ENERGY SUSTAINABILITY: CONCEPT, SUSTAINABILITY ISSUES OF A TRANSITION COUNTRY-BULGARIA

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1. On the concept of the sustainable energy

1.1. Introductory remarks

Sustainable development – a definition. There are a great number of definitions on the notion "sustainable development". We adhere to the concept that the sustainable development is such one, which satisfying the needs and the expectations of the actual generation provides the same opportunities for the next generations too.

Energy is one of the biggest end most complex systems, created by the mankind. The strategy to sustainability should be adequate to its systems features and the present and future energy challenges.

Energy as a system. The system features of energy have been an area of extensive academic investigations. [1,2,3]. Here we only enumerate some of them of grate importance to the energy analysis, innovation and development policy.

- The systems unity of energy expressed by interchangeability of energy resources and energy carriers at all stages of their transformation and utilization;
- Strong ties of energy with economy, environment and society (a case analysis-in part 2);
- World, regional, national and local levels of energy problems and prospects;
- Functioning and development determined by internal and external factors;
- Inertial structural evolution, requiring long-term development modeling and strategy. A principal scheme of national strategic energy forecasting is shown on Fig.1[4]

Challenges to sustainable energy development[5, 6]:

- Limited conventional energy resources;
- Increasing energy consumption;

- Environmental impacts of energy resources production, transport, conversions and end-use. (Further below we present an idea on European energy externality cost studies);
- Low energy efficiency;
- Economic and social constraints to energy functioning and development
  Energy policy is a goal oriented activity to:
- Reliable energy supply;
- Efficient energy transformation and end-use;
- Environment preservation corresponding to international norms and agreements;
- Strategically oriented energy development;
- Socially acceptable cost and prices.
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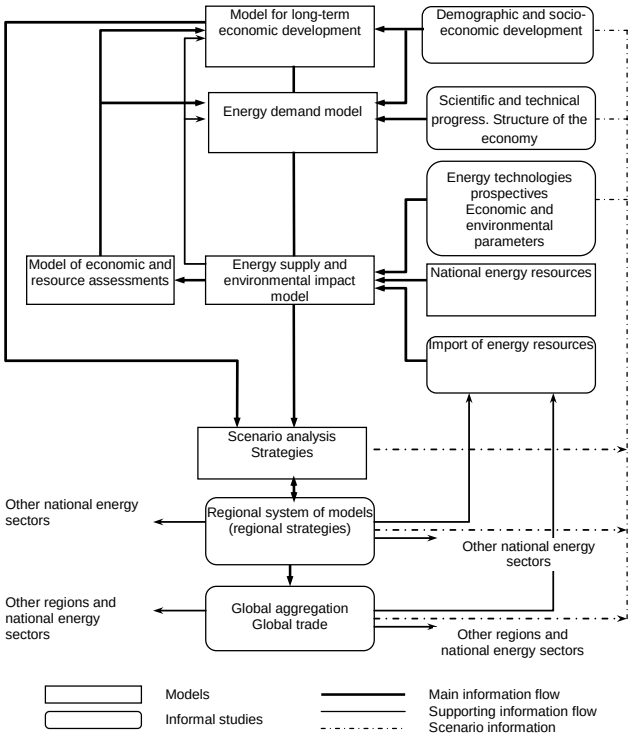
Fig. 1. Principal scheme of long-term development forecasting of the energy sector in Bulgaria



1.2 External cost of Energy.

1.2.1 European ExternE project [http://www.externE.info/]

Human activities like electricity and heat generation or transport cause substantial environmental and human health damages for the most part not integrated into the pricing system. By societal welfare principles, policy should aim to ensure that prices reflect total costs of an activity, incorporating the cost of damages caused by employing taxes, subsidies, or other economic instruments.

To support this internalization, socio-environmental damages must first be estimated and monetized. Over the past 15 years, there has been much progress in the analysis of environmental damage costs, particularly through the "ExternE" (External costs of Energy) European Research Network. Since 1991, the ExternE project has involved more than 50 research teams in over 20 countries (including ARMINES and CEPN from France). NEEDS is a current ExternE project continuation. METHODEX and HEATCO use the ExternE methodology.

