European Commission

Nuclear Decommissioning Assistance Programme (NDAP) – Assessment of the robustness of the financing plans considering the economic-financial-budgetary situation in each concerned Member State and of the relevance and feasibility of the detailed decommissioning plans

Deloitte.

FINAL REPORT

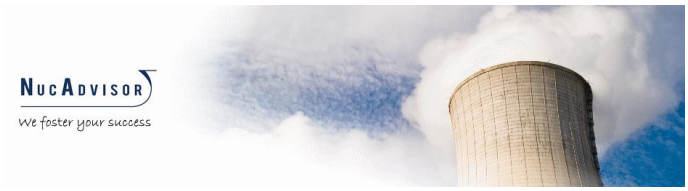
A study prepared for the European Commission

DG Energy

This study was carried out for the European Commission by

Deloitte.

and partners



VVA
VALDANI VICARI & ASSOCIATI
Market, economic and regulatory advice

with the support of Norbert Jousten

Luxembourg: Publications Office of the European Union, 2019

ISBN: 978-92-76-08798-4

doi: 10.2833/79376

MJ-02-19-513-EN-N

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Abstract

The present study assesses the robustness of the financing plans for the Kozloduy, Ignalina and Bohunice decommissioning programmes, considering the economic-financial-budgetary situation in each concerned Member State, and the relevance and feasibility of the corresponding decommissioning plans. In this respect, the study assesses whether the detailed decommissioning plans initiated at the outset of the current financial framework are complete and sufficiently comprehensive with regard to the general objective and, in particular, appropriate to meet the specific objectives for the financing period 2014-2020.

The Review shows that the detailed decommissioning plans prepared by the three Member States are broadly complete, relevant and comprehensive (i.e. include all necessary activities to reach the defined brownfield end-state). The pre-set key milestones have by and large been achieved so far and the planned condition of the three decommissioning sites by 2020 will represent a significant improvement in their safety. Hence, the plans are deemed to meet the general objective and the specific safety-related objectives financed until 2020 as set out in the relevant Council Regulations establishing the Union's financial assistance.

The overall base cost estimations of the three decommissioning programmes, as stated in the respective decommissioning plans, are generally appropriate. These may continue to be enhanced in line with evolving international experience.

The Review finds that sufficient EU and national resources are available to implement the decommissioning plans until 2020 in the three programmes.

Beyond 2020, there are financing gaps on all three programmes. The scale of the financing gaps is comparable for the Kozloduy and Bohunice programmes, while it is significantly higher for the Ignalina Programme. The analysis of the state budgets of all three Member States shows that they appear able to absorb the additional financing needs. However, given the size of the gap the expected impact of this would be more significant for Lithuania. Failure to do so could however cause timeline extensions and, as a consequence, cost overruns, in fully implementing the currently approved decommissioning plan after 2020.

As the allowances made for contingencies in the cost estimations of all three programmes are considered by the Review to be at the lower end of international practice in this field, planning for financing needs and financing gaps should more prudently take into account additional contingencies.

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Executive Summary

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The present study assesses the robustness of the financing plans for the Kozloduy, Ignalina and Bohunice decommissioning programmes considering the economic-financial-budgetary situation in each concerned Member State and the relevance and feasibility of the corresponding decommissioning plans.

Decommissioning programme cost estimations

Each of the Kozloduy, Ignalina and Bohunice decommissioning programmes has been defined in relation to a precise end state of the installation, once all the decommissioning works are completed. These end states are not identical for the three countries, depending on the regulatory environment as well as on other nuclear installations operating at the same site (in the cases of Bulgaria and Slovakia). The Review team considers the decommissioning plans prepared by the three Member States to be complete, relevant and comprehensive with regard to the general objective and appropriate to meet the specific objectives for the financing period 2014-2020 with reference to the defined key milestones based on the respective foreseen end states.

The Review shows that the overall cost estimations of the three decommissioning programmes as stated in their current baseline plans are generally appropriate, with the exception of the treatment of contingencies (see below). This assessment is based on the analysis of the costing methodology used in the various programmes and corroborated by the analysis of specific sample projects. On the one hand, some information presented for earlier projects during their development stages does not appear to have been prepared in a thorough manner, especially when compared to the actual project cost. On the other hand, more recently produced costs estimates indicate that a sound methodical approach is now used for estimation of the base cost of projects, which is further favoured by competitive international tendering of works, showing that lessons were learnt and the project management was definitely improved.

As a way to further increase confidence in the cost estimations of the programmes and to aim at reducing the financing gaps post 2020, the Review team recommends:

- To consider the execution of an independent expert review of each of the decommissioning plans after the next periodic revisions mandated by the national regulatory requirements. The reviews should be coordinated by the Commission. This will help provide funding parties with assurance on the robustness of the revised cost estimates and schedules and act as a mechanism for comparison with a wider range of

decommissioning experience and knowledge than may be available within the decommissioning license holder organisation.

- To encourage the adoption of a more rigorous and consistent approach to the assessment of contingency (estimating uncertainty) allowances within cost estimates. This will encourage review and further understanding of the "unknowns" associated with each cost item and allow greater visibility and scrutiny.
- To initiate the adoption by each of the Member State programmes of a methodical process of quantitative assessment of risks associated with the overall programme and its constituent projects. This would build on the existing *qualitative* risk processes already in place within each programme.
- To initiate “a lessons learned process” among the three programmes as regards waste characterisation issues. A lack of characterisation of wastes before placement of processing contracts may indeed lead to cost overruns.
- To take the fullest benefit possible from competitive procurement procedures. This would not only lead to lower contract values, but could also provide tested information on current market conditions that can be used for any upcoming cost estimation.

Increased confidence in cost estimations will in turn lead to reducing the level of contingencies.

Reaching key milestones

The NDAP detailed implementation procedures [7] list a number of key milestones associated with each of the three decommissioning programmes in the framework 2014-2020. These milestones are linked to the specific objectives defined in the NDAP regulation [6]. Following review of the schedule presented, the Review team concludes that the schedules do generally show compliance with the target dates. Some deviations (over and underperformances) are indicated in the study.

Each of the programmes has already achieved significant milestones and can demonstrate measurable progress against the indicators from the NDAP detailed implementation procedures [7] associated with key future milestones. In particular, it should be noted that the planned condition of the three decommissioning sites by 2020 will represent a significant improvement in their safety, based on the remaining untreated hazard, than at the start of the period and will clearly demonstrate achievement of the general objective of "assisting the member states concerned in the implementation the steady progress towards the decommissioning end state ... whilst maintaining the highest level of safety".

Risk assessment and contingencies to completion / end dates

While the Review finds that all three programmes make allowances in their cost estimations for contingencies (either estimating uncertainty or risk), the level of these contingencies included in the financing plans is considered to be at the lower end of international practices in this field (albeit when comparing to contingency levels at the outset of similar programmes). We also consider that the contingencies have been applied using a mechanistic approach rather than by considering the specific "unknowns" associated with each project and calculating an addition to the estimate that should be adequate in the most likely scenarios.

The Review has therefore considered, for all three programmes, both an “intermediate contingency” and a "high contingency" case simulation, based on a contingency level of 12% and 16% respectively, consistent with other international decommissioning programmes, in order to estimate more conservative funding requirements than are currently recognised. The study recommends as a prudent approach that the three programmes plan for financing needs and financing gaps resulting from the “high contingency” case. This does not change the order of magnitude of the financing gaps relative to state budgets or GDP for any of the three Member States.

The Review team notes that all three programmes have processes in place to facilitate the identification, qualitative assessment and management of project risks. The processes adopted are typical of good practices on other similar programmes. The Ignalina Programme is moving towards a quantitative assessment process that could enhance the reliability of the contingency estimation and, if confirmed, could usefully be adopted by the two other programmes. The existing risk processes in place would provide a good foundation of this enhanced process and would minimise the additional work required to achieve its benefit.

Certain additional costs incurred at project level after contract placement have generally arisen due to regulatory approval processes being underestimated, poor contractor performance or poor specifications (including poor waste characterization data within the specification). Initial cost estimates prior to contract placement have also at times been lower than received tender prices. These aspects should be looked into when assessing project risks.

Funding until 2020

The study indicates that, even with the contingency allocation under the “high contingency” case, sufficient EU and national resources are available to implement the decommissioning plans until 2020 in the three programmes.

The Review team considers that the current EC funding approval process could be further streamlined to obtain more efficient responses to change requests at project level. This issue could be recognised as a topic for simplification of the NDAP detailed implementation procedures in the context of the mid-term evaluation of the programmes. Moreover, the EC and the EBRD/CPMA should align and cooperate to develop more efficient procedures that accommodate, to the extent possible, each of their procedural requirements without negatively affecting project schedules and funding needs.

Improvements introduced before 2020 on the aspects highlighted above could reduce the overall project cost post 2020 and would further reduce the need for additional national resources.

Funding beyond 2020

Financing gap

Contrary to the period until 2020, the decommissioning financing plans identify financing gaps on all three programmes beyond 2020, taking into account all available guaranteed EU and national funding.

The scale of the financing gaps is comparable for the Kozloduy and Bohunice Programmes, while it is significantly higher for the Ignalina Programme.

Additional sources for financing decommissioning

It appears that all three governments are aware of the current financing gaps in the decommissioning financing plans and willing to seek suitable solutions.

An option for Kozloduy could be to accumulate funds through income generated by the longer term operation of Kozloduy NPP units 5-6 should their operational lives be extended subject to the ongoing procedures in this respect. Presently Bulgaria does not officially consider this option.

For Bohunice, additional financial resources could potentially come from adjustments of existing mechanisms (e.g. a nuclear levy, contributions from operating nuclear units, contribution from the Slovak transmission system operator). However, the Slovak government has not officially considered this option as a solution to the financing gap.

For Ignalina, no revenues are possible from operational nuclear plants, as there are none. As the segregated decommissioning fund, which was accumulated over the design life of the plant, is insufficient to cover the decommissioning costs, other national sources would need to be found. Presently Lithuania has not yet officially considered any option.

In all three cases, follow up discussions would benefit from the implementation of the Review's recommendations regarding cost estimations and contingency calculations.

Robustness of the state budgets to absorb the financing gaps

Were the three Member States obliged to fund the financing gaps in their decommissioning programmes beyond 2020 from national resources, the same differentiation between the cases of Bulgaria and Slovakia versus Lithuania would exist. The state budgets of all three Member States seem to be able to absorb the additional financing needs, but the impact of doing so by Lithuania would be more significant, at around 0.3-0.5% of the annual state budget over seven years, and therefore politically more difficult for the Government to implement.

The three concerned Member States should therefore plan and ensure appropriate additional resources to cover the financing gaps. The review team recommends to regularly monitor and review the process of defining the alternative solutions to finance the post 2020 gaps.

The table below provides a consolidated view of the decommissioning programmes' costs and financing gaps.

Nuclear Power Plant	Total Decommissioning Cost (EUR mil)	Decommissioning Timescale	Financing gap in "intermediate contingency" case (EUR mil.)	Financing gap in "high contingency" case (EUR mil.)
Kozloduy 1-4 Bulgaria	1,106.99	2003 - 2030	212	237
Ignalina 1-2 Lithuania	3,376.98	2000 - 2038	1,833	1,929
Bohunice V1 Slovakia	1,245.61	2003 - 2025	109	144

Table 1: Overall values of the three programmes as stated in the baseline plans

Français

La présente étude analyse la robustesse des plans de financement pour les programmes de démantèlement de Kozloduy, Ignalina et Bohunice, tenant compte des situations economique, financière et budgétaire de chacun des états membres concernés, et eu égard à la pertinence et la faisabilité des plans de démantèlement en question.

Estimations du coût des programmes de démantèlement

Chacun des trois programmes de démantèlement en Bulgarie (KNPP), en Lituanie (INPP) et en Slovaquie (V1 NPP) a été défini par rapport à un état final précis de l'installation, une fois que les travaux de démantèlement seront terminés. Ces états finaux ne sont pas identiques pour les trois pays, compte tenu du contexte national règlementaire, ainsi que de l'existence d'autres installations nucléaires en opération sur le même site dans les cas de la Bulgarie et de la Slovaquie. L'étude considère que les plans de démantèlement préparés par les trois états membres sont complets, pertinents et compréhensifs par rapport à l'objectif général, et appropriés pour atteindre les objectifs spécifiques pour le financement dans la période 2014-2020 eu égard aux étapes clé définies sur base des états finaux prévus.

L'étude montre que les estimations globales des coûts des trois programmes de démantèlement tels que décrits dans leurs plans de référence actuels sont d'une manière générale adéquats, à l'exception de la prise en compte des aléas (voir ci-dessous). Cette conclusion est basée sur l'analyse de la méthodologie d'estimation des coûts utilisée dans les différents programmes et corroborée par l'analyse d'échantillons de projets spécifiques. D'une part, l'information présentée pour les plus anciens de ces projets dans leurs fiches d'identification, ne semblait pas avoir été élaborée de manière robuste, spécialement en comparaison des coûts réels des projets. D'autre part, les documents des projets plus récents ont montré qu'une méthodologie solide est à présent utilisée, bénéficiant notamment de la passation de marchés compétitive, montrant de ce fait que les leçons ont été retenues et que la gestion des projets a définitivement été améliorée.

Afin d'augmenter d'autant plus la confiance dans l'estimation des coûts des programmes et en vue de réduire les déficits de financement au-delà de 2020, l'étude recommande :

- D'envisager la mise en œuvre d'un processus de révision par des experts indépendants de chacun des plans de démantèlement après la prochaine adaptation périodique mandatée par les exigences réglementaires nationales. Cette révision devrait être coordonnée par la Commission. Cela aidera à fournir l'assurance aux bailleurs de fonds de la robustesse des estimations révisées de coûts et des plannings ainsi que de permettre une comparaison avec un une gamme plus étendue d'expériences et de connaissances en matière de démantèlement que celle détenue par les organisations détentrices de permis de démantèlement.
- D'encourager l'adoption d'une approche plus rigoureuse et consistante pour la prise en compte des aléas dans les estimations des coûts. Cela entrainera une meilleure compréhension des "inconnus" associés à chaque élément de coût, ainsi qu'une meilleure transparence et surveillance.

- D'initier l'adoption par chaque programme d'état membre d'un processus d'évaluation quantitative des risques associés au programme dans son ensemble et de ses projets. Cela permettrait d'étendre les processus d'analyse quantitative déjà en place au sein des programmes.
- De lancer un processus de partage d'expérience entre les trois programmes concernant les problèmes de caractérisation des déchets. Un manque de caractérisation des déchets avant la signature de contrats de traitement peut en effet conduire à des suppléments de coûts.
- De bénéficier au maximum des procédures compétitives d'appels d'offres des marchés. Ceci pourrait conduire non seulement à des valeurs de contrats moindres, mais pourrait également fournir une information solide sur l'état actuel du marché qui pourra être utilisée pour toute estimation ultérieure des coûts.

Une confiance accrue dans le processus d'estimation des coûts permettra en retour de réduire le niveau des provisions pour aléas.

Atteindre les étapes clés

Les procédures détaillées de mise en œuvre NDAP [7] montrent un nombre d'étapes clés associées à chacun des programmes de démantèlement dans la période 2014-2020. Ces étapes sont liées aux objectifs spécifiques définis dans le règlement NDAP [6]. Après avoir évalué le planning mis à sa disposition, l'étude conclut que les plannings sont d'une manière générale compatibles avec les dates cibles. Certaines déviations (sur- et sous-performances) sont relevées dans l'étude.

Chacun des programmes a déjà atteint des étapes clés, et peut démontrer des progrès quantifiables en termes des indicateurs des procédures détaillées de mise en œuvre NDAP [7] associés aux étapes clé futures. En particulier, nous notons que les états des trois sites de démantèlement représenteront une amélioration significative au niveau de leur sécurité d'ici 2020 sur base des déchets restant à traiter, par rapport à leur état en début de période. Cela démontre clairement que l'objectif général "d'assister les états membres concernés dans l'implémentation continue vers l'état final de démantèlement...tout en maintenant le niveau le plus élevé de sécurité".

Evaluation du risque et des aléas (jusqu'à la fin des programmes de démantèlement)

L'étude a trouvé que pour les trois programmes, des provisions pour aléas ont été constituées (soit une provision pour incertitude d'évaluation soit pour risque), mais il apparaît que le niveau de ces provisions dans les plans de financement des programmes de démantèlement se trouve au niveau inférieur de la pratique utilisée de manière internationale dans ce secteur (tenant compte d'une comparaison des niveaux de provisions en début de programmes similaires). Nous considérons aussi que les provisions ont été appliquées en utilisant une approche « mécanique » plutôt que de considérer les « inconnues » spécifiques associées à chaque projet et de calculer un supplément à l'estimation qui serait appropriée dans les

scénarios les plus probables. Le programme d'Ignalina a toutefois lancé un processus d'évaluation quantitatif qui pourrait accroître la fiabilité des estimations des provisions pour aléas et qui, si cela se confirme, pourrait utilement être adopté par les deux autres programmes. Comme ce processus est seulement en cours, l'étude a considéré, pour les trois programmes, deux cas de simulation de calculs de provisions, à savoir un « scénario intermédiaire » et un « scénario haut », basés sur une incertitude de 12% et de 16% respectivement, et cela en conformité avec d'autres programmes de démantèlement internationaux, afin de proposer des demandes de financement plus réalistes que celles actuellement retenus. Au stade actuel, l'étude recommande une approche prudente en ce qui concerne les besoins de financement et des déficits de financement qui en résultent et de considérer à cet effet les montants découlant du « scénario haut ». Cela ne change pas l'ordre de grandeur des déficits de financement relatifs aux budgets d'état ou au PNB des trois états membres.

L'étude note que les trois programmes ont des processus en place pour faciliter l'identification, l'analyse qualitative et la gestion des risques des projets. Les processus adoptés ressemblent aux bonnes pratiques d'autres programmes similaires. Le programme d'Ignalina est en train d'adopter un processus d'analyse quantitative qui pourrait augmenter la fiabilité des estimations d'aléas. Si ce résultat est confirmé il serait utile d'intégrer cette approche aux deux autres programmes. Les processus existants de gestion des risques fourniraient une bonne base pour ce processus amélioré et réduiraient la charge additionnelle de travail pour en tirer les bénéfices.

Certains coûts supplémentaires encourus au niveau des projets après la passation des marchés sont en général dus à la sous-estimation initiale des processus d'approbation réglementaires, à la mauvaise performance des contractants ou à de mauvaises spécifications (y compris la mauvaise caractérisation des déchets dans ces spécifications). Il y a aussi des cas où les estimations préalables des coûts ont été inférieures aux offres reçues. Ces aspects devraient être analysés lors de l'évaluation des risques.

Financement jusqu'en 2020

L'étude montre que, même en prenant en compte le scénario haut pour le calcul des provisions pour aléas, suffisamment de fonds en provenance de l'Union européenne et des ressources nationales sont disponibles pour mettre en œuvre les programmes de démantèlement jusqu'en 2020 pour les trois pays.

L'étude considère de plus que le processus actuel d'approbation des financements par la Commission européenne pourrait utilement être rendue plus souple. Ceci permettrait de mieux répondre à des changements possibles dans l'estimation des coûts de projets déjà approuvés ou dans le cas où les fonds requis dépassent l'estimation initiale. Cette problématique pourrait faire partie des sujets à analyser pour la simplification des procédures détaillées de mise en œuvre NDAP lors de l'étude à mi-échéance des programmes par la DG Energie. De plus, la Commission européenne et la BERD/CPMA devraient s'aligner et coopérer afin de développer des procédures plus efficientes qui accommodent, dans la mesure du

possible, les exigences procédurales de chacun sans nuire les plannings et besoins de financements des projets.

Des améliorations mises en œuvre avant 2020 relatifs aux aspects mentionnés ci-dessus pourraient réduire le coût global du projet au-delà de 2020 et de ce fait également réduire les besoins de financement nationaux supplémentaires.

Financement au-delà de 2020

Déficit de financement

Contrairement à la période jusqu'à fin 2020, les plans de financement montrent des déficits de financement pour les trois programmes au-delà de 2020, en prenant en compte tous les financements garantis tant de l'Union européenne que des ressources nationales.

Le déficit de financement est d'une échelle comparable pour les programmes de Kozloduy et de Bohunice, mais il est significativement plus élevé pour le programme d'Ignalina.

Sources additionnelles de financement du démantèlement

Il apparaît que les trois gouvernements sont informés des déficits actuels des plans de financement des programmes de démantèlement et sont prêts à trouver des solutions acceptables.

Une option pour Kozloduy serait d'accumuler les fonds à travers des revenus générés par l' opérations à plus long terme des unités 5-6 de la centrale nucléaire de Kozloduy sujet au prolongement de leur durée de vie opérationnelle suite aux procédures ad hoc en cours à cet égard. La Bulgarie n'envisage pas encore cette option de manière officielle.

Pour Bohunice, les ressources financières supplémentaires pourraient venir de l'ajustement des mécanismes existants (comme par exemple une taxe nucléaire, des contributions des centrales nucléaires en activité, la contribution du réseau de transport d'électricité Slovaque). Cependant, le gouvernement Slovaque n'envisage pas officiellement cette option comme solution au déficit de financement.

Pour Ignalina, il n'y a pas de revenus possibles de centrales nucléaires opérationnelles, comme il n'y en a pas. Comme le fond de démantèlement accumulé est insuffisant pour couvrir les coûts de démantèlement, d'autres ressources nationales doivent être identifiées. Pour le moment, la Lituanie n'a encore considéré aucune option de manière officielle.

Dans les trois cas, des discussions pour le suivi bénéficieraient de la mise en œuvre de nos recommandations concernant l'estimation des coûts et du calcul des provisions pour aléas.

Robustesse des budgets des états pour absorber les déficits de financement

Si les trois états membres étaient obligés de financer les déficits de financements de leur programme de démantèlement au-delà de 2020 à partir de leurs ressources nationales, la même différenciation devrait être faite entre les cas de la Bulgarie et de la Slovaquie d'un côté et le cas de la Lituanie de l'autre côté. Si les budgets des trois états semblent être en mesure d'absorber les besoins de financement additionnels, l'impact dans le cas de la Lituanie serait

plus significatif, aux environs de 0,3-0,5% du budget national sur sept ans, et une telle décision serait ainsi politiquement plus difficile à mettre en œuvre.

Les trois états membres concernés devraient rechercher des ressources additionnelles pour couvrir les déficits de financement. L'étude recommande un suivi et un contrôle régulier du processus de recherche de solutions alternatives pour le financement des déficits de financement pour la période au-delà de 2020.

Le tableau ci-dessous donne un aperçu synthétique des coûts des programmes de démantèlement et des déficits de financement.

Centrale nucléaire	Coûts de démantèlement (EUR mil)	Période de démantèlement	Déficit de financement dans le "scenario intermédiaire" (EUR mil.)	Déficit de financement dans le "scenario haut" (EUR mil.)
Kozloduy 1-4 Bulgarie	1,106.99	2003 - 2030	212	237
Ignalina 1-2 Lituanie	3,376.98	2000 - 2038	1,833	1,929
Bohunice V1 Slovaquie	1,245.61	2003 - 2025	109	144

Table 2: Valeurs agrégées des trois programmes selon les plans de référence

1 Introduction

1.1 Purpose and structure of the document

This is the Final Report from Deloitte and its partners NucAdvisor and VVA to the European Commission, Directorate-General Energy (DG ENER) for the tender "Nuclear Decommissioning Assistance Programme (NDAP) – Assessment of the robustness of the financing plans considering the economic-financial-budgetary situation in each concerned Member State and of the relevance and feasibility of the detailed decommissioning plans" under the Framework Contract N° ENER/A4/516/2014 for Impact Assessments and Evaluations in the field of Energy.

The study aims to provide the Commission with an independent verification of the robustness of the financing plans for the Kozloduy, Ignalina and Bohunice decommissioning programmes considering the economic-financial-budgetary situation in each concerned Member State and the relevance and feasibility of the corresponding decommissioning plans. In this respect the study assesses whether the detailed decommissioning plans prepared at the outset of the current financial framework were complete and sufficiently comprehensive with regard to the general objective and, in particular, appropriate to meet the specific objectives for the financing period 2014-2020.

The structure of the document is as follows:

- Chapter 1 introduces the document and the purpose of the study;
- Chapter 2 presents the methodology that was used in order to perform the study;
- Chapter 3 contains the main results resulting from the study. As agreed with DG ENER, the findings are structured by country, evaluation criteria and evaluation question;
- Chapter 4 summarises the general conclusions and recommendations stemming from the analysis, structured per analytical tool;
- Chapter 5 consists of the annexes, including e.g. the Terms of Reference, interview transcripts, technical details and further input on the analyses.

The reader will find **a glossary** with the various technical terms and acronyms used throughout the text in annex.

1.2 Context and scope of the study

1.2.1 Context

Since the early 1990's, after the fall of the Berlin wall and the ensuing global reshaping of the political landscape in Europe, the European Union (of 15 Member States as of 1995 [1]) and its eastern neighbours have found themselves in a position where they were able to cooperate on nuclear safety. As the Chernobyl disaster showed in 1986, any nuclear accident may have transboundary effects and widely impact the international community.

As a result, a major international effort was undertaken to help the countries of Central and Eastern Europe and the Newly Independent States (NIS) to improve their levels of nuclear safety. The EU enlargement process initiated in 1997 has added a new dimension and one of the pillars of EU policy was to examine the scope for replacing the least safe nuclear plants by the development of alternative energy sources and more efficient use of energy and to examine the potential for upgrading plants of more recent design.

In the framework of their EU accession negotiations, Bulgaria, Lithuania and Slovakia took a formal commitment to close the 8 non-upgradable Units located on their territories. The three countries operated old soviet design nuclear reactors which the international community, in line with the G7 multilateral programme of action adopted at the Munich G7 summit in 1992, concluded could not be upgraded to meet the minimum required safety standards at an economically acceptable cost[2]. These were: Kozloduy Units 1 to 4 (VVER-440/230 type reactors) in Bulgaria, Ignalina Units 1 and 2 (RBMK type reactors) in Lithuania and Bohunice VI Units 1 and 2 (VVER-440/230 type reactors) in Slovakia. The reactors were shutdown, as per the timescales set out in the Accession Treaties, the last one in 2009.

Since the early 1990s, the Commission has been working closely with the governments of Bulgaria, Lithuania and Slovakia to meet the closure commitments and to support the decommissioning process, recognising the related exceptional social and economic efforts. The decommissioning of a nuclear installation involves all activities from shutdown and removal of nuclear material to the environmental restoration of the site, in order to reach the approved end state for the facility. The whole process can extend over a period of roughly 30 years.

Considerable financial assistance has been, and continues to be, provided through the EU budget. This was first delivered through the PHARE ("Poland and Hungary Assistance for Restructuring their Economies") technical assistance programme and then through specific programmes, the so-called "Nuclear Decommissioning Assistance Programmes" (NDAP). The three current NDAPs - the Kozloduy Programme for Bulgaria, the Ignalina Programme for

[1] Finland, Sweden and Austria joined the EU in 1995.

[2]European Parliament (2010) "On the efficiency and effectiveness of EU funding in the area of decommissioning nuclear power plants in the new Member States (2010/2104(INI))" – 14 March 2011

Lithuania and the Bohunice Programme for Slovakia - cover the period 2014 – 2020 with a total budget provision of nearly EUR 1 billion.

Unlike their predecessors, the current NDAPs do not propose further support from the EU to mitigate the consequences of the early closure of the nuclear power plants, but concentrate exclusively on the support of the "steady process towards their decommissioning end-state in accordance with the decommissioning plans, whilst maintaining the highest level of safety".

The relevant EU regulations covering the EU NDAP support provide for a mid-term evaluation to be established, by the end of 2017, by the European Commission in close cooperation with the concerned Member States on the achievement of the objectives of all measures related to the three programmes.

As a follow-up to internal audits and in preparation of the mid-term evaluation, the Commission has entrusted Deloitte to prepare an assessment of the financing plans considering the economic-financial-budgetary situation in each concerned Member State and of the relevance and feasibility of the detailed decommissioning plans issued by the license holders and approved by the respective concerned Member States.

1.2.2 Scope and evaluation criteria

This study covers the following scope:

1) An evaluation of the decommissioning programmes' global cost estimations, including the completeness of the corresponding plans' scope of work and budget, and the uncertainties/risks linked to estimation of contingencies for each plan.
2) An overall risk assessment, including:
    a. the risk that the decommissioning programmes would not be completed with the available funds based on the financial resources earmarked for decommissioning and the uncertainties identified;
    b. the risk that the financed measures will not be effective, efficient and economical;
    c. the limits of the decommissioning plans - with a view to clearly identify the included waste management activities - and their interfacing with long-term waste management activities, e.g. the spent fuel and high level waste disposal.
    d. a proposal of mitigating actions, considering further Union financial assistance as a last resort.
3) An analysis of the national funds and other sources for financing decommissioning, waste and spent fuel management, in order to verify whether or not the safe completion of the decommissioning programmes is secured financially. In particular, we analysed the capacity of provisioning resources earmarked for decommissioning and/or waste management.
4) An analysis of the robustness of the state budgets of Bulgaria, Lithuania, and Slovakia respectively, and in particular of the ability of the Governments or the operators to:
    a. cover additional financial contingencies that may arise before 2020, and for the whole programme;

b. absorb the financing needs resulting from the uncertainties identified in the decommissioning plan and in the dedicated sources of funding (taking into account what these represent as a proportion of total concerned Member State budget expenditures and GDPs).

The assignment was performed in line with EU evaluation standards and particularly the better regulation guidelines. In terms of evaluation criteria covered, the evaluation therefore includes[3]:

- Relevance:
  - Are the detailed decommissioning plans comprehensive and complete with reference to the defined end-states?
  - Do the financing plans respond to the needs of the decommissioning plans?
- Effectiveness:
  - Do the detailed decommissioning plans and the financing plans meet the objectives of the NDAP regulations?
  - Do the detailed decommissioning plans *and the financing plans* meet the objective of the safe completion of decommissioning beyond the MFF 2014-2020?
  - ***What is the ability of the the state budgets of BG, LT, and SK respectively or the operators to cover additional financial contingencies that may arise before 2020, or absorb the financing needs resulting from the uncertainties identified in the decommissioning plans?***
  - Evaluation of to what extent the states are willing to provide the missing funding.
- Efficiency/Economy:
  - Are the cost estimates of the decommissioning plans appropriate to the objectives of the NDAP Regulations and to the long-term objectives?
  - *Is the size of the assistance budget appropriate and proportional to the NDAP Regulations objectives?*
  - Are the outputs obtained at a reasonable cost?
  - *Are financial resources of the concerned Member State likely to be available in due time, in appropriate quantity and quality at the best price?*
- Sustainability:
  - Are the decommissioning plans sustainable in the long term, i.e. after 2020, without further intervention of the Union assistance?
- Risk[4]:
  - Are the contingencies properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios?

[3] ***Bold italic*** indicates a question added to the list provided in those highlighted on p6 of the ToR, while *italic* indicates questions (or parts thereof) referring specifically to the decommissioning financial plans while non-italic questions refer to the decommissioning plans themselves.

[4] Risk is not a standard evaluation criterion under the better regulation guidelines but was added by the EC given the nature of this specific study.

2 Methodology

In order to provide the Commission with an independent verification of the robustness of the decommissioning financing plans for the Kozloduy, Ignalina and Bohunice Programmes, we have first assessed the relevance and feasibility of the corresponding detailed decommissioning plans. Combined with a view of the economic-financial-budgetary situation in each concerned Member State, and of the other existing funds in the decommissioning financing plans, this has allowed us to provide an informed view of the robustness of the decommissioning financing plans. Figure 1 represents this sequential approach:

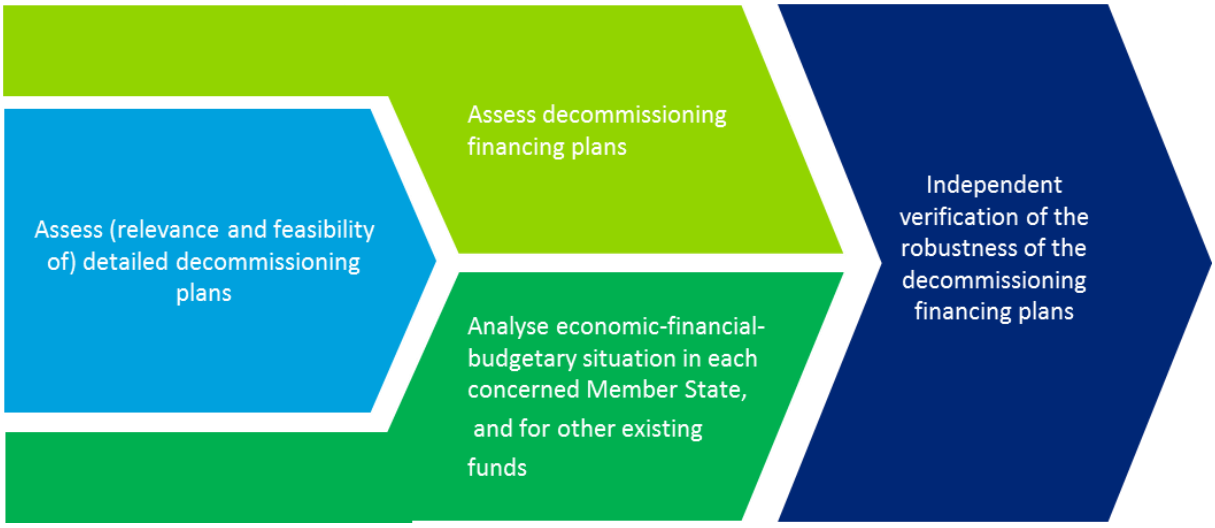


Figure 1: Study logic

2.1 Analytical framework

Four analytical tools were used for the study:

i. An evaluation of the decommissioning programmes' global cost estimations:

In order to evaluate the decommissioning programmes' global cost estimations we used the following four stage process to ensure that (a) the decommissioning programmes' scope of work are complete, relevant and necessary, (b) the budgets for these are complete, reasonable and realistic, and (c) the uncertainties/risks in each corresponding decommissioning plan properly estimated contingencies:

1) Checking the work breakdown structures for completeness / possible omissions,
2) Verifying the cost and schedule estimate methods and calculations used in the programmes and the selected key projects, and their suitability,

3) Assessing the extent to which experience from other programmes and projects was used in the planning of the programmes and the selected key projects,
4) Analysing the processes for collating the detailed planning and estimate data into comprehensive costed programme.

15 sample projects selected by the Commission (5 each for the Kozloduy, Ignalina and Bohunice Programmes)[5] were used, where applicable, to determine whether the cost and schedule estimates for the sample projects have been constructed using a methodical and thorough process to give an answer that has a clearly understood level of confidence. Application of this approach to the selected projects, as a sample of the totality of the projects within the programme, provided reassurance that the individual elements making up the whole programme are properly planned and estimated. This informed the degree of confidence we may have that the programmes' remaining work will outturn as forecasted, also considering resource level benchmarks from NucAdvisor's database of reference programmes, and recognised industry practice, such as the ISDC reference document to help confirm completeness of scope, as well as items potentially out of scope when assessing the Work Breakdown Structure (WBS), or costing methodologies.

ii. An overall risk assessment:

Taking into account the recognised practice within the nuclear industry - and indeed in many other industries, particularly where infrastructure projects are concerned - of including contingencies in cost estimates for projects to account for possible cost overruns due to "estimating uncertainty" or "risks", we analysed contingencies included in the decommissioning programme's overall cost estimations compared to benchmark cases. Contingencies may cover "estimating uncertainty" to allow for uncertainties within the scope and estimates of projects in the decommissioning programmes, or "risk" to cover events outside the normal project scope. Contingencies included in the decommissioning programme's cost estimations should take into account the experience of benchmark cases. Section 5.3.1 of the Annex explains cost build up and contingencies in more detail.

As a "stress test", the effect of including additional estimating uncertainty was assessed, for example, on the ability of current funding arrangements and/or national budgets to accommodate the resulting higher cost estimates. The effects of two higher levels of estimating uncertainty were assessed to give an "intermediate contingency" case and a less likely "high contingency" case[6].

The Review team examined progress of the programmes against the targets set by the NDAP detailed implementation procedures [7] and reviewed the current, rather than previous, approach to estimating of costs to determine if the financed measures could be considered effective, efficient and economical.

[5] See Annex 5.2 for details

[6] Please refer to sections 3.1.5, 3.2.5, 3.3.5

The Review team reviewed the programmes' plans for waste management and disposal with a view to identifying that the required facilities for long-term waste management were in place or were being delivered to meet the programmes' need.

Finally, we considered how Member States could meet the funding gap at the levels currently identified and at the higher levels as suggested by the "stress test" calculations.

It should be underlined that the cost estimate analysis performed in this study, and thus the recommended contingency levels, take into account the most recently confirmed[7] cost estimations done for the three decommissioning programmes by their operators.

iii. An analysis of the national funds and other sources for financing decommissioning, waste and spent fuel management:

We verified whether or not the safe completion of the decommissioning programmes is secured financially by checking the solidity and reliability of the financial commitments and whether the funds foreseen for this are sufficient, differentiating between the period up to 2020 and thereafter[8]. In particular, we analysed the capacity of provisioning resources earmarked for decommissioning and/or waste management.

Given their expected share in the decommissioning financing plans, national budget earmarking capacity was specifically analysed.

iv. An analysis of the robustness of the state budget of Bulgaria, Lithuania and Slovakia respectively:

We analysed the concerned Member States' ability to finance the decommissioning programmes on a long-term basis (including the coverage of additional financial contingencies) through the Member State budgets by assessing each country's macroeconomic situation and growth estimates, as well as their ability to cover potential additional decommissioning costs into their budgets through three ratios:

- Decommissioning financing gap vs. State budget expenditure: to show the effect of decommissioning gap on budget expenditure/increase in deficit.
- Decommissioning financing gap vs. State budget expenditure line related to energy: to show the magnitude of the financing gap as compared to the existing funding.
- Decommissioning financing gap vs. public debt: to show how much the debt would increase if the State would finance the gap.

As no internationally accepted threshold values exist for the above ratios, our opinion was qualified based on a comparison to evolutions in budget expenditures in the Member States.

[7] During the review process, the review team learnt that the revised cost estimate by SERAW is due to come out by the end of 2016.

[8] Taking into account that EU funds are committed until 2020

For these calculations, the assessment built on the previous analyses from which we were able to derive the additional funding needs resulting from the uncertainties with the concerned Member State's financial capacities.

The four analytical tools briefly described above and further detailed in Annex 5.3.1 enabled the Review team to answer the evaluation questions, taking into account the mapping presented in Figure 2 below.

		Evaluation of the decommissioning programmes' global cost estimations	Overall risk assessment	Analysis of the national funds and other sources for financing decommissioning, waste and spent fuel management	Analysis of the robustness of the state budgets of BG, LT, and SK respectively
Relevance	Are the detailed decommissioning plans comprehensive and complete with reference to the defined end-states?		x	x	x
	Do the financing plans respond to the needs of the decommissioning plans?	x	x	x	x
Effective-ness	Do the detailed decommissioning plans and the financing plans meet the objectives of the NDAP regulations?	x	x	x	x
	Do the detailed decommissioning plans and the financing plans meet the objective of the safe completion of decommissioning beyond the MFF 2014-2020?	x	x	x	x
	How robust are the state budgets of BG, LT, and SK respectively, and what is the ability of the Governments or the operators to cover additional financial contingencies that may arise before 2020, or absorb the financing needs resulting from the uncertainties identified in the decommissioning plans?				x
	Evaluation of to what extent the states are willing to provide the missing funding				x
Efficiency/ Economy	Are the cost estimates of the decommissioning plans appropriate to the objectives of the NDAP Regulations and to the long-term objectives?	x	x		
	Is the size of the assistance budget appropriate and proportional to the NDAP Regulations objectives?	x	x	x	
	Are the outputs obtained at a reasonable cost?	x	x		
	Are financial resources of the concerned Member State likely to be available in due time, in appropriate quantity and quality at the best price?			x	
Sustaina-bility	Are the decommissioning plans sustainable in the long term, i.e. after 2020, without further intervention of the Union assistance?	x	x	x	x
Risk	Are the contingencies properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios?		x		

Figure 2: Four-part methodology mapping

2.2 Data sources

Several data sources were triangulated for this study as illustrated in Figure 3:

- Interviews (primary[9] data):
  - Strategic interviews held at the initial stage of the implementation;
  - Interviews of stakeholders
- Desk review (secondary data):
  - Review of general programme and contextual documents;
  - Detailed review of case study documents (sample of projects) to collect more granular data.
- Focus group with selected stakeholders.

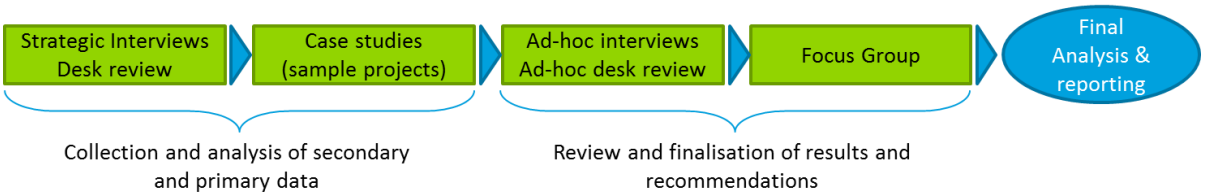


Figure 3: Overview of data collection tools and aims for the overall purpose of the study

Stakeholders' engagement and primary data collection

We identified the stakeholders to be interviewed as: DG ENER, EBRD, CPMA, IAEA, concerned Member States' governments (Bulgarian and Lithuanian Ministries of Energy, Slovak Ministry of Economy) and operators of the nuclear facilities under decommissioning (SERAW, JAVYS, and State Enterprise Ignalina Nuclear Power Plant)[10]. All stakeholders except for IAEA were interviewed through face-to-face interviews, and in some cases they were also further consulted through additional teleconferences.

Initial interviews with DG ENER (ad hoc to fill data gaps) and EBRD allowed us to fine-tune our approach for subsequent interviews with the other stakeholders.

Semi-structured interviews were adopted as a suitable tool for collecting qualitative data of both a retrospective and prospective nature. Specific interview guides were developed in advance as well as brief interview guidelines, so to assure a coherent and consistent primary data collection process. The interview minutes are available in Annex 5.6.

Desk review and secondary data collection

Relevant documents and datasets (those publicly available as well as those received from DG ENER and other contacted stakeholders) have been collected and reviewed. Documentation made available during the inception phase has been pre-assessed and a number of information gaps have been identified with requests for further information being handled by

[9] Primary data is information gathered through interviews, while secondary data represents existing documents

[10] A full list of interviewees is available in annex 5.1..

the Commission. Information gaps were then filled through interviews and other methods of engaging with stakeholders.

Case studies (sample projects) analysing diverse decommissioning projects

Fifteen case studies (sample projects) were selected by the Commission (five each for the Kozloduy, Ignalina and Bohunice Programmes) in order to collect granular data for assessment of the decommissioning programmes[11]. Although missing documentation was identified for a number of these, the interviews and fieldwork enabled us to fill information gaps.

Focus group and fine-tuning of emerging results

A focus group was held with key stakeholders to fine-tune the emerging findings from the analysis of data collected, and to identify areas for recommendation of further EU action.

The focus group took the form of an extended steering group meeting with representatives from:

- DG ENER (mainly as observer),
- Member States (Bulgarian Ministry of Energy, Lithuanian Ministry of Energy, and Slovak Ministry of Economy);
- CPMA (Ignalina Programme Division); and
- Members of the Review team.

The EBRD was unable to attend the focus group but provided input during a separate teleconference.

The aim of the focus group was to present draft findings, conclusions and recommendations and to discuss them in this forum. Findings, conclusions and recommendations were presented at the overall "fund level" during a full day session split across the study's evaluation criteria.

[11]The list is available in Annex 5.2.

3 Results

The study covered the Kozloduy, Ignalina and Bohunice decommissioning programmes in Bulgaria, Lithuania and in Slovakia. For comparison and setting of context, the overall cost estimates of these three programmes, as stated in each Member State's approved decommissioning plan document, are shown in Table 3. The "Decommissioning Timescale" is the period for which costs are presented in the individual decommissioning plan documents:

NPP	Total Decommissioning Cost (EUR mil)	Shutdown	Decommissioning Timescale
Kozloduy 1-4 Bulgaria	1,106.99[12]	Unit 1 & 2: Dec 2002 Units 3 & 4: Dec 2006	2003 - 2030
Ignalina 1-2 Lithuania	3,376.98[13]	Unit 1: Dec 2004 Unit 2: Dec 2009	2000 - 2038
Bohunice V1 Slovakia	1,245.61[14]	Unit 1: Dec 2006 Unit 2: Dec 2008	2003 - 2025

Table 3: Overall values of the three programmes as stated in the baseline plans

The total decommissioning cost numbers include inflation and contingency or risk as stated in the decommissioning plan documents.

3.1 Bulgaria

3.1.1 Relevance

Question 1: *Are the detailed decommissioning plans comprehensive and complete with reference to the defined end-states?*

The planned end state of the Kozloduy decommissioning programme covering Kozloduy Units 1-4 is stated in Chapter 1 of the decommissioning plan as "brownfield" status and entails:

- all technical equipment dismantled from all buildings, and external pipe connections severed and permanently isolated;
- all technical equipment and wastes processed, packaged and sent for disposal;
- all buildings cleaned to radiological clearance level;

[12] ENER-2015-00646-00-00-EN-TRA-00 (C21 Financial Resources); Ref [8]

[13] LT INPP Decommissioning Plan; Ref [50]

[14] DDP V1 NPP 10_2014; Ref [91]

- final site status to be as agreed with the regulator;
- spent fuel placed in secure safe storage awaiting disposal.
- some of the site buildings will be retained for industrial reuse.

The Regulatory Authority approved the defined end-state through the issuance of the decommissioning license and future changes are beyond the scope of this programme, and under the full responsibility of the Member State.

When compared to other decommissioning plans a number of comments can be made:

- The schedule presented in the draft Annual Work Programme (AWP) 2016 [16] does not include building demolition, which is reasonable given the proposed end state for the site. As noted above, should this aspect of the proposed end state change, demolition would be the responsibility of the Member State.
- Chapter 21 of the Decommissioning Plan [8] notes (Section 21.7) that the associated cost estimate "... *does not take into account the costs of the decommissioning of the RAM (Radioactive Material) and RAW (Radioactive Waste) treatment and intermediate storage facilities.*" As these facilities will also be used by the two still operating Units on site (Units 5-6), their decommissioning would be outside the planned timeframe of the decommissioning of Units 1-4. Decommissioning of these facilities is therefore assumed to be the responsibility of KNPP plc as operator of Units 5-6, and included in their decommissioning plan.
- EBRD informed the Review team that the Dry Interim Spent Fuel Storage Facility is now complete and operational and that the intention was that all spent fuel should be removed from the wet storage pools of Units 1-4 and loaded in the dry store by 2022 for ongoing management. However, it was noted that the decommissioning plan cost estimate includes no costs for spent fuel management beyond the 2003-2013 period. At the meeting between the Review team and SERAW[15], it was explained that as Units 1-4 were operating under waste management facility licenses, and more recently under decommissioning licenses, they are not permitted under Bulgarian regulations to hold nuclear material such as fuel. Responsibility for the fuel had therefore been transferred to KNPP plc (operator of Units 5-6) and as a result, the ongoing cost of fuel management is not shown in the Units 1-4 cost estimate but is included in KNPP plc plans.
- No third party independent review has to date been carried out of the complete decommissioning plan, particularly the cost estimate and schedule, apart from the SERAW consultants. This was confirmed by SERAW and the Ministry of Energy, the latter stating that the development and validation of the decommissioning plan are outside its responsibilities. Interdepartmental expert groups were established under the National Funds, which review and communicate with the Funds' Management Boards all matters of concern related to the decommissioning programme. This lack of independent review and the fact that validation of the plan is outside the Ministry's responsibility suggests that there is an absence of an informed customer outside of

[15] State Enterprise Radioactive Waste

SERAW. This is a similar situation to that which existed in Lithuania and steps are now being taken to address this issue in Lithuania (see Section 3.2.1).

With the exception of the above recognised and understood remarks, the study concludes that the decommissioning plan is generally complete with reference to the defined end state.

Question 2: *Do the financing plans respond to the needs of the decommissioning plans?*

Due to the short period of the operation of Kozloduy Units 1-4 after the 1990 regime change, the funds raised from contributions to the relevant National Funds were insufficient to cover their total decommissioning costs. In order to contribute partially towards the financing gap, EU support was granted. Despite this EU support, there remains a financing gap.

The decommissioning funding by sources and periods is as follows (also refer to Table 30):

KNPP Units 1-4 Decommissioning funding structure for 2003 – 2030

EURmil.		2003 - 2030
Estimated decommissioning costs	A	**1,107**
EU assistance untill 2009	B	288
EU assistance for 2010-2013	C	180
EU assistance for 2014-2020	D	293
National funds (NFDF) for 2003 - 2015 (spent)	E	24
National funds (NFDF) for 2016 - 2030 (available)	F	123
Total financing assistance	**G=B+C+D+E+F**	**908**
Financial gap (2021-2030)	**H=A-G**	**199**

Source: 1. ECA Special Report 16/2011 "EU Financial assistance for the decommissioning of nuclear plants in Bulgaria, Lithuania and Slovakia: Achievements and future challenges"; 2. Report from the Commission to the EU Parliament and the Council COM (2015) 78 final/3.03.2015, Annex 1; 3. [4.0] Ares(2015)4608214 - Report V1.00

Table 4: Kozloduy Units 1-4 Decommissioning funding structure for 2003 – 2030

During Bulgaria's pre-accession period to the EU (1999-2006), the country received financial assistance under the PHARE Programme. In 2001, the Kozloduy International Decommissioning Support Fund (KIDSF) was established under a Framework Agreement between the EBRD and the Bulgarian government, for the purposes of managing EU grants in relation to the decommissioning of Units 1-4. The fund was financed mainly by contributions from the EC and other donors (other EU member countries). Being the principal donor, the EC has a decisive vote in the allocation of funds. In 2013, the EU reassessed and confirmed the role of the EBRD in the management of the KIDSF for the period 2014–2020.

EU assistance to the decommissioning of Kozloduy Units 1-4 was provided in stages (for details, refer to Table 32) and represents 84% (EUR 761 mil.) of the total funding and 69% of the total estimated decommissioning cost, of which EUR 293 mil. are allocated for the period 2014-2020.

Assuming no further EU financial support beyond 2020, national funding through the Nuclear Facilities Decommissioning Fund (NFDF) covers circa 13% (EUR 147 mil.) of the total decommissioning cost. The available national funds were accumulated from the operations of Kolzuduy Units 1-4 prior to their shut down, of which:

- EUR 24 mil. were spent during the period 2003 – 2015;
- EUR 123 mil. are available and committed for the period 2016 – 2030. The funds have not been allocated to specific projects as at the date of this Report.

The financing gap of EUR 199 mil., pursuant to the latest approved decommissioning plan, is expected to arise in the period 2021-2030.[16]

These data do not include allowances for additional contingencies.

3.1.2 Effectiveness

Question 1: *Do the detailed decommissioning plans and the financing plans meet the objectives of the NDAP Regulations?*

Decommissioning plan

The NDAP detailed implementation procedures [7] list a number of key milestones and indicators associated with the Kozloduy Units 1-4 decommissioning programme in the framework 2014-2020. These milestones and indicators are linked to the specific objectives defined in the NDAP Regulation. The schedules presented in Annex 7-3 of the Decommissioning Plan [132, 146] and the updated version in the draft Annual Work Programme (AWP) 2016 [16] do generally show compliance with the specified milestone dates from the detailed implementation procedures.

It is not possible to definitively conclude if the specified targets in the NDAP detailed implementation procedures [7] will be achieved as these relate to removal or management of an identified mass of material at future dates. It is however possible to examine the performance against the targets achieved to date based on data presented in AWP 2015 [15] and the two monitoring reports for 2015 [22, 47a]. Some of the relevant activities were not scheduled to start until 2016, but for those in progress during the period 2014/15 the percentages shown in Table 5 were achieved against the various removal targets:

[16] According to SERAW, and at the same level of contingencies, the financing gap is reduced to EUR 28mil.The revised financing gap is due to be confirmed by the end of 2016 according to SERAW Management.

