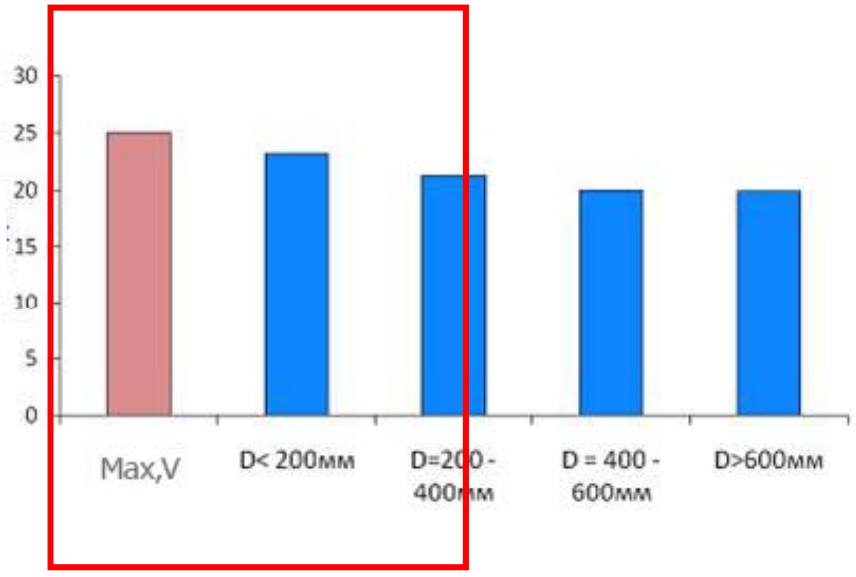


Russia along with other industrially developed countries confronts the need to start the next investment cycle in energy sector. In addition to replacement of retired capacities in Russia the Ministry of Energy plans the annual growth in energy consumption of 2,2 to 3,1 per cent (i.e. 78-93 GW of new capacities should be launched by 2020 and и 171-225 GW — by 2030 году). Besides, automobilization of the country would continue and consumption of motor fuel would grow.

Age of generating facilities in years , the share in total capacity of the specified type of stations



