Proceedings of the Korean Nuclear Society Autumn Meeting, Seoul, Korea, October 25-26, 2001

BRIEF REVIEW OF KEY ISSUES OF THE UKRAINIAN NUCLEAR POLICY

Yuriy TREHUB

National Nuclear Energy Generating Company of Ukraine

Un-Soo CHUNG and Ki-Jung JUNG

Korea Atomic Energy Research Institute

Abstract

The energy policy is one of the most important elements of the general state policy and its achievements are inseparably coupled with the stability and achievements of the Ukrainian Fuel-Energy Complex development. At present, the Nuclear-Energy Industry of Ukraine is the most powerful component of its National Fuel-Energy Complex and the announced decision to develop the Nuclear-Energy Industry has no alternative in the foreseeable future. This review gives information about some peculiarities of the Ukrainian Nuclear-Energy Industry development and an expert point of view about the key issues of the Ukrainian Nuclear Policy for the next two decades.

1. PRELIMINARY INFORMATION CONCERNING STATE OF UKRAINIAN NUCLEAR ENERGY BRANCH

1.1 Energy situation

The Fuel-Energy Complex (FEC) is a comprehensive complex inter-sector system for the mining and production of fuel and power, their transportation, distribution and utilization. The FEC of Ukraine consists of 2 economically independent sectors: *fuel industry and power production (Table 1).*

The *fuel industry* covers the whole process related to the mining of the organic origin fuel and it's reprocessing; both processes are performed by the coal and peat, gas and oil processing industries. Moreover, the sizable contribution to the national fuel provision belongs to uranium-mining & extracting enterprises of the Ukrainian nuclear industry.

The *power production sector* (and, in particular, its electric power production part) is based on the technology and operation of various electric power plants, namely: thermal electric power plants (TPSs), heat-electric generating stations (HEGSs), hydroelectric power plants (HPSs) and high-capacity nuclear power plants (NPPs).

The NPPs provide the biggest segment, about 45%, of the national electric power production. These NPPs, the enterprises of uranium & zirconium extractions and some other enterprises of machinery construction (components manufacturing) can be combined as the National *Nuclear-Energy Industry* (NEI), which represents the most viable and available segment of the National FEC.

1.2 Fuel industry and energy sources

The main organic primary energy sources of Ukraine are coal and brown coal or lignite. And brown coal amounts to only about 5.5% of the total coal reserves (Fig. 1).

At the same time, during the last several years, the total annual consumption (for non-nuclear installations) was about 257 million tons of coal (or 170 million tons of the equivalent fuel), and in

Table 1 Ukrainian Fuel and Energy Complex

Ministry of Fuel and Energy			
State Department of Electric-Power Industry	**State Department of Nuclear Energy**	**State Department of Oil, Gas and Oil-Refining Industry**	**State Department of Coal-Mining Industry**
Power production sector		*Fuel industry sector*	
-National Energy Company "Ukrenergo" - State Enterprise "EnergoRynok" - TPSs, HPSs, Hydro-Accumulator Power Stations and Heat-Electric Generating Stations	-National Nuclear Energy Generating Company "EnergoAtom" with NPPs - State Enterprise "Chornobyl NPP" -The Enterprises on Mining and Processing (extraction) of Uranium and Zirconium	- National Stock Company "NaftoGas of Ukraine" (means – Oil&Gas of Ukr) - Stock Holding Company "UkrNaftoProduct" - Others Private and joint companies	- State Enterprise "UkrVugleRestructuryzaciya" - State Enterprise "Ukrtorf" - Others Coal Mining and Processing Enterprises	- National Stock Company "Nadra of Ukraine" ("Nadra" means - Bowels of the Earth)

