Renewable Energy Sources in Energy Abundant Economy: Russia is in the Focus

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Russian Energy Sector in the World Economy in 2011

	Volume	World position	Share in the World	Net exports
Oil. mill. t	517	2	12.9	246
Gas. bill. cubic m	677	1	20	196
Coal. mill. t	334	6	4.3	99
Energy from HPS. bill. kWt-h	170	4	6.2	
Energy from NPS. bill. kWt-h	168	5	4.8	
Petroleum products. mill. t	240	3	6.3	111
Electric Energy. bill. kWt-h	1036	4	4.8	17
Energy production. mill. oil. equ.	1315	3	10.0	592
Energy consumption. mill. oil. equ.	731	3	5.6	
Renewables (RE). mill. oil equ.	17.7		1.34	
RE without HPS. mill. oil. equ.	3.5		0.25	
GDP. $ bill. PPP	2376	6	3.0	
Population. mill. of persons	142.9	9	2.06	

Sources: Rosstat RF. IEA. and IMF

Russia and Some Other World Economies in 2010, USA=100%

	Per capita			Per GDP	
	GDP PPP	Energy use	Electricity use	Energy use	Electricity use
Canada	83	104	126	125	152
Czech Republic	54	60	60	112	110
Finland	74	97	109	131	146
Germany	76	56	54	74	72
Greece	63	36	38	57	60
Israel	62	44	56	71	91
Japan	72	55	62	76	87
Netherlands	85	70	50	81	58
Russia	**34**	**70**	**52**	**209**	**154**
Sweden	82	79	116	96	141

Calculated using WB & IEA data

Renewable energy (RE) in the World and selected world economies. t. of oil e., 2011

	Per capita energy output	Per capita energy use	Per capita RE output	RE share in energy output. %	RE output to ener. use ratio. %
Canada	12.02	7.40	1.33	11.04	17.93
Denmark	3.80	3.25	0.55	14.43	16.84
Finland	3.25	6.61	1.73	53.14	26.13
Germany	1.52	3.83	0.38	25.19	10.04
Iceland	15.45	18.42	15.45	100.00	83.83
Japan	**0.41**	**3.65**	**0.15**	**37.80**	**4.23**
Netherlands	3.82	4.60	0.19	4.88	4.06
Norway	41.64	6.00	2.55	6.12	42.50
Spain	0.68	2.69	0.29	43.31	10.96
United States	5.70	7.00	0.43	7.61	6.20
World	1.91	1.89	0.25	12.89	12.98
OECD Total	3.13	4.31	0.35	11.09	8.05
Russia	**9.20**	**5.12**	**0.12**	**1.35**	**2.43**

Structure of renewable energy produced by sources. Percent, 2011, Total RE=100%

	Russia	Japan	OECD Europe	OECD Total	World
Hydro	80.42	36.63	23.41	27.94	17.64
Geothermal	2.53	12.70	6.58	7.64	3.87
Solar Photovoltaics	0.00	2.27	2.09	1.16	0.31
Solar Thermal	0.00	2.10	1.51	1.49	1.08
Tide. Wave and Ocean	0.00	0.00	0.02	0.01	0.00
Wind	0.00	2.01	8.47	6.61	2.19
Renewable Muni. Waste	0.00	3.19	4.95	3.24	0.87
Solid Biomass	17.05	40.54	41.29	38.27	68.91
Landfill Gas	0.00	0.00	1.57	2.08	0.53
Sludge Gas	0.00	0.00	0.69	0.34	0.09
Other Biogas	0.00	0.56	3.34	1.53	0.90
Biogasoline	0.00	0.00	0.92	6.63	2.06
Biodiesel	0.00	0.00	4.29	2.61	1.02
Other Liquid Biofuels	0.00	0.00	0.86	0.42	0.50