Heat network by age of pipelines



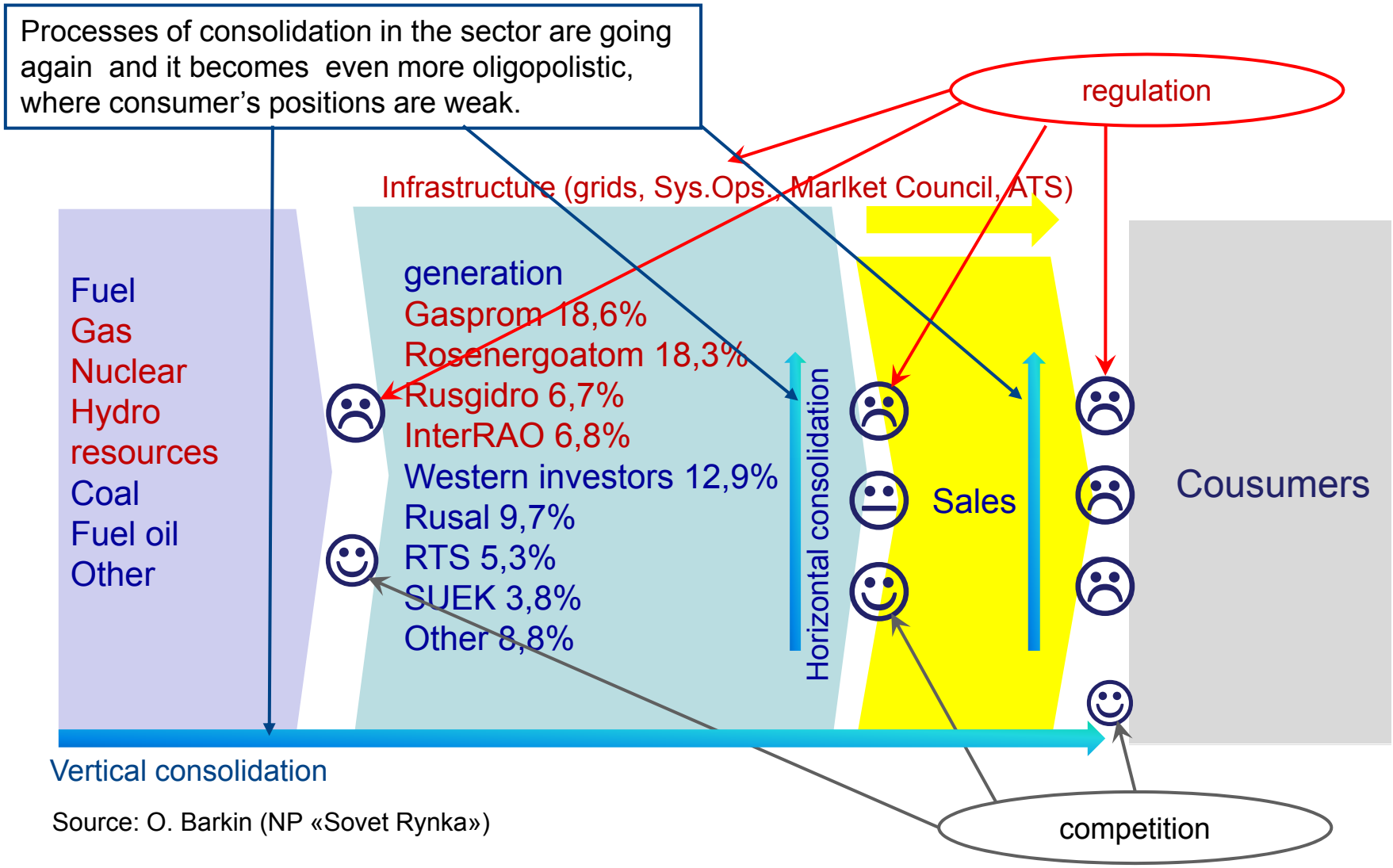
Source: RF Ministry of Energy

Decisions on preservation or replacement of capacities should be taken within 10 years

16.5 GW should be put ouit of operation by 2030

Up to 60% of heat network in centralized heat supply systems

The new investment cycle begins in the situation when Phase I of reforms in electric power industry has not been completed (only wholesale market of electric power is relatively competitive). Completion of this phase of reforms would take 3-5 years. Natural gas market has not been liberalized and prospects for liberalization remain unclear.



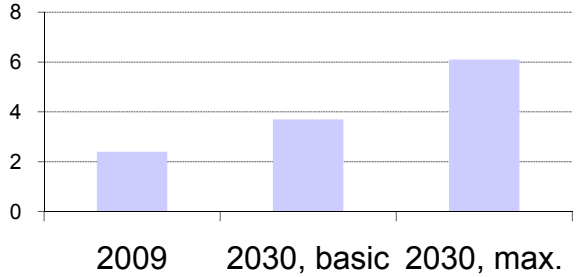
Source: O. Barkin (NP «Sovet Rynka»)

Investment plans have been created to comply with reconstruction and modernization of the old architecture of power system: hyper concentrated generation, centralized power systems, consolidated players at the fuel market, preservation of principal energy balance parameters.

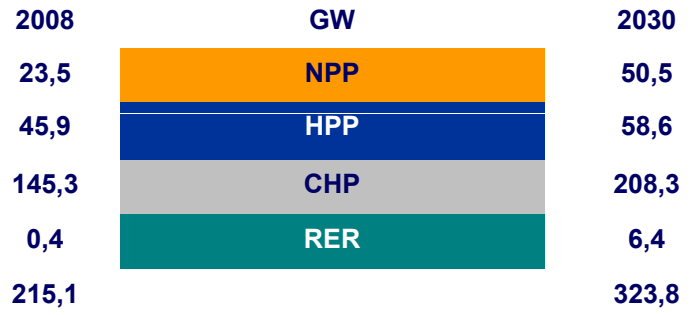
The share of large electric power plants (over 600 MW) in the existing power system is about 64% of the total installed capacity (including industrial isolated generating plants).
The share of small distributed generation including RER is about 1,5%.

In accordance with the «General plan of electric power facilities allocation in Russia till 2020. with due regard to prospects till 2030» development of distributed small generation will be conducted on the basis of cogeneration (including gas turbine plants- heating power plant sand combined cycle gas turbine units-heating power plants with low power up to 25MW), and also use of renewable energy sources (small HPP, Bio-TPP, biothermal PP, Wind PP и Wind-diesel PP, tidal PP, solar PP). By 2030 the share of renewable energy (except HPP) in the energy balance should grow from current 0,2% to 4,5%.