The Damages assessed. The current research aims at constantly enlarging list of health and environmental effects covering "Impact Category"(Human Health-mortality, Human Health-morbidity, Building Materials, Crops, Global Warming, Amenity Loses, Ecosystems), large number of Pollutant/Burden and Effects.

The ExternE methodology. The impact pathway approach - and coming along with this approach, the EcoSense model, an integrated software tool for environmental impact pathway assessment - was developed within the ExternE project series and represents its core. Impact pathway assessment is a bottom-up-approach in which environmental benefits and costs are estimated by following the pathway from source emissions via quality changes of air, soil and water to physical impacts, before being expressed in monetary benefits and costs.

Applications. ExternE methodology has been applied for a large number of European and national studies to give advice for environmental, energy and transport policies. One of the first objectives of the ExternE program was to make a comparative evaluation of different technologies and fuel cycles for electricity generation. A decade of research has resulted in detailed set of data for impacts from a wide range of fuels, technologies and locations. They include:

- fossil fuels : coal and oil technologies with varying degrees of flue gas cleaning, natural gas, centralized systems and CHP;
- nuclear : PWR, open and closed systems for fuel provision;
- Renewable: onshore and offshore wind, hydro, a wide range of biomass fuels (waste wood, crops) and technologies.

Uncertainty and Reliability. Individual sources of uncertainty have to be identified and quantified. It is appropriate to group them into different categories, even though there may be some overlap:

i. data uncertainty, e.g. slope of a dose-response function, cost of a day of restricted activity, and deposition velocity of a pollutant;
ii. model uncertainty, e.g. assumptions about causal links between a pollutant and a health impact, assumptions about form of a dose-response function (e.g. with or without threshold), and choice of models for atmospheric dispersion and chemistry;
iii. uncertainty about policy and ethical choices, e.g. discount rate for intergenerational costs, and value of statistical life;
iv. uncertainty about the future e.g. the potential for reducing crop losses by the development of more resistant species;
v. idiosyncrasies of the analyst e.g. interpretation of ambiguous or incomplete information

Can ExternE numbers be used for policy preparation? Numbers have indeed already been used in several policy areas, such as economic evaluations of the draft directive on non-hazardous waste incineration, the Large Combustion Plant Directive, the EU strategy to combat acidification, the National Air Quality Strategy, the Emission Ceilings Directive, proposals under the UN-ECE multi-pollutant, multi-effect protocol and many more policies, green accounting research projects, and air quality objectives.

1.2.2. European CASES (Cost Assessment of Sustainable Energy) Project [http://www.feem-project.net/cases/]

Objective I: To compile detailed estimates of external and internal costs of energy production for different energy sources for the EU-25 Countries and some non-EU Countries (Bulgaria, Turkey, Brazil, India, China) within a coherent dynamic framework, under energy scenarios to 2030.

Objective2: To evaluate policy options for improving the efficiency of energy use, taking account of the full cost data.

Objective 3: To disseminate research findings to energy sector producers and users and to the policy making community.

Research institutions: 21 EU and 5 non-EU research centers.

Work Packages. CASES consists of 13 integrated work packages (WPs**):**

- **WP1** provides electricity demand and primary energy source options scenarios up to 2030 for each of the country studied (25 EU Countries, Bulgaria, Turkey, Brazil, India, China) taking into account different local conditions across countries.

- **WP2** focuses on human health**,** materials and crops external costs. The deliverables are a database on life cycle emissions for electricity and heat generation technologies, a Report on methodology for estimating external costs to human health, crops and materials and updated and extended version of ECOSENSE tool.

- **WP3** updates the estimates of non-human health related environmental costs of different energy sources based on life cycle impacts for EU and non-EU countries with specific attention to 'new impacts' (acidification, eutrophication and visual intrusion);

- **WP4** investigate private costs of generating electricity and heat by combustible renewables, focusing on heat generation technologies (oil, gas and bio-mass heating systems, heat exchanger, heat pump;

- **WP5** estimates externalities related to energy supply insecurity for EU and other selected countries;

- **WP6** focuses on the consistent set of national level full costs estimates for the 25 EU countries for different energy sources;

- **WP7** focuses on the consistent set of national level full costs estimates for Bulgaria, Turkey, Brazil, India and China;

- **WP8** assess policy instruments to internalize environment related external costs in EU Member States, excluding renewables;

- **WP9** assess policy instruments to internalize environment related external costs in EU Member States, via promotion of renewables;

- **WP10** assess policy instruments to internalize externalities in non EU Member States, via promotion of renewables and consider the social and fiscal implications that these measures have, especially on poor and vulnerable groups;

- **WP11** assists WPs 8-10 by providing the guidelines for the assessment methods, including Cost-Benefit-Analysis (CBA) and Multi-Criteria Decision Analysis (MCDA);

- **WP11** is devoted to dissemination**.**

- **WP13** encompasses the running of the project co-ordination and management activities.

