

REVISED DECOMMISSIONING PROGRAM FOR NPP KRŠKO

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ABSTRACT

As required by the paragraph 10 of the Agreement between the governments of Slovenia and Croatia on status and other legal issues related to investment, exploitation, and decommissioning of Nuclear power plant Krško Decommissioning program for Krško NPP including LILW and spent fuel management was drafted. The Intergovernmental body required that the Program should be extensive revision of existing program as one of several iterations to be prepared before final version.

The purpose of the joint Program is estimating the expenses of the future decommissioning, radioactive waste and spent fuel management for Krško NPP. Costing estimation with target sums needed at the beginning of decommissioning was the basis for establishing special fund in Croatia or correction of the rate for existing decommissioning fund in Slovenia.

The Program development was entrusted to specialized organizations both in Croatia and Slovenia which formed the Project team as the operative body. Consulting firms from Croatia and Slovenia were involved as well as experts from International Atomic Energy Agency (through short visits to Zagreb and Ljubljana) for specialized fields (e.g. economic aspects of decommissioning, pre-feasibility study for spent fuel repository in crystalline rock, etc.)

Analysis was performed in several steps. The first step was to develop rational and feasible integral scenarios (strategies) of decommissioning and LILW and spent fuel management on the basis of detailed technical analysis and within defined boundary conditions. Based on technological data every scenario was attributed with time distribution of expenses for all main activities. In the second step financial analysis of scenarios was undertaken aiming at estimation of total discounted expense and related annuity (19 installments to the single fund, empty in 2003) for each of the scenarios. The third step involves additional analysis of the chosen scenarios aiming at their (technical or financial) improvements even at the price of loosening some of the boundary conditions. The fourth step includes financial comparison of the estimated expenses for chosen scenario with the available data on decommissioning expenses for similar power plants or LILW and spent fuel repositories.

By variations of the original SID strategy seven rational decommissioning scenarios were formulated respecting boundary conditions and other limitations. Three of them are ending up with local disposal of spent fuel and four of them are assuming permanent export of spent fuel. After financial analysis two scenarios could be singled out and optimized. They were labeled SID-45 with disposal and SID-45 with export. A choice on the one to be finally executed is up to the stakeholders deciding on scenario's social acceptability. Both of the scenarios are structurally

similar with almost identical discounted expenses enabling simple switching from one scenario to another for several decades from now.

INTRODUCTION

The Agreement between the governments of Slovenia and Croatia on the status and other legal issues related to investment, exploitation, and decommissioning of Nuclear power plant Krško requires that the two countries develop a joint NPP decommissioning program and a program for its radioactive waste and spent fuel management. The Intergovernmental body coordinating the implementation of the Agreement (IGB) decided that a single program for the plant decommissioning and waste and spent fuel management will be produced.

The Intergovernmental body required that the Program should be an extensive revision of the first NPP decommissioning plan [1, 2, 3], which was adopted by Slovenia in 1996, and that several iterations should be prepared before the final version is produced just prior to the end of the useful life of NPP Krško. It was required also that the Program should be based on all known data and international standards as well as the best practice in the field.

Purpose of the Program

The purpose of the joint Program is to estimate the expenses of the future decommissioning, radioactive waste and spent fuel management for Krško NPP. Costing estimation with target sums needed at the beginning of decommissioning will be the basis for establishing special fund in Croatia or correction of the rate for existing decommissioning fund in Slovenia.

Organization of the Work

Program development was entrusted to specialized organizations both in Croatia and Slovenia (APO d.o.o. & ARAO) which formed the Project team as the operative body. Also, IGB nominated the Advisory board with experts from Croatia and Slovenia. The role of the Advisory board was supervising the activities of the Project team and resolving issues raised by the Project team (setting the boundary conditions). NPP Krško was supplying needed data. Consulting firms from Croatia and Slovenia were involved as well as experts from International Atomic Energy Agency (through short visits to Zagreb and Ljubljana) for specialized fields (e.g. economic aspects of decommissioning, pre-feasibility study for spent fuel repository in crystalline rock, etc.)