Potential of Energy Production from RES in Russia*

	Potential. bill. kWt-h		
	Technical	Economic	Industrial
Small HPS (<25 Mw)	372	205	6-10
Wind PS	6517	326	70-90
Geothermal PS	34905	335	40-60
Biomass PS	412	203	90-130
Tidal PS	253	61.6	16-45
Solar HPS	2714	435	5-10
In Total	45173	1566	227-342

*Sourse: OAO “RusHydro” in 2010

A specific reason to develop RES in Russia: extremely large country

- About 2/3 of the country surface square with population of 20 mill is out of access to a centralized grid. The electricity prices here are extremely high (30-60 cent./kWt-h and even higher);
- The most of administrative regions of Russia lack their own energy sources and need to import fuels and energy from other regions. The problem of energy security is as important for them as for the energy importing countries;
- Only about 50% of urban and 35% of rural residential areas in Russia have access to gas networks. Both coal and petroleum fuels being ecologically harmful are used in this places to produce electricity and heat;
- Given a persistent growth of energy prices and costs to connect to the centralized energy networks offline energy production develops more rapidly. Consumers pursue to secure themselves with their own power and heat sources.

What could be estimated as successes?

- Russia entered the number of the World leading pellets producing economies (2 mill t per a year). However. they are mainly produced for exports to Europe,
- There are certain results in constructing tidal energy devices based on original national designing,
- Some companies are concentrated on a development of large size production of photoelectric converters, though also for exports.

Summarized data on electricity production from renewable energy sources (RES) in Russia, 2010

Types of RES	Generation capacity, Mw	Power generation. mill. kwh	Share in industrial potential, %	Share in economic potential, %
Wind ES	13.2	14.2	0.02-0.02	0.004
Small HPS (<25 Mw)	700	2800	46.7-28.0	1.37
Geothermal PS	81.2	474	1.2-0.8	0.14
Solar PS	0	0	0.0-0.0	0.00
Tidal PS	1.1	1.2	0.0-0.0	0.00
Biomass PS	520	2600	2.9-2.0	1.28
In Total	1315.5	5889.4	2.6-1.7	0.38
Share of RES in total electricity production, %	0.57	0.58		

*Sourse: OAO “RusHydro” in 2010

- In *Novosibirsk region* (Oblast): Long Run Program «Energy supply and increasing of energy efficiency in Novosibirsk region for the period up to 2015» It foresees elaboration of several investment programs and among them:
- Investment program «Small size energy in Novosibirsk region»
- «Investment programs in life-support systems and local energy objects of municipal units in Novosibirsk region»

- RES resources in Novosibirsk region:

- *Wind ES* is used now and will be used for individual consumption. Engines of 5-40 kWt. There are no conditions favorable for wind energy development in the size comparable with centralized energy system due to climate peculiarities
- *Agriculture wastes* 5 mill t per a year. wastes from wood processing and forest sanitary felling - 2 mill t per a year.
- *Peat reserves* - about 2 bill t. annual increment of reserves - 50 mill t. This increment equals a half electricity and heat production need for fuels. Peat is the most promising type of RES in Novosibirsk region

The Reasons why RES development fails in Russia:

- General market non-competitiveness of RES developing projects with respect to the energy projects based on the fossil fuels;

- Institutional barriers associated with the lack of legislative acts promoting RES in the sphere of electricity production and absence of federal and regional programs aimed at large scale support of RES usage;

- Absence of infrastructure necessary for successful development of RES energy generation; in that number:

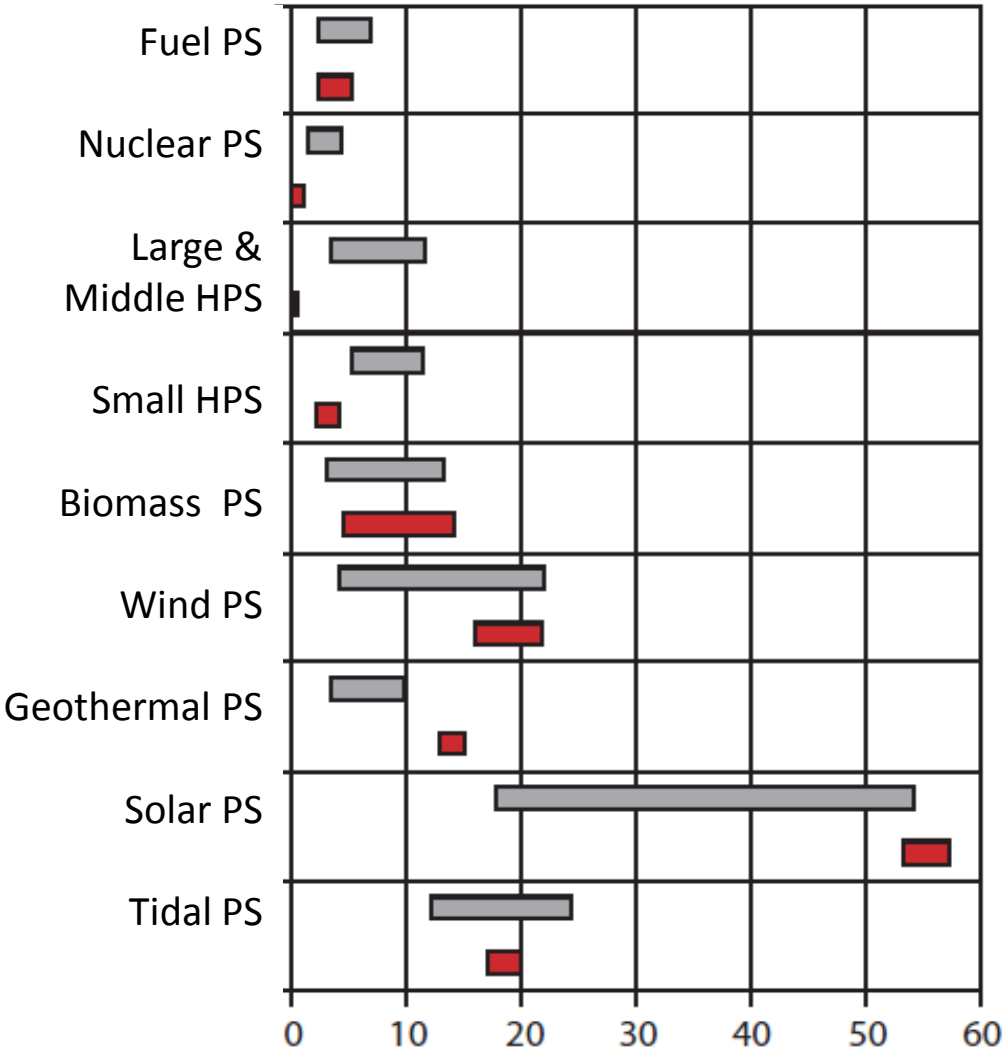
- lack of scientific support,

- lack of information environment including the data on both existing RES and their probable technical and economic parameters,

- absence of regulatory technical and methodical documentation, and appropriate software required for projection, construction, and exploration of RES PS,

- lack of personnel training and support.

Electricity Production ***Cost*** in Leading World Economies and in Russia, 2007



Sources: IEA, EFC "APEEC" and JSC "RusHydro",

Two Legislative Acts:

- The Low "On Energy Saving and Raising Energy Efficiency" - version from November 23, 2013
- The Federal Low from March, 26, 2003, N 35-ФЗ "On Electric Energy Sector (revised)"

✓provide for possibility to set feed-in tariffs or markups for RE,

✓promise a Government commitment to guarantee access to grid with budget compensations,

✓guarantee obligations of network companies to purchase all the RE produced (e. g. using green certificates).

But these institutions do not work

The main reason for this is extremely long and expensive certification procedure.