CASES is an ambitious project towards more profound knowledge on energy-environment-society interactions and internalization of externalities in the energy market and policy.

2. Sustainability issues of Bulgaria

2.1 Energy and energy policy status

Integrated economy-energy-environment indicators of some European countries and Bulgaria. During the last years IEA, IAEE and other international institutions worked out indicators of sustainable development. *Table 1* compares some of them for Bulgaria, some European and neighboring countries. The indicators show that in line with the energy reform Bulgaria needs great efforts in a umber of interrelated economic, social and technological areas, including energy efficiency, energy carriers structure improving, import dependency decreasing.

Energy strategy [8]. The actual energy strategy was approved in 2002 and covers overall energy policy, sectors policy and key actions and expected results in 2002-2005: legal framework, regulatory framework, privatization, electricity, gas and heat supply, coal mining, social protection. The expected results are shown in Fig.2.

Comments on the scope and the results of the strategy. From the position of 2006 one could, to some extent disputably, do an assessment of this strategy. **Between the positive results** one could mention:

- Developed and acting energy regulatory body;
- Substantial price subsidies reduction;
- Introduction of regulatory rules for setting energy prices;
- Realization of the fought-level stages of electricity prices increase-a serious stimuli for energy efficiency;
- Introduction of socially oriented double rate tariff for the domestic sector.;

Table 1. **Where is Bulgaria**

Indicator/Country	DK	DE	EL	FR	IT	HU	AT	BG	RO	TR
Population (million)	5.38	82.54	11.02	59.63	57.32	10.14	8.07	7.85	21.77	70.80
GDP (bln. EUR 1990)	187.3	2130.3	146.4	1549.4	1297	71.5	222.7	16.9	47.9	200
En.Cons./GDP(toe/1990 MEUR)	0.106	0.161	0.203	0.169	0.134	0.352	0.138	1.108	0.746	0.375
En. Cons/Cap(toe/inhab.)	3.680	4.164	2.695	4.384	3.029	2.485	3.804	2.385	1.642	1.059
El. Gen. /Cap(GWh/inhab.)	7291.8	6925.7	4955.5	9370.95	4961.6	3566.1	7742.3	5436.9	2523.7	1827.7
CO2Emissions/Cap(tCO2 /inhab.)	9872	10293	8559	5962	7406	5388	7588	5300	4129	2764
Import Dependency, %	-41.1	60.5	70.7	50.3	86.7	58.2	66.0	74.1	25.51	67.82

Source: EU Energy and Transport in Figures, 2004 [7]

- **With 2153 EUR/cap Bulgaria is one of the poorest nations in Europe (EU15-24510, Austria-27596, Denmark-34814, Germany-25809, France-25984, Italy-22627, Greece-13285, Hungary-7051, Turkey-2825)**
- **Bulgaria is one of the most energy intensive (toe/1990 MEUR) countries (6.97, 8.03, 10.45, 8.27, 5.46, 3.15, 2.95 times more than EU15, Austria, Denmark, Italy, Greece, Hungary, Turkey correspondingly)**
- **With CDP/cap. times less than Italy, Greece, Hungary and Turkey Bulgaria consumes compatible or more kWh/cap than those countries**
- **Bulgaria is one of the most energy import depending countries in Europe**

Between **the not accomplished objectives, weaknesses of the reform and the practices in the last years** one could mention:

- The "strategy" do not outline a quantitative vision of the development and is in fact a four years plan for market reform and privatization;
- Serious deviance from the declared investment policy to use the limited investment capacity of the state mainly for energy projects. We could not miss to indicate the not grounded considerable investment (300 mln.Euro) in units 1-4 of NPS "Kozlodui", without defending their future. or the contract of "Maritza-East" on the principal "take or pay", or the preparation to construct the new NPS "Belene " with dominant state guarantee;
- No improvement in the energy carrier policy. Bulgaria is continuing to be a country with near zero building gasification;
- Insufficient transparency and doubtful expedient of the privatization in some energy sectors, in particular peace of the state sovereignty in electricity distribution at the dispose of foreign, including foreign state owners;
- The declared social protection and social guaranties fall short. The fast energy price increase, much above the four levels, became a heavy burden for the common Bulgarian citizen;
- With the exemption of the accession of the electric system to UCPE, , practically nothing has been achieved in improving regional energy infrastructure and diversification of energy resources import;
- The "strategy" does not set at all the objective of integrated energy planning in energy utilization and supply.

The energy policy of the last years id dominated by corporate interests and is against the essence of energy sustainability.

Energy efficiency policy [9]. The energy efficiency policy, leaded by the State Energy Efficiency Agency, based on National EE program till 2015 is expected to decrease GDP primary energy intensity by 17% and final energy intensity by 8%. The program covers mainly the final energy use, including building insulation. The most part (99%) of energy resources pass through conversion, transportation and distribution prices not included in this program.

Environment policy [10]. The Environment policy is related to international agreements and European Directives. The international agreements are the Convention on transborder long distance air polluted prevention and the UN Framework Convention on climate change. The European Directives are the Directive 2001/80/EC on limitation of some air pollutants from big burning installations, 1996/61/EC Directive for complex prevention and control of pollution, Directive 2003/87/EC on creation of emission trade quote scheme;

Directive 2001/77/EC on RES, Directive 93/76/eec for limitation of carbon dioxide emission, Directive on CHP and Directive on biofuels or other RES in the transport.

The long-term preservation of high radioactive waste is an unsolved problem.Two strategic approaches are possible: farther cooperation with Russia or search of a solution on international level.

National electricity system. The electricity system prospects are between the most disputable issues of national energy policy. The tables 2, 3, 4, 5 [11] indicates the state and the author position on the issue.

Table 2. **Potential of generated capacities**

Generating capacities	**Installed capacity,** MW	**Utilization** h/yearo	**Potential, TWh/year**		
			by 2010 г.	by 2015 г.	by 2020 г.
NPP "Kozloduy"	**2000**	**7000÷7500**	**14,0÷15,0**	**14,0÷15,0**	**14,0÷15,0**
TPP "Maritsa East – 1"	**670**	**7000**	**4,7**	**4,7**	**4,7**
TPP "Maritsa East – 2"	**1545**	**6500**	**10,0**	**10,0**	**10,0**
TPP "Maritsa East – 3"	**908**	**7000**	**6,3**	**6,3**	**6,3**
TPP "Varna"	**1260**	**4500÷6000**	**5,7÷7,6**	**5,7÷7,6**	**5,7÷7,6**
TPP "Bobovdol"	**630**	**4500÷6000**	**2,8÷3,8**	**2,8÷3,8**	**2,8÷3,8**
TPP "Rousse"	**220**	**4500÷6000**	**1,0÷1,3**	**1,0÷1,3**	**1,0÷1,3**
HTPP	**700**		**1,5÷2,0**	**1,5÷2,0**	**1,5÷2,0**
Industrial TPP	**1040**		**3,0÷3,5**	**3,0÷3,5**	**3,0÷3,5**
HPP			**4,1**	**4,6**	**5,0**
Total			**53,1÷58,3**	**53,6÷58,8**	**54,0÷59,2**