Method

Analysis was performed in several steps.

The first step was to develop rational and feasible integral scenarios (strategies) of decommissioning and LILW and spent fuel management on the basis of detailed technical analysis and within defined boundary conditions. Each of the scenarios is a time sequence of interrelated and coordinated jobs on: (a) dismantling of Krško NPP, (b) transport and storage of spent fuel, (c) export or disposal of spent fuel in geological repository, and (d) disposal of LILW in near surface repository. Based on technological data every scenario was attributed with time distribution of expenses for all main activities.

In the second step financial analysis of scenarios was undertaken aiming at estimation of total discounted expense and related annuity (19 installments to the single fund, empty in 2003) for each of the scenarios. It was assumed that annuity is good financial description of given scenario

so that by comparing them financially affordable scenarios could be identified. Furthermore, some of the scenarios were eliminated as being less rational than others or as being temporally inflexible (e.g. sensitive on achieving goals on time).

The third step involves additional analysis of the chosen scenarios aiming at their (technical or financial) improvements even at the price of loosening some of the boundary conditions. Based on such rationalized scenarios total discounted expense is determined and its corresponding annuity. Using this abstract annuity Croatia and Slovenia could determine real annuities for their national decommissioning funds. Values of annuities in Croatia and Slovenia could be different due to the existing unsymmetrical situation but accumulated sums in both of the funds in December 2022 should be the same or nearly same and put together sufficient for all the future expenses.

The fourth step includes financial comparison of the estimated expenses for the chosen scenario with the available data on decommissioning expenses for similar power plants or LILW and spent fuel repositories. Conclusions and recommendations were formulated.

Contents of the Program

The Program is divided in 7 separate units – modules – where: (a) Previous work on decommissioning and waste or spent fuel management for NPP Krško is described. Boundary conditions are also presented here (modules 1 and 2); (b) Technical solutions for decommissioning, dry storage, spent fuel management and disposing of LILW waste are explained (modules 3, 4 and 5); (c) Scenarios are formulated respecting boundary conditions. Scenario analysis is done; the optimal scenario is chosen and improved (modules 6 and 7).

CONTEXT

Situation [4, 5, 6]

- a) During the year 2000 NPP Krško undertook a modernization project including exchange of steam generators. Output power was increased to 676 MWe. Replaced steam generators were temporarily stored on location in specially prepared building. In the same time spent fuel pit reracking was successfully finished enabling enough capacity of pool until 2023. Heat exchanger was replaced; the old one was stored in decontamination building. Modernization was aimed at extension of fuel cycle from 12 to 18 months.
- b) NPP Krško is having presently 1694 locations in spent fuel pool. 663 places were taken, 603 with fully spent fuel elements and 59 with partially spent fuel elements, at the end of 2002. It is estimated that until 2023, with assumed extension of fuel cycle and increased power output, $1,531 \pm 20$ spent fuel elements will be produced with total of about 620 tones of metallic uranium.
- c) At the end of 2002 in the storage on location of NPP Krško there were $2,208 \text{ m}^3$ of operational solid LILW. Most of the waste is short lived with very low content of alpha emitters. With present technology of conditioning and packaging it was estimated that $3,615 \text{ m}^3$ of waste will be generated until the end of useful NPP life. If we add up LILW to be generated by decommissioning and replacement of major components, total quantity of LILW is estimated at $17,500 \text{ m}^3$. Approximately 1 % of that volume will be the long-lived LILW.