Objective	Target During Period 2014/15	Actual During Period 2014/15	Percentage Achievement
Total metal for dismantling in Units 1 to 4 Turbine Hall	11544 te	10824 te	93.76%
Dismantling of metals from Reactor Buildings of Units 1&2	200 te	147 te	73.50%
Release of Material from Regulation	11318 te	7923 te	70.00%

Table 5: BG Achievement of NDAP specified targets during 2014/15

As can be seen, none of the three objectives above appear to be fully achieved in terms of fulfilling the target, notably:

- For the Turbine Hall dismantling indicator, the metal removal quantity achieved over the period is close the target. It is also noted that a rate of 130% of planned achievement was recorded during the latter half of 2015 [48]. This suggests that there may be additional capacity to ensure that the underachievement can be recovered.
- Dismantling of the Reactor Building is reported to have started late due to regulatory issues, leading to underachievement of the target. It is not possible to assess whether the targeted dismantling rate could have been achieved without this delay, or if the rate can be increased to recover the underachievement. Nevertheless, the percentage achievement suggests that it might have been achieved without the initial delay.
- In the case of release of material, low achievement during the first half of 2015 accounts for much of the underachievement. The reasons for the underachievement's are not clear. In the second half of 2015 the achievement was 91% of target with no reported specific reason why the target was not achieved, which does not provide confidence that the underachievement can be easily recovered without further action by SERAW. It may be beneficial for SERAW to examine the reasons for the underachievement against this target. If there are temporary issues that SERAW identify as the root cause, there may be steps that SERAW management can take to prevent reoccurrence. If the root cause is more permanent such as a capacity "bottleneck" in the processing systems, it may be possible for SERAW to justify additional investment to remove the bottleneck and accelerate progress towards achieving the objective on time or even earlier.

Progress to date is not considered sufficiently different from target to suggest that the specified targets cannot be achieved. Achievement will require close monitoring and control by SERAW management and timely intervention when it is observed that achievement rates are below those required.

Financing plan

The financing plan indicates sufficient EU and national resources to implement the decommissioning programme until 2020. The decommissioning programme is directly managed and executed by SERAW, therefore SERAW is able to adjust the level of effort on

individual tasks, in order to optimise the costs and available resources. The decommissioning projects are executed by external organisations (contractors, consultants and suppliers). For these projects, the Earned Value is generally equal to the Actual Costs, i.e., the principle "what we have is what we have paid for" is applied, and therefore the CPI (cost performance index) is always equal to 1.0, as stated by SERAW Management.

In the opinion of the Review team a CPI which is always 1.0 may indicate that the CPI is being calculated on the basis of pre-agreed payment milestone values and not on a true calculation of earned value delivered for the expenditure to date. Use of a CPI in this way does not provide a useful indicator to Project Managers. We would recommend that SERAW base CPI calculations on a real assessment of the value delivered, either assessed by themselves or specialists. In the case of any projects where this is not considered possible then SERAW should investigate the use of other performance measures that provide a better reflection of the actual progress and give better indicators to Project Managers.

On average 73% of total decommissioning costs for 2014 – 2016 were planned to be covered by KIDSF funding, the outstanding portion by the national funds.

The planned costs for 2013 – 2015 as per the AWP are equal to the costs of the decommissioning plan. However, the actual costs incurred during the period 2013 – 2015 were EUR 32mil. on average lower than the costs as per the decommissioning plan, primarily driven by the decrease in actual spending on investment projects under Phase 3 "Procurement of equipment".

The planned costs in the 2016 AWP (draft 03) were EUR 20.6 mil. lower than the yearly cost as per the decommissioning plan. In addition, the planned costs in the 2015 AWP were EUR 64.1 mil., or EUR 1.5 mil. lower than the costs as per the decommissioning plan (EUR 65.6 mil.). The level of detail of the presented information does not allow us to comment on the differences. However, the achievement of the decommissioning plan targets suggests a certain delay which could explain the lower spending.

Past project delays (SERAW Projects 5a, 5b, 9b and Project R-10, according to AWP 2016 - Draft 03) resulted in additional costs (e.g. EUR 2.9 mil. for Project 5a), which had to be reallocated from other activities and were caused mainly by technical difficulties, contractual modifications, delays in the construction works, different facility suppliers (with different timing and quality of supplies and services, which additionally complicated the decommissioning programme implementation. In addition, certain activities were discontinued (e.g. Phase 1 of the Project 9b) due to inconsistency of the results compared to the assigned tasks to the contractor. A new contractor must be selected which may result in additional costs (e.g. new public procurement) and delays. The selection process is said to be improved through lessons learnt. Furthermore, according to AWP 2016 (Draft 03), the overall decommissioning cost increased in 2015 by EUR 15.5 mil., due to delays in the activities in the Controlled area of Units 1-4 and related Project 44 scope increase (EUR 3 mil., incl. EUR 0.5 mil. contingencies) and EUR 12.5 mil. Relating to the construction of NDF Phase 1 (GA 046). The next update of the decommissioning schedule and related cost is expected for Q4 2016.

Despite project delays and cost overruns prior to 2016, there were no significant project delays in 2016 and SERAW appears to have made efforts to fit the decommissioning programme to the budget. As presented in the AWP 2016, specific mitigation measures were put in place against future project delays, e.g. regular activity monitoring and progress meetings (Project 5a), intensive coordination with BNRA and the Contractor (Project 5b), developing a new way-forward strategy, including a market survey to determine the most appropriate facilities (Project 9b). Current dismantling activities and projects with previous delays were performed according to a newly established schedule, to be included in the updated plan. SERAW's focus was on decommissioning process optimisation. It aimed primarily at applying accumulated experience and knowledge of both SERAW specialists and their consultants in terms of planning and management of the decommissioning activities, and improved cooperation among different stakeholders.

The detailed decommissioning plan and financing plans meet the general objective of the NDAP Regulation, i.e. to assist the Member State in implementing the steady process towards the decommissioning end state. There is no suggestion that this general objective, or the specific objectives of the NDAP detailed implementation procedures [7] will not be achieved at some point. However, the Review team conclude that the quantity-based specific objectives will not all be met by the required dates without action by SERAW management.

Main causes of delay experienced by the Kozloduy sample projects

Change to delivery strategy:

None identified

Late procurement processes (compared to PIS, excluding funding processes):

KNPP Project 1d - Interim Spent Fuel Storage Facility;

SERAW Project 5b - Facility for Treatment and Conditioning of Solid Radioactive Wastes with a High Volume Reduction factor

SERAW Project 9b - Supply of a Facility for Retrieval and Processing of the Solidified Phase from Evaporator Concentrate Tanks Located in Aux Buildings 1 & 2 at KNPP site

Funding approval processes:

SERAW R-10 Construction of Phase 1 of the National Disposal Facility for Low and Intermediate Level Radioactive Waste (delay occurred in predecessor project);

Longer than planned regulatory / approval processes:

SERAW R-10 Construction of Phase 1 of the National Disposal Facility for Low and Intermediate Level Radioactive Waste (delay occurred in predecessor project);

SERAW Project 5b - Facility for Treatment and Conditioning of Solid Radioactive Wastes with a High Volume Reduction factor

Uncertain characterisation of wastes as presented in technical specification:

SERAW Project 9b - Supply of a Facility for Retrieval and Processing of the Solidified Phase from Evaporator Concentrate Tanks Located in Aux Buildings 1 & 2 at KNPP site

Other issues with data presented in the technical specification:

None identified

Technical difficulties during delivery:

None identified

Question 2: *Do the detailed decommissioning plans and the financing plans meet the objective of the safe completion of decommissioning beyond the MFF 2014-2020?*

As noted in Section 3.1.1, the decommissioning plan is generally complete with respect to the activities required to safely remove and manage the radioactivity from the plant. The plan includes projects for waste processing facilities (e.g. Projects 5b and 9b), waste storage (Project R-10) activities for system isolations, general and radiological area deplanting and identified schedule activities for health and safety related actives. As noted in Section 3.1.1, ongoing management of the spent fuel is not included in the plan due to a change in responsibility for it.

The plan extends beyond the current MFF 2014-2020 period, with completion forecast for 2030. Activities forecasted beyond 2020 are presented in similar detail to those immediately before this date. It is noted that staff numbers and annual decommissioning expenditure in

the period after 2020 are less than before 2020. This may be a consequence of the completion of high value infrastructure projects.

Generally, the decommissioning plan meets the objective of the safe completion of decommissioning of Kozloduy Units 1-4 beyond the MFF 2014-2020.

The financing plan identifies secured EU and national funding which appears to be sufficient to cover the decommissioning costs within the current financial framework (2014 – 2020). This funding also covers circa 35% (EUR 108 mil.) of total decommissioning costs (EUR 307 mil. per Plan) foreseen for the period 2021-2030. The financing gap to meet the objectives of safe completion of the decommissioning programme beyond the MFF 2014-2020, is estimated at EUR 199 mil. as per Plan. [17] Under the "intermediate and high contingency" cases submitted by the Review team, the gap is estimated at higher values.

The existence of a financing gap means that, as of now, the objective of the full completion of the decommissioning programme is not secured. Nevertheless, the projects and activities in progress and planned under the MFF 2014-2020 at Kozloduy concerning radiological system dismantling and waste management ensure that the plant will be in a safer condition than at present. The primary radiological hazard on site, the spent nuclear fuel, is and will continue to be safely stored in the Interim Spent Fuel Storage Facility. Progress toward processing, conditioning and temporary storage of radioactive wastes will be well advanced, and the site will have the facilities to continue management and reduction of remaining hazards beyond that date. The waste disposal facility being delivered under Project R-10 will be close to completion and soon able to receive wastes for final disposal. The most significant radiological hazards expected to remain will be the activated and contaminated materials of some plant systems associated with the reactor buildings, and any potentially contaminated soils. Activated and contaminated materials from plant systems are a more stable, less mobile waste form than radioactive wastes such as contaminated liquids, and present a lesser risk than more mobile wastes.

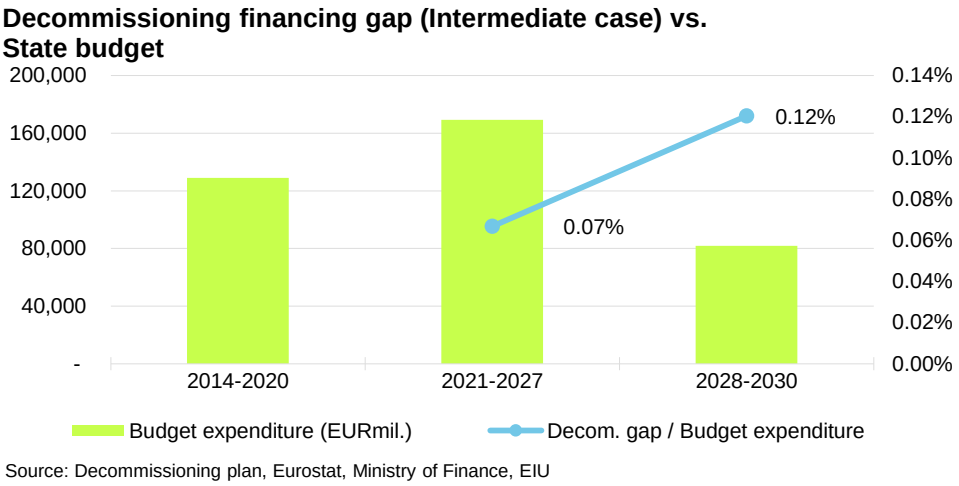
Question 3: *What is the ability of the state budgets of BG, LT, and SK respectively or the operators to cover additional financial contingencies that may arise before 2020, or absorb the financing needs resulting from the uncertainties identified in the decommissioning plans?*

In line with the overall methodology applied to assess this issue (section 2.1.), revised cost estimates were calculated for the Kozloduy decommissioning plan based on an "intermediate contingency" case and a "high contingency" case. The robustness of Bulgaria's State budget, and its ability to cover additional financial contingencies that may arise, or absorb the financing needs resulting from the uncertainties identified in the Plan were assessed on this basis.

[17] During the review process, the review team learnt that the financing gap is currently estimated by SERAW to be lower, at EUR 28mil as of June 2016. The revised figure was represented to be finalised by end 2016.

"Intermediate contingency" case

There is currently no additional financing need that should arise until 2020 in relation to the implementation of the decommissioning plan. Under the "intermediate contingency" case, a total financing gap of EUR 212 mil. (EUR 199 mil. financing gap plus EUR 13 mil. risk contingencies) is expected to arise for the period 2021-2030, circa 54% (EUR 113 mil.) of which forecasted for 2021-2027. Measured as a percentage of State budget expenditures for the respective periods, the financing gap would increase from 0.07% between 2021 and 2027 to 0.12% between 2028 and 2030.



Source: Decommissioning plan, Eurostat, Ministry of Finance, EIU

Figure 4: Comparison of decommissioning financing gap with State budget expenditure ("intermediate contingency" case)

The Bulgarian national budget deficit amounted to 2.1% of GDP as of December 2015, below the 3% threshold defined by the Stability and Growth Pact (SGP). It is forecasted to decrease to 0.5% of GDP in 2019. Financing of the full decommissioning financing gap by the State budget would seem to have a negligible effect on the budget and deficit.

On average, the Bulgarian State already allocates between 0.1% and 0.3% of annual budget spending for expenses related to the Ministry of Energy (2007-2015). The decommissioning financing gap is expected to increase energy related expenditures by 20% and 36% for the periods 2021-2027 and 2028-2030, respectively, as presented in the figure below.

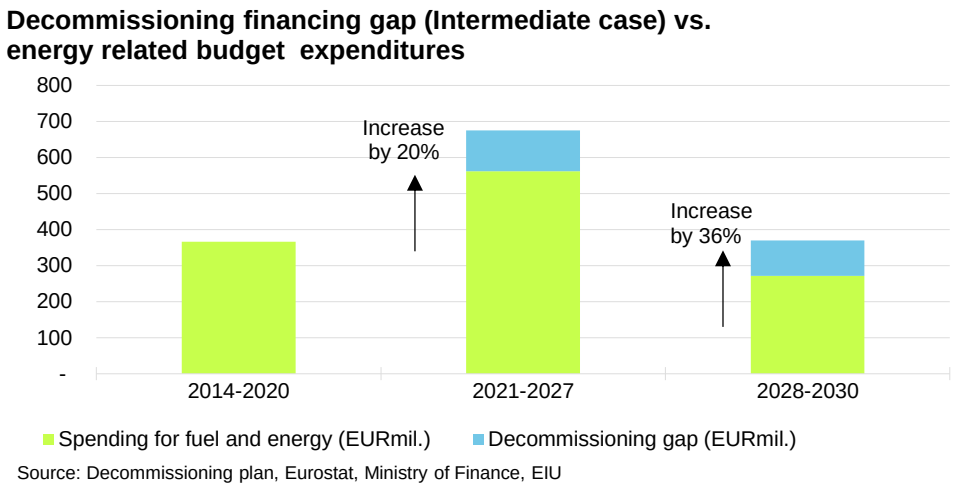


Figure 5: Comparison of decommissioning financing gap with state budget expenditure for Fuel & Energy sector ("intermediate contingency" case)

Although this could be considered a substantial increase in terms of the budget of the Ministry of Energy, when measured as a percentage of total budgetary expenditures the energy related budget (including the decommissioning gap) would remain below 0.45%.

The decommissioning financing gap represents below 0.05% of forecasted GDP for the period 2021-2030, as shown in the following figure.

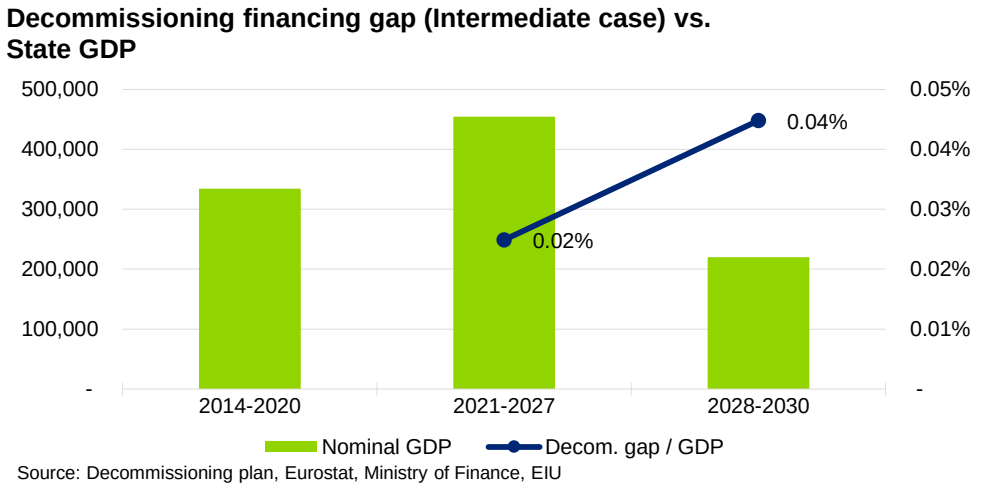


Figure 6: Comparison of decommissioning financing gap with GDP ("intermediate contingency" case)

"High contingency" case

The financing gap that is expected to arise in the period 2021-2030 under the "high contingency" case amounts to EUR 237 mil. (including EUR 38 mil. of risk contingencies). EUR 126 mil. (or 53%) of it is forecasted for the period 2021-2027. Measured as a percentage of state budget expenditures for the respective periods, the financing gap would increase from 0.07% between 2021 and 2027 to 0.14% between 2028 and 2030, as represented in the figure below:

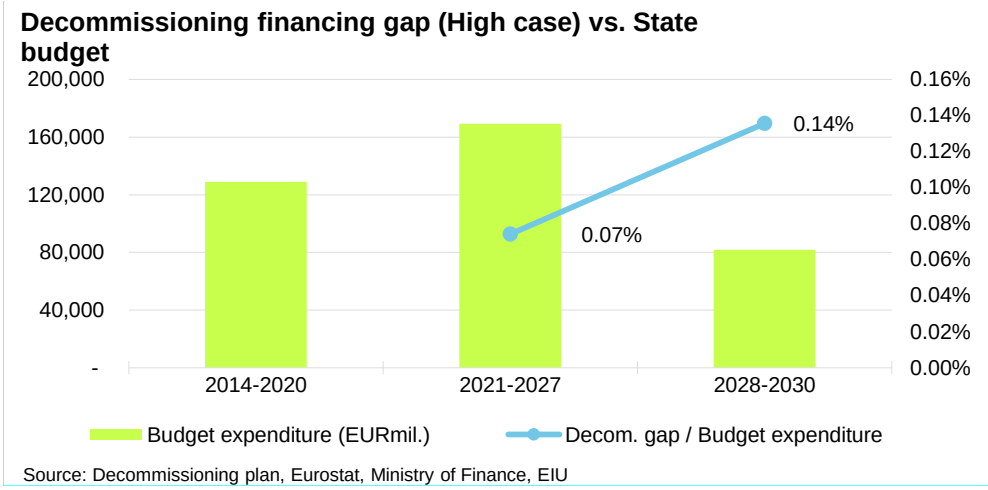


Figure 7: Comparison of decommissioning financing gap with state budget expenditure ("High contingency" case)

According to our estimates, this financing gap would increase energy related expenditures by 22% and 41% in the period 2021-2027 and 2028-2030 respectively, as presented in the figure below.

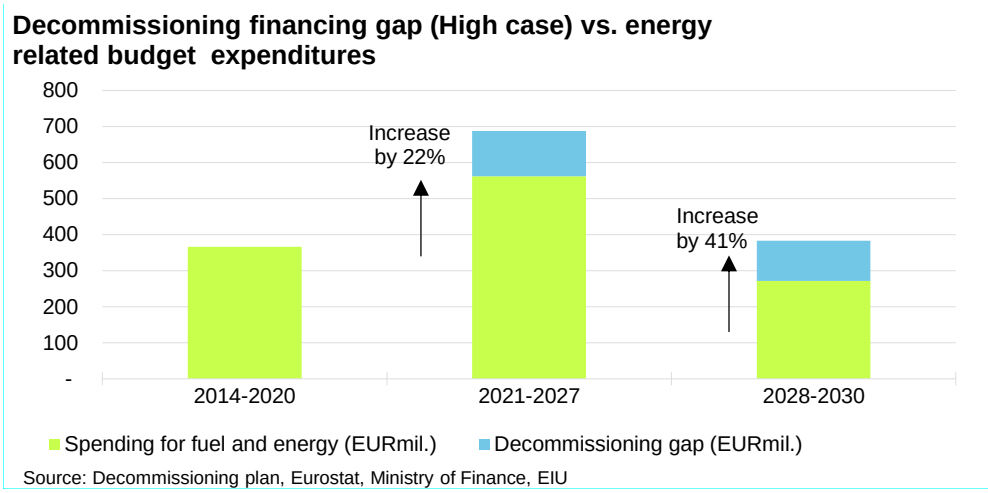


Figure 8: Comparison of decommissioning financing gap with state budget expenditure for Fuel & Energy sector ("High contingency" case)

The energy related budget (including the EUR 237 mil. financing gap) would still remain below 0.45%, when measured as a percentage of total budgetary expenditures.

The financing gap ("high contingency" case) represents 0.05% of forecasted GDP for the period 2028-2030 and 0.04% on average between 2021 and 2030, as presented in the figure below.

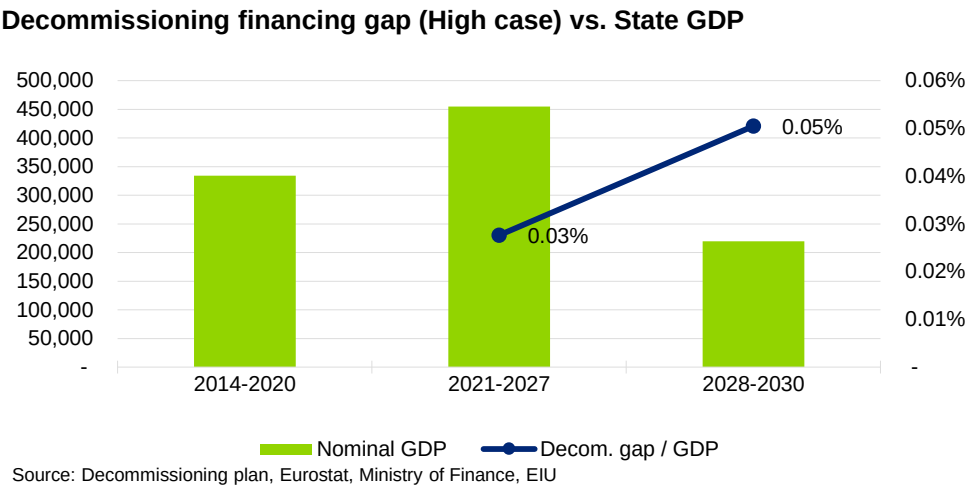


Figure 9: Comparison of decommissioning financing gap with GDP ("High contingency" case)

At 26.3% of GDP as of December 2015, Bulgarian government debt was one of the lowest among the EU 28.

Decommissioning gap and public debt

	EURmil.	% of GDP
Nominal GDP (2015)	44,162	
Public debt (2015)	11,614	*26.3%*
Decommissioning gap (Intermediate case)	212	*0.5%*
Decommissioning gap (High case)	237	*0.5%*

Source: Decommissioning plan, Ministry of Finance

Table 6: Decommissioning financing gap and public debt

Based on the analysis above, it can be concluded that the Bulgarian economy and State budgets are robust and should be able to absorb the total decommissioning financing gap expected to arise in the period 2021-2030 under either risk-based scenario - EUR 212 mil. ("intermediate contingency" case) or EUR 237mil. ("high contingency" case).

This result is generally in line with a recent study performed for DG ENER (Assessment of the macroeconomic effects of the decommissioning programmes in BG, LT and SK in the QUEST model), under which the effects on Bulgarian GDP was zero or slightly negative (below 0.1% in the worst case scenario) in the medium term in the cases where debt levels were fixed.

Question 4: *Evaluation of to what extent the states are willing to provide the missing funding.*

The national funding for Kozloduy is provided through the two national funds NFDF and RAWF, which are guaranteed by the Bulgarian Government (refer to Table 31).

The sources of financing of the national funds are clearly identified, where the main source is the Kozloduy nuclear power plant itself. Contributions to the funds are primarily from electricity price levies specified by the Bulgarian Council of Ministers. These amount to 3% of revenue from electricity power sold for the RAWF and a further 7.5% for the NFDF. No change in the contribution rates is planned, according to the Ministry of Energy.

EUR 147 mil. of NFDF total accumulated resources consisted of contributions from Units 1-4 dedicated to the programme. Circa 16% (EUR 24 mil.) of total NFDF resources for the decommissioning programme were utilised and spent between 2003–2015, such that EUR 123 mil. were available to cover decommissioning costs until 2030.

In an official letter to DG ENERGY, Ref. № E-92-00-155 from 17 March 2015, the Bulgarian Deputy Minister of Energy confirmed the total amount of accumulated funds for the decommissioning of KNPP Units 1-4 to equal EUR 147 mil, of which EUR 70 mil. were stated as to be spent in 2014-2020 and EUR 77 mil. further available to be utilised in 2021-2030. Based on the latest discussion and information received from SERAW, out of the EUR 147 mil., EUR 24 mil. were actually spent and EUR 123 mil. remain to be spent as explained above and reflected in our analysis.

SERAW commented that EUR 35 mil. of the RAWF funds were contributions from the operations of Units 1-4 and were also dedicated to the programme, EUR 28.5 mil. of which were already utilised between 2010-2015. EUR 4.1 mil. of the outstanding EUR 6.5 mil. are planned to be allocated to the programme from 2016, according to the Kozloduy AWP 2016 (Draft 03). The funds were not taken into consideration for the calculation of the EUR 199 mil. gap (see Table 4), because they were not confirmed at the time of the then approved plan for the decommissioning of Units 1-4. The decommissioning plan is under revision as of the date of this Report and the ongoing revised calculation of the gap includes the above amount of EUR 35 mil. The financing gap under revision is currently estimated at EUR 28 mil. The revision is to be finalised in Q4 2016.

No further NFDF and RAWF assistance are envisaged by the Ministry of Energy.

Resources accumulated in the NFDF and RAWF from 2007 onwards are primarily from the operational Units 5-6 contributions and shall be used for their own decommissioning.

As evidence of the timely availability of national funds, SERAW explained that there have only been three instances of emergency funding requests to the State budget (mid-year, following the annual budget approval), which were all satisfied and related to:

1) The transfer of the Novi Han depository ownership, based on a Council of Ministers decision dated August 2006, whereby EUR 2.3 mil. were reallocated from the State budget;
2) Declaring Kozloduy Units 1-2 as RAW facilities and their transfer to SERAW, based on a Council of Ministers decision dated October 2010. The emergency funding amounted to EUR 1.4 mil.; and
3) EUR 11.3 mil. of funding, according to a Council of Ministers decision dated July 2014, of which:
    - EUR 2.1 mil. to secure the national co-funding under Project 5b; and EUR 9.2 mil. related to the transfer of Kozloduy Units 3-4 to SERAW.

3.1.3 Efficiency/Economy

Question 1: *Are the cost estimates of the decommissioning plans appropriate to the objectives of the NDAP Regulations and to the long-term objectives?*

The current cost estimate presented in Chapter 21 of the decommissioning plan [8] presents some shortcomings.

Costs are presented under the four ISDC cost elements of labour, investments, running costs and contingency. Costs for investments are based on the estimates as per the investment programme financed by EBRD; running costs are based on real costs in previous periods. Labour costs associated with the dismantling and processing of wastes are presented based on a simplistic calculation. It used the gross amount of material to be removed and processed during the programme from each of seven identified work areas (corresponding to specific areas of the plant) and applies removal and processing production rates to generate the personnel required in each assuming all works are completed within a predetermined fixed period. Allowance is then made for associated engineering personnel at 10% of the required number of manual workers.

At this stage in the programme it would be expected that the decommissioning plan would have been developed by summation of the labour requirements of individually planned dismantling projects or tasks. These planned projects or tasks would typically take account of the need to set-up work areas for access and radiological control, install services and equipment, sequence the removal of specific large components in an area, and take account of limits on the number of workers that can safely work within each area or on a particular task.

It may be that very well chosen production rates based on extensive experience may give a satisfactory result when used in this way. The labour estimate presented may therefore be adequate, but the methodology presented suggests that detailed planning has yet to be performed.

At the time of writing, SERAW are revising the decommissioning plan. It is not known if the same methodology for calculating decommissioning labour requirements will be used in the revised version.

SERAW explained that certain costs per Plan were higher than actual costs (e.g. labour costs) and are under ongoing revision. It appears that the decommissioning cost estimate did not take into account the employees needed for the operation of new RAW management facilities, built in 2015 and planned for commissioning in 2017.

However, SERAW stated that all decommissioning activities are currently being revised and it intends to decrease the interim activities and discontinue those, which do not lead to the expected outcome, thereby improving the future planning process based on past experience. In addition, SERAW explained that they intend to start the implementation of one of the most important projects, which will additionally decrease costs for interim storage (e.g. radiation testing of dismantled equipment) at the end of 2016.

With respect to cost estimates for the specific sample projects considered in this study, some of the information presented in the Project Identification Sheets for earlier projects does not appear to have been prepared in a thorough manner, especially when compared to the actual project cost. The Project Identification Sheet for Project 5b [35] is an example of this as it shows a very simply prepared initial estimate dating from around 2005 which is increased by over 300% following initial engagement with the supply chain in 2007 and by a further 28% at contract placement in 2009. SERAW stated that comparison was made with other projects when preparing the project cost estimates. They stated examples of comparisons made including Project 5b, which made comparison with similar plants in Balakovo (Russia) and Bohunice. In the case of Project R-10, comparison was made with El Cabril in Spain (by the PMU Consultant). For Project 9b SERAW stated that comparison was made with similar work at Bohunice.

Given the improved estimating process demonstrated by these more recent documents, the Review team consider that it would be beneficial for SERAW to update older project estimates in the Kozloduy decommissioning programme, should any still exist, to align with the new approach.

It is noted that the decommissioning plan cost estimate for Kozloduy is relatively low compared to the other two programme estimates. Whilst comparison with Ignalina is complicated by the fact that the plants are based on very different reactor technology, comparison with Bohunice V1 which is based on similar VVER440 V230 plant technology is more useful.

As can be seen in Table 3, the total cost for Kozloduy is estimated at EUR 1,107.0 mil. compared to a higher estimate of EUR 1,245.6 mil. for Bohunice. This is despite the fact that Bohunice V1 consists of only two reactor units compared to the four at Kozloduy. While not doubling the total work required, having twice the number of units does mean that there is significant additional work required at Kozloduy. Kozloduy having a lower estimate than Bohunice (or vice versa) is therefore counter intuitive.

This observation is considered in Section 5.3.1 of the Annexes. For the purpose of normalising the comparison between the Kozloduy and Bohunice programmes, the Annex escalates the readily identifiable local labour element of the Kozloduy cost estimate up to Slovakia labour cost levels - using EUROSTAT data [182] - which gives a revised comparable cost of EUR 1,743.2 mil. for the Kozloduy programme. This revised figure would put the Kozloduy estimate in a more expected position relative to the Bohunice estimate and suggests that the counter intuitive relative levels of the costs estimates may largely be explained by the difference in typical labour costs between the two countries. This provides some reassurance that the estimates may be more consistent than the total costs initially suggest. There is no suggestion that this alternative Kozloduy cost is expected or has any real risk of occurring given that it is highly unlikely that Bulgarian labour rates will rise to Slovak Republic levels in a very short period of time.

An important element of the cost estimate of such complex projects is related to the level of contingency included within the estimate. Section 3.1.5 specifically addresses this issue by

comparison to other decommissioning plans and suggests that an increased level of contingency should be considered for the purposes of prudent planning the funding of the Kozloduy programme (as is taken into account in section 3.1.2 above).

In conclusion, it can be said that the quality of the cost estimate, and its appropriateness in relation to the objectives of the NDAP Regulations suffers from the presented estimation of labour requirements for the decommissioning plan.

Question 2: *Is the size of the assistance budget appropriate and proportional to the NDAP Regulations objectives?*

The NDAP Regulations objectives refer primarily to the specific objectives to be achieved in the framework 2014-2020.

EU assistance to the Kozloduy Units 1-4 decommissioning from 2014 to 2020 under the NDAP Regulation is of EUR 293 mil. This represents some 37% of the total project cost up to 2020 (EUR 800 mil.) and 89% of the 2nd project period costs (EUR 330 mil.).

Funding by Sector and Subsector (% of total EU assistance to energy projects in Bulgaria)

	Allocated to Projects							
Sector	**> 2014**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Decontamination and dismantling	*38%*	*84%*	*82%*	*75%*	-	-	-	-
Waste storage and disposal	*12%*	*8%*	*12%*	*16%*	-	-	-	-
Regulatory and administrative assistance	*3%*	*6%*	*4%*	*6%*	-	-	-	-
Pre-decommissioning activities	*1%*	*1%*	*1%*	*0%*	-	-	-	-
KNPP Units 1-4 decommissioning	***54%***	***99%***	***99%***	***97%***	**-**	**-**	**-**	**-**
Administrative overheads of the decommissioning program	-	*2%*	*1%*	*3%*	-	-	-	-
Technical assistance in program	-	-	-	-	-	-	-	-
Program administration	**-**	***2%***	***1%***	***3%***	**-**	**-**	**-**	**-**
Energy infrastructure	*26%*	-	-	-	-	-	-	-
Energy efficiency	*18%*	-	-	-	-	-	-	-
Other – energy sector consequential measures	***44%***	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Total	***98%***	***100%***	***100%***	***100%***	**-**	**-**	**-**	**-**

Source: KNPP AWP 2016 (Draft 03)

Note: The allocation of 2% of total EU assistance to nuclear energy sector in Bulgaria until 2014 was not identified.

Table 7: Funding by Sector and Subsector (% of total EU assistance to energy projects in Bulgaria)

This suggests that the assistance budget is indeed appropriate and proportional to the NDAP Regulation specific objectives.

When it comes to the general objective of the NDAP Regulation, which is to assist the Member State in implementing the steady process towards the decommissioning end state, it should be mentioned that this process is indeed secured during the period of application of the Regulation, but that the financing gap for 2021 – 2030 may jeopardise the process.

Question 3: *Are the outputs obtained at a reasonable cost?*

It appears that some major projects have had higher costs than initially anticipated. This seems to be caused by a mix of issues such as lack of characterisation of wastes before placement of processing contracts (Project 9b) or by expectations set by low estimates produced in the early

development of projects (Project R-10). Issues related to uncertain waste characterisation at the start of projects are typical of nuclear decommissioning programmes and have potential to cause contractual and technical difficulties during project delivery. Experience of this issue should be the basis for a lesson learned and shared across the three programmes. Low estimates that are revised as more detail is developed or exceeded as competitively tendered supplier responses are received are also typical and funding systems need to be able to react appropriately to them.

Stakeholders raised the point that they believe that the EC funding approval process does not align optimally with the normal development of a project in that it cannot quickly respond to changes in the estimated cost of projects already approved or instances where the requested funds are higher than originally estimated. Project R-10 was cited as an example of this. In this and other instances, delays caused by this process were small relative to delays caused by other factors occurring before reaching this point. However, the reported issue of funding process alignment is identified and foreseeable, and can therefore be the subject of action aimed at removing or minimising its potential to introduce new delays.

***Project R-10* - Construction of Phase 1 of the National Disposal Facility for Low and Intermediate Level Radioactive Waste**

The original funding for the project, as requested in the Project Identification Sheet of 2012 [32] and approved in Grant Agreement 46 [31] of 2013, was based on a preliminary design for the facility. Construction was estimated at EUR 56.7 mil. and forecast to commence Q4 2013.

After completion of the detailed design and its approval by the regulatory authorities, which led to some modifications, the cost estimate was updated under a new contract with the designer. The preliminary updated estimate was available at the end of 2015, at which point the project was over two years behind the PIS schedule. In December 2015, EBRD indicated the new cost estimate to EC and on 1st March 2016 asked for formal agreement to amend the Grant Agreement.

The tendered price for the construction work (by a different contractor to the designer) was within the revised cost estimate, at a value of EUR 71.82 mil, an increase of ~26% over the original PIS estimate. At the time of the Review team meeting with EBRD in May 2016, EC had not yet made additional funds available and hence the construction contract could not be signed. As the delay was extended EBRD were concerned that the construction would not be able to commence before winter and the 2016 construction season would be lost. Although the delay directly attributable to the funding process was small compared to delays to that point, its timing had the potential to lose the construction season and meant that the process risked a greater consequential impact.

Funding issues were resolved at the end of June 2016, and the contract was subsequently signed on 7th July 2016.

At the current point in the programmes' schedules, implementation delays could be relatively costly, though the impact is not always immediate or easily quantified. At the present point, in the Kozloduy schedule, approximately 650 people are employed on site, which based on Grant Agreement 48a [34] will cost approx. EUR 11.3 mil. in 2016, or EUR 0.94 mil. per month.

If critical path tasks are delayed at this time by funding issues, the monthly delay cost could be as high as the full cost of employment plus other site running costs; however, this impact would not be seen in the current year's annual costs but rather in subsequent years.

This issue is recognised by DG Energy, as is the importance of prudent management of donors' funds. One possible solution may centre around the more methodical application of contingency and risk assessment processes. For example, estimates for funding applications are currently made without contingency or risk allowances as part of the estimate. Future applications might be accompanied by a separate assessment of identified and quantified contingencies and risks which results in pre-approval by the EC of reserve funding held back from the beneficiary. In the event that the beneficiary is able to demonstrate to the satisfaction of EBRD (CPMA in the case of Lithuania) that one of the events considered in the assessment has occurred, a suitable amount of the reserve is released. Occurrence of events outside the pre-assessment would be less conducive to building EC confidence in the beneficiary's understanding of their programme and any further funding to cover such events would need to be justified as per the present system.

In conclusion, it can be said that there is room for improvement for the outputs to be obtained at a reasonable cost.

Question 4: *Are financial resources of the concerned Member State likely to be available in due time, in appropriate quantity and quality at the best price?*

As previously mentioned, the financial resources of Bulgaria for the financing of the decommissioning plan are managed through two dedicated national funds, the NFDF and the RAWF.

The national funds' revenue and expenditures are collected, reported and centralized in the System of Single Account through using a separate transit account and a separate transit code in the System for Electronic Budget payments. The account was opened by the Ministry of Energy with the Bulgarian National Bank (BNB).

The accumulated national funds for the decommissioning of Units 1-4 in NFDF and RAWF, as presented by the Ministry of Energy, were as follows:

- NFDF - EUR 147 mil. contributions from the operations of the Units 1-2 (1999 – 2002) and Units 3-4 (1999 – 2006), respectively. EUR 24 mil. of those contributions were spent during the period 2003-2015. Therefore, as of December 2015, the total available NFDF funds amounted to EUR 123 mil. and were committed for the period 2016-2030.
- RAWF - EUR 35mil. contributions from Units 1-4, of which EUR 29 mil. were spent up to 2015. Therefore, as of December 2015, the total available RAWF funds for the decommissioning of Units 1-4 amounted to EUR 6 mil., expected to be used during the period 2016-2030. The amount of EUR 35 mil. is included in the currently revised financing gap calculation which is to be further finalised. The funds were not taken into consideration for the calculation of the EUR 199 mil. gap, because they were not

confirmed at the time of the then approved plan for the decommissioning of Units 1-4.

Further to the available national resources for the decommissioning of Units 1-4, Kozloduy Units 5 and 6 were also contributing funds to NFDF and RAWF. The available contributions from the operational units amounted to approximately EUR 635 mil. as of December 2015. As confirmed by the Ministry of Energy, this amount is intended to be used for their own decommissioning when needed and used as a last resort for Units 1-4 decommissioning after other sources of income to be generated by SERAW.

As mentioned above (section Effectiveness, Question 4) there were three instances of emergency funding to the program, which were requested from the State Budget following its annual approval. All of them were satisfied and it appears that the committed national funding channelled through dedicated funds are likely to be available in due time, and in appropriate quantity and quality.

National funds spending is forecasted annually, according to the budget of the Ministry of Energy. SERAW funds and expenditures are reported on a monthly, quarterly, semi-annual and annual basis at the Ministry of Energy. Financial statements are submitted to the Ministry of Finance every 3 months. The "Financial and Economic Council", established within SERAW, is responsible for the review of the 3-year financial programs and detailed draft budget for the next year and to submit them for approval by the National Funds Management Boards. Two financial controllers within SERAW review each expense and confirm its proper and lawful spending and accounting. The Ministry of Energy is responsible for approving and granting the national co-financing and the implementation of relevant activities. Each year, prior to submitting its Annual work program (AWP) to KIDSF, SERAW requests an approval from the Ministry of Energy. The AWP includes information on the activities implemented in the previous year and an action plan for the next period. Identified weaknesses and mitigating actions are considered in the preparation of the AWP for the next period.

Agency	Standard & Poor's	Moody's	Fitch Ratings
Rating (long-term)	**BB+**	**Baa2**	**BBB-**
Outlook	Stable	Stable	Stable
Valid from	03.06.2016	05.06.2015	22.7.2016

Source: Ministry of Finance

Table 8: Bulgarian credit rating

As detailed above, the national funding contributions for Kozloduy Units 1-4 decommissioning are held in a separate account with the (BNB) and are guaranteed by the Bulgarian government. There is no available rating on the national funding contributions. Being backed by the Bulgarian government, the long-term credit ratings for Bulgaria apply. Latest available ratings currently range between non-investment grade (Standard & Poor's) and lower medium grade (Moody's and Fitch Ratings), with unanimous stable outlook.

The credit rating agencies have accounted for the moderate level of public debt, which could potentially allow Bulgaria to respond to external and domestic fluctuations through additional

debt. However, the real GDP growth rate of Bulgaria is expected to slow down for the period 2016 – 2019, compared to 2015. The slowdown is expected to result from lower investments and lagging utilization of EU funds for the following period.

Were Bulgaria to have to fund the financing gap, we believe that national financial resources could likely be made available and refer to question 3 in section 3.1.2, although the final solution for financing of the abovementioned financing gap still needs to be determined.

3.1.4 Sustainability

Question 1: *Are the decommissioning plans sustainable in the long term, i.e. after 2020, without further intervention of the Union assistance?*

The financing gap considered to date is EUR 199mil. and appears post 2020 (see Table 10).[18]

The study recommends to take into account an additional contingency of EUR 13 mil. to cover an "intermediate contingency" case and EUR 38mil. to cover a "high contingency" case, respectively.

Overall, the decommissioning financing gap (based on the scenarios below) as a percentage of total EU funding is as follows:

- Current Plan (EUR 199 mil.) - 17% of total EU funding to the Bulgarian decommissioning programmes (including energy infrastructure and efficiency) (EUR 1,161 mil.), and 26% of EU assistance to the Kozloduy Units 1-4 decommissioning programme (EUR 761 mil.) up to 2020;
- "Intermediate contingency" case (EUR 212 mil.) - 18% of total EU funding to the Bulgarian decommissioning programmes (including energy infrastructure and efficiency) and 28% of EU assistance to the Kozloduy Units 1-4 decommissioning programme up to 2020;
- "High contingency" case (EUR 237 mil.) - 20% of total EU funding to the Bulgarian decommissioning programmes (including energy infrastructure and efficiency) and 31% of EU assistance to the Kozloduy Units 1-4 decommissioning programme up to 2020.

Total EU funding to Bulgaria in the period 2000-2015 amounted to EUR 15.1bn, EUR 13.6bn (or 90%) of which related to 2007-2015. 10% of total funding related to pre-accession strategy. The decommissioning financing gap varies between 1.5% (current plan) and 1.7% (high case) of total EU funding to Bulgaria in 2007-2015, depending on the case.

[18] According to SERAW, and at the same level of contingencies, the financing gap is reduced to EUR 28mil.The revised financing gap is due to be confirmed by the end of 2016 according to SERAW Management.

Based on historical data (1999 – 2015) for the accumulated contributions (mainly from KNPP) to the national funds, it appears that sufficient resources will indeed be available to cover this financing gap.

Information provided by SERAW clarified that no national resources accumulated from the operation of Kozloduy Units 5-6 are intended to be used to cover the gap, but that other sources could be used to cover the gap, such as:

1) Interest on accumulated resources in the national funds, which were not already spent;
2) Income from the sale of a dismantled equipment;
3) Rent of premises, which can be used for another purposes;
4) Implementation of projects, such as the Project for laser cutting equipment, which could generate additional income from external services to third parties. Such activities have already started for the peripheral devices, according to an approved programme;
5) EUR 11 mil. already granted, but not utilized under Grant 048 (EUR 8mil.) and Grant 16 (EUR 3 mil.), respectively.

Interest income represented an insignificant portion of total national funds. The unutilised resources under Grant 048 were confirmed to detail the breakdown of planned vs. actual disbursements in the period 2014 – 2015. With respect to other sources of income, we requested, but were not provided with supporting or additional data and information to confirm them.

Despite the EUR 199mil. financing gap after 2020, the Kozloduy Units 1-4 decommissioning plan appears to remain sustainable, even though the final solution to bridge it has not been identified. Furthermore, the latest financing gap estimate as prepared by SERAW in 2016 noted a decrease to EUR 28 mil. (to be confirmed formally).

3.1.5 Risks

Question 1: *Are the contingencies properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios?*

Contingency allowances to cover estimating uncertainty are generally made in the production of decommissioning cost estimates. SERAW have adopted this practice and have added a common 10% contingency to all future spend, as described in Chapter 21 of the decommissioning plan [8].

While inclusion of a contingency allowance of this type within the decommissioning plan estimate is prudent, the addition of a fixed percentage to all costs is not best practice, as described in ISDC [180]. It states that "*Early decommissioning cost estimates included a contingency of 25% that was applied to the total project cost. More recent and accurate*

approaches apply contingencies on a line-item basis, yielding a weighted average contingency for the cost estimate."

The 10% allowance added is at the lower end of the range presented in Table 26. There is insufficient data available for the Kozloduy programme to allow the Review team to perform a line by line assessment of contingencies that could be included. For the purposes of the analysis presented in this study, and in line with the approach set out in Section 2.1, modified percentages of 12% ("intermediate contingency" case) and 16% ("high contingency" case) are used as these are more typical of the values in Table 26 and are similar to the two contingency levels suggested for Ignalina (see Section Risks). The resulting increased contingency levels are shown in the table below.

Basis	Contingency (EUR mil)	Cost (2013-30) incl. inflation (EUR mil)	Total Cost (2003-30) (EUR mil)	Total Delta (EUR mil)
Current Plan	62.58	688.40	1106.99	0
"Intermediate contingency" Case	75.10	700.92	1119.51	12.52
"High contingency" Case	100.13	725.95	1144.54	37.55

Table 9: Suggested additional contingency (estimating uncertainty) for the Kozloduy programme

SERAW appear to operate conventional risk identification, qualitative assessment and management system typical of a large work programme, as evidenced by SERAW provided documents for Project 1 and their risk procedure [143, 145]. These identified risks are not currently used as the basis of a calculated allowance to cover the potential cost of risk events. Given that this risk identification and assessment process is in place, it would not be a major step to move to quantitative assessment of risk and calculation of risk allowances if this was considered of benefit.

We would conclude that contingencies are not currently properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios. However, we also conclude that the additional work required to address this would be relatively small.

As discussed in Section 3.1.3 we believe that the labour cost estimate included in the decommissioning plan [8] has been, in part at least, calculated in a simplistic manner. SERAW also identified some other known issues with the labour cost estimate. In the event that the revision of labour costs, or indeed of other costs, in the revised 2016 decommissioning plan were to have the net effect of generating a significantly different estimate of the total costs, the effect on the potential change in the contingency cases presented here would need to be considered.

3.2 Lithuania

3.2.1 Relevance

Question 1: *Are the detailed decommissioning plans comprehensive and complete with reference to the defined end-states?*

According to the Lithuanian regulatory documents, upon completion of the economic activity, the activity area must be restored to the "status quo ante". Therefore, the planned end state requires that the site be radiologically decontaminated and generally restored to its forested condition before the site was constructed, though some below ground building foundations may remain. The option is left open that some buildings may attract interest for reuse. Not all parts of the site will be delicensed as some areas will be retained to provide waste repositories. The overall site end-state may therefore be considered "brown-field".

The Ignalina Final Decommissioning Plan (FDP) [50] appears complete and sufficiently comprehensive to deliver the defined end state. Some activities are presented without detail, for example, the dismantling of the reactors themselves, each being shown as consisting of two bars of approximately 4 years (Zones R1, 2) and 7 years (Zone R3). At this stage in the programme, this is to be expected; more detail will be added later as specific project teams and contractors complete detailed engineering. The durations allowed for these tasks appear reasonably conservative at this stage.

A minor observation was noted concerning the final activities presented in the Ignalina schedule. The schedule currently shows individual buildings being granted unrestricted release, then demolished, followed very quickly by completion of site remediation. It might be expected after demolition of buildings that site wide ground surveys might be required, particularly around any areas disturbed during demolition. These might then require a period of assessment by regulators prior to starting the site remediation. Delicensing will be a new activity for both Ignalina and the regulator so it would be worth liaising to develop an agreed approach for inclusion in the plan, if not already done.

The Review team did not identify any significant activities that appeared to be missing from the decommissioning plan. The proposed Ignalina breakdown structure for the overall programme was compared with the approach employed and decommissioning experience gained by Energiewerke Nord GmbH (EWN) at Greifswald. Throughout the development of the breakdown structure EWN's experience regarding the definition of sub-programmes and constituent projects was taken into account. The breakdown structure, the scopes of works and corresponding costs had been reviewed by Tractebel (part of the AMEC-Tractebel-Vattenfall consortium, which provides Ignalina with consultancy services).

The FDP itself does identify some activities added between the previous and current version of the FDP; these were generally activities that had been identified during the intervening period and were already in progress to some degree. No further changes to the scope have been identified since approval of the current FDP.

Stakeholders noted that no third party independent review of the complete decommissioning plan had to date been carried out, particularly in relation to the cost estimate and schedule. This was corroborated during a meeting with the Ministry of Energy, who confirmed that the approval process by the ministry is primarily concerned with compliance, environmental impacts, etc. This situation could be described as the "absence of an informed customer" for the decommissioning plan and cost estimate in that there is no critical review made of the estimate by the bodies issuing the formal approval.

The Ministry of Energy recognised this as an issue and have now assigned a decommissioning plan and cost estimate oversight role to RATA, the state Radioactive Waste Management Agency. RATA has launched a tender exercise to engage an expert consultant to perform the first detailed review of the scope and costs of the decommissioning plan. Tender submissions were due for return to RATA on 9th May 2016. This review process introduces a further diversity of expertise and experience as well as constructive "challenge" into the development of an approved plan, and can be considered an example of emerging good practice within the overall Lithuanian decommissioning programme.

The study concludes that the Final Decommissioning Plan version 7 is generally complete and includes the main activities required to safely achieve decommissioning of the site to the defined end state. As is normal at this stage for plans that extend into the future, future dated activities are not yet planned in detail but the Review team conclude that appropriate activities have been included and reasonable allowance has been made for their duration.

Question 2: *Do the financing plans respond to the needs of the decommissioning plans?*

A segregated decommissioning fund would normally accumulate funding over the entire design life of the plant. However, given the short period of time between the regime change and the early shutdown, the possibility to gather the necessary funds was reduced. Accordingly, the funds raised from contributions to the SEIDF (State Enterprise Ignalina Nuclear Power Plant Decommissioning Fund) were insufficient to cover their decommissioning costs. The primary sources of funding were the EU and other international donors through the IIDSF, managed by EBRD, and the IP fund, managed by CPMA.

Currently, there are no earmarked funds for the full decommissioning period that would satisfy the needs of the decommissioning plan. Based on the information provided, the estimated financing gap as of 31st December 2013 amounted to EUR 1,644 mil. before inclusion of additional allowance for risk.

The gap was calculated as a difference between total decommissioning costs and funds which were already allocated or available/committed at the end of 2013 (please refer to Annex

5.3.2.3 for a more detailed split and the sources for the calculation of the financing gap). The table below summarises the estimated financing gap:

		€m
Total decommissioning costs	A	3,377
EU & other donors' funds allocated until the end of 201	B	1,134
EU funds committed for 2014-2020	C	451
National assistance disbursed until the end of 2013	D	110
National assistance committed for 2014-2016	E	38
Total financing assistance	F=B+C+D+E	1,733
Financing gap before additional risks	G=A-F	**1,644**

Sources: INPP decomissioning plan, Ministry of Energy, NA Monitoring Report 2015-H2 Section C, Inter-institutional decommissioning plan

Table 10: Ignalina Units 1-2 decommissioning funding structure for 2000-2038

Total financing assistance includes only those funds which were already committed, therefore it is likely that the financing gap would be lower due to national funds which will be allocated to the decommissioning after 2016. The exact amount of national funds to be provided for the decommissioning is approved only one year ahead.

These data do not include allowances for additional contingencies.

3.2.2 Effectiveness

Question 1: *Do the detailed decommissioning plans and the financing plans meet the objectives of the NDAP Regulations?*

The NDAP detailed implementation procedures [7] list a number of key milestones associated with the Ignalina decommissioning programme in the framework 2014-2020. These milestones are linked to the specific objectives defined in the NDAP Regulation. Following review of the schedule presented in the FDP [16] and in the draft AWP 2016 [54], the Review team concludes that both schedules do generally show compliance with the specified dates from the Regulations. One minor deviation in the plan as presented is that draft AWP 2016 [54] shows the start of operation of B2/3/4, the solid waste management and storage facilities, as Q1 2019 compared with a target of Q4 2018 presented in the Regulations. In the previous versions of the AWP from 2014 [52] and 2015 [53] this milestone was shown being achieved by the original Q4 2018 date, so it is now showing a small slippage against the plan.