Belgorod (a city in European Russia) is a leader in using RES. Even in this place given a high experience and strong lobbing power it took a year to certificate a pilot solar power station (100 kWt)

As a rule local grids reject to accept the connection of RES plants due to their unstable character. The power provided by them is considered to be of law quality

The degree of capacity utilization by RES types. in %

Fuel PS in Russia	52.9
Large Hydro PS	40
Small Hydro PS	~ 45
Wind PS	~ 25-40
Solar PS	~ 20

Draft of Government Act: “On measures to stimulate the use of RES using wholesale market mechanisms”. This Act is expected to provide for -

- the main tool to promote the use of RES – a contract on power capacity supplying (which guarantees investment return) on the basis of the results of competitive selection

What is being Expected?

"General Directions of the Government Policy in the Sphere of Increasing Energy Efficiency of Power Generation Sector Based on RES Usage for the period up to 2020": RES based electricity production share in its total generation in ***2020*** r. should reach 4.5%. i.e. 51 bill. kWt-h (about 14.7 mill. kWt of installed capacity)

At the same time :

"General Scheme of Location of Power Generation Objects for the period up to ***2030*** ": foresees Installation of only 6.1 mill. kWt of generation capacity in the minimum variant and 14.3 mill. kWt –in the maximum one.

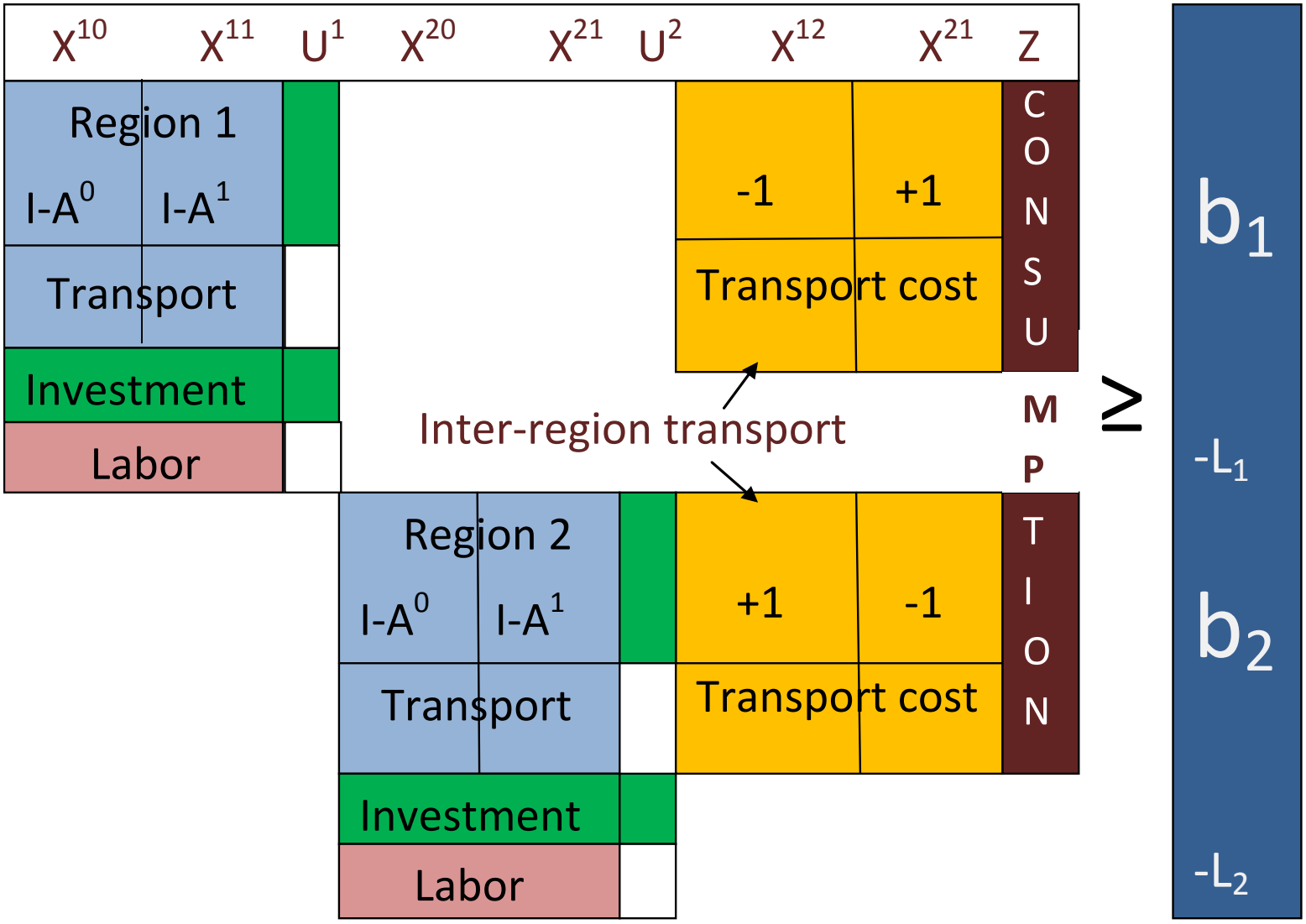
RES Installed Power Generation Capacities Structure according to "General Scheme of Location of Power Generation Objects for the period up to 2030", in %