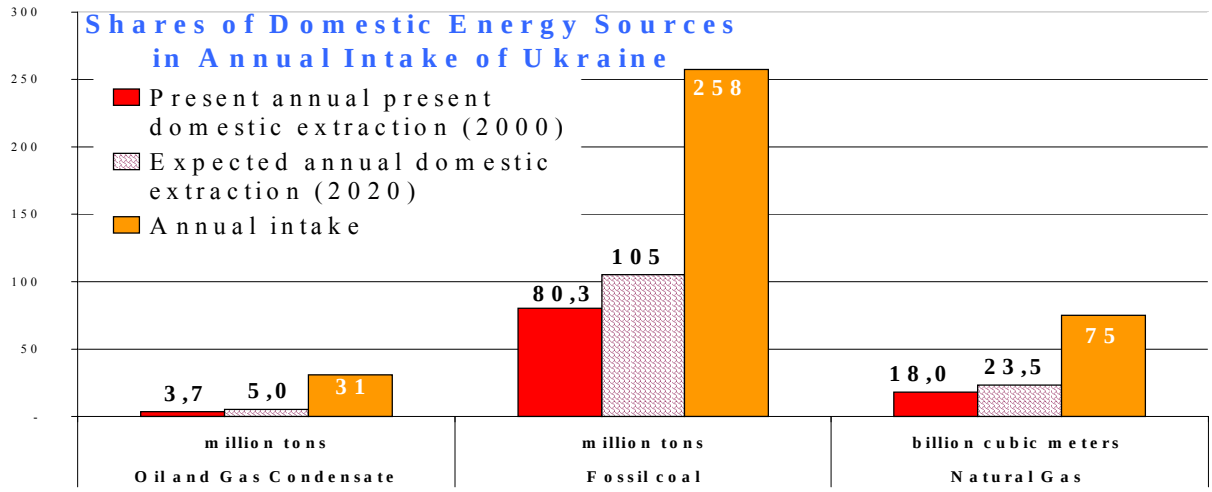

Fig. 1 Shares of Domestic Energy Sources in Annual Intake of Ukraine

this quantity only about 105 million tons (or 60 million tons of the equivalent fuel) are from domestic coal-mining[1].

In addition to the aforesaid, the Ukrainian fuel industry extracts:

- Approximately 3.7 million tons of Oil and Gas Condensate or 12% of the total national demand, that is 13.7 million tons;

[1] According to the new reform concept of the Ukrainian coal industry (based on general assumptions about 300 billion tons of the total coal reserves in Ukraine, as of 1999), the actual annual capability of the branch is assessed 100 million tons. As the heat generation capacities amounts to 4500-5000 Kcal/kg (or 18.7-20.8 joules/kg), such volume of at mining is equivalent to 64.3-71.4 million tons of the equivalent fuel or is approximately 21.4-23.8% of the overall demand of Ukraine for the primary fuel-energy resources. Up to the present day, Ukraine has been partially importing coal from Poland, Russia and Kazakhstan.

- Approximately 18.0 billion cubic meters of Natural Gas or 24% of the total national demand, that is 75.0 billion cubic meters.

In expectation of the National program "Oil and Gas of Ukraine 2010" owing to the enforcement of exploration work and vigorous exploitation of new deposits (subsurface), domestic Oil and Condensate production can be increased up to a level of 5.2-5.4 million tons, and domestic Natural Gas production can be increased up to 23.5 billion cubic meters.

1.3 The electric power production sector

The above-mentioned specifies the huge deficiency of domestic Oil and Gas production. At the same time, Oil and Gas combustion in Thermal Power Stations (TPSs) should be reduced because of the more advisable utilization of Oil and Gas for transport engines, and also as raw materials for the manufacturing of fuel-lubricating materials, for Oil and Gas chemistry, mechanical engineering, technological processes of metallurgy, etc.

Nevertheless, at present time, the replacement of Oil & Gas is not possible by means of the coal fuel in the TPSs, as, unfortunately, the expanded application of coal fuel is restrained by a significant deterioration (80-90%) of the TPSs' basic equipment that has been in operation for a very long time. And besides, TPSs reduced electricity production by more than twice due to the lack of domestic supplies of organic fuels and the increasing of organic fuel prices.

The contributions of various power resources into the Annual Electricity Generation (for 2000) are shown in Figure 2.