It is not possible to definitively conclude if the specified indicators will be achieved as these relate to removal of an identified mass of material, or processing of a specified volume of waste by 2020. While future performance remains unknown, it is possible to examine the performance against these indicators achieved to date based on data presented in AWP 2015 [53] and the 2015 monitoring report [90]. Some of the relevant activities were not scheduled to start yet, but for those in progress during the period 2014/15 the percentage achievements shown in the following table were reported against the various removal targets:

Objective	Target During Period 2014/15	Actual During Period 2014/15	Percentage Achievement
Shutdown and Isolation of Process Systems	17 systems in progress	17 systems in progress	100%
Dismantling of process equipment and components	12,434 te	14,335 te	115%
Treatment (processing) of Radioactive Waste	4,700 te (2014) 1,100 m3 (2015)	6250 te (2014) 1,164 m3 (2015)	134% 106%
Radioactive Waste Storage	1,210 m3	1,208 m3	100%

Table 11: LT Achievement of NDAP specified targets during 2014/15

Within these high level targets, some specific lower level targets set by Ignalina themselves have not been achieved but, as suggested by the overall percentage achievements, Ignalina have compensated for these by over achievement in other areas. The percentage achievements against target to date provide reassurance that the specified indicators can be achieved if similar productivity can be maintained.

In terms of the financing plan, available financing ensures implementation of those objectives, which are scheduled to be completed by the end of 2020.

The detailed decommissioning plans and financing plans meet the general objective of the NDAP Regulation, i.e. to assist the Member State in implementing the steady process towards the decommissioning end state.

Based on the information presented above, it also appears that the specific objectives of the NDAP detailed implementation procedures [7] are likely to be met.

Main causes of delay experienced by the Ignalina sample projects

Change to the delivery strategy:

UP01 - Unit 1 reactor dismantling (representing the reactor dismantling work stream including previous projects in this area)

Late procurement processes (compared to PIS, excluding funding processes):

Project B1 - Design and Construction of an Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2

Project B2/3/4 - Design and Construction of New Solid Waste Management and Storage Facilities

Project B9/1 - INPP Unit 1 Turbine Hall Equipment Decontamination and Dismantling Project Development

Project B25-1 - Near Surface Repository for Low and Intermediate Short-Lived Radioactive Waste (Design and Construction)

Funding approval processes:

Project B1 - Design and Construction of an Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2

Longer than planned regulatory / approval processes:

Project B2/3/4 - Design and Construction of New Solid Waste Management and Storage Facilities

Project B25-1 - Near Surface Repository for Low and Intermediate Short-Lived Radioactive Waste (Design and Construction)

Uncertain characterisation of wastes as presented in technical specification:

None identified

Other issues with data presented in the technical specification:

Project B1 - Design and Construction of an Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2

Project B2/3/4 - Design and Construction of New Solid Waste Management and Storage Facilities

Technical difficulties during delivery:

Project B1 - Design and Construction of an Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2

Project B2/3/4 - Design and Construction of New Solid Waste Management and Storage Facilities

Project B9/1 - INPP Unit 1 Turbine Hall Equipment Decontamination and Dismantling Project Development

Question 2: *Do the detailed decommissioning plans and the financing plans meet the objective of the safe completion of decommissioning beyond the MFF 2014-2020?*

Generally, the activities included in the decommissioning plan meet the objective of safe completion of decommissioning.

As noted above, the decommissioning plan is generally complete with respect to the activities required to reach the defined end-state. The plan includes plans for waste processing and storage facilities (e.g. Projects B2/3/4), activities for system isolations, general and radiological area replanting and identified schedule activities for health and safety related actives.

Other key enabling activities include the construction of the Interim Spent Fuel Store (Project B1), the Near Surface Repository (B25) and the VLLW Landfill (B19-2).

All facilities required to process and package the radiological waste for disposal or passive storage to await final disposal appear to be included in the plan.

In terms of the financing plan, we estimated on the basis of the available information, that currently earmarked financing sources will be sufficient to cover decommissioning costs during the current financial framework (2014-2020) and will only cover less than 10% of decommissioning costs beyond that period, for which a financing gap thus exists.

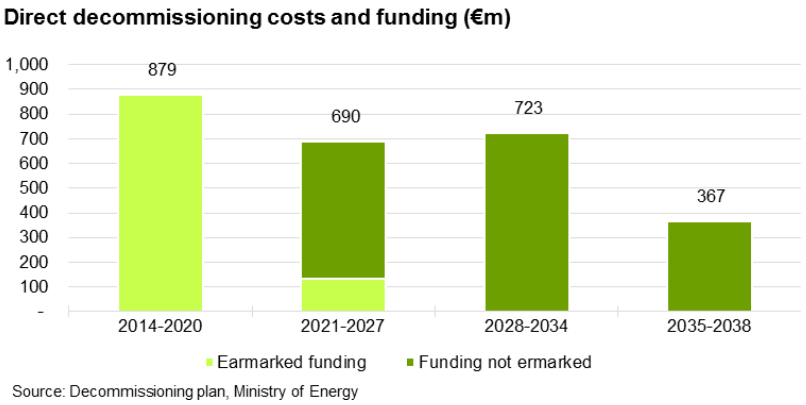


Figure 10: Planned Ignalina decommissioning direct costs and secured funding for 2014-2038

Under the additional "intermediate and high contingency" cases submitted by the Review team, the gap is estimated at higher values.

The existence of a financing gap means that, as of now, the objective of the full completion of the decommissioning programme is not secured. Nevertheless, the projects and activities in progress and planned under the MFF 2014-2020 at Ignalina concerning radiological system dismantling, spent fuel management and waste management ensure that the plant will be in a safer condition than at present. The most significant development will be the commissioning of the Interim Storage Facility for RBMK Spent Nuclear Fuel in 2017. This will allow spent nuclear fuel from Reactor 1 (already defuelled with spent fuel stored in the fuel pool) and from Reactor 2 (which currently contains fuel) to begin being placed into passively safe and secure storage to await final disposal. Completion of the transfer of fuel to the new store is scheduled for end of 2021. The spent fuel accounts for the majority of the radiological inventory of the

site (>95% for a typical power plant). The site will also have the facilities to continue management and reduction of remaining hazards beyond that date.

Question 3: *What is the ability of the the state budgets of BG, LT, and SK respectively or the operators to cover additional financial contingencies that may arise before 2020, or absorb the financing needs resulting from the uncertainties identified in the decommissioning plans?*

In line with the overall methodology applied to assess this issue (section 2.1.), revised cost estimates were calculated for the Ignalina decommissioning plan based on an "intermediate contingency" case and a "high contingency" case. The robustness of Lithuania's State budget, and its ability to cover additional financial contingencies that may arise, or absorb the financing needs resulting from the uncertainties identified in the Plan were assessed on this basis.

An analysis was performed for two scenarios, the “intermediate and high contingency” scenarios, based on additional risk allowance calculations, as described in section 3.2.5.

The figures below illustrate the effect that absorbing the full financing gap would have on the Lithuanian State budget and GDP.

“Intermediate contingency” case

In this case, the financial burden would increase from 0.1% to 0.3-0.5% as a percentage of budget expenditure and from 0.04% to 0.11%-0.17% as a percentage of GDP after 2020 if the Ignalina decommissioning financing gap was fully financed by Lithuanian funds.

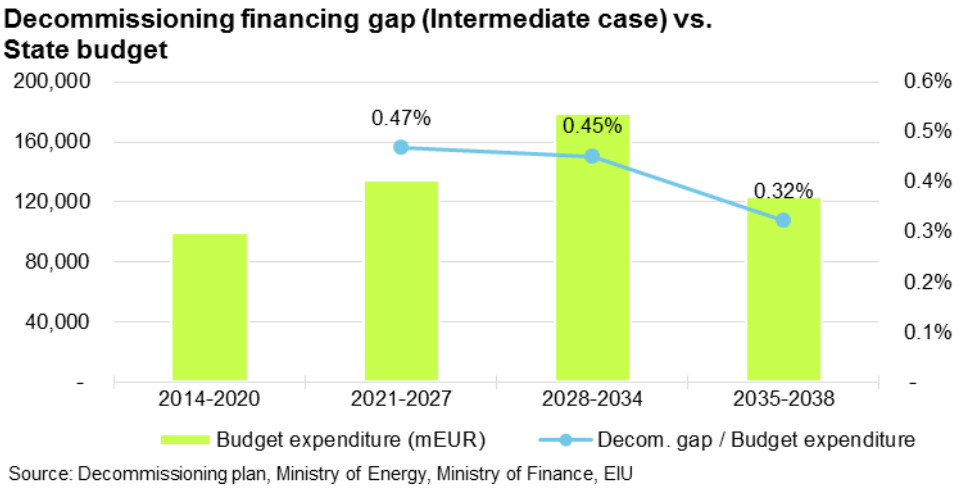


Figure 11: Comparison of decommissioning financing gap with state budget expenditure (“intermediate contingency” case)

According to Lithuania’s stability program, approved by the government and submitted to the European Commission, it is planned that the State budget goes from a budget deficit to a budget surplus in 2018 (for the first time since 2007). Financing of the full gap by the State would have a negative effect on the budget and the commitment to balance the budget would be highly unlikely in the coming years.

On average, the Lithuanian State already allocates 1-2% of annual budget spending to the Fuel and Energy sector (2008-2015). As presented in the graph below, if the decommissioning financing gap were to be fully financed by the Lithuanian budget, spending related to the Fuel and Energy sector would increase by 30-44% during the 17-year period from 2021 to 2038, which is a meaningful increase of the financial burden on the State's budget.

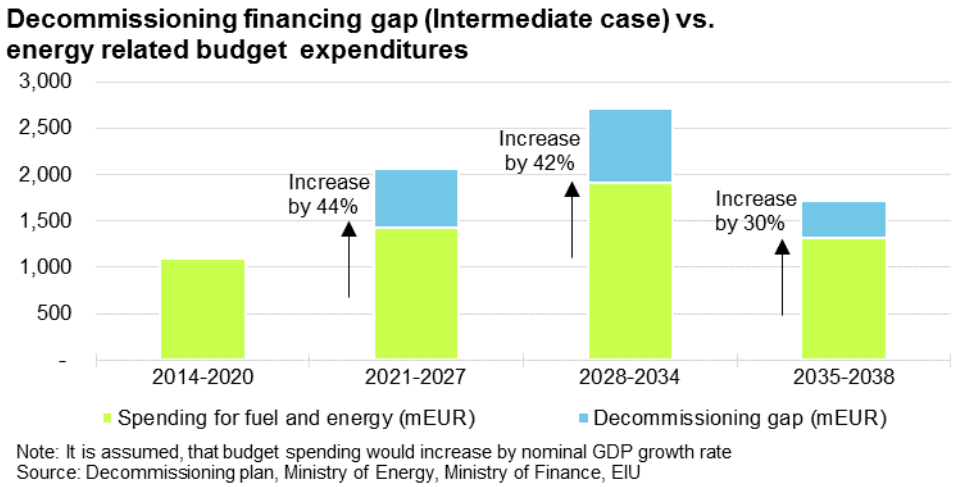


Figure 12: Comparison of decommissioning financing gap with state budget expenditure for Fuel & Energy sector ("intermediate contingency" case)

The decommissioning financing gap accounts for 0.11-0.16% of the forecasted GDP during 2021-2038, which is significantly higher than 0.04% - the historical ratio of decommissioning costs financed by national funds to GDP.

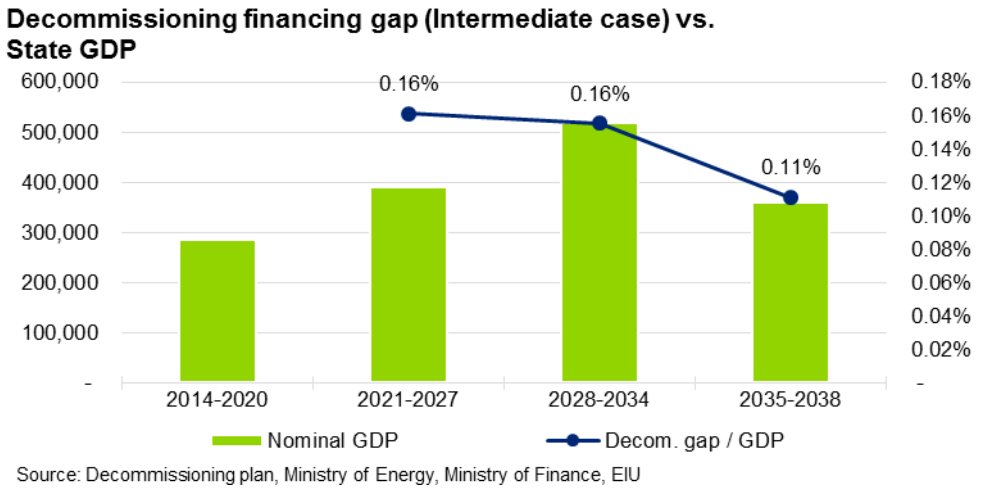


Figure 13: Comparison of decommissioning financing gap with GDP ("intermediate contingency" case)

The Lithuania government debt to GDP ratio amounted to 45.2% by the end of 2015, which is an all-time high. Assuming full funding of the financing gap by national debt would further increase the State's indebtedness by over 10%, the equivalent of 4.9% of 2015's GDP.

	EUR mil	% as of GDP
Nominal GDP (2015)	37,124	-
Public debt (2015)	16,791	45.2%
Total decommissioning gap ("intermediate contingency" case)	1,833	4.9%

Table 12: Decommissioning gap and public debt

"High contingency" case

Additional contingencies estimated under the "high contingency" case amount to EUR 285 mil. As the increase in relation to the "intermediate contingency" case is minor compared to the total value of the financing gap, its effect does not lead to significantly different results from the previous case.

The figures below illustrate the effect that absorbing the full financial gap would have on the Lithuanian State budget and GDP. The financial burden would increase from 0.1% (for historical period) to 0.32-0.51% as a percentage of budget expenditure and from 0.04% to 0.11%-0.18% as a percentage of GDP after 2021 if the Ignalina decommissioning financing gap was fully financed by Lithuanian funds.

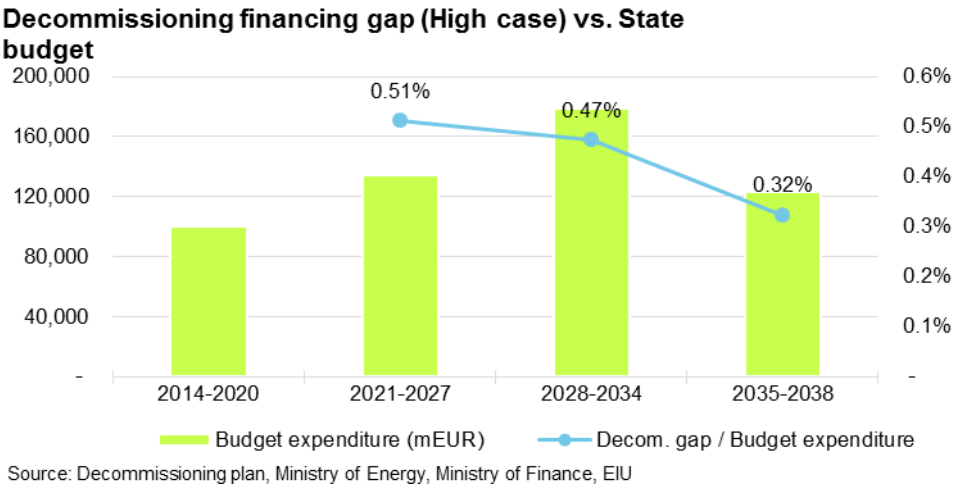


Figure 14: Comparison of decommissioning financing gap with state budget ("high contingency" case)

As presented in the graph below, if the decommissioning financing gap were fully financed by the Lithuanian budget, spending related to the Fuel and Energy sector would increase by 30-48% during the 17-year period from 2021 to 2038, which would be a meaningful increase of the financial burden on the State's budget.

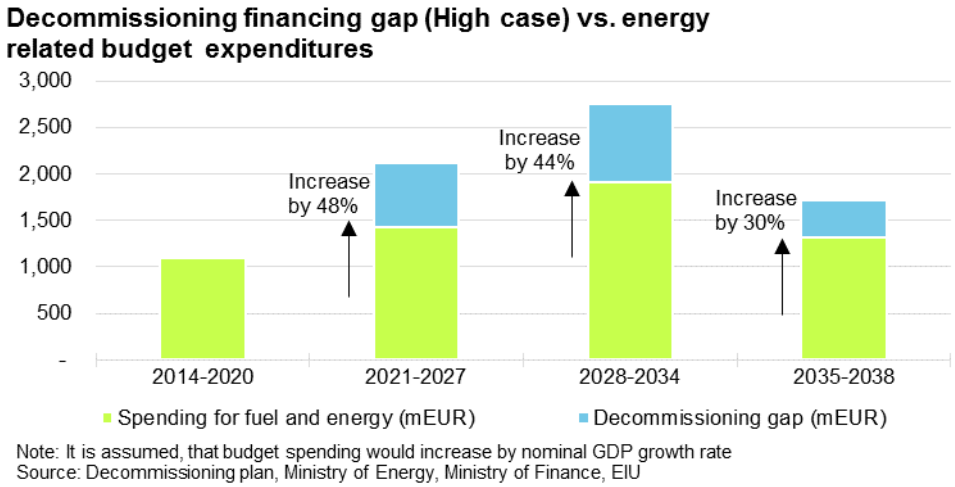


Figure 15: Comparison of decommissioning financing gap with energy related budget expenditure ("high contingency" case)

The decommissioning financing gap amounts to 0.11-0.18% of the forecasted GDP during 2021-2038, which is significantly higher than 0.04% - the historical ratio of decommissioning costs financed by national funds to GDP.

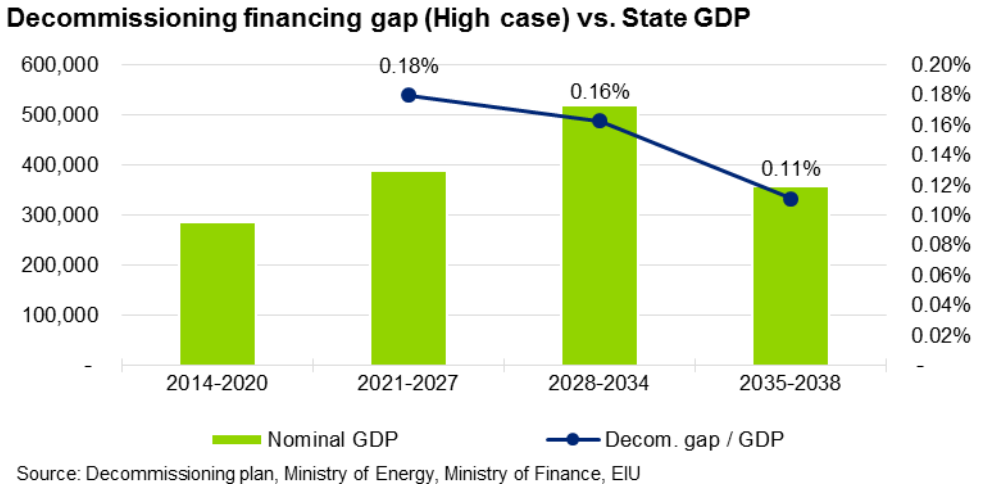


Figure 16: Comparison of decommissioning financing gap with GDP ("high contingency" case)

The financing of the gap by national funds would increase the State's indebtedness by up to 5.2%.

	EUR mil	% as of GDP
Nominal GDP (2015)	37,124	-
Public debt (2015)	16,791	45.2%
Total decommissioning gap (High case)	1,929	5.2%

Table 13: Decommissioning gap and public debt

Based on the analysis above, the Review team finds that funding of the total decommissioning financing gap by national sources after 2021 would entail a significant increase in Lithuania's budget deficit, and either a decrease in budget spending on non-energy areas, a higher national debt level, or a combination thereof.

The State's budget can be considered robust to cover additional financial contingencies, particularly until 2020, though we refer to the question below on the State's willingness to fund the financing gap from national sources beyond 2020.

Question 4: *Evaluation of to what extent the states are willing to provide the missing funding.*

Until the end of 2013, the State contribution to the decommissioning process amounted to 32% of total decommissioning costs incurred, and 15% of direct decommissioning costs as presented in the table below. Although national funds for decommissioning are secured only one year ahead, based on discussions with the Ministry of Energy, it is expected that the State budget will continue contributing to approximately 15% of total planned decommissioning costs in the future.

	Direct costs (EUR mil)	%	Indirect costs (EUR mil)	%	Total (EUR mil)	%
Financed by National funds	110	15%	324	50%	434	32%
Financed by EU and other donors' funds	608	85%	312	50%	920	68%
Total	**718**		**635**		**1,354**	

Sources: Ministry of Energy

Table 14: Decommissioning costs incurred (i.e. funds spent) until the end of 2013 (direct and indirect)

The table above presents the decommissioning costs incurred until the end of 2013 and their financing sources (national, and EU and other donors' funds). Direct costs are decommissioning costs which are included in the FDP. Indirect costs are mainly related to mitigation of the economic and social consequences of the decommissioning of Ignalina, which are not part of the FDP. The presented figures do not include aggregated funds that are

not yet spent. The graphs below present costs incurred (funds spent) by each financing source – IIDSF fund (managed by EBRD), IP fund (managed by CPMA) and national funds.

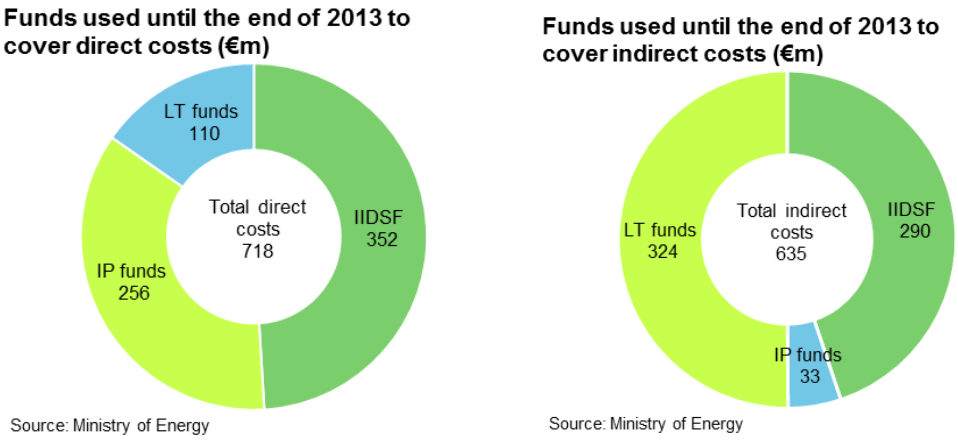


Figure 17: Total funds spent for decommissioning process at the end of 2013

Based on comments provided by the Ministry of Energy, in addition to State budget allocated funds, a new source of national funding is being considered: revenues from Public Service Obligations (PSO) fees. PSO fees are incorporated into the electricity tariffs and managed by electricity companies in order to achieve national strategic goals. Inclusion of decommissioning activities under PSO would mean that electricity prices would increase and, therefore, would have an impact on the competitiveness of the Lithuanian economy. The decision to use PSO fees for the Ignalina decommissioning project is at an early stage of discussion and it is highly unlikely that it will be introduced in the short-term.

The funding of a large financing gap from national resources would be a sensitive decision at the political level given its visible impact on State debt and budget deficit. This is not a scenario currently envisaged by the Lithuanian government.

3.2.3 Efficiency/Economy

Questions 1: *Are the cost estimates of the decommissioning plans appropriate to the objectives of the NDAP Regulations and to the long-term objectives?*

The Review team were able to compare the performance of the Ignalina sample projects considered in this study with the original estimated cost. In the case of the oldest project that was considered, Project B2/3/4 "Design and Construction of New Solid Waste Management and Storage Facilities", the project cost to date is significantly above the initial estimate with a 53% increase. This was originally estimated in 2002.

For the other two projects the situation is better. Project B9/1 "INPP Unit 1 Turbine Hall Equipment Decontamination and Dismantling Project Development" estimated in 2006 was delivered for less than the initial estimate. B25-1 "Near Surface Repository for Low and Intermediate Short-Lived Radioactive Waste (Design and Construction)" was estimated in

2008 and is in progress, having started in 2009. It is expected to be complete in 2018. The current contract value is ~6% above the initial estimate.

Costs estimates are now prepared on a bottom up basis with reference to a standardised database of Lithuanian costs for applicable purchased goods. Project cost estimates are prepared by Ignalina project planning specialists in collaboration with Project Managers and Ignalina project management groups. Estimating specialists or external cost consultants are not used, though the experience of Tractebel and EWN Greifswald has been used in some instances.

Outside of the cycle of FDP revisions, costs estimates within Ignalina are now more "live" documents than previously. The scheduling software used to plan projects also includes cost data (labour rates, unit rates etc.). As project forecasted timescales change, time dependent costs also change and are used to make updates to the internal project estimates contained within each Project Management Plan document. Updates to estimates are made based on progress of the project itself or from experience gained from other ongoing Ignalina projects.

The Review team were shown cost information in the scheduling software and how this is used to generate overall project costs. The Review team were presented with a number of updated summary cost estimates for projects including B2/3/4, B9-1 and B25 [159, 160, 161, 162, 163, 164]. These appeared to have been developed in a methodical manner and, together with the demonstration of the software, provided reassurance of the methodical approach to production and maintenance of cost estimates.

The only issue identified was the absence of explicit identification and assessment of contingency associated with the estimates (see Section 3.2.5).

However, this is not considered sufficient grounds to conclude that the cost estimates of the decommissioning plan are not appropriate for the objectives.

Question 2: *Is the size of the assistance budget appropriate and proportional to the NDAP Regulations objectives?*

The NDAP Regulation objectives refer primarily to the specific objectives to be achieved in the framework 2014-2020.

Until the end of 2013, in total EUR 1,354 mil. were already spent for the programme, EUR 920 mil. of which were financed by the EU and other donors (financing of both direct and indirect costs). Until the end of 2013, the non-Lithuanian contribution to the programme amounted to 68% of total costs incurred as a consequence of Ignalina's shut-down, 85% of the direct decommissioning costs incurred. Starting from 2013, the EU has ceased financing of indirect decommissioning costs.

As explained in section 3.2.2, indirect costs are mainly related to mitigation of the economic and social consequences of the decommissioning, which are not part of the FDP. In the case of Ignalina these are e.g.: energy saving projects, compensations to electricity providers for

selling electricity in Visaginas at lower than market prices, Visaginas region unemployment reduction initiatives, etc.

The graph below presents funds which were committed by the EU and other donors at the end of 2013. Part of these funds have not yet been disbursed.

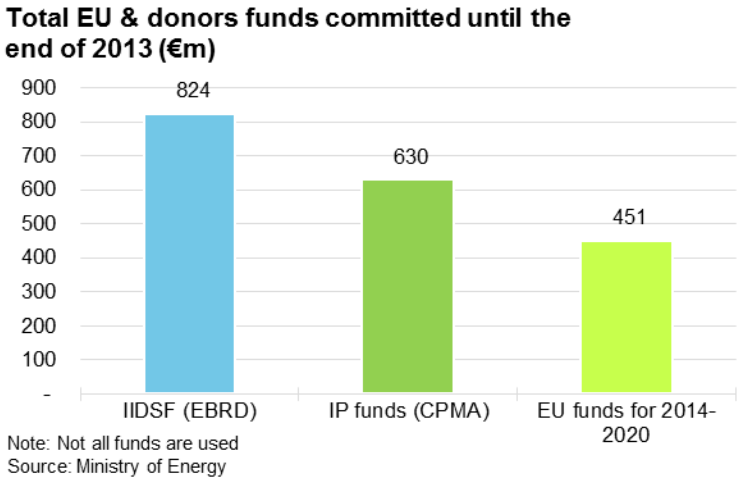


Figure 18: Total funds committed for decommissioning process at the end of 2013

This suggests that the assistance budget is indeed appropriate and proportional to the NDAP Regulation specific objectives.

When it comes to the general objective of the NDAP Regulation, which is to assist the Member State in implementing the steady process towards the decommissioning end state, it should be mentioned that this process is indeed secured during the period of application of the Regulation, but that it may be put in jeopardy thereafter if no further funding sources are identified for the period beyond 2020.

Question 3: *Are the outputs obtained at a reasonable cost?*

Ignalina has experienced some significant project overruns compared to the original estimate. These include Project B1, the spent fuel store, and B2/3/4, the waste treatment and interim storage facilities. Ignalina stated during the meeting with the Review team that lessons have been learnt as a result. These lessons learnt centre around the need to thoroughly check the technical specifications, in particular looking for possible alternative interpretations that may be used as the basis of claims for additional costs by suppliers. They also acknowledged a need to check the tenderer response in greater detail and ensure that a common understanding is reached with the tenderer regarding the data provided in the specification.

Ignalina also made reference to the delay introduced by funding procedures in the event of higher than expected tender prices (Project B1).

During the meeting with CPMA, issues linked to Ignalina's tendency to self-perform tasks with their own staff (resulting in high staff numbers on-site), rather than to reduce numbers and

engage external suppliers, were raised. This applies mainly to on-site works but has also been the approach applied to the design and assessment works of Project UP01. Clearly, this has a potential to increase costs for the Ignalina programme but, presumably, at the benefit of other national funds. CPMA encourage more efficient working where possible via conditions and stated expectations in their grant agreements, but have no authority to instruct Ignalina to adopt alternative make/buy strategies.

Project UP01 **- Unit 1 Reactor Dismantling**

Work to assess the dismantling of the Unit 1 Reactor was originally covered by Project B9/4. This project was bid externally and a notice of non-objection was issued by EBRD for the placement of the contract in 2009, expecting contract signature in 2010. However, at this stage there was a change in the management of Ignalina and a new government, at which point Project B9/4 was cancelled and the work brought in-house.

The in-house review of the dismantling performed by Ignalina was funded by CPMA as a workforce activity rather than a stand-alone project.

Since then Ignalina have been performing their assessment and in 2015 decided that they did not have sufficient capability to assess the dismantling of the central part of the reactor, though they have prepared some detailed work on the upper and lower pipework zones. This assessment work will now be offered for tender as Project UP.01 funded by CPMA. A Project Management Plan [80] and Project Description [81] have been prepared for the project by Ignalina.

In conclusion, the Review team conclude that there is still room for improvement for the outputs to be obtained at a reasonable cost. It is recognised that Ignalina entered the decommissioning phase with higher staff numbers than the other Member State programmes, and moving away from these arrangements represents a greater challenge than elsewhere.

Question 4: *Are financial resources of the concerned Member State likely to be available in due time, in appropriate quantity and quality at the best price?*

National funds used to finance the decommissioning include:

- State Enterprise Ignalina Nuclear Power Plant Decommissioning Fund (SEIDF) – the fund which was accumulated during the life of Ignalina. It is not supplied with additional funds anymore after termination of the power generation. The administrator of the fund is the Ministry of Energy. The sources coming from the fund are used to co-finance projects and other low value operating costs.
- Funds from the budget of the Republic of Lithuania – the amount of the funds is confirmed annually for the upcoming year by the parliament as part of the State budget approval. State budget is used to compensate State security sensitive expenses (e.g. guards) and all taxes related to Ignalina activities: social taxes, land taxes, taxes on natural resources, VAT, income tax, etc.
- Income from activities of Ignalina – Ignalina generates revenue from sale of unused assets, investments and other activities. These funds are used to finance redundancy

payments and other low value operating costs. All funds generated by Ignalina are transferred to SEIDF.

The Ministry of Energy is responsible for the preparation of the plan, which foresees the amounts of national funds from the sources listed above to be allocated for the decommissioning of Ignalina in the next three years.

Financing for further periods is not planned, therefore the currently earmarked funds from national sources to cover the direct decommissioning costs amount to about 4% of the total (see Table 10). However, the Lithuanian government expects the State budget to continue to contribute approximately 15% of total planned decommissioning direct costs, i.e. the same share as in previous periods (see Table 14).

As the main source of national funds are the State budget and activities of Ignalina (a public entity), the quality of these funds may be evaluated based on Lithuania's credit rating. The credit rating of Lithuania is currently A- or A3 (see Table 15) and has a stable outlook.

The key drivers of the current ratings are the competitiveness and resilience of Lithuania's economy, the continuation of the government's fiscal consolidation and the country's membership of the Euro zone.

It is expected that government revenues will be supported by robust economic growth, and institutional improvements in tax collection will help offset planned increases in spending, keeping the fiscal deficit contained. In addition, Lithuania's recent entry into the Euro area will support fiscal discipline as part of the government's commitment to remain in accordance with the EU's fiscal compact. It is expected that continued healthy nominal GDP growth and the stabilisation of the budget deficit to GDP ratio, will result in a decrease of the general government debt.

Given the rating and stable outlook there are no indications that national funds would not be available as planned.

Agency	Standard & Poor's	Moody's	Fitch Ratings
Rating	A-	A3	A-
Outlook	Stable	Stable	Stable
Valid from	April 2014	May 2015	June 2014

Source: Ministry of Finance

Table 15: Lithuania credit rating

However, concerning the financing gap post 2020, the Lithuanian authorities do not at this stage plan to earmark sufficient national funds so as to continue the decommissioning plan on the current basis if additional EU funds are not committed.

3.2.4 Sustainability

Question 1: *Are the decommissioning plans sustainable in the long term, i.e. after 2020, without further intervention of the Union assistance?*

As presented in Section 3.2.2, the financing gap considered to date is EUR 1,659 mil. For its part, the study recommends to take into account an additional contingency of EUR 189 mil. to cover an "intermediate contingency" case and EUR 285 mil. to cover a "high contingency" case.

We have compared the estimated financing gap for 2021-2038 to total EU assistance provided/planned for Lithuania in the periods 2007-2013 and 2014-2020. As presented in the table below, financing gap accounts for 9.5-11.1% of total EU assistance based on annual figures.

€m	Total for the period	Average annual
Designated EU assistance to Lithuania for 2007-2013	6,775	968
Designated EU assistance to Lithuania for 2014-2020	6,709	958
Total EU assistance for 2007-2020	**13,484**	**963**
Financing gap before additional risks for 2021-2038	1,644	91
Annual financing gap as of annual EU assistance, %		*9.5%*
Financing gap incl. additional risks for 2021-2038 (intermediate case)	1,833	101.85
Annual financing gap as of annual EU assistance, %		*10.6%*
Financing gap incl. additional risks for 2021-2038 (high case)	1,929	107.17
Annual financing gap as of annual EU assistance, %		*11.1%*

Source: Decomissioning plan, Ministry of Finance, Ministry of Energy

Table 16: Comparison of financing gap to EU assistance

As commented above, available financing sources will be sufficient for the current financial framework (including additional estimated risk allowance). Under a no policy change scenario, Lithuania currently explicitly relies on EU support to cover the financing gap for 2021-2038. If additional national funds are not secured, the decommissioning process may be suspended and/or delayed, which would further increase the currently estimated decommissioning cost.

3.2.5 Risks

Question 1: *Are the contingencies properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios?*

Ignalina's project estimates do not typically include a methodically assessed contingency to cover estimating uncertainty. Instead, estimates are prepared on the basis that the estimator prepares the best possible estimate they can. There are inevitably unknowns related to projects to be performed in the future; typical unknowns are listed in Annex 5.3.2.

Without an explicitly considered assessment of the possible effect of these unknowns on the final cost of the project scope being estimates, there is the potential for "optimism bias" in formulating this estimate. This is the "*demonstrated systematic tendency for appraisers to be over-optimistic about key project parameters. It must be accounted for explicitly in all appraisals and can arise in relation to:*

- *Capital costs;*
- *Works duration;*
- *Operating costs, and*
- *Under delivery of benefits."* [181]

It is possible that, in preparing estimates, the estimators have taken into account such uncertainties in a way that gives rise to the same net effect on the estimate as if an estimating uncertainty had been explicitly calculated and stated. However, without the explicit statement of the level of allowances made, the consistency of approaches to estimating uncertainty by different estimators cannot be compared, and confidence in the overall estimate is reduced to some extent.

As was done for Kozloduy in Section 3.1.5, “intermediate and high contingency” case estimating uncertainty allowances are calculated for Ignalina.

Ignalina is the only one of the three European Commission funded programmes to declare an addition to their cost estimate for risk events equating to EUR 90 mil. plus inflation. The likelihood that this risk amount will be required is dependent on the occurrence of the identified risk events; however, this amount has generally been included in all declared cost estimates such as the FDP and in previous estimates of the funding gap. The risk allowance should strictly sit outside the calculation of the estimating uncertainty, but the calculation needs to recognise that it has already been included when presenting results, particularly "deltas" from the current cost forecasts.

The EUR 90 mil. has been allocated across a number of work areas in Table 17 of the Final Decommissioning Plan. The application of percentage additions to these Project Groups has been used to identify the percentage additions applied to the specific programmes of the Ignalina Megaproject. The effect of replacing these percentages with the current values used in costs estimates prepared by TLG Services (who prepare most USA decommissioning estimates) has then been considered to give the resulting allowance for a "high contingency" case; see [179] for an example. In addition, an alternative which generally uses lower percentages has been considered. This is based on the Review team's assessment of which work areas INPP would have gained sufficient experience in to produce robust cost estimates at the time that the FDP was prepared. This gives an "intermediate contingency" case.

These two assessments result in increased contingency allowances as shown in the following table:

Basis	Contingency (EUR mil)	Cost (2014-38) incl. inflation (EUR mil)	Total Cost (2004-38) (EUR mil)	Total Delta (EUR mil)
Current FDP	125.70[19]	2,658.68	3,376.98	0
"Intermediate contingency" Case	314.82	2,847.80	3,566.10	189.12
"High contingency" Case	410.64	2,943.62	3,661.92	284.94

Table 17: Suggested additional contingency (estimating uncertainty) for the Ignalina programme

The additional EUR 90 mil. plus inflation currently included in FDP7 represents an addition of 4.96% to the base cost for the period 2014-2038. For comparison, the "intermediate and high contingency" cases in Table 17 equate to additions of 12.43% and 16.21% respectively.

As noted above, Ignalina is the only one of the three European Commission funded programmes to declare an addition to their cost estimate for risk. However, they do not estimate a cost allowance for risks to the entire programme in a bottom-up quantitative way, though risks to individual projects are identified and assessed qualitatively. This is an area where the Review team meeting with Ignalina staff demonstrated that improvements are clearly in progress and they are working to introduce new systems for quantitative assessment of risk.

The EUR 90 mil. currently included for risk in the Final Decommissioning plan is calculated by reference to the EUR 190 mil. originally estimated for risk and included in the Lithuanian Government document "Meeting the Cost" [51]. Those risks included in the document for which the opportunity to occur has passed are assessed as contributing EUR 100 mil. to the original total; the balance of EUR 90 mil. is used as the basis of the Final Decommissioning Plan [50].

Ignalina deploy a conventional risk management approach, with risk associated with each individual project identified, logged and assessed qualitatively. The risks are then managed and reported on by the project manager. The projects also have their own project risk allowances but these do not add up to the EUR 90 mil. referred to above, nor are they currently used to underpin it. A project specific assessment of risk and risk allowances then used to determine the risk allowance for the entire programme is expected to be part of the new risk management system being introduced by Ignalina.

We would conclude that contingencies are not currently properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios. However, we also conclude that much of the additional work to address risk assessment is already in progress. More effort

[19] Currently included in the FDP7 total as risk rather than estimating uncertainty. EUR 125.70 mil. is the EUR90mil. included for risk plus inflation derived from **Error! Reference source not found.** of FDP7 [50]

may be needed to adopt a more conventional approach to estimating uncertainty to help ensure robustness of cost estimates.

3.3 Slovakia

3.3.1 Relevance

Question 1: *Are the detailed decommissioning plans comprehensive and complete with reference to the defined end-states?*

The planned end state of the Bohunice site is stated in Chapter 3 of the Detailed Decommissioning Plan (DDP) [91] as "brownfield status". In the case of Bohunice V1 this will mean demolition of civil buildings performed down to the bottom of the construction pit. A radiation survey will be performed in the area remaining after building demolition that will verify that the area can be released for restricted use. Site voids will be backfilled with suitable materials, and compacting and final landscaping will be performed. The site at this status will be prepared to handover to its user.

The radiation survey will be used to justify release of the site from regulatory control after demonstration of compliance with the authorized regulatory clearance levels for *restricted* use.

The DDP [91] appears complete and sufficiently comprehensive to deliver the defined end state, noting that shared facilities such as the Interim Spent Fuel Store and Bohunice Radwaste Treatment Centre will be retained for ongoing use. At this stage in the plan some activities are presented without detail. This is to be expected, more detail will be added later as specific project teams and contractors complete detailed engineering and design. The durations allowed for most tasks appear reasonably conservative at this stage, with the notable exception of Project D4.2 (see Section 3.3.2).

The Review team did not identify any significant activities that appeared to be missing from the decommissioning plan.

The overall programme structure was developed using the outputs from Projects B6.1, B6.3 and B6.5, which prepared the Conceptual, First Stage and Second Stage Decommissioning Plans. These were prepared by diverse contractors including EWN (Greifswald), STM, AMEC, VUJE, DECOM and Westinghouse ensuring utilisation of a wide range of other experiences.

The Review team noted that no third party independent review had to date been carried out of the complete decommissioning plan, particularly the cost estimate and schedule.

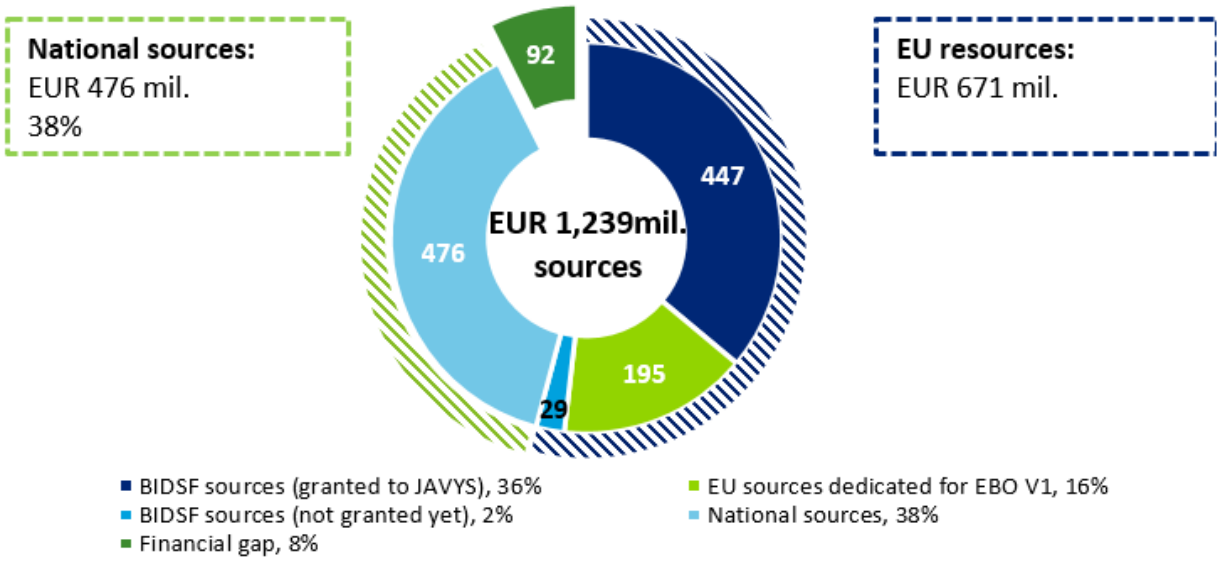
The Review team conclude that the decommissioning plans comprehensive and complete with reference to the defined end-states.

Question 2: *Do the financing plans respond to the needs of the decommissioning plans?*

Based on information provided by JAVYS and BIDSF-PMU, the estimated financing gap, calculated as the difference between the cost estimate for the whole decommissioning programme until 2025 and the total funds allocated or committed to the Bohunice NPP V1

decommissioning programme by the EU and the Slovak Republic, stood at EUR 92 mil. on 31 December 2015.

The pie-chart below presents the breakdown of the financial resources for the Bohunice decommissioning programme, including the share of national resources (both incurred and planned) as of 2015.



Source: JAVYS documentation

Figure 19: Slovakia decommissioning sources for Bohunice (EUR mil.)

EURmil.		2003-2025
Estimated decommissioning costs	A	**1,239**
EU resources prior 2013	B	446
EU resources 2014-2020	C	225
National sources prior 2015	D	424
National sources post 2016 (interest)	E	52
Total financing assistance	F=B+C+D+E	**1,147**
Financial gap	G=A-F	**92**

Source: JAVYS documentation

Table 18: Slovakia decommissioning sources for Bohunice (EUR mil.)

The financing gap of EUR 92 mil. represents the liabilities which are covered neither by the EU resources nor by the national resources. Possible options to fund the current financing gap are being analysed and the final solution needs to be determined.

These data do not include allowances for additional contingency cases.

3.3.2 Effectiveness

Question 1: *Do the detailed decommissioning plans and the financing plans meet the objectives of the NDAP Regulations?*

The NDAP detailed implementation procedures [7] list a number of key milestones associated with the Bohunice decommissioning programme in the period 2014-2020. These milestones are linked to the specific objectives defined in the NDAP Regulation Following review of the schedule presented in the DDP [91], the Review team conclude that this schedule does generally show compliance with the target dates associated with specific objectives (a) and (b) of the Regulations with some minor deviations related to Project 3.1B for demolition of the Cooling Towers and Project D4.4C "Auxiliary Circuit System Phase 2" which both show a one month delay to achievement of their targets.

Review of the Annual Work Plans indicates that a number of key milestones related to completion of projects have been achieved, including those related to completion of the following projects:

- Project D3.1A "Dismantling and demolition of the Bohunice V1 external buildings - Phase 1";
- Project D3.2 "Dismantling of outdoor not contaminated facilities and objects";
- Project D3.3 "Dismantling of electric power systems";
- Project D4.3A "Dismantling of insulation in the Bohunice controlled area".

Review of the draft Annual Work Plan 2016 [96] shows a number of additional or increased deviations from the target compared to the schedule presented in the DDP [91]. These include:

- Project D1.2 "Dismantling of the technical equipment in the V1 NPP turbine hall" showing complete mid-2016 compared to an end 2015 target;
- Project D3.1B "Dismantling and demolition of V1 NPP cooling towers" showing complete Q3 2018 compared to a target of end 2016;
- Project D4.4C "Dismantling of systems in V1 NPP controlled area - Part 2" showing as complete by mid-2022 compared to a target of end 2020. This activity is on the critical path.

The most significant deviation is the completion of the dismantling of the Nuclear Steam Supply System (NSSS) under Project D4.2 "Reactor coolant system large components dismantling".

The objectives presented in the NDAP detailed implementation procedures [7] require this project to be complete by September 2020. The draft Annual Work Plan 2016 [96] shows completion by Q1 2021. The Review team conclude that neither of these dates can now be achieved.

***Project D4.2* - Dismantling of Reactor Coolant System Components**

A Technical Study [106] was prepared for this project in 2013 which estimated the total cost of this project at EUR 119.159 mil. of which EUR 62.824 mil. would be the contract value for the deplanting contractor.

An updated estimate was prepared during the preparation of the tender specification in 2016 [107]. This remains confidential as the tendering process is currently in progress; however, a significant increase is expected.

The DDP [91] milestone schedule shows "engineering and documentation activities" and mobilisation complete at the end of May 2016, leading to completion in September 2020, in accordance with the NDAP regulations.

The tender process commenced on 3 June 2016 with a first stage tender return date of September 2016. Based on like-for-like slippage of the schedule, the Review team estimate completion closer to mid-2023. This assumes contract placement at end Q1 2017. It was noted during the Review team meeting with EBRD that major V1 NPP projects have, on occasion, been subject to extended procurement periods while EBRD made secondary reviews of the tenders and contract assessments; examples are Projects C9.4 VLLW/LLW Disposal Facility and D3.1B Demolition of Cooling Towers. Mid-2023 completion assumes that the D4.2 procurement proceeds without such delay. This Mid 2023 date represents a three-year delay to the completion of the milestone identified in the NDAP implementation procedures.

The scope of the project, though technically challenging, includes works identical or similar to those successfully completed on various other decommissioning projects. Hence, there is no suggestion that the project scope will not be completed and the NDAP objective achieved, only that it will be delivered later than planned.

Project D4.2 is a critical path activity. This means that delays to project D4.2 will likely result in equivalent delays to the programme end date. On this basis Bohunice decommissioning would not be completed until end Q3 2027. This compares to the draft Annual Work Plan 2016 [96] which shows project D4.2 completed by end Q1 2021 with no impact on the 2025 programme end date.

The draft Annual Work Plan 2016 [96] suggests that the slipped time may be recovered by shortening the time and increasing the work intensity of successor activities which, if achievable, could be factored into the original plan. It is noted that the final activity Project D6.2 “Final survey and site release” takes two years following completion of building demolition and may offer an opportunity to recover some time but this will be largely under the control of the regulator and the time they need to review and approve the survey results and complete the delicensing processes.

It is not possible to conclude if specific objective (c) of the NDAP detailed implementation procedures [7] "Safely managing the decommissioning waste in accordance with a detailed waste management plan, to be measured by the quantity and type of safely conditioned waste" will be achieved, as this relates to treatment of specified masses of conventional, hazardous and radioactive wastes each year until 2020. It is possible to examine the performance against these indicators achieved to date based on data presented in AWP 2015

[95] and the two monitoring reports for 2015 [109, 110]. For those in progress during the period 2014/15 the percentages shown in Table 19 were achieved against the various removal targets:

Objective	Target During Period 2014/15	Actual During Period 2014/15	Percentage Achievement
Treatment of Conventional waste	67782 te	74632 te	110%
Treatment of Hazardous waste	178 te	191 te	100%
Treatment of Radioactive Waste	408 te	303 te	74%

Table 19: SK Achievement of NDAP specified targets during 2014/15

In the case of the underachievement of the target for treatment of radioactive waste, the 2015 monitoring reports [109, 110] identify underperformance of Project D2 and "technical issues" affecting treatment of wastes arising from Project C7-B (now complete). The Q4 Monitoring Report [110] states that the "Volume of processed RAW is dependent on the availability of JAVYS a.s. RAW treatment capacities in respective time", which may suggest some down-time with the processing plant. However, it is noted that percentage achievements reported are 2014 = 88%, 2015 Q1-Q3 = 66% and 2015 Q4 = 70%, which is more suggestive of an ongoing underachievement issue rather than the occurrence of a temporary problem. It may be beneficial for JAVYS to examine the reasons for the underachievement against this target. If there is a temporary issue at the root cause, there may be steps that JAVYS management can take to prevent reoccurrence. If the root cause is more permanent such as a capacity "bottleneck" in the processing systems, it may be possible to justify additional investment to remove the bottleneck.

The targets above are taken from the monitoring reports themselves rather than the NDAP detailed implementation procedures [7]. The targets stated there are presented with the comment that the values will be recalculated based on the output from Project B6.5; this appears to have been the case, so it is not easy to make a direct comparison between the targets currently in use and the originals. It is noted that the original targets from the NDAP detailed implementation procedures [7] show a significant increase in annual RAW waste processing in 2016 (by a factor of ~7) compared to previous years. This increase is not reflected in the draft AWP 2016 [96].

The detailed decommissioning plans and financing plans meet the general objective of the NDAP regulation, i.e. to assist the Member State in implementing the steady process towards the decommissioning end state. There is no suggestion that this general objective, or the specific objectives of the NDAP detailed implementation procedures [7] will not be achieved at some point. However, based on the information presented above, it appears that some of the specific objectives of the NDAP detailed implementation procedures [7] are unlikely to be met by the specified dates.

Main causes of delay experienced by the Bohunice sample projects

Change to delivery strategy:

None identified

Late procurement processes (compared to PIS, excluding funding processes):

Project C7-B - Treatment of Historical Waste – Sludges & Sorbents

Project C9.4 - Design and Erection of New Disposal Facilities for LLW and VLLW from V1 NPP Decommissioning at NRR Mochovce

Project D2 - Decontamination of Primary Circuit

Project D4.2 - Dismantling of Reactor Coolant System Components

Funding approval processes:

None identified

Longer than planned regulatory / approval processes:

None identified

Uncertain characterisation of wastes as presented in technical specification:

Project C7-B - Treatment of Historical Waste – Sludges & Sorbents

Other issues with data presented in the technical specification:

None identified

Technical difficulties during delivery:

Project D2 - Decontamination of Primary Circuit

Question 2: *Do the detailed decommissioning plans and the financing plans meet the objective of the safe completion of decommissioning beyond the MFF 2014-2020?*

The NDAP Regulation's objectives refer primarily to the specific objectives to be achieved in the framework 2014-2020.

Generally, the activities included in the decommissioning plan meet the objectives of safe completion of decommissioning. The Bohunice decommissioning plan currently shows a need for a comparatively short period beyond 2020 to achieve safe decommissioning of the V1 plant and clearance of the occupied area to suit the declared end-state of *restricted* reuse. The schedule includes the activities required to remove redundant plant and buildings, to perform release surveys to the satisfaction of the regulators and to return the site area to a backfilled and restored condition outside of regulatory control. As Bohunice V1 is part of a larger integrated nuclear site it is unlikely to be practical or necessary to contemplate remediation of the occupied area for unrestricted use, while the rest of the site remains operational. Hence there are fewer projects for provision of new infrastructure necessary to support completion of the decommissioning programme. Project C9.4, the LLW and VLLW disposal facility, is the most significant project of this type.