Boundary Conditions

Establishment of a finite number of rational scenarios (strategies) integrating decommissioning and waste management for NPP Krško requires setting up some assumptions on the processes and their time limitations. These assumptions are here named boundary conditions. Since this iteration of the Program is the first revision of the original Slovenian plan (which was based on a study prepared during 1995-96 by a German company with considerable experience in the field, NIS Ingenieurgesellschaft mbH), significant number of the boundary conditions was kept. But some of the boundary conditions were changed according to suggestions formulated at Ljubljana 2000 and Ljubljana 2001 workshops which reviewed the NIS study (e.g. incorporating risk registry). Advisory Board of the project made a revision of the entire set of boundary conditions as well as formulation of some new ones chosen particularly for this iteration of the Program. The most important boundary conditions in this study are:

- a) NPP Krško will work until 2023;
- b) Only variations of the SID strategy introduced by the NIS study will be evaluated, in particular SID-15 and original version of SID-96, while SID-30 will be examined in sensitivity analysis (SID is short for Strategy Immediate Dismantling from the NIS study, indicating that decommissioning takes place immediately after shut down; numerical index specifies the period in which all the activities described in this Program will completed, whereas the NPP dismantling period may be considerably shorter);
- a) Financial results should be expressed in euros (€2002) as: (1) estimation of nominal and discounted costs; and (2) cash flow of accumulation and expenditure on a time scale;
- b) One LILW repository (either in Slovenia or Croatia), near surface type (tunnel), operational from 2013;
- c) One geological repository for spent fuel (either in Slovenia or Croatia), operational from 2030, but permanent export will be analyzed also;
- d) The Program will address dry storage of spent fuel;
- e) Discounting is done with the inflation rate $i = 1.0073$ and the interest rate $k = 1.0429$ (with corresponding discounting rate $d = 1.035$). Annuity for decommissioning fund is calculated from the total discounted expenses, assuming 19 equal payments into presently empty fund.

Additional Assumptions

In addition, the following was assumed:

- a) All the expenses are without taxes;
- b) Expenses for institutional control are not taken into account;
- c) All the expenses of LILW storage expansion or modification on the location of NPP Krško and all the related expenses (e.g. local incentives) are operational expenses;
- d) All the expenses for additional operational LILW waste stabilization and conditioning possibly required by repository (based on waste acceptance criteria) are NPP Krško operational expenses.

DESCRIPTION OF TECHNOLOGIES AND CALCULATION OF NOMINAL EXPENSES

The quality of data used for evaluation of decommissioning expenses as well as expenses for waste and spent fuel management is variable:

- LILW management and disposal is well known, based on several good feasibility studies.
- Spent fuel management and/or disposal is less known: export expenses are known only as the first and preliminary offers; only one prefeasibility study was available transposing Swedish disposal technology for spent fuel into local (very different) social and economical circumstances. Calculation of expenses was generic and quite simplified.
- Overall dismantling costs are known with less accuracy than in the NIS study, the reason being additional corrections and recalculations for new circumstances (e.g. US\$1996 into €2002, and particularly the work force expenses).

Difference in accuracy was compensated with the addition of extra sums in the form of contingency. Where the accuracy was better (e.g. expenses for establishing LILW repository) 10% was added to the total sum, and where it was lower (e.g. expenses for establishing SF repository) 30% was added to the total sum.

LILW Disposal

Based on thorough analysis of different approaches in various countries near surface type of repository was chosen as the most appropriate one. This type of repository could be constructed in the two forms: as a tunnel and as a surface vault type. This Program uses primarily analysis for establishing a tunnel type of repository for 17,500 m³ of NPP Krško LILW which is enough for all the waste generated during operation and decommissioning.

For construction, operation and closure of the repository the estimate of expenses was mostly derived from existing feasibility studies. However some of the expenses were internally assessed with the assistance of IAEA experts. The most of the expenses are related to the construction of repository and needed infrastructure. The construction of the underground objects to be finished from 2011 to 2013 is the biggest single expense.