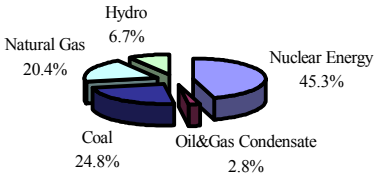

Fig. 2 The contributions of various power resources to Ukrainian Annual Electricity Generation for 2000

At the same time, NPPs and the uranium ore deposits are vital for improving the self- supply of the Ukrainian FEC. The Vostochny (Eastern) Mining&Concentrating Industrial Complex (located at the Zhovty Vody site of the Dnypropetrovsk region) is a unique Ukrainian enterprise intended for uranium ore mining and concentrate production. The future prospect and development of the industrial complex as well as the uranium ore mining industry in Ukraine are closely related to the industrial commissioning of the Novokonstantinovsky uranium ore deposit. Even though Ukraine will exploit just the first line of this Novokonstantinovsky uranium ore deposit, it affords an opportunity to provide the national nuclear energy's demands over 50 years[2].

As a matter of fact, according to "The National Energy Program of Ukraine for the period until 2010" (abr.NEP)[3] the following prospective activities must be undertaken for successful electric power industry development:

1. Implementation of energy saving measures;
2. Fuel utilization orientation towards the Ukrainian fossil fuel base: the refurbishment of fossil fuel production's balance by means of increasing coal utilization and decreasing the utilization of natural gas and crude oil in the electric power production;
3. Further development of the nuclear industry in the future, due to the present deficiency in organic fuel in Ukraine. (This NEI provides for placing into commission two units with a high degree of

[2] Олександр Гудима, народний депутат України, голова Комітету Верховної Ради України з питань паливно-енергетичного комплексу, ядерної політики та ядерної безпеки. Стаття "Реалії та перспективи ядерно-паливного циклу України" надрукована в газеті "Зеркало недели", №2, 2001

[3] "The National Energy Program of Ukraine for period till 2010" (abridgement – NEP, approved resolution of Verkhovna Rada (Parliament) of Ukraine on May 15, 1996 №191/96)

readiness, namely - Khmelnytsky #2 and Rivne # 4, and two other units with medium readiness – Khmelnytsky #3 and Khmelnytsky #4);

4. The commissioning of new hydropower capacities is foreseen at Dnystr River and the Kanev site (at Dnypro River), taking into account the capacity deficiency of the hydropower stations for daily load spike regulation in the integrated electricity system of Ukraine;
5. The technical upgrading and rehabilitation of thermal power plants in order to extend their plant life to an additional period of 15 to 20 years and to improve their environmental and economic states.

In such a way (item covered #3) the Ukrainian Parliament has just confirmed the barest necessity of keeping and reinforcing the nuclear power industry as the most economic and very promising direction for the FEC's development and national energy demand's satisfaction.

1.4 Nuclear Power Industry

At present, nuclear power is a very important component of the power industry of Ukraine (Fig. 3). After the final closure of Chornobyl NPP, there are thirteen water-cooled power reactors at the four NPP's in operation with total installed capacity of 11820 MW (e) in Ukraine, including:

- 11 units with WWER-1000 type reactor, total capacity - 11000 MW (e);
- 2 units with WWER-440 type reactor, total capacity - 820 MW (e).

Fig. 3 Soviet Designed Nuclear Power Plants

Their electric productivity accounts for roughly 22% of the total installed capacity of all electric stations. The preliminary timetable of exploitation of Ukrainian NPPs is submitted in Table 2.

Table 2 The preliminary timetable of exploitation of Ukrainian NPPs

NPP name & unit #	Reactor's type	Installed capacity per unit MW(e)	Launch date of the commercial operation DD-MM-YYYY	Initial date of decommissioning DD-MM-YYYY
Chornobyl # 1**	RBMK-1000	800	26.09.1977	In fact 1999
Chornobyl # 2***	RBMK-1000	1000	21.12.1978	In fact 1997
Chornobyl # 3	RBMK-1000	1000	03.12.1981	In fact 15.12.2000
Rivne # 1	WWER-440	402	22.12.1980	2010
Rivne # 2	WWER-416	416	22.12.1981	2011
Rivne # 3	WWER-1000	1000	21.12.1986	2016
Rivne # 4	WWER-1000	1000	Under construction	30 years after launch
South Ukraine # 1	WWER-1000	1000	31.12.1982	2012
South Ukraine # 2	WWER-1000	1000	06.01.1985	2015
South Ukraine # 3	WWER-1000	1000	20.09.1989	2019
Zaporizhzhya # 1	WWER-1000	1000	10.12.1984	2014
Zaporizhzhya # 2	WWER-1000	1000	22.07.1985	2015
Zaporizhzhya # 3	WWER-1000	1000	10.12.1986	2016
Zaporizhzhya # 4	WWER-1000	1000	18.12.1987	2017
Zaporizhzhya # 5	WWER-1000	1000	14.08.1989	2019
Zaporizhzhya # 6*	WWER-1000	1000	19.10.1995	2025
Khmelnytsky # 1	WWER-1000	1000	22.12.1987	2017
Khmelnytsky # 2	WWER-1000	1000	Under construction	30 years after launch