The actual Bohunice financing projection follows the decommissioning needs until the safe completion. A significant part of national resources required for the expected future costs is already accumulated in the National Nuclear Fund.

The Bohunice decommissioning plan extends up to 2025. Total Bohunice decommissioning costs estimated for the period after 2020 are of EUR 249 mil.

The financing gap to meet the objectives of safe completion of the decommissioning programme beyond the MFF 2014-2020, is estimated at EUR 92mil. as per Plan. Under the additional “intermediate and high contingency” cases submitted by the Review team, the gap is estimated at higher values.

The existence of a financing gap means that, as of now, the objective of the full completion of the decommissioning programme is not secured. Nevertheless, the projects and activities in progress and planned under the MFF 2014-2020 at Bohunice concerning radiological system dismantling and waste management ensure that the plant will be in a safer condition than at present. Spent nuclear fuel has already been removed from the power plant buildings and is stored in an interim storage facility on site. Some campaigns of radioactive waste processing have been completed and the waste transported to the repository for disposal; other wastes will be processed and disposed of during the period. During the period, significant progress is planned towards segmentation and processing of the activated/contaminated materials of the reactor building, including the reactors themselves. The site will have the facilities to continue management and reduction of remaining hazards beyond that date which, by that time, should be limited to some remaining systems of the controlled area, contamination associated with building structures and any ground contamination that may be identified.

Question 3: *What is the ability of the the state budgets of BG, LT, and SK respectively or the operators to cover additional financial contingencies that may arise before 2020, or absorb the financing needs resulting from the uncertainties identified in the decommissioning plans?*

In line with the overall methodology applied to assess this issue (section 2.1.), revised cost estimates were calculated for the Bohunice decommissioning plan based on an "intermediate contingency" case and a "high contingency" case. The robustness of Slovakia's State budget, and its ability to cover additional financial contingencies that may arise, or absorb the financing needs resulting from the uncertainties identified in the Plan were assessed on this basis.

The Slovak State budget deficit ranges between EUR 32 bn. and EUR 39 bn. annually in the 2014-2020 period.

The decommissioning gap amounts to EUR 109 mil. under the “intermediate contingency” case, and to EUR 144 mil. under the “high contingency” case.

It should be noted that the decommissioning is expected to be finalized in 2025 – i.e. during the 2021-2027 programme period (no decommissioning gap is therefore presented after the 2021-2027 programme period).

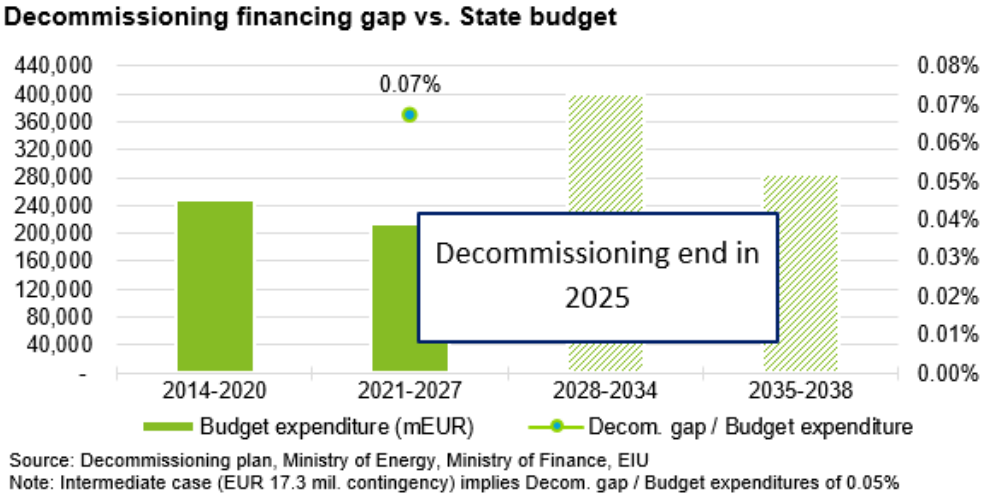


Figure 20: Decommissioning financing gap vs. State budget

Given the forecasted energy related budget expenditures in the form of spending for fuel and energy, the decommissioning gap would amount to a 16% increase in the 2021-2027 programme period (due to the decommissioning deadline in 2025 no further increase of energy related budget expenditures is expected beyond this period).

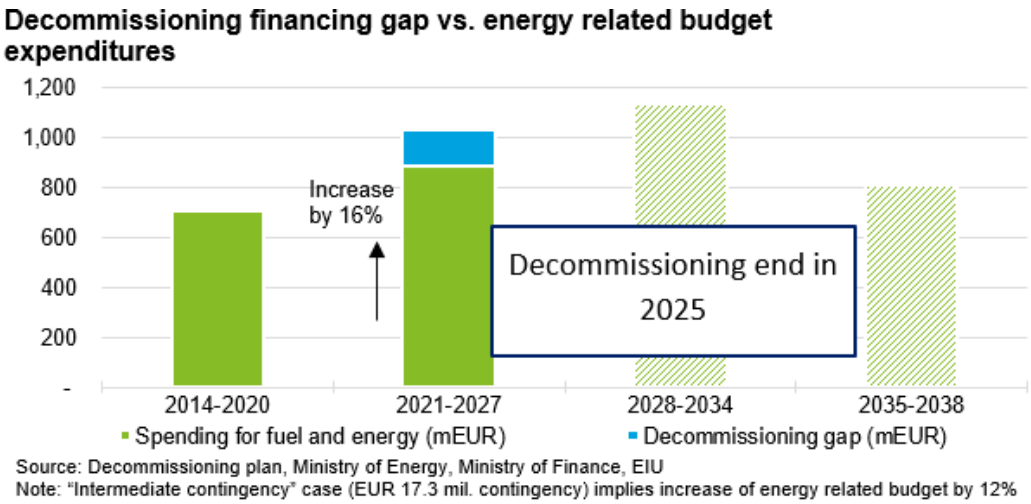
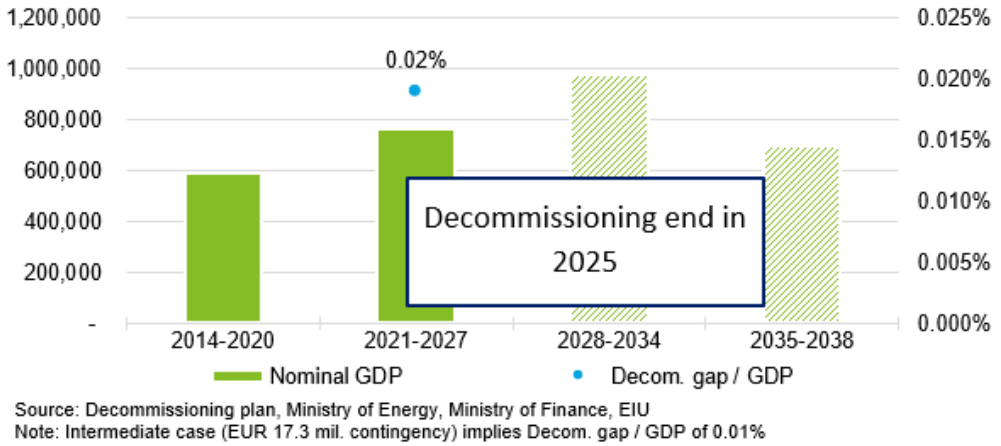


Figure 21: Decommissioning financing gap vs. energy related budget expenditures

The decommissioning gap amounted to 0.2% of nominal GDP in 2014. When comparing the decommissioning gap with cumulative forecasted state GDP in the programme period 2021-2027 the share amounts to less than 0.02%.



Source: Decommissioning plan, Ministry of Energy, Ministry of Finance, EIU
Note: Intermediate case (EUR 17.3 mil. contingency) implies Decom. gap / GDP of 0.01%

Figure 22: Decommissioning financing gap vs. State GDP

Decommissioning gap and public debt

mEUR	At end of 2014	% as of GDP
Nominal GDP	75,560	
Public debt	40,725	*53.9%*
Decommissioning gap ((“High contingency” case)	144	*0.2%*
Decommissioning gap (“Intermediate contingency” case)	109	*0.1%*

Source: Decommissioning plan, Ministry of Energy, Ministry of Finance, EIU

Table 20: Decommissioning gap and public debt

Given the State budget of EUR 32 bn. and GDP of circa EUR 76 bn. in 2014, the State budget and GDP seem to be robust and able to absorb the potential financing needs. The decommissioning cost amounts to 0.5% of the State budget and 0.2% of GDP in 2014. This robustness is also supported by public debt reaching levels slightly above 50% of GDP in 2014.

Question 4: *Evaluation of to what extent the states are willing to provide the missing funding.*

The government is aware of the current financing gap in the decommissioning project of Bohunice and declared its willingness to search for a suitable solution. The situation is monitored, periodically assessed and the relevant government bodies are searching for a solution.

Based on data provided by JAVYS and BIDSF-PMU, the estimated financing gap as of 31 December 2015 was EUR 92mil.

The final solution on how to bridge the financing gap still needs to be determined; however, Slovakia has defined the following funding sources for Bohunice decommissioning:

a) **Sources from the EU or other donors** (e.g. through BIDSF). Slovakia participates in the process and encourages the EU to create conditions for further EU co-financing

structure after 2020 (the same position and expectations were declared also by the other relevant Member States - Lithuania and Bulgaria).

b) **National funds** - National Nuclear Fund, JAVYS resources from other commercial activities, or other government budget resources, if necessary. Slovakia introduced in 1995 a specific legal mechanism to ensure the financing of NPP decommissioning. In 2010 a special levy was introduced to cover the historical decommissioning debt (i.e. EB V1 NPP). The abovementioned legislation (for details please refer to Annex 5.4.3) constitutes an essential framework for the financing of Bohunice decommissioning from national sources.

Given the 7-year EU programme periods, expected resolution of funding of the decommissioning gap is set to 2018. This is in line with the schedule, as the decommissioning process should include the most complex activities (e.g. dismantling and decontamination of the primary circuit of V1 NPP). Therefore, during this period a periodic decommissioning budget update is planned which should substantially increase the accuracy of the cost estimations for the remaining period of decommissioning.

3.3.3 Efficiency/Economy

Question 1: *Are the cost estimates of the decommissioning plans appropriate to the objectives of the NDAP Regulations and to the long-term objectives?*

Based on the information provided via DG ENER, and from the meeting with JAVYS, the Review team believe that the Bohunice planning team understand the scope of the project and are planning and estimating costs for it in a methodical and reasonable way. In the case of highly complex projects such as D4.2 "Dismantling of Reactor System Large Components" the adopted approach includes re-estimating the project cost based on the evolution of the specification prior to the start of the tendering process. While not always yielding the result a funding body would want, such a re-estimate based on the actual specification to be issued is considered an example of good practice.

In the case of the sample projects considered in this study, delivery within or close to the initial project estimate has been achieved in the cases of Project C7-B "Treatment of Historical Waste – Sludges & Sorbents" and Project C9.4 "Design and Erection of New Disposal Facilities for LLW and VLLW from V1 NPP Decommissioning at NRR Mochovce". Project D2 "Decontamination of the Primary Circuit" has experienced some difficulty but JAVYS still expect completion within the original project costs estimate. Project D4.2 is not in contract yet, but the fact that this project was re-estimated as a result of producing the technical specification and taking account of the outcome of the similar scope project completed at Jose Cabrera in Spain may be considered as demonstrating that JAVYS do recognise when an estimate is lower than perhaps it should be.

Cost estimates for decommissioning make use of published references from industry, such as the UNIKA series of standard civil engineering tariff books. This is good practice as it allows the narrow field of nuclear decommissioning to draw on reference costs and productivities

experienced in other industries within Slovakia where there is likely to be greater activity. Similar reference publications are commonly used in other Member States and in the USA; depending on the nature of the task being planned, allowance may need to be made to account for factors specific to the nuclear site environment. The estimating process also uses the respected OMEGA software code developed by DECOM a.s., which estimates plant and system decommissioning costs in accordance with the ISDC structure based on experience from previous projects collected by the software developer.

The review team were not able to access the data within the OMEGA system, only outputs from it. These and the cost assessments presented in Technical Studies [94] and the DDP [91] and appendices [93] provide evidence of a detailed cost estimate for the programme.

In conclusion, the Review team consider that cost estimates of the decommissioning plan are appropriate to the long-term objective.

Question 2: *Is the size of the assistance budget appropriate and proportional to the NDAP Regulations objectives?*

The funds have been provided throughout several EU programme periods as well as via the "Phare" transition facility prior to Slovakia's EU membership.

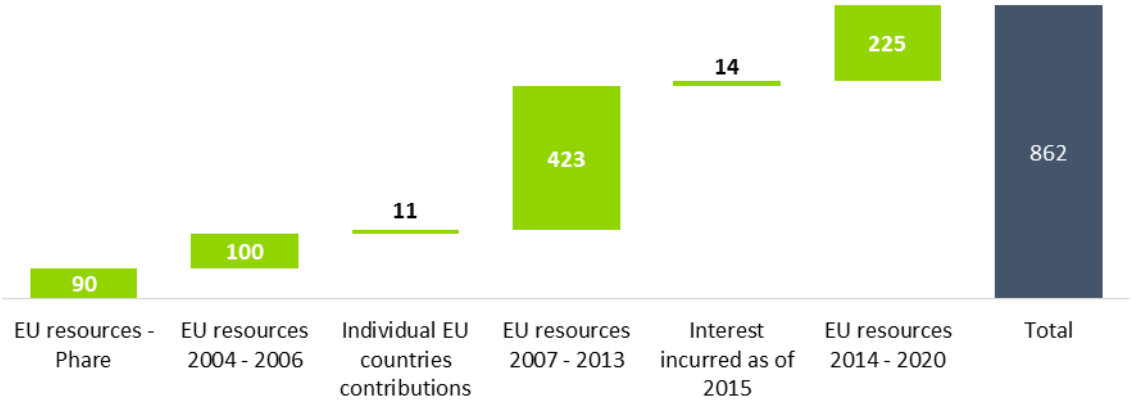


Figure 23: Breakdown of EU contributions (EUR mil.)

Prior to 2015, part of the EU funds (approx. EUR 191 mil.) were used to finance decommissioning and energy savings projects managed by SLOVSEFF (EUR 40 mil.) in accordance with EU agreements. As a result, the financial resources attributable to the Slovak Republic amounted to EUR 672 mil. (EUR 447 mil. + EUR 225 mil.).

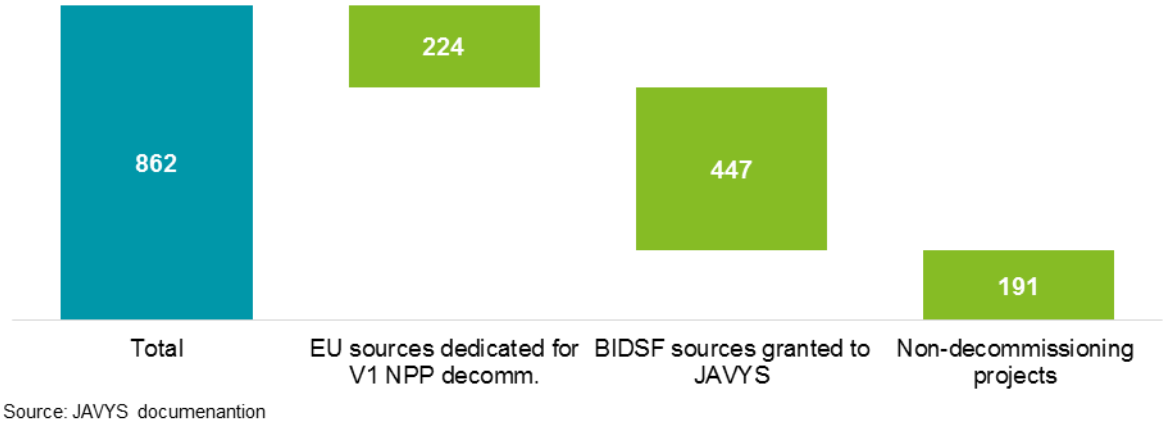


Figure 24: Allocation of EU contributions (EUR mil.)

Use of EU and national resources

According to the draft Annual Work Programme 2016, the costs of the individual decommissioning activities (amounting to circa EUR 1,239 mil.) can be broken down to four main cost categories as follows:

Source	EUR mil.	
Labour costs	563	Represent all items of payments to employees according to national legislation
Investment costs	103	Represent the sum of costs for deliverables, works and services performed and delivered
Expenses	495	Include all payments related to decommissioning activities that are not identified as labour cost or investment cost
Contingencies	78	Represent specific provisions for unforeseeable elements of costs within the defined project scope.
Total	**1,239**	

Source: JAVYS documentation

Table 21: Breakdown and description of Bohunice decommissioning activities (EUR mil.)

Also according to the draft Annual Work Programme 2016, approximately EUR 398 mil. (32% of total decommissioning costs) had been spent by 2015 – consisting of approximately EUR 149 mil. of national sources. It is expected that the remaining part of the decommissioning programme will cost EUR 841 mil. during 2016-2025 (thereof EUR 249 mil. after 2020).

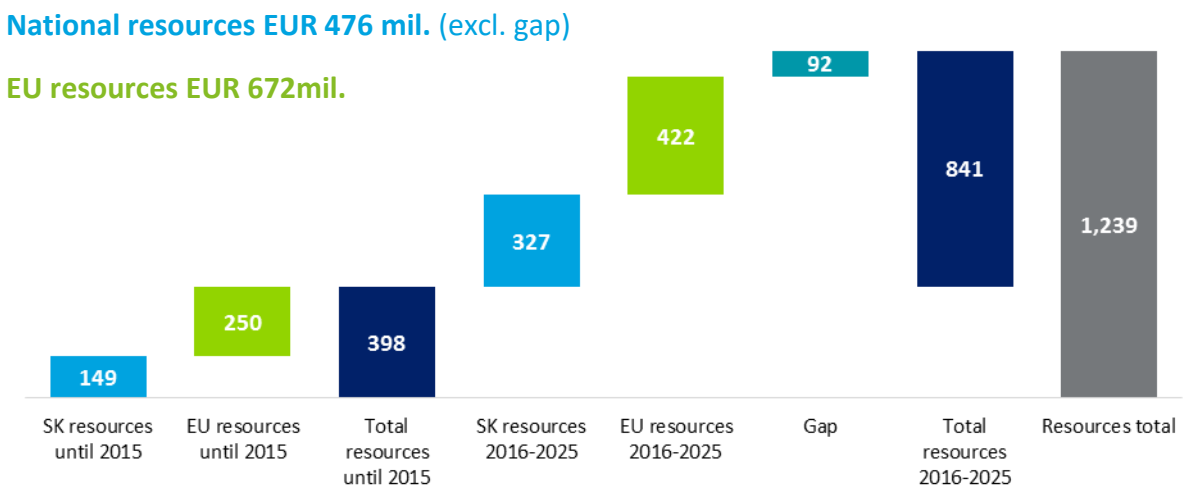


Figure 25: Resources for Bohunice decommissioning project (EUR mil.)

Given the fact that projects as well as related funding for this programme period (2014-2020) are set, no financial gap is expected.

Question 3: *Are the outputs obtained at a reasonable cost?*

As with the other programmes, the Bohunice decommissioning programme has experienced projects that have run into difficulty, and for some ordinary reasons such as a characterisation of wastes (Project C7B).

Of particular note is Project D2 for decontamination of the primary circuit. The contract for this project was placed via a procurement under EBRD rules. At the meeting with JAVYS they reported that only one tenderer submitted a proposal; this tenderer was neither of the two organisations dominant in this technology. On this basis the contract was awarded and the contractor subsequently failed to successfully complete the task. An audit performed by the Electric Power Research Institute (EPRI) concluded that there was only one contractor that could now successfully complete the project (one of the two dominant players that did not tender). This raises the question*, not possible to answer during this review*, of what aspect of the specification or procurement process resulted in no submissions from the most experienced and capable contractors.

Project D2 will now be awarded to the contractor recommended by EPRI as a single tender action. At the meeting with the Review team JAVYS stated that the combined cost of the cancelled and new contracts would remain within the original project budget. However, this ignores the potential for other cost impacts.

Project D2 was a key predecessor task to Project D4.2 Dismantling of Reactor Coolant System Components. As noted in Section 3.3.2, Project D4.2 is on the critical path and is now subject to a delayed start. This and other potentially avoidable delays such as those caused by extended procurement activities (see Section 3.3.2) are not without potential for other cost impacts not directly borne by the individual project. Delays to removal of plant and systems, even if not on the critical path, delay the potential for staff reductions and maintenance

savings that may be achieved when those items are removed. As noted previously, if critical path tasks are delayed, the monthly delay cost could be as high as the full cost of employment for the site plus other site running costs; this impact would not be seen in the current year's annual costs but rather in subsequent years.

The Review team conclude that while the outputs representing individual projects appear to be obtained at reasonable costs, there is potential for further improvement with respect to the overall programme. This is due to the impact of project delays on the cost of the overall programme even if they do not directly impact the cost of the specific project. There may be delay to the overall completion date of the programme or a slowdown in the reduction of staff numbers and site operating costs.

Question 4: *Are financial resources of the concerned Member State likely to be available in due time, in appropriate quantity and quality at the best price?*

The national resources dedicated to the Bohunice decommissioning programme are held and managed by the National Nuclear Fund. As a significant part of the Member State resources are already accumulated (contributions EUR 269 mil. + Interest as of 2015 EUR 63 mil.) in National Nuclear Fund accounts they will likely be available in time for disbursement.

The National Nuclear Fund invests the accumulated contributions in low risk financial instruments (mainly national treasury) in order to achieve an efficient management of the funds. Example of investments of the National Nuclear Fund are:

- EUR 700 mil.; interest 4.05%, maturity 2020
- EUR 120 mil.; interest 4.95%, maturity 2021
- EUR 70 mil.; interest 1.50%, maturity 2017
- EUR 70 mil.; interest 2.95%, maturity 2022
- EUR 140 mil.; interest 2.59%, maturity 2023
- EUR 125 mil.; interest 2.40%, maturity 2034

As the contributions are invested in the Slovak national treasury, no risk rating is available, however the contributions are backed by the Slovak Republic. The credit rating of Slovakia is A+ or A2 (see Table 22) and has a stable outlook. The main positives the agencies considered are the attractiveness of Slovakia for foreign investors, its stable banking system and its membership of the Eurozone.

The rating agencies also expect improvement in Slovakia's fiscal position as a result of the reduction of the government deficit and rapid economic growth. These factors should result in the reduction of public debt. Given the rating and positive outlook of Slovakia’s fiscal position there are no expectations that the funds managed by the Slovak national treasury should not be available as planned.

Agency	Standard & Poor's	Moody's	Fitch Ratings
Rating	**A+**	**A2**	**A+**
Outlook	Stable	Stable	Stable
Valid from	1.08.2015	4.10.2013	8.7.2008

Source: National bank of Slovakia

Table 22: Slovakia credit rating

Moreover, the National Nuclear Fund manages contributions of EUR 1.4 bn. that are collected also for other nuclear power plants operating in Slovakia. As there are several other projects) running (other than the V1 NPP decommissioning the contributions should be liquid and available as planned and needed.

The break-down of national funds for Bohunice decommissioning is as follows:

	EUR mil.
National nuclear fund resources	**384**
of which: Accumulated contributions	*269*
of which: Interest (till 2015)	*63*
of which: Interest (expected 2016-2025)*	*52*

*Note: *Estimated interest based on long term deposits in the national treasury.*
Source: JAVYS documentation

Table 23: Breakdown of national funds (EUR m)

In the hypothetical scenario that Slovakia would need to fund the financing gap solely from its national sources, we believe that financial resources may be potentially collected via existing mechanisms (e.g. nuclear levy, contributions of producers, etc.).

However, the final solution for financing of the abovementioned financing gap still needs to be determined as the Slovak government did not present any official statement with respect to the solution of the financing gap. Thus, the abovementioned hypothetical scenario may be perceived as the solution of last resort.

3.3.4 Sustainability

Question 1: *Are the decommissioning plans sustainable in the long term, i.e. after 2020, without further intervention of the Union assistance?*

The financing gap as per the current baseline plan amounts to EUR 92 mil. That is equivalent to 22% of EU contributions for Bohunice decommissioning for the 2016-2025 period[20] and

[20] Based on JAVYS estimate and documentation

14% of total EU resources committed to Bohunice decommissioning[21] (including EU resources committed to 2007-2013, 2014-2020 programme periods, PHARE resources and other EU resources).

We recommend to take into account additional contingencies to cover “intermediate and high contingency” cases. These additional contingencies represent respectively 4% and 12% of EU contributions for the 2016-2025 period, and 3% and 8% of total EU resources dedicated to the decommissioning process of V1 NPP.

The government is aware of the current financing gap post 2020 (EUR 92 mil.) in the decommissioning project of Bohunice and is in the process of determining suitable solutions.

Despite the possibly increased overall financing gap identified, the Bohunice decommissioning plan appears, nonetheless, to remain sustainable even if the final solution to bridge this financing gap has not yet been defined.

3.3.5 Risks

Question 1: *Are the contingencies properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios?*

Major projects within the overall Bohunice programme are allocated a contingency (estimating uncertainty) percentage based on where they are in the EBRD funding cycle. Contingencies of 20% are typically added to estimates for projects not yet subject to an EBRD Grant Agreement (they can be higher for significantly complex/uncertain projects) and 10% is typically added to estimates for project covered by a Grant Agreement but not yet in progress. For projects in progress or completed, the project contingency and the (currently) unallocated element of the Grant Agreement is presented as the overall project contingency. As new information about the expected outcome of the project becomes available as the project progresses or as contract prices are agreed, the balance between the outcome and the original estimated cost becomes part of the contingency. This leads to presentation of very large contingency percentages of up to ~497% in the Detailed Decommissioning Plan [91].

The overall contingency of EUR 91.5 mil. presented in the Detailed Decommissioning Plan [91] equates to an addition of 7.9% onto the total of the base estimate (i.e. total of labour, investment costs and expenses), which may be considered low for a programme of this complexity. However, reviewing Appendix 9 of the plan shows that the contingency allocated to the period 2015-2025 is only 5.8%.

The resulting percentage contingency allocated to specific projects is highly variable. For example, 27.6% allocated to D6.2 “Final survey and site release”, which might be considered reasonable given the time until that project is performed and the likely lack of experience of such a project within JAVYS. However, for project D4.2 "Dismantling of reactor coolant system large components" only ~4% is allocated, which would be considered low given the complexity

[21] Financing gap expressed as % from EU contribution for Bohunice decommissioning for respective period

of the task. This project has been re-estimated prior to the start of the June 2016 tender period, which resulted in an increased project estimate. It is noted that the draft 2016 Annual Work Plan [96] includes an increased total for this project, which for the purposes of calculating the "intermediate and high contingency" cases below will be substituted into the DDP estimate to allow for this revision.

If all EUR 91.5 mil. contingency remains available for future projects, then this equates to a 10.1% addition on the modified base estimate for the 2015-2025 costs, which is close to the levels proposed for Ignalina and the levels used in the Swedish Forsmark and Oskarsham studies shown in Table 26.

As was done for Kozloduy in Section 3.1.5 and Ignalina in Section 3.2.5, "intermediate and high contingency" case estimating uncertainty allowances are calculated for V1 NPP. A small addition may be proposed but based on the revised forecast for the overall programme as presented in the draft 2016 Annual Work Plan [96], this may not actually be necessary if the EUR 91.5 mil. contingency remains [22]. The result of a small increase to a 12% overall contingency is shown in Table 24 as the "intermediate contingency" case. A "high contingency" case based on a contingency level of 16%, similar to the higher level proposed for Ignalina (Section 3.2.5) is also shown.

Basis	Contingency (EUR mil)	Cost (2014-25) incl. inflation (EUR mil)	Total Cost (2003-25) (EUR mil)	Total Delta (EUR mil)
Current DDP	**91.5**	**940.1**	**1245.6**	**0**
"Intermediate contingency" Case[23]	**102.6**	**957.4**	**1262.9**	**17.3**
"High contingency" Case[21]	**136.8**	**991.6**	**1297.1**	**51.5**

Table 24: Suggested additional contingency (estimating uncertainty) for the Bohunice programme

Project risks are identified and assessed in a qualitative manner [177] but the risk process does not include the calculation of a specific risk allowance to account for these risks.

The Detailed Decommissioning Plan [91] includes (within Section 7.4) a Monte Carlo based analysis of different levels of Uncertainty (Contingency) appropriate to different timescales and for the main ISDC category activities. Monte Carlo based methods are often used for calculation of risk allowances; in this instance it has been used as an alternative approach to calculating contingency such that a sensitivity analysis can be carried out and a percentage

[22] *contributions that shall be used for Bohunice decommissioning (deep repository and specific part of storage of spent fuel excluded).*

Total cost in AWP 2016 is accounted for by the reduction in contingency presumably to account for two years of completed work and hence potentially less requirement for contingency on the work that remains. The "Intermediate contingency" case is considered to require no addition only if the contingency amount remains unchanged for the time being despite two years' progress.

[23] Includes revised estimate for Project D4.2 from AWP 2016

probability assigned to the contingency level previously calculated in the overall decommissioning cost estimate.

Given that the practice of identification and management of risks is already established, the introduction of quantitative risk analysis, if considered beneficial, would be relatively straightforward.

We conclude that contingencies are not currently properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios. However, we also conclude that the additional work required to address this would be relatively small.

4 General conclusions and recommendations

4.1 Conclusions

4.1.1 Evaluation of the decommissioning programmes' global cost estimation

The overall cost estimations of the three programmes are generally appropriate. They are generally complete with respect to the projects required to safely deliver the planned end states.

Cost estimates for individual projects of the Ignalina and Bohunice decommissioning programmes now appear to be produced in a methodical way with reference to standard cost references where available. These individual estimates then sum to make the total programme cost. Ignalina decommissioning programme projects do not make a specific consideration of estimating uncertainty within their cost estimates, i.e. inclusion within the estimate of allowances for cost uncertainties within the planned scope of the project, such as uncertainty regarding the hours required for a task or the quantity of material to be managed. Assessment of an allowance for estimating uncertainty amount is normal in the estimating of projects where such information remains unknown; it is often shown as "Contingency" or some similar term. It is good practice to show this separately for clarity and so that it can be revised later in light of new information. Its absence suggests such uncertainties may not be acknowledged and/or allowed for.

The estimation of decommissioning labour costs for the Kozloduy decommissioning programme seems less thorough, and is not based on an approach that would be considered typical at this stage in the programme. Other aspects of the cost estimate such as for investment costs are more conventionally prepared with evidence provided of a robust estimating approach supported by underpinning data. EBRD also stated that they have no concerns associated with estimates prepared for investment projects, which supports the evidence provided.

It is noted that - for all three programmes - there is no ongoing international third party independent review process of the entire decommissioning plans and cost estimates. EBRD/CPMA review the estimates associated with specific applications made to them, and national governments review requests for access to their funds, but there is no ongoing review of the integrated whole. International fund providers may welcome the reassurance provided by reviews made by experts with wider ranging experience than the decommissioning license holders who prepare them.

4.1.2 Overall risk assessment

The Kozloduy and the Bohunice programmes make allowances in their cost estimates for contingencies (estimating uncertainty) but at lower levels than seen in other international decommissioning programmes' cost estimates. As noted above Ignalina do not show contingencies (estimating uncertainty) within their estimates but are the only programme to include an estimated cost allowance for risk (i.e. allowance for events *outside* the planned scope) but this is not conventionally calculated. The Review team have calculated new values for contingencies for all three programmes using two scenarios, an "intermediate contingency" case and a "high contingency" case. These new calculated values of contingency have been based on typical values seen in other costed decommissioning plans. While they provide a useful indication of possible contingency levels that may need to be considered in future funding plans, they are not a substitute for a thorough assessment of the real uncertainties associated with each element of each programme, and detailed evaluation of the actual extra cost that could result.

All three programmes use a methodical risk identification, qualitative assessment and management process. The Ignalina programme is moving towards a quantitative assessment process that could be used to determine the cost of risk events under various scenarios of different probability. Given the risk management arrangements in place at the Kozloduy and the Bohunice programmes, this is something that could fairly easily be adopted by those programmes if considered beneficial.

Measures financed under the three decommissioning programmes can be considered generally effective, efficient and economical.

The Review team also considers that the decommissioning plans include a well identified set of waste management activities taking into account the end state as agreed upon by the authorities. Their interfacing with long-term waste management activities, e.g. the spent fuel and high level waste disposal is clearly defined. In all three Member State programmes the required projects to establish the required waste disposal or long term storage facilities are in progress.

The additional level of contingencies calculated in the study lead to an increase in the financing gaps in the three programmes. The financing gap is most substantial in the case of Ignalina.

4.1.3 Analysis of the national funds and other sources for financing decommissioning, waste and spent fuel management

Bulgaria

The total decommissioning cost (2003–2030) was estimated at EUR 1.1 bn. and according to the Plan, it does not include the cost of SNF and RAW treatment and interim storage facilities, as it is financed by the RAWF. SNF management is a KNPP responsibility and covered by the NFDF. The secured EU and national funding amounts to EUR 908 mil. (82% of total decommissioning cost), 84% of which is EU assistance. EU financing is intended for the period

pre-2020. No financing gap appears to exist for the period pre-2020. National funds are intended to cover the cost post-2020 until the full decommissioning of Units 1-4 in 2030. Taking into consideration the currently available resources, a financing gap of EUR 199 mil. (18% of total cost per the Plan) is expected to appear in the period 2021-2030. A revised estimate of the financing gap by SERAW is expected by the end of 2016. Under the "intermediate contingency" case the financing gap would increase by EUR 13 mil., and under the "high contingency" case by EUR 38 mil.

Lithuania

Decommissioning of Ignalina is financed from EU funds and national (Lithuanian) funds. According to the information provided by the Ministry of Energy (please refer to Section 3.2.2, in particular Table 14), historically, Lithuania's contribution to the decommissioning amounted to 15% of direct decommissioning costs, the remaining costs being financed from EU & International funds. However, the earmarked funds until 2016 are such that the secured Lithuanian contribution currently stands at 4% of direct decommissioning planned and incurred costs (please refer to Section 3.2.3, Table 10). Based on available funding sources, the estimated financing gap as of 31 December 2013 amounts to EUR 1.644 mil. or approximately half of total decommissioning costs. Available financing sources will be sufficient until 2020; financing post-2020 is not secured. Under the "intermediate contingency" case the financing gap would increase by EUR 189 mil., and under the "high contingency" case by EUR 285 mil.

Slovakia

The analysis of JAVYS and BIDSF-PMU data as at 31 December 2015 showed a potential financing gap amounting to EUR 92 mil. The gap represents the difference between total funds which were spent, available and/or committed by the end of 2015 and total decommissioning costs incurred and estimated for the whole Bohunice decommissioning programme (until 2025). Under the "intermediate contingency" case the financing gap would increase by EUR 17 mil., and under the "high contingency" case by EUR 52 mil.

4.1.4 Analysis of the robustness of the state budget of BG, LT and SK respectively

Bulgaria

The Bulgarian public finance indicators are within the defined levels of the Stability and Growth Pact, which aims to ensure sound fiscal policies for EU member states. The Bulgarian budgetary deficit and government debt amounted to 2.1% and 26%, respectively of nominal GDP as of December 2015.

The Bulgarian economy and state budget seem robust and should be able to cover the financing gap for the decommissioning of Kozloduy, as the financing gap under the "high contingency" case would only represent 0.09% of the State's budget expenditures.

Lithuania

The Lithuanian government is expecting that the State budget will continue to contribute approximately 15% of total planned decommissioning costs beyond 2020, i.e., the same share as in previous periods. Lithuania thus explicitly relies on EU support to cover the financing gap for 2021-2038. The Ministry of Energy expects negotiations with the EU to start in 2017 and if further financial support from the EU is not guaranteed, the decommissioning process may be suspended or delayed.

The funding of the financing gap - under any of the considered contingency cases – fully from national resources would increase the State's budget expenditures from 0.1% (historically) to 0.3-0.5% The political decision to fund the financing gap from national resources is currently not considered by the Lithuanian government.

Slovakia

Assuming it would need to be fully absorbed by the Slovak State budget, the financing gap under the "high contingency" case would represent 0.07% of the state budget expenditures over the period 2021-2025. The size of this financing gap compared to the state budget of EUR 32 bn. and GDP of circa EUR 76 bn. in 2014 is sufficiently limited to allow us to assume that the Slovak State budget could absorb its funding without a too significant negative impact on public finances.

4.2 Recommendations

4.2.1 On the evaluation of the decommissioning programmes global cost estimations

General

There was some evidence that more recently prepared cost estimates for individual projects are more rigorously prepared than may have been the case earlier in the programmes. We would recommend that any remaining older cost estimates, prepared before the adoption of improved practices, are re-evaluated based on the current approach and lessons learned.

Moreover, consideration should be given to the adoption of EU coordinated reviews when new updates occur in the different decommissioning programmes in line with their nationally prescribed revision cycle. International fund providers may welcome the reassurance provided by experts with wider ranging experience than the decommissioning license holders who prepare them.

Bulgaria

SERAW should be encouraged to move to a more detailed assessment of the various decommissioning tasks to better develop the labour element of their cost estimate. They are

in the process of revising the decommissioning plan and have identified a number of improvements they will make in the next Plan update, scheduled for Q4 2016.

The development and validation of the Plan are outside of the Ministry of Energy's responsibilities and no other third party independent review was carried out to the complete decommissioning plan, particularly the cost estimate and schedule, apart from the SERAW consultants, which suggests that there is an absence of an informed customer outside of SERAW. As noted above, the use of a EU coordinated review should be given consideration.

SERAW needs to carefully analyse the effect that the remuneration (wage salaries) and staff number reductions may have on the level of expertise within the enterprise, and the robustness of such estimates and assumptions.

Licensing issues (e.g. delays in obtaining licenses) should be carefully considered within the risk assessment and should not be understated, because failures and delays in this field can have major consequences for the decommissioning process. Kozloduy Units 3-4 decommissioning licenses were received in July 2016.

Project delays in the past resulted in additional costs, which had to be reallocated from other project activities. Positive progress was noted in this respect, as there were no significant project delays in 2016 and SERAW appears to make efforts to fit the decommissioning programme to plan. The regular progress monitoring and activities coordination with BNRA are among the measures undertaken by SERAW against future delays. SERAW represented that current dismantling activities and projects with previous delays were performed according to a newly established schedule, to be included in the next update of the Plan. However, there is a risk for future project delays and, taking into account the additional funding requests (e.g. staff number reassessment) and the long-term of the decommissioning project, the financial plan should be updated as required to ensure the validity of the cost estimations.

Lithuania

The Lithuanian State Radioactive Waste Enterprise (RATA) is taking on the role of organising more sophisticated reviews of the Ignalina decommissioning plan and cost estimate on behalf of the Lithuanian Ministry of Energy. The Review team consider the adoption of such independent reviews to be an example of good practice as it demonstrates a will to strengthen their capacity to manage the programme. However, as noted above, the use of a EU coordinated review should be given consideration.

Slovakia

No third party independent review of the complete decommissioning plan, particularly the cost estimate and schedule, has to date been carried out. As noted above, it could be beneficial to initiate such a third party review and make this part of an ongoing process.

4.2.2 On the overall risk assessment

The three programmes have different approaches to the assessment of contingency (estimating uncertainty). The adoption of a more rigorous and consistent approach may improve the quality of estimates and EC confidence in the overall programme cost estimates.

The use of **quantitative risk assessment** by the three programmes should be considered, at least at investment project level. This could provide a means of allowing EC to better understand the possible cost band within which a project will fall, and hence devise a funding approval mechanism that allows projects to proceed without delay, provided they remain within that band.

Ignalina's progress with implementation of quantitative risk assessment should be monitored. However, the use of such a process to support funding requests is likely to require a consistency of approach that may only be possible by adoption of a single approach across all three programmes.

4.2.3 On the analysis of the national funds and other sources for financing decommissioning, waste and spent fuel management

General recommendation

The financing of the Lithuanian and Bulgarian decommissioning plans appears to be based on a relatively constant level of annual expenditure. This suggests that the plans have been prepared to work within a predetermined annual budget limit.

This is not considered the best way to fund programmes of this type, consisting of multiple projects with varying work scopes required each year to successfully achieve completion. There may also be opportunities to significantly reduce the cost of subsequent years through additional expenditure earlier in the programme.

If the plans have been based on an annual budget, we would recommend that both site management teams prepare alternative decommissioning plans based only on the limits set by site resource levels, capacity of the project and supply chains to deliver, and on the natural predecessor-to-successor relationships between projects. An assessment of the benefits of each option would provide the programme stakeholders (e.g. funding organisations) with information to help determine how best to optimise the funding profile for efficient use of the financial resources available.

Bulgaria

One of the options, considered by the Strategy for managing SNF and RAW until 2030, is to finance the financing gap with NFDF contributions by the operating Kozloduy NPP Units 5-6. However, there are no plans to use those resources to cover the gap (2021-2030), as stated by SERAW and the Ministry of Energy, as they will be utilised for Units 5-6's own decommissioning. In an official letter to DG ENERGY, ref. № E-92-00-155 from 17 March 2015, the Bulgarian Deputy Minister of Energy expressed the possibility for contributions from Units

5-6 to be used for the decommissioning of Units 1-4, dependent on the extension of the lives of the operational Units 5-6 with another 20 years and used as last resource as necessary. The procedure for extending the exploitation periods is ongoing as of the date of the Report. The outcome of the procedure should be monitored.

Since the contributions from Units 5-6 are not being currently envisaged for the decommissioning of Units 1-4, other sources should be carefully considered. SERAW stated that other such sources may include:

- Interest on accumulated resources in the national funds, which were not already spent. According to the Ministry of Energy, interest income (incl. interest from management of funds and interest from overdue payments of contributions) amounted to:
    a. EUR 42.3mil. on resources in NFDF for the period 2007-2009
    b. EUR 9.7mil. on resources in RAWF for the period 2007 – 2014.

  There were no interest inflows in any of the funds after 2014. No further information on the amount actually available as of the Report date was made available to the Review team;
- Income from the sale of dismantling equipment;
- Rent of premises, which can be used for other purposes;
- Implementation of projects for finding other sources of financing, such as the Project for laser cutting equipment – those activities have already started for the peripheral devices, according to an approved programme;
- EUR 11 mil. unutilised funds under Grant 048 (EUR 8 mil.) and Grant 16 (EUR 3 mil.), respectively.

We recommend that regular monitoring process is implemented for considering the proper allocation of funds between Units 1-4 and Units 5-6 decommissioning respectively, as it may be challenged or potentially change in future depending on the revised financing gap and the above additional income sources.

We recommend to regularly monitor and review the process of defining solutions for the financing gap.

Lithuania

The fund which was accumulated during the life of Ignalina, is already spent and is not supplied with additional funds anymore after termination of the power generation. Therefore, the main source of national funds are the State budget and activities of Ignalina NPP. The amount of State funds to be allocated is confirmed annually for the upcoming year by the parliament. Although national funds are secured only one year ahead, based on discussions with the Ministry of Energy, it is expected that the State budget will continue contributing to approximately 15% of total planned decommissioning costs in the future.

In addition to the expected ongoing State budget financing, other financing sources are considered by the Government. E.g. the Lithuanian State is planning to evaluate the possibility to introduce Public Service Obligations (PSO) fees (which would be incorporated into the electricity tariffs), that could be partially used to finance the gap.

We recommend to regularly monitor and review the process of defining the alternative financing solutions to finance the gap.

Slovakia

Given the 7-year EU programme periods, preliminary deadline to finalize the funding of the gap is set to 2018. This is in line with the schedule as the decommissioning process should include the most complex activities (e.g. dismantling and decontamination of the primary circuit of V1 NPP). Therefore, during this period a periodic decommissioning budget update is planned which should further improve the accuracy of price forecast for the remaining period of decommissioning. We recommend to regularly monitor and review the process of defining the financing solutions for the financing gap.

4.2.4 On the analysis of the robustness of the state budget of BG, LT and SK respectively

Bulgaria and Slovakia

As the analysis shows that the ability of state budgets to absorb the potential financing needs (at their current levels) seems to be robust, we recommend to monitor the future development of the Bulgarian and Slovak economies in view of the presented and analysed indicators or additional ones, as applicable.

Lithuania

The additional financial burden for funding the financing gap with national funds would visibly impact Lithuania's public finances, and such a decision would not easily be taken by the government due to political sensitivity of the question. Therefore, while the Lithuanian State budget may be considered robust to absorb additional financial needs, we recommend to monitor the future development of the Lithuanian economy in view of the presented and analysed indicators (or additional ones, as applicable), and to observe the evolution of the national policy for fully implementing and financing the currently set decommissioning plan.

5 Annexes

5.1 List of stakeholders interviewed

Meetings on the subject of the decommissioning plans, projects, costs and risk were held with the following stakeholders:

- European Bank of Reconstruction and Development - Nuclear Safety Department
- International Atomic Energy Agency
- Ministry of Energy, Republic of Bulgaria
- State Enterprise Radioactive Waste, Bulgaria
- Ministry of Energy of the Republic of Lithuania
- Central Project Management Agency, Lithuania
- State Enterprise Ignalina Nuclear Power Plant, Lithuania
- Ministry of Economy, Slovakia
- National Nuclear Fund, Slovakia
- Jadrová a vyraďovaciaspoločnosť, a.s. (JAVYS a.s.), Slovakia

5.2 Case study – Sample project summaries

5.2.1 Bulgaria – Kozloduy Decommissioning Programmes Projects considered during this study

5.2.1.1 KNPP Project 1d - Interim Spent Fuel Storage Facility

The original Project Identification Sheet [24] was prepared sometime before 2003 (exact date unknown) and estimated project completion by 3rd quarter 2005. The document does not contain a cost estimate.

The first stage of the tender submission had the deadline August 2003. Three tenders were received.

On 03 May 2004 KNPP notified RWE-NUKEM that their offer was accepted [26] with an initial contract value of EUR 48.697 mil. The contract concerns storage capacity for an initial quantity of fuel and includes a design outline for the initial storage and a potential extension, the design and build of the initial store and 34 spent fuel casks. The contract was signed on 31 May 2004 [25].

Subsequent contract amendments issued between the contract signature and 27 June 2011 increased the contract value to EUR 71.187 mil. which is an increase of EUR 22.490 mil. or 52% of the original value. The most significant amendment is Amendment 12 [29], issued in

December 2009 increasing the contract value by EUR 12.892 mil. which was for an extension to the Spent Fuel Store Building to increase storage capacity.

The other contract amendments increased the contract value by the remaining ~19%. In a project funding environment which works with contingency allowances, the Review team consider that these changes would be within the level of contingency that could reasonably be added to a complex design and build project for a facility that would be subject to regulatory scrutiny of the design.

The potential for a storage extension was included in the original contract. It is not clear from the information available whether the extension became necessary due to the occurrence of a risk event, or if it was part of a planned phased construction. A comprehensive risk identification and assessment is presented in the project risk register [143] but this does not appear to include an identified risk that any of the planned capacity of the storage may change.

Spent fuel has continued to be returned to Russia for reprocessing which has meant that, so far, it has not been necessary to utilise the extended storage capacity. Should fuel shipments to Russia be stopped (for any reason) the constructed storage may be filled. EBRD stated that, should KNPP not propose a credible use for the extension that meets the eligibility criteria for receipt of EC funding, KNPP would be expected to refund the EUR 12.892 mil. store extension cost to the EC.

The significant issue with this sample project is therefore considered to be the decision on the potentially unnecessary store extension. This is primarily a project/programme management issue.

5.2.1.2 SERAW 04_R-10 - Construction of Phase 1 of the National Disposal Facility for Low and Intermediate Level Radioactive Waste

The original funding for the project, as requested in the Project Identification Sheet of November 2012 [32] and approved in Grant Agreement 46 [31] of June 2013, was based on a preliminary design for the disposal facility. The estimated value of the works contract was EUR 56.71 mil. No stated contingency was included in the PIS estimate. The PIS schedule anticipates the construction phase project being ready to start in September 2013, with on site civil construction commencing in January 2014.

The estimated costs in Grant Agreement 46 for supporting consultancy was EUR 8 mil. plus EUR 1 mil. "unallocated" as a contingency for the full scope of the project.

From the presentation of the estimate in the PIS, the civil construction works are presented in a way that suggests some detail has been developed for these cost elements. A list of work areas is provided, e.g. architecture, water supply, fire protection etc. with unrounded costs presented.

For "software" elements of the project, e.g. development of elements of the working design, development of documentation etc., three lump sums are included which appear to be rounded to EUR 0.5 mil. This suggests uncertainty of scope or pricing of these elements which would typically be accounted for by inclusion of an appropriate contingency amount based on the degree of uncertainty.

After completion of the detailed design and its approval by the regulatory authorities, which resulted in modifications to the proposed design, the cost estimate was updated under a new contract with the designer, a Westinghouse-led team which included Westinghouse Spain (designer of the El Cabril disposal facility in Spain) and ENRESA, the operator of El Cabril, as well as a local Bulgarian contractor. The cost estimate [48y] is presented at a high level of detail and is based on a detailed itemisation of material quantities and rates for construction of the facility.

The first revision of the updated estimate was submitted to SERAW for review in November 2015; at this point the project was now at least 2 years 6 months behind the PIS schedule. On receipt of the new estimate, SERAW informed the EBRD that the new version had increased the estimated cost to approximately EUR 74 mil. Reference to the revised estimate is made in the draft KIDSF Thirteenth Work Programme [20] of 20 November 2015, and it is reported by DG ENER that this was discussed at the KIDSF Assembly of Contributors on 3 December 2015. The EBRD indicated the new cost estimate to the EC and asked for agreement to amend the Grant Agreement. The tendered price for the construction work (by a different contractor to the designer), then due for receipt on 29 December 2015, was within the revised cost estimate.

On 1 March 2016, the EBRD requested approval of the GA 46 amendment to cover the project's increased cost. At that time the cost increase was not yet reflected in the draft AWP 2016 [16] under discussion. On 16 March 2016 clarifications were requested by the Commission to justify the cost increase.

In the subsequent period the issue was discussed between the parties, and co-financing aspects of the project were analysed.

At the time of the Review team meeting with the EBRD in May 2016, it was reported that the EC had not made additional funds available and hence the construction contract could not be signed. As the delay increased, EBRD were concerned that the construction would not be able to commence before winter and the 2016 construction season would be lost. The issue was resolved by the KIDSF Assembly of Contributors of 28th June 2016.

The contract was signed on 7 July 2016 at a value of EUR 71.82 mil. compared to an estimate in the PIS [32] of EUR 56.71 mil. This represents an increase over the 2012 estimate of ~26% and a delay of approximately 2 years 9 months compared to the original PIS schedule.

The Review team consider that the time taken for the approval process will not have had any impact on the contract cost of the specific project, assuming that works scheduled for before any shut down of site work for winter are completed as planned. As the project is not listed

as a critical path project in the draft AWP 2016 [16], it is not anticipated to have an impact on the cost of the overall decommissioning programme.

In the opinion of the Review team this is primarily an example of a failure to make adequate allowance within the schedule for the extensive regulatory review that would be expected on a project with this level of safety significance. A secondary issue is that of the project and its funding process not being in alignment. No clear evidence has been identified to suggest that the project estimate that was current at any point during the development of the project was an obvious underestimate. Rather it would seem that the estimate increased with the evolution of the design and that the high probability of this occurring was not accounted for through the addition of a contingency in the project budget or schedule.

5.2.1.3 SERAW GA 048 - Grant Agreement 48 (13.01.2014)

This Grant Agreement covers the salaries of the V1 NPP staff and is based on annual employee numbers. It covers a 4 year period at a cost of approx. EUR 45 mil. for salaries and associated social charges etc. for about 650 people.

A comparative analysis of the numbers of staff appropriate for a decommissioning project of this type is difficult due to variations in the approach to decommissioning projects.

In some countries, a decommissioning nuclear power plant will be part of a fleet of plants and facilities managed by a common owner. For example, French decommissioning plants owned by EdF, UK plants owned by the Nuclear Decommissioning Authority and managed by Magnox plc, and the Spanish decommissioning plants managed by ENRESA. In these situations, a "headquarters" organisation exists that is able to supplement the individual sites' own staff with specialist knowledge and experience, while not being counted as part of the site staff. In the case of the Magnox plc managed decommissioning, this is taken a step further in that the fleet-wide decommissioning is managed as a series of major headquarters based programmes that deliver the same scope of work at each site with much reduced input required from the sites themselves. Examples include its ILW programme and large structures programme teams.

This is not the case for Kozloduy Units 1-4, which must have its in-house resource requirements in full with little opportunity for sharing resources.

The following table shows staff numbers at Magnox sites during 2013 [185].