The share of distributed generation (from the total installed power capacity), %



The structure of installed capacity in accordance with the General plan of electric power facilities allocation



Source: Agency on Forecasting Balances in Electric Power, General plan of electric facilities allocation in Russia till 2020 with due regard to prospects till 2030

The problem of mobilization of finance for modernization of hyper concentrated and centralized power system remains unsolved. Financing «by default» is expected to come from budgetary sources and due to increase in electricity tariff.

Name	Unit of measure	1990	2007	Indices similar to 2007
Technological constraints of electric power plans capacity	Million KW	12,0	28,0	Non-existent in the period of 1946-1990
Putting into operation of nee power facilities (energy constructing potential	Million KW/year	4,9	2,2	1959
Specialized sectoral maintenance (energy maintenance potential)	Number of experts	40 000	7 000	1952
Wear of fixed assets	%	40,6	56,4	1947
Losses of electric power in grids	%, Billion,	8,2 82,0	14,0 112,0	1946
Specific fuel consumption for electrical supply	Tones of conventional fuel/kilowatt-hour	31 1,9	333,5	1976
Capacity servicing factor	%	57,2	51,9	Non-existent in the period of 1946- 1990
Tariff for industrial consumers	Cent/kWh	1,2	5,7	Non-existent in the period of 1946- 1990
R&D financing	Million dols.	150	10	1950
Share of domestically produced equipment in new projects	%	99,0	35,0	1940
Remuneration of top managers compared to industry average	Exceeds, times	3-5	70-100	Non-existent in the period of 1946-1990

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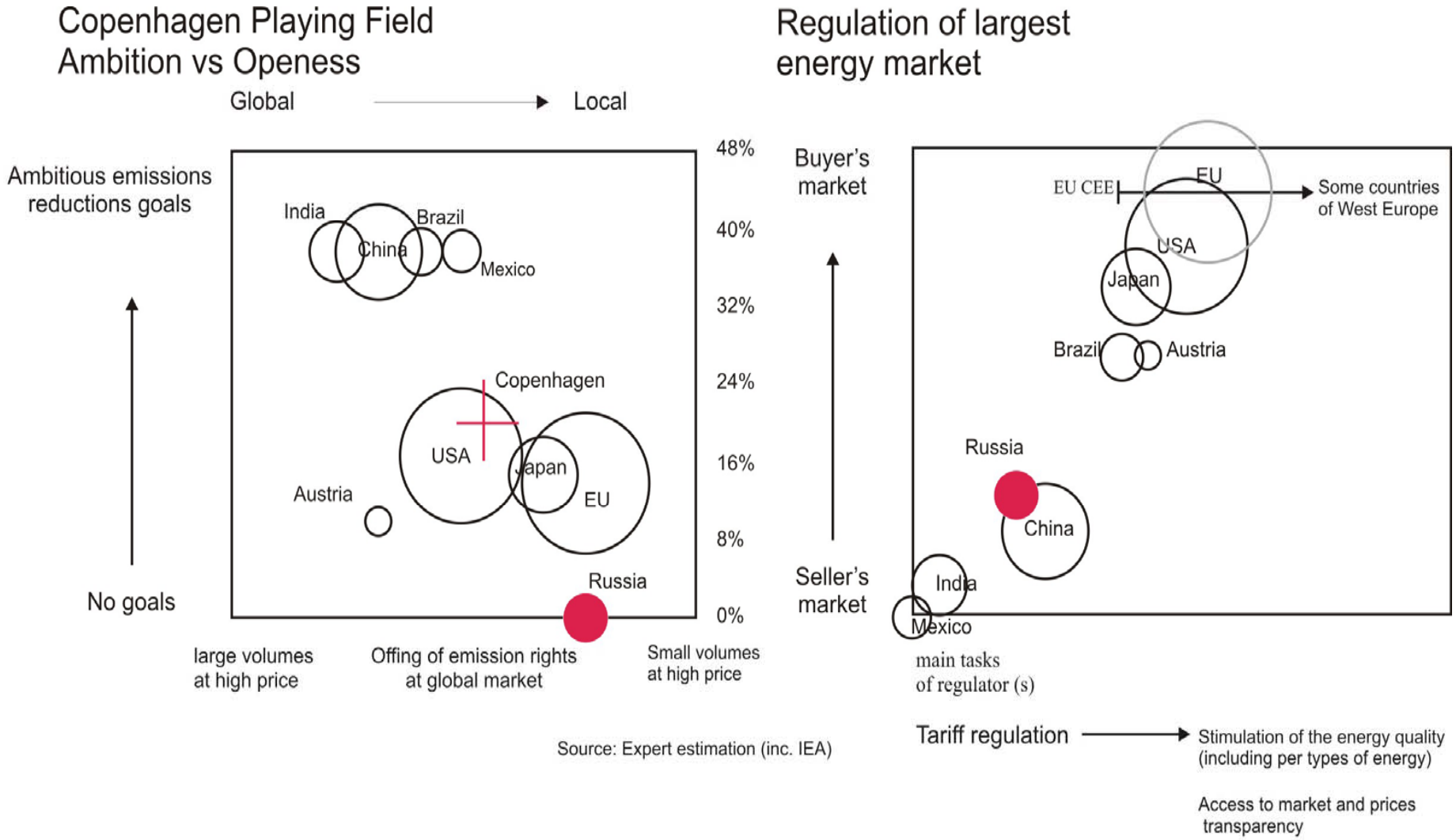
For the present energy policy and the system of regulation are poorly coordinated with tasks of Investment cycle 4 and Phase 2 of energy markets' reforms in other industrially developed countries.