* real commercial operation since 02.04.97;
** formal decommission mode since 30.11.96;
*** had been shut down along of fire in the turbine hall since October 11, 199l.

The annual electricity production volume of Ukrainian Nuclear Power Plants (as of end 2000) has reached the level of 77.355 GWh (billions kWh) and its share has been increased up to 45.3% of the total electricity production volume of Ukraine. The remaining part of annual electricity generation was produced by TPPs and HPPs. In view of the present status of the transient economics process of Ukraine based on the long-term factors we may assume this trend will continue in the future. By the way, the HPPs generation share has been decreased from 9.2% to 6.7% during the last year.

The contribution of nuclear energy to total electric power production in Ukraine over the period from 1985 to 2000 is shown in Figure 4.

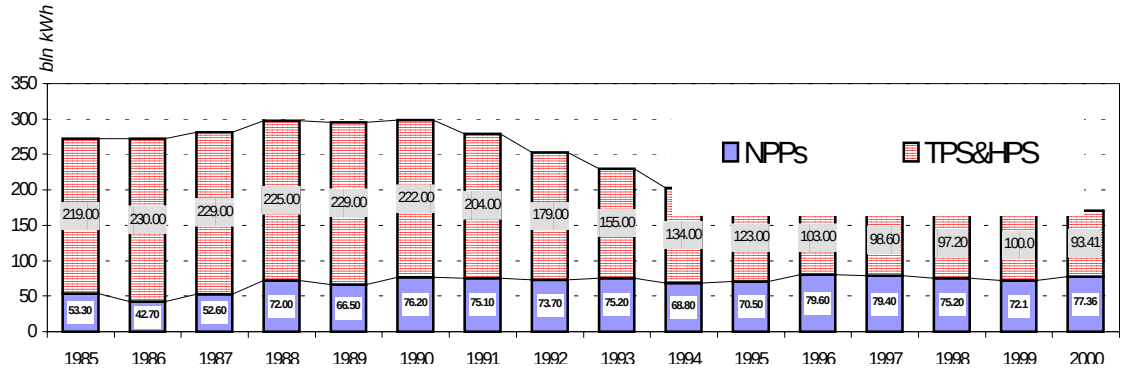

Fig. 4 Annual contribution of nuclear energy into electricity production in Ukraine over the period from 1985 to 2000

2. NUCLEAR ENERGY POLICY

In spite of the actual significance level, the retention and development of the Ukrainian nuclear power branch is tied to an integrated solution and overcoming of a very complicated problem of lop-sided development.

The exploitation of all nuclear units is entirely depended on the Russian Federation with respect to the fresh nuclear fuel supplies, the spent nuclear fuel acceptance for reprocessing, some portion of spare parts (renewable equipments) supplies, as well as some scientific support (and service) of

Russian key scientific research institutes[4], because after the independent statehood achievement, Ukraine lost the majority of scientific & technical support institutes and nuclear industry enterprises, as they are located in the Russian Federation area historically.

This characteristic feature is the large weakness of National Nuclear Energy Generating Industry. Unfortunately, a scope of scientific support components does not meet the current requirements. Ukraine has to create domestic scientific support which covers various aspects such as: availability diagnostics, calculation codes, water chemistry, technology for the spent fuel and radwastes management, equipment certification, decommissioning issues, etc.

On the other hand, the closest analysis of the present Ukrainian fuel-energy complex's condition shows that *an elimination of the above mentioned disharmony is the shortest and cheapest way* for reinforcement of the energy supply self-dependence basis.