The methodology used differentiates two periods: the first, development and construction of repository, covers expenses for site selection, negotiation with local community, preparation of requests and obtaining various licenses, construction of repository and infrastructure, disposal technology and safety assessments as well as incentives; the second period starting with 2014 onwards covers the expenses for routine operation of repository, repository closure and incentives for local community.

SF Disposal

Disposal in deep geological formations is considered to be the only technically feasible and safe long-term solution for spent fuel and high-level waste (HLW). Swedish model (developed by Swedish agency for waste management – SKB as KBS-3 concept) was adopted for the evaluation of the expenses related to development and construction of such a repository 500 m underground in hard rock (e.g. granite). This is logical choice since KBS-3 is the most developed disposal concept which is also going to be used in Finland in the first operational repository in Europe. Basic characteristics of the concept are: (a) direct disposal of spent fuel (no reprocessing); (b) capacity for 1,531 fuel elements or 620 metric tons of metallic uranium with a small additional volume of HLW (~16 m³). All the phases of development, operation and closure were studied: (a) research and development; (b) site selection and characterization; (c) design and construction; (d) operation; (e) closure. Swedish methodology for evaluation of expenses was used along with the model.

Referent scenario was analyzed in two versions: (a) beginning of repository operation is 2030 (spent fuel in pool); and (b) beginning of repository operation is 2050 (spent fuel in dry storage).

Since Russian Federation has recently put into force three laws opening the possibility of spent fuel import to Russia for reprocessing and/or permanent disposal, a prospect for export of the NPP Krško spent fuel is opened. The Program analyzes circumstances in which such an export could be conceived. Assuming that social and political conditions for agreement on the issue could be met, export of spent fuel was analyzed as a symmetrical option to disposal in the local repository in scenarios where this was technically possible.

It could be seen from comparison with other decommissioning programs that fixed expenses are the biggest part in establishing deep geological repository. Because of that the price per disposed kg of spent fuel will be high where the quantities of spent fuel are comparatively small as is the case with the NPP Krško.

NPP Dismantling

According to boundary conditions the NIS study was used as the only source of data for estimation of dismantling costs. Expenses were “decomposed” on basic activities, its revalorization was done and then they were “composed” in new entities (with some modifications or added activities), and distributed in time accordingly. This was accomplished with the support by the IAEA experts. Analysis of NIS expenses was used to separate expenses for establishing and operation of LILW repository and SF disposal originally integrated in the total NIS price. In particular, work force expenses were scrutinized since the NIS study assumes that work force expenses compose 60% of all the expenses. Furthermore, average salary was set to be based on 16 DEM-95/h, which is rather low. Also, it was assumed that 75% of the total work force expenses are for the NPP personal and 25% for the local companies.

Based on this, revision of original expenses was done: per hour salary was doubled for all the workers and then a contingency was added (50% for technological expenses and 20% for expenses related to spent fuel management). Recalculated expenses were then converted (DEM-96 into €2002).

Appropriate modifications with different dismantling options were introduced in the SID-96 original technological sequence to be used in integral scenarios which differ from the scenarios analyzed in the NIS study.

RESULTS

Integral Scenarios Development and Their Financial Evaluation

By variations of original SID strategy seven rational decommissioning scenarios were formulated respecting boundary conditions and other limitations. Three of them are ending up with local disposal of spent fuel and four of them are assuming permanent SF export.

Original SID-96 scenario could be adapted to new boundary conditions without variations in technology and without changes in sequence of dismantling activities (SID-96 with disposal). The same sequence of dismantling activities but with permanent export of spent fuel is a basis for the symmetrical scenario (SID-96 with export).

Since it is impossible to dispose spent fuel immediately after the NPP shut down, scenario of fast decommissioning could not be constructed as simple shortening of the original SID-96, except in the case of permanent export of spent fuel (SID-15 with export). For this scenario, and the rest of scenarios considered here (apart from two aforementioned SID-96 scenarios), 80 years of on site storage for the main components and reactor vessel is canceled and technological modifications are introduced to enable their dismantling, cutting and disposal prior to the rest of decommissioning operations.