The system for regulation of electric power markets is in the process of establishment and completion of this cycle would require a considerable amount of time. Undivided competency is left:

Reliability of electric power supply

Long-term forecast of demand supply

Minenergo, Sys.Ops.

Reliability assurance system

Sys.Ops, FSK, network companies

Peak load management

Sys.Ops.

Balance solutions

RF Federal Tariff Service, Sys.Ops.

Market formation

Speed of market opening

RF Government, Ministry of Economic Development, Ministry of Energy, Federal Antimonopoly Service, Federal Tariff Service

Rules of wholesale and retail market

RF Government, Ministry of Economic Development, Ministry of Energy, Federal Antimonopoly Service, Federal Tariff Service, Market Council

Development of competition in competitive sectors RF Federal Antimonopoly Service ?

Regulation of professional market players – issue of specialized permissions/licenses and their monitoring

Market Council in the part of professional wholesale market players -?

Investments in generation (new facilities и and modernization):

Planning

Ministry of Energy, Ministry of Economic Development, Sys.Ops.

including RF Federal Tariff Service

approval

No exact order

realization - ?

monitoring -? including RF Federal Tariff Service

Investments in transmission and distribution (new facilities and modernization)

- planning

RF Ministry of Energy, Ministry of Economic Development, Federal Tariff Service, Regional Energy Commissions, FSK, RSK

- approval - ?
- realization - FSK,MRSK,RSK
- control -?, including RF Federal Tariff Service

Protection of environment

Renewable resources -?

- Energy efficiency Federal Tariff Service, -?
- Emissions control -?

Ministry of Energy

Prices and tariffs

Wholesale prices (in regulated part)

RF Federal Tariff Service

Retail prices

establishment and control

Regional Energy Commissions, RF Federal Tariff Service

Tariffs for transmission and distribution

RF Federal Tariff Service,

Regional Energy Commissions

Connection charge

RF Federal Tariff Service,

Regional Energy Commissions

Monitoring of wholesale market

Ministry of Energy, Market Council, RF Federal Antimonopoly Service, RF Federal Tariff Service

Monitoring of retail market

RF Federal Tariff Service, RF Federal Antimonopoly Service, Regional Energy Commissions

Protection of consumers

Monitoring of supply safety

Planned by RF Federal Tariff Service, Regional Energy Commissions (planned within RAB framework)

Protection of vulnerable categories of customers -?