Nowadays, Ukraine has achieved definite results on the way to create its *scientific & technical NEI's support infrastructure* and expertise support institutes for a state nuclear regulatory system. It is associated with institutions:

Under the Nuclear Energy Industry's Branch:

The Kyiv Design Institute "Kyivenergoproject" (with functions of the General Designer for RNPP, KhNPP and ChNPP), the Kharkiv Design Institute "Kharkivenergoproject" (with functions of the General Designer for ZNPP and SUNPP), the Ukrainian Scientific-Research and Design-Exploration Institute for Industrial Technology (Zhovty Vody, Main Designer on Raw Materials Extraction, abbr. USR&DE Institute for IT), the Scientific and Technical Centre (Zhovty Vody, abbr. ZhS&TC), the State Scientific Engineering Centre of Control Systems and Emergency Response, the Institutes of NPPs' Exploitation Support, the Engineering Technological Centre Personnel Training for Nuclear Power Industry, the Crimean Scientific Engineering Centre, the Vostochny (Eastern) Maining&Concentrating Industrial Complex "VostGOK".

Under the State Committee of Nuclear Regulation:

The State Scientific and Technical Centre on N&R Safety of Ukraine, the State Scientific and Technical Centre on quality certification of NEI's Equipment.

Under the National Academy of Sciences of Ukraine:

The Kyiv Institute for Nuclear Research, the Kharkiv Scientific Center "Physics Technological Institute" (abbr. KhSC"Physics Technological Institute"), the State Scientific and Technical Centre "Core" (this "core"-fissionable zone, abbr.SS&TC"Core"), the various institutes of National Academy of Sciences of Ukraine (thermal engineering, welding, problems of strength etc.)

Under the Heavy Industrial's Branch:

The State Mining and Smelting Industrial Complex (town Vilnogirsk), the Zirconium State Research-and-Production Enterprise "Zirconium", the Kharkiv Scientific-Industrial Association "TurboAtom", the Zaporizhzhya Industrial Association "Zaporizhtransformator", the State Enterprise "Pridnyprovsky Plant of non-ferrous materials", the Pridnyprovsky plant for pipe duct productive, the Pridnyprovsky Hydro-Metallurgical Plant, the State Enterprise "Pridnyprovsky Chemical Plant", the Dnypropetrovsk Technological Institute (abbr.DTI) etc.

Since 1994 the Ukrainian Government has been taking actions for the organization of its own domestic nuclear fuel manufacture. Named sizeable uranium ore deposits and mining & concentrating enterprises (Zhovty Vody site), as well as the zirconium's concentrating enterprises and Pridnyprovsky pipe duct productive plant (Dnypropetrovsk region) are a good initial basis for own domestic fuel elements and nuclear fuel assemblies production.

For this purpose a new joint-development company has been created by united efforts of Ukraine, Kazakhstan and the Russian Federation. Furthermore, within the bounds of Ukraine-USA collaboration (project "Qualification of Ukrainian Nuclear Fuel"), Ukraine is acquiring the up-to-date technologies for its nuclear fuel improvement and other technologies of Nuclear Fuel Cycle.

Such planned domestic nuclear fuel manufacture in conjunction with the commissioning of intermediate spent fuel storage facilities and the wide spectrum of varied radioactive waste

[4] Scientific management of NPP development – All-Russian Scientific-Research Center "Kurchatov Istitute", Russian SRC "the Scientific-Research Institute of Atomic Reactors" (Димитровград),
Energy equipment development – Scientific-Research Institute of Energy Technology (НИИКИЭТ, Москва), Experimental-Design Office "Hydropres" (ОКБ "Гидропресс", Подольск), All-Russian Scientific-Research Institute of Inorganic Materials (ВНИИНМ, Москва) etc.

management facilities[5] will enable the production of the most essential set of the domestic nuclear fuel cycle's components.

Evidently, Ukraine does not have alternative technologies for nuclear energy utilization, and thereby the thorough elaboration of the national nuclear energy development's strategy, at least for the period until 2030, is an indisputable necessity.

Unfortunately, so far, strategy of this kind has not been approved and consequently we *have to adopt the following as logical assumptions* made on the prerequisites and the main economic policy principles of an independent state.