FIG. 2. EXPECTED RESULTS

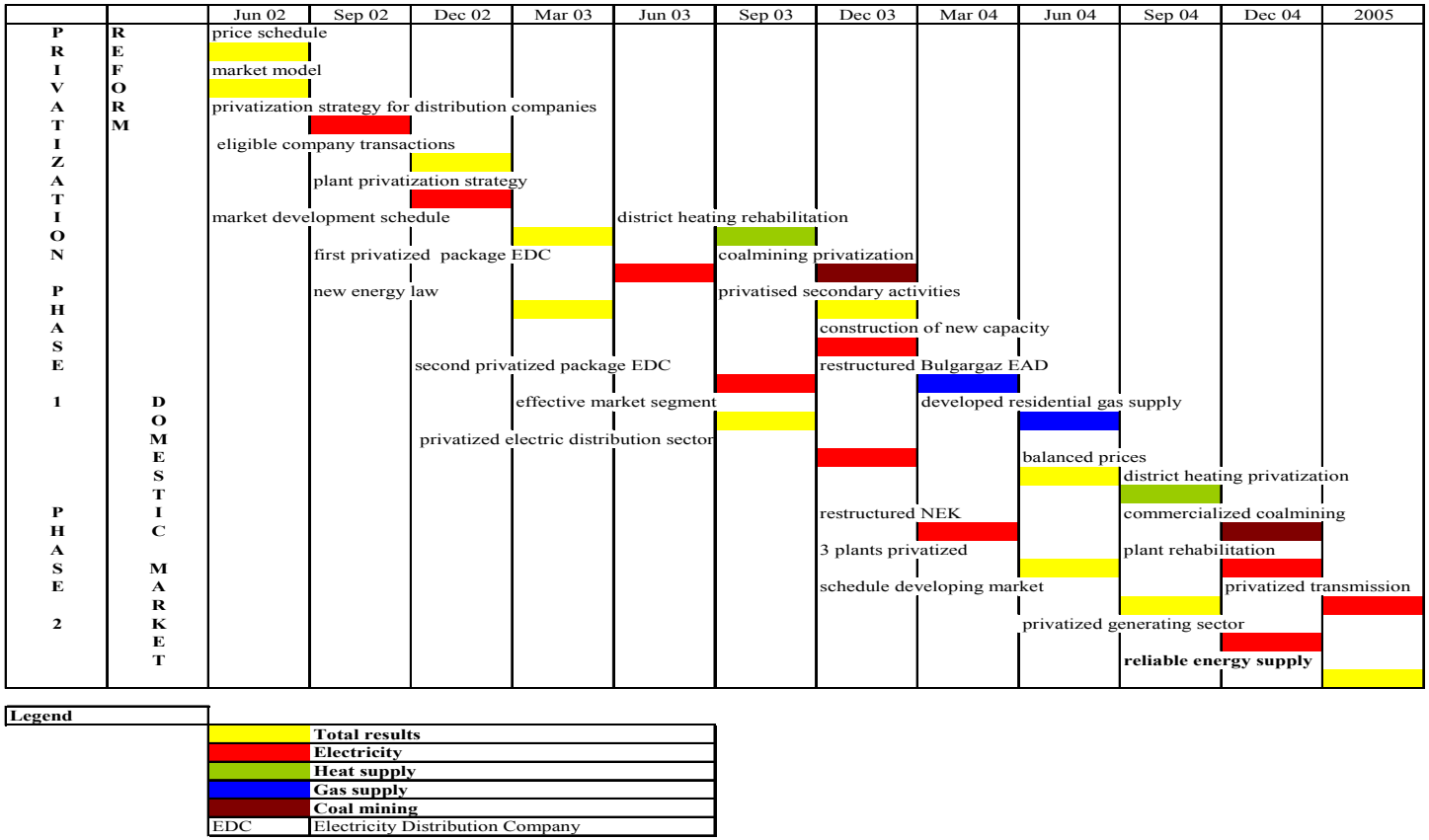


Table 3. **Expected electricity demand, TWh/year**

Year	2000	2005	2010	2015	2020
Electricity demand-gross, TWh/year	36,3	36,6	39,0	42,0	45,0

Table 4. **Expected maximal and minimal load in summer and winter average day**

Year	2000	2005	2010	2015	2020
Maximal/minial load, MW	7300/3100	7500/3200	7900/3900	8700/4100	9100/4300

Table 5. **Electricity balance, TWh/year**

Year		2005	2010	2015	2020
Potential, TWh/year.	With TPP "Maritsa East – 1"		48,4÷53,6	48,9÷54,1	49,3÷54,5
	Without TPP "Maritsa East – 1"		53,1÷58,2	53,6÷58,8	54,0÷59,2
Expected electricity demand, TWh/year	Minimal NEC forecast (2005)	36,6	40,0	46,0	53,3
	Maximal NEC forecast (2005)	36,6	40,5	47,7	55,3
	Author's forecast (2006)	36,6	39,0	42,0	45,0

A general conclusion:

- The most actual objective till 2010 is the rehabilitation of the existing electricity production, transport and distribution capacities;
- After the rehabilitation of the existing production capacities and the construction of the replacing 670 MW "Maritza-East 1" and the utilization of a part of hydroenergy potential, the electricity demand could be satisfied till 2015-2017 with some possibility for electricity export;

- New units bigger then 400 MW, exceptionally 600 MW are not acceptable taking care of reliability and manageability of the electric power system

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2.2. Policy issues of energy sustainability.