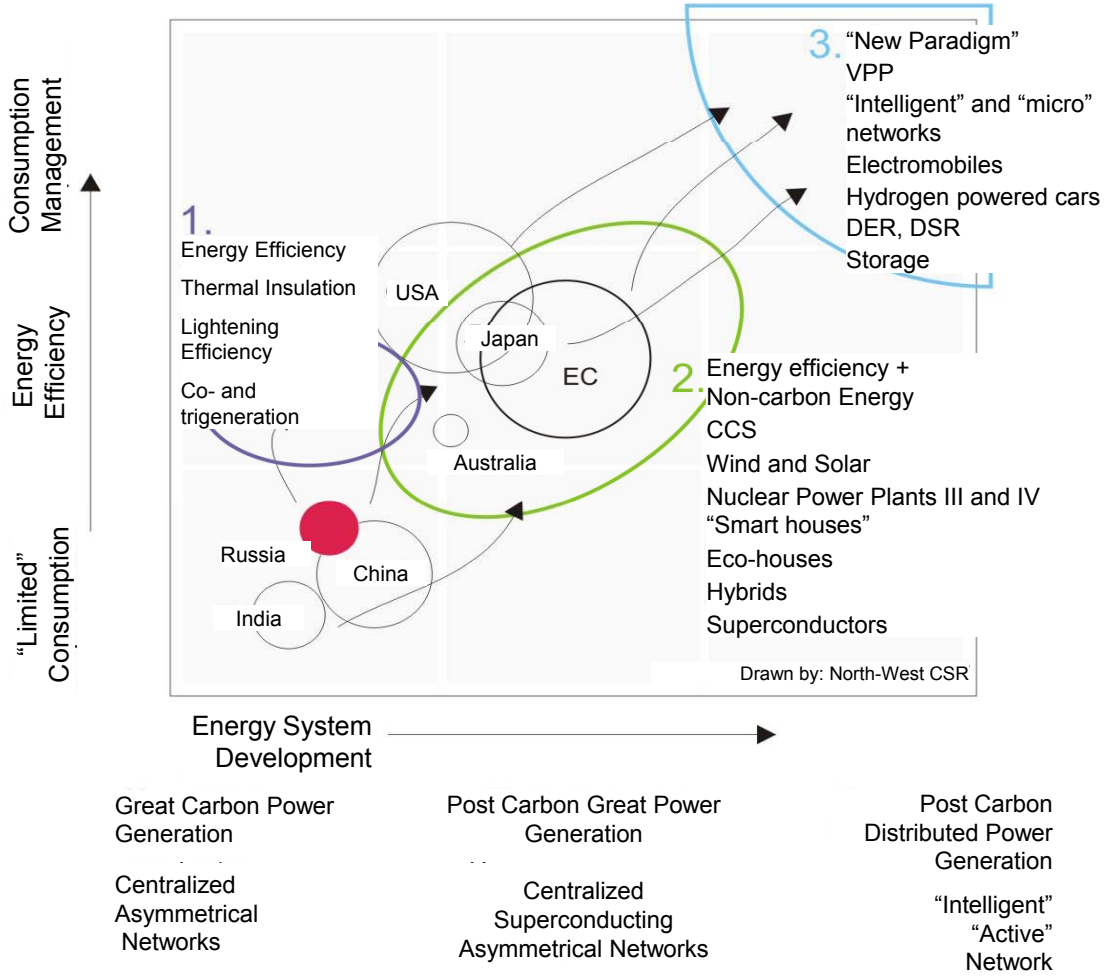
Pre-trial settlement of disputes

RF Federal Tariff Service + Regional Energy Commissions ?

Source: O. Alilluyeva (RF Federal Tariff Service)

At present energy companies in Russia are not among drivers of technological growth of the sector. In the next 3-5 years they will be busy restructuring assets acquired during privatization and fulfilling their investment obligations. Raw materials and technology companies are not among leaders of global market transformation. Formulation of technology models and scenarios for development of future energy sector confronts apparent problems.

Technological basis of the energy in the future



Completion of the first stage of electric power industry reforms as well as the formula for attracting investments in the sector, created in the time of the privatization of assets, on one side, would conserve the existing model and, on the other, would create the danger of the appearance of "Black swans".