In compliance with these principles, which were formulated in the draft "The Conception of Ukrainian National Energy Policy for the period until 2020" (chapter 3.1)[6]" a new long-term National Energy Program of Ukraine has to *concentrate its attention on appropriate national authorities upon successful achievements of such ultimate aims*:

1. N&R safety's reinforcement on a level with the highest world standards by means of the incorporation of the European Community's safety standards (ISO- International Organization for Standardization) into the domestic energy industry.
2. Implementation of urgent special programs for reinforcement of energy supply independence and economics.
3. Utilization efficiency increase and production capabilities expansion of nuclear facilities in compliance with a growing national demand.

For achievement of the above-stated purposes the long-term national nuclear energy development's program has to consider the realization necessity of the specific NEI's tasks, namely:

1. Improvement of a nuclear legislation basis.

1.1 The development of legislation in the area of nuclear power utilization to cover in full all issues concerning rights, obligations and responsibilities of actors participating in the nuclear power utilization sector.

1.2 Creation of an advisable structure for state management and regulation on nuclear power utilization and effective implementation of advanced technologies.

1.3 Sanction and validation of effective financing mechanisms for realization of strategically important programs in national NEI.

2. Safety and reliability improvement of WWER nuclear power units (WWER-1000 and WWER-440) on the basis of the current existing level of knowledge, expertise and strategic planning.

2.1 Upgrading of nuclear power units in compliance with the safety improvement programs of WWER.

2.2 Development of R&D institutes for both the scientific & technical NEI's support and the expertise support of a state nuclear regulatory system.

3. Development of an all-sufficient infrastructure for scientific & technical NEI's support.

3.1 Elaboration and implementation of a Spent Fuel Management Program (commissioning of AFR ISFSF and total completion of AR spent fuel storage pools reracking) and Radioactive Waste Management (commissioning of radwastes facilities for intermediate storage, reprocessing, pretreatment, compacting and removal for final disposal.

3.2 Preparation and organization of a domestic institute for nuclear core designing, qualifying and upgrading of nuclear fuels, as well as developing of new nuclear fuel cycle technologies.

3.3 Development of domestic enterprises for the nuclear fuel manufacture (at first the most essential components) and the wide spectrum manufacture of the varied equipment and spare parts for front and back sides of the Nuclear Fuel Cycle. The existing "Comprehensive Program for Nuclear Fuel Cycle Formation" and the "Program of Equipment Manufacture and Technology Mastering for NPPs" are base for a Spent Fuel Management Program.

4. Increasing of NPPs' utilization efficiency and operational reliability, as well as construction completion and commissioning of new nuclear power units.

---

[5] The term "waste management facilities" includes facilities for intermediate storage, reprocessing, pretreatment, compacting and removal for final disposal.

[6] Проект «Концепция государственной энергетической политики Украины на период до 2020 года» разработан Украинским центром экономических и политических исследований имени Александра Разумкова и опубликован в газете «ЭнергоИнформ, №10 (90) 8-14 марта 2001г.

4.1 Commissioning of the unfinished nuclear power units: Khmelnytsky # 2, Rivne # 4 and later Khmelnytsky # 3 and Khmelnytsky # 4.

4.2 Overhaul-period renewal (license renewal on operating) of nuclear power units extra initial designed lifetime within 10-20 years after completion of their designed lifetime by procedures realization of Plant Life Management and Plant Life Extension.

4.3 Supplies' diversification on nuclear fuel, spare parts (renewable equipments), as well as scientific research, technical and industrial services.

5. Nuclear fuel cycle optimization and enhancement of nuclear fuel utilization.

5.1 Acquisition of licenses for 4-year commercial utilization of WWER-1000 fuel and for 5-year commercial utilization of WWER-440 fuel.

5.2 Increasing of fuel consumption's efficiency (rate of installed capacity's use) of nuclear units by prolongation of fuel reload cycles from 12 to 18 months.

5.3 Thorough considerations of alternative and decision selection between reprocessing and final spent fuel disposal in deep geological repository. *What is NFC reasonable, "Entire nuclear fuel cycle" or "Once through nuclear fuel cycle (direct)"?* Strategic *issue.*

5.4 Attribute identification of new type reactor for replacement of nuclear power units that have exhausted designed lifetime and selection of promising designs for new reactors types (thereupon *"The DUPIC alternative"consideration* is very appropriately).