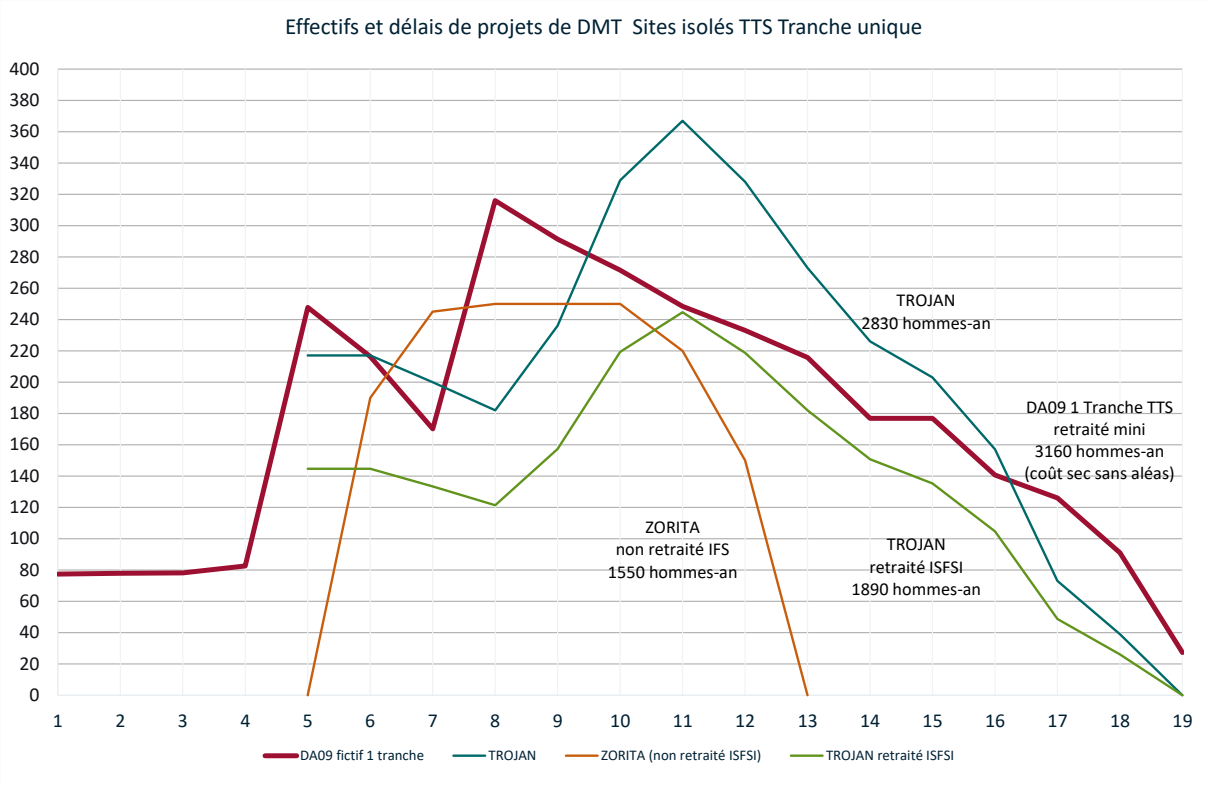
Site	Shutdown Date	Full Time Equivalent Staff Number
Berkeley (2 small unit Magnox)	1989	213
Bradwell (2 unit Magnox)	2002	372
Chapelcross (4 unit Magnox)	2004	422
Dungeness A (2 unit Magnox)	2006	269
Hinkley Point A (2 unit Magnox)	2000	264
Hunterston A (2 unit Magnox)	1990	238
Oldbury (2 large unit Magnox)	2012	403
Sizewell A (2 unit Magnox)	2006	319
Trawsfynydd (2 unit Magnox)	1991	365
Wylfa (2 large unit Magnox)	2015	602 operating number

Table 25 - Magnox site staff numbers

Magnox plc has a strategy of contracting out "hands on" work rather than performing dismantling activities with its own staff. Compared to the numbers above, the staffing level included in GA048 of 443 staff at 2016 (excluding those directly engaged on dismantling) initially appears high.

However, as noted above, Magnox sites are able to draw upon headquarters based expertise in key areas. In some respects the work currently in progress on Magnox sites is similar to that for Kozloduy, i.e. retrieval and processing of wastes, decommissioning preparatory works and simpler dismantling activities etc., but Magnox plc does not have the additional responsibility of establishing a waste disposal facility. Given this difference in scope, availability of offsite expertise and the number of units per site, Kozloduy numbers look comparable.

The Review team have also drawn on data with the NucAdvisor decommissioning database regarding staff numbers at sites in various countries. The graph below shows staff numbers in the years following plant shutdown for Zorita Spain, including construction of the Spent Fuel Store (ISFSI), Trojan USA, both with and without the Spent Fuel Store and Dampierre France without a Spent Fuel Store.



These are all single unit plants, so it would be expected that Kozloduy staff numbers would peak at a value higher than that shown for these plants. The magnitude of the increase is not easy to quantify but it would be expected that a second unit would require less than a doubling of the numbers associated with one unit as a number of staff roles would be required per site rather than per unit. Further additional units would require smaller increases.

With regard to the 207 staff directly associated with deplanting, the Review team note that Labour costs associated with the dismantling and processing of wastes presented in Chapter 21 of the decommissioning plan [8] and presumably the basis of GA048 are based on a simplistic calculation. The calculation uses the gross amount of material to be removed and processed during the programme from each of seven identified work areas (corresponding to specific areas of the plant) and applies removal and processing production rates to generate the personnel required in each. All works are assumed to be completed within a predetermined fixed period. Allowance is then made for associated engineering personnel at 10% of the required number of manual workers.

At this stage in the programme it would be expected that the decommissioning plan would have developed more elaborated labour requirements based on individually planned dismantling projects or tasks. These planned projects or tasks would typically take account of the need to set-up work areas for access and radiological control, install services and equipment, sequence the removal of specific large components in an area, and take account of limits on the number of workers that can safely work within each area or on a particular task.

It may be that very well chosen production rates based on extensive experience may give a satisfactory result when used in this way. The labour estimate presented may therefore be

adequate, but the methodology presented suggests that detailed resource planning has yet to be performed.

At the time of writing, SERAW are revising the decommissioning plan. It is not known if the same methodology for calculating decommissioning labour requirements will be used in the revised version. The Review team consider that here may be a risk that the staff numbers required to maintain the programme is revised. This may not directly affect GA048 over its current timescale but may affect subsequent grants by slowing the rate of reduction in staff numbers compared to that presented in Chapter 21 of the decommissioning plan [8].

Although not shown in GA048, the Review team consider that the current resource plan presented in Chapter 21 of the decommissioning plan [8] reduces the number of Project Management related staff significantly between 2016 and 2020. This may be an effect of how staff are accounted for within the various groupings but it does imply a reduction in the required Project Management and Engineering capability in a period in which significant dismantling activities are continuing.

In summary, the Review team conclude that the current staffing numbers as set out in GA048/A do not appear to be unreasonable given the scope of Kozloduy project and the SERAW approach to delivery of it.

SERAW report that its staff numbers include a group of personnel transferred over from KNPP some of who subsequently retired which will result in lower staff costs. They also advise that as KNPP employees personnel received an additional monthly remuneration which will not apply while they are employed by SERAW. This will also result in lower actual costs compared to the Grant Agreement.

SERAW recognise that these reductions look like "bad planning" but they state that the estimate was developed based on information available at the time; the changes in payments etc. will be reflected in the new decommissioning plan being prepared mid-2016.

5.2.1.4 SERAW Project 5b - Facility for Treatment and Conditioning of Solid Radioactive Wastes with a High Volume Reduction factor

Revision 3 of the Project Identification Sheet [35] was issued July 2007. This is written after engagement with the supply chain and provides an update of the project estimated cost based on that engagement. In Appendix 1 of the PIS, the cost is estimated at EUR 23.2 mi. "as opposed to the original EUR 7 mil. prediction" - this earlier estimate presumably dates back to the earlier issues of the PIS in 2003 and 2005 prior to supply chain engagement.

The Rev 3 PIS estimate includes EUR 20.54 mil. for the Plasma Arc equipment which is based on the cost of conventional incinerators at Bohunice and Balakavo plus additional allowances due to inflation and a relatively small uplift to cover the changed technology. No supporting detail has been provided to justify the cost estimate presented which, with the benefit of hindsight appears simplistically prepared and optimistic. Small additions have been made to the cost of the conventional incinerators to account for the changed technology and uplift

added to cover escalation. No additional design and design substantiation cost has been specifically included despite the proposed technology being different to the basis of the estimate and being sufficiently unusual as to require some additional justification. No associated contingency is declared. Rev 3 is prepared in response to engagement with the market but before tender prices have been received against the technical specification which was issued in February 2008.

In April 2009 a contract is placed with a Joint Venture formed by Iberdrola Ingeniería y Construcción, SAU and Belgoprocess NV (The Contractor), for a total price of EUR 29.896 mil., which is ~28% above the PIS estimate. The contract includes modification of an existing building to house the equipment, and completion is scheduled for 220 weeks (4.25 years) later, i.e. approximately mid July 2013.

A total of six Amendments are subsequently issued (with Amendment 7 reported by SERAW to be awaiting signature and Amendment 8 to be prepared after *"...the settlement of two significant claims from the Contractor, namely 'Disruption caused by BNRA Comments', and 'Access to the Site/Nuclear Indemnity Agreement'. Both claims have their origin before the novation of the Contract."*

Amendments 1 to 6 are of relatively small value adding EUR 0.181 mil. to the contract value; some simply nominate new individuals in key positions related to the contract (e.g. KNPP Executive Director). Of significance is Amendment 2, issued in July 2009, which adds 87 weeks to the contract schedule. The current contract price as of issue of Amendment 6 is EUR 30.1 mil., or less than 1% over the original contract price.

EBRD stated that the project history includes various reviews and audits, with statements made by auditors and others to key stakeholders that the chosen technology was experimental and an irresponsible choice. EBRD also pointed out that the chosen technology is based on that in use at the operational SWILAG facility in Switzerland.

It is noted from SERAW's own description of the project history [139] that Amendment 5 and the planned Amendment 8 both refer to being caused by requests made by BNRA (the nuclear regulatory authority).

EBRD reported during the meeting with the Review team in May 2016 that the installation work was progressing and that the plant would be ready for cold commissioning in September 2016.

Given that the plant employs an existing, though not common, technology, it is possible that issues with this project relate more to not obtaining the "support" (or non-objection) of key stakeholders such as regulators early enough in the project rather than any fundamental fault with the proposed technology.

The Review team consider the quality of the initial estimate included within Rev 3 of the PIS to be very poor. The apparent lack of rigour with which the initial estimates are prepared and revised prior to receipt of tender prices may also have contributed to poor management of funding bodies' expectations by the then PMU.

5.2.1.5 SERAW Project 9b - Supply of a Facility for Retrieval and Processing of the Solidified Phase from Evaporator Concentrate Tanks Located in Aux Buildings 1 & 2 at KNPP site

The contract was awarded in March 2009 [40] with an ONET Technologies led team at a value of EUR 22.534 mil. The PIS made available to the Review team is a revision made after receipt of tenders. Thus the Review team cannot compare the contract price to the original estimate.

The project was implemented as a two phased project:

- Phase 1 - Sampling and characterisation of tank stored legacy wastes (solid phase)
- Phase 2 - Design and build of the required retrieval and processing equipment for the legacy wastes.

The original tender included an assumed characterisation of the waste. Following the work carried out by the tenderer in Phase 1, this characterisation was proven incorrect in terms of waste nature, radiation levels and chemical/physical characteristics. It is noted that the PIS includes the statement "there is no detailed data for the chemical composition or radionuclide content of the solid phase".

After the granting of three separate contract extensions in Amendments 1, 3 and 4 [41] totalling 241 weeks, the conclusion was eventually reached, in conjunction with ONET, that ONET did not have an industrial scale solution to the processing of the actual waste form.

As a result, Contract Amendment 6 [41] was issued effectively in October 2015, which deleted the Phase 2 work from the ONET scope of work and the contact was closed at a value of EUR 10.983 mil.

At the time of the Review team meeting with EBRD in May 2016, it was reported that SERAW and the PMU were drafting a new technical spec for Phase 2 which would be subject of a new tendering exercise later in 2016.

Characterisation of wastes is a difficult issue on many waste management projects. In this particular case the difference between the assumed and actual characterisation of the waste was sufficient to preclude the possibility of using the tendered solution. This subsequent resulted in cancelling the contract and potential further project delay due to the retendering process. In some instances the difference in characterisation can be accommodated so the impact to the contract is small (see V1 NPP project C7-B), but this is not always possible. A review of the accuracy and detail of the characterisation data is required to assess the risk of the actual waste being different enough that the technical solution may change. Therefore, it is recommended to perform the characterisation campaign (project phase 1) before tendering the processing contract.

5.2.1.6 Summary

A number of observations can be made following review of the Kozloduy sample projects:

(1) In the case of projects which include the design of nuclear facilities, it is a foreseeable risk that the design review process will identify changes that are necessary to obtain approval to proceed. In the case of high profile facilities that will be subject to regulatory scrutiny, such as waste processing and storage facilities, the probability of this occurring is sufficiently high that it should be accounted for within both the estimate and the funding arrangements, e.g. through allocation of an estimating uncertainty allowance. Such high probability design and approval issues should also be accounted for in the schedule.

The Review team understand that, for projects funded via EBRD, significant additional allowances for such uncertainties are not included, or are included at minimal values. There may be sensible reasons for this approach but it does mean that projects may be subject to repeat requests for adjustment of funding levels. In this instance these requests should not necessarily be considered a symptom of poor estimating or management, but rather as a result of the design of the funds release mechanism.

(2) The quality of characterisation data available to a project can be a major factor in its success. Design and build projects for waste management process are particularly exposed to this risk. Ideally accurate characterisation data will be obtained via a specific characterisation task before commencing. If this is not preferred, the characterisation data needs to be presented in a way that communicates to the contractor the possible range of characterisation that is expected. Even so it may be necessary to include a "break point" in the contract to accommodate for a situation in which the actual characterisation is outside the forecast range. The waste "belongs" to the site; the risk associated with its characterisation therefore also belongs to the site until such point as its real characterisation is available to the contractor. While this risk remains it needs to be accounted for in project cost estimates (through suitable allowances) and managed.

(3) Some of the sample project had their original estimates prepared several years ago. Since then management arrangements for the project have changed and the original information may not be a true reflection of the current practices within the project. In recognition of this, the Review team asked SERAW to provide more recent examples that would better demonstrate the current approach.

In response SERAW provided additional documents relating to Project 39 "Back-up Power Supply for Units 1&2 and Dismantling of DGS-1 Equipment for Use of the Building for Decommissioning" [128, 129], and Project 13a "Turbine Hall Dismantling" [130]. The Project 39 documents from 2015 show a more detailed "bottom up" estimate of the project cost using quantity based estimates with associated unit rates. This rates based approach is well suited to a project of this type where the constituent components can be quantified. The Project 13a document from 2016 is a market research document which contains the results of a market price survey of various equipment items that may be used in the construction of the project estimate. This approach to keeping data current is very useful for cost items not included in

service databases or typical costs. The documents presented are supportive of a much improved approach to that seen in the older estimate data.

5.2.2 Lithuania –Ignalina Decommissioning Programme Projects considered during this study

5.2.2.1 UP01 - Unit 1 reactor dismantling

The work to assess the dismantling of the Unit 1 Reactor was originally covered by Project B9/4. This project was tendered and a notice of non-objection was issued by EBRD for placement of the contract in 2009. Expected contract signature was 2010. However, at this point there was a change in the management of INPP and a new government, contributing to the cancellation of Project B9/4 and bringing the work in-house.

INPP performed the dismantling review in-house and it was funded by CPMA as a workforce activity rather than a stand-alone project tendered to external contractors.

Since then INPP have been performing their assessment. In 2015 they decided that they have insufficient capability to assess the dismantling of the central part of the reactor. However, they did prepare for some detailed work on the upper and lower pipework zones. This assessment work will now be offered for tender as Project UP.01 funded by CPMA. A Project Management Plan [80] and Project Description [81] have been prepared for the project by INPP. The Project Management Plan [80] contains a reasonably detailed summary of the main project estimate.

The cancellation of B9/4 and the taking of the work in-house is considered by EBRD a significant driver for the extended Ignalina decommissioning programme.

This would appear to be an example of a strategy that has not been fully agreed by all parties, or at least a strategy that changes when one of the parties changes (management at Ignalina and/or government). It also suggests that a more thorough "make/buy" analysis could have been performed before deciding to perform the work in house instead of engaging external specialists from the beginning.

5.2.2.2 Project B1 - Design and Construction of an Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2

The Project Identification Sheet Issue 3 [90x] for the project was prepared in 2002. At that point the estimated cost was EUR 70 mil. plus a contingency of EUR 10.5 mil. (or 15%).

The work was broken in six smaller work packages; WP1 was an overall design and auxiliary equipment manufacture package valued at EUR 6.5 mil. while the remaining five were phased manufacture/construction/commissioning packages each valued at EUR 12.7 mil.

Contract award was scheduled for September 2003, followed by completion of the first of the five storage phases in 2005 and commissioning of the final phase in 2009.

The PIS was prepared by INPP and reviewed by the PMU consultant. On the basis of the PIS, funding was approved by the Assembly of Donors and a Grant Agreement issued by the EBRD.

A Technical Specification was then prepared which was accepted by the regulatory body (VATESI) and the EBRD.

The Technical Specification was then used as the basis of a two-stage tender process. The return date for first-stage tender documents was 11 November 2003 [60], which is late compared to the PIS schedule.

Three tenders were received. A preliminary First Stage Tender Evaluation Report was prepared by INPP and was given an EBRD "no-objection" on 11 February 2004. As a result of the assessment of the technical proposals, and the recommendation with the tender evaluation report, only one tenderer, GNB-NUKEM was invited to proceed to the second, priced stage of the tender process.

The return date for the second stage priced proposal was 14 June 2004 [61]. The initial GNB-NUKEM tendered price was EUR 165.1 mil. which was significantly above the PIS estimate and hence above the level for which funding had been approved. As a result, there was a period of delay while funding arrangements were revised. The contract was signed on 12 January 2005, approximately 15 months late compared to the PIS.

When work began a number of contractual issues emerged. The contractor identified discrepancies within the technical data presented for the fuel and claimed additional costs as a result. There were also issues that arose relating to enrichment levels of the fuel and changes in metal price. The contractor produced a heavier container than originally tendered which had consequential impacts on the safety margins provided for the lifting equipment to handle the casks. The issues resulted in amendments and cost increases, which were agreed with the EBRD as they arose. Outstanding commercial issues were resolved in 2014 with the result that the contract value now stands at EUR 193.5 mil., an increase of 140% on the original PIS estimate.

The project is now reported to be progressing well, with the store construction now completed and hot trials expected to complete during Q3 2017.

INPP reported that, as the cask supplier for Project B1 was to be GNS, who made the casks for the exiting spent fuel store, they expected the project to progress with fewer issues than did occur. They felt confident as GNS already knew some information about the fuel. However, the proposed solution was different to that previously used, with a heavier cask and a different loading procedure.

INPP reported that they have learned lessons from this project. They recognise the need to check the technical specification thoroughly and to check very carefully the technical proposal that is received in response to it. They also recognise that a common understanding of the data included in the specification needs to be reached with potential contractors.

The Review team noted that these learning points are similar to those for Project B2/3/4. It is also noted that these two projects were initiated early in the programme. This, coupled with

INPP's reliance on their own resources rather than the supply chain during the operation of the plant, may suggest that INPP perhaps lacked the necessary experience of large procurements at this early stage of the programme. These lessons learned should be of benefit to subsequent procurements.

5.2.2.3 Project B2/3/4 - Design and Construction of New Solid Waste Management and Storage Facilities

The original Project Identification Sheet [89] for the project was prepared around 2002 along with a Project Delivery Strategy [82] prepared by the then PMU team. The estimated cost at that point was EUR 69 mil.; in addition, a EUR 10.35 mil. (15%) contingency was identified. Completion was forecast for Q2 2007 (or Q3 2009 if additional capacity options were taken up).

After the second (priced) stage of the initial tender process, which closed June 2004, it was clear that EUR 70 mil. was far short of the market price as tenders were offering prices greater than EUR 130 mil [62].

A new specification was then issued based around a modified container size. The EBRD's non-objection to issue of the tender was signed in December 2004 [83]. The new tender return date was 21 February 2005.

As a result, an EBRD non-objection was issued [84] and the contract was signed in November 2005. The contract was placed with NUKEM and valued at EUR 120.066 mil. with a forecast completion of December 2009. This cost was built up of Lot 1 (B2) EUR 32.806 mil., and Lot 2 (B3,4) 87.259 mil.

Significant delay to completion has occurred, in part due to lengthy regulatory approval processes (national and local), poor quality design documentation from the contractor (in INPP's view) and design changes resulting in part from intrusion of the original facility design into an exclusion zone requiring relocation of the site fence (which is a significant regulatory issue). The document giving the requirements for the security fence was referenced in the original specification but was not attached to the tender documentation package. After the contract was placed the contractor asked for sight of this document which resulted in the non-permissible intrusions into the exclusion zone being identified.

The various issues resulted in the contractor submitting a claim for approx. EUR 100 mil. This was independently assessed and resulted in agreement being reached between the contractor and INPP to settle at EUR 55 mil. The EBRD stated that they were not consulted on this final agreement; they estimate that three years of the delay to date can be attributed to the extended time taken to reach this agreement.

The current contract value is EUR 184.012mil. consisting of Lot 1 EUR 46.994mil. and Lot 2 EUR 137.017mil. which is an increase of ~53%.

INPP reports that the lesson learned from their point of view is to review specifications to look for alternative interpretations of what is written and to ensure that key requirements are repeated in the main specification document rather than referenced out to other documents.

5.2.2.4 Project B9/1 - INPP Unit 1 Turbine Hall Equipment Decontamination and Dismantling Project Development

The Project Identification Sheet [85] issued in November 2006 gives the estimated value of the contract as EUR 10 mil. plus a contingency of 15%. Completion was forecasted for Q2 2009.

Requests for Proposals were issued in February 2007; three tenders were received. The tender evaluation report [65] prepared in August 2007 by INPP recommences negotiation of a contract with a United Kingdom Atomic Energy Authority (UKAEA)-led consortium.

In November 2007 the EBRD signed a non-objection for contract placement with UKAEA at a value of EUR 3.978 mil. plus GBP 2.893 mil. [86], i.e. less than the PIS estimate. This was approx. four months late compared to the plan in the Project Identification Sheet.

It was reported that the initial quality of some of the documents prepared by the contractor was not good [87], resulting from a lack of understanding of the regulator's requirements. The project completion report also suggested that the contractor did not provide sufficient resource to some tasks. However, all documents were eventually approved.

Five contract amendments were issued, with those affecting the contract price deleting works from the scope as it was "optional" work not required by INPP, e.g. assistance during the actual performance of the decommission by INPP staff using the procedures prepared during the contract.

The contract works were complete May 2012 at a final contract value of EUR 3.612 mil and GBP 2.586 mil. [87].

EBRD and INPP report no significant issues from their perspective.

5.2.2.5 Project B25-1 - Near Surface Repository for Low and Intermediate Short-Lived Radioactive Waste (Design and Construction)

A Project Identification Sheet [88] was prepared in 2008 which gave the estimated costs as EUR 10 mil. and the date for operation of the site as commencing April 2016.

Invitations to Tender were issued in March 2009 with a deadline of 16 June 2009. Three tenders were received. The Tender Evaluation Report of August 2009 [64] recommended placement of the contract with an AREVA-led consortium who had submitted a tender of EUR 10.298 mil. which was close to the original estimate. The contract was signed in October 2009.

As of April 2016, a total of nine amendments to the contract had been increasing the total contract value to EUR10.626 mil., or ~6% above the original estimate.

EC/EBRD funds are financing the production of safety and technical reports. Approval of these is taking longer than expected but a regulatory decision is expected later in 2016. At that point detailed design will commence. The design contractor will then continue to be available to the detailed designer on a fee basis.

INPP report no significant issues from their perspective.

The extended period of regulatory review experienced on this project, compared to that originally anticipated, suggests a possible lack of engagement with regulators to ensure a good understanding of how long approval processes would take in practice. Given that the INPP project is unique in Lithuania it may be that the regulators cannot offer reliable guidance in advance regarding timescales for their work. However, there would still be value in liaising with them regarding forward plans and schedules if this does not now routinely occur.

5.2.2.6 Summary

A number of observations can be made following review of the Ignalina sample projects:

(1) As a consequence of practices during its operational history, INPP operate in a more self-sufficient manner, with high numbers of site employees performing roles that might typically be performed by contractors. This is generally the case at craft level roles but may also influence the make/buy decisions for other aspects of the programme.

In the case of the Unit 1 reactor dismantling project, the decision was made in 2009, almost at the point of signing the contract, to bring the work in house; the background to this decision is not examined here. Reactor dismantling is potentially the most technically challenging task to be performed during the Ignalina programme and one which would benefit from input from other organisations that have performed similar tasks, though recognising that none can offer an identical reference.

At the conclusion of the in-house assessment of the task, INPP have concluded that they can design part of the task but not all of it. The part they cannot design is the far greater part, valued at EUR 70.6mil. of a total of EUR 79.3mil. according to the project estimate included in the Project Management Plan [80]. This part will now be tendered to the supply chain. Reactor dismantling will be the critical path of the programme, so a significant part of the time from the decision not to sign the original contract until signature of the new contract is expected to contribute to the overall Ignalina programme duration and hence the overall programme costs.

(2) The oldest project considered here, B2/3/4 estimated in 2002 while the plant was still operating, has proven to have had the least accurate initial project estimate, being subject to a 53% cost increase to date. In the case of Projects B9/1 and B25-1, originally estimated in 2006 and 2008 respectively, the estimates have proven very close to the outturn cost, with

B9/1 completed for less than estimated and B25-1 being subject to a 6% increase to date, seven years into the project.

(3) INPP acknowledge the error made in the tender documents for Project B2/3/4 and the resulting impact. However, they also note the impact of the lengthy regulatory approval process. As was noted for Bulgaria, in the case of projects for the design of high profile facilities that will be subject to regulatory scrutiny, such as waste processing and storage facilities, the probability of design changes and approval delays occurring is sufficiently high that it should be accounted for within both the estimate and funding arrangements, and in the project schedule.

(4) Issues regarding regulatory approval were referenced in respect of a number of the projects by INPP and EBRD. If not already done, it would be useful to liaise with regulators during project planning to understand their timescales, availability to respond during the planned programme and their other requirements specific to the project plan. These can then be factored into the project planning and incorporated where required in the tender specification so that contractors are aware of the requirements they will need to satisfy.

5.2.3 Slovakia – Bohunice Decommissioning Programme Projects considered during this study

5.2.3.1 Project C7-B - Treatment of Historical Waste – Sludges & Sorbents

The Technical Study [103] prepared for this project by PMU-BIDSF in 2006 estimated the value of this project as EUR 60.0 mil. including EUR 22.4 mil. for the external contract value (plus EUR 4.7 mil. contingency).

EBRD reported that the first tender process for this contract was cancelled as they were not satisfied with the process; no detailed explanation for this was provided.

As a result of the completed tender process, a contract was awarded to AMEC Nuclear Slovakia on 11th June 2012 at a value of EUR 9.474 mil. which represents a significant saving compared to the original estimated contract value.

During performance of the contract, the characterisation of the stored wastes was found to be different (higher activity) from that originally expected and there was a greater volume of waste; this resulted in more waste containers being used to process and package the waste. An amendment (No. 1) was issued on 24 October 2014 to address these and other lesser issues, resulting in a final contract value of EUR 11.189 mil. which is still within the original estimate by a significant factor.

The contract was completed on 14 May 2015. EBRD stated that the contract was performed well and professionally.

In this instance the risk associated with placing a waste processing contract based on incomplete characterisation data has occurred but without preventing the project reaching a successful conclusion and without cost impact outside the bounds of the estimate. It is unclear

how well this characterisation risk was understood at contract placement. The characterisation data presented in the technical study [103] is presented without reference to uncertainty of the data and the summary data tables presented for the waste generally show single point values for the various parameters rather than ranges of possible values; this suggests confidence in the data.

5.2.3.2 Project C9.4 - Design and Erection of New Disposal Facilities for LLW and VLLW from V1 NPP Decommissioning at NRR Mochovce.

The Technical Study [104] prepared for this project by PMU-BIDSF in 2012 estimated the value of this project as EUR 16.525 mil. for the LLW part of the scope, and EUR 5.160 mil. for the VLLW part; a total of EUR 21.685 mil. (plus EUR 2.168 mil. contingency).

Prequalification submissions were opened on 14 April 2014. Formal tender returns were opened 03 September 2015. A contract for EUR 21.700 mil. was awarded to VUJE on 9th December 2015; this value is almost identical to the 2012 estimate.

EBRD reported that the project was subject to an extended tender period. This was, in part, because they felt that the assessment of the pre-qualification submissions and the financial requirements to bid stated in the invitation to tender documents unnecessarily reduced competition for the contract. This limiting of the number of potential tenderers occurs on some of the V1 NPP projects considered under this review project. It is not clear if this is due to a deliberate desire to limit the workload associated with review of numerous tender returns or is an unplanned consequence of setting very strict qualification criteria; the Review team recommend that great care is taken not to inadvertently exclude suitable bidders as appears to have happened in Project D2 below.

JAVYS report that the project has progressed to date without any difficulties.

5.2.3.3 Project D0 - Implementation of the Decommissioning Programme Using Human Resources Available at Bohunice V1 NPP: Project 8

This project covers the salaries of the V1 NPP staff and is based on annual employee numbers.

The Project Identification Sheets for the years 2014, 2015 and 2016 set out the estimated staff number requirements for various departments within the project in a methodical way.

Staff numbers are presented in two main groups; full time staff directly associate with the delivery of the V1 NPP project, and "part-time" staff which might more correctly be described at the percentage of time other "non-V1 NPP" full time JAVYS employees spend supporting the V1 NPP project. This implies that there is a functioning time-recording system within JAVYS that allows personnel to record the tasks that they work on, typical of a multi-project or programme organisation. Operation of such a system requires some discipline on the part of staff and monitoring by Project Managers to ensure time is correctly allocated but this is a normal situation in all such organisations.

Certain aspects of the staff costs are paid for by Slovak funds, e.g. pension insurance, meal contribution, personnel training, health service and social funds allowances. The training paid for by Slovak resources is assumed to be general development training rather than task specific decommissioning training.

EBRD reported that the actual cost each year is generally less than initially estimated. This is confirmed by the following data:

- PIS estimate for 2014 = EUR 7.034 mil. Actual payments = EUR 6.512 mil.
- PIS estimate for 2015 = EUR 7.241 mil. Actual payments to end Q3 Eur 5.139 mil (balance = EUR 2.102 mil.)

It cannot be stated if the apparent under-spend is due to a conservative estimating approach or to non-achievement of planned work scope.

In the PIS documents the part time staff are presented in both actual numbers and as "Full Time Equivalents" (FTE). Over the period 2014-2016 the forecast overall staff requirement, including both full and part-time staff, has increased slightly from 232 FTEs (of which 147 full time) to 246 FTEs (170 full time).

It is reasonable to expect that the numbers for V1 NPP would be lower than for KNPP:

- V1 NPP has fewer decommissioning units,
- V1 NPP has some supporting infrastructure on site that it does not need to specifically provide to support this project,
- the V1 NPP team gives more work to the supply chain for hands on performance, and
- the V1 NPP team is able to make more efficient use of personnel by drawing on other JAVYS staff only when needed.

It would also be expected that the numbers of staff would be lower than the Magnox and other sites considered in Section 5.2.1.3 as, from review of the PIS documents, V1 NPP are able to make use of shared JAVYS resources from a wider range of support available from adjacent facilities. As can be seen, this is the case.

The Review team conclude that the staff numbers estimated under this project do not appear to be unreasonable for the specific situation of V1 NPP decommissioning and the JAVYS approach to delivery of it.

The grant application is checked by the Ministry of Economy and performance is subject an annual audit, performed in recent years by Deloitte.

5.2.3.4 Project D2 - Decontamination of Primary Circuit

The Technical Study [105] prepared for this project by PMU-BIDSF in 2009 estimated the value of this project as EUR 6.814 mil. The time schedule presented indicates contract award at the end of 2010 and completion of the project by October 2012.

A tender process was launched in 2012 for which 13 organisations registered an interest as of 30 March 2012 [108]; these 13 included AREVA and Westinghouse who can be considered the dominant organisations in this technical area. The tender return date is 5 June 2012.

Only one tenderer submitted a proposal, ONET Technologies. A contract was then awarded on 21 December 2012 with ONET for EUR 6.258 mil. which is within the original estimate. Contract placement is two years late compared to the Technical Study [105]; the reasons for this are not clear.

A number of difficulties occurred during the performance of the contract for which the EBRD and JAVYS hold ONET responsible. Javys report issues related to:

- Occurrence of safety events resulting from lack of control of the process and breach of Safety Culture/Nuclear Safety by the Contractor;
- Rate of progress: extension of project implementation from 20 to 38 months;
- Production of RAW: substantially higher volumes than planned, different type of RAW than planned, higher activity of RAW than planned which resulted in difficulties in processing of this RAW on JAVYS processing facilities;
- Contractor's Personnel: Absence of the Contractor`s key-experts and the Project Manager on site, inexperienced staff on site, exceeding of individual and collective doses of the Contractor`s staff;
- No final technical solution to the plant state following decontamination attempts developed by the Contractor;
- Breach of the Decontamination strategy.

As a result of these difficulties, a technical review of the project was performed by the Electric Power Research Institute (EPRI), who own the rights to the chemical process deployed by ONET. EPRI concluded that there was only one contractor that could now successfully complete the project; this was Westinghouse, who had originally registered interest in the original tender but had not submitted an offer.

The contract with ONET was terminated on 14 March 2016. The proposed way forward is the launch of a new project D2-A as a single tender contract with Westinghouse for completion of the decontamination. A PIS prepared for project D2-A [110x] indicates that the decontamination will now be completed by June 2017, which is 4 years and 9 months late compared to the original technical study [105]. This project is the critical path predecessor to key aspects of Project D4.2 (below) which is also on the critical path. The late completion of this project is therefore likely to have had a negative impact on the overall V1 NPP programme schedule.

The history of this project raises the question, not possible to answer during this review, of what aspect of the specification or procurement process resulted in no submissions from the most experienced and capable contractors.

5.2.3.5 Project D4.2 - Dismantling of Reactor Coolant System Components

A Technical Study [106] was prepared for this project in 2013 which estimated the total cost of this project at EUR 119.159 mil. of which EUR 62.824 mil. would be the contract value for the deplanting contractor.

An updated estimate was prepared during the preparation of the tender specification in 2016 [107]; this revised estimate remains confidential as the tendering process is still in progress having commenced with issue of an invitation to tender on 03 June 2016. However, a significant increase is expected.

There are a limited number of experienced organisations working in the area of reactor dismantling. It might therefore be considered beneficial that all such experienced organisations be given the opportunity to submit an offer. However, the tender documentation [176] appears to limit the number of tenderers that can make offers by requiring that:

- only previous projects completed within under Slovak or EU member state regulations may be offered. This effectively eliminates organisations with only experience from outside the EU, including the extensive US decommissioning market;
- the tenderer must have prepared documentation and completed performance of a reactor and large component dismantling project in a Nuclear Power Plant Controlled Area. Research reactors are specifically excluded though some of these can be comparably large;
- the tenderer must have performed a project related to removal of sludge, sediment and crystals contained in equipment and systems in a Nuclear Power Plant Controlled Area. An equivalent project performed in any other complex nuclear facility is not admissible. This is confirmed in the responses by JAVYS to tender queries.

First stage tenders (non-priced technical proposals) are due for return on 22 September 2016.

5.2.3.6 Summary

A number of observations can be made following review of the Bohunice sample projects:

(1) The tendered prices for the selected sample projects have been close to the original project estimates.

(2) On a number of occasions, contracts have been subject to an extended procurement period before placement. Two examples were noted in the sample projects (C7-B, C9.4); during the Review team meeting with EBRD, Project D3.1B relating to demolition of the cooling towers was also mentioned as having a similar issue. These events risk introducing a cost impact on the overall programme even if they do not directly impact the cost of the specific project. This is due to the potential delay they may cause to eventual completion of the programme or to the reduction of staff numbers and site operating costs.

(3) The fact that only one tender was received for Project D2 Decontamination of Primary Circuit is noted. This is interesting as there is a strong competition between AREVA and Westinghouse for work of this type with both regularly winning contracts to perform such decontaminations and both having a long history of projects in this area. The only tender received was from a contractor without this history who then proved unable to successfully deliver the work. The reasons for no-bids from more capable contractors should be examined and taken account of in the preparation of future requests for tenders. It is also noted that requirements stated in the Project D4.2 Dismantling of Reactor Coolant System Components may exclude bids from capable contractors which may have resulted in a lower price.

5.3 Technical annex

5.3.1 Detailed methodology

5.3.1.1 Application of the Better Regulation Guidelines in the approach and study logic

Our proposed approach has allowed us to respond to all questions for this study in a complete and relevant manner, respecting the principles of objectivity, reliability and evidence-based assessment, based on methodologies that comply with the requirements of the Evaluation Guidelines and build on best practices in the nuclear decommissioning industry in the last years.

We have combined a top-down and bottom-up driven approach supported by detailed desk research. This has allowed us to triangulate the collected data, and correspondingly base our judgement and conclusions on robust findings.

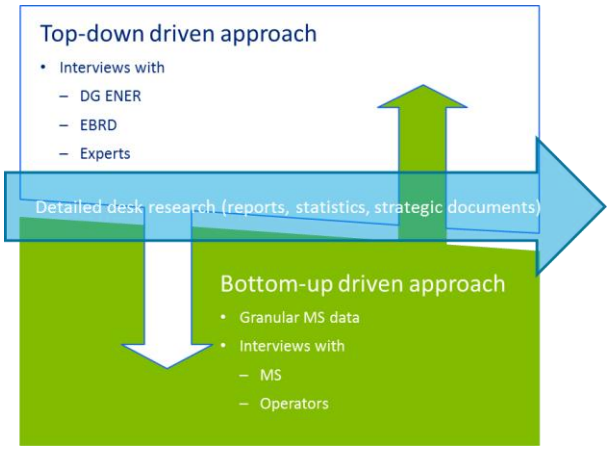


Figure 26: Combined top-down and bottom-up approach

Our overall guidelines for the activities within our approach have been:

- the intervention logic defined for the decommissioning programmes;
- the analytical framework;
- a comprehensive set of analytical tools;
- the work plan that was presented in the proposal and refined as relevant.

This approach has enabled us to meet the foreseen time schedule whilst maximising the input of the different stakeholders to ensure robust results. The approach included the following features:

- a comprehensive approach for gathering and analysing data to ensure a strong base of evidence;
- suited and diversified analysis tools (Evaluation of the decommissioning programmes global cost estimation, Overall Risk assessment analysis of the national funds and other

sources for financing decommissioning, waste and spent fuel management, and analysis of the robustness of the state budget of Bulgaria, Lithuania and Slovakia respectively);

- an organised and managed work plan which grouped and simultaneously handled the different methodological tools;
- Inception, Intermediate and (draft) Final Reports in a readable and comprehensive format, combining primary and secondary data, stakeholders' opinions and our objective and independent analysis, conclusions, and recommendations.

In order to provide the Commission with robust and relevant conclusions we have taken care to respect the requirements that lead to a successful evaluation. We list below these requirements and present our approach for their coverage:

1. Analytical – *The study is based on recognised research techniques*. Our methodology was based on both qualitative and quantitative analyses:

- Qualitative analysis:
  To perform such analysis, we have collected the opinion of the various stakeholders on the foreseen aspects of the decommissioning plans and financing plans via face-to-face interviews and phone interviews, and desk research. This approach allowed us to take into account a diversity of perspectives.
- Quantitative analysis:
  In order to perform quantitative analysis, we have collected data on different aspects of the decommissioning plans and financing plans. Where relevant, we have tried to integrate sources of quantitative data favoured by DG ENER.
  This data has been used for the cost and financial/risk analyses.

The qualitative and quantitative analyses were interlinked as both analyses contributed to answer the evaluation questions stipulated in the terms of reference.

In order to collect primary and secondary data, we have used different sources (desk research, interviews, visits in the concerned Member States). The multiplicity of sources has allowed us to triangulate the data that is a *sine qua non* requirement to lead to robust conclusions.

2. Systematic – *The study will be based on careful planning and consistent use of the chosen techniques*.

When conducting studies, we have used Deloitte's management standard as developed in the Framework Contract related to this specific call. Moreover, our study team is used to carrying out studies for the European Commission, and particularly for DG ENER for several years, and making use of evaluation techniques and monitoring tools, systematically applying best practice methodologies.

Our approach means that the key stakeholders (principally DG ENER, EBRD, CPMA, concerned Member States Governments (Energy and Economy ministries) and Members of the Energy community (such as IAEA) have been involved in the study process at both concerned Member State and EU levels. The stakeholders have been identified in cooperation with DG ENER and the steering group.

3. Reliable - *the findings of the study are reproducible by a different contractor with access to the same data and using the same methods of data analysis*.

The method that Deloitte and partners NucAdvisor and VVA used to perform this study is fully in line with EU guidelines and standards such as "*The Guide, The Means, Evaluating EU Activities – A Practical Guide for the Commission Services"*. The Sec Gen has updated the latter together with the publication of the new Better Regulation Guidelines published in May 2015. We have paid attention to apply the new guidelines in this study[24]. The use of these recognised practices constitutes a guarantee of the reproducibility by other assessors and of the objectivity of our conclusions.

4. Issue-oriented - *The study addresses important issues relating to the decommissioning and financing plans, including the robustness of the financing plans and the relevance and feasibility of the detailed decommissioning plans*.

Usually, the EU Better Regulation Guidelines recommend to evaluate the *effectiveness, efficiency, coherence, relevance and EU added* of an EU intervention.

5. User-driven - *The study was designed and implemented to provide useful information to decision-makers, given the political circumstances, programme constraints and available resources*.

Our expertise in the nuclear energy sector has allowed us to *contextualise* our conclusions according to the most recent developments. During the Kick-off meeting, we have discussed our approach with the Commission and in particular with the designated project officer, in order to make the evaluation as appropriate and useful as possible.

Moreover, key project team resources had the relevant financial expertise and/or technical proficiency, and have been able to draw on the extensive expertise of the consortium members in these fields to guide their activities on the assignment.

5.3.1.2 Analytical tools

The following four analytical tools were employed on the project:

i. An evaluation of the decommissioning programmes' global cost estimation;
ii. An overall risk assessment;
iii. An analysis of the national funds and other sources for financing decommissioning, waste and spent fuel management; and
iv. An analysis of the robustness of the state budget of BG, LT and SK respectively.

[24] http://ecirca europa.eu/smart-regulation/guidelines/toc_tool_en.htm

Evaluation of the decommissioning programmes global cost estimation:

The key to development of the cost estimation of any decommissioning programme or project is a clear understanding of the scope of the work, in order to develop a comprehensive Work Breakdown Structure (WBS) and a clear understanding of how the WBS elements relate to each other. Any omissions at this point can have a significant effect on the accuracy of the final cost and schedule estimate.

Following development of the WBS a common industry practice is to produce a list of "work packages" to be developed jointly by technical and cost experts. These work packages can be defined in a number of ways and a typical complex programme or project will use a mix of these. Work packages can consist of the scope of a major project or contract, or can also include other activities across a defined period of the programme such as ongoing plant maintenance, regulatory fees, staff transition costs etc. Both the WBS and defined work packages must cover the entire scope of the programme without omission or duplication and the alignment between both must be understood. Exclusions from the programme scope should be clearly stated by the programme owner.

Development of the WBS can be benchmarked against publicly available decommissioning plans, for example for sites in Germany, Sweden and USA, and against the ISDC document to help confirm completeness, as well as items potentially out of scope.

Once the work packages are defined the technical and cost experts contributing to the work package can assess the technical approach required to perform the agreed content. Work packages will have an agreed start and end point which can be defined in terms of a period (e.g. maintenance costs in Phase 1), delivery of a specific contributor to the programme (e.g. obtain Article 37 opinion), or to transform a facility from an agreed start condition to an agreed end condition (e.g. Turbine Building Post Operational Clean Out (POCO) is already complete, remove all equipment except stairs, walkways, overhead crane using contractor organisation).

With the technical content of a work package agreed it can then be costed and the work package's internal schedule/logic developed. Costing can be performed in a number of ways, (as described in the ISDC document), but it is important to use a method appropriate to the scope and how it is to be delivered. For bottom-up estimates a common resource pool of standard labour, plant and material types and costs is used, ensuring that, for example, scaffolders have the same hourly cost regardless of which work package uses them. Parametric costs can also be used but these may become less accurate as the source estimate deviates by such factors as country, scope, regulatory regime, currency or time.

An estimating uncertainty allowance, typically a percentage range, is often allocated to account for potential inaccuracies in the estimate; these need to be recorded to allow estimates to be reassessed later on a prioritised basis.

The cost estimates and schedules of each work package are collated into the overall programme cost and schedule. Time dependent costs need to be allowed for based on the schedule that results from sequencing of the various work packages. For example, while an

annual cost for security of the site during decommissioning can be developed in a work package, the total cost over the duration is only calculated once the work packages are sequenced and the resulting duration can be assessed.

This structured approach to development of the cost estimate should be evident when examining the decommissioning programmes to be considered. Such a structured approach will contribute to confidence in the programme estimates.

Benchmarking with other programmes' outturns and estimates can be a useful tool though it is often difficult to find suitable projects costs recorded or presented in sufficient detail for an accurate comparison. However, other project estimates can often indicate areas of high resource usage, high cost, high uncertainty or high risk which may have equivalence in the project being planned. In this way areas of focus can be identified.

In summary, in order to evaluate that(a) the plans' scope of work is complete, relevant and necessary, (b) the budget is complete, reasonable and realistic, and (c) the uncertainties/risks per each plan in order to verify whether or not the contingencies have been properly estimated, we will produce conclusions based on a review of:

- the WBS for completeness / possible omissions,
- the cost and schedule estimate methods and calculations used in the programmes and the selected key projects, and their suitability,
- the extent to which experience from other programmes and projects was used in the planning of the programmes and the selected key projects,
- the processes for collating the detailed planning and estimate data into comprehensive costed programme.

The sample projects have also been reviewed against these points, where applicable, to determine whether the cost and schedule estimates for the sample projects have been constructed using a methodical and thorough process to give an answer that has a clearly understood level of confidence. Application of this approach to the selected key projects, as a sample of the totality of the projects within the programme, will provide reassurance that the individual elements making up the whole programme are being properly planned and estimated. This will inform the degree of confidence DG ENER may have that the programmes' remaining work will outturn as forecast.

Overall risk assessment

Risk assessment can be used at a number of stages within the programme.

At a high level, risks can be assessed during the conceptual phases of the programme to ensure that the WBS and work package definition and phasing recognise key risks. For example, there might be a risk that approvals take longer than expected which may lead to a work package covering regulator and stakeholder engagement at a much earlier point than may otherwise

be necessary. There may also be a technical risk, for example, associated with plant condition, resulting in an early work package covering a full structural survey of the plant.

More detailed risk assessment is typically carried out once the initial programme cost and schedule is complete. Risks associated with each planned stage of the programme are evaluated, often in a series of meetings of experts, with full knowledge of the scope, timing and cost of that phase. With this information available, the cost and schedule impact of those risks, and the cost, schedule and work scope impacts of actions to mitigate the risks can be assessed.

Risks may be internal to the programme or external to it, for example a common source of risk might be the limited resources of regulators to review the many submissions made to them by the programme, or the availability of waste facilities.

One of the most important outputs from any risk assessment exercise is the risk management plan which details who (an organisation, or ideally an individual) is allocated ownership of each risk and the planned actions to manage the mitigation against and response to the occurrence of each risk. In some cases, the risk owner may not be within the programme team, for example, risks that the programme team cannot influence or manage may need to be owned by funding organisations or other stakeholders. In instances such as these where there is a risk of increased cost (or of planning slippages), there must be clear communication of these risks to the external risk owners, and an acknowledgement by them that these risks are understood and accepted. Evidence of active risk management as well as a structured approach to calculating allowances for cost and schedule risk will contribute to confidence in the programme estimates and overall management of the programme.

We have reviewed the three programmes (in Slovakia, Bulgaria and Lithuania) for the application of a structured and thorough risk assessment and management process, such as that outlined above. In this way we were able to make an assessment of the preparedness and capability of the three programmes to manage risk events.

One of the specific questions this study seeks to address with respect to the three Member States' decommissioning plans is "*Are the contingencies properly estimated and addressed to ensure achievement of the objectives in the most likely scenarios?*"

Contingencies may be considered in two parts of the purpose of this review. The first part, termed estimating uncertainty, is intended to allow for uncertainties within the project scope and estimate. The second part is termed risk and is intended to cover events outside the normal project scope. Section 5.3.1 of the Annex explains cost build up and contingency in more detail.

Table 26 shows the weighted average estimating uncertainty from other available decommissioning estimates and the three EC funded programmes (using current included estimating uncertainty and forecast future spends only).

Plant Name (type, date)	Weighted Ave. Contingency
Ignalina, INPP (2 x RBMK, 2014)	0% [25]
Kozloduy, KNPP (4 x VVER, 2014)	10.0%
Bohunice, V1 NPP (2 x VVER, 2014)	10.1%
Forsmark Units 1-3 (3 x BWR, 2013)	11.8%
Oskarshamn Units 1-3 (3 x BWR, 2013)	14.3%
Vandellos 2 (PWR, 2003)	16.1%
Cofrentes (BWR, 2006)	16.2%
Monticello (BWR, 2008)	17.2%
Prairie Island Unit 2 (PWR, 2011)	17.4%
Prairie Island Unit 1 (PWR, 2011)	17.5%
Vermont Yankee (BWR, 2012)	17.9%
Wolf Creek (PWR, 2011)	18.5%
Barseback Unit 1 (BWR, 2006)	18.6%
Ringhals Units 1-4 (1 x PWR & 3 x BWR, 2013)	22.2%

Table 26: Weighted average estimating uncertainty from various decommissioning cost estimates (at outset of programmes other than for Kozloduy, Ignalina and Bohunice)

It can be seen that the estimating uncertainty included in the three decommissioning plans is at the lower end of the range, particularly considering that some of the more technically challenging tasks such as removal of the reactors and primary circuits remain to be done (we note, however, that the contingencies for programmes other than Kozloduy, Ignalina and Bohunice are those at the outset of these programmes, and might therefore be expected to be slightly higher than for programmes which are in progress).

As a "stress test", the effect of including more typical levels of estimating uncertainty were assessed, for example, on the ability of current funding arrangements and/or national budgets to accommodate the resulting higher cost estimate.

In the country specific sections above (3.1.5, 3.2.5, 3.3.5) the effect of two higher levels of estimating uncertainty are shown to give an "intermediate contingency" and a less likely "high contingency" case. Both are used in this study as the primary basis of the assessment of the robustness of national funding to complete the decommissioning programmes. The less likely “high contingency” case is the true stress test which might be considered by funding organisations in "what if" scenarios as a possible potentially challenging situation with a lower

[25] The INPP Final Decommissioning Plan [47] includes an allowance for risk equating to ~5% of the base cost but no specific allowance for estimating uncertainty. Kozloduy and Bohunice plans do not specifically include identified risk allowances.

probability of occurring. The impact of the “high contingency” case will also be examined in the study in order to assess its impact, should it prove to be closer to the actual project cost.

The “intermediate and high contingency” level for Ignalina was assessed at a "sub-programme" level in Section 5.3.2.3 based on levels suggested by TLG Services Inc. for particular areas of work scope. The result was an “intermediate and high contingency” level of ~12% and ~16% respectively. These values lie within the range suggested by Table 25 and have therefore been used as the basis of the intermediate and high case for Kozloduy and Bohunice.

It should be noted that the concept of a contingency added to a project base cost estimate is not unique to the nuclear industry. Other large infrastructure projects also use the same approach with varying degrees of success. Bent Flyvberg of Oxford University has examined the outturn costs of major infrastructure projects in the transport sector [183]. His results suggest that the average cost overrun of individual projects in the transport sector varies between 20-45% and would therefore be the basis of assessing contingency to be applied to these projects. However, these figures are based on the actual cost at completion compared to the initial estimate, rather than an assessment part way through performance of a project as is the situation in each of the Member State's decommissioning plans.

It should be noted also Flyvberg's assessment is based on individual projects, and projects of a type that are subject to various uncertainties such as risk of design change. In the case of the Member State's decommissioning programmes, the scope consists of a number of related projects and other associated costs making up a large programme of work. Some of these have little or no risk of design change or other large uncertainty, e.g. staffing costs, despite being significant contributors to the overall cost. As illustrated in Figure 45 individual areas of scope within a decommissioning programme may be considered to attract very high levels of uncertainty while others attract much less. The average result over the entire programme is therefore lower than that for many of the component projects, and is lower than Flyvberg's assessment suggests may be appropriate for transport sector projects. It is this average figure that Table 24 presents and is used in the Review team's identification of an "intermediate" and "high" contingency case.