	2010	2030-I	2030-II
Total in ths. kWt	1315.5	7400	15600
Wind ES	1.0	26.6	48.9
Small HPS (<25 Mw)	53.2	27.4	20.5
Geothermal PS	6.2	4.1	2.9
Solar PS	0.0	0.0	0.0
Tidal PS	0.1	0.2	0.1
Biomass PS	39.5	41.7	27.6
In Total	100.0	100.0	100.0

Suslov N. ***Inter-Sector Inter-Region Analysis: Estimating Consequences of Realization of Large Investment Projects in Energy Sector of Russian Economy*** //Development of Macro and Interindustrial Methods of Economic Analyses: proceedings of the 21st INFORUM World Conference. Listvyanka. 26-31 August 2013 / ed. by A. Baranov. V. Suslov; Inst. of Econ. and Industrial Engineering of Sib. Branch of RAS. - Novosibirsk : IEIE SB RAS. 2014. - P. 188-210.

Approach to Modeling National Economy and Estimation of RES Investment Projects

- Inter-sector interactions: Leontief Input-Output framework;
- inter-region interactions : each region of a large country is described by its own input-output (intra-regional) block; inter-region transportations of sector products are modeled using transport modeling techniques incorporating transport technologies;
- the model includes both a scope of input-output tables and transport blocks, thus optimization is feasible;
- all the endogenous variables are defined for the last year of a long period considered; at the same time investments (gross fixed capital formation) for this year are non-linear functions of investments in initial (base) year of the period;
- the total volume of investment for all the years of the period considered is also an endogenous variable;



A principle structure of OMMM for 2 regions: Intra-

OMMM-Energy: present version

- ***OMMM-Energy*** – Optimization Inter-sector Inter-region model including energy sector with energy products in physical units. It captures both inter-sector and inter-region relations of national energy sector.

- ***Presentation of economic dynamics***: it is a composition of two sub-models for time periods 2008-2020 and 2021-2030. The dynamics of investment are treated as non-linear functions being adapted with the help of linearization techniques;

- ***Includes 45 products*** and within them ***8 energy products***:
  - ✓rough oil
  - ✓Gas
  - ✓coal
  - ✓dark petroleum products
  - ✓light petroleum products.
  - ✓products of coal processing
  - ✓Electricity
  - ✓heat

OMMM-Energy: present version

•***Model also includes some non-energy*** sectors which are ***important*** given energy sector analysis:

✓drilling for oil and gas
✓pipelines (as a kind of transport).
✓production of special equipment for energy production. transportation and consumption
✓petroleum chemistry

•***Model captures some peculiarities*** of energy production and consumption which detracts the model from canonical OMMM:

✓Oil and gas reserves are monitored: annual output to volume of reserves ratio is fixed in the model; output growth is followed by investment into growth of reserves;
✓Diminishing returns to scale in oil and gas extraction sector are captured.
✓substitution between different kinds of energy is captured as well: 20 types of technologies to produce heat and electricity in each region are incorporated.