To achieve fast decommissioning without export of spent fuel, original SID scenario should be modified enabling dismantling while spent fuel is still cooling down in the pool. If wet storage is introduced, the scenario could be finished in less than 15 years even if disposal of spent fuel starts at 2031 (SID-15WS with disposal). Spent fuel could be kept in wet storage for the same number of years prior to export in symmetrical scenario (SID-15WS with export). Figure 1 illustrates the charts used for scenario timetable comparison.

| SF repository | SF storage | where is SF? | LILW repository | Year | NPP dismantling | | | | where is HLW? | nominal costs | | | | | | | | |
|---------------|------------|--------------|-----------------|------|------------------------------------|--|----------------------|-----------|---------------|-----------------|--------------------------|---------------|-----------------------|------------|------|------|-----|-------|
| | | | | | main components and reactor vessel | buildings demantle. & site restoration | all other facilities | transport | | NPP dismantling | SF transport and storage | LILW disposal | SF disposal or export | | | | | |
| development | operation | closure | operation | | removal | decommissionation | cutting | storage | transport | export | disposal | dry store | wet store | NPP-SF pit | | | | |
| | | | | 2023 | | | | | | | | | | | 7,8 | 31,1 | 3,7 | 208,0 |
| | | | | 2024 | | | | | | | | | | | 7,8 | 31,1 | 3,7 | 208,0 |
| | | | | 2025 | | | | | | | | | | | 6,9 | 31,1 | 3,7 | 208,0 |
| | | | | 2026 | | | | | | | | | | | 8,1 | 8,6 | 3,7 | 208,0 |
| | | | | 2027 | | | | | | | | | | | 24,6 | 8,3 | 3,7 | |
| | | | | 2028 | | | | | | | | | | | 15,9 | | 3,7 | |
| | | | | 2029 | | | | | | | | | | | 27,3 | | 3,7 | |
| | | | | 2030 | | | | | | | | | | | 27,3 | | 3,7 | |
| | | | | 2031 | | | | | | | | | | | 27,7 | | 3,7 | |
| | | | | 2032 | | | | | | | | | | | 21,9 | | 3,7 | |
| | | | | 2033 | | | | | | | | | | | 10,4 | | 3,7 | |
| | | | | 2034 | | | | | | | | | | | 5,8 | | 3,7 | |
| | | | | 2035 | | | | | | | | | | | 5,8 | | 3,7 | |
| | | | | 2036 | | | | | | | | | | | 3,5 | | 3,7 | |
| | | | | 2037 | | | | | | | | | | | | | 3,7 | |
| | | | | 2038 | | | | | | | | | | | | | 5,0 | |
| | | | | 2039 | | | | | | | | | | | | | 5,0 | |
| | | | | 2040 | | | | | | | | | | | | | 5,0 | |
| | | | | 2041 | | | | | | | | | | | | | 5,0 | |
| | | | | 2042 | | | | | | | | | | | | | 5,0 | |
| | | | | 2043 | | | | | | | | | | | | | 5,0 | |
| | | | | 2044 | | | | | | | | | | | | | 5,0 | |
| | | | | 2023 | | | | | | | | | | | 20,8 | 11,0 | 3,7 | 18,3 |
| | | | | 2024 | | | | | | | | | | | 34,8 | 6,0 | 3,7 | 19,0 |
| | | | | 2025 | | | | | | | | | | | 16,7 | 6,0 | 3,7 | 24,7 |
| | | | | 2026 | | | | | | | | | | | 27,3 | 6,0 | 3,7 | 56,4 |
| | | | | 2027 | | | | | | | | | | | 27,3 | 6,0 | 3,7 | 72,6 |
| | | | | 2028 | | | | | | | | | | | 27,8 | 6,0 | 3,7 | 65,8 |
| | | | | 2029 | | | | | | | | | | | 22,3 | 6,0 | 3,7 | 20,5 |
| | | | | 2030 | | | | | | | | | | | 10,4 | 22,5 | 3,7 | 15,3 |
| | | | | 2031 | | | | | | | | | | | 5,8 | 6,4 | 3,7 | 21,4 |
| | | | | 2032 | | | | | | | | | | | 5,8 | 6,4 | 3,7 | 22,5 |
| | | | | 2033 | | | | | | | | | | | 3,5 | 6,4 | 3,7 | 27,5 |
| | | | | 2034 | | | | | | | | | | | | 6,4 | 3,7 | 27,5 |
| | | | | 2035 | | | | | | | | | | | | 6,4 | 3,7 | 27,5 |
| | | | | 2036 | | | | | | | | | | | | 6,4 | 3,7 | 8,7 |
| | | | | 2037 | | | | | | | | | | | | 5,0 | 3,7 | 7,2 |
| | | | | 2038 | | | | | | | | | | | | 3,7 | | 13,3 |
| | | | | 2039 | | | | | | | | | | | | | 5,0 | 13,6 |
| | | | | 2040 | | | | | | | | | | | | | 5,0 | 12,8 |
| | | | | 2041 | | | | | | | | | | | | | 5,0 | 12,8 |
| | | | | 2042 | | | | | | | | | | | | | 5,0 | |
| | | | | 2043 | | | | | | | | | | | | | 5,0 | |
| | | | | 2044 | | | | | | | | | | | | | 5,0 | |