«Black swan» for Russia energy sector - 1

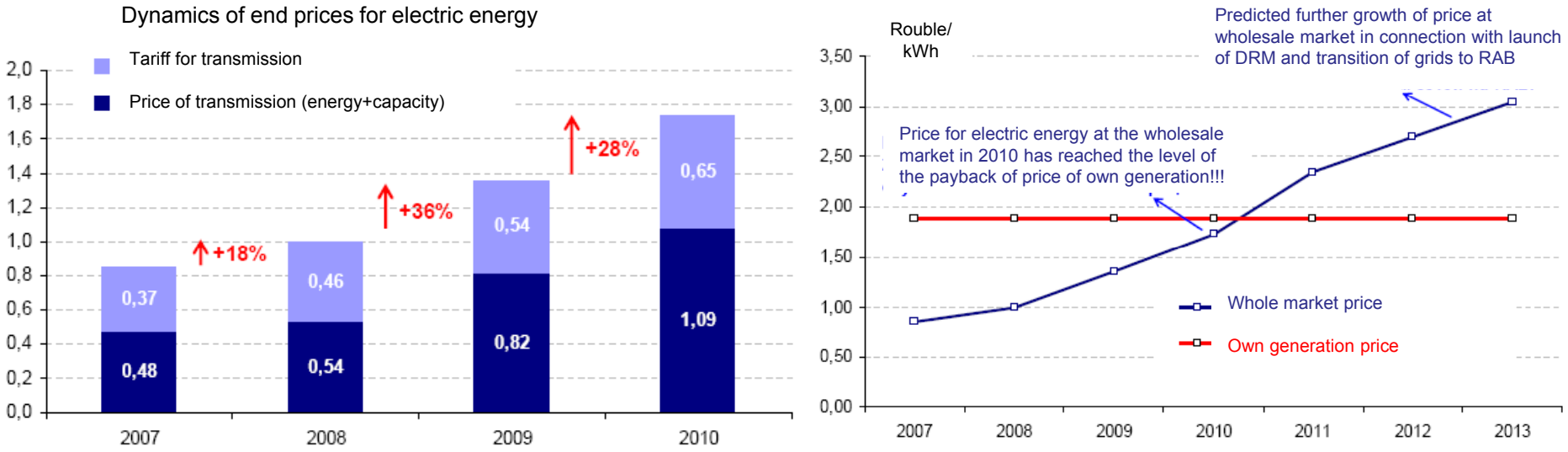
1. Danger of blackouts caused by sharp reduction of reliability of centralized power accident on Sayano-Shushenskaya HPP (2009), blackouts in Moscow (2005) and in St. Petersburg (2010) fail to correspond to the increased complexity and volatility of consumers at the energy market, and also to the fact that numerous new subjects implementing uncoordinated plans start to operate at the market of generation. It is not only the technical condition, but also the changes in the architecture, in systems of management of the dynamic market (En+, Siemens etc.).

Blackout	Technological consequences	Direct and indirect losses to economy
2005: Moscow and also territories of Moscow, Ryazan', Tula and Kaluga oblasts.	Switching off of electricity for several hours at the territory with the population of over 2 million	1,0-1,5 billion roubles
2010: districts in St. Petersburg and 4 districts in Leningrad Oblast.	Switching off of electricity for several hours at the territory with the population of over 2,5 million.	250-300 billion roubles

«Black swans» for Russia's energy sector - 2

2. Constant growth of prices within the framework of hyper concentrated and centralized energy industry (which is justified by goals of mobilization of investments) provokes the «flight» of consumers from this energy sector: a) establishment of their own local generation. Notably, in most unproductive way – as distributed local generation and not as a decentralized unified energy system; b) growth of non-payments and thefts of electric power at retail market. There is a possibility that all viable energy systems would "escape" from the energy system and its operation would became not an economic but a political issue.

Actual prices for electric energy and calculation of prices for autonomous generation on the example of Tyumen region (TNK-Nyagan)



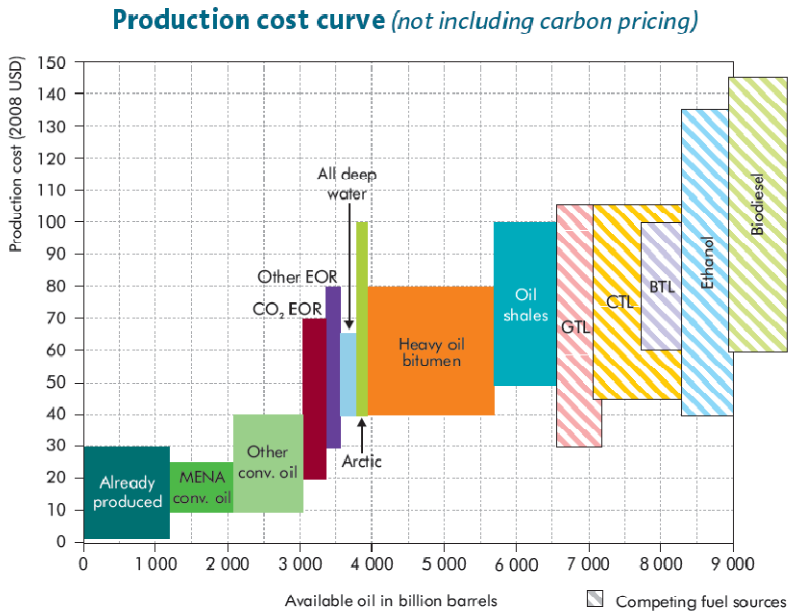
Source: TNK-BP

Example: TNK-BP has established eight own power generating facilities with total capacity of 137 MW at its oilfields and plans to build another eight small generation facilities with the capacity of 650 MW.