Model application: scenario approach

Model makes it feasible to evaluate complex consequences and efficiency of realization of policy measures in the sphere of energy production, processing and consumption. Previously it was applied to treat the following problems:

- evaluation of the economic consequence of concentration of energy-intensive production in the South Siberia areas,
- evaluation of the economic consequence of gasification in the regions of the South Siberia,
- evaluation of the economic consequence of reduction of energy intensity of production in national economy,
- evaluation of the economic consequence of spreading of heat pumps technology in the different regions of national economy,

Recent result:

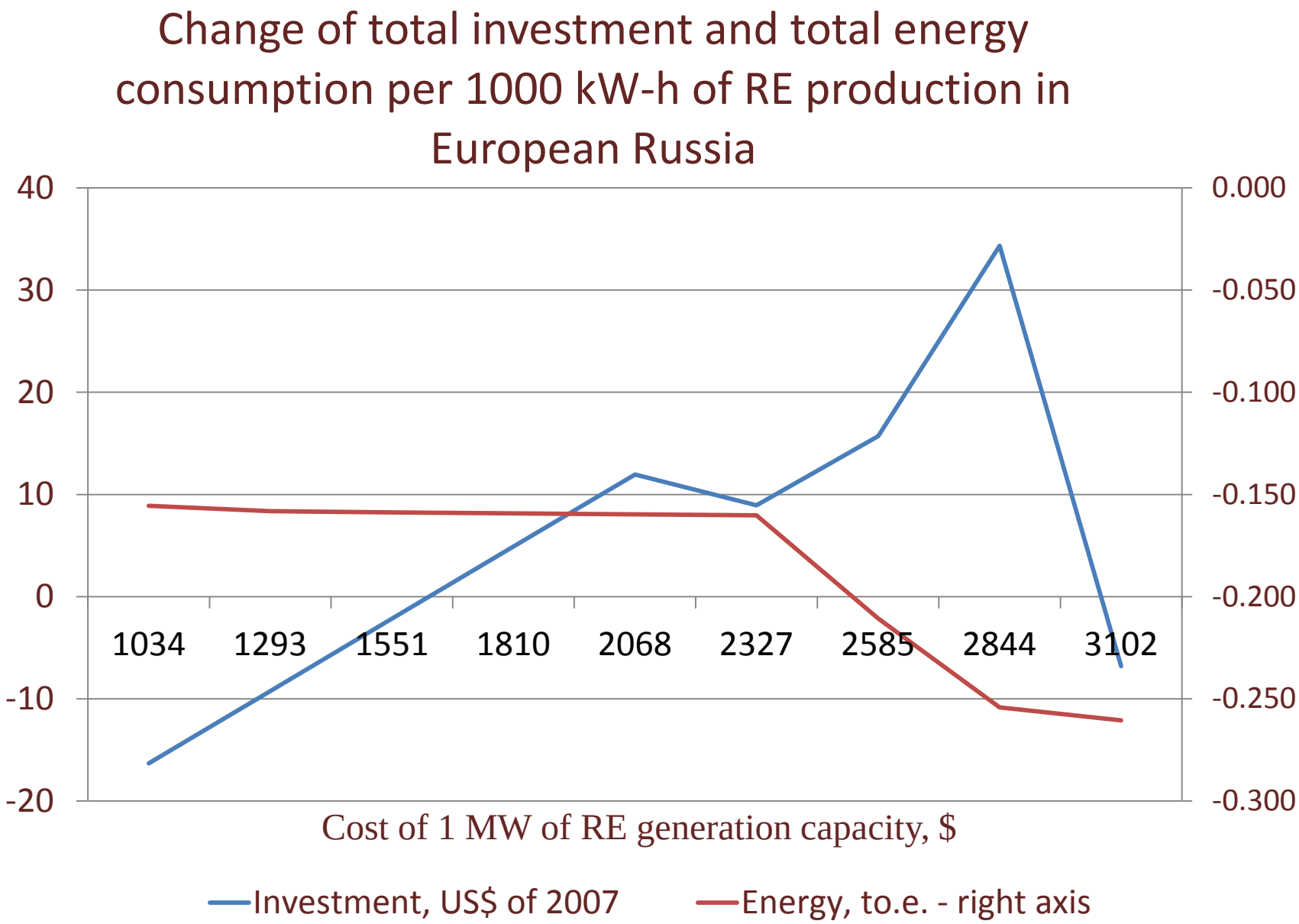
Both in European Russia and in Western Siberia RES based electricity generating technologies are efficient given cost of 1 kWt of installed capacity not higher than $2000-2010