Fig. 1. Partial scenario timetables

If it would be necessary to store spent fuel for more than 10 years (as is the case with SID-15WS scenarios) dry storage is indicated as better solution since it is cheaper for longer periods than

wet storage. Corresponding scenarios lasting approximately 30 years (SID-30 with disposal and SID-30 with export) were derived from technological operations of the original SID in the similar way it was done for SID-15 with export. Location for dry storage was not defined in this Program: it could be on the NPP Krško site or elsewhere.

The set of seven presented scenarios contains all feasible decommissioning options which are respecting boundary conditions.

Each of the seven scenarios was described with temporal distribution of expenses for all of the central activities (dismantling, transport and storage of spent fuel, disposal of LILW and disposal or export of spent fuel). Financial analysis for which all of the needed tools were developed (financial model and computer program) produced discounted total cost for every scenario and corresponding annuity for hypothetical decommissioning fund.

Selection of Appropriate Scenario

After financial analysis the most expensive scenarios were eliminated (SID-96 with export, SID-15 with export and SID-15WS export). Among the financially superior scenarios (SID-96 with disposal, SID-30 with export, SID-30 with disposal and SID-15WS with disposal) some are technically better than others: SID-96 with disposal (inherited from the NIS study) is based on rather complicated and expensive solutions, related particularly to SF disposal; SID-15WS with disposal was introduced as realistic solution in a response to boundary condition requiring fast decommissioning. Both of them are technologically weak in the same way: they are inflexible to changes in planned operations with SF (e.g. extended site selection process or late approval of licenses, consequently causing considerable expenses for extended wet storage).

Two SID-30 scenarios could be singled out. They are having both of the required properties: low expenses and adaptability to possible changes. In addition, since SID-30 scenarios are based on dry storage of SF, some changes were scrutinized in order to make scenarios more realistic and cheaper. Lower expenses could be accomplished by slight modifications of boundary conditions. Obviously, lowering nominal costs is one possibility and shifting the costs in time is the other, if discounting is considered. In our case, three options are possible: (a) later disposal/export of SF; (b) later opening and shorter lifespan of LILW repository; and (c) surface type of LILW repository. Other optimizations of expenses are also possible, in particular those anticipating further development of nuclear technology. At this early time of Program development they are not considered.