«Black swans» for Russia's energy sector - 3

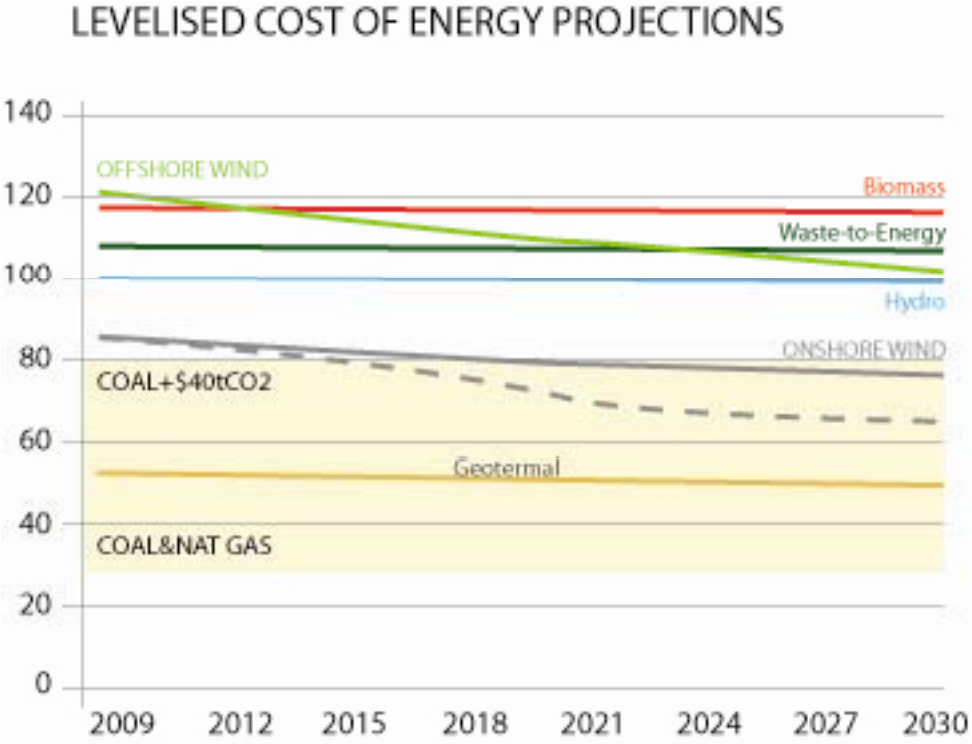
3. Economy of the energy sector could change in short time. Complex of renewable energy technologies is quickly "scaled" to mass solutions and with lower barriers for investors compared to large scale traditional generation. At the same time, prices for hydrocarbon energy would go up. The future of coal generation economy is questionable. In this situation our cheap energy balance could become super-expensive and inefficient.

The growing cost price of production and resource potential by types of liquid hydrocarbons.