Compare to:

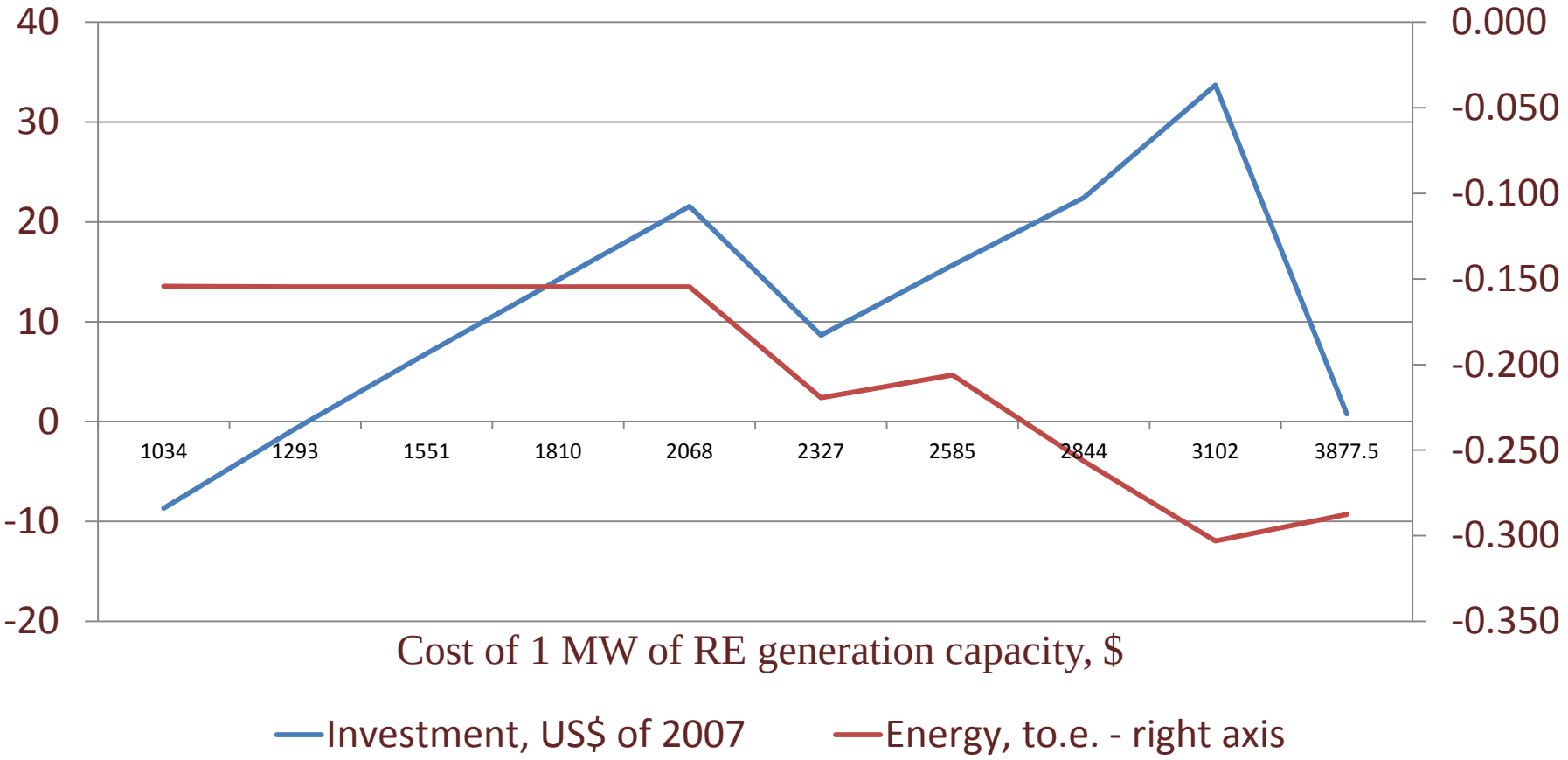
Expected cost of RES capacity installed in Russia according to existing projections averages $2300- 2500