It will be seen from the examination of the Member States decommissioning programmes' sample projects (Annex 5.2) that design changes are cited as a cause of delay and cost increase in some cases. The EC has its own prior experience of this issue in respect of the "Galileo" project, Europe's satellite based navigation system. The mid-term evaluation report for this project [184] examines this issue and draws a conclusion that should be considered relevant to the planning of the decommissioning programmes. The report notes:

> *"The overall cost is now estimated at 1,557.4 M€.....This is equal to an increase of app. 37%. The budget increase can be interpreted in two different ways.*
>
> *The first version is the conventional interpretation of cost increases. It argues that the cost increase is not a cost overrun since it can be justified in design changes and delays imposed upon the project by political decision-makers after the budget was given.*

The other interpretation is given by the emerging literature on optimism bias; a concept used to capture the fact that there seems to be a systematic tendency for planners to be over-optimistic when planning mega-projects. Optimism bias typically shows itself in the form of underestimation of outturn cost. Innovative projects such as Galileo are inherently risky due to the long planning horizon and complex interfaces.

According to this interpretation, the cost increases are caused by legitimate occurrences and circumstances such as design changes and delays imposed upon the project 'from outside'. However, it argues that such changes are not exceptional but on the contrary are the norm; the standard situation to be planned for. In other words; a planner must know, that he does not know. This information shall be used actively in the form of reference forecasting i.e. comparing a given project with outturn costs of a group of similar projects. In doing so the planner moves away from treating design changes and delays as 'surprises' to seeing them as 'normality'.

The same lesson learned should be applied to the cost estimates of the Member States decommissioning programmes, i.e. that design changes and their consequential cost impacts are the norm and should be treated as such at the planning stage. Risk needs to be specifically assessed for each project within the programme taking account of the unique features of those projects and the programme within their own countries. As such there is not a simple comparison that can be used in reviewing each programme. The various approaches to risk will be presented in the programme specific analyses.

It should be underlined that the cost estimate analysis performed in this study, and thus the recommended contingency levels, take into account the most recently updated cost estimations done for the three decommissioning programmes by their operators. As the contingency levels recommended by this study thus refer to programmes whose implementation is already fully in process, they should not be compared as such to available information on cost overruns related to initial estimates.

Analysis of the national funds and other sources for financing decommissioning, waste and spent fuel management

We verified whether or not the safe completion of the decommissioning programmes is secured financially by checking whether the funds foreseen for this are sufficient based on requirements from the decommissioning plans. In particular, the capacity of provisioning resources earmarked for decommissioning and/or waste management was assessed.

Our proposed methodology includes the following analyses:

A- Financial planning capacity
   a) Identification of the financial plan elaborated (by the Member States) for the decommissioning plan including:
      i. Funding structure per source

ii. Related funding contribution (i.e. lump sum, fixed amounts or % of the total amount of the plan)
iii. Type of funding (i.e. loan, grant, guarantee, treasury bonds)

b) Review of detailed lists/ schedules/ copies of agreements (high-level) relating to co-funding and commenting upon:
   i. Third parties co-funding: Grant/ loan agreement key financial terms
   ii. Member States co-funding: earmarking decree/ budget commitment, or any other budget earmarking guarantee/ financial terms

c) Review of availability/ liquidity of third parties funding
   i. Conditions for release/ instalments
   ii. Timeframe
   iii. Currency

d) Review of availability/ liquidity of national funding (earmarking)
   i. Budget earmarking process review
   ii. Assessment or reversibility of earmarked funds
   iii. Analysis of the stability in time of the sources of funding
   iv. Analysis of the pressures on the various sources for funding, according to both external and internal factors
   v. Share of line budget (i.e. as a % of overall budget for line expenditure/ e.g. national infrastructure for energy)

e) Overall assessment of the quality of the elaboration of the financial plan:
   i. Process owner
   ii. Financial planning procedures applied
   iii. Approval circuit guaranteeing segregation of duties
   iv. External review (i.e. audited by an external/ independent body)
   v. High-level benchmarking with funding of other decommissioning plans

B- Funds management capacity

a) Assessment of the treasury management scheme
   i. Use of a single treasury account/separate account
   ii. Netting/pooling options and subsequent guarantees related to decommissioning earmarked/ reserved funds
   iii. Allocation of resources

b) Transactions/ disbursements
   i. Review payment authority and delegations scheme as well as authorisation processes and monitoring and controls set in place
   ii. Pre-approved beneficiaries

The outcome of the assessment procedures which include the elements described above consists of, for each source of funding, an opinion on the solidity and reliability of the financial commitments. Given its expected share in the financing plan, national budget earmarking capacity will be specifically analysed.

Analysis of the robustness of the state budget of BG, LT and SK respectively

The robustness of the state budgets of Bulgaria, Lithuania, and Slovakia was assessed, and in particular the ability of the governments to:

- cover additional financial contingencies that may arise before 2020, and for the whole programme;
- absorb the financing needs resulting from the uncertainties identified in the decommissioning plan and in the dedicated sources of funding.

The overall objective of this analysis is to provide an opinion on the capacity of these concerned Member States to finance the decommissioning programme on a long term basis including contingencies.

The assessment includes the following elements:

a) Assessment of the Member States long-term risk management plan for the decommissioning programme including:
    i. identification and (financial) commentary of potential contingencies
    ii. risk mitigating measures
    iii. appropriate corrective measures and related financial impact/provisions

b) Analysis of the share of the long-term financial plan (including contingencies based on prior risk analysis) as a percentage of:
    i. Member States annual GDP (i.e. for each year of the programme)
    ii. Member States budget expenditure (more specifically in Member States Mid Term Expenditure Framework)
    iii. Member States budget expenditure for the domain/budget pledge concerned (i.e. energy)
    iv. Budget/financial capacities of related responsible operators (e.g. energy agencies/ministerial commissions)

c) Review of the approval and endorsement process of the long-term financial plan including:
    i. Segregation of duties
    ii. Independent review (e.g. by Court of the Auditors/external auditors)
    iii. Endorsement process (i.e. assignment of responsibility and accountability for the plan)

The outcome of these procedures consists of an overall assessment of the robustness of the long-term financial plans and their capacities to anticipate and address risks inherent to the programmes.

This assessment builds on the previous analyses from which we are able to compare the additional funding needs resulting from the uncertainties with the concerned Member State's financial capacities.

As an additional means to confirm the robustness of the state budgets of Bulgaria, Lithuania and Slovakia, we aimed to conduct high-level comparisons with other Member States' decommissioning financing plans in order to identify the proportion between the original financing plans and additional funding needs, and the Member States budgets and GDP for instance. This analysis was ultimately not felt to be practically feasible or of added value given that the Review team were unable to find comparable examples of published decommissioning plans with which to benchmark the studied programmes in Member States for which the situation of public finances and the economy could be considered as analogous.

5.3.2 Extended research findings

This annex comprises first a broader analysis of the Greifswald decommissioning project and of the estimation of decommissioning costs and contingencies.

This is followed by three country sections (Bulgaria, Lithuania and Slovakia) presenting more specific information on:

- Decommissioning costs
- Contingency adjustments
- Funding sources overview
- Financing gap estimate

5.3.2.1 General

Comparison with Greifswald

The decommissioning programmes for Kozloduy (KNPP 1-4) and Bohunice (V1 NPP) involve the decommissioning of a VVER-440 type reactor plant.

A similar model plant consisting of four operating units plus one at completion of commissioning has been decommissioned at Greifswald in Germany and is therefore often used as a reference when considering decommissioning of similar plants. Personnel involved in the Greifswald project have been consulted by Kozloduy, Bohunice and Ignalina during the development of their own plans; such consultation is to be considered an example of good practice.

Although this consultation can prove useful for topics such as planning, waste management, dismantling techniques etc., it is of limited benefit when considering some of the most complex dismantling tasks to be performed at Kozloduy and Bohunice. This is due to differences in the scope of work performed at Greifswald compared to that planned for the other sites.

At Kozloduy and Bohunice the large components of the primary circuit (the reactor vessels and internals, and the Steam Generators) will be segmented and packaged in approved

disposal containers for final disposal at the respective national repositories. Such segmentation projects are highly complex, requiring the design and development of specialist equipment deployed for extended periods on site. The components themselves are large (e.g. Reactor Vessel: 270te, reactor internals: 50te).

At Greifswald a different approach was adopted. Although the reactor internals from Units 1 and 2 were subject to some segmentation and packaging, the five reactor vessels, internal components for Units 3-4, various steam generators etc., were removed intact and placed into shielded storage containers. These are now stored on site awaiting final disposal.

This simpler approach has the benefit to Greifswald of allowing the overall dismantling of the units to be accelerated by decoupling it from a highly complex and relatively lengthy task. This in turn allowed personnel numbers to fall quickly. It also provides for a period of radiological decay which may be useful in countries that do not have final disposal sites suitable for these items. However, it does leave significant work yet to be completed.

In the case of Kozloduy and Bohunice, the national decommissioning programmes are providing suitable disposal facilities for the resulting wastes, and the Greifswald approach does not align with the strategy of complete decommissioning and final disposal of the resulting materials.

Although there may be many useful points of reference with Greifswald at the level of individual projects, which the EC funded programmes have recognised, the significant differences in the decommissioning strategy mean that a more general comparison with overall timescales and costs can be misleading and of lesser benefit.

An Explanation of Decommissioning Cost Estimates and Contingencies

A cost estimate for a decommissioning project or programme is typically constructed of a number of elements which are illustrated in Figure 27.

The overall cost estimate can be considered in two main parts: an in-scope part and an out-of-scope part.

The in-scope part consists of the cost estimate for the planned scope of work of the project. This estimate will be made up of a number of elements, which in the ISDC [180] system are:

- Labour: the calculated cost of the labour that is known to be required for the project, comprising the cost of:
  - salaries
  - social charges
  - employee benefits
  - overheads
- Investments: the calculated cost of investments (capital, equipment and material costs) which are known to be required for the project including:
  - equipment and machinery to be used
  - installation of new systems and buildings required
  - contracted out works

    - materials
- Expenses: the calculated cost of expenses (or running costs) which are known to be required for the project, which includes
    - consumables,
    - spares
    - protective equipment
    - utilities
    - insurances
    - rents
    - licenses
    - permissions
    - etc.

These costs will be based on known labour rates, market prices, quantities of materials, comparison with other purchases, etc.

In some cases, the cost of these items cannot be estimated as there is not enough information available, although it is known that they will be needed for performance of the project. For these items, an allowance is included, which is effectively an informed guess of the approximate cost based on the estimator's experience. These allowances are typically one of the areas of focus for further work as the estimate develops with the aim of converting allowances into more conventionally prepared estimates.

Onto the cost of the various known elements of the cost estimate is added "contingency" to provide for uncertainties.

There are two kinds of contingency. The first is to cover uncertainties which are within the planned scope of the programme or project. In decommissioning cost estimates these are often called "estimating uncertainty". Their purpose is to account for uncertainties with the project cost estimate, not uncertainties in the project scope. These uncertainties may arise from the fact that various factors contributing to the cost estimate are not precisely known, such as:

- variability of labour rates,
- market response to Requests for Tender and the resulting prices,
- inexact data on the quantity and condition of materials to be managed.

As the purpose is to account for uncertainties in the cost of the planned scope, the expectation would generally be that the contingency/estimating uncertainty monies will most likely be spent.

The final element of the cost estimate is an allowance for risk. Risk is intended to cover uncertainties that are outside the scope of the planned project. The OECD document on Cost Estimation for Decommissioning [178] gives the following examples of changes beyond the defined project scope:

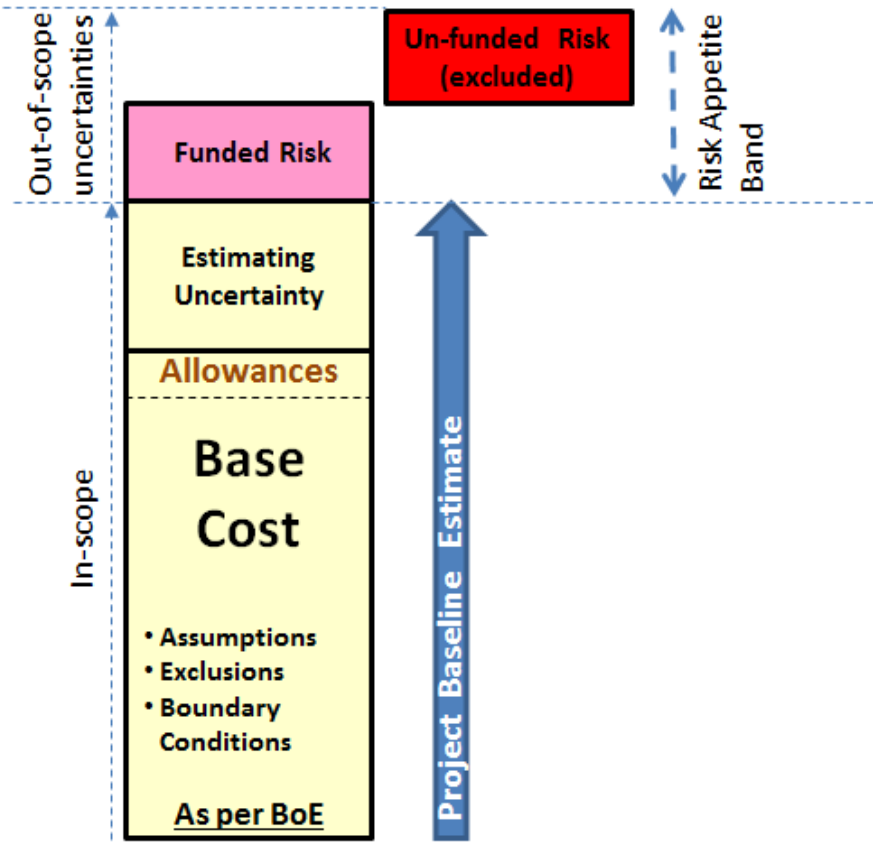
- extraordinary increases in waste disposal costs,

- inordinately high increases in labour and material costs,
- new more stringent regulations for worker safety and environmental protection,
- potential accidents relating to project shutdowns for extended periods.

These are typical risks considered at programme level. At more detailed project level, other risks are considered which may result in changes both to the base cost and additional risk allowance. For example:

- A decommissioning project may rely on the continued use of the reactor building crane despite it being old and not being regularly used since the plant shutdown. The activity for which it is to be used is on the critical path of the project. A risk is identified that the crane may suffer breakdown and need repairing with parts that are difficult to obtain due to the age of the crane; it is assessed that there is a 50% probability that this will occur during the project resulting in a delay of 4 months. The consequence of the delay in repairing the crane is a delay to the critical path of the project and hence the completion date. The large number of people involved in the programme at this point means the monthly cost of delay is high, EUR250k per month.
- As a result of the high consequence of this risk, it is decided to mitigate the risk by refurbishing the crane with modern components at a cost of EUR75k. This reduces the probability of failure to 10% and also speeds up the repair time in the event of failure to 0.5 months.
- The risk allowance to be added to the overall cost estimate to accommodate the initial risk would typically be 50% (probability of occurrence) of the delay cost of EUR1 mil., or EUR500k. The risk allowance to be added to accommodate the modified risk after refurbishment would typically be 10% of the delay cost of EUR125k, or EUR12.5k. The EUR75k costs of refurbishment also now need to be added to the project base estimate as the refurbishment is now adopted as part of the defined scope of the project. The total cost of the mitigation and remaining risk is therefore EUR87.5k. As this is less that the risk allowance to accommodate the initial risk, the mitigation would generally be considered worth implementing.

The total value of all risks is typically assessed using a probabilistic approach, such as Monte Carlo analysis which results in total value which is less than the sum of all the risks. In the event of risks occurring, the funding organisation will need to find the funds to cover them. The probabilistic analysis allows the funding organisation determine the balance between how much of the potential risk they want to proactively or reactively fund depending on their risk appetite and the availability of funds to be allocated to the project in advance of risks occurring.



Source: IAEA conference presentation on the forthcoming document *"Addressing Uncertainties in Cost Estimates for Decommissioning Nuclear Facilities",* OECD/NEA, expected 2016

Figure 27: Illustration showing build-up of a cost estimate

While the Review finds that all three programmes make allowances in their cost estimations for contingencies (either estimating uncertainty or risk), the level of these contingencies included in the financing plans is considered to be at the lower end of international practices in this field (albeit when comparing to contingency levels at the outset of similar programmes). We also consider that the contingencies have been applied using a mechanistic approach rather than by considering the specific "unknowns" associated with each project and calculating an addition to the estimate that should be adequate in the most likely scenarios. The Ignalina Programme is moving towards a quantitative assessment process that could enhance the reliability of the contingency estimation and, if confirmed, could usefully be adopted by the two other programmes. The Review has therefore considered, for all three programmes, both an “intermediate contingency” and a "high contingency" case simulation, based on a contingency level of 12% and 16% respectively, consistent with other international decommissioning programmes, in order to estimate more conservative funding requirements than are currently recognised. The study recommends as a prudent approach that the three programmes plan for financing needs and financing gaps resulting from the “high contingency” case.

5.3.2.2 Bulgaria

Decommissioning costs

The Kozloduy Units 1-4 decommissioning plan (the "Plan") was revised in stages to reflect the "Updated strategy for the decommissioning of KNPP Units 1-4" and the acceleration of units' decommissioning by 5 years. The initial decommissioning term was until 2035 and subsequently reduced to 2030.

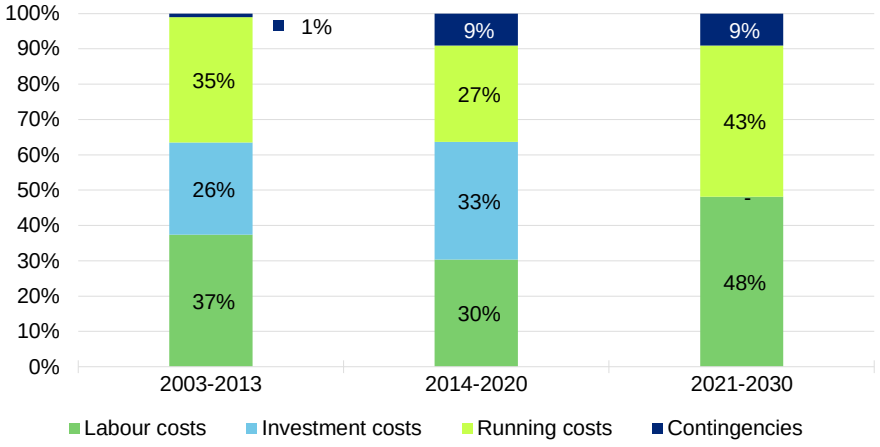
Kozloduy Units 1-4 decommissioning cost estimates per key activity and period of the project is presented in the table below.

EURmil.	2003 - 2013	2014 - 2020	2021-2030	Total
01 Pre-decommissioning activities	11	3	-	14
02 Facility shutdow n activities	76	16	-	92
03 Procurement of general equipment and materials	207	119	1	327
04 Dismantling activities	14	51	97	162
05 Waste processing, storage and disposal	0	87	145	232
06 Site security, surveillance and maintenance	75	47	56	177
07 Project management and engineering	10	7	8	25
08 Fuel and nuclear materials management	77	-	-	77
Total cost estimate	**470**	**330**	**307**	**1,107**

Source: [3.4] 04_C_2014_5449_F1_ANNEX_4_Plan_BG

Table 27: Allocation of Kozloduy Units 1-4 decommissioning costs to key activities and periods (2003-2030)

Kozloduy Units 1-4 decommissioning costs were allocated to four key cost groups as presented in the figure below.



Source: Decommissioning plan of KNPP Units 1-4 (revised in Jul-14)

Figure 28: Decommissioning costs of Kozloduy Units 1-4 allocation per key cost group and project period

As presented by the SERAW Management, the Plan is under ongoing revision and its approval for issuance is expected in Q4 2016. All projects included in the Plan are reviewed and will be updated accordingly. Certain activities which were discontinued are expected to be excluded and the new activities launched are expected to be included in the Plan. The financing gap is also up for revision.

We requested but were not provided with a Draft version of the revised Kozloduy Units 1-4 decommissioning plan, except for the revised staff and labour cost estimation for the period 2014 – 2030. Based on the SERAW latest forecast of the labour cost for 2014 -2030, a decrease of EUR 60 mil. could be expected as compared to the labour cost as per the current Plan. However, the labour cost estimate is expected to be finalised in Q4 2016, therefore not included in this study. [26]

Comment on low Programme Cost of Kozloduy Compared to Bohunice V1

An observation that occurs when reviewing the cost estimate for Kozloduy Units 1-4 is that it is relatively low compared to the other programme estimates. Whilst comparison with Ignalina is complicated by the fact that the plants are based on very different reactor technology, comparison with Bohunice V1 which is based on similar VVER440 technology is more useful.

As can be seen in Table 3, the total cost for Kozloduy is estimated at EUR 1,107.0 mil. compared to a higher estimate of EUR 1,245.6 mil. for V1 NPP. This is despite the fact that Bohunice consists of only two reactor units compared to the four at Kozloduy. While not doubling the total work required, having twice the number of units does mean that there is significant additional work required at Kozloduy. Kozloduy having a lower estimate than Bohunice (or vice versa) is therefore counter intuitive. This discrepancy between Kozloduy and Bohunice is noted in the EC's report on the Nuclear Decommissioning Assistance Programme Ex-ante Conditionalities [1]. The difference in estimates raises the possibility that some scope may be missing from the Kozloduy decommissioning estimate (or that Bohunice may be overestimated).

Part of this cost difference may be explained by differences in wage levels. The table below presents data from EUROSTAT [182] shows average total labour costs in Euros in the three Member States. Labour costs are made up of costs for wages and salaries plus "non-wage" costs such as employers social contributions etc.

	Total Average Hourly Labour Costs (EUR/hr)						
Member State	2000	2004	2008	2012	2013	2014	2015
Bulgaria	1.3	1.6	2.6	3.4	3.6	3.8	4.1
Lithuania	2.6	3.2	5.9	5.9	6.2	6.5	6.8
Slovakia	2.8	4.1	7.3	8.9	9.2	9.7	10.0

Table 28: Average labour costs in the three Member States (by recent years)

For comparison purposes, labour costs in the Kozloduy decommissioning plan are escalated to Slovakian levels, applying suitable average wage differential factors to prior years' costs and assuming that the current wage differential factor continues to apply for future years. Such escalation results in a revised estimated cost of EUR 1,743.2 mil. This revised figure puts the Kozloduy estimate in a more expected position relative to the Bohunice estimate and provides

[26] For more details please refer to Annex 5.7.

some reassurance that the estimates may be more comparable than initially suggested. Local labour costs are also likely to be an element of the costs paid for other parts of the estimate such as investment costs and expenses but detail is not available to make an assessment of the impact on those costs.

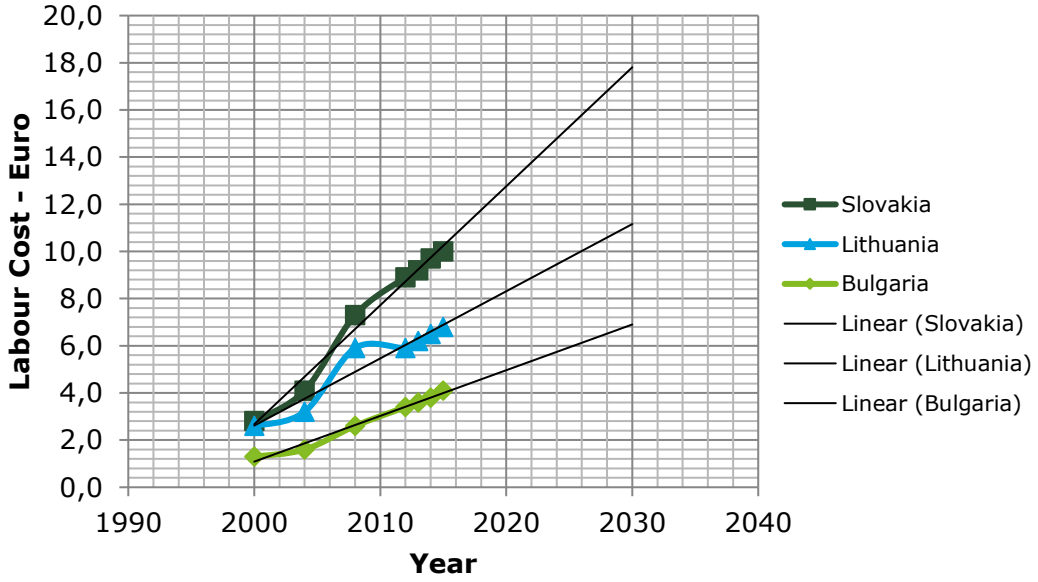


Figure 29: BG, LT and SK Ave. Labour Costs by Time

Contingency adjustments

Adjustment of Kozloduy overall contingency has been made based on 12% ("intermediate contingency" Case) and on 16% ("high contingency" case) as these are more typical of the values in Table 29 and are similar to the two contingency levels suggested for Ignalina (see Section 3.2.5).

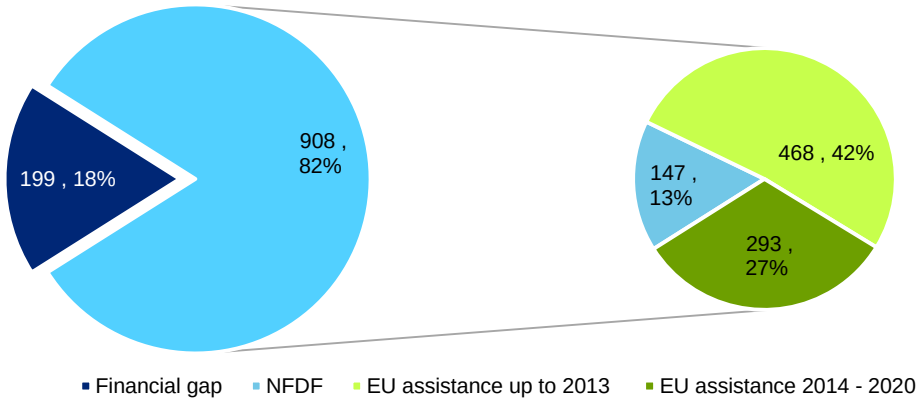
The adjustment calculation is shown in Table 29. The calculation shows that under the "intermediate contingency" case the total decommissioning cost estimate increases by EUR 12.5 mil. and that under the "high contingency" case the total decommissioning cost estimate increases by EUR 38 mil.

	2003-2012				2013-2030					% Contingency	2013-2030						2013-2030					
Main decommissioning activity groups	**Labour costs**	**Investment costs**	**Running costs**	**Total, MEUR**	**Labour costs**	**Investment costs**	**Running costs**	**Conting. costs**	**Total, MEUR**		**Labour costs**	**Investment costs**	**Running costs**	**Conting. costs**	**Total, MEUR**		**Labour costs**	**Investment costs**	**Running costs**	**Conting. costs**	**Total, MEUR**	
01. Pre-decommissioning activities	5.961	0.614	3.576	10.151	1.216	2.021	0.523	0.376	4.136	10%	--- Unchanged ---			0.451	4.211	12%	--- Unchanged ---			0.602	4.362	16%
02. Facility shutdown activities	44.467	0	26.68	71.147	13.239	0	5.863	1.911	21.013	10%	--- Unchanged ---			2.292	21.394	12%	--- Unchanged ---			3.056	22.158	16%
03. Procurement of general equipment and material	46.903	101.476	28.142	176.521	18.704	109.627	8.556	13.688	150.575	10%	--- Unchanged ---			16.426	153.313	12%	--- Unchanged ---			21.902	158.789	16%
04. Dismantling activities	5.183	0	3.11	8.294	95.109	5.933	38.681	13.972	153.695	10%	--- Unchanged ---			16.767	156.490	12%	--- Unchanged ---			22.356	162.079	16%
05. Waste processing, storage and disposal	0	0	0	0	54.733	11.916	143.898	21.055	231.602	10%	--- Unchanged ---			25.266	235.813	12%	--- Unchanged ---			33.688	244.235	16%
06. Site management and maintenance	40.883	0.793	24.53	66.205	70.942	0.62	29.333	10.089	110.984	10%	--- Unchanged ---			12.107	113.002	12%	--- Unchanged ---			16.143	117.038	16%
07. Project management and engineering	5.622	0	3.373	8.996	10.562	0	4.346	1.491	16.399	10%	--- Unchanged ---			1.789	16.697	12%	--- Unchanged ---			2.385	17.293	16%
08. Fuel and nuclear material management	9.936	0	67.337	77.273	0	0	0	0	0		--- Unchanged ---			0.000	0.000	12%	--- Unchanged ---			0.000	0.000	16%
Total, MEUR	**158.956**	**102.882**	**156.748**	**418.586**	**264.505**	**130.117**	**231.2**	**62.582**	**688.404**	10%	**264.505**	**130.117**	**231.200**	**75.099**	**700.921**		**264.505**	**130.117**	**231.200**	**100.132**	**725.954**	
														Delta	**12.517**					Delta	**37.550**	
								Total	**1106.990**					Total	**1119.507**					Total	**1144.540**	

Table 29: Calculation of revised Kozloduy overall weighted contingency

Funding sources overview

Kozloduy Units1-4 decommissioning funding structure is as presented in the figure below:



Source: ECA Special Report 16/2011 "EU Financial assistance for the decommissioning of nuclear plants in Bulgaria, Lithuania and Slovakia: Achievements and future challenges", Annex 1 to Report from the Commission to the EU Parliament and the Council COM (2015) 78 final/3.03.2015, [4.0] Ares(2015)4608214 - Report V1.00

Figure 30: Kozloduy Units 1-4 Decommissioning funding structure2003 – 2030 (EUR mil.)

The financing gap amounted to EUR 199 mil. and is expected to appear post 2020.

The Kozloduy Units 1-4 decommissioning funding structure as estimated by SERAW as of June 2016 is presented in the table below. The key differences to the previous funding structure (refer to the Figure 19 above) relate to the addition of RAWF and KNPP funding. The below structure to be formally confirmed and finalised in Q4 2016.

EURmil.	2003 - 2030
Estimated decommissioning cost	**1,107**
EU assistance (2003 - 2013)	456
EU assistance (2014 - 2020)	276
Total KIDSF financing	**731**
KNPP (2003 - 2013)	157
NFDF	156
RAWF	35
Total National Funding	**348**
Total financing	**1,079**
Financial gap (2021-2030)	**28**

Source: SERAW

Table 30: Kozloduy Units 1-4 Decommissioning funding structure for 2003 – 2030 in EUR mil. (SERAW)

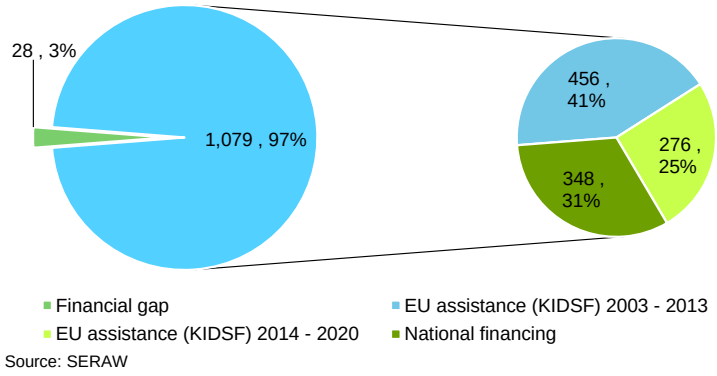


Figure 31: Kozloduy Units 1-4 Decommissioning funding structure (EURmil.)

KIDSF

KIDSF was established at EBRD in 2001 to manage the EU decommissioning assistance (grants). The aim of the fund was to mitigate the negative consequences of the Kozloduy Units premature shutdown through finance/co-finance:

1. the development and implementation of projects, related to the decommissioning of Kozloduy Units 1-4 ("nuclear window" projects) and
2. the measures derived from Bulgaria's premature shutdown of Kozloduy Units 1-4 and measures supporting the restructuring, rehabilitation and modernization of the production, energy transmission and distribution sectors, as well as increasing energy efficiency ("non-nuclear" projects).

KIDSF is a multi-donor fund, the EU being the principal donor with a decisive vote. In 2013, the EU reassessed and confirmed the role of EBRD in the management of the KIDSF for the period 2014–2020.

National funds Management bodies

The control over the funds is performed by a National Funds Management Boards, chaired by the Ministry of Energy.

NFDF management Board meets at least once every 3 months. RAWF Management Board meets each month. The Management Boards responsibilities are specified in the ASUNE, art.54 (NFDF) and art.86 (RAWF), respectively. There are independent interdepartmental expert groups (the "Groups") established to the national funds, which meet every 2 months and review all matters of concern with respect to the decommissioning program. The Groups propose a decision to be taken to the Management Boards. Each year, NFDF and RAWF approve a 3-year working programme, included in the Funds budgets. Then a proposal to the Ministry of Energy is submitted to finance the decommissioning activities within the approved budget. Following the approval, Management Boards of the NFDF and RAWF adopt draft budget for the implementation of the decommissioning programme. The adopted draft budgets are included in the draft budget of the Ministry of Energy, available through the Ministry of Finance under the Public Finance Act of Bulgaria. At least once in 5 years, the

Management Boards shall review the cost estimated for decommissioning in case of change of the licensee and periodically, and if necessary amends the amount of the payments.

Responsibilities of the Ministry of Energy of Bulgaria

The Ministry of Energy, through its Directorate "Security of the energy supply and Crisis Management" has the responsibility to:

1. monitor the implementation and coordinate measures in the nuclear facilities decommissioning, including project activities financed by the KIDSF;
2. analyse and offer solutions to problems related to nuclear power;
3. coordinate the development and the submission to the EC of the decommissioning work program, participate in its discussion, monitors its implementation and participates in the presentation of the results and for new proposals to the Assembly of Donors of the KIDSF.

The Ministry of Energy is not responsible for the development and validation of the Decommissioning plan. It is not involved in the management of resources under the KIDSF funded projects.

The Ministry of Energy responsibilities relate to the granting and approving expenditures for co-financing of decommissioning projects, as well as the implementation of decommissioning activities, which are not funded by the KIDSF, based on the SERAW Annual programmes, approved by the NFDF and RAWF Management Boards.

Funds managements and monitoring

Each year SERAW prepares a 3-year financial plan and a detailed draft budget for the next year, which are reviewed by the Financial and Economic Council of SERAW, according to the Rules of Organization and Procedure of the financial and economic council. Then, the financial plan and budget are submitted for approval by the National Funds Management Boards. According to the "Instruction for the preparation of dossiers for commitments and expenses" applicable at SERAW, a complete file for each expense is submitted to the financial controllers for the purpose of the proper and lawful spending and accounting of funds.

The monitoring on the implementation of the decommissioning activities is performed by a specialized administration of the Ministry of Energy, where SERAW submits a "Report for the implementation and progress of activities", including relevant projects and expenses, as well as "Reports for the implementation of SERAW annual program". In addition, checks on-site are organised for monitoring the physical implementation of the activities.

There are two financial controllers within SERAW, based on the provisions of the Public Law. The funds are reported by SERAW on a monthly, quarterly, semi-annual and annual basis at the Ministry of Energy. Annual reports are being approved by the Management board, the Directorate "Security of energy supply and crisis management" approves the monthly and quarterly reports. In addition, SERAW submits to the Bulgarian Ministry of Finance a financial statement at each 3 months.

NFDF and RAWF sources of funding and management

NFDF and RAWF assistance to the Kozloduy Units 1-4 decommissioning is in accordance with art. 51-55i and art.95-97 of the ASUNE. The procedure for establishing, collection, spending and control on the funds and the amount of the payments made by the National Funds is determined by Ordinance, adopted by the Council of Ministers on the basis of proposal from the Ministry of Energy and the Ministry of Finance, respectively.

The sources of funding to the two relevant national funds, are presented in the table below.

Nuclear Facilities Decommissioning Fund (NFDF)	Radioactive Waste Fund (RAWF)
- Legal entities operating nuclear facilities - *KNPP* - State budget resources - Interest from the management of the accumulated resources - Interest from overdue payments of the contributions - Donations - Other income	- Legal entities and physical persons who generate RAW - *KNPP and institutional RAW generators* - State budget resources - Interest from the management of the accumulated resources - Interest from overdue payments of the contributions - Donations - Other income

Source: [8.0] Ares(2014)3431605, Ministry of Energy

Table 31: Sources of funding of the Bulgarian National Funds (NFDF and RAWF)

The national funds revenue and expenditures are collected, reported and centralized in the System of Single Account through using a separate transit account and a separate transit code in the System for Electronic Budget payments. The account was opened by the Ministry of Energy with the Bulgarian National Bank (BNB).

National Funds spending are forecasted annually, according to the budget of the Ministry of Energy as described above. According to Section V, art.50 of the ASUNE, the NFDF and RAWF resources shall be expensed solely for the purpose of financing nuclear decommissioning activities, including:

1. Annual programme of the licensee operating the nuclear facility being decommissioning;
2. Expenses for the storage and disposal of RAW generated as result of decommissioning activities;
3. Management of the Fund, including administrative and financial costs;
4. Other activities provided for in the law and associated with the safe decommissioning.

When the realization of the project for decommissioning turns to be more expensive than the cost approved by the respective Management Board, the necessary additional funding shall be borne by the last individual/legal entity operating the nuclear facility, in accordance to the issued operating license.

Financing Gap

Financing gap estimate 2021-2030

The financing gap between the planned decommissioning costs (EUR 1,107 mil.) and the secured EU and national funding (EUR 908 mil. in total) is estimated at EUR 199 mil. EU

assistance to Kozloduy Units 1-4 decommissioning was secured in terms of solidarity. However, it remains the responsibility of the licence holder and the Bulgarian Government to raise the resources for decommissioning and waste management.

The decommissioning costs (EUR 470 mil.) in 2003–2013 were covered by the EU and national assistance, including the emergency funding form the State budget. Planned costs for 2014-2020 were estimated at EUR 330 mil. Total KIDSF funding for that period was agreed at EUR 293mil. The outstanding EUR 37 mil. are expected to be covered by the NFDF and RAWF available funds, estimated at total EUR 129.3 mil. as of December 2015, as follows:

- EUR 24 mil. from total EUR 147 mil. NFDF funds were spent until 2015, therefore EUR 123 mil. available;
- EUR 28.5 mil. from total EUR 34.8 mil. RAWF funds were spent until 2015 and EUR 6.3mil. planned to be spent post 2015. However, RAWF were not included in the current funding structure.

The financial gap as estimated at EUR 199 mil. is identified in the last decommissioning period (2021-2030)[27]. The updated funding structure is being currently prepared as part of the next revision of the Kozloduy Units 1-4 decommissioning plan, expected to be approved for issuance in the Q4 2016. Taking into account that the lower estimate is not officially approved as of the date of the Report, it is not taken into consideration in this study.

The current Plan does not include contingency provisions for unexpected risks in relation to the decommissioning activities. We have suggested the following scenarios for additional risks:

- "Intermediate contingency" case, resulting in additional costs of EUR 13 mil;
- "High contingency" case, resulting in additional costs of of EUR 38 mil.

Funds raised from Units 1-4 contributions to the national funds were insufficient to cover their decommissioning costs. To contribute partially towards the financing gap KIDSF was established.

EU assistance by stages

Total EU assistance to the Bulgarian nuclear and non-nuclear projects up to 2020 is estimated at EUR 1,161 mil., 66% (or EUR 761 mil.) of which was allocated to the Kozloduy Units 1-4 decommissioning (also Table 30 above). The EU assistance was implemented in distinct periods as presented in the table below.

[27] During the review process, the review team learnt that the financing gap is currently estimated by SERAW to be lower, at EUR 28mil as of June 2016. The revised figure was represented to be finalised by end 2016.

EURmil.	Until 2009	2010 - 2013	2014 - 2020	2021 - 2030	Total
EU pre-accession period (1999 - 2006)	*342*	-	-	-	342
EU accession period (2007 - 2009)	226	-	-	-	226
EU post-accession period	-	*300*		-	300
EU assistance (2014 - 2020)	-	-	293	-	293
Total EU assistance to Bulgarian nuclear and non-nuclear projects	**568**	**300**	**293**	**-**	**1,161**
of which allocated to KNPP Units 1-4 decommissioning	***288***	***180***	***293***	***-***	***761***

Source:

1. "Report from the Commission to the EU Parliament and the Council on implementation of the work under the nuclear decommissioning assistance programme to Bulgaria, Lithuania and Slovakia in the period 2010-2014" (the "Report"), (COM(2015) 78 Final, Brussels 3.3.2015 (cover data until 2009 and 2010 - 2013) and Annex 1 to the Report.\;
2. Council regulation (EURATOM) №1368/2013 of 13 December 2013 on Union support for the nuclear decommissioning assistance programmes in Bulgaria and Slovakia and repealing Regulation (Euratom) №549/2007 and (Euratom) №647/2010 (the "Council Regulation") and Corrigendum to Council Regulation, dated 20 December 2013

Note: The EU financial assistance above related to KNPP Units 1-4 decommissioning programme (nuclear window projects) and non-nuclear projects related to Bulgarian energy infrastructure and efficiency in line with the national energy policies.

Table 32: Summary of EU financial assistance to Bulgaria for nuclear decommissioning

The decommissioning gap as a percentage of EU funding – to Bulgarian nuclear and non-nuclear projects and Kozloduy Units 1-4 decommissioning up to 2020, respectively is presented in the table below.

EURmil.	2003-2030
Decommissioning costs (per Plan)	**1,107**
EU funding to Bulgarian nuclear and non-nuclear projects up to 2020	**1,161**
EU assistance to KNPP Units 1-4 decom. up to 2020	**761**
Decommissioning gap (Current plan)	**199**
Decom. gap as % of EU funding to Bulgarian nuclear and non-nuclear projects up to 2020	*17%*
Decom. gap as % of EU assistance to KNPP Units 1-4 decom.	*26%*
Decommissioning gap (Intermediate case)	**212**
Decom. gap as % of EU funding to Bulgarian nuclear and non-nuclear projects up to 2020	*18%*
Decom. gap as % of EU assistance to KNPP Units 1-4 decom.	*28%*
Decommissioning gap (High case)	**237**
Decom. gap as % of EU funding to Bulgarian nuclear and non-nuclear projects up to 2020	*20%*
Decom. gap as % of EU assistance to KNPP Units 1-4 decom.	*31%*

Source: KNPP Units 1-4 decommissioning plan, Ministry of Energy, SERAW information

Table 33: Decommissioning gap and EU funding

Kozloduy Units 5-6

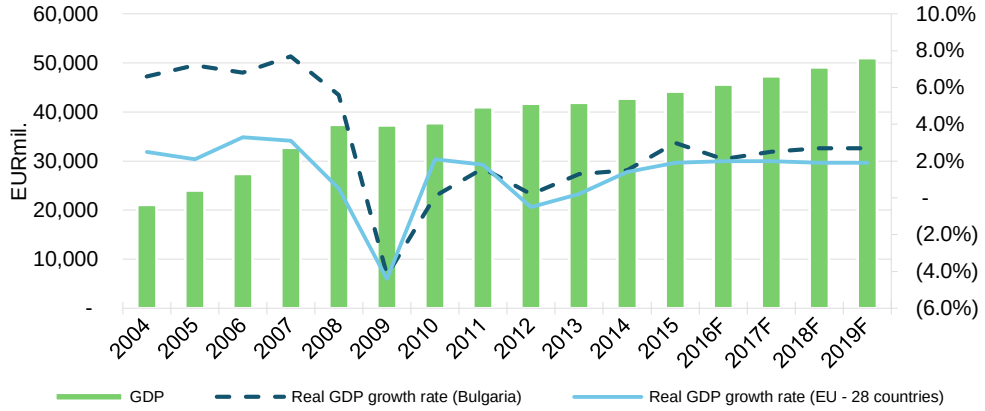
One of the options, considered by the Strategy for managing SFS and RAW until 2030, is to finance the financing gap with national resources (NFDF and RAWF), accumulated by contributions by the operating Kozloduy Units 5-6. There are however no plans to use those contributions for the purpose of the covering the financing gap, as represented by the SERAW and Ministry of Energy.

Currently Units 5 and 6 are licensed to operate until 2017 and 2019, respectively. Steps were taken towards the extension of their operational license for more than 20 years and if agreed, it is expected, based on historical contributions to the national funds, that there will be sufficient resources to cover the financing gap. The operating programme for Unit 5 is in progress, 242 measures for implementation until the end of the license period in 2017 were planned. As of 31 December 2015, the implementation of all measures for Unit 5 have been started. As represented, 55 of 242 measures were already completed.

Macroeconomic overview

Gross Domestic Product and inflation rates

The gross domestic product (GDP) of Bulgaria increased from EUR 42.8 mil. in 2014 to EUR 44.2 mil. in 2015, representing circa 3% real growth rate. The growth was driven by an increase in both external and domestic demand. Bulgaria has continuously achieved positive GDP growth rates during the period 2010 – 2015 and has repeatedly outperformed the EU (28 countries) in terms of the real GDP growth between 2012 and 2015. This trend is expected to continue in the foreseeable future, even though at lower rates compared to 2015 (increasing from 2.1% for 2016 to 2.7% for 2018 onwards), as presented in the figure below.

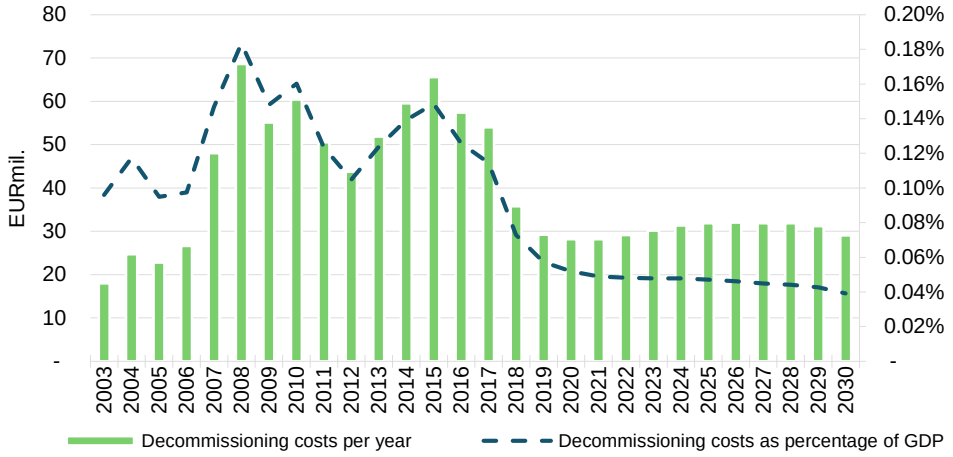


Source: Eurostat (2004 - 2015) and Ministry of Finance of Bulgaria (forecast 2016 - 2019)
Note: 2003 was not included due to lack of available data on real GDP growth rates; real GDP growth rate for Bulgaria was negative in 2009 (4.2)%.

Figure 32: Bulgarian nominal GDP and real growth rates (2004 – 2019F)

The Bulgarian economic growth in the period 2016 – 2019 is forecasted to be driven by the private consumption, further supported by an increase in investments between 2018 and 2019. The changes in the EU external environment, e.g. migration crisis and lower demand, are considered the main potential risk factors for future economic growth.

The estimated annual overall decommissioning costs, measured as a percentage of the nominal GDP, fluctuate between 0.18% (2008) and 0.04% (2030), as shown in the figure below.



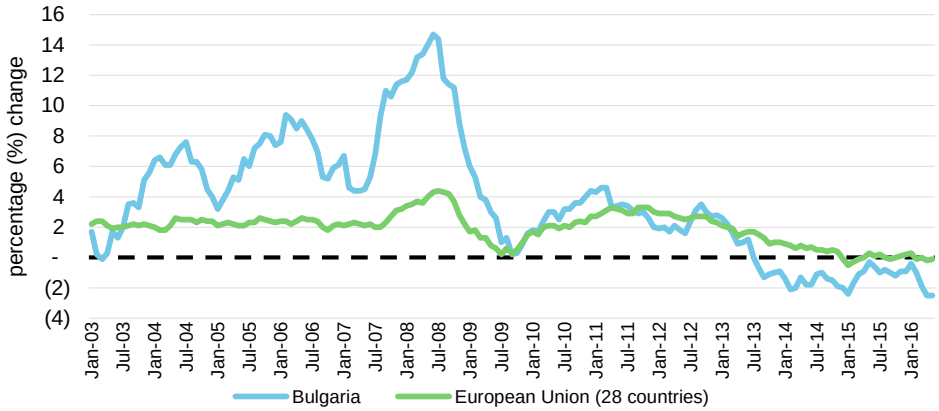
Source: Eurostat; Ministry of Finance of Bulgaria; The Economist Intelligence Unit; KNPP Units 1-4 Decommissioning

Note: Actual GDP data for 2003 – 2015 was sourced from Eurostat. Forecasted GDP levels for the period 2016 – 2019 are based on the "Spring macroeconomic forecast", issued by the Bulgarian Ministry of Finance. Forecasted GDP for the period 2020 – 2030 was based on the nominal increases in GDP, according to the Economist Intelligence Unit for the respective period.

Figure 33: Estimated decommissioning costs for Kozloduy vs GDP (2003 – 2030F)

The annual inflation rates in Bulgaria, compared to the EU (28 countries) average inflation, were higher and more volatile in the period 2003 – 2009. However, since March 2009, changes in Bulgarian prices, as measured by the HICP, were below 5% and moved closer to the average EU levels. Between August 2013 and May 2016, there has been consistent deflation in Bulgaria.

The inflation rates in Bulgaria and the EU (28 countries) for the period January 2003 – May 2016 are presented in the figure below:



Source: Eurostat

Note: * Above zero - inflation, below zero - deflation. The percentage change is measured as the change in prices for a respective month compared to the same month of the previous year.

Figure 34: Annual inflation rates in Bulgaria as measured by HICP (2003 – 2016)

Budgetary balance

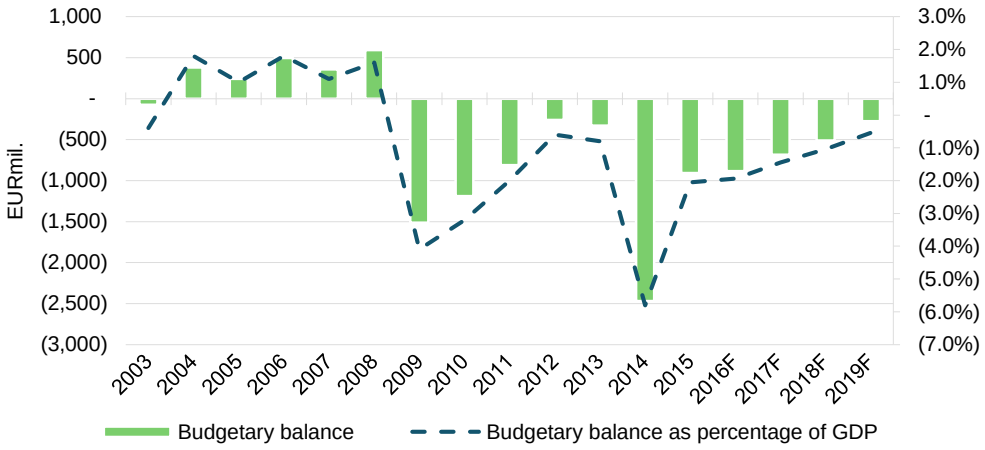
According to Eurostat, Bulgaria had one of the largest General budget deficits in terms of the GDP among the EU countries at 5.4% as of December 2014 (e.g. Spain 5.9%, Portugal 7.2%,

Cyprus 8.9%, Croatia 5.5% and United Kingdom 5.6%). Pursuant to the Excessive Deficit Procedure (EDP), governed by art. 126 of the Treaty on the functioning of the European Union, the countries with a budget deficit exceeding 3% of the GDP, shall provide a corrective action plan, including deadlines for its achievement. Bulgaria did not submit a correction plan to the EU, but due to an exceptional circumstance, the collapse of Corporate Commercial Bank, the fourth largest bank in Bulgaria, no procedures have been started against the country.

The Bulgarian deposit insurance fund was forced to make payments on guaranteed deposits equal to circa 3% of the GDP (approx. EUR 1.3b), part of which was taken into account in the budgetary deficit calculation. The Bulgarian budgetary deficit decreased by 3.7 p.p. to 2.1% of GDP as of December 2015, compared to 5.4% as of December 2014.

According to the Ministry of Finance mid-term budgetary strategy (2017 – 2019), the budgetary deficit as percentage of the GDP is forecasted to decrease from 1.9% in 2016 to 0.5% in 2019.