Options (a) and (b) were chosen for our optimization (later disposal/export for SF and shorter lifetime for LILW repository). This was done primarily to make total expenses for export and disposal comparable, and to enable postponement of final decision on the disposal/export for SF.

Introduced extensions in timing are formally reflected in the names of new scenarios which we labeled as SID-45 with disposal and SID-45 with export. For SID-45 scenarios annuities and other financial indicators were calculated. Both scenarios have comparable expenses. A choice on the one to be finally executed is up to the stakeholders deciding on scenario's social acceptability.

Table I summarizes nominal and discounted costs of dry storage scenarios, including the annuity. Figure 2 shows discounted annual expenses for the four major components of the Program in the scenario SID-45 with disposal. All amounts are in millions €2002.

Table I. Costs of dry storage scenarios

| | LILW disposal | | SF trans&store | | SF disposal | | dismantling | | total | | a |
|------------------------|---------------|-------|----------------|-------|-------------|-------|-------------|-------|---------|-------|-------------|
| | nom. | disc. | nom. | disc. | nom. | disc. | nom. | disc. | nom. | disc. | |
| SID-30 export | 268.5 | 119.7 | 175.3 | 77.0 | 982.1 | 146.1 | 206.3 | 80.9 | 1,632.2 | 423.7 | 34.5 |
| SID-30 disposal | 268.5 | 119.7 | 175.3 | 77.0 | 509.7 | 111.4 | 206.3 | 80.9 | 1,159.8 | 388.9 | 31.6 |
| SID-45 export | 310.2 | 107.8 | 190.3 | 78.7 | 982.1 | 77.8 | 206.3 | 80.9 | 1,689.0 | 345.3 | 28.1 |
| SID-45 disposal | 186.0 | 93.9 | 189.3 | 78.6 | 567.7 | 85.1 | 206.3 | 80.9 | 1,149.3 | 338.5 | 27.5 |