6. Arrangements implementation for enhancement of daily load spike regulation of integrated electricity system of Ukraine.

6.1 Construction completion of Tashlyk hydro-accumulating complex that includes HPP and hydro-accumulator PP[7]. Here Tashlyk water storage basin is the cooling pond for South-Ukraine NPP (SuNPP).

6.2 Preparation and implementation of working conditions for participation enlarging of WWER units in daily load spike regulation of integrated electricity system by means manoeuvring of units' capacity in the scope of 70-100% of nominal capacity.

7. Consequences elimination of ecocatastrophe at Unit 4 of Chornobyl NPP and Decommissioning of Chornobyl NPP.

7.1 Stabilization and Transformation of Object "Shelter" into ecologically safe zone depending upon the international assistance provided under the Shelter Implementation Plan.

- Creation of infrastructure for Radioactive Waste Management of Object "Shelter".
- Effective implementation of advanced technologies for removal of fuel carrying (containing) materials (FCM).
- Reprocessing of FCM and radwastes for long-term storage and pretreatment for removal for final disposal.

7.2 Accomplishment of activities according to ChNPP's Decommissioning Plan. See the illustration of "Waste Management Scheme[2]".

8. Development, optimisation and implementation of general strategy for decommissioning of nuclear installations.

8.1 Development of basis plans for the decommissioning of all existing nuclear energy units taking into account the acceptabilities for Lifetime Extension and best site reassignment.

8.2 Engineering documentation preparation for carrying out the decommissioning procedures (WWER and RBMK) according to international standards.

8.3 Creation, validation and support of effective financing mechanisms for realization of nuclear instillations decommissioning programs.

3. CONCLUSIONS

The above-mentioned list of specific NEI's tasks do not claim thoroughness or comprehensive analysis and can be improve appreciably, but the sizeable NPPs' contribution into Ukrainian energy production *presses for* the all-inclusive elimination of the existent disharmony of the domestic NEI's development. Here, conventionally, the whole problem complex can be represented as a creation

[7] Construction of Dniester and Tashlyk hydro power complexes delayed due to shortage of finance and negative attitude of local authorities to construction of Tashlic complex that include HPP and hydro-accumulator PP.

problems of efficient infrastructure for the scientific & technical NEI's support on the one hand and on the other hand as the commissioning of main enterprises for native NFC' s formation.

Not long ago, South Korea had overcome the majority of similar problems, therefore, its experience can be a good basis for creating of high level mutual Korean-Ukrainian cooperation in these peaceful utilization of nuclear energy. At the same time, the abundant experience of Ukrainian nuclear energy will be helpful to South Korea.

Undoubtedly, mutual Korean-Ukrainian cooperation in the peaceful utilization of nuclear energy will create a good impact for decision acceleration of many existing problems concerning environmental safety and increasing the effectiveness of nuclear energy utilization.

ACKNLOWLEDGEMENT

This study has been carried out under the nuclear R&D plan by the Ministry of Science and Technology

REFERENCES

[1] "National Energy Program of Ukraine to 2010 year", approved resolution of Verkhovna Rada (Parliament) of Ukraine on May 15, 1996 №191/96

[2] "Implementation Plan for Facilities of the Pre-Decommissioning Period", OSAT Chernobyl (Tacis), 25.06.1999

[3] "The decommissioning of WWER Type Nuclear Power Plants (Final report of an IARA Regional Technical Co-operation Project, January 2000), IAEA-TECDOC-1133.

[4] "Spent Fuel Management Programme in Ukraine till 2010" (in progress).

[5] Проект "Концепция государственной энергетической политики Украины на период до 2020 года" разработан Украинским центром экономических и политических исследований имени Александра Разумкова и опубликован в газете "ЭнергоИнформ", №10 (90) 8-14 марта 2001г.

[6] Олександр Гудима, народний депутат України, голова Комітету Верховної Ради України з питань паливно-енергетичного комплексу, ядерної політики та ядерної безпеки. Стаття "Реалії та перспективи ядерно-паливного циклу України" надрукована в газеті "Зеркало недели", №2, 2001