Variants of Economic Development Indices as Function of RES Generation Capacities

European part of Russia						
RES power generation cost, thousands US $* / 1 MW	2,1	2,3	2,6	2,8	3,1	
RES power generation, bln. kWt-h.	21,8	8,1	5,8	5,5	1,2	0,0
Incremental GDP growth per 1000 RES kWth, US $ (2007)	19	21	25	38	-3	
Western Siberia						
RES power generation cost, thousands US $* / 1 MW	2,1	2,3	2,6	2,8	3,1	3,9
RES power generation, bln. kWt-h.	21,8	8,1	7,2	5,6	4,0	1,2
Incremental GDP growth per 1000 RES kWth, US $ (2007)	32	25	27	31	37	3


Change of total investment and total energy consumption per 1000 kW-h of RE production in European Russia
40
30
20
10
0
-10
-20
0.000
-0.050
-0.100
-0.150
-0.200
-0.250
-0.300
1034
1293
1551
1810
2068
2327
2585
2844
3102
Cost of 1 MW of RE generation capacity, $
Investment, US$ of 2007
Energy, to.e. - right axis

Change of total investment and total energy consumption per 1000 kW-h of RE production in Western Siberia



Summary

1. Though Russia is an energy abundant country certain conditions favorable to develop RES are present here. Its extremely large surface square is a specific reason to increase their usage and share in energy balance and electricity generation.
2. In general RES are less competitive as compared to traditional energy technologies. However, there are areas where RES based technologies are effective just at present time. Probably future conditions will change in favor of RES.
3. It is doubtful that the role of RES in Russia will ever be as important as in Europe, Japan, and Northern America. or in the most of other countries. Though their importance is expected to grow in Russia as well.

Summary

4. In order to facilitate the RES development Russian Government should elaborate and conduct sound policy measures to support the RES business.

5. Current Russian legislative foresees the possibility to set feed-in tariffs, promises a Government commitment to guarantee access to grid with budget compensations, guarantees obligations of network companies to purchase all the RE produced (e. g. using green certificates).

Summary

6. The main reason why these institutions set do not work is extremely long and expensive certification procedure. As a rule local grids reject to accept the connection of RES plants due to their unstable character. The power provided by them is considered to be of law quality.
7. The main tool to promote the use of RES is a contract on power capacity supplying (which guarantees investment return) on the basis of the results of competitive selection. But legislation necessary to implement it is not completely prepared.

Thank You for Your Attention!