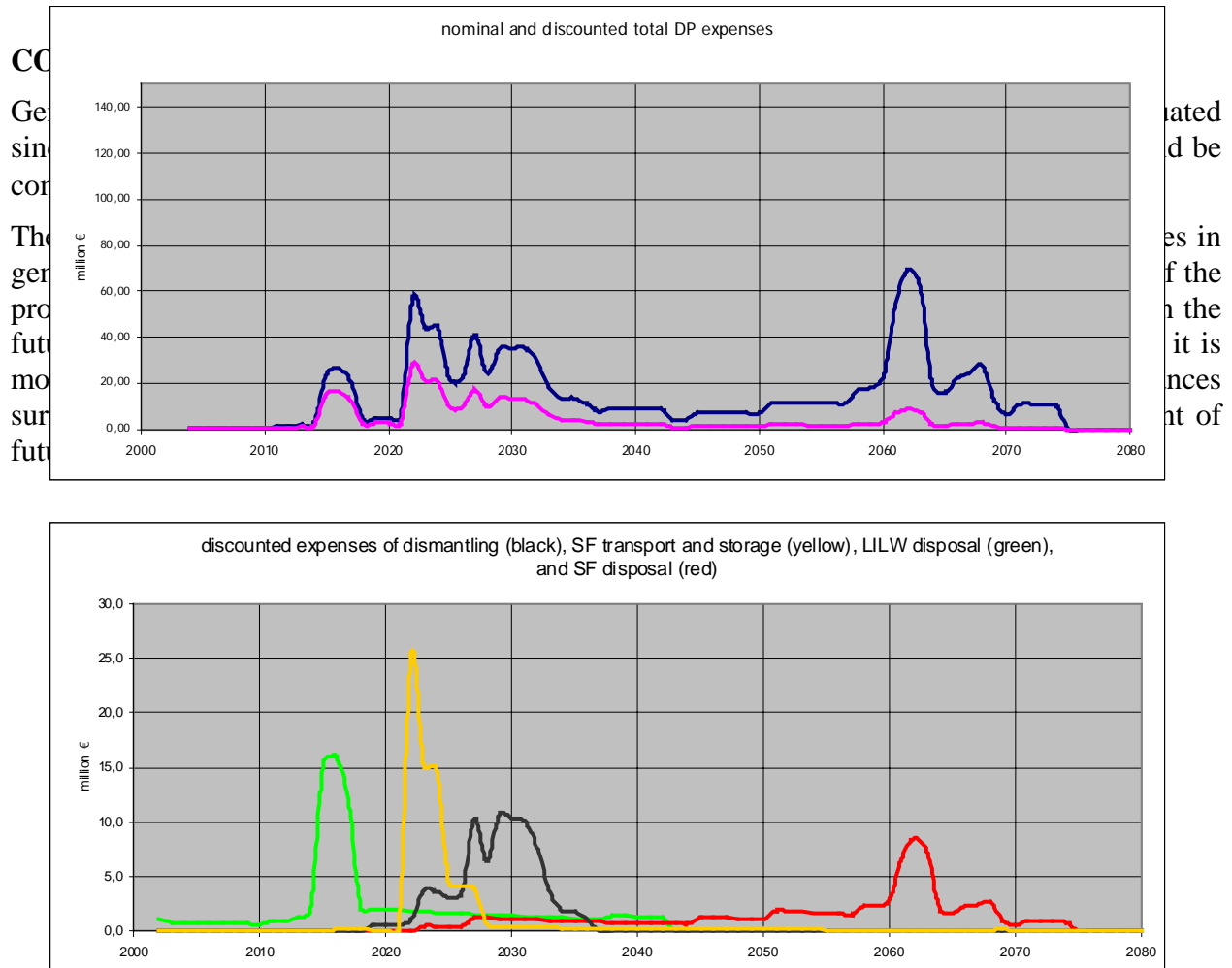


Fig. 2. Scenario SID-45 with disposal annual expenses

To assess suitability of calculations in this project, comparison of estimated decommissioning as well as SF and LILW management expenses was undertaken with estimations or real expenses for comparable nuclear power plants or spent fuel and waste management in repositories of similar type or size [9]. Such a comparison is complex even dubious for several reasons (e.g. differences in methodology of estimation; different technical solutions; specific financial models; difficulties in exchange of currencies from one monetary system to another; etc.) [10]. However, it could be shown that expenses evaluated by this Program are well within the range of published values: for some segments the expenses are nearer to the average (decommissioning, SF storage, disposal of LILW) and for some on the more expensive side (SF disposal).

The most important conclusions and recommendations of the Program are:

- a) Modifications to SID-30 transforming it in SID-45 are improving scenario financially and technologically.
- b) Both of the modified scenarios (SID-45 with disposal and SID-45 with export) are structurally quite similar with almost identical discounted expenses, enabling simple switching from one scenario to another and back for several decades from now. Furthermore, dry storage which is important part of SID-45 scenarios enables simple adjustment to changes of circumstances on time scale: simple translation of solutions for several years (e.g. opening of SF repository several years later than planned or changes in schedule of SF export) will not significantly influence financial plan.
- c) Due to specific circumstances several limitations were imposed by TOR to the process of the Program preparation. Next iteration of the Program should be prepared differently, especially its basis: the NIS should be dropped altogether as decommissioning foundation, consequently starting anew decommissioning, dry storage and spent fuel transport programs using new European unified nomenclature of decommissioning jobs [11]. Next iteration should respect the NPP Krško specificities as well as specific solutions for SF and LILW, with as little as possible generic solutions in all four considered segments. Some of the technical solutions could be based on Slovenian or Croatian industries. Next iteration should be started as soon as possible since two to three years are needed to finish it.
- d) The Program estimated discounted total expenses of decommissioning and SF and LILW management based on the SF dry storage scenarios. This sum is used as the starting point for evaluation of financial arrangements for decommissioning funds in both countries.

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