2.2.1. Energy strategy for the next 20-25 years.

It is the first time for decades Bulgaria does not have a national energy strategy grounded on energy demand prospects, energy balance and technology development, investment and infrastructure policy for the next 20-25 years.The working out of a such strategy is possible on the base of some **initial preconditions:**

- Drop out the extensive energy development and the devoid of resource and economic sense myth "Bulgaria –energy island (center) of the Balkans":
  - Bulgaria imports [12] over 74% of the energy resources and exports 5-7 TWh/year-12-15% of electricity production. Electricity-the only energy export is 21.4 % of country's final energy. *Importing 74% of primary energy we export 2.5-3.2 % of final energy***:**
  - The energy resources payments account for 2005 [13] is 3 bln.Euro.(An increase per rapport of 2004-62%). The exported electricity with an average price 3.5 cents/kWh leads to an amount of 175-210 mln.Euro/year; the profit is around 30-60 mln.Euro/year. *The import expenses exceed 50-100 times the profit*. Let us add that in 2005 NEC exported only 10%. The other 90% has been exported by private dealers, getting the most part of the profit.
- Cover all energy processes and systems: extraction, processing, energy conversions, transportation distribution and utilization should be analyzed as an unity The realization of such approach is a world practice and is a guaranty for grounded energy development , competitive energy and economy and social acceptance;
- Combine the Bulgarian energy development with the new EU strategy, oriented towards energy dependency decrease and development of European and South-East infrastructure, including NABUCO, Burgas-Alexandropulos and Burgas –Macedonia-Vleora projects;.
- Insert in the strategy the world trend and policy to horizontally integrated (including RES) energy supply and energy consuming systems on local and municipal levels.

2.2.2 Energy policy and liberalization of the energy market.

We are at the point of full liberalization of electricity and gas market with unclear price levels, resource policy and behavior of the big "players"

in Europe and neighboring regions. In these conditions of uncertainty the short-term policy should choose profit –making actions in all scenarios ("win-win" strategy). For Bulgaria this means a much grater concentration to al energy efficiency areas, rehabilitation of existing capacities with good chances of competitiveness and full drop out of state guaranties for construction of capacities for electricity export.(The last recommendation was put forward in UNDP and World Bank study in 2000 [14].

2.2.3. Energy prices, competitive economy and social status of the mass consumer

The sharp increase of electricity and heat price sand potentially of natural gas leads to serious economic and finance problems of the industry and mass consumer. The electricity price for industry (7.40 Euro/100 kWh) is above the prices of the most European countries [7]. The prices in the building sector already reached the level of considerable part of European countries. Many factors, including the policy of the new monopolists of electricity distribution, lead to future price increase. The price pressure could be limited by:

- A firm and consistent policy of the State Regulation Commission. Haw this could be realize in full liberalization of the energy market?
- By already stressed necessity for redirection of energy policy from extensive development, leading to future energy increase to energy efficiency, creation of alternatives for consumer and state policy to decrease energy expenses in production sphere, transport and buildings.

2.2.4 Energy policy and society

As in many other areas, the energy policy is a possessing of limited circle of political elite. The society is far from the objectives and development alternatives, investment policy, privatization contracts…and even don't understand well its district heating bills. A lot has to be done for the transpensibility in energy and the culture of society.

Conclusion

Energy is one of the biggest and most complex systems created by the mankind. The strategy towards sustainability should be grounded on extended knowledge of its economy and environment interactions, , present and long-term challenges and adequate policy mechanisms.

- The energy sustainability of Bulgaria needs vigorous reorientation of its energy policy towards essential objectives-competitive economy and well being of the society.

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