The historical budgetary balances (2003 – 2015) and the forecasted levels (2016 – 2019) are presented in the figure below:



Source: Eurostat (2003 - 2015) and Ministry of Finance of Bulgaria (2016F - 2019F)

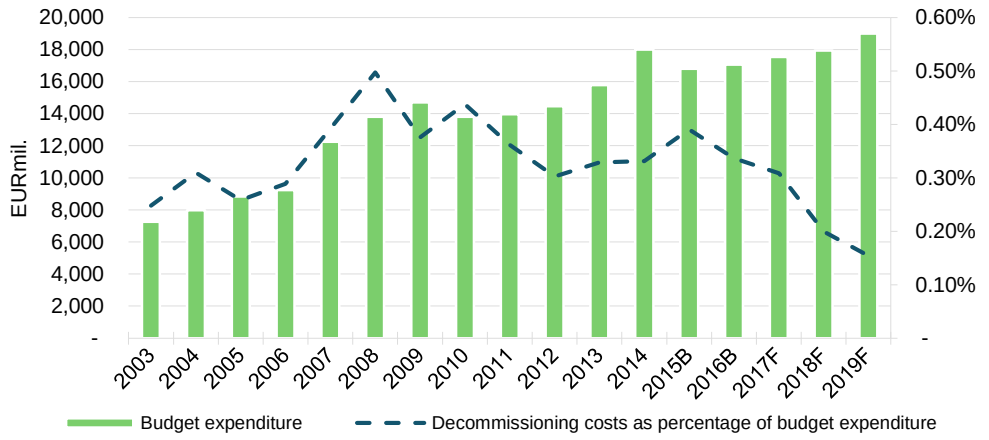
Note: Data for the period 2003 – 2014 was sourced from Eurostat and comprised the subsectors: Central Government, State Government, Local Government and social security funds. Data 2015B – 2018F was sourced from the Bulgarian Ministry of Finance's medium term budget forecast and comprised budgetary balances as per consolidated fiscal program.

Figure 35: Bulgarian budget balances (2003 – 2019)

The consolidated budgetary surplus of Bulgaria as of April 2016 amounted to EUR 1.2 bn., of which EUR 0.7 bn. and EUR 0.5 bn. national budget and European funds surpluses, respectively.

The Bulgarian fiscal reserve account amounted to EUR 6.2 bn. as of April 2016, or circa 60% increase compared to December 2015 (EUR 3.8 bn.). The fiscal reserve comprised balances in all bank accounts of budgetary organizations (excl. municipalities), assets of the State Fund for Guaranteeing the Stability of the State Pension System (approximately EUR 1.3 bn. as of April 2016) and EU funds, related to certified expenditures, advances and/or receivables (EUR 460 mil. as of April 2016).

The estimated annual decommissioning costs, as measured in comparison to budgetary expenditures, are forecasted to decrease from 0.34% in 2016 to 0.15% in 2019, as presented in the figure below:



Source: Eurostat; Ministry of Finance of Bulgaria and KNPP Units 1-4 Decommissioning Plan

Figure 36: *Estimated decommissioning costs for Kozloduy Kozloduy vs budget expenditures (2003 – 2018)*

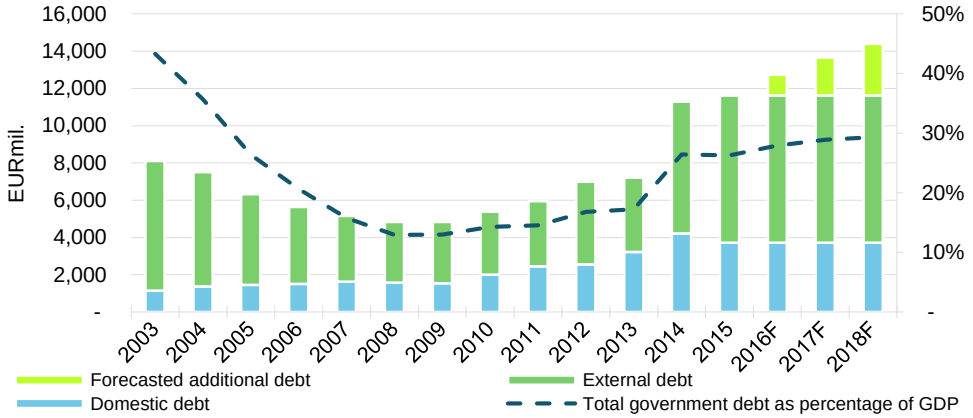
Bulgarian Government debt

The Bulgarian Government debt as of December 2014 amounted to EUR 11.3bn, a 57% increase compared to December 2013 (EUR 7.2 bn.), mainly due to the budgetary deficit and the collapse of the Corporate Commercial Bank. The Government debt as of December 2014 was 27% of the GDP, which was among the lowest levels throughout EU countries. The nominal amount of government debt as of December 2015 was EUR 11.6bn, of which 68% external and 32% internal debt, respectively.

In order to finance the budgetary deficits forecasted in 2016 – 2018, the Bulgarian Government intends to apply for additional financing at the amount of EUR 2.8 bn. until 2018 year-end, when the Government debt balance is expected to increase to 30% of the GDP.

Bulgarian Government debt balances (2003 – 2015) and forecasted development (2016 – 2018) are presented in the figure below:

Note: Forecasted additional debt for the period 2016F – 2018F is cumulative and is based on forecasted budgetary deficits for the same period.



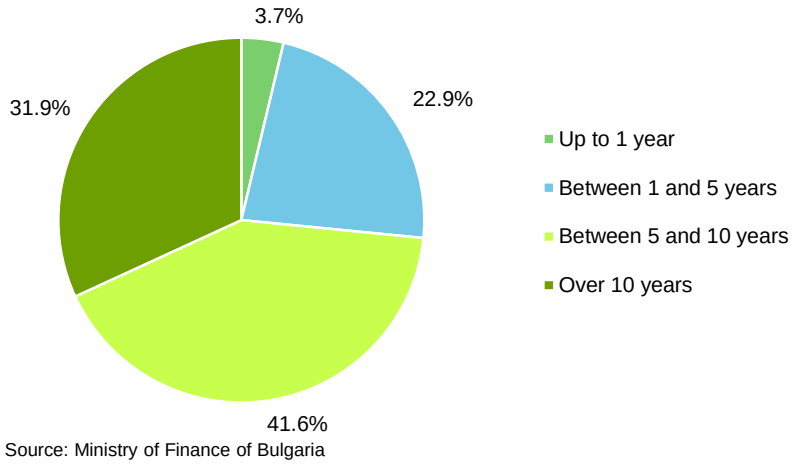
Source: Ministry of Finance of Bulgaria
Note: Forecasted additional debt for the period 2016F – 2018F is cumulative and is based on forecasted budgetary deficits for the same period.

Figure 37: Bulgarian government debt (2003 – 2018F)

The Bulgarian Government debt as a percentage of the GDP varies between 13% in 2008 and 2009, respectively to 43% in 2003. Based on the Ministry of Finance mid-term (3-year) forecast, the Government debt as a percentage of the GDP is expected to vary between 28% - 29% in the period 2016 – 2018.

The Bulgarian Government debt as of April 2016 amounted to EUR 13.3bn, representing a 15% increase compared to December 2015, mainly due to two international bond issues in 2016 of total EUR 2 bn. According to the State budget law effective in 2016, the nominal value of the new Government debt in 2016 shall not be higher than EUR 2.7 bn., therefore total Government debt at 2016 year-end shall account up to EUR 13.6 bn.

The Government debt maturity structure as of April 2016 is presented in the figure below:



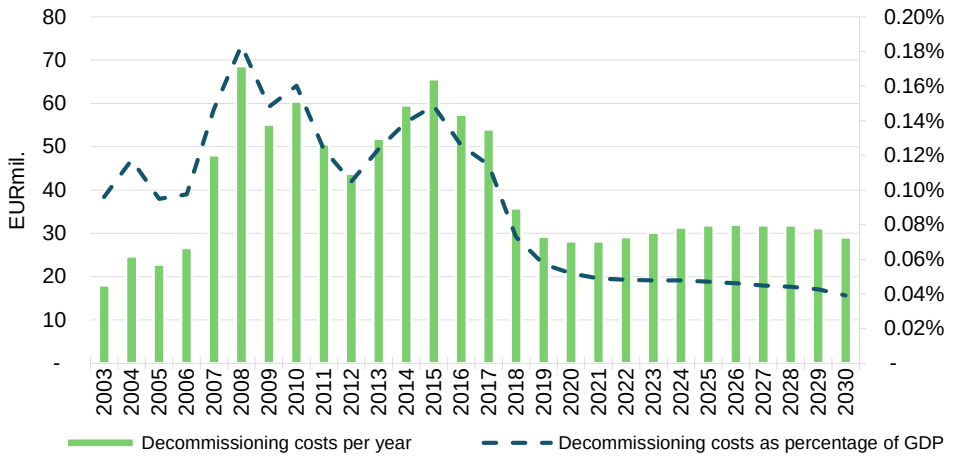
Source: Ministry of Finance of Bulgaria

Figure 38: Maturity of outstanding Bulgarian government debt as of Apr-16

The Government debt, which matures within between 5 and 10 years' accounts for 42% of the outstanding balance as of April 2016. 32% of total Government debt as of April 2016 matures in more than 10 years.

Kozloduy Units 1-4 annual decommissioning costs as percentage of the GDP

The Kozloduy Units 1-4 annual decommissioning costs as percentage of the GDP (actual and forecasted) are presented in the figure below:



Source: Eurostat; Ministry of Finance of Bulgaria; The Economist Intelligence Unit; KNPP Units 1-4 Decommissioning

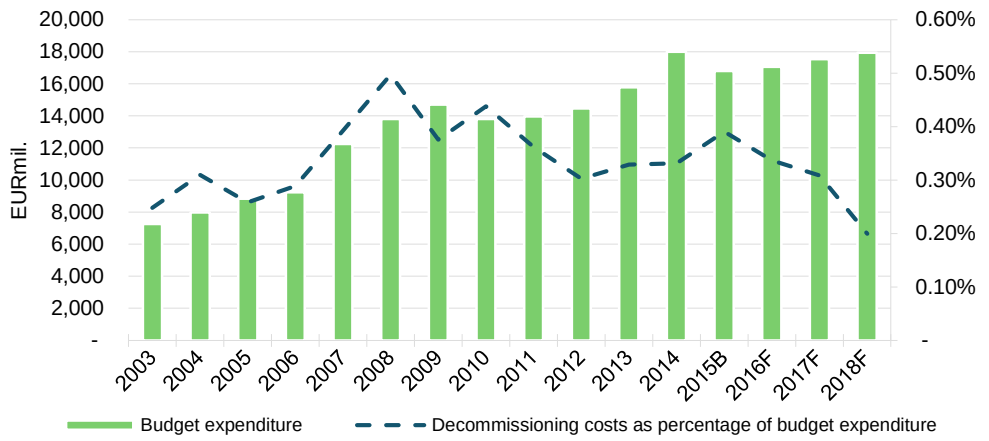
Note: Actual GDP data for 2003 – 2015 was sourced from Eurostat. Forecasted GDP levels for the period 2016 – 2019 are based on the "Spring macroeconomic forecast", issued by the Bulgarian Ministry of Finance. Forecasted GDP for the period 2020 – 2030 was based on the nominal increases in GDP, according to the Economist Intelligence Unit for the respective period.

Figure 39*:* Kozloduy Units 1-4 decommissioning costs vs GDP (2003 – 2030F)

The annual decommissioning costs fluctuate between 0.18% (2008) and 0.04% (2030) of the respective GDP. The estimated annual costs between 2015 and 2020 gradually decrease from 0.15% to 0.05%, respectively of the forecasted GDP and are expected to comprise less than 0.05% of the GDP from 2020 until 2030, the estimated completion of the decommissioning plan.

Kozloduy Units 1-4 annual decommissioning costs as percentage of the State budget expenditures

The Kozloduy Units 1-4 decommissioning costs as percentage of the State budget expenditures fluctuated between 0.25% (2003) and 0.5% (2008) in the period 2003 – 2015. The estimated annual decommissioning costs are forecasted to decrease from 0.34% in 2016 to 0.20% in 2018, as presented in the figure below:



Source: Eurostat; Ministry of Finance of Bulgaria and KNPP Units 1-4 Decommissioning Plan

Note: Actual GDP data for 2003 – 2015 was sourced from Eurostat. Forecasted GDP levels for the period 2016 – 2019 are based on the "Spring macroeconomic forecast", issued by the Bulgarian Ministry of Finance. Forecasted GDP for the period 2020 – 2030 was based on the nominal increases in GDP, according to the Economist Intelligence Unit for the respective period.

Figure 40: Estimated decommissioning costs for Kozloduy vs budget expenditures (2003 – 2018)

The estimated financing gap of the Kozloduy Units 1-4 decommissioning programme at EUR 199 mil. for the period 2021 - 2030, represents circa 0.45% of the nominal GDP for 2015 and circa 1.2% of the State budget expenditures in 2015.

A financing gap of EUR 28 mil., as per latest estimates of SERAW, would represent circa 0.06% of the nominal GDP for 2015 and 0.2% of the State budget expenditures in 2015.

5.3.2.3 Lithuania

Decommissioning costs

Final Decommissioning Plan (FDP), issue 07, dated 25 August 2014, prepared by Ignalina, estimated that decommissioning costs amount to EUR 3,377 mil. for the whole decommissioning process of Ignalina, inclusive of inflation, risks and actual decommissioning costs incurred by 2013. The entire decommissioning process of Ignalina is phased over approximately 40 years' period, which started with preparatory planning in 2001 and will be finished with the demolition of on-site structures by the end of 2038. The decommissioning plan is reviewed every 5 years, therefore an updated version of estimations may be expected by 2019.

During the decommissioning process two types of costs are incurred: direct and indirect costs. Direct costs relate to generic activities and are estimated and included in FDP (waste removal, dismantling, site clearance etc.). Indirect costs are mainly related to mitigation of the economic and social consequences of Ignalina NPP decommissioning (e.g. energy saving projects), which do not form part of FDP. Until the end of 2013, EUR 1,354 mil. were spent for the decommissioning process, EUR 718 mil. of which were direct costs.

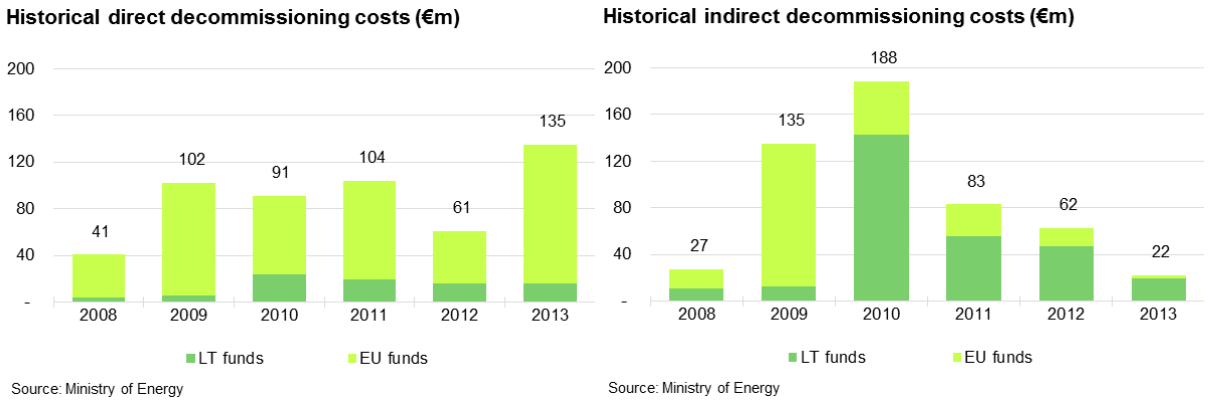


Figure 41: Direct and Indirect Ignalina decommissioning costs for 2008-2015

Contingency adjustments

Ignalina Contingency Adjustments

Adjustment of Ignalina programme specific contingency percentages has been made based on ("high contingency" case) TLG Services Inc. published percentages and ("intermediate contingency" case) judgement of Review team, taking account of the expected knowledge gained by the Ignalina team in the course of the programme so far.

TLG Services Inc. standard contingency levels are shown in Figure 42 (from [179]):

related activities. For this study, TLG examined the major activity-related problems (decontamination, segmentation, equipment handling, packaging, transport, and waste disposal) that necessitate a contingency. Individual activity contingencies ranged from 10% to 75%, depending on the degree of difficulty judged to be appropriate from TLG's actual decommissioning experience. The contingency values used in this study are as follows:

• Decontamination	50%
• Contaminated Component Removal	25%
• Contaminated Component Packaging	10%
• Contaminated Component Transport	15%
• Low-Level Radioactive Waste Disposal	25%
• Reactor Segmentation	75%
• NSSS Component Removal	25%
• Reactor Waste Packaging	25%
• Reactor Waste Transport	25%
• Reactor Vessel Component Disposal	50%
• GTCC Disposal	15%
• Non-Radioactive Component Removal	15%
• Heavy Equipment and Tooling	15%
• Supplies	25%
• Engineering	15%
• Energy	15%
• Characterization and Termination Surveys	30%
• Construction	15%
• Taxes and Fees	10%
• Insurance	10%
• Staffing	15%

Figure 42: TLG Services Inc. standard contingency rates

The calculation shows that under the "Intermediate contingency" case the total decommissioning cost estimate increases by EUR 189.1 and that under the "high contingency" case the total decommissioning cost estimate increases by EUR 285 mil.

The adjustment calculation is shown in Table 34

ORIGINAL DATA FROM FINAL DECOMMISSIONING PLAN ISSUE 7							AS FDP7			INTERMEDIATE CASE			HIGH CASE			
		2014-2020 MEUR	2021-2027 MEUR	2028-2034 MEUR	2035-2038 MEUR	TOTAL MEUR	Risk Group (Table 15.11)	Current Risk %	Allowance MEUR	Proposed Cont. %	Proposed MEUR	Delta MEUR	TLG Extreme Cont. %	Extreme MEUR	Delta MEUR	Activity
P.0	Total	110.49	113.82	86.42	25.19	335.92										Organizing of the Enterprise Activity
	P.0 Inflation	9.21	29.26	32.67	12.24	83.38										
	P.0 Total exc. Inflation	101.28	84.56	53.75	12.95	252.54										
	P.0 Own Staff Costs	53.97	53.96	34.15	8.3	150.38										
	P.0 Contractural Work / Services etc	47.09	30.56	19.58	4.93	102.16										
	P.0 Other	0.22	0.04	0.02	-0.28	0										
P.1	Total	288.86	45.65	48.24	3.53	386.28										Preparation for Decommissioning
	P.1 Inflation	11.38	11.5	18.76	1.7	43.34										
	P.1 Total exc. Inflation	277.48	34.15	29.48	1.83	342.94										
	P.1 Own Staff Costs	19.49	7.79	4.61	1.59	33.48										
	P.1 Contractural Work / Services etc	257.97	26.4	24.88	0.16	309.41										
	P.1 Other	0.02	-0.04	-0.01	0.08	0.05										
	P1.1 Subprogram	3.89	3.33	3.32	1.6	12.14	Equipment Decc	9%	1.09	10%	1.21	0.12	15%	1.82	0.73	Provision of Preliminary Conditions for INPP Decommissioning
	P1.2 Subprogram	265.64	24.45	24.21	0.16	314.46	Major Investme	5%	15.72	7.5%	23.58	7.86	15%	47.17	31.45	Infrastructure Modification
	P1.3 Subprogram	6.51	6.27	1.67	0.14	14.59	Preparation for	8%	1.17	10%	1.46	0.29	10%	1.46	0.29	Systems and Equipment Isolation
	P1.4 Subprogram	1.45	0.19	0.05	0	1.69	Equipment Decc	9%	0.15	30%	0.51	0.35	50%	0.85	0.69	Decontamination of Process Systems, Equipment and Structures
	Subprogram total	277.49	34.24	29.25	1.9	342.88										
P.2	Total	135.11	155.27	321.17	240.73	852.28										Dismantling/Demolition of Facilities and the Site Restoration
	P.2 Inflation	11.42	40.18	121.91	116.76	290.27										
	P.2 Total exc. Inflation	123.69	115.09	199.26	123.97	562.01										
	P.2 Own Staff Costs	91.84	70.27	103.21	4.44	269.76										
	P.2 Contractural Work / Services etc	31.85	44.84	96.05	119.52	292.26										
	P.2 Other	0	-0.02	0	0.01	-0.01										
	P2.1 Subprogram	19.79	56.12	78.43	0	154.34	Preparation for	8%	12.35	50%	77.17	64.82	75%	115.76	103.41	Units 1&2 Reactor Installations Dismantling
	P2.2 Subprogram	99	44.3	22.69	2.24	168.23	Preparation for	8%	3.12	20%	33.65	30.52	25%	42.06	38.93	Process Equipment, Systems Dismantling and Initial Waste Processing
	P2.3 Subprogram	4.9	14.61	97.98	111.56	229.05	Equipment Decc	9%	20.61	15%	34.36	13.74	15%	34.36	13.74	Structures Demolition
	P2.4 Subprogram	0	0	0.15	10.15	10.3	INPP Site Restor	10%	1.03	50%	5.15	4.12	50%	5.15	4.12	Site Restoration
	Subprogram total	123.69	115.03	199.25	123.95	561.92										
P.3	Total	6.82	3.62	2.78	1.87	15.09										Spent Nuclear Fuel Handling
	P.3 Inflation	0.67	0.84	1.1	0.91	3.52										
	P.3 Total exc. Inflation	6.15	2.78	1.68	0.96	11.57										
	P.3 Own Staff Costs	4.69	2.04	1.4	0.8	8.93										
	P.3 Contractural Work / Services etc	1.47	0.73	0.28	0.16	2.64										
	P.3 Other	-0.01	0.01	0	0	0										
	P3.1 Subprogram	4.02	0.67	0	0	4.69	Waste Managen	8%	0.38	8%	0.38	0	8%	0.38	0.00	Post-operational SNF Handling
	P3.2 Subprogram	0.13	0.06	0	0	0.19	Waste Managen	8%	0.02	8%	0.02	0	8%	0.02	0.00	SNF Unloading and Transportation
	P3.3 Subprogram	1.91	2.05	1.68	0.96	6.6	Waste Managen	8%	0.53	8%	0.53	0	8%	0.53	0.00	SNF Storage
	Subprogram total	6.06	2.78	1.68	0.96	11.48										
P.4	Total	100.62	170.09	129.84	47.76	448.31										Waste Handling
	P.4 Inflation	9.47	43.74	49.64	23.17	126.02										
	P.4 Total exc. Inflation	91.15	126.35	80.2	24.59	322.29										
	P.4 Own Staff Costs	62.16	93.19	61.93	20.3	237.58										
	P.4 Contractural Work / Services etc	28.98	33.16	18.31	4.31	84.76										
	P.4 Other	0.01	0	-0.04	-0.02	-0.05										
	P4.1 Subprogram	1.4	1.4	1.4	1.2	5.4	Waste Managen	8%	0.43	10%	0.54	0.11	10%	0.54	0.11	Non-radioactive Waste Handling
	P4.2 Subprogram	74.49	110.4	67.31	20.78	272.98	Waste Managen	8%	21.84	10%	27.30	5.46	10%	27.30	5.46	Solid Radioactive Waste Handling
	P4.3 Subprogram	15.18	14.37	11.32	3.01	43.88	Waste Managen	8%	3.51	10%	4.39	0.88	10%	4.39	0.88	Liquid Radioactive Waste Handling
	Subprogram total	91.07	126.17	80.03	24.99	322.26										

P.5 Total	204.54	160.76	101.2	28.39	494.89				Post-operation
P.5 Inflation	17.77	41.13	39.63	13.79	112.32				
P.5 Total exc. Inflation	186.77	119.63	61.57	14.6	382.57				
P.5 Own Staff Costs	57.37	31.7	18.18	4.83	112.08				
P.5 Contractural Work / Services etc	129.36	87.91	43.46	9.8	270.53				
P.5 Other	0.04	0.02	-0.07	-0.03	-0.04				
P5.1 Subprogram	5.04	5.04	5.04	2.88	18				Operation of Facilities and Structures Remaining in Operation for the Entire Decommissioning Period
P5.2 Subprogram	62.89	35.32	19.54	4.47	122.22				Maintenance of to Be Decommissioned Facilities and Structures until their Dismantling/Demolition
P5.3 Subprogram	118.74	79.27	36.93	7.25	242.19				Saving of Energy Resources
Subprogram total	186.67	119.63	61.51	14.6	382.41				
TOTAL CALCULATION AS PER FDP7									
TOTAL EXC INFLATION AND RISKS	786.46	482.62	426.08	178.95	1874.11	Calculated Risk	81.95		
Inflation	59.92	166.66	263.72	168.57	658.87	+ Risk Table 15.11	8		
Total Calculated Risk	30	30	20	10	90	Total	89.95		
Risk Inflation	2.84	10.39	13.11	9.37	35.7				
TOTAL	879.22	689.67	722.91	366.89	2658.68				
TOTAL inc. previous spend					**3376.98**	**Overall % Contingency**	**4.96%**		
TOTAL DELTA (inc effect of inflation)					**0.00**				
INTERMEDIATE CASE USING REVIEW TEAM ESTIMATED PERCENTAGE RISK ALLOWANCES									
TOTAL EXC INFLATION AND RISKS	786.46	482.62	426.08	178.95	1874.11				
Inflation	59.92	166.66	263.72	168.57	658.87				
Calculated Cont.	*61.42*	*54.80*	*68.99*	*25.02*	*210.23*	Calculated Risk	210.23	128.28	
+ Risk Table 15.11	*3.20*	*2.20*	*1.30*	*1.30*	*8.00*	+ Risk Table 15.11	8		
Total Calculated Cont.	64.62	57.00	70.29	26.32	218.23	Total	218.23		
Cont. Inflation	6.12	19.74	46.08	24.66	96.59				
TOTAL	917.12	726.02	806.17	398.50	2847.80				
TOTAL inc. previous spend					**3566.10**	**Overall % Contingency**		**12.43%**	
TOTAL DELTA (inc effect of inflation)					**189.12**				
HIGH CASE USING TLG ESTIMATED PERCENTAGE RISK ALLOWANCES									
TOTAL EXC INFLATION AND RISKS	786.46	482.62	426.08	178.95	1874.11				
Inflation	59.92	166.66	263.72	168.57	658.87				
Calculated Cont.	*91.72*	*73.0849*	*91.7259*	*25.2228*	*281.76*	Calculated Risk	281.76	199.81	
+ Risk Table 15.11	*3.20*	*2.20*	*1.30*	*1.30*	*8.00*	+ Risk Table 15.11	8		
Total Calculated Cont.	94.92	75.28	93.03	26.52	289.76	Total	289.76		
Cont. Inflation	8.99	26.07	60.98	24.85	120.88				
TOTAL	950.29	750.64	843.80	398.89	2943.62				
TOTAL inc. previous spend					**3661.92**	**Overall % Contingency**		**16.21%**	
TOTAL DELTA (inc effect of inflation)					**284.94**				

Table 34: Calculation of revised Ignalina overall weighted contingency

Funding sources overview

The state enterprise Ignalina Nuclear Power Plant (INPP) is carrying out the decommissioning of Ignalina nuclear power plant. The chart below illustrates Ignalina decommissioning financing sources.

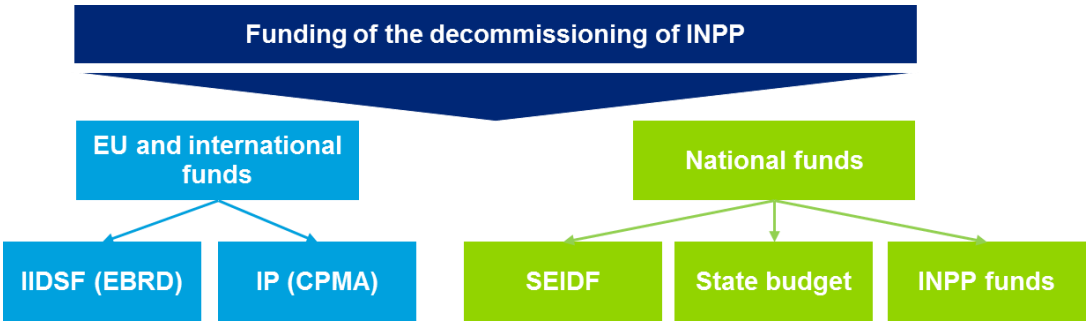


Figure 43: Ignalina decommissioning financing sources

EU and international funds (further referred as "EU funds") comprise of:

- Ignalina International Decommissioning Support Fund (IIDSF) – EU and 15 bilateral donor countries have contributed to the fund. This fund is administered by European Bank for Reconstruction and Development (EBRD) and is used to fund investment projects related to the decommissioning. Currently, the fund is focused on completion of previously initiated projects.
- Ignalina Programme funds (IP) – EU funds managed by Central Project Management Agency (CPMA). It is the key financing source for the staff, utilities, equipment, services related costs and decommissioning projects.

EU funds may be distributed via IP or IIDSF fund. Currently, new grants are allocated only to CPMA managed fund.

National funds (referred as "LT funds") comprise of:

- State Enterprise Ignalina Nuclear Power Plant Decommissioning Fund (SEIDF) – the fund which was accumulated during the life of Ignalina. After termination of power generation, it is not supplied with additional funds anymore. The administrator of the fund is Ministry of Energy. The sources from the fund are used to co-finance projects and other low value operating costs.
- Funds from the budget of the Republic of Lithuania – annually confirmed amount from the budget.
- Income from activities of Ignalina – funds generated by Ignalina itself.

As the owner of the Ignalina nuclear power plant, the Ministry of Energy supervises activities of decommissioning, including financing. The Ministry of Energy is responsible for the preparation of the plan, which foresees amounts from the financing sources to be allocated

for the decommissioning of Ignalina for the next three years. The plan is approved by the government of the Republic of Lithuania.

The process of funding is summarised by each source below.

EU & International funds

European Union through the Ignalina Programme (IP)

The European Union manages its budget in seven-year periods ("multiannual financial frameworks"). Before the MFF, a political agreement is reached with Lithuania on the level of funding for the period. Funding is allocated (but not transferred) to CPMA cumulatively by annual EC decisions. The presentation of an Annual Work Programme (prepared by the Ministry of Energy) is a prerequisite for such a decision, the document includes goals and objectives specified to be achieved during the decommissioning period. However, the actual amount is determined by the EC own financial management not by the AWP.

Once funding has been allocated, CPMA has until the expiry of its agreement with the EC to assign it to projects and to disburse it. Funding is transferred to CPMA based on the sum of the budgets of approved projects. Savings/underspend in completed projects is retained in the Programme. At the end of the fund validity period, all undisbursed funds will be returned to the European Union.

The following activities are financed from IP fund:

1. Investment projects, performed by subcontractors
2. Activities performed by INPP workforce
3. Various tools and materials that are needed to perform the work by INPP workforce

Low-value procurements by INPP are not funded from the Ignalina Programme.

INPP prepares application for financing of each activity annually. Each application for financing is verified and approved by the CPMA.

Ignalina International Decommissioning Support Fund (IIDSF)

IIDSF is used to fund large investment projects related to the decommissioning. Currently, the fund is focused on completion of previously initiated projects and new funds are not allocated.

New project proposals are submitted by INPP for approval to the EBRD. EBRD reviews, accepts and drafts grant agreement for the financing. Donors Assembly approves financing of the project. EBRD pays directly to the contractor after INPP signs a work receipt act and the EBRD inspects project documentation.

National funds

State enterprise Ignalina NPP Decommissioning Fund (SEIDF)

The Ministry of Energy approves and Energy Agency controls applications to SE INPP Decommissioning Fund.

The following procurements are covered from the SE INPP decommissioning fund:

- Those procurements that cannot be combined into big ones and are small value procurements;
- Annual works and services, which are not expensive and their check and documentation approval by the CPMA experts is labour-intensive and unreasonable as compared with the procurement cost;
- Procurements related to safety and confidentiality, which documentation cannot be in public use.

Budget of the Republic of Lithuania

The amount of the funds is confirmed annually for the upcoming year by the parliament as part of the state budget approval. State budget is used to compensate state security sensitive expenses (e.g. guards) and all taxes related to INPP activities: social taxes, land tax, natural resources tax, VAT, income tax, etc.

Income from activities of INPP

INPP generates revenue from sale of unused assets, investments and other activities. These funds are used to finance redundancy payments and other low value operating costs. All funds generated by INPP are transferred to SEIDF.

As described above, Ministry of Energy and INPP are involved in the planning of the financing need and controlling of funding process. Relevant control procedures are also established by funding managers, including regular communication with fund responsible parties:

- Reports on usage of funds (monthly/quarterly/semi-annual/annual progress reports, reports on earned value management, project completion reports, reports on request).
- Daily / weekly communication by letters, e-mails, phone.

Representatives of EBRD, CPMA and the Energy Agency on regular basis make on-the-spot inspections.

Financing gap estimate

The gap was calculated as a difference between funds which are available/committed at the end of 2013 and decommissioning costs planned for the 2014-2038 period plus additional potential risk and contingencies.

The figure below summarises direct decommissioning costs planned by INPP and committed (available) financing sources.

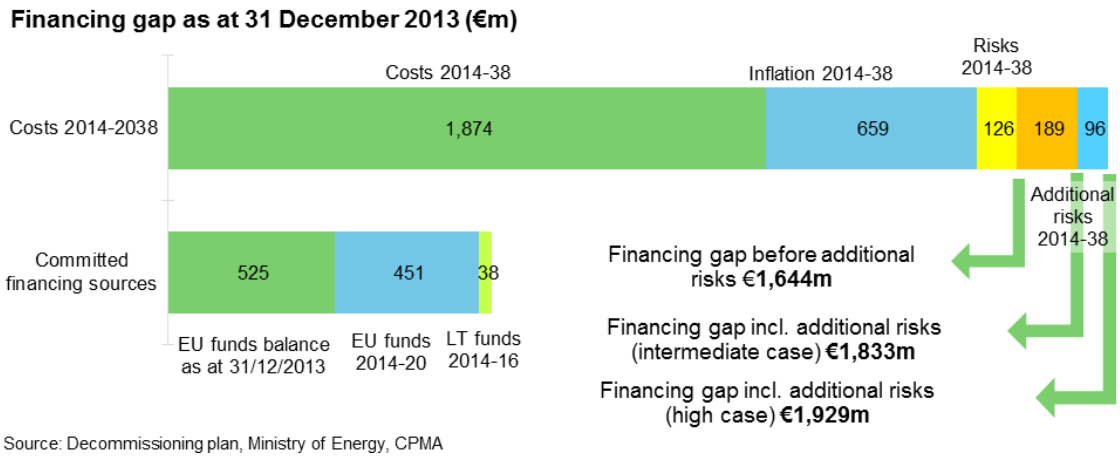


Figure 44: Estimation of financing gap at the end of 2013

Available funds were estimated as follows:

- EU Funds that are available at the end of 2013 consist of undistributed balances of IIDSF and IP based on the information provided to us (please note, that we have subtracted indirect costs which were already incurred in 2014 and 2015 and were covered by EU from the balance of EU funds).
- EU funds for 2014-2020 amount to EU assistance (EUR 451mil.) designated for the financial framework period of 2014-2020, which will have to be distributed until 2026.
- LT funds represent actually spent national funds in 2014 and 2015 and approved budgeted funds for 2016 for the decommissioning of Ignalina.

Decommissioning costs for 2014-2038 were estimated as follows:

- Decommissioning costs, inflation and allowance for risk, presented in the figure above is based on the Final Decommissioning Plan.
- Originally, allowance for risk was estimated at the level of EUR 126 mil. (incl. inflation of EUR 36 mil.). Based on the analysis performed as described above, the current estimate was considered too low, therefore additional allowance for risk and contingencies under "Intermediate contingency" case was estimated in the amount of EUR 189 mil. (incl. inflation of EUR 61 mil.) and "high contingency" case – in the amount of EUR 285 mil. (incl. inflation of EUR 85 mil.) for the period of 2014-2038.

The table below provides more detailed breakdown of the calculation of the decommissioning financing gap.

Fund srouce		mEUR	Data source
Total decommissioning costs	**A**	**3,377**	INPP decomissioning plan, issue 07
EU funds allocated until the end of 2013, net of indirect cost financing, incl:	**B**	**1,134**	
EU funds allocated until the end of 2013, gross (direct + indirect costs), incl:	B1	1,454	
IP	B1.1	630	INPP decomissioning plan
IISDF (fund)	B1.2	737	Ministry of energy
IISDF (Donors)	B1.3	33	Ministry of energy
IISDF (Interest)	B1.4	54	Ministry of energy
EU funds allocated until the end of 2015 (indirect costs only), incl:	B2	(320)	
IP	B2.1	(40)	Ministry of energy
IISDF	B2.2	(280)	Ministry of energy
EU funds committed for 2014-2020	**C**	**451**	Ministry of Energy
LT funds allocated until the end of 2013, incl:	**D**	**110**	
LT funds allocated until the end of 2013 gross (direct +indirect costs), incl:	D1	434	
State budget	D1.1	36	Ministry of energy
SEIDF	D1.2	148	Ministry of energy
INPP income from activities	D1.3	12	Ministry of energy
Other sources (municipalities' funds, energy sector companies' funds)	D1.4	238	Ministry of energy
LT funds allocated until the end of 2013 (indirect costs), incl:	D1	(403)	
State budget	D1.1	(2)	Ministry of energy
SEIDF	D1.2	(84)	Ministry of energy
INPP income from activities	D1.3	-	Ministry of energy
Other sources (municipalities' funds, energy sector companies' funds)	D1.4	(238)	Ministry of energy
LT funds committed for 2014-2016	**E**	**38**	Ministry of energy; 2016 LT budget guidelines
Total financing assistance	F=B+C+D+E	**1,733**	
Financing gap before additional risks	G=A-F	**1,644**	

Sources: Ministry of energy, INPP decomissioning plan, 2016 Lithuanian budget guidelines, Inter-institutional decommissioning pla, NA Monitoring Report 2015-H2 Section C.

Table 35: Decommissioning financing cost

Macroeconomic overview

Lithuania is one of the smaller economies of the eight central and east European countries that joined the EU in May 2004. It is also one of the poorest EU states, although it has improved relative to its neighbours in the post-crisis years. Its GDP per head was at EUR 13k in 2015, which is 75% of the EU average.

Lithuania's economy was growing at a moderate to high pace (1.6-6% in terms of real GDP) during 2008-2015 period, except for 2009 when the credit crisis hit the country's economy, which resulted in a recession and contraction of real GDP by 15%.

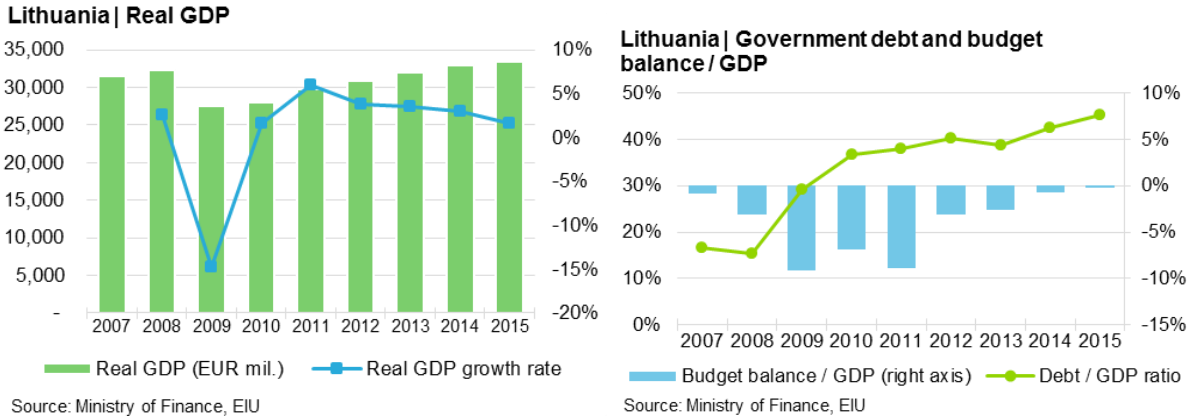


Figure 45: Lithuania's real GDP and budget balance for 2007-2015

Recession strongly affected the country's government debt development, which increased more than two times – from 18% (in 2007) to around 40% (in 2009-2010), estimated as percentage of nominal GDP. Public debt has risen moderately in recent years, but at 45% in 2015 was well below the 60% Maastricht threshold and relatively low compared with other EU countries.

Government budget was also strongly impacted by recession and changed sharply from -0.8% in 2007 to -8.4% in 2009. Alongside a gradual economic recovery since 2010, a combination of spending cuts and tax increases has reduced the budget deficit, however the balance remains negative until now, but the deficit is within EU requirements (under -3%). Record low deficit in 2015 (-0.2%) was reached due to improvement in tax collections and positive inflow (non-recurring) from State deposit insurance.

Macroeconomic indicators outlook

According to Economist Intelligence Unit (EIU) analysts and their forecast, country's real GDP is expected to continue growing at a moderate rate of 2.5-34% during 2016-2020 period, driven by growth of private consumption, increasing investments and recovering export.

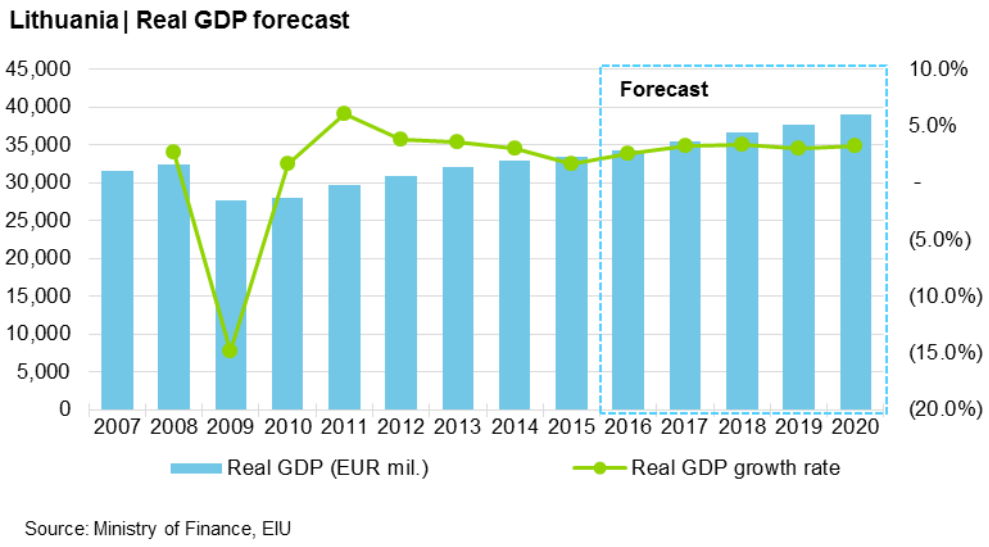


Figure 46: Lithuania's real GDP forecast

According to the same forecast, it is expected that State government balance will be somewhat negative (0.8-1.1%). Better revenue collection and stronger economic growth should allow to achieve this result.

Government debt/GDP ratio is also expected to decrease by 1-3 p.p. per year, as a result of general economy growth.

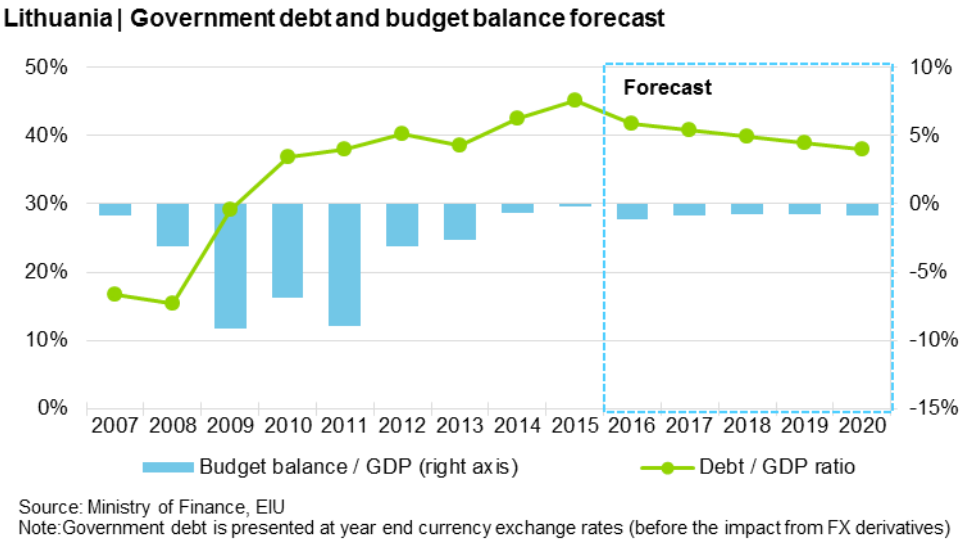


Figure 47: Lithuania's debt and budget balance forecast

5.3.2.4 Slovakia

Decommissioning costs

As of 2015, EUR 398 mil. were spent (32%) out of estimated EUR 1,239 mil. decommissioning estimate. The entire decommissioning process of Bohunice V1 is phased over approximately 23 years' period, which commenced in 2003 and is expected to be finalized in 2025. Decommissioning costs and decommissioning process are periodically reviewed by National Nuclear Fund, JAVYS and other regulatory bodies.

The financing of incurred historical decommissioning costs between 2003-2015 was split between Slovak resources (37%) and EU resources (63%).

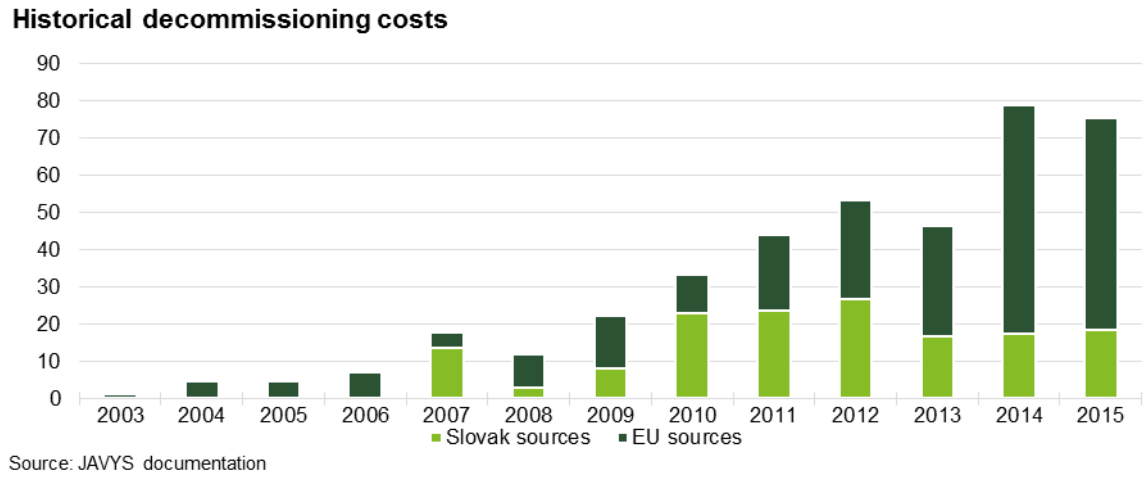


Figure 48: Historical decommissioning costs 2003-2015 (EUR mil.)

Contingency adjustments

Adjustment of Bohunice overall contingency has been made based on 12% ("intermediate contingency" case) and on 16% ("high contingency" case) as these are more typical of the values in

Nuclear Power Plant	Total Decommissioning Cost (EUR mil)	Decommissioning Timescale	Financing gap in "intermediate contingency" case (EUR mil.)	Financing gap in "high contingency" case (EUR mil.)
Kozloduy 1-4 Bulgaria	1,106.99	2003 - 2030	212	237
Ignalina 1-2 Lithuania	3,376.98	2000 - 2038	1,833	1,929
Bohunice V1 Slovakia	1,245.61	2003 - 2025	109	144

Table 1 and are similar to the two contingency levels suggested for Ignalina (see above).

The adjustment calculation is shown **Error! Reference source not found.**. The calculation s hows that under the “intermediate contingency” case the total decommissioning cost estimate increases by EUR 17.3 and that under the “high contingency” case the total decommissioning cost estimate increases by EUR 52 mil.