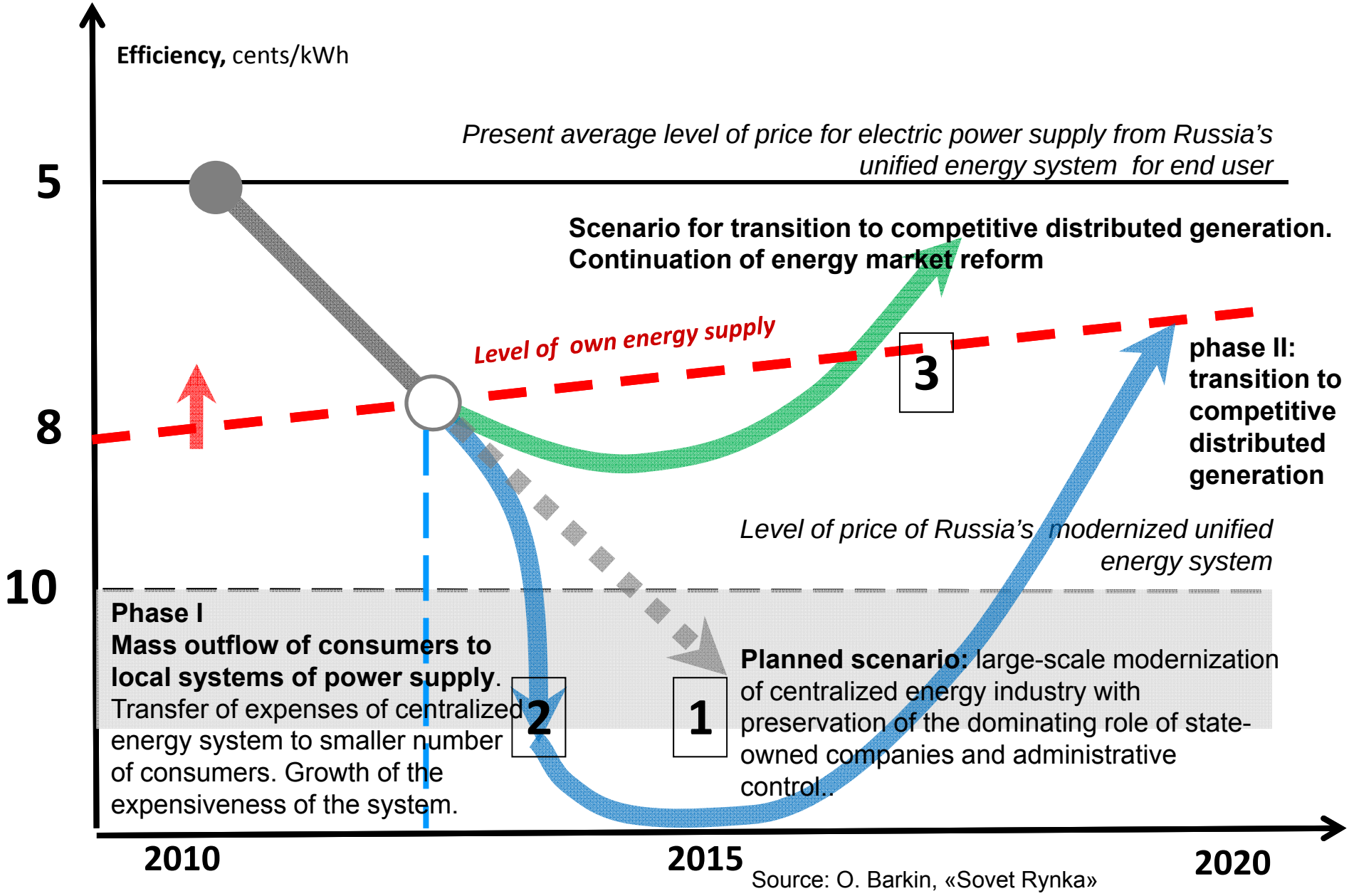
Source: EIA

Cost price of onshore wind energy may grade up to the cost of traditional generation (in case of adoption of emission norms) by 2015.



Source: Bloomberg New Energy Finance, GE2M analysis

Three possible scenarios for development of the RF energy market for the next 10-20 years



Source: O. Barkin, «Sovet Rynka»

What global models and development scenarios are relevant for Russia's energy sector for the next 10-20 years?

1. In the next 10-15 years Russia has to complete the previous investment cycle – to realize « Energy efficiency+».

2. To modernize existing large energy systems, changing approach to management of their architecture, to secure transition to decentralized systems with unified management basis.

3. To develop energy sector segments, that provide new paradigm possible only on the basis of government efforts. In particular, this refers to:
   - Energy storage markets in different technological versions (electric cars with supporting infrastructure); transfer of certain types of generation, like hydro generation, from basic to peak and storage; development of technologies for energy accumulation.)
   - Support of technologies for capture and storage of carbon dioxide
   - Markets of technologies for consumption control.

4. To make us feel system changes it would be necessary to secure the scale of government efforts with setting of goals:
   - The share of renewable energy – no less than 10%;
   - Legal and institutional conditions for integration to the consumers-producers system (+ liberalized consumer market contribute to creation of competitive gas market.

5. To prepare for adoption of strict international standards which ensure sustainable development (for carbon dioxide, later, possibly, for water).

The Center for Strategic Research "North-West" Foundation is the coordinator of the project "Energy foresight for the Russian Federation". The project is aimed to creation of the system for technological prognostication in the Russian Federation energy industry.

We invite you to participate in the **International Energy Conference**, that will be held within the framework of the project. The topic of the Conference is ***Technological basis for the formation of the new Russian energy industry"***
November 25-26 2010, Moscow, Moscow School of Management Skolkovo

The session is supported by RF Ministry of Energy, Federal Tariff Service, SUEK public corporation, Rosatom state corporation, the Foundation for Development of the Center of Research and Commercializing of New Technologies in Skolkovo. The Center for Strategic Research "North-West" Foundation is the coordinator of the preparation for the session

For more information, regarding the program, please contact Marina Lipetskaya, foresight project coordinator of the Center for Strategic Research "North-West" Foundation, marilip@csr-nw.ru
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