Project	Title	2003-2014					2015-2025						2015-2025				
		Labour costs	Investment costs	Expenses	Contingency	TOTAL COSTS	Labour costs	Investment costs	Expenses	Contingency	TOTAL COSTS	Project % Contingnecy	Labour costs	Investment costs	Expenses	Contingency	TOTAL COSTS
A1.1	PMU Consultant Phase 1	8,848,858 €	0 €	2,212,215 €	238,926 €	11,300,001 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A1.2	PMU Consultant Phase 2	2,515,808 €	0 €	628,952 €	634,780 €	3,779,541 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A1.3	PMU Consultant Phase 3	3,160,835 €	0 €	788,190 €	1,396,325 €	5,345,351 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A1.4	PMU Consultant Phase 4	2,297,046 €	0 €	574,261 €	1,448,166 €	4,319,475 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A1.5	PMU Consultant Phase 5	2,927,978 €	0 €	731,994 €	767,490 €	4,427,462 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A1.6	PMU Consultant Phase 6	8,720,136 €	0 €	2,106,447 €	911,588 €	11,738,173 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A1.7 - x (from	PMU Consultant Phase 7 - x	0 €	0 €	0 €	0 €	0 €	3,879,900 €	0 €	910,100 €	610,000 €	5,400,000 €	12.73%					
A2.1	Development of comprehensive documentation necessary for V1 NPP decommissioning licensing phase and decommissioning implementation phase	2,067,462 €	0 €	108,813 €	0 €	2,176,275 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A2.2	Documentation configuration management system	863,785 €	0 €	215,946 €	192,436 €	1,272,167 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A3-A	Reconstruction of Area protection system AKOBOJE	5,151,100 €	4,182,479 €	1,109,563 €	0 €	10,443,142 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A3-B	Reconstruction of the Public Warning and Notification System	184,794 €	150,152 €	39,966 €	175,089 €	550,000 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-A1a	Feasibility study for modification of the JAVYS and SE power supply scheme after V1 shutdown	68,546 €	0 €	6,779 €	0 €	75,325 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-A1b	Temporary Reserve Power Supply of V1 and V2 NPP of 220 kV till 2012	156,773 €	96,311 €	14,447 €	144 €	267,675 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-A2	Modification of the JAVYS power supply scheme after V1 final shutdown	3,286,674 €	6,171,342 €	1,303,280 €	4,728,705 €	15,490,000 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-A3	Optimization of Electric Scheme	0 €	0 €	0 €	0 €	0 €	341,000 €	479,000 €	180,000 €	100,000 €	1,100,000 €	10.00%					
A5-B0	Modification of the local heating system - Feasibility study	30,514 €	0 €	1,606 €	0 €	32,120 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-B1	Modification of heating and steam distribution system	1,648,506 €	3,362,169 €	142,678 €	314,526 €	5,467,880 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-B2	Reliable Heat and Steam Supply: Reconstruction of the Auxiliary Boiler Station at the Bohunice Site	1,101,015 €	3,026,026 €	311,059 €	0 €	4,438,099 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-C	Modification of Cooling and Service Water Systems, and Raw Water Inlet System	1,554,674 €	1,287,614 €	337,005 €	400,707 €	3,580,000 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-D	Modification to site supplies of essential fluids systems	433,963 €	359,417 €	94,070 €	414,550 €	1,302,000 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-E	Spent fuel management	279,270 €	0 €	59,239 €	54,400 €	392,908 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A5-F	Storage Casks for Spent Fuel	514,352 €	3,963,405 €	1,088,823 €	871,000 €	6,437,580 €	0 €	0 €	0 €	0 €	0 €	0.00%					
A6&B8	V1 Decommissioning centre	912,297 €	950,000 €	69,815 €	1,993,166 €	3,925,278 €	0 €	0 €	0 €	0 €	0 €	0.00%					
B6.1	The V1 NPP Conceptual Decommissioning Plan	463,045 €	0 €	115,761 €	0 €	578,806 €	0 €	0 €	0 €	0 €	0 €	0.00%					
B6.2	The Environmental Impact Assessment Report of V1 NPP Decommissioning	387,318 €	0 €	96,829 €	0 €	484,147 €	0 €	0 €	0 €	0 €	0 €	0.00%					
B6.3	The V1 NPP Decommissioning 1st Stage Plan & Other Documentation	3,396,472 €	0 €	192,687 €	1,623,261 €	5,212,420 €	0 €	0 €	0 €	0 €	0 €	0.00%					
B6.4	Decommissioning database	2,917,688 €	0 €	606,123 €	628,510 €	4,152,323 €	0 €	0 €	0 €	0 €	0 €	0.00%					

B6.4A	Decommissioning Database - technological upgrade	86,581 €	0 €	20,952 €	24,729 €	132,262 €	471,203 €	0 €	115,026 €	98,917 €	685,146 €	16.87%						
B6.5	V1 NPP Decommissioning 2nd Stage Plan & Licensing Documentation	3,961,047 €	0 €	990,262 €	2,467,207 €	7,418,515 €	0 €	0 €	0 €	0 €	0 €	0.00%						
B6.6A	Decommissioning Support Surveys	0 €	0 €	0 €	0 €	0 €	2,339,642 €	0 €	570,361 €	390,000 €	3,300,003 €	13.40%						
B6.7	Environmental Impact Assessment Report of 2nd Stage of V1 NPP Decommissioning	321,452 €	0 €	80,363 €	98,184 €	499,999 €	0 €	0 €	0 €	0 €	0 €	0.00%						
B7.2	Personnel Training for the Purposes of 1st Stage of V1 NPP Decommissioning	454,459 €	0 €	52,765 €	84,490 €	591,714 €	3,039 €	0 €	360 €	9,388 €	12,787 €	276.20%						
B8/1	Equipment for PMU Offices and V1 NPP decommissioning information centre	53,400 €	184,000 €	11,202 €	506,259 €	754,861 €	0 €	0 €	0 €	0 €	0 €	0.00%						
B8/2	Publicity equipment for V1 NPP decommissioning information centre	53,400 €	160,000 €	22,450 €	519,011 €	754,861 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C10	Free Release of Decommissioning Materials	1,354,947 €	913,447 €	268,961 €	1,931,397 €	4,468,750 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C12	Refurbishment of the Radiation Protection Monitoring Equipment	2,410,119 €	1,624,799 €	478,412 €	786,669 €	5,300,000 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C12.1	Laboratory Equipment Necessary for the Process of V1 NPP Decommissioning	115,034 €	305,662 €	48,831 €	128,365 €	597,892 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C12.2	Laboratory equipment necessary in the process of V1 NPP Decommissioning Stage II	0 €	0 €	0 €	0 €	0 €	115,071 €	255,610 €	32,519 €	44,800 €	448,000 €	11.11%						
C13	Disposal of Loose Radwaste	140,913 €	0 €	34,352 €	48,736 €	224,001 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C14	Disposal of Remote Handled Waste from Mogilnik	0 €	0 €	0 €	0 €	0 €	590,506 €	560,000 €	5,130,319 €	700,000 €	6,980,825 €	11.15%						
C15-A	Integrated computer system for V1 NPP decommissioning logistic system	614,694 €	0 €	129,595 €	50,400 €	794,689 €	1,955,706 €	0 €	401,208 €	201,600 €	2,558,514 €	8.55%						
C15-B	Transport and Packaging Forms for Decommissioning of V1 NPP– Stage1	682,515 €	2,090,109 €	162,923 €	300,000 €	3,235,547 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C16.1	Conditioning of Buffer Storage Areas	429,613 €	0 €	50,286 €	426,150 €	906,048 €	5,340 €	0 €	1,231 €	0 €	6,571 €	0.00%						
C17.1	Building Conditioning – Premises for Technical Documentation Centre	393,121 €	262,049 €	86,371 €	334,680 €	1,076,220 €	19,314 €	0 €	4,466 €	0 €	23,780 €	0.00%						
C7-A1	Feasibility study of Treatment of Metallic waste & Procurement of portable fragmentation and decontamination equipment for metallic and building materials	73,920 €	0 €	18,480 €	7,600 €	100,000 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C7-A2	Increasing capacity of existing fragmentation and decontamination facilities	765,178 €	634,469 €	209,104 €	175,781 €	1,784,532 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C7-A3	Erection of the new large capacity F&D facility NPP V1	1,246,079 €	3,739,755 €	233,956 €	645,447 €	5,865,234 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C7-A4	Metallic RAW melting facility	0 €	0 €	0 €	0 €	0 €	551,312 €	1,065,942 €	82,747 €	200,000 €	1,900,001 €	11.76%						
C7-B	Treatment of Historical Waste – Sludges and Sorbents	2,877,636 €	142,000 €	875,413 €	5,551,951 €	9,447,000 €	9,167,834 €	1,561,045 €	1,117,819 €	4,406,301 €	16,252,999 €	37.19%						
C7-C	Treatment and conditioning of historical waste	1,237,674 €	2,716,624 €	457,541 €	322,500 €	4,734,338 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C7-D1	Supply of One Double-Walled Transport Container for Concentrates	14,107 €	0 €	153,837 €	0 €	167,944 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C7-D2	Sampling, Analysis and Characterization of "wet waste"	34,415 €	0 €	13,785 €	0 €	48,200 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C7-D3	Sampling, Analyses and Characterization of Ra- Sediments in Storage Tanks	90,535 €	0 €	36,265 €	0 €	126,800 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C8	Interim Storage of RAW at Bohunice Site	268,391 €	0 €	61,780 €	141,724 €	471,895 €	2,578,433 €	3,447,601 €	721,954 €	2,220,349 €	8,968,337 €	32.90%						

C8-B	Interim Storage of RAW for Specific Waste	0 €	0 €	0 €	0 €	0 €	3,423,261 €	2,260,644 €	1,550,157 €	839,668 €	8,073,730 €	11.61%						
C9.1	Enlargement of the National Repository at Mochovce	708,420 €	0 €	236,140 €	155,440 €	1,100,000 €	0 €	0 €	0 €	0 €	0 €	0.00%						
C9.4	Design and Erection of New Disposal Facilities for LLW and VLLW from V1 NPP Decommissioning at NRR Mochovce	0 €	0 €	0 €	0 €	0 €	10,394,000 €	7,052,800 €	4,253,200 €	2,200,001 €	23,900,001 €	10.14%						
D1.1	Dismantling of insulation in V1 NPP Turbine Hall	954,005 €	88,895 €	344,242 €	97,506 €	1,484,649 €	0 €	0 €	0 €	0 €	0 €	0.00%						
D1.2	Dismantling of the Technical Equipment in the V1 NPP Turbine Hall	4,187,220 €	552,022 €	1,199,678 €	5,505,103 €	11,444,021 €	1,119,265 €	146,740 €	312,695 €	1,835,034 €	3,413,734 €	116.24%						
D2	Decontamination of the Primary Circuit	2,346,251 €	2,040,566 €	9,519,366 €	1,999,454 €	15,905,637 €	0 €	0 €	0 €	0 €	0 €	0.00%						
D2.1	Decontamination of Spent Fuel Pools and Other Contaminated Tanks in the V1 NPP – Part 1	0 €	0 €	0 €	0 €	0 €	1,326,962 €	175,000 €	2,088,038 €	89,792 €	3,679,792 €	2.50%						
D3.1A	Dismantling and demolition of V1 NPP external buildings – Phase 1	31,702 €	0 €	5,856 €	0 €	37,558 €	751,332 €	0 €	186,059 €	2,993,715 €	3,931,106 €	319.37%						
D3.1B	Dismantling and demolition of V1 NPP cooling towers	0 €	0 €	0 €	0 €	0 €	15,558,400 €	442,000 €	6,099,600 €	389,099 €	22,489,099 €	1.76%						
D3.2	Dismantling of Outdoor Not Contaminated Facilities and Objects	581,925 €	110,343 €	85,900 €	1,257,043 €	2,035,212 €	0 €	0 €	0 €	0 €	0 €	0.00%						
D3.3	Dismantling of Electric Power Supply Systems	1,648,557 €	516,113 €	56,590 €	1,747,457 €	3,968,717 €	0 €	0 €	0 €	0 €	0 €	0.00%						
D3.4	Diesel Group Dismantling	99,482 €	0 €	21,121 €	0 €	120,603 €	503,911 €	126,500 €	33,023 €	3,894,041 €	4,557,475 €	586.95%						
D3.4A	Diesel Group Dismantling. Erection of the Additional AKOBOJE Fence	0 €	0 €	0 €	0 €	0 €	57,700 €	15,000 €	27,300 €	528 €	100,528 €	0.53%						
D4.1	Modification of the Plant and Installation of New Equipment	0 €	0 €	0 €	0 €	0 €	1,836,221 €	1,984,389 €	1,177,932 €	140,850 €	5,139,392 €	2.82%						
D4.2	Dismantling of reactor coolant system large components	0 €	0 €	0 €	0 €	0 €	31,947,781 €	11,799,258 €	121,354,368 €	7,000,000 €	172,101,407 €	4.24%		AWP 2016 figures shown in place of 2014 DDP				
D4.3A	Dismantling of Insulation in the V1 NPP Controlled Area	0 €	0 €	0 €	0 €	0 €	733,300 €	341,100 €	1,065,600 €	45,776 €	2,185,776 €	2.14%						
D4.4A	Auxiliary Buildings System Removal – Stage 1	0 €	0 €	0 €	0 €	0 €	2,999,400 €	622,600 €	178,000 €	60,822 €	3,860,822 €	1.60%						
D4.4A1	Construction of the access road to the auxiliary building including facilities AKOBOJE	0 €	0 €	0 €	0 €	0 €	420,500 €	150,000 €	29,500 €	9,604 €	609,604 €	1.60%						
D4.4B	Dismantling of Systems in V1 NPP Controlled Area – Part 1	0 €	0 €	0 €	0 €	0 €	9,604,534 €	3,383,637 €	12,038,251 €	633,825 €	25,660,247 €	2.53%						
D4.4C	Dismantling of systems in V1 NPP controlled area - Part 2	0 €	0 €	0 €	0 €	0 €	17,113,461 €	5,951,317 €	25,855,372 €	3,500,000 €	52,420,150 €	7.15%						
D4.5	Buildings decontamination	0 €	0 €	0 €	0 €	0 €	43,304,984 €	0 €	16,991,073 €	3,170,468 €	63,466,525 €	5.26%						
D4.6	Building demolition and backfilling	0 €	0 €	0 €	0 €	0 €	124,300,127 €	0 €	30,908,693 €	13,097,055 €	168,305,875 €	8.44%						
D6.1	Site restoration	0 €	0 €	0 €	0 €	0 €	1,523,309 €	40,971 €	843,596 €	240,044 €	2,647,920 €	9.97%						
D6.2	Final survey and site release	0 €	0 €	0 €	0 €	0 €	1,523,656 €	0 €	398,434 €	529,532 €	2,451,622 €	27.55%						
D7.1	Feasibility Study for the Management of V1 NPP Primary Circuit Components	597,921 €	0 €	199,307 €	23,764 €	820,992 €	0 €	0 €	0 €	0 €	0 €	0.00%						
JAVYS Manag	JAVYS Preparation for decommissioning	12,746,135 €	0 €	0 €	0 €	12,746,135 €	0 €	0 €	0 €	0 €	0 €	0.00%						
JAVYS Manag	JAVYS Project management, engineering and support	15,053,750 €	0 €	16,869,129 €	0 €	31,922,879 €	63,547,372 €	0 €	79,090,305 €	0 €	142,637,677 €	0.00%						

JAVYS Fuel a	JAVYS Fuel and nuclear material	0 €	0 €	9,465,828 €	0 €	9,465,828 €	0 €	0 €	8,072,543 €	0 €	8,072,543 €	0.00%						
JAVYS Facility	JAVYS Facility shutdown activities	11,193,950 €	15,603,454 €	11,099,884 €	0 €	37,897,288 €	0 €	0 €	0 €	0 €	0 €	0.00%						
JAVYS Waste	JAVYS Waste processing, storage and disposal	196,890 €	0 €	2,933,938 €	0 €	3,130,828 €	12,163,104 €	0 €	6,168,523 €	0 €	18,331,627 €	0.00%						
JAVYS Site in	JAVYS Site infrastructure and operation	18,411,209 €	3,405,914 €	46,737,032 €	0 €	68,554,154 €	50,518,092 €	0 €	74,809,853 €	0 €	125,327,945 €	0.00%						
JAVYS Conve	JAVYS Conventional dismantling	0 €	0 €	8,377 €	0 €	8,377 €	0 €	0 €	1,661,212 €	0 €	1,661,212 €	0.00%						
JAVYS Establi	JAVYS Establishment of general supporting infrastructure for the decommissioning project	6,928 €	0 €	5,488 €	0 €	12,416 €	0 €	0 €	11,334 €	0 €	11,334 €	0.00%						
Funds admin	Funds administration NATIONAL AGENCY	0 €	0 €	0 €	0 €	0 €	2,660,000 €	0 €	2,465,000 €	175,000 €	5,300,000 €	3.41%						
Funds admin	Funds administration EBRD + interest	6,525,920 €	0 €	-12,794,893 €	39,055 €	-6,229,918 €	3,561,846 €	0 €	-2,229,540 €	234,330 €	1,566,636 €	17.59%						
JAVYS Miscel	JAVYS Miscellaneous expenditures (Principal Activity 11)	101,624 €	0 €	-3,492,421 €	0 €	-3,390,797 €	904,059 €	0 €	-15,578,081 €	0 €	-14,674,022 €	0.00%						
TOTAL		**146,960,028 €**	**58,639,136 €**	**99,954,996 €**	**42,169,871 €**	347,724,031 €	**423,814,877 €**	**41,861,154 €**	**389,130,150 €**	**50,060,539 €**	904,866,720 €	New Future		**423,814,877 €**	**41,861,154 €**	**389,130,150 €**		
							46.84%	**4.63%**	**43.00%**	**5.53%**					Intermediate Percentage	12%	**102,576,742 €**	
															High Percentage	16%	**136,768,989 €**	
							Future Contingency / Future Cost			**5.86%**								
							All contingency / Future Cost			**10.12%**		Prev.		**146,960,028 €**	**58,639,136 €**	**99,954,996 €**	**42,169,871 €**	347,724,031 €
												Intermediate Total		**570,774,905 €**	**100,500,290 €**	**489,085,146 €**	**102,576,742 €**	1,262,937,083 €
												Delta					11,046,330 €	17,327,169 €
												Prev.		**146,960,028 €**	**58,639,136 €**	**99,954,996 €**	**42,169,871 €**	347,724,031 €
												High Total		**570,774,905 €**	**100,500,290 €**	**489,085,146 €**	**136,768,989 €**	1,297,129,330 €
												Delta					45,238,577 €	51,519,416 €

Table 36: Calculation of revised Bohunice overall weighted contingency

Funding sources overview

In general, the basic conceptual, legal and financing framework for decommissioning programme in Slovakia is formed by the following regulations:

- Act no. 541/2004 Coll. on Peaceful use of nuclear energy;
- Act no. 238/2006 on national nuclear fund for decommissioning of nuclear equipment and spent fuel and radioactive waste treatment;
- Regulation no. 426/2010 on amount of levy from supplied electricity and manner of its collection for National Nuclear Fund

(hereinafter together as the "**Atomic Acts**")

According to the updated decommissioning strategy[28] (hereinafter the "**Back-end strategy**") approved by the Slovak government in 2014, the primary sources of financing for decommissioning project Bohunice were defined as follows:

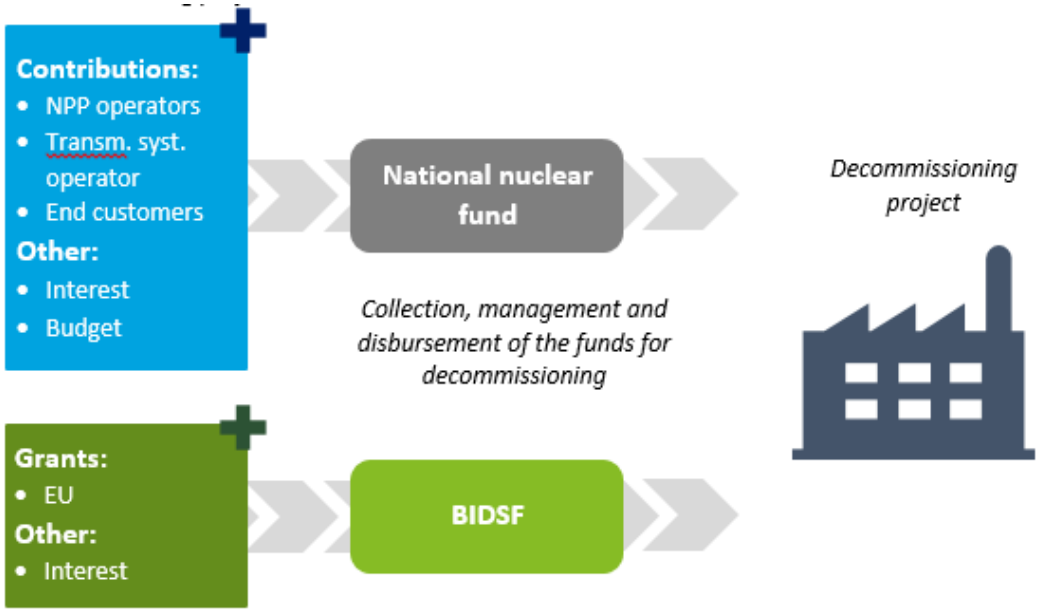


Figure 49: Slovakia general nuclear decommissioning framework

National funding

The Atomic Acts define a basic financial framework for decommissioning on the national level which is primarily managed via National Nuclear Fund ("**NNF**"). The national collection model is fundamentally based on the fixed and variable contributions:

a) **Fixed contribution**: NPP operators are obliged to pay a contribution to the NNF calculated based on the total installed NPP capacity in MW of EUR 14,483 per MW (2016)

[28] *National Policy and National Programme for handling of spent nuclear fuel and radioactive wastes in SR (July 2015).*

b) **Variable contribution 1**: NPP operators' contribution is calculated as 5.95% of revenues from nuclear production

c) **Variable contribution 2:** End customers pay a nuclear levy to NNF through the final electricity prices to cover historical decommissioning deficit

All contributions are subject of further annual valorisation.

EU funding

BIDSF was established based on the Slovak Government Decision on immediate decommissioning of Bohunice V1 as a special purpose vehicle used for the implementation of EU compensation scheme. The prime administrator of the BIDSF is the European Bank for Reconstruction and Development.

Financing gap estimate

The decommissioning gap was calculated as a difference between funds which are available/committed for the whole decommissioning period ending in 2025 plus additional potential risk and contingencies.

The figure below summarises total decommissioning resources for decommissioning of V1 NPP. Under the intermediate case the decommissioning gap totals to EUR 92 mil. with potentially additional EUR 52 mil. costs under the pessimistic scenario.

Decommissioning costs are periodically reviewed and monitored and last updated was issued if 2015, where decommissioning costs forecast was slightly adjusted to EUR 1,239 mil.

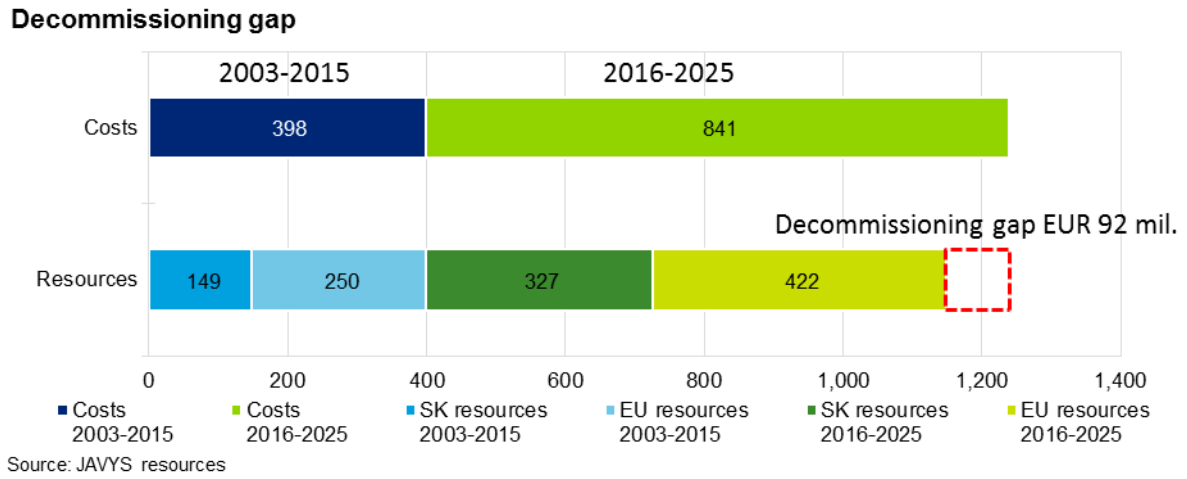


Figure 50: Resources and costs for Bohunice decommissioning project (EUR mil.)

Macroeconomic overview

Slovak GDP was growing fast relatively to other European countries prior to 2009 when the credit crisis hit country's economy hardly and GDP fell by 6.6% in 2009. Afterwards GDP growth rate was recovering to 5.6% in 2010, but slowed down to 3.3% in 2015. However, Slovakia is still experiencing one of the fastest growth rate within EU28. Slovakia's dynamic growth has depended mainly on export-oriented manufacturing FDI.

Recession and Euro debt crisis in 2009 - 2010 strongly effected country's government debt development, which increased from 30% of GDP in 2007 to 53% of GDP in 2015. The gross debt to GDP ratio started to decline after 2013. However, it was primarily driven by nonrecurring government measures that do not improve the condition of public finances in Slovakia.

Government budget expenditures were following GDP growth trends. Government budget expenditures were increasing rapidly from 2007 to 2015.

Similarly, the government budget was strongly impacted by the recession and the deficit changed from -1.7% in 2007 to -7.9% in 2009. The budget balance remains negative up to 2016, but the deficit remains within EU requirements (under -3.0%).

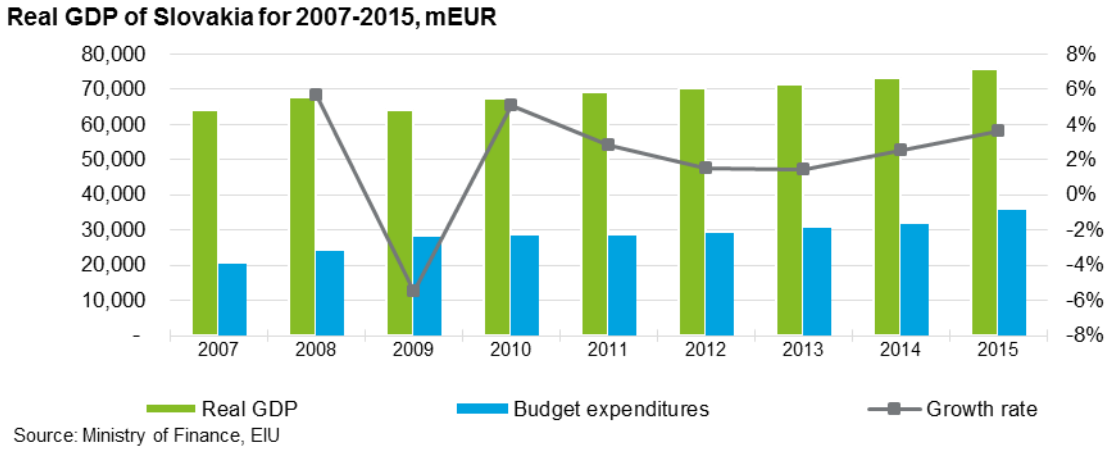


Figure 51: Historical Slovak GDP (EUR mil.)

Macroeconomic indicators outlook overview

In 2017 and 2018 moderate growth is expected in private consumption driven by slow growth in disposable income due to the gradually recovering inflation. Economic growth should reach 3.0% in 2016, 2.7% in 2017 and accelerate to 4.6% in 2018. Further improvement is driven by the new investments in the automotive industry.

Government debt/GDP ratio is also expected to decrease, as a result of economy growth and target budget balance. On the other hands, there are also contingencies related mainly to aging of the population that may affect the long-term sustainability of public finances.

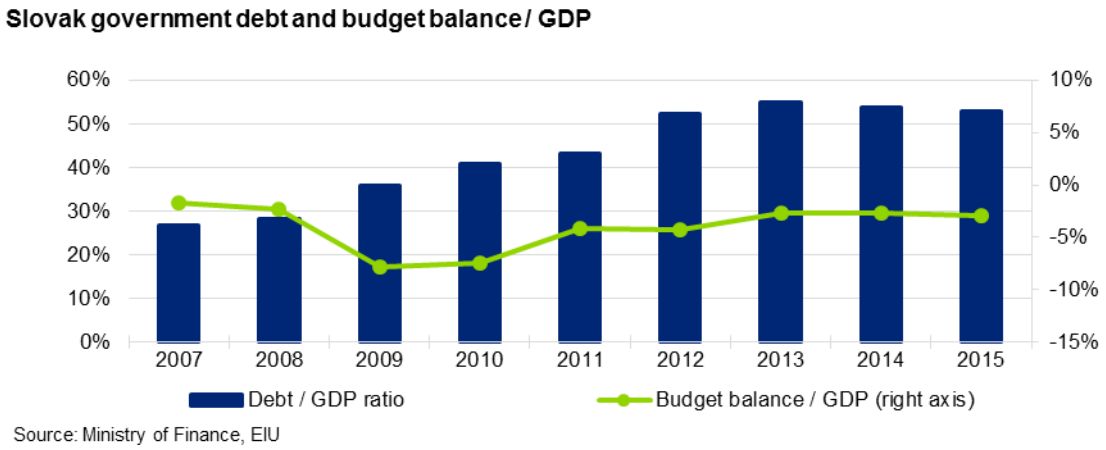


Figure 52: Historical Slovak government debt and budget balance/GDP

5.4 Glossary

GLOSSARY OF TERMS	
2015B	Budgeted figures for 2015
2016F – 2030F	Forecasted figures for the period 2016 - 2030
Q4 2016	Fourth quarter of 2016
ASUNE	Act on the safe use of nuclear energy
AWP	Annual Work Programme
bn.	Billion
BNB	Bulgarian National Bank
BNRA	Bulgarian Nuclear Regulatory Agency
Brownfield	This term generally refers to the unrestricted release of a site but without complete restoration of the ground, e.g. below ground concrete structures may remain. It is also sometimes used to describe release of a nuclear site from regulatory control subject to ongoing conditions such as restrictions in use.
CCB	Corporate Commercial Bank
CPI	Cost Performance Index
Delicencing	No longer subject to nuclear regulation.
Deplanting	System removal.
D-R PMU	Decommissioning-Repository Project Management Unit
EBRD	European Bank for Reconstruction and Development
EDP	Excessive Deficit Procedure
EIU	Economist Intelligence Unit
Estimating Uncertainty	Estimating uncertainty is the addition made to a cost estimate to account for uncertainty in some aspect of the estimated cost of the known project scope, for example uncertainty in the quantity of material required, unit price of an item, market responses to Requests for Tender, etc.
EU	European Union
EU funds	EU and international funds, comprised of IISDF and IP funds
EWN	Energiewerke Nord GmbH
FDP	Final Decommissioning Plan
GDP	Gross Domestic Product
Government debt; budget	Consolidated government debt (budget), including central and local governments, social security and other non-budget funds.

GLOSSARY OF TERMS	
Greenfield	This term generally refers to the unrestricted release of a site and remediation of the ground to the prior condition. It is also sometimes used to describe release of a nuclear site from regulatory control without ongoing conditions such as restrictions in use.
HICP	Harmonized Index of Consumer Prices
IAEA	International Atomic Energy Agency
IISDF	Ignalina International Decommissioning Support Fund, contributed by EU and 15 bilateral donor countries and administered by European Bank for Reconstruction and Development (EBRD)
INPP	Ignalina Nuclear Power Plant, "Ignalina"
IP	Ignalina Programme funds, EU funds managed by Central Project Management Agency (CPMA).
ISDC	International Structure for Decommissioning Costing- OECD document).
KIDSF	Kozloduy International Decommissioning Support Fund
KNPP	Kozloduy Nuclear Power Plant Units 1-4, "Kozloduy"
KNPP plc	The operator of Kozloduy Units 5&6
LT funds	National Lithuania funds, comprised of SEIDF, state budget and INPP funds.
MINISTRY OF ENERGY	Ministry of Energy of the Republic of Bulgaria
MF-B	Ministry of Finance of the Republic of Bulgaria
mil.	Million
NDAP	Nuclear Decommissioning Assistance Programmes
NDF	Nuclear decommissioning facility
NFDF	Nuclear Facilities Decommissioning Fund
NPP	Nuclear Power Plant
NSI	National Statistical Institute
PMU	Project Management Unit
PSO	Public Service Obligations
RAM	Radioactive materials
RATA	Lithuanian Radioactive Waste Management Agency
RAW	Radioactive Waste
RAWF	Radioactive Waste Fund

GLOSSARY OF TERMS	
SEIDF	State Enterprise Ignalina Nuclear Power Plant Decommissioning Fund, accumulated during the life of Ignalina nuclear power plant
SERAW	State Enterprise Radioactive Waste, operator of the Kozloduy NPP Units 1-4
SNF	Spent nuclear fuel
vs.	Versus
V1 NPP	Bohunice V1 Nuclear Power Plant, Units 1&2, "Bohunice"
WP	Work programme

5.5 References and Sources

5.5.1 Information sourced from the EU Communication and Information Resource Centre for Administrations, Businesses and Citizens ("CIRCABC")

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
	General	
1	[4.0] Ares(2015)4608214 - Report V1.00	Note for the file - Nuclear Decommissioning Assistance Programme - Report on the assessment of NDAP ex-ante conditionalities
2	[8.0] Ares(2014)3431605	Letter to DG-ENER from Deputy Minister of Economy and Energy, Republic of Bulgaria
3	[8.1] Ares(2014)3431605 -annex	Attachment to above
4	[1.0] 2013_12_13_CR_BG-SK_1368_2013	
5	[1.1] 2013_12_13_CR_BG-SK_1368_2013_CORRIGENDUM	
6	[3.0] 00_C_2014_5449_F1_Commissision_Implementing_Decision _EN_V7_P1_775834	
7	[3.1] 01_C_2014_5449_F1_ANNEX_1_Detailed_Ojectives	

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
	Bulgaria / KNPP, Kozloduy	
8	ENER-2015-00646-00-00-EN-TRA-00 (C21 Financial Resources)	Plan for the decommissioning of Units 1 AND 2 of NPP Kozloduy - Chapter 21: estimation of the financial resources required for decommissioning
9	ENER-2015-00647-00-00-EN-TRA-00 (C12 Dimantling Techniques)	Plan for the decommissioning of Units 1 AND 2 of NPP Kozloduy - Chapter 12: Description of the Dismantling Techniques and Equipment Available and Planned
10	KNPP U12 Decom Plan Summary	Kozloduy NPP Units 1&2 Decommissioning Plan Summary
11	SERAW_DPlan_011_3_EN	DECOMMISSIONING PLAN FOR UNITS 1 AND 2 OF KOZLODUY NPP - Chapter 11: Description of decontamination Activities
12	SERAW_DPlan_011_Attachment 11-1_3_EN	APPENDIX 11 – 1: Decontamination Alternatives
13	SERAW_DPlan_013_3_EN	Kozloduy NPP Units 1 and 2 Decommissioning Plan - Chapter 13: RAW Management Programme
14	Kozloduy AWP 2014	Annual Work Programme <Kozloduy> Programme 2014
15	Kozloduy AWP 2015	Annual Work Programme <Kozloduy> Programme 2015
16	Kozloduy AWP 2016 DRAFT	Annual Work Programme <Kozloduy> Programme 2016 Ref Number: Draft 01
17	KIDSF-1404 (WP-27 Jun 2014)	KOZLODUY INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-SEVENTH WORK PROGRAMME
18	KIDSF-1408 (WP-28 Nov 2014)	KOZLODUY INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-EIGHTH WORK PROGRAMME
19	KIDSF-1503.(WP-29 May 2015)	KOZLODUY INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-NINTH WORK PROGRAMME

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
20	KIDSF-1507 (WP-30 Nov 2015)	KOZLODUY INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT THIRTIETH WORK PROGRAMME
21	KIDSF-1603 (WP – 14 Jun 2015)	KOZLODUY INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT THIRTY-FIRST WORK PROGRAMME
22	04 KPMC Monitoring Report H1 2015	Monitoring Report - Period: January-June 2015
23	Pages from KPMU_DSF_PIS	Project Identification Sheet KISF nuclear 01 Interim Spent Fuel Storage Facility
24	KPMU_ESF_001_0	Project Identification Sheet - Project 1D extension of the Capacity of the Dry Spent Fuel Storage Facility for all WWER 440 Fuel on site
25	Contract_Agreement	Contract Agreement No 847002 between KNPP and RWE NUKEM GmbH and GNB GesellschaftfürNuklear-BehältermbH
26	A_Letter of acceptancePr1	Dry Spent Fuel Storage Facility for Kozloduy NPP Letter of Acceptance
27	B_Letter of Tender Pr1	Kozloduy International Decommission Support Fund Dry Spent Fuel Storage Facility - Second Stage Tender Letter of Tender (from RWE NUKEM)
28	F_Employer s Requirements	Technical Specification Dry Storage Facility for Spent Fuel from VVER 440 and VVER 100 Reactors of Kozloduy NPP Plc
29	KPMU_INC_06_269, KPMU_INC_06_444, KPMU_INC_07_092, KPMU_INC_07_194, KPMU_INC_08_647, KPMU_INC_08_647, KPMU_INC_08_999, KPMU_INC_09_578, KPMU_INC_09_1023, KPMU_INC_09_1153_NO, KPMU_INC_11_485	Dry Storage Facility Contract Amendments (various)

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
30	TOC Copy of original	Project Design and Implementation of a Dry Spent Fuel Storage Facility Engineers Taking-Over Certificate
31	01. GA 046	KIDSF Grant Agreement for the Construction of Phase 1 of the National Radioactive Waste Disposal Facility (NDF)
32	02. PIS	Project Identification Sheet - Construction of Phase 1 of the National Disposal Facility for Low and Intermediate Level Radioactive Waste
33	GA 048	KIDSF Grant Agreement for Implementation of the Decommissioning Programme by State Enterprise Radioactive Waste
34	GA 048A	KIDSF Grant Agreement for Implementation of the Decommissioning Programme by State Enterprise Radioactive Waste
35	KPMU_RWT_001_3	Project Identification Sheet Item No KIDSF Grant 005a, Project 5b Facility for Treatment and Conditioning of Solid Radioactive Wastes with a High Volume Reduction Factor
36	07. GA 038C	KIDSF Grant Agreement for the Design, Supply and Implantation of projects within the Initial and Second Stage Decommissioning Investment and Service Package for Kozloduy NPP and the Advance Decommissioning Programme of Units 1-4 of Kozloduy NPP
37	Contract Form	Contract Form No 394000001 between KNPP and Iberdrola Ingenerieria y Construccion SAU
38	Amendment 1, 05. Att 1-2, Amendment 2, Amendment 3, Amendment 4, Amendment 5, Amendment 6	Facility for Treatment and Conditioning of Solid Radioactive Wastes with a High Volume Reduction Factor Contract Amendments (various)

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
39	KPMU_SPR_001_8	Project Identification Sheet Project 9B/SPR Supply of a Facility for Retrieval and Processing of the Solidified Phase from Evaporator Concentrate Tanks Located in Auxiliary Buildings 1 and 2 at Kozloduy NPP Site
40	02. Contract Form	Contract Form No 394000002 between KNPP and ”Onet Technologies Grands Projets”
41	01. Amendment 1, 02. Amendment 2, 03. Amendment 3, 04. Amendment 4, 05. Amendment 5, 06. Amendment 6	Facility for the Retrieval and Processing of the Solidified Phase from the Evaporator Concentrate Tanks Contract Amendments (various)
42	[3.4] 04_C_2014_5449_F1_ANNEX_4_Plan_BG	
43	[5.0] PlanDecomm_31 July 2014 (KNPP Units 1-2) and relevant chapters	
44	[9.0] ASUNE	
45	[13.0] ISDC-nuclear-installations	
46	[14.0] SSM-Rapport-2014-01	
47	[15.0] 7201-costs-decom-npp	Costs of Decommissioning Nuclear Power Plants, OECD, 2016
48	Kozloduy Monitoring Report H2-2015 final (approved)	Monitoring Report Period: July-December 2015
48x	Assessment of the macroeconomic effects of decommissioning programmes in BG - UPDATE	Assessment of the macroeconomic effects of decommissioning programmes in BG, LT and SK in the QUEST model
48y	EQEB-1107-TM-CED-R01	Part Cost Estimate Documentation Phase 1 Explanatory Note
	Lithuania / INPP, Ignalina	
49	[33] Overview and methodology	Information requested by EC (ref. Ares (2016) 1054396 – 01-03-2016
50	[6] LT INPP Decommissioning Plan	Ignalina Nuclear Power Plant Final Decommissioning Plan issue 07
51	[8] Meeting the Costs	Ignalina NPP Closure and Decommissioning Meeting the Cost

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
52	LT AWP 2014 adopted	Annual Work Programme <Ignalina> Programme 2014
53	LT AWP 2015 adopted	Annual Work Programme <Ignalina> Programme 2015
54	LT AWP 2016 2nd draft EN	Annual Work Programme Ignalina Programme 2016
55	IIDSF-1403 (WP-26 Jun 2014)	IGNALINA INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-SIXTH WORK PROGRAMME
56	IIDSF-1407 (WP-27 Oct 2014)	IGNALINA INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-SEVENTH WORK PROGRAMME
57	IIDSF-1503 (WP-28 May 2015)	IGNALINA INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-EIGHTH WORK PROGRAMME
58	IIDSF-1507 (WP-29 Nov 2015)	IGNALINA INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-NINTH WORK PROGRAMME
59	INPP EVM report 2015-H1	INPP EVM report 2015-H1
60	[21] 2004-03-30_Final_First_Stage_Tender_Evaluation_Report_Rev01	Final First Stage Tender Evaluation Report for Design and Construction of an Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2 (B1) Issue 01
61	[22] 2004-07-28_Second_Stage_Tender_Evaluation_Report_Rev03	Second Stage Tender Evaluation Report for Interim Storage Facility for RBMK Spent Nuclear Fuel Assemblies from Ignalina NPP Units 1 and 2 (B1) Issue 03
62	[23] B234_SSTER_Issue 02	Second Stage Tender Evaluation Report Design and Construction of New Solid Waste Management and Storage Facilities

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
63	[24] Single Stage Tender Evaluation Report B234_TER_C6C_01_issue_04	Single Stage Tender Evaluation Report for Procurement on a Turnkey Contract Basis of Lot 1 - Design and Construction of New Solid Waste Retrieval Facility and Lot 2 - Design and Construction of New Solid Waste Treatment and Storage Facilities
64	[25] B25-1 Final Tender Evaluation Report 2009 08 28	Tender Evaluation Report Project B25-1 Near Surface Repository for Low and Intermediate Level Short-Lived Radioactive Waste (Design)
65	[26] B9-1_TER_C6C_01_issue_01_Proposals Evaluation Report	Proposals Evaluation Report Project B9-1 INPP Unit 1 Turbine Hall Equipment Decontamination and Dismantling Project Development
66	[27] B9-1_TER_C6C_02_Amendment 1 to Proposals Evaluation Report	Amendment No 01 to Proposals Evaluation Report Project B9-1 INPP Unit 1 Turbine Hall Equipment Decontamination and Dismantling Project Development
67	[30] Evaluation Report PMU - phase 1	Evaluation Report for Project Management Unit (PMU) Consultant Phase 1
68	[31] Evaluation Report for Short-listing of PMU	Evaluation Report for Short-listing of PMU Consultants
69	[2.0] 2013_12_13_CR_LT_1369_2013	
70	[2.1] 2013_12_13_CR_LT_1369_2013_CORRIGENDUM	
71	[10.0] LT law XII-914	
72	[10.1] LT law XII-914_EN	
73	[11.0] Law 12-915 (2014-06-05)	
74	[11.1] LT law XII-915_EN	
75	EBRD monitoring report 2015-H1	
76	NA Monitoring Report 2015-H1 Sections A+B (DRAFT)	
77	NA Monitoring Report 2015-H1 Sections C+D (DRAFT)	

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
78	NA Monitoring Report 2015-H1 Sections E+F (DRAFT)	
79	NA Monitoring Report 2015-H1 Section G+Annex 1 (DRAFT)	
80	MtDPl-1(15.80.1)	ПЛАН УПРАВЛЕНИЯ ПРОЕКТОМж: Р.2.1 Демонтаж РУ 1-го блока (Project Management plan - P.2.1 Dismantling of Unit 1 reactor facility)
81	TAp-5(3.67.18)	ОПИСАНИЕ ПРОЕКТА "ИНЖЕНЕРНЫЕ РАБОТЫ ПО ДЕМОНТАЖУ КОНСТРУКЦИЙ ИЗ ШАХТ РЕАКТОРОВ 1-ГО И 2-ГО ЭНЕРГОБЛОКОВ" UP01 (Project Description "Engineering work on dismantling the reactor cavity structures from the 1st and 2nd units", UP01)
82	B234_PDS_A2_02_Issue_02	Project Delivery Strategy Relationships And Options For (B2/3/4) New Solid Waste Management And Storage Facility
83	B234_A1B_0027 (Bank no-objection on TD)	Fax to INPP from EBRD 23/12/2004
84	B234_A1B_0042 (Bank no-objection for signing the Contract)	Fax to INPP from EBRD 30/11/2005
85	B9_PIS_A2A_01_issue_05_Project Identification Sheet	Project Identification Sheet - Project B9-0 and B9-1 - INPP Building 117/1 and Unit 1 Turbine Hall Decontamination and Dismantling Project Development
86	B9_LFEBRD_A1B_0018	Fax to INPP from EBRD 12/11/2007
87	B9-1_CC_D12A_34_Final Report on Project Completion	Final Report on Project Completion - Contract B9-1/CA13/D1/01 INPP Unit 1 Turbine Hall Equipment Decontamination and Dismantling Project Development
88	B25 PIS Issue 05 11 November 2008	Project identification Sheet Project B25-1 Near Surface Repository for Low and Intermediate Level Short Lived Radioactive Waste (Design)
89	B234_PIS_A2_ Issue 2	Project Identification Sheet - PIS B 2-3-4

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
90	AWP_2015_report_2H_ 0505_4_(Approved)	Monitoring Report. Ignalina Programme Evaluation Period: July - December 2015
90x	[1]Project_Identification_Sheet_Rev03_(file_pdf,B1_PIS_A2A_01_issue_03)"	Project Identification Sheet - PIS B-1
	Slovakia / V1 NPP, Bohunice	
91	TIME DISTRIBUTION FV.xlsx	Detailed Decommissioning Plan of V1 NPP (2016)
92	APPENDIX 8 Cost estimation for each BIDSF project	Detailed Decommissioning Plan of V1 NPP (2014) - APPENDIX 8: COST ESTIMATION FOR EACH BIDSF PROJECT OF V1 NPP DECOMMISSIONING
93	APPENDIX 9 Indicative costs of V1 NPP decommissioning	Detailed Decommissioning Plan of V1 NPP (2014) - Appendix 9 (electronic): Indicative costs of V1 NPP decommissioning in BIDSF projects and activities provided by JAVYS through all the years
94	Bohunice AWP 2014	Annual Work Programme <Bohunice> Programme 201472529/1500
95	Bohunice AWP 2015	Annual Work Programme <Bohunice> Programme 2015
96	Bohunice AWP 2016 DRAFT (+ Appendices 1-6 Draft)	Annual Work Programme <Bohunice> Programme 2016 Ref. Number: Draft 01
97	BIDSF-1403 (WP-26 Jun 2014)	BOHUNICE INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-SIXTH WORK PROGRAMME
98	BIDSF-1408 (WP-27 Nov 2014)	BOHUNICE INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-SEVENTH WORK PROGRAMME
99	BIDSF-1503 (WP-28 May 2015)	BOHUNICE INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-EIGHTH WORK PROGRAMME
100	BIDSF-1507 (WP-29 Nov 2015)	BOHUNICE INTERNATIONAL DECOMMISSIONING SUPPORT FUND DRAFT TWENTY-NINTH WORK PROGRAMME

No.	FILENAME (as shown on EC-CIRCABC)	DOCUMENT TITLE
101	[3.3] 04_C_2014_5449_F1_ANNEX_3_Plan_SK	
102	[12.0] Act No 238 2006	
103	C7B-TT-PMU-05001.rev4.valid	Treatment of Historical Wastes - Sludges and Sorbents, C7-B, Technical Study
104	C94-TT-PMU-07002-EN.rev1.valid	Design and Erection of New Disposal Facilities for LLW and VLLW from V1 NPP Decommissioning at NRR Mochovce (C9.4) Technical Study
105	D2-TT-PMU-08001-EN.rev2.valid	Decontamination of Primary Circuit (D2) Technical Study
106	D42-TT-PMU-07001-EN.rev1.valid	Dismantling of Reactor Coolant System Large Components (D4.2) Technical Study
107	D42-TS-PMU-07004-EN.rev1.valid	Dismantling of Reactor Coolant System Large Components (D4.2) Technical Specification
108	D2_Register of potential tenderers	Register of Potential Tenderes - March 30, 2012 D2 - Decontamination of the Primary Circuit
109	Monitoring Report - Bohunice Programme	Monitoring Report - Bohunice Programme - Evaluation Period 01 - 09/2015
110	000-MT-PMU-08001-EN-002_rev1_(Approved)	Monitoring Report - Bohunice Programme - Evaluation Period 10 - 12/2015
110x	D2-PS-PMU-07001-EN.rev3.valid	Decontamination of the Primary Circuit - II. Stage (D2-A)

5.5.2 Information originated from other external sources

No.	Source information
	Bulgaria
111	Bulgarian Nuclear Regulatory Agency (“BNRA”) - http://www.bnra.bg/
112	Bulgarian Atomic Forum (“BULATOM”) - http://www.bulatom-bg.org
113	Kozloduy Nuclear Power Plant (“KNPP”) - Annual reports and publications http://www.kznpp.org

114	European Union ("EU") internet site publication – Report from the Commission to the European Parliament and the Council on the implementation of the work under the nuclear decommissioning assistance programme to Bulgaria, Lithuania and Slovakia in the period 2010-2014 http://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0078
115	European Commission ("EC")/Directorate General for Energy ("DG ENER") internet site publication – "Nuclear decommissioning assistance programmes" http://ecirca europa.eu/energy/en/topics/nuclearenergy/decommissioning-nuclear-facilities
116	State Enterprise Radioactive Waste ("SERAW") - http://dprao.bg
117	European Bank for Reconstruction and Development ("EBRD") – "Kozloduy NPP Units 1-4 Decommissioning Programme and the National Disposal Facility" http://www.ebrd.com/work-with-us/procurement/p-pn-150807b.html
118	Bulgarian Ministry of Finance - Mid-term estimates for the period 2016-2018, Government Debt Review, Spring 2016 macroeconomic forecast - http://www.minfin.bg/en/
119	Bulgarian Ministry of Energy - https://www.me.government.bg/en
120	World Nuclear Association - http://www.world-nuclear.org
121	SERAW - Financial Assessment of Risks for the KIDSF-funded KNPP decommissioning support project/activities up to 2020", prepared by SERAW, in cooperation with the EBRD at EC request, dated April 2016, including relevant date "Decommissioning risk assessment summary as of April 2016" and "NDF overall cost estimate based on cost breakdown (2013) as of April 2016"
122	Ministry of Energy - NFDF Funds accumulated per year (2007–May 2016), breakdown of NFDF Funds accumulated by source of funding (2007–May 2016), NFDF expenses to the KNPP Units 1-4 decommissioning program (2003-2015)
123	Ministry of Energy - RAWF Funds accumulated per year (2007–May 2016), breakdown of NFDF Funds accumulated by source of funding (2007–May 2016)
124	Ordinances on procedure for determining, collection and management of funds and contributions to the NFDF and RAWF, respectively.
125	Inquiries to the SERAW Management and Ministry of Energy (NFDF and RAWF)
126	Inquiries and written representations by SERAW Management
127	Inquiries and written representations by the Ministry of Energy (NFDF and RAWF)
128	D-R PMU_D RDB_wc_011_1 - Assessment of The Possibility of Reconstruction of The Building of DGS1 For The Purpose of Decommissioning Part: Supply And Sanitation
129	D-R PMU_D RDB_h_011_1 - Assessment of The Possibility of Reconstruction of The Building of DGS1 For The Purpose of Decommissioning Part: Machinery
130	D-R PMU-DTD-ENPR-1704 - Market research for the additional equipment for the purposes of the dismantling at the Turbine Hall under Project 13a

131	AWP_2016_ 03_17 08 2016 Final updatedlist
132	SERAW_DPlan_007_Attachment 7-3_2_BG Приложение 7 – 3 Предварителен План - График Към Плана За Извеждане От Експлоатация На Блокове 1 И 2 На Аец”Козлодуй” (Annex 7-3 Preliminary Plan - Schedule to Plan for Removal of Operation of Units 1 and 2 of NPP Kozloduy"
133	SERAW Meeting Notes 14 06 2016
134	Att 1 WBS of Decommissioning plan
135	Att 2 D-R PMU_DTR_ENPR-1325_1_EN
136	Att 3 Project R-10 History
137	Att 4 KPMU_RWT_001_3
138	Att 5 KPMU_SPR_001_8
139	Att 6 Project 5b History
140	Att 7 Project 9b History
141	KPMU_DPL_TP_04(Risk Register Template)
142	KPMU_DSF_006 Rev 5 Risk Register - Project 1, Dry Spent Fuel Storage Facility
143	KPMU_DSF_006_4.pdf - KNPP Dry Spent Fuel Storage Facility Risk Register
144	KPMU_DSF_RR-001 - Risk Register Dry Spent Fuel Storage Facility
145	KPMU_ENG_007_2 (Risk Management) - Risk Management
146	SERAW_DPlan_007_3_4 Обобщен график за непрекъснат демонтаж на блокове 3 и 4 (Summary schedule of continuous dismanlting of Units 3 and 4)
	Lithuania
147	Reports prepared by INPP - www.iae.lt
148	Information and comments provided by the Ministry of Energy of Lithuania
149	NA Monitoring Report 2015-H2 Sections A (DRAFT)
150	NA Monitoring Report 2015-H2 Sections B (DRAFT)
151	NA Monitoring Report 2015-H2 Sections C (DRAFT)
152	NA Monitoring Report 2015-H2 Sections D1 (DRAFT)
153	NA Monitoring Report 2015-H2 Sections D2 (DRAFT)
154	NA Monitoring Report 2015-H2 Sections D3 (DRAFT)
155	NA Monitoring Report 2015-H2 Sections E-G (DRAFT)
156	Presentation of Ignalina Programme by CPMA
157	INPP decommissioning interinstitutional activities plan
158	Ignalina Programme (Jan 2016) - presentation by CPMA

159	Ведомость Оценки Продолжительнотсти И Затрат На Выполнение Проекта 1202 - Statement Of Estimates And Duration Of The Cost Of The Project Implementation 1202 (Project B2)
160	Ведомость Оценки Продолжительнотсти И Затрат На Выполнение Проекта 1203 - Statement Of Estimates And Duration Of The Cost Of The Project Implementation 1203 (Project B3/4)
161	Ведомость Оценки Продолжительнотсти И Затрат На Выполнение Проекта 1203 - Statement Of Estimates And Duration Of The Cost Of The Project Implementation 1203 (Project B9-1(1))
162	Ведомость Оценки Продолжительнотсти И Затрат На Выполнение Проекта 2206 - Statement Of Estimates And Duration Of The Cost Of The Project Implementation 2206 (Project B9-1(2))
163	Ведомость Оценки Продолжительнотсти И Затрат На Выполнение Проекта 2206 - Statement Of Estimates And Duration Of The Cost Of The Project Implementation 2206 (Project B9-1(2))
164	Ведомость Оценки Продолжительнотсти И Затрат На Выполнение Проекта 1207 - Statement Of Estimates And Duration Of The Cost Of The Project Implementation 1207 (Project B25)
	Slovakia
165	Legislative framework – Act. 238/2006 Coll. on the National Nuclear Fund for decommissioning of nuclear facilities and for management of spent fuel and radioactive waste (the Nuclear Fund Act)
166	Legislative framework – Act No. 541/2004 Coll., on the peaceful use of nuclear energy (the Atomic Act)
167	Ministry of Economy – Strategy for the final stage of peaceful utilization of the nuclear energy in SR (Jan 2014)
168	Ministry of Economy – National Policy and National Programme for handling of spent nuclear fuel and radioactive wastes in SR (Aug 2014)
169	National Nuclear Fund – Annual reports and Financial statements (including notes)
170	National Nuclear Fund – Declarations of closing balance for accounts
171	National Nuclear Fund – Disbursement plan for funds managed by the Fund
172	Annual valorisation statements effective for nuclear levy (contributions)
173	Other information prepared by National Nuclear Fund – http://www.njf.sk/
174	Other information prepared by Ministry of Economy – http://www.economy.gov.sk/
175	Other information prepared by National nuclear decommissioning company JAVYS – http://www.javys.sk/

176	D4.2 – Dismantling Of Reactor Coolant System Large Components BIDSF 023 1 001 - Tender Documents
177	Project Risk.pdf
	General
178	Cost Estimation for Decommissioning, OECD, 2010
179	Decommissioning Cost Analysis For The Wolf Creek Generating Station, TLG Services Inc, 2011
180	International Structure for Decommissioning Costing (ISDC) of Nuclear Installations, OCED, 2012
181	UK HM Treasury "The Green Book - Appraisal and Evaluation in Central Government"
182	EUROSTAT website http://ecirca europa.eu/eurostat/statistics-explained/index.php/Wages_and_labour_costs
183	Survival of the Unfittest: Why the Worst Infrastructure Gets Built - And What We Can Do About It (Article in Oxford Review of Economic Policy · December 2009)
184	European Commission, DG TREN Midterm Evaluation of the Galileo project for the period 2002-2004 Final Report June 2006
185	Magnox Plan Summary - Magnox Lifetime Plan 2013, NDA / Magnox plc

5.6 Interview transcripts

Please refer to the accompanying documents 1.1., 1.2., 1.3., 2.1., 2.2., 2.3., 2.4., 2.5., 3.1., 3.2., 3.3., 3.4. and 4.1 available in the file.

5.7 Detailed datafiles

Please refer to the accompanying documents 2.6., 3.5. and 4.2. available in the file.

DOI: 10.2833/79376 ISBN 978-92-76